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DEPARTMENT OF THE ARMY
KANSAS CITY DISTRICT, CORPS OF ENGINEERS

RI/FS FORMER LAKE ONTARIO ORDNANCE WORKS
LEWISTON/PORTER, NIAGARA COUNTY, NEW YORK

CONTRACT NO. DACA41-88-C-0005

PD-7
FINAL REMEDIAL INVESTIGATION REPORT

January 1989

ACRES INTERNATIONAL CORPORATION

ACRES

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EXECUTIVE SUMMARY

General

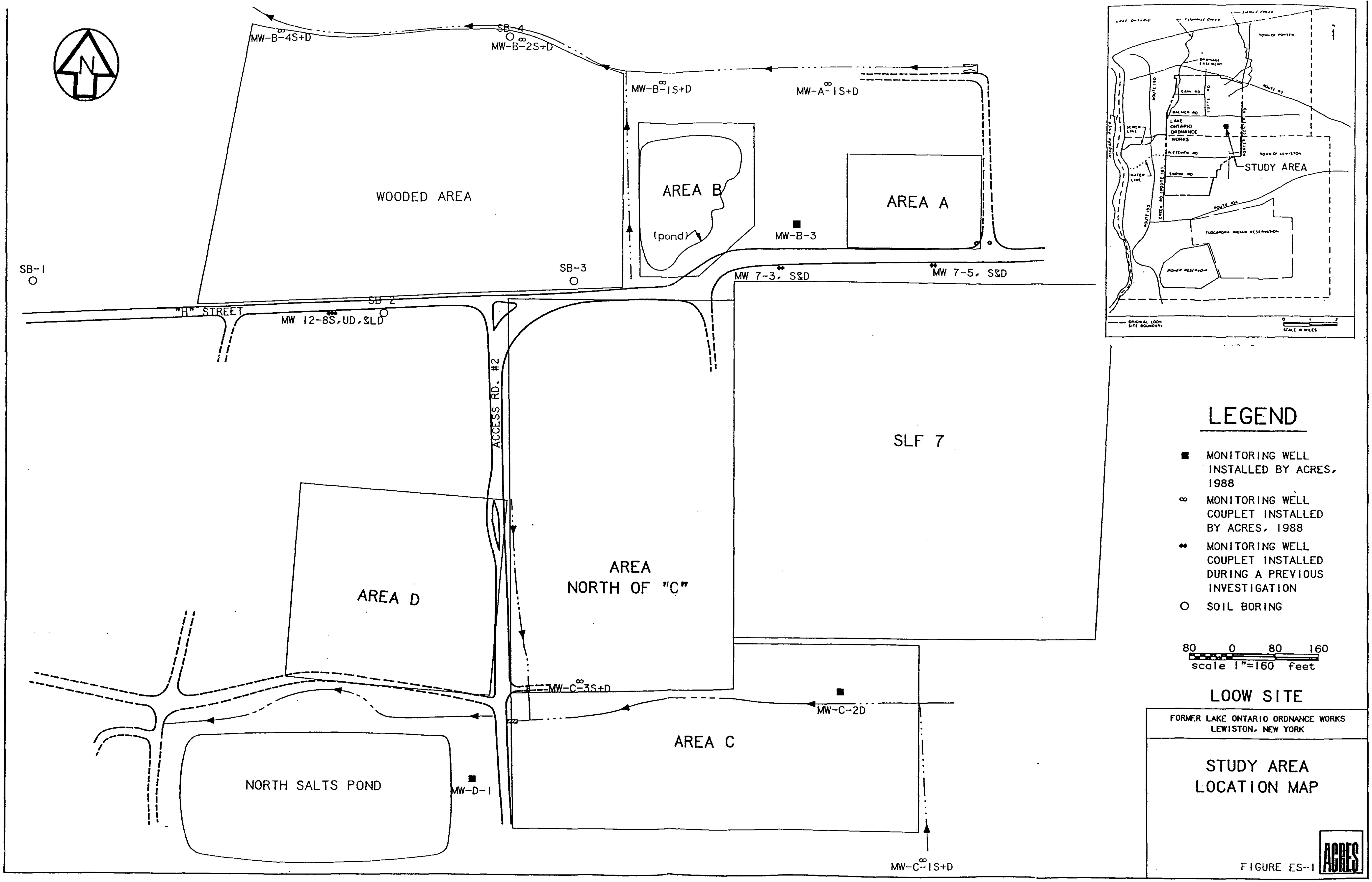
Under the authority of the Defense Environmental Restoration Program (DERP), the Department of the Army, Kansas City District, Corps of Engineers (COE) has undertaken a Remedial Investigation/Feasibility Study (RI/FS) at the Former Lake Ontario Ordnance Works (LOOW) site located in the towns of Lewiston and Porter, Niagara County, New York. Acres International Corporation, under contract to the COE, is responsible for performing the RI/FS including the management of all contractors and subcontractors required to complete the project.

The entire LOOW site encompasses approximately 7500 acres with actual site activities occurring on 2500 acres and the balance of the property used as a buffer zone. This investigation targeted six sites occupying a small portion (approximately 20-25 acres) of the property located in the southwest quadrant of the LOOW site, as shown in Figure ES-1. This property is presently occupied by Chemical Waste Management, Inc. (formerly SCA Chemical Services, Inc.).

Site History

During the early 1940s, the LOOW was used as a manufacturing plant producing explosives [trinitrotoluene (TNT), dinitrotoluene (DNT), and mononitrotoluene (MNT)] for World War II. These operations included the manufacturing plant, toluene storage tanks, shipping and storage areas, and an extensive system of underground water, acid, TNT, and sewer lines. Portions of the LOOW site have since been utilized by several branches of the Department of Defense and Department of Energy for various manufacturing and storage activities.

In 1969, Chem-Trol Pollution Services, Inc. acquired portions of the LOOW for the development of a hazardous waste treatment, storage, and disposal facility. Chem-Trol was acquired by SCA Chemical Services, Inc. (SCA) in



LOOW SITE

FORMER LAKE ONTARIO ORDNANCE WORKS
LEWISTON, NEW YORK

STUDY AREA
LOCATION MAP

ACRES

FIGURE ES-1

1973 and subsequently acquired by Chemical Waste Management, Inc. (CWM) in the early 1980's.

Since the 1969 acquisition of the site by Chem-Trol, the site has been used as a hazardous waste treatment, storage, and disposal facility. Recent CWM operations at the site include a waste receiving area, metal hydroxide (salts) ponds, chemical treatment facilities, biological treatment lagoons, transfer stations, and one operating and eight closed secure landfills.

Site Investigation

The site investigation included the following activities to identify sources of contamination and assess contaminant migration:

- Geophysical investigation;
- Groundwater monitoring well installations;
- Subsurface soil (borings) sampling and analysis;
- Surface water and surface soil sampling and analysis;
- Drum waste sampling and analysis; and
- Groundwater sampling and analysis.

These activities were performed in seven discrete areas suspected of containing contamination associated with a Department of Defense and Department of Energy high energy fuels production facility. The areas are located on the CWM property and included the following:

- Area A;
- Area B;
- Area C;
- Area D;
- Area North of C;
- The Wooded Area; and
- Buried TNT and Acid Waste Lines.

A total of 22 monitoring wells were sampled including seven previously existing and 15 newly installed wells. Subsurface soils were collected from seven test pits, eight borings, and two background locations. One surface water sample and one surface sediment sample were collected and five excavated waste drums were sampled. Several TNT and acid waste lines were to be sampled. However, these lines were never located and therefore, never sampled. A limited air monitoring program for worker protection was also performed.

Contamination Identified

Investigation of the following areas did not reveal any significant soil or groundwater contamination:

- Area C;
- Area D;
- Area North of C; and
- The Wooded Area. (Based on limited data; additional investigations are recommended).

However, elevated levels of contamination were found in Areas A and B. The geophysical survey and subsequent test pit excavations verified the presence of buried drums in Area A. Samples of the drums indicated relatively high levels of volatile organics (up to 4906 ug/kg) and semi-volatile organics (primarily polycyclic aromatic hydrocarbons - up to 2814 ug/kg). The soils in the test pit contained volatile organic contamination more reflective of the drum contamination. Trace levels of several pesticides and no PCBs were found in the drums. Although most total metal concentrations were elevated, concentrations of EP Toxicity metals did not exceed RCRA levels of hazardous wastes.

Area B, known as the "burn-pit", also proved to be relatively contaminated. Concentrations of total volatile organic compounds ranged up to 13190 ug/kg and the semi-volatile organics ranged up to 44360 ug/kg. Pesticides found in Area B totaled 2212 ug/kg and some metals, in particular boron and lithium, were also found at elevated levels. These two metals are indicative of the boron and lithium based high energy fuels which were incinerated in the "burn-pit".

While both Area A and Area B recorded elevated levels of total volatile and semi-volatile organic compounds, the compounds found were not the same. For example, the volatile organic compounds found in Area A were primarily acetone and 2-butanone while the volatiles found in Area B were primarily methylene chloride and chlorinated aromatic compounds. The semi-volatile compounds in Area A were primarily polycyclic aromatic hydocarbons while in Area B mostly clorinated benzenes and some pesticides were observed. The apparent different make-up of the contaminants found seems to indicate different origins of the wastes observed in these two areas.

Groundwater immediately adjacent to these areas is impacted; at least in the upper water-bearing zone. However, monitoring wells downgradient of these areas indicate that no significant migration of contaminants has occurred either laterally or downward to the next water bearing zone.

Conclusions and Recommendations

Table ES-1 provides a synopsis of the remedial investigation findings by area. It outlines, for each area, a summary of identified problems; related offsite conditions and migration; assessed contamination source; assessed risk to public health, onsite personnel, and the environment; lacking site data and recommended additional investigations; and the need for remediation.

Based on the remedial investigations completed, localized contamination problems have been identified in two of the six study areas (Areas A and B) and are suspected in a section of one area (the Wooded Area). However, some site data are lacking and additional investigations are needed to further confirm site conditions for each of these three areas. The recommended additional investigations would: provide a complete confirmation of specific site and downgradient conditions for which data gaps presently exist; better define the actual extent of the identified problems; and provide input to the formulation, costing, and evaluation of remedial alternatives.

The potential risks to public health, onsite personnel, and the environment associated with each of the identified problem areas have been preliminarily assessed and judged to be low.

A preliminary search of available remedial technologies has also identified technologies that are applicable and feasible in remediating the identified problems. The technologies identified fall into the following groups:

- No Action;
- Non-Removal;
- Removal;
- Transportation;
- Dewatering of Soils;
- Treatment of Drums;
- Treatment of Soils/Solids;
- Treatment of Groundwater/Liquids; and
- Disposal.

TABLE ES-1 - (Cont'd)

Investigated Area	Identified Contamination	Associated Offsite Conditions/Migration	Assessed Sources	Preliminary Assessed Risk (To)			Lacking Data/Additional Investigations Needed	Need for Remediation
				Public Health	Onsite Personnel	Environment		
Area North of C	Geophysics screening indicated no evidence of drum burial areas. No significant contamination identified.	None apparent	None apparent	None apparent based on investigation results	None apparent based on investigation results	None apparent based on investigation results	No information or evidence to warrant further investigation of this area	No significant problem identified for remediation.
D	Elevated concentration of acetone in upgradient well TMW-14S. Geophysics screening indicated no evidence of buried drums. Groundwater sampling downgradient of area indicated no evidence of a problem.	None apparent	Other possible upgradient source for acetone contamination	Negligible	Negligible	Negligible	No information or evidence to warrant further investigation of this area.	No significant problem identified for remediation
Wooded Area (North of "H" Street)	1. Southeast section could have soils contamination associated with adjacent burn pit area. 2. Downgradient groundwater quality appears not to be impacted.	None apparent	None apparent	None identified to date	None identified to date	None identified to date	1. Additional surface soil sampling at the southeast corner adjacent to the burn pit and at a few random locations within the wooded area. 2. A second deeper boring is also suggested in SE corner to confirm the geophysics anamoly	Require additional information/data in order to make decision regarding need for remediation
Buried TNT and Acid Waste Lines	Lines could not be located during the field investigations so sampling of residual in lines and surrounding soil could not be carried out.	Not likely	- - - -	The potential risk associated w/any remaining buried lines has been assessed to be low based on non-hazardous conditions in previously excavated lines	Same as noted for assessed public health risk.	- - - -	Need for further investigation is not warranted at this time. Any further site investigations might disrupt current owner activities. Should lines be uncovered during future onsite activities residue sampling could be performed at that time.	No significant problem identified for remediation.

TABLE ES-1

SUMMARY OF REMEDIAL INVESTIGATION FINDINGS

Investigated Area	Identified Contamination	Associated Offsite Conditions/Migration	Assessed Sources	Preliminary Assessed Risk (To)			Lacking Data/Additional Investigations Needed	Need for Remediation
				Public Health	Onsite Personnel	Environment		
A (Drum Burial Area)	1. Appears to be localized problems resulting from buried drums including: - Undetermined no. of buried drums containing wastes; - Surrounding soil contamination; and - Localized GW contamination (pit water).	Investigations to date indicate no apparent downgradient migration although sampling of all potential transport media are incomplete	Buried drums disposed of in area	Low to negligible risk for offsite population based on data collected to date. Low risk of exposure by direct contact because of restricted site access	Low risk for exposure to air and water contaminants. Greatest hazard posed by direct contact w/ contaminated soils & waste, if excavated	Not Significant	The following need to be confirmed/investigated: - Southern extent of drum burial area - Quality of downgradient surface water and sediment - Contamination of surface soils in vicinity of drum burial	Yes, consideration of: - Drum and contaminated soil removal; and - Localized groundwater contamination
B (Burn Pit Area)	1. Contaminated sediments in pit area. 2. Accumulated surface water in pit area has only minor contamination w/boron: levels above NYSDOH drinking water standards (no other applicable standard). 3. Remnant contamination surrounding pit as evidenced in well B-3 & MW-7-3S. Appears to be localized upgradient of the pit. 4. Elevated levels of carbon tetrachloride, chloroform, methylene chloride in upgradient groundwater (source is suspect).	1. Upgradient groundwater contamination noted that is localized and possibly from remnants of burn pit operations. 2. No evidence of downgradient contamination of groundwater. 3. Lacking data on downgradient surface water & sediment along potential migration pathways.	1. Burn pit and immediate surrounding area. 2. Possible other onsite source for parameters detected in upgradient groundwater.	Same as Area A	Same as Area A	Not signigicant	1. Lacking info. on: - Surface water & sediment quality along downgradient drainage pathways; and - Surface soils in the immediate area (need to confirm limits of contamination). 2. Additional sampling suggested to confirm burn pit water quality & depth of contaminated sediments (& underlying soil) in the pit area	Yes: Appears to be problem confined to local burn pit area. Investigation of remediation of the following problems are suggested: - Localized contaminated sediment; and - Localized contamination of groundwater.
C	1. Elevated levels of 1,2-dichloroethene in upgradient well MW-C-1S	None apparent	3. Other possible upgradient source for 1,2-dichloroethene contamination	Negligible	Negligible	Negligible	No info. or evidence to warrant further investigation of this area.	No significant problem identified for remediation

1 - INTRODUCTION

1.1 - General

The Kansas City District, Corps of Engineers (COE) authorized Acres International Corporation (Acres) in December 1987 to conduct a Remedial Investigation/Feasibility Study (RI/FS) at the former Lake Ontario Ordnance Works (LOOW) site located in the townships of Lewiston and Porter in Niagara County, New York. This action has been undertaken in accordance with the Defense Environmental Restoration Program (DERP) Act of 1985.

The first phase of field investigations (DERP Site Investigation I) was carried out by Acres during the period from April through July 1988 and covered the following areas located on the properties of Chemical Waste Management, Inc. (CWM) (refer to Figure 2-4 on page 2-5).

- An area suspected to contain approximately 30 buried drums identified as Area A;
- An area used for open incineration of wastes identified as Area B;
- Two areas suspected to contain 200 to 300 buried drums (Areas C and D);
- An area of suspected buried drums in the wooded area west of Area B; and
- Existing underground TNT and acid pipelines beneath the site.

These initial study areas and detailed scope of the field investigations were defined by the COE based on previous site reconnaissance and background information. Additional portions of the LOOW site have been subsequently identified as potentially contaminated areas and will be investigated and reported separately under subsequent site remedial investigations planned for the LOOW site.

The following report presents the findings of the first site remedial investigations of the above defined study areas.

1.2 - Definition of the Problem

The original LOOW site acquired by the Department of the Army in the early 1940's was approximately 7500 acres in size. The original property extended from between Route 104 and Swann Road in Lewiston on the south to roughly Route 93 (Youngstown-Lockport Road) in Porter on the north. The approximate east and west site limits are defined by Creek Road and Porter Center Road, respectively. Past activities of the federal government were limited to an approximate 2500 acre area. The remaining acreage served as a buffer area and was sold to private owners beginning in 1945.

A number of federal entities have been involved with the LOOW site since the early 1940s. Groups identified with past activities at the site have included:

- Department of the Army;
- Department of the Air Force;
- Chemical Warfare Service;
- War Assets Administration;
- Army National Guard;
- Manhattan Engineering District of the Corps of Engineers;
- Atomic Energy Commission;
- Department of Energy;
- General Services Administration;
- Department of Labor; and
- Department of the Navy.

Operations conducted by the federal government on the LOOW site have included:

- Manufacture of explosives;
- Storage and detonation of explosives and ordnances;
- Storage of chemical warfare agents;
- Storage and disposal of radioactive materials and residues;
- Separation of boron isotopes for fission reactors;
- Operation of a Nike missile base;

- Construction of defense communication systems;
- Production of high energy fuels; and
- Various classified activities.

The review of available site background information, former site inventories, site investigations, and studies conducted to date suggest that hazardous materials and contamination associated with these types of past activities may be present on the LOOW site. Many of these potential hazardous areas are located on sections of the site presently owned by private parties and the local government.

Six of the seven areas designated for study under the initial phase of investigations are sections of the site that previous investigations have identified as potential problem areas. Site investigations completed in 1985 by Ecology and Environment (E&E) indicated soil and surface water contamination remaining in the Olin Burn pit area (Area B); buried drums previously found by CWM (formerly SCA) in the area north of SLF-7 (Area A); and possible presence of buried drums in an unidentified area to the south and west of SLF-7 (suspected Areas C and D and north of Area C).

In addition, interviews of former Air Force Plant 68 employees by the New York State Department of Environmental Conservation (DEC) in 1981 identified possible drum disposal activities in the wooded area west of the Olin Burn pit.

The seventh area of study is the buried TNT and acid waste lines associated with the original TNT manufacturing plant.

1.3 - Objectives of the Remedial Investigation

The purpose of the first phase RI program was to perform the necessary site investigations of the above suspected problem areas in order to determine the nature and extent of contamination. To fulfill this purpose the following objectives were defined:

- Determine the degree and sources of contamination;

- Define the potential pathways of contaminant migration;

- Complete a site characterization including:
  - o contamination assessment
  - o public health assessment
  - o environmental assessment

- Evaluate risks and potential impacts of site conditions on public health, welfare and the environment; and

- Assess need and options for remedial action.

1.4 - Scope of Remedial Investigation

The scope of the RI as specified by the COE in the contract scope of work included the following investigation activities for the first phase designated study areas.

1.4.1 - Geophysical Investigation Survey

A comprehensive geophysical investigation survey was conducted using terrain conductivity and magnetometer techniques to determine the presence of subsurface contamination, buried ferrous materials and underground utilities, structures and facilities. The survey included the following:

- Magnetometer survey conducted in Areas A, C, and D to locate buried drums;

- Magnetometer and terrain conductivity surveys of the area north of Area C and west of SLF-7;

- Magnetometer and terrain conductivity surveys of the Wooded Area perimeter and accessible traverses through the area; and

- Magnetometer survey of 16 proposed monitoring well locations.

1.4.2 - Subsurface Investigation

The following activities were conducted as part of the subsurface investigation program (refer to Figures 5-1 through 5-4 for various borings, wells, and test pit locations).

1. A total of 19 subsurface borings were completed. Four of these borings were located along the perimeter of the wooded area and advanced to an approximate depth of 10 ft each. Two soil samples were taken from each boring for limited chemical analysis. The remaining 15 borings were completed as groundwater monitoring wells.

2. Groundwater quality sampling and analyses were conducted at the 15 developed monitoring wells and seven existing CWM wells.

3. Test pits were excavated and logged at seven locations of suspected drum burial. Sampling and analyses were carried out at three of the six locations.

    - Two pits were excavated in Area C to an approximate depth of 15 ft and soil samples were taken at 5 ft vertical intervals and composited by level in each trench.

    - A test pit was excavated in the southeast portion of Area A where drums were found. Drum, soil, and pit water samples were taken at this location.

    - Four additional test pits were excavated in Area A to determine the western and northern limit of the buried drum area. No samples were taken at these additional locations.

4. Exploratory test pits were excavated at four locations in an attempt to verify the locations and identify potential hazards of

buried TNT and acid pipelines (see Figure 5-3). Approximate locations for the exploratory pits were based on site plans of the original explosives plant facilities.

1.4.3 - Surface Investigations

One composite sediment sample was taken from the Olin Burn pit area (Area B). A surface water sample was taken from the ponded water within the pit.

1.4.4 - Site Characterization

Results of the field investigations and analyses were interpreted and assessed in order to define existing site conditions and identify potential hazardous substance contamination problems related to past federal government activities.

1.4.5 - Search of Available Technology

A preliminary list of feasible remedial technologies was identified. The list identifies technologies which appear to be applicable either individually or in combination to effectively ameliorate the environmental contamination problems at the site.

1.5 - Report Organization

The Draft Remedial Investigation Report (Phase 1) is divided into two volumes. Volume 1 contains the main report text including all associated tables, figures, and plates. Volume II contains the appendices to the report. Actual laboratory analytical data results and detailed information on analyses and data validation procedures are presented in a separate supplement to the RI report that is available upon request.

Sections 2 through 4 present information on site background for the reader who is unfamiliar with the site. Section 5 outlines the field methods and analytical procedures followed for the site investigations. Sections 6 through 9 present the investigation results including the interpretation and analysis of data. Sections 10 through 12 summarize the findings and recommendations along with identification of applicable remedial technologies for further evaluation.

The following provides a synopsis of the information contained in each section:

Section 2 - Environmental Setting: presents information obtained during the background reconnaissance activities including a description of the regional and local physical features, drainage, climatology, demography, ecology, geology, and hydrogeology.

Section 3 - Site History and Use: presents information obtained during the document search and background reconnaissance activities on previous and present site ownership, site development, and use and potential contamination associated with past use.

Section 4 - Previous Site Investigations: summarizes previous site investigations including study findings, hazardous substance inventories, and other relevant site data.

Section 5 - Field Methodologies and Analyses: describes the field methods and analytical procedures followed in completing the remedial investigation program. The section includes a description of the various methods and equipment utilized during air monitoring, geophysical survey, subsurface investigations, and sampling program. The field and laboratory analyses performed are also discussed.

Section 6 - Results of Geophysical Survey: summarizes the results of the geophysical survey completed for the designated study areas, interpretation of the results, and how surveys were used to define subsequent investigation activities.

Section 7 - Analytical and Monitoring Results: presents the results of the geotechnical and chemical analyses including those for air monitoring, soil boring, drum waste, sediment, surface water, and groundwater sampling.

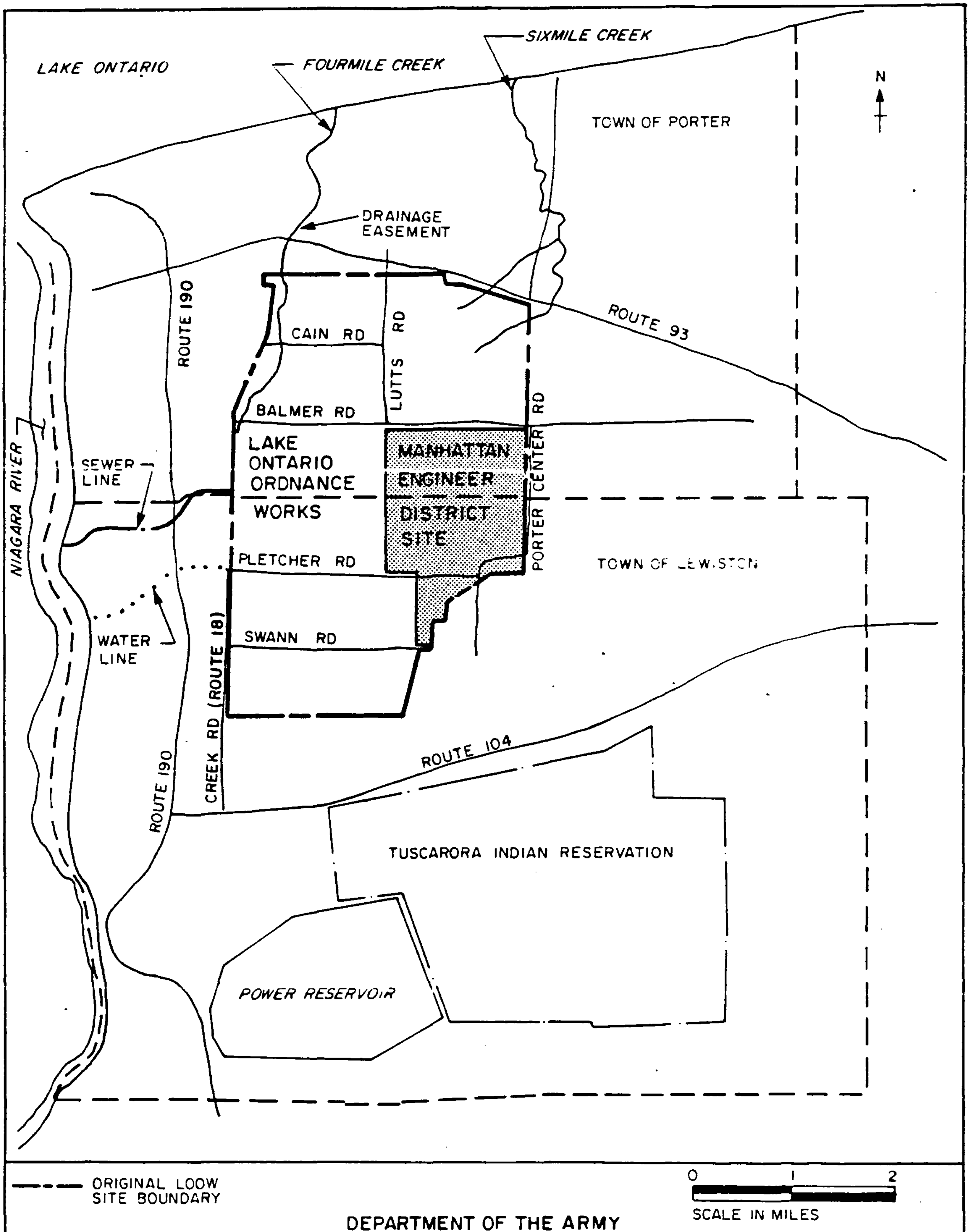
<u>Section 8 - Site Characterization</u>: provides an interpretation and assessment of the results of RI activities completed as related to existing site conditions. The section includes an assessment of site geology and hydrogeology, air quality, soil contamination, existing drum wastes, abandoned process lines, surface water quality, sediment contamination, and groundwater quality.

<u>Section 9 - Risk Assessment</u>: describes the results of the baseline risk assessment including a summary of identified hazardous substance characteristics and toxicity, sources and routes of contamination, receptors, evaluation of potential health risk posed, and assessed environmental impacts.

<u>Section 10 - Summary of Remedial Investigations</u>: summarizes the RI findings including the identified site contamination problems, site characteristics, assessment of risk, and assessed need for remediation in each of the designated study areas.

<u>Section 11 - Identification of Remedial Technologies</u>: identifies and briefly describes feasible technologies for remediation of each area based on the determined site contamination problems and associated risks. The compiled listing of remedial technologies will be evaluated and developed in more detail during the Feasibility Study.

<u>Section 12 - Recommendations</u>: contains the recommended approach with respect to additional studies and/or field activities that are necessary.



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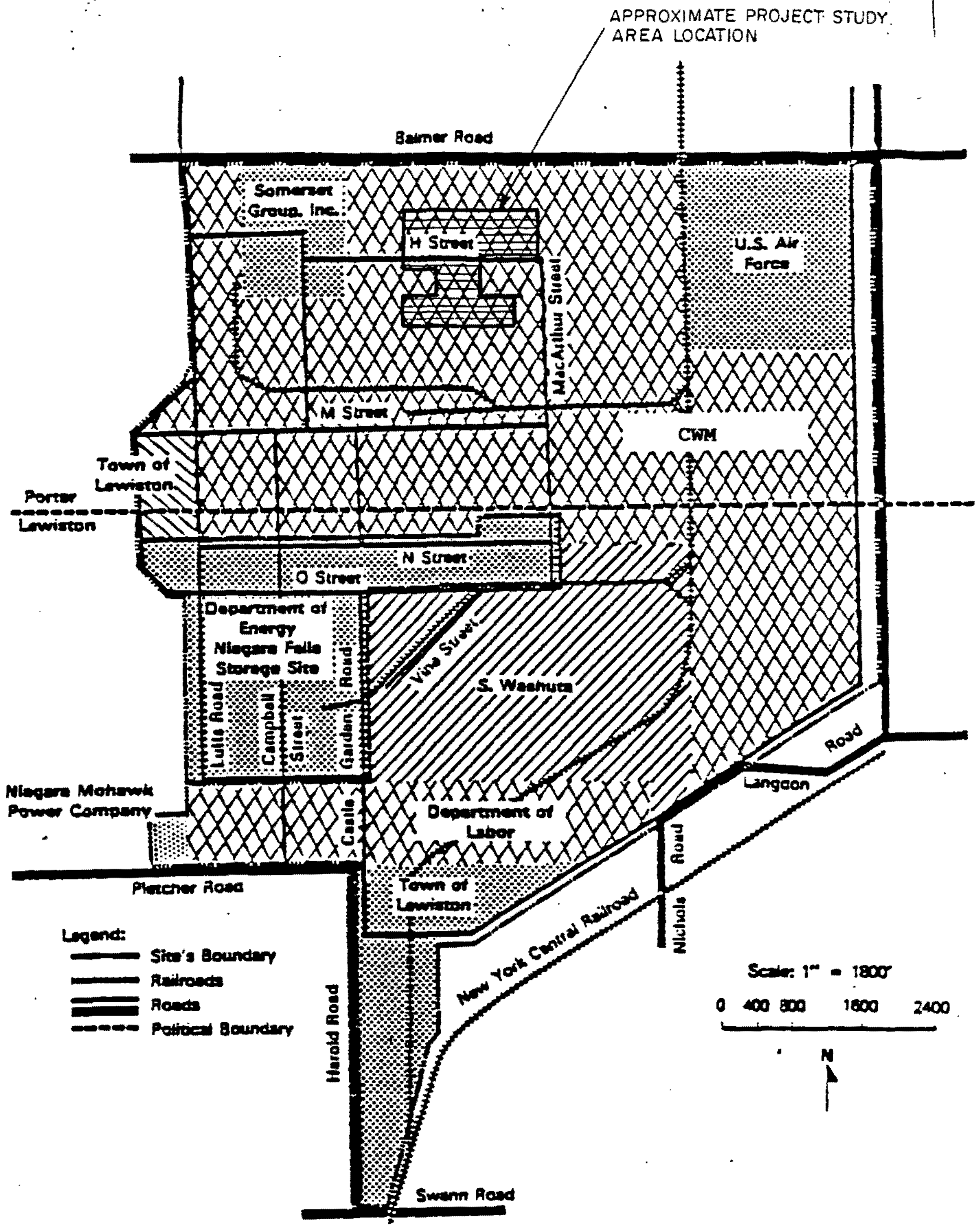
CORPS OF ENGINEERS

LOOW LOCATION MAP

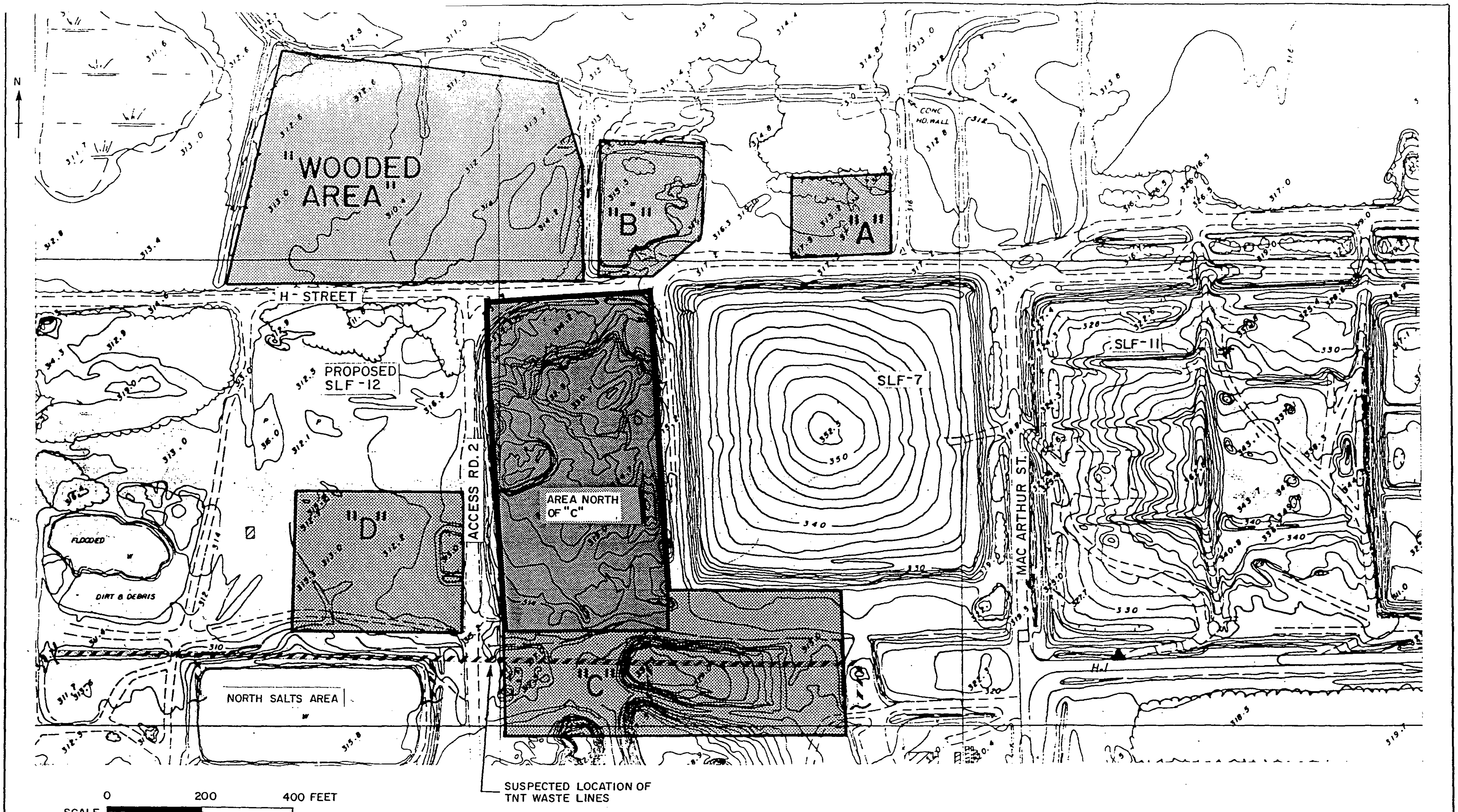
FIGURE 2-2



DEPARTMENT OF THE ARMY
KANSAS CITY DISTRICT
CORPS OF ENGINEERS
LAND OWNERSHIP IN THE FORMER AEC
PORTION ON THE LOOW

TAKEN FROM DOE REPORT NO
ATR-82(7963-04)-1 DATED 11/82

FIGURE 2-3



NOTE: THE SUSPECTED LOCATIONS OF THE ACID WASTE LINES ARE LOCATED OFF BOUNDARIES OF THIS FIGURE.

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PROJECT STUDY AREA

- Area A, 0.8 acres;
- Area B, 1.4 acres;
- Area C, 4.5 acres;
- Area D, 2.5 acres;
- Wooded Area, 9.0 acres; and
- Area north of C, 5.6 acres.

These six study areas and the TNT and acid waste lines will be collectively referred to as the project study area for this RI/FS.

2.2 - Physiography

2.2.1 - Regional Physiography

The former LOOW site is located within the Erie-Ontario Lowlands physiographic province of New York State. This province extends from the shores of Lake Erie and Lake Ontario to the Appalachian Uplands Physiographic province (Figure 2-5).

The Erie-Ontario Lowlands consist of six physiographic regions. These divisions are (from north to south):

- Lake Ontario Plain;
- Niagara Escarpment;
- Lake Tonawanda Plain;
- Onondaga Escarpment;
- Lake Erie Plain; and
- Portage Escarpment.

The physiographic regions of the Erie-Ontario Lowlands are shown on Figure 2-6 (Johnston, 1964; Broughton et al., 1966). The Portage Escarpment forms the boundary between the Erie-Ontario Lowlands and the Appalachian Uplands provinces in western New York (Broughton et al., 1966).

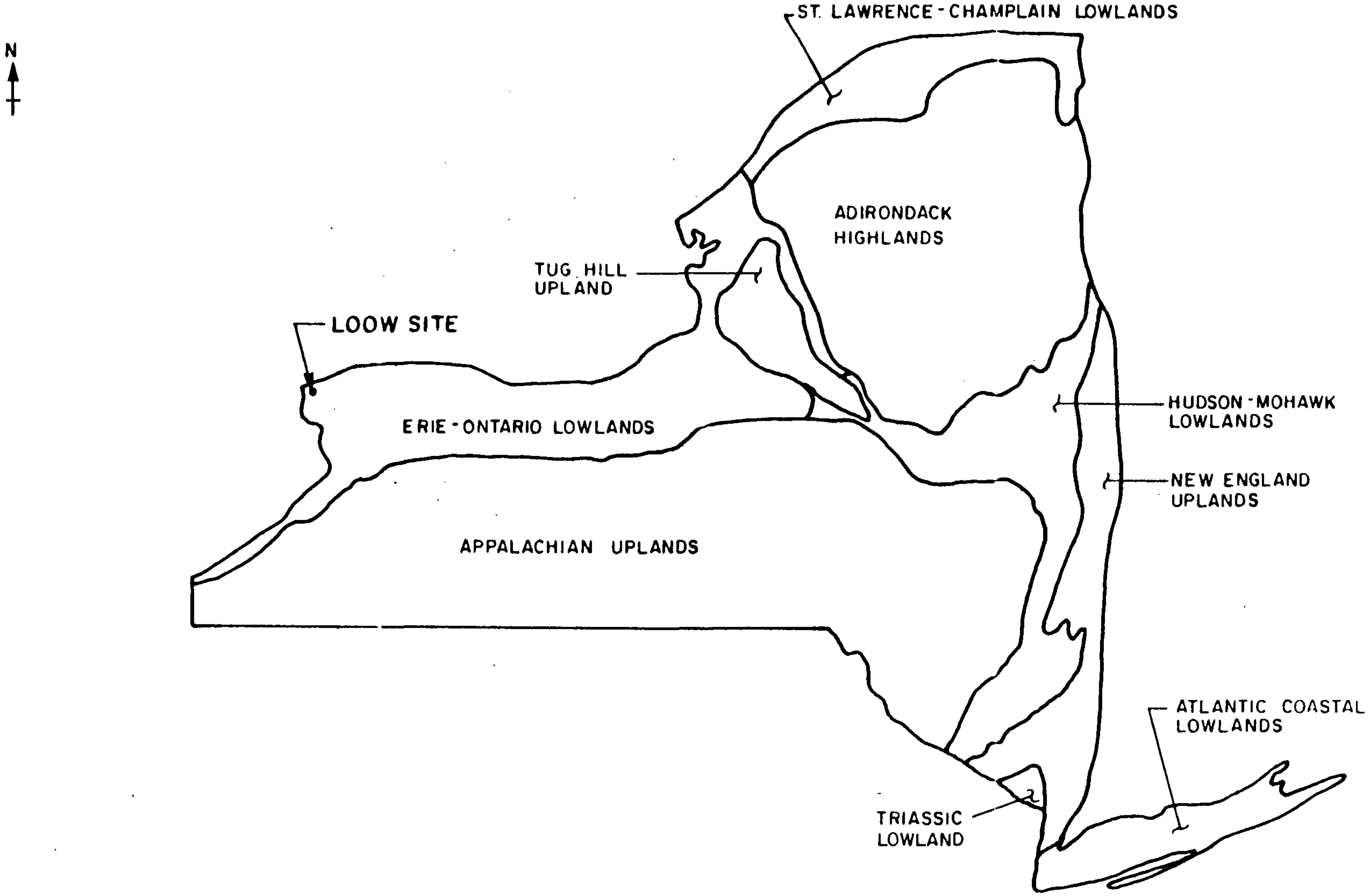

FIGURE 2-5

DEPARTMENT OF THE ARMY
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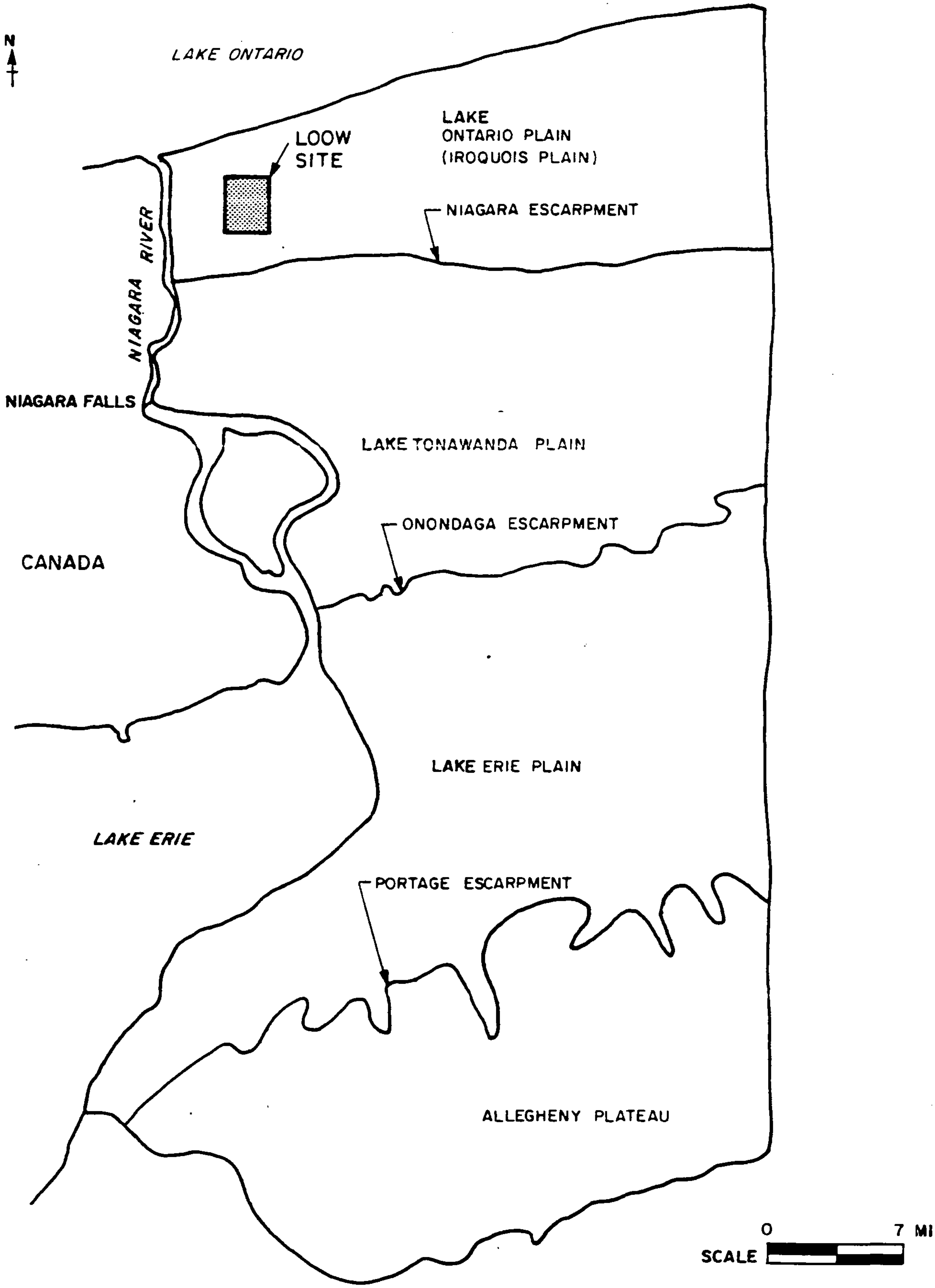
PHYSIOGRAPHIC PROVINCES OF NEW YORK

(BROUGHTON et al, 1966)



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PHYSIOGRAPHIC REGIONS OF WESTERN NEW YORK

FIGURE 2-6

ACRES

The former LOOW site is located on the Lake Ontario Plain, an area characterized by relatively flat to gently rolling terrain. The Lake Ontario Plain originates at the Niagara Escarpment and slopes gently northward towards Lake Ontario at a rate of approximately 20 ft per mile. The Niagara Escarpment is a northward facing bluff that separates the Lake Ontario Plain to the north from the Lake Tonawanda Plain to the south. Land elevations at the top and bottom of the Niagara Escarpment are approximately 630 ft and 360 ft above mean sea level (MSL), respectively. The elevation at Lake Ontario is approximately 250 ft MSL.

The terrain of the Lake Ontario Plain consists of slightly undulating hills near the Niagara Escarpment and a relatively flat glacial plain in the central and northern areas. A number of southwest to northwest trending valleys formed by the actions of the major drainages occur in the plain. The Niagara Gorge, formed by the Niagara River, is a major geomorphic feature along the western boundary of the Lake Ontario Plain in New York State (Acres, 1981; Ecology and Environment, 1985; DOE, 1986).

2.2.2 - Topography and Soils

Topography in the area including the former LOOW site is generally level. Topographically, the land slopes gently to the northwest at natural elevations ranging from 318 to 321 ft MSL. Man-made ditches and waste landfills have altered the natural relief of the area.

Natural soils on the LOOW site consist predominantly of silt loams belonging to the Rhinebeck-Ovid-Madalin association. These soils are nearly level to gently sloping, deep, and somewhat to very poorly drained. Subsoils are moderately fine to fine-textured. The soils have medium to low value for farming. Other soil types in the area include the Appleton, Canandaigua, Niagara, and Sun silt loams (SCS 1972).

In the project study area, Made Land (Me) is almost the exclusive type of soil encountered. Areas A, B, C, north of C, and D are classified as Made Lands. Made Lands are areas that have been extensively disturbed and filled. Only the Wooded Area west of Area B has natural soils. The Appleton (ApA), Madalin (Ma), and Canandaigua (Ca) silt loams occur in this area (SCS, 1972).

The soil properties could affect the selection and implementation of remedial measures. As indicated in Table 2-1, the Appleton, Madalin, and Canandaigua silt loams have a high percentage of fine-grained particles. Accordingly, the permeabilities of these soils are low and the water tables are high (SCS, 1972). The properties of the soils which may affect engineering activities are summarized in Table 2-2. Subsurface soils and overburden deposits are described in Section 2.7 of this report.

2.3 - Surface Hydrology and Drainage

Surface drainage patterns in the area of the former LOOW site are presented in Figure 2-7. Site specific drainage patterns are shown on Figure 2-8. Fourmile, Sixmile and Twelvemile Creeks receive natural surface runoff, agricultural drainage and treated and institutional waste discharges before emptying into Lake Ontario. Major sections of these streams are intermittent. These creeks are used primarily for boating and fishing. Where Fourmile and Twelvemile Creeks flow into Lake Ontario, the creeks are designated as recreational areas with public swimming sites.

Fourmile Creek is a New York State Class B water body from its mouth at Lake Ontario to 0.9 miles upstream which is located 0.3 miles southeast of the intersection of Lake Road and Creek Road. The New York State descriptions of the best usage of fresh waters are as follows:

- Class B is suitable for primary contact recreation and any other uses except as a source of water supply for drinking, culinary or food processing purposes;

Table 2-1

GRAIN SIZE DISTRIBUTION OF PROJECT
STUDY AREA SOILS (From SCS, 1972)

Percentage Passing Through	Soil Type* ApA	 Ca	 Ma
#4 Sieve (47 mm)	70 - 90%	95 - 100%	95 - 100%
#10 Sieve (2 mm)	65 - 90%	90 - 100%	90 - 100%
#40 Sieve (0.42 mm)	45 - 90%	80 - 100%	80 - 100%
#200 Sieve (0.74 mm)	25 - 80%	65 - 95%	65 - 100%

*Soil Type

ApA = Appleton silt loam
Ca = Canandaigua silt loam
Ma = Madalin silt loam

TABLE 2-2

PROPERTIES OF SOILS WITHIN THE PROJECT STUDY AREA

(Adapted from SCS, 1972)

I. Appleton Silt Loams (ApA)

- Seasonal high water table;
- Cut slopes subject to seepage and sloughing;
- Adequate strength for supporting high embankments;
- High to moderately high bearing capacity, low compressibility; and
- Slow to moderately slow permeability.

II. Canandaigua Silt Loam (Ca)

- Prolonged high water table;
- Cut slopes subject to seepage and sloughing;
- Surface layer high in organic matter;
- Cut subgrade subject to differential frost heave;
- Variable bearing capacity and compressibility;
- Sand lenses subject to seepage and piping; and
- Slow permeability.

III. Madalin Silt Loam (Ma)

- Prolonged high water table;
- Moderate shrink-swell potential of clays;
- Cut slopes and subgrades unstable and subject to seepage;
- Low strength and high to moderately high compressibility; and
- Slow permeability.

IV. Made Lands (Me)

Properties extremely variable.

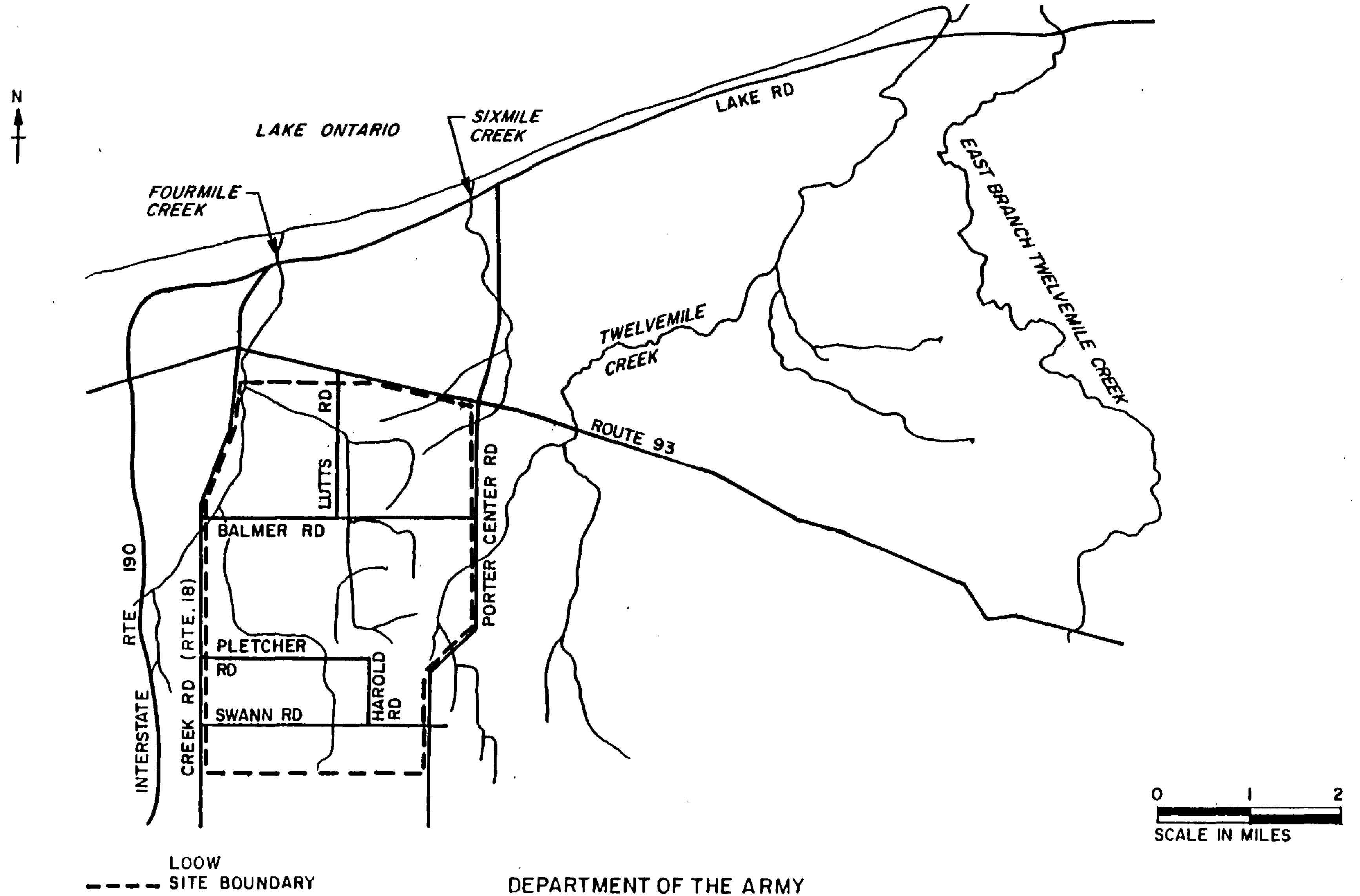

FIGURE 2-7

DEPARTMENT OF THE ARMY
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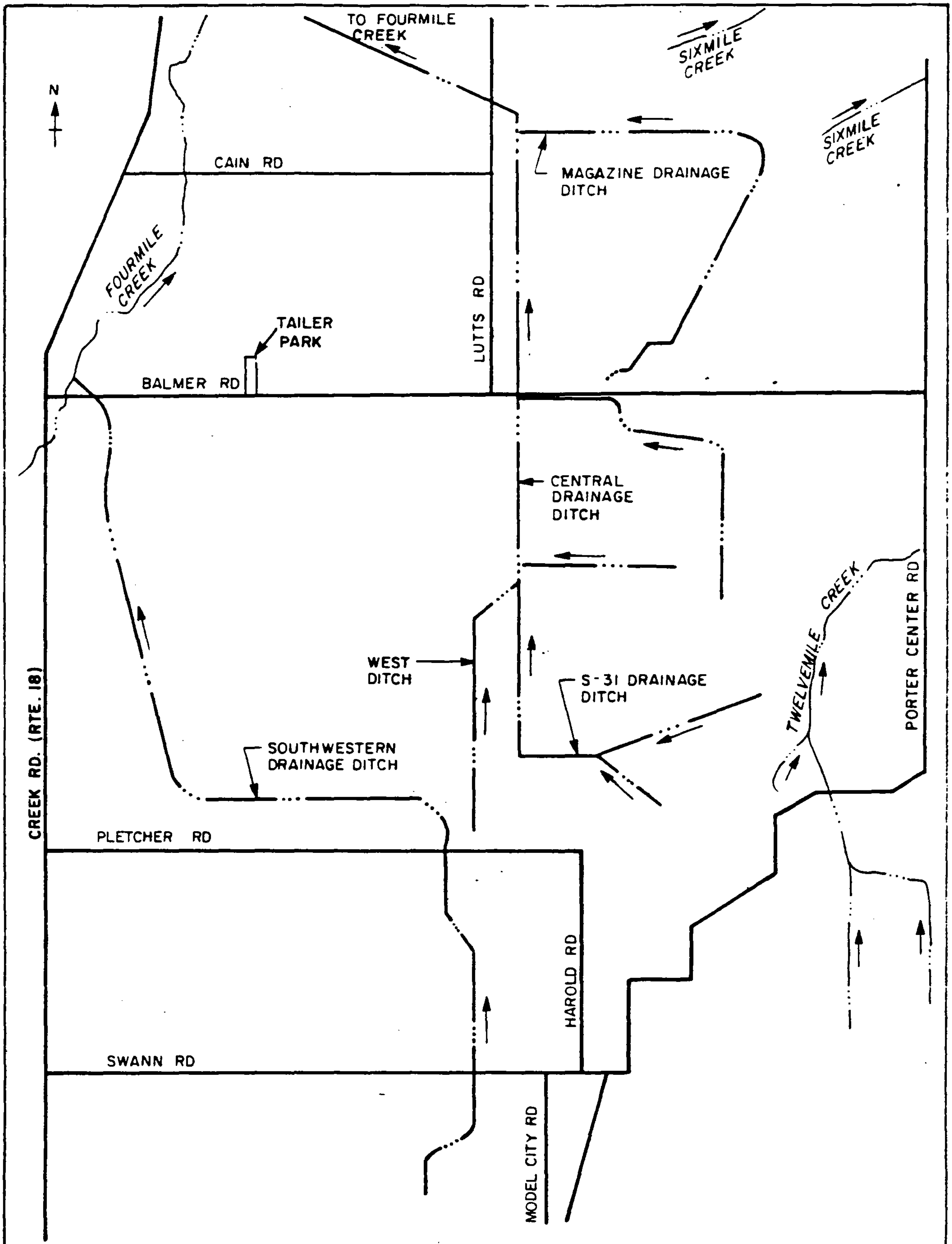
SURFACE DRAINAGE PATTERNS FORMER LOOW SITE AND VICINITY



DEPARTMENT OF THE ARMY
KANSAS CITY DISTRICT
CORPS OF ENGINEERS

DRAINAGE PATTERNS AT THE FORMER LOOW SITE

FIGURE 2-8

- Class C is suitable for fishing and all other uses except as a source of water supply for drinking, culinary or food processing purposes and primary contact recreation; and

- Class D is suitable for secondary contact recreation but due to such conditions as intermittence of flow, water conditions are not conductive to propagation of game fishery or stream bed conditions. The waters will not support the propagation of fish (see Table 2-3.)

Fourmile Creek is identified as a Class D water body from the 0.9 mile point to its source located 0.3 miles east of the intersection of Ridge Road and Lewiston Road.

Sixmile Creek is identified as a Class D water body along its entire length.

Twelvemile Creek is classified as a Class B water body from its mouth at Lake Ontario to the NY Route 18 bridge. Twelvemile Creek is a Class C water body from the NY Route 18 bridge to 1.3 mile upstream and a Class D water body from that point to its source near the intersection of Nichols Road and New York Central Railroad 1.7 miles northeast of Model City.

As part of the former LOOW site operations in the 1940s, a system of ditches was constructed to drain surface waters from the site to the Central Drainage Ditch (Figure 2-8). The section of Sixmile Creek which originally flowed through the site was diverted to the Southwestern Drainage Ditch and Fourmile Creek. Drainage from the southwestern portion of the site that had once flowed eastward into Twelvemile Creek was diverted to the S-31 ditch. Several additional ditches at the site drain into the Central Drainage Ditch which ultimately discharges into Fourmile Creek. The Central Drainage Ditch is a channelized ditch measuring approximately 10-15 ft deep, 10-20 ft wide at the bottom, and 40-50 ft wide at the surface. The ditch is approximately three miles in length.

A flood zone map for the former LOOW site is presented as Figure 2-9. The 100-year flood level in the area including the site is estimated to be

TABLE 2-3

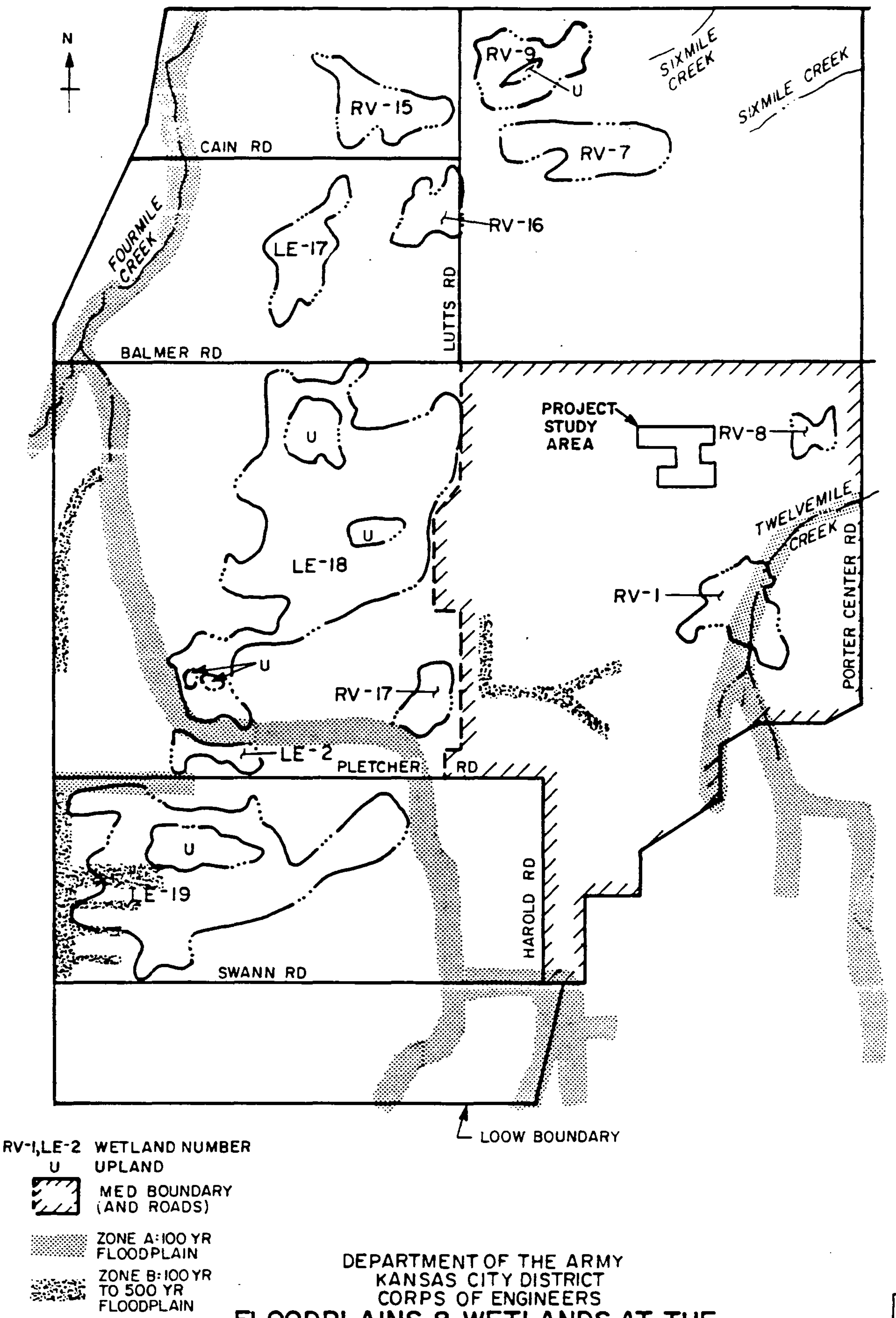
NEW YORK STATE FRESH WATER QUALITY STANDARDS[1)]

	Class				
Parameter	AA	A	B	C	D
Coliform (mg/100 ml sample)	<50	<5,000	<2,400	<10,000	---
pH (s.u.)	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.0-9.5
Total Dissolved Solids (mg/l)	<500	<500	<500	<500	---
Dissolved Oxygen					
(mg/l trout waters)	>7.0	>7.0	>7.0	>7.0	>3
(mg/l non-trout waters)	>4.0	>4.0	>4.0	>4.0	>3
Phenolic Compounds (mg/l)	<0.001	<0.005	---	---	---
Radioactivity					
- Gross Beta (pCi/l)	<1,000	<1,000	-	-	-
- Radium 226 (pCi/l)	<3	<3	-	-	-
- Strontium 90 (pCi/l)	<10	<10	-	-	-

All Waters:

NH_3	<2 mg/l
CN	<0.1 mg/l
FE (CN)	<0.4 mg/l
Cu	<0.2 mg/l
Zn	<0.3 mg/l
Cd	<0.3 mg/l

[1)] Title 6 New York State Code Rules and Regulations Part 701.



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CORPS OF ENGINEERS

FLOODPLAINS & WETLANDS AT THE FORMER LOOW SITE

FIGURE 2-9

approximately 319 ft MSL. On the LOOW site, 100-year floodplains exist along Fourmile Creek, Twelvemile Creek, and the Southwestern Drainage Ditch (DEC, 1980). Flooding is generally contained within the Central Drainage Ditch. The project study area does not lie within either a 100-year or 500-year floodplain.

During most of the year, there is very little surface flow. Major runoff occurs in the spring and ponded water is common during and following spring snow melt and periods of heavy precipitation (Acres, 1981; DOE, 1986).

There are eleven wetlands designated by the DEC under the Freshwater Wetlands Maps and Classification regulation, 6NYCRR664, on the LOOW site (DEC, 1984). The locations of these wetlands are shown in Figure 2-9. The classifications are listed on Table 2-4.

Seven of these wetlands have been designated as Class II wetlands by the DEC. The other four are Class III wetlands (DEC, 1984). To establish the relative value of wetlands, the DEC established a system containing four classes. Under this system, Class I wetlands have the highest rank or value and Class IV the lowest. Characteristics considered in determining the classification of a wetlands include (DEC, 1980):

- Ecological associations and cover types;
- Special features, such as threatened and endangered species;
- Hydrological features;
- Pollution control features; and
- Distribution and location.

None of the 11 wetlands designated by the state on the LOOW site fall within the project study area.

