MALCOLM PIRNIE

MALCOLM PIRNIE, INC.
ENVIRONMENTAL ENGINEERS, SCIENTISTS & PLANNERS

August 12, 1983

Norman H. Nosenchuck, Director
Division of Solid and Hazardous Waste
New York State Department of
Environmental Conservation
50 Wolf Road
Albany, New York 12233

Re: Site Investigations and Remedial
Action Alternatives, Love Canal

Dear Mr. Nosenchuck:

Submitted herewith is the Environmental Information Document (EID) for Task VI, 102nd Street Outfall. As marked, this report is a draft and is subject to revision based upon your review, USEPA Region II comments, as well as the reviews performed by other cognizant New York State agencies.

A voluminous amount of detailed supporting documentation stands behind this EID. That back-up information which includes sampling logs, chain-of-custody forms, analytical data, QA/QC reports, and so on, will be submitted to you separately. Additionally, a summary document will be prepared to address all five project task areas. That summary document is intended to be submitted with the final EIDs.

We would be pleased to make a presentation to you concerning this report at your request. If either of the undersigned may be of further assistance to you, please feel free to contact us.

Very truly yours,

MALCOLM PIRNIE, INC.

John C. Henningson
Vice President

Michael J. Mann, P.E.
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Enclosures

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TABLE OF CONTENTS

TABLE OF CONTENTS (Cont'd.)

LIST OF TABLES

TABLE OF CONTENTS (Cont'd.)

LIST OF TABLES (Cont'd.)

LIST OF FIGURES

TABLE OF CONTENTS
(Continued)

1.0 INTRODUCTION

The former chemical waste disposal site at Love Canal occupies a 16-acre rectangular plot of ground in the LaSalle District of Niagara Falls, New York as shown on Figure 1-1. The site is bounded by Colvin Boulevard on the north, 99th Street on the east, Frontier Avenue on the south, and 97th Street on the west. Two roads, Read and Wheatfield Avenues, cross the landfill in an east-west direction. A public elementary school, known as the 99th Street School, occupies a portion of the land between Read and Wheatfield Avenues and was built adjacent to the eastern boundary of the landfill. The southernmost portion of the site is approximately 1,500 feet north of the Niagara River.

The first signs of serious chemical contamination at Love Canal became evident in 1975, and by November 1976 the frequency and magnitude of the problems cited by area residents prompted an investigation of the site by the New York State Department of Environmental Conservation (NYSDEC). As a result of this investigation, a barrier drain, a clay cap over the former canal, and permanent on-site leachate treatment facilities were completed by the end of 1979.

The primary objectives of this initial remedial construction at Love Canal were to halt further lateral contaminant migration from the landfill, prevent runoff of contaminated surface water, and to minimize leachate generation. A U.S. Environmental Protection Agency (USEPA) study, released in May 1982, concluded that the barrier drain was functioning effectively to halt the lateral transport of contaminants through the soil.

In January 1983 five engineering investigations were initiated in areas adjacent to Love Canal. These engineering

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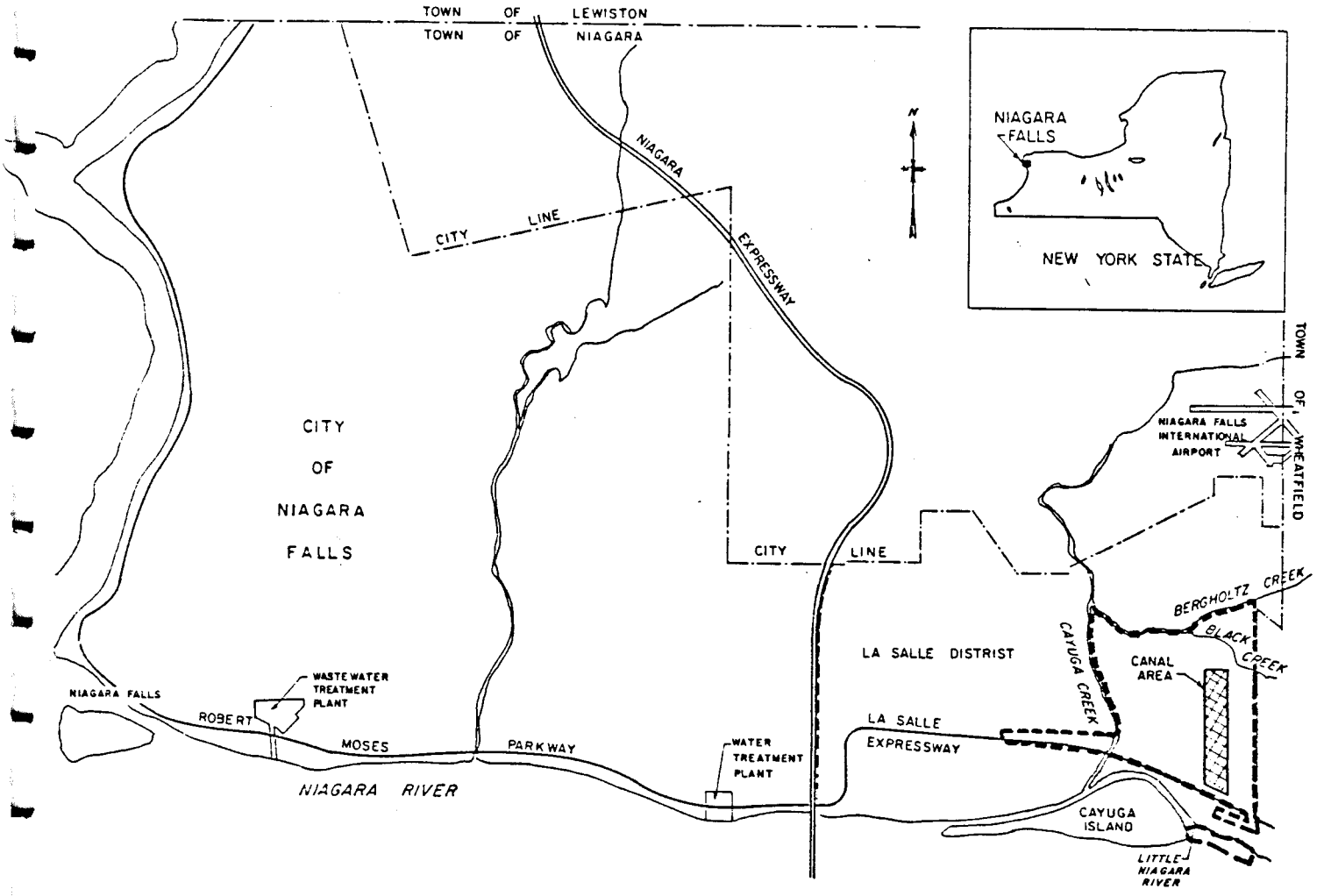
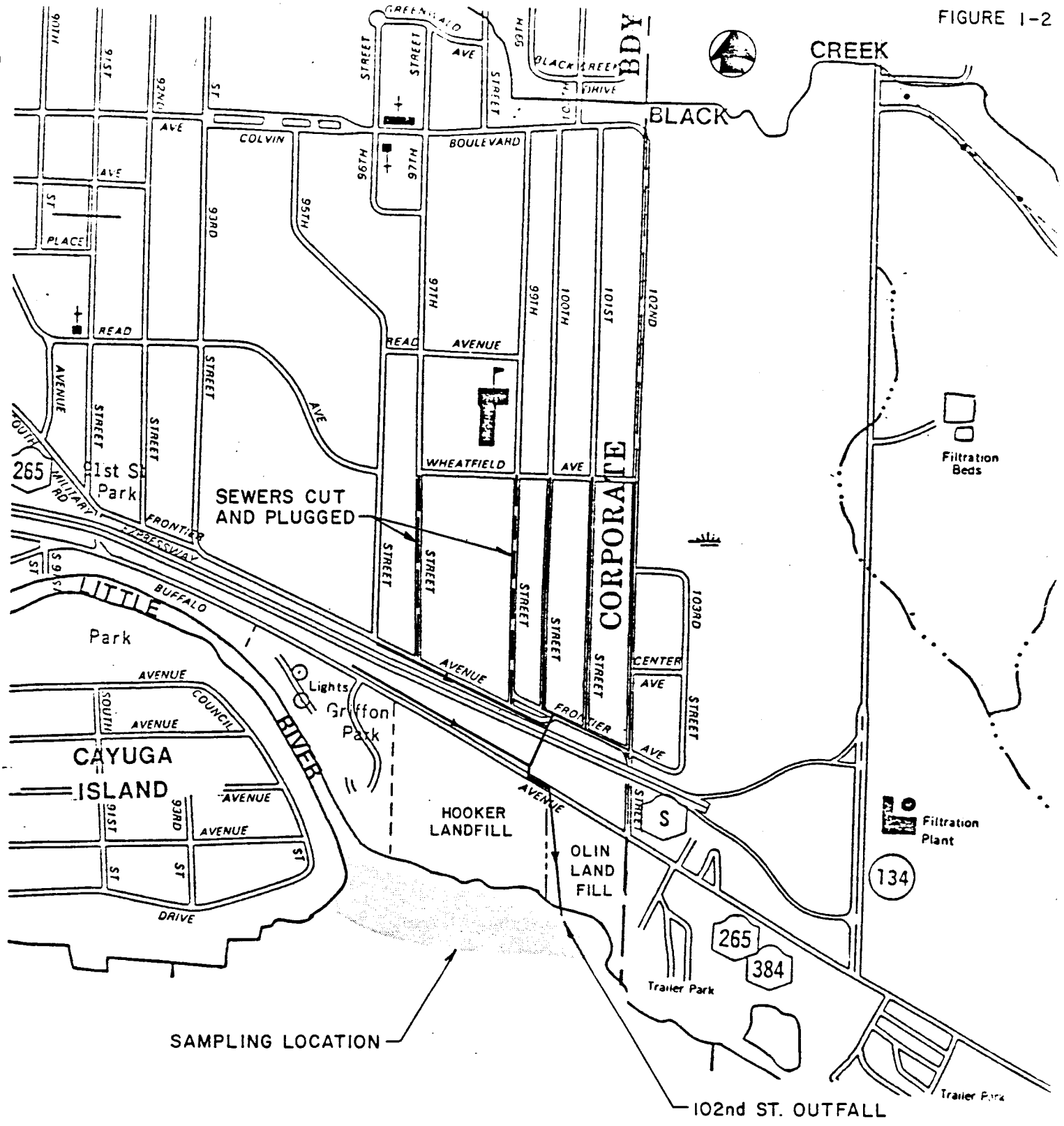


LOVE CANAL
SITE INVESTIGATIONS AND REMEDIAL ACTION ALTERNATIVES
REGIONAL MAP

investigations were conducted by Malcolm Pirnie, Inc. as part of seven additional Love Canal remedial projects being administered by the NYSDEC Division of Solid Waste under a cooperative agreement with the USEPA. Task Areas II, IV and VII address contamination in adjacent storm and sanitary sewers, while Task Areas III and VI are concerned with contaminated sediments in Black and Bergholtz and Cayuga Creeks and in the Niagara River near the 102nd Street storm sewer outfall. The Study Area comprised of the five Task Areas, the area encompassed by the May 1980 emergency declaration, and the immediate canal area (i.e. Rings 1 and 2 inside the fence) is illustrated on Figure 1-2.

This Environmental Information Document (EID) presents a detailed contamination assessment and evaluates remedial alternatives for Task Area VI, the 102nd Street storm sewer outfall. EIDs addressing the four other Task Areas and a summary document describing the findings in all five Task Areas have been prepared separately.

FIGURE 1-2



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LOVE CANAL
FIVE ENGINEERING STUDIES

102nd ST. OUTFALL
TASK VI

VICINIY MAP

2.0 PROJECT OBJECTIVES

2.1 Overall Program

The overall objective of the project is to develop the most environmentally sound and economically feasible remedial action plan for any Love Canal related contamination which has migrated away from Rings 1 and 2. The specific work items associated with each of the five Task Areas are summarized below:

- Determination of the extent of contamination in storm and sanitary sewers, rivers and streams in the task area;
- Identification of the pathways for migration of contaminants into and away from the task area;
- Assessment of the contaminants in and migrating from the task area;
- Development of remedial alternatives to prevent further contamination of the environment from the contamination in the task area;
- Evaluation of the implementability of each alternative; and
- Recommendation of the alternative to be implemented.

2.2 Task Specific Objectives

The specific objectives for Task Area VI are to delineate the existence, extent, mode and path of migration of contaminants which may have been discharged via the 102nd Street storm

sewer outfall and to recommend a program which will mitigate the effects of the contamination on the environment.

Existing information was reviewed and a sampling program conducted to assess the extent of contamination of sediment deposits in the Niagara River at the end of the outfall sewer. Based upon the findings of the sampling program and other pertinent data, remedial alternatives were developed. These alternatives include no action, temporary and permanent in-situ stabilization of the sediments, and removal and disposal of contaminated sediments near the 102nd Street outfall. The alternatives were evaluated based upon their technical, environmental and economic feasibility and a recommended program has been developed.

3.0 BACKGROUND INFORMATION

3.1 Site Description

The 102nd Street outfall is a 42-inch storm sewer outfall which discharges to the Niagara River approximately 1,500 feet from the southernmost portion of the Love Canal. The outfall originally discharged stormwater collected in tributary storm sewers on 97th, 99th, 100th, 101st and 102nd Streets and a portion of Frontier Avenue. The 97th and 99th Street storm sewers have recently been cut and plugged to prevent any further discharge of storm water from Love Canal, but storm drainage from Frontier Avenue and the area from 100th Street to 102nd Street south of Wheatfield Avenue is still carried by the outfall sewer. South of Frontier Avenue, the outfall sewer passes under an expressway and Buffalo Avenue and through an inactive industrial waste disposal site to the Niagara River. It is estimated from historic data that the outfall and the tributary storm sewers are approximately 60 years old, and therefore, were in place while Love Canal was being used as a landfill.

The locations of the 102nd Street outfall sewer, tributary sewers and the sampling site in the Niagara River area were shown on Figure 2-1. The sampling site is a small inlet area on the north shore of the river at the head of Cayuga Island, where a deltaic deposit of sediments has built up at the end of the outfall sewer. Detailed information concerning the site's physical characteristics, which were deemed important influences on the sampling program, are contained in Section 4.3 of this report.

3.2 USEPA Monitoring Report

As part of a multifaceted environmental monitoring program performed by the United States Environmental Protection Agency (USEPA), five sediment samples were collected from an area near the mouth of the 102nd Street outfall. Sampling activities were performed from August to October 1980 and results of this program are reported in "Environmental Monitoring at Love Canal" published by the USEPA.

Of the five sediment samples which were analyzed from the Task VI Study Area, three were taken upstream of the outfall discharge and two were taken downstream. The sediment sampling work revealed highly contaminated sediment samples near the mouth of the outfall sewer. Among the significant contaminants reported were BHC (20-2,500 ppb), toluene (14-528 ppb), benzene (below detection to 400 ppb) and 2,3,7,8-TCDD, dioxin (0.023-0.102 ppb).

3.3 Other Pertinent Reports and Findings

Numerous documents exist which directly or indirectly address Love Canal and nearby inactive hazardous waste disposal sites. However, with the exception of the USEPA monitoring report, discussed above, there is limited river water and sediment sampling information for the 102nd Street Outfall Area.

One study performed by the New York State Department of Health consisted of sampling and analysis of storm sewer and creek sediments for 2,3,7,8-TCDD (dioxin). One of the sampling locations was near the 102nd Street outfall discharge. This sample was collected on November 16, 1979, prior to full containment of the Love Canal area, and contained 31 ppb of dioxin. The USEPA samples collected in this area after contain-

ment of the Love Canal area indicated only trace concentrations of 2,3,7,8-TCDD.

Some information has been obtained from past mapping of the area. Aerial photos taken in 1964 and the 1965 U.S. Geological Survey map of the West Tonawanda quadrangle indicate a breakwater area near the 102nd Street outfall discharge point. The breakwater was approximately 50 feet in width and extended from a point near the Olin/Hooker boundary line on the 102nd Street Landfill site to the west for appoximately 300 feet. The outfall discharged within this area, and the breakwater would appear to have trapped sediments upstream of the outfall discharge. Based upon recent mapping of the area and the sampling program conducted for this project, it is apparent that this breakwater has been removed and the shoreline redeveloped.

3.4 Other Hazardous Waste Disposal Sites

Inactive hazardous waste disposal sites in the Niagara Falls area are believed to be a major source of persistent chemical substances that contribute to the contamination of the Niagara River. Investigations by the NYSDEC and the Interagency Task Force have identified 155 disposal sites within three miles of the Niagara River. Several of these sites are located near the 102nd Street outfall area and, therefore, complicate the identification of contamination sources and any proposed remedial measures. The sites which are of particular concern for this area are Lynch Park, Niagara River Site, Griffon Park, 102nd Street Landfill (Hooker) and 102nd Street Landfill (Olin). These sites are identified on Figure 3-1.

FIGURE 3-1

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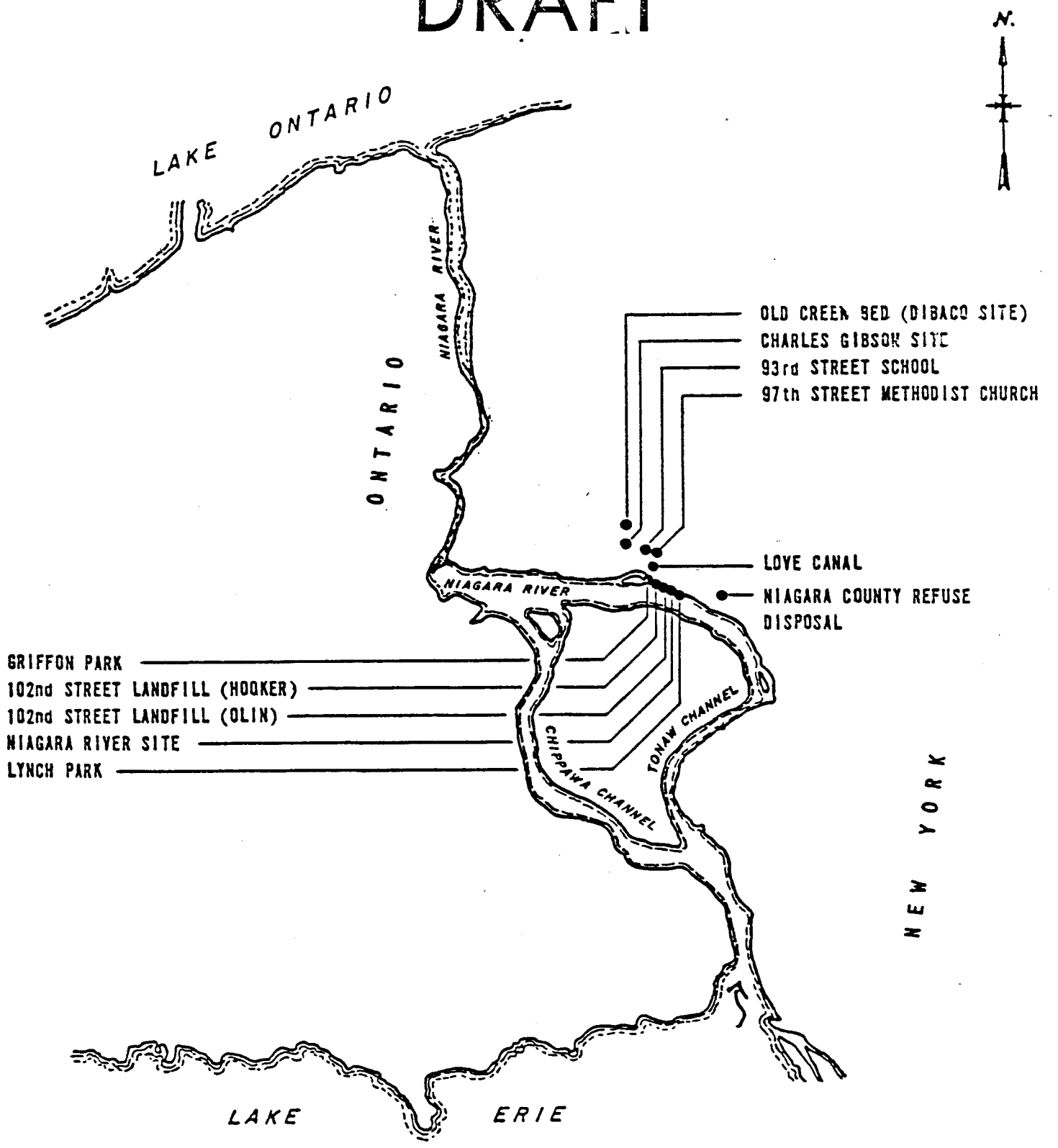


LOVE CANAL
FIVE ENGINEERING STUDIES

HAZARDOUS WASTE DISPOSAL SITES OF CONCERN

No information could be obtained for Lynch Park, the Niagara River Site and Griffon Park. However, there is some information available on the 102nd Street Landfill.

The 102nd Street Landfill is owned, in part, by Hooker Chemical and Plastics Corporation (Hooker) and by the Olin Corporation (Olin). The Hooker owned site is located to the west of the Olin portion and the 102nd Street outfall passes through the Olin portion. The Griffon Park site is located immediately to the west of the Hooker portion of the 102nd Street Landfill.

The 102nd Street Landfill was active between 1943 and 1971, according to previous findings. Some site remediation (i.e. grading, cover, rip rap of slopes, etc.) has continued through the years and, in 1983, the face of the Olin's landfill was covered with rip-rap along the river bank.

Previous findings have determined that Olin disposed of approximately 63,000 tons of inorganic wastes and about 3,000 tons of chlorinated organic compounds on their portion of the 102nd Street Landfill. Lindane isomers are of most concern at this site at this time. An infiltration study performed by Olin indicates that the landfill contributes less than 10 gpm of infiltration to the 102nd Street outfall sewer which passes through the landfill. No information on contaminant loads could be obtained.

The historic findings for the Hooker Chemical and Plastics Corporation's portion of the 102nd Street Landfill indicate that approximately 23,000 tons of predominantly inorganic wastes were disposed of at this site. Of this waste, approximately 2,600 tons of BHC cake (including lindane), chlorobenzenes, and other chlorinated organics were landfilled.

During a recent hydrogeologic study of this area, leachate flows were observed discharging near the east end and below the bulkhead of the 102nd Street outfall before entering the Niagara River.

4.0 CONDUCT OF FIELD INVESTIGATIONS

4.1 General Approach

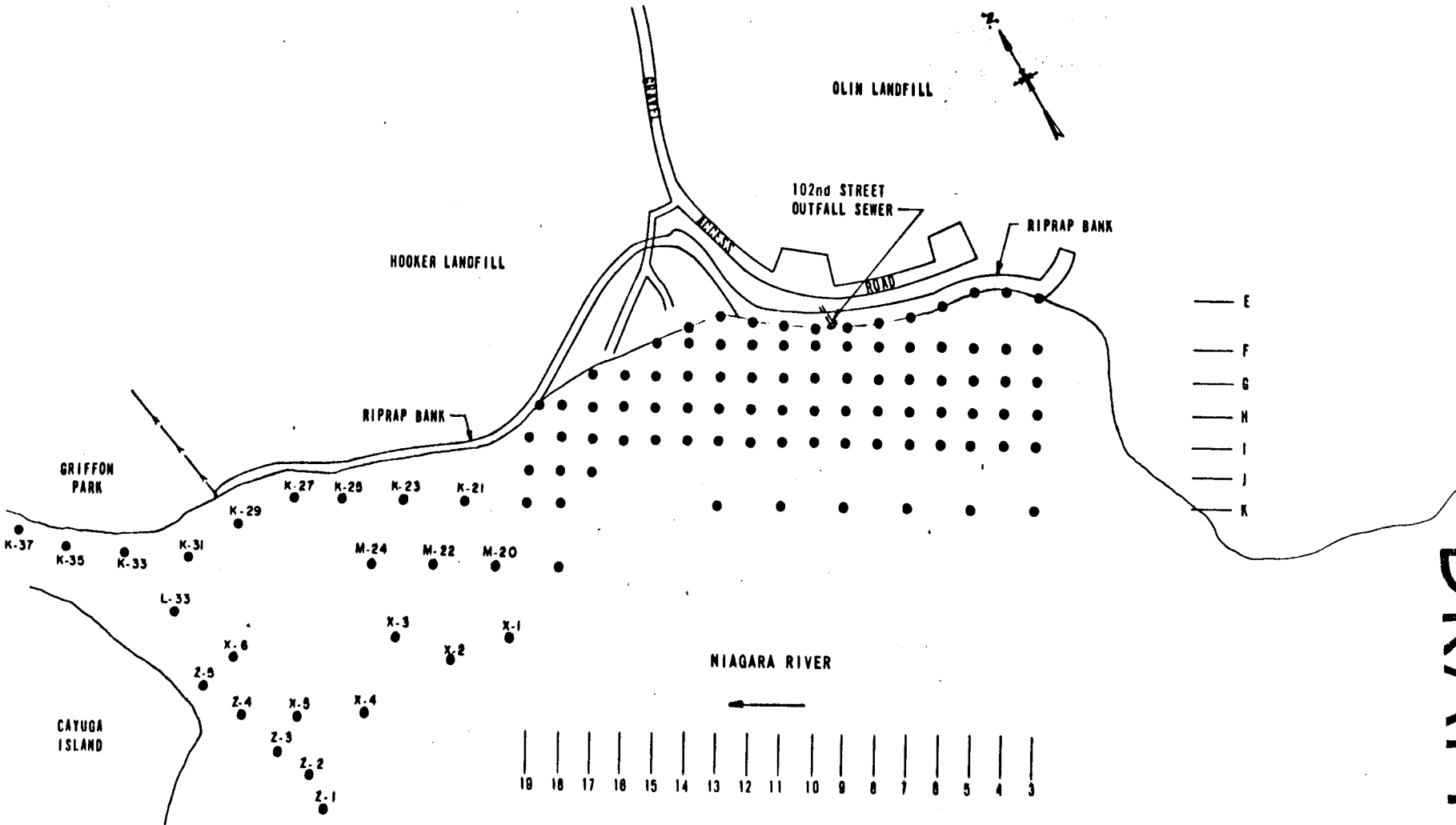
A field office was established at the corner of Colvin Boulevard and 98th Street to coordinate the sampling activities in each task area. A work trailer was sited within the restricted canal area to allow for outfitting and decontaminating the sampling crews. The vehicles used by the crews were divided into "clean" and "dirty" sections. The "clean" section was used to transport the crew to the sampling site. The "dirty" section was used to return both crew and samples to the trailer for decontamination. Upon completion of the project, the "dirty" sections underwent a thorough decontamination. The samples were decontaminated at the work trailer and transported to the field office for final packaging before shipment to the analytical laboratory.

Safety was a prime consideration throughout the sampling program. In addition to the dangers associated with sampling potentially hazardous wastes, the sampling crews had to work in cold waist deep water encumbered by many layers of protective clothing and gear. To ensure rapid communication and response in the event that a crewmember fell in the icy river or sustained accidental injury, two-way radios were carried by the men in the river and the shore crew and a base station was continuously monitored in the office.

4.2 Task Specific Approach and Sample Location

The selection of the sampling locations was designed to accomplish the basic program objectives: first, to establish the existence and location of chemical contamination which may have migrated from the former canal area; and second, to establish the probable extent and path of any migration. The

FIGURE 4-1



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LOVE CANAL
FIVE ENGINEERING STUDIES
102nd STREET OUTFALL
TASK VI

SAMPLING LOCATION POINTS

specific sampling locations were selected based upon historic and observed physical characteristics of the area.

The following factors affected the location and extent of sampling.

- The distance off-shore of the sampling was limited by the ability to extract the sample in water above waist deep. However, the river bottom material became more sandy with distance off-shore, and all of the area containing a predominance of fine silts and muck were encompassed by the sampling grid.

- The extent of upstream river sampling above the outfall was decided based on historic data concerning the prevailing winds, wave action resulting from the winds, and old maps which showed what appeared to be a breakwater located off the end of the outfall.

