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Environmental Information Document

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DIVISION OF SOLID WASTE

SITE INVESTIGATIONS AND REMEDIAL ACTION ALTERNATIVES LOVE CANAL

Task VII
West Storm and Sanitary Sewers

For

Division of Solid and Hazardous Waste
New York State Department
of Environmental Conservation
Albany, New York

August 1983

DRAFT

By

Malcolm Pirnie, Inc.
Niagara Falls, Albany and White Plains, New York

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 VII, West Storm and Sanitary Sewers. 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.

Michael J Mann

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1.0 INTRODUCTION

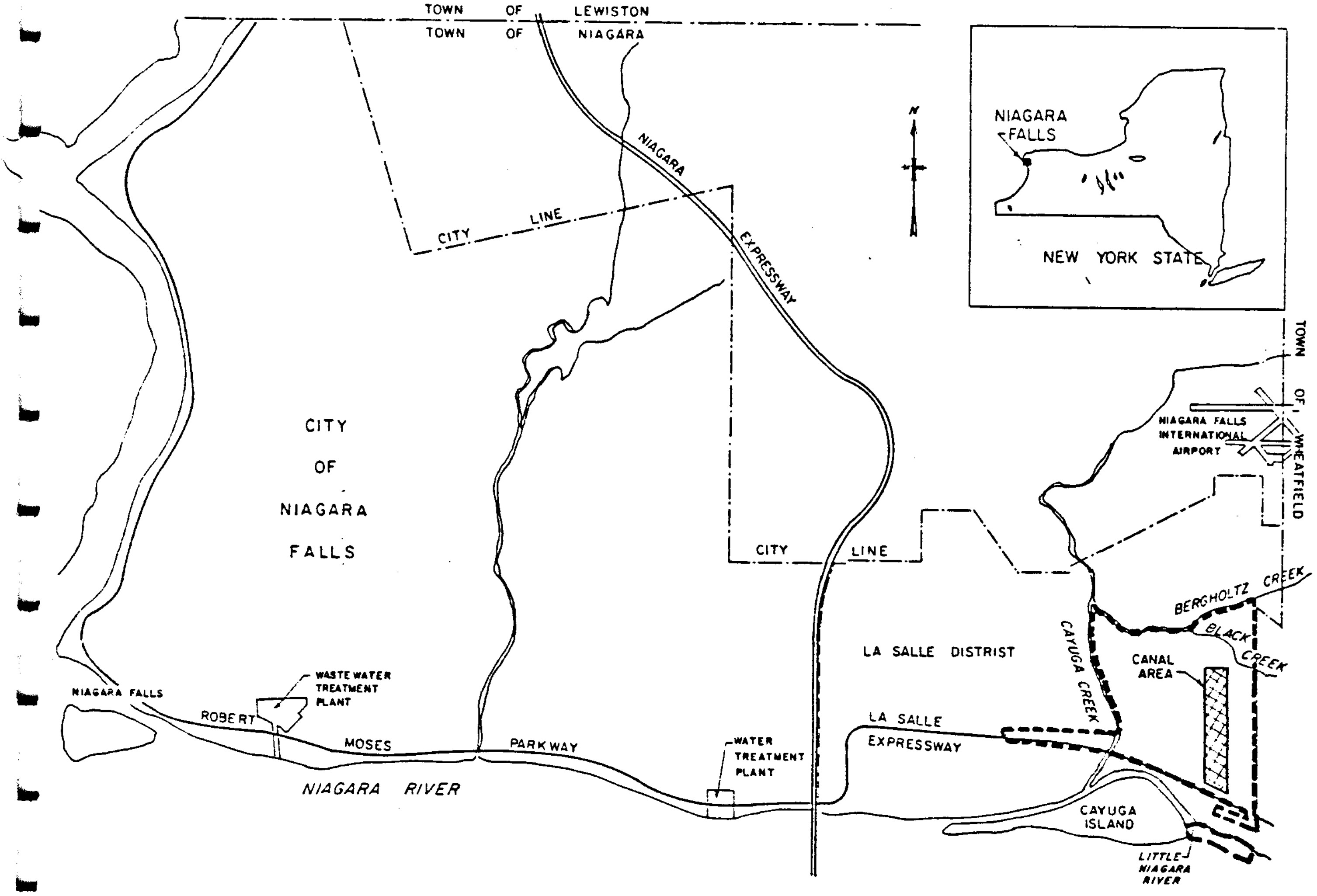
The former chemical waste disposal site at Love Canal occupies a 16-acre rectangular plot of ground in the LaSalle District of Niagara Falls, New York. A regional map illustrating its location is presented as Figure 1-1.

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, crossed the landfill in an east-west direction. A public elementary school, known as the 99th Street School, occupied a portion of the land between Read and Wheatfield Avenues and was built adjacent to the eastern boundary of the landfill. The southermost 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.

FIGURE I-1



LOVE CANAL
SITE INVESTIGATIONS AND REMEDIAL
ACTION ALTERNATIVES
REGIONAL MAP

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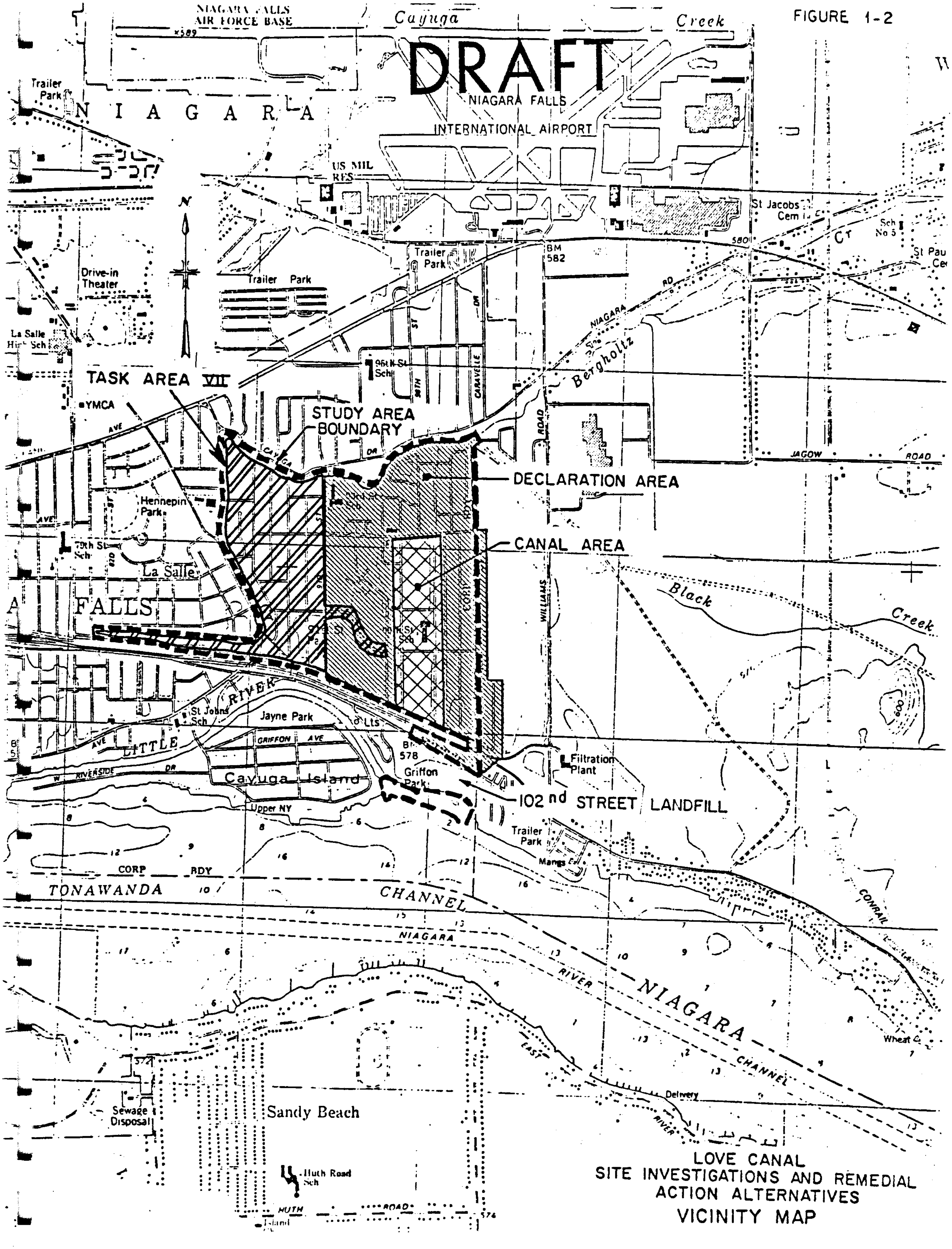
In January 1983 five engineering investigations were initiated in areas adjacent to Love Canal. These engineering investigations were conducted by Malcolm Pirnie, Inc. as part of seven additional Love Canal remedial projects being administered by the NYSDEC Division of Solid Waste under a cooperative 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) are illustrated in the vicinity map presented as Figure 1-2.