2.4 - Climate and Weather

Niagara County has a humid, continental climate which is characterized by warm summers and long, cold winters. The seasonal changes in temperature in the region are moderated by Lakes Erie and Ontario, which tend to cool

TABLE 2-4

FRESHWATER WETLAND CLASSIFICATION
NIAGARA COUNTY (DEC, 1984)

Wetland Number	Classification
LE-2	Class II
LE-17	Class III
LE-18	Class II
LE-19	Class II
RV-1	Class II
RV-7	Class III
RV-8	Class III
RV-9	Class II
RV-15	Class II
RV-16	Class III
RV-17	Class II

the air in summer and warm the air in winter. Basic climatologic data are presented in Table 2-5. The mean annual temperature is approximately 48°F with a normal seasonal temperature range of between 25° and 76°F. The mean annual precipitation in the Lewiston area is approximately 29.44 inches. Precipitation is fairly evenly distributed throughout the year (DEC, 1966). Snowfall for the Lewiston area averages about 50.8 inches per year and occurs primarily between November and March. Annual wind data for the region indicate that the wind is predominantly from the southwest with average monthly wind speed ranging from 9.9 to 14.3 miles per hour. An annual wind rose developed for the study area vicinity during 1985 is presented in Figure 2-10 (DEC, 1966; Acres, 1981; DOE, 1986; Bechtel, 1987).

2.5 - Demography

2.5.1 - Land Use and Zoning

Land use within the townships of Lewiston and Porter is primarily rural and includes agriculture, orchards, second-growth forests and recreational areas (Figures 2-11 and 2-12, Table 2-6). Existing and projected land uses for the Towns of Lewiston and Porter are presented in Table 2-7. Nine agricultural districts comprised of 176,592 acres of land are found in Niagara County. This total represents 52 percent of the land area of Niagara County. The former LOOW site is not located in any agricultural district.

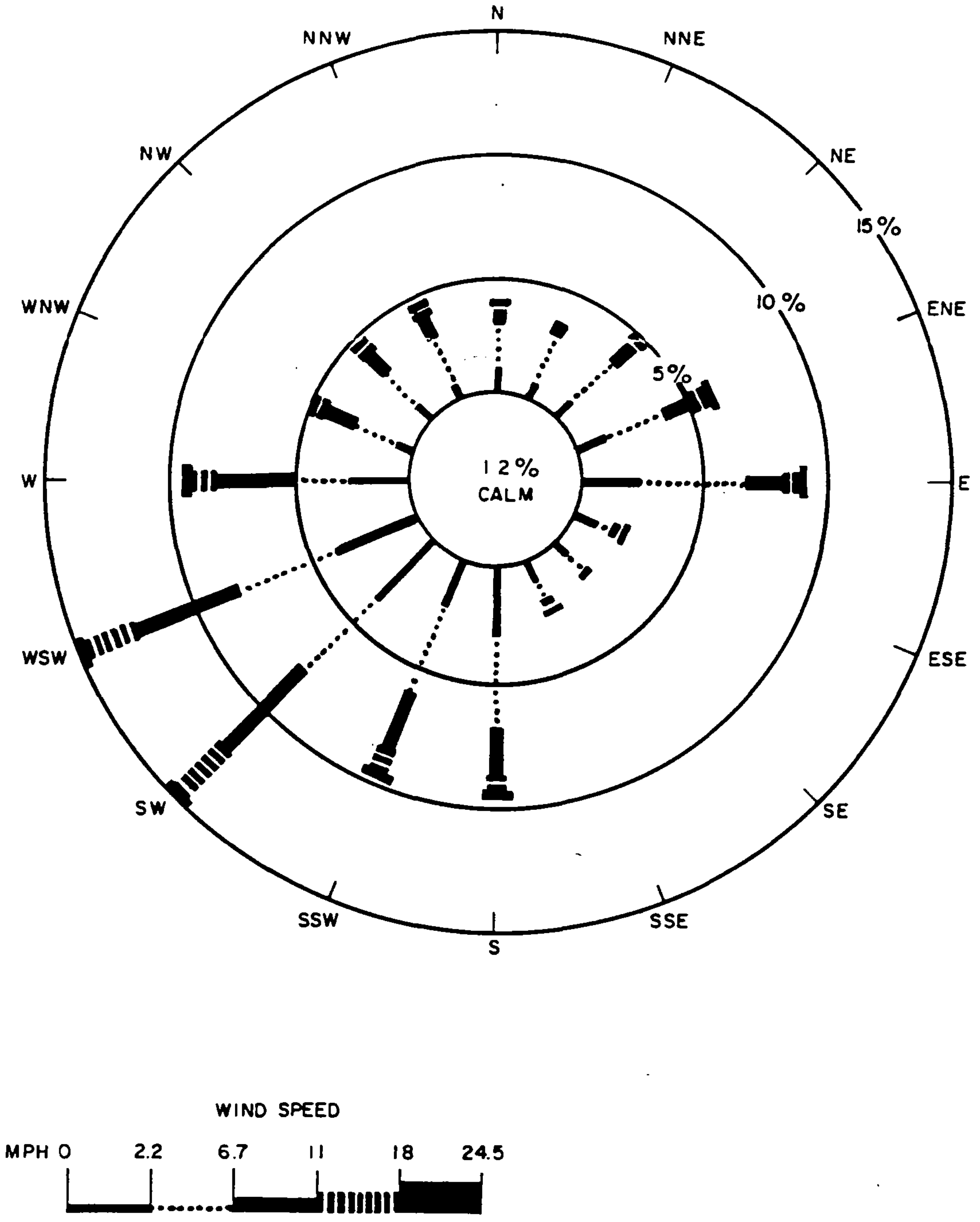
Relative to the project study area, a trailer park is located 1.3 miles to the northwest on Balmer Road (see Figure 2-8). The nearest permanent residence is 0.8 miles to the northwest on Balmer Road. The Lewiston - Porter Central schools are located two miles to the west on Creek Road. An area north of Balmer Road is owned by the U.S. Air Force and is currently inactive. Another area north of Balmer Road is used by the National Guard for maneuvers and for detonation of out-of-date explosives (DOE, 1986).

Land use within the former MED (i.e., AEC) property is indicated in Figure 2-3. The project study area is located within the property

TABLE 2-5

MEAN MONTHLY AND ANNUAL PRECIPITATION, SNOWFALL, AND TEMPERATURE, LEWISTON, NY (DEC, 1966)

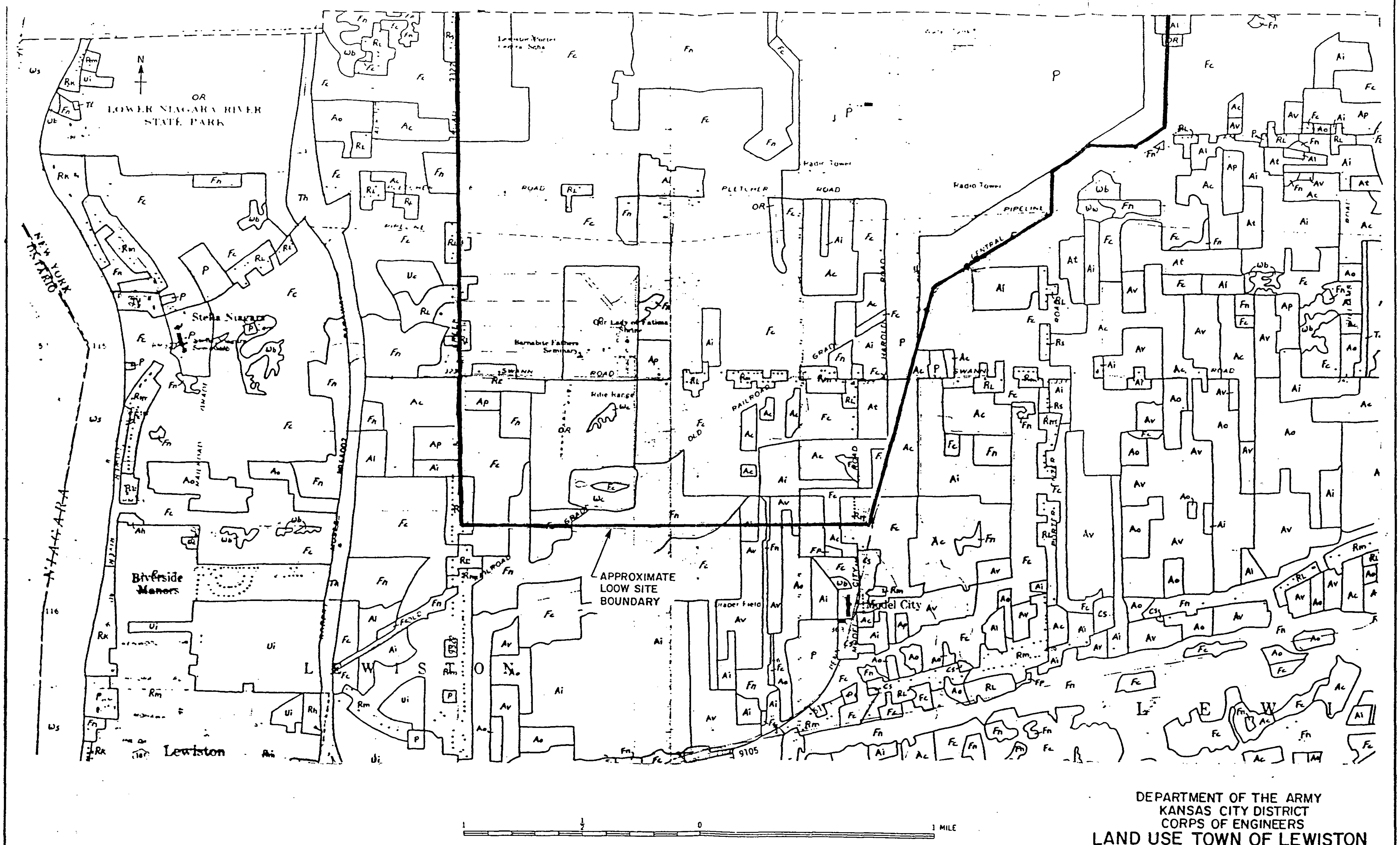
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual Aug.	Years of Record
Mean Precipitation (inches)	1.98	2.35	2.49	2.66	3.08	2.22	2.38	2.51	2.94	2.51	2.32	2.00	29.44	25
Mean Snowfall (inches of Snow)	12.6	13.5	9.5	1.4	0	0	0	0	0	0	4.2	9.6	50.8	24
Mean Minimum Temperature (°F)	19.4	20.0	25.8	35.9	45.9	55.9	61.0	60.1	52.8	43.1	34.2	24.1	39.8	25
Mean Maximum Temperature (°F)	33.7	35.4	42.7	56.4	68.7	79.1	84.0	82.5	74.5	63.2	49.1	37.4	58.9	25
Mean Temperature (°F)	26.6	27.6	34.3	46.2	57.4	67.5	72.5	71.4	63.7	53.2	41.7	30.8	49.4	25



DEPARTMENT OF THE ARMY
KANSAS CITY DISTRICT
CORPS OF ENGINEERS
ANNUAL WIND ROSE FOR THE LOOW

(BECHTEL, 1987)

FIGURE 2-10



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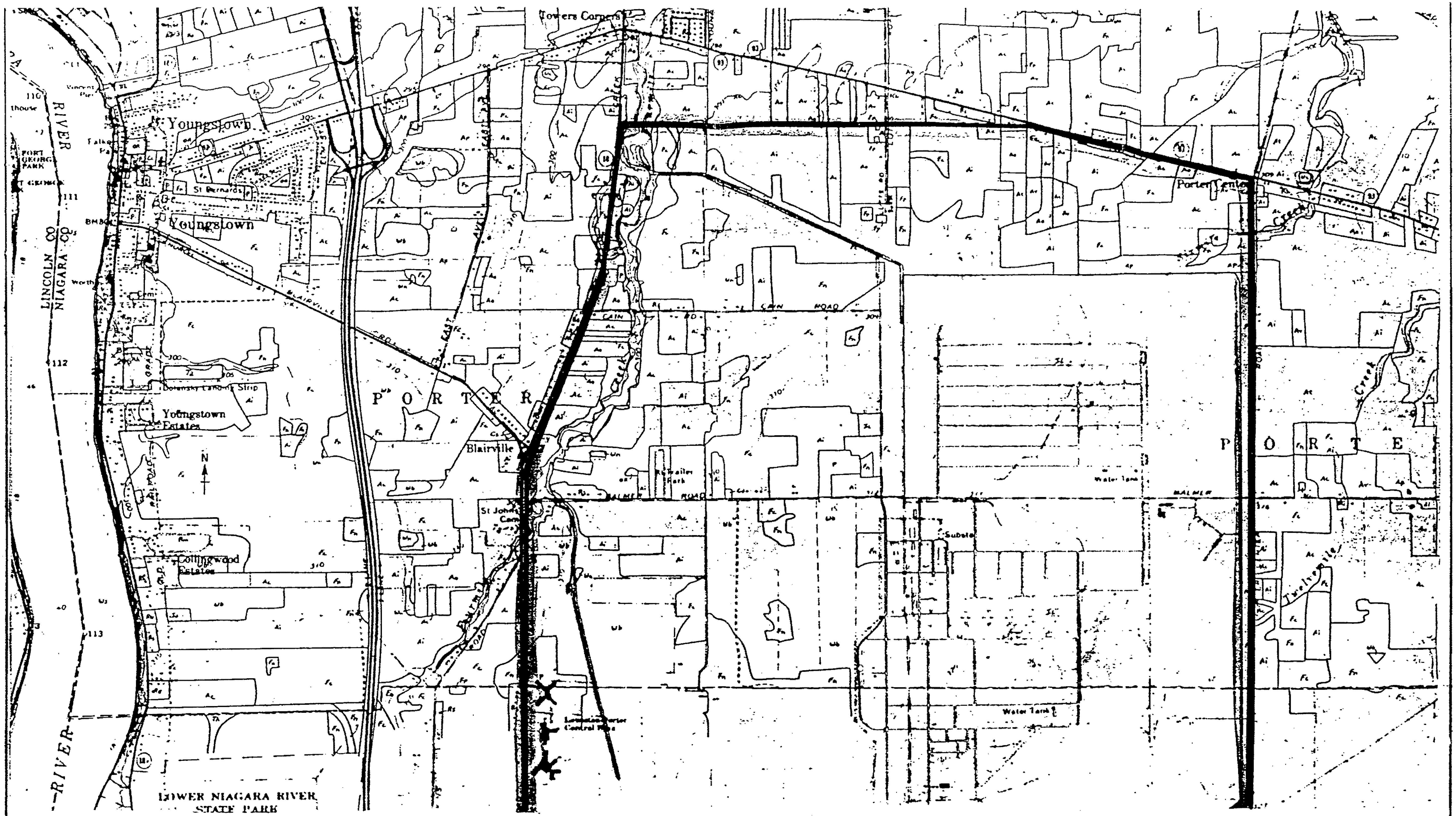
LAND USE TOWN OF LEWISTON NIAGARA COUNTY, NEW YORK

REFER TO TABLE 2-6 FOR EXPLANATION OF LAND USE CATEGORY SYMBOLS

(FROM NIAGARA COUNTY ENVIRONMENTAL MANAGEMENT COUNCIL, 1987)

FIGURE 2-11

ACRES



DEPARTMENT OF THE ARMY
KANSAS CITY DISTRICT
CORPS OF ENGINEERS

LAND USE TOWN OF PORTER
NIAGARA COUNTY, NEW YORK

REFER TO TABLE 2-6 FOR EXPLANATION OF LAND USE CATEGORY SYMBOLS

(FROM NIAGARA COUNTY ENVIRONMENTAL MANAGEMENT COUNCIL, 1987)

FIGURE 2-12

TABLE 2-6

CATEGORY SYMBOLS - AREA LAND USE DATA
NEW YORK STATE LAND USE AND NATURAL RESOURCES INVENTORY

(Source: Niagara County Environmental Management Council)

Active

Ao	Orchard
Av	Vineyard
Ah	Horticulture
At	High intensity -
Ac	Cropland/cropland pasture
Ap	Permanent pasture

Inactive

Ai	Agriculture
Ui	Urban Inactive
Uc	Ui under construction

Speciality Farm

Ay	Minks, game, aquatic Agriculture, horse farms

Forestland

Fc	Brush cover up to fully stocked poles less than 30 feet
Fn	Forest over 30 feet
Fp	Plantations, any size

Water

Wn	Natural, any size
Wc	Artificial, one acre
Ws	Streams, rivers - 100 feet

Wetlands

Wb	Bogs, shrub wetlands
Wm	Marine wetlands, navigable (St. Lawrence)
Wh	Hudson River

Non-Productive

Ns	Sands
Nr	Exposed rocks

Public

P	All categories

Communications

Tt	Area of service facilities

Residential

Rh	High density, 50 feet frontage
Rm	Medium density, 50-100 feet frontage
Rl	Low density, over 100 feet frontage
Rs	Strip with max of 1/3 intermixture of Cs commercial
Rr	Rural hamlet
Re	Estates, 5 acres
Rc	Farm labor camp

Shoreline

Rk	Shoreline developed

Commercial

Cu	Urban (Downtown)
Cc	Shopping center
Cs	Commercial strip with max of 1/3 intermixture of Rs or density housing
Cr	Resorts

Industrial

Il	Light manufacturing
Ih	Heavy manufacturing

Outdoor Recreation

OR	All categories

Extractive

Eg	Gravel, sand
Es	Stone quarries
Em	Minerals, cement, clay
Eu	Oil, gas, salt

Transportation

Th	Highway (limited access)
Tb	Barge canal (channel, lock)
Tp	Port or dock
Tl	Locks or dams
Ts	Shipyards
Ta	Airport, any type
Tr	Railroad

Land Area Not in New York State

No

TABLE 2-7

EXISTING (1975) AND PROJECTED (2000) LAND USES FOR THE TOWNS (TOWNSHIPS) OF LEWISTON AND PORTER AND FOR NIAGARA COUNTY[1]

Location	Status of Land Use	Percent of Land Area						
		Residential	Commercial/ Public/ Semipublic	Industrial	Forest/Brush/ Outdoor Recreation/ Vacant	Agriculture	Water/ Wetland	Transportation
Town of Lewiston (10,000 ha)	Existing	7.7	6.2	1.0	32	44	7.7	1.4
	Projected	8.0	6.5	1.0	32	43	7.7	1.4
Town of Porter (8,500 ha)	Existing	4.1	4.6	1.5	26	62	0.3	1.6
	Projected	4.2	4.8	1.5	26	62	0.4	1.6
Niagara County (140,000 ha)	Existing	6.4	2.1	1.7	20	65	3.5	0.9
	Projected	6.6	2.2	1.8	20	65	3.6	0.9

[1] All values rounded to two significant figures.

Data from Interstate Commerce Commission (1981).

Table taken from U.S. DOE Final EIS for Long-Term Management of the Existing Radioactive Wastes and Residues at the Niagara Falls Storage Site, April 1986.

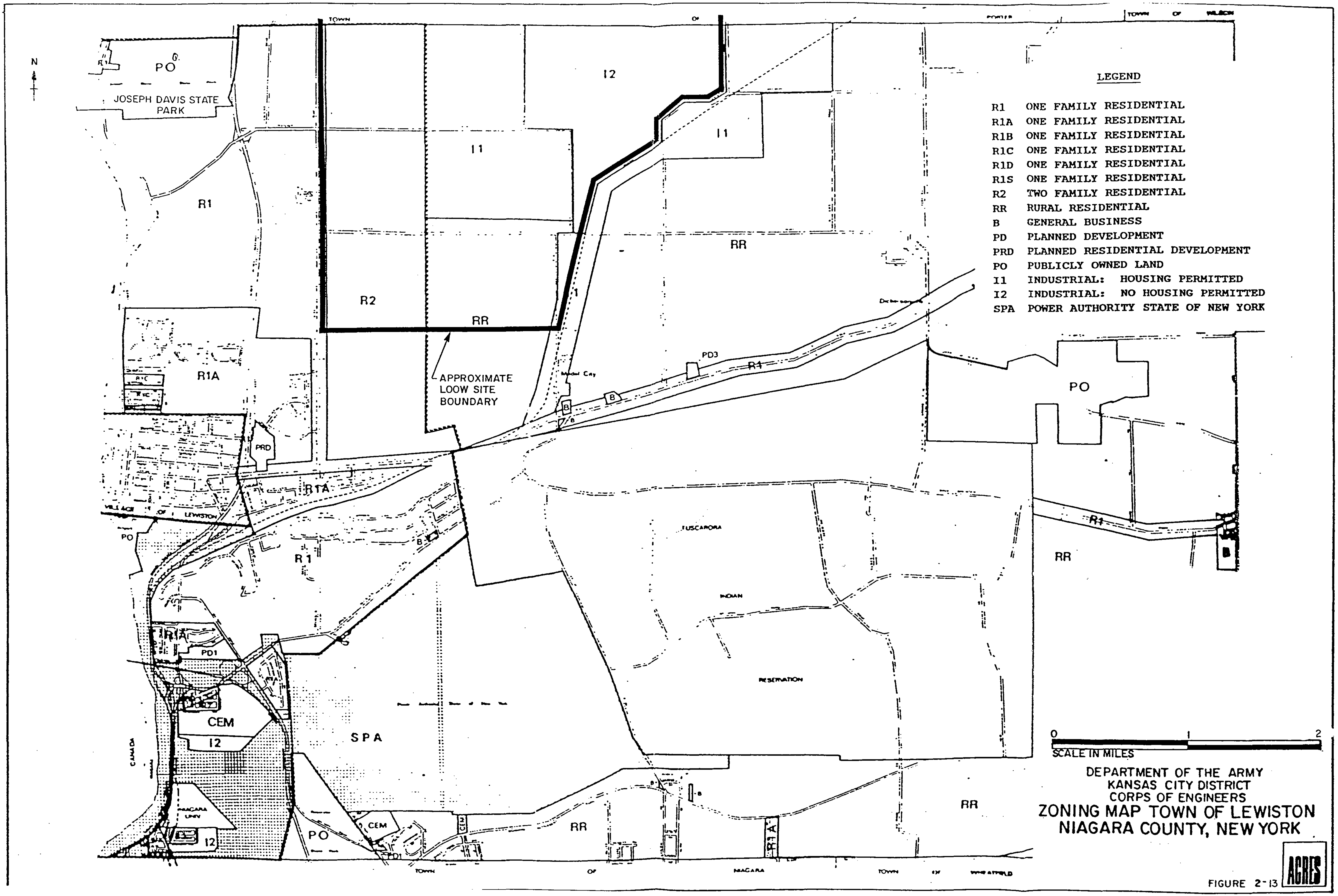
boundaries of the hazardous waste management facility operated by CWM. Southeast of the CWM property is the Niagara Falls Storage Site (NFSS). The NFSS has been used since 1944 for the storage of radioactive wastes and residues and is currently administered by the U.S. Department of Energy (DOE). South of the CWM property and east of the NFSS is a sanitary landfill operated by Modern Disposal, Inc. (Shown as S. Washuta on Figure 2-3). Immediately south of the sanitary landfill is federal government property controlled by the Department of Labor (DOL). This property is used for training construction equipment operators. The town of Lewiston maintains a closed sanitary landfill south of the DOL property and also owns a tract of land which was formerly the LOOW wastewater treatment facility located to the southwest of the project study area.

Zoning maps for the towns of Lewiston and Porter are presented in Figures 2-13 and 2-14. The northern, western, and southern portions of the former LOOW site are zoned agricultural and residential; the eastern and central portions are zoned industrial. The areas surrounding the former LOOW site are primarily zoned agricultural and residential.

2.5.2 - Population

According to 1980 U.S. Bureau of the Census data, the population of Niagara County was 227,100. Population density of Niagara County in 1980 was approximately 430 persons per square mile, with three-quarters of the population living in urban areas. The majority of the population in the vicinity of the LOOW is centered in the towns of Lewiston (16,200), Porter (7,250) and Niagara (9,650) and the city of Niagara Falls (71,400), all in Niagara County. Population changes from 1970 to 1980 for Niagara County and municipalities in Niagara County were as follows:

- Niagara County, decrease of 4 percent;
- Lewiston, increase of 2 percent;
- Porter, decrease of 2 percent;
- Niagara, increase of 15 percent; and
- City of Niagara Falls, decrease of 17 percent (DOE, 1986).



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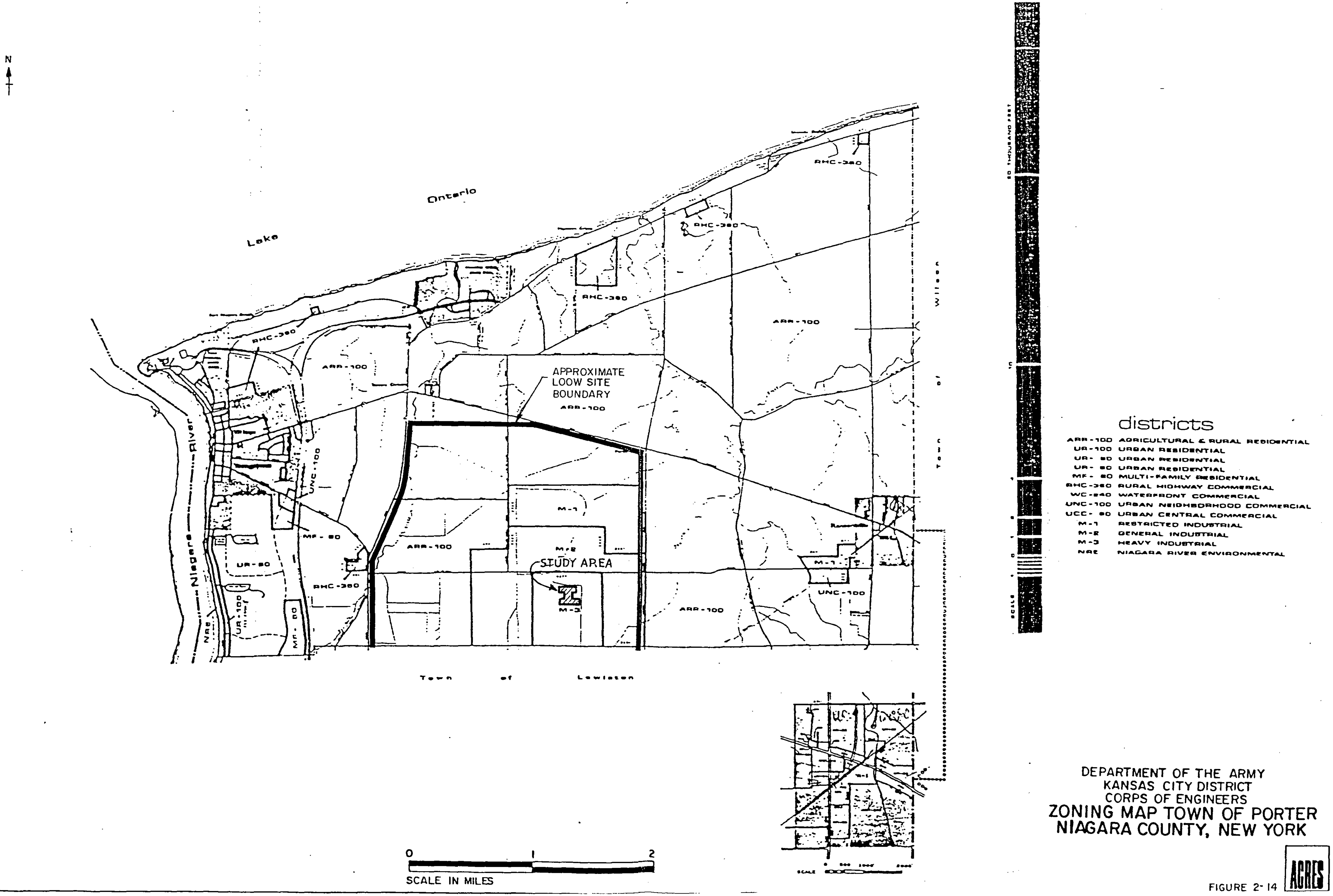
KANSAS CITY DISTRICT
CORPS OF ENGINEERS

ZONING MAP TOWN OF LEWISTON
NIAGARA COUNTY, NEW YORK

FIGURE 2-13



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CORPS OF ENGINEERS

**ZONING MAP TOWN OF PORTER
NIAGARA COUNTY, NEW YORK**

FIGURE 2-14

ACRES

Limited population growth is projected for the area, which is expected to remain rural through the year 2000.

2.6 - Ecology

2.6.1 - Vegetation

The original forest once found throughout the Western New York region including the former LOOW site was cleared in the 1800s as a result of logging activities and agricultural development. The deep, poorly-drained soils predominant in the area were suitable for red maple and white oak which dominated the forests. Second-growth forest found in wooded areas of the site vicinity is characterized by the predominance of maple, ash, and oak species.

In addition to second-growth forest, other plant communities present in the study area include northern shrub, pasture-grass and cattail - marsh grass. The northern shrub and pasture-grass communities probably represent communities in the later stages of secondary succession. The cattail-marsh grass community is found at the site in drainage ways and low-lying areas with very poor drainage (DOE, 1986).

Construction and cleanup activities at the site have resulted in the removal of considerable amounts of soil and vegetation. Closed landfills and other recovered areas in the vicinity of the project study area have been seeded with various grass and perennial species.

2.6.2 - Wildlife and Fish

Although no quantitative wildlife surveys have been conducted in the project study area, animals and birds observed there are common to Niagara County and characteristic of the available habitat (see Table

2-8). Bird population surveys conducted in the vicinity of the project study area indicate that at least 60 species may breed in the area (DOE, 1986).

No plant or animal species designated as threatened or endangered under State or Federal law are known to inhabit the area.

Fourmile Creek is known to support spawning populations of northern pike and various panfish. The DEC stocks Fourmile Creek with chinook salmon. The creek reportedly supports a limited spring migration of coho salmon and rainbow trout (DOE, 1986).

2.7 - Regional Geology

The western New York region is overlain by a thin cover of unconsolidated glacial deposits which were laid down during the closing phases of the Pleistocene Epoch. These glacial deposits directly and unconformably overly bedrock in most areas. The bedrock throughout the region consists of nearly flat-lying sedimentary sequences of shale, siltstone, sandstone, dolostone and limestone which were deposited during the Ordivician, Silurian and Devonian Periods of the Paleozoic Era. The following subsections present descriptions of the bedrock and unconsolidated glacial deposits and various engineering properties of those deposits which may be relevant to remedial efforts at the LOOW site.

2.7.1 - Unconsolidated Deposits

Three primary types of glacial deposits have been identified in the western New York region (Johnston, 1964). These are:

- Glacial till composed of an unsorted mixture of boulders, clay, and sand which was deposited by the glacial ice sheets;
- Clay, silt, and fine sand which was deposited in lakes that formed during the melting of the ice sheet; and

TABLE 2-8
ANIMAL RANGES EXTENDING INTO NIAGARA COUNTY

Mammals

Opossum	Didelphis virginiana
Masked Shrew	Sorex cinereus
Smoky Shrew	Sorex fumeus
Pygmy Shrew	Microsorex hoyi
Short-Tailed Shrew	Blarina brevicauda
Least Shrew	Cryptotis parva
Hairy-Tailed Mole	Parascalops breweri
Star-Nosed Mole	Condylura cristata
Little Brown Bat	Myotis lucifugus
Keen's Bat	Myotis keeni
Small-footed Bat	Myotis leibii
Silver-haired Bat	Lasionycteris noctivagans
Eastern Pipistrelle	Pipistrellus subflavus
Big Brown Bat	Eptesicus fuscus
Red Bat	Lasiurus borealis
Hairy Bat	Lasiurus cinereus
Eastern Cottontail	Sylvilogus floridanus
Eastern Chipmonk	Tamias striatus
Woodchuck	Marmota monax
Gray Squirrel	Sciurus carolinensic
Red Squirrel	Tamiasciurus ludsonicus
Southern Flying Squirrel	Glaucomys volans
Northern Flying Squirrel	Glaucomys sabrinus
Beaver	Castor canadensis
White-footed Mouse	Peromyscus leucopus
Gapper's red-backed Mouse	Clethrionomys gapperi
Meadow Vole	Microtus pennsylvanicus
Pine Mouse	Microtus pinetorum
Muskrat	Ondotra zibethica
Southern Bog Lemming	Synaptomys cooperi
Norway Rat	Ratlers norvegicus
House Mouse	Mus musculus
Meadow Jumping Mouse	Zopus hudsonicus
Woodland Jumping Mouse	Napaeozapus insignia
Porcupine	Erethizon dorsatum
Coyote	Canis latrans
Red Fox	Vulpes vulpes
Gray Fox	Urocyon cinereoargentatus
Eastern Raccoon	Procyon lotor
Ermine	Mustela erminea
Long-tailed Weasel	Mustela frenata
Mink	Mustela vison
Striped Skunk	Mephitis mephitis
River Otter	Lutra canadensis
Bobcat	Lynx rufus
White-tailed Deer	Adocoileus virginionus

TABLE 2-8
ANIMAL RANGES EXTENDING INTO NIAGARA COUNTY
(Cont'd)

Reptiles	
Northern Ring-neck Snake	Diadophis punctotus
Eastern Smooth Green Snake	Opheodrys vernalis
Black Rat Snake	Elaphe obsoleta
Milk Snake	Lampropeltis triangulum
Water Snake	Natrix sipedon
Northern Brown Snake	Storeria dekayi
Northern Red-bellied Snake	Storeria occipitomaculata
Northern Ribbon Snake	Thamnophis sauritus
Garter Snake	Thamnophis sirtalis
Northern Black Racer	Coluber constrictor
Timber Rattlesnake	Crotalus Larridus
Stinkpot	Sternotherus odoratus
Snapping Turtle	Chelydra serpentina
Spotted Turtle	Clemmys guttata
Midland Painted Turtle	Chrysemys picta
Map Turtle	Graptemyi geographica
Eastern Spiny Softshell	Trionyx spiniferus
Amphibians	
Mudpuppy	Necturus maculosus
Newt	Notophthalmus viridescens
Spotted Salamander	Ambystoma maculatum
Blue-spotted Salamander	Ambystoma laterole
Jefferson Salamander	Ambystoma jeffersonionum
Red-backed Salamander	Plethodon cinereus
Slimy Salamander	Plethodon glutinosus
Northern Two-lined Salamander	Eurycea bislineata
Dusky Salamander	Desmognathus fuscus
Mountain Dusky Salamander	Desmognathus ochrophaeus
Mountain Spring Salamander	Gyrinophilus porphyriticus
Four-toed Salamander	Hemidoctylium scutatum
American Toad	Bufo americanus
Northern Spring Peeper	Hyla crucifer
Western Chorus Frog	Pseudacris triseriata
Gray Treefrog	Hyla versicolor
Bullfrog	Rana catesbeiana
Green Frog	Rana clamitans
Pickerel Frog	Rana palustris
Leopard Frog	Rana pipiens
Wood Frog	Rana sylvatica

TABLE 2-8
ANIMAL RANGES EXTENDING INTO NIAGARA COUNTY
(Cont'd)

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A Field Guide to Reptiles and Amphibians of Eastern and Central North America. 1975. Roger Conant. Houghton Mifflin Company, Boston.

- Sand and gravel which was either deposited by streams carrying meltwater from the ice sheet or was produced by reworking till and other deposits along the shores of glacial lakes.

Specific types of glacial deposits found throughout the western New York area include end moraines, eskers, and drumlins. In some areas the glaciers have scoured away the overburden exposing the bedrock surface.

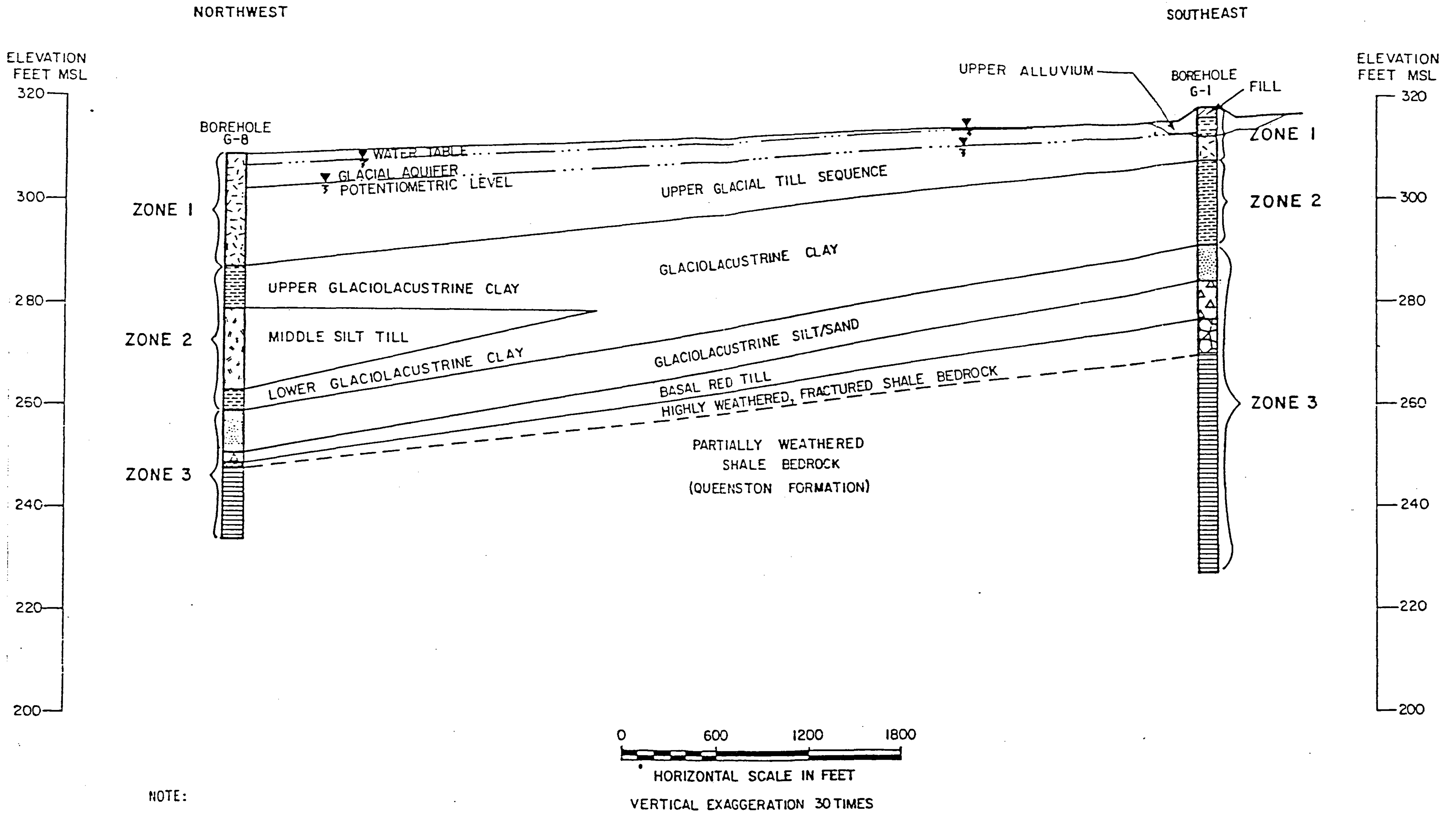
Over the past several years, numerous hydrogeologic investigations have been conducted on the CWM, Modern Landfill and Niagara Falls Storage Site properties (herein collectively referred to as the Model City facility). As a result of those investigations, over 400 test borings and test pits for monitoring wells, piezometers, exploratory borings, and foundation borings were performed throughout the facility. The subsurface information obtained from these investigations indicate that the Model City facility is underlain by 30 to 60 ft of unconsolidated glacial deposits. These deposits unconformably overlay the shale bedrock of the Queenston Formation. The unconsolidated material consists of, in ascending stratigraphic order:

- Lodgement till;
- Glaciolacustrine silt and sand;
- Glaciolacustrine clay;
- Middle silt till;
- Upper glacial till sequence; and
- Recent alluvium.

A typical geologic cross-section of the Model City facility is shown in Figure 2-15 (The location of the cross-section is presented in Figure 2-17). These glacial deposits are briefly described below in ascending stratigraphic order (oldest to youngest).

(a) Lodgement Till

The lower-most glacial unit occurring throughout the Model City facility is a red lodgement till. A lodgement till is a till



NOTE:

This figure is a schematic representation of the geologic stratigraphy made by straight line interpolation between boreholes G-1 and G-8. Some of the strata shown are discontinuous.

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GENERAL SITE STRATIGRAPHY

(FROM GOLDER, 1985)

FIGURE 2-15

deposited beneath a moving glacier. The deposit is characterized by compact fissile structures and stones oriented with the long axes parallel to the direction of glacial flow. The lodgement till encountered at the Model City facility was found to be reddish in color with high density and dry indurated texture. Red and green shale clasts originating from the underlying Queenston Formation are common features in the lodgement till. The deposit, referred to as the basal red till unit during previous hydrogeologic investigations, is commonly composed of silt and fine to coarse sand and little fine gravel. This unit is classified as an ML soil according to the Unified Soil Classification System.

The basal red till is generally dry to moist with an average moisture content of 11 percent. The unit has a relative density ranging from medium to very dense and is generally non-plastic or only slightly plastic (Golder, 1985a). The moisture content and plasticity of the unit varies across the Model City facility as a function of the gravel and clay content.

The surface elevation of the basal red till ranges from approximately 260 ft MSL in the northern portion of the site to about 280 ft MSL in the southern portion of the site. The basal red till ranges in thickness from 0 to 21.5 ft with an average thickness of 5 ft. The unit is absent over a large area of the northern portion of the site and in a few isolated areas throughout the remainder of the site (Golder, 1985a). In general, the topography of the unit varies with that of the bedrock surface.

(b) Glaciolacustrine Silt and Sand

Overlying the basal red till is a sequence of glaciolacustrine silt and sand. This unit has been found to vary in composition across the Model City facility. Golder (1985a) has identified four major subcategories of this unit:

- Stratified coarse sand composed of very dense, brown to multicolored coarse to fine sand with little silt and fine gravel (SP-SM);
- Non-stratified silt and sand composed of poorly sorted compact to very dense brown silt and coarse to fine sand with little fine gravel (ML);
- Stratified silt and fine sand composed of well sorted, brown-gray to brown silt with some fine sand (ML) and silt (SM); and
- Interlayered silt, sand, and clay composed of laminated soft gray silty clay (CL) with 1/2-inch to 6-inch silt (ML) or fine sand layers. This sub-unit is transitional in some areas with the overlying glaciolacustrine clay unit.

The silt and sand unit, referred to as the glaciolacustrine silt/sand, has filled into the surface of the bedrock and basal red till unit. The glaciolacustrine silt/sand varies in elevation from about 265 ft MSL in the northern portion of the facility to about 290 ft MSL in the southern portion of the facility. The glaciolacustrine silt/sand is absent in areas where the basal red till unit has occurred as high points on the bedrock surface.

(c) Glaciolacustrine Clay

A glaciolacustrine clay unit typically overlies the glaciolacustrine silt/sand unit. This clay unit is typically composed of laminated, very soft to firm, gray to gray brown silty clay (CL and CL-ML) with traces of fine sand. Laminations may occur as thin red-brown to gray silt and fine sand layers. Laminations are more common near the base of this unit.

The clay is of low to medium plasticity with an average plasticity index of 16. The majority of the unit has a high natural moisture content, averaging about 28 percent. Table 2-9 presents the ranges of some engineering properties of the glaciolacustrine unit which may be pertinent to any potential remedial activities.

The glaciolacustrine clay unit attains a thickness of up to 25 ft in the southwestern portion of the Model City facility. The unit is separated into two units in the northwestern portion of the facility by a till deposit. In this area, the two strata of clay are identified as the upper and lower glaciolacustrine clay units. The upper glaciolacustrine clay unit ranges in thickness up to 10 ft. The lower glaciolacustrine clay unit ranges up to 6 ft in thickness. The two clay strata are discontinuous and may be absent in some areas.

(d) Middle Silt Till Unit

The glaciolacustrine clay unit is separated into two members by a till unit referred to as the middle silt till unit. This till unit is composed of well graded, compact to very dense, gray to gray-brown silt and coarse to fine sand with a trace of fine gravel. The middle silt till unit only occurs in the northwestern and western portion of the Model City facility. This unit has not been identified in all of the previous site investigations.

(e) Upper Glacial Till Sequence

A sequence of glacial tills overlies the glaciolacustrine clay unit. This sequence can be frequently divided into two strata: an upper silt till unit and an upper clay till unit.

The upper silt till unit is discontinuous across the facility, commonly being absent in the southern portion of the site. This unit is typically composed of compact to very dense, brown to

TABLE 2-9

RANGES OF VALUES OF ENGINEERING PROPERTIES OF SOILS AT THE LOOW SITE*

Parameter	Upper Glacial Till	Glaciolacustrine Clay
Dry Unit Weight V (lbs/cf)	108 to 122	79 to 107
Standard Penetration Resistance (blows/ft)	10 to 47	3 to 20
Moisture Content w (%)	13.0 to 27.2	19.2 to 42.5
Undrained Sheer Strength $T_1-T_3/2$ (PSF)	991 to 4,268	680 to 962
Preconsolidation Stress (Pc - Tsf)	3.0 to 7.0	1.7 to 3.6
Compression Index (Cc)	0.05 to 0.20	0.19 to 1.00

* From Acres, 1981. Values represent soils from NFSS.

purple-brown silt (ML), and coarse to fine sand with little fine gravel. Wet discontinuous layers of silt and sand are occasionally found within the unit. The unit is generally non-plastic.

The upper clay till unit is commonly composed of non-stratified to faintly laminated, stiff to hard brown to purple-brown clayey silt (CL to CL-ML) with some fine to coarse sand and little fine gravel. This deposit occasionally contains cobbles and discontinuous, wet sand, gravel, and silt layers. This unit exhibits low to medium plasticity with an average plasticity of 13 and an average moisture content of 15 percent. Table 2-9 presents the ranges of some engineering properties which may be pertinent to any potential remedial activities conducted at the site.

The combined thickness of the upper silt and clay till units is fairly uniform across the site varying from 15 to 20 ft. The units become thinner toward the southern portion of the facility, averaging 10 to 15 ft. The differentiation of the upper silt till and the upper clay till have not been made in all past site investigations.

(f) Recent Alluvium

Alluvium is found discontinuously across the facility. This unit is typically laminated and varies from a fine sand with some silt to a silt or silty clay (SM, ML, or CL). This layer may occur in thicknesses of up to 5 ft.

(g) Fill

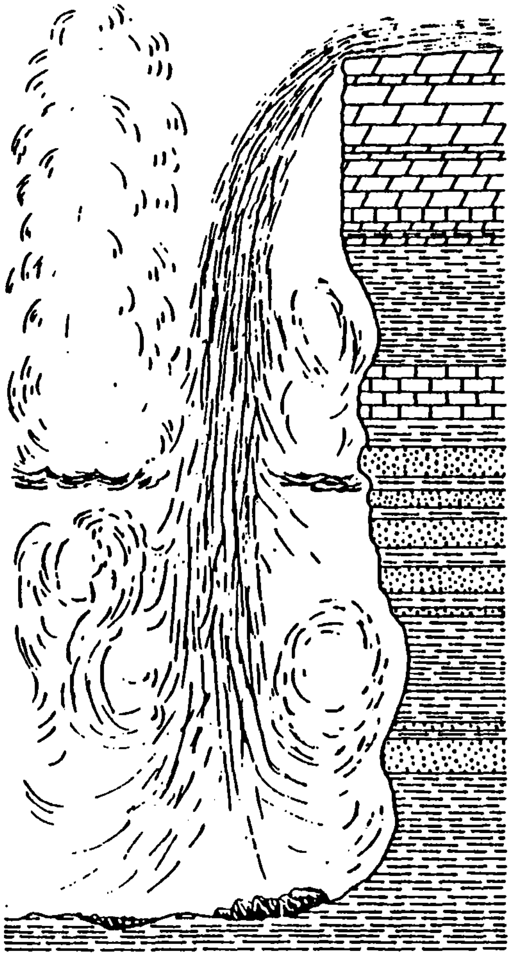
Because the Model City facility has been used for various purposes including the original agricultural activities prior to the construction of the LOOW and subsequent landfilling and building construction activities, the natural topography and composition of the surface and near surface soils has been significantly altered. In addition to the obvious landfills and buildings constructed on the site, some areas have received "borrow material" which was either brought into the site or moved from one area of the site to another. Because much of this "borrow material" is locally derived, it is commonly of similar composition to the native deposits and may only be distinguishable by signs of disturbance or inclusion of foreign material such as wood, metal, etc.

2.7.2 - Bedrock

As previously mentioned, the bedrock throughout the Western New York region consists of nearly flat-lying sedimentary sequences of shale, siltstone, sandstone, dolostone, and limestone deposited during the Ordovician, Silurian and Devonian periods of the Paleozoic Era.

The bedrock sequence dips gently to the south at about 30 ft per mile; thus the oldest rock units are exposed to the north and the youngest to the south. The bedrock formations exposed at Niagara Falls, which is located approximately ten miles south of the LOOW site, are illustrated in Figure 2-16.

The lower-most unit exposed in the Niagara Falls area is the Queenston Formation of Upper Ordovician age. The Queenston Formation underlies most of the Ontario Plain in the western New York region. This sequence is composed primarily of red or purplish-red finely-bedded to massive shale interbedded with siltstone and silty dolostone. The Queenston commonly contains greenish beds and streaks found along bedding planes and joints. The Queenston was deposited in a marine deltaic environment and is reported to be between 700 and 1200 ft thick (Tesmer, 1981; Johnston, 1964). As shown in Figure 2-16, the upper contact of the Queenston Formation is located near the base of the Niagara Escarpment and the Falls. The lower contact of the Queenston is not exposed in the western New York area.



System		Group	Formation	Thickness 1/ (feet)	Description
Silurian	Middle		Lockport Dolomite	150	Dark-gray to brown, massive to thin-bedded dolomite, locally containing algal reefs and small, irregularly shaped masses of gypsum. At the base are light-gray, coarse-grained limestone (Gasport Limestone Member) and gray shaly dolomite (DeCew Limestone Member of Williams, 1919).
		Clinton	Rochester Shale	60	Dark-gray calcareous shale weathering light-gray to olive.
			Irondequoit Limestone	12	Light-gray to pinkish-white coarse-grained limestone.
			Reynales Limestone	10	White to yellowish-gray shaly limestone and dolomite.
			Neahga Shale of Sanford (1933)	5	Greenish-gray soft fissile shale.
	Lower	Albion	Thorold Sandstone	8	Greenish-gray shaly sandstone.
			Grimsby Sandstone of Williams (1914)	45	Reddish-brown to greenish-gray cross-bedded sandstone interbedded with red to greenish-gray shale.
			Unnamed unit	40	Gray to greenish-gray shale interbedded with light-gray sandstone.
			Whirlpool Sandstone	20	White, quartzitic sandstone.
Ordovician	Upper		Queenston Shale	1,200	Brick-red sandy to argillaceous shale.

1/ Average figure for area. Thickness at falls is not necessarily the same.

FIGURE 2-16

ACRES

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BEDROCK FORMATIONS IN THE NIAGARA FALLS AREA

(JOHNSTON, 1964)

2.8 - Regional Hydrogeology

2.8.1 - Unconsolidated Materials

Groundwater occurrence within the unconsolidated overburden in the LOOW area is primarily controlled by the type and occurrence of glacial deposits and locally by fluvial deposits. Past investigations in the LOOW area indicate that glacial deposits occur up to 100 ft in thickness. Permeabilities of these glacial deposits vary from low permeability ground moraines and glacial lake deposits to highly permeable sand and gravel outwash deposits. Interspersed throughout the glacial deposits in the LOOW area are fluvial stream and beach deposits which generally have high permeabilities but are typically of limited extent.

Groundwater flow within the unconsolidated deposits generally conforms to the local topography with overall flow generally toward Lake Ontario to the north and the Niagara River to the west.

The subsurface stratigraphy of the Model City facility has been divided into three hydro-stratigraphic units. These units are identified as:

- Zone 1: consists of the unconfined water-bearing zone within the upper glacial till, alluvium, and fill units;

- Zone 2: consists of the relatively impermeable glaciolacustrine clay unit; and

- Zone 3: consists of a confined water-bearing zone occurring predominantly within the glaciolacustrine silt/sand unit and to a lesser degree, within the basal red till and upper portion of bedrock.

The hydraulic conductivities (permeabilities) of the geologic formations are summarized in Table 2-10. The glaciolacustrine silt/sand unit is the most permeable formation and, as such, the primary aquifer being monitored by CWM at the facility.

TABLE 2-10

HYDRAULIC CONDUCTIVITIES OF STRATIGRAPHIC UNITS AT THE MODEL CITY FACILITY*

(cm/sec)

Zone	Stratigraphic Unit	Hydraulic Conductivity (cm/sec) Vertical	Hydraulic Conductivity (cm/sec) Horizontal
1	Upper Clay Till Upper Silt Till	6×10^{-7}	2×10^{-6}
	Middle Silt Till	1×10^{-7}	3×10^{-6}
2	Glaciolacustrine Clay	2×10^{-8}	5×10^{-8}
3	Glaciolacustrine Silt/Sand		
	- Stratified Coarse Sand		2×10^{-4}
	- Non-Stratified Silt and Fine Sand		3×10^{-5}
	- Stratified Silt and Fine Sand		1×10^{-5}
	- Interlayered Silt Sand and Clay		3×10^{-6}
	Basal Red Till	3×10^{-8}	4×10^{-8}

* Hydraulic permeabilities calculated by Golder, 1987.

Potentiometric groundwater surface contours in the glaciolacustrine silt/sand unit (Zone 3) indicate that groundwater flow is generally to the northwest across the project study area (Figure 2-17). Potentiometric contours indicate a strong westerly component of groundwater flow in the northwestern area of the facility. Apparent horizontal hydraulic gradients across the project study area vary from 0.01 to 0.002.

The potentiometric surface map for the Zone 1 water-bearing zone, using water level data recorded in December 1986, is presented in Figure 2-18. The data indicate the presence of localized mounding of groundwater as a result of landfill mounds, facultative ponds and lagoons. Generally, groundwater levels of the Zone 1 potentiometric surface are approximately 4 ft above the potentiometric surface representation for Zone 3; indicating a downward migration potential between the two zones.

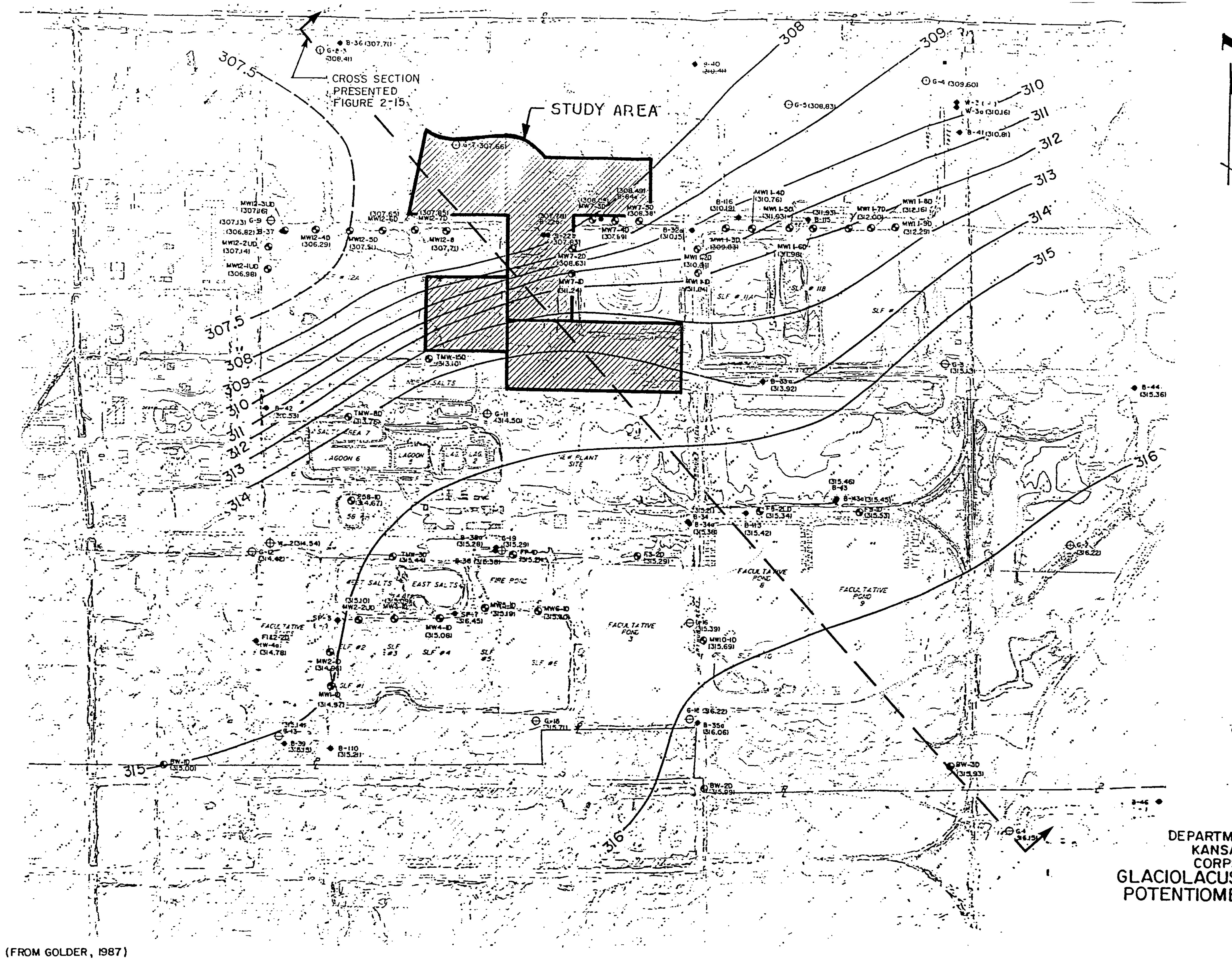
2.8.2 - Bedrock

Well yields from the Queenston Formation are typically less than seven gallons per minute, however, in unweathered portions of the formation, well-yields are estimated to be less than one gallon per minute (Johnston, 1964).

Water within the Queenston Formation is moderately to highly mineralized. The total dissolved solids (TDS) concentration within the water averages 2,600 ppm and ranges between 533 and 8920 ppm. The higher levels of TDS are largely attributed to elevated levels of sodium, calcium, and chlorides in connate water within the formation (Johnston, 1964).

2.8.3 - Groundwater Use

Groundwater usage in the area of the LOOW site is limited. All residences in the Town of Porter are serviced by public water. In



LEGEND

-311-	POTENTIOMETRIC ELEVATION CONTOUR IN FEET MSL
MW1-1D	BORINGS BY GOLDER ASSOCIATES
◆ B-39	BORINGS BY OTHERS
G-16	PIEZOMETERS BY GOLDER ASSOCIATES
(315.42)	ELEVATION DATA

NOTES:

1. GROUNDWATER POTENTIOMETRIC CONTOURS SHOWN ARE FROM MEASUREMENTS TAKEN ON DECEMBER 18, 19, 1986 UNLESS OTHERWISE NOTED.
2. G SERIES DATA FROM NUMBER 2 PIEZOMETERS UNLESS OTHERWISE NOTED.
3. DATA WITH A LINE THROUGH THE VALUE ARE NON-REPRESENTATIVE DUE TO WELL SEAL OR CASING PROBLEMS OR TO SUSPECTED SURVEYING ERRORS AND WERE NOT USED IN INTERPRETING CONTOURS.

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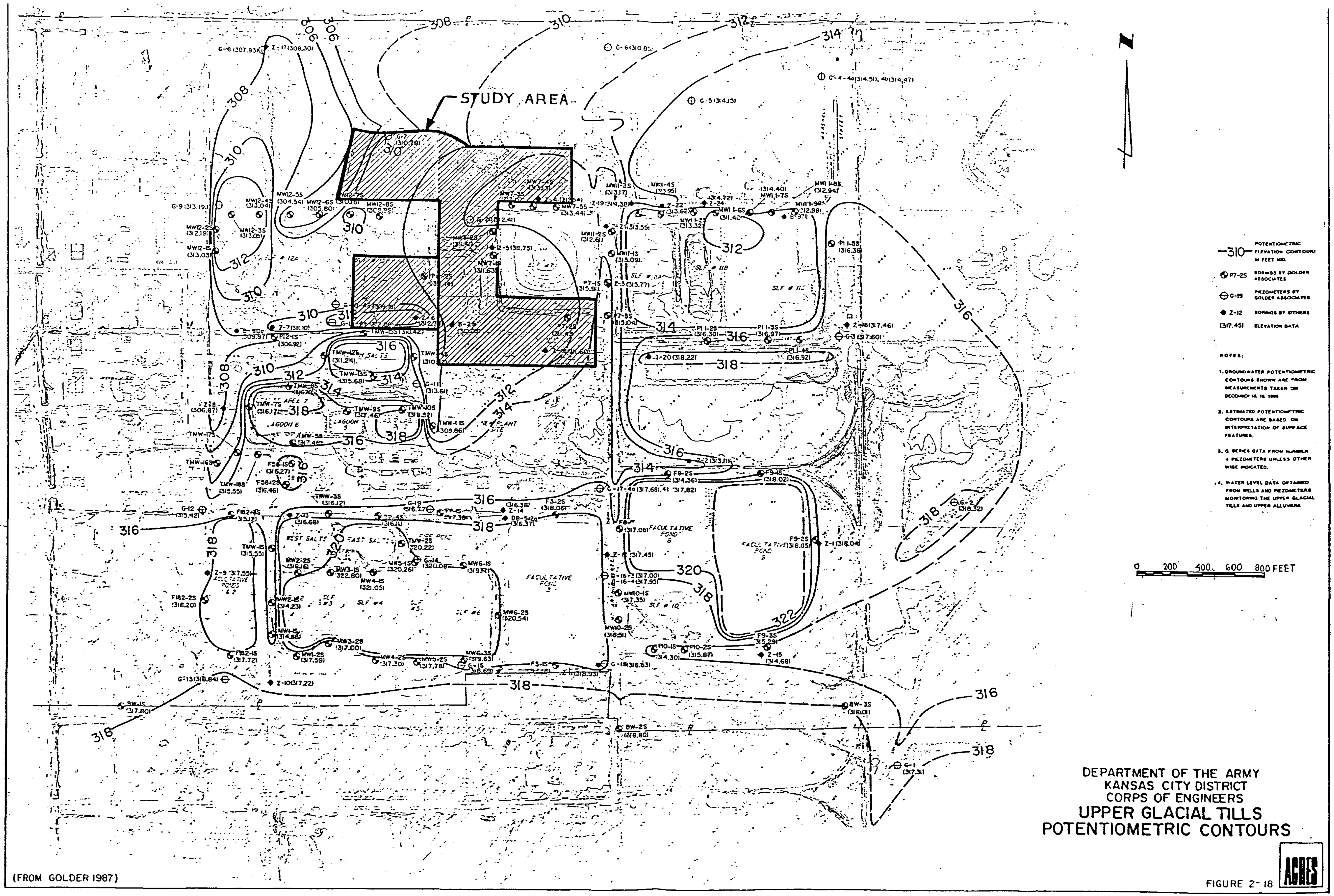
GLACIOLACUSTRINE SILT/ SAND POTENTIOMETRIC CONTOURS

(FROM GOLDER, 1987)

FIGURE 2-17

ACRES



—310— POTENTIOMETRIC ELEVATION CONTOURS IN FEET MSL

P7-2S BORINGS BY GOLDER ASSOCIATES

G-19 PIEZOMETERS BY GOLDER ASSOCIATES

Z-12 BORINGS BY OTHERS

(317.45) ELEVATION DATA

NOTES:

1. GROUNDWATER POTENTIOMETRIC CONTOURS SHOWN ARE FROM MEASUREMENTS TAKEN ON DECEMBER 14, 15, 1986

2. ESTIMATED POTENTIOMETRIC CONTOURS ARE BASED ON INTERPRETATION OF SURFACE FEATURES.

3. G SERIES DATA FROM NUMBER 4 PIEZOMETERS UNLESS OTHERWISE INDICATED.

4. WATER LEVEL DATA OBTAINED FROM WELLS AND PIEZOMETERS MONITORING THE UPPER GLACIAL TILLS AND UPPER ALLUVIUM.

(FROM GOLDER 1987)

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UPPER GLACIAL TILLS
POTENTIOMETRIC CONTOURS

FIGURE 2-18

ACRES

Lewiston, two homes use groundwater for their water supply. All other residences within at least 3 miles of the site are tied into public water.

Many residences in the townships of Lewiston and Porter have old wells on their property and some usage of groundwater for lawn and garden watering may occur. However, many farms in the area irrigate with pond water because of the general low yield and high salinity and sulfur content of the groundwater.