- The extent of sampling downstream from the outfall sewer was limited by the water depth at the head of Little Niagara River. Samples in this area were located randomly rather than on a set grid pattern.

The sampling locations for this Task Area are shown on Figure 4-1. Also shown are significant land features which were obtained from a survey of the area. A total of 111 sediment cores were taken during the period from January 3 to January 14, 1983. The 111 sediment cores were divided into 329 sediment samples which were then analyzed.

4.2.1 Sampling Procedures and Techniques

The sediment sampling technique proposed for the river sediments was the standard Shelby Tube technique

often used for in-situ soil sampling. It was thought that this procedure would allow collection of an undisturbed, 36-inch sample of bottom sediments. Unfortunately, the Shelby Tube would not retain the sediments when pulled from the river bottom. A modification, described below, proved successful in all but two of the samples taken in this Task Area.

The sediment sample was extracted using a one and one half inch diameter thin-walled conduit approximately eight feet in length. This conduit was driven into the sediment by use of a post driver until the necessary amount of sediment was in place. Once in place, an air-tight plug was installed at the top to maintain suction forces which prevented the sediment from escaping from the conduit as it was removed. Removal was performed by two men with pipe wrenches steadily pulling the conduit up out of the sediment. As the conduit cleared the water surface, the bottom was quickly covered with a teflon lined rubber cap to prevent any loss of sediment.

At the time the sediment core was taken, the conduit containing the sample was marked to indicate grid location and the approximate location of the sample within the sampling tube, and excess water was decanted from the top of the sample. The conduits were kept in a sloped position to keep the sample as intact as possible prior to and during transfer to shore where processing for shipment took place. As each sample was taken, communication with the shore crew was maintained so that the elevation, grid location, sample identification number and other relevant data would be officially recorded on log sheets.

Once on shore, the sampling tubes were cut to a length approximately six inches longer than the indicated

sample length as measured by the river crew. Each conduit was then topped with approximately one inch of wax and allowed to solidify. Newspaper was packed tightly above this layer of wax, and a final, sealing layer of approximately one half inch of wax was applied to keep the sample intact. The top was then capped with three layers of duct tape to prevent damage during shipment.

Once the top was sealed, the temporary teflon lined cap was removed from the bottom. A teflon liner was inserted and covered with two stretched surgical gloves which were taped to this end to prevent loss of the sample. Three layers of duct tape were again applied to prevent damage during shipment. Each sampling tube was then cleaned with decontamination solution, wiped dry and numbered as logged in the field book in accordance with its grid location. The samples were then boxed and tagged with a chain of custody form for shipment to the laboratory for analysis.

The river crew consisted of four persons who utilized a small 12-foot aluminum boat for transport and containment of tools, conduit and other necessary items.

The shore crew generally consisted of three persons who maintained survey and field records, prepared samples and provided support to the river crew during the sampling program.

4.2.2 Consolidation of River Sediments

The sampling technique utilized in the Task VI Area apparently caused some consolidation of sediment while driving the sampling conduit. This phenomenon was initially

noted when it was found that nearly five feet of conduit had to be driven to capture a three foot sediment sample. At random, five sample locations were chosen in an attempt to correlate the sample length with the actual in-situ depth. The results of this correlation are contained in Table 4-1. There appears to be little variation with depth among these samples. Further, it appears that for all samples the first foot of sample was retrieved by one foot of conduit. After the first foot, however, the amount of sample retrieved ranged from four inches to nine inches per foot of conduit. Since the actual sampling analysis was performed based upon approximately one foot intervals and composited prior to analysis, no significant change in results should be recognized.

The depth of sampling was limited to 36 inches of sample by the contract scope. This depth was also limited by the sampling technique utilized, although it may have been possible to obtain a maximum four foot sample. This particular limitation was recognized prior to sampling. However, the findings of the sampling program may dictate more extensive sampling at greater depths. At that time alternative methods of sampling should be investigated.

4.3 Physical Findings

4.3.1 Description of Sampling Site

The shore area at the 102nd Street outfall site consists mostly of a rip-rapped slope along the southern portion of the 102nd Street Landfill. A break in the rip-rap is located at the boundary of the Hooker and Olin's portions of the landfill. A small, low lying area with an access road exists at this point (see Figure 4-1). The landfill area behind the rip-rap is fairly flat and grassed.

TABLE 4-1

SAMPLE CONSOLIDATION EFFECTS

Grid Location	Driven Length of Conduit (in)	Total Driven Length (in)	Length of Sample Obtained (in.)	Total Length Sample (in.)
I-4	12	12	12	
	12	24	6	
	12	36	7	
	12	48	8	
	12	60	9	42
I-6	12	12	12	
	12	24	6	
	12	36	6	
	12	48	5	
	12	60	7	36
I-8	12	12	12	
	12	24	6	
	12	36	5	
	12	48	4	
	12	60	6	33
I-10	12	12	12	
	12	24	6	
	12	36	5	
	12	48	6	
	12	60	7	36
I-12	12	12	12	
	12	24	7	
	12	36	4	
	12	48	4	
	12	60	6	31

The property to the east of the sampled inlet area was used extensively by the on-shore work crew to provide access to the river from Buffalo Avenue. Miscellaneous debris such as broken grinding wheels, glass and construction debris, discarded household goods, and the foundation of a razed structure were scattered through this area. Griffon Park is located at the west end of the sampling site and abuts the Hooker portion of the landfill and the Little Niagara River. This area appeared to have been filled with clay soil and developed into a City park.

4.3.2 River Characteristics

The stream bed near the area of 102nd Street outfall slopes gently from the shoreline toward the navigational channel near the center of the river. In the sampling area, the slope is approximately one percent or less. The only large changes in slope which were encountered during the sampling program were near the small boat channel at the entrance to the Little Niagara River.

The river bed at the sampling site was littered with miscellaneous debris such as logs, portions of piers, pipe, tires, flattened drums, bottles, grinding wheels, etc. The bulk of the debris was found within 125 feet of the shore. In addition, rip-rap, as well as large diameter gravel used for rip-rap bedding, was encountered near the shoreline. Deterioration of the rip-rap by the wave action of the river and recent construction of a new rip-rap face probably deposited this material.

Historically, the average water surface elevation of the upper Niagara River at Cayuga Island is approximately 562 feet USGS Datum. The fluctuations noted during the sampling period are presented in Table 4-2. These water

TABLE 4-2

NIAGARA RIVER WATER LEVEL FLUCTUATIONS

Date	Time	Elev. (ft. USGS)	24 hr. (ft.)
1/7/83	8:00 a.m.	561.7	-
	10:00 a.m.	562.5	-
	12:00 p.m.	562.8	-
	2:00 p.m.	562.7	-
	4:00 p.m.	562.6	-
1/8/83	8:00 a.m.	561.65	- 0.05
	10:00 a.m.	561.7	- 0.8
	12:00 p.m.	561.6	- 1.2
	2:00 p.m.	561.6	- 1.1
	4:00 p.m.	561.6	- 1.0
1/9/83	8:00 a.m.	561.0	- 0.65
	10:00 a.m.	561.1	- 0.60
	12:00 p.m.	561.0	- 0.60
	2:00 p.m.	561.05	- 0.55
	4:00 p.m.	561.0	- 0.60
1/10/83	8:00 a.m.	561.3	+ 0.3
	10:00 a.m.	561.5	+ 0.4
	12:00 p.m.	561.6	+ 0.6
	2:00 p.m.	561.7	+ 0.65
	4:00 p.m.	561.7	+ 0.70
1/11/83	8:00 a.m.	561.4	+ 0.1
	10:00 a.m.	562.0	+ 0.5
	12:00 p.m.	562.0	+ 0.6
	2:00 p.m.	562.1	+ 0.6
	4:00 p.m.	562.2	+ 0.5
1/12/83	8:00 a.m.	562.1	+ 0.7
	10:00 a.m.	562.1	+ 0.1
	12:00 p.m.	562.2	+ 0.2
	2:00 p.m.	562.1	0.0
	4:00 p.m.	562.0	- 0.2
1/13/83	8:00 a.m.	561.4	- 0.7
	10:00 a.m.	561.5	- 0.6
	12:00 p.m.	561.5	- 0.7
	2:00 p.m.	561.4	- 0.7
	4:00 p.m.	561.5	- 0.5
1/14/83	8:00 a.m.	561.1	- 0.3
	10:00 a.m.	561.2	- 0.3
	12:00 p.m.	561.4	- 0.1
	2:00 p.m.	561.4	0.0
	4:00 p.m.	561.3	- 0.2

levels are measured at the plant intake of the Power Authority of the State of New York which is about four miles distance downstream.

The information shown in Table 4-2 indicates fluctuations in water levels ranging from minus 1.2 feet to plus 0.7 feet during a 24-hour period. The difference between the highest and lowest water surface elevations observed during the sampling program was approximately 2.8 feet. An attempt was made to approximate the depth at each sampling location based upon this information. However, a consistent correlation between the three daily levels recorded at the 102nd outfall and the levels recorded at the power plant intake could not be developed. A deviation as large as eight inches was noted in this attempt. The deviations and fluctuations in water surface elevations are the result of both weather conditions and the withdrawal of flow for power generation by New York and Canadian power companies.

Wind markedly affects the elevation of the Niagara River. A strong wind from the southwest will result in a rise in the elevation of the river. A report on the Niagara Power Project indicates that wind and pressure patterns act on Lake Erie to tilt its surface, sometimes toward and sometimes away from its outlet at Buffalo. At times, this tilting effect results in larger Niagara River flow variations in a single day than are experienced on a monthly average basis over an entire year.

A strong southwest wind will tend to restrict flow over Niagara Falls and at the same time increase flow from Lake Erie and raise the water elevation of the Niagara River. This increase in water elevation restricts flow from the 102nd Street outfall, and causes large

fluctuations in water depths at the shoreline. As a result of these large fluctuations, erosion of the shoreline can occur.

A second cause for the large fluctuations in water elevation is withdrawal of flows by the power companies. The Power Authority of the State of New York and Ontario Hydro are allowed to withdraw all flows in excess of 100,000 cfs during the day and 50,000 cfs at night during the tourist season. During the non-tourist season all flows in excess of 50,000 can be withdrawn. Thus, in the summer the two power companies must allow 100,000 cfs to flow over the falls during the day and 50,000 cfs at night. The 50,000 cfs increase in flow withdrawal allowed at night lowers the Niagara River elevation approximately one to two feet at Cayuga Island.

The fluctuations observed during the sampling program were probably the result of weather changes since the power companies are normally maintaining their constant flow requirements at this time of year.

The Corps of Engineers has recorded flood elevations near the 102nd Street outfall and near Cayuga Island since the early 1940's. These elevations are presented in Table 4-3. As shown the 100-year flood elevation is 568.9 and the 10-year elevation is 568.0.

The underlying currents in the sampling area were noted by physical observance only. Several times during sampling, sediment transport was noted as east to west toward the mouth of the Little Niagara River by scuffing the bottom sediments. It did not appear that any sediment

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TABLE 4-3

FLOOD ELEVATIONS
NIAGARA RIVER

	Frequency or Date	Water Surface Elevation
102nd Street Outfall		
	100 year	568.9
	50 year	568.7
	10 year	568.0
Cayuga Island		
	March 1955	568.3
	December 1972	568.05
	March 1975	568.1

was moving into the main channel area until the observer was beyond the sampling grid. These observations could only be made on relatively calm days, therefore limiting any sound conclusions as to what might occur during high flow or high runoff conditions.

4.3.3 Description of Pertinent Downstream Areas

The areas immediately downstream of the 102nd Street outfall serve multiple uses. These include public docks, private marinas, power plant intakes and water supply intakes for the City of Niagara Falls Water Treatment Plant. Of these facilities, the most important impacts from any remedial actions would be on the Niagara Falls water supply intake located approximately 14,000 feet downstream from the 102nd Street outfall sewer.

5.0 ANALYTICAL METHODS

The next aspect of the site investigation for the Love Canal involved the generation of chemical analysis data on samples collected from the site. These data were used to establish the presence or absence of contaminants. Further, where contamination was indicated, the data were essential to establish the type and magnitude of that contamination. The use of the analytical data was for the determination of contaminant migration pathways, development and evaluation of alternatives to deal with that presence and migration, and ultimately to recommend remedial action alternatives to minimize impacts from that contamination.

The challenge to the analytical laboratory was manifold: to keep the time required to analyze a large number of samples to a minimum; to design a program to minimize the total number of samples; to design an analytical program which would maximize information output on all samples while limiting detailed quantitative analyses to only those samples indicating a need for such work; and finally, to execute that analytical program for maximum benefit-to-cost ratio and maximum quality.

The analytical scheme which evolved to address these challenges was a two-phase program executed in a sequential manner. The first phase required the "screening" of a representative and therefore large population of samples from the five specific task areas under study. The objective of the screening analysis phase was to expeditiously, and inexpensively feed back preliminary analytical data to the engineer. These data were used as a decision-making tool to select only those samples with a likelihood of producing significant positive results after undergoing more costly, detailed quantitative analysis.

The second phase of the analytical effort was the detailed qualitative and quantitative analysis of selected samples for targeted and nontargeted contaminants. The analytical effort of this phase was comprised of three parts: qualitative and quantitative analysis of organic compounds; quantitative analysis for 2,3,7,8-TCDD (Dioxin); and quantitative analysis for inorganics (toxic elemental metals).

5.1 Contaminant Screening Analysis by GC/MS

The screening of all samples from the Love Canal site was necessary to determine the location and magnitude of contaminated areas for more detailed study. Given the history of materials disposed at the site, the screen had to be capable of detecting a wide variety of different chemicals at widely varying concentrations. The screening approach implemented was a solvent extraction of the sample followed by direct injection of the extract for GC/MS (gas chromatography/mass spectrometry) analysis. While other screening techniques were available, they were not as informative as the extraction -- GC/MS analysis method ultimately used.

The specific methodology involved the extraction of both liquid and solid (sludge, soil, sediments) matrices with the solvent hexadecane using mechanical agitation. After extraction, the solvent portion was separated from the sample and internal standards were added to the extract. These standards served two purposes: as retention time markers to classify contaminants as volatile or semi-volatile components, and as a benchmark from which estimated concentrations of contaminants could be established.

After sample preparation, the hexadecane extract was directly injected into the GC/MS instrument. The controlling

GC/MS software examined the number, location (with respect to retention time), and magnitude of contaminants present in each sample screened.

The data output from the contaminant screening analysis was formatted in such a way as to allow the rapid and justifiable selection of a subset of samples to be subjected to full and detailed quantitative analysis. The tabular output indicated the sample identification, number of volatile and/or semi-volatile contaminants detected above a threshold value and the concentration range of each of those contaminants. A reconstructed ion chromatogram was also presented for each sample.

5.2 Organic and Inorganic Analyses

5.2.1 Introduction

After completion of the contaminant screening phase of the project, specific samples from the total population were selected to undergo detailed and extensive chemical analysis. This section discusses two components of that work: quantitative and qualitative GC/MS analysis for both target and nontarget organic compounds and instrumental analysis of ICAP (inductively coupled argon plasma) for toxic elemental metals.

5.2.2 GC/MS Analysis of Organics

5.2.2.1 Conceptual Approach

The analysis for organic constituents required that specific target compounds be quantitated against authentic calibration standards. Additionally, a

qualitative and semi-quantitative analysis was carried out for any other nontarget compounds present in the sample above a threshold level. The target compounds were those 113 organics commonly referred to as the "Priority Polluants" (40 CFR 136, Appendix I). These compounds were quantitatively analyzed as two classes of compounds: volatiles and semivolatiles.

The nontarget compounds were any other organic constituents present in the sample which were not a member of the set of 113 compounds. These compounds were qualitatively identified by comparison of the mass spectrum of the unknown with a computer library of over 30,000 spectra of organic chemicals. Additionally, an estimated concentration of each of these nontarget compounds was computed.

5.2.2.2 Analytical Method

Each sample subjected to quantitative analysis underwent two separate preparatory and instrumental techniques: one for volatiles, and one for semivolatile compounds. The volatile sample preparation differed depending on whether the sample was a liquid or solid matrix. For liquid samples, preparation was minimal and simply involved aliquoting a portion of the original sample into a sparging vessel attached to the GC/MS. Appropriate surrogates and internal standards were added to each sample to monitor sparging efficiency and allow accurate quantitation respectively. After sparging the sample, the sparged constituents were trapped within the instrument and subsequently desorbed into the GC section of the GC/MS. Constituents were consequently

chromatographed and then introduced into the mass spectrometer for generation of the mass spectral data. After data acquisition, the mass spectra of the components in the sample were compared to spectra of authentic calibration standards of the priority polluants. Spectral and retention time matches of a sample component with a calibration standard resulted in the subsequent identification of that component as a priority pollutant. If such a match occurred, that component was then quantitated using the method of internal standard calculation.

Sample preparation for solids required a significantly different technique due to the special challenges presented with solid matrices. Solids, by defintion, are not as homogeneous as liquids. Consequently, special efforts must be employed to obtain as representative a solid sample as possible for volatile analysis. The approach utilized by the laboratory was two-fold. First, the "as-received" solid sample was mechanically composited to present as uniform a sample as possible to the second stage of preparation. That stage consisted of an extraction of the volatile constituents from the solid using tetraglyme (tetraethylene glycol dimethyl ether). The solid/liquid extraction was carried out by either vortexing or sonification of the mix. As with liquid volatiles, surrogate standards were added prior to the extraction. An aliquot of the tetraglyme extract was added, along with internal standards, to 5 milliliters of water in a sparging vessel attached to the GC/MS.

The instrumental analysis for volatiles in solids proceeded as previously described for volatiles in liquids. Both utilized a 1 percent SP1000 on 6/80 mesh carbopack gas chromatographic column.

Any constituents present in the sample which were not identified as a volatile priority pollutant underwent a mass spectral library search to attempt to identify that unknown constituent. The library search was carried out if the peak of interest had a peak height to of 25 percent or greater of the height of the nearest internal standard (this criterion was established to prevent searching peaks which were components of the natural "noise" level of the sample). If the match of the unknown peak mass spectrum to the spectrum of the compound in the spectral library were of high enough quality, an estimated concentration of the tentatively identified peak was computed by comparison of the peak height of the nearest internal standard (of known concentration) to the peak height of the identified compound.

The second subset of the 113 priority pollutant compounds prepared and analyzed were the semi-volatiles. The subset is comprised of 82 compounds with different chemical characteristics which required that two separate extractions be undertaken to provide the most reliable data. For liquid samples, a liquid/liquid extraction was performed using methylene chloride as the extraction solvent. The extraction was carried out in a separatory funnel. The extraction process on any sample resulted in the generation of two final extracts. The preparation involved adding one liter of original sample to a two liter

separatory funnel. The pH was first adjusted to 11 or greater using sodium hydroxide. Surrogate standards and methylene chloride were then added after which the extraction of base/neutral/pesticide compounds was undertaken. This extract was set aside while the pH was again adjusted to 2 or less with sulfuric acid. Again, methylene chloride was added and the second extraction for acid extractable compounds was undertaken.

After the acid and base/neutral pesticide extracts were obtained, the extracts were independently concentrated in constant temperature water baths in a Kuderna-Danish apparatus with an evaporative flask and concentrator tube attached. The extracts were concentrated to a final volume of 1 ml. After concentration, internal standards were added to both concentrates prior to analysis.

After sample preparation was concluded, both concentrates underwent quantitative analysis by GC/MS for the target priority pollutant compounds. Further, the qualitative and semi-quantitative analyses for nontarget compounds were accomplished by GC/MS in conjunction with the quantitative analysis. Unlike the sample introduction technique used for volatile compounds, the semi-volatile compounds were introduced to the GC/MS by directly injecting 1 micro-liter of the concentrate into the gas chromatograph section of the GC/MS. A separate injection was performed for the acid fraction and the base/neutral/ pesticide fraction on different instruments tuned and calibrated for the compounds of interest in each

fraction. The qualitative, quantitative and semi-quantitative instrumental analysis proceeded in the same fashion as described for the volatile instrumental analysis.

5.2.2.3 Data Output

The data output from the GC/MS organics analysis was compiled into a summary data report for ease and speed of reference. Each data report included a laboratory chronicle providing the history of events which the sample underwent. For the quantitative analysis, a compound list displayed each of the 113 target compounds. For each compound, the detection limit achieved on that sample was displayed. If the compound was detected at or above the detection limit, the actual quantitated value was given along with the scan number for that compound peak on the reconstructed ion chromatogram.

For the library search output, the name of the tentatively identified compound was provided if the quality (purity) of the spectrum match was above 800 (out of a possible maximum value of 1,000). The computed estimated concentration and scan number for that peak was given. The organic fraction which contained the nontargeted peak was also indicated. Summary results are presented in Appendix A.

5.2.3 Analysis of Inorganics

5.2.3.1 Conceptual Approach

The inductively coupled argon plasma (ICAP) instrument was utilized for the analysis of elemental

metals except for mercury. Mercury analysis was conducted by an automated cold vapor technique. The elements of interest were the 13 priority pollutant toxic metals. With the large numbers of samples involved, high anticipated concentrations, and varying matrices, the ICAP technique represented both the most cost and time-effective approach to the project. Mercury, having special physio-chemical characteristics was best addressed with the cold vapor technique.

5.2.3.2 Analytical Method

The sample preparation for both liquid and solid matrices is similar. A measured volume or mass of sample was placed into appropriate glass-ware. The aliquot was subjected to a solution of nitric acid which initiates the digestion of the metals present in the sample. The digestion solution was then taken to near dryness and the cycle was repeated until the digestion process was completed. The final digestion solution was then diluted with pure water and subsequently filtered to remove solids. The filtrate was then taken to final volume with pure water. The prepared sample was now ready for instrumental analysis.

The instrumental analysis was carried out using a sequential multi-element ICAP. The procedure involved producing an aerosol of the digestion solution. This aerosol is then introduced into the argon plasma torch which produces characteristic atomic-line emission spectra if elements are present.

When produced, the spectra are dispersed and wavelengths and intensities are compared to the wavelength and intensity of authentic calibration standards. Through this comparison, the presence and concentration of elements was established.

5.2.3.3 Data Output

The data output for the elemental metals analysis was straightforward. A compound list of the 13 elements of interest was prepared for each sample. The concentration of each element detected at or above the detection limit was provided. The detection limit for each element was also displayed. Summary results are presented in Appendix A.

5.2.4 2,3,7,8-TCDD (Dioxin) Analysis

5.2.4.1 Conceptual Approach

The analytical approach to the analysis for 2,3,7,8-TCDD went through several stages of evolution before the final methodology was selected and executed. Originally, a qualitative analysis by GC/MS was to be performed. The analysis was to be run on a split from the base/neutral/pesticide concentrate with 1,2,3,4-TCDD being added to the sample prior to extraction. The split extract was to be cleaned up to eliminate potential intereferences, then, the concentrate would be analyzed for GC/MS in the selected ion monitoring (SIM) mode to search specifically for ions of 2,3,7,8-TCDD. The 1,2,3,4 isomer was to be used as a retention time marker and surrogate for the 2,3,7,8 isomer. This technique was to simply detect the presence or absence of the 2,3,7,8

isomer. If detected, that sample would then undergo a re-extraction specific to the TCDD compound and then be subjected to quantitative GC/MS analysis.

The quantitative GC/MS technique was to be performed by application of EPA Method 613, adapated to accommodate solid matrices. The use of Cl isotopically labeled 2,3,7,8-TCDD was envisioned for the internal standard while 1,2,3,4-TCDD was to be added as a surrogate standard.

During the project time frame, Region VII, USEPA was developing methods specific to the analysis of TCDD in conjunction with studies they were undertaking at Times Beach, Missouri. The methods developed were then provided to laboratories qualified by and under contract to the EPA. One such protocol was published in February 1983 and colloquially came to be called the "February Protocol."

In the ensuing period, it was agreed that all samples which displayed positive contaminant screening reuslts and were then relegated to full quantitation would also undergo full quantitation for TCDD. No screening for the presence of TCDD would be performed -- all would be quantitated.

When the final decision was received to proceed with the quantitative analysis of TCDD, a new protocol has been published called the "May Protocol." As it was desired to use the most recent EPA dioxin protocol for the Love Canal study, the May protocol was specified. Unfortunately, the May protocol has not been in the hands of the EPA contract laboratories

long enough to confirm that all details of the methodology were effective and appropriate. As experience was gained, it was determined that the GC column specified in the May protocol (an SP2340) was not adequate for the analysis. A dioxin workshop sponsored by EPA in mid-July 1983 supported this conclusion.

Because of this fact, the Love Canal samples were analyzed using the DB-5 column specified in the February protocol but employing sample preparation, cleanup, and analytical procedures specified in the May protocol.

5.2.4.2 Analytical Method

The method employed utilizes high resolution gas chromatography/low resolution mass spectrometry in the SIM mode. As most samples were solid matrices, the following discussion relates to that matrix. Differences appropriate for water matrices will be highlighted.

All samples were spiked with isotopically labeled 2,3,7,8-TCDD. The $^{37}Cl_4$ isotope was used as a surrogate standard while $^{13}C_{12}$ isotope was used as the internal standard. After spiking, anhydrous sodium sulfate was mixed with the sample prior to adding a mixture of methanol and hexane. The sample was then extracted using the jar technique with a platform mechanical shaker. After extraction, a phase separation was undertaken for solid samples to obtain the final extract. This extract was then

concentrated prior to application of any cleanup procedures or instrumental analysis.

The method provided for the application of four concentrate cleanup procedures in the event of analytical interferences, difficulty with concentration, difficulty in achieving desired detection limits, or coloration, viscosity or cloudiness of the concentrate. The specific options included acid and base washes, and column chromatography using silica gel, activated alumina, or activated carbon. The actual instrumental analysis was executed by injecting 1 to 3 ul of concentrate into the GC/MS. The SIM mode was used to search for specific ions of both isotopically labelled isomers of 2,3,7,8-TCDD and native 2,3,7,8-TCDD. If the proper ions were observed in the proper ratio, the presence of native 2,3,7,8 was confirmed. Once confirmed, quantitation was based on the response of native TCDD relative to the isotopically labeled TCDD internal standard. Method performance is assessed by monitoring the isotopically labeled surrogate standard results.

5.2.4.3 Data Output

The data output for the TCDD analysis is straightforward. The compound was listed along with the detection limit achieved on each sample. If detected above that limit, the concentration quantitated was given. Each sample output also displays the level of recovery of the surrogate standard. The summary reports for Dioxin are shown in the supporting documents. All dioxin hits, however, are shown on the hot spot maps of Section 6.

5.4 Summary of Quality Assurance and Quality Control Programs

5.4.1 Intent and Purpose of QA and QC Programs

Mead CompuChem, the analytical subcontractor, has an established Quality Assurance Program which covers all projects. The objective of the QA program is to provide the desired level of data quality for the customer. This is accomplished by specifying criteria for methods and performance on samples received, and by providing appropriate standards for referencing results against absolute values. Project-specific quality control programs are designed to determine that the criteria established for specific methods and sample types are met. These include control limits for blanks, spikes, duplicates, and surrogate recoveries, as well as criteria for review of data prior to release to customers. As part of the criteria, corrective actions are required if data exceed control limits.

5.4.2 QA Programs in Effect for this Study

For this study, standards were prepared at the Research Triangle Park, North Carolina (RTP) location, tested, and shipped weekly to the Cary, Illinois facility for organics analysis. Metals standards were prepared and tested for use in the RTP lab. Standard Operating Procedures were written and analysts were trained in their use prior to sample receipt. Methods used were evaluated for their applicability to the matrices in the study, using approved analytical techniques referenced above in Sections 5.2 and 5.3. Acceptance criteria for the quality control samples associated with the study were established and applied.