This Environmental Information Document (EID) presents a detailed contamination assessment and evaluates remedial alternatives for Task Area VII, the West Storm and Sanitary Sewers. EIDs addressing the four other task areas have been prepared separately.

FIGURE 1-2



LOVE CANAL
SITE INVESTIGATIONS AND REMEDIAL
ACTION ALTERNATIVES
VICINITY MAP

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2.0 PROJECT OBJECTIVES

2.1 Overall Program

The overall objective of the project was 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 both storm and sanitary sewers in the task area;
- Identification of the pathways for migration of contaminants into and away from the task area;
- Assessment of 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 Specific Task Area VII Objectives

Task Area VII, West Storm and Sanitary Sewers is bounded by 96th Street on the east, Cayuga Creek on the south, Bergholtz

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Creek on the north and Military Road on the south. This area is shown on Figure 1-2.

In addition to the general objectives stated in Section 2.1, several additional work items have been identified for Task Area VII and are summarized below:

- Determination extent of contamination in Pumping Stations No. 1, 4, and 6 and the overflow bypass stations at Military Road and Cayuga Creek.
- Determine the degree and extent of Love Canal related contamination which has migrated outside the Declaration Area, specifically in the 20-inch sewer along Frontier Avenue between Cayuga Creek and Lift Station No. 6.
- Identification and delineation of surcharge area in the vicinity of 91st, 92nd and 93rd Streets.
- Assessment of the contaminants which can enter into Cayuga Creek via overflow bypasses from Lift Station Nos. 1, 4, and 6.
- Determine if contamination exists in storm sewers which empty into Cayuga and Bergholtz Creeks.
- Determine if active migration of contaminants from the canal area is still occurring.
- Evaluate if significant movement of contaminants is occurring in storm sewers during storm events.

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- Determine the degree and extent of contamination of pipe bedding materials and assess the potential of bedding material to act as a migration pathway.

- Determine the potential for volatilization of contamination in the sewer and the impact of chemical volatilization upon remedial efforts.

- Develop data base to determine if sanitary sewers in the task area are contaminated with Love Canal type contaminants. Prior to this engineering study, the EPA had sampled only one sanitary sewer in the Declaration Area.

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3.0 BACKGROUND INFORMATION

3.1 Site History (summarized from EPA Monitoring Study)

The Love Canal landfill takes its name from William T. Love, whose plan was to dig a power canal between the upper and lower Niagara River to provide cheap hydroelectric power for a proposed model industrial city. The Model City project and partially-dug canal were abandoned before the turn of the century. In 1942, the Hooker Chemicals and Plastics Corporation entered into an agreement with the Niagara Power and Development Company (then owner of the canal) to purchase Love's unfinished canal. Hooker has acknowledged that it used the canal between 1942 and 1953 for the disposal of at least 21,800 tons of various chemical wastes. It is also know that the City of Niagara Falls disposed of solid wastes (mainly in the portion of the canal bounded today by Read and Wheatfield Avenues) in Love Canal.

Shortly after Hooker terminated disposal activities at Love Canal in 1953 the land was acquired by the Niagara Falls Board of Education for the purpose of constructing an elementary school on the site. In 1955, the 99th Street Elementary School located adjacent to the eastern edge of the landfill on 99th Street between Read and Wheatfield Avenues was completed and opened.

As early as 1938, a number of private residences were located near the northeast corner of Love Canal. By 1952 approximately 6 to 10 houses existed on 99th Street (the backyards of these houses faced toward the active dumping in the canal), mainly located around the central and south-central portions of the canal. By 1962, virtually all of the 99 houses on 97th and 99th Streets whose backyards faced the former canal, the so-called "Ring 1" houses, were completed. In general, residential development around Love Canal occurred primarily from the mid-1950's through the early 1970's. By 1966, all evidence of earlier excavation at the site had been eliminated by subsequent construction activities.

In the mid 1970's a number of problems in the general Love Canal area were noticed by residents. These problems included: unpleasant chemical odors, oily and corrosive residues in basement sumps; and ponded surface water, physical subsidence, and surfaced drums in the landfill itself.

Numerous investigations conducted between 1976 and 1980 showed that serious contamination and potential health risks existed in residences adjacent to Love Canal. As a result of these investigations and related events New York State eventually purchased all homes within Rings 1 and 2, and most homes included in the May 1980 emergency declaration (the so-called Declaration Area). These actions led to the permanent relocation of canal area residents and the initiation of USEPA Love Canal environmental monitoring studies described in Section 3.2.

Since the latter part of 1978, a series of remedial construction activities have been undertaken in the Canal Area. A leachate collection system was installed around the entire perimeter of the former canal in order to prevent continuing lateral migration of contaminants from the landfill. Lateral trenches were dug from the main barrier drain trench towards the former canal and filled with sand to hasten dewatering of the site and to facilitate construction. A clay cap was also installed over portions of the landfill to minimize volatilization of contaminants, prevent human contact with hazardous wastes, prevent runoff of contaminated surface water, and to minimize the amount of precipitation infiltrating the landfill and thus reduce the generation of leachate. Leachate collected on the site is treated at a permanent activated carbon facility which became operational at the end of 1979. In July and August of 1982, all Ring 1 and 2 houses within the fenced canal area were demolished to make way for a more complete cap over the landfill.

In February of 1983, work began on a permanent cap consisting of clay and synthetic materials, and on an impermeable barrier wall to further restrict contaminant transport through upper soil strata. More recently, in June of 1983, the 99th Street School was also demolished to accommodate the final cap.

3.2 USEPA Love Canal Monitoring Study

The most recent and comprehensive report on environmental contamination, "Environmental Monitoring at Love Canal," was published by the USEPA in May 1982. The report was based on extensive analyses of air, water, sediment and biota samples collected during August, September and October 1980. The USEPA data revealed a limited pattern of environmental contamination in the area immediately adjacent to the canal, probably caused by "localized and highly selective migration of toxic substances from the former canal to the vicinity of certain Ring 1 houses." The data also revealed that contamination was present in storm sewer lines which originated near the former canal. No evidence of Love Canal-related contamination was found in storm sewers which were isolated from direct canal area flow.

A total of 26 sampling sites within the study area were included in the storm sewer portion of the monitoring program. A pattern of direct Love Canal-related contamination was

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evident in storm sewer lines connected to the sewers on 97th and 99th Streets. Numerous compounds were detected including chlorinated benzenes and toluenes, and several pesticides including Lindane and other isomers of hexachlorocyclohexane (BHC). The ranges of contaminant concentrations in storm sewer sediments were 0 to 169 ppb, 0 to 237 ppb and 0 to 79 ppb for benzenes, toluenes and Lindane, respectively. Contaminant concentrations in sewer sediment samples were generally higher than those detected in sewer water samples, and were also generally found to decrease with increasing distance from the canal area.

Similar to other Love Canal-related contaminants, the presence of 2,3,7,8-tetrachlorodibenzo-p-Dioxin (2,3,7,8-TCDD) was detected in a number of storm sewer sediment samples with decreasing concentrations as distance from the former canal increased. 2,3,7,8-TCDD was detected at concentrations up to 650 ppb.

Apart from these findings, the monitoring data revealed no clear evidence of environmental contamination in the area encompassed by the emergency declaration order that was directly attributable to the migration of substances from Love Canal. Furthermore, the data revealed that the barrier drain system surrounding the landfill was effectively intercepting substances migrating laterally from Love Canal, and was drawing near-surface ground water back to the drains for collection and subsequent treatment.