3 - SITE HISTORY

3.1 - Site Ownership and Development

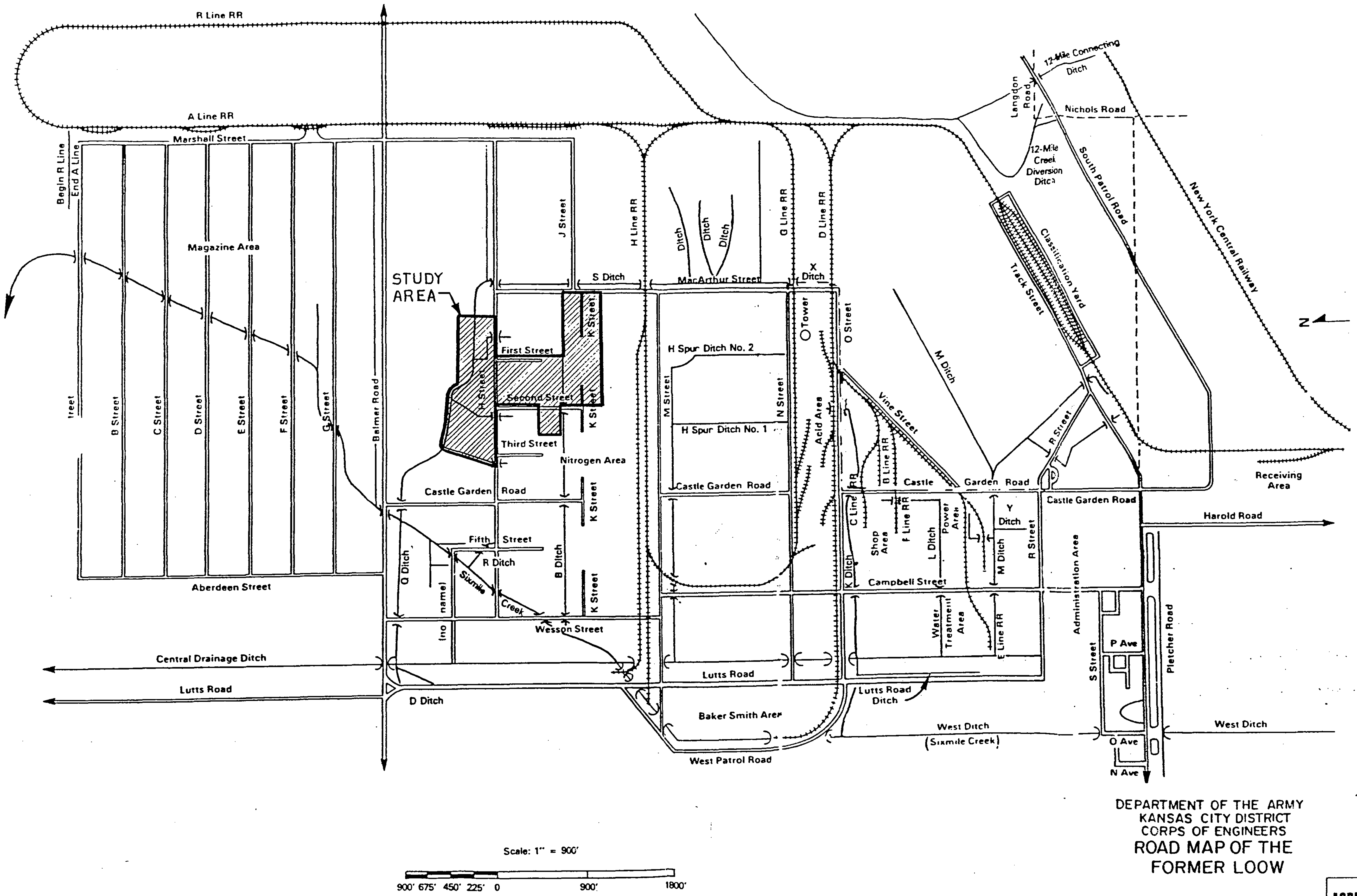
The LOOW site originated in early 1942 with the acquisition by the Army of 7567 acres of land in northwestern New York State. The land was acquired by purchase and condemnation from 149 private landowners, primarily farmers and orchard growers. The property included 7453 acres in fee and 114 acres of easements. The fee property included a 12 acre parcel adjacent to the Niagara River which was acquired for a water intake pumping station. The remainder was a continuous area, as shown in Figure 2-2. The easements included:

- Approximately 80 acres of Fourmile Creek extending from the northern boundary of the LOOW to Lake Ontario;

- 12 acres extending from the water intake pumping station to the western boundary of the LOOW for electrical transmission lines and water mains; and

- 23 acres for a sewer line extending from the western boundary of the LOOW to the Niagara River (Pugh, 1981).

The LOOW was initially developed for the construction of a trinitrotoluene (TNT) manufacturing plant. This work involved the demolition of most of the 125 acquired farmhouses and 538 barns. Some of the structures were converted for use by the Army. The construction of the plant began in January 1942, employing more than 7500 workers. In all, approximately 33 miles of roads and over 500 structures were built. A map of the road network at the LOOW plant is provided in Figure 3-1. Once completed, the complex contained a power plant, a hospital, a fire department, a water supply system adequate for a city of 100,000, a water treatment system, toluene and acid storage tanks, and an extensive system of underground water, sewage, acid and TNT pipelines. These pipelines were buried one to 14 feet below ground (NYS Assembly, 1981).



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ROAD MAP OF THE FORMER LOOW

(FROM AEROSPACE 1982)

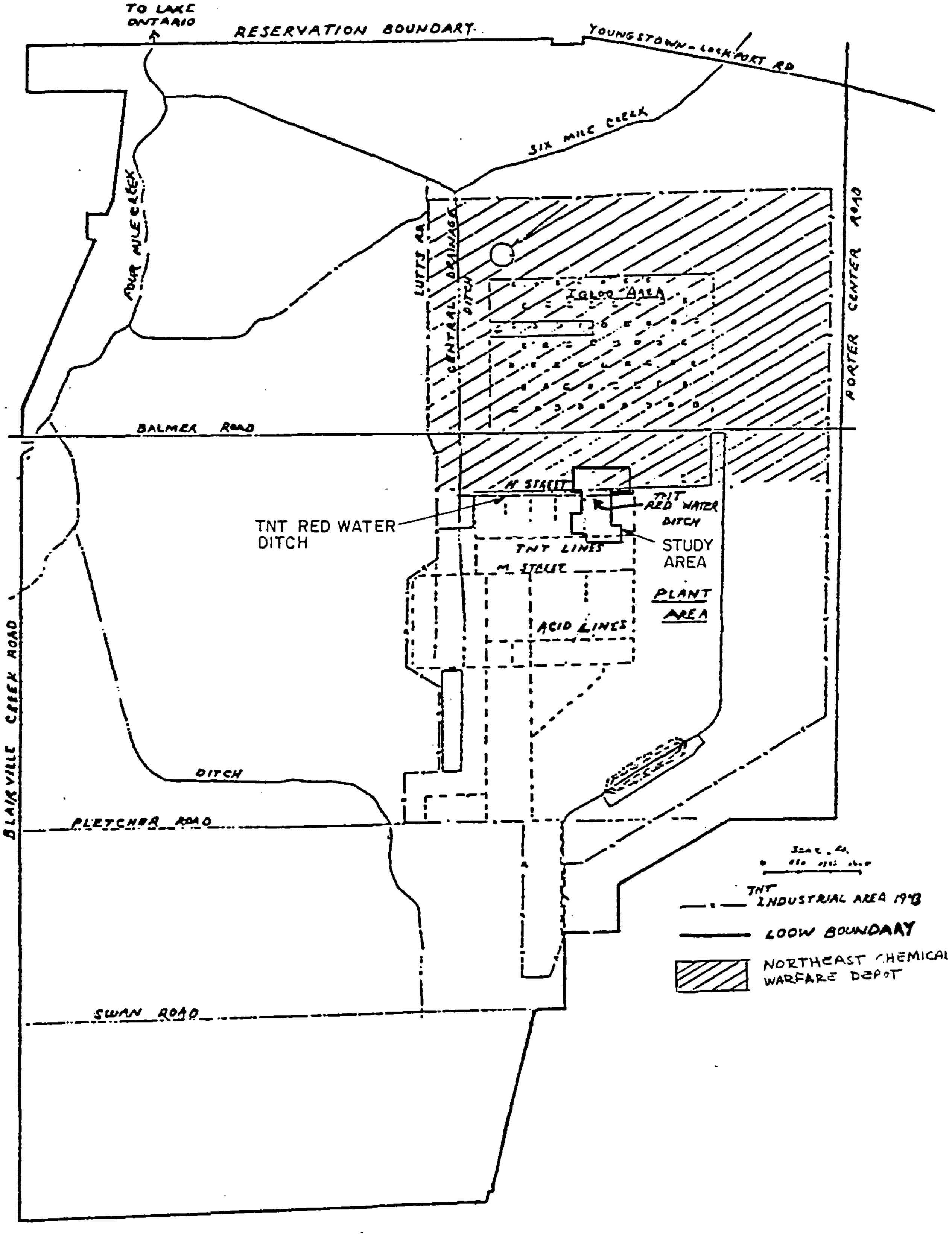
FIGURE 3-1

The manufacturing portion of the plant was situated in the central southeastern section of the LOOW, south of Balmer Road (Figure 3-2). The manufactured explosives were stored in reinforced concrete magazines ("igloos") located in the area north of Balmer Road. The remaining portion of the LOOW was unused and acted as a buffer zone.

The TNT produced at the plant was a general-purpose explosive used in bombs and warheads. The explosive was produced by the trinitration of toluene with nitric and sulfuric acids. Basically, the production process involved separation of 2,4,6-trinitrotoluene (alpha TNT) from undesirable isomers by selliting (a reaction with sodium sulfite solutions). The selliting process removed the small amount of undesirable side products. A wastewater solution of dinitrotoluene sulfonates ("red liquors") was produced during the process. The pure TNT was then melted and charged as a liquid into ordnance casings or used in combination with other explosives (Hazards Research, 1983).

When in production, the TNT plant had six production lines with a daily capacity of 390,000 pounds of TNT. An overestimation by the Army of the need for TNT during World War II resulted in the closure of the TNT plant in July, 1943 after only nine months of operation. After closing the plant, most of the water supply piping was dismantled and shipped for use at a gaseous diffusion plant in Oak Ridge, TN. Some of the TNT plant buildings are still in use today, although for different purposes.

In the 1944 to 1946 period, the Chemical Warfare Service (CWS) obtained approximately 1100 acres of the LOOW. The acquisition primarily consisted of 990 acre portion of land containing the storage igloos north of Balmer Road (Figure 3-2). This area was redesignated the Northeast Chemical Warfare Depot. The Northeast Chemical Warfare Depot was used for the temporary storage and transshipment of munitions and chemicals. Two of the chemicals which may have been stored at the depot included phosgene, a toxic gas; and impregnite, a chemical developed by the CWS. The latter was used to impregnate clothing and make the material impermeable in gas warfare. Both of these chemicals were produced during and after the war in the western New York region for CWS. The Northeast Chemical Warfare Depot was also used for the storage of incendiary and napalm bombs and aluminum scrap.



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NORTHEAST CHEMICAL WARFARE DEPOT LOOW TNT PLANT

(FROM NYS ASSEMBLY, 1981)

FIGURE 3-2

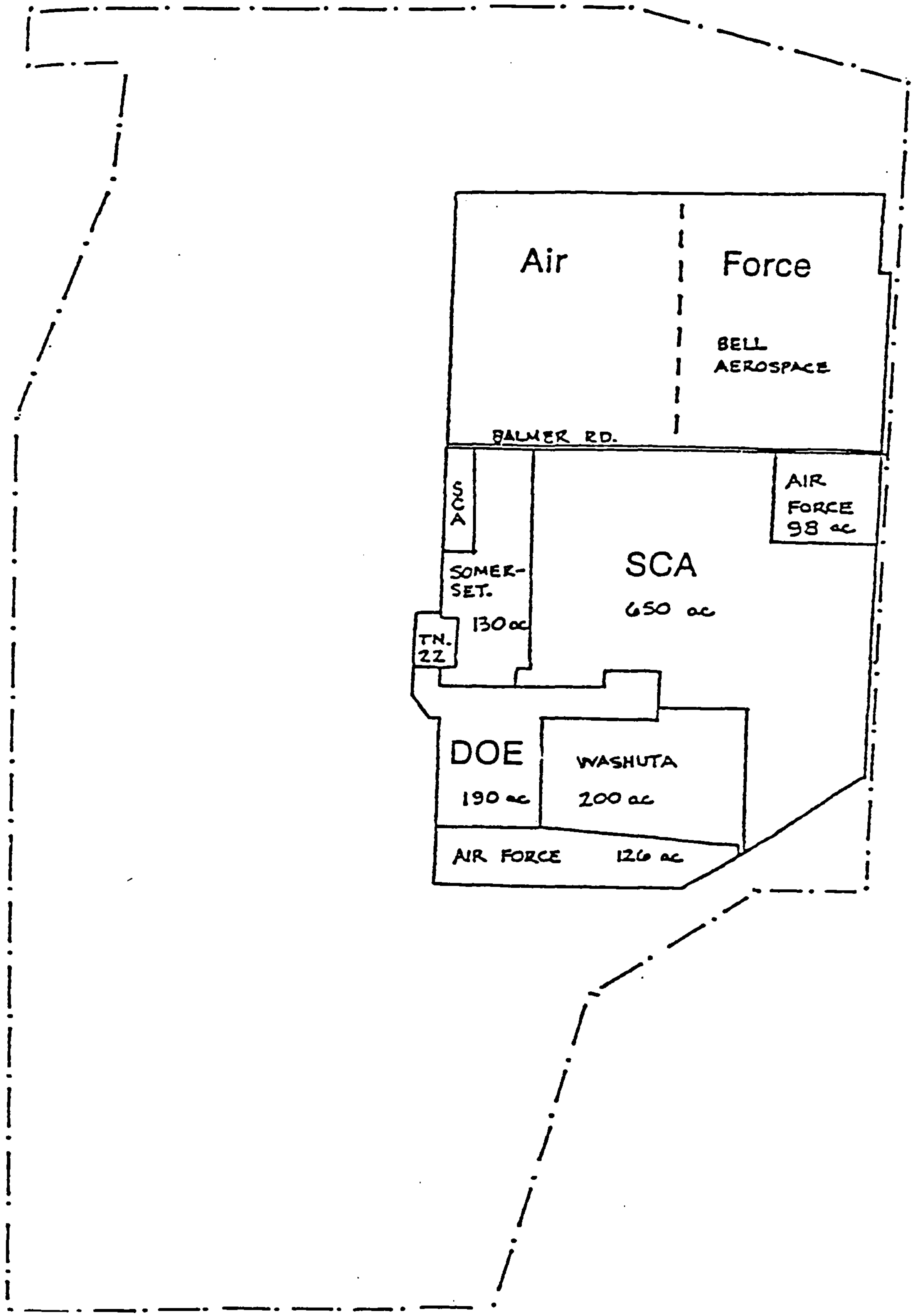
ACRES

On October 20, 1947, the 990 acre igloo storage area of the Northeast Chemical Warfare Depot was transferred to the War Assets Administration (WAA). On November 3, 1947, 850 acres of this parcel were transferred to the Air Force for the construction of Air Force Plant 38. An additional 13 acres were withdrawn from the WAA in 1952 for addition to Air Force Plant 38.

In April 1955, nine acres of Air Force Plant 38 were transferred to the Army. An additional 332 acres of Air Force Plant 38 were transferred to the Army on January 31, 1979. The Army National Guard presently utilizes this site for maneuvers, equipment and munitions storage, and detonation of out-of-date munitions. Until recently, Bell Aerospace, under contract with the Air Force, used the remaining portion of Air Force Plant 38 for rocket propellant and laser operations (Figure 3-3).

On October 30, 1945, the LOOW buffer zone, consisting of 5067 acres, was transferred to the Farm Mortgage Corporation. This parcel was subsequently sold to many private owners from 1945 to 1950. In 1951, 13 acres were reassumed by the COE and transferred to the Air Force on November 3, 1954.

In February 1944, the Manhattan Engineering District (MED), the Army unit responsible for the Manhattan Project, acquired approximately 30 acres in the Baker-Smith area of the former TNT plant (Figure 3-1). This property was used for the storage of low grade radioactive residues from the Linde Air Products facility in Tonawanda, New York (Aerospace, 1982). The radioactive residues resulted from the processing of pitchblende ore. The ore was obtained by the federal government through contracts with African Metals Corporation (Afrimet). Afrimet was a subsidiary of Union Miniere du Haut Kantanga of Brussels, Belgium. The procurement contracts with Afrimet were for the uranium concentrations in the ore only. All other minerals remaining in the residues were to be shipped to Belgium when conditions permitted. This residue was therefore stored at the MED site for later shipment to Europe. In 1983, the agreement between the DOE and Afrimet expired. As a result of further negotiations, Afrimet agreed to pay the DOE $8 million and the DOE took title to the residues (DOE, 1986).



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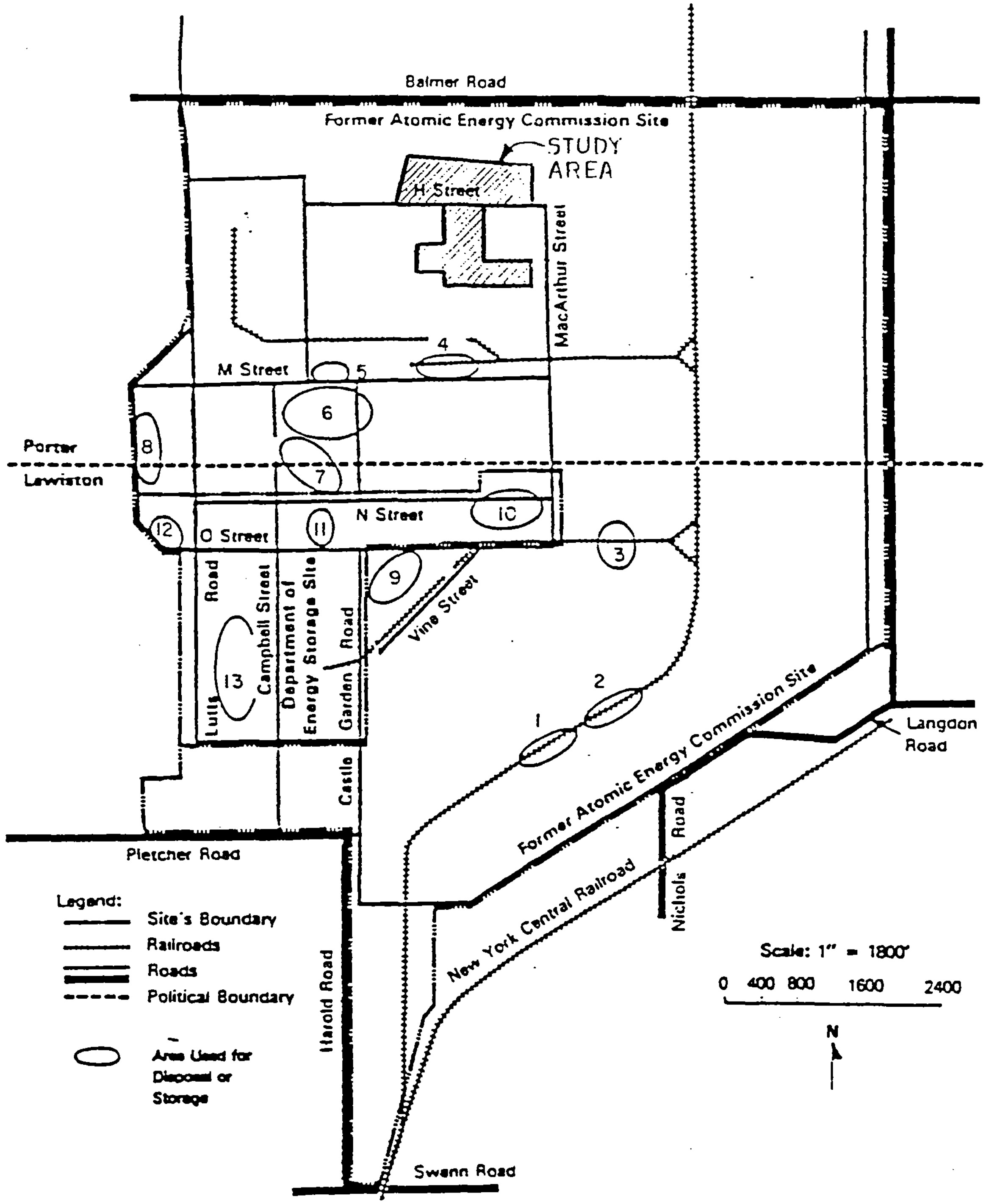
FORMER LOOW 1972

(FROM NYS ASSEMBLY, 1981)

FIGURE 3-3

ACRES



LEGEND

1 SCRAP METAL DISPOSAL AREA
2 SCRAP METAL DISPOSAL AREA
3 SCRAP METAL DISPOSAL AREA, RADIOACTIVITY UP TO 6 MILLIROENTGENS PER HOUR (PRIOR TO CLEANUP)
4 BURIAL GROUND NORTH OF "M" STREET AND FIRST STORAGE AREA OF KNOLLS ATOMIC POWER LABORATORY
5 RUBBISH AREA NORTH OF "M" STREET
6 CASTLE GARDEN DUMP
7 ROCHESTER BURIAL AREA
8 SEWAGE TREATMENT AREA NEAR WESTERN AEC BOUNDARY
9 TITANIM-RESIDUE BURIAL AREA
10 HIGH GRADE PITCH BLEND RESIDUE (K-65) STORAGE AREA
11 DUMP OF SCRAP AND WASTE FROM NAVY-MATHIESON AREA
12 SECOND STORAGE AREA FOR KNOLLS ATOMIC POWER LABORATORY WASTE
13 SECOND STORAGE AREA FOR KNOLLS ATOMIC POWER LABORATORY WASTE. ORES OWNED BY AFRIMET (L-30 AND L-50) AND THOSE OWNED BY THE FEDERAL GOVERNMENT (R-10)

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PREVIOUS STORAGE LOCATIONS
AT THE FORMER AEC SITE

(NYS ASSEMBLY, 1981)

FIGURE 3-4

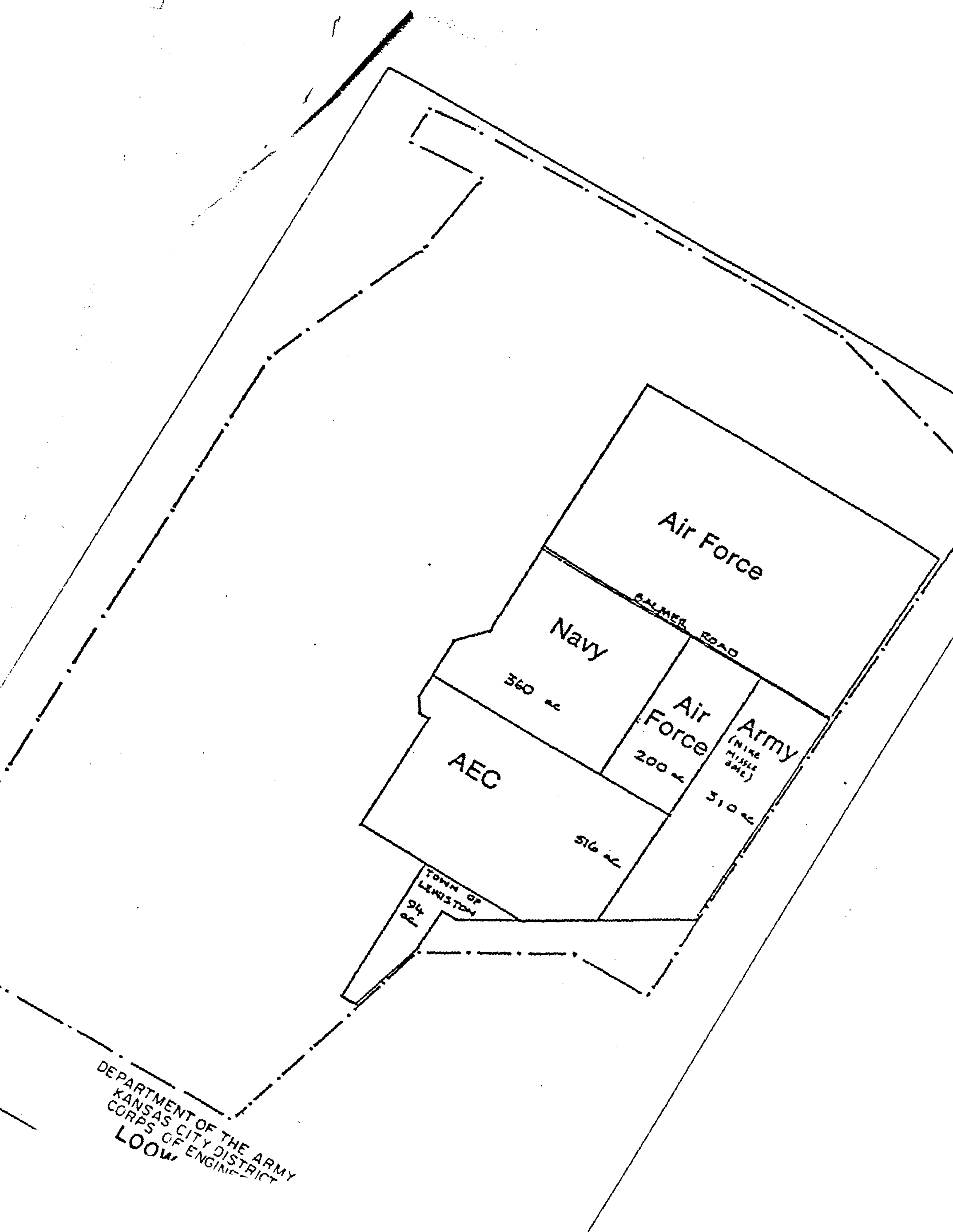
ACRES

In 1953-1954, the AEC contracted Hooker Electrochemical to build and operate a boron isotope separation plant at the LOOW. Hooker worked in conjunction with the architect-engineer for the project (Singmaster-Breyer) to modify the on-site steam plant (Power Area, Figure 3-1). The boron separation plant separated the isotope boron 10 which was used as a neutron absorber in fission reactors. The plant began operation in 1954 under the administration of Hooker Electrochemical and operated until 1958, when the facility was put on stand-by status. The plant was reactivated in 1964 under the supervision of Nuclear Materials and Equipment Corporation of Apollo, PA and operated until 1971 when the operation was again put on stand-by (NYS Assembly, 1981). The boron separation operation was accomplished by the dimethyl (association-dissociation) process. No hazardous materials were associated with the project and no radioactive materials were used in the operation. No information was available on the final fate of the boron plant.

On April 25, 1955, approximately 310 acres in the eastern portion of the LOOW were transferred to the Army for the construction of a Nike ground-to-air missile base (Figure 3-5). An additional 89 acres were acquired for the base on March 18, 1957. The completed Nike Battery, NF-03, consisted of 36 anti-aircraft missiles. From April 1955 until Nike-Ajax rocket sites in the area were decommissioned, the LOOW igloo area was used as a consolidation point for liquid fuel components for Nike-Ajax rockets. This fuel was then shipped from the igloo area to outside destinations, primarily Edgewood Arsenel in Maryland.

The 89 acre parcel of Nike Battery was declared excess by the Army on May 2, 1960 and sold by the GSA to the Town of Lewiston on May 4, 1961. The GSA reserved a seven acre railroad easement for the Air Force.

In 1955, the Navy acquired 360 acres and the Air Force 200 acres of the former TNT plant from the AEC (Figure 3-5). On November 1, 1956, the Air Force acquired an additional 5.3 acres which included the former water intake station on the Niagara River. On November 1,1957, the Air Force

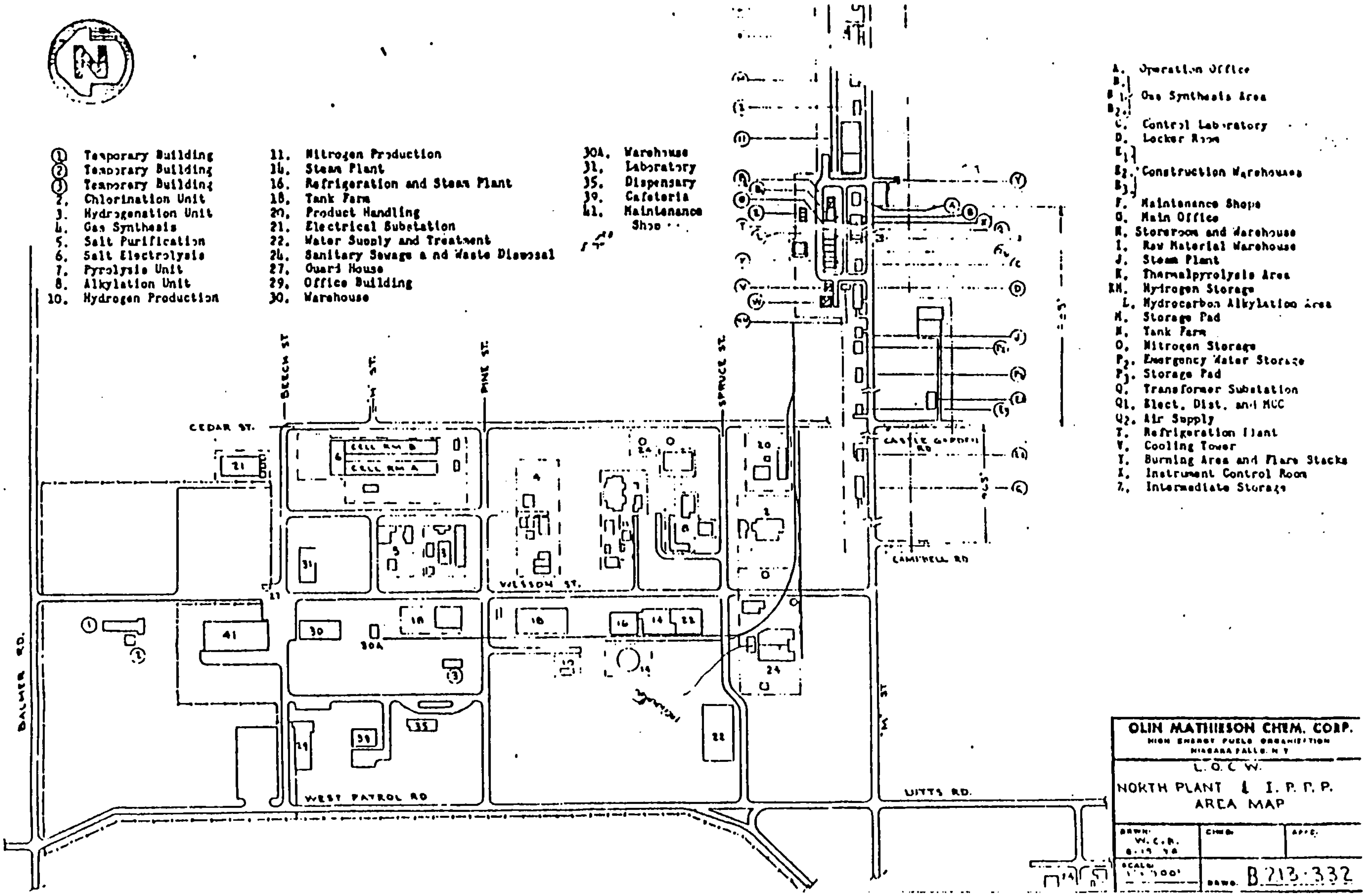

Air Force
BALMER ROAD
Navy
360 ac
Air Force
200 ac
Army
(NIKE MISSLE BASE)
310 ac
AEC
516 ac
TOWN OF LEWISTON
94 ac
DEPARTMENT OF THE ARMY
KANSAS CITY DISTRICT
CORPS OF ENGINEERS
LOOW

received a use permit from the AEC for an additional 22 acres. The acquisition of the properties by the Navy and the Air Force was for the joint development of a high energy fuels production project. The Air Force subsequently acquired the parcel of land owned by the Navy when the Air Force assumed responsibility for the joint project.

The Navy (Bureau of Aeronautics) funded $20 MM for an interim production pilot plant (IPPP) to produce 1600 lbs/day of high energy fuels. The Navy relinquished interest in the program to the Air Force which contracted Olin to continue and complete work initiated under the Navy contract (AF 33 (600) - 33920). Another plant was built for the Air Force to demonstrate a cheaper process (est. $5/lb vs. $18/lb by IPPP process). Contract AF 33 (600) - 33060, valued at $47 MM, covered the design, construction and equipping of the North Plant, a facility capable of producing 5 tons per day of high energy fuels, particularly HEF-2 (isopropyl pentaborane) and boron hydride intermediates (Figure 3-6).

The North Plant consisted of a number of basic processing areas, integrated to allow recycling of intermediates. Each of the processing areas was essentially a complete plant, with provision for raw material storage, production storage, control room, and small locker room. Each area was supplied with utilities necessary to support that area. After the plant was built and was in start-up activity, the Government canceled the contract.

The high energy fuels project plant was identified as Air Force Plant 68 (DEC, 1981). The plant included 79 structures and was operated by Olin-Mathieson Corporation under contract to the Air Force. The facility actually consisted of two separate plants: the Navy Plant [or Interim Production Pilot Plant (IPPP)], and the Air Force Plant (North Plant) (Figure 3-7). The IPPP was located where the laboratories of SCA are presently located. This plant produced sodium-boron based fuels (pentaborane and decaborane). The IPPP process used purchased sodium borohydride (Na BH_4) from Metal Hydrides in Danvers Massachusetts and boron trichloride (BCl_3) from Stouffer in Niagara Falls. to produce diborane (B_2H_6). The basic chemistry of this production process was as follows:



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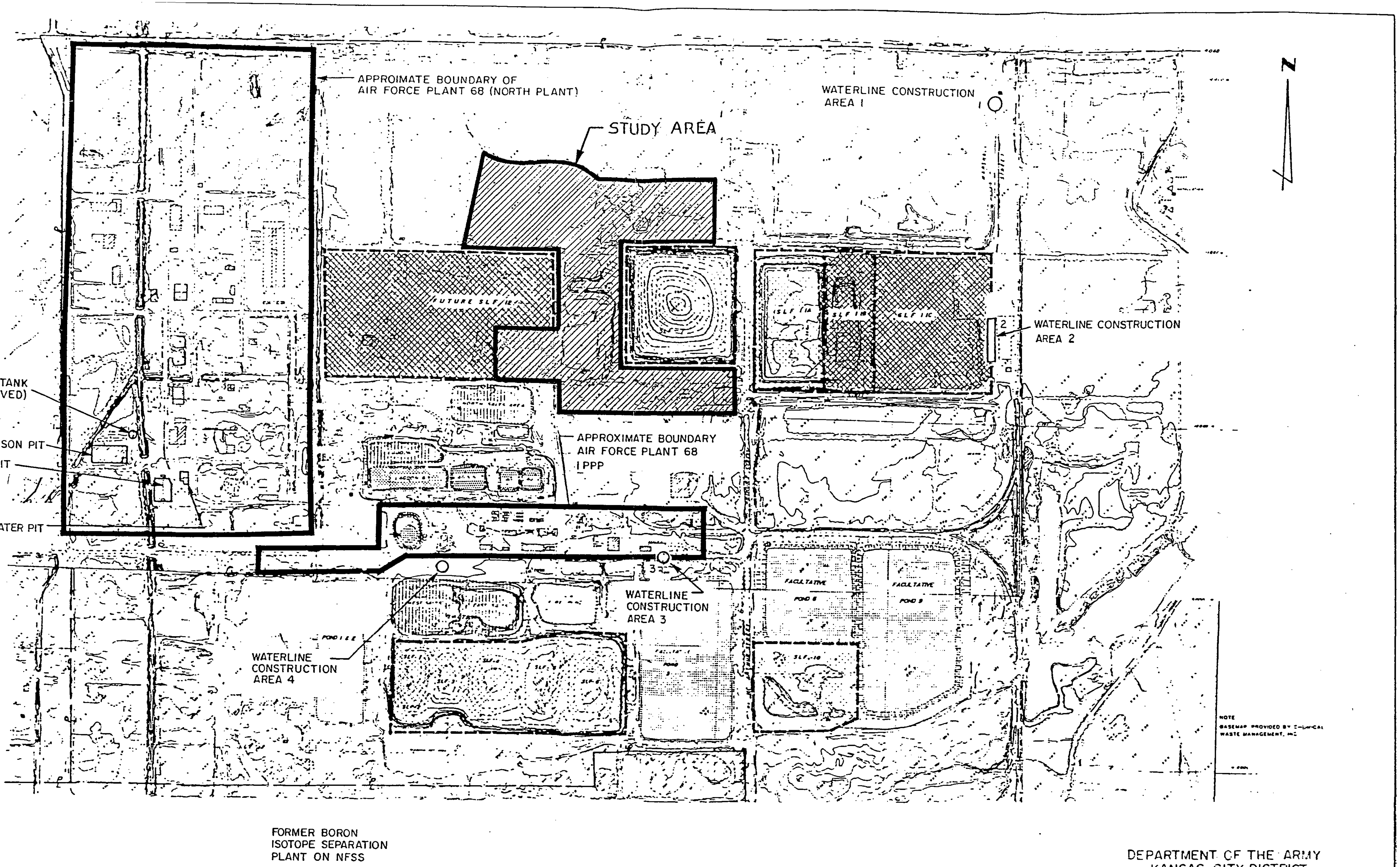
NORTH PLANT AND IPPP AREA MAP

FIGURE 3.6



DEPARTMENT OF THE ARMY
KANSAS CITY DISTRICT
CORPS OF ENGINEERS

AREAS OF PAST GOVERNMENT ACTIVITIES

ACRES

(FROM GOLDER 1987)

$$3NaBH_4 + BCl_3 \xrightarrow[\text{slurry}]{\text{toluene}} 2B_2H_6 + 3NaCl$$

The waste salt was filtered off and wasted to the sewer. The diborane was thermally decomposed to pentaborane (B_5H_9) and decaborane ($B_{10}H_{14}$).

$$\underset{\text{(gas)}}{B_2H_6} \xrightarrow{\text{pyrolysis}} \underset{\text{(liquid)}}{B_5H9} \text{ Pentaborane}$$

$$\underset{\text{(gas)}}{B_2H_6} \xrightarrow{\text{pyrolysis}} \underset{\text{(solid)}}{B_{10}H_{14}} \text{ Decaborane}$$

The North Plant was located in the area presently occupied by the CWM Administration offices and the parcel of land currently owned by Somerset Group. The North Plant had a production process similar to the IPPP. The North Plant, however, utilized lithium in the process as compared to the IPPP process which used sodium. The North Plant produced diborane by reacting boron trichloride with lithium borohydride. Boron trichloride was produced by a reaction of purchased boric acid and petroleum coke with chlorine in a fluidized bed. Lithium borohydride was produced from lithium hydride and recycled diborane. The basic chemistry of this process was as follows:

$$\text{Boric Acid} + \text{petroleum coke} + Cl_2 \longrightarrow BCl_3$$

$$3B_2H_6 + 6LiH \longrightarrow 6LiBH_4$$

$$6LiBH_4 + 2BCl_3 \longrightarrow 4B_2H_6 + 6LiCl$$

The lithium chloride byproduct was purified and sent to an electrolysis process which recovered lithium metal and chlorine. The chlorine was used to make boron trichloride and the lithium metal went to a hydrogenation process to form lithium hydride. The synthesis of diborane and the subsequent pyrolysis and alkylation steps to produce HEF-2 and HEF-3 (ethyl decaborane) were never run in Air Force Plant 68 with process chemicals. Ethyl chloride, ether and methanol were also used in the production process (DEC, 1981).

Air Force Plant 68 was decommissioned by the Air Force in 1959 while the plant was still in pilot plant status. Olin then held a 1-year maintenance contract for the plant. Other contractors, listed in Table 3-1, followed Olin in maintenance and subsequently in demolition and disposal at Air Force Plant 68.

The 5.3 acre water intake property for Air Force Plant 68 was declared excess on July 31, 1962 and was deeded to the Town of Lewiston on February 20, 1967. The permit for use of the AEC properties was returned to the AEC on September 17, 1962 and the use permit for an easement through the Army property was returned to the Army on October 25, 1962.

In 1965, approximately 575 acres containing the former TNT manufacturing plant and 275 acres of the former Nike missile base were advertised for bid by GSA. On July 28, 1966, these properties were sold to the Fort Conti Corporation.

On September 16, 1966, approximately 99 acres of the former missile base were transferred to the Air Force for the construction of the Youngstown Test Annex, a defense communications system (Figure 3-3). The Fort Conti Corporation acquired approximately 64 acres of this parcel on July 28, 1967. The remaining 35 acres of this parcel remains in the possession of the Air Force and functions as a radar station.

On September 18, 1961, 126 acres of land in the southern portion of the LOOW were transferred to the Air Force. This property was used for the construction of an additional defense communications system referred to as the Ransomville Test Annex. This parcel was declared excess on July 26, 1967. In 1976, 125 acres of this parcel were transferred to the Department of Labor (Figure 2-3). The remaining 0.43 acres of this parcel were transferred to Monroe Frank.

On March 17, 1967, 204 acres in fee and seven acres in easements were declared excess. The easements were transferred to the Air Force on July 2, 1968. The Niagara Mohawk Power Corporation purchased 5.4 acres on

TABLE 3-1

FORMER CONTRACTORS AT AIR FORCE PLANT 68

Olin Mathieson Chemical Corp. Niagara Falls, New York	- Design, construct, equip and operate Air Force Plant 68.
Page Airways Rochester, New York	- Low bidder for cleanup and maintenance for two-year period.
JA&S Pittsburgh, Pennsylvania	- Low bidder for second two-year period.
North Vernon Contractors	
Paul Tane's Contractor, Philadelphia, Pennsylvania	
Locker Equipment Canada	- Bought all metal, set up area as a junk yard and sold metal.
Lockey Brothers, Waterloo, Ontario, Canada	- Owned locker equipment.

October 9, 1968. A 5.1 acre railroad easement and a 1.2 acre water line easement through the former Ransomville Test Annex were retained by the Air Force. The 200 acre tract of land acquired by Monroe Frank was later sold to Modern Landfill, Inc. (S. Washuta) for the development of a sanitary landfill (Figure 2-3).

On November 10, 1972, the AEC submitted a report of excess to the GSA for the 22 acre area within the LOOW which contained the sewage treatment facility, and the 23 acre easement for the sewage outfall running to the Niagara River. The report indicated the presence of low-level radiation contamination in certain areas of the facility. The contamination was a result of the MED radioactive residue and waste storage activities. The sewage treatment plant was subsequently decontaminated to a level acceptable to AEC guidelines for unrestricted use. The plant was later transferred to the Town of Lewiston on February 25, 1975.

In 1969, Chem-Trol Pollution Services, Inc. purchased approximately 280 acres of the LOOW site for the development of a hazardous and industrial waste treatment, storage, and disposal facility. Initially, Chem-Trol conducted two major operations at the site: incineration and aqueous waste treatment. The incineration operation was used to dispose of unreclaimable solvents. As part of the aqueous waste treatment, some aqueous wastes were stored in lagoons and the liquid portions of the wastes were mixed with lime in a patented neutralizer.

In 1973, Chem-Trol was acquired by SCA. In 1976, additional properties were acquired by SCA resulting in the present 706 acre facility. Chemical Waste Management (CWM) acquired the facility in September 1984 as part of an acquisition of SCA by Waste Management, Inc., the parent company of CWM.

Current operations conducted by CWM include chemical and biological treatment facilities, transfer stations, fuels and recoverables blending, drum management, PCB treatment, and transformer decommissioning. CWM is attempting to minimize use of the metal hydroxide (salts) ponds; however, the East/West Salts Pond is still in operation. The facility presently contains eight closed secure landfills (SLF-1 through SLF-7 and SLF-10) and one active secure landfill (SLF-11). CWM has completed design and is currently in the permitting process of an additional secure landfill SLF-12). SLF-12 is proposed for use beginning in early 1989 (Golder, 1987a).

The present ownership of the 1511 acre LOOW site is shown in Figure 2-3. The past ownership of the LOOW site is summarized in Table 3-2.

TABLE 3-2

SUMMARY OF LOOW OWNERSHIP

DATE	OWNER
1942 - 1943	Army - TNT Manufacturing Plant
1944 - 1946	Army - Northeast Chemical Warfare Depot
1944 - Present	DOE (Formerly MED and AEC) - Radioactive Waste Storage
1947 - Present	Air Force - Air Force Plant 38
1955 - Present	Army National Guard
1955 - 1960	Army - Nike Missle Battery
1955 - 1957 (?)	Navy - Interim Production Pilot Plant
1956 - 1959	Air Force - Air Force Plant 68
1961 - 1967	Air Force - Ransomville Test Annex
1962 - Present	Lewiston - Water Intake Easement
1966 - Present	Air Force - Radar Station (formerly Youngstown Test Annex)
1968 - Present	Niagara Mohawk - Power Easement
1969 - Present	Modern Landfill - Sanitary Landfill
1969 - Present	CWM (formerly Chem-Trol and SCA Chemical Services) Hazardous Waste Treatment, Storage and Disposal
1975 - Present	Lewiston - Closed Wastewater Treatment Facility
1976 - Present	Department of Labor

4 - PREVIOUS SITE INVESTIGATIONS

Based upon the review of the information available to date, past activities of the federal government and the government contractors may have contaminated various portions of the LOOW site. This contamination may have occurred from:

- TNT and acid residues;
- Radioactive residues and wastes;
- High energy fuels production related wastes;
- Structures related to the Nike Missile Base;
- The storage or burial of chemical warfare compounds; and
- Wastewater treatment facilities.

Table 4-1 presents a chronological list of past investigations at the LOOW with a brief scope of work for each study. The information available on the associated potential concerns is summarized in the following subsections. Only those activities related to the use of the LOOW site by the federal government are discussed.

4.1 - Previous Investigations - Areas of Known Contamination

4.1.1 - TNT Manufacturing Plant

Following the decommissioning of the TNT manufacturing plant in 1943, the Army conducted a limited decontamination of the LOOW site. As part of the effort, the Army contracted an outside consultant, Industrial Research Corporation (IRC), to conduct an inventory and survey of the site. The purpose of this effort was to determine the extent of remaining contamination and to recommend methods for further decontamination of the site. The IRC produced a report for the Army later in 1948 which indicated the deficiency of the Army's decontamination program in three principal respects (NYS Assembly, 1981):

TABLE 4-1

PAST SITE INVESTIGATIONS AT LOOW

DATE	FIRM/DEPARTMENT	SCOPE OF WORK
1948	Industrial Research Corp.	Inventory and survey of TNT plant and assess contamination
1970	Atomic Energy Commission	Radiological Survey of LOOW
1972	Atomic Energy Commission (EG&G, Inc.)	Radiological decontamination of 6.5 acres as a result of 1970 survey
1978, 1982	SCA	Excavate, sample, and plug TNT and acid waste lines
1979	Department of Energy (Battelle Columbus Laboratories)	Radiological suvey of LOOW
1981	SCA - Olin Corporation	Trench excavation to locate 200 drum disposal area. Partial remediation of Olin Burn area
1982-Present	Deparatment of Energy (Bechtel National, Inc.)	Radiological decontamination of LOOW
1985	Army Corps of Engineers (Ecology and Environment, (Inc.)	Geophysical survey and soil sampling in areas A, B, C, and D
1986-1987	Department of Energy (Bechtel National, Inc.)	Sampling and disposal of drums found in Area G
1987	Storch Engineers	Sampling and removal of an underground fuel tank in the area near the Nike stand by generator plant.
1974-Present	SCA (and formerly ChemTrol)	Numerous groundwater investigations for site groundwater monitoring requirements
1986	SCA	Removal of contaminated soil found during waterline installations

- The ground surface area and drainage ditches were contaminated with TNT and TNT residues;

- Buildings and equipment at the site had been improperly decontaminated; and

- The underground waste and sewer lines at the plant were contaminated with TNT and TNT residues.

During the operation of the TNT plant, the Army allegedly discharged the red liquors through the underground pipe system into an open ditch which ran along H Street. The open ditch discharged into Fourmile Creek and ultimately to Lake Ontario. The purpose of discharging the red liquors into the ditch was to dilute the red liquors with stream waters in an attempt to "reduce the color and to eliminate the toxic effects". These red liquors were highly acidic and toxic and contained particles of TNT.

The IRC report stated that the method of decontamination used at the site may have only removed the contamination from the surfaces of equipment, buildings and the ground surface. The work may have moved the contamination "from plain view into hidden crevices" (NYS Assembly, 1981). In an attempt to decontaminate the buried acid and TNT waste lines, the Army flushed the waste lines with a caustic solution. This flushing may have stabilized, rather than neutralize the TNT (NYS Assembly, 1981). The potential for residual contamination remained.

The IRC cautioned about the removal of the buried pipelines. The IRC stated that the lines could be coated with:

- Wastes from TNT neutralization;
- TNT waste treated with sodium sulphide;
- Waste from sodium carbonate purification from washing and melting TNT; and
- TNT.

The IRC noted that the wastes in the buried pipelines could form a very stable and powerful explosive material, tetranitromethane.

In addition to describing the known contamination at the LOOW site, the IRC identified seven possible hazards:

- Danger of detonation by impact of surface TNT or isomers;
- Danger of fire from cigarettes, matches, or sparks;
- Danger of inexperienced persons or youths picking up an accumulated quantity of explosive;
- Danger of detonation when digging wells, post holes, or foundations or possibly when plowing;
- Danger of fire or explosion resulting from spontaneous combustion;
- Danger of detonation when dismantling buildings; and
- Possibility of detonation of materials shipped from the plant.

The Army discontinued further decontamination of the site. The Army stated that (NYS Assembly, 1981):

> "a decontamination program was initiated but was not completed as it was determined that it would be to the advantage of the Government to defer this program until the property is disposed of. It is reasoned that in the event the manufacturing area is disposed of to a concern manufacturing chemicals, decontamination would not be required".

A final decontamination of the TNT facility was never completed.

The only known investigations of the buried TNT, acid, sewer and water pipeline system conducted since the 1948 IRC investigation were performed by SCA in 1978 and 1982. These investigations by SCA were conducted because of concerns of both the public and SCA about the potential migration of chemical waters from SCA lagoons off the SCA property through the underground pipeline system and the explosion potential of the pipeline contents.

In an attempt to preclude any migration of wastes through the underground system, SCA removed and/or plugged several of the waste, sewer, and water pipelines. SCA located these lines using an old LOOW plot plan. The locations of the plugged or removed lines were plotted on a more recent drawing (Wehran Drawing No. 7 of 7, Project No. 01361186). During the removal and plugging activities, there were no incidents of explosions or fires due to residual TNT contamination.

An additional investigation of the underground pipeline system was conducted on October 2, 1982. This investigation was conducted because of public concern about the potential explosive nature of the TNT residues. As part of this investigation, SCA excavated TNT lines at six locations. At each location, a sample of TNT residue was collected from the inside of removed pipe. The TNT residue samples were analyzed by the Hazards Research Corporation of New Jersey.

A report was produced by Hazards Research Corporation on January 21, 1983 (Hazards Research, 1983). The report indicated that the TNT residues within the pipes sampled were composed of a maximum of 35 percent by weight of TNT. The report also indicated that the residues in the pipes sampled were essentially non-detonable when wet. The drier residues were found to be slightly impact sensitive, but would not be expected to propagate a detonation. The report cautioned that while the material was evaluated under existing conditions encountered in the pipelines (i.e. unconfined and maximum 35 percent by weight of TNT), the possibility exists for the presence of higher concentrations of residues within the pipelines.

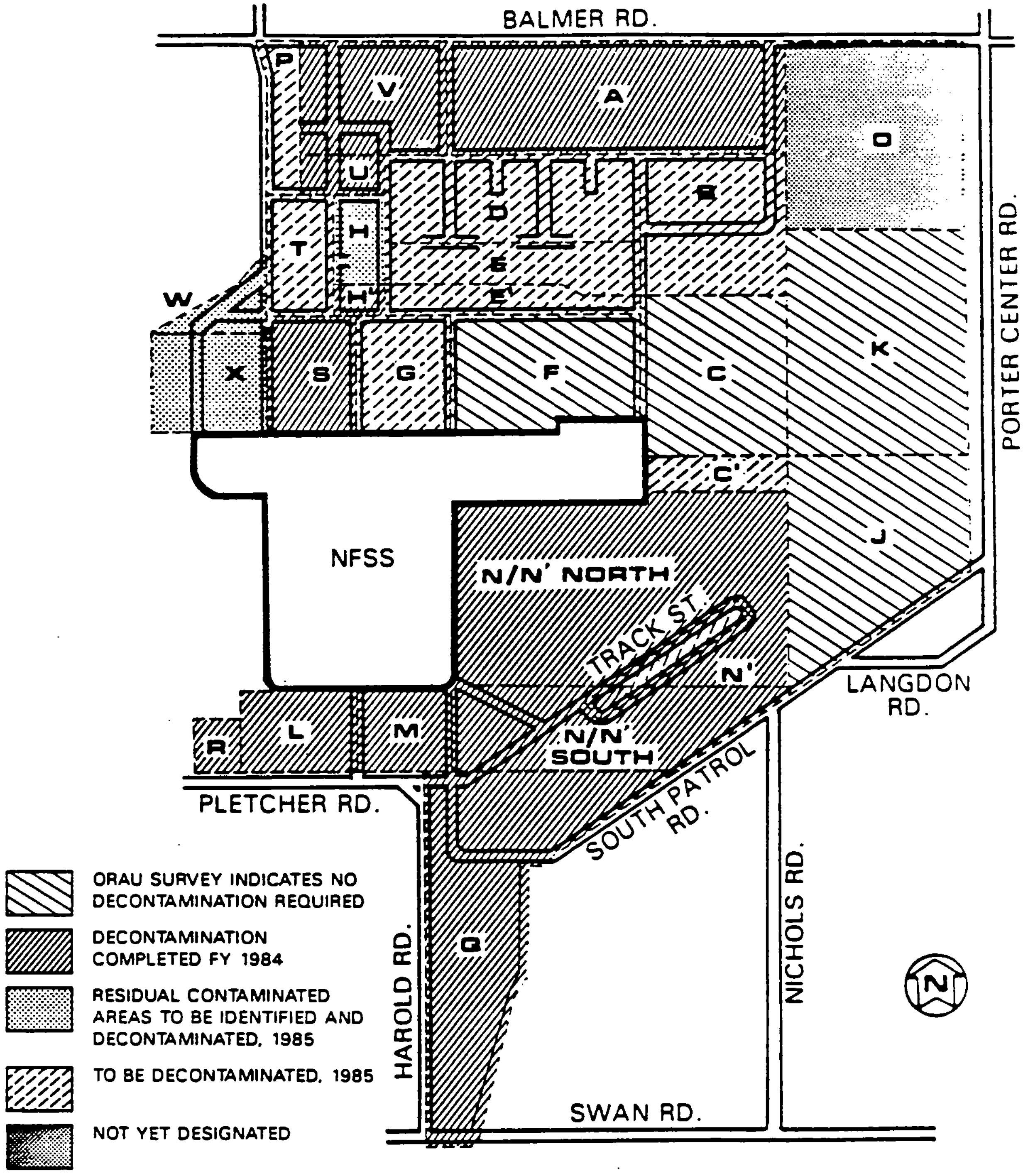
In summary, the underground TNT, acid, sewer and water pipeline system was never completely decontaminated or removed. Numerous sections of the underground system were plugged and these locations were identified on a map by SCA. Analyses of the contents of the TNT pipes indicate that while the contents encountered were not in concentrations which were detonable, there may exist more concentrated pockets of TNT.

4.1.2 - Radioactive Contamination

In the late 1940s, knowledgeable of the TNT related contamination at the LOOW site, the WAA declared that the LOOW site would only be sold to an interest that was qualified to properly decontaminate the site (NYS Assembly, 1981). After numerous attempts to sell the 1511 acre site, the site was finally transferred to the AEC. The AEC requested the site because of the need of additional storage space for radioactive residues and contaminated materials. The need for the site was further justified by the level of contamination on the 30 acre parcel; the AEC felt the site was so contaminated that practical and economical methods to decontaminate and restore the buildings to the original condition did not exist. The AEC also indicated that sporatic occurrences of slight contamination existed throughout the entire 2326 acre portion of the LOOW owned by the WAA.

In October 1970, radiation surveys of the LOOW site by the AEC indicated that some areas had radiation readings that exceeded AEC guidelines. Additional surveys determined that 6.5 acres of the 1298 acres formerly held by the AEC exceeded the AEC standard of 50 uR/hr (DOE,1979). Decontamination of the 6.5 acres was conducted in May, 1972 by the AEC. As a result of the decontamination, a total of 15,000 to 20,000 cubic yards of contaminated soil and debris was placed on a one acre spoil pile within the NFSS. Since 1972, additional limited surveys were conducted at the LOOW site.

In 1981, the DOE contracted Bechtel National, Inc. as the Project Management Contractor for additional site remediation activities. Bechtel initiated an extensive decontamination of the entire industrial area of the LOOW in 1982 (Figure 4-1). The ongoing decontamination activities are being conducted in the 191 acre NFSS. These activities include the placement of all radioactively contaminated wastes into an 8.5 acre interim radioactive waste containment



NOTE: ALL VICINITY PROPERTIES
REMEDIATED AS OF 1/89.

DEPARTMENT OF THE ARMY
KANSAS CITY DISTRICT
CORPS OF ENGINEERS

**STATUS OF NFSS VICINITY PROPERTIES
AT END OF 1984**

(CAMPBELL & COXON, 1985)

FIGURE 4-1

ACRES

facility. Once completed, the containment facility will contain more than 250,000 cubic yards of contaminated material (Campbell and Coxon, 1985).

As part of the decontamination activities, an environmental monitoring program was designed for the NFSS. This program measures:

- Radon gas concentrations in air;
- Radium and uranium concentrations in surface water and groundwater; and
- External gamma radiation.

To obtain these measurements, the NFSS maintains 34 monitoring stations located on the site and at the site boundaries.

As previously mentioned, the waste containment facility is an interim status facility. The final disposition of the containment facility will be decided by the DOE in accordance with the National Environmental Policy Act (NEPA) process. Argonne National Laboratory, the contractor responsible for ensuring NFSS project compliance with NEPA, prepared a draft Environmental Impact Statement (EIS) in August 1984 and a final EIS in April 1986. The preferred alternative chosen by the DOE was for the long-term management at NFSS with modified containment. This alternative will require the removal of the interim cap and construction of a long-term cap.

4.1.3 - Air Force Plant 68

During the operating life of Air Force Plant 68, certain off-specification compounds and other combustible wastes were disposed of on the AEC property. In addition, during the decommissioning of the plant, quantities of hazardous compounds including lithium chloride, kerosene, methanol, and potassium chloride were drummed and buried on the AEC property by Olin or by other government subcontractors (see Table 3.2).

On May 1, 1981, the DEC conducted an inspection of the former Air Force Plant 68 in an attempt to identify areas of disposal. In attendance at the inspection were personnel from SCA and Olin Corporation. During the inspection, Olin personnel identified five possible areas of contamination. Three were areas at the former Interim Production Pilot Plant (IPPP) and two were at the former North Plant.

The three areas of potential contamination of the IPPP consisted of a burning pit, a pond and the plant incinerator. The burning pit was used for the open incineration of sodium borohydride. The pond, with dimensions of 20 x 25 x 3.5 feet, was used to burn any liquid which would not be burned in the plant incinerator. The liquid was burned in the pond with the addition of kerosene.

The incinerator was located in the area of the northeast corner of the CWM east salts area. The pond has since been removed and the area is now occupied by the "fire pond". A tank farm has been constructed at the site of the burning pit.

The North Plant utilized a burning pit for the open incineration of lithium and sodium hydride, kerosene and some unstable gases produced when diborane was converted to either pentaborane or decaborane. The gases were contained in cylinders. The cylinders were brought to the Olin Burn area (Area B, Figure 2-4), placed in the pit, perforated with bullets, and burned. It is believed that a water line was run to the Olin Burn area to be used to extinguish fires (DEC, 1980).

Olin personnel indicated that approximately 200 to 300 drums were placed in an east-west trending trench, 12 to 15 feet deep, located west of SLF-7. The drums were placed in the trench in rows one drum high and approximately six drums wide, for the entire length of the trench. The drums contained waste materials generated during decommissioning of the Air Force Plant. The following materials and amounts were believed to be contained in the buried drums:

- 13 tons of lithium chloride;
- Unknown quantities of lithium metal and hydroxide;
- 14.6 tons of potassium chloride;
- 8 tons of lithium chloride contaminated with kerosene;
- 20,000 gallons of salt contaminated with methanol;
- 25 tons of salt contaminated with lithium chloride; and
- Unknown quantities of sludge from the sludge basin of the water treatment facility.

An additional drum burial area, apparently related to the operation and decommissioning of Air Force Plant 68, was discovered by SCA in 1981 in the area immediately north of SLF-7. Analyses of the drums indicated that the drums contained high concentrations of lithium and boron. A geophysical survey of the area indicated the possible presence of approximately 30 drums.

During a DEC interview with a former Olin employee involved in the decommissioning of Air Force Plant 68, the former employee indicated the presence of buried drums in the wooded area west of the Olin Burn area (DEC, 1980). The former employee also noted that there were two basements of abandoned buildings that were filled with unknown materials. The employee could not identify the locations of these areas.

As a result of the DEC inspection of Air Force Plant 68, the Olin Burn area and the 200 drum disposal trench were placed on the New York State Registry of Inactive Hazardous Waste Sites. The areas were assigned registry numbers of 932061A and 932061B, respectively. The registry for the Olin Burn pit also includes the burn pit located at the former south plant where a tank farm has been constructed. Each site has been assigned a Code 2 classification. A Code 2 classification identifies a site which poses a significant threat to public health or the environment and where further action is required.

SCA and Olin Investigation

As a result of the DEC inspection of Air Force Plant 68 in 1981, the DEC requested Olin to determine if there was a threat to the environment due to past Olin activities in the 200 drum disposal trench west of SLF-7. Olin was also requested to remediate the Olin Burn pit. Later in that year, Olin and SCA entered an agreement for the cleanup of the Olin Burn area and an investigation to determine the presence of buried drums west of SLF-7.

As part of the investigation and cleanup activities in the Olin Burn pit and buried drum area, several activities were conducted. Initial activities involved the collection and analyses of three surface soil samples taken from the Olin Burn area and three groundwater samples taken from monitoring wells B-21, B-32, and B-36 (see Figure 4-2). All samples were analyzed for lithium and boron.

Analytical results for groundwater samples indicated no contaminated conditions. Two of the soil samples were contaminated with lithium with one of these samples also having elevated concentrations of boron. The third soil sample did not have elevated concentration levels of either lithium or boron (Table 4-2).

Approximately 30 test holes and two trenches were excavated in the buried drum area (see Figure 4-3). No drums were found. Olin believed that the drums had been removed in the past. The entire drum area (dimensions unknown) was initially excavated to depths of 6 to 8 feet below ground surface (bgs). Test holes and trenches were then excavated an additional 8 to 10 feet for total depths of 14 to 18 feet bgs.

The Olin Burn pit was excavated to an approximate depth of 6 to 8 feet bgs. A total of 2088 tons of soil was removed from an area substantially larger than the original burn pit. The additional excavation occurred primarily to the north and east of the pit. Several burned and corroded drums and gas cylinders were also removed

TABLE 4-2

1981 ANALYTICAL RESULTS - OLIN BURN AREA*

SOIL

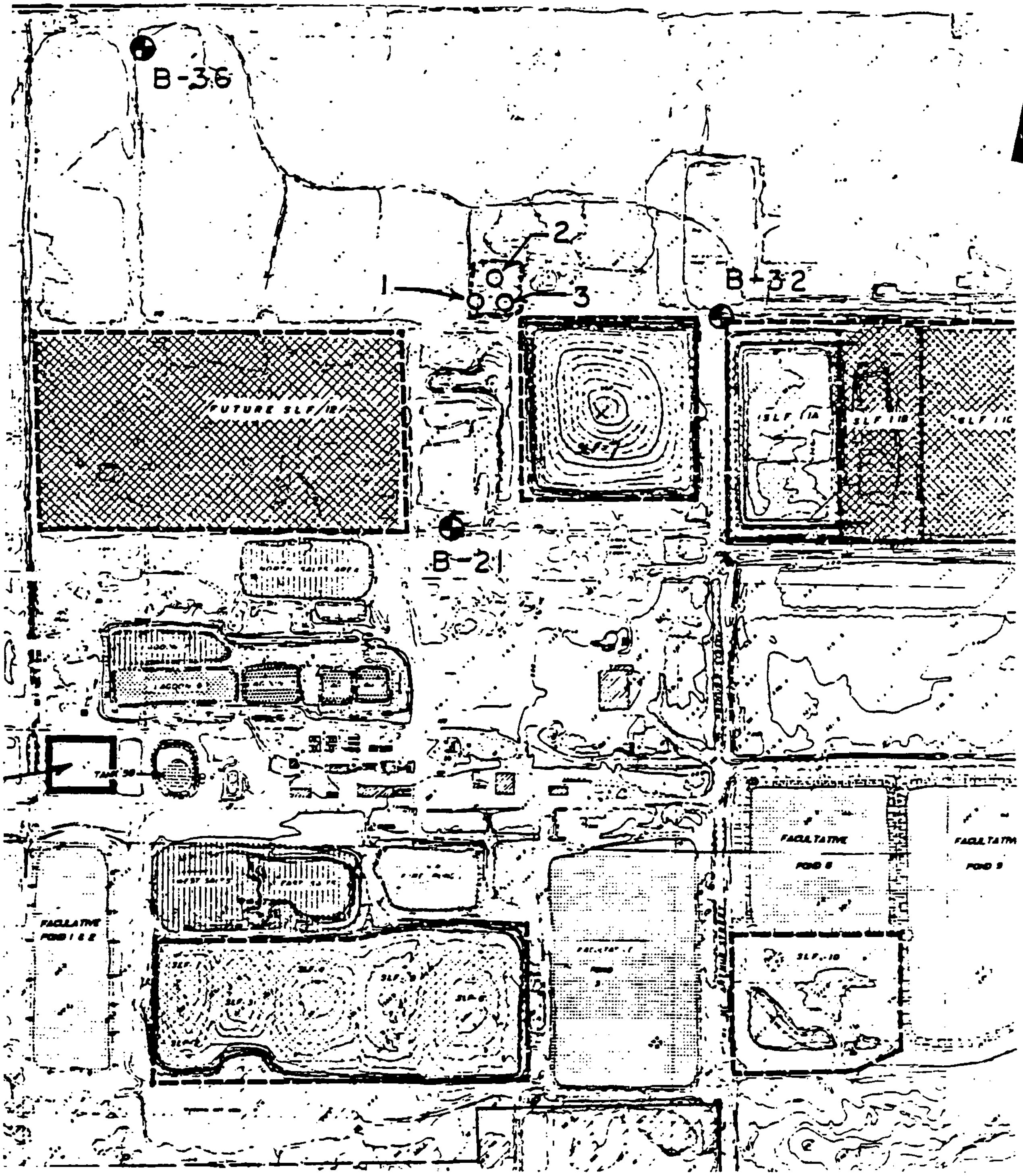
WATER EXTRACTABLE (mg/kg dry)

Sample Location	No.	Lithium	Boron
Undisturbed soil West 6-8" below surface	1	1,150.0	558.0
Undisturbed soil North 8-10" below surface	2	304.0	25.5
Disturbed soil East	3	8.2	20.6

GROUNDWATER (mg/l)

B-21		0.06	0.81
B-32		0.06	0.48
B-36		0.02	0.34

*Sampling and analyses conducted by SCA. See Figure 4-1 for approximate sample locations.