5.4.2.1 QC Program for Screening Analysis

For the organic screening analyses, blanks, spikes and duplicates were prepared and analyzed. This procedure is qualitative and semi-quantitative; it is intended to determine whether certain classes of organic compounds are present, and the approximate numbers and concentration levels of these classes. Then a decision could be made to whether or not to analyze them for particular compounds. For these analyses, blanks were run with each set of samples prepared to verify there was no laboratory contamination during preparation. Spiked and duplicate samples were prepared and analyzed at the rate of 5 percent each, to verify that consistent and accurate results were produced by the methods applied. The spike mixtures consisted of several levels of organic volatile and semi-volatile compounds added to samples.

5.4.2.2 QC Programs for Organic Priority Pollutant Analyses

For analysis of volatile and semi-volatile organic compounds using EPA-approved methods, the quality control program specified 5 percent of samples prepared in duplicate, 5 percent spiked, and a blank prepared each time samples were extracted. Calibration multipoint standards were analyzed prior to initiating work, and at least one standard per 8-hour shift was run on each instrument used during the study. Each instrument met a tuning calibration specification each 8-hour shift. The spike compound recoveries and duplicate precision were monitored for each fraction. Surrogate compounds in 100 percent

of all sample fractions were spiked prior to preparation for analysis; surrogate recoveries were evaluated to monitor the extraction efficiencies of these and similar classes of compounds from the samples. Recoveries could be effected by sample matrix type, or other extraction conditions. Those fractions with recoveries or precision outside control limits were examined for such effects and possible repeat analysis to confirm the causes of such recoveries or precision.

5.4.2.3 QC Programs for Inorganic Priority Pollutants Analyses

Inorganic samples were prepared as described in the above-referenced methods. Blanks were prepared with each batch of samples. Spikes were prepared at the rate of 5 percent. Standards were analyzed (at least 3 levels) before and after each set of samples to establish a calibration curve. Known values of reference standards (EPA or NBS) were compared to those obtained and prepared by CompuChem to document accuracy.

5.4.2.4 QC Programs for TCDD (Dioxin) Analyses

Dioxin samples were analyzed using the most recent EPA methodologies. Standards were obtained from and/or referenced against EPA solutions, whose levels had been established from interlaboratory studies. Blanks were prepared with each set of samples. Spikes and duplicates were prepared at the rate of 5 percent each. Each instrument was required to be calibrated each 8-hour shift, following initial

6.0 CONTAMINATION ASSESSMENT

The contamination assessment is a crucial element of the investigation since it provides the basis for selection of remedial action. Priority areas have been mapped based on the results of the contamination assessment. A "hot spot" map identifying dioxin contamination has also been prepared.

The contamination assessment provides an approach whereby a large number of samples containing a range of compounds at varying concentrations and with differing toxicities and persistence characteristics can be numerically evaluated. The results of these evaluations are considered in light of the potential for human exposure on a site-specific basis and other contaminant-related considerations to arrive at an estimate of the relative contamination at one sample site compared to another.

6.1 Objective

The objective of the contamination assessment is to serve as a decision-making tool for the selection of remedial action alternatives. The intent is to rank or prioritize areas so that appropriate remedial action can be recommended and not to make an absolute determination of the risk to human health. The utility of the approach is as a method for organizing the large amount of analytical information, as an aid in interpreting the significance of the analytical results and as a basis for evaluating remedial action alternatives.

6.2 Discussion of Approach

6.2.1 Overall Concept

The contamination assessment examines, for each sample site, the following factors:

- o Contaminants detected
- o Concentrations of individual contaminants
- o Toxicity of individual contaminants, represented primarily by drinking water standards or water quality criteria for the protection of human health
- o Persistence of individual contaminants, as indicated by physical/chemical/biological properties
- o Factors affecting potential exposure pathways

The two conceptual components of the contamination assessment are a toxicity assessment and an exposure assessment. Toxicity is the ability of a chemical to affect living orgamisms adversely and, as such, is an intrinsic property of a contaminant. Exposure (the actual contact with a chemical) is affected by properties of the contaminant(s) in question (nonsite-specific factors) which determine persistence and mobility and by site-specific factors (noncontaminant-specific) which determine potential pathways of exposure. Intrinsic properties of the contaminant(s) which determine toxicity, and persistence have been expressed in a quantitative manner in a "matrix" (Table 6-1). Input to the matrix consists, for each sample, of the contaminants identified and their concentrations. The calculations in the matrix are completed (to account for toxicity and persistence) resulting in a "score" for the sample. The "scores" are then indicated on the intermediate "work maps." The expo-

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TABLE 6-1 SAMPLE MATRIX

LOVE CANAL CONTAMINATION ASSESSMENT
FOR HYPOTHETICAL SAMPLE SITE

CONTAMINANT	CONCENTRATION ug/KG or ug/L	CRITERION ug/L	PERSISTENCE SCORE	PRODUCT = conc./crit. x pers.
CARCINOGENS				
A.BHC isomers				
alpha-BHC	1000	.092	11	119565
beta-BHC	1000	.163	11	67485
delta-BHC	1000	.147	11	81633
gamma-BHC	1000	.186	12	59140
		A.Subtotal		327822
B.PAH				
phenanthrene	1000	.028	9	321429
anthracene	1000	.028	9	321429
pyrene	1000	.028	11	392857
chrysene	1000	.028	12	428571
benzo(a)anthracene	1000	.028	12	428571
		B.Subtotal		1892857
C.Monocyclic aromatics				
benzene	100	6.6	6	909
hexachlorobenzene	1000	.0072	12	1666667
2,4,6-trichlorphenol	1000	12	9	750
		C.Subtotal		1668326
D.Halogenated aliphatics				
1,2-dichloroethane	100	9.4	6	638
1,1,1-trichloroethane	1000	2	7	3500
1,1,2,2-tetrachloroethane	100	1.7	9	5294
trichloroethylene	1000	27	7	259
tetrachloroethylene		8	7	875
carbon tetraclhloride	1	4	7	1750
chloroform	100	1.9	7	3684
bromoform	100	1.9	8	4211
trichlorofluoromethane	100	1.9	7	3684
methylene chloride	100	1.9	6	3158
hexachlorobutadiene	100	4.5	9	2000
		D.Subtotal		29054
E.Miscellaneous				
1,2-diphenylhydrazine	1000	.422	10	23697
bis(2-chloroethyl)ether	1000	.3	8	26667
		E.Subtotal		23697
CARCINOGEN SCORE: (Sum A-E Subtotals)				3941756

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TABLE 6-1 (Cont'd) SAMPLE MATRIX

LOVE CANAL CONTAMINATION ASSESSMENT
FOR HYPOTHETICAL SAMPLE SITE

CONTAMINANT	CONCENTRATION ug/KG or ug/L	CRITERION ug/L	PERSISTENCE SCORE	PRODUCT = conc./crit. x pers.
NON-CARCINOGENS				
F.PAH				
naphthalene	1000	1000	8	8
fluoranthene	1000	42	12	286
		F.Subtotal		294
G.Metals				
arsenic	1000	50	12	240
chromium	1000	50	14	280
cadmium	1000	10	15	1500
antimony	1000	146	13	89
mercury	100	.146	11	75342
lead	10	50	12	240
nickel	1000	13	12	896
thallium	1000	13	15	1154
copper	1000	1000	14	14
zinc	1000	5000	15	3
		G.Subtotal		79758
H.Monocyclic aromatics				
chlorobenzene	1000	480	7	15
1,4-dichlorobenzene	1000	400	9	23
1,2-dichlorbenzene	1000	400	9	23
1,3-dichlorbenzene	1000	400	9	23
1,2,4-trichlorobenzene	1000	100	10	100
1,2,3-trichlorobenzene	1000	100	10	100
1,2,3,4-tetrachlorobenzene	1000	38	10	263
1,2,4,5-tetrachlorobenzene	1000	38	10	263
pentachlorobenzene	1000	74	11	149
ethylbenzene	1000	1400	6	4
toluene	1000	1350	6	4
phenol	1000	3500	7	2
2,4-dichlorophenol	1000	3090	8	3
pentachlorophenol	1000	1010	13	13
p-chloro-m-cresol	1000	1010	9	9
		H.Subtotal		992
I.Phthalates				
dimethyl phthalate	1000	313000	10	0
diethyl phthalate	1000	350000	11	0
dibutyl phthalate	1000	34000	13	0
bis-2-ethylhexylphthalate	1000	15000	13	1
butylbenzyl phthalate	1000	15000	12	1
di-n-octyl phthalate	1000	15000	14	1
		I.Subtotal		3
J.Miscellaneous				
2-chloronaphthalene	1000	15	10	667
		J.Subtotal		667
NON-CARCINOGEN SCORE: (Sum F-J Subtotals)				81714
TOTAL SCORE (carcinogen + non-carcinogen)				4023470

sure pathway factors and a discussion of other considerations related to specific contaminants are integrated with the maps to identify the relative hazard at each site (or groups of sites). The final output is a task area contamination assessment map which reflects the integration of exposure pathway factors, sample scores and other contaminant-related considerations. Additionally, a "hot spot" map is created by plotting concentration data for dioxin, a contaminant of special concern. In conjunction, the contamination assessment map and the "hot spot" map serve as the basis for determining levels of remedial action. Figure 6-1 depicts the overall approach of the contamination assessment.

6.2.2 The Matrix

A matrix has been developed to organize and interpret the extensive amount of analytical data. It is used to evaluate contaminant concentrations in terms of toxicity and persistence in order to provide an overall numerical value for each sampling site. An example of the matrix is attached as Table 6-1. The individual components of the matrix, as indicated by the column headings in Table 6-1, are explained below.

6.2.2.1 Contaminants

The left hand column is the list of "CONTAMINANTS." Under the column heading, the word "CARCINOGENS" appears. On the second page of the table is the heading "NONCARCINOGENS." Contaminants are classified into either category based upon their classification in the EPA's 1980 Water Quality Criteria (discussed further in 6.2.2.3); these classifications were reviewed by consultants from the Department of

OVERVIEW OF CONTAMINATION ASSESSMENT METHODOLGY

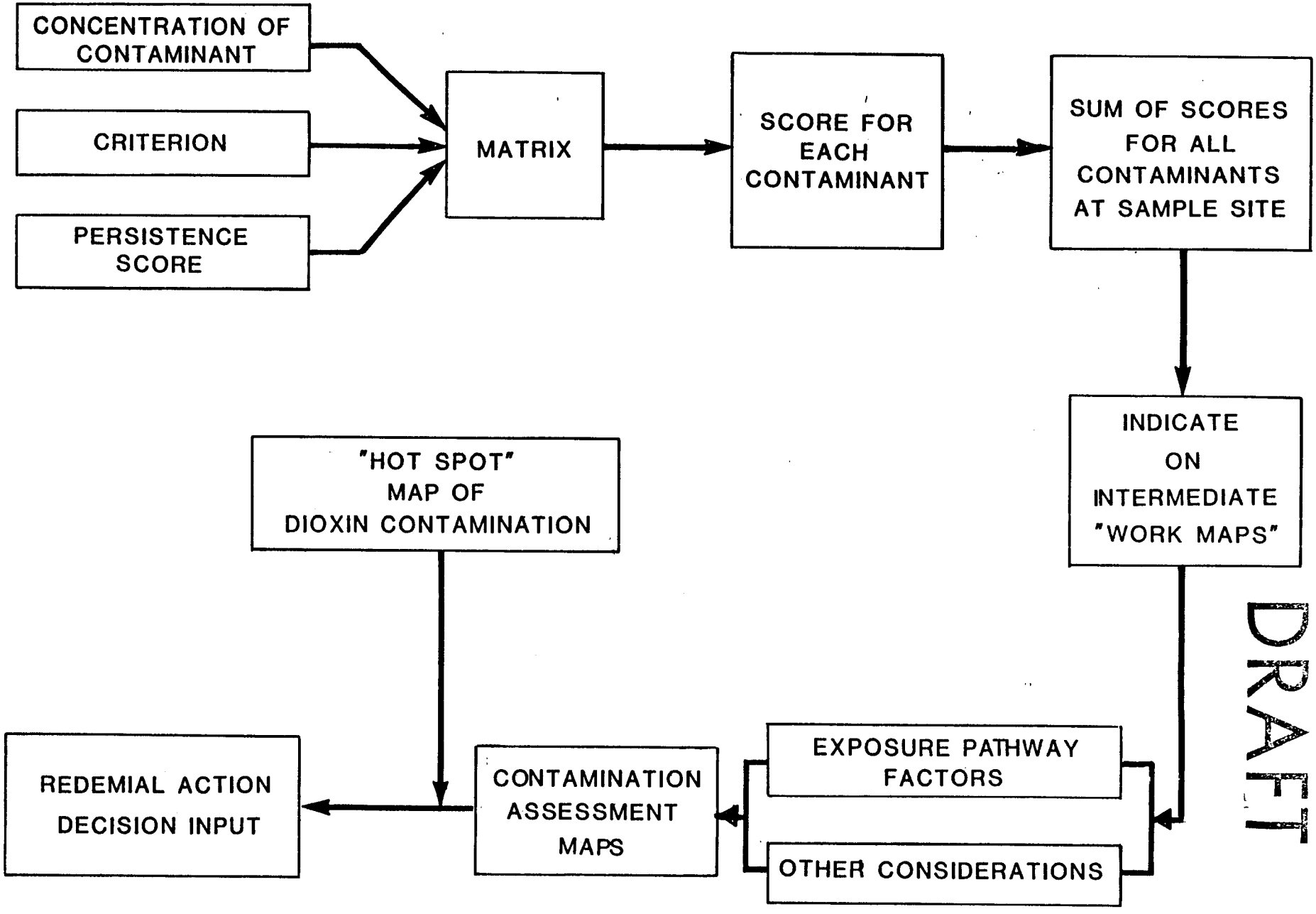

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FIGURE 6-1

Environmental Medicine at the Mt. Sinai Medical Center. Scores are computed separately for the carcinogens and the non-carcinogens since the Water Quality Criteria are derived differently for these two types of contaminants.

Within each group (carcinogens and non-carcinogens), related contaminants are placed in groups designated by alphabetic letters, such as "A. BHC isomers," "B. PAH (Polynuclear Aromatic Hydrocarbons)," etc. The matrix contains the names of all the contaminants detected in the samples taken in the five task areas. Only those compounds which were identified to a confidence level of 80 percent or greater were included in the matrix. Compounds which were identified by a "library search" but for which the confidence level was less than 80 percent were not included, since contaminant identification was less certain and the concentrations measured were only estimates.

The resultant carcinogen and non-carcinogen scores are added to yield a total score for the sample. Because the criteria values for the carcinogens are lower than for the non-carcinogens, the carcinogen score invariably dominates the total score. The purpose of grouping related contaminants within the two larger categories and calculating subtotals is to provide a clear picture of which contaminants are contributing most to the total score.

6.2.2.2 Concentration

The concentration data, in ug/kg (ppb) or ug/L (ppb), is entered into the matrix. On the example attached, all concentrations have been arbitrarily set at 1000 for illustrative purposes.

6.2.2.3 Criterion

The third column heading, "CRITERION," refers, in most cases, to the available water quality criterion for each contaminant. Units are ug/L (ppb). For organic contaminants, these values were taken from:

USEPA
Water Quality Criteria Documents:
Availability. Federal Register,
Vol. 45, No. 231, Nov. 28, 1980

This publication refers to criteria developed for 64 toxic pollutants or pollutant categories pursuant to Section 304(a)(1) of the Clean Water Act. A separate document exists for each pollutant (or pollutant category) describing recommended maximum permissible pollutant concentrations consistent with the protection of aquatic organisms and human health. These criteria are not rules and have no regulatory impact.

The values entered in the "CRITERION" column are taken directly from the EPA publication. "Criteria for suspect or proven carcinogens are presented as concentrations in water associated with a range of incremental cancer risks to man...(since) there is no scientific basis for estimating "safe" levels for

carcinogens." "Criteria for non-carcinogens represent levels at which exposure to a single chemical is not anticipated to produce adverse effects in man" (USEPA Water Quality Criteria Documents, November 28, 1980).

The inclusion of the criterion value serves two purposes. First, it takes into consideration the relative toxicity of the various contaminants; the criteria values were derived based upon the best toxicity information available at the time. Second, dividing the concentration data by the criteria values serves to "normalize" the concentrations, insuring that the significance of a highly toxic contaminant does not get obscured by virtue of a detected low concentration, or, conversely, the significance of a minimally toxic contaminant does not get over-emphasized by virtue of a detected high concentration. The EPA's Water Quality Criteria were chosen to "normalize" the concentration data for the following reasons:

- They are fairly recent (1980).
- They are most applicable to exposure via water, as opposed to Threshold Limit Values for occupational exposure via inhalation.
- They are most comprehensive in that criteria exist for a majority of the contaminants detected. SNARLs (Suggested No Adverse Response Level) or ADIs (Acceptable Daily Intakes) exist for a much more limited list of substances, and it was necessary to have consistency in the normalization procedure.

For most of the inorganics (heavy metals) EPA Interim Primary Drinking Water Standards exist. These are generally identical to the EPA Water Quality Criteria.

However, where these values differed, the drinking water standards, which are enforceable regulations, were selected. Drinking water standards were not available for antimony, nickel or thallium; water quality criteria were used for these contaminants.

It is acknowledged that the criteria used in the matrix are for water and not sediment; however, there are no recognized criteria or guidelines for contaminants in sediment.

As stated, the EPA has expressed the criteria for carcinogens as concentrations associated with an increase in cancer risk of 10^{-7}, 10^{-6} or 10^{-5}, meaning one additional cancer in a population of ten million, one million and 100,000, respectively. The value entered in the matrix for each contaminant is the criterion corresponding to an incremental cancer risk of 10^{-5}. This was arbitrarily chosen, and could just as well have been the criterion for a 10^{-6} or 10^{-7} increase in risk, since the objective is to compare the contaminants relative to one another. This is not an attempt to establish a level of acceptable risk, which is a matter of policy.

The human health criteria for non-carcinogens are presented as concentrations not expected to

cause adverse effects in man. Derivation of both no-effect (non-carcinogen) and specified risk (carcinogen) concentrations are based upon extrapolation from animal toxicity or human epidemiology studies; details of the methods used to derive the criteria are given in "Guidelines and Methodology Used in the Preparation of Health Effect Assessment Chapters of the Consent Decree Water Criteria Documents, Appendix C, Federal Register, Vol. 45, No. 231, Friday, November 1980, pp. 79347-79357.

For each contaminant (carcinogen or non-carcinogen), the EPA has expressed the criterion for the protection of human health in two ways: 1) based upon ingestion of contaminated water and aquatic organisms, and 2) based upon consumption of aquatic organisms only. The former value was selected.

There were no EPA Water Quality Criteria for the following compounds:

- naphthalene
- acenaphthene
- p-chloro-m-cresol
- butylbenzyl phthalate
- di-n-octyl phthalate
- 2-chloronaphthalene

The procedures used to determine appropriate criteria for these compounds are discussed in the Supporting Documents. These derived criteria values were reviewed by consultants from the Department of Environmental Medicine at Mt. Sinai Medical Center. The Mt. Sinai team also recommended the use of more

rigorous criteria than the EPA's Water Quality Criteria for two compounds, as discussed in Supporting Documents.

6.2.2.4 Persistence Score

The next column heading, "PERSISTENCE SCORE," referes to the persistence score calculated for each contaminant. This score represents the relative environmental persistence of each contaminant based upon its partitioning between air and water (expressed as Henry's Law Constant), partitioning between water and sediment/soil (expressed as the log of the octanol: water partition coefficient) and biodegradability.

Each contaminant is rated for each of these three factors and the ratings are summed. The lowest possible score (least persistent contaminant) is a 3, while the highest possible score (most persistent contaminant) is a 15.

Various literature sources were searched for information on the Henry's Law Constant, octanol:water partition coefficient and biodegradability of each contaminant. These values were calculated and/or recorded for each contaminant, and rated as detailed below.

- Volatility was expressed in terms of H, the Henry's Law Constant, where

$$H = \frac{\text{Partial Pressure in atmosphere, Pa}}{\text{water solubility, gm}^{-3}\text{/molecular weight}}$$

The values were rated as follows, with a 1 representing the most volatile (least persistent) contaminant:

Value of H	Rating
>1000	1
100-999	2
10-99	3
1-9	4
<1	5

- A high octanol:water partition coefficient indicates a high tendency to adsorb onto sediments (particularly sediments high in organic content) and a high tendency to bioaccumulate. The most common expression of this value is as a logarithm, log Kow. The values were rated as follows, with a 1 representing the least tendency to adsorb onto sediment (least persistent):

Value of log Kow	Rating
>6	6
5-5.99	5
4-4.99	4
3-3.99	3
2-2.99	2
<2	1

- Biodegradability scores are based primarily upon scores given in "Methodology for Rating the Hazard Potential for Waste Disposal Sites," JRB Associates, which appears in the "National Oil and Hazardous Substances Contingency Plan," USEPA, 1982. Information from other sources (Callahan, et al., 1979, Water Related Environmental Fate of 129 Priority Pollutants, and Geating, 1981, Literature Study of the Biodegradability of Chemicals in Water) was also used. The ratings are on a scale of 1 to 4, as follows:

	Rating
Highly resistant to biodegradation	4
Resistant, but biodegradation is known or believed to occur in some cases	3
Amenable to biodegradation	2
Readily biodegradable	1

The ratings in each of the three categories are added together to yield the persistence score. Persistence scores are presented in Table 6-2.

6.2.2.5 Subtotals and Totals

As indicated on the sample matrix, subtotals are calculated for the individual contaminant groups. The subtotals for the carcinogen groups are added, yielding the CARCINOGEN SCORE. The same procedure is applied to the non-carcinogens, yielding a NON-CARCINOGEN SCORE. These two scores are added, yielding the TOTAL SCORE.

6.2.2.6 Matrix Output

The calculated TOTAL SCORES are represented visually on intermediate "work maps" to provide a pictorial indication of the matrix results. In the next step, the potential pathways for contaminant exposure are examined and other considerations related to various contaminants in the study area are discussed.

TABLE 6-2

CALCULATION OF PERSISTENCE SCORES

Contaminant	H	H Rating	Log Kow	Log Kow Rating	Biodegradability Rating	Sum of Ratings
Alpha-BHC	0.595	5	3.81	3	3	11
Beta-BHC	0.016	5	3.80	3	3	11
Delta-BHC	0.031	5	4.14	4	3	12
Gamma-BHC	0.05	5	3.72	3	3	11
phenanthrene	12.52	3	4.46	4	2	9
anthracene	63.5	3	4.45	4	2	9
pyrene	0.13	5	4.92	4	2	11
chrysene	est. 0.015	5	5.61	5	2	12
benzo(a)anthracene	0.011	5	5.61	5	2	12
benzene	555.2	2	2.13	2	2	6
hexachlorobenzene	172.3	2	6.18	6	4	12
2,4,6-trichlorophenol	32.9	3	3.38	3	3	9
1,2-dichloroethane	92.6	3	1.48	1	2	6
1,1,1-trichloroethane	3557	1	2.17	2	4	7
1,1,2,2-tetrachloroethane	38.6	3	2.56	2	4	9
trichloroethylene	922	2	2.29	2	3	7
tetrachloroethylene	2063	1	2.88	2	4	7
carbon tetrachloride	2351	1	2.64	2	4	7
bromoform	use 106	est. 2	2.30	2	est. 4	8
chloroform	343	2	1.97	1	4	7
trichlorofluoromethane	11114	1	2.53	2	4	7
hexachlorobutadiene	1044	1	3.74	3	4	8
methylene chloride	323	2	1.25	1	3	6
1,2-diphenylhydrazine	"low"	est. 4	3.03	3	est. 3	10
bis(2-chloroethyl) ether	1.34	4	1.58	1	3	8
naphthalene	24.41	3	3.31	3	2	8
fluoranthene	1.03	4	5.33	5	3	12
arsenic	can be impt. in reducing envir.	4	4.35 calc	4	4	12
chromium	not impt.	5	5.23	5	4	14
cadmium	not impt.	5	6.68	6	4	15
lead	vol. poss. in	4	4.17	4	4	12
nickel	not impt.	5	3.93	3	4	12
thallium	not impt.	5	6.50	6	4	15
copper	not impt.	5	5.93	5	4	14
antimony	vol. poss.	4	5.71	5	4	13
mercury	1155	1	6.36	6	4	11
zinc	not imp.	5	6.03	6	4	15
chlorobenzene	398	2	2.84	2	3	7
1,4-dichlorobenzene	276	2	3.38	3	4	9
1,2-dichlorobenzene	197	2	3.38	3	4	9

TABLE 6-2 (Cont'd)

CALCULATION OF PERSISTENCE SCORES

Contaminant	H	H Rating	Log Kow	Log Kow Rating	Biodegradability Rating	Sum of Ratings
1,3-dichlorobenzene	267	2	3.38	3	4	9
1,2,4-trichlorobenzene	144	2	4.18	4	4	10
1,2,3-trichlorobenzene	approx. 144	est. 2	est. 4.18	est. 4	4	10
1,2,3,4-tetrachlorobenzene	approx. 567	est. 2	est. 4.93	est. 4	est. 4	10
1,2,4,5-tetrachlorobenzene	567	2	4.93	4	est. 4	10
pentachlorobenzene	no data	est. 2	5.63	est. 5	est. 4	11
ethylbenzene	652	2	3.15	2	2	6
toluene	601	2	2.49	2	2	6
phenol	0.132	5	1.46	1	1	7
2,4-dichlorophenol	0.58	5	2.75	2	3	13
pentachlorophenol	0.026	5	5.01	5	3	13
p-chloro-m-cresol	low	est. 5	2.95	2	2	9
dimethyl phthalate		est. 5	2.12	2	3	10
diethyl phthalate		est. 5	3.22	3	3	11
dibutyl phthalate		est. 5	5.2	5	3	13
bis (2-ethyhexyl) phthalate	0.026	5	5.3	5	3	13
butyl benzyl phthalate	0.108	5	4.8	4	3	12
di-n-octyl phthalate		est. 5		est. 6	3	14
2-chloronaphthalene	54.7	3	4.01	4	3	10
bis (2-chloroethyl) ether	1.34	4	1.58	1	3	8

6.2.3 Exposure Pathways

This subsection describes potential pathways for human exposure to contaminants originating from the Love Canal area and identifies which of these potential pathways appear to be active based on the sampling results. An active pathway indicates that Love Canal-related contaminants are presently found there and that the transport of these contaminants through this medium appears to occur. In terms of the potential for actual human exposure to contamination via the active pathways, this discussion considers the theoretical worst-case potential only, assuming no remedial action is taken.

In Task Area VI, the Niagara River in the vicinity of the 102nd Street storm sewer outfall is a potential pathway for human exposure to Love Canal contaminants. The Niagara River flows east to west and is south of Love Canal and several other chemical waste landfills which border the river. The river is a source of water supply for the City of Niagara Falls, with intakes located approximately 2.5 and 3.5 miles downstream from the study area. The closer intake, located in the direct flow line of the river, is currently the only intake in use.

The sampling results indicate that the sediments in the Niagara River at and around the 102nd Street outfall contain Love Canal-related contaminants, and therefore, the river is an active pathway for contaminant transport and potential human exposure. The extent to which contaminants are transported out of the outfall area in surface water sediments is dependent upon wind patterns and flow conditions. Southwest winds tend to influence flows and move sediments landward into the cove east of the outfall,

while during periods of easterly winds, sediment moves outward toward the main part of the river. The potential for dispersion of the more highly contaminated sediments near the outfall sewer to downstream areas is judged to be reasonably high. In the past, wave action has damaged the heavy rip-rap placed along the shoreline, and, even on calm days, sediments disturbed by the sampling crews at work during this study were observed to move toward the Little Niagara River. Sampling indicated that contaminated sediments occur in the cove area as well as at and riverward of, the outfall itself. Limited recreational use may occur in the area, and human exposure could potentially result from direct or indirect skin contact with contaminants or from the inhalation of volatile compounds. Few volatile compounds were detected, although one such compound (methylene chloride) was found in a large number of samples. Another possibility for exposure is from the accidental ingestion of contaminants in water. This exposure pathway is less likely than the pathways mentioned previously because of the preferential partitioning of the majority of contaminants detected into sediment versus water, the distance to the water supply intake, and the fact that the water is treated prior to consumption.