3.3 Other Pertinent Reports and Findings

3.3.1 Storm and Sanitary Sewers

Residences in the LaSalle District, which encompasses the entire study area, originally used septic tanks and tile fields to dispose of sanitary wastewater. When storm sewers were installed prior to annexation of the District by the City of Niagara Falls in 1927, many of the septic systems were connected to the storm sewers. Installation of sanitary sewers began shortly after the annexation and continued as the area was further developed and as needs arose (see Report to City of Niagara Falls, LaSalle Infiltration/Inflow Analysis). Most sanitary sewers in the study area are between 45 and 50 years old, except for those serving the Griffon Manor housing development which were installed around 1973. Shortly after the canal was filled in 1953, Read and Wheatfield Avenues were built across the landfill. In 1960, the City of Niagara Falls installed a storm sewer line under Read Avenue, which entered the canal site from 97th Street and ended in a catch basin located approximately midway between 97th and 99th Streets. Field inspection notes reported that only excavated soils were used to fill the trench. City records do not identify the construction of storm sewer laterals on Wheatfield Avenue connecting into storm sewer lines on 97th and 99th Streets. However, field inspection notes reported that storm sewer laterals were built along Wheatfield Avenue from both 97th and 99th Streets, each running towards the former canal for approximately 170 feet (see Report to City of Niagara Falls, LaSalle Infiltration/Inflow Analysis). As with other sewer lines installed by the City of Niagara Falls around Love Canal, these were also reportedly backfilled with excavated soils.

The western limits of the entire study area (Task Areas II, IV and VII) is Lift Station No. 6. Once the flow reaches Lift Station No. 6, there are two potential routes to the City of Niagara Falls Wastewter Treatment

Plant. These routes are shown on Figure 3-1 and described below.

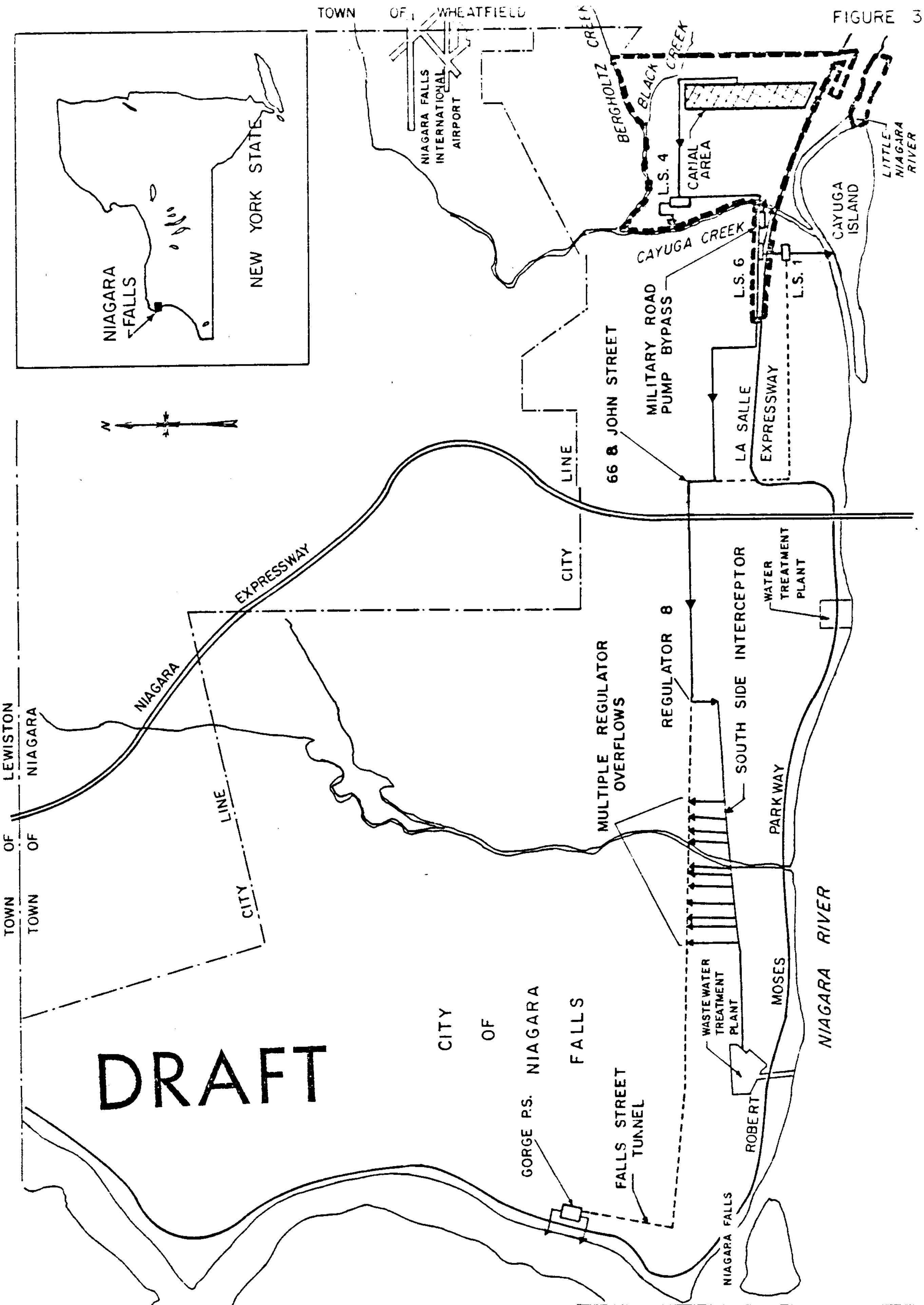
The vast majority of the wastewater leaves Lift Station No. 6 in a westerly direction via the gravity sanitary sewer on Frontier Avenue. At 74th Street the wastewater turns north and flows to Girard Avenue where the wastewater turns west and flows to 66th Street.

At very infrequent intervals, the wastewater from Lift Station No. 6 can overflow into Lift Station No. 1. From Lift Station No. 1, the wastewater heads west by gravity along Stephenson Avenue. At 66th Street, the wastewater turns north and flows to Girard Avenue. At the intersection of Girard Avenue and 66th Street, the wastewater from both potential flow routes combines into one sewer. At this point, wastewater from the northern industrial area of the City of Niagara Falls combines with the wastewater stream from the study area. This industrial contribution would hinder any attempts at identifying specific Love Canal contaminants beyond this point.

From Girard Avenue and 66th Street, the wastewater flows north by gravity to John Street. At John Street, the wastewater turns west and flows via gravity to 47th Street and Royal Avenue at which point the Southside Interceptor begins.

During dry weather conditions the wastewater in the Southside Interceptor flows directly to the City of Niagara Falls Wastewater Treatment Plant. During high flow periods, normally caused during rainfall periods, the Southside Interceptor can overflow through regulators

FIGURE 3-1



LOVE CANAL FIVE ENGINEERING STUDIES
SANITARY SEWER OVERFLOWS

into the Falls Street Tunnel. The Falls Street Tunnel flows to the Gorge Pumping Station where the wastewater is pumped to the City of Niagara Falls Wastewater Treatment Plant or bypassed directly to the Niagara River.

3.3.2 Previous Contamination Investigations

Numerous documents exist which directly or indirectly address Love Canal, nearby inactive hazardous waste disposal sites, and their effect on the environment. The following summarizes the findings of these previous reports on the extent of contamination in the study area sewers.

- A liquid sample collected by the City in May 1980 at the 99th Street and Wheatfield sanitary sewer indicated concentrations of 89 ppm, 22 ppm and 1.5 ppm of chlorinated benzenes (total all species), lindane and hexachlorobutadiene (C-46), respectively (see memos from John Westendorf, chemist for City of Niagara Falls). These high contaminant concentrations prompted the City to plug the Wheatfield sanitary sewer at 99th Street in October 1980. Subsequent samples collected from the lift station influents after the Wheatfield sanitary sewer was plugged show steadily decreasing contaminant concentrations with a large seasonal and weather-dependent variability.

- Samples were taken with assistance from City of Niagara Falls Personnel from baffles in the 91st Street and 81st Street Pumping Stations for the USEPA on May 1, 1980 (see Addendum

Report, "Chemical Contamination in the Sanitary Lift Stations"). Approximately 500 grams of sediment was taken from each station. The sample from the 91st Street Pump Station had high concentrations of Love Canal type contaminants. The highest concentration was 2,340 ppm of BHC (gamma). The 81st Street Pump Station also recorded concentrations of Love Canal type contaminants. The highest concentration was 1,964 ppm of BHC (Beta). Many other Love Canal type organic contaminants were identified but not quantified.

o The New York State Departments of Health and Environmental Conservation conducted an extensive sampling program in the spring and summer of 1979 involving collection and analysis of approximately 80 storm sewer water and sediment samples (see Special Report to Governor and Legislature, Love Canal).