○ SOIL SAMPLING LOCATION

⊕ MONITORING WELL LOCATION

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OLIN BURN AREA
SOIL & GROUNDWATER SAMPLING LOCATIONS -1981

FIGURE 4-2

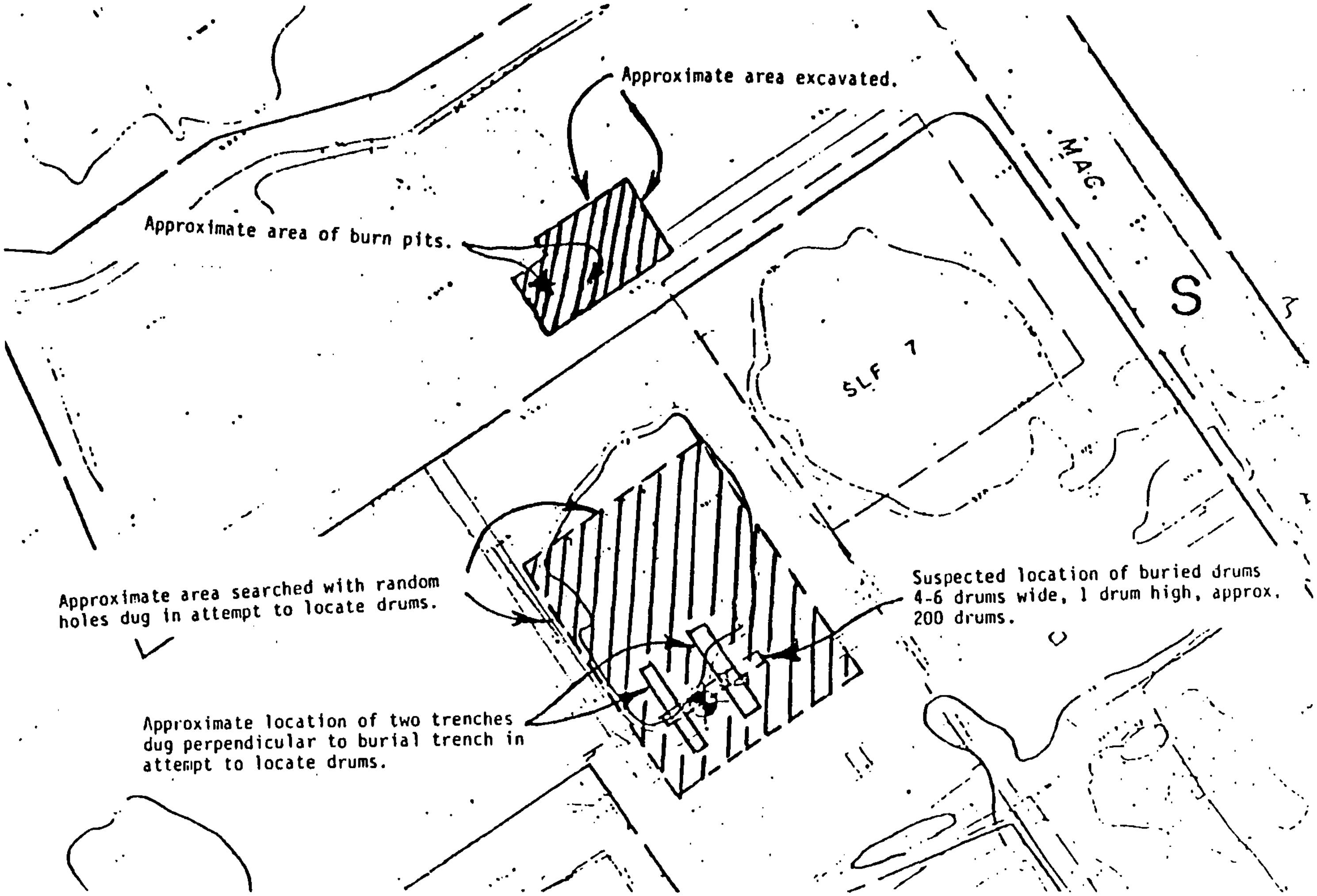


FIGURE 4-3

DEPARTMENT OF THE ARMY
KANSAS CITY DISTRICT
CORPS OF ENGINEERS

OLIN BURN AREA
TRENCH EXCAVATION LOCATIONS

(OLIN, 1981)

form the burn pit. All removed materials were placed in one of the SCA secure landfills. A berm was placed around the Olin Burn area. This area was never filled in up to grade.

COE Investigation

In 1985, the COE, Huntsville Division, contracted Ecology and Environment, Inc. (E & E) to conduct further investigations into the areas previously investigated by SCA and Olin in 1981. Because SCA and Olin did not find the 200 buried drums during the previous trenching activities, E&E was required to investigate alternate areas where the drums were suspected to have been buried.

During the cleanup of the Olin Burn area by SCA in 1981, SCA encountered six drums buried directly north of SLF-7. Analyses of two of these drums (Table 4-3) indicated that the drummed waste may have originated from the operation or decommissioning of Air Force Plant 68. Following the sampling and analyses, SCA reburied the drums and did not mark the site. E&E was also required to investigate this area in 1985.

The purpose of the E&E investigation was to expeditiously confirm the presence or absence of hazardous waste contamination in soil, surface water, and subsurface water in three areas which were associated with the operation or decommissioning of Air Force Plant 68.

As part of this investigative program, E&E conducted geophysical surveys and soil and water sampling (E&E, 1985). The geophysical survey was conducted in four areas identified as Areas A, B, C and D as shown on Figure 4-4. Two geophysical methods were used: electromagnetic induction and magnetometry. Only electromagnetic induction was used in Area B due to the large amounts of surface water and metal debris. In addition, the portion of Area C which was investigated was reduced due to the presence of surface water in the north portion west of SLF-7.

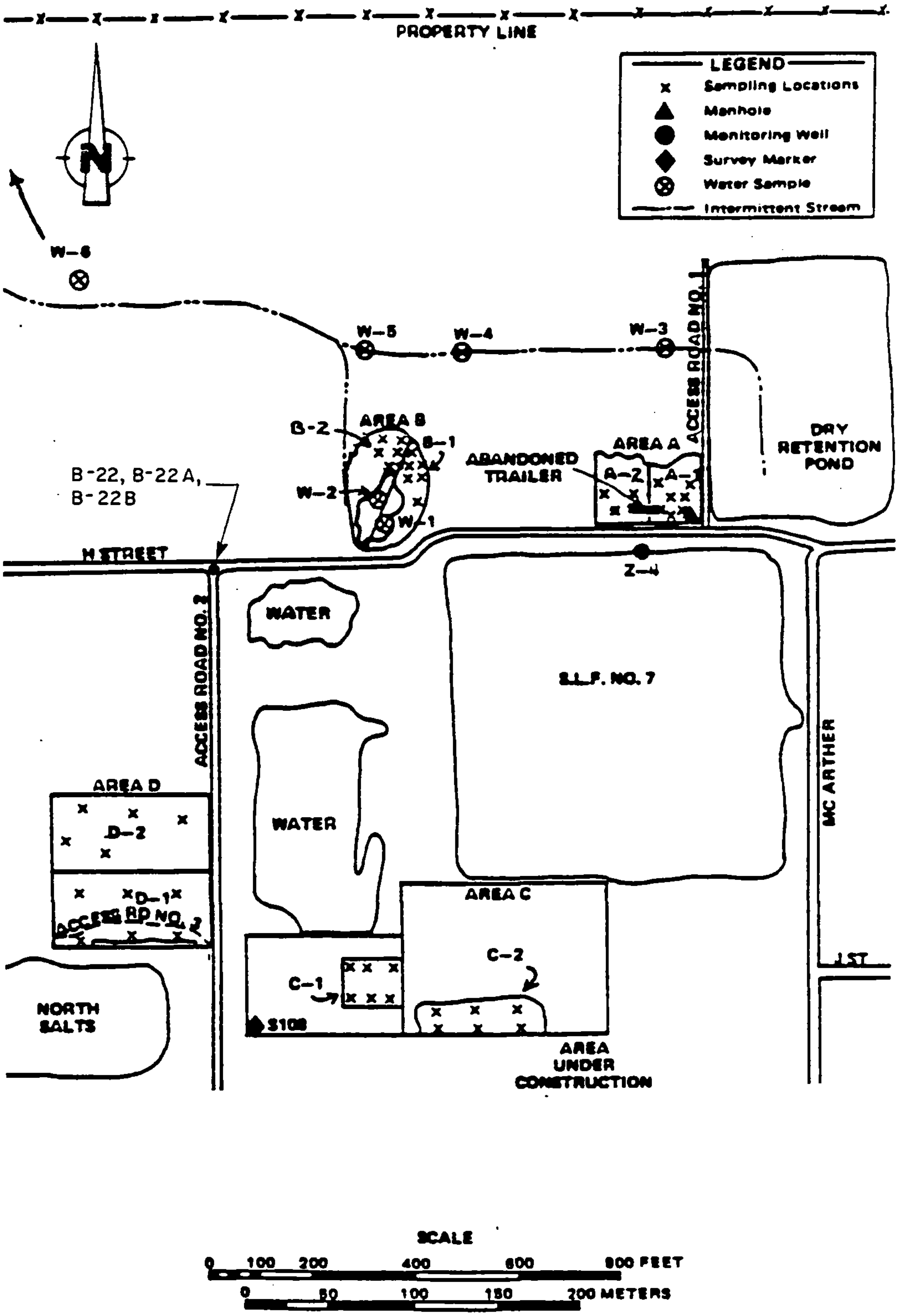
TABLE 4-3

ANALYTICAL RESULTS FOR DRUMS UNEARTHED NORTH OF SLF-7*

(November 23, 1981)

Parameter	Sample Number	
----	1	2
pH	7.58	7.93
Cond (umohs/cm)	749	2450
TOC (mg/l)	88.5	410
Li (mg/l)	10.5	134
B (mg/l)	79.0	84.0
Ni (mg/l)	<0.1	0.34
Co (mg/l)	0.15	<0.1
Fe (mg/l)	3.08	11.72
Mn (mg/l)	0.41	4.59
Cu (mg/l)	<0.06	<0.06
Cr (mg/l)	<0.2	<0.2
Cd (mg/l)	<0.03	<0.3
Zn (mg/l)	<0.05	0.14

*Sampling and analyses performed by SCA



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CORPS OF ENGINEERS

OLIN BURN AREA
SOIL AND WATER SAMPLING LOCATIONS

(ECOLOGY & ENVIRONMENT, 1985)

FIGURE 4-4

ACRES

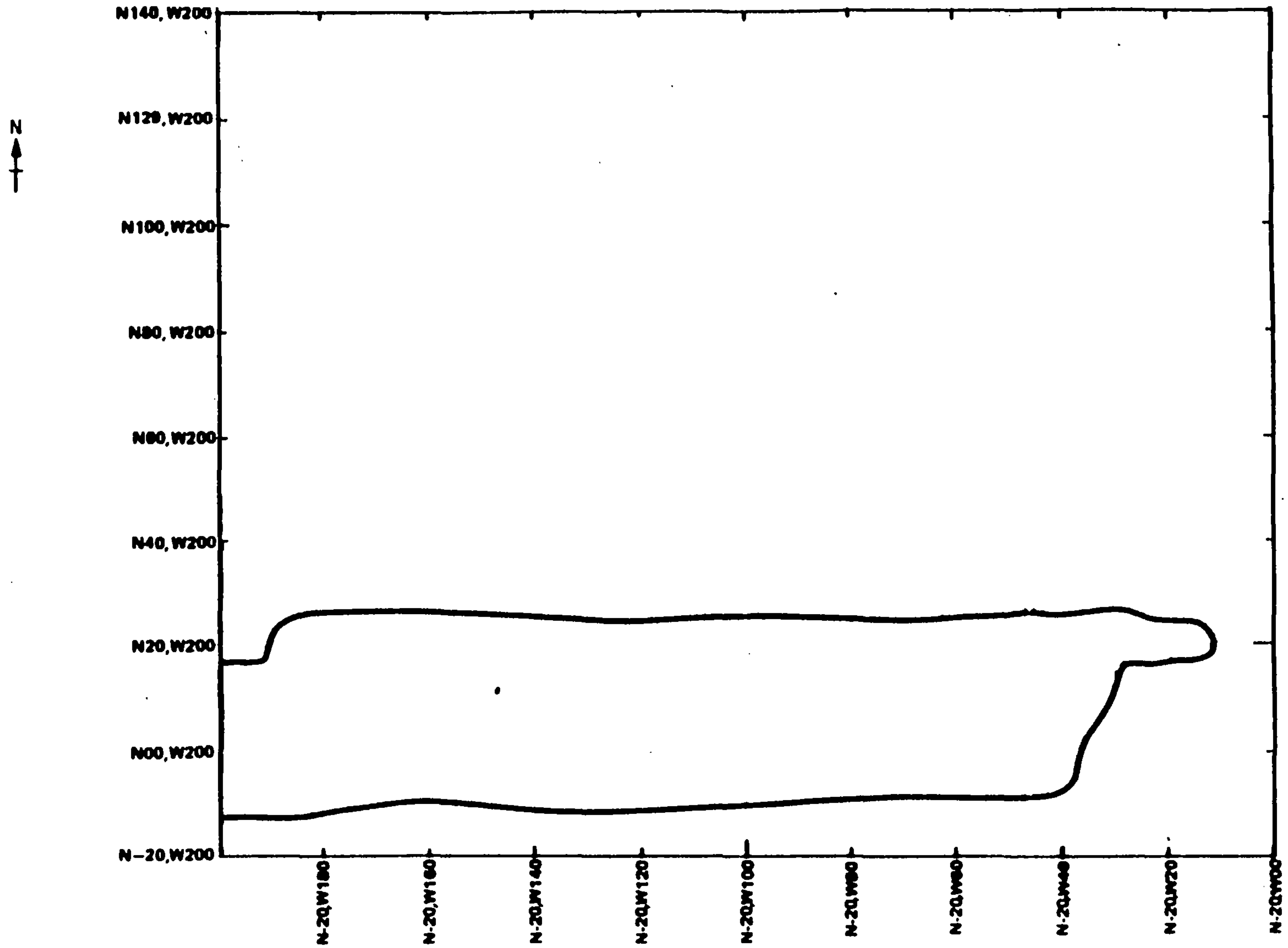
The sampling program involved the collection of six soil samples from each of the four areas and subsequent compositing of the samples into two composite soil samples per area. A total of six surface water samples were also collected. Four of the samples were collected from a stream north of Areas A and B (see Figure 4-4). The remaining two water samples were collected from Area B. All soil and water samples were analyzed for volatile organic compounds and proximity scan for extractable organics.

Geophysical results indicated no evidence of contamination or buried drums in Areas B or D. The surveys did indicate the possible presence of buried metal in Areas A and C.

In Area A, magnetic measurements indicated a trench-shaped feature approximately 140 feet by 20 feet in size, trending in an east-west direction (see Figure 4-5). This magnetic anomoly may have represented the buried drums encountered by SCA.

Two large magnetic anomalies were identified in Area C (see Figure 4-6). One anomaly, identified as M-1, was approximately 200 feet by 20 to 40 feet in size, trending in an east-west direction. This magnetic anomaly may have represented the presence of the 200 buried drums. The second anomaly, M-2, was much smaller than M-1 and could indicate buried drums or scrap metal.

Analytical results for surface water and soil samples are summarized in Tables 4-4 and 4-5, respectively. Analytical results for the surface water samples indicated the presence of trichloroethene in samples BW-1 and W-6 at concentrations of 6.7 and 6.9 ug/l, respectively. Volatile organic compounds were not detected in any of the remaining surface water or soil samples. However, benzene was present but below the working detection limits of 0.05 ug/g in the two composite soil samples from Area B and one composite soil sample from Area A. Toluene was also present below the working detection limit in one composite soil sample from Area D and one surface water sample from Area B.



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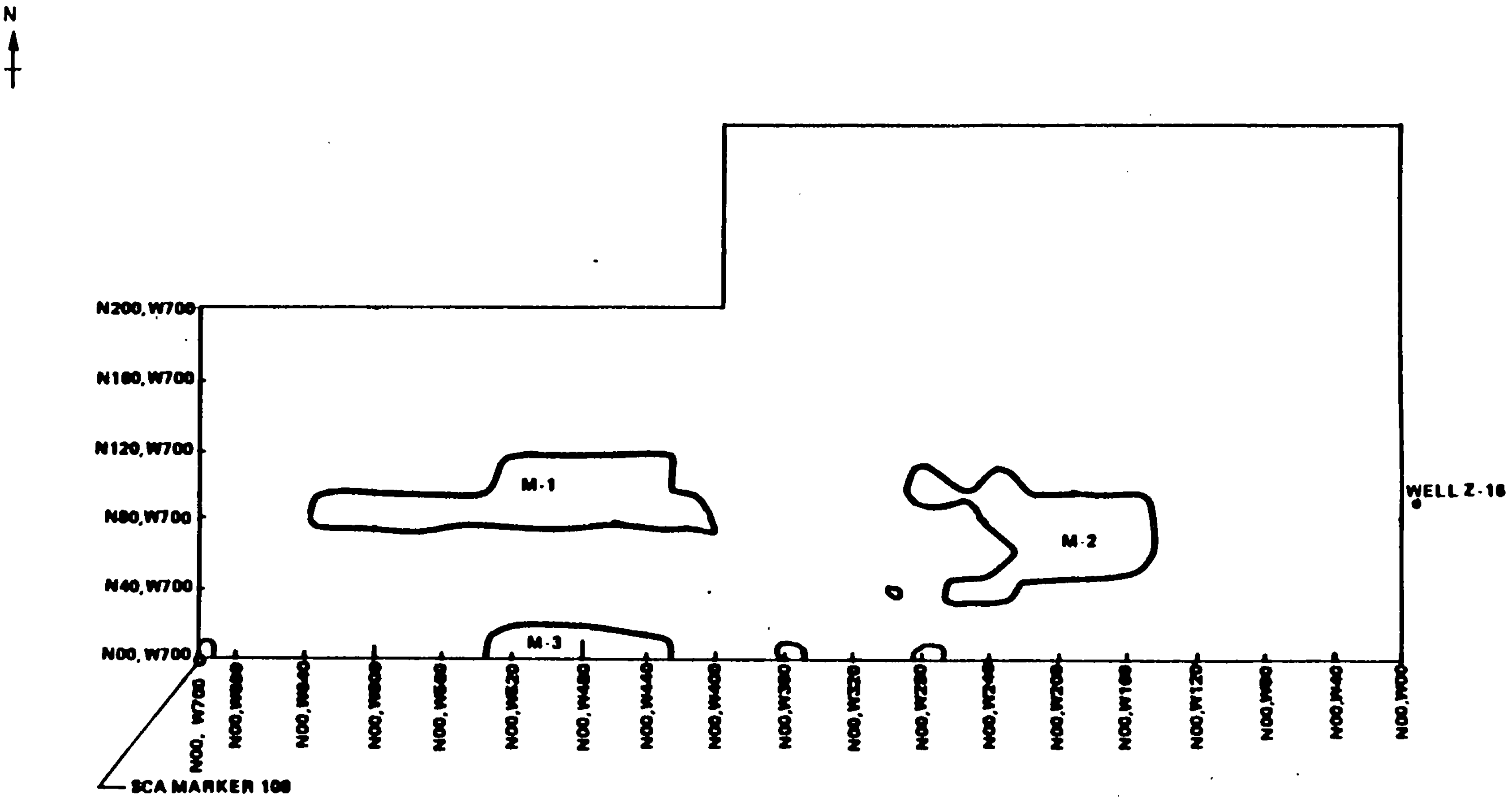
MAGNETIC ANOMALY - AREA A

FIGURE 4-5

ACRES

(ECOLOGY AND ENVIRONMENT, 1985)



DEPARTMENT OF THE ARMY
KANSAS CITY DISTRICT
CORPS OF ENGINEERS

MAGNETIC ANOMALIES - AREA C

(ECOLOGY AND ENVIRONMENT, 1985)

FIGURE 4-6

ACRES

TABLE 4-4

ANALYTICAL RESULTS OF SURFACE WATER SAMPLES
Ecology and Environment, 1985 (ug/l)

	SAMPLE NO.					
Parameter	W-3	W-4	W-5	W-6	BW-1	BW-2
Toluene	< 5	< 5	< 5	< 5	≤ 5	< 5
Trichloroethene	< 5	< 5	< 5	6.9	6.7	< 5
Boron	219	195	188	148	22200	25500
Lithium	<2000	<2000	<2000	<2000	25700	27800
Potassium	3520	3230	3970	2490	1900	2050

< = Not detected at working detection limit.
≤ = Compound present but at concentrations below working detection limit.

See Figure 4-4 for sample locations.

TABLE 4-5

ANALYTICAL RESULTS OF COMPOSITE SOIL SAMPLES

Ecology and Environment, 1985

(ug/g)

	SAMPLE NO.							
Parameter	A1	A2	B1	B2	C1	C2	D1	D2
Benzene	<0.05	≤0.05	≤0.05	≤0.05	<0.05	<0.05	<0.05	<0.05
Toluene	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	≤0.05
Boron	<9	<9	281	178	13.6	40	<10	10.1
Lithium	18.8	20.6	230	644	50.2	20.7	21.4	21.1
Potassium	1080	1120	1090	841	2830	1920	2280	2430

< = Not detected at working detection limit.
≤ = Compound present but at concentrations below working detection limit.

See Figure 4-4 for sample locations.

Boron and lithium were detected in the two surface water and two composite soil samples from Area B at concentrations substantially greater than in samples from the remaining surface water sample locations.

Summary of Air Force Plant 68 Investigations

Remedial activities of the Olin Burn pit and 200 drum disposal trench by SCA apparently failed to completely clean up the site. Analyses indicate that boron and lithium contamination still exists in the Olin Burn area. Trenching activities by SCA and further geophysical surveys by E&E did not identify the presence of the alleged 200 drums west of SLF-7. However, the E&E investigation did indicate the possible presence of the buried drums in an area to the south of SLF-7.

In addition, the initial investigation of Air Force Plant 68 identified possible drum disposal activities in the wooded area west of the Olin Burn pit and the possible presence of drums buried in two former building basements which were later covered. The locations of these areas are unknown.

4.2 - Additional Areas of Possible Contamination

Several other areas exist which could potentially be contaminated with hazardous wastes. These areas include:

- Syms Lagoons;
- Nike Missile Base;
- Waterline construction area;
- Property "G";
- Phosgene cylinder area;
- Air Force Plant 38;
- Somerset Group Property; and
- Wastewater Treatment Facility (property owned by Town of Lewiston).

Information on the potential contamination at these locations is summarized below.

4.2.1 - Syms Lagoons

In 1986, as part of the 6NYCRR Part 373 permit requirements, SCA was required to produce a report identifying all known past or present solid waste management units (SWMU's) or waste areas at the site and to provide a brief history of the design and operation of the units. In the SWMU's report, SCA identified five waste management areas within the water supply and treatment and sewage treatment and disposal areas of the former North Plant facility (URS, 1986). Four of these areas are identified as the Houghson Pit, Acid Pit, Oil/Water Pit and Syms Tank area (Figure 3-7). The three pits are collectively referred to as the Syms Lagoons. The lagoons, formerly containment structures for the various treatment facilities, were used during the period 1971 to 1975 by Chem-Trol for the temporary storage of waste and recoverable materials. These lagoons were emptied in the late 1970s.

The Syms Tank was a 500,000 gallon, 40 foot diameter tank. The tank was moved to SCA's tank farm in 1984 and presently functions as a holding tank for water supply for fire protection.

The fifth area identified in the SWMU's report is referred to as the Syms Property Underground Tanks. This area consists of three underground tanks. One of these tanks has been removed by SCA and placed in a location adjacent to the excavation site. The former use of these underground tanks is unknown.

4.2.2 - Nike Missile Base

The Nike Missile Base was apparently never completely decommissioned. An underground fuel tank was discovered in the vicinity of the Nike stand-by generator plant. The tank is approximately 10.5 ft long with a four foot diameter. The tank is filled to capacity (approximately 1,000 gallons) with an apparent petroleum hydrocarbon and water mixture.

The Nike tank is currently under investigation by Storch Engineers. Storch Engineers is working under contract to the COE for the removal of the tank and its contents under the Defense Environmental Restoration Account (DERA) program. As part of their investigation, Storch Engineers have sampled the contents of the tank and the surrounding soils. The sample of the tank contents was improperly analyzed in the lab for petroleum hydrocarbons, and therefore no results are available for these compounds. The soil samples indicated the presence of petroleum hydrocarbons (see Table 4-6). The soil samples were also analyzed for PCBs and EP toxicity metals. The results indicated that PCBs were not detected and EP toxicity metals were below method detection limits. One soil sample, B-3A, was also analyzed for RCRA waste characteristics with the following results:

- Reactive cyanide .... <0.2 ppm;
- Reactive sulfide .... <0.5 ppm;
- pH .... 6.79; and
- Flash point .... 107°F.

The sample of the tank contents indicated the absence of PCBs and had the following RCRA waste characteristics:

- Reactive cyanide .... <0.1 ppm;
- Reactive sulfide .... <0.5 ppm;
- pH .... 7.91; and
- Flash point .... >140°F.

Storch Engineers is currently negotiating with the DEC for the removal of this tank.

TABLE 4-6

ANALYTICAL RESULTS OF SOIL SAMPLES - NIKE BATTERY NF-03

Storch Engineers, 1987

	SAMPLE NO.							
Parameter	B-1A	B-1B	B-2A	B-2B	B-3A	B-3B	B-4A	B-4B
Depth of Samples (ft)	2-4	4-6	4-6	6-8	4-6	6-8	4-6	6-8
Petroleum Hydrocarbon Content (ppm)	<20	190	290	<20	240	56	<20	<20

< = Not detected at working detection limit.

4.2.3 - Waterline Construction Area

In April 1986, while excavating trenches for the installation of new waterlines, SCA encountered visibly contaminated and odoriferous soils near the main entrance of the facility and on M Street (URS, 1986). A total of five trenches were excavated at separate locations (Figure 3-7). SCA removed over 600 cubic yards of contaminated soils with the soil disposed of in SLF-11. Additional soil contamination may exist outside of the limits of the trenches. The origin and composition of the contamination is unknown.

4.2.4 - Property "G"

In August 1986, while conducting remedial action activities at the NFSS, the DOE noted a partially exposed drum in an area identified as property "G" along the boundary of SCA and NFSS (see Figure 4-1). Upon further investigation, a total of 31 drums of sludge waste were discovered and 49 drums of suspected contaminated soils were packed (Bechtel, 1987b).

The DOE conducted radiological analyses of the 31 drums of sludge and determined that some of the material exceeded the current subsurface DOE guidelines of 15 pCi/g (picocuries per gram) for thorium-232 and radium-226. The analyses ranged from 2 to 5 pCi/g for thorium-232, 3 to 28 pCi/g for radium 226, and 3.4 to 11 pCi/g for uranium-238 (Bechtel, 1987b).

Radiological sampling of the 49 soil-filled drums indicated levels below DOE guidelines.

The contents of the 31 drums were also analyzed for numerous organic compounds. The analyses indicated the presence of the following compounds:

benzene
toluene

anthracene
fluoranthene

ethylbenzene
xylenes
phenol
4-methylphenol
napthalene
2-methylnapthalene
acenaphthylene
dibenzofuran
fluorene
phenanthrene
pyrene
benzo (a) anthracene
chrysene
benzo (b) fluoranthene
benzo (a) pyrene
indeno (1,2,3,-cd) pyrene
dibenzo (a,h) anthracene
benzo (g,h,i) perylene

These compounds were noted as commonly found in coal tars and in coal tar derivatives. These materials are classified as hazardous waste under 40 CFR 260 and 261 of RCRA. Twenty-five of the drums were located at the NFSS. The remaining drums were located on SCA property. The DOE accepted bids for the disposal of these drums. SCA was awarded this work and the drums have been disposed of in SLF-11.

4.2.5 - Phosgene Cylinders

During a radiological survey by the AEC in 1970, a phosgene cylinder burial area was discovered. The area was identified by a sign at the site warning "Danger, Phosgene 601 Stored Here" (NYS Assembly, 1981). When excavated by Army Chemical Warfare experts from Edgewood Arsenal the gas cylinders were empty. The location of this area is presently unknown.

4.2.6 - Air Force Plant 38

In past years, hundreds of gallons of rocket fuel, nitric acid, rocket fuel oxidizer, and sodium hydroxide neutralizer were burned in open pits at Air Force Plant 38. Since 1973, these wastes have been burned in an incinerator at the plant (Interagency Task Force, 1979). The disposition of the incinerator ash has not been identified. The amount, if any, of contamination to the environment from these activities is unknown.

4.2.7 - Somerset Group Property

This site was previously part of Air Force Plant 68. Many buildings, process areas and tank farms, and associated debris are present.

4.2.8 - Wastewater Treatment Facility (property owned by Town of Lewiston).

This facility was used to collect and treat wastewater from manufacturing activities at the LOOW and Air Force Plant 68 sites. A sewer discharge line connected this plant with an outfall into the Niagara River.

4.3 - Summary of Existing Analytical Data

Past investigations have indicated the presence of hazardous substances in a number of media. Hazardous contamination has been detected in groundwater, surface water, soils and on-site wastes. The existing analytical data are summarized, by medium, below.

4.3.1 - Groundwater

As a result of the groundwater evaluation of the CWM facility in 1985 (Golder, 1985), SCA identified only one incidence of groundwater contamination in the project study area which SCA attributed to past federal government activities. The detection of chloroform and toluene at concentrations below the working detection limit in monitoring well Z-4 (see Figure 4-4) in December 1984 was attributed to the buried drums discovered by SCA in 1981 in the area north of SLF-7 or from contamination from the Olin Burn area. During the installation of this trench well, foam was encountered running up the augers during the installation and purging of the well. The occurrence of this foam supports the probable contamination of groundwater in the area of this well.

Additional evidence of groundwater contamination was found in a more recently installed monitoring well (MW-7-3S) located along the northern edge of SLF 7 (see Figure 2-17), south of the Olin Burn area and west of well Z-4. Analytical results for this well, installed in May 1986, indicate the presence of low concentrations of carbon tetrachloride, chloroform, toluene and methylene chloride (see Table 4-7).

The contaminants carbon tetrachloride and chloroform were also detected in piezometer P12-2S located on Access Rd. #2, west of the area north of C (see Figure 2-18). The results of an investigation conducted by SCA regarding the source for these contaminants was not available at the time of preparation of this report.

In the project study area, a few wells have been identified as having anomalous concentrations or indicators of groundwater contamination. Monitoring well B-22, located at the northwest corner of the area north of C (see Figure 4-4) was found to have low levels of methylene chloride in August 1982 which was determined to be probable laboratory contamination. Additional wells at this location, B-22A and B-22B, were also noted as having possible contamination problems. Groundwater from well B-22A had a high pH in January 1984 which was ascertained to be a result of grout contamination. Monitoring well B-22B had high specific conductance values in August 1984 which was believed to be a result of improper instrument calibration or sample collection from the wrong well.

Additional monitoring wells in the project study area also have had repeated detections of methylene chloride (possible laboratory contaminant) and occasional instances of detections of other organic compounds (see Table 4-7).

4.3.2 - Surface Waters

Analyses of surface water samples during the E&E investigation in 1985 indicated the presence of trichloroethene near or at the method detection limits at concentrations of 6.7 and 6.9 ug/l in samples BW-1 and W-6, respectively. Sample BW-1 also contained toluene at a

TABLE 4-7
HISTORICAL SUMMARY OF CHEMICAL COMPOUNDS DETECTED IN CWM MONITORING WELLS LOCATED IN PROJECT STUDY AREA

Sheet 1 of 2

Monitoring Well No.	Sampling Date	Chemical Compound	Concentration Detected (ug/l)	Method Detection Limit (ug/l)
MW-7-3S	08/86	Carbon Tetrachloride	275	2.80
	08/86	Chloroform	463	1.60
	08/86	Methylene Chloride	8.44	2.80
	11/86	Carbon Tetrachloride	234	2.80
	11/86	Chloroform	382	1.60
	11/86	Methylene Chloride	22.9	2.80
	11/86	Toluene	58.8	6.00
	03/87	Carbon Tetrachloride	208	2.80
	03/87	Chloroform	249	1.60
	03/87	Methylene Chloride	16.0	2.80
MN-7-3D	08/86	None Detected	-	NA
	11/86	None Detected	-	NA
	03/87	Methylene Chloride	11.8	2.80
MW-7-5S	08/86	Methylene Chloride	6.23	2.80
	11/86	Methylene Chloride	5.73	2.80
	03/87	Methylene Chloride	6.66	2.80
MW-7-5D	08/86	Methylene Chloride	6.25	2.80
	11/86	Methylene Chloride	26.9	2.80
	03/87	Methylene Chloride	5.40	2.80
MW-12-8S	10/86	Tetrachloroethylene	7.59	NA
	11/86	Methylene Chloride	17.4	NA
	02/87	Methylene Chloride	5.24	NA
	04/87	None Detected	-	-
	07/87	Methylene Chloride	8.43	NA
MW-12-8UD	10/86	Dichlorodifluoromethane	43.0	NA
	11/86	Methylene Chloride	4.20	NA
	02/87	None Detected	-	-
	04/87	None Detected	-	-
	07/87	Methylene Chloride	16.9	NA
Z-4	12/84	Carbon Tetrachloride	BMDL	10
		Chloroform	BMDL	10
		Toluene	BMDL	10

TABLE 4-7
(Cont'd)

Sheet 2 of 2

Monitoring Well No.	Sampling Date	Chemical Compound	Concentration Detected (ug/l)	Method Detection Limit (ug/l)
B-22 (Zone 3)	01/83	Tetrahydrofuran	4728	NA
	01/83	Methy Ethyl Ketone	1723	NA
	03/83	Tetrahydrofuran	5090	NA
	03/83	Methyl Ethyl Ketone	1840	NA
	02/84	Tetrahydrofuran	40	NA
	02/84	Methyl Ethyl Ketone	<10	10
	11/84	Methylene Chloride	8.7	5
B-22A (Zone 3)	01/84	pH	12.80 S.U.	NA
B-22B (Zone 3)	08/84	Specific Conductance	5526 cm/sec	NA
P12-2S	NA	Chloroform	NA	NA
		Carbon Tetrachloride	NA	NA

NOTE

NA - Not Applicable

Source: Golder, 1985 + 1987

concentration below the detection limit of 5 ug/l. Sample BW-1 was collected downstream of the SCA facility at Balmer Road. No other surface water samples had detectable quantities of volatile organic compounds.

Boron was detected at concentrations of 22.2 and 25.5 mg/l in samples BW-1 and BW-2, respectively. These samples also had elevated levels of lithium at concentrations of 25.7 mg/l (BW-1) and 27.8 mg/l (BW-2). The remaining surface water samples had substantially lower concentrations of boron. In these samples boron ranged from 0.148 to 0.219 mg/l. Lithium was undetected at the detection limit of 0.20 mg/l.

Surface water samples were again collected on September 13, 1985 by SCA. The analytical results for the single sample collected from the Olin Burn area indicated no evidence of volatile organic, acid organic, base/neutral organic, or pesticide/PCB compounds in the sample. Di-n-butyl phthalate was detected below the method detection limit of 3.85 mg/l. The presence of this compound was attributed to contamination from the phenolic cap of the sample bottles. Total cyanide and total phenolics were also detected below the method detection limits. Elevated concentrations of boron (33,100 ug/l) and lithium (29,000 ug/l) were detected in the sample. Halogenated Organics (TOX) were also detected at a concentration of 375.25 ug/l.

4.3.3 - Soil Analyses

Soil samples from the Olin Burn area were analyzed in 1981 as part of the initial investigation by the DEC, and in 1985 as part of the E&E investigation. Soil samples were collected by SCA on June 1, 1981. Analytical results indicated relatively high concentrations of lithium (1,150 and 304 ug/l) and boron (558 and 25.5 ug/l) in two of the three samples.

Six additional soil samples from the Olin Burn area were collected on November 3, 1981. Analytical results of the six samples indicated boron concentrations ranging from 150 to 760 ug/g and lithium concentrations ranging from 6.2 to 590 ug/g.

Analyses of a soil sample taken from the vicinity of the drum exhumed by SCA indicated concentrations of 0.2 ug/g of lithium and less than 10.0 ug/g boron.

In 1985, E&E analyzed eight composite soil samples from four areas of investigation (Areas A, B, C and D). Analytical results indicated relatively high concentrations of boron and lithium in two samples from Area B and one sample from Area C. All samples indicated potassium concentrations ranging from 841 to 2830 ug/g. No volatile organic compounds were detected in any of the samples.

4.3.4 - Waste Analyses

The samples from two drums excavated in the area north of SLF-7 by SCA in 1981, indicated concentrations of lithium at 10.5 and 134 mg/l and boron at 79.0 and 84.0 mg/l. These samples, analyzed by SCA, were essentially identical in lithium and boron composition to duplicate samples analyzed by an outside laboratory, Acts Testing Labs, Inc. of Buffalo, New York.

TABLE 4-8 Sheet 1 of 2

COMPOUNDS POTENTIALLY PRESENT AT THE LOOW AS A RESULT OF PAST-GOVERNMENT ACTIVITIES

Compounds Associated With High Energy Fuels Production:

- pentaborane
- decaborane
- diborane
- sodium borohydride
- potassium chloride
- lithium chloride
- boron
- lithium
- hydrazine compounds
- hydrogen
- chlorine
- hydrogen chloride
- carbon
- Fuel Oil No. 2
- carbon dioxide
- carbon monoxide
- oxygen
- isopropyl chloride
- ethyl chloride
- diethyl ether
- silicon tetrachloride
- sodium hydroxide
- calcium hydroxide
- calcium chloride
- calcium carbonate
- aluminum chloride
- lithium chloride
- pentane
- calcium metaborate
- aluminum hydroxide
- sodium chloride
- propane
- dispersion oil

Compounds Associated With TNT Production:

- trinitrotoluene
- dinitrotoluene
- mononitrotoluene
- toluene
- nitric acid

TABLE 4-8
(Cont'd)

Sheet 2 of 2

Compounds Associated With TNT Production (Cont'd)

- trichloroethane
- trinitrobenzene
- 4,6-dinitroanthranil
- 2,4,6-trinitrobenzaldehyde
- 2,4,6-trinitrobenzoic acid
- 2,4,6-trinitrobenzyl alcohol
- sulfuric acid

Compounds Associated with Chemical Warfare Storage:

- ethylether
- kerosene
- methanol
- phosgene
- impregnite

5 - FIELD METHODOLOGIES AND ANALYSES

5.1 - Overview of Field Activities

The field investigation for the LOOW RI/FS was directed at determining the presence and extent of contamination of portions of the LOOW as a result of past government activities, specifically in Areas A, B, C, North of C, D, the Wooded Area, and the areas containing buried acid and TNT pipelines (refer to Figure 2-4). In this endeavor, field activities included a geophysical survey, air and radiation monitoring, soil borings and monitoring well installations, test pit excavations, and subsequently, sampling and analyses. The following subsections present descriptions of each field activity undertaken at the LOOW during the period of April 25 through August 5, 1988. More detailed descriptions of field activities are presented in Appendices A, B and C.

5.2 - Air Monitoring

The Health and Safety Plan for LOOW required that an air monitoring program be implemented during site work. The air monitoring program included the use of real-time instrumentation and documentation sampling to monitor for air-born concentrations of organic and inorganic vapors, explosive gases, oxygen deficiency and radioactivity. These air monitoring activities were conducted to document contaminant exposure of onsite personnel while performing site tasks, and to upgrade or downgrade the level of respiratory protection for personnel conducting specific intrusive tasks.

An air monitoring program was concentrated during the well installation and trenching activities conducted at the LOOW site. The monitoring, performed by the Site Safety Officer (SSO), consisted of using real-time instruments to monitor for organic vapors, explosive gasses and oxygen deficiency and radiation, and the collection of samples for subsequent analysis for metals, organic vapors and radiation using pump and collection media. The methods used followed applicable NIOSH and ASTM guidelines for the sampling of the breathing zone of workers.

Samples were taken as Occupational Safety and Health Administration (OSHA) time weighted average (TWA) samples. Dupont Alpha 1 air sampling pumps were attached to the individual who was deemed to be at the greatest risk of exposure to airborne contaminants (the driller's helper during well installation, and the spotter during trenching). Metal dusts were collected on 8 micron filter paper, while organic vapors were collected in charcoal tubes. Sampling pumps were calibrated prior to sampling. Metal samples were calibrated at 2.0 l/min and allowed to run for a full 8 hour period. This yielded the desired 750 to 1000 liters total volume. Organic vapors were also calibrated at 2.0 l/mil, but had a run time of less than one hour to avoid overloading the charcoal tube. Organic vapor samples were kept on ice until they were sent to MDS laboratories in Reading, Pennsylvania.

Analysis of the charcoal tubes included both A and B hydrocarbon scans. This scan was completed using a packed column gas chromatograph equipped with flame ionization detector. This method allows for detection of a wide range of solvents commonly found in industrial processes. Metal samples were analyzed according to NIOSH method 7300, which utilizes atomic absorption spectrophotometry.

5.3 - Geophysical Investigation

A limited geophysical investigation was conducted at the project study area by Delta Geophysical Services of Clinton, New Jersey. The field activities for the survey were conducted during the period of April 25 through May 5, 1988. The purpose of the geophysical survey was to:

- Confirm the presence of geophysical anomalies in Areas A and C as identified by E&E;

- Confirm the absence of geophysical anomalies in Area D as indicated by E&E;

- Locate possible sources of contamination (i.e. buried drums) in the area North of C and the Wooded Area;

- Aid in the selection of proposed test pits in Areas A and C; and

- Identify any buried metallic material which may hinder drilling at proposed boring locations.

In order to attain these objectives, two geophysical survey techniques were employed: a terrain conductivity survey and a magnetometer survey. The terrain conductivity survey was used to measure the electrical conductivity (free ion concentration) of the earth which is a function of the type of soil and/or rock, its porosity and permeability and the fluids which fill the pore spaces. Because natural soils have an electrical conductivity, areas of interest can be identified by variations in those conductivities. These variation or anomalies in electrical conductivities may be caused by changes in soil moisture content, soil type, the specific conductance of groundwater, depth of soil cover over bedrock, and thickness of soil and rock layers. Local changes in soil or rock types and structural features such as fractures or disturbances in soil materials caused by trenching may also produce changes in conductivity.

The terrain conductivity survey of the LOOW study area was conducted utilizing a Geonics EM-31 survey meter. The EM-31 is an one-man operated horizontal boom-type instrument which has an estimated effective depth of 20 ft below ground surface. An EM-31 survey was conducted in the Wooded Area and in the area North of C.

The magnetometer survey utilized a Geometrics G856 Proton Magnetometer. The magnetometer measures the intensity of the earth's magnetic field. The presence of ferrous metal causes variations in the local intensity of that field permitting the detection of the variations. The magnetometers response is proportional to the mass and depth of the ferrous material; a single drum buried at a shallow depth may produce a similar variation in the the magnetic field as numerous drums buried at a deeper depth. Typically, a single drum can be detected at depths down to 20 ft below ground surface.

At the LOOW project study area, magnetometer surveys were conducted in Areas A, B, C, North of C, the Wooded Area, and at proposed monitoring well locations.

The geophysical survey was initiated by establishing a reference grid in Areas A, C, North of C, and D. These grids were used as field references for the geophysical survey and to provide a quick and accurate location for specific ground-truthing (i.e. test pits, soil borings, etc.). The reference grids were laid out in the field using a Brunton compass and measuring tape. Each areas reference grid was made by first establishing a baseline using a reference point in the field such as a power pole, road, etc. Once each baseline was established reference lines parallel and perpendicular to the baselines were established. Each reference line was marked with flags located at 40 ft intervals. The EM-31 and magnetometer surveys were then made along the survey lines perpendicular to the baselines.

In the area north of C, an EM-31 survey was performed with data collected at 20 ft intervals along survey lines spaced 20 ft apart. In the Wooded Area, conductivity measurements were recorded along two perimeter lines (Lines P1 and PA) and five approximately north-south transect lines. The conductivity data was recorded in the field along with any field observations such as the presence of surface metal, culverts, etc. Upon completion of the EM-31 survey, the data was entered into a computer which was used to plot the data and produce survey profile lines.

The magnetometer survey followed the same survey lines as the EM-31 survey in the Wooded Area and the area north of C. In addition, magnetometer surveys were performed along survey lines in Areas A, C, and D and at each proposed monitoring well location. At each proposed well location, the magnetometer survey was performed at 5 ft intervals over a 20 ft by 20 ft grid established over each proposed well location. The magnetometer survey was extended in the vicinity of proposed well MW-B-3 as a result of conversations with SCA employees regarding the possible existence of buried metal in this area. Also, the location of proposed monitoring well MW-D-1 was overlooked during the survey.

Upon completion of the magnetometer survey the data was entered into a computer which corrected the data for diurnal fluctuations in the earth's magnetic field. These fluctuations were recorded with a base station magnetometer located at the site which recorded fluctuations every 20 seconds over the duration of the survey. The computer was then used to produce a plot of the corrected data and profile specific survey lines.

5.4 - Subsurface Investigations

As an integral portion of this remedial investigation extensive subsurface investigations were conducted at the LOOW project study area in an attempt to:

- Locate and sample buried drums and related soils;
- Locate and sample buried TNT and acid waste lines and underlying soils;
- Obtain subsurface soil samples from select soil borings for chemical analyses;
- Characterize subsurface hydrogeologic conditions; and
- Install monitoring wells and subsequently sample and analyze groundwater in an attempt to determine the presence of contamination as a result of past government activities.

The various field activities associated with these subsurface investigations are presented in the following subsections.

5.4.1 - Test Pit Excavations

Test pit excavation activities were conducted in Areas A and C in an attempt to locate buried drums. Additional test pits were excavated immediately west of the North Salts area in an attempt to locate TNT waste lines and in the area immediately west of CWM Lagoon 7 to locate buried acid waste lines. All test pit excavation activities were conducted by Synergist during the period of July 18 through July 22, 1988. Test pit excavation was accomplished using a John Deere 690 excavator. Because of the potential hazard of exposure to volatile, explosive, or toxic gases, all test pit excavation activities were conducted using Level B personal protection. Once each test pit was excavated, samples were collected, if required, and the test pit soils classified by the Acres Site Representative according to the Unified Soil Classification System.

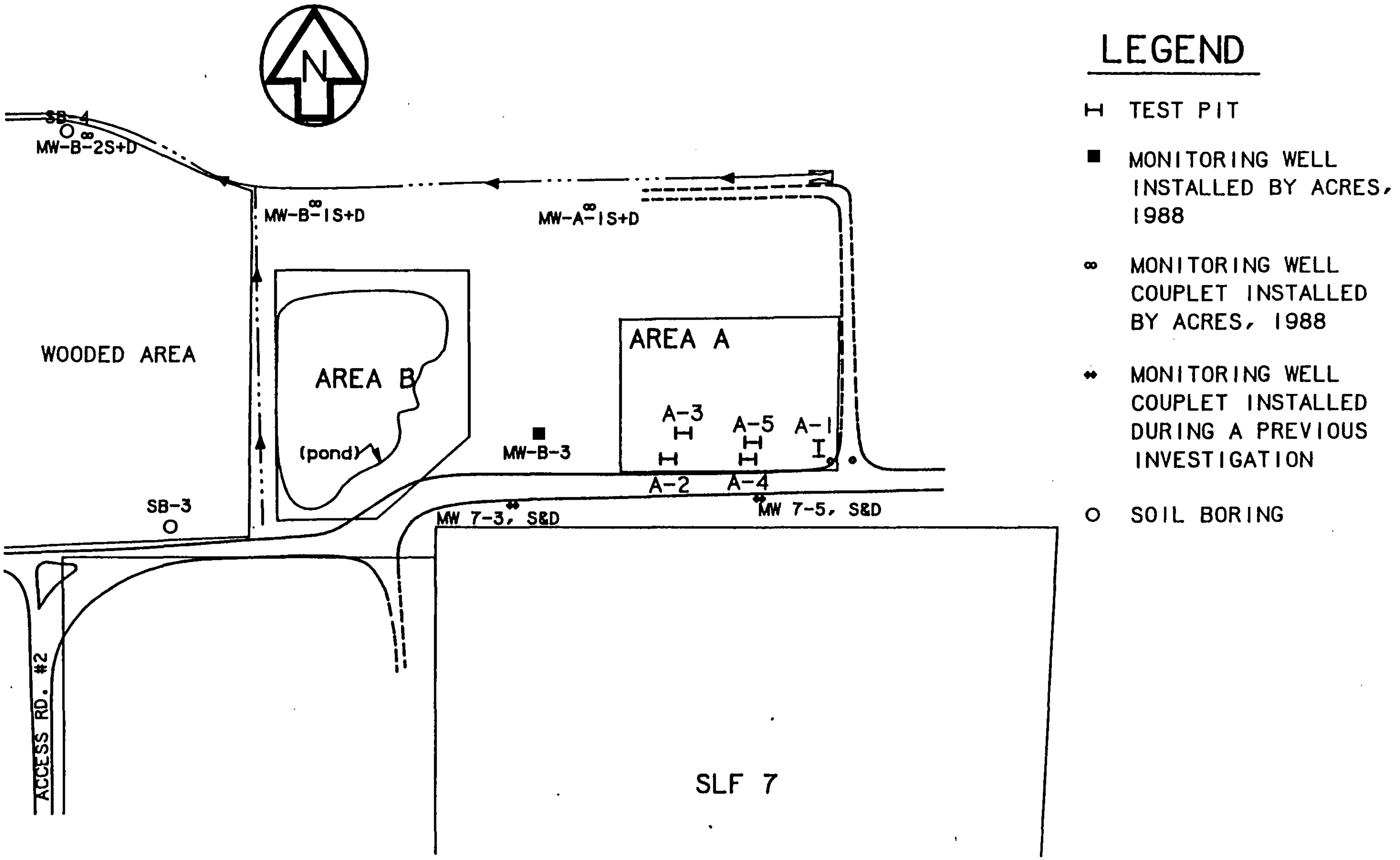
The following subsections describe test pit excavation activities performed in each area of concern:

Area A

Based on information obtained from CWM, DEC, and previous geophysical survey results by E&E and confirmation of those results as part of this remedial investigation, Area A was highly suspected of containing buried drums. Prior to initiating any test pit excavation activities, the boundaries of the geophysical anomoly in Area A, as determined by Delta Geophysical, were located in the field. In an attempt to locate and sample any buried drums in Area A, test pit excavation activities were initiated near the eastern boundary of the anomoly. The selected test pit location was based upon significantly elevated magnetic anomoly results (see Geophysical Report, Appendix D).

The first test pit excavated in Area A, TP-A1, was performed on July 20, 1988. The progression of all test pit excavations was directed by Synergist under the guidance of Acres Site Representative. As a precaution against personal injury resulting from any explosive conditions within the test pits, the directing of all test pit excavations was conducted behind a portable blast shield.

Test pit TP-A1 was excavated to a depth of about 6 ft and a length of 23 ft in a north-south direction (see Figure 5-1). Drums were



TEST PIT
LOCATION MAP
AREA A

FIG. 5-1

ACRES

encountered at approximately 3 ft below ground surface extending from the southern end of the test pit (located just north of H Street) to about 15 ft north in the test pit. Upon encountering the drums a substantial quantity of groundwater entered the test pit filling the test pit to the top of the drums. The drums found were predominantly 55 gallon drums with some 5 and 10 gallon drums. All drums were partially crushed and in various states of deterioration. Five drums were removed from the test pit using the excavation bucket and placed on plastic for subsequent sampling. Once sampling was completed (described in Section 5.5.2), each drum was placed in a separate over-pack Salvage drum, labeled and placed on plastic in a secure area until the final disposition of the drums is determined. The test pit was backfilled after soil samples from the test pit wall and bottom were collected.

As a result of negotiations with the COE regarding additional test pit excavations in Area A, the sequence of test pit excavations resulted in the excavator moving to excavate test pits in search of TNT and acid waste lines prior to returning to Area A. Prior to excavating any test pits in other areas the excavator bucket was decontaminated with high-pressure water by CWM personnel.

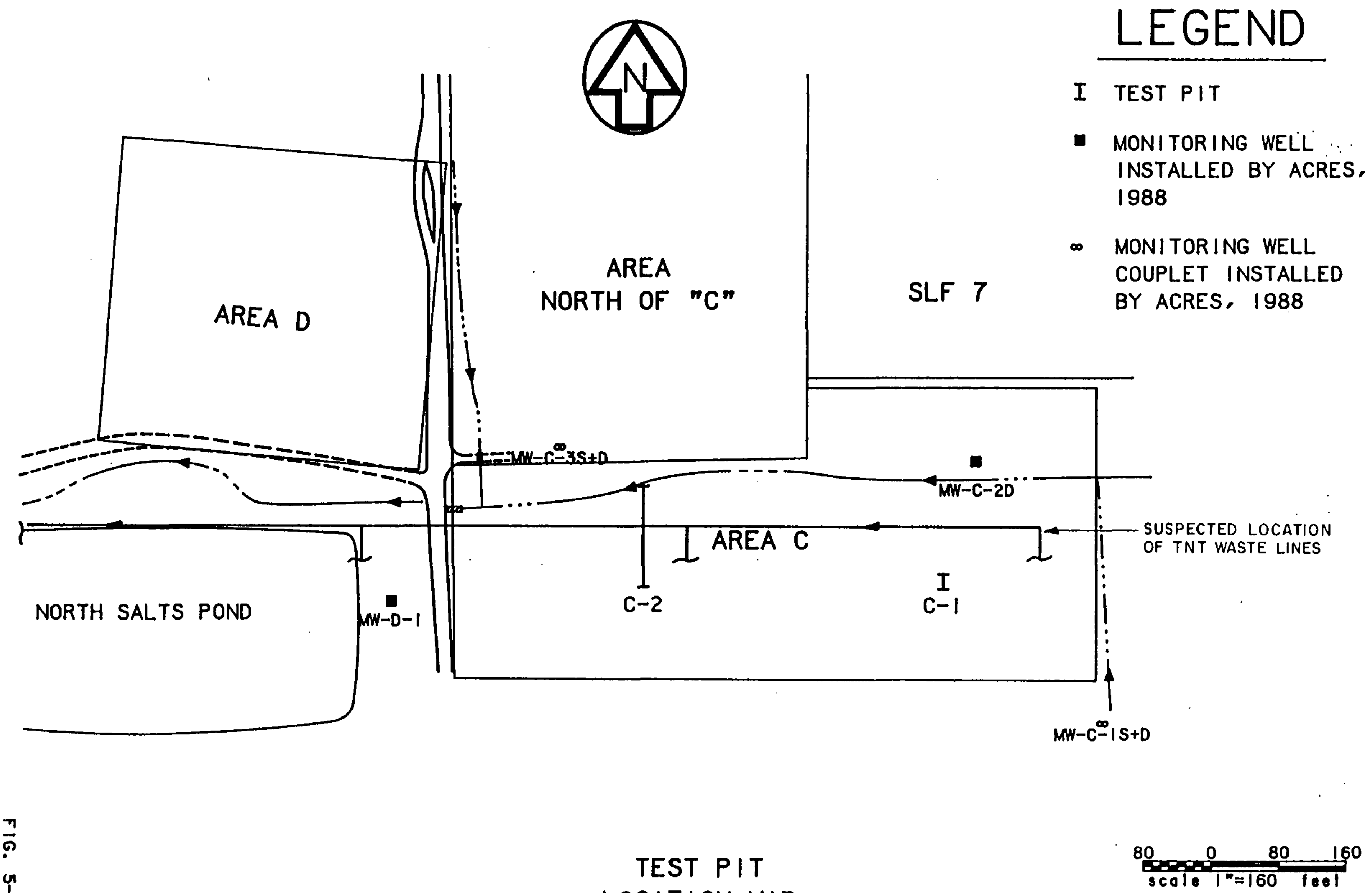
On July 22, 1988, additional test pits, TP-A2 through TP-A5, were excavated in Area A in an attempt to determine the boundaries of the drum burial trench. Test pits TP-A2 and TP-A3 were excavated in an east-west trend at the western end of the previously field-located geophysical anomoly. Each test pit was excavated to a depth of 8 ft and 20 ft in length. No drums or groundwater were encountered in these two test pits. Test pit excavation activities were then moved further east about 150 ft into the magnetic anomoly. During the excavation of test pit TP-A4, also excavated in an east-west direction, drums and groundwater were encountered at about 3 ft below ground surface. Test pit TP-A4 was then laterally extended to the north in an attempt to define the northern boundary of the drum burial trench. Test pit TP-A5 was excavated approximately 20 ft in length, 7 ft north of the original test pit TP-A4. No drums or groundwater were encountered in test pit TP-A5. The final test pit TP-A4 to TP-A5 excavation sequence resulted in a shape resembling a sideways "H". Based upon the excavation activities in Area A, the original drum burial trench would have had approximate dimensions of 20 ft wide by 100 ft long and about 8 to 10 ft deep. However, the width of the drum burial trench may be greater as the drums appeared to extend toward and possibly under the northern side of H Street.

Area C

Test pit excavation activities were conducted in Area C on July 19, 1988. Test pit TP-C2 was performed prior to test pit TP-C1. Test Pit TP-C2 was excavated in a north-south direction in the western geophysical anomoly previously field-located in Area C (see Figure 5-2). The test pit was excavated to a depth of 14 ft and 30 ft in length. No drums or signs of contamination were encountered in test pit TP-C2. However, an apparent building foundation, possibly a remnant of a former TNT manufacturing building, was encountered at a depth of about 4 ft approximately 12 ft from the southern end of the test pit. The building foundation, composed of concrete, was about 2 ft wide and 3 ft deep. The length of this foundation, trending in an east-west direction, was not defined.

Once it was determined that there were no drums in test pit TP-C2, the test pit was extended to the north in an attempt to locate TNT waste lines believed to be located in that area. The test pit was extended to the north to a total length of 90 ft and to a maximum depth of 17 ft. There were no signs of any buried waste lines found in this test pit. Upon completion of the excavation of test pit TP-C2, the test pit was backfilled to the original 30 ft length. Soil samples were then collected from the original test pit walls and bottom. Once the test pit was logged and sampled it was backfilled to the original grade.

Test pit TP-C1 was excavated on July 19, 1988 within the magnetic anomoly located in the eastern portion of Area C. During the excavation of this test pit, building debris consisting of reinforced



TEST PIT
LOCATION MAP
AREA C

FIG. 5-2

ACRES

steel, concrete, wood, etc. was encountered at a depth of about 3 ft. Groundwater was also noted flowing into the test pit through the building debris. Test pit TP-C1 was excavated to a final depth of about 10 ft and 30 ft in length. There were no drums encountered in this test pit. Once the test pit was logged and sampled it was backfilled to the original grade.

TNT Waste Line

Prior to initiating any test pit excavation activities to locate the Acid and TNT wastelines Acres personnel performed the following activities:

- Conducted discussions with CWM employees knowledgeable of past TNT wasteline excavations including field identification of possible excavation locations; and

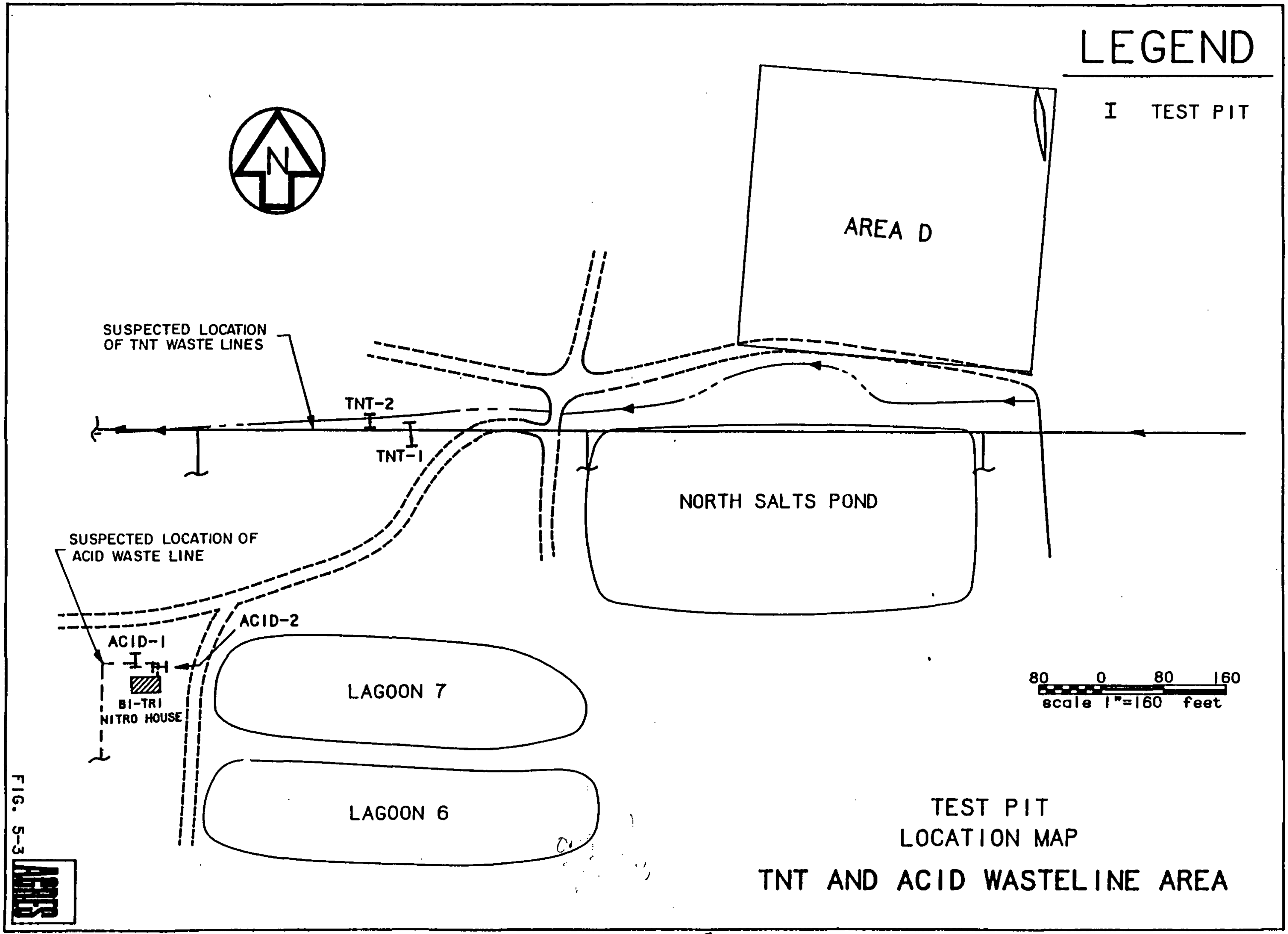
- Reviewed maps of the former TNT Plant layout. The maps included wasteline locations, pipe compositions and sizes, and invert elevations.

In addition, Acres consulted with the geophysical subcontractor, Delta Geophysical, regarding geophysical investigations to detect the vitrified clay wastelines. Delta Geophysical's conclusions were that non-metallic pipes are detectable by EM and magnetics only if the line contains a magnetic electrical property contrast and that ground penetrating radar, the preferred method for detecting non-metallic pipe, would probably not work due to the natural soil conditions at the site. As Acres had maps locating the wastelines, the geophysical surveys were not conducted.

On July 20, 1988 two test pits were excavated in an attempt to locate and sample buried TNT waste lines in the vicinity west of the North Salts Pond. The locations for these test pits were selected based upon a plot plan of the TNT manufacturing plant which had been prepared for SCA by Wehran Engineering (Project Numbers 01361186 and 368020). The plot plans had been prepared from plot plans developed in 1945 by J.G. White. The first test pit excavated in this area TP-TNT1, was located approximately 150 ft west of the North Salts Pond (see Figure 5-3). Test pit TP-TNT1 was excavated in a north-south direction to a maximum depth of 12 ft and 29 ft in length. Although no TNT waste lines were encountered in this test pit, a building foundation similar to that found in TP-C2 was encountered at a depth of about 5 ft below ground surface. The test pit excavation operation was then moved 50 ft west of TP-TNT1 in an attempt to locate the TNT waste lines. Test pit TP-TNT2 was excavated to a depth of 12 ft below ground surface and 23 ft in length without encountering TNT waste lines. Both test pits were then logged and backfilled to the original grade. All test pits were terminated in visually undisturbed materials.