6.2.4 Other Considerations

Three groups of contaminants, the phthalate esters, methylene chloride, and the inorganics, were found throughout in the Task VI Study Area. Phthalate esters and inorganics were also found in samples from outside of the influence of Love Canal (the "upstream" samples on Black and Bergholtz Creeks, taken in conjunction with Task III investigations). In some samples, the only compounds

detected were inorganics and phthalate esters or inorganics and methylene chloride. It was not felt that, in the absence of other organic contaminants which are more likely to be of Love Canal origin, and considering the potential exposure pathways, such samples would necessitate remedial action. An explanation of the rationale for this decision follows.

6.2.4.1 Phthalate Esters

Four compounds belonging to a class of chemicals known as phthalate esters or phthalic acid esters were detected in the samples taken in the Task VI Study Area. These include dibutyl phthalate, butyl benzyl phthalate, bis(2-ethylhexyl) phthalate, and di-n-octyl phthalate. One of these compounds, bis(2-ethylhexyl) phthalate was detected fairly frequently throughout the study area, but never in concentrations exceeding the criteria value used in the matrix. This compound was also found in the "upstream" samples taken in Black Creek and Bergholtz Creek at concentrations similar to those found in sampling areas potentially influenced by Love Canal.

It is not surprising that phthalate esters were found throughout the sampling area. They are recognized to be ubiquitious in the environment. They are used as plasticizers in building and construction, home furnishings, clothing, cars, food wrappings and medical supplies, and as nonplasticizers in pesticides, cosmetics, fragrances and oils. Phthalate ester residues in foods such as margarine, cheese and milk may, in fact, reach 50 ppm (EPA Ambient Water Quality Criteria for Phthalate Esters, 1980).

Phthalate esters have also been detected in soil, water, and air and in fish flesh and animal and human tissue. They have been detected in varied matrices and in areas remote from industrial sites, including the Sargasso Sea (EPA, 1980 Ambient Water Quality Criteria for Phthalate Esters).

Several factors contributed to a decision that the presence of phthalate esters at a sampling location did not in and of itself warrant remedial action. These factors are:

- Presence of phthalate esters in upstream sediment samples in Black and Bergholtz Creeks at concentrations similar to those found in sampling areas potentially influenced by Love Canal.

- Ubiquitous occurrence of phthalate esters in the environment in general.

- Phthalate esters were detected in only eight of the 155 liquid samples analyzed in the investigation of the other task areas. Therefore, the potential exposure route via ingestion of contaminated water, which would be of most concern, does not appear likely.

- Phthalate esters are believed to be capable of absorption through the skin, which is a potential route of exposure for the sediment. However, phthalate esters are considered to be of a low order of toxicity (EPA Ambient Water Quality Criteria for Phthalate Esters, 1980).

6.2.4.2 Methylene Chloride

Methylene chloride (also known as dichloromethane) is a common industrial solvent found in pesticides, metal cleaners, paints and paint or varnish removers. It is used in aerosols and in plastics processing and it is also widely used in laboratory analyses. It is not considered to be among the chemicals characterized as Love Canal-related (EPA Monitoring Report, 1982).

Methylene chloride was found fairly consistently throughout Task Area VI, and at moderately high concentratons (in general, 1 to 9 ppm). These concentrations in sediment are unexpected; given the physical/chemical properties of methylene chloride, persistence in sediment should be low. The possibility of laboratory contamination can neither be confirmed nor ruled out.

The criterion used in the matrix for methylene chloride is based upon a criterion of carcinogenic risk for the entire class of halomethanes, which is derived from the evidence of carcinogenicity for chloroform. The carcinogenic potential of methylene chloride itself is under investigation. The EPA water quality criterion for methylene chloride based on noncarcinogenic risks is 12.4 mg/l; hence, the criterion of 1.9 ug/l used in the matrix is very conservative. In addition, since methylene chloride was not found in any of the 155 liquid samples analyzed in the investigations of the other task areas, even where it did occur in the sediment, it

appears that the potential exposure route via ingestion of contaminated water, which would be of most concern, is of little likelihood. It was concluded that the presence of methylene chloride at a sampling location did not, in and of itself, warrant remedial action.

6.2.4.3 Inorganics (Heavy Metals)

Inorganics were found in the majority of the samples throughout the Task VI Study Area. Concentrations of inorganics detected in study area sediment samples are comparable, to a large degree, with levels found in samples collected "upstream" on the Black and Bergholtz Creeks and with levels found in sediments in "control" areas during the EPA Monitoring Study (EPA, 1982).

Several factors contributed to a decision that the presence of inorganic constituents at a sampling location did not in and of itself warrant remedial action. These factors were:

- Presence of inorganics in upstream sediment samples in Black and Bergholtz Creeks at concentrations similar to those found in sampling areas potentially influenced by Love Canal.

- Ubiquitous and natural occurrence of heavy metals in the environment in general.

- Heavy metals were detected in only one of the eight liquid samples from the investiga-

tions of the various task areas for which inorganics analyses were performed. Therefore, the potential exposure route via ingestion of contaminated water, which would be of most concern, does not appear to be very likely.

- Heavy metals, in the forms in which they are likely to occur in the sediments, do not present a significant concern via the most likely exposure routes for sediment (direct or indirect skin contact).

6.2.5 Contamination Assessment Map

The product of the contamination assessment is a contamination assessment map for the Task VI Study Area, as shown in Figure 6-2. This map depicts areas of relative low, medium and high priority. These rankings were determined by evaluating the matrix results, the work maps, the potential exposure pathways and other considerations. The lows, mediums and highs are relative rankings and are used to identify areas where some form of remedial action should be considered.

The low, medium and high rankings are defined as follows:

- Low: Low matrix score, indicating inorganic compounds occurring at or near "upstream" concentrations; organic compounds, if any, not specifically Love Canal-related; and/or existing contaminants appear to have minimum potential for human exposure.

- o Medium: Intermediate matrix score, indicating a limited number of Love Canal-related compounds occurring at low to moderate concentrations; and/or existing contaminants appear to have moderate potential for human exposure.

- o High: High matrix score, indicating several or numerous Love Canal-related compounds occurring at significant concentrations; and/or existing contaminants appear to have a high potential for human exposure.

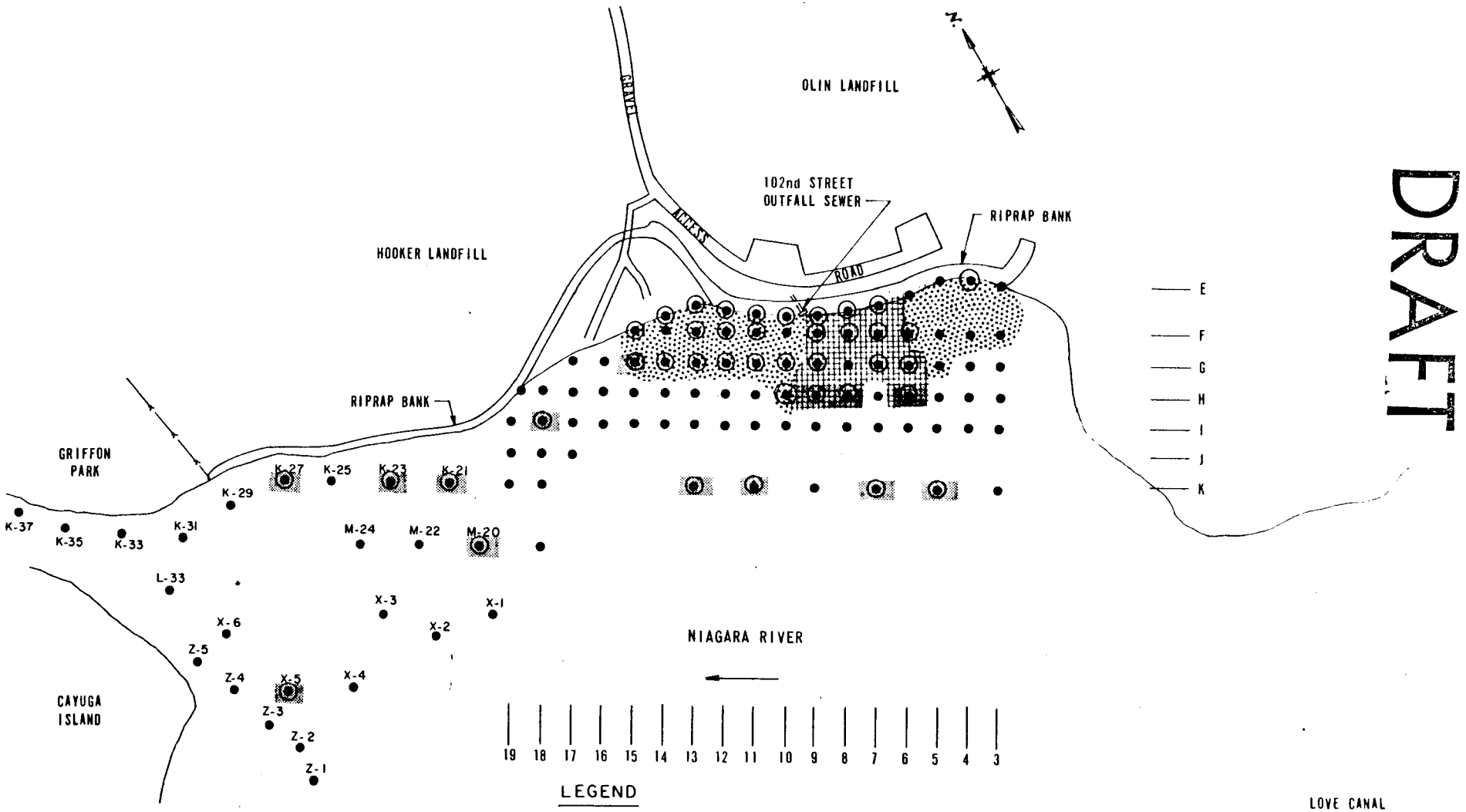
6.2.6 Hot Spot Map

A separate "hot spot" map has been prepared for a dioxin, a contaminant of particular concern. The map (Figure 6-3) identifies the sampling locations where this compound was found and the concentrations detected. The "hot spot" map has been used in conjunction with the contamination assessment map in determining appropriate remedial measures for the task area.

6.3 Discussion of Results

In Task Area VI, Love Canal-related contaminants (including BHC isomers and chlorinated benzenes) were found in a moderate number of sediment samples. Contaminants were detected in all three levels of sediment sampled. There was a general trend of more contamination in the upper layer than in the bottom two layers but no definitive pattern was evident. The intermediate task area map indicated that samples taken in the proximity of the 102nd Street outfall had the highest scores, with samples taken further from shore exhibiting decreasing scores. The sample sites given high scores in the matrix were

FIGURE 6-2



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LEGEND

CONTAMINATION ASSESSMENT
PRIORITY LEVELS

HIGH
MEDIUM
LOW
NO SHADE: NO CONTAMINANTS DETECTED
⊙ QUANTITATED SAMPLE

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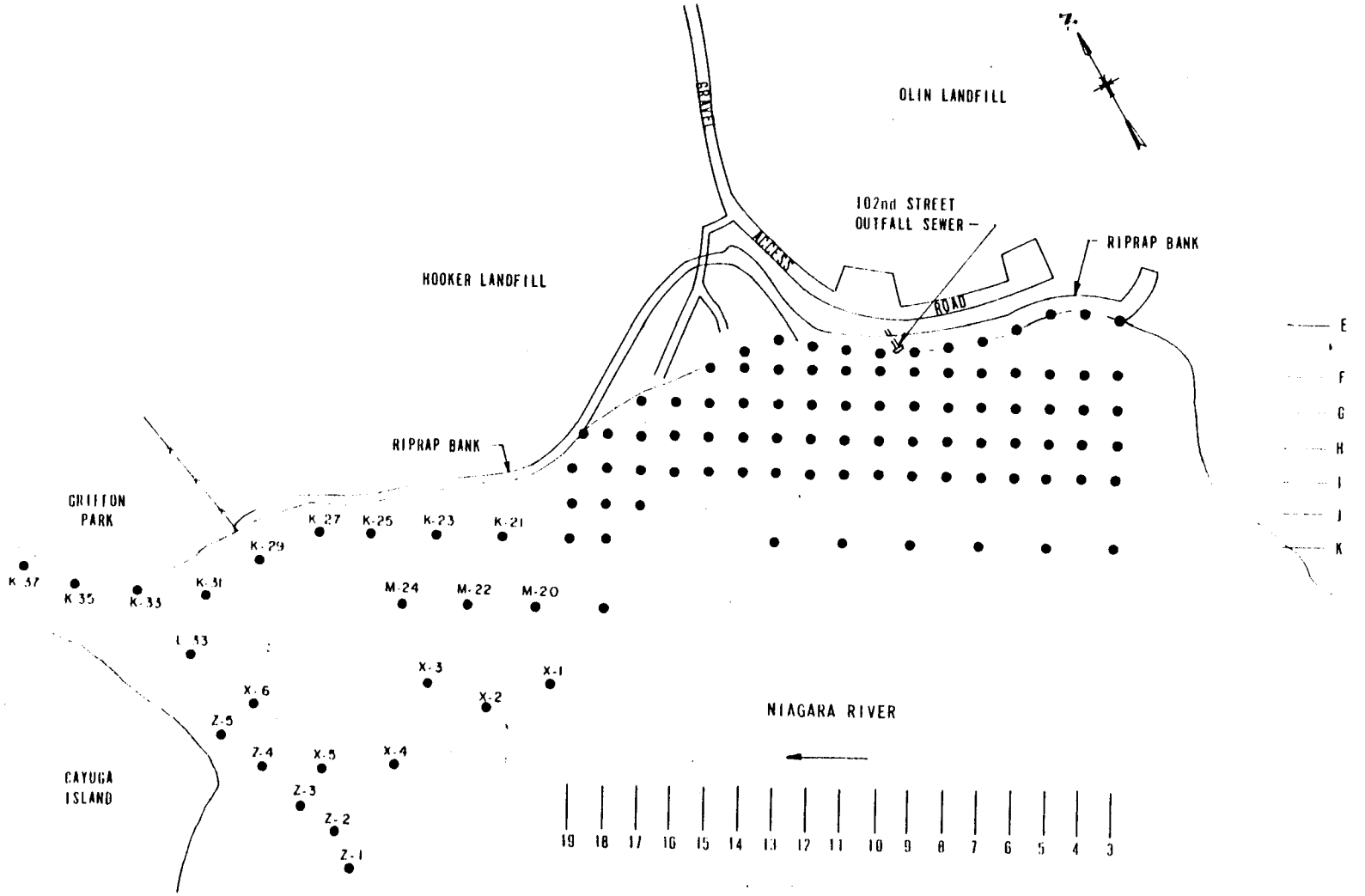
102nd STREET OUTFALL
TASK VI

CONTAMINATION ASSESSMENT MAP

FIGURE 6-3



DIOXIN HOT SPOTS

LOCATION	CONCENTRATION (ppb)
F-8	3.3

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102nd STREET OUTFALL
TASK VI

characterized, in general, by both a relatively large number of contaminants and relatively high concentrations of these contaminants.

The potential pathways for human exposure have been discussed in Section 6.2.3. The potential for exposure to contaminated sediment decreases somewhat with increasing distance from shore. The sample sites close to shore have higher exposure potential and higher scores and are thus assigned high contamination assessment priority levels.

All samples which passed the screening analysis are indicated on the contamination assessment map and designated as high, medium or low. Samples that did not pass or exceed the qualitative screen are assumed not be contaminated. The shaded area representing the high priority level encompasses all samples designated as "high," although not all individual samples within the area were designated as high (some were "low"). Similarly, the area on the map representing the medium priority level includes all samples designated as "medium," although samples of "low" priority and "no contaminants detected" are included. The pattern of distribution of highs, mediums and lows was somewhat inconsistent; consequently, lines were drawn using the most conservative approach. In addition, the designation of a sample site as high, medium or low was based upon the highest score given to any of the three sediment layers (A, B, or C), which was the most conservative approach.

Contamination was not found at most sample sites outside the medium priority area. There are a few spots where some contamination was detected. With the exception of samples K-6A and K-21A, the contaminants found were not Love Canal-related, i.e., the contaminants detected were inorganics,

phthalate esters and methylene chloride. These sites were given low scores in the matrix. At sites K-6A and K-21A, moderately low levels of Love Canal-related contaminants (BHC isomers, 1,2,4-trichlorobenzene) occurred. However, these isolated occurrences probably do not contribute significantly to the overall contaminant load. Additionally, these sites are not in close proximity to the shore where the exposure potential would be greater. Thus, they were assigned low priority ratings.

The "hot spot" map for 2,3,7,8-TCDD indicates that dioxin was found at one sample site, adjacent to the outfall. This area has already been determined to be a high priority area.

7.0 REMEDIAL ALTERNATIVES

7.1 General

A "remedial action zone" map has been prepared on the basis of the contamination assessment. This "action zone" is on Figure 7-1 and encompasses the areas with high and medium contamination assessment priority levels.

Alternatives considered for alleviating the problems associated with contaminated sediments in the remedial action zone include the following:

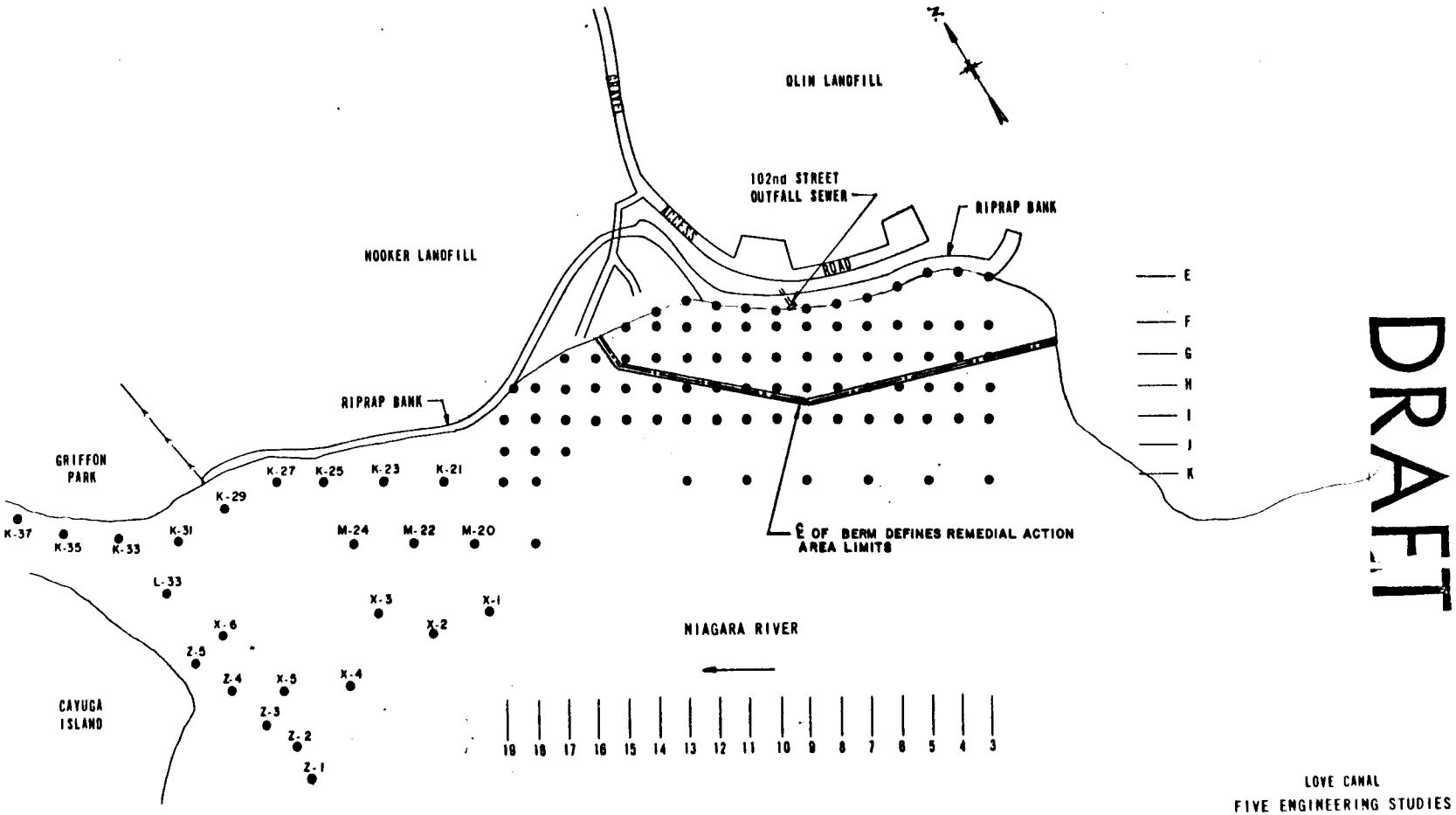
- No action
- Temporary in-situ stabilization followed by removal and disposal or long-term stabilization
- Long-term in-situ stabilization
- Immediate removal and disposal

In developing the list of alternatives, consideration has been given to the fact that the sediment deposits are located adjacent to the Olin and Hooker landfills, and that the 102nd Street storm sewer may still be contributing contamination to the river. Each of the alternatives is described below. An evaluation of the various possible courses of action and their associated costs is presented in Section 8.

7.2 No Action

The no action alternative refers to leaving the contaminated sediments identified in the Task VI Study Area in place and not performing any remedial measures to stabilize or

FIGURE 7-1



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102nd STREET OUTFALL
TASK VI

REMEDIAL ACTION ZONE

remove them. However, because very little is known about the stability of the sediment deposits, a monitoring program would be required to determine the rate of transport of contaminated sediments to downstream areas. The monitoring program would include the periodic collection and analysis of both sediment and water samples from the Task VI Study Area and from the Little Niagara River near the eastern end of Cayuga Island, particularly during periods of high flow. The monitoring program would be designed to keep track of the contaminated sediment, but would also be useful in determining the success of any remedial actions taken at the Hooker and Olin landfills in the future.

A major disadvantage of this alternative is that a flood could occur and transport all or a portion of the contaminated sediments downstream and distribute the sediments over a larger area. Should this occur, the possibility of stabilizing the sediments or removing them from the river might be lost forever.

In addition, the intake for the City of Niagara Falls Water Treatment Plant is located 14,000 feet downstream from the Task VI Study Area. Contaminated material could be transported downstream and cause adverse impacts at this plant.

Further, the channel of the Little Niagara River is dredged periodically for maintenance. If the contaminated material within the Task VI Study Area is washed into this channel in significant concentrations, maintenance dredging of the Little Niagara River Channel could prove more expensive than any remedial actions to stabilize or remove the sediments at this time.

7.3 Temporary In-Situ Stabilization

Temporary in-situ stabilization has been listed as a possible alternative because of the uncertainties associated with the ultimate fate of the Hooker and Olin landfills along the river bank. Two temporary methods of reducing the potential for dispersion are covering the deposits with filter fabric and stone fill, or constructing a berm or wall around the contaminated area.

Either method of temporary stabilization would substantially reduce the potential for erosion of contaminated sediments while agreements are reached regarding the remedial actions to be taken at the Olin and Hooker landfills. After remedial action has been completed at the landfills, the sediment could be excavated and disposed or stabilized in place. It should be noted, however, that neither method will prevent contaminant losses to the water column, their potential volatilization or their migration downward through the sediment deposits.

7.3.1 Temporary Stabilization with Filter Fabric and Stone Fill

Under this method of stabilization, filter fabric would be placed on the river bottom and covered with a layer of stone approximately 18-inches in depth to hold the fabric in place and stabilize the sediments during high flow periods. The filter fabric would prevent mixing or migration of the fine materials through to the surface of the stone and substantially reduce the potential for erosion and transport of the sediments to downstream areas.

Approximately 9,000 square yards of filter fabric and 4,500 cubic yards of stone fill would be required to cover the action area shown on Figure 7-1.

7.3.2 Temporary Stabilization by Construction of a Berm or Wall

An earth berm approximately 900 feet long with rip-rap on the face exposed to the river currents or a steel sheet pile wall could be constructed around the contaminated sediments to form a protected backwater which would reduce the potential for erosion of the sediments during high flow periods. A weir, approximately 20 feet in length, would be constructed in the berm or wall to permit surface runoff from the shore and flow from the 102nd Street outfall sewer to reach the river without causing an excessive differential in water depths between the impounded area and the river.

If an earth berm were constructed, tongue and groove timber sheeting would be driven through the fill to a depth approximately 10 feet below the existing river bottom to reduce the potential for migration of contaminants under the berm. If only a sheet pile wall were constructed, interlocking steel sheet piling would be driven to a depth of 16 feet below the river bed and stiffened along its upper edge to resist ice and other pressures due to river currents. The top of the sheet pile wall or earth berm would be constructed at elevation 568.0, which is the 10-year flood elevation.

7.4 Long-Term In-Situ Stabilization

The stabilization of the bed and banks of a river for time periods measuring from 50 to 100 years should be feasible.

A number of methods of long-term stabilization are discussed below. Only one, burial of the sediments in place, is considered to be practical for the Task VI Study Area.

7.4.1 In-place Solidification or Destruction

A method for turning contaminated sediments into a concrete-like material has been developed in Japan. However, its long-term stability has not been proven, and the necessity of mixing the gelling agent with the sediments generally requires that the contaminated area be enclosed to prevent downstream losses. Over time, the solidified material will deteriorate and be subject to erosion. Should it then be decided to remove the material to an on-shore disposal site, difficulties might be encountered in breaking up the remaining solid mass for removal.

In place biological and/or chemical destruction of contaminants has been tested in laboratories for certain compounds such as PCB's. No known tests have shown, however, that these methods are suitable for the compounds found in the sediments near the 102nd Street outfall. The number of compounds identified in the sediments makes it very unlikely that these techniques would be practical. Therefore, in-place solidification is not recommended for the Task VI Study Area.

7.4.2 Burial-in-Place

Should the current litigation relative to the Hooker and Olin landfills result in a program for in-situ containment of the landfill material, then the contaminated sediments could be permanently stabilized in place. A temporary earth berm could be constructed while awaiting the outcome of the litigation. If in-place containment

is required for the landfill, then the area between the berm and the current shoreline could be backfilled with clean fill, capped with clay or a synthetic membrane, top soiled and seeded. The 102nd Street storm sewer would be extended through the filled area to the river, and a new shore line established beyond the limits of contaminated sediments.

The new shoreline would be protected by rip-rap, designed to withstand the 100 year flood, and a clay slurry wall or other cut off wall would be constructed near the river's edge to prevent horizontal migration of contaminants out of the area.

The slurry wall constructed along three sides of the sediment deposits would be tied into whatever containment facilities are constructed along the existing shoreline at the face of the landfills. An impermeable cap would be placed above the fill material and tied into the slurry wall. The cap would substantially reduce or eliminate volatilization as well as any migration of contaminants out of the area horizontally through the soils. However, no soil borings have been taken in the river to determine whether sufficient clay or impermeable bedrock lies beneath the sediments to prevent the downward migration of contaminants into the ground water. A soil boring program would be required to define subsurface conditions prior to design of the slurry wall.

7.5 Removal and Disposal

The removal and disposal of contaminated sediments could be accomplished immediately or following temporary stabilization measures, when any remedial measures taken at the Olin and Hooker landfills are completed. A variety of methods for removing the sediments have been considered and include:

- o Mechanical excavation utilizing shore-based equipment
- o Mechanical excavation utilizing a combination of shore-based and barge-based equipment
- o Clamshell dredging
- o Hydraulic dredging

Regardless of the method used, the sediment would be excavated to a depth of at least four feet below the existing river bed. Based upon a four-foot depth of excavation throughout the area shown on Figure 7-1, approximately 11,000 cubic yards of sediment would be removed. Additional sediment samples are required, however, to determine the maximum depth of penetration of contaminants before excavation begins.

Excavation at the toe of the rip-rapped slope along the Olin landfill will undermine the stone. One method to prevent this would be to drive sheeting along the edge of the rip-rap, backfill the excavated area for a short distance from shore and withdraw the sheeting. A more practical approach, however, would be to remove some of the rip-rap and replace it to the depth of the excavation.