Results from approximately 3 locations in Task Area VII reported the locations where Love Canal type contaminants were found are subject to surcharge conditions from Bergholtz Creek.

o In February 1980, the City initiated a monitoring program for chlorinated organics in canal area sanitary sewers by sampling influents to Lift Stations No. 4 (91st and Luick Avenue) and No. 6 (81st and Frontier Avenue) (see memos from John Westendorf). This program was prompted by severe chemical odors associated with an accumulation of black viscous material in the lift station wet wells. Initial sampling results indicated the presence of relatively high levels of Love Canal-related contaminants including chlorinated benzenes (predominately trichloro- and tetrachloro- species and lesser amounts of dichloro- and pentachloro- species) chlorotoluene, and lindane concentrations ranging from 600 to 2500 ppb, 300 to 1400 ppb and 10 to 350 ppb, respectively, in both lift station influents.

3.4 Other Abandoned Hazardous Waste Disposal Sites

Inactive hazardous waste disposal sites are believed to be a major source of persistent chemical substances that contribute to contamination of water supplies, fish and waterfowl in the Niagara River and Lake Ontario. Investigations by NYSDEC, Niagara River Toxics Project, and the Interagency Task Force on Love Canal have identified 155 disposal sites within three miles of the Niagara River (see Overview of Environmental Pollution in the Niagara Frontier, USEPA 1982, and Hazardous Waste Disposal Sites in New York State, Volume 3, NYSDEC, June 1980). Several sites are located close to the study area (see Figure 3-2), thereby complicating planning for remedial activity in certain task areas.

3.4.1 93rd Street School

Three thousand cubic yards of flyash and BHC cake excavated from the Love Canal site was used in early 1954 for the 93rd Street School's construction. The school is located on 93rd Street north of Colvin Boulevard along Bergholtz Creek. The NYSDEC has found the soil to be contaminated with trichlorobenzene and tetrachlorobenzene.

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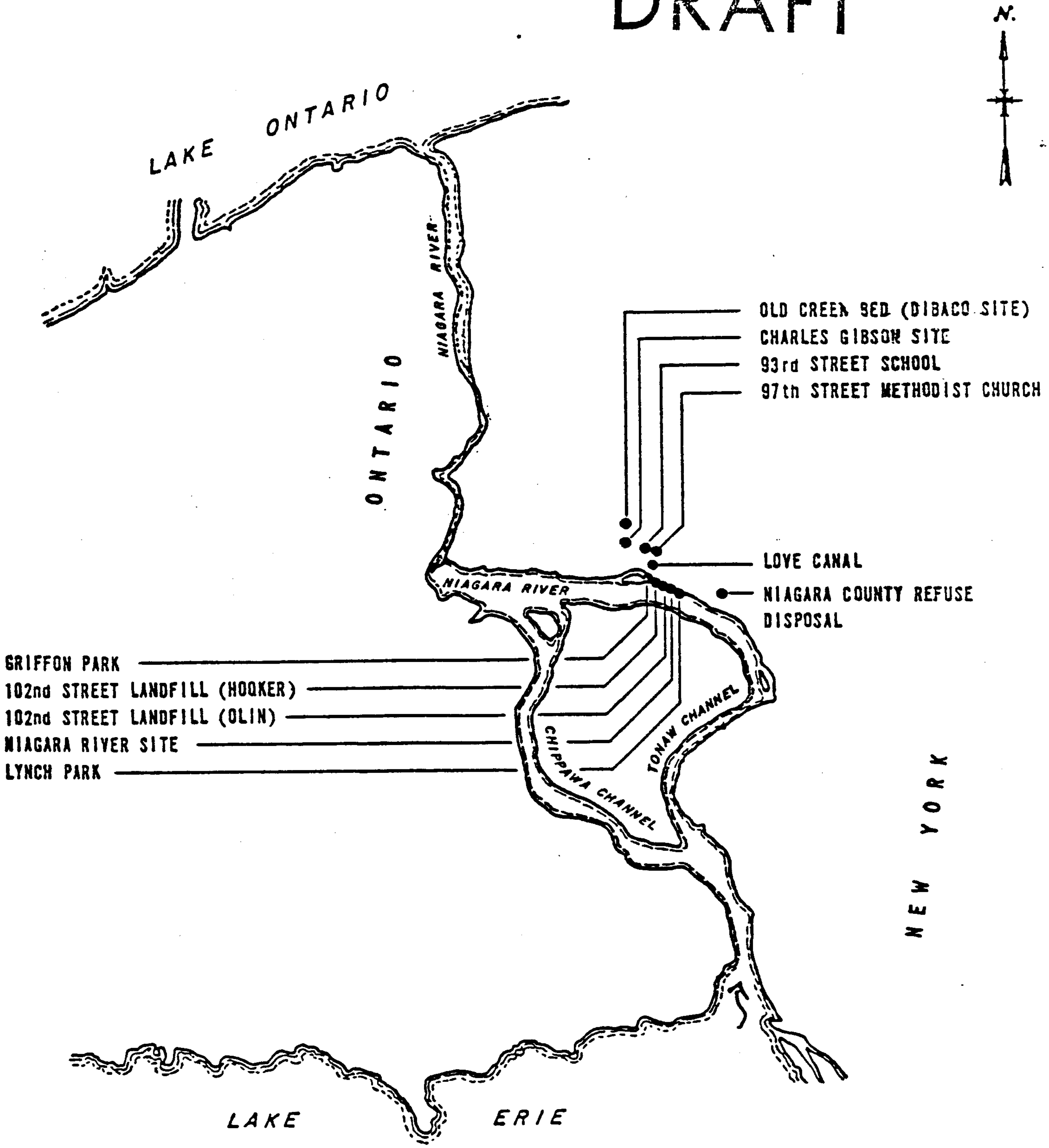
Results of monitoring conducted by the USEPA in 1989 indicated trace levels of Love Canal-related contaminants in the shallow ground water and relatively high cadmium concentrations in the soil at the site (see Overview of Environmental Pollution in the Niagara Frontier, USEPA 1982, and Hazardous Waste Disposal Sites in New York State, Volume 3, NYSDEC, June 1980).

FIGURE 3-2



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FIVE ENGINEERING STUDIES

HAZARDOUS WASTE DISPOSAL SITES OF CONCERN

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4.0 FIELD INVESTIGATION

4.1 General Approach

4.1.1 Storm and Sanitary Sewers

Field investigations in Task Area VII were conducted from January 3 to January 21, 1983 and March 10 and March 11, 1983. The investigations included collection of liquid, sediment and sewer bedding material samples; assessment of manhole condition; and estimation of sewer sediment deposition. Investigations were conducted by three man crews consisting of two environmental technicians working under the direction of an engineer.

Grab samples were manually collected at selected manholes during both dry weather and storm event conditions. The collection point within the manholes was typically in the actual pipe channel, although solids were collected from the manhole benches at locations where sediment deposition was minimal.

Liquid samples were collected by submerging the sampling container directly into the ponded or flowing liquid, if sufficiently deep. Where this was not possible due to flow conditions, the samples were collected using stainless steel scoops and poured into the sampling containers taking care to minimize volatilization due to agitation. All sediment samples were collected using stainless steel scoops and packed into sampling containers after manually pouring off the bulk surface liquid in the scoop.

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The following criteria were used in selecting sample locations:

- All storm and sanitary sewer lines originating in or adjacent to the canal;
- Approximately every 200 feet on straight runs, where physically possible;
- All affected junctions and bends;
- Storm sewer outfalls to Bergholtz and Cayuga Creeks;
- Sewer reaches suspected of being contaminated based on visual inspection, discussions with City personnel or previous monitoring results;
- Known or suspected interconnections between sanitary and storm sewers;
- Areas of known surcharge.
- All lift stations in task area.

All manholes on the selected sewer reaches of the task area were opened regardless of whether or not they were sampled to assess their condition, identify pipeline material, depths, sizes and orientation, and to record the amount of sediment present.

Strict decontamination procedures were followed in the field to prevent cross contamination of samples by equipment or personnel. Collection, handling and analytical techniques utilized were in accordance with procedures established by NYSDEC and USEPA. To ensure the integrity of the samples, strict chain of custody protocol was also followed throughout the course of the field investigation.

4.1.2 Bedding Material

In general, bedding material sampling locations were spread out over the task area and chosen close to earlier sewer sampling locations suspected of having contamination, sewer lines orginating from the Canal Area, or sewer lines suspected of having select granular bedding.