Acid Waste Line

After the three unsuccessful attempts to locate the TNT waste lines (TP-C2, TP-TNT1, and TP-TNT2) test pit excavation activities were moved to the vicinity of an existing TNT building (identified as the Bi-Tri Nitro House on SCA's plot plan) located to the west of Lagoon 7. The first test pit excavated in this area, TP-ACID1, was initiated 23 ft north of the north western corner of the Bi-Tri Nitro House and advanced in a northerly direction (see Figure 5-3). Test pit TP-ACID1 was excavated to a depth of 15 ft below ground surface and 20 ft in length without encountering any acid waste lines. The test pit was then logged and backfilled to the original grade. The next test pit excavated in this area, TP-ACID2, was located 26 ft north of the northeast corner of the Bi-Tri Nitro House and excavated in an east-west direction to a depth of 8 ft below ground surface and 26 ft in length without encountering any acid waste lines. The test pit was then logged and backfilled to the original grade. Test pit logs are presented in Appendix I.



TEST PIT
LOCATION MAP
TNT AND ACID WASTELINE AREA

FIG. 5-3

5.4.2 - Subsurface Drilling

Drilling activities at the LOOW project study area were performed during the period of May 25 to July 15, 1988 by Rochester Drilling Company, Inc. of Rochester, New York. Drilling was accomplished using two Mobile Drill B-61 truck-mounted drill rigs using auger and wash rotary techniques. Each drilling rig was operated by a crew of one driller and two driller's helpers. The performance of each drilling crew was directed and supervised by an Acres Geologist.

Subsurface drilling involved the drilling of four shallow soil borings, performed in order to obtain soil samples for chemical analyses, and 15 well borings which were completed as groundwater monitoring wells. Pertinent soil/well boring and monitoring well construction information is presented on Table 5-1. The following subsections present descriptions of subsurface boring and well installation and development activities. Subsurface boring logs are presented in Appendix H.

Soil Borings

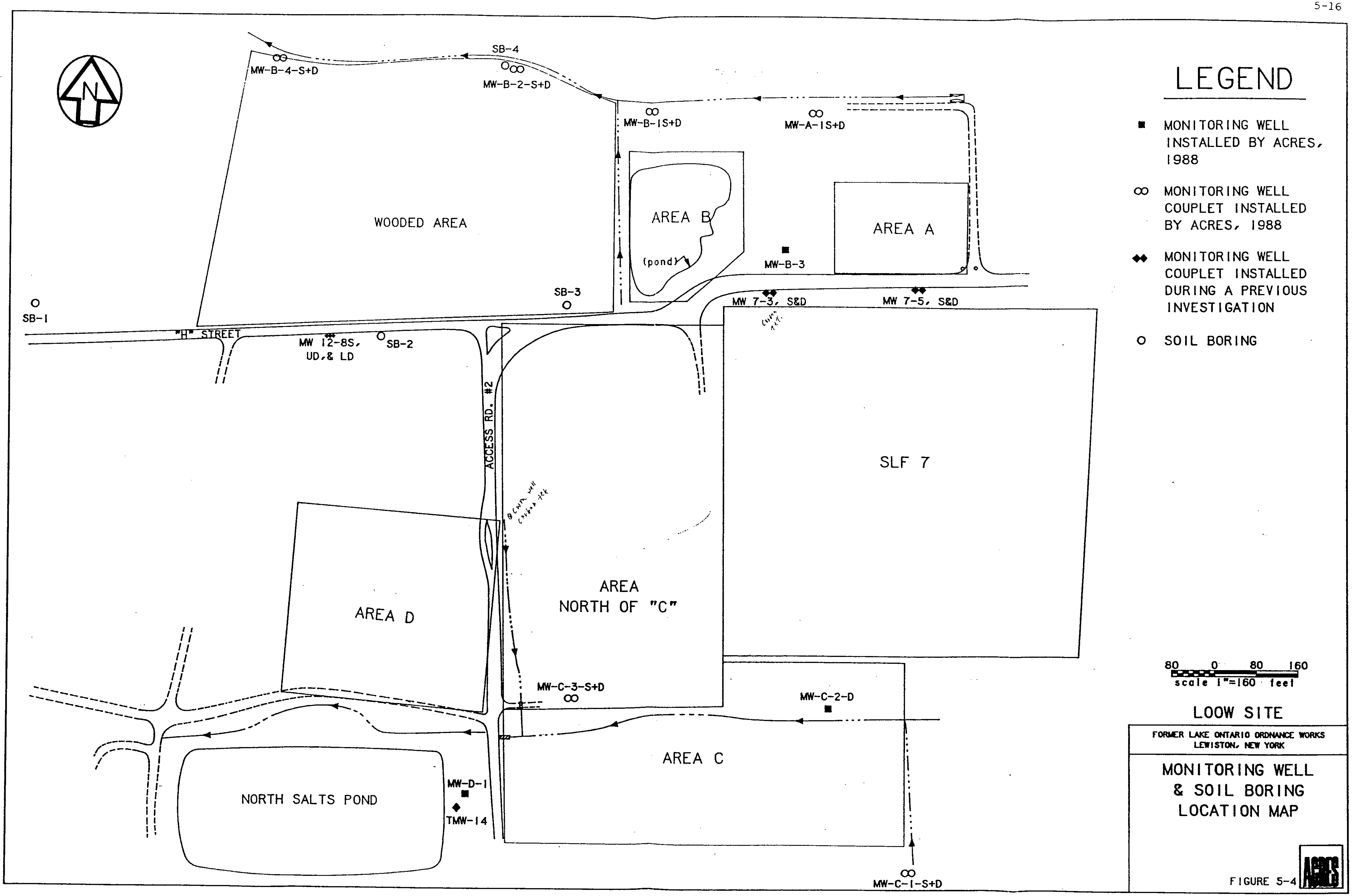
Four soil borings, identified as SB-1 through SB-4, were performed at locations which were suspected as being areas of possible contamination (see Figure 5-4). Soil boring SB-1 was located along H Street near the southwestern corner of the Wooded Area. This site was chosen in an attempt to identify the source of 2,4-dinitrophenol contamination detected in SCA monitoring well MW-12-5S. Soil boring SB-2 was performed off the southern side of H Street directly south of the Wooded Area. This location was chosen in an attempt to identify any TNT contamination as a result of a "Red Liquor" drainage ditch alleged to have been located in this area. Soil borings SB-3 and SB-4 were performed in areas identified during the geophysical survey as having moderate magnetic anomolies. Soil boring SB-4 was located along the northern edge of the Wooded Area while boring SB-3 was located along the southeastern edge of the Wooded Area.

TABLE 5-1

LOOW MONITORING WELL/SOIL BORING INFORMATION

WELL ID	COORDINATE LOCATION		ELEVATION			STICK-UP		TOTAL DEPTH		TOP OF UPPER CLAY	TOP OF MIDDLE SILT TILL	TOP OF LOWER CLAY	TOP OF SILT/SAND	TOP OF RED TILL	TOP OF ROCK	TOP OF SCREEN	BOTTOM OF SCREEN	TOP OF SANDPACK	TOP OF BENTONITE SEAL
	NORTHING	EASTING	GROUND SURFACE	PVC CASING	PROTCTV CASING	PVC CASING	PROTCTV CASING	FT	ELEV	FT	FT	FT	FT	FT	FT		FT	FT	FT
MW-A-1S	11323.04	10556.53	313.1	314.68	315.05	1.6	2.0	20.0	293.1	15.8	-	-	-	-	-	8.3			3.0
MW-A-1D	11323.22	10546.16	313.1	314.55	315.02	1.4	1.9	39.1	274.0	18.0	24.5	30.00	32.5	-	-	27.2	37.2		[illegible]
MW-B-1S	11326.84	10243.19	312.0	313.40	313.80	1.4	1.8	22.0	290.0	17.4	-	-	-	-	-	7.7	17.7		
MW-B-1D	11320.36	10236.04	312.8	314.00	314.60	1.2	1.8	47.0	265.8	18.3	-	-	33.5	45.0	-	34.9	44.9	32.0	
MW-B-2S	11404.31	9983.08	310.2	311.32	311.83	1.1	1.6	15.0	295.2	-	-	-	-	-	-	5.9	14.8	3.4	0.5
MW-B-2D	11410.64	9993.16	310.3	311.75	312.18	1.4	1.9	49.8	260.5	14.4	20.3	-	29.5	-	49.4	24.2	48.0	22.2	18.9
MW-B-3	11066.29	10498.20	314.7	316.41	316.64	1.7	1.9	18.0	296.7	16.4	-	-	-	-	-	7.5	17.5	4.0	1.0
MW-B-4S	11420.06	9534.25	311.1	312.58	313.19	1.5	2.1	13.5	297.6	-	-	-	-	-	-	5.0	12.0	3.0	0.3
MW-B-4D	11423.34	9545.91	311.4	312.73	313.16	1.3	1.8	54.9	256.5	14.9	20.3	-	22.8	53.0	54.9	27.1	53.1	22.5	18.3
MW-C-1S	9895.49	10731.40	317.4	318.55	319.34	1.2	1.9	20.0	297.4	15.2	-	-	-	-	-	5.8	15.8	3.5	0.5
MW-C-1D	9899.68	10742.80	317.3	318.57	319.13	1.3	1.8	39.5	277.8	13.8	-	-	27.3	37.3	39.5	30.0	38.0	27.9	22.8
MW-C-2D	10203.51	10580.57	312.9	315.10	315.50	2.2	2.6	34.5	278.4	10.0	-	-	22.5	33.5	35.0	22.9	32.9	21.0	19.0
MW-C-3S	10220.91	10090.01	311.5	312.63	313.17	1.1	1.7	20.0	291.5	15.2	-	-	-	-	-	5.8	15.8	3.5	0.5
MW-C-3D	10223.28	10103.26	311.7	313.43	314.01	1.7	2.3	34.0	277.7	15.5	23.4	24.0	16.0	28.7	34.0	21.0	29.0	18.5	15.5
MW-D-1	10040.10	9890.30	313.5	314.72	315.23	1.2	1.7	35.5	278.0	7.0	10.0	14.9	21.3	31.8	35.5	23.0	33.0	21.0	8.0
SB-1	10954.10	9073.60	313.2	-	-	-	-	9.5	303.7	-	-	-	-	-	-	-	-	-	-
SB-2	10898.70	9727.70	309.0	-	-	-	-	9.5	299.5	-	-	-	-	-	-	-	-	-	-
SB-3	10960.60	10079.20	313.4	-	-	-	-	9.5	303.9	-	-	-	-	-	-	-	-	-	-
SB-4	11409.30	9960.00	310.1	-	-	-	-	9.5	300.6	-	-	-	-	-	-	-	-	-	-

Note: Depth of bedrock based upon drilling refusal; actual bedrock was not penetrated.
Coordinate locations and elevations based upon CWM site grid system and datum and are not related to any established State or Federal grid system or datum.



LOOW SITE

FORMER LAKE ONTARIO ORDNANCE WORKS
LEWISTON, NEW YORK

MONITORING WELL
& SOIL BORING
LOCATION MAP

FIGURE 5-4

Each soil boring was advanced with hollow stem augers to a depth of 9.5 ft below ground surface. Two soil samples were collected from each boring for chemical analyses. At each boring, samples were collected at 2 ft and 8 ft below ground surface. Upon completion each boring was backfilled to ground surface with a cement/bentonite grout.

Well Borings/Installations

A total of 15 well borings were performed at the LOOW site as part of this remedial investigation (see Figure 5-4). Each well boring was completed as a groundwater monitoring well designed to monitor upper glacial till water-bearing zone (Zone 1) or the lower glaciolacustrine silt and sand water bearing zone (Zone 3). Twelve of the 15 wells were installed as monitoring well couplets at six locations. The remaining three monitoring wells were installed at separate locations. Each monitoring well couplet consisted of a shallow (Zone 1) and a deep (Zone 3) monitoring well.

As previously mentioned in Section 2.8, overall groundwater flow at the site is generally to the north west. The locations of the newly installed monitoring wells were selected so that groundwater quality in both water bearing zones (Zones 1 and 3) could be monitored upgradient and downgradient of each area of concern (i.e. Areas A, B, C, D, and the Wooded Area). At some locations existing CWM monitoring wells were incorporated into the groundwater monitoring network.

In Area A, existing CWM monitoring well couplet MW-7-5S+D was used as the upgradient monitoring well couplet. Monitoring well couplet MW-A-1S+D was installed to monitor groundwater quality downgradient of Area A.

Existing CWM monitoring well couplet MW-7-3S+D was used to monitor groundwater quality upgradient to Area B. In addition, shallow (Zone 1) monitoring well MW-B-3 was installed to monitor upgradient groundwater quality in the area east of Area B. This particular upgradient location was selected because previous use of the area by SCA as a temporary drum storage site may have impacted local groundwater quality. Monitoring well couplet MW-B-1S+D was installed to monitor groundwater quality downgradient of Area B.

Monitoring well couplet MW-C-1S+D was installed to monitor groundwater quality upgradient of Area C. Monitoring well couplet MW-C-3S+D and deep (Zone 3) monitoring well MW-C-2 were installed to monitor groundwater quality downgradient of Area C. A monitoring well couplet was originally proposed for location MW-C-2, but the absence of groundwater in the upper till zone precluded the installation of a shallow well at this location. In Area C each downgradient monitoring well location was selected so that the groundwater quality could be monitored directly downgradient of the proposed test pit excavation locations.

Deep (Zone 3) monitoring well MW-D-1 was installed to monitor groundwater quality upgradient of Area D. Existing CWM monitoring well TMW-14 was used to monitor groundwater quality in Zone 1 upgradient of this area. Existing SCA monitoring wells MW-12-8S+UD were used to monitor groundwater quality downgradient of Area D. This CWM well couplet was also selected as an upgradient monitoring point for the Wooded Area.

Monitoring well couplets MW-B-2S+D and MW-B-4S+D were installed to monitor groundwater quality downgradient of the Wooded Area. Monitoring well couplet MW-B-2S+D was originally proposed to monitor groundwater quality downgradient of Area B, however, due to inaccessability at the proposed location immediately west of Area B, the monitoring well couplet was relocated to the present location.

Well Borings

At each proposed monitoring location, the boring for the deep monitoring well was initiated before drilling the shallow boring (except at monitoring well location MW-B-4S+D where the shallow boring was performed first). Drilling was accomplished utilizing either 6-1/4 inch ID; 6-5/8 inch ID, or 8-1/4 inch ID continuous flight hollow stem augers. Drilling of the deeper portions of the Zone 3 monitoring wells was accomplished utilizing 6-1/4 ID flush-joint spin casing and wash rotary techniques.

At each well couplet location, except at MW-B-4S+D, the deep well boring was continuously split spoon sampled. At monitoring well couplet MW-B-4S+D the shallow well boring was continuously sampled; the deep well boring was then augered to the depth of the shallow well boring and continuously sampled from that point until the final depth was reached. The three individual wells, MW-B-3, MW-C-2, and MW-D-1 were continuously sampled throughout the advancement of each boring.

The drilling of the deep well borings was accomplished in two phases. The first phase consisted of drilling down into the glaciolacustrine clay aquitard with 6-1/4 inch ID, 6-5/8 inch ID, or 8-1/4 inch ID hollow steam augers, depending upon the availability of the augers being shared between the two drilling rigs. Once the deep well boring was drilled to the desired depth into the aquitard, a permanent 8 inch steel casing was grouted into place with a cement/bentonite grout. After the grout had cured for a minimum of 48 hours, or 24 hours if an accelerator ($CaCl_2$) had been used, the borehole was readvanced with 6-1/4 inch ID flush-joint spin casing and wash rotary techniques while continuously collecting split spoon samples. The second phase of drilling was completed once the desired depth was reached and verified with a weighted tape.

Drilling of the well borings for the shallow (Zone 1) monitoring wells was typically performed during the time period when the grout in the 8 inch separation casing for the deep well of the couplet was curing. The drilling of the shallow well borings utilized the same augers as used for the first phase of the deeper boring.

At each well boring, split spoon sampling was accomplished using 2 inch OD by 2 ft long split spoon samplers advanced in accordance with ASTM D-1586. Upon recovery of each sampler, the length of the sample was recorded and each sample characterized for color and classified using the Unified Soil Classification System. Each borehole and recovered sample were monitored for organic vapors with an OVA or HNu, explosive gases with a combustible gas indicator and radioactivity with a Geiger counter.

Monitoring Well Construction

Each of the 15 well borings was completed as a groundwater monitoring well designed to monitor groundwater occurring in the upper glacial till (Zone 1) and glaciolacustrine silt and sand (Zone 3) water bearing zones. Each well was constructed of 4 inch ID schedule 80 PVC riser and varying lengths of 4 inch ID schedule 80 PVC #10 slotted (0.010 inch) screen. The length of the screen was dependent upon the thickness of the zone to be monitored with each zone screened through its entire thickness (see Table 5-1).

Once the well screen and riser were placed in the borehole, a No. 2 Q-Rock sandpack was placed in the annular space around the well screen by use of a tremie pipe to at least 2 ft above the screen and riser joint. A minimum of 2 ft of 3/8 inch diameter bentonite pellets were placed above the sandpack to prohibit downward migration of water within the borehole.

Once the bentonite pellet seal was allowed to hydrate (a minimum of five days), a minimum of 0.5 ft of sand was placed above the bentonite seal. The remaining annulus was then backfilled with a cement/bentonite grout by use a tremie pipe. Each well was supplied with a 6 inch ID steel protective casing and locking cap seated within the cement/bentonite grout. Each well was completed with a concrete collar mounded around the base of the protective casing to direct precipitation runoff away from the well. Table 5-1 summarizes the well construction details for each newly installed monitoring well at the LOOW site.

5.5 - Sampling

In an attempt to determine the presence or absence of contamination of various media which may have resulted from the government's past use of the LOOW site, samples for chemical analyses were collected from groundwater, subsurface soils from borings and test pits, excavated drums, and surface water and sediment. All samples were placed in pre-cleaned sample containers obtained from I-Chem Research Co. The following subsections present sampling details for each media of concern.

5.5.1 - Test Pit Sampling

Soil samples for chemical and geotechnical analyses were collected from test pits TP-A1, TP-C1, and TP-C2 in an attempt to determine the presence/absence of contamination as a result of the government's past waste disposal practices. Although no drums were found in test pits TP-C1 and TP-C2, soil samples were collected to determine if any contamination was present as a result of backfilling of any contaminated waste into the buried building foundations.

In each test pit, soil samples were collected at 5 ft intervals along discrete horizons. The soil samples from each horizon were then homogenized resulting in one composite sample representative of each horizon. Soil samples scheduled for volatile organic analyses were collected directly into 4 oz. Teflon lined screw cap glass sample containers prior to homogenizing the sample.

Select horizons of each test pit were sampled utilizing precleaned dedicated stainless steel spoons and homogenization bowls. At each sampling location within the test pits, the soils on the surface of the test pit wall were scraped away using a dedicated-by-level steel shovel, thus exposing fresh formation soils.

The required volumes of soils were then scraped into the appropriate homogenization bowls using the stainless steel spoons. All test pit sampling equipment was decontaminated prior to use following details presented in Section 5.5.7. The following text presents specific sampling activities particular to each test pit.

Test Pit TP-A1

Test Pit TP-A1 was the only test pit in which drums were encountered. As previously mentioned in Section 5.4, the drums found in this test pit were partially crushed and in various states of deterioration with many sharp edges exposed. As a result of the potential hazard posed to sampling personnel by the exposed metal edges coupled with the presence of groundwater within the test pit, sampling personnel did not enter the test pit to collect soil samples. In lieu of directly sampling the test pit walls, representative soil samples were removed from the test pit with the excavator bucket. The sampling was accomplished by using the excavator to remove a bucket load of sample from the horizon to be sampled. In this test pit a bucket-load of soil was removed from the 5 ft horizon and from the bottom of the test pit. Once each bucket load of soil was withdrawn from the test pit the soils on the outside of the bucket-load of soil, still remaining in the bucket, were scraped away with the stainless steel spoon. The required volumes of each sample were then collected and placed directly into the appropriate sample containers. Two soil samples were collected from test pit TP-A1 and analyzed for the parameters listed in Table 5-2.

In addition to the two soil samples, a water sample was collected from test pit TP-A1. The water within the test pit was collected in a one liter amber glass jar attached to a pond sampler. The water sample was collected from just below the water surface. An attempt was made to include some of the water's surface which had an oily sheen. Once the sampler was removed from the water, the sample was

TABLE 5-2

ANALYTICAL PARAMETERS AND SAMPLE CONTAINERS[1) FOR TEST PIT SAMPLES

Parameters	Soil	Water	Drum Waste
Volatile Organics	4 oz glass	2-40 ml VOA vial	4 oz glass
Semi-volatile Organics	8 oz amber glass	1 l. amber glass	8 oz amber glass
Pesticides/PCBs	8 oz amber glass	1 l. amber glass	8 oz amber glass
Ignitability, Corrosivity, Reactivity Paint Filter Test, and EP Toxicity	----	1 l. amber	2-8 oz amber glass
Metals	8 oz amber glass	1 l. plastic	8 oz amber glass
Moisture Content	8 oz glass	----	----

1) All sample containers except 8 oz glass for moisture content analyses supplied by I-Chem Research Co.

transferred into the appropriate sample containers. The water sample collected from test pit TP-A1 was analyzed for the parameters listed in Table 5-2.

Upon collection, each sample was visually characterized (Unified Soil Classification System for soils), chilled to 4°C, chain-of-custody originated and shipped to the appropriate laboratory for analyses. The water sample scheduled for metals analyses was preserved to a pH of less than two standard units with nitric acid prior to chilling.

Test Pit TP-C1

Two composite soil sample sets were collected from the soils and associated building debris in test pit TP-C1. One composite was collected from the 5 ft depth level and one composite set from the bottom of the test pit (approximately 8 ft). The soil samples were collected for analyses of parameters presented in Table 5-2.

Test Pit TP-C2

Three composite soil sample sets were collected from test pit TP-C2. Each set represented soils from the bottom of the test pit and from the 5 and 10 ft soil horizons. Each sample set was analyzed for the parameters listed in Table 5-2.

5.5.2 - Drum Sampling

Five drums (DS-1 through DS-5) from test pit TP-A1 were sampled for the chemical parameters listed in Table 5-2. The additional parameters of ignitability, corrosivity, reactivity, paint filter test, and E.P. toxicity were included in the analytical program so as to determine if the drum contents would be considered hazardous wastes thus effecting the final disposition of the excavated drums.

Drum sampling was performed once each drum was removed from the test pit and placed on plastic sheeting. Samples were collected from the drums through existing openings using a stainless steel spoon. Upon bailer, well wizard, or an ISCO Model 1580 peristaltic pump with dedicated 3/8-inch polyethylene tubing and silastic rubber hose. Table 5-5 contains a summary of the evacuation method and associated information obtained from each well location.

After purging, groundwater samples (except at monitoring well MW-C-3S) were collected using either precleaned, single check-valve (bottom fill) stainless steel bailers or dedicated well wizard system. Due to the negligible recharge of MW-C-3S, a stainless steel bailer was utilized to only collect two 40 ml vial samples. In order to collect the maximum amount of sample possible from MW-C-3S, a ISCO Model 1580 peristaltic pump with Teflon intake and discharge tubing was used to fill the remaining sample containers. Onsite measurements of physio-chemical parameters (pH, temperature, and specific conductance) were taken and recorded from each monitoring well after sample collection. Excess water from each well sample was transferred into separate labeled sample containers for these measurements. Section 7 contains a summary of the pH, conductivity, and temperature readings obtained for each sampling point. All physio-chemical measurements were made in accordance with the protocols outlined in the methods for chemical analysis of water and wastes (EPA-600/4-79-0920).

Specific details regarding sample collection methodology can be found in Appendix B.

5.5.7 - Decontamination Procedures

All drilling, excavation, and sampling equipment was decontaminated prior to use. Two decontamination procedures were followed depending upon the intended use of the equipment. In general, all drilling and excavation equipment was cleaned with soap and high pressure steam while equipment used to collect samples for chemical analyses were put through a more rigorous decontamination procedure.

TABLE 5-5
GROUNDWATER SAMPLING CHARACTERISTICS

Sheet 1 of 2

WELL I.D.	EVACUATION DATE	TIME	SIZE/TYPE OF CASING	WATER LEVEL (FT)*	BOTTOM OF WELL (FT)*	VOLUME OF STANDING WATER (GAL.)	METHOD OF EVACUATION	VOLUME EVACUATED (GAL.)	RECHARGE RATE +
MW-A-1S	7/27/88	0915 1010	4" PVC	15.29	19.58	2.80	Peristaltic Pump	8 to dry	Very slow
MW-A-1D	7/27/88	0915 1040	4" PVC	12.66	38.07	16.58	Stainless Steel Bailer	50	Rapid
MW-B-1S	7/28/88	1045 1120	4" PVC	10.00	22.00	7.83	Peristaltic Pump	23.5	Slow
MW-B-1D	7/28/88	1055 1205	4" PVC	12.30	47.00	22.65	PVC Bailer	68	Rapid
MW-B-2S	7/27/88	1040 1055	4" PVC	9.70	15.00	3.45	Peristaltic Pump	7.5 To Dry	Rapid
MW-B-2D	7/27/88	1030 1115	4" PVC	10.05	49.30	25.62	PVC Bailer	77	Rapid
MW-B-3	7/27/88	1100 1115	4" PVC	10.22	18.93	5.68	PVC Bailer	9 To dry	Very slow
MW-B-4S	7/27/88	0845 0915	4" PVC	7.60	13.50	3.85	Peristaltic Pump	8 To dry	Very slow
MW-B-4D	7/27/88	0840 1015	4" PVC	11.00	54.90	28.65	PVC Bailer	86	Rapid
MW-C-1S	7/28/88	0940 1025	4" PVC	2.85	20.00	11.19	Peristaltic Pump	34	Slow
MW-C-1D	7/28/88	0950 1015	4" PVC	6.00	39.50	21.86	PVC Bailer	28 To dry	Rapid
MW-C-2D	7/28/88	1120 1153	4" PVC	1.43	34.25	21.42	PVC Bailer	65	Rapid
MW-C-3S	7/27/88	1130 1150	4" PVC	12.27	13.03	.49	Peristaltic w/Teflon Tubing PVC Bailer	.5 to dry	Negligible

TABLE 5-5
(Cont'd)

Sheet 2 of 2

WELL I.D.	EVACUATION DATE	TIME	SIZE/TYPE OF CASING	WATER LEVEL (FT)*	BOTTOM OF WELL (FT)*	VOLUME OF STANDING WATER (GAL.)	METHOD OF EVACUATION	VOLUME EVACUATED (GAL.)	RECHARGE RATE +
MW-C-3D	7/27/88	1130 1155	4" PVC	1.62	30.52	18.86	PVC Bailer	28 to dry	Slow
MW-D-1	7/27/88	1040 1105	4" PVC	1.45	33.82	21.13	PVC Bailer	28 to dry	Rapid
MW-7-3S	7/27/88	1000	2" SS	7.01	20.16	2.10	Stainless Steel Bailer	3.0 to dry	Slow
MW-7-3D	7/27/88	1000	2" SS	14.06	43.63	4.80	Well Wizard	9.9 to dry	Rapid
MW-7-5S	7/27/88	0915	2" SS	7.61	25.92	3.00	Stainless Steel Bailer	6.0 to dry	Slow
MW-7-5D	7/27/88	0915	2" SS	15.20	40.29	4.00	Well Wizard	5.9 to dry	
MW-12-8S	7/27/88	1050	2" SS	12.61	42.91	5.00	Well Wizard	15.0	Rapid
TMW-14S	7/27/88	1150	2" SS	3.74	17.93	2.30	Stainless Steel Bailer	3.5 to dry	Slow

* From top of inner casing.

\+ Recharge rate determined by the following criteria:
- Continuous: no drop in water level during evacuation.
- Rapid: recharges within one (1) hour.
- Slow: recharges after eight (8) hours.
- Very slow: must return another day.
- Negligible: does not recharge within 48 hours.

Drilling and Excavation Equipment Decontamination

Equipment falling into this category includes well purging bailers, the John Deere excavator, drilling rigs, PVC screens and riser pipes, augers, rods, standard split spoon samplers, and apurtenant equipment. Prior to use at the site and before each boring the equipment was decontaminated using the following procedure:

- Removal of all loose soil;
- Steam clean with soap and potable water;
- Steam clean rinse with potable water; and
- All decontaminated equipment was placed on clean support structures.

In addition, the split spoon samplers used to collect soil samples for visual classification and geotechnical analyses were cleaned at the drill rig after each sampling attempt using the following procedure:

- Removal of all loose soils;
- Wash with Alconox and potable water; and
- Potable water rinse.

Chemical Sampling Equipment

All equipment used to collect samples scheduled for chemical analyses were decontaminated using the following procedures:

- Removal of all loose soils;
- Alconox and water wash;
- Potable water rinse;
- Distilled/deionized water rinse;
- Isopropanol rinse;
- Total air dry; and
- Final rinse with laboratory prepared distilled/deionized water.

Equipment decontaminated according to this procedure included groundwater sampling bailers and stainless steel split spoon samplers, homogenization bowls, and transfer spoons. The stainless steel split spoons, homogenization bowls, and transfer spoons used at the soil borings were decontaminated prior to use and dedicated to collecting one sample per boring with each sampling set being reused after decontamination at a different boring.

The stainless steel homogenization bowls and transfer spoons used to obtain soil samples from the test pits and exhumed drums were purchased new, decontaminated, and dedicated to one sample only and not used again in the field investigation.

5.6 - Analytical Procedures

5.6.1 - Analytical Schedules

The analytical parameters for samples collected for this remedial investigation are listed on six schedules presented in Table 5-6. The parameters of Schedule A of this table include volatiles, semivolatiles and pesticides/PCBs which were analyzed using the methodologies described in SW846, Third Edition. However, the compounds specifically analyzed for were those included in the Target Compound List (TCL) presented in the latest USEPA Contract Laboratory Program (CLP) Statement of Work (SOW). These procedures also required that up to 10 non-targeted volatile compounds and up to 20 non-targeted, semi-volatile compounds receive tentative identification by a computer library search of mass spectra and quantification against the nearest eluted standard.

The metals analysis of Schedules B and C was performed according to SW846 Third Edition methods using flame, vapor or graphite furnace atomic adsorption techniques. Total and dissolved metals were performed for groundwaters while only total metals were analyzed for surface water, sediment soil and waste samples. The groundwater samples for dissolved metals were filtered in the field using a 0.45 micron membrane filter prior to preservation and subsequent shipment to the lab.

TABLE 5-6
(Cont'd)

REFERENCES

1. "Test Methods for Evaluating Solid Waste", SW 846, Third Edition, USEPA, Office of Solid Waste and Emergency Response, November 1986.

2. "Method for Chemical Analysis of Water and Wastes", EPA 600/4-79-020, USEPA, Environmental Monitoring and Support Laboratory, Revised March 1983.

3. "Standard Methods for the Examination of Water and Wastewater", APHA, AWWA, WPCF, 16th Ed. 1985.

4. Methods for nitroaromatics in water samples (UW05) and soil samples (LW07) were developed by metaTRACE according to USATHAMA specifications. Method numbers presented (UW05 and LW07) are USATHAMA certification numbers issued for these methods as developed by metaTRACE.

Radiation analyses (Schedule D) performed on selected groundwater samples include quantification of gross alpha and beta particles. This analysis was subcontracted by Recra Environmental Inc. to Teledyne Isotope Laboratories.

Schedule E included analysis of nitroaromatic and other explosives related compounds. This analysis was performed on selected groundwater and soil samples. The methods employed were developed by the subcontracted laboratory, metaTRACE, according to USATHAMA specifications.

Schedule F concludes the parameter list with sulfates and nitrates. These analyses were scheduled for samples from the acid waste lines indicated on site drawings and allegedly encountered during construction and excavation activities by subsequent owners of the site. However, these lines could not be located during the remedial investigation which resulted in no samples analyzed for these parameters.

5.6.2 - Deliverable Package

The deliverable analytical report from the laboratory as requested by the COE was a "standard" report as opposed to a full CLP deliverable package. The report included:

- All analytical results in tabular form;
- Matrix spike and matrix spike duplicate analysis;
- Field blank (trip VOAs, rinse blanks) results;
- Field duplicate analysis (submitted blind);
- Laboratory duplicate results (other than organic analyses);
- Laboratory blank results;
- Surrogate spike and recovery data;
- A list of tentatively identified (non-targeted) compounds (TIC) for volatile and semi-volatile analyses; and
- Chain-of-custody records.

A summary of the analytical results listing all compounds detected including negated data and compounds below the contract required quantification limit (CRQL) is presented in Appendix E. A copy of the complete original analytical report is available from Acres upon written request to Acres (with subsequent approval from COE). Summary tables listing only quantifiable non-negated target compound concentrations are provided in Section 7 - Analytical and Monitoring Results.

5.6.3 - Summary of Analyses Performed

The following is a description of analyses performed for each sample type. Included is a description of variations from the work plan for field collections or subsequent analyses. A complete list of all samples collected and analyses performed is presented in Table 5-7.

Test Pit

A total of 12 trench soils plus required QA field duplicates were originally planned. However, as a result of a shallow water table (Area A) and not finding the acid or TNT waste lines, only seven samples plus one QA duplicate were collected. These eight test pit samples along with associated QC samples were analyzed for the parameters listed in Table 5-7.

Boring Soils

Four test borings drilled in the Wooded Area were sampled at two depths each. In addition, two field duplicates were collected. The resulting 10 samples plus associated QC samples were analyzed for the parameters in Table 5-7.

TAL 5-7
LOOW SAMPLES AND ANALYSES PERFORMED

Sheet 1 of 5

KEY: X = Analysis Performed   - = Not Required   O = Not Performed (Lost Sample/Insufficient Volume)

SAMPLE ID	VOA	SEMI-VOA	PEST/PCB	METALS		GROSS ALPHA/BETA	NITRO AROM	EP TOX MET/ORG	IGNIT. REACT. CORROS. PAINT FILT.
				TOT	SOL				
TEST PIT SOILS									
TP-A1-CS-5	X	X	X	X	-	-	-	-	-
TP-A1-CS-BOT	X	X	X	X	-	-	-	-	-
TP-C1-CS-5	X	X	X	X	-	-	-	-	-
TP-C1-CS-BOT	X	X	X	X	-	-	-	-	-
TP-C2-CS-5	X	X	X	X	-	-	-	-	-
TP-C2-CS-10	X	X	X	X	-	-	-	-	-
TP-C2-CS-BOT	X	X	X	X	-	-	-	-	-
QC									
TP-DUP-1	X	X	X	X	-	-	-	-	-
TP-C1-CS-5MS	X	X	X	X	-	-	-	-	-
TP-C1-CS-5MSD	X	X	X	X	-	-	-	-	-
TB-1	X	-	-	-	-	-	-	-	-
TB-3	X	-	-	-	-	-	-	-	-
SOIL BORING SAMPLES									
SB-1-2-3.5	-	-	-	X	-	-	X	-	-
SB-1-8-9.5	-	-	-	X	-	-	X	-	-
SB-2-2-3.5	-	-	-	X	-	-	X	-	-
SB-3-2-3.5	-	-	-	X	-	-	X	-	-
SB-3-8-9.5	-	-	-	X	-	-	X	-	-
SB-4-2-3.5	-					-	X	-	-
SB-4-8-9.5	-					-	X	-	-

TABLE 5-7
LOOW SAMPLES AND ANALYSES PERFORMED

Sheet 2 of 5

KEY: X = Analysis Performed   - = Not Required   O = Not Performed (Lost Sample/Insufficient Volume)

SAMPLE ID	ANALYTICAL PARAMETERS								
	VOA	SEMI-VOA	PEST/PCB	METALS		GROSS ALPHA/BETA	NITRO AROM	EP TOX MET/ORG	IGNIT. REACT. CORROS. PAINT FILT.
				TOT	SOL				
QC									
SB-DUP-1	-	-	-	X	-	-	X	-	-
SB-DUP-2	-	-	-	X	-	-	X	-	-
SB-RB-1	-	-	-	X	-	-	X	-	-
SB-RB-2	-	-	-	X	-	-	X	-	-
SURFACE SOILS									
SS-B1	X	X	X	X	-	-	X	-	X
QC									
SS-DUP-1	X	X	X	X	-	-	X	-	X
BACKGROUND SOILS									
BGD-SS1	X	X	X	X	-	-	-	-	-
BGD-SS2	X	X	X	X	-	-	-	-	-
QC									
SS-DUP	X	X	X	X	-	-	-	-	-

TABLE 5-7
LOOW SAMPLES AND ANALYSES PERFORMED

Sheet 3 of 5

KEY: X = Analysis Performed   - = Not Required   O = Not Performed (Lost Sample/Insufficient Volume)

	ANALYTICAL PARAMETERS								
				METALS					
SAMPLE ID	VOA	SEMI-VOA	PEST/PCB	TOT	SOL	GROSS ALPHA/BETA	NITRO AROM	EP TOX MET/ORG	IGNIT. REACT. CORROS. PAINT FILT.
DRUM SAMPLES									
DS-1	X	X	X	X	-	-	-	X	X
DS-2	X	X	X	X	-	-	-	X	X
DS-3	X	X	X	X	-	-	-	X	X
DS-4	X	X	X	X	-	-	-	X	X
DS-5	X	X	X	X	-	-	-	X	X
QC									
DS-DUP-1	X	X	X	X	-	-	-	-	X
TB-2	X	-	-	-	-	-	-	-	-
TEST PIT WATER									
TP-A1-WAT	X	X	X	X	-	-	-	X	X
GROUNDWATERS									
MW-A-1S	X	X	X	X	X	X	X	-	-
MW-A-1D	X	X	X	X	X	-	-	-	-
MW-B-1S	X	X	X	X	X	X	X	-	-
MW-B-1D	X	X	X	X	X	-	-	-	-
MW-B-2D	X	X	X	X	X	X	X	-	-
MW-B-2S	X	X	X	X	X	-	-	-	-
MW-B-3	X	X	X	X	X	X	O	-	-
MW-B-4S	X	X	X	X	X	X	X	-	-

TAL 5-7

LOOW SAMPLES AND ANALYSES PERFORMED

Sheet 4 of 5

KEY: X = Analysis Performed   - = Not Required   O = Not Performed (Lost Sample/Insufficient Volume)

	ANALYTICAL PARAMETERS								
				METALS					
SAMPLE ID	VOA	SEMI-VOA	PEST/PCB	TOT	SOL	GROSS ALPHA/BETA	NITRO AROM	EP TOX MET/ORG	IGNIT. REACT. CORROS. PAINT FILT.
GROUNDWATERS									
MW-B-4D	X	X	X	X	X	X	X	-	-
MW-C-1S	X	X	X	X	X	X	X	-	-
MW-C-1D	X	X	-	X	X	-	-	-	-
MW-C-2D	X	X	-	X	X	-	-	-	-
MW-C-3S	X	O	-	O	X	-	-	-	-
MW-C-3D	X	X	-	X	X	-	-	-	-
MW-D-1	X	X	X	X	X	X	X	-	-
MW-7-3S	X	X	-	X	X	-	-	-	-
MW-7-3D	X	X	-	X	X	-	-	-	-
MW-7-5S	X	X	-	X	X	-	-	-	-
MW-7-5D	X	X	-	X	X	-	-	-	-
MW-12-8S	X	X	-	X	X	-	-	-	-
MW-12-8UD	X	X	-	X	X	-	-	-	-
TMW-14	X	X	-	X	X	-	-	-	-
QC									
MW-2S-DUP	-	-	X	-	-	-	-	-	-
MW-DUP-2	X	X	X	X	X	X	X	-	-
MW-4D-MS	X	X	X	X	X	-	-	-	-
MW-4D-MSD	X	X	X	X	X	-	-	-	-
MW-RB-1	X	X	X	X	X	-	-	-	-
MW-RB-2	X	X	X	X	X	-	-	-	-
TB-4	X	-	-	-	-	-	-	-	-
TB-5	X	-	-	-	-	-	-	-	-

TABLE 5-7
LOOW SAMPLES AND ANALYSES PERFORMED

Sheet 5 of 5

KEY: X = Analysis Performed - = Not Required O = Not Performed (Lost Sample/Insufficient Volume)

	ANALYTICAL PARAMETERS								
				METALS					
SAMPLE ID	VOA	SEMI-VOA	PEST/PCB	TOT	SOL	GROSS ALPHA/BETA	NITRO AROM	EP TOX MET/ORG	IGNIT. REACT. CORROS. PAINT FILT.
SURFACE WATERS									
SW-B1	X	X	O	X	-	-	-	-	-
QC		QC SAMPLE SUBMITTED TO LAB WITH GROUNDWATERS							
POTABLE WATER									
PW	X	X	X	X	-	-	-	-	-
QC									
PW-TB	X	-	-	-	-	-	-	-	-

Surface Soils

One sediment sample was collected from the pond in Area B. This sample, plus a field duplicate, was analyzed for the parameters listed in Table 5-7.

Background Soils

Two background soils were collected from Joseph Davis State Park located approximately four miles west of the LOOW Site (see Figure 2-12). These soils, which would be used for comparison purposes with on-site soils, were analyzed for the parameters listed in Table 5-7.

Drum Wastes

The test pit excavation in Area A confirmed the presence of drums. Several drums were excavated and five were sampled and analyzed. A duplicate sample was mistakenly collected and received a partial analysis before the error was discovered and a hold placed on the analysis. Analyses completed on the drum samples are presented in Table 5-7.

Waste Lines

It was originally planned that the acid and TNT waste lines would be sampled and analyzed. However, the waste lines could not be located and no samples were analyzed.

Test Pit Water

When test pit TP-A1 was excavated, groundwater was encountered approximately 3 ft below the surface. Drums were also encountered at this depth and the excavation was terminated at a depth of about 8 ft. Although not in the original scope of work, a field decision was made to collect a sample of the water in the pit and analyze for the parameters presented in Table 5-7.

Groundwater

Groundwater samples were collected from 22 wells and analyzed for the parameters presented in Table 5-7. One well (MW-C-3S) did not fully recharge after being purged to dryness. The samples were collected over a two day period which resulted in only two sets of QC samples (instead of the originally planned three sets). Three samples did not receive complete analysis as a result of insufficient sample volume: Sample MW-B-3 did not receive nitroaromatics analysis as a result of breakage during shipping; Sample MW-C-3S did not receive total metal and semi-volatile analyses due to insufficient volume in the well; and the fraction of Sample SW-B1 scheduled for pesticide and PCB analyses was broken in transit to the laboratory.

An explanation is required for sample MW-DUP-1 which was never analyzed as a field duplicate of sample MW-B4-D. Insufficient sample volume was sent to the lab to perform both MS/MSD and field duplicate analyses. Therefore, the lab was instructed to use MW-DUP-1 (blind field duplicate of MW-B-4D) to make up the required volume of sample to perform MS/MSD on MW-B-4D. The balance of MW-DUP-1 was used to perform field duplicate analyses for the semi-volatile fraction as sample MW-B-4D-DUP. Sample MW-B-2S contained sufficient volume to perform a field duplicate (MW-B2S-DUP) for the pesticide/PCB fraction. However, not enough sample volume remained (of MW-B-2S-DUP) to perform a field duplicate analysis for VOA or metals. Therefore, a field duplicate for VOA and metals was not analyzed by Acres' subcontracted laboratory, but a field duplicate of MW-B-4D for these analyses was sent to the COE MRD QA laboratory. The MRD analyses could be used to evaluate field precision or variability for VOA and metals. This proposed solution was relayed to the COE QA Manager in Kansas City and accepted.

Surface Water

A single surface water sample was collected from the pond in Area B. As a result of a miscommunication between the field crew and the laboratory, PCB analysis, although planned, was never completed.

(The significance of the lack of this sample is discussed in Section 7.5.) The balance of analyses which were completed included the parameters presented in Table 5-7. This sample was submitted with the groundwater samples and therefore required no additional QC analyses.

Potable Water

Prior to the initiation of the drilling program at the LOOW site, samples of the water source for drilling purposes (grout, drilling, and steam cleaning) was sampled and analyzed for the parameters listed in Table 5-7.

5.7 - Land Survey

Upon completion of all drilling, test pit and sample collection activities, the locations of the newly installed monitoring wells, soil borings and several field reference points were surveyed for coordinate locations and elevations by Ivan R. Klettke, licensed land surveyor. The grid coordinator system and elevation datum referenced in the land survey are CWM site systems and datum and are not related to any state or federal plane coordinate system or elevation datum. The elevation datum is, however, approximately equal (within 1 ft) of mean sea level datum.

The results of the land survey are presented in Appendix E. The elevation survey included the elevations of ground surface at each monitoring well and soil boring location, as well as the elevations of the top of the PVC and protective steel casing for each monitoring well. The ground surface elevations for each monitoring well and soil boring have been included on the associated subsurface boring logs presented in Appendix H. All monitoring well and soil boring locations are presented on Figure 5-4.

6 - RESULTS OF THE GEOPHYSICAL SURVEY

The chief purposes of the geophysical survey were to help guide subsequent subsurface field activities of the remedial investigation and to aid in interpreting groundwater or soil contamination data from subsequent sample collection. The magnetometer survey was generally successful in attaining the first goal and was useful in determining the locations of the proposed test pits. The electromagnetic conductivity survey, on the other hand, did not provide data as conclusive as the magnetometer survey, largely a result of the nature of the electromagnetic survey and the effects of natural soil conditions. While the goal of electromagnetic survey was to reveal zones of soil or groundwater contamination, increased subsurface conductivity readings may have also been caused by other factors such as increased moisture content of soils or increased clay or silt content. Therefore, the results of the electromagnetic survey are much more subject to interpretation.

Magnetometer Survey

The magnetometer survey was useful in locating buried metallic objects in Areas A and C (see Appendix C). Since historical records indicated that limited burying of drummed materials may have occurred in these areas, the magnetic anomalies observed were prime locations for the proposed test pits. A large anomaly was detected in the southern third of Area A. Subsequent excavation of test pits in this area revealed the presence of drums a few feet below the surface in the eastern half of this anomaly. The test pits excavated in the western end of the anomaly detected no drums or other metallic objects, however, the area did contain some black granular material as well as other foreign fill materials which may have affected the magnetometer survey results.

Two major magnetic anomalies were identified in Area C. The one at the western end of the area coincided with historical references of drum burial at that location. However, upon excavating test pits in both anomalies, only former building foundations were encountered. The strong magnetic signal was probably from the reinforcement bars (rebar) used in these concrete foundations.

A magnetometer survey was also conducted at each of the proposed well locations to ensure that the drilling would not encounter any buried metal, utilities or potentially dangerous drums or gas cylinders of which historical references have been found. The results of the magnetometer survey indicated the absence of buried metal at the proposed locations and subsequently, none was encountered during drilling.

Electromagnetic Conductivity Survey

The electromagnetic conductivity survey revealed several broad areas and one area of limited extent with moderate to high conductivity readings. The broad anomalies were primarily located in the Wooded Area and in the area north of C, generally extending across area north of C and into the southeast portion of the Wooded Area. The readings in area north of C are probably a result for variations in moisture content and the thickness of the clay which was stored in this area for (CWM) site landfill cover operations. The readings which were noted in the Wooded Area are also possibly a result of moisture since the presence of heavy vegetation kept this area from becoming as dried out as other areas of the site.

The area with the more confined conductivity anomalies was found between Area B and the Wooded Area. The high readings found here were probably the result of the higher moisture in the drainage swail present at this location or possibly from metallic debris buried in the berm constructed around Area B.

In summary, the magnetometer survey was very helpful in determining the presence of buried metal onsite while the electromagnetic conductivity survey produced results which, in general, could be explained by known site surface or subsurface conditions related to the physical parameters of soil particle size (clay) and moisture content. Geophysical data is presented in Appendix C.

7 - ANALYTICAL AND MONITORING RESULTS

This section describes methods used to validate as well as present the analytical data. A summary of validated data is presented in a series of tables in this section. Complete analytical results are provided in Appendix E.

The discussion of the analytical results will include some preliminary comparisons with existing standards where they exist. Acceptable standards for soil cleanup are, for the most part, still in the development stage. Therefore, the soil evaluation initiated in this section and more thoroughly developed in Section 8 will primarily consist of comparisons between site soils and background soils and recognized naturally occurring levels. Water standards, however, do exist and for this comparison the following standards were used for comparison purposes:

- USEPA Maximum Contamination Levels (MCL) for drinking water;
- New York State Class GA Groundwater Standards;
- New York State Department of Health Drinking Water Standards; and
- USEPA Ambient Water Quality Criteria (for the Protection of Human Health).

7.1 - Data Validation

Prior to using the analytical data to assess site contamination, the data was subjected to a data validation QA procedure. The QA validation of the data was performed internally by Acres QA personnel. An outline of the data QA validation procedure and a summary of data quality is presented in Appendix E-1.

7.2 - Air Monitoring

Analyses for airborne concentrations of hydrocarbons were performed using gas chromotography. This method has a detection limit of 0.01 mg. Analysis of samples taken during the field investigation showed no concentrations above this detectable amount. Analysis for metals (arsenic, cadmium, lithium, mercury, lead and zinc) was performed using atomic absorption spectrophotometry. This method has a detection limit of 0.001 mg for most metals, 0.01 ug for arsenic, and 0.02 ug for mercury. Of the 6 different metals analyzed for, three were detected above the detection limits. These included mercury (0.04 ug), arsenic (0.020 ug) and zinc (0.001 mg). When these results are converted to TWA's, the resulting concentrations are well below ACGIH TLV's.

Real time air monitoring was also performed during the field investigations at LOOW. This monitoring program included organic vapor analyzers, combustible gas indicators and radiation detectors. The SSO recorded only one instance in which organics were detected above background during well drilling at monitoring well location MW-B-3. All other well drilling and installation operations were completed without detecting organics, combustible gases or radiation above background levels. Trenching operations were also monitored with real time instruments with no readings detected above background. However, during drum sampling procedures, organic vapors were detected at a level of 5 ppm from drum DS-1. Radiation and combustible gases were not detected above background levels. All other operations at the LOOW site did not yield any readings above background levels, with respect to radiation, combustible gases or organics.

7.3 - Analytical Results - Soil Samples

The following subsections present the chemical analytical results for soil samples collected during the field investigation for this RI/FS. The discussion of analytical results are presented in separate subsections representing results for volatile organics; semi-volatile organics; pesticides and PCB's; metals; and nitroaromatics. The analytical results presented and discussed herein pertain to soil samples collected from two background sampling points located offsite; test pits TP-A1, TP-C1, and TP-C2; and soil borings SB-1 through SB-4. Also presented are analytical results for one composite sediment sample collected from Area B (Olin Burn Pit). The analytical results are summarized on Tables 7-1 and 7-2. The results

TABLE 7-1
SUMMARY TABLE OF TARGET ORGANIC COMPOUNDS FOR SOIL AND SEDIMENT SAMPLES

Sheet 1 of 2

	TEST PIT SOIL SAMPLES							
CHEMICAL PARAMETERS	TP-A1-5	TP-A1-BOT	TP-C1-CS-5	TP-C1-CS-BOT	TP-C2-CS-5	TP-C2-CS-10	TP-C2-CS-BOT	TP-DUP-1
VOLATILE ORGANIC COMPOUNDS - ug/kg								
Methylene Chloride		30BD						10
Acetone		990D						
1,2-Dichloroethene (Total)		12DJ		2J				
Trichloroethene				0.8J				
Benzene		11DJ	1J	2J				
Toluene		150D	1J	0.7J				
Ethylbenzene		10DJ	2J					
Styrene		9DJ						
Total Xylenes		46D	4J	0.9J				
Total Volatile Organic Compounds		1258	8	6.4				10
SEMI-VOLATILE ORGANICS - ug/kg								
2-Methylnaphthalene		360J						
Diethylphthalate	52J							
Total Semi-Volatile Organics	52	360						
PESTICIDES/PCB'S - ug/kg								
alpha-BHC					3.8J			7.3J
delta-BHC		50						
Endosulfan I	6.1J			2J		12	4.2J	5.2J
4,4'- DDT	1.3J							
Total Pesticides/PCB's	7.4	50		2	3.8	12	4.2	12.5

NOTES

1) Quantities listed indicate detectable concentrations;
2) No data entry indicates the following: no detectable concentration; or data were negated. See Appendix E for complete summary tables for target and non-target compounds.
3) J indicates that the detected concentration is below the Contract Required Quantification Limit (CRQL).
4) B indicates the presence of the compound in the method blank.
5) D identifies all compounds identified in an analysis at a secondary dilution factor.

TABLE 7-1
(Cont'd)

Sheet 2 of 2

	SEDIMENT SAMPLES		BACKGROUND SOIL SAMPLES		
CHEMICAL PARAMETERS	SS-B1	SS-DUP-1	BGD-SS1	BGD-SS2	SS-DUP
VOLATILE ORGANIC COMPOUNDS - ug/kg					
Methylene Chloride	5600B	6500B			
Benzene	270J		0.5J	0.3J	0.3J
Toluene	800J	780J			
Chlorobenzene	1500	1800			
Ethylbenzene	7100	7300			
Styrene	4400	4800			
Total Xylenes		310J			
Total Volatile Organic Compounds	19670	21490	0.5	0.3	0.3
SEMI-VOLATILE ORGANICS - ug/kg					
1,4-Dichlorobenzene	5500J	5900J			
1,2,4-Trichlorobenzene	33000	35000			
2-Methylnaphthalene	560J	600J			
Diethylphthalate	1100BJ	860BJ			
N-Nitrosodiphenylamine	1700BJ	2000BJ			
Di-n-Octyl Phthalate	84BJ				
Total Semi-Volatile Organics	41944	44360			
PESTICIDES/PCB'S - ug/kg					
alpha-BHC	740	1200			
Aldrin	40	41			
Heptachlor epoxide	20	39			
Endosulfan I	2J	2J			24
Dieldrin		930			
4,4'-DDE	14J		5.6J	12J	4.4J
4,4'-DDT				14J	
Total Pesticides/PCB's	816	2212	5.6	26	28.4

NOTES

1) Quantities listed indicate detectable concentrations;
2) No data entry indicates the following: no detectable concentration; or data were negated.
3) J indicates that the detected concentration is below the Contract Required Quantification Limit (CRQL).
4) B indicates the presence of the compound in the method blank.
5) D identifies all compounds identified in an analysis at a secondary dilution factor.

TABLE 7-2
SUMMARY TABLE OF TOTAL METALS FOR SOIL AND SEDIMENT SAMPLES

Sheet 1 of 3

CHEMICAL PARAMETERS	TEST PIT SOIL SAMPLES							
	TP-A1-5	TP-A1-BOT	TP-C1-CS-5	TP-C1-CS-BOT	TP-C2-CS-5	TP-C2-CS-10	TP-C2-CS-BOT	TP-DUP-1
METALS - ug/g								
Total Arsenic	9.6	10	2.7	2.4	3.8	2.2	2.8	4.4
Total Barium	100	130	97	71	110	80	110	93
Total Beryllium	0.67		1.3	1.3	1.4	1.1	1.2	1.3
Total Chromium	18	19	23	22	24	16	21	22
Total Copper	30	32	29	23	30	43	41	33
Total Iron	22460	35790	21760	22240	24580	18910	20510	27790
Total Lead	13	16	13	4.6	16	16	10	16
Total Lithium	28	62	28	28	30	22	26	28
Total Mercury								0.76
Total Nickel	22	17	20	21	21	16	20	27
Total Potassium	3870	3190	5720	5750	5180	4080	5230	6430
Total Silver						0.57	0.58	
Total Zinc	62	71	59	50	58	51	51	54

NOTES

1) Quantities listed indicate detectable concentrations;
2) No data entry indicates the following: no detectable concentration; or data were negated.

TABLE 7-2
(Cont'd)

Sheet 2 of 3

	SEDIMENT SAMPLES		BACKGROUND SOIL SAMPLES		
CHEMICAL PARAMETERS	SS-B1	SS-DUP-1	BGD-SS1	BGD-SS2	SS-DUP
METALS - ug/g					
Total Arsenic	1.2	1.3	10	3.7	3.0
Total Barium	120	110	54	52	49
Total Boron	130	950			
Total Chromium	24	24	10	13	10
Total Copper	35	34	7.7	13	8.7
Total Iron	18060	15010	12060	26060	20750
Total Lead	28	29	17	20	18
Total Lithium	160	160	20	17	17
Total Manganese	700	790			
Total Mercury		0.21			
Total Nickel	12	16	8.4	11	8.4
Total Potassium	1480	1490	1210	1130	780
Total Zinc	220	91	61	68	58

NOTES

1) Quantities listed indicate detectable concentrations;
2) No data entry indicates the following: no detectable concentration; or data were negated.

TABLE 7-2
(Cont'd)

Sheet 3 of 3

CHEMICAL PARAMETERS	SOIL BORING SAMPLES									
	SB-1-2-3.5	SB-1-8-9.5	SB-2-2-3.5	SB-2-8-9.5	SB-DUP-01	SB-3-2-3.5	SB-3-8-9.5	SB-DUP-2	SB-4-2-3.5	SB-4-8-9.5
METALS - ug/g										
Total Arsenic	2.9	3.5	4.4	3.3	3.2	7.5	3.3	3.6	9.1	1.3
Total Barium	67	87	150	100	94	110	61	56	110	13
Total Beryllium						1.2	0.77		1.2	
Total Boron								670		
Total Cadmium		0.67		0.64						
Total Chromium	15	21	24	110	89	29	22	21	37	9.3
Total Copper	34	27	53	62	63	37	25	26	40	27
Total Iron	13460	17720	21010	45350	21980	33550	19520	20930	34220	12140
Total Lead		13	6.9			8.2				8.0
Total Lithium	12	19	27	19	18	30	26	26	37	8.4
Total Nickel	13	17	22	31	32	33	22	17	31	9.3
Total Potassium	2710	4300	4750	3620	3500	6230	5700	5970	7770	1800
Total Silver	6.3	1.0		1.1	1.1	0.82				
Total Zinc	43	45	61	50	48	88	49	57	73	44
NITROAROMATICS - ug/g										
Total Nitroaromatics										

NOTES

1) Quantities listed indicate detectable concentrations;
2) No data entry indicates the following: no detectable concentration; or data were negated.

presented on these summary tables are for those organic compounds or metals detected at least once in any one sample. Complete analytical results are presented in Appendix E.

7.3.1 - Volatile Organics

A total of nine volatile organic compounds were detected in the test pit soil samples with the majority of the detected compounds occurring in samples TP-A1-BOT, TP-C1-CS-5 and TP-C1-CS-BOT. As shown on Table 7-1, analytical results indicate the presence of eight organic compounds in sample TP-A1-BOT with four of the eight compounds occurring at concentrations above the contract required quantification limit (CRQL). Of these four compounds, acetone was detected at a concentration of 990 ug/kg, toluene at 150 ug/kg, and total xylenes at 46 ug/kg. Methylene chloride was detected at a concentration of 30 ug/kg, however, the presence of this compound is suspect as it also occurred in the method blank thus indicating possible laboratory contamination. The four compounds detected at concentrations below the CRQL are 1,2-dichloroethene (12 ug/kg), benzene (11 ug/kg), ethylbenzene (10 ug/kg) and styrene (9 ug/kg).

As shown on Table 7-1, the volatile organic compounds detected in both soil samples from test pit TP-C1 were at concentrations below the CRQL. In addition, methylene chloride was detected in sample TP-DUP-1 (duplicate sample of TP-C1-CS-5) at a concentration of 10 ug/kg. This compound was not detected in sample TP-C1-CS-5.

As shown on Table 7-1, benzene was the only volatile organic compound detected in the background soil samples. However, the reported concentrations were below the CRQL.

The composite sediment sample (SS-B1) and duplicate sediment sample (SS-DUP-1) collected from Area B displayed the highest concentrations of volatile organic compounds of all the soil samples analyzed with total volatile organic concentrations of 19670 and 21490 ug/kg, respectively (see Table 7-1). These two samples contained elevated concentrations of chlorobenzene (1500 and 1800 ug/kg), ethylbenzene

(7100 and 7300 ug/kg) and styrene (4400 and 4800 ug/kg). Methylene chloride was also detected at elevated concentrations (5600 and 6500 ug/kg), however, this compound was also detected in the method blank making its concentration in the soil samples suspect.

Three other compounds (benzene, toluene and total xylenes) were also detected in the two sediment samples but at concentrations below the CRQL. Two compounds, benzene and toluene, were detected in sample SS-B1 at concentrations of 270 and 800 ug/kg, respectively. In the duplicate sample, toluene was detected at a concentration of 780 ug/kg and total xylenes at a concentration of 310 ug/kg. Benzene was not detected in the duplicate sample.

7.3.2 - Semi-Volatile Organics

There were no semi-volatile organic compounds detected in the background samples (see Table 7-1). In the test pit samples, only two semi-volatile organic compounds were detected, although at concentrations below the CRQL; 2-methylnaphtalene was detected at 360 ug/kg in sample TP-A1-BOT and diethylphthalate was detected in sample TP-A1-5 at 52 ug/kg (see Table 7-1).

The sediment and duplicate samples (SS-B1 and SS-DUP-1) from Area B displayed the highest concentration of semi-volatile organic compounds at 41944 and 44360 ug/kg, respectively (see Table 7-1). Of the six compounds detected in these samples only one, 1,2,4-trichlorobenzene, was detected above the CRQL at 33000 and 35000 ug/kg. The remaining compounds detected below the CRQL were 1,4-dichlorobenzene, 2-methylnaphthalene, diethylphthalate, n-nitrosodiphenylamine and di-n-octyl phthalate. Di-n-oxtyl phthalate was detected in sample SS-B1 and not in the duplicate sample.

7.3.3 - Pesticides and PCB's

Two samples from the test pits (TP-A1-BOT and TP-C2-CS-10) had detectable concentrations of pesticides above the CRQL. In sample TP-A1-

BOT, delta-BHC was detected at a concentration of 50 ug/kg while sample TP-C2-CS-10 had a detected concentration of Endosulfan I at 12 ug/kg. Endosulfan I was also detected at concentrations below the CRQL in samples TP-A1-5, TP-C1-CS-BOT, TP-C2-CS-BOT and TP-DUP-1 (duplicate sample of TP-C1-CS-5). In addition, alpha-BHC was detected in samples TP-C2-CS-5 and TP-DUP-1 at concentrations below the CRQL and 4,4-DDT was detected below the CRQL in sample TP-A1-5.

Again, the sample and duplicate sample from Area B had the highest concentrations of analytical compounds. Alpha-BHC was detected at 740 and 1200 ug/kg in samples SS-B1 and SS-DUP-1, respectively. Aldrin was detected at concentrations of 40 and 41 ug/kg and Heptachlor Epoxide at 20 and 39 ug/kg. Dieldrin was detected in the duplicate sample only at a concentration of 930 ug/kg. Endosulfan I was detected below the CRQL in both samples while 4,4-DDE was detected below the CRQL in sample SS-B1 only.

Background duplicate sample SS-DUP-1, was the only background sample to have a pesticide compound detected at a concentration above the CRQL. In this sample, Endosulfan I was detected at 24 ug/kg. The pesticide 4,4-DDE was detected in both background samples at concentrations below the CRQL. The pesticide 4,4-DDT was detected in sample BGD-SS-2 at a concentration below the CRQL. There were no PCB's detected in any of the soil or sediment samples.

7.3.4 - Metals

As shown on Table 7-2, most metals are ubiquitous in the site and background soils. The metals arsenic, barium, chromium, copper, iron, lithium, nickel, potassium and zinc were detected in all samples in concentrations within the common range for these metals in soils (see Table 7-3). The metals selenium and thallium were not detected in any of the soil samples. Mercury was detected in sample SS-DUP-1 (duplicate of sample SS-B1) at a concentration of 0.21 ug/kg

TABLE 7-3
GENERAL COMPOSITION OF SOILS

Element	Dry Soil Mean Concentration (ppm)	Dry Soil Concentration Range (ppm)
Arsenic (As)	6.0	0.1 - 40
Barium (Ba)	500	100 - 3000
Beryllium (Be)	6.0	0.1 - 40
Boron (B)	10	2 - 100
Cadmium (Cd)	0.06	0.01 - 0.7
Chromium (Cr)	100	5 - 3000
Copper (Cu)	20	2 - 100
Iron (Fe)	38000	7000 - 550000
Lead (Pb)	10	2 - 200
Lithium (Li)	30	7 - 200
Manganese (Mn)	850	100 - 4000
Mercury (Hg)	0.03	0.01 - 0.3
Nickel (Ni)	40	10 - 1000
Potassium (K)	14000	400 - 30000
Selenium (Se)	0.2	0.01 - 2
Silver (Ag)	0.1	0.01 - 5
Sodium (Na)	6300	750 - 7500
Thallium (Tl)	0.1	
Zinc (Zn)	50	10 - 300

NOTES:

The figures refer to oven-dried soils. Soils near mineral deposits have been omitted in computing ranges. There are insufficient data for Ag, Be, Cd, and Tl; and the values quoted for these elements may require revision.