Sites considered for the disposal of excavated materials include the adjacent landfills as well as nearby DEC approved and permitted land burial facilities. The Hooker and Olin landfills have been included among the potential sites under the assumption that some agreement might be reached whereby the river sediments would be removed and disposed concurrently with remedial actions at one or both landfills. Whether the use of these sites is, in fact, practical or feasible will depend upon the results of the litigation presently underway.

7.5.1 Land-based Mechanical Excavation

The excavation of contaminated sediments near the shoreline could be readily accomplished through the use of clamshells, draglines or backhoes. The maximum digging reach of a clamshell is approximately 80 feet, a dragline 68 feet and a backhoe 30 feet. Contaminated sediments in the Task VI Study Area extend for approximately 150 feet off shore in the widest area, and although the water depth at low flow is generally less than two feet, the sediments will not support the weight of heavy equipment. Therefore, a gravel haul road would have to be constructed in the river along the base of the existing rip-rapped slope, and berms or mud mats would be required to reach the sediments furthest from shore. The gravel fill would be removed during the excavation process and would have to be disposed with the sediments. The use of a clamshell with the longest reach available would reduce the need for extensive berms.

In order to trap floating solids and turbidity caused by excavation and prevent the loss of contaminated sediments downstream, silt curtains, temporary sheet pile walls or a combination thereof would be necessary. If the sediment deposits have previously been enclosed by an earth berm or sheet pile wall as described under temporary in-situ stabilization alternatives, no additional measures would be required.

The sediment deposits to be removed are generally too fine to drain freely during the excavation process and will require some dewatering prior to disposal. To accomplish this, a lined basin containing perforated pipe drains installed in a layer of granular material above the liner could be constructed on the Olin or Hooker

landfills. Alternatively, the wet sediments could be hauled in watertight trucks and dewatered in a filter press at a DEC approved and permitted land burial facility.

If a dewatering basin were constructed near the excavation site, the wet material would be hauled to the basin in watertight trucks. The water collected by the underdrains would be pumped through a carbon filter for treatment and returned to the river. After dewatering, the sediments would be reloaded into trucks for hauling to a disposal site unless arrangements could be made for direct burial as part of the remedial actions taken at the Hooker and/or Olin landfills.

7.5.2 Mechanical Excavation Using Shore-Based and Barge-Mounted Equipment

As has been noted above, the excavation of contaminated sediments more than about 80 feet from shore using land-based equipment would require the construction of gravel berms on which the equipment would be placed. Because of the high cost associated with the ultimate disposal of the gravel fill, particularly in a DEC approved and permitted land burial facility, the use of a clamshell mounted on a barge has been considered.

Under this alternative, a gravel berm access road would be constructed in the river along the toe of the rip-rapped slope at the Olin landfill. Contaminated materials within reach of this access road would be excavated using a clamshell and loaded into trucks. Rather than construct a berm to reach the sediments further from shore, however, the clamshell would then be mounted on a barge which would be floated or dragged along a line parallel to the access road from 70 to 75

feet off shore. This clamshell could excavate the sediments as far as 150 feet off shore and place the material into trucks on the access road. While the production rate would be quite low due to the necessity of swinging the clamshell boom through 180 degrees of arc for each bucketful, all of the contaminated sediments within the area could be removed without disposing additional materials used for berm construction.

7.5.3 Clamshell Dredging

A clamshell dredge operates in the same manner as a shore-based clamshell, except that the boom is generally much shorter and the excavated materials are placed in a scow and floated to shore. The scow is then unloaded using a shore-based clamshell or other excavating equipment.

If a small clamshell dredge were utilized, it would not be necessary to construct an access road or fill at the base of the rip-rapped slope and would eliminate the need to dispose of fill material required for these roads. However, a number of other difficulties arise through this method of excavation:

- Additional equipment is needed on shore to unload dredge spoils;
- Additional rehandling of contaminated sediments is required to unload scows;
- Without the access road, it will be more difficult to restore the rip-rapped slope along the face of the Olin landfill.

- o If a berm is constructed for temporary stabilization, the advantage of using a barge mounted clamshell is eliminated.

Considering the difficulties associated with use of a barge-mounted clamshell, this method is not recommended for the removal of contaminated sediments from the Task VI Study Area.

7.5.4 Hydraulic Dredging

Hydraulic dredges use water as a transport medium to convey dredge material. The material to be excavated is mixed with water and pumped as a slurry directly to a disposal area. At the disposal area, the sediments settle and overflows are treated before being returned to the river.

There are several types of hydraulic dredges available in the United States including, among others, the cutterhead, plain suction, and dustpan dredges.

The cutterhead dredge excavates material by a rotating cutter at the end of a suction pipe. The cutter suspends the material into a slurry which is then pumped through a pipeline and discharged to the disposal area. By varying the rate of swing and the cutter rotation speed, the material loss at the cutter can be controlled to some extent.

A variation of the standard cutterhead dredge is a Mud Cat Dredge which uses horizontal auger cutters and has a mud shield which surrounds the cutter assembly and aids in reducing turbidity generation.

The plain suction and dustpan dredges use water jets to first loosen material. As a result, suspension of material can develop. Inasmuch as the material to be removed from the Task VI Study Area is composed of mucky, fine-grained contaminated sediments, plain suction and dustpan these types of dredges are not recommended.

Either a Mud Cat dredge or a small, (8 inch or 10 inch diameter suction) cutterhead dredge would be suitable for hydraulic dredging of the sediments in the Task VI area, but production rates will be hampered by trees, logs and other debris in the area. Dredges of this size are generally capable of pumping a slurry for a maximum distance of 1,500 feet, depending upon the difference in elevation between the dredge and the discharge point. Therefore, hydraulic dredging should only be considered in conjunction with a plan to incorporate the dredge spoils in either the Hooker or Olin landfills. A lined cell equipped with perforated pipe drains would be constructed on one of the landfills to dewater the material and allow placement of a cover over the material.

The handling of dredge return water would require the construction of a treatment facility at or near the disposal site. In order to keep the sediments in suspension in the dredge piping, flow velocities of from 16 to 18 feet per second must be maintained. Assuming a 6 inch diameter discharge line and a slurry consisting of 15 percent solids approximately 1,300 gallons per minute of return water would require treatment when the dredge is operating. Alternatively, storage facilities would be provided to hold some of the water pumped during one shift for treatment over a 24 hour period. No studies have been made of the type or degree of return water treatment required for this project. Reports on pilot

plant work for similar, fine-grained and silty sediments indicate that at a minimum, chemical flocculation and clarification would be needed. If granular activated carbon filtration is required to remove organic contaminants from the return water, sand filtration may also be needed prior to carbon filtration to avoid plugging the carbon filters.

One advantage of hydraulic dredging is that it does not produce as much turbidity in the stream as do clamshell dredging and other mechanical excavation methods. If immediate removal of the sediments is determined necessary, the use of an hydraulic dredge would reduce or even eliminate the need for silt curtains and other devices to prevent the loss of material downstream. However, the costs for a dredge spoil settling and containment cell plus a dredge return water treatment plant will significantly outweigh the cost savings associated with the silt curtains. Furthermore, because small hydraulic dredges are unable to pump dredge slurry long distances unless an agreement could be reached whereby the dredge spoils would be disposed in the adjacent landfills, this method of removing sediments will not be practical. Considering the high costs associated with treatment of return water flows and the uncertainty with respect to the availability of using the 102nd Street Landfill for disposal, this method is not recommended for the Task VI Study Area.

8.0 EVALUATION OF ALTERNATIVES

8.1 Summary of Alternatives

The basic alternatives described in Section 7 can be combined in many ways to develop an overall, remedial action program for the Task VI Study Area. Of the removal and disposal methods discussed previously, only land-based excavating equipment or a combination of land-based and barge-mounted excavating equipment would be applicable for the Task VI Study Area. In addition, only two possibilities exist for disposal of sediments which are removed. The sediments could be hauled to a DEC approved and permitted land burial facility for disposal or incorporated within the closure of the 102nd Street Landfill. A summary of the various possible combinations is presented below.

Alt. 1. No action.

Alt. 2. Temporary in-situ stabilization utilizing filter fabric and stone fill followed by burial in place.

Alt. 3. Temporary in-situ stabilization utilizing an earth berm followed by burial in place.

Alt. 4. Temporary in-situ stabilization utilizing a steel sheet pile wall followed by burial in place.

Alt. 5. Temporary in-situ stabilization utilizing filter fabric and stone fill followed by removal and disposal (two removal methods and two disposal sites).

Alt. 6. Temporary in-situ stabilization utilizing an earth berm followed by removal and disposal (two removal methods and two disposal sites).

Alt. 7. Temporary in-situ stabilization utilizing a steel sheet pile wall followed by removal and disposal (two removal methods and two disposal sites).

Alt. 8. Immediate long term stabilization by burial in place.

Alt. 9. Immediate removal and disposal (two removal methods and two disposal sites).

8.2 Preliminary Screening of Alternatives

In order to remove from the list of possible alternatives those which are least practical or acceptable, a preliminary screening of alternatives has been undertaken. In this preliminary screening, each alternative has been evaluated and given a score from one to ten for each of the six different parameters. The parameters included in this screening are: effectiveness, reliability, worker safety, ease of implementation, absence of unacceptable environmental effects during implementation, and anticipated public acceptance. A high score for a given parameter indicates that the alternative meets the criteria described by the parameter, while a lower score indicates that the alternative is less acceptable as regards to that parameter. It should be noted that for the initial screening, no differentiation was made between removal methods or disposal sites under the removal and disposal alternative nor was consideration given to difference in probable costs for the various alternatives.

A separate, scoring worksheet was prepared for each alternative and lists pertinent reasons for a high or low score. The scores were then summarized into a matrix, shown in Table 8-1, for comparison purposes.

Preliminary Screening Alternative

Alternative 1

No Action

Parameter	Score	Comments
Effectiveness	1	If floods occur, transport of sediments downstream likely.
Reliability	1	Since contaminated sediments would not be stabilized, the no action alternate is not reliable.
Worker Safety	10	Not applicable because no construction.
Ease of Implementation	10	Only the monitoring program would require planning.
Environmental Impacts	1	Over the long term, impacts could be severe if floods occur.
Public Acceptance	1	Presence of dioxin as well as other contaminants. Public is not expected to accept no action.
	24	

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Preliminary Screening Worksheet

Alternative No. 2

Temporary in-situ stabilization utilizing filter fabric and stone fill followed by burial in place

Parameter	Score	Comments
Effectiveness	5	Leachate from landfill will not be contained initially. May not prevent long term downward migration of contaminants if suitable subsoils are not present.
Reliability	6	Less short term reliability compared to earth berm or steel sheeting.
Worker Safety	3	Hand placement of filter fabric required.
Ease of Implementation	7	Requires construction of earth berm for final burial plan.
Environmental Impacts	6	No containment of leachate over short term; water quality impacts during fill emplacement; permanent loss of habitat due to burial in place.
Public Acceptance	4	Leachate not contained over short term; over long term, removal may be preferred by public.
	31	

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Preliminary Screening Worksheet

Alternative No. 3

Temporary in-situ stabilization utilizing an earth berm followed by burial in place

Parameter	Score	Comments
Effectiveness	7	Earth berm more effective than stone and filter fabric; impoundment would serve as a settling basin. May not prevent long term downward migration of contaminants if suitable subsoils are not present.
Reliability	7	Comparable to steel sheeting.
Worker Safety	6	Little worker contact with sediments required .
Ease of Implementation	8	Earth berm would be utilized in final burial plan.
Environmental Impacts	7	Short term water quality impacts during berm construction and fill emplacement; permanent loss of habitat due to burial in place.
Public Acceptance	5	Over long term, removal may be preferred by public.
	40	

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Preliminary Screening Worksheet

Alternative No. 4

Temporary in-situ stabilization utilizing a steel sheet pile wall followed by burial in place

Parameter	Score	Comments
Effectiveness	7	Approximately equal to earth berm followed by burial in place; impoundment would serve as a settling basin. May not prevent long term downward migration of contaminants if suitable subsoils are not present.
Reliability	7	Comparable to earth berm.
Worker Safety	6	Little worker contact with sediments required.
Ease of Implementation	7	Driving sheeting in shallow water will be difficult. Final burial will require construction of perimeter berm.
Environmental Impacts	6	Short term water quality impacts during installation of sheeting and fill emplacement; permanent loss of habitat due to burial in place.
Public Acceptance	5	Over long term, removal may be preferred by public.
	38	

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Preliminary Screening Worksheet

Alternative No. 5

Temporary in-situ stabilization utilizing filter fabric and stone fill followed by removal and disposal

Parameter	Score	Comments
Effectiveness	6	Earth berm or steel sheet pile wall is more effective temporary stabilization method.
Reliability	6	Less short term reliability compared to earth berm or steel sheeting.
Worker Safety	2	Hand placement of filter fabric required; more contact with sediment necessary for removal or disposal compared to in place burial.
Ease of Implementation	6	Stone and fabric would have to be removed and disposed.
Environmental Impacts	5	Mitigating measures, i.e., silt curtains, would be required to trap contaminated sediments resuspended during removal.
Public Acceptance	5	Leachate not contained over short term; over long term, public may prefer removal over burial in place.
	30	

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Preliminary Screening Worksheet

Alternative No. 6

Temporary in-situ stabilization utilizing an earth berm followed by removal and disposal

Parameter	Score	Comments
Effectiveness	8	Provides for short term stabilization prior to removal.
Reliability	7	Comparable to steel sheeting.
Worker Safety	5	More contact with sediments necessary for removal and disposal compared to in-place burial.
Ease of Implementation	7	Removal and disposal of earth berm will be required, but berm provides equipment access to off-shore sediments.
Environmental Impacts	8	Short term water quality impacts both during placement of berm and during removal of sediments and berm; temporary loss of habitat.
Public Acceptance	7	Over long term, public may prefer removal over burial in place.
	42	

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Preliminary Screening Worksheet

Alternative No. 7

Temporary in-situ stabilization utilizing a steel sheet pile wall followed by removal and disposal

Parameter	Score	Comments
Effectiveness	8	Provides for short term stabilization prior to removal.
Reliability	7	Comparable to earth berm.
Worker Safety	5	More contact with sediments necessary for removal and disposal compared to in-place burial.
Ease of Implementation	8	Eliminates need to dispose of earth berm, but does not provide access to off-shore sediments.
Environmental Impacts	8	Short term water quality impacts both during placement of sheeting and during removal of sediments and sheeting; temporary loss of habitat.
Public Acceptance	7	Over long term, public may prefer removal over burial in place.
	43	

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Preliminary Screening Worksheet

Alternative No. 8

Immediate long-term stabilization by burial in place

Parameter	Score	Comments
Effectiveness	8	Additional contamination by landfill leachate possible, but would be contained within an enclosed area. Will not prevent downward migration of contaminants over long term.
Reliability	5	Not as reliable as providing temporary stabilization measures pending resolution of litigation.
Worker Safety	6	Little worker contact.
Ease of Implementation	9	Does not require short term stabilization measures.
Environmental Impacts	5	Short term water quality impacts during fill emplacement; permanent loss of habitat; contamination of fill material by landfill leachate possible.
Public Acceptance	4	Probably not acceptable to public because possible contamination from landfill leachate may occur prior to resolution of landfill litigation.
	37	

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Preliminary Screening Worksheet

Alternative No. 9

Immediate removal and disposal

Parameter	Score	Comments
Effectiveness	7	Area may be recontaminated by landfill leachate and require future removal.
Reliability	5	Not as reliable as providing temporary stabilization measures pending resolution of litigation.
Worker Safety	5	More contact with sediments necessary for removal and disposal in comparison to in-place burial.
Ease of Implementation	8	Does not require short term stabilization measures.
Environmental Impacts	5	Short term water quality impacts and temporary loss of habitat; possible recontamination of area due to landfill leachate.
Public Acceptance	3	Removal probably preferred by public, but prior to resolution of landfill litigation, continued contamination from landfill leachate may occur and will not be contained.
	33	

As shown in Table 8-1, Alternative 1, the no action alternative, received the lowest score of of the alternatives. This alternatives does not protect the public from contact with the sediments or against dispersion of the contaminated sediments downstream during a flood. The uncertainties associated with the effects of sediment dispersion on the environment are judged significant enough to rule out this alternative.

Alternatives 2, 3, and 4 all involve temporary stabilization of contaminated sediments in place while decisions are reached concerning the ultimate disposition of the 102nd Street landfills, followed by long-term stabilization in place. Of these, Alternative 3, the construction of an earth berm followed by filling and capping the area between the berm and the shore, achieved the highest combined score because of the relative ease of constructing the berm, the temporary protection against dispersal of contaminants afforded by the berm, and the fact that the fill material used in constructing the berm would be left in place as part of the final long-term solution.

Alternatives 5, 6, and 7 also involve temporary in place stabilization of contaminated sediments to provide time for a resolution of the landfill problems. However, these alternatives assume that, ultimately, the sediments will be excavated and disposed elsewhere. Alternative 7, the construction of a steel sheet pile wall for temporary containment purposes, followed by excavation and disposal, received the highest score in this group although it is only slightly higher than Alternative 6, which considers placement of an earth berm in lieu of sheeting. There will be some problems encountered in placing the sheeting in the river from a barge because of the shallow water depth. In addition, the material to be excavated furthest from the shoreline will be more difficult to remove without a berm which would support excavating equipment.

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TABLE 8-1

SUMMARY OF ALTERNATIVE EVALUATIONS

	SCORE								
	Alternative								
Parameter	1	2	3	4	5	6	7	8	9
Effectiveness	1	5	7	7	6	8	8	8	7
Reliability	1	6	7	7	6	7	7	5	5
Worker Safety	10	3	6	6	2	5	5	6	5
Ease of Implementation	10	7	8	7	6	7	8	9	8
Environmental Impacts	1	6	7	6	5	8	8	5	5
Public Acceptance	1	4	5	5	5	7	7	4	3
	24	31	40	38	30	42	43	37	33

Despite these difficulties, Alternative 7 received a slightly higher score than Alternative 6 because Alternative 6 requires both placement of the earth berm and ultimate removal and disposal of the berm when the contaminated sediments are removed.

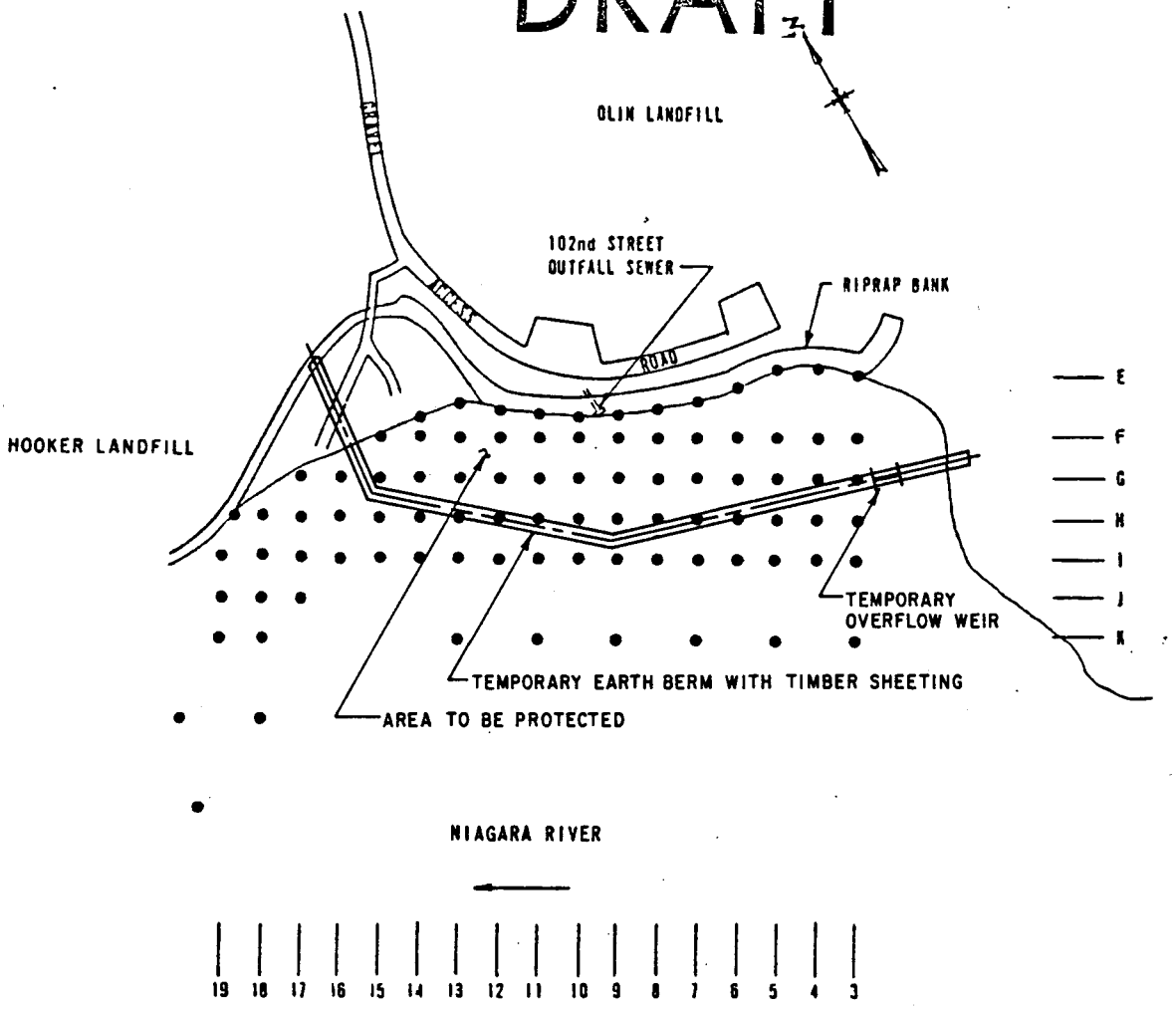
Alternatives 8 and 9 consider immediate, long-term stabilization in place or removal of contaminated sediments and scored lower than alternatives involving a temporary stabilization step. Of this group, Alternative 8, immediate long-term in place stabilization, received the higher score because it offers immediate protection of the face of the landfills on shore as well as prevents the loss of contaminated sediments downstream. The immediate excavation and disposal of the sediments scored lower because of the probability that at least part of the excavated area would be recontaminated during future remedial activities at the landfills and by the current loss of leachate from the landfills.

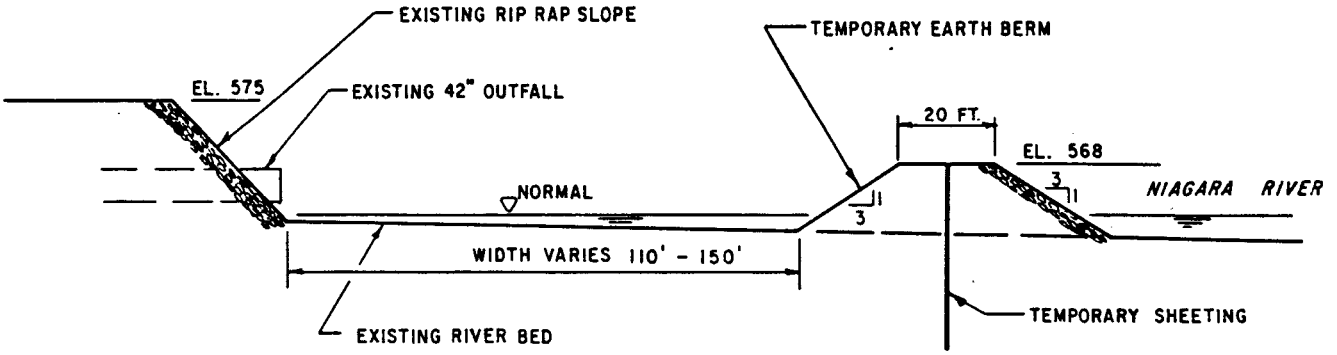
8.3 Selection of Specific Alternatives

Based upon the preliminary scoring of alternatives, Alternatives 3, 6, and 7 are judged to have the most merit.