Each boring was supervised by an experienced inspector, under the immediate supervision of a Certified Professional Geologist. Worker safety was maintained in accordance with approved "Work and Safety Plan." The precise location to drill was determined in the field. The manhole crews, as part of their sampling process, painted onto the ground surface the centerline of the sewers which intersected the manholes to show their alignment and determined depth to the sewer invert. The borings were located off of the centerlines a distance of about 1 foot from the outside edge of the sewer pipe. A 2-mil thick sheet of plastic about 9 feet x 12 feet was centered over the boring location with a 1-foot diameter hole through which the boring was drilled. The boring was advanced to a predetermined depth approximately 12 inches below the sewer invert with hollow stem augers with a plug in the auger bit. The plug was removed and either a 2-inch or 3-inch diameter, 24 inches long, split spoon sample was taken. The 3-inch spoon was used in locations of known or suspected select granular bedding material (to assure that sufficient volume of sample was collected). In cases where the

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sewer lines were larger, or where the spoon samples did not confirm the bottom of the bedding material, a second sample was collected and blended with the first to form a single representative sample. Any "clean" soil the boring after the augers were pulled out of the ground was swept off the plastic and tamped back down into the hole. The top 6 inches of a boring completed in a street were backfilled with a "ready mix" asphalt and tamped with a 140-pound hammer. Any soil suspected of containing contamination were shoveled into 55 gallon drums for proper disposal. Decontamination of the drilling equipment and workers was done in accordance with the approved "Work and Safety Plan."

4.2 TASK SPECIFIC APPROACH AND SAMPLING PROGRAM

The storm and sanitary sewer reaches and manholes selected for investigation in Task Area VII are shown in Figures 4-1 and 4-2, respectively. A total of 45 liquid samples, 36 sediment samples, and 16 bedding material samples were collected during the investigations.

4.2.1 Sanitary Sewers and Lift Stations

No sanitary sewers in Task Area VII were investigated in previous studies. However, previous samples taken in lift stations No. 4 and No. 6 indicated high quantities of Love Canal-related contaminants. Therefore, the sewers which lead to and exit from these lift stations have been given additional attention.

In discussions with City personnel, it was determined that surcharging occurs in the area of 91st St., 92nd St., 93rd St. and Read Ave. during high flow periods.

FIGURE 4-1

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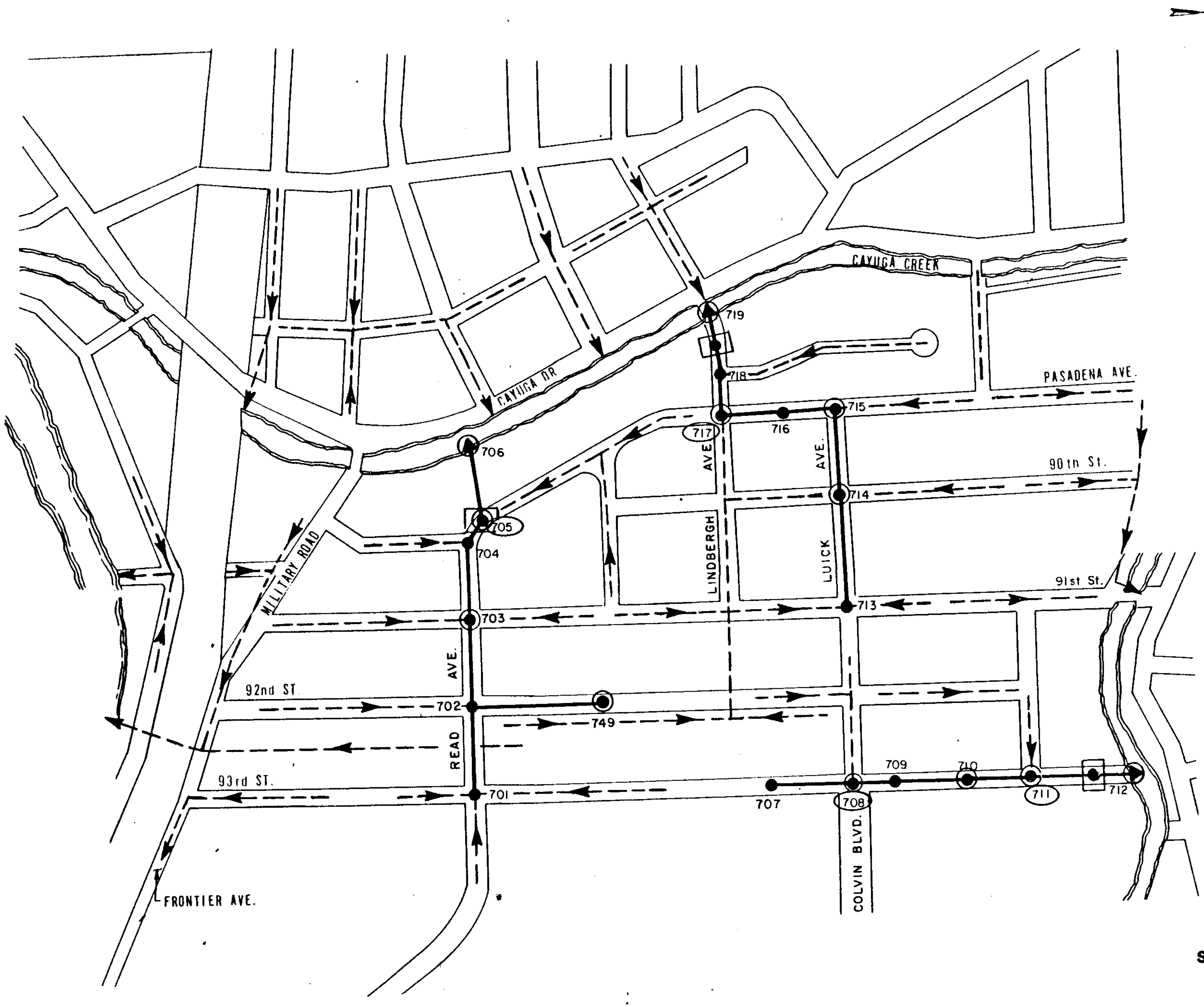
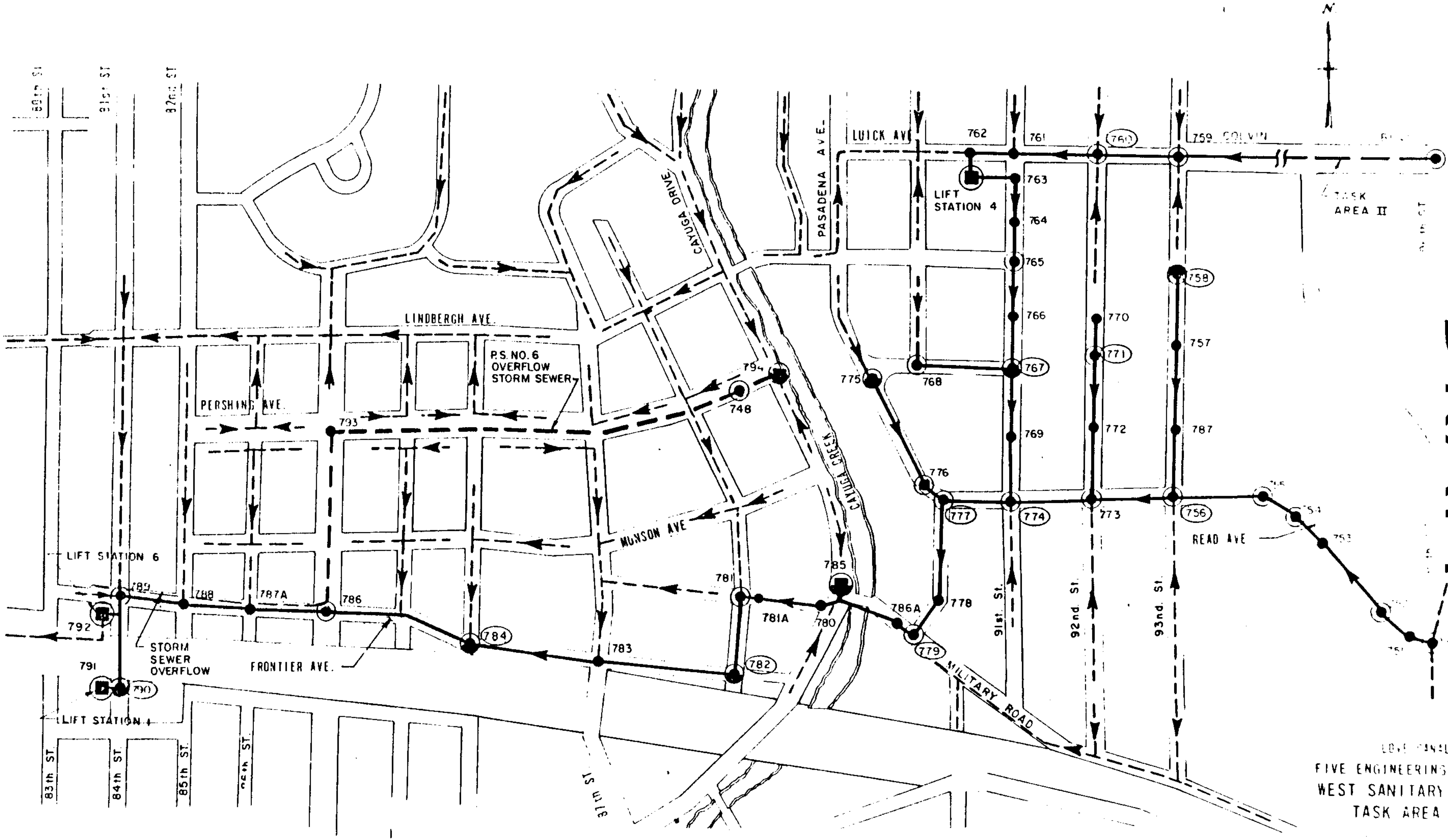