Source: Overcash and Pal, 1979

and in sample TP-DUP-1 (duplicate of sample TP-C1-CS-5) at 0.76 ug/kg. The concentration of mercury in the latter sample is above the common range of 0.01 to 0.03 ppm for this metal in soils (Overcash and Pal, 1979). Silver was detected in several samples with only one sample (SB-1-2-3.5) displaying a concentration of 6.3 ug/kg which is above the common range for silver in soils (0.01-5 ppm).

Boron was detected in three samples only. Each sample, SB-DUP-02 (duplicate of SB-3-8-9.5), SS-B1 and SS-DUP-1, had concentrations of boron (670, 130, and 950 ug/g, respectively) which exceeded the common range for this element in soils (Overcash and Pal, 1979). Lithium was detected in the samples from Area B (SS-B1 and SS-DUP-1) at concentrations several times greater than background and other site soils.

7.3.5 - Nitroaromatics

Nitroaromatics were not detected on any of the soil samples analyzed.

7.4 - Analytical Results - Drum Waste

Drum waste material collected from the five drums removed from test pit TP-A1 was analyzed by Recra for the following analytical parameters:

- Target and non-target volatile organics;
- Target and non-target semi-volatile organics;
- Pesticides;
- PCB's;
- Total metals;
- EP toxicity test extract for organics;
- EP toxicity test extract for metals; and
- RCRA waste characteristics.

Table 7-4 summarizes the results for all contaminants detected from the drum waste samples.

TABLE 7-4
SUMMARY TABLE OF TARGET ORGANICS AND INORGANIC COMPOUNDS FOR DRUM SAMPLES

Sheet 1 of 2

	DRUM SAMPLES								
CHEMICAL PARAMETERS	DS-1	DS-2	DS-3	DS-4	DS-5	DS-DUP-1			
VOLATILE ORGANIC COMPOUNDS - ug/kg									
Methylene Chloride		97B		90B	76B	80B			
Acetone	980E	7300E	1500E	4600E	3200E	2800E			
1,1 Dichloroethane				5J	5J				
1,2-Dichloroethene (Total)		9	10	12	9	4J			
2-Butanone		79		52	37	32			
Trichloroethene		1J	1J	1J	0.5J				
Benzene	2J	6J	7	8	10	3J			
Tetrachloroethene		2J	0.5J	3J	3J				
Toluene	24	86	94	100	170	38			
Ethylbenzene	0.7J	4J	18	6J	6	4J			
Styrene	1J	4J	5J	5J	7	1J			
Total Xylenes	4J	15	10	24	33	14			
Total Volatile Organics	1011.7	7603	1645.5	4906	3556.5	2976			
SEMI-VOLATILE ORGANICS - ug/kg									
Naphthalene				86J	76J				
2-Methylnaphthalene		90J	280J	370J	330J	350J			
Acenaphthylene					9J				
Acenaphthene						41J			
Diethylphthalate	33J		100J	75J	52J	51J			
N-Nitrosodiphenylamine (1)			150J	330J	83J				
Phenanthrene	46J		230J	1500	130J	220J			
Anthracene				45J					
Fluoranthene				54J					
Pyrene	25J		25J	300J		37J			
Chrysene				54J					
Total Semi-Volatile Organics	104	90	785	2814	680	699			

NOTES

1) Quantities listed indicate detectable concentrations;
2) No data entry indicates the following: no detectable concentration; or data were negated. See Appendix E for complete summary tables for target and non-target compounds.
3) J indicates that the detected concentration is below the Contract Required Quantification Limit (CRQL).
4) B indicates the presence of the compound in the method blank.
5) E identifies compounds whose concentrations exceed the calibrated range of the GC/MS instrument for that specific analysis.

TABLE 7-4
(Cont'd)

Sheet 2 of 2

	DRUM SAMPLES								
CHEMICAL PARAMETERS	DS-1	DS-2	DS-3	DS-4	DS-5	DS-DUP-1			
PESTICIDES/PCB'S - ug/kg									
Heptachlor epoxide	2.0J								
Endosulfan I	29		8.5J		2J				
4,4'-DDE	19J								
Total Pesticides/PCB's	50		8.5		2				
METALS - ug/g									
Total Arsenic	7.6	11	7.7	7.6	6.2	19			
Total Barium	81	77	85	110	110	100			
Total Beryllium	0.62	0.63							
Total Chromium	19	20	15	16	14	22			
Total Copper	44	35	32	26	28	40			
Total Iron	46690	34970	41160	27120	28540	39690			
Total Lead	11	13	13	12	15	21			
Total Lithium	62	67	60	66	63	59			
Total Nickel	21	19	20	21	15	17			
Total Potassium	3570	2940	3290	2830	2710	2870			
Total Silver				0.65	1.1				
Total Zinc	63	58	64	74	75	71			

NOTES

1) Quantities listed indicate detectable concentrations;
2) No data entry indicates the following: no detectable concentration; or data were negated. See Appendix E for complete summary tables for target and non-target compounds.
3) J indicates that the detected concentration is below the Contract Required Quantification Limit (CRQL).
4) B indicates the presence of the compound in the method blank.
5) E indicates compounds whose concentrations exceed the calibrated range of the GC/MS instrument for that specific analysis.

7.4.1 - Volatile Organics

Volatile organic compounds were the most common organic contaminants found in the drum samples. A total of 12 volatile organic compounds were detected in the drum samples at concentrations above the CRQL. Methylene chloride, acetone, 2-butanone, toluene, and total xylenes were the volatile organic compounds which were found in the highest concentrations. The sum total of volatile organic compounds ranged from a high concentration of 7603 ug/kg detected in DS-2 to a low concentration of 1011.7 ug/kg found in DS-1. In general, most of the volatile organic compounds found in the drum samples were detected at concentrations less than 100 ug/kg. However, acetone was detected in all of the drum samples, except DS-1, in concentrations in excess of 1000 ug/kg. In sample DS-1, acetone was detected at a concentration of 980 ug/kg.

7.4.2 - Semi-Volatile Organics

Semi-volatile organic compounds were the second most common contaminants found in the drum samples. A total of 11 semi-volatile organic compounds were detected. 2-methylnanthalene, diethylphthalate, n-nitrosodiphenylamine, phenanthrene and pyrene were the semi-volatile organic contaminants which were detected in the highest concentrations. However, a majority of the concentrations detected for semi-volatile organic compounds were below the CRQL. Phenanthrene was detected at a concentration of 1500 ug/kg in DS-4. Total semi-volatile organics ranged from a high concentration of 2814 ug/kg detected in DS-4 to a low concentration of 90 ug/kg found in DS-2.

7.4.3 - Pesticides/PCBs

Relatively low concentrations of pesticides were detected in samples collected from drums DS-1, DS-3, and DS-5. Heptachlor Epoxide, Endosulfan I, and 4,4-DDE were the only pesticide contaminants detected. Total pesticide concentrations ranged from a high of

50 ug/kg detected in DS-1 to a low of 2 ug/kg found in DS-5. Endosulfan I, found in DS-1, was the only pesticide compound detected above the CRQL. No PCB's were detected in any of the drum samples.

7.4.4 - Metals

Concentrations of metals in the drum samples were fairly low and tended to reflect the total metal concentrations detected in soil samples obtained from test pits and background soils. In general, the only elevated metal concentration detected in the drum samples were lithium and total iron.

7.4.5 - EP Toxicity and RCRA Waste Characteristics

EP toxicity and RCRA waste characteristic tests results are summarized in Table 7-5. EP toxicity results indicate that all of the drums are below the USEPA maximum concentration of contaminant levels. There were no detectable concentrations of EP Toxicity organics found.

7.5 - Analytical Results - Surface Water

7.5.1 - Volatile and Semi-Volatile Organics and Pesticides/PCBs

A single surface water sample, SW-B1 was collected from the pond in Area B and analyzed for organics and metals (Table 7-6). Only one volatile organic compound, toluene, was detected at 0.8 ug/l which is below the CRQL of 5 ug/l. The semi-volatile organic analysis revealed the presence of bis (2-ethylhexyl) phthalate (4 ug/l) at concentration below the CRQL. The sample scheduled for pesticide/PCB analysis was lost as a result of breakage during shipment. Previous analytical results for surface water samples collected from the Olin Burn Pit in 1985 by SCA indicated the absence of pesticide and PCB compounds. Based upon those results, the lack of pesticides/PCB data during this remedial investigation does not appear to be significant.

TABLE 7-5

SUMMARY TABLE OF EP TOXICITY AND RCRA WASTE CHARACTERIZATION FOR DRUM SAMPLES

Sheet 1 of 1

	EPA MAX. CONC.	DRUM SAMPLES							
CHEMICAL PARAMETERS	(mg/l)	DS-1	DS-2	DS-3	DS-4	DS-5	DS-DUP-1		
EP TOXICITY - METALS									
Total Barium	100	2.1	0.78	1.8	1.9	2.4			
Total Cadmium	1.0				0.007	0.006			
Total Chromium	5.0		0.01	0.013					
Total Selenium	1.0	0.021	0.006	0.011	0.009				
RCRA WASTE CHARACTERISTICS									
Corrosivity (Std. Units) Leaching pH		8.43	7.63	7.69	7.97	7.74	7.56		
Flash Point (3F)		>200	>200	>200	>200	>200	>200		
Oxidizer Spot Test		NEG	NEG	NEG	NEG	NEG	NEG		
Total Available Cyanide (mg/kg)		<10	<10	<10	<10	<10	<10		
Total Available Sulfide (mg/kg)		<10	<10	<10	<10	<10	<10		
Paint Filter Free Test		PASS	PASS	PASS	PASS	PASS	PASS		

NOTES

1) Quantities listed indicate detectable concentrations.
2) No data entry indicates the following: no detectable concentration; or data were negated.

TABLE 7-6
SUMMARY TABLE OF TARGET ORGANIC AND INORGANIC COMPOUNDS FOR MISCELLANEOUS WATER SAMPLES

Sheet 1 of 2

		TEST PIT WATER		SURFACE WATER	POTABLE WATER				
CHEMICAL PARAMETERS	MCL	TP-A1-WAT	TP-A1-WAT-DL	SW-B-1	LOOW-PW				
VOLATILE ORGANIC COMPOUNDS - ug/l									
Vinyl Chloride	2	12	12DJ						
Acetone	*	1600E	1700DE						
1,1-Dichloroethane	*	31	30D						
1,2-Dichloroethene (total)	*	110	110D						
Chloroform	100+				30				
2-Butanone	*	120	130D						
Bromodichloromethane	*				12				
Trichloroethene	5	11	10D						
Dibromochloromethane	*				5.1				
Benzene	5	32	32D						
cis-1,3-Dichloropropene	*		7DJ						
4-Methyl-2-Pentanone	*	6J	6DJ						
Tetrachloroethene	*		0.8DJ						
Toluene	*	260E	260D	0.8J					
Ethylbenzene	*	4J	4DJ						
Styrene	*	6	7DJ						
Total Xylenes	*	16	16D						
Total Volatile Organic Compounds	-	2208	2324.8	0.8J	47.1				
SEMI-VOLATILE ORGANICS - ug/l									
Phenol		97							
1,4-Dichlorobenzene	*				11				
2-Methylphenol	*	26							
4-Methylphenol	*	64							

NOTES

1) Quantities listed indicate detectable concentrations;
2) No data entry indicates the following: no detectable concentration; or data were negated. See Appendix E for complete summary tables for target and non-target compounds.
3) J indicates that the detected concentration is below the Contract Required Quantification Limit (CRQL).
4) B indicates the presence of the compound in the method blank.
5) D identifies all compounds identified in a analysis at a secondary dilution factor.
6) E identifies compounds whose concentrations exceed the calibrated range of the GC/MS instrument for that specific analysis.
7) MCL is the EPA maximum contaminant level.
8) * indicates that no MCL exists for that particular chemical parameter.
9) + the MCL for chloroform represents total trihalomethanes.

TABLE 7-6
(Cont'd)

Sheet 2 of 2

		TEST PIT WATER		SURFACE WATER	POTABLE WATER				
CHEMICAL PARAMETERS	MCL	TP-A1-WAT	TP-A1-WAT-DL	SW-B-1	LOOW-PW				
<u>SEMI-VOLATILE ORGANICS</u> - ug/l									
2,4-Dichlorophenol	*	7J							
Naphthalene	*	25							
2-Methylnaphthalene	*	29							
Phenanthrene	*	5J							
Di-n-Butylphthalate	*	1J							
Pyrene	*	0.4J							
bis-(2-Ethylhexyl) Phthalate	*			4J					
Total Semi-Volatile Organics	-	157.4		4	11				
<u>METALS</u> - mg/l									
Total Arsenic	0.05	0.012							
Total Barium	1.0	0.14		0.050					
Total Boron	*	120		24					
Total Cadmium	0.01				0.005				
Total Chromium	0.05			0.015					
Total Copper	*	0.015			0.007				
Total Iron	*	7.7		0.48	0.11				
Total Lead	0.05	0.010		0.014					
Total Lithium	*	38		19					
Total Nickel	*	0.16							
Total Potassium	*	5.0		5.8	2.3				
Total Selenium	0.01				0.019				
Total Sodium	*	65		12	10				
Total Zinc	*	0.34		0.033	0.012				
Total Manganese	*			0.34					

NOTES

1) Quantities listed indicate detectable concentrations;
2) No data entry indicates the following: no detectable concentration; or data were negated. See Appendix E for complete summary tables for target and non-target compounds.
3) J indicates that the detected concentration is below the Contract Required Quantification Limit (CRQL).
4) B indicates the presence of the compound in the method blank.
5) D identifies all compounds identified in a analysis at a secondary dilution factor.
6) E identifies compounds whose concentrations exceed the calibrated range of the GC/MS instrument for that specific analysis.
7) MCL is the EPA maximum contaminant level.
8) * indicates that no MCL exists for that particular chemical parameter.
9) + the MCL for chloroform represents total trihalomethanes.

7.5.2 - Metals

Metals found in SW-B1 included barium, boron, chromium, iron, lead, lithium, manganese, potassium, sodium, and zinc. Of the metals detected, boron and lithium occur in the greatest concentrations at 24 and 19 mg/l, respectively.

7.6 - Analytical Results - Groundwater

The groundwater monitoring program included the sampling of all 15 wells drilled for this investigation and seven wells previously installed by CWM. The groundwater samples from the newly installed wells were collected by Recra on July 27 and 28, 1988. CWM wells were sampled by CWM personnel on July 27, 1988. During the collection of groundwater samples, field measurements for pH, specific conductance and temperature were performed (Table 7-7). The pH values ranged from 6.92 to 11.81 with the majority of wells falling between 7.00 and 9.00. Two wells, MW-C-3S and MW-C-3D, recorded pH values of 10.29 and 11.81, respectively. A possible cause of the high pH values is presented in Appendix A-2.

Specific conductance (SC) values ranged from a low of 310 umhos/cm for well MW-C-3S to 2600 umhos/cm for MW-B-3. The shallow wells, excluding MW-B-3, average 740 umhos/cm. MW-B-3 at 2600 umhos/cm indicates a significantly elevated SC reading of the groundwater at this location. The deeper wells (monitoring Zone 3) displayed an average SC of 1105 umhos/cm with no well displaying significantly elevated readings from this average.

In general, the groundwater results which are summarized in Table 7-8 did not display widespread organic contamination with respect to volatiles, semi-volatiles, pesticides or PCB analysis. Most values recorded were either found in blank analysis (and negated) or below the CRQL. However, a few exceptions were noted.

7.6.1 - Volatile Organic Compounds

Volatile organic compounds found in MW-7-3S included 140 ug/l of chloroform, 51 ug/l of carbon tetrachloride and 6 ug/l of methylene

TABLE 7-7
FIELD MEASUREMENTS OF GROUNDWATER AND SURFACE WATER SAMPLES COLLECTED AT LOOW

Sample I.D.	Date	pH (Standard Units)	Specific Conductance (umhos/cm)	Temp. (°C)
MW-A-1S	07/27/88	8.29	0800	18
MW-A-1D	07/27/88	8.40	1200	16
MW-B-1S	07/28/88	7.62	0740	18
MW-B-1D	07/28/88	8.70	1100	13
MW-B-2S	07/27/88	6.95	0600	16
MW-B-2D	07/27/88	7.69	1000	15
MW-B-3	07/27/88	6.92	2600	14
MW-B-4S	07/27/88	7.65	0700	20
MW-B-4D	07/27/88	7.71	0950	14
MW-C-1S	07/28/88	7.31	0920	16
MW-C-1D	07/28/88	8.23	0950	17
MW-C-2D	07/28/88	7.82	1000	22
MW-C-3S	07/28/88	10.29	0310	18
MW-C-3D	07/27/88	11.81	1500	15
MW-D-1	07/28/88	8.76	1200	18
SW-B-1	07/28/88	9.19	0540	33
MW-RB-2	07/28/88	6.88	0010	30
MW-7-5S	07/27/88	7.20	0800	17
MW-7-5D	07/27/88	7.44	0800	13
MW-7-3S	07/27/88	7.39	1600	12
MW-7-3D	07/27/99	7.69	1000	20
MW-12-8S	07/27/88	6.76	0700	12
MW-12-8D	07/27/88	7.31	1400	8
TMW-14	07/27/88	7.41	0500	14
TP-A1-WAT	07/22/88	8.04	1084	16

chloride. Concentrations for these compounds exceed the EPA maximum contamination levels (MCL) for drinking water and the New York State Standard for Class GA Groundwater. MW-7-3S also revealed the presence of 0.7 ug/l of benzene which is below the MCL of 5 ug/l but above the NYS GA groundwater level of "not-detectable" by current analytical methods. The only other volatile compounds found at elevated concentrations was 28 ug/l of 1,2 dichloroethene in MW-C-1S and 70 mg/l of acetone in TMW-14S. Although no MCL or NYS groundwater standard currently exists for 1,2 dichloroethene, the detected concentration of 28 ug/l in sample MW-C-1S does exceed the MCL of 7 ug/l which has been established for the isomer 1,1 dichloroethene.

The common laboratory solvents of methylene chloride, acetone, and carbon disulfide were found in several other wells at levels at or below the CRQL for these compounds. Several other volatile organic compounds including 1,1,1 trichloroethane, trichloroethene and tetrachloroethene were found in several other wells also at levels below the CRQL.

7.6.2 - Semi-Volatile Organics

The semi-volatile organic analysis showed virtually no contamination with respect to targeted compounds with the exceptions of several phthalatic esters found in three wells at levels below the CRQL.

7.6.3 - Pesticides/PCB's

No PCB Aroclors were observed in any of the wells sampled. Two BHC isomers were found in three wells (MW-A-1D, MW-B-1D, and MW-D-1) at levels below the CRQL and the gamma BHC isomer (Lindane) was observed on the rinse blank MW-RB-1 collected with the July 27 samples. The Lindane concentration found in this rinse blank was 29 ug/l which is below the CRQL. The significance of the presence of this anomolous compound in the rinse blank is probably moot since Lindane was not present in any other groundwater sample analyzed.

TABLE 7-8
SUMMARY TABLE OF ORGANIC COMPOUNDS FOR GROUNDWATER SAMPLES

Sheet 1 of 3

CHEMICAL PARAMETERS	MCL	MONITORING WELLS							
		MW-A-1S	MW-A-1D	MW-B-1S	MW-B-1D	MW-B-2S	MW-B-2D	MW-B-3	MW-B-4S
VOLATILE ORGANIC COMPOUNDS - ug/l									
Methylene Chloride	*								6
Acetone	*								
Carbon Disulfide	*								
1,2-Dichloroethene (Total)	*								
Chloroform	100+	3J		2J		4J	1J	1J	1J
1,1,1-Trichloroethane	200								
Carbon Tetrachloride	5								
Trichloroethene	5								
Benzene	5								
Tetrachloroethene	*								
Total Volatile Organic Compounds	*	3		2		4	1	1	7
SEMI-VOLATILE ORGANICS - ug/l									
Butylbenzylphthalate	•	2J					2J		
Bis-(2-Ethylhexyl) Phthalate	•				2J				
Di-N-Octyl Phthalate	•						0.6J		
Total Semi-Volatile Organics	*	2			2		2.6		
PESTICIDES/PCB'S - ug/l									
beta-BHC	•		0.028J						
delta-BHC	•				0.005J				
Total Pesticides/PCB's	•		0.028		0.005				
NITROAROMATICS - mg/l									
Total Nitroaromatics	*								

NOTES

Quantities listed indicate detectable concentrations;

1) Quantities listed indicate detectable concentrations;
2) No data entry indicates the following: no detectable concentration; or data were negated. See Appendix E for complete summary tables for target and non-target compounds.
3) J indicates that the detected concentration is below the Contract Required Quantification Limit (CRQL).
4) B indicates the presence of the compound in the method blank.
5) MCL is the EPA maximum contaminant level.
6) • indicates that no MCL exists for that particular chemical parameter.
7) + the MCL for chloroform represents total trihalomethanes.

TABLE 7-8
(Cont'd)

Sheet 2 of 3

CHEMICAL PARAMETERS	MCL	MONITORING WELLS							
		MW-B-4D	MW-C-1S	MW-C-1D	MW-C-2D	MW-C-3S	MW-C-3D	MW-D-1	MW-7-3S
VOLATILE ORGANIC COMPOUNDS - ug/l									
Methylene Chloride	*	6				5	4J		6
Acetone	*					2J	1J		1J
Carbon Disulfide	*	0.5J							0.6J
1,2-Dichloroethene (Total)	*		28						
Chloroform	100+	0.8J	4J	1J					140
1,1,1-Trichloroethane	200								
Carbon Tetrachloride	5								51
Trichloroethene	5		3J						
Benzene	5								
Tetrachloroethene	*		2J						0.6J
Total Volatile Organic Compounds	*	7.3	37	1		7	5		199.2
SEMI-VOLATILE ORGANICS - ug/l									
Butylbenzylphthalate	*								
Bis-(2-Ethylhexyl) Phthalate	*								
Di-N-Octyl Phthalate	*								
Total Semi-Volatile Organics	*								
PESTICIDES/PCB'S - ug/l									
beta-BHC	*								
delta-BHC	*							0.005J	
Total Pesticides/PCB's	*							.005	
NITROAROMATICS - mg/l									
Total Nitroaromatics	*								

NOTES

1) Quantities listed indicate detectable concentrations;
2) No data entry indicates the following: no detectable concentration; or data were negated. See Appendix E for complete summary tables for target and non-target compounds.
3) J indicates that the detected concentration is below the Contract Required Quantification Limit (CRQL)
4) B indicates the presence of the compound in the method blank.
5) MCL is the EPA maximum contaminant level.
6) * indicates that no MCL exists for that particular chemical parameter.
7) + the MCL for chloroform represents total trihalomethanes.

TABLE 7-8
(Cont'd)

Sheet 3 of 3

CHEMICAL PARAMETERS	MCL	MONITORING WELLS							
		MW-7-3D	MW-7-5S	MW-7-5D	MW-12-8S	MW-12-8UD	TMW-14	MW-DUP-1	MW-DUP-2
VOLATILE ORGANIC COMPOUNDS - ug/l									
Methylene Chloride	*	5			5	5			
Acetone	*				1J		70		
Carbon Disulfide	*				0.2J				
1,2-Dichloroethene (Total)	*								
Chloroform	100+								
1,1,1-Trichloroethane	200		3J						
Carbon Tetrachloride	5								
Trichloroethene	5						2J		
Benzene	5		0.7J						
Tetrachloroethene	*								
Total Volatile Organic Compounds	*	5	3.7		6.2	5	72		
SEMI-VOLATILE ORGANICS - ug/l									
Butylbenzylphthalate	*								
Bis-(2-Ethylhexyl) Phthalate	•								
Di-N-Octyl Phthalate	*								
Total Semi-Volatile Organics	•								
PESTICIDES/PCB'S - ug/l									
beta-BHC	*								
delta-BHC	*								0.013J
Total Pesticides/PCB's	*								0.013
NITROAROMATICS - mg/l									
Total Nitroaromatics	•								

NOTES

1) Quantities listed indicate detectable concentrations;
2) No data entry indicates the following: no detectable concentration; or data were negated. See Appendix E for complete summary tables for target and non-target compounds.
3) J indicates that the detected concentration is below the Contract Required Quantification Limit (CRQL).
4) B indicates the presence of the compound in the method blank.
5) MCL is the EPA maximum contaminant level.
6) • indicates that no MCL exists for that particular chemical parameter.
7) + the MCL for chloroform represents total trihalomethanes.

7.6.4 - Total and Soluble Metals

Groundwater samples were analyzed for both total and soluble metals (Tables 7-9 ad 7-10). The data reveal significant differences between the two analyses for a number of metals. For example, total iron and total lead are present in a majority of wells at levels greater than the NYS Standard for GA Groundwaters. Also, total chromium was detected in half of the sampled wells including two wells (MW-7-3S and MW-B-4S) which contained levels exceeding the EPA MCL for drinking water. However, the soluble metal results reveal iron to be present at greatly reduced levels, occurring in only two wells, MW-B-4S and MW-12-8S. Soluble chromium was present in only one well while soluble lead was not found in any of the wells.

The soluble metals which are most prevalent in the groundwater samples are arsenic, barium, lithium, potassium, sodium and manganese. Of these, soluble arsenic was detected in several wells at levels below the MCL of 0.05 mg/l but above the EPA Ambient Water Quality Criteria level of 2.2 ng/l (2.2 ppt). Soluble barium was observed in many of the same wells and at similar concentrations as total barium.

Soluble lithium was found at similar levels in the same wells that total lithium was observed with two exceptions: at most wells where soluble lithium was found, the levels observed were between 0.01 and 0.4 mg/l with no pattern identified between the shallow and deep wells. However, at MW-B-3 and MW-7-3S, concentrations of soluble lithium were found at 26 and 10 mg/l, respectively. Also found at these two wells were substantial concentrations of boron; MW-B-3 contained 12 mg/l of boron while MW-7-3S contained 11 mg/l. While there is no state or federal standard for these two elements in groundwater, the levels found in these two wells were greater than the levels found in other wells at the site.

The other soluble metals previously mentioned as common to many of the wells, including potassium, sodium and manganese, were generally

TABLE 7-9

SUMMARY TABLE OF TOTAL METALS IN GROUNDWATER

Sheet 1 of 3

CHEMICAL PARAMETERS	MCL	MONITORING WELLS							
		MW-A-1S	MW-A-1D	MW-B-1S	MW-B-1D	MW-B-2S	MW-B-2D	MW-B-3	MW-B-4S
TOTAL METALS - mg/l									
Total Arsenic	0.05	0.008	0.008	0.080	0.0095				0.18
Total Barium	1.0	0.10	0.12	0.62	0.065	0.06	0.06	0.23	2.0
Total Beryllium	*								0.007
Total Boron	*							11	
Total Cadmium	0.01								
Total Chromium	0.05	0.007		0.12					0.25
Total Copper	*	0.012		0.21	0.012	0.010	0.007	0.006	0.54
Total Iron	*	2.3	0.71	140	3.2	0.94	1.1	0.36	320
Total Lead	0.05			0.042	0.046		0.01		0.064
Total Lithium	*	0.038	0.14	0.22	0.12	0.005	0.12	26	0.42
Total Mercury	0.002							0.0007	
Total Nickel	*			0.16					0.40
Total Potassium	*	8.3	9.8	19	14	1.4	6.8	13	25
Total Sodium	*	37	160	36	150	12	170	43	19
Total Zinc	*	0.019		0.42	0.13			0.037	0.94
Total Manganese	*	0.18	0.027	6.0	0.091	0.82	0.096	1.5	14

NOTES

1) Quantities listed indicate detectable concentrations.
2) No data entry indicates the following: no detectable concentration; or data were negated.
3) MCL is the EPA maximum contaminant level.
4) * indicates that no MCL exists for that particular chemical parameter.

TABLE 7-9
(Cont'd)

Sheet 2 of 3

CHEMICAL PARAMETERS	MCL	MONITORING WELLS							
		MW-B-4D	MW-C-1S	MW-C-1D	MW-C-2D	MW-C-3S	MW-C-3D	MW-D-1	MW-7-3S
TOTAL METALS - mg/l									
Total Arsenic	0.05			0.008	0.022			0.016	0.024
Total Barium	1.0	0.07	0.08	0.04	0.07		0.25	0.09	0.26
Total Beryllium	*								
Total Boron	*							0.86	6.0
Total Cadmium	0.01						0.005		
Total Chromium	0.05						0.007	0.018	0.41
Total Copper	*				0.031		0.008	0.032	0.067
Total Iron	*	1.2	0.52	1.1	19		0.09	20	43
Total Lead	0.05		0.010	0.051	0.022		0.007	0.065	0.018
Total Lithium	*	0.095	0.038	0.044	0.11		0.031	0.097	5.9
Total Mercury	0.002								0.0004
Total Nickel	*								0.24
Total Potassium	*	8.2	2.4	6.8	10		16	13	7.7
Total Sodium	*	120	27	130	130		86	300	46
Total Zinc	*		0.006	0.24	0.064			0.25	0.12
Total Manganese	*	0.062	0.25	0.10	0.82			0.79	1.8

NOTES

1) Quantities listed indicate detectable concentrations.
2) No data entry indicates the following: no detectable concentration; or data were negated.
3) MCL is the EPA maximum contaminant level.
4) • indicates that no MCL exists for that particular chemical parameter.

TABLE 7-9
(Cont'd)

Sheet 3 of 3

CHEMICAL PARAMETERS	MCL	MONITORING WELLS							
		MW-7-3D	MW-7-5S	MW-7-5D	MW-12-8S	MW-12-8UD	MW-TMW-14	MW-DUP-1	MW-DUP-2
TOTAL METALS - mg/l									
Total Arsenic	0.05	0.014		0.008	0.01	0.006	0.008		0.019
Total Barium	1.0		0.12	0.06	0.16	0.07	0.06		0.11
Total Beryllium	*								
Total Boron	•								0.94
Total Cadmium	0.01				0.006				
Total Chromium	0.05	0.009	0.012	0.009	0.021	0.071	0.006		
Total Copper	*		0.01		0.052		0.008		0.036
Total Iron	•	3.1	0.74	1.2	16	0.66	1.1		24
Total Lead	0.05		0.006		0.011		0.012		0.019
Total Lithium	•	0.11	0.21	0.063	0.028	0.079	0.043		0.10
Total Mercury	0.002								
Total Nickel	•					0.08			
Total Potassium	*	8.9	2.7	5.3	3.9	6.7	1.8		13
Total Sodium	•	140	20	85	32	250	49		150
Total Zinc	•				0.038		0.024		0.13
Total Manganese	•	0.12	0.054	0.037	0.70	0.089	0.028		5.2

NOTES

1) Quantities listed indicate detectable concentrations.
2) No data entry indicates the following: no detectable concentration; or data were negated.
3) MCL is the EPA maximum contaminant level.
4) * indicates that no MCL exists for that particular chemical parameter.

TABLE 7-10

SUMMARY TABLE OF SOLUBLE METALS IN GROUNDWATER

Sheet 1 of 3

		MONITORING WELLS							
CHEMICAL PARAMETERS	MCL	MW-A-1S	MW-A-1D	MW-B-1S	MW-B-1D	MW-B-2S	MW-B-2D	MW-B-3	MW-B-4S
TOTAL SOLUBLE METALS - mg/l									
Total Soluble Arsenic	0.05	0.005	0.012		0.008				
Total Soluble Barium	1.0	0.05	0.07	0.030	0.06	0.05	0.05	0.15	0.16
Total Soluble Beryllium	•								
Total Soluble Boron	•							12	
Total Soluble Cadmium	0.01								
Total Soluble Chromium	0.05								
Total Soluble Copper	•				0.11				0.006
Total Soluble Iron	•								0.04
Total Soluble Lead	0.05								
Total Soluble Lithium	•	0.036	0.14	0.027			0.13	26	0.025
Total Soluble Mercury	0.002							0.0007	
Total Soluble Nickel	*								
Total Soluble Potassium	•	8.6	10	7.6	14	1.5	7.8	13	5.3
Total Soluble Sodium	*	38	90	35	100	11	100	41	19
Total Soluble Zinc	•					0.005		0.006	
Total Soluble Manganese	*	0.13	0.011	0.31		0.86	0.058	1.2	0.18

NOTES

1) Quantities listed indicate detectable concentrations;
2) No data entry indicates the following: no detectable concentration; or data were negated.
3) MCL is the EPA maximum contaminant level.
4) • indicates that no MCL exists for that particular chemical parameter.

TABLE 7-10
(Cont'd)

Sheet 2 of 3

CHEMICAL PARAMETERS	MCL	MONITORING WELLS MW-B-4D	MW-C-1S	MW-C-1D	MW-C-2D	MW-C-3S	MW-C-3D	MW-D-1	MW-7-3S
TOTAL SOLUBLE METALS - mg/l									
Total Soluble Arsenic	0.05			0.008	0.013			0.006	
Total Soluble Barium	1.0	0.07	0.060	0.03		0.13	0.26		0.22
Total Soluble Beryllium	•								
Total Soluble Boron	•								11
Total Soluble Cadmium	0.01								
Total Soluble Chromium	0.05		0.019						
Total Soluble Copper	•								
Total Soluble Iron	*								
Total Soluble Lead	0.05								
Total Soluble Lithium	•	0.099	0.038	0.044	0.091	0.015	0.031	0.070	10
Total Soluble Mercury	0.002								
Total Soluble Nickel	•								0.09
Total Soluble Potassium	•	8.7	2.4	7.0	8.7	5.2	17	10	5.1
Total Soluble Sodium	•	120	27	90	100	31	90	100	70
Total Soluble Zinc	*								0.024
Total Soluble Manganese	•	0.034	0.24	0.065	0.026			0.014	0.13

NOTES

1) Quantities listed indicate detectable concentrations;
2) No data entry indicates the following: no detectable concentration; or data were negated.
3) MCL is the EPA maximum contaminant level.
4) • indicates that no MCL exists for that particular chemical parameter.

TABLE 7-10
(Cont'd)

Sheet 3 of 3

CHEMICAL PARAMETERS	MCL	MONITORING WELLS							
		MW-7-3D	MW-7-5S	MW-7-5D	MW-12-8S	MW-12-8UD	TMW-14	MW-DUP-1	MW-DUP-2
TOTAL SOLUBLE METALS - mg/l									
Total Soluble Arsenic	0.05	0.013		0.013		0.010	0.006		0.006
Total Soluble Barium	1.0		0.08		0.12		0.06		0.13
Total Soluble Beryllium	*								
Total Soluble Boron	*								
Total Soluble Cadmium	0.01								
Total Soluble Chromium	0.05								
Total Soluble Copper	*								
Total Soluble Iron	*				0.04				0.10
Total Soluble Lead	0.05								
Total Soluble Lithium	*	0.11	0.23	0.063	0.012	0.081	0.040		0.071
Total Soluble Mercury	0.002								
Total Soluble Nickel	*								
Total Soluble Potassium	*	9.4	3.0	5.4	2.1	7.5	1.6		10
Total Soluble Sodium	*	80	20	84	35	140	48		100
Total Soluble Zinc	*				0.012				0.007
Total Soluble Manganese	*	0.019	0.009		0.15	0.076			0.013

NOTES

1) Quantities listed indicate detectable concentrations;
2) No data entry indicates the following: no detectable concentration; or data were negated.
3) MCL is the EPA maximum contaminant level.
4) • indicates that no MCL exists for that particular chemical parameter.

found at concentrations below regulatory standards for these metals with the exception of manganese. Samples from monitoring wells MW-B-1S, MW-B-2S and MW-B-3 contained concentrations of manganese at 0.31 mg/l, 0.86 mg/l and 1.2 mg/l, respectively, all of which are above the NYS Standard for Class GA Groundwater (0.3 mg/l). The other soluble metals seen in a reduced number of wells included chromium, copper, mercury, nickel and zinc. In each case, the metal was observed in three wells at levels near or just below the CRQL. For example, soluble zinc was observed in three wells: MW-7-3S, MW-12-8S and the duplicate sample MW-DUP-2 (duplicate of MW-D-1) at levels of 0.024, 0.012 and 0.007 mg/l, respectively. None of these concentrations exceeds state or federal regulatory levels for zinc. Copper and chromium were found only in single wells. Copper was observed in well MW-B-4S at a concentration of 0.006 mg/l (below the CRQL) and chromium was observed in MW-C-1S at a concentration of 0.019 mg/l. Neither of these concentrations exceed state or federal regulatory levels for these compounds. Mercury and nickel were also seen in single wells. Mercury was present in MW-B-3 at a concentration of 0.0007 mg/l which is below the MCL (0.002 mg/l). Nickel was found in MW-7-3S at a concentration of 0.09 mg/l. The balance of the soluble metals including beryllium, cadmium, selenium, silver, and thallium were not found in any of the wells sampled.

Ten of the 22 wells were sampled and analyzed for nitroaromatics (Table 7-8). The sample from well MW-B-3 was lost due to breakage during shipment to metaTRACE, the subcontracted laboratory for this analysis. None of the nine nitroaromatic compounds were detected in any of the wells analyzed.

7.7 - Test Pit Water

It was originally planned to excavate test pit TP-A1 to a depth of 15 ft and collect soil samples at each 5 ft horizon. However, groundwater encountered at a depth of approximately 3 ft below ground surface, precluded continuation of the excavation and a field decision was made to substitute a water sample for a soil sample from the test pit for analysis.

7.7.1 - Volatile Organics

The water sample, TP-A1-WAT, collected from an area of the pit in which drums were encountered, revealed elevated levels of organics and inorganic compounds (Table 7-6). Volatile organic analysis indicated the presence of 12 compounds totaling 2208 ug/l. The greatest concentrations were from acetone (1600 ug/l), 1,1 dichloethane (31 ug/l), 1,2 dichloroethene (110 ug/l), 2-butanone (120 ug/l), benzene (32 ug/l) and toluene (260 ug/l). Other compounds found in concentrations slightly above the CRQL were vinyl chloride (12 ug/l), trichloroethene (11 ug/l), 4 methyl-2-pentanone (6 ug/l), ethybenzene (4 ug/l), styrene (6 ug/l) and total xylenes (16 ug/l).

Of the volatile compounds identified, vinyl chloride, trichloroethene benzene, toluene and ethylbenzene exceed EPA water quality criteria for human health protection.

7.7.2 - Semi-Volatile Organics

Semi-volatile organic analyses of the test pit water revealed the presence of several compounds not detected in any other groundwater samples including several phenolic and polynuclear aromatic hydrocarbon (PAH) compounds. The phenolic compounds detected include phenol (97 ug/l), 2-methylphenol (26 ug/l), 4-methylphenol (64 ug/l) and 2,4-dichlorophenol (7 ug/l). The PAHs which were seen include naphthalene (25 ug/l), 2-methylnaphthalene (29 ug/l), phenanthrene (5 ug/l) and pyrene (0.4 ug/l). Also found was di-n-butyphthalate (1 ug/l) at a level below the CRQL. Of these compounds, phenanthrene, pyrene and 2,4-dichlorophenol exceed EPA Ambient Water Quality Criteria for human health.

7.7.3 - Metals

Eleven metals were also detected in the test pit water sample. Two of the metals, barium (0.14 mg/l) and iron (7.7 mg/l), were detected in concentrations which exceed the NYS Groundwater Standards for these metals. Analytical results also indicate the presence of boron (120 mg/l) and lithium (38 mg/l). No standards of MCL exists for either of these metals.

7.7.4 - RCRA Waste Characteristics

The test pit water sample was analyzed for RCRA waste characteristics and, according to the RCRA analytical results alone, the water within the test pit does not qualify as a RCRA waste (Table 7-11).

7.7.5 - Radiation Parameters

Analyses for Gross Alpha and Gross Beta was performed on groundwater samples from eight newly installed monitoring wells (plus rinse blanks and duplicate samples). Analytical results indicate no detections of Gross Alpha and very low concentrations of Gross Beta in all samples which probably reflect background concentrations (Table 7-12).

TABLE 7-11
RCRA WASTE CHARACTERISTICS

Test Pit TP-A1 Water

Corrosivity (leaching pH)	8.30 (standard units)
Flash Point	>200°F
Oxidizer Spot Test	NEG
Total Available Cyanide	<10 mg/kg
Total Available Sulfide	<10 mg/kg

TABLE 7-12

SUMMARY TABLE OF RADIATION ANALYSIS RESULTS

Sample Identification/Source	Parameter Gross Alpha (pCi/liter)	Gross Beta (pCi/liter)
MW-A1S	<5.0	1.6 ± 2.0
MW-B1S	<3.0	1.4 ± 2.0
MW-B2S	<4.0	7.8 ± 1.6
MW-B3	<10	4.4 ± 12
MW-B4D	<4.0	1.4 ± 2.0
MW-B4S	<4.0	1.0 ± 2.0
MW-C1S	<4.0	7.0 ± 1.7
MW-D1	<4.0	1.8 ± 2.0
MW-RB1	<0.3	9.7 ± 0.54
MW-RB2	<0.3	<0.7
MW-DUP-1	<4.0	1.3 ± 2.0
MW-DUP-2	<4.0	1.8 ± 2.0

New York State drinking water standards:

Gross Alpha = 15 pCi/l - excluding radon and uranium
Gross Beta = 1000 pCi/l - excluding Strontium 90 and alpha emitters

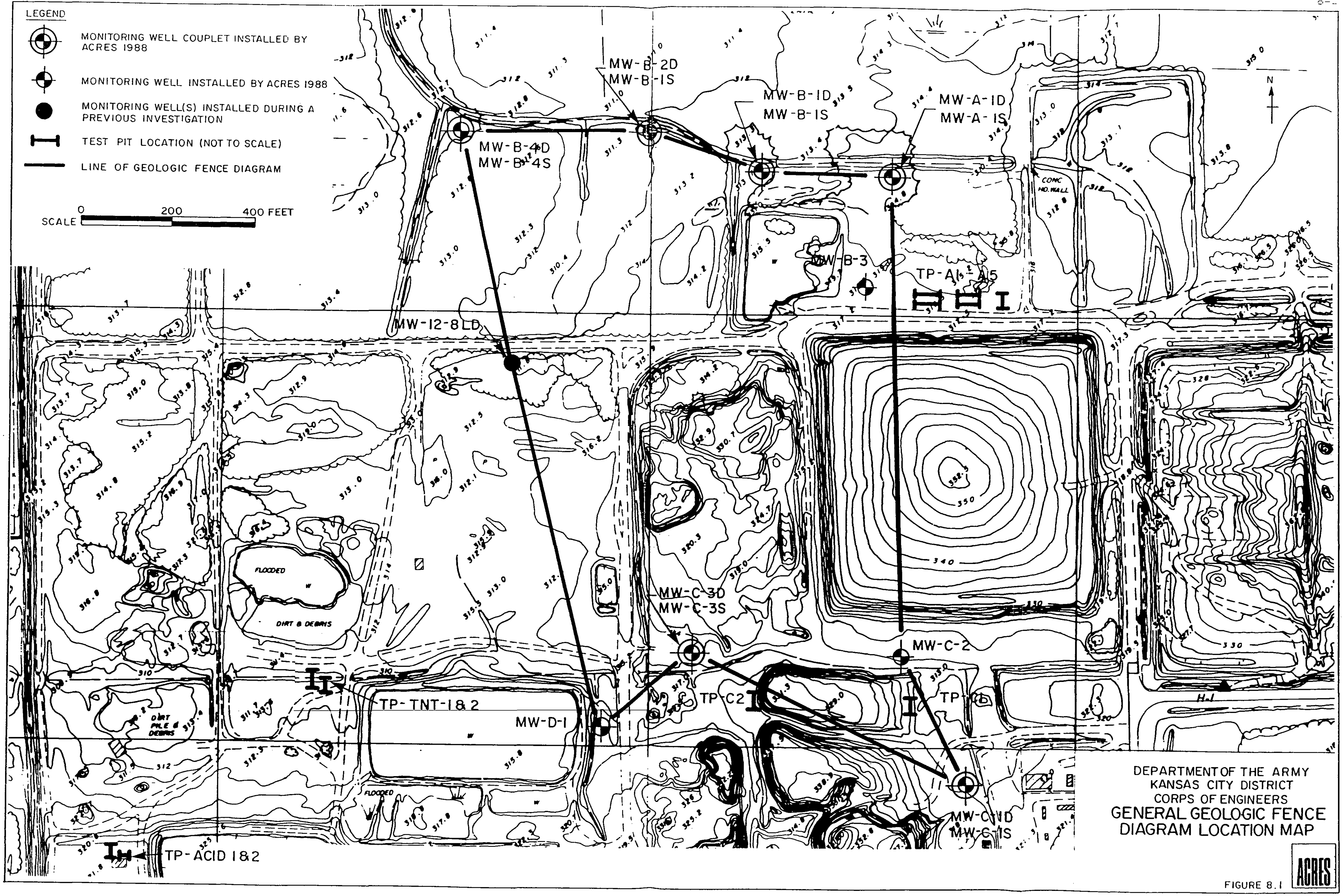
8 - SITE CHARACTERIZATION

8.1 - Site Geology

The specific subsurface information for the project study area discussed in the following subsections represents a compilation of data obtained from the 22 soil/well borings and 11 test pits performed as part of this investigation as well as from other existing CWM monitoring wells and piezometers located within the project study area. A geologic fence diagram, geologic cross section location map, and four geologic cross sections constructed using data from the soil/well borings and test pits are presented in Figures 8-1 through 8-7. The locations of all soil borings and monitoring wells referenced in the following subsections are presented on the Geologic Cross-Section Location Map (Figure 8-3). The subsurface logs for the soil/well borings used in the interpretation of the hydrogeology of the project study area are presented in Appendix H.

8.1.1 - Bedrock

Although bedrock was not penetrated or sampled during the subsurface investigative portion of this RI, previous investigations have determined that the project study area is underlain by the Queenston Formation. The Queenston Formation in this area was found to be composed of red fissile shale with occasional 1-inch to 24-inch thick green shale bands with occasional 1/2-inch to 1-inch diameter gypsum nodules (Golder, 1985, 1988; Wehran, 1979). The upper 5 to 10 ft of the rock surface is generally highly weathered and the weathered bedrock is sometimes difficult to distinguish from the overlying till. In some areas, glacial erosion has completely removed the highly weathered rock (Golder, 1988). In the project study area, the surface of the Queenston Formation slopes toward the northwest with elevations ranging from about 270 ft in the southeast (i.e. at Area C) to about 250 ft in the northwest corner of the site (i.e. at piezometers G-8 and G-9). A low in the bedrock surface trends in a southwest-northeast direction beginning in the southern portion of Area C and extending to the western boundary of the site. As



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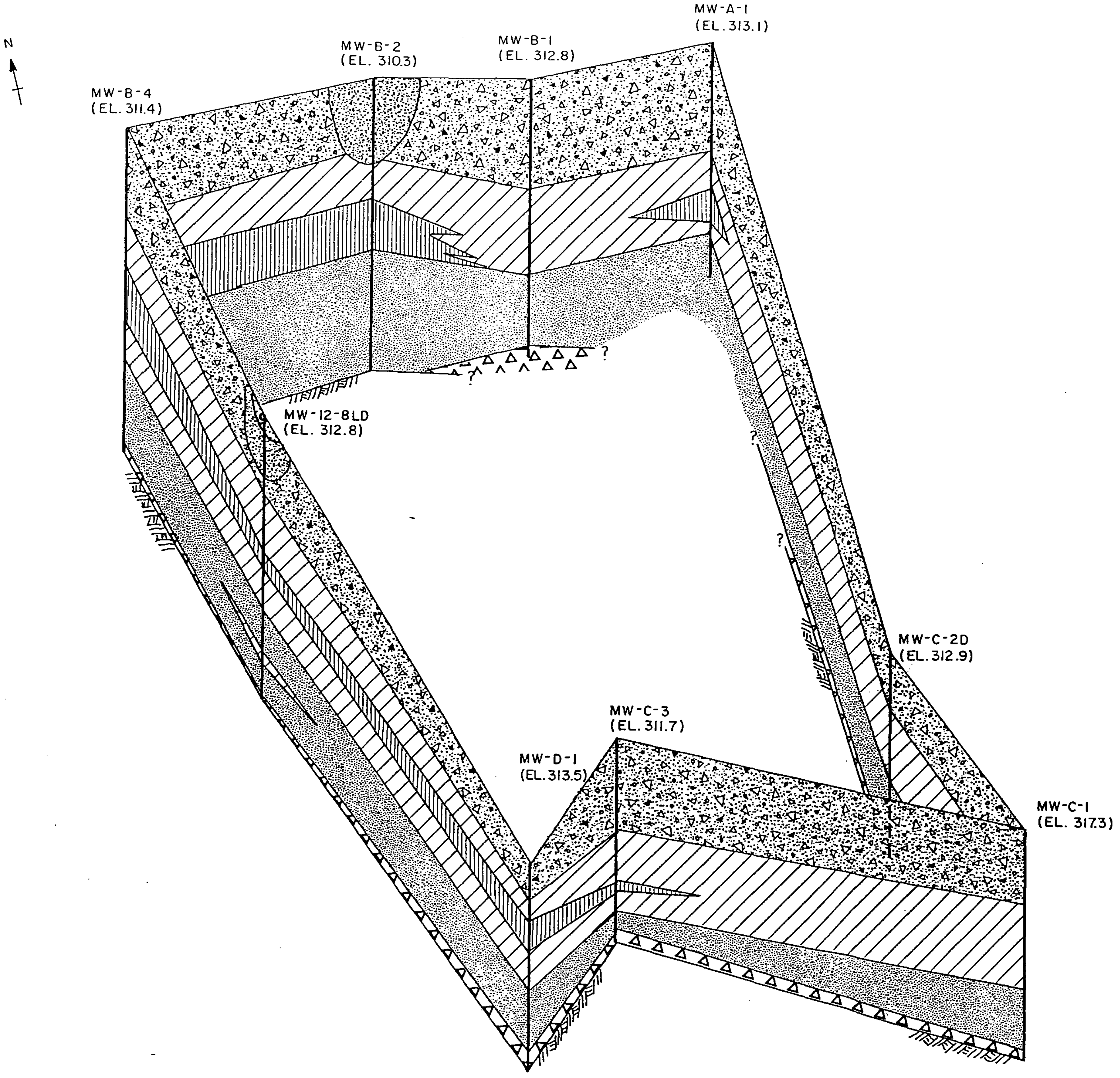
GENERAL GEOLOGIC FENCE DIAGRAM LOCATION MAP

ACRES

FIGURE 8.1



LEGEND

░	BROWN FINE SAND, LOOSE, DILATANT, SOME BROWN AND BLACK SPECS. (ALLUVIUM)
▒	FILL- ROAD ASPHALT AND GRAVEL, LANDFILL BERMS, ETC.
▓	BROWN TO GRAY BROWN SILTY CLAY TO CLAYEY SILT, TRACE TO SOME SAND AND GRAVEL, VERY STIFF TO FIRM (UPPER GLACIAL TILL)
▨	GRAY TO GRAY BROWN CLAY TO SILTY CLAY, SOFT, TRACE TO LITTLE SAND AND GRAVEL, WET (GLACIOLACUSTRINE CLAY)
▥	DARK BROWN CLAYEY SILT, SOME SAND AND GRAVEL, STIFF (MIDDLE SILT TILL)
░	BROWN TO GRAY BROWN SILTY CLAY TO CLAYEY SILT TO SILT TO SILTY SAND, TRACE TO SOME GRAVEL, DENSE TO VERY DENSE (GLACIOLACUSTRINE SILT / SAND)
△	RED BROWN SILTY SAND TO SANDY SILT, DENSE TO VERY DENSE, SOME GREEN AND RED SHALE GRAVEL (BASAL RED TILL)
TD	TOTAL DEPTH FEET BELOW GROUND SURFACE

NOTES:

MONITORING WELLS WITHIN EACH COUPLET ARE LOCATED WITHIN 10 FT. OF EACH OTHER.

ELEVATION IN SCA DATUM (APPROXIMATELY MSL)

SCALE HORIZONTAL - 1" = 200'
VERTICAL - 1" = 20'

THE REPRESENTATION OF SUBSURFACE STRATA WAS CONSTRUCTED USING ACCEPTED HYDROGEOLOGIC PRACTICES AND PRINCIPLES. ACTUAL CONDITIONS MAY VARY FROM THOSE SHOWN.

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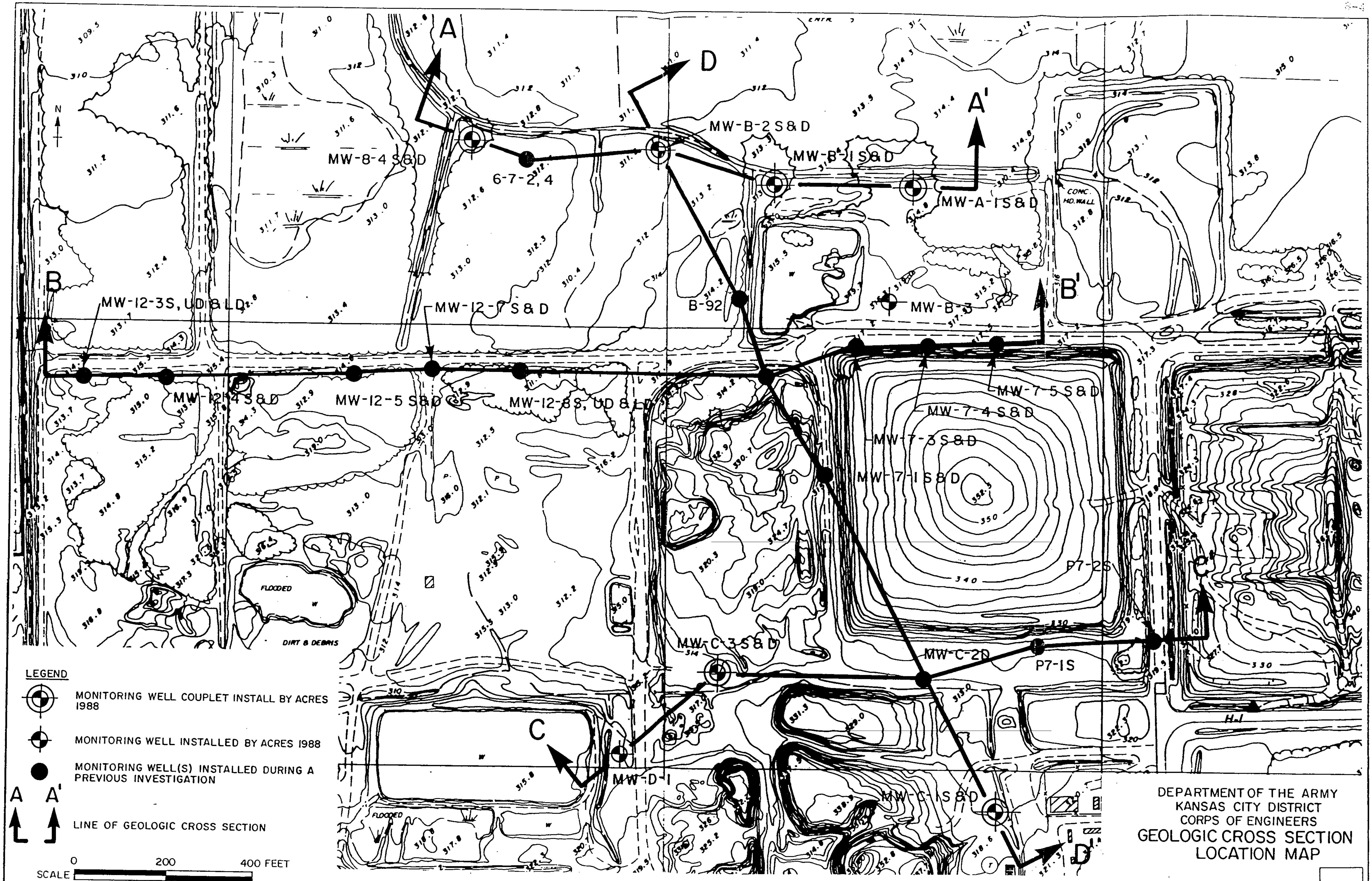
GENERALIZED GEOLOGIC FENCE DIAGRAM

FIGURE 8.2

ACRES



LEGEND

⊕ MONITORING WELL COUPLET INSTALL BY ACRES 1988

⊕ MONITORING WELL INSTALLED BY ACRES 1988

● MONITORING WELL(S) INSTALLED DURING A PREVIOUS INVESTIGATION

A A' LINE OF GEOLOGIC CROSS SECTION

SCALE 0 200 400 FEET

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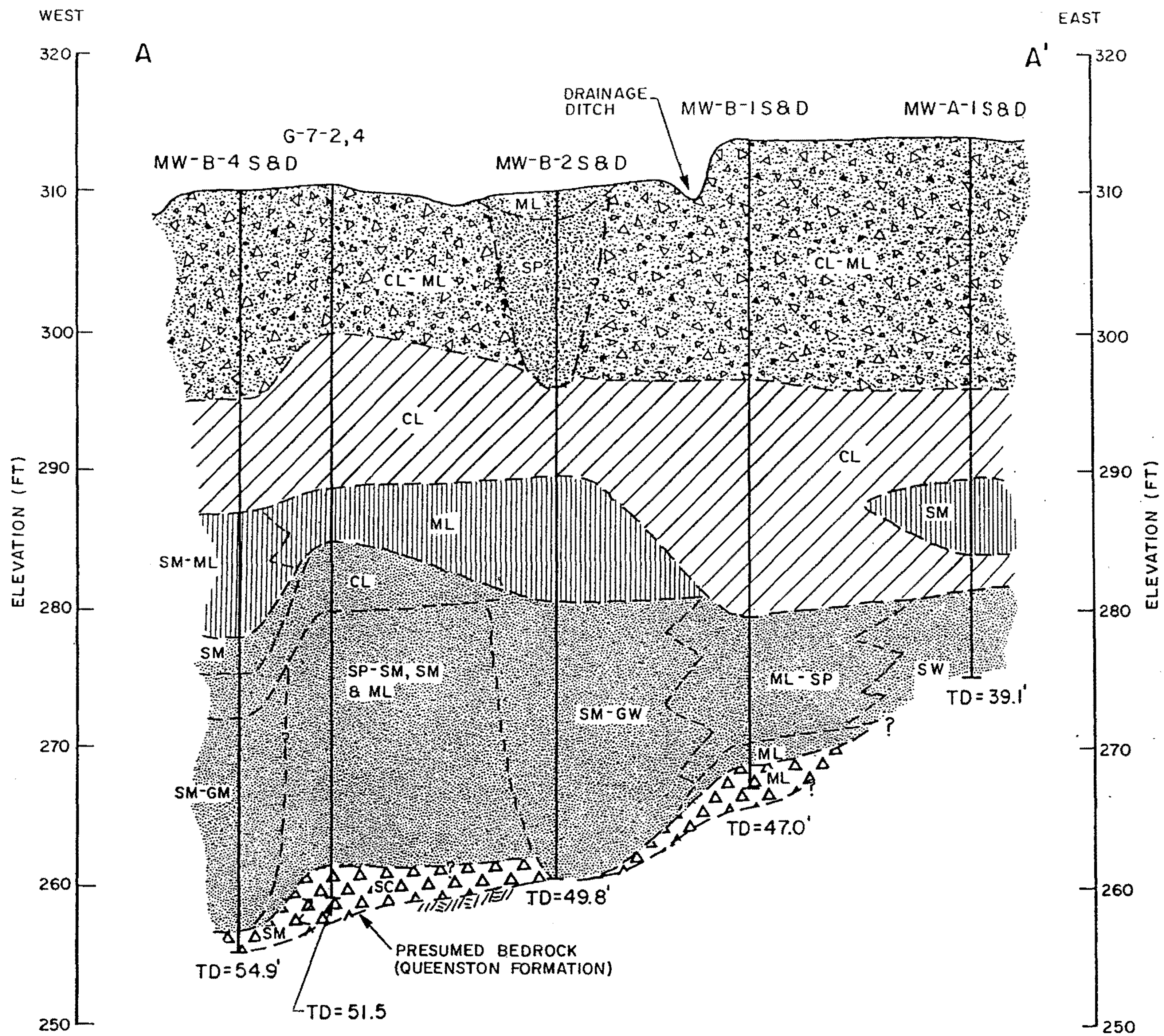
GEOLOGIC CROSS SECTION LOCATION MAP

ACRES

FIGURE 8.3



LEGEND

░	BROWN FINE SAND, LOOSE, DILATANT, SOME BROWN AND BLACK SPECS. (ALLUVIUM)
▒	FILL - ROAD ASPHALT AND GRAVEL, LANDFILL BERMS, ETC.
▓	BROWN TO GRAY BROWN SILTY CLAY TO CLAYEY SILT, TRACE TO SOME SAND AND GRAVEL, VERY STIFF TO FIRM (UPPER GLACIAL TILL)
▨	GRAY TO GRAY BROWN CLAY TO SILTY CLAY, SOFT, TRACE TO LITTLE SAND AND GRAVEL, WET (GLACIOLACUSTRINE CLAY)
▥	DARK BROWN CLAYEY SILT, SOME SAND AND GRAVEL, STIFF (MIDDLE SILT TILL)
▒	BROWN TO GRAY BROWN SILTY CLAY TO CLAYEY SILT TO SILT TO SILTY SAND, TRACE TO SOME GRAVEL, DENSE TO VERY DENSE (GLACIOLACUSTRINE SILT / SAND)
△	RED BROWN SILTY SAND TO SANDY SILT, DENSE TO VERY DENSE, SOME GREEN AND RED SHALE GRAVEL (BASAL RED TILL)
TD	TOTAL DEPTH FEET BELOW GROUND SURFACE

NOTES:
MONITORING WELLS WITHIN EACH COUPLET ARE LOCATED WITHIN 10 FT. OF EACH OTHER.

ELEVATION IN SCA DATUM (APPROXIMATELY MSL)

SCALE HORIZONTAL - 1" = 200'
VERTICAL - 1" = 20'

THE REPRESENTATION OF SUBSURFACE STRATA WAS CONSTRUCTED USING ACCEPTED HYDROGEOLOGIC PRACTICES AND PRINCIPLES. ACTUAL CONDITIONS MAY VARY FROM THOSE SHOWN.

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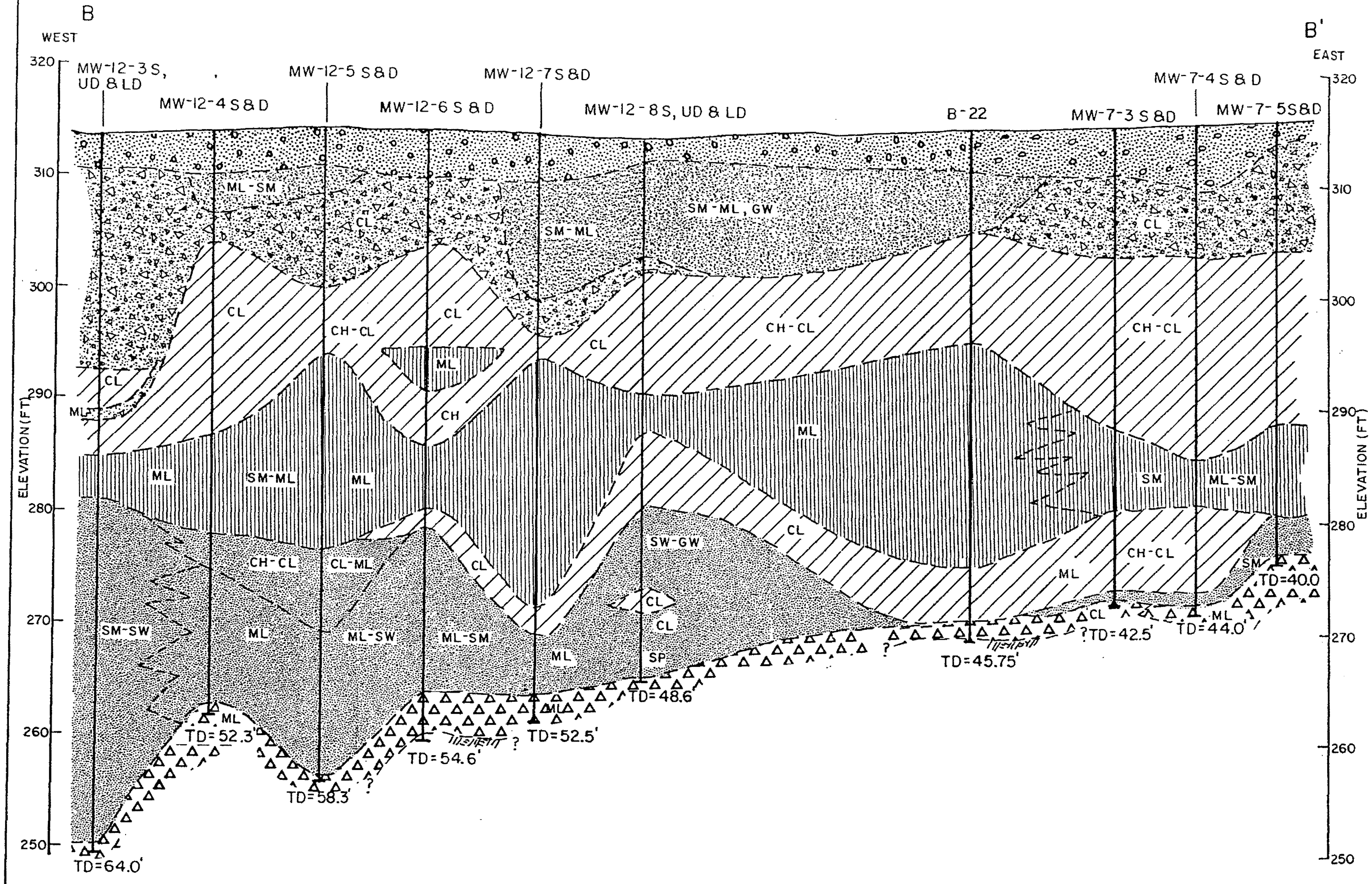
GEOLOGIC CROSS SECTION
A-A'

FIGURE 8.4 ACRES



LEGEND

- ▨ BROWN FINE SAND, LOOSE, DILATANT, SOME BROWN AND BLACK SPECS. (ALLUVIUM)
- ▨ FILL - ROAD ASPHALT AND GRAVEL, LANDFILL BERMS, ETC.
- ▨ BROWN TO GRAY BROWN SILTY CLAY TO CLAYEY SILT, TRACE TO SOME SAND AND GRAVEL, VERY STIFF TO FIRM (UPPER GLACIAL TILL)
- ▨ GRAY TO GRAY BROWN CLAY TO SILTY CLAY, SOFT, TRACE TO LITTLE SAND AND GRAVEL, WET (GLACIOLACUSTRINE CLAY)
- ▥ DARK BROWN CLAYEY SILT, SOME SAND AND GRAVEL, STIFF (MIDDLE SILT TILL)
- ▨ BROWN TO GRAY BROWN SILTY CLAY TO CLAYEY SILT TO SILT TO SILTY SAND, TRACE TO SOME GRAVEL, DENSE TO VERY DENSE (GLACIOLACUSTRINE SILT / SAND)
- △ RED BROWN SILTY SAND TO SANDY SILT, DENSE TO VERY DENSE, SOME GREEN AND RED SHALE GRAVEL (BASAL RED TILL)

TD TOTAL DEPTH FEET BELOW GROUND SURFACE

NOTES:

MONITORING WELLS WITHIN EACH COUPLET ARE LOCATED WITHIN 10 FT. OF EACH OTHER.