Figure 8-1 locates the placement of the earth berm for temporary in-situ stabilization. Figure 8-2 presents a section through the Task VI Study Area for permanent in-situ stabilization. Figure 8-3 presents a section for the ultimate removal alternatives. Each of these alternatives provides for the temporary in place stabilization of contaminated sediments followed by long-term stabilization (Alternatives 3) or removal and disposal (Alternatives 6 and 7). The removal and disposal alternatives would be more effective in reducing the risk of transport of contaminated sediments downstream as compared to long-term, in-situ stabilization. In addition, the removal

FIGURE 8 - 1





LOVE CANAL
FIVE ENGINEERING STUDIES

102nd ST. OUTFALL
TASK VI

PROPOSED TEMPORARY EARTH BERM

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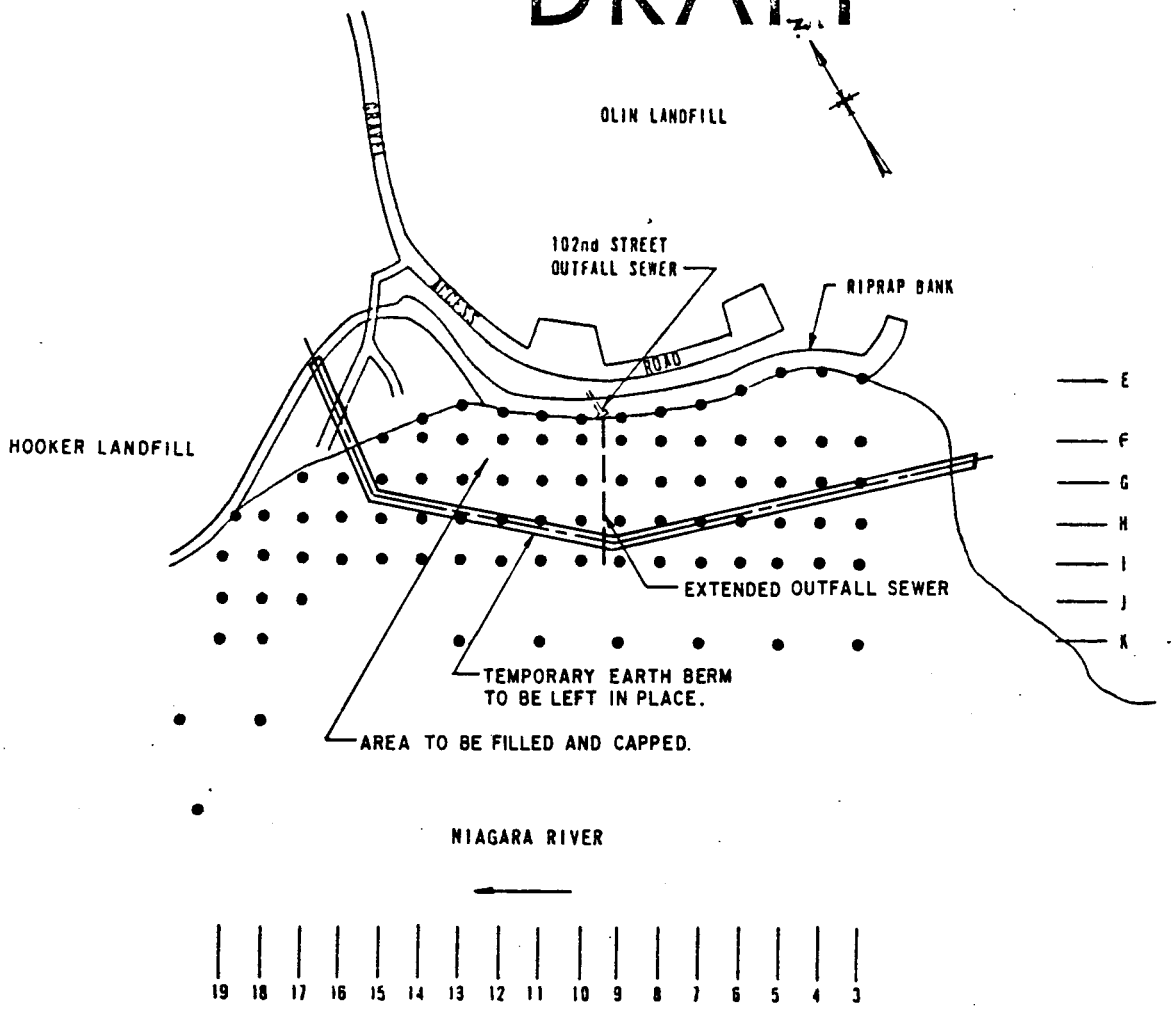
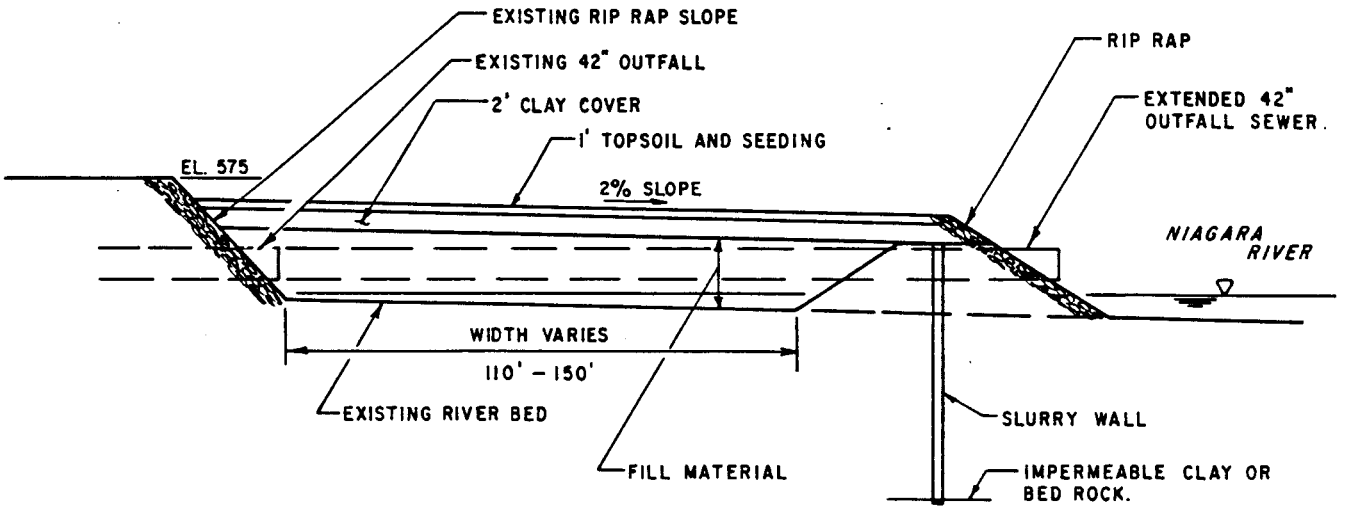
FIGURE 8-2





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102nd ST. OUTFALL
TASK VI
PERMANENT IN-SITU STABILIZATION ALTERNATIVE

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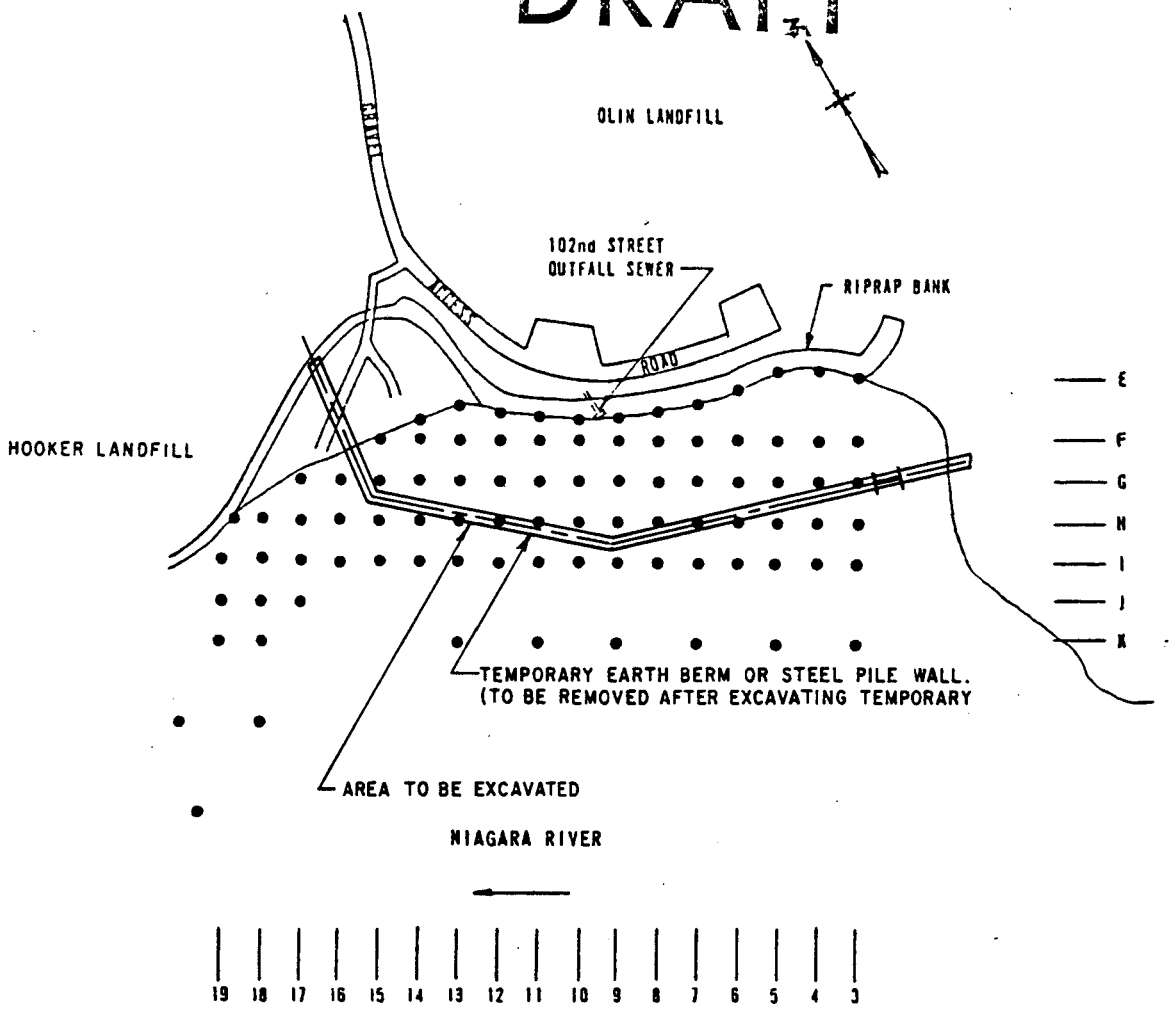
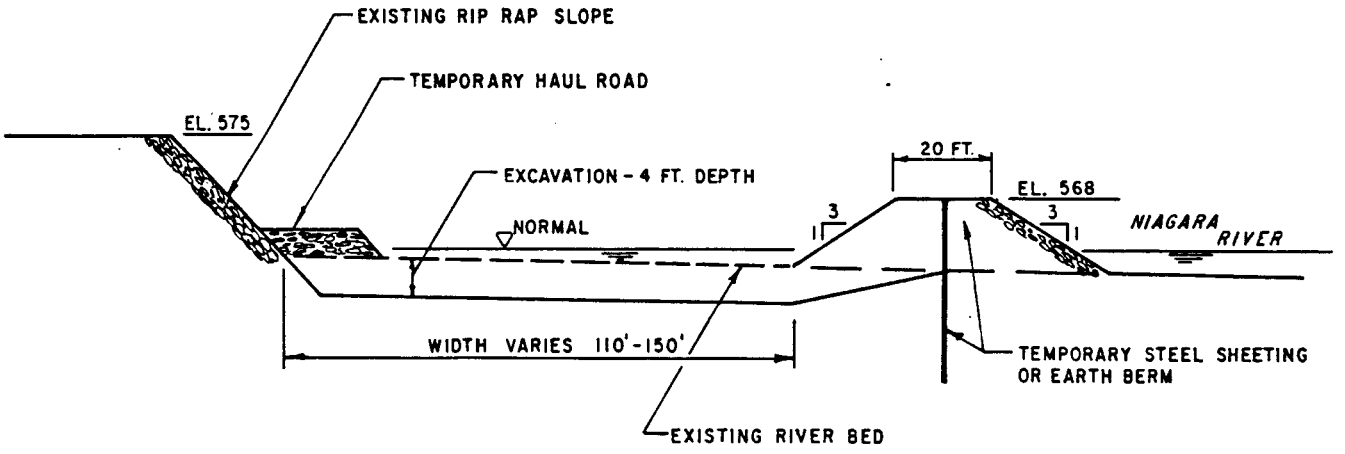
FIGURE 8-3





LOVE CANAL
FIVE ENGINEERING STUDIES

102nd ST. OUTFALL
TASK VI
REMOVAL AND DISPOSAL ALTERNATIVES

and disposal alternatives would probably be more acceptable to the public than in-situ stabilization. With respect to reliability, worker safety and ease of implementation, all three alternatives are relatively equal.

In terms of environmental impact, the initial construction activities associated with Alternatives 3, 6, or 7 would be comparable. Implementation of these alternatives would require construction of either an earth berm (Alternatives 3 and 6) or a sheet pile wall (Alternative 7) approximately 120 to 150 feet south of the shoreline near the 102nd Street outfall. The berm or sheet piling would extend approximately 900 feet, connecting to the shoreline east and west of the outfall. Emplacement of earth fill or sheet piling would disturb bottom sediments, resulting in increased turbidity levels and resuspension of contaminated sediments. Some downstream transport of contaminants would occur. Mobile aquatic organisms in the impounded area would be negatively affected. Except for flows over the weir in the berm or sheet pile wall, there would be no interchange between the impounded area and the river. Fish and other organisms in the proposed impoundment area at the time of construction would be trapped. Benthic organisms would be destroyed by berm or wall construction and sediment redistribution.

Discharges from the 102nd Street outfall would continue through the existing outfall structure after construction of the berm or sheet pile wall. The impoundment would promote settling of contaminated sediments from the outfall. A weir in the berm or sheet pile wall would control the water level in the impounded area.

Other impacts associated with Alternatives 6 and 9 relate to the proposed excavation of contaminated sediments from within the impounded area. Existing benthic communities would

be destroyed. Other aquatic resources, such as fish and waterfowl, could be temporarily affected. These impacts should be temporary in nature since recolonization of the area would be expected following excavation and removal of the berm or sheet pile wall. During excavation, sediments and associated contaminants would be entrained in the water column and losses over the weir in the berm or sheet pile wall would be expected. Although the extent of these sediment and contaminant losses cannot be estimated, the impoundment should act as a settling basin to reduce the overall extent of the losses. Short-term impacts on water quality would also result from the removal of the sheet piling or earth berm following sediment excavation. In comparison to removing sheet piling, removal of the earth berm would have more significant short-term impacts in terms of sediment disturbances and temporary water quality degradation.

Implementation of Alternative 3, in-situ stabilization of the area, should not cause significant resuspension of contaminated sediments, although fill emplacement required for stabilization would increase turbidity levels in the water column and could result in sediment losses over the weir. This sediment, however, would be primarily clean fill material rather than contaminated river sediments. Again, the protected conditions within the bermed or sheet piled area should facilitate settling and minimize sediment losses.

The long-term environmental impacts associated with Alternative 5 are more significant than for Alternatives 6 and 7. In-situ stabilization of the near-shore area around the 102nd Street outfall would permanently remove existing aquatic habitat for benthic organisms, fish and waterfowl. Any recreational use of the area by fishermen or duck hunters would be affected. However, this area is not expected to have significant or unique biological value due to the presence of contaminated river sediments and miscellaneous debris which indicate

past dumping activity in the river and along the shoreline. Flow patterns in the river would be altered by in-situ stabilization, resulting in potential affects on downstream erosion and sedimentation patterns. The 102nd Street outfall would be extended through the filled area to the rip rap face along the river. The long-term environmental impacts associated with Alternatives 6 and 7 are less significant. After excavation of the contaminated area and removal of the earth berm or sheet pile wall, recolonization could occur and over the long-term, a natural biological community would develop. The removal of contaminated material could improve the habitat value in this area and allow the re-establishment of a healthier and more diverse community.

In summary, the short-term environmental impacts associated with Alternatives 6 and 7, the excavation of contaminated sediments, are more significant than for Alternative 3, in-situ stabilization. Temporary water quality degradation would occur as a result of sediment and contaminant resuspension during material excavation and subsequent removal of the berm or sheet piling.

Over the long-term, the loss of habitat associated with Alternative 3, in-situ stabilization, is greater than for the other two alternatives. However, since the aquatic habitat which would be destroyed is not considered to be especially significant or unique, the impact of this loss should be minimal.

The selection of one of the three alternatives is made difficult by the uncertainty as to the final outcome of the litigation of the 102nd Street Landfill. If it is ultimately decided that the Hooker and Olin landfills will be stabilized in place, the in-place stabilization of the contaminated sediments in the river becomes an attractive solution for Task

Area VI. In this case, the preferred method of temporary stabilization of sediments could be the construction of an earth berm, as described under Alternative 3, which would be incorporated in the final long-term stabilization project. The stabilized sediments with surrounding slurry wall and rip-rapped berm would provide a buffer zone between the river's edge and the face of the landfill.

However, if the ultimate solution of the landfill problems calls for the excavation and removal of the landfilled wastes, it may not be practical to attempt to stabilize the contaminated sediments in place as a long-term solution. This would be particularly true if excavation of the landfilled material were to result in a large pit along and north of the current shoreline. In this event, the contaminated sediments should be removed, and the preferred method of temporary stabilization of sediments would be the construction of a steel sheet pile wall around the contaminated area rather than an earth berm which would later require removal.

In order to assist in the selection of a recommended alternative, preliminary construction cost estimates have been prepared for each of the three alternatives. These estimates are presented in Tables 8-2 through 8-4. Costs for removal and disposal were developed assuming that land-based excavation equipment would be utilized for removal if the earth berm were initially constructed (Alternative 6). For Alternative 7, a combination of land-based and barge-mounted excavation equipment would be utilized in order to reach the entire area. The costs shown for Alternatives 6 and 7 further assume that the contaminated sediments would be removed to a depth of four feet and would be loaded on watertight trucks for hauling to a disposal site without prior dewatering. The costs of trucking from the loading point to the disposal area plus the costs associated with dewatering and ultimate disposal of the sedi-

ments are included at $110 per cubic yard which should be adequate for disposal at a nearby DEC approved and permitted land burial facility. Should it become feasible to dispose of the sediments at either the Hooker or Olin landfills as part of the final closure of these sites, a reduction in the disposal costs should be possible.

Costs for permanent in-situ stabilization (Alternative 3) include costs for fill material, clay cover, topsoil and seeding. In addition, costs for a slurry wall approximtely 20 feet in depth were estimated. It is important to note that this depth was assumed at this time in order to develop preliminary cost estimates. No data regarding depth to impermeable clay or bedrock currently is available for sediments within the Task VI Study Area. A soil boring program would be required after temporary stabilization measures are constructed in order to determine the depth actually required should permanent in-situ stabilization be selected. Further, a sediment sampling program at depths greater than three feet would be required in order to determine if the four-foot removal depth will be adequate.

Operation and maintenance costs are not presented in Tables 8-2 through 8-4. Both maintenance of the rip-rapped shoreline and cap and some long-term monitoring would be required for the stabilization in place alternative. For Alternatives 6 and 7 annual costs for operation and maintenance would depend upon the ultimate location of the disposal site. If the material is disposed of at a secure land burial facility, cost for disposal would include these costs. If the material is incorporated within the closure of the 102nd Street Landfill, any costs for monitoring the site would depend upon the agreement made with the owner(s) of the landfill.

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TABLE 8-2

PRELIMINARY CONSTRUCTION COST ESTIMATE
ALTERNATIVE 3
TEMPORARY EARTH BERM FOLLOWED BY
LONG-TERM STABILIZATION IN-PLACE

Description	Quantity	Unit Cost	Total
Earth Berm			
Gravel fill	6100 cy	$ 12	$ 73,200
Timber sheeting	14000 sf	$ 5	70,000
Rip rap	1130 cy	$ 35	39,550
	Subtotal Temporary Stabilization		$182,750
	Contingencies at 20 percent		36,550
	Total Temporary Stabilization		$219,300
Fill and Cover In-Place			
Fill	16000 cy	$ 7	112,000
Clay cap	7000 cy	$ 15	105,000
Bentonite slurry wall(1)	44800 cf	$ 4.20	188,200
Topsoil	3700 cy	$ 10	37,000
Seeding	2.3 acres	$1200	2,800
Extend 102nd St. Outfall	150 lf	$ 150	22,500
	Subtotal Temporary Stabilization		$467,500
	Contingencies at 20 percent		93,500
	Total Temporary Stabilization		$516,000
Total Construction Cost			$780,300
		say	$780,000

Note:

1. Based upon a 20-foot depth, a soil boring program would be required to confirm the depth to impermeable clay or bedrock.

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TABLE 8-3

PRELIMINARY CONSTRUCTION COST ESTIMATE
ALTERNATIVE 6
TEMPORARY EARTH BERM FOLLOWED BY EXCAVATION AND DISPOSAL

Description	Quantity	Unit Cost	Total
Earth Berm			
Gravel fill	6100 cy	$ 12	$ 73,200
Timber sheeting	14000 sf	$ 5	70,000
Rip rap	1130 cy	$ 35	39,550
Subtotal Temporary Stabilization			$182,750
Contingencies at 20 percent			36,550
Total Temporary Stabilization			$219,300
Excavate and Load on Trucks			
Access Road at base of landfill slope	1100 cy	$ 10	11,000
Excavate sediments(1)	14800 cy	$ 12	177,600
Remove earth berm and rip rap	7130	$ 12	85,560
Remove access road	1100 cy	$ 12	13,200
Trucking, dewatering & disposal	23030 cy	$ 110	2,533,300
Subtotal Removal and Disposal			$2,820,660
Contingencies at 20 percent			564,130
Total Removal and Disposal			$3,384,790
Total Construction Cost			$3,604,090
		say	$3,600,000

Note:

1. Based upon a four-foot removal depth. A sediment sampling program would be required to confirm that contamination does not exist below three feet.

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TABLE 8-4

PRELIMINARY CONSTRUCTION COST ESTIMATE
ALTERNATIVE 7
TEMPORARY STEEL SHEET PILE WALL
FOLLOWED BY EXCAVATION AND DISPOSAL

Description	Quantity	Unit Cost	Total
Sheet Pile Wall			
Steel Sheeting	22440 sf	$ 20	$ 449,000
	Subtotal Temporary Stabilization		$ 449,000
	Contingencies at 20 percent		84,800
	Total Temporary Stabilization		$ 538,800
Excavate and Load on Trucks			
Access Road at base of landfill slope(1)	1100 cy	$ 10	11,000
Excavate sediments by using shore-based clamshell	7500 cy	$ 12	90,000
Excavate sediments by using barge-based clamshell	7300 cy	$ 5	109,500
Remove Access Rd.	1100 cy	$ 12	13,200
Trucking, Dewatering & Disposal	15900 cy	$ 110	1,749,000
	Subtotal Removal and Disposal		$1,972,700
	Contingencies at 20 percent		394,540
	Total Removal and Disposal		$2,367,240
Total Construction Cost			$2,906,040
		say	$2,910,000

Note:

1. Based upon a four-foot removal depth. A sediment sampling program would be required to confirm that contamination does not exist below three feet.

Table 8-5 presents a summary of construction costs associated with each of these alternatives. In order to further compare the alternatives, it was assumed that litigation proceedings and implementation of ultimate long-term remedial actions would take approximately ten years. Therefore, these costs which would be incurred in the future were discounted at eight percent in order to compare the alternatives on a present worth basis.

As shown in Table 8-5, the in-situ stabilization alternative is significantly less expensive than either of the removal and disposal alternatives. This is due to the high costs associated with hauling and disposing contaminated material at a DEC approved and permitted land burial facility. Of the two removal and disposal alternatives, Alternative 6 has a lower initial cost, but a higher total present worth, because the earth berm is less expensive to construct but incurs costs for removal and disposal when the ultimate solution is implemented. It is important to note that although present worth costs for the earth berm removal and disposal alternative are only $150,000 more than the sheet pile wall/removal and disposal alternative, initial costs are approximately $320,000 less. In addition, constructing the earth berm initially allows for flexibility with respect to the ultimate containment decision. Considering that the ultimate decision to stabilize the sediments in place or remove and dispose the sediments depends significantly on the outcome of the litigation of the 102nd Street landfill, it is concluded that the earth berm should be constructed initially and that the sheet pile wall (Alternative 7) should not be considered further.

With respect to the ultimate containment decision, three outcomes are possible from the litigation currently underway:

TABLE 8-5

PRESENT WORTH COST COMPARISON OF ALTERNATIVES
(CONSTRUCTION COST ONLY)

Alternative	Initial Costs	Future Costs	Total Present Worth
3	$219,300	$ 561,000	$ 479,000
6	$219,300	$3,384,800	$1,787,000
7	$538,800	$2,367,200	$1,635,000

- The owner(s) of the 102nd Street Landfill are not required to do any remedial work;

- The owner(s) of the 102nd Street Landfill are required to remove the material within the landfill to a secure land burial facility; or

- The owner(s) of the 102nd Street Landifll are required to provide long-term, in-situ stabilization of the material deposited in the landfill.

Should the courts decide that no action from the landfill owners is necessary, the best ultimate containment measure for the Task VI Study Area would be containment in place. In this way, the contaminated sediments would be contained and any contamination leaching from the landfill would have to travel further and would be contained within the slurry wall.

If the outcome of the litigation requires the owners of the landfill to remove the material within the landfill, then removal and disposal of the contaminated sediments is the only feasible alternative. It is recommended that the contaminated sediments be removed after removal of the landfill material. In this way, any contaminants disturbed from the landfill removal operation would be trapped by the earth berm.

Should the owners of the landfill be required to stabilize the landfill material in place, several options are feasible:

- Removal of the contaminated sediments and disposal at a nearby secure land burial facility;

- Removal of the contaminated sediments and incorporation within the closure of the 102nd Street Landfill; or

o Stabilization in place.

The first option, which has been discussed previously, would be the most expensive due to the high costs for disposal at a land burial facility. In addition, this option requires committment of a volume of approximately 23,000 cubic yards at a secure land burial facility for disposal of the material. The ability to locate a DEC approved and permitted land burial facility in this area could be difficult considering removal and disposal would not occur for at least 5-10 years. At that time, capacities at these facilities could become more valuable, especially considering the general area in which the Task VI Study Area is located. Therefore, this option, although technically and environmentally feasible, should only be considered if other possible methods cannot be implemented.

The second option considers incorporating the contaminated sediments within the closure of the 102nd Street Landfill. It appears that an agreement between the state and owner(s) of the 102nd Street Landfill would be required to determine appropriate costs and implementation feasibility. Although this option may be more difficult to implement than disposal at an existing land burial facility, costs for disposal should be significantly reduced. This option would require some dewatering of sediments prior to final placement and incorporation within the landfill.

The third option considers stabilizing the sediments in place. This would contain the sediments and would provide some additional protection against any leachate from the landfill reaching the river, as described previously.

9.0 RECOMMENDATIONS

9.1 Findings and Conclusions

As discussed in Section 8.0, it is recommended that a temporary earth berm be constructed at the perimeter of the area as shown on Figure 8-1. The berm would be utilized to temporarily stabilize the contaminated sediments until the issues concerning the 102nd Street Landfill are resolved. A decision as to the ultimate disposal of the sediments can be made at that time. However, if studies undertaken during litigation of the landfill problems indicated that the landfills can be successfully secured in place, it is further recommended that every effort be made to obtain an agreement with the landfill owner(s) whereby the contaminated river sediments may be removed and disposed in the landfill.

If the current litigation does not result in any remedial action at the landfill, it is recommended that the contaminated sediments be stabilized in place as shown in Figure 8-2. This would provide at least some protection against future loss of contaminants from the landfill as well as prevent dispersion of the sediment throughout the river system. However, the state would have to provide for the long-term maintenance of the cap and rip-rapped face of the fill as well as undertake a monitoring program to determine if contaminants break through the slurry wall.

As shown in Table 8-5, the cost of removing the sediments and disposing of them in a DEC approved and permitted land burial facility is very high. This approach should only be undertaken if the landfilled materials at 102nd Street are excavated and disposed elsewhere. In this event, removal of the contaminated sediments should take place concurrently with the removal of the landfilled materials.

9.2 Temporary In-Situ Stabilization

The proposed earth berm would be constructed of earth fill material to elevation 568.0, which is the 10-year flood elevation on the Niagara River. In order to provide access for vehicles, a berm width of 20 feet and side slopes of approximately one foot vertical to three feet horizontal are recommended. The outside river face of the berm would be rip rapped to prevent erosion and tongue and groove timber sheeting would be driven through the berm to a depth of approximately ten feet below the river bed to reduce seepage through and under the berm. In addition, a weir approximately 20 feet long would be cut into the earth berm to allow storm flows from the outfall to discharge to the Niagara River.

The berm would be constructed starting from the existing access roads located in the low lying area of the shoreline, and would be tied into the shoreline. Construction costs for the earth berm were presented in Section 8 and include placement of the berm, timber sheeting and rip rap for the protection of the outside face. Table 9-1 summarizes the total project costs for the initial construction phase. Included in the engineering, legal and administration costs are costs associated with conducting a soil boring program and some additional sediment sampling. The purpose of this work is to determine the depth to impermeable clay or bedrock and to confirm that contamination does not exist below three feet. The information obtained from this program along with the resolution of the litigation concerning the 102nd Street Landfill will be utilized to arrive at the ultimate decision regarding the contaminated sediments.

9.3 Implementation

The construction of an earth berm around the contaminated sediments will require that permits be obtained from the New

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TABLE 9-1

ESTIMATED PROJECT COSTS
TEMPORARY IN-SITU STABILIZATION
WITH AN EARTH BERM

Description	Quantity	Unit Cost	Total
Gravel fill	6,100 cy	$12/cy	$ 73,200
Timber Sheeting	14,000 cy	$ 5/sf	70,000
Rip-Rap	1,130 cy	$35/cy	39,550
Subtotal			$182,750
Contingencies at 20 percent			$ 36,550
Engineering Design and Project Inspecton			55,000
Additional Soil Borings and Sediment Sampling			30,000
Legal and Administrative at 9 percent			6,600
Total Estimated Project Cost			$310,800

York State Department of Environmental Conservation and, possibly, from the U.S. Army Corps of Engineers. An easement will also be required from the owner(s) of the 102nd Street Landfill for access to the river bank during construction.

The construction of the berm, complete with tongue and groove timber sheeting, rip-rapped face and outlet weir should not require more than 6 months. The time required to prepare construction plans and specifications, obtain permits and easement, advertise for and receive bids, and award a construction contract is estimated to be approximately 6 months, provided that financing is arranged while the design work is underway. Thus, approximately one year will be required to complete the temporary in-situ stabilization project once a decision is made to go ahead with it.

Soil borings and additional sediment sampling would be accomplished after completion of the berm to verify some of the assumptions made herein regarding the construction of a slurry wall and the depth to which the sediments have been contaminated. In the meantime, attornies involved in litigation of the 102nd Street Landfill problems should be asked to explore the possibility of a cooperative agreement with the landfill owner(s) regarding the ultimate disposal of the sediments in the landfill.