LOVE CANAL
FIVE ENGINEERING STUDIES
WEST STORM SEWERS
TASK AREA VII

SAMPLE LOCATION POINTS

FIGURE 4-2



LOVE CANAL
FIVE ENGINEERING STUDIES
WEST SANITARY SEWERS
TASK AREA VII

SAMPLE LOCATION POINTS

This area was given special attention because of the potential for Love Canal Area contaminated wastewater to surcharge into areas which were not directly connected into sewers emigrating from the Love Canal Area.

All wastewater from the entire Declaration Area, including the Canal Area, passes through Task Area VII. This main flow route was given special attention because of the potential for contamination which originated in the Canal Area.

4.2.2 Storm Sewers

Storm sewers in Task Area VII known to be contaminated from previous studies are located on 93rd Street just south of Bergholtz Creek. Additionally, any storm sewer in Task Area VII which discharges into Bergholtz Creek has the potential for contamination because of the possibility of sewer surcharging during periods when the creek experiences high water levels. Therefore these storm sewers were given special attention in this study.

Lift Stations No. 4 and No. 6 have overflow bypasses which discharge into storm sewers during high flow periods. These storm sewers were chosen as specific sampling locations.

Liquid samples were also collected during a storm event on March 10 and 11, 1983 to assess contaminant transport under increased storm sewer flows. Storm event sampling in Task Area VII was limited to storm sewer outfalls. Based on previous studies and observations made during the initial field investigations, outfall sampling was considered adequate to give an indication of contaminant mobility during a storm event.

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4.2.3 Bedding Material - Task Area VII

Bedding material samples along the storm sewer lines were collected from near Manhole Nos. 705, 711 and 717 because they were downgradient of most of storm sewers in the study area and because each of these sewers can receive overflow bypasses from sanitary sewers.

Bedding material sampling locations near MH Nos. 760, 767, 774, 777, 779, 782, and 784 were selected to provide sampling along the main sanitary sewer interceptor in the study area. The highest levels of contamination could be expected along this interceptor route.

Bedding material samples were collected near MH Nos. 758, 771, and 756 to determine if bedding material contamination could have occurred because of surcharged sewers.

A bedding material sample was taken near MH 790 to determine if bedding material for the overflow pipe between Lift Station Nos. 1 and 6 was contaminated.

4.3 Physical Findings

4.3.1 Sanitary Sewers

Most sanitary sewers in Task Area VII are constructed of vitrified clay with mortar joints. Pipe sizes range from 8 to 15 inches in diameter. Sanitary sewers are generally a minimum of 5 feet below street level at the upstream end of sewer lines. The maximum depth is reached in manholes just upstream of the pump stations. The greatest depth is approximately 24 feet just upstream of Lift Station No. 4.

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The condition of the sanitary manholes was reviewed during the sampling and inspection program. In general, sanitary manholes had clean walls with few, if any, major cracks or leaks. However, many had loose bricks near the manhole cover frame. These loose bricks are a potential source of sediment and debris which could collect in the sewers. Most sanitary sewers had little or no sediment in the channel, although many had accumulations on the manhole benches. Table 4-1 summarizes the sediment quantities in the sanitary manholes and sewers in Task Area VII. Detailed logs of the sanitary sewer sampling and inspections are presented in supporting documents.

Many of the sewers were surcharged in the portion of Task Area VII along Read Avenue east of 92nd Street. However, little sediment was felt in probing the flooded channels with a survey rod. This surcharging was probably caused by a clogged pipe on Read Avenue between 91st and 92nd Streets. This was evident because surcharging was not observed downstream of this area.

During high flow periods, sanitary sewers in Task Area VII are occassionally pumped into adjacent storm sewers. According to City personnel, this has occurred at the following locations in Task Area VII:

- Pasadena Avenue at Read Avenue
- Lift Station Nos. 4 and 6
- Colvin Boulevard and 93rd Street
- 93rd Street and Cayuga Creek

4.3.2 Sanitary Sewer Pumping Stations

Three sanitary lift stations and one sanitary overflow station in Task Area VII were sampled as part of the field

TABLE 4-1

SANITARY SEWER SEDIMENT QUANTITY IN TASK AREA VII

Location/ Manhole	Sediment Depth (in.)		Location/ Manhole	Sediment Depth (in.)	
	Channel	Bench		Channel	Bench
736	0	0	772	0	0.5
750	3-6	3-6	773	0	0.5
751	1	0.25	774	1	1
752	0	-	775	0	0
753	0.25	0.25	776	0	0.25
754	2	-	777	0	0
755	2	-	778	0	0
756	0	0.25	779	0.75	0
757	0	0	780	-	-
758	1	-	781	0.25	0
759	0	0.25	781A	0	0
760	0	0.5	782	0	0
761	0	0.25	783	0	0
764	0	-	784	0	0
765	0	-	786A	0	0
766	0	0	786B	0	0.25
767	0	0.25	787A	0	0
768	1	-	787B	0	0.25
769	0	0.25	788	0	0
770	1	0	789	2	2
771	0	0.25	790	0	0

investigation. These were: Lift Station No. 4 at 91st and Luick Avenue; Lift Station No. 6 at Frontier Avenue and 81st Avenue; Lift Station No. 1 at 81st and the LaSalle Expressway; and the overflow station at Military Road and Cayuga Drive.

The three lift stations are similar in configuration. Each station has three levels; wetwell, bar screen cleaning platform and pump room. For each of the sanitary lift stations, sediment samples were taken from either the bar screen platform or from the top of the divider wall in the wetwell. Liquid samples were taken from the wetwell.

The overflow station at Military Road and Cayuga Creek only operates during high flow periods at which time the overflowing sanitary sewer is discharged directly to Cayuga Creek. No sediment was found in this pumping station.

Lift Station No. 4 receives all of its flow from sewers within the study area. The overflow station at Military Road and Cayuga Drive also receives all of its flow from sewers within the study area. Lift Station No. 6 receives flow from the study area and from areas east of Cayuga Creek. No flow from the study area reaches Lift Station No. 1 under normal conditions. However, during high flow periods, it is possible for Lift Station No. 6 to overflow into Lift Station No. 1 and vice-versa.

Lift Stations No. 4 and No. 6 are equipped with overflow pumps which will pump sewage from the pump station into nearby strom sewers during high flow periods. Lift Station No. 4's surcharge pump discharges into the storm sewer on Luick Avenue which empties into Cayuga

Creek at Lindberg Ave. Lift Station No. 6's surcharge pump discharges into the storm sewer on Frontier Avenue which empties into Cayuga Creek at Pershing Ave.

4.3.3 Storm Sewers

Most storm sewers are constructed of vitrified clay or concrete. The manholes are typically constructed of brick with mortar joints. The storm sewers range from 6 to 11 feet below street level. The greatest depth occurs just upstream of the creek outfalls.

The condition of the storm manholes was reviewed during the sampling program in Task Area VII. In general, the storm manholes were in worse condition than the sanitary manholes, with considerable amounts of sediment on the manhole walls and benches. Most manholes had loose bricks under the cover frame, a source of sediment in the sewer channels. However, the most likely source of sediment in the sewers probably originates from drain inlets or catchbasins which collect runoff from the roadways. Many of the manholes had sediment on the benches which probably accumulated during periods of high flow. The sediment quantity in the storm sewer manholes is illustrated in Table 4-2. Approximately 60% of the storm sewer manholes investigated had no sediment in the channel. Detailed logs of the storm sewer sampling program are found in supporting documents.

Little flow was observed in the storm sewers during the dry weather sampling. However, many of the sewers did have standing water (usually less than 1/2"). This is an indication of improperly aligned sewers, settlement, or small quantities of sediment causing a damming effect.