ELEVATION IN SCA DATUM (APPROXIMATELY MSL)

SCALE HORIZONTAL - 1" = 200'
VERTICAL - 1" = 20'

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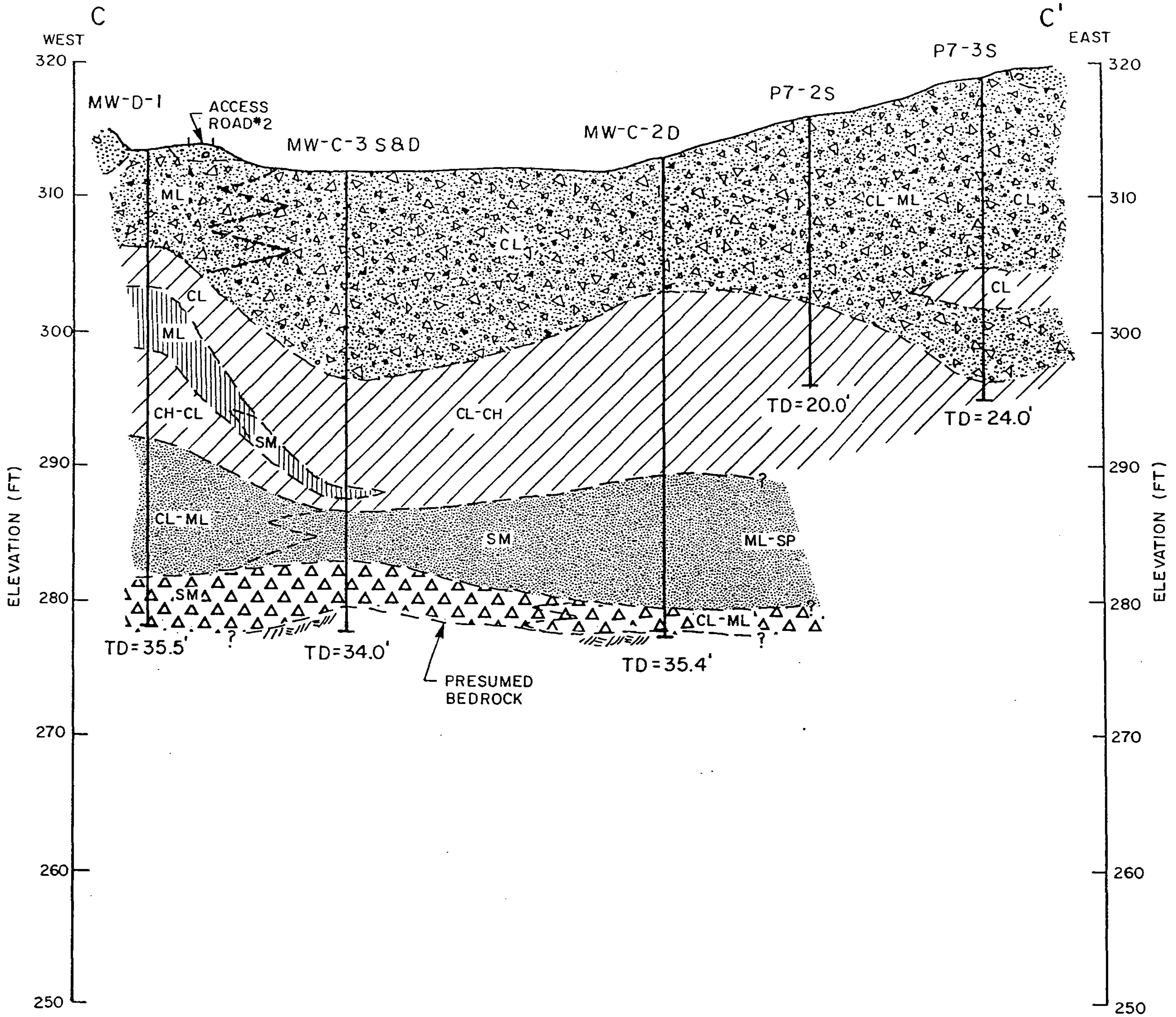
GEOLOGIC CROSS SECTION
B-B'

THE REPRESENTATION OF SUBSURFACE STRATA WAS CONSTRUCTED USING ACCEPTED HYDROGEOLOGIC PRACTICES AND PRINCIPLES. ACTUAL CONDITIONS MAY VARY FROM THOSE SHOWN.

FIGURE 8.5

ACRES



LEGEND

░	BROWN FINE SAND, LOOSE, DILATANT, SOME BROWN AND BLACK SPECS. (ALLUVIUM)
▒	FILL - ROAD ASPHALT AND GRAVEL, LANDFILL BERMS, ETC.
▓	BROWN TO GRAY BROWN SILTY CLAY TO CLAYEY SILT, TRACE TO SOME SAND AND GRAVEL, VERY STIFF TO FIRM (UPPER GLACIAL TILL)
▨	GRAY TO GRAY BROWN CLAY TO SILTY CLAY, SOFT, TRACE TO LITTLE SAND AND GRAVEL, WET (GLACIOLACUSTRINE CLAY)
▥	DARK BROWN CLAYEY SILT, SOME SAND AND GRAVEL, STIFF (MIDDLE SILT TILL)
░	BROWN TO GRAY BROWN SILTY CLAY TO CLAYEY SILT TO SILT TO SILTY SAND, TRACE TO SOME GRAVEL, DENSE TO VERY DENSE (GLACIOLACUSTRINE SILT / SAND)
△	RED BROWN SILTY SAND TO SANDY SILT, DENSE TO VERY DENSE, SOME GREEN AND RED SHALE GRAVEL (BASAL RED TILL)
TD	TOTAL DEPTH FEET BELOW GROUND SURFACE

NOTES-

MONITORING WELLS WITHIN EACH COUPLET ARE LOCATED WITHIN 10 FT. OF EACH OTHER.

ELEVATION IN SCA DATUM (APPROXIMATELY MSL)

SCALE HORIZONTAL - 1" = 200'
VERTICAL - 1" = 20'

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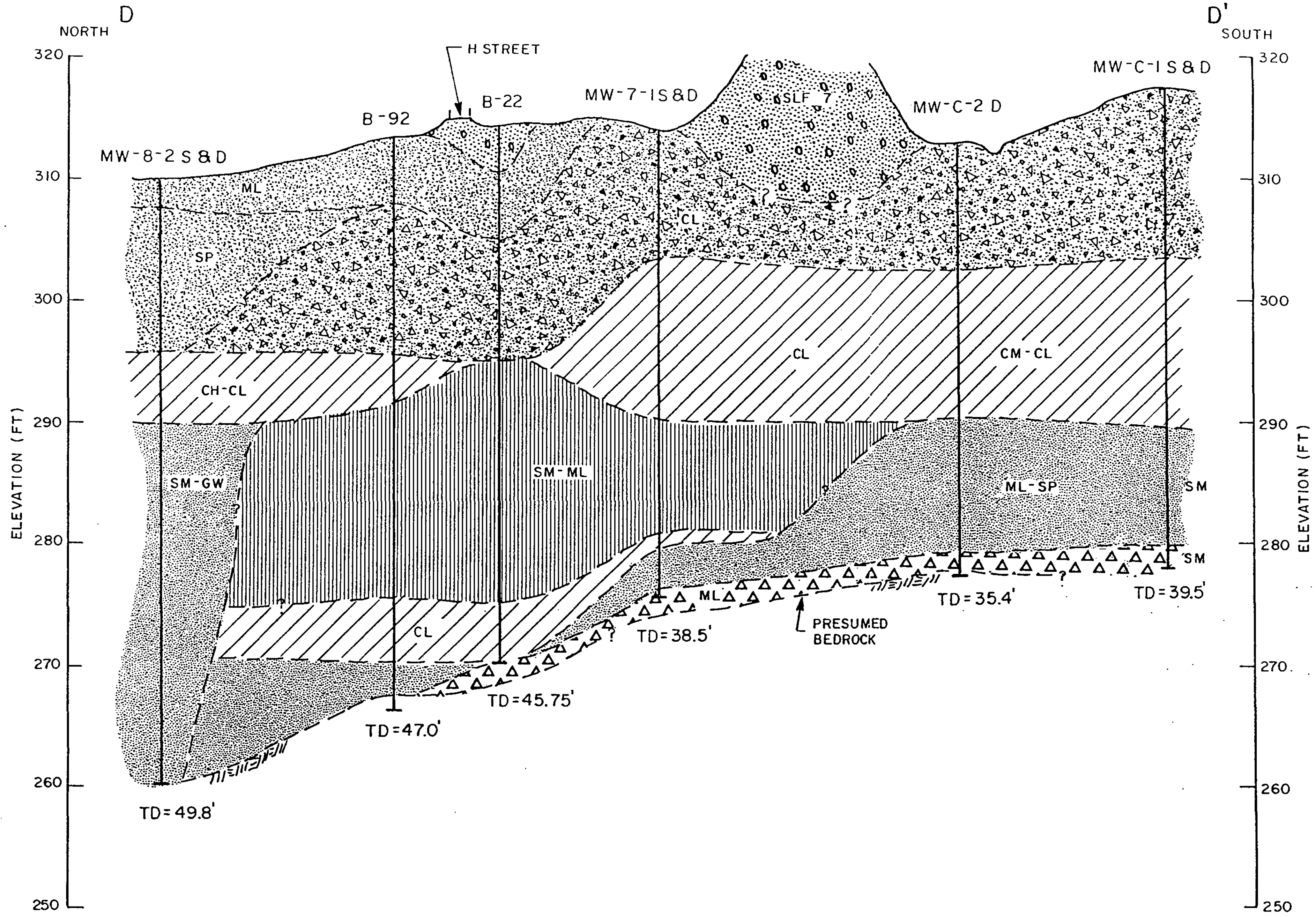
GEOLOGIC CROSS SECTION
C-C'

THE REPRESENTATION OF SUBSURFACE STRATA WAS CONSTRUCTED USING ACCEPTED HYDROGEOLOGIC PRACTICES AND PRINCIPLES. ACTUAL CONDITIONS MAY VARY FROM THOSE SHOWN



LEGEND

▒ BROWN FINE SAND, LOOSE, DILATANT, SOME BROWN AND BLACK SPECS. (ALLUVIUM)

▒ FILL- ROAD ASPHALT AND GRAVEL, LANDFILL BERMS, ETC.

▒ BROWN TO GRAY BROWN SILTY CLAY TO CLAYEY SILT, TRACE TO SOME SAND AND GRAVEL, VERY STIFF TO FIRM (UPPER GLACIAL TILL)

▨ GRAY TO GRAY BROWN CLAY TO SILTY CLAY, SOFT, TRACE TO LITTLE SAND AND GRAVEL, WET (GLACIOLACUSTRINE CLAY)

▥ DARK BROWN CLAYEY SILT, SOME SAND AND GRAVEL, STIFF (MIDDLE SILT TILL)

▒ BROWN TO GRAY BROWN SILTY CLAY TO CLAYEY SILT TO SILT TO SILTY SAND, TRACE TO SOME GRAVEL, DENSE TO VERY DENSE (GLACIOLACUSTRINE SILT / SAND)

△ RED BROWN SILTY SAND TO SANDY SILT, DENSE TO VERY DENSE, SOME GREEN AND RED SHALE GRAVEL (BASAL RED TILL)

TD TOTAL DEPTH FEET BELOW GROUND SURFACE

NOTES·

MONITORING WELLS WITHIN EACH COUPLET ARE LOCATED WITHIN 10 FT. OF EACH OTHER.

ELEVATION IN SCA DATUM (APPROXIMATELY MSL)

SCALE HORIZONTAL - 1"= 200'
VERTICAL - 1"= 20'

THE REPRESENTATION OF SUBSURFACE STRATA WAS CONSTRUCTED USING ACCEPTED HYDROGEOLOGIC PRACTICES AND PRINCIPLES. ACTUAL CONDITIONS MAY VARY FROM THOSE SHOWN.

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GEOLOGIC CROSS SECTION
D-D'

FIGURE 8.7 ACRES

determined from the field investigation program for this RI, unconsolidated materials in the project study area range from 34 to 54.9 ft in thickness. The thickest deposits occur in the northwestern portion of the project study area, coinciding with the lower bedrock surface. This trend also correlates well with information from previous investigations (i.e. Golder, 1985 and 1988) which indicate that the thickest overburden deposits occur at piezometer G-9 at a thickness of 66.5 ft. The unconsolidated overburden deposits overlying bedrock are composed primarily of glacial deposits. Interpretation of the subsurface stratigraphy in the project study area, as encountered during the subsurface portion of this investigation, was performed in an attempt to be consistent with previous interpretations of the subsurface stratigraphy of the Model City Facility as determined by Golder whose interpretations were based on reviews in 1985 and 1988 of information obtained from over 590 borings and test pits located across the facility.

The following stratigraphic sequence of unconsolidated deposits was encountered in the project study area (from oldest to youngest):

- Basal Red Till;
- Glaciolacustrine Silt/Sand;
- Middle Silt Till;
- Glaciolacustrine Clay;
- Upper Glacial Till; and
- Upper Alluvium and/or Fill.

This stratigraphy of the project study area is diagrammatically presented on the fence diagram in Figure 8-2 and on geologic cross sections presented in Figures 8-4 through 8-7. The location of the geologic cross sections are located on Figure 8-3. The following subsections present descriptions of the unconsolidated stratigraphic deposits unconformably overlying bedrock in the project study area.

8.1.2 - Basal Red Till

The Basal Red Till unit immediately and unconformably overlies bedrock across most of the project study area. This unit is generally composed of red brown silty SAND to sandy SILT (SM-ML) with trace to some green and red shale clasts. The Basal Red Till may vary in composition to a silty CLAY (i.e. boring MW-7-3D). The unit is commonly dry and dense to very dense. As shown on Figures 8-2 and 8-4 through 8-7, the Basal Red Till generally conforms to the bedrock surface, sloping to the northwest. As also shown on these figures, the Basal Red Till is absent in some areas (i.e. MW-B-2D and B-92).

The red color, high density, and presence of green and red shale clasts indicate that the Basal Red Till was deposited as a lodgment till with most of the material being locally derived from reworked Queenston shale. It is believed that the unit was deposited during the advance of the Wisconsin ice sheet southwestward out of the Lake Ontario Basin into the Lake Erie Basin (Johnston, 1964).

8.1.3 - Glaciolacustrine Silt/Sand

Overlying the Basal Red Till across most of the project study area is the Glaciolacustrine Silt/Sand unit. The Glaciolacustrine Silt/Sand unit is believed to have been deposited within a proglacial lake (Lake Iroqois) which developed in front of the glacier as it retreated northward into the Lake Ontario Basin (Johnston, 1964; Golder, 1988). The variability in character of the deposits within the unit and in relation to the overlying clay unit is due to the different stages of development of the glacial lake. The coarser deposits within the Glaciolacustrine Silt/Sand unit, particularly those encountered at monitoring wells MW-B-2S+D and MW-B-4S+D, indicate possible glacial outwash streams associated with the glacial lake.

The Glaciolacustrine Silt/Sand was found to vary in composition from coarse sand and gravel (SM-GW) to varying sand-silt-clay mixtures (CL-ML to ML to SM-SW). In general, the coarser deposits, indicative of a high energy depositional environment, were found along the northern portion of the project study area, particularly at monitoring well locations MW-A-1S+D, MW-B-2S+D, and MW-B-4S+D. The results of this high energy depositional environment is especially noted at monitoring well location MW-B-2S+D where the Basal Red Till unit appears to have been eroded away and the Glaciolacustrine Silt/Sand unit deposited directly on the bedrock surface.

During the subsurface investigation, the Glaciolacustrine Silt/Sand unit was found to range in thickness from 3.7 to about 21 ft with the thicker deposits occurring in the northwestern portion of the site where the bedrock is deepest. In addition, previous investigations have shown that the Glaciolacustrine Silt/Sand unit is absent in some areas (i.e. B-22). However, for the most part, the Glaciolacustrine Silt/Sand unit appears to have filled in most of the depressions in the bedrock/Basal Red Till surface with the uppermost surface of the unit being fairly flat.

8.1.4 - Glaciolacustrine Clay

The Glaciolacustrine Clay unit overlies the Glaciolacustrine Silt/Sand and is generally composed of gray to gray brown CLAY to silty CLAY (CH-CL to CL). The unit is typically soft, as noted by the low blow counts, and has trace to little sand and gravel throughout. The Glaciolacustrine Clay has moderate to high plasticity and is frequently wet and faintly laminated. As shown in Figures 8-2 through 8-7, the Glaciolacustrine Clay unit has been divided into lower and upper members by the presence a middle till sequence. In general, the upper unit is thicker than the lower unit ranging in thickness from 3 to 15.2 ft; the lower clay unit was found up to 6.4 ft in thickness. Where the middle till unit is absent (and consequently the lower clay is absent) the portion of the clay unit present was considered as part of the upper glaciolacustrine clay. The Glaciolacustrine Clay is believed to have been deposited in the same glacial lake (i.e. Lake Iroqois) as the underlying Glaciolacustrine Silt/Sand, albeit from a lower energy depositional environment.

8.1.5 - Middle Silt Till

The Glaciolacustrine Clay is divided into upper and lower strata by the occurrence of a middle till deposit. This unit, referred to as the Middle Silt Till by Golder (1985 and 1988) was found to be composed of brown to dark brown clayey SILT to silty fine SAND (ML-SM). The unit contains varying amounts of fine to coarse sand and gravel and is commonly stiff to dense. As shown on Figure 8-2 through 8-7 the Middle Silt Till is discontinuous across the site occurring predominantly in the western portion of the site. Where present, the Middle Silt Till was noted as having a thickness of up to 20 ft (i.e. B-22). The Middle Silt Till is believed to have been deposited during a local readvance of the glacier from the Lake Ontario Basin.

8.1.6 - Upper Glacial Till

The Upper Glacial Till covers most of the surface across the project study area and is commonly brown to red brown clayey SILT to silty CLAY (CL-ML) with some fine to coarse sand and gravel throughout. The Upper Glacial Till is typically stiff to very stiff and dry to moist with low plasticity. Occasional discontinuous vertical partings with gray clay fillings are also present within the upper 10 ft of the till. The unit also contains occasional fine sand or silt lenses up to 2 ft in thickness.

Golder (1988) has noted in their review of the Model City Facility stratigraphy that the Upper Glacial Till may occur as two distinct units: a discontinuous Upper Silt Till occurring more prevalent in the northern portion of the facility and a Upper Clay Till which is generally continuous across the facility. The Upper Silt Till has been described as being composed of brown to gray brown Silt and coarse to fine Sand. The Upper Clay Till has been described as predominantly brown to purple brown Clayey Silt to Silty Clay with some coarse to fine sand and little fine gravel (Golder 1985 and

1988). However, the physical differences allowing differentiation of these two subunits were not noted during the subsurface investigation in the project study area.

8.1.7 - Upper Alluvium

A local alluvial deposit was encountered in the northern portion of the project study area at monitoring well location MW-B-2S+D. The deposit consisted of brown fine Sand (SW) with some black and rust brown specks up to a 1/4-inch in size. The deposit was loose to dense, commonly wet to saturated, dilatant, and contained occasional silty clay lenses near the bottom of the deposit. This deposit may be related to other alluvial deposits encountered during previous investigations at monitoring well locations (e.g. MW-12-7, MW-12-8 and B-22).

8.1.8 - Fill

Due to the past and present uses of the site for the construction of buildings, landfill operations and road construction, there exists extensive areas of fill deposition and reworking of the surface of the glacial and alluvial deposits. In some instances, the fill deposits are easily distinguished from natural deposits (e.g. road fill) while other fill deposits are less readily identifiable. For example, the upper portion of the unconsolidated deposits in the vicinity of monitoring well couplet MW-C-1S+D has been extensively reworked (as evidenced by the ongoing fill storage and removal operations occurring during the field investigative program). Even with the visual evidence of an active fill deposition in this area, the distinction between the fill (of local origin) being stockpiled and the soil types encountered during drilling was practically imperceptible. Areas of known fill activities include Areas A, B, C, D, the area north of C and the areas investigated in an attempt to find the acid and TNT waste lines. The Wooded Area appears to be the only virgin land in the project study area.

8.2 - Site Hyrogeology

As previously mentioned in Section 5, groundwater monitoring wells were installed in the project study area to monitor groundwater quality within the Upper Glacial Till (Zone 1) and the Glaciolacustrine Silt/Sand water-bearing zones (Zone 3). The placement of the intake intervals for the monitoring wells were designed to monitor the entire thickness of each monitoring zone as completely as possible. The monitoring well intake intervals of the newly installed wells are diagrammatically depicted on Figures 8-8 through 8-10 and on the associated boring logs presented in Appendix H. The results of geotechnical analyses of select soil samples from the screened interval of each new monitoring well are presented in Table 8-1.

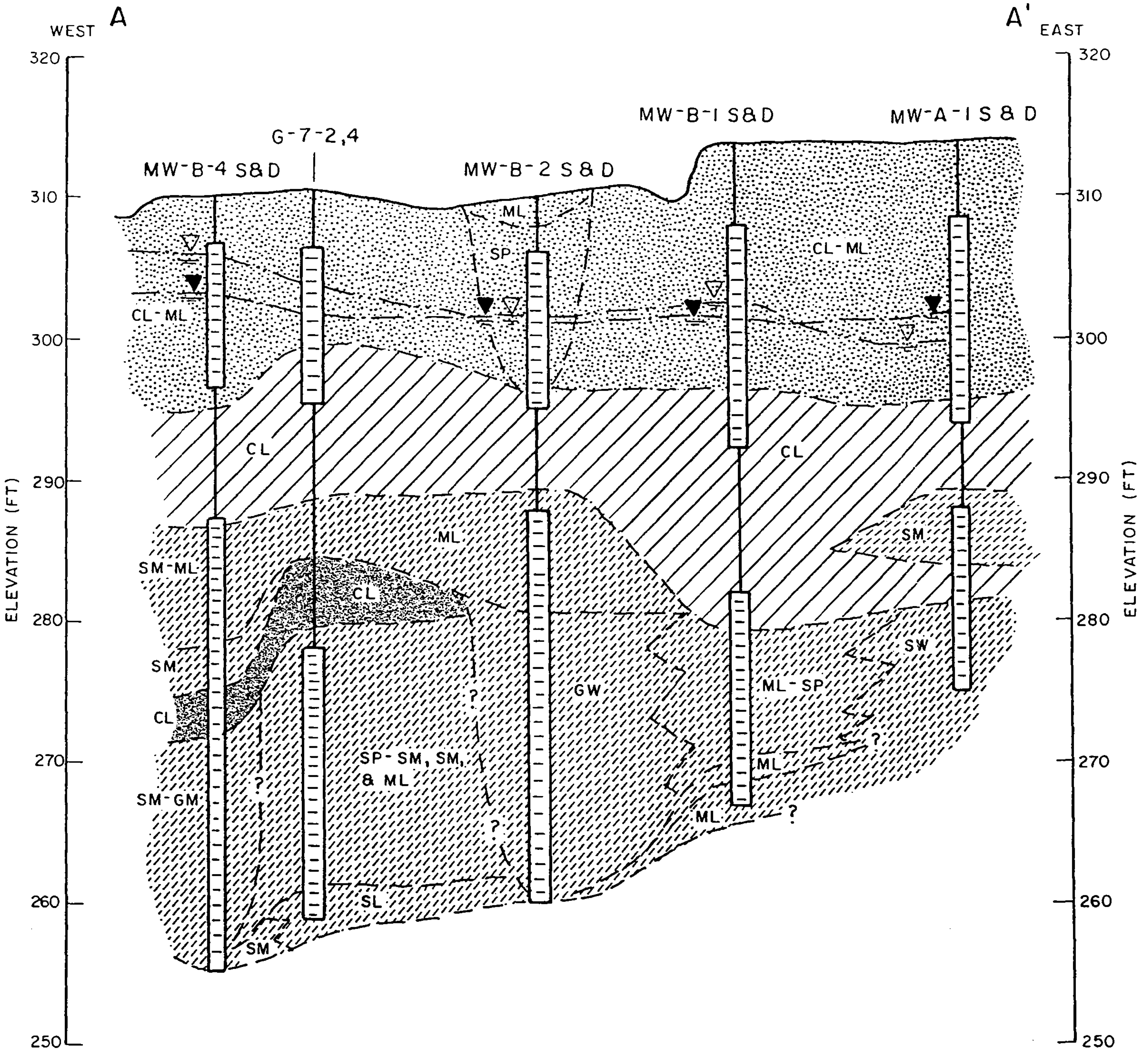
The location of each monitoring well was selected in an attempt to monitor groundwater quality within each water-bearing zone of concern both up-gradient and downgradient of areas A, B, C, D, and the Wooded Area. Seven of SCA's existing monitoring wells were utilized in this endeavor.

A total of 11 Zone 1 monitoring wells were used as part of the groundwater investigative portion of this RI; seven of those monitoring wells were installed as part of this study. The initial design of the Zone 1 monitoring program proposed that eight monitoring wells be installed as part of the field program. However, during the drilling for proposed monitoring well MW-C-2S, located downgradient of the eastern portion of Area C, there was no groundwater encountered. The borehole was left open for several days to determine if any groundwater would be produced. However, the hole remained dry and the borehole was grouted to the ground surface and this monitoring point was abandoned.

All of the Zone 1 monitoring wells were drilled down to the Glaciolacustrine Clay with the depth from ground surface to the clay included as the intake interval of the well as completely as practical. Each well was constructed of Schedule 80 PVC riser pipe and #10 (0.010 inch) slotted screen. A #2 Q-Rock sand was placed in the annular space around each screen to a minimum height of 2 ft above the screen and riser coupling. A

TABLE 8-1
RESULTS OF GEOTECHNICAL ANALYSES OF SELECT SOIL SAMPLES FROM SCREENED INTERVALS

WELL ID	SAMPLE NUMBER	SAMPLE DEPTH	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	SAMPLE DESCRIPTION	% PASSING #200 SIEVE
MW-A-1S	SS-1	12-14	--	NP	--	silty Sand with trace of Gravel	44.5
	SS-2	14-16	--	NP	--	silty Sand with trace of Gravel	47.8
MW-A-1D	SS-18	34-36	--	NP	--	silty sandy Gravel	11.3
	SS-19	36-38	--	NP	--	silty sandy Gravel	17.5
MW-B-1S	SS-1	10-12	21.2	16.8	4.4	gravely silty Sand	31.9
	SS-2	16-17.4	--	NP	--	silty Sand with some Gravel	42.0
MW-B-1D	SS-18	36.5-38.5	--	NP	--	silty gravely Sand	13.0
	SS-20	40.5-42.5	--	NP	--	Sand with trace of Silt	2.9
MW-B-2S	SS-1A	8-10	--	NP	--	sandy Silt	62.6
	SS-2A	10-12	--	NP	--	sandy Silt	63.4
MW-B-2D	SS-18A	10-12	--	NP	--	silty gravely Sand	13.0
	SS-22	42-44	--	NP	--	silty gravely Sand	9.3
MW-B-3	SS-3	4-6	--	NP	--	silty Sand with trace of Gravel	39.1
	SS-7	12-14	24.6	10.2	14.4	silty clayey Sand w/some Gravel	33.6
MW-B-4S	SS-4A	6-8	21.7	18.5	3.2	silty clayey Sand w/some Gravel	35.8
	SS-6A	10-12	20.9	11.1	9.8	gravely clayey Sand	29.1
MW-B-4D	SS-20A-1	38-40	--	NP	--	silty sandy Gravel	16.6
	SS-22A	42-44	--	NP	--	silty fine Sand	15.9
MW-C-1S	SS-1A	8-10	29.1	19.9	9.2	gravely clayey Sand	27.1
	SS-3A	13-15	19.9	15.6	4.3	silty clayey Sand	34.4
MW-C-1D	SS-15A	28-30	15.8	13.4	2.4	silty Sand w/trace of Gravel	43.8
	SS-17A	32-34	17.4	13.2	4.2	silty Sand w/trace of Gravel	45.9
MW-C-2D	SS-17B	33.5-33.8	--	NP	--	gravely silty Sand	14.6
	SS-18	34-35	--	NP	--	silty Sand with some Gravel	20.5
MW-C-3S	SS-1A	8-10	18.6	13.9	4.7	gravely silty Sand	27.2
	SS-2A	10-12	--	NP	--	gravely silty Sand	40.2
MW-C-3D	SS-14A	26-28	--	NP	--	gravely sandy Silt	55.7
	SS-15A	28-30	--	NP	--	gravely sandy Silt	43.2
MW-D-1	SS-13A	24-26	--	NP	--	sandy Silt w/trace of Gravel	57.7
	SS-15A	28-30	--	NP	--	gravely silty Sand	39.6



LEGEND

▨ ZONE 1 UPPER GLACIAL TILL UNCONFIRMED WATER BEARING ZONE

▨ ZONE 2 GLACIOLACUSTRINE CLAY AQUITARD

▨ ZONE 3 GLACIOLACUSTRINE SILT/SAND (INCLUDES MIDDLE SILT TILL AND BASAL RED TILL) CONFIRMED WATER BEARING ZONE

▨ GLACILACUSTRINE CLAY AQUITARD LOCALLY CREATING ON UPPER ZONE 3 AND LOWER ZONE 3 MONITORING ZONES - EACH ZONE SEPERATELY MONITORED BY SCA

▽ POTENTIOMETRIC SURFACE ZONE 1 MEASUREMENTS TAKEN ON JULY 27, 1988.

▼ POTENTIOMETRIC SURFACE ZONE 3 MEASUREMENTS TAKEN ON JULY 27 AND 28, 1988.

MONITORING WELL INTAKE INTERVAL

NOTE:
MONITORING WELLS WITHIN EACH COUPLET ARE LOCATED WITHIN 10 FT OF EACH OTHER. FOR ACTUAL CONSTRUCTION OF EACH WELL SEE ASSOCIATED WELL LOGS PRESENTED IN APPENDIX H.

SCALE HORIZONTAL-1"= 200'
VERTICAL-1"= 20'

THE POTENTIOMETRIC SURFACE REPRESENTATION WAS CONSTRUCTED USING ACCEPTED HYDROGEOLOGIC PRACTICES AND PRINCIPLES. ACTUAL CONDITIONS MAY VARY FROM THOSE SHOWN.

DEPARTMENT OF THE ARMY
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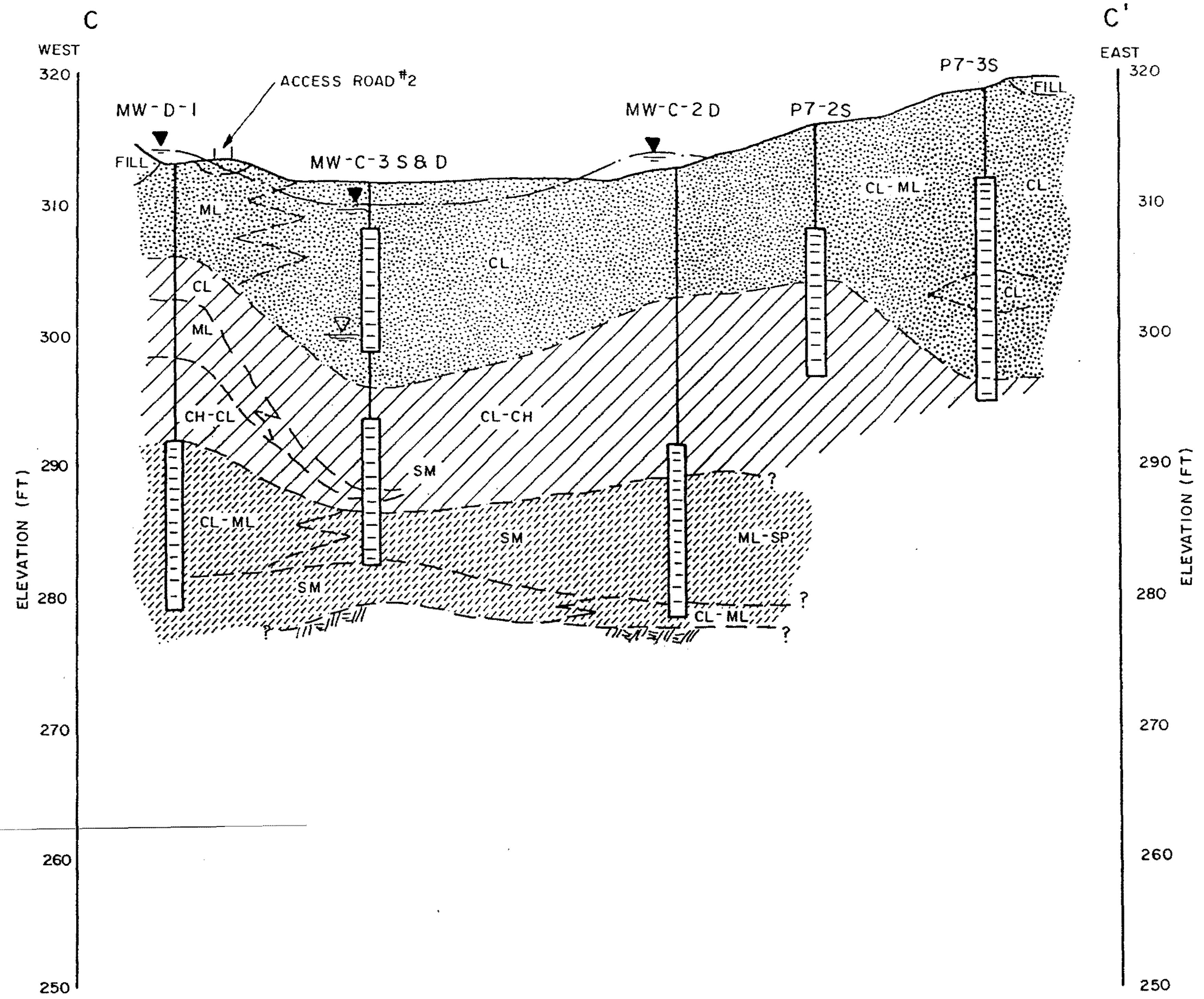
CORPS OF ENGINEERS

HYDROLOGIC CROSS SECTION A-A'

FIGURE 8.8

ACRES



LEGEND

▨ ZONE 1 UPPER GLACIAL TILL UNCONFIRMED WATER BEARING ZONE

▨ ZONE 2 GLACIOLACUSTRINE CLAY AQUITARD

▨ ZONE 3 GLACIOLACUSTRINE SILT/ SAND (INCLUDES MIDDLE SILT TILL AND BASAL RED TILL) CONFIRMED WATER BEARING ZONE

▨ GLACILACUSTRINE CLAY AQUITARD LOCALLY CREATING ON UPPER ZONE 3 AND LOWER ZONE 3 MONITORING ZONES - EACH ZONE SEPERATELY MONITORED BY SCA

▽ POTENTIOMETRIC SURFACE ZONE I MEASUREMENTS TAKEN ON JULY 27, 1988.

▼ POTENTIOMETRIC SURFACE ZONE 3 MEASUREMENTS TAKEN ON JULY 27 AND 28, 1988.

MONITORING WELL INTAKE INTERVAL

NOTE:
MONITORING WELLS WITHIN EACH COUPLET ARE LOCATED WITHIN 10 FT OF EACH OTHER. FOR ACTUAL CONSTRUCTION OF EACH WELL SEE ASSOCIATED WELL LOGS PRESENTED IN APPENDIX H.

SCALE HORIZONTAL-1" = 200'
VERTICAL-1" = 20'

THE POTENTIOMETRIC SURFACE REPRESENTATION WAS CONSTRUCTED USING ACCEPTED HYDROGEOLOGIC PRACTICES AND PRINCIPLES. ACTUAL CONDITIONS MAY VARY FROM THOSE SHOWN.

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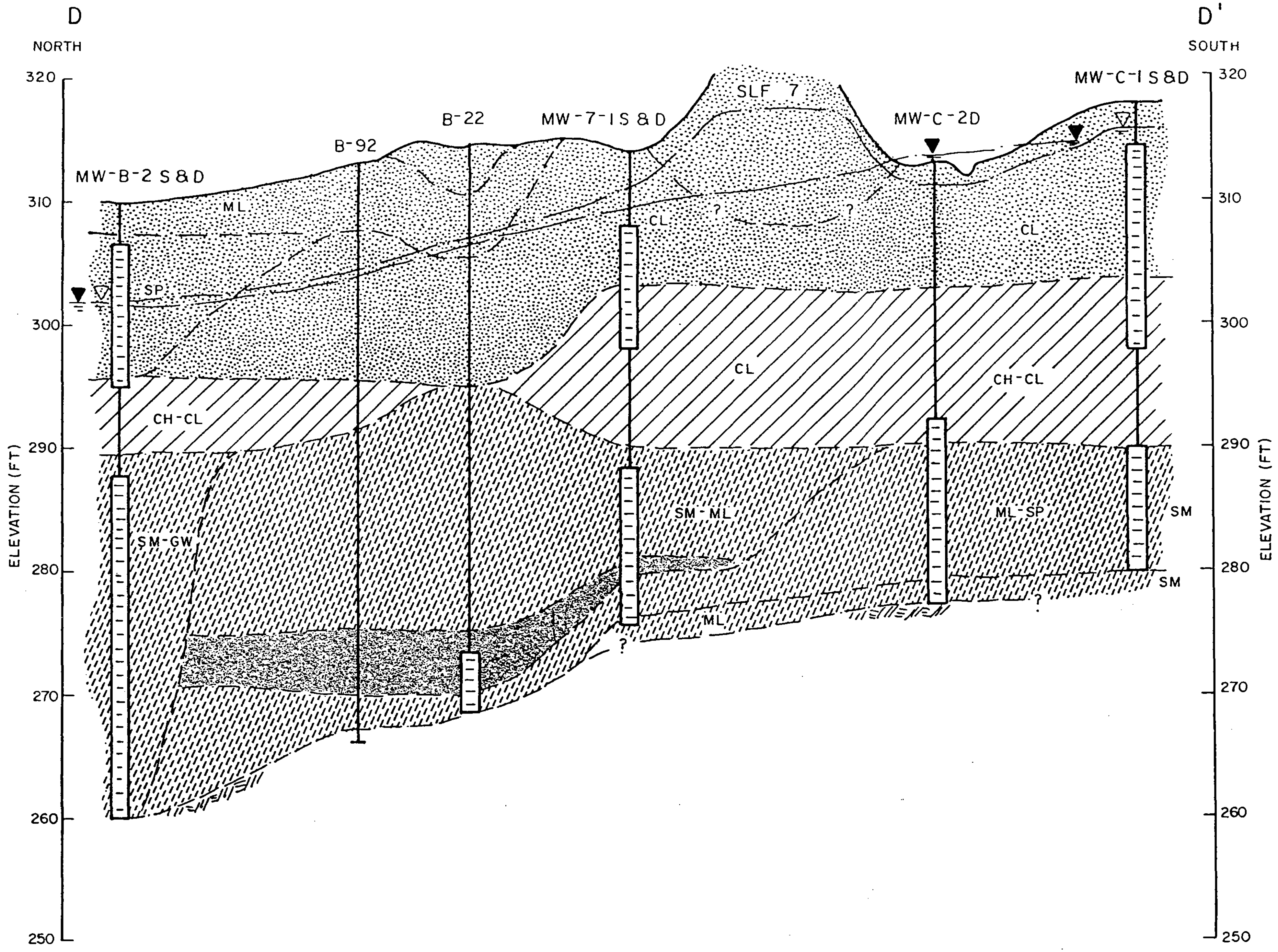
HYDROLOGIC CROSS SECTION C-C'



LEGEND

▨ ZONE I UPPER GLACIAL TILL UNCONFIRMED WATER BEARING ZONE

▨ ZONE 2 GLACIOLACUSTRINE CLAY AQUITARD

▨ ZONE 3 GLACIOLACUSTRINE SILT/ SAND (INCLUDES MIDDLE SILT TILL AND BASAL RED TILL) CONFIRMED WATER BEARING ZONE

▨ GLACILACUSTRINE CLAY AQUITARD LOCALLY CREATING ON UPPER ZONE 3 AND LOWER ZONE 3 MONITORING ZONES - EACH ZONE SEPERATELY MONITORED BY SCA

▽ POTENTIOMETRIC SURFACE ZONE I MEASUREMENTS TAKEN ON JULY 27, 1988.

▼ POTENTIOMETRIC SURFACE ZONE 3 MEASUREMENTS TAKEN ON JULY 27 AND 28, 1988.

MONITORING WELL INTAKE INTERVAL

NOTE:
MONITORING WELLS WITHIN EACH COUPLET ARE LOCATED WITHIN 10 FT OF EACH OTHER. FOR ACTUAL CONSTRUCTION OF EACH WELL SEE ASSOCIATED WELL LOGS PRESENTED IN APPENDIX H.

SCALE HORIZONTAL-1" = 200'
VERTICAL-1" = 20'

THE POTENTIOMETRIC SURFACE REPRESENTATION WAS CONSTRUCTED USING ACCEPTED HYDROGEOLOGIC PRACTICES AND PRINCIPLES. ACTUAL CONDITIONS MAY VARY FROM THOSE SHOWN.

DEPARTMENT OF THE ARMY
KANSAS CITY DISTRICT
CORPS OF ENGINEERS

HYDROLOGIC CROSS SECTION D - D'

FIGURE 8.10

bentonite pellet seal was then placed on top of the sandpack and allowed to completely hydrate for a minimum of five days. The top of the sandpack was kept at least 3 ft below the ground surface in order to protect the well from frost heave.

The groundwater monitoring wells installed as part of this investigation for monitoring groundwater quality within Zone 3 were constructed so as to prevent commingling of groundwater between Zones 1 and 3. This was accomplished by installing a permanent separation casing composed of 8-inch diameter steel casing seated within the Glaciolacustrine Clay aquitard. An attempt was also made to maintain a bentonite seal below or within the lower portion of the separation casing. The remainder of each newly constructed Zone 3 monitoring well was constructed in a similar fashion as the Zone 1 monitoring wells.

The following subsections present the hyrdological data obtained from the groundwater monitoring investigation.

8.2.1 - Upper Glacial Till - Zone 1

Groundwater elevations were recorded from the newly installed monitoring wells and from CWM's monitoring wells used as part of this program on July 27 and 28, 1988. These water levels were recorded prior to purging the wells for subsequent sampling. The configuration of the water table surface constructed using this data is presented on the Hydrologic Cross Sections presented on Figures 8-8 through 8-10 and on the Water Table Surface Contour Map presented on Figure 8-11. The water level data used to construct these figures are presented on Table 8-2.

The field data indicate that the groundwater within this zone occurs under water table conditions irregularly across the project study area. The configuration of the water table surface is probably

TABLE 8-2
GROUNDWATER ELEVATIONS

July 27 and 28, 1988

MONITORING WELL ID	REFERENCE ELEVATION[1]	WATER LEVEL[2]	WATER ELEVATION	GROUND SURFACE ELEVATION
MW-A-1S	314.68	16.9	297.78	313.1
MW-A-1D	314.55	12.6	301.95	313.1
MW-B-1S	313.40	11.0	302.40	312.0
MW-B-1D	314.00	12.1	301.90	312.8
MW-B-2S	311.32	9.5	301.82	310.2
MW-B-2D	311.75	9.9	301.85	310.3
MW-B-3	316.41	13.8	302.61	314.7
MW-B-4S	312.58	6.3	306.28	311.1
MW-B-4D	312.73	10.9	301.83	311.4
MW-C-1S	318.55	2.7	315.85	317.4
MW-C-1D	318.57	3.8	314.77	317.3
MW-C-2	315.10	1.2	313.90	312.9
MW-C-3S	312.63	12.2	300.43	311.5
MW-C-3D	313.43	2.7	310.73	311.7
MW-D-1	314.72	0.5	314.22	313.5
MW-7-3S	317.34	7.01	310.33	315.5
MW-7-3D	316.70	14.06	302.64	315.2
MW-7-5S	318.22	7.61	310.61	316.2
MW-7-5D	318.31	15.20	303.11	316.4
MW-12-8S	314.76	12.45	302.31	312.9
MW-12-8UD	314.49	12.61	301.88	313.2
TMW-14S	314.72	3.74	310.98	312.5

[1] Reference elevation is top of the inner casing. All elevations in SCA datum (approximately MSL).

[2] Water levels measured in feet below reference elevation.

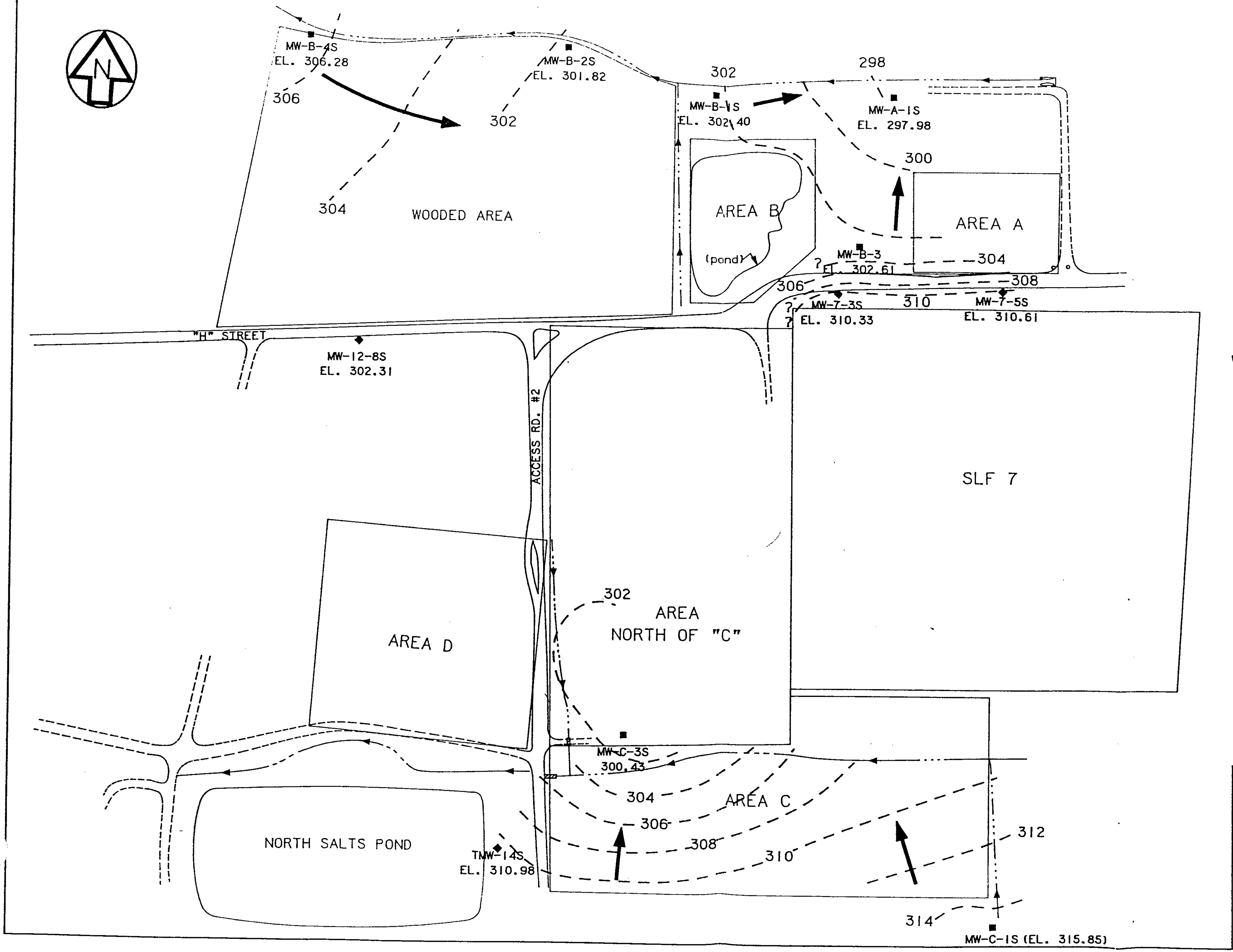
effected by surficial features such as landfills, roads, and buildings, etc. The water table surface in the vicinity of SLF-7 may also be influenced by the landfill leachate and surface water collection systems.

As indicated during drilling, groundwater within Zone 1 appears to occur primarily along discontinuous fractures within the Upper Glacial Till and would be locally effected by surface features, precipitation and runoff in addition to the location, orientation, depth, and interconnections of the fractures. Although the horizontal hydraulic gradient as measured from Figure 8-11 would vary significantly depending on the area of measurement, historical hydraulic gradients for Zone 1 measured across the site indicate a natural range (from areas not influenced by surface features) of about 0.001 to 0.004 for horizontal hydraulic gradients and an average of about 0.006 for the vertical hydraulic gradient (Golder, 1988).

Although hydraulic conductivities were not measured as part of this study, previous investigations (Acres, 1981; Golder, 1985 and 1988; and Wehran, 1979) indicate that the geometric mean of the horizontal conductivity of the Upper Glacial Till is about 3 x 10^{-6} cm/sec with a range of 10^{-8} to 10^{-5} cm/sec. These values were obtained as a result of the measurement and review of hydraulic conductivities for all available Upper Glacial Till monitoring wells and piezometers as well as laboratory results (Golder, 1988). Based upon laboratory results, a vertical hydraulic conductivity of 2 x 10^{-8} cm/sec is considered representative of the Upper Glacial Till unit, however a value of 6 x 10^{-7} cm/sec is considered representative of field conditions (Golder, 1988).

8.2.2 - Glaciolacustrine Clay

Field and laboratory tests from previous investigations indicate that the vertical hydraulic conductivity of the Glaciolacustrine Clay (Zone 2) is about 2 x 10^{-8} cm/sec and the horizontal hydraulic conductivity is about 5 x 10^{-8} cm/sec (Golder, 1985). These hydraulic



LEGEND

MW-A-1S
EL. 297.98

MONITORING WELL INSTALLED BY ACRES, 1988, WITH GROUNDWATER ELEVATION. MEASURED 7/27&28/88

MW-7-5S
EL. 310.61

MONITORING WELL INSTALLED DURING A PREVIOUS INVESTIGATION WITH GROUNDWATER ELEVATION MEASURED 7/27&28/88

302

WATER TABLE SURFACE CONTOUR. CONTOUR INTERVAL = 2 FT.

GROUNDWATER FLOW LINE

NOTE: THE POTENTIOMETRIC SURFACE CONTOUR CONFIGURATION SHOWN HERE WAS CONSTRUCTED USING ACCEPTED HYDROGEOLOGIC PRACTICES AND PRINCIPLES. ACTUAL CONDITIONS MAY VARY FROM THOSE SHOWN HERE.

80 0 80 160
scale 1"=160 feet

LOOW SITE

FORMER LAKE ONTARIO ORDNANCE WORKS
LEWISTON, NEW YORK

WATER TABLE SURFACE
CONTOUR MAP
ZONE I

FIGURE 8-11

ACRES

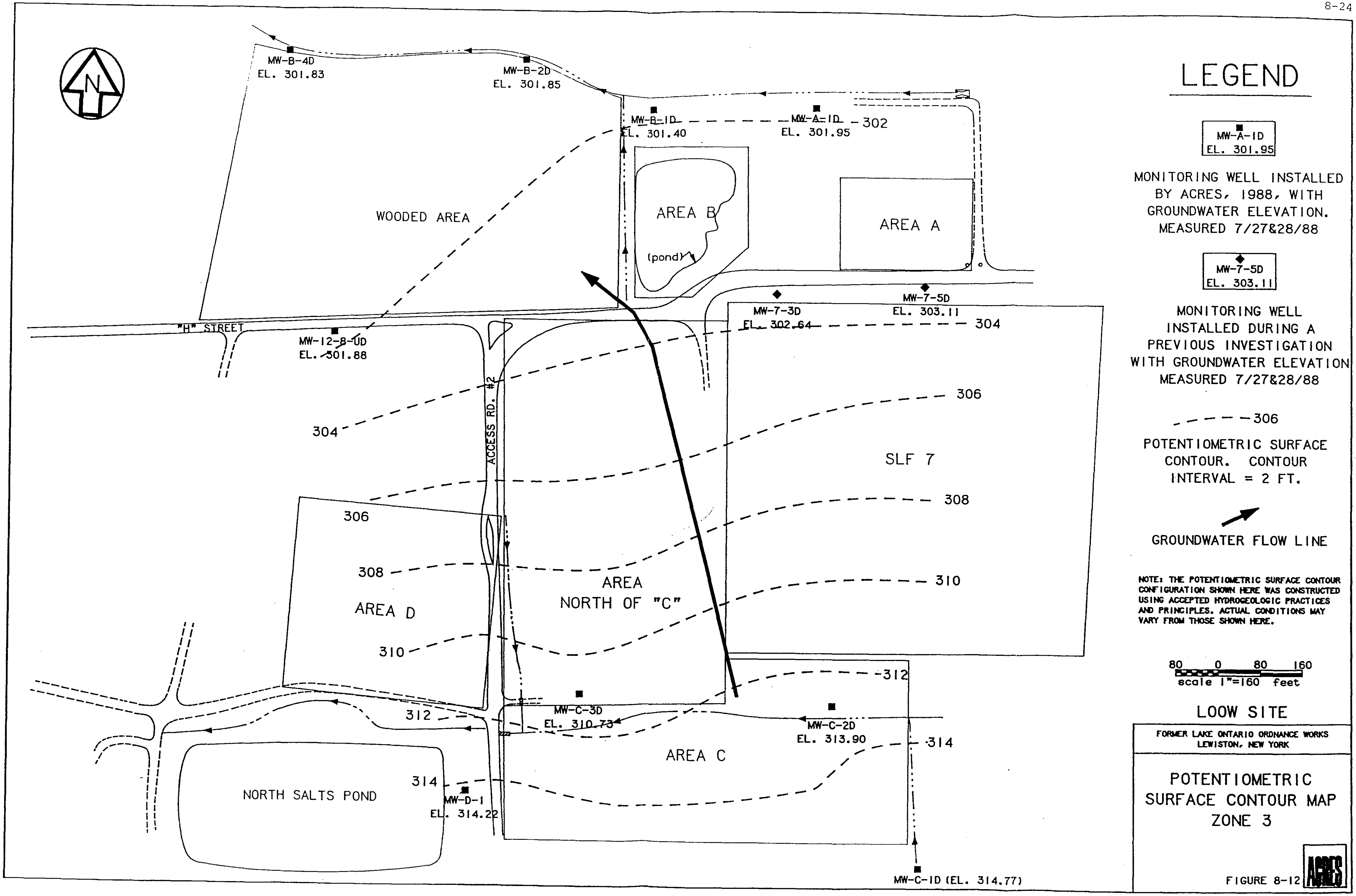
conductivities and the continuous occurrence of the Glaciolacustrine Clay across the site create confined aquifer conditions for the underlying Zone 3 water-bearing zone.

8.2.3 - Glaciolacustrine Silt/Sand- Zone 3

The groundwater in Zone 3 monitored as part of this investigation includes the entire water-bearing zone occurring beneath the Glaciolacustrine Clay (or Upper Glaciolacustrine Clay) and down to the Basal Red Till. As part of CWM's monitoring program, several subzones within Zone 3 are individually monitored (i.e. Middle Silt Till, Basal Red Till). However, it is the intention of this RI/FS to determine the presence/absence of contamination as a result of the federal government's past waste disposal activities and, consequently, detailed analyses of groundwater occurrence within this water-bearing zone was not performed.

The potentiometric surface representation of groundwater within Zone 3 is presented on Figure 8-12 and on Figures 8-8 through 8-10. The direction of groundwater flow within this zone as determined from this study is in good agreement with historical information with groundwater flow moving uniformly in a northwesterly direction. The horizontal hydraulic gradient associated with this potentiometric surface representation ranges from 0.01 to 0.006. The hydraulic conductivity for Zone 3 varies depending on the type of material and ranges from 2 x 10^{-4} cm/sec for coarser deposits to 3 x 10^{-6} cm/sec for finer grained deposits (Golder, 1988).

Overall, the potentiometric surface representation of groundwater within Zone 3 is within a couple feet of the Upper Glacial Till water table surface indicating confined groundwater conditions within Zone 3. Although the apparent direction of groundwater flow from one zone to the other may vary depending upon the location of measurement (i.e. as a result of mounding around lagoons, etc.), overall, the vertical gradient of groundwater flow would be from downward from Zone 1 to Zone 3.



LEGEND

MONITORING WELL INSTALLED BY ACRES, 1988, WITH GROUNDWATER ELEVATION. MEASURED 7/27&28/88

MONITORING WELL INSTALLED DURING A PREVIOUS INVESTIGATION WITH GROUNDWATER ELEVATION MEASURED 7/27&28/88

POTENTIOMETRIC SURFACE CONTOUR. CONTOUR INTERVAL = 2 FT.

GROUNDWATER FLOW LINE

NOTE: THE POTENTIOMETRIC SURFACE CONTOUR CONFIGURATION SHOWN HERE WAS CONSTRUCTED USING ACCEPTED HYDROGEOLOGIC PRACTICES AND PRINCIPLES. ACTUAL CONDITIONS MAY VARY FROM THOSE SHOWN HERE.

LOOW SITE

FORMER LAKE ONTARIO ORDNANCE WORKS
LEWISTON, NEW YORK

POTENTIOMETRIC SURFACE CONTOUR MAP ZONE 3

FIGURE 8-12

In summary, the Glaciolacustrine Silt/Sand is the primary water-bearing zone at the Model City Facility and occurs under confined conditions as a result of the presence of the Glaciolacustrine Clay unit (Zone 2). Groundwater flow within Zone 3 is generally toward the northwest with a westerly component in the northwestern portion of the facility. The average hydraulic conductivity of this unit as determined from previous investigations is on the order of 10^{-4} to 10^{-3} cm/sec, depending on the coarseness of the deposit. The minimum and maximum groundwater flow velocities calculated using these hydraulic conductivity values, the hydraulic gradients as determined from this study, and an effective porosity of .15 would be expected to range from 0.01 to 0.2 ft/day. The Upper Glacial Till deposit may also contain and transmit groundwater; however, due to the predominance of low permeability clays, the occurrence of groundwater within this unit is controlled by the presence of fractures and sand or silt lenses and consequently, groundwater flow within Zone 1 would be discontinuous across the site.

8.3 - Assessment of Contamination

The assessment of contamination in the project study area is presented in the following subsections with each subsection presenting the assessment of contamination for each individual area of concern (i.e., Areas A, B, C, D, and the Wooded Area). The assessment of each area includes the types and concentrations of contaminants found; the areal extent of contamination; and identification of the source and migration pathways, if possible.

8.3.1 - Area A

The geophysical survey and subsequent test pit excavation program confirmed the presence of buried drums in Area A. The drum contents, test pit soils, test pit water and surrounding groundwater monitoring wells were all sampled and analyzed. The analytical results indicate a significant amount of contamination exists in this area.

Analytical results of the test pit soils and drums were similar and unique to Area A. The six drums (including field duplicate) averaged a total volatile organic compound (VOC) concentration of 3616 ug/l (Table 8-3) with acetone the primary compound ranging from 980 to 4600 ug/l. The test pit sample from the bottom of the pit approximately 8 ft below the surface (TP-A1-BOT) contained 1002 ug/l VOC with 990 ug/kg of acetone. Semi-volatile results of the drums indicated an average concentration of 862 ug/kg consisting primarily of compounds known as polycyclic aromatic hydrocarbons (PAHs). PAHs include compounds such as naphthalene, 2-methylnaphthalene, phenanthrene, anthracene, fluoromthene, pyrene and chrysene. This group of compounds may be formed in any combustion process (Settig, 1981) and are commonly associated with oil or coal tar pitch. The PAHs found in the drums and, to a lesser extent, the test pit soils appear to be limited to Area A and are not found in soil or water samples from adjacent areas.

After the location of the drum burial trench was verified by the geophysical survey, a groundwater monitoring program was defined for the area. The groundwater monitoring program consisted of utilizing an existing monitoring well couplet previously installed by CWM (MW-7-5S+D) to function as an upgradient monitoring point and the placement of a new monitoring well couplet (MW-A-1S+D) installed downgradient by Acres as part of the field investigative program. The resultant groundwater monitoring system consisted of the upgradient monitoring point being located approximately 70 ft to the southeast (upgradient) of the buried trench and the downgradient monitoring well couplet located approximately 300 ft to the northwest of the buried drums.

The analytical results (Table 8-4) of the monitoring wells indicate very little contamination exists upgradient or downgradient of Area A. A sample of the test pit water showed no volatiles, pesticides/PCBs or the metals of lithium or boron. However, 194 ug/l of semi-volatiles were found which were entirely comprised of phenolic compounds (phenol, 2-methylphenol and 4-methyphenol). These phenolic

TABLE 8-3
KEY CONTAMINANT GROUPS FOR
AREAS A AND B SOILS AND DRUMS

Compounds	SS-B1	SS-DUP-1	SB-3-2-3.5	SB-3-8-9.5	SB-DUP-2	TP-A1-5	TP-A1-BOT	Average Drum	Average Background
Volatiles (ug/kg)									
Total VOC	19670	21490					1002	3616	0.3
Total Chlorinated VOC	7100	8300					12	68	
Total Aromatic VOC	14070	14990						118	0.3
Total Non-Chlorinated VOC	12570	13190					990	3548	
Semi-Volatiles (ug/kg)									
Total Semi-VOC	41944	44360					360	862	
Total PAH	560	600					369	716	
Total Phenolics									
Total Phthalates	1184	860							
Total Chlorinated Compounds	38500	40900							
Pesticide/PCBs (ug/kg)									
Total Pesticides	814	2212						10.1	20
Total PCBs									
Metals (ug/g)									
Boron	130	950			670				
Lithium	160	160	30	26	17	28	62	62.8	18

TABLE 8-4
KEY CONTAMINANT GROUPS FOR
AREAS A AND B GROUNDWATERS/SURFACE WATERS

Compounds	MW-B-1S	MW-B-1D	MW-B-2S	MW-B-2D	MW-B-3	MW-7-3S	MW-7-3D	MW-7-5S	MW-7-5D	TP-A1-WAT	SW-B1
Volatiles (ug/l)											
Total VOC	2		4	1	1	199.2	5	3.7		2208	0.8
Total Chlorinated VOC	2		4	1	1	197.2	5	3		164	
Total Aromatic VOC								.7		324	0.8
Total Non-Chlorinated VOC						2		.7		2144	
Semi-Volatiles (ug/l)											
Total Semi-VOC		2		3							
Total PAH										254	4
Total Phenolics										59	
Total Phthalates		2		3						194	
Total Chlorinated Compounds										1	1
Pesticide/PCBs (ug/l)											
Total Pesticides			0.005								
Total PCBs											
Metals (mg/l)											
Boron					11	6				120	24
Lithium	0.22	0.12	0.005	0.12	26	5.9	0.11	0.23	0.06	38	19

compounds were not found in the drum samples, the test pit soils or any of the groundwaters adjacent to Area A, indicating the source and extent of the contamination are very localized.

Metals analysis of the test pit water also did not indicate the presence of lithium or boron, both of which are found in adjacent well MW-B-3 at fairly significant levels. These two metals are found in soils from Area B where they may be indicative of the incineration of lithium and boron based fuels in the former "burn-pit". Neither lithium nor boron were found in MW-7-5S+D or the downgradient wells of Area A. The presence of these metals in MW-B-3 may be a result of MW-B-3 being located in the former "burn-pit" area rather than the result of groundwater migration of contaminants from Area B to Area A. This conclusion is supported by the analytical results of both Areas A and B and by the hydrogeology of the area.