APPENDIX A
SUMMARY OF ANALYSIS

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-015S-A
Location ID: E-4
CompuChem #: 2321

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	222	Methylene Chloride	6,100	2,000	160
Acid	LS	Unknown	280	EC	1245
	LS	Unknown	1,200	EC	1515
Base/Neutral/ Pesticide	413	BIS (2-Ethylhexyl) Phthalate	320	200	1525
	702	Alpha-BHC	220	200	1116
	LS	Pentatriacontane	8,000	EC	1545
	LS	Pentatriacontane	10,000	EC	1632
	LS	Pentatriacontane	11,000	EC	1737
	LS	Pentatriacontane	10,000	EC	1864
	LS	Hexatriacontane	7,800	EC	2017

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	15	1.0
105	Chromium, Total	34	1.0
106	Copper, Total	6.2	1.0
107	Lead, Total	8.9	1.0
109	Nickel, Total	7.2	1.0
112	Thallium, Total	5.6	1.0
113	Zinc, Total	28	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-073S-B
Location ID: E-7
CompuChem #: 2531

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	222	Methylene Chloride	4,700	2,000	151
Acid	LS	Benzene,Chloro-	260	EC	531
	LS	Phenol,Pentafluoro-	280	EC	777
Base/Neutral/ Pesticide		None Detected			

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	12	1.0
105	Chromium, Total	3.4	1.0
106	Copper, Total	6.5	1.0
107	Lead, Total	10	1.0
109	Nickel, Total	5.3	1.0
112	Thallium, Total	5.5	1.0
113	Zinc, Total	37	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-073S-C
Location ID: E-7
CompuChem #: 2532

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	207	Chlorobenzene	3,300	2,000	712
Acid	LS	Benzene,Chloro-	1,400	EC	530
	LS	Benzene,1,4-Dichloro-	430	EC	721
	LS	Benzene,1,4-Dichloro-	380	EC	746
	LS	Unknown	340	EC	777
Base/Neutral/ Pesticide	420	1,2-Dichlorobenzene	330	200	694
	422	1,4-Dichlorobenzene	420	200	674

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	14	1.0
105	Chromium, Total	6.7	1.0
106	Copper, Total	6.0	1.0
107	Lead, Total	11	1.0
109	Nickel, Total	5.1	1.0
112	Thallium, Total	3.7	1.0
113	Zinc, Total	37	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-074S-A
Location ID: E-8
CompuChem #: 2533

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	222	Methylene Chloride	49,000	2,000	152
Acid	LS	Benzene,Chloro-	810	EC	531
	LS	Benzene,1,2,4-Trichloro-	470	EC	844
	LS	Benzene,1,2,4-Trichloro-	1,400	EC	888
	LS	Unknown	400	EC	1179
	LS	Cyclohexane,1,2,3,4,5,6-Hexachloro-,(1.Alpha., 2.Alpha.,3.Beta.,4.Alpha)	1,500	EC	1307
Base/Neutral/ Pesticide	446	1,2,4-Trichlorobenzene	1,800	200	804
	702	Alpha-BHC	5,800	200	1129
	703	Beta-BHC	1,700	200	1152
	LS	Unknown	530	EC	737
	LS	Benzene,1,2,3,5-Tetrachloro-	340	EC	910
	LS	Benzene,1,2,3,5-Tetrachloro-	400	EC	943
	LS	Unknown	580	EC	1031

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-074S-A
Location ID: E-8
CompuChem #: 2533

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	14	1.0
105	Chromium, Total	11	1.0
106	Copper, Total	10	1.0
107	Lead, Total	14	1.0
109	Nickel, Total	5.1	1.0
112	Thallium, Total	4.2	1.0
113	Zinc, Total	35	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-O-074S-B
Location ID: E-8
CompuChem #: 2534

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile		None Detected			
Acid	LS	Benzene,Chloro-	300	EC	530
Base/Neutral/ Pesticide	LS	Benzene,Chloro-	310	EC	523
	LS	Unknown	480	EC	702
	LS	2,5,8,11,14-Penta-oxapentadecane	530	EC	992
	LS	Unknown	670	EC	1769

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	14	1.0
105	Chromium, Total	6.4	1.0
106	Copper, Total	7.0	1.0
107	Lead, Total	9.5	1.0
109	Nickel, Total	5.0	1.0
112	Thallium, Total	4.2	1.0
113	Zinc, Total	33	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-074S-C
Location ID: E-8
CompuChem #: 2535

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	207	Chlorobenzene	5,200	2,000	717
	222	Methylene Chloride	3,400	2,000	161
Acid	LS	Cyclotrisiloxane, Hexamethyl-	250	EC	494
	LS	Benzene,Chloro-	760	EC	531
	LS	Cyclotetrasiloxane, Octamethyl-	220	EC	686
	LS	Benzene,1,4-Dichloro-	200	EC	722
Base/Neutral/ Pesticide		None Detected			

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	8.0	1.0
105	Chromium, Total	3.4	1.0
106	Copper, Total	4.4	1.0
107	Lead, Total	5.7	1.0
109	Nickel, Total	2.9	1.0
112	Thallium, Total	1.6	1.0
113	Zinc, Total	21	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-075S-A
Location ID: E-9
CompuChem #: 2536

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	207	Chlorobenzene	9,100	2,000	721
	224	Tetrachloroethylene	26,000	2,000	648
	225	Toluene	3,200	2,000	685
	229	Trichloroethylene	6,200	2,000	477
Acid	LS	Benzene,1,2,4-Trichloro-	200,000	EC	940
	LS	Benzene,1,2,3,5-Tetrachloro-	160,000	EC	1079
	LS	Unknown	300,000	EC	1125
	LS	Unknown	240,000	EC	1237
	LS	Cyclohexane,1,2,3,4,5,6-Hexachloro-,(1.Alpha., 2.Alpha.,3.Beta.,4,Alpha	200,000	EC	1366
Base/Neutral/ Pesticide	411	BIS (2-Chloroethyl) Ether	5,200	4,000 [1]	630
	413	BIS (2-Ethylhexyl) Phthalate	4,800	4,000 [1]	1523
	420	1,2-Dichlorobenzene	36,000	4,000 [1]	679
	421	1,3-Dichlorobenzene	64,000	4,000 [1]	654
	422	1,4-Dichlorobenzene	54,000	4,000 [1]	659
	433	Hexachlorobenzene	52,000	4,000 [1]	1126

[1] Sample extract could not be concentrated to 0.5 ml, thus the detection limits are higher than normal.

Malcolm-Pirnie ID#: VI-0-075S-A
Location ID: E-9
CompuChem #: 2536

ORGANICS, Cont'd.

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Base/Neutral/ Pesticide	444	Phenanthrene	20,000	4,000 [1]	1160
	446	1,2,4-Trichlorobenzene	300,000	4,000 [1]	791
	703	Beta-BHC	49,000	4,000 [1]	1141
	LS	Benzene,2,4-Dichloro-1-Methyl-	28,000	EC	746
	LS	Benzene,2,4-Dichloro-1-(Chloromethyl)-	17,000	EC	874
	LS	Unknown	40,000	EC	929
	LS	Unknown	43,000	EC	1019
	LS	Benzene,1,1'-/Oxybis (Methylene)/Bis-	20,000	EC	1079

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	79	1.0
104	Cadmium, Total	1.0	1.0
105	Chromium, Total	12	1.0
106	Copper, Total	40	1.0
107	Lead, Total	46	1.0
109	Nickel, Total	6.5	1.0
112	Thallium, Total	1.2	1.0
113	Zinc, Total	69	1.0

[1] Sample extract could not be concentrated to 0.5 ml, thus the detection limits are higher than normal.

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-075S-B
Location ID: E-9
CompuChem #: 2537

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile		None Detected			
Acid	LS	Benzene,1,2,4-Trichloro-	2,400	EC	944
	LS	Benzene,1,2,4-Trichloro-	540	EC	978
	LS	Benzene,1,2,3,5-Tetrachloro-	1,200	EC	1082
	LS	Benzene,1,2,3,5-Tetrachloro-	3,600	EC	1127
	LS	Benzene,Pentachloro-	1,400	EC	1241
Base/Neutral/ Pesticide	403	Anthracene/Phenanthrene	200	200	1160 [1]
	420	1,2-Dichlorobenzene	300	200	679
	421	1,3-Dichlorobenzene	1,700	200	653
	422	1,4-Dichlorobenzene	300	200	658
	433	Hexachlorobenzene	960	200	1125
	444	Phenanthrene/Anthracene	200	200	1160 [1]
	446	1,2,4-Trichlorobenzene	12,000	200	791
	702	Alpha-BHC	4,100	200	1115
	703	Beta-BHC	360	200	1140
	704	Gamma-BHC	440	200	1148

[1] Indistinguishable isomers.

Malcolm-Pirnie ID#: VI-0-075S-B
Location ID: E-9
CompuChem #: 2537

ORGANICS, Cont'd.

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Base/Neutral/ Pesticide	705	Delta-BHC	260	200	1170
	LS	Benzene,2,4-Dichloro-1-Methyl-	340	EC	746
	LS	Benzene,1,2,4-Trichloro-	380	EC	817
	LS	Benzene,1,2,3,5-Tetrachloro-	480	EC	897
	LS	Benzene,1,2,3,5-Tetrachloro-	760	EC	930
	LS	Benzene,Pentachloro-	720	EC	1019

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	9.4	1.0
105	Chromium, Total	2.6	1.0
106	Copper, Total	7.2	1.0
107	Lead, Total	6.4	1.0
109	Nickel, Total	4.7	1.0
113	Zinc, Total	28	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-075S-C
Location ID: E-9
CompuChem #: 2538

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	211	Chloroform	2,000	2,000	312
	222	Methylene Chloride	9,000	2,000	159
	LS	Pentane	7,600	EC	355
Acid	LS	Benzene,1,2,4-Trichloro-	17,000	EC	920
	LS	Benzene,1,2,4-Trichloro-	3,200	EC	955
	LS	Benzene,1,2,3,5-Tetrachloro-	8,200	EC	1059
	LS	Unknown	52,000	EC	1104
	LS	Unknown	13,000	EC	1217
Base/Neutral/ Pesticide	413	BIS (2-Ethylhexyl) Phthalate	820	200	1504
	433	Hexachlorobenzene	780	200	1118
	446	1,2,4-Trichlorobenzene	6,400	200	785
	702	Alpha-BHC	360	200	1108
	LS	Unknown	5,300	EC	892
	LS	Benzene,1,2,3,4-Tetrachloro-	16,000	EC	925
	LS	Benzene,1,1'-/Oxybis (Methylene)/Bis-	310	EC	1071

Malcolm-Pirnie ID#: VI-0-075S-C
Location ID: E-9
CompuChem #: 2538

ORGANICS, Cont'd.

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
	LS	Cyclobutane,1,2-Dichloro 3,4-Bis(Dichloromethylene)-	490	EC	1118

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	11	1.0
105	Chromium, Total	3.6	1.0
106	Copper, Total	7.2	1.0
107	Lead, Total	9.4	1.0
109	Nickel, Total	6.0	1.0
112	Thallium, Total	3.7	1.0
113	Zinc, Total	31	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-076S-A
Location ID: E-10
CompuChem #: 2539

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	222	Methylene Chloride	2,300	2,000	153
Acid	LS	Unknown	410	EC	792
	LS	Benzene,1,2,3,4-Tetrachloro-	330	EC	1096
	LS	Unknown	290	EC	1210
Base/Neutral/ Pesticide		None Detected			

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	7.8	1.0
105	Chromium, Total	5.4	1.0
106	Copper, Total	5.0	1.0
107	Lead, Total	6.7	1.0
109	Nickel, Total	2.3	1.0
112	Thallium, Total	1.3	1.0
113	Zinc, Total	22	1.0

Malcolm-Pirnie ID#: VI-0-076S-B
Location ID: E-10
CompuChem #: 2540

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	222	Methylene Chloride	2,700	2,000	161
Acid	LS	Benzene,Chloro-	220	EC	530
	LS	Benzene,1,4-Dichloro-	330	EC	721
	LS	Benzene,1,4-Dichloro-	300	EC	746
	LS	Unknown	720	EC	768
Base/Neutral/ Pesticide	LS	Unknown	190	EC	583

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	14	1.0
105	Chromium, Total	3.8	1.0
106	Copper, Total	5.8	1.0
107	Lead, Total	7.2	1.0
109	Nickel, Total	4.4	1.0
112	Thallium, Total	2.2	1.0
113	Zinc, Total	25	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-076S-C
Location ID: E-10
CompuChem #: 2541

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	207	Chlorobenzene	14,000	2,000	713
	222	Methylene Chloride	3,100	2,000	162
Acid	LS	Benzene,Chloro-	2,200	EC	529
	LS	Benzene,1,4-Dichloro-	1,400	EC	720
	LS	Benzene,1,4-Dichloro-	710	EC	745
	LS	Unknown	810	EC	767
	LS	Unknown	700	EC	1075
Base/Neutral/ Pesticide	LS	Benzene,Chloro-	310	EC	495

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	12	1.0
105	Chromium, Total	9.7	1.0
106	Copper, Total	8.1	1.0
107	Lead, Total	11	1.0
109	Nickel, Total	5.5	1.0
112	Thallium, Total	5.7	1.0
113	Zinc, Total	33	1.0

Malcolm-Pirnie ID#: VI-0-077S-B
Location ID: E-11
CompuChem #: 2415

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	207	Chlorobenzene	2,300	2,000	712
	222	Methylene Chloride	3,900	2,000	161
Acid	LS	Benzene,Chloro-	1,200	EC	546
	LS	Benzene,1,4-Dichloro-	570	EC	741
	LS	Benzene,1,4-Dichloro-	500	EC	767
	LS	Unknown	400	EC	1100
Base/Neutral/ Pesticide	420	1,2-Dichlorobenzene	560	200	668
	422	1,4-Dichlorobenzene	680	200	648
	LS	Benzene,Chloro-	1,300	EC	496

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	12	1.0
105	Chromium, Total	2.8	1.0
106	Copper, Total	7.9	1.0
107	Lead, Total	8.4	1.0
109	Nickel, Total	5.1	1.0
112	Thallium, Total	5.1	1.0
113	Zinc, Total	33	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-O-077S-C
Location ID: E-11
CompuChem #: 2416

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	207	Chlorobenzene	14,000	2,000	714
	222	Methylene Chloride	3,700	2,000	161
Acid	LS	Cyclohexane,Methyl-	240	EC	370
	LS	Benzene,Chloro-	1,100	EC	531
	LS	Benzene,1,4-Dichloro-	1,100	EC	721
	LS	Benzene,1,3-Dichloro-	700	EC	746
	LS	Unknown	1,400	EC	1077
Base/Neutral/ Pesticide	420	1,2-Dichlorobenzene	1,200	200	667
	421	1,3-Dichlorobenzene	360	200	642
	422	1,4-Dichlorobenzene	1,800	200	647
	LS	Benzene,Chloro-	2,800	EC	495
	LS	Cyclotetrasiloxane, Octamethyl-	220	EC	615
	LS	2,5,8,11,14-Pentaoxa-pentadecane	230	EC	969

Malcolm-Pirnie ID#: VI-0-077S-C
Location ID: E-11
CompuChem #: 2416

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	7.6	1.0
105	Chromium, Total	2.3	1.0
106	Copper, Total	6.4	1.0
107	Lead, Total	7.9	1.0
109	Nickel, Total	4.1	1.0
112	Thallium, Total	3.4	1.0
113	Zinc, Total	24	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-078S-A
Location ID: E-12
CompuChem #: 2417

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile		None Detected			
Acid	LS	Benzene, Chloro-	260	EC	570
	LS	Unknown	240	EC	1262
	LS	Unknown	1,300	EC	1460
	LS	Unknown	420	EC	1511
	LS	Unknown	200	EC	1528
Base/Neutral/ Pesticide	413	BIS (2-Ethylhexyl) Phthalate	1,600	200	1493
	LS	Unknown	220	EC	1023
	LS	Unknown	540	EC	1392
	LS	Unknown	660	EC	1450
	LS	Unknown	400	EC	1466

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	7.1	1.0
105	Chromium, Total	2.0	1.0
106	Copper, Total	4.4	1.0
107	Lead, Total	12	1.0
109	Nickel, Total	3.5	1.0
112	Thallium, Total	3.7	1.0
113	Zinc, Total	33	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-078S-B
Location ID: E-12
CompuChem #: 2418

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	222	Methylene Chloride	3,000	2,000	160
	LS	Formicacid,Methylester	7,900	EC	83
Acid	LS	Benzene,Chloro-	570	EC	528
	LS	Unknown	210	EC	775
Base/Neutral/ Pesticide	LS	Unknown	250	EC	476
	LS	Unknown	290	EC	560

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	14	1.0
105	Chromium, Total	3.7	1.0
106	Copper, Total	7.7	1.0
107	Lead, Total	11	1.0
109	Nickel, Total	5.7	1.0
112	Thallium, Total	7.2	1.0
113	Zinc, Total	34	1.0

Malcolm-Pirnie ID#: VI-0-078S-C
Location ID: E-12
CompuChem #: 2419

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	207	Chlorobenzene	2,200	2,000	680
	222	Methylene Chloride	2,800	2,000	154
Acid	LS	Benzene,Chloro-	170	EC	554
Base/Neutral/ Pesticide	LS	Benzene,Chloro-	200	EC	496
	LS	2,5,8,11,14-Penta-oxapentadecane	620	EC	968

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	13	1.0
105	Chromium, Total	2.6	1.0
106	Copper, Total	7.6	1.0
107	Lead, Total	9.4	1.0
109	Nickel, Total	4.7	1.0
112	Thallium, Total	6.0	1.0
113	Zinc, Total	33	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-079S-A
Location ID: E-13
CompuChem #: 2420

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	222	Methylene Chloride	4,000	2,000	160
Acid		None Detected			
Base/Neutral/ Pesticide	LS	Unknown	250	EC	1461

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	17	1.0
105	Chromium, Total	6.8	1.0
106	Copper, Total	12	1.0
107	Lead, Total	23	1.0
109	Nickel, Total	7.4	1.0
112	Thallium, Total	3.9	1.0
113	Zinc, Total	42	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-O-079S-B
Location ID: E-13
CompuChem #: 2421

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	206	Carbon Tetrachloride	2,300	2,000	371
	222	Methylene Chloride	5,100	2,000	152
Acid	LS	Benzene,Chloro-	280	EC	553
Base/Neutral/ Pesticide		None Detected			

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	15	1.0
105	Chromium, Total	3.7	1.0
106	Copper, Total	9.6	1.0
107	Lead, Total	11	1.0
109	Nickel, Total	5.6	1.0
112	Thallium, Total	6.1	1.0
113	Zinc, Total	42	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-079S-C
Location ID: E-13
CompuChem #: 2422

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile		None Detected			
Acid	LS	Benzene, Chloro-	280	EC	575
Base/Neutral/ Pesticide	413	BIS (2-Ethylhexyl) Phthalate	3,400	200	1550
	LS	Pentacosane	400	EC	1490
	LS	Pentacosane	570	EC	1656
	LS	Pentacosane	550	EC	1765
	LS	Eicosane	510	EC	1900
	LS	Pentacosane	340	EC	2064

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	11	1.0
104	Cadmium, Total	1.2	1.0
105	Chromium, Total	3.5	1.0
106	Copper, Total	9.2	1.0
107	Lead, Total	8.7	1.0
109	Nickel, Total	6.7	1.0
113	Zinc, Total	33	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-080S-A
Location ID: E-14
CompuChem #: 2423

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	222	Methylene Chloride	6,000	2,000	160
	230	Trichlorofluoromethane	2,500	2,000	220
Acid	LS	2,5,8,11,14-Penta-oxapentadecane	850	EC	1138
Base/Neutral/ Pesticide		None Detected			

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	21	1.0
105	Chromium, Total	7.4	1.0
106	Copper, Total	15	1.0
107	Lead, Total	20	1.0
109	Nickel, Total	9.5	1.0
112	Thallium, Total	3.2	1.0
113	Zinc, Total	47	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-001S-A
Location ID: F-3
CompuChem #: 2291

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	222	Methylene Chloride	8,800	2,000	162
	LS	Pentane	7,600	EC	365
	LS	Unknown	5,800	EC	513
Acid	LS	Unknown	200	EC	1245
Base/Neutral/ Pesticide	413	BIS (2-Ethylhexyl) Phthalate	2,100	200	1553
	LS	Eicosane	3,400	EC	1495
	LS	Pentacosane	5,400	EC	1571
	LS	Pentacosane	6,800	EC	1664
	LS	Pentacosane	6,400	EC	1776
	LS	Pentacosane	5,400	EC	1912

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	14	1.0
105	Chromium, Total	30	1.0
106	Copper, Total	6.5	1.0
107	Lead, Total	9.0	1.0
108	Mercury, Total	1.0	1.0
109	Nickel, Total	5.3	1.0
112	Thallium, Total	3.7	1.0
113	Zinc, Total	35	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-001S-B
Location ID: F-3
CompuChem #: 2292

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	222	Methylene Chloride	2,500	2,000	160
Acid	LS	Unknown	250	EC	778
	LS	Unknown	280	EC	992
Base/Neutral/ Pesticide	LS	Unknown	310	EC	1450
	LS	Unknown	400	EC	1518
	LS	Unknown	480	EC	1599
	LS	Unknown	440	EC	1698
	LS	Hexatriacontane	370	EC	1817

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	15	1.0
105	Chromium, Total	9.2	1.0
106	Copper, Total	5.3	1.0
107	Lead, Total	11	1.0
109	Nickel, Total	5.0	1.0
112	Thallium, Total	4.4	1.0
113	Zinc, Total	33	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-002S-B
Location ID: F-6
CompuChem #: 2309

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	222	Methylene Chloride	6,700	2,000	151
	LS	Formicacid,Methylester	13,000	EC	77
Acid		None Detected			
Base/Neutral/ Pesticide	LS	Unknown	200	EC	478
	LS	Unknown	260	EC	561
	LS	Unknown	240	EC	619

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	12	1.0
105	Chromium, Total	17	1.0
106	Copper, Total	5.1	1.0
107	Lead, Total	9.7	1.0
109	Nickel, Total	5.5	1.0
112	Thallium, Total	7.2	1.0
113	Zinc, Total	32	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-005S-A
Location ID: F-7
CompuChem #: 2312

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	207	Chlorobenzene	2,800	2,000	713
	222	Methylene Chloride	2,100	2,000	162
Acid	LS	Benzene,Chloro-	2,100	EC	531
Base/Neutral/ Pesticide	LS	Benzene,Chloro-	1,600	EC	498

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	13	1.0
105	Chromium, Total	5.5	1.0
106	Copper, Total	5.0	1.0
107	Lead, Total	7.8	1.0
109	Nickel, Total	4.4	1.0
112	Thallium, Total	2.6	1.0
113	Zinc, Total	28	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-005S-C
Location ID: F-7
CompuChem #: 2314

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	207	Chlorobenzene	27,000	2,000	714
	222	Methylene Chloride	8,400	2,000	159
	LS	Formicacid,Methylester	27,000	EC	81
	LS	Unknown	4,900	EC	513
Acid	LS	Benzene,Chloro-	2,300	EC	529
	LS	Unknown	200	EC	775
Base/Neutral/ Pesticide	LS	Benzene,Chloro-	4,800	EC	524

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	14	1.0
105	Chromium, Total	5.6	1.0
106	Copper, Total	9.0	1.0
107	Lead, Total	14	1.0
109	Nickel, Total	6.8	1.0
112	Thallium, Total	6.0	1.0
113	Zinc, Total	40	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-006S-A
Location ID: F-8
CompuChem #: 2396

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile		None Detected			
Acid	LS	Cyclohexane,1,2,3,4,5,6-Hexachloro-,(1.Alpha., 2.Alpha.,3.Beta.,4.Alpha)	29,000	EC	1305
Base/Neutral/ Pesticide	413	BIS (2-Ethylhexyl) Phthalate	820	200	1549
	702	Alpha-BHC	780	200	1131
	703	Beta-BHC	300	200	1155
	LS	Pentacosane	4,000	EC	1428
	LS	Pentacosane	4,400	EC	1492
	LS	Pentacosane	4,200	EC	1569
	LS	Pentacosane	4,000	EC	1661
	LS	Pentacosane	4,000	EC	1772

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	16	1.0
104	Cadmium, Total	1.1	1.0
105	Chromium, Total	8.1	1.0
106	Copper, Total	7.3	1.0
107	Lead, Total	9.5	1.0
108	Mercury, Total	5.0	1.0
109	Nickel, Total	5.4	1.0
113	Zinc, Total	27	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-006S-B
Location ID: F-8
CompuChem #: 2397

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile		None Detected			
Acid	LS	Cyclohexane	3,200	EC	329
	LS	Benzene,Chloro-	960	EC	570
	LS	Unknown	320	EC	1260
	LS	Unknown	1,200	EC	1468
Base/Neutral/ Pesticide	413	BIS (2-Ethylhexyl) Phthalate	290	200	1552
	LS	Unknown	270	EC	1055
	LS	Pentacosane	360	EC	1430
	LS	Eicosane	630	EC	1494
	LS	Pentacosane	830	EC	1570
	LS	Pentacosane	1,031	EC	1662

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	12	1.0
105	Chromium, Total	9.9	1.0
106	Copper, Total	6.4	1.0
107	Lead, Total	8.1	1.0
109	Nickel, Total	5.1	1.0
113	Zinc, Total	25	1.0

Malcolm-Pirnie ID#: VI-0-006S-C
Location ID: F-8
CompuChem #: 2398

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	222	Methylene Chloride	3,500	2,000	162
Acid	LS	2,5,8,11,14-Penta-oxapentadecane	570	EC	1168
Base/Neutral/ Pesticide		None Detected			

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	16	1.0
105	Chromium, Total	5.5	1.0
106	Copper, Total	7.9	1.0
107	Lead, Total	10	1.0
109	Nickel, Total	5.8	1.0
112	Thallium, Total	4.9	1.0
113	Zinc, Total	34	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-007S-A
Location ID: F-9
CompuChem #: 2393

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile		None Detected			
Acid	LS	Benzene,2,4-Dichloro-1-Methyl-	6,800	EC	887
	LS	Benzene,1,2,4-Trichloro-	9,200	EC	944
	LS	Benzene,1,2,3,4-Tetrachloro-	19,000	EC	1128
	LS	Benzene,Pentachloro-	11,000	EC	1242
	LS	Cyclohexane,1,2,3,4,5,6-Hexachloro-,(1.Alpha., 2.Alpha.,3.Beta.,4.Alpha	7,400	EC	1371
Base/Neutral/ Pesticide	413	BIS (2-Ethylhexyl) Phthalate	10,000	4,000 [1]	1523
	421	1,3-Dichlorobenzene	6,400	4,000 [1]	654
	422	1,4-Dichlorobenzene	9,600	4,000 [1]	659
	433	Hexachlorobenzene	6,800	4,000 [1]	1126
	446	1,2,4-Trichlorobenzene	88,000	4,000 [1]	790
	702	Alpha-BHC	48,000	4,000 [1]	1116
	703	Beta-BHC	7,600	4,000 [1]	1141

[1] Sample extract could not be concentrated to 0.5 ml, thus the detection limits are higher than normal.

Malcolm-Pirnie ID#: VI-0-007S-A
Location ID: F-9
CompuChem #: 2393

ORGANICS, Cont'd.