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TABLE 4-2

STORM SEWER SEDIMENT QUANTITY IN TASK AREA VII

Location/ Manhole	Sediment Depth (in.)		Location/ Manhole	Sediment Depth (in.)	
	Channel	Bench		Channel	Bench
701	0.25	0.25	711	0	1
702	0.25	0	713	0.25	0.25
703	3	-	714	1.5	-
704	0.25	0.5	715	0.75	0
705	0.5	1	716	2.5	0.75
707	0	0.25	717	1	2
708	0.5	-	718	0.5	0
709	0.25	0.25	748	0	2
710	0.25	-			

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4.3.4 Bedding Material - Task Area VII

None of the samples collected along the storm sewer lines showed any select granular bedding material. The samples from near Manhole Nos. 711 and 717 were bedding material of red-brown clay with coarse granular material mixed in. This indicates that the original trench material was used as backfill.

The samples from near Manhole Nos. 705 and 708 were red-brown clay with laminations and were probably not samples of the actual bedding material. It appears the borings for these samples were not close enough to the sewer pipe to get into the bedding material.

None of the samples collected along the sanitary sewer lines showed any select granular bedding material. The samples from near Manhole Nos. 756, 758, 767, 774, 777, 779 and 782 were bedding material of red-brown clay with coarse granular material or construction debris (mostly pieces of concrete) mixed in. This indicates that the original trench material measured as backfill material. The samples from near Manhole Nos. 750, 760, 771, 784 and 790 were red-brown clay with laminations and probably not samples of the actual bedding material. It appears the borings for these samples were not sufficiently close to the sewer pipe to get into the bedding material.

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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

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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 pollutants. 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

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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 microliter 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 glassware. 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 $^{37}\mathrm{Cl}_{40}$ isotope was used as a surrogate standard while $^{13}\mathrm{C}_{12}$ 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 multipoint calibration at at least three levels of standards. Criteria for calibration and analytical acceptability applied were those in the EPA methodology.

5.4.3 Summary of Acceptability of QC Results

The quality control data generated from the screen, organics, inorganics, and TCDD analyses demonstrated that the analytical performance was within acceptance criteria limits, and that the analytical systems were operating as desired to produce data of appropriate quality.

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. "Hot spot" maps identifying dioxin contamination have 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:

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- Contaminants detected
- Concentrations of individual contaminants
- Toxicity of individual contaminants, represented primarily by drinking water standards or water quality criteria for the protection of human health
- Persistence of individual contaminants, as indicated by physical/chemical/biological properties
- 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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SAMPLE MATRIX

TABLE 6-1
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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SAMPLE MATRIX

TABLE 6-1 (Cont'd)
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

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sure pathways 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 task area contamination assessment maps which reflect the integration of exposure pathway factors, sample scores and other contaminant-related considerations. Additionally, "hot spot" maps are created by plotting concentration data for dioxin, a contaminant of special concern. In conjunction, the contamination assessment maps and the "hot spot" maps 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

FIGURE 6-I

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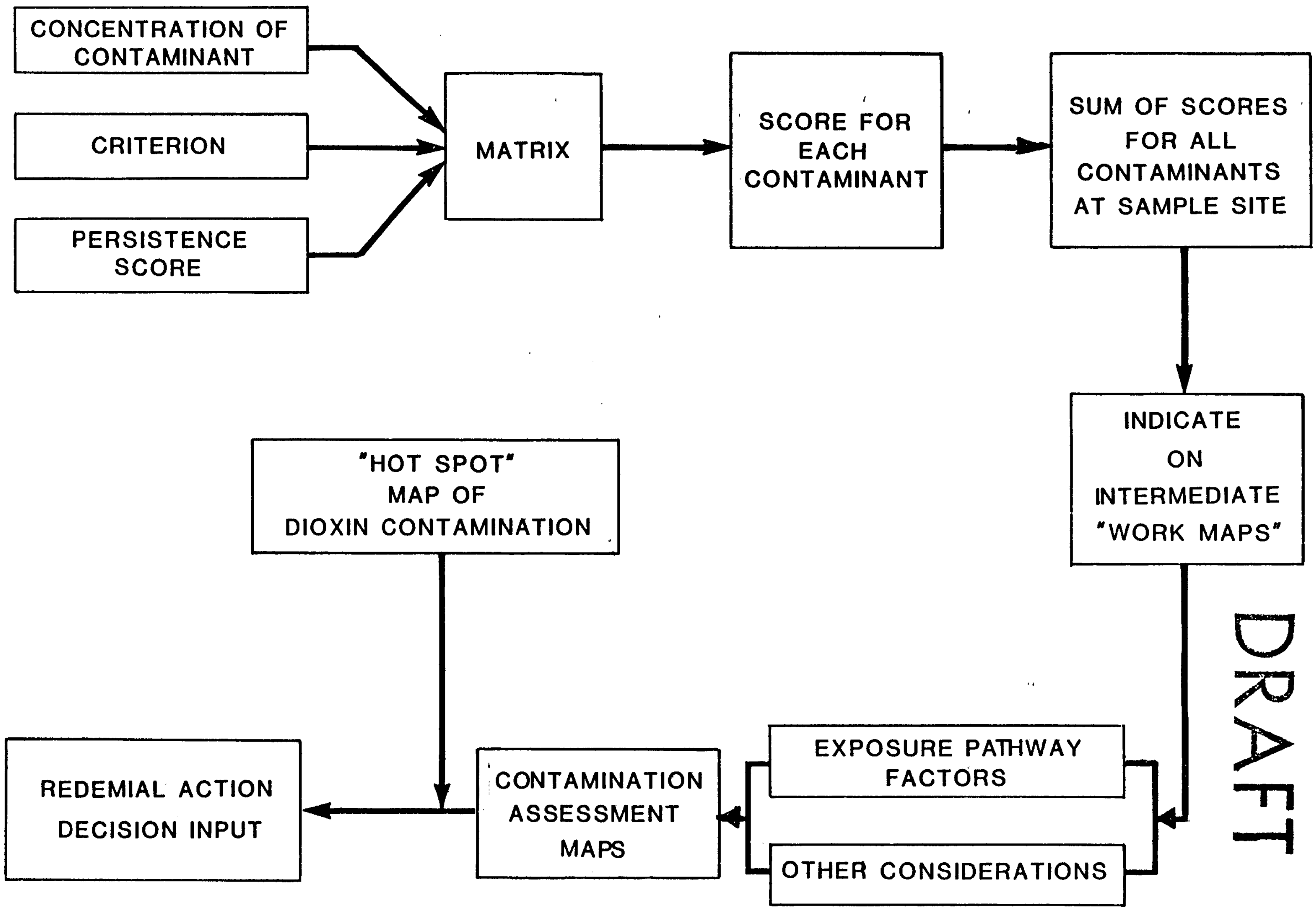
OVERVIEW OF CONTAMINATION ASSESSMENT METHODOLGY



reviewed by consultants from the Department of 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; Availability, 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 the Supporting Documents.

6.2.2.4 Persistence Score

The next column heading, "PERSISTENCE SCORE" refers 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.

o 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
J1000	1
100-999	2
10-99	3
1-9	4
F1	5

o 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
J6	6
5-5.99	5
4-4.99	4
3-3.99	3
2-2.99	2
F2	1

o 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.

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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

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TABLE 6-2 (Cont'd)

CALCULATION OF PERSISTENCE SCORES

Contaminant	H	H Rating	Log Kow	Log Kow Rating	Biodegrad-ability 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

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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 contaminants through this medium appears to occur. In terms of the potential for actual human exposure to contamination via the active pathway, this discussion considers the theoretical worst-case potential only, assuming no remedial action is taken.

> In Task Area VII, both the sanitary and storm sewers may serve as potential pathways for contaminant transport and human exposure. The primary potential pathway for human exposure via the sanitary sewers is the major sewer line on Colvin Boulevard heading south and west across Cayuga Creek to Lift Station No. 6. This line transports flows from all the sewer lines in Task Area VII downstream to Lift Station No. 6. The potential for exposure exists at Lift Station No. 4, where sanitary overflows are pumped into the adjacent storm sewer with eventual discharge into Cayuga Creek at Lindbergh Avenue. Another sanitary overflow into Cayuga Creek occurs at the sanitary overflow station at the intersection of Cayuga Drive and Military Road. A third overflow location is at Lift Station No. 6. Overflows are pumped into the adjacent storm sewer and discharged into Cayuga Creek at Pershing Avenue through a 60-inch outfall. Exfiltration from sewer lines to ground water, or surcharge conditions which discharges

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to surface waters could be potential secondary pathways for exposure.