For example, as shown on Figure 8-12, groundwater flow within Zone 1, the water-bearing zone in which the drums are buried, is theoretically toward the north while groundwater flow in Zone 3 is toward the north-northwest. Using the hydraulic gradient of 0.017 for Zone 1 in this area and the mean horizontal hydraulic conductivity of 3×10^{-6} cm/sec for the Upper Glacial Till as determined in previous investigations (Golder, 1985 and 1987) and an assumed burial date 30 years ago, the edge of a northward migrating (downgradient) contaminant plume would be within 4 ft of the northern limits of the drum burial trench. However, the actual plume may be further downgradient due to the presence of fractures and silt and sand lenses within the Upper Glacial Till unit.

It appears that the sources of contamination are in Zone 1, the Upper Glacial Till unit and that very little if any contamination has reached the Zone 3 aquifer. However, if any contaminants had migrated into the Zone 3 water-bearing zone, it is estimated that using the hydraulic gradient of 0.005 for this area, a hydraulic permeability on the order of 10^{-4} cm/sec, an effective porosity of

8.3.4 - Area D

The investigation in Area D consisted of conducting a geophysical survey to determine the presence of any buried ferrous material (i.e., drums) and installing an upgradient monitoring well (MW-D-1). An existing monitoring well, TMW-14, was used to monitor groundwater quality in Zone 1 upgradient of Area D and monitoring well couplet MW-12-8S+UD were used to monitor downgradient groundwater quality.

The results of the geophysical survey showed no anomaly in Area D. Analytical results of the downgradient monitoring well couplet indicated the presence of methylene chloride at a concentration of 5 ug/l in both groundwater samples. Acetone and carbon disulfide were also detected in the sample from monitoring well MW-12-8S but at concentrations below the CRQL. Analytical results for the Zone 1 upgradient monitoring well, TMW-14, indicated a concentration of 70 ug/l of acetone. Trichloroethene was also detected at concentrations below the CRQL.

8.3.5 - Area North of C

The results of the geophysical survey in the area north of Area C indicated broad areas of moderate to high conductivity readings. The readings in this area are believed to be a result of variations in moisture content and the thickness of the clay which is stored in this area by CWM. Evidence of possible drum burial in this area was not found and no further investigations were conducted.

8.3.6 - Wooded Area

Two downgradient monitoring well couplets (MW-B-2S+D and MW-B-4S+D) were installed along the northern perimeter of the Wooded Area. Methylene chloride was found at a concentration of 6 ug/l in both wells of couplet MW-B-4S+D. (As previously mentioned, methylene chloride was detected in monitoring well couplet MW-12-8S+UD, the upgradient wells for the Wooded Area). Carbon disulfide and chloroform were also detected in monitoring wells MW-B-2S+D and MW-B-4S+D but at concentrations below the CRQL.

Analytical results for metals analyses for both groundwater and soil samples collected from the shallow borings around the perimeter of the Wooded Area indicated no significant levels of these metals. It appears the areas of moderate magnetic anomolies detected during the geophysical survey area were artifacts of the soil conditions.

Analytical results for nitroaromatics did not detect the presence of any of the compounds analyzed.

8.3.7 - Acid and TNT Wastelines

A total of five test pits were excavated in an attempt to locate and sample the buried acid and TNT wastelines. As none of these lines were found, an assessment of the contamination associated with these wastelines was not possible.

9 - RISK ASSESSMENT

9.1 - Overview of Risk Assessment

9.1.1 - General

A risk assessment is a complex evaluation of the chemicals which may contact human or environmental targets and the results of such contact. A risk assessment actually involves two distinct steps including first, a hazard determination and second, a risk assessment. "Hazard" may be defined as the potential to cause harm. Determining if a hazard exists requires a careful assessment of the chemical, physical, and toxicological data available for all material revealed to be present from the analytical data. The investigator must distinguish, however, between hazard and risk. Whereas hazard is the potential to cause harm, "risk" is the estimation of the probability that harm will actually occur. Toxic materials introduced into the environment present potential hazards to all living organisms; however, a risk assessment must be performed to determine the likelihood that adverse effects will ensue.

In order to perform a comprehensive risk assessment, several types of data and information are needed. These include:

1. Types of toxic materials present and their concentrations;
2. Sources of toxic materials entering the environment;
3. Chemical and physical data for contaminants;
4. Behavior of toxics in the environment;
5. Toxicological data and information;
6. Potential population exposures;
7. Routes of entry to populations at risk; and
8. Regulatory status for the chemicals present, including any existing environmental standards.

A risk assessment cannot be performed unless the following three items have been defined:

1. Source and types of contamination.
2. Population potentially at risk. No health risk exists unless a recipient of that risk can be identified.
3. Potential routes by which the population at risk can contact the hazard. If a hazardous material is released into the environment, but the contaminant is isolated from the population, then no risk of an adverse impact can be proven.

9.1.2 - Scope of the LOOW Site Health Risk Assessment

As stated in the previous section, a risk assessment cannot be performed unless there exists a population which can be shown to potentially contact a release of a hazardous material. After these criteria have been satisfied, the extent of the risk assessment is greatly influenced by the quantity and quality of the data. If the population and exposure route data set is complete, human health risk assessment can be based on existing numerical standards, e.g., water quality standards, OSHA permissible exposure limits, etc. Environmental health risks can be assigned based on federal standards and guidelines published in the Clean Air Act, Clean Water Act, Safe Drinking Water Act, and the Resource Conservation and Recovery Act. Unfortunately, comprehensive health hazard data does not exist for all chemicals in all environmental media. A qualitative risk assessment provides a scientific opinion as to the relative level of risk resulting from an environmental release. A quantitative risk assessment assigns a numerical risk factor to the outcomes of exposures to hazardous materials. Generally, a quantitative risk assessment is required in situations where contamination has been proven to migrate beyond the source. Conversely, a qualitative risk assessment is applied to sites where contaminants have not migrated much beyond the source.

The following subsection presents a summary of site specific data which has been incorporated into a qualitative risk assessment of the designated study areas. Several assumptions have been made in completing the preliminary risk assessment. These assumptions will be verified and additional data collected to fill in any data gaps during the Feasibility Study (FS) phase. The recommended additional sampling analyses and related data collection activities are outlined in Section 12 - Recommendations. The finalized qualitative risk assessment will be included in the Final FS Report.

9.1.3 - Summary of Site-Specific Data

Chemical Identification

This qualitative risk assessment primarily identifies potential human and environmental health risks presented to onsite personnel as a result of past waste disposal practices conducted by the Department of Defense or its contractors on Areas A and B.

A qualitative risk assessment requires the identification of what types and concentrations of chemicals were disposed at the site and what types and concentrations of those chemicals or their degradation by-products exist at the site today. In Area A, the original source and content of the buried drums has not been established, although it is suspected that the drums originated from Air Force Plant 68. The drums found in Area A may have been related to drums containing Air Force Plant 68 wastes which were suspected to have been buried in Area C. The drums were believed to have contained lithium chloride, lithium metal and hydroxide, potassium chloride, methanol, kerosene, and sludge from the waste treatment facility (refer to Section 4.1.3).

In addition to the detection of elevated concentrations of boron and lithium, analytical results for soil, groundwater, and the five drums excavated from Area A indicate the presence of 16 organic compounds detected at concentrations above the CRQL (refer to Section 7). The summed total concentration of the 16 organic compounds is over 12 ppm with acetone accounting for over 75 percent of the total organic concentration.

The analytical results for groundwater samples taken from monitoring wells upgradient and downgradient of the drum burial trench indicate that the contamination is localized. Additional sampling and analyses are required to determine the presence and extent of contamination in the local surrounding soils and surface water.

During the operation and decommissioning of Air Force Plant 68, Area B, the Olin Burn area, was used for the open incineration of wastes from the Air Force Plant 68. Waste materials identified as being incinerated in Area B included lithium and sodium hydrides, kerosene, and some unstable gases produced when diborane was converted to either decaborane or pentaborane (see Section 4.1.3).

Analytical results for the sediment composite sample collected from Area B indicate the presence of elevated concentrations of boron and lithium and seven organic compounds specific to Area B (see Section 7). The summed total concentration of the seven organic compounds is over 57 ppm with 1,2,4-trichlorobenzene accounting for about 60 percent of the total organics. The surface water samples collected from Area B indicated the presence of elevated concentrations of boron and lithium only. The detection of boron and lithium in groundwater samples from upgradient monitoring points indicates that the contamination probably extends beyond the confines of the ponded area. Analytical results for downgradient groundwater samples indicate that the contamination is not migrating very far from the bermed pond. Further sampling and analyses, as recommended in Section 12, is required to better define the extent of contamination related to the Olin Burn Pit.

Surrounding Population

As stated in Section 2, the LOOW site is situated in a rural area with an approximate population of 3,000 people located within three miles of the project study area (based upon an USGS topographic house count and 3.8 people per residence). An approximate additional 2,800 students and faculty are also present at the Lewiston Porter Schools daily throughout the school year (two schools located within three miles of the study area).

The daily population at the CWM facility is approximately 250 persons, 155 of which are CWM employees. The remaining site population consists of engineers, truck drivers, contractors, etc. Access to the site is restricted with a guard on duty 24 hours a day. Daily entrance to the site is through one gate attended by security. An additional gate, also attended by security, is used by contractors during special operations and/or construction activities such as receipt of clay borrow material. It should be noted that CWM activities in Areas A and B were restricted during completion of the RI/FS investigation.

The following subsections present information on the environmental fate of the detected contaminants (Section 9.2); contaminant transport pathways (Section 9.3); and potential receptors (Section 9.4). A human health risk assessment, based upon available data, is presented in Section 9.5. An environmental risk assessment is presented in Section 9.6. As previously mentioned, the qualitative risk assessment will be finalized as part of the Feasibility Study and after further sampling/data collection activities are carried out.

9.2 - Environmental Fate Information

In evaluating the environmental fate of the contaminants associated with the site, five chemical properties are of significant importance: water solubility, vapor pressure, Henry's law constant, organic carbon partition coefficient (KOC), and persistence in various media. Appendix G summarizes the pertinent available data for the compounds detected. Depending on the factor, a high or low value may yield an enhanced exposure potential to various receptors. For those compounds which do not have published data, estimation techniques are available that can be applied.

When a large number of chemicals are detected for a given site, such as at the LOOW site, standard practice details a precedence of determining a list of indicator chemicals. This preliminary list is compiled via a series of steps involving a review of toxicity data, transport pathways, chemical specific information, and potential receptors. Due to the lack of sample data concerning all transport pathways and receptors, a full environmental fate review cannot be conducted at this time. However, the following discussion summarizes the interpretation methods applied to the environmental fate data.

9.2.1 - Solubility

The solubility of a given chemical will affect that chemical's capacity for leaching from soil into groundwater or surface water. Hence, solubility is also one of the controlling factors regarding leachate concentration strength and migration of contaminants. It has been demonstrated that high solubilities are indicative of higher biodegradations, lower absorptions, and lower volatilization rates. If contaminants are detected at concentrations which exceed their solubilities, this may indicate a potential phase separation exists within the aqueous layer sampled.

A review of the compounds in Appendix G indicates a wide range of solubilities, from essentially 0 mg/l (arsenic, beryllium) to 1,000,000 mg/l (acetone). Most organic compounds have solubilities ranging from 1 to 100,000 ppm. In general, metals do not solubilize in water, although their water solubilities can be increased in acidic or basic aqueous environments. When total metals and soluble metal for the LOOW site sample results are compared, a decrease in the frequency of occurrence and concentration is apparent.

9.2.2 - Vapor Pressure and Henry's Law Constant

These parameters assess chemical volatility and are useful in evaluating air exposure pathways. Liquid vapor pressures range from 0.001

to 760 mmHg, with solid vapor pressures down to 10^{-7}. As vapor pressure measures the volatility of a substance, its primary use is in evaluating exposure pathways involving releases to air from spills or contaminated soil. Henry's Law Constant, which takes into account vapor pressure, solubility, and molecular weight, is more useful in evaluating releases to air from contaminated water and therefore exposure pathways involving ground and surface water. If the air exposure pathway is not a concern, vapor pressure and Henrys' Law Constant should not be used in selecting an indicator chemical list.

The compounds detected at LOOW exhibit a wide range of vapor pressures and Henry's Law Constants, as shown in Appendix G. As with solubilities, organic compounds, particularly volatiles, have vapor pressures much higher than metal compounds, which would be expected. For example, acetone has a vapor pressure of 270 mmHg, while chromium is 0.00 mmHg, or insignificant. These environmental fate parameters are useful in determining an indicator list of chemicals, which will be possible upon the acquisition of additional sample data from transport pathways and receptors.

9.2.3 - Organic Carbon Partition Coefficient (Koc)

This environmental fate factor evaluates the relative sorption potential for organic compounds and is useful when evaluating any exposure pathway. As a measure of sorption, Koc is independent of soil properties. Normal values range from 1 to 10^7, with greater sorption potential indicated by a higher value. For inorganics, other parameters of partition coefficients should be utilized, such as Kd, which is soil-type dependent. With regards to groundwater pathways, low Koc values indicate faster leaching potential from the waste source and rapid transport through an aquifer. For surface water pathways, a high Koc value indicates tight bonding of a chemical to soil and subsequently less runoff potential. However, the high Koc value also will enhance bioaccumulation, once in a surface water pathway.

The values of Koc for the compounds detected at LOOW are listed in Appendix G. Depending upon the transport pathway of concern for the various chemicals, the Koc values should be evaluated as summarized above. During the selection of indicator chemicals, this procedure is conducted. As is evident, the Koc values range from very low (2.2 for acetone) to very high (4,400,000 for DDE) for the compounds detected.

9.2.4 - Persistence

This parameter, as measured by half-lives in various environmental media, is a critical component of an environmental fate evaluation. The half-life values presented in Appendix G are based upon a determination of how various mechanisms (phase transfer, chemical transformation, biological transfermination) remove a compound from the environment. Half-lives vary from a few seconds to thousands of years. Obviously, the shorter the half-life, the less the persistence hazard posed by that compound. Half-lives for a specific medium should not be used as indicators of half-life in a different medium, as the removal processes may be quite different.

Appendix G details a wide range of half-life values for the compounds detected at LOOW. For the selection of an indicator list of chemicals, the half-life data is used in conjunction with the other environmental fate data, to arrive at a manageable list of compounds to be used in a full risk assessment.

9.3 - Transport Pathways

As discussed in Section 9.1.1, an important step in the identification of risks associated with a site is the delineation of transport pathways, by which site-related contaminants may be released to the environment. For the LOOW site, the potential transport pathways include groundwater, surface water, air, and direct contact. Each of these site-specific pathways is discussed in the following sections.

9.3.1 - Groundwater

The discussion in Section 8.2 describes the groundwater regime associated with the LOOW site. The glaciolacustrine silt/sand is the primary waterbearing zone at the LOOW site. Groundwater flow is generally toward the northwest, with a westerly component in the northwestern portion of the facility. The upper glacial till deposit may also contain and transmit groundwater, although the presence of fractures and sand or silt lenses would cause groundwater occurrence to be discontinuous across the site.

Very few volatiles, semi-volatiles, pesticides and metals were detected in the groundwater wells sampled. Wells upgradient and downgradient of potential source areas did not reveal significant contamination with one exception. The exception (MW-7-3S), an upgradient well, contained elevated levels of chloroform and carbon tetrachloride which were not found in any of the source areas (investigated in this study). Downgradient wells from the heavily contaminated sources in Areas A and B do not indicate any groundwater transport of contaminants from these sources.

9.3.2 - Surface Water

As discussed in Section 2.3, a system of onsite ditches drains surface waters from the LOOW to the Central Drainage Ditch, which eventually discharges to Fourmile Creek. The Southwestern Drainage Ditch, also part of the constructed drainage system, discharges to Fourmile Creek as well. Drainage from the southwestern portion of the LOOW, which once flowed eastward, is collected by the S-31 ditch.

As detailed in Figure 2-7, a total of three creeks (Fourmile, Sixmile, and Twelvemile) receive surface drainage from the LOOW site, via the site drainage ditch system. These creeks are characterized by intermittent flow along their major sections. One sample of surface water was obtained from the LOOW site source Area B (sample

SW-B1). This sample contained one volatile, and one semi-volatile at concentrations below the CRQL, and ten total metals. Analyses were not conducted for pesticides, soluble metals and nitroaromatics.

Surface water sampling and analyses have not been conducted at locations along the drainage system downgradient of the identified problem areas (A and B). Additional sampling (as recommended in Section 12) is therefore required to verify any contaminant migration via this transport pathway.

9.3.3 - Air

Section 2.4 discusses the climate and weather data for the LOOW site. Annual wind data shows the wind is predominantly from the south-westerly direction, at average monthly wind speeds ranging from 9.9 to 14.3 miles per hour. Figure 2-10 presents a wind rose for the site. These data are considered when evaluating potential air transport of contaminants via wind or diffusion mechanisms.

An air sampling program was conducted during field investigation activities at the LOOW site, as discussed in Sections 5.2 and 7.2. This program included analysis for volatiles and heavy metals. Compounds, detected above the detection limit included zinc, mercury, and arsenic. The calculated concentrations for these three compounds were 0.001 mg/m^3, <0.001 mg/m^3, and 0.029 mg/m^3, respectively, all of which are below any applicable OSHA or NIOSH levels.

As stated previously, the air monitoring conducted to date at the site mainly addressed personal health and safety considerations and was not designed to characterize ambient atmospheric conditions. However, based on the relatively low measurements recorded in the immediate vicinity (in open excavation work areas) of identified problem areas it is reasonable to assume that even lower levels would be measured at downwind locations. Additional data collection and review (as recommended in Section 12) will be carried out during the

FS phase of work to verify this assumption. This verification will include the review of any relevant air monitoring data available from CWM.

9.3.4 - Direct Contact

The direct contact transport route refers to the potential for people to come into immediate contact with any hazardous materials. This route includes such possibilities as open storage of wastes, otherwise exposed materials, and source area gas emissions, leading to either ingestion or dermal exposure. As discussed in Section 8, the suspected sources of the wastes are essentially confined to subsurface considerations. No ground surface deposits of wastes associated with the designated source areas have been identified other than those sediments lying below the pond in Area B.

Additional soil sampling and analyses are recommended for Areas A and B to further verify the extent of any surface contamination that may exist (refer to Section 12).

9.4 - Potential Receptors

After a determination of sources, transport pathways, and environmental fate, the identification of potential receptors is necessary. These include both human (on- and offsite), and environmental (flora, fauna, endangered species, wetlands, etc.) receptors. For the LOOW site, the potential receptors include onsite humans (CWM work force), offsite humans (Towns of Lewiston and Porter in Niagara County), vegetation, wildlife, fish, and wetlands. Each of these potential receptors is discussed in the following sections.

9.4.1 - Human Receptors

Onsite

The most obvious potential human receptors to any contamination associated with the designated source areas are the CWM work force. As part of their routine duties, these individuals frequently travel in/or near the areas of suspected contamination (Areas A, B, C, D, and Wooded Area), performing a variety of tasks. As those tasks often involve landwork, subsurface disturbance, sampling, and grounds maintenance, they are potentially at risk at encountering the source area materials via all four transport pathways (groundwater, surface water, air, and direct contact).

Offsite

Section 2.5 details the demographics and land use in the vicinity of the LOOW site. Approximately one-half of the land use in the area is agricultural in nature. The most proximate human habitations of concern are a trailer park 1.3 miles west on Balmer Road and a permanent dwelling 0.8 miles to the west on Balmer Road. With the exception of two homes in Lewiston, all residences within three miles of the LOOW site utilize public drinking water supplies, which are obtained from the Niagara River. It is known, however, that old private wells are still intact in Lewiston and Porter, and may be used for lawn and garden watering purposes. Farms in the area tend to rely on surface water for irrigation, due to the low yields and high salinity and sulfur associated with local groundwater supplies.

9.4.2 - Environmental Receptors

Section 2.6 discusses the ecology of the area in the vicinity of the LOOW site. Maple, ash, and oak are the predominant species of trees found in the surrounding second growth forest. Northern shrub, pasture grass, and cattail marsh are other plant communities found in the vicinity. Table 2-8 details the animal and bird species found in the project study area. There are no known endangered plant or animal species inhabiting the area of the LOOW site. Creeks receiving drainage from the site (Fourmile, Sixmile, and Twelvemile) are used for recreational purposes, including fishing. Fish known to inhabit these creeks include northern pike, various panfish, chinook and coho salmon, and rainbow trout. Eleven wetlands are located on the LOOW site. The wetland locations and NYSDEC classifications are presented in Figure 2-9.

Onsite

Section 7 describes the results of the analyses from the various samples obtained from the LOOW site. Although predominantly at low levels, the analytical results indicate that some of the groundwater, surface water, sediment, surface soil, air and subsurface soil matrices contain chemicals and compounds which are not naturally occurring. These contamination levels, even at low levels, indicate that the onsite environment in the vicinity of the designated source areas has been contaminated. This onsite environmental contamination is the primary receptor of concern, based on the sample set obtained during the investigation.

Offsite

Offsite sample collection only consisted of two background soil samples.

Sample data was not obtained of any air, surface, water, streambed sediments, animal tissue, plant matter, or groundwater from environmental areas offsite of the LOOW site. The presence of contamination, and if present, its source, cannot be defined at this time.

9.5 - Health Risk Assessment

Sections 9.2 through 9.4 of this chapter have defined the factors which combine to form a health risk assessment. The source of contamination under study, as well as the populations at risk have been established. Routes of potential exposure to contaminants have also been identified. This section presents the human health hazard data for the contaminants present in onsite environmental media. Finally, the above factors have been combined to provide a preliminary qualitative risk assessment for onsite and offsite human populations. This assessment will be finalized during the FS phase of work.

9.5.1 - Health Data Review

Appendix Tables G-1 through G-6 summarize the human health data available for contaminants at the LOOW site. A discussion of the various classes of chemicals is presented in the following paragraphs.

(a) Heavy Metals

Heavy metals vary widely in toxicity, with some species considered virtually nontoxic, while others are potential human carcinogens. The highest concentrations of metals on the LOOW site were found in drum samples and soil borings. Metals were found in groundwater samples predominantly at part per billion levels.

Arsenic. Arsenic compounds are irritants of the skin, mucous membranes, and eyes. Dermatoses and skin cancers have been reported after exposures to arsenic compounds. Chronic arsenic ingestion has resulted in gastrointestinal disturbances. Lung cancers have been observed among workers with a history of exposure to inorganic arsenic compounds.

Barium. Some compounds of barium are skin and eye irritants. Heavy exposure to barium dusts has produced bronchial irritation. Ingestion of large amounts of barium carbonate causes gastroenteritis in humans.

Beryllium. Beryllium and its compounds produce a variety of serious health effects in humans. Skin exposures have resulted in contact dermatitis. Inhalation of beryllium compounds has resulted in acute cases of pneumonitis as well as chronic lung diseases. Some beryllium compounds have induced lung tumors in various animal species.

Chromium. The toxicity associated with chromium metal and salts varies considerably. Chromium metal and its insoluble salts are relative nontoxic. Chromite dusts have caused pneumoronioses in some workers. Chromic acid and chromate salts have a corrosion action on the skin and mucous membranes. Chromate salts are suspected carcinogens of the lung, stomach, nasal cavity, and larynx.

Lead. The health hazards associated with lead exposures are well established. Cases of lead poisoning have been documented in both occupational and public settings. Prolonged lead absorption results in gastrointestinal disturbances and anemia. Neuromuscular and kidney dysfunctions are also associated with chronic lead exposures. Epidemiologic studies have not shown a relationship between lead exposures and cancer.

Mercury. The health hazards associated with mercury exposures depend on the type of mercury compounds presents. Metallic mercury and its inorganic salts typically cause gastrointestinal disturbances, while organic mercury compounds affect the central nervous system.

Nickel. Nickel and most salts of nickel generally do not cause systemic disorders. Ingestion of large amounts of nickel have been shown to cause intestinal disorders in dogs. Chronic inhalation of nickel has been associated with cancers of the nasal cavity. The most common affect resulting from exposure to nickel is a dermatitis referred to as "nickel itch".

Boron. Boron is considered an industrial poison. Boron poisoning affects the central nervous system and causes depression of the circulation, persistent vomiting and diarrhea, followed by profound shock and coma.

Lithium. Lithium compounds have been implicated in development of aplastic anemia. Lithium oxide, hydroxide and other salts are strong bases and their solutions in water are very caustic. Lithium ions are toxic to the central nervous system. Large doses of lithium compounds have caused dizziness and prostration. Exposures to lithium can cause kidney damage, anorexia, nausea, apathy, coma, and death.

Other. Several other metals were identified in samples from the LOOW site. Species such as copper, iron, potassium, and sodium are abundant in many soils and are considered to be relatively nontoxic. Chronic manganese poisoning is a clearly characterized disease of the central nervous system, but cases typically do not develop until after one to three years of heavy exposure. Selenium, silver, and thallium have all shown evidence of systemic toxicity after long periods of exposure. Their toxicity is related to their potential to bioaccumulate.

(b) Volatile Organics

The volatile organic chemicals, like the heavy metals, include compounds with a wide variety of health effects. Unlike the metals, few members of this group of chemicals occur naturally. Volatile organic compounds were found in part per million levels in the drum and sediment samples from the LOOW site, while they were found only in part per billion levels in groundwater samples. For the purposes of this discussion, the volatile organics found at the site will be grouped into three categories: aliphatic hydrocarbons (those substances containing only carbon, hydrogen, oxygen, and/or sulfur), aromatic hydrocarbons (containing a benene-ring structure), and chlorinated hydrocarbons.

Aliphatic Hydrocarbons. The aliphatic hydrocarbons include acetone, 2-butanone (methyl ethyl ketone), 4 methyl 2-pentanone (methyl isobutyl ketone), and carbon disulfide. These compounds are common industrial solvents. With the exception of carbon disulfide, the health effects associated with these compounds are limited to skin and eye irritation and a narcotic effect upon exposures to high concentrations of vapors. Carbon disulfide is used as a solvent and as a fumigant. Its chief toxic effect is on the central nervous system, acting as a narcotic in acute poisonings. Central and peripheral nervous system damage may occur upon chronic exposure. Animal experiments have identified carbon disulfide as a mutagen and a teratogen.

Aromatic Hydrocarbons. The term "aromatic" describes a group of hydrocarbons which contain a benzene ring as part of their chemical structure. Benzene is the simplest of this group. A wide variety of health effects have been associated with benzene, ranging from irritation and narcosis upon short-term exposures to high concentrations of vapor to effects on the hematopoietic system. Chronic benzene exposures have been associated with an increase incidence of leukemia in workers. The USEPA has developed a one in a million cancer risk level estimate for benzene (0.66 ug/l). Other chemicals classified as aromatic hydrocarbons include toluene, xylene, ethylbenzene, and styrene. Toluene, xylene and ethylbenzene are common industrial solvents. The primary health effects associated with these solvents are skin and eye irritation and narcosis upon exposures to high levels of vapors. There is some evidence that ethylbenzene has teratogenic potential in some animal species.

Chlorinated Hydrocarbons. The chlorinated hydrocarbon compounds have been widely used as cleaning and degreasing solvents, dry cleaning agents, and in some cases, as anesthetic gases. The chlorinated solvents do not occur naturally; their presence in environmental media is indicative of human activity. The health effects associated with exposure to chlorinated solvents range form narcosis with short-term high exposures to chronic liver injury. Several of these compounds have been identified as potential human carcinogens. Chloroform, the simplest of the chlorinated hydrocarbons, is regulated under the Clean Water Act. Viny chloride, the monomer used to manufacture polyvinyl chloride, is listed by the International Agency for Research on Cancer (IARC) as a known human carcinogen. As a result of their potency for producing liver injury, many of the chlorinated solvents currently have only limited use. The degreasing solvent trichloroethylene has had such widespread use that some estimates have determined that trichloroethylene is present in trace levels in nearly one-third of all U.S. groundwater supplies. The USEPA has published one per million cancer risk level estimates for drinking water. These estimates range from 0.19 microgram per liter for chloroform to 2.7 micrograms per liter for trichloroethylene.

(c) Semi-Volatiles

The chemicals which are included under the broad classification of "semi-volatile" compounds are the polycylic aromatic hydrocarbons, the phthalate ester plasticizers, phenolic compounds, and nitrogen-containing organics. Little toxicologic information is available for many of these substances, although many have shown carcinogenic potential in animal species. The semi-volatiles were found at part per billion levels in the LOOW groundwater samples and part per million levels in soil and drum samples.

Polycyclic aromatic hydrocarbons. Polycyclic aromatic hydrocarbons (PAHs) are found in many petroleum based substances and include "Coal tar pitch volatiles" (CTPV). CTPV refers to the volatile matter emitted when coal tar or coal tar pitch is heated. CTPV contains thousands of organic substances, including benzo-a-pyrene and other PAHs. PAHs may also form during the incineration of petroleum based substances. Occupation exposures to CTPVs have caused eye irritation and photosensitization of the skin. Skin cancer has occurred in rats and mice from repeated application of coal tar or certain components, such as benzo-a-pyrene. Skin carcinomas have been observed in occupations in which there is contact with pitch, tar, tar products, and products of fractionation and distillation of oil. The USEPA has developed one in a million drinking water cancer risk level estimates for several of the coal tar pitch volatiles, ranging from 0.0028 ug/l for anthracene, chrysene, phenanthrene, and pyrene to 0.03 ug/l for acenaphthylene.

Phthalate esters. The phthalate esters have been found at trace levels in nearly all hazardous waste site investigations as a result of man's widespread use of plastics. These substances primarily act as irritants and are considered to be of low toxicity. Occupational exposure limits have been published for the most commonly used phthalate ester plasticizers.

Nitrogen-containing Organics. Two nitrogen-containing compounds were identified at the LOOW site. 6-dinitro 2-methylphenol is an irritant in short-term high level exposure and has been determined to be an experimental mutagen. N-nitrosodiphenylamine is a suspected human carcinogen, with a USEPA one per million can risk level set at 4.9 ug/l for drinking water.

(d) Pesticides/PCBs

Several pesticides were identified in the samples taken from the LOOW site. Pesticides were present in part per trillion concentrations in groundwater samples and at part per billion levels in the drum, test pit, and surface soil samples. The pesticides of concern in this study are those regulated under the Clean Water Act. These include Aldrin, Dieldrin, Lindane, Heptachlor, and DDT and its metabolites. The USEPA has published one in a million cancer risk level estimates for these substances, ranging from 0.024 to 18.6 nanograms per liter.

No polychlorinated biphenyls (PCBs) were found at the LOOW site.

9.5.2 - Health Risks Summary

In order to evaluate the health risks associated with the chemicals found at the site, a number of factors must be considered. The presence of a chemical alone does not constitute a health risk. A relationship between the chemicals present and human population needs to be established. For the site, there are two potential populations at risk: onsite personnel (CWM employees and site investigators) and offsite persons residing in the area surrounding the site. After the population at risk has been identified, routes by which this population can contact the chemicals must be established. Finally, the concentrations of chemicals to which the population may be exposed must be evaluated by direct measurements of environmental media or estimated through environmental fate modeling.

(a) Health Risks to Onsite Personnel

CWM site workers do not appear to be at risk of exposure to the contaminants identified in this investigation via dermal contact, inhalation of vapors or inhalation of contaminated dusts. While a number of wells contained organic or inorganic compounds at concentrations above EPA Maximum Contamination Levels (MCL) or NYS Groundwater Standards, drinking water is not a source of exposure for site personnel since the site is on a public drinking water supply (with the Niagara River as its source).

Exposure to volatile organic vapors was evaluated during the preliminary site investigation through the use of direct-reading instruments. No significant levels of organic vapors were identified. Inhalation of contaminated dusts does not appear to be of concern to onsite personnel, since percentage levels of contaminants are typically needed before exposures to dust-laden chemicals will approach the permissible exposure limits.

The most significant contamination found onsite is essentially subsurface in nature (test pit soils, drums and pond sediments).

Therefore, the greatest potential for site personnel to be exposed to hazardous chemicals is via direct contact during excavation activities in the contaminated areas.

(b) Health Risks to Offsite Personnel

While no samples were collected in this study at offsite receptor locations, data from onsite downgradient well locations indicate very little potential exists for the offsite migration of contaminants via groundwater. What little onsite surface contamination that was documented (eg. HNU and personnel sampling) is also not a risk since it would be considerably diluted to inconsequential (if not immeasurable) levels by the time it reached offsite populations. The only route of exposure to offsite population which may not have been fully examined, is surface water. However, the single surface water that was sampled, SW-B-1, indicated very low contamination levels with very little potential for offsite migration and therefore very low potential for risk to the offsite receptors.

9.5.3 - Conclusions

The health risks to onsite personnel from air and water contaminants are low, based on the results of field monitoring and groundwater analysis conducted to date. It is unlikely that site personnel will consume contaminated groundwater. Real-time air monitoring has shown low levels of organic vapors, and soil contaminant levels are too low to present a significant inhalation hazard. The greatest hazard to onsite personnel is direct contact with contaminated soils and wastes as a result of excavation activities in those areas identified to contain contaminated materials. This risk can be minimized through the use of chemical-resistant protective clothing, respiratory protection and thorough decontamination techniques.

While no offsite receptors were sampled, a preliminary assessment of potential health risks based on the current levels of contaminants found in onsite soils and groundwater and their potential for offsite migration, would indicate a low risk to the public attributable to areas of this investigation of the LOOW site. The levels of airborne and groundwater contaminants would be lower offsite than onsite based on the general principles of dilution. The general population is also at low risk of direct contact with contaminated soils and wastes since access to the LOOW site is restricted.

9.6 - Environmental Risk Assessment

9.6.1 - Applicable Standards

In evaluating the environmental risks posed by the designated source areas (Areas A, B, C, D and Wooded Area) and potential release of contaminants, the primary standard used is the USEPA Ambient Water Quality Criteria Documents. Table 9-1 summarizes the freshwater aquatic life limits for the compounds detected at the LOOW site. In conjunction with the USEPA Drinking Water Standards (Table 9-2) and Drinking Water Health Advisories (Table 9-3), concentrations of contaminants in the environment can be evaluated. Sample data obtained during the investigation did not include samples from offsite environmental media, such as groundwater, surface water, streambed sediments, fish tissue, or other potential environmental receptors. Thus, a determination of the extent, if any, of offsite environmental contamination and any subsequent risks, is limited. Samples were obtained from onsite surface water, groundwater, and soils although the stations were limited in number. Given these restrictions, the following discussions outline the perceived risks posed by transport of contaminants, and the subsequent risks posed to environmental receptors.

TABLE 9-1
USEPA AMBIENT WATER QUALITY CRITERIA

Compound	Aquatic Organisms and Drinking Water	Adjusted for Just Drinking Water
Acenapthene	20 ug/l	20 ug/l
Aldrin	0 (0.074 ng/l)	0 (1.2 ng/l)
Arsenic	0 (2.2 ng/l)	(25 ng/l)
Benzene	0 (0.66 ug/l)	0 (0.67 ug/l)
Beryllium	0 (3.7 ng/l)	0 (3.9 ng/l)
Cadmium	10 ug/l	10 ug/l
Carbon Tetrachloride	0 (0.4 ug/l)	0 (0.42 ug/l)
Trichlorobenzene	Insufficient Data	Insufficient Data
Trichloroethane	18.4 mg/l	19 mg/l
1,1 Dichloroethane	Insufficient Data	Insufficient Data
Chloroform	0 (0.19 ug.l)	0 (0.19 ug/l)
Chromium Cr + 6	50 ug/l	50 ug/l
Cr + 3	170 mg/l	179 mg/l
Copper	1 mg/l (organoleptic)	1 mg/l (organoleptic)
DDT	0 (0.024 ng/l)	0 (>1.2 ng/l)
2,4-Dichlorophenol	3.09 mg/l	3.09 mg/l
Dichloropropenes	87 ug/l	87 ug/l
Dieldrin	0 (0.071 ng/l)	0 (1.1 ng.1)
Endosulfan	74 ug/l	138 ug/l
Ethylbenzene	1.4 mg/l	2.4 mg/l
Fluoranthene	42 ug/l	188 ug/l
Toluene	14.3 mg/l	15 mg/l
Vinyl Chloride	0 (2.0 ug/l)	0 (2.0 ug/l)
Zinc	5 mg/l (organoleptic)	5 mg/l (organoleptic)

TABLE 9-2
POTENTIAL APPLICABLE STANDARDS*

Compound	MCL	PROPOSED MCL	MCLG	PROPOSED MCLG	NAAQS
Arsenic	0.05 mg/l	0.03 mg/l		0.05 mg/l	
Barium	1.0 mg/l	5.0 mg/l		1.5 mg/l	
Benzene	0.005 mg/l		0 mg/l		
Cadmium	0.01 mg/l	0.005 mg/l		0.005 mg/l	
Carbon Tetrachloride	0.005 mg/l		0 mg/l		
Lead	0.05 mg/l			0.02 mg/l	1.5 (90-day) ug/m^3 (3-month arithmetic mean concentration)
Mercury	0.002 mg/l	0.002 mg/l		0.003 mg/l	
Selenium	0.01 mg/l	0.05 mg/l		0.045 mg/l	
Silver	0.05 mg/l				
Styrene		0.005 mg/l		0 mg/l	
Heptachlor Epoxide		0.00002 mg/l		0 mg/l	
Chromium	0.05 mg/l	0.1 mg/l		0 mg/l	
Copper				1.3 mg/l	
Ethylbenzene		0.7 mg/l		0.7 mg/l	
Toluene		2.0 mg/l		2 mg/l	
Xylene		10 mg/l		10 mg/l	
Vinyl Chloride	0.002 mg/l		0 mg/l		

*Drinking Water Maximum Contaminant Levels (MCL), Maximum Contaminant Level Goals (MCLGs), Proposed MCLs and MCLGs (March 1988), and National Ambient Air Quality Standards (NAAQS)

TABLE 9-3
USEPA DRINKING WATER HEALTH ADVISORIES[1]

Compound	1 Day ug/l	10 Day ug/l	Longer Term (ug/l) 10 kg	Longer Term (ug/l) 70 kg	Lifetime (ug/l)	Reference Concentration (ug/l)
Arsenic	50	50	50	50	50	0.0022
Barium	--	--	--	--	1800	NA
Benzene	--	--	--	--	NA	0.35
2-Butanone	75000	7500	2500	8600	860	NA
Cadmium	43	8	5	18	18	NA
Carbon Tetrachloride	4000	160	71	250	--	0.3
Chlorobenzene	1800	1800	9000	30000	3150	NA
Chromium	1400	1400	240	840	170	NA
Dichlorobenzene	8930	8930	8930	31250	3125	NA
Ethylbenzene	21000	2100	--	--	3400	NA
Heptachlor Epoxide	--	--	--	--	--	0.0006
Lead	--	--	20 ug/day	20 ug/day	20 ug/day	0.031
Mercury	--	--	--	--	5.5	--
Nickel	--	1000	--	--	350	NA
Styrene	27000	20000	20000	70000	--	0.014
Toluene	18000	6000	--	--	10800	NA
Trichloroethane	14000	35000	35000	125000	1000	22000
Vinyl Chloride	2600	2600	13	46	NA	0.015
Xylenes	12000	7800	7800	27300	2200	NA

NOTES:

(1) Source: Superfund Public Health Evaluation Manual, USEPA, October 1986.
The health advisories are currently under review with some modifications (not included) in draft stage.

9.6.2 - Transport Pathway Risk

Groundwater

As stated previously, no offsite downgradient wells were sampled in this investigation. However, the absence of contamination present in wells downgradient of the source areas indicates a very low potential for both onsite and offsite transport of contaminants from the designated source areas via the groundwater transport route.

Surface Water

Sample data have not been obtained to date, to characterize the receiving surface waters up- and downgradient of the LOOW site. Factors considered in evaluating surface water transport of contaminants offsite included the low level of the contamination present in the accumulated surface water sampled (which is directly associated with the Source Area), the intermittent nature of the area's surface water system, and the present lack of ground surface deposits of waste-source material. However, while these factors indicate a low potential for both onsite and offsite transport of contaminants via surface water as the site presently exists, past practices and site configurations may have provided a surface water pathway for an offsite contaminant release. Additional sampling along the downgradient drainage pathway will be performed during the FS phase as recommended in Section 12.

Air

Although the air sampling program was occupational in nature, the air sampling apparatus was located directly in the vicinity of subsurface investigations involving the source areas. The lack of any contaminant detection and the lack of any ground-surface deposits of wastes are factors to be considered when evaluating air transport of contaminants. A low potential for transport of contaminants both onsite and offsite from the designated source areas via the air route has been assessed to date based on available site investigation data.

9.6.3 - Environmental Receptor Exposure Risk

The exposure risk to environmental receptors is the primary exposure risk posed by any releases from the designated source areas. Relative to onsite environmental receptors outside the study area, the low concentrations of compounds detected and the lack of significant transport pathways indicate a low risk for exposure to source area releases. It should be noted that this determination applies to environmental receptors located within the Model City Facility but outside of the project study area. It was discussed in Section 9.5.2 how contamination of the environment within the project study area has been demonstrated.

With regards to environmental receptors located offsite of the Model City Facility, the low concentrations of compounds detected, and the lack of transport pathways, also indicate a low risk of exposure to source area related releases. Accordingly, the overall environmental exposure risk posed by the designated source areas within the project study area has been determined to be of a low magnitude.

10 - SUMMARY OF REMEDIAL INVESTIGATIONS

The following section summarizes the findings and conclusions drawn from obtained site information, site investigations, and subsequent analyses and data interpretation. For clarity, findings are discussed by study area and include a summary of identified contamination; assessed contaminant source; associated offsite conditions and contaminant migration; assessed risk to public health, onsite personnel, and the environment; any lacking information and site data; and need for remediation. The recommended additional site investigations needed for filling in any data gaps and first-hand confirmation of site conditions is outlined in Section 12. Table 10-1 presents an outline summary of the findings by area for each of these items.

10.1 - Assessment of Area A

Identified Contaminant Source(s): The problems identified in Area A appear to be localized resulting from buried drums in the southern portion of the area adjacent to (and possibly extending under) "H" Street. The buried drums are in deteriorated condition, and their leaking contents appear to have contaminated the surrounding soil and local groundwater. Identified contaminants include volatiles and semi-volatile organics consisting of polycyclic aromatic hydrocarbons (PAH).

Related Offsite Conditions/Contaminant Migration: Groundwater sampling to date indicates no apparent downgradient migration of contaminants. The sampling of other potential transport media, primarily surface water and sediment along downgradient drainage pathways, is incomplete.

Preliminary Assessed Risk: The risks posed to the public health and onsite personnel by contaminants in Area A have been qualitatively assessed as low. The greatest risk will be posed by direct contact with the contaminated soil and waste materials during any future excavation activities. Because of the site access restrictions to the public and the strict enforcement of

TABLE 10-1

SUMMARY OF REMEDIAL INVESTIGATION FINDINGS

Investigated Area	Identified Contamination	Associated Offsite Conditions/Migration	Assessed Sources	Preliminary Assessed Risk (To)			Lacking Data/Additional Investigations Needed	Need for Remediation
				Public Health	Onsite Personnel	Environment		
A (Drum Burial Area)	1. Appears to be localized problems resulting from buried drums including: - Undetermined no. of buried drums containing wastes; - Surrounding soil contamination; and - Localized GW contamination (pit water).	Investigations to date indicate no apparent downgradient migration although sampling of all potential transport media are incomplete	Buried drums disposed of in area	Low to negligible risk for offsite population based on data collected to date. Low risk of exposure by direct contact because of restricted site access	Low risk for exposure to air and water contaminants. Greatest hazard posed by direct contact w/ contaminated soils & waste, if excavated	Not Significant	The following need to be confirmed/investigated: - Southern extent of drum burial area - Quality of downgradient surface water and sediment - Contamination of surface soils in vicinity of drum burial	Yes, consideration of: - Drum and contaminated soil removal; - Localized groundwater contamination
B (Burn Pit Area)	1. Contaminated sediments in pit area. 2. Accumulated surface water in pit area has only minor contamination w/boron: levels above NYSDOH drinking water standards (no other applicable standard). 3. Remnant contamination surrounding pit as evidenced in well B-3 & MW-7-3S. Appears to be localized upgradient of the pit. 4. Elevated levels of carbon tetrachloride, chloroform, methylene chloride in upgradient groundwater (source is suspect).	1. Upgradient groundwater contamination noted that is localized and possibly from remnants of burn pit operations. 2. No evidence of downgradient contamination of groundwater. 3. Lacking data on downgradient surface water & sediment along potential migration pathways.	1. Burn pit and immediate surrounding area. 2. Possible other onsite source for parameters detected in upgradient groundwater.	Same as Area A	Same as Area A	Not signigicant	1. Lacking info. on: - Surface water & sediment quality along downgradient drainage pathways; and - Surface soils in the immediate area (need to confirm limits of contamination). 2. Additional sampling suggested to confirm burn pit water quality & depth of contaminated sediments (& underlying soil) in the pit area	Yes: Appears to be problem confined to local burn pit area. Investigation of remediation of the following problems are suggested: - Localized contaminated sediment; and - Localized contamination of groundwater.
C	1. Elevated levels of 1,2-dichloroethene in upgradient well MW-C-1S	None apparent	3. Other possible upgradient source for 1,2-dichloroethene contamination	Negligible	Negligible	Negligible	No info. or evidence to warrant further investigation of this area.	No significant problem identified for remediation

TABLE 10-1 - (Cont'd)

Investigated Area	Identified Contamination	Associated Offsite Conditions/Migration	Assessed Sources	Preliminary Assessed Risk (To)			Lacking Data/Additional Investigations Needed	Need for Remediation
				Public Health	Onsite Personnel	Environment		
Area North of C	Geophysics screening indicated no evidence of drum burial areas. No significant contamination identified.	None apparent	None apparent	None apparent based on investigation results	None apparent based on investigation results	None apparent based on investigation results	No information or evidence to warrant further investigation of this area	No significant problem identified for remediation.
D	Elevated concentration of acetone in upgradient well TMW-14S. Geophysics screening indicated no evidence of buried drums. Groundwater sampling downgradient of area indicated no evidence of a problem.	None apparent	Other possible upgradient source for acetone contamination	Negligible	Negligible	Negligible	No information or evidence to warrant further investigation of this area.	No significant problem identified for remediation
Wooded Area (North of "H" Street)	1. Southeast section could have soils contamination associated with adjacent burn pit area. 2. Downgradient groundwater quality appears not to be impacted.	None apparent	None apparent	None identified to date	None identified to date	None identified to date	1. Additional surface soil sampling at the southeast corner adjacent to the burn pit and at a few random locations within the wooded area. 2. A second deeper boring is also suggested in SE corner to confirm the geophysics anamoly	Require additional information/data in order to make decision regarding need for remediation
Buried TNT and Acid Waste Lines	Lines could not be located during the field investigations so sampling of residual in lines and surrounding soil could not be carried out.	Not likely	- - - -	The potential risk associated w/any remaining buried lines has been assessed to be low based on non-hazardous conditions in previously excavated lines	Same as noted for assessed public health risk.	- - - -	Need for further investigation is not warranted at this time. Any further site investigations might disrupt current owner activities. Should lines be uncovered during future onsite activities residue sampling could be performed at that time.	No significant problem identified for remediation.

personnel protective clothing and onsite safety requirements, the risk of such exposure has been assessed as low. Potential risks to the environment have also been judged to be low.

Need for Remediation: Based on the investigation results completed to date, there appears to be a need for remediation of the localized contaminant problems. Such remediation should address the removal and disposal of the deteriorated drums, the surrounding soil and the localized contaminated groundwater associated with the buried drums.

10.2 - Assessment of Area B

Identified Contaminant Source(s): The problems identified in Area B that appear to be localized and result from the past use of the burn pit include:

- Contaminated sediments in the immediate pit area;

- Low level boron contamination of accumulated surface water within the pit (measured levels were above NYSDOH drinking water standards, there are no other applicable standards); and

- Groundwater contamination probably resulting from remnant contamination surrounding the pit as noted in wells MW-B-3 and MW-7-3S. This groundwater contamination appears to be localized and upgradient of the actual burn pit.

Identified contaminants included volatile and semi-volatile organics including some pesticides. Inorganic contamination included primarily lithium and boron.

Elevated levels of carbon tetrachloride, chloroform, and methylene chloride have also been identified in the upgradient groundwater. These contaminants do not appear to be directly related to the previous burn pit activities and possibly are a result of another onsite source.

Related Offsite Conditions/Contaminant Migration: Groundwater sampling has not indicated any apparent downgradient migration of contaminants from the burn pit area. However, the sampling of other potential routes of migration, primarily surface water and sediment along the downgradient drainage pathways, is incomplete. Therefore, further sampling is needed in order to confirm the presence or absence of offsite contaminant migration.

Preliminary Assessed Risk: The risks posed by Area B conditions to the public health and onsite personnel are similar to those assessed for Area A. The greatest risk is posed by direct contact with the contaminated soils and sediments. However, site access restrictions and onsite safety procedures and protective clothing make such exposure a relatively low risk.

As evidenced by the presence of vegetation within the burn pit area, the offsite risk to the environment has been assessed to be low.

Need for Remediation: Based on the remedial investigation results, there appears to be a need for remediation of the contamination problems that are generally confined to the immediate burn pit area. However, additional field investigations are needed to define the actual extent of the problem areas.

Investigation results to date indicate remediation should focus on cleanup of the localized contaminated sediments, soils, and groundwater.

10.3 - Area C

The only problem identified in this area was the recorded elevated level of 1,2-dichloroethene in upgradient monitoring well MW-C-1S. There were no drums encountered during the test pit investigation of the area nor was there significant contamination identified by the sampling program (except for the elevated level of 1,2-dichloroethene). The elevated level of this contaminant is suspected to be related to an unidentified upgradient source and does not appear to be related to former federal agency activities at the site.

Based on the remedial investigation of Area C, the assessed risk of the identified contamination is low to negligible and there is no evidence to warrant further follow-up investigations of the area.

10.4 - Area North of C and Area D

Similar to Area C, the only problem in Area D is the presence of acetone in the upgradient monitoring well TMW-14S. There is no other evidence of significant contamination problems or buried drums identified in these two areas. In addition, there were no magnetic analomies identified within either area, and the sampling of monitoring wells downgradient of these areas indicated no evidence of a contamination problem associated with the areas. The acetone contamination is suspected to be related to an unidentified upgradient source and does not appear to be related to former federal government activities at the site.

Based on the field investigation and analytical results, no apparent onsite or offsite problems were identified. Assessed risks related to these areas are considered to be low or non-existent. Consequently, further follow-up investigations of these areas are not warranted.

10.5 - Wooded Area (North of "H" Street)

Identified Contaminant Source(s): No significant contamination problems have been identified in this area by the field investigations to date. However, possible soil contamination is suspected in the southeast corner of this area. This contamination may be residual spillover from the nearby burn pit area (Area B).

Some sampling data to date have indicated elevated levels of boron at soil boring SB-3 for one sample only. However, the detection of boron in the sample is suspect and additional confirmation of the analytical results is required.

Groundwater quality downgradient of the Wooded Area does not appear to be impacted. No significant contamination was revealed in the analytical results.

Related Offsite Conditions/Contaminant Migration and Assessed Risks: There are no apparent offsite contamination problems or conditions that can be related to this area. Based on the available site data, no risks attributed to this area can be identified. However, additional soil sampling data in the southeast corner of the area is needed in order to make a final decision on any need for remediation.

10.6 - Buried TNT and Acid Waste Lines

The TNT and acid waste lines could not be located during the field investigations. Consequently, sampling of the residue in the lines and surrounding pipe bedding/soil material could not be carried out. The potential risks that could be associated with any remaining buried lines have been reviewed by a munitions/explosives consultant and determined to be low and likely negligible. This is based on the presumption that the lines are isolated by burial and probably located below the groundwater table (as evidenced by previously encountered saturated conditions within the lines and a typically high water table). Any remaining residual materials are probably saturated and not ignitable. This speculative conclusion is based upon the non-hazardous conditions of TNT and acid lines that have been excavated during previous CWM site activities.

It has therefore concluded that the need for any follow-up investigation of the lines is not warranted at this time. However, if any lines are uncovered during future onsite activities (by COE or CWM), sampling should be performed at that time.

Based on the remedial investigations carried out in the designated areas, problems have been identified that require remediation in two of the five study areas (Areas A and B) and problems are suspected in one area (the "Wooded Area"). Additional investigations are needed to further confirm the extent of contamination in each of these three areas. The recommended investigations needed to provide the necessary site data are discussed further in Section 12.

11 - IDENTIFICATION OF REMEDIAL TECHNOLOGIES

11.1 - Objective

The objective of this section is to provide a preliminary identification of technologies which appear to be applicable, either individually or together, as a means to mitigate the environmental contamination problem that exists in the study areas. Technology, for the purpose of this study, is defined as any activity which, in combination with other activities or by itself, can be used to address the site contamination. These technologies also include activities that are necessary support actions but do not directly reduce the contamination. For example, transportation is important for the removal of contaminants but does not, itself, directly reduce pollution. In the feasibility study appropriate technologies will be combined to form alternatives that address the entire contamination problem.

The remainder of this section will identify individual technologies as they apply to any of the three specific media (groundwater, soil, or drum waste) being considered in this study. The main technological groups that will be discussed are organized into nine separate categories:

- No Action;
- Non-Removal;
- Removal;
- Transportation;
- Dewatering of Soil;
- Treatment of Drums;
- Treatment of Soils/Solids
- Treatment of Groundwater/Liquids; and
- Disposal.

Table 11-1 provides a summary by category of available remedial technologies identified for further consideration.

TABLE 11-1
SUMMARY OF AVAILABLE REMEDIAL TECHNOLOGIES FOR CONSIDERATION

General Response Category	Applicable Technologies for Consideration
No Action	(1) Increase public awareness - post signs - hold public meetings (2) Restrict access - fence area - hold public meetings (3) Monitor conditions over time - sample/analyze soil - sample/analyze surface and ground water
Non-removal	(1) In-place stabilization or containment - biodegradation - vitrification - chemical fixation (i) sorbents (ii) grout or other chemical bonding agents - clay cap - synthetic liner - slurry wall (2) In-situ treatment (3) Dilution
Removal	(1) Excavation by backhoe; bulldozer; front end loader; scraper) (2) Pumping (air-lift pump; suction (trash) pump; submersible pump)
Transportation	(1) Pipeline (2) Rail (3) Truck
Dewatering of Soil/Sediments	(1) Fixation (2) Mechanical/physical dewatering - dehydro drying beds - drying beds - gravity thickners - in-place evaporation - portable sediment processing unit - sedimentation basin - site dewatering - ultrasonic dewatering (3) Secondary solids dewatering - belt filter - centrifuge - drying beds - filter press - vacuum filters (4) Calcination

TABLE 11-1
(Cont'd)

General Response Category	Applicable Technologies for Consideration
Treatment of Drums and Associated Soil/and Waste Materials	(1) Biological Treatment (2) Chemical Treatment - acidification - clarification - activated carbon - flocculation - neutralization (3) Extraction/Recovery (4) Incineration - multiple hearth incinerator - rotary kiln incinerator *- arc pyrolysis (destruction of drums as well as contaminants)
Treatment of Supernatant (Water/Liquid)	(1) Biological Treatment (2) Electrodialysis (3) Electrolytic Recovery (4) Evaporation (5) Ion Exchange (6) Mixed Media Filtration (7) Neutralization (8) Reverse Osmosis (9) Sorption
Disposal	(1) Hazardous Waste Material - disposal at existing landfill (most likely existing CWM) - construct new landfill (on CWM property) - other new or existing landfill within the county (2) Non-Hazardous Waste - existing county landfill - new landfill (in county) - onsite disposal (at original source location) (3) Recovered Chemicals

* This technology, although feasible, has not been developed into a successful full scale operation to date.

11.2 - No Action

Although No Action is not a technology, it is used here to categorize a group of activities which can be used to address the contamination problem. Three methods are proposed for consideration to reduce the public health risks: increase public awareness, restrict access, and monitor conditions over time. The possible activities under No Action and how they may relate to any of the three media are noted in Table 11-1.

11.3 - Non-Removal

Non-removal actions involve technologies which are directed toward the reduction of contaminant risk without removing the contaminated materials. The technologies that were considered under this category are presented in Table 11-1 and include in-place stabilization of contaminants, in-situ treatment, and dilution.

(1) In-place stabilization and containment include two main techniques that could be applicable. The first deals with covering the contaminated areas with various types of material such as clay or synthetic liner and enclosing the affected area to prevent migration. The second main stabilization technique entails altering the materials as they exist in place so that the contaminants are no longer toxic, hazardous, and/or mobile. This might be accomplished by using microbes, chemicals or electricity to change the chemical state of the contaminants and soil.

(2) In-situ treatment uses a chemical agent to remove contaminants without removing all the soil or groundwater.

(3) Dilution is a simple process whereby clean material (soil or water) is added to the contamination and mixed. By thoroughly mixing enough clean material the concentrations can be reduced to an acceptable level.

11.4 - Removal

Removal technologies include those techniques that might be used to take the contaminants out of their in-situ locations. Removal is divided into two major processes for consideration: excavation and pumping. Table 11-1 lists these two major categories and all the individual technologies under each that are applicable to the site.

(1) Under excavation, equipment that is normally used on dry land is presented. The types of excavating equipment considered included backhoes, front end loaders, scrapers and bulldozers.

(2) Pumping equipment is normally utilized to remove liquids and mixed soil/water from a wet environment. Therefore, the types of pumps considered would include air-lift, suction "trash" pump, and submersible pump.

11.5 - Transportation/Transfer

This is a support activity which will consider possible transportation means for conveying either contaminated, non-contaminated, and/or support material to or from the work area. Three transportation modes considered applicable for this site are pipeline, rail, and truck.

(1) Pipelines would be most useful in conjunction with removal and treatment options. The enclosed pipelines reduce direct contact with the environment and are most applicable for short transport distances (i.e., within CWM property boundaries).

(2) Rail transport would be attractive if the materials had to be transported a significant distance (i.e., across the state or out of state).

(3) Trucks are considered the most common method that could be used to haul materials to offsite disposal locations.

For any single alternative developed in the subsequent feasibility study, it may be unlikely that a single transportation system would be applicable for all media. It is more probable that a combination of the above three types of transportation/transfer would make up the optimum solution.

11.6 - Dewatering of Soil

Dewatering technologies that could be applicable to the site fall into four categories: fixation, mechanical/physical dewatering, secondary solids dewatering, and calcination.

(1) Fixation is a process whereby chemical agents are added to the soils. These agents absorb excess water so that the material is easier to handle and stabilize the contaminants present in the soil so that the environmental mobility of the contaminants is reduced.

(2) Mechanical/Physical Dewatering utilizes mechanical processes, physical processes (gravity) or a combination of both to remove excess water from the soils. Drying beds, sedimentation basins, thickners, and in-place evaporation methods use natural processes such as gravity, temperature, sun-light as the primary means of dewatering. The site dewatering method uses mechanical means to remove accumulated water from the work area. Dehydro drying beds, portable sediment processing units, and ultrasonic dewatering all apply combined mechanical and physical processes for dewatering purposes.

(3) Secondary dewatering of solids (as listed in Table 11-1) further removes additional free water so as to improve the handling of the soil and reduce the volume of material to be stored or treated.

(4) Calcination is a volume reduction process in which the sediments are heated and the organics and water in the soil are burned off. Temperatures used in this process are not as high as required for incineration.

11.7 - Treatment of Soil

Biological treatment, chemical treatment, extraction/recovery, and incineration are applicable technologies to be considered for treating onsite contaminated materials. Alternative technologies under these categories are listed in Table 11-1.

(1) Biological treatment - involves the introduction of bacterial colonies that will remove the organics from the soil or water. Proper control of the environment in which the microbes perform the removal is essential to overall success of the process.

(2) Several chemical treatment processes can be combined to form an effective chemical treatment of the soils/solids. Treatment methods to be considered should include neutralization, flocculation, clarification, acidification, if necessary, and filtration with activated carbon.

(3) Extraction/recovery is the most common technique for the removal and salvaging of chemicals. This process involves the addition of a solvent to combine with the contaminant and the subsequent recovery of these chemicals.

(4) Incineration involves the burning of the wastes, soil, water, and drums at high temperatures to destroy the hazardous chemical contaminants. It should be noted that although incineration will not destroy metals, the ash/ceramic waste from this process is expected to be stable and its resistance to leaching is expected to be high. Three types of incinerators to be considered for possible use are the multiple hearth, rotary kiln, and arc pyrolysis. Arc pyrolysis will additionally destroy any container in which the waste enters the incinerator. However, it should be noted that the arc pyrolysis technology has not been developed into a successful full scale operation to date.

11.8 - Treatment of Supernatant

The contaminated liquid that is present at the site must undergo treatment to remove any contaminants prior to release back to the environment. Possible treatment methods that could be applied include biological treatment, electrodialysis, electrolytic recovery, evaporation, ion exchange, mixed media filtration, neutralization, reverse osmosis, and sorption.

(1) As previously noted under soil treatment technologies, biological treatment requires the introduction of bacterial colonies to the waste stream to remove the contaminants.

(2) Electrodialysis is a concentrating technique that uses ion exchange membranes to collect the chemicals present.

(3) Electrolytic recovery is a method in which the specific metals are recovered on electrodes while an electric current is passed through the recirculated supernatant.

(4) Evaporation is a simple and reliable concentrating technique that requires substantial energy if performed by thermal mechanical equipment and long time periods if performed using solar radiation.

(5) Ion exchange is a cost-effective treatment process but the supernatant must be at low concentrations (dilute) in order for the process to be effective. The waste stream is passed through an ion exchange agent (i.e., resin) and the resin electrochemically exchanges ions and traps suspended solids, allowing the remaining fluid to pass through the system.

(6) Mixed media filtration is an inexpensive filtering system that can effectively remove suspended solids from the supernatant. For such a system, fine sand, and adsorbing agents are placed in sequential

layers to filter or absorb the certain chemicals from the waste stream.

(7) Neutralization is a method in which the pH of the supernatant is adjusted to a desired level such as the pH of the receiving water body.

(8) In reverse osmosis the supernatant is fed through a membrane to remove contaminants. This is a very delicate process and its reliability is limited by the life of the membranes.

(9) Sorption is a method whereby the waste stream is passed through an adsorbing (or absorbing) agent for removal of contaminants. Sorption typically could be part of a mixed media filtration system.

11.9 - Disposal

It will most likely be necessary to dispose of some of the contaminated/ waste materials generated from the remedial actions. The waste material generated will fall into three general categories: hazardous waste, non-hazardous waste, and recovered chemicals. Disposal options for each of these categories are listed in Table 11-1 and summarized as follows:

(1) Disposal of Hazardous Material: For this study, three alternative sites will be investigated for possible disposal of hazardous wastes. The sites that will be considered include an existing landfill, a new landfill on CWM property, and a new or existing landfill in the county.

(2) Disposal of Non-Hazardous Waste: Three sites will be assessed for the disposal of non-hazardous wastes. An existing county landfill site could be used for the disposal of non-hazardous wastes. A new landfill could be constructed somewhere in the county. Non-hazardous soil/ash/sludge could also be redeposited in the location from which they were removed.

(3) Disposal of Recovered Chemicals: Some treatment processes may result in the recovery of chemicals. It is anticipated that these chemicals could then be salvaged and possibly used by a local chemical manufacturer.

These technologies will be further reviewed and evaluated in terms of applicability in remediating the identified on-site problems during the ongoing feasibility study.

12 - RECOMMENDATIONS

Several data gaps or areas lacking information have been identified based upon the review of the remedial investigation results. In some cases, the extent of contaminant migration has not been adequately verified for all potential transport media.

Specifically, further investigations and/or confirmation of site conditions are needed for the identified (or potential) problems associated with Area A, Area B, and the Wooded Area north of "H" Street. These recommended additional investigations and data collection activities are as follows:

12.1 - Area A

Recommended follow-up investigations for this area would consist of:

- Further test pit exploration to confirm southern extent of the buried drum area;

- Sampling and analyses of surface water and sediments along the downgradient drainage pathways conveying runoff offsite to confirm downgradient conditions and related risk associated with possible contaminant migration (sampling at two locations is suggested); and

- Additional soil sampling in the vicinity of the buried drum area to identify the potential of surface contamination that may exist in the area and the extent of any subsurface soil contamination.

12.2 - Area B

Recommended follow-up investigations for this area would consist of:

- Sampling and analyses of surface drainage and sediments downgradient of the burn pit area (could be covered by sampling previously outlined for Area A) to assess conditions in these media;

- Sampling and analyses of surface soils adjacent to the pit area to confirm limits of contamination (sampling at an estimated 10 locations). This sampling program would extend over into the eastern section of the Wooded Area to confirm any potential spillage of contamination from the pit area;

- Resample (one sample) and analyze ponded water in the pit area to confirm water quality determined during previous sampling (these results indicated relatively low levels of contaminants, but only a single sample was taken); and

- Additional sediment core sampling in the pit area at several locations (4 to 6 locations) to verify lateral extent and depth of contaminated sediment and underlying soil in the pit area.

12.3 - Wooded Area (North of "H" Street)

Further investigations should consider:

- Additional soil sampling and analyses in the southeast corner and along the east perimeter of the Wooded Area located adjacent to the burn pit area. As previously discussed under Area B above, this additional soil sampling/analyses program is to be an extension of the recommended soil sampling in Area B. A few random soil samples should also be taken in the remaining Wooded Area to confirm that surface contamination is not present; and

- A deeper soil boring may be required in the southeast corner to investigate the geophysics anamoly recorded in this area and verify the suspect duplicate analytical results for the soil sample previously taken in this area (soil boring No. SB-3, depth 8-9.5 ft, boron present).

12.4 - Other Areas

Due to the dissimilarity between historic groundwater flow directions for the upper tills (Zone 1) and groundwater flow directions as determined in

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