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Base/Neutral/ Pesticide	LS	Benzene,1-Chloro-2-Methyl-	11,000	EC	607
	LS	Benzene,2,4-Dichloro-1-Methyl-	30,000	EC	746
	LS	Benzene,2,4-Dichloro-1-(Chloromethyl)-	12,000	EC	873
	LS	Benzene,1,2,3,5-Tetrachloro-	29,000	EC	897
	LS	Benzene,1,2,3,5-Tetrachloro-	77,000	EC	931

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	9.5	1.0
105	Chromium, Total	11	1.0
106	Copper, Total	14	1.0
107	Lead, Total	33	1.0
108	Mercury, Total	50	1.0
109	Nickel, Total	4.4	1.0
113	Zinc, Total	40	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-007S-B
Location ID: F-9
CompuChem #: 2394

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile		None Detected			
Acid	LS	Benzene,Chloro-	1,100	EC	571
	LS	Benzene,2,4-Dichloro-1 -Methyl-	460	EC	876
	LS	Benzene,1,3,5-Trichloro-	760	EC	933
	LS	Benzene,1,2,3,5-Tetrachloro-	1,200	EC	1114
	LS	Benzene,Pentachloro-	500	EC	1228
Base/Neutral/ Pesticide	411	BIS (2-Chloroethyl) Ether	1,200	200	646
	446	1,2,4-Trichlorobenzene	800	200	806
	702	Alpha-BHC	340	200	1129
	LS	Benzene,2,4-Dichloro-1 -Methyl-	320	EC	761
	LS	Benzene,1,2,3,5- Tetrachloro-	290	EC	912
	LS	Benzene,1,2,3,5- Tetrachloro-	1,300	EC	945
	LS	Benzene,Pentachloro-	660	EC	1032
	LS	Unknown	200	EC	1094

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-007S-C
Location ID: F-9
CompuChem #: 2395

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	222	Methylene Chloride	3,700	EC	162
Acid	LS	Benzene,Chloro-	310	EC	551
Base/Neutral/ Pesticide	411	BIS (2-Chloroethyl) Ether	1,100	200	623
	LS	Unknown	200	EC	476
	LS	Benzene,Chloro-	580	EC	501
	LS	Unknown	530	EC	682

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	13	1.0
105	Chromium, Total	3.3	1.0
106	Copper, Total	6.0	1.0
107	Lead, Total	11	1.0
109	Nickel, Total	4.2	1.0
112	Thallium, Total	4.7	1.0
113	Zinc, Total	31	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-007S-B
Location ID: F-9
CompuChem #: 2394

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	12	1.0
104	Cadmium, Total	1.0	1.0
105	Chromium, Total	7.8	1.0
106	Copper, Total	7.7	1.0
107	Lead, Total	7.8	1.0
109	Nickel, Total	5.7	1.0
113	Zinc, Total	26	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-009S-C
Location ID: F-11
CompuChem #: 2317

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	207	Chlorobenzene	13,000	2,000	679
	222	Methylene Chloride	5,300	2,000	151
	LS	Formicacid,Methylester	15,000	EC	76
Acid	LS	Benzene,Chloro-	1,400	EC	549
	LS	Benzene,1,3-Dichloro-	320	EC	743
	LS	Benzene,1,3-Dichloro-	330	EC	769
	LS	Unknown	210	EC	799
Base/Neutral/ Pesticide	420	1,2-Dichlorobenzene	360	200	672
	422	1,4-Dichlorobenzene	260	200	652
	LS	Benzene,Chloro-	1,900	EC	501

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	13	1.0
105	Chromium, Total	4.8	1.0
106	Copper, Total	6.5	1.0
107	Lead, Total	11	1.0
109	Nickel, Total	4.7	1.0
112	Thallium, Total	3.0	1.0
113	Zinc, Total	34	1.0

Malcolm-Pirnie ID#: VI-0-010S-C
Location ID: F-12
CompuChem #: 2299

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	222	Methylene Chloride	1,500	2,000	149
Acid	LS	Benzene,Chloro-	1,200	EC	531
Base/Neutral/ Pesticide	LS	Unknown	290	EC	476
	LS	Benzene,Chloro-	320	EC	501
	LS	Unknown	270	EC	560

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	10	1.0
105	Chromium, Total	5.1	1.0
106	Copper, Total	7.1	1.0
107	Lead, Total	10	1.0
109	Nickel, Total	5.7	1.0
112	Thallium, Total	5.5	1.0
113	Zinc, Total	31	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-O-011S-A
Location ID: F-13
CompuChem #: 2387

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	222	Methylene Chloride	2,000	2,000	154
Acid		None Detected			
Base/Neutral/ Pesticide	411	BIS (2-Chloroethyl) Ether	780	200	623
	LS	Unknown	310	EC	476
	LS	Benzene,Chloro-	280	EC	502
	LS	Unknown	310	EC	561
	LS	2,5,8,11,14-Penta-oxapentadecane	220	EC	970

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	13	1.0
105	Chromium, Total	4.0	1.0
106	Copper, Total	7.7	1.0
107	Lead, Total	8.8	1.0
109	Nickel, Total	5.8	1.0
112	Thallium, Total	4.7	1.0
113	Zinc, Total	29	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-011S-B
Location ID: F-13
CompuChem #: 2388

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	222	Methylene Chloride	2,500	2,000	154
Acid		None Detected			
Base/Neutral/ Pesticide	411	BIS (2-Chloroethyl) Ether	480	200	622
	LS	Unknown	190	EC	559

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	14	1.0
105	Chromium, Total	5.5	1.0
106	Copper, Total	7.1	1.0
107	Lead, Total	8.8	1.0
109	Nickel, Total	5.1	1.0
112	Thallium, Total	6.2	1.0
113	Zinc, Total	30	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-013S-A
Location ID: F-15
CompuChem #: 2318

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile		None Detected			
Acid	LS	Benzene,1,2,3,5-Tetrachloro-	520	EC	1100
	LS	Unknown	260	EC	1247
Base/Neutral/ Pesticide	413	BIS (2-Ethylhexyl) Phthalate	5,100	200	1505
	LS	Pentacosane	5,100	EC	1452
	LS	Pentacosane	9,100	EC	1521
	LS	Pentacosane	12,000	EC	1605
	LS	Pentacosane	10,000	EC	1704
	LS	Unknown	8,300	EC	1825

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	21	1.0
105	Chromium, Total	8.6	1.0
106	Copper, Total	16	1.0
107	Lead, Total	18	1.0
109	Nickel, Total	10	1.0
112	Thallium, Total	6.4	1.0
113	Zinc, Total	49	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-060S-A
Location ID: G-6
CompuChem #: 2372

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	222	Methylene Chloride	3,400	2,000	153
Acid	LS	Benzene,Chloro-	1,300	EC	529
	LS	Unknown	1,100	EC	1293
	LS	Unknown	19,000	EC	1340
	LS	Unknown	1,400	EC	1359
	LS	Unknown	1,800	EC	1397
Base/Neutral/ Pesticide	413	BIS (2-Ethylhexyl) Phthalate	230	200	1505
	418	Chrysene	710	200	1521
	420	1,2-Dichlorobenzene	5,200	200	668
	421	1,3-Dichlorobenzene	3,000	200	642
	422	1,4-Dichlorobenzene	5,800	200	648
	426	Di-N-Butyl Phthalate	250	200	1210
	429	Di-N-Octyl Phthalate	530	200	1663
	445	Pyrene	540	200	1317
	446	1,2,4-Trichlorobenzene	21,000	200	778
	702	Alpha-BHC	45,000	200	1104
	703	Beta-BHC	26,000	200	1132
	704	Gamma-BHC	2,400	200	1139

Malcolm-Pirnie ID#: VI-0-060S-A
Location ID: G-6
CompuChem #: 2372

ORGANICS, Cont'd.

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Base/Neutral/ Pesticide	LS	Benzene, Chloro-	10,000	EC	495
	LS	Unknown	7,700	EC	807
	LS	Unknown	5,700	EC	865
	LS	Unknown	16,000	EC	1043
	LS	Unknown	10,000	EC	1114

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	1.2	1.0
105	Chromium, Total	12	1.0
106	Copper, Total	5.0	1.0
107	Lead, Total	2.9	1.0
108	Mercury, Total	6.4	1.0
109	Nickel, Total	3.7	1.0
113	Zinc, Total	68	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-061S-C
Location ID: G-7
CompuChem #: 2377

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	207	Chlorobenzene	2,500	2,000	684
Acid	LS	Unknown	400	EC	1260
	LS	Unknown	340	EC	1386
	LS	Unknown	420	EC	1393
	LS	Unknown	400	EC	1401
Base/Neutral/ Pesticide		None Detected			

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	8.6	1.0
105	Chromium, Total	2.9	1.0
106	Copper, Total	6.6	1.0
107	Lead, Total	6.1	1.0
109	Nickel, Total	4.6	1.0
113	Zinc, Total	27	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-063S-A
Location ID: G-9
CompuChem #: 2381

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	222	Methylene Chloride	8,100	2,000	161
	LS	Unknown	5,900	EC	513
Acid	LS	Unknown	200	EC	1246
	LS	Cyclohexane,1,2,3,4,5,6-Hexachloro-,(1.Alpha., 2.Alpha.,3.Beta.,4.Alpha)	300	EC	1378
Base/Neutral/ Pesticide	413	BIS (2-Ethylhexyl) Phthalate	4,600	400 [1]	1554
	702	Alpha-BHC	8,600	400 [1]	1133
	LS	Eicosane	140,000	EC	1432
	LS	Tricosane	220,000	EC	1499
	LS	Tricosane	310,000	EC	1672
	LS	Tricosane	280,000	EC	1785
	LS	Pentacosane	110,000	EC	1921

[1] Sample extract could not be concentrated to 0.5 ml, thus the detection limits are higher than normal.

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-063S-A
Location ID: G-9
CompuChem #: 2381

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	8.8	1.0
105	Chromium, Total	6.5	1.0
106	Copper, Total	5.8	1.0
107	Lead, Total	8.2	1.0
109	Nickel, Total	6.2	1.0
112	Thallium, Total	2.3	1.0
113	Zinc, Total	30	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-066S-A
Location ID: G-11
CompuChem #: 2921

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	222	Methylene Chloride	2,900	2,000	153
Acid	LS	Cyclotetrasiloxane, Octamethyl-	300	EC	685
Base/Neutral/ Pesticide	LS	Eicosane	450	EC	1526
	LS	Eicosane	600	EC	1608
	LS	Unknown	610	EC	1707
	LS	Unknown	570	EC	1826
	LS	Unknown	390	EC	1972

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	11	1.0
105	Chromium, Total	4.6	1.0
106	Copper, Total	6.4	1.0
107	Lead, Total	8.5	1.0
109	Nickel, Total	5.2	1.0
112	Thallium, Total	3.6	1.0
113	Zinc, Total	28	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-066S-B
Location ID: G-11
CompuChem #: 2922

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	222	Methylene Chloride	5,100	2,000	161
Acid	LS	Benzene,Chloro-	390	EC	529
	LS	Unknown	210	EC	776
	LS	2,5,8,11,14-Penta-oxapentadecane	260	EC	1138
Base/Neutral/ Pesticide		None Detected			

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	8.1	1.0
105	Chromium, Total	4.4	1.0
106	Copper, Total	3.6	1.0
107	Lead, Total	6.0	1.0
109	Nickel, Total	2.9	1.0
112	Thallium, Total	4.6	1.0
113	Zinc, Total	24	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-066S-C
Location ID: G-11
CompuChem #: 2923

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	207	Chlorobenzene	1,100	2,000	679
	222	Methylene Chloride	2,000	2,000	154
Acid	LS	Benzene,Chloro-	350	EC	530
Base/Neutral/ Pesticide	LS	Benzene,Chloro-	270	EC	523

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	14	1.0
105	Chromium, Total	4.2	1.0
106	Copper, Total	6.0	1.0
107	Lead, Total	10	1.0
109	Nickel, Total	4.6	1.0
112	Thallium, Total	4.2	1.0
113	Zinc, Total	30	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-067S-A
Location ID: G-12
CompuChem #: 2924

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile		None Detected			
Acid	LS	Unknown	1,100	EC	1113
	LS	Unknown	1,600	EC	1551
Base/Neutral/ Pesticide	413	BIS (2-Ethylhexyl) Phthalate	6,700	200	1522

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	11	1.0
105	Chromium, Total	6.8	1.0
106	Copper, Total	7.2	1.0
107	Lead, Total	13	1.0
109	Nickel, Total	6.1	1.0
112	Thallium, Total	2.3	1.0
113	Zinc, Total	33	1.0

Malcolm-Pirnie ID#: VI-O-067S-B
Location ID: G-12
CompuChem #: 2925

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	222	Methylene Chloride	3,800	2,000	152
	LS	Formicacid,Methylester	15,000	EC	78
Acid		None Detected			
Base/Neutral/ Pesticide	LS	Pentacosane	480	EC	1449
	LS	Pentacosane	720	EC	1518
	LS	Pentacosane	840	EC	1699
	LS	Unknown	720	EC	1819
	LS	Unknown	440	EC	1966

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	13	1.0
105	Chromium, Total	6.6	1.0
106	Copper, Total	5.8	1.0
107	Lead, Total	9.6	1.0
109	Nickel, Total	3.6	1.0
112	Thallium, Total	4.9	1.0
113	Zinc, Total	33	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-068S-C
Location ID: G-13
CompuChem #: 2929

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	222	Methylene Chloride	3,700	2,000	153
Acid	LS	Cyclotetrasiloxane, Octamethyl-	210	EC	685
Base/Neutral/ Pesticide		None Detected			

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	14	1.0
105	Chromium, Total	5.2	1.0
106	Copper, Total	8.9	1.0
107	Lead, Total	12	1.0
109	Nickel, Total	5.7	1.0
112	Thallium, Total	6.1	1.0
113	Zinc, Total	41	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-069S-A
Location ID: G-14
CompuChem #: 2569

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	211	Chloroform	2,800	2,000	319
	222	Methylene Chloride	6,100	2,000	161
	LS	Formicacid,Methylester	50,000	EC	84
	LS	Unknown	5,000	EC	511
	LS	Pentane	8,800	EC	363
Acid		None Detected			
Base/Neutral/ Pesticide	702	Alpha-BHC	340	200	1129
	LS	Unknown	1,500	EC	1462
	LS	Unknown	940	EC	1473
	LS	Unknown	14,000	EC	1504
	LS	Unknown	14,000	EC	1523
	LS	Unknown	2,200	EC	1558

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)	
106	Copper, Total	3.3	1.0	LS
109	Nickel, Total	8.3	1.0	
112	Thallium, Total	4.0	1.0	
113	Zinc, Total	42	1.0	

Malcolm-Pirnie ID#: VI-0-070S-C
Location ID: G-15
CompuChem #: 2574

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	211	Chloroform	1,400	2,000	303
	222	Methylene Chloride	3,800	2,000	153
	LS	Pentane	8,000	EC	347
Acid	LS	Unknown	210	EC	774
	LS	Cyclotetrasiloxane, Octamethyl-	180	EC	684
Base/Neutral/ Pesticide		None Detected			

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	1.0	1.0
105	Chromium, Total	3.0	1.0
106	Copper, Total	6.5	1.0
107	Lead, Total	3.0	1.0
109	Nickel, Total	2.2	1.0
112	Thallium, Total	1.3	1.0
113	Zinc, Total	29	1.0

Malcolm-Pirnie ID#: VI-0-042S-A
Location ID: H-6
CompuChem #: 2942

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	222	Methylene Chloride	5,700	2,000	158
	LS	Formicacid,Methylester	24,000	EC	81
	LS	Unknown	5,000	EC	514
Acid		None Detected			
Base/Neutral/ Pesticide		None Detected			

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	9.3	1.0
105	Chromium, Total	5.3	1.0
106	Copper, Total	4.1	1.0
107	Lead, Total	7.6	1.0
109	Nickel, Total	3.4	1.0
112	Thallium, Total	2.7	1.0
113	Zinc, Total	27	1.0

Malcolm-Pirnie ID#: VI-O-044S-C
Location ID: H-8
CompuChem #: 2428

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile		None Detected			
Acid	LS	Unknown	2,400	EC	1465
	LS	Unknown	4,000	EC	1568
Base/Neutral/ Pesticide	411	BIS (2-Chloroethyl) Ether	260	200	632
	413	BIS (2-Ethylhexyl) Phthalate	1,500	200	1523
	LS	Pentacosane	1,200	EC	1540
	LS	Pentacosane	1,600	EC	1625
	LS	Pentacosane	740	EC	1468
	LS	Pentacosane	1,600	EC	1728
	LS	Pentacosane	1,300	EC	1853

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	9.7	1.0
105	Chromium, Total	8.6	1.0
106	Copper, Total	6.2	1.0
107	Lead, Total	8.7	1.0
109	Nickel, Total	5.5	1.0
113	Zinc, Total	34	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-045S-C
Location ID: H-9
CompuChem #: 2431

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	222	Methylene Chloride	2,400	2,000	152
Acid	LS	Cyclotrisiloxane, Hexamethyl-	190	EC	494
	LS	Cyclotetrasiloxane, Octamethyl-	280	EC	686
Base/Neutral/ Pesticide		None Detected			

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	14	1.0
105	Chromium, Total	6.4	1.0
106	Copper, Total	7.4	1.0
107	Lead, Total	11	1.0
109	Nickel, Total	6.1	1.0
112	Thallium, Total	4.8	1.0
113	Zinc, Total	36	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-046S-A
Location ID: H-10
CompuChem #: 2432

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	222	Methylene Chloride	5,600	2,000	163
	LS	Formicacid,Methylester	26,000	EC	84
	LS	Ethanol,2-Methoxy-, Carbonate	9,900	EC	514
Acid	LS	Benzene,1-Chloro-2-Methyl-	500	EC	645
	LS	Benzene,2,4-Dichloro-1 -Methyl-	870	EC	821
	LS	Unknown	520	EC	1168
	LS	Unknown	230	EC	1295
	LS	Unknown	250	EC	1504
Base/Neutral/ Pesticide	446	1,2,4-Trichlorobenzene	560	200	809
	LS	Benzene,2,4-Dichloro-1 -Methyl-	500	EC	764
	LS	Benzene,2,4-Dichloro-1 -(Chloromethyl)-	180	EC	900
	LS	Unknown	420	EC	1035
	LS	Unknown	240	EC	1366
	LS	Dodecane,1,1'-Thiobis-	240	EC	1686

Malcolm-Pirnie ID#: VI-0-046S-A
Location ID: H-10
CompuChem #: 2432

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
105	Chromium, Total	8.5	1.0
106	Copper, Total	6.0	1.0
107	Lead, Total	8.5	1.0
108	Mercury, Total	1.0	1.0
109	Nickel, Total	3.9	1.0
112	Thallium, Total	2.1	1.0
113	Zinc, Total	40	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-033S-A
Location ID: I-18
CompuChem #: 2506

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	222	Methylene Chloride	5,800	2,000	155
	LS	Formicacid,Methylester	9,300	EC	79
Acid	LS	Unknown	400	EC	776
Base/Neutral/ Pesticide	LS	Unknown	810	EC	1425
	LS	Unknown	6,500	EC	1463
	LS	Unknown	6,300	EC	1480
	LS	Unknown	640	EC	1602
	LS	Unknown	600	EC	1702

INORGANICS

INSUFFICIENT SAMPLE MATERIAL AVAILABLE TO PERFORM INORGANICS ANALYSIS.

Malcolm-Pirnie ID#: VI-0-017S-A
Location ID: K-6
CompuChem #: 2384

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	222	Methylene Chloride	2,400	2,000	149
Acid	LS	Benzene,Chloro-	800	EC	552
	LS	Cyclohexane,1,2,3,4,5,6-Hexachloro-,(1.Alpha., 2.Alpha.,3.Beta.,4.Alpha)	940	EC	1339
	LS	Unknown	260	EC	1373
	LS	Unknown	5,100	EC	1467
Base/Neutral/ Pesticide	702	Alpha-BHC	350	200	1097
	LS	Cyclotrisiloxane, Hexamethyl-	100	EC	457
	LS	Unknown	210	EC	467
	LS	Benzene,Chloro-	350	EC	492
	LS	Unknown	230	EC	1191
	LS	Unknown	270	EC	1452

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	13	1.0
105	Chromium, Total	8.3	1.0
106	Copper, Total	7.4	1.0
107	Lead, Total	11	1.0
109	Nickel, Total	4.7	1.0
112	Thallium, Total	2.9	1.0
113	Zinc, Total	35	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-017S-B
Location ID: K-6
CompuChem #: 2385

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	222	Methylene Chloride	2,200	2,000	154
Acid	LS	Benzene,Chloro-	390	EC	550
Base/Neutral/ Pesticide		None Detected			

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	11	1.0
105	Chromium, Total	14	1.0
106	Copper, Total	4.7	1.0
107	Lead, Total	9.3	1.0
109	Nickel, Total	3.6	1.0
112	Thallium, Total	3.1	1.0
113	Zinc, Total	30	1.0

Malcolm-Pirnie ID#: VI-0-017S-C
Location ID: K-6
CompuChem #: 2386

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	222	Methylene Chloride	2,300	2,000	154
Acid	LS	Benzene,Chloro-	1,400	EC	552
Base/Neutral/ Pesticide	LS	Benzene,Chloro-	1,100	EC	524

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	14	1.0
105	Chromium, Total	8.7	1.0
106	Copper, Total	7.5	1.0
107	Lead, Total	11	1.0
109	Nickel, Total	5.4	1.0
112	Thallium, Total	4.0	1.0
113	Zinc, Total	33	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-054S-A
Location ID: K-7
CompuChem #: 2903

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	222	Methylene Chloride	6,300	2,000	151
	LS	Pentane	5,800	EC	347
Acid	LS	Cyclotrisiloxane, Hexamethyl-	240	EC	492
	LS	Cyclotetrasiloxane, Octamethyl-	200	EC	684
	LS	Unknown	270	EC	1535
	LS	Unknown	450	EC	1545
Base/Neutral/ Pesticide	LS	Tricosane	1,100	EC	1563
	LS	Tricosane	1,400	EC	1654
	LS	Pentacosane	1,200	EC	1763
	LS	Pentacosane	1,000	EC	1896
	LS	Pentacosane	580	EC	2059

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	13	1.0
105	Chromium, Total	7.1	1.0
106	Copper, Total	6.0	1.0
107	Lead, Total	13	1.0
109	Nickel, Total	5.5	1.0
112	Thallium, Total	4.2	1.0
113	Zinc, Total	46	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-054S-B
Location ID: K-7
CompuChem #: 2904

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	222	Methylene Chloride	3,800	2,000	164
	LS	Formicacid,Methylester	20,000	EC	85
	LS	Unknown	6,300	EC	513
Acid		None Detected			
Base/Neutral/ Pesticide	415	Butyl Benzyl Phthalate	280	200	1399
	LS	Unknown	350	EC	478
	LS	Benzene,1,3-Dimethyl-	200	EC	523
	LS	Unknown	200	EC	548
	LS	Unknown	330	EC	562

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	1.4	1.0
105	Chromium, Total	2.8	1.0
106	Copper, Total	4.3	1.0
107	Lead, Total	5.7	1.0
109	Nickel, Total	3.4	1.0
113	Zinc, Total	28	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-056S-A
Location ID: K-11
CompuChem #: 2909

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	LS	Formicacid,Methylester	21,000	EC	84
	LS	Pentane	9,000	EC	363
	LS	Unknown	6,000	EC	512
Acid	LS	Cyclotrisiloxane, Hexamethyl-	200	EC	492
	LS	Cyclotetrasiloxane, Octamethyl-	240	EC	683
Base/Neutral/ Pesticide	LS	Pentacosane	640	EC	1488
	LS	Heneicosane	1,000	EC	1563
	LS	Hexatriacontane	1,300	EC	1654
	LS	Hexatriacontane	1,200	EC	1763
	LS	Pentacosane	980	EC	1897

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	14	1.0
104	Cadmium, Total	1.1	1.0
105	Chromium, Total	9.3	1.0
106	Copper, Total	6.5	1.0
107	Lead, Total	11	1.0
109	Nickel, Total	6.9	1.0
112	Thallium, Total	3.2	1.0
113	Zinc, Total	42	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-056S-C
Location ID: K-11
CompuChem #: 2911

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	222	Methylene Chloride	4,500	2,000	152
Acid	LS	Cyclotetrasiloxane, Octamethyl-	200	EC	684
	LS	Unknown	240	EC	776
Base/Neutral/ Pesticide		None Detected			

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	21	1.0
105	Chromium, Total	19	1.0
106	Copper, Total	10	1.0
107	Lead, Total	8.1	1.0
109	Nickel, Total	8.4	1.0
112	Thallium, Total	4.3	1.0
113	Zinc, Total	38	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-057S-A
Location ID: K-13
CompuChem #: 2912

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	LS	Formicacid,Methylester	15,000	EC	83
	LS	Unknown	5,200	EC	512
Acid		None Detected			
Base/Neutral/ Pesticide	LS	Pentacosane	1,700	EC	1487
	LS	Pentacosane	2,700	EC	1563
	LS	Pentacosane	3,500	EC	1654
	LS	Tricosane	3,200	EC	1763
	LS	Pentacosane	2,700	EC	1897

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	11	1.0
105	Chromium, Total	5.9	1.0
106	Copper, Total	6.0	1.0
107	Lead, Total	9.3	1.0
109	Nickel, Total	4.5	1.0
112	Thallium, Total	2.9	1.0
113	Zinc, Total	32	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-089S-A
Location ID: K-21
CompuChem #: 2512

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	222	Methylene Chloride	4,500	2,000	155
	LS	Formicacid,Methylester	17,000	EC	79
Acid	LS	Cyclohexane,1,2,3,4,5,6-Hexachloro-,(1.Alpha., 2.Alpha.,3.Beta.,4.Alpha)	430	EC	1305
Base/Neutral/ Pesticide	446	1,2,4-Trichlorobenzene	280	200	806
	702	Alpha-BHC	2,600	200	1130
	703	Beta-BHC	580	200	1154
	LS	Eicosane	780	EC	1489
	LS	Pentacosane	1,200	EC	1565
	LS	Pentacosane	1,400	EC	1655
	LS	Pentacosane	1,300	EC	1765
	LS	Pentacosane	1,100	EC	1899

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	4.4	1.0
105	Chromium, Total	3.6	1.0
106	Copper, Total	6.5	1.0
107	Lead, Total	10	1.0
109	Nickel, Total	6.5	1.0
112	Thallium, Total	1.2	1.0
113	Zinc, Total	37	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-093S-C
Location ID: K-23
CompuChem #: 2359

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	222	Methylene Chloride	5,300	2,000	163
	LS	Formicacid,Methylester	15,000	EC	84
	LS	Unknown	2,700	EC	512
Acid		None Detected			
Base/Neutral/ Pesticide	LS	Unknown	260	EC	586

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
106	Copper, Total	2.0	1.0
107	Lead, Total	1.0	1.0
109	Nickel, Total	4.1	1.0
113	Zinc, Total	50	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-095S-B
Location ID: K-27
CompuChem #: 2364

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	222	Methylene Chloride	4,100	2,000	156
	LS	Formicacid,Methylester	14,000	EC	80
Acid		None Detected			
Base/Neutral/ Pesticide		None Detected			

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
106	Copper, Total	2.1	1.0
109	Nickel, Total	1.3	1.0
113	Zinc, Total	33	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-087S-B
Location ID: M-20
CompuChem #: 2897

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile		None Detected			
Acid	LS	Cyclotrisiloxane, Hexamethyl-	1,800	EC	491
	LS	Cyclotetrasiloxane, Octamethyl-	3,800	EC	683
Base/Neutral/ Pesticide	413	BIS (2-Ethylhexyl) Phthalate	2,300	200	1525
	LS	Pentacosane	340	EC	1542
	LS	Unknown	320	EC	1628
	LS	Pentacosane	340	EC	1731
	LS	Unknown	360	EC	1856
	LS	Unknown	340	EC	2009

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	8.1	1.0
105	Chromium, Total	3.5	1.0
106	Copper, Total	6.8	1.0
107	Lead, Total	7.3	1.0
109	Nickel, Total	7.0	1.0
112	Thallium, Total	7.0	1.0
113	Zinc, Total	38	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VI-0-110S-B
Location ID: X-5
CompuChem #: 2352

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	222	Methylene Chloride	4,500	2,000	156
	LS	Formicacid,Methylester	12,000	EC	79
Acid	LS	Unknown	410	EC	679
Base/Neutral/ Pesticide	LS	Unknown	190	EC	586

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
105	Chromium, Total	1.0	1.0
106	Copper, Total	6.4	1.0
107	Lead, Total	7.8	1.0
109	Nickel, Total	1.4	1.0
112	Thallium, Total	4.6	1.0
113	Zinc, Total	30	1.0

APPENDIX B
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APPENDIX B

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"B" - Fred Hart Associates Report-Ground Water Contamation

"C" - Sampling Plan to Define Chemical Migration

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