The primary potential pathways for human exposure to contaminants from the storm sewer system in Task Area VII are the 30-inch outfall on Cayuga Creek at Lindbergh Avenue, the 18-inch outfall off Read Avenue, and the outfall on Bergholtz Creek at 93rd Street. To a lesser degree, other potential pathways include exfiltration through damaged pipes into ground water or discharges into surface waters resulting from sanitary sewer surcharged overflow byapsses into storm sewers.

Based on the sampling results, the sanitary sewer line originating on Colvin Boulevard and terminating at Lift Station No. 6 is an active pathway for the transport of contaminants from sewer lines in Task Area VII. As such, it provides a pathway for potential human exposure to contamination as a result of lift station overflows into storm sewers. Sanitary sewers throughout Task Area VII were found to contain contaminanted sediment; however, no liquid samples exhibited Love Canal-related contamination. Contaminants were also detected in sediments from Lift Stations No. 4 and No. 6, although no contamination was detected at the overflow station at Cayuga Drive and Military Drive. Sanitary sewer overflows ultimately discharged to Cayuga Creek or wastewater discharged from manholes as a result of surcharged conditions could provide a mechanism for human exposure. The sampling results indicate that no Love Canal-related contaminants have exfiltration from sanitary sewer lines into the bedding material

The sampling results confirm that both the Lindbergh Avenue storm sewer outfall and the 93rd Street outfall are active pathways for contaminant transport from the storm sewer system. However, it appears from the sampling data that the 18-inch outfall on Cayuga Creek near Read Avenue is not an active contaminant pathway. Contamination in area storm sewers was found in the sediments; no organic contamination was detected in liquid samples.

The potential for human exposure via direct or indirect skin contact or via ingestion to contaminated sediment in the storm and sanitary sewers is remote. However, since contaminats are apparently migrating into the surface waters in the area, as indicated by the sampling data at the outfalls, exposure could potentially occur via surface water pathways, as discussed in the report of investigations in Task Area III. Human exposure to contaminants in the sewers could also potentially result from the inhalation of volatile compounds subsequent to their partitioning from sediment to liquid, although this possibility is quite remote. A moderate number of samples were found to contain contaminants considered volatile, but in low concentrations.

Exfiltration from storm sewer lines in Task Area VII to bedding material does not appear to be an active pathway for contaminant transport to ground water. The potential for human exposure to bedding material is extremely remote.

6.2.4 Other Considerations

Two groups of contaminants, the phthalate esters and the inorganics, were found consistently in the Task VII

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 II investigations). In some samples, the only compounds detected were inorganics and phthalate esters. 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

Two compounds belonging to a class of chemicals known as phthalate esters or phthalic acid esters were detected in the samples taken in the Task VII Study Area. One of these compounds, bis(2-ethylhexyl) phthalate was detected fairly consistently throughout the study area, but rarely in concentrations exceeding the criteria values used in the matrix for this compound. Bis(2-ethylhexyl) phthalate 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

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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 Ambient Water Quality Criteria for Phthalate Esters, 1980).

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 various task area investigations. Moreover, the likelihood of ingestion of contaminated water in sewer lines is remote.
- Phthalate esters are believed to be capable of absorption through the skin, which is

only a remotely potential route of exposure for the sediment. Moreover, phthalate esters are considered to be of a low order of toxicity (EPA, Ambient Water Quality Criteria Phthalate Esters, 1980).

6.2.4.2 Inorganics (Heavy Metals)

Inorganics were found in the majority of the samples throughout the Task VII 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 investigations of the various task areas for

which inorganics analyses were performed. Moreover, the likelihood of ingestion of contaminated water in sewer lines is remote.

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

6.2.5 Contamination Assessment Maps

The product of the contamination assessment is a set of contamination assessment maps (Figures 6-2 and 6-3) for the Task VII Study Area. These maps depict 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.

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- 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.

- 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 Mapping

Separate "hot spot" maps (Figures 6-4 and 6-5) have been prepared for dioxin, a contaminant of particular concern. The maps identify the sampling locations where this compound was found and the concentrations detected. The "hot spot" maps have been used in conjunction with the contamination assessment maps in determining appropriate remedial measures for the task area.

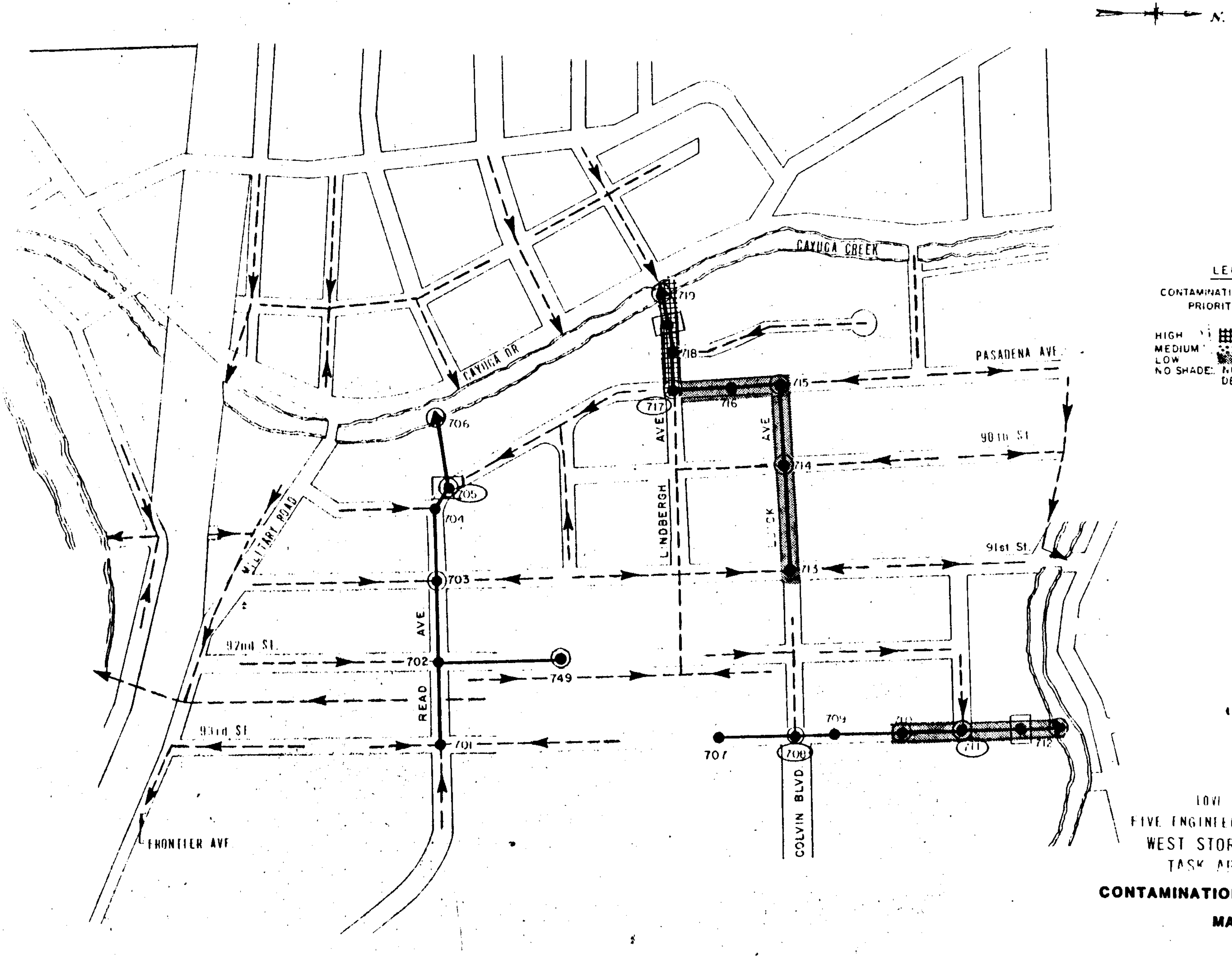
6.3 Discussion of Results

6.3.1 General

This subsection explains the method used to graphically interpolate from the contaminant assessment priority levels at each sample location to produce the contamination assessment maps shown on Figures 6-2 and 63.

Each manhole location sampled which passed the screening analysis was designated as a high, medium or low contamination assessment priority level based upon

FIGURE 6-2



LEGEND

CONTAMINATION ASSESSMENT PRIORITY LEVELS

HIGH	▦
MEDIUM	▨
LOW	▒
NO SHADE:	NO CONTAMINANTS DETECTED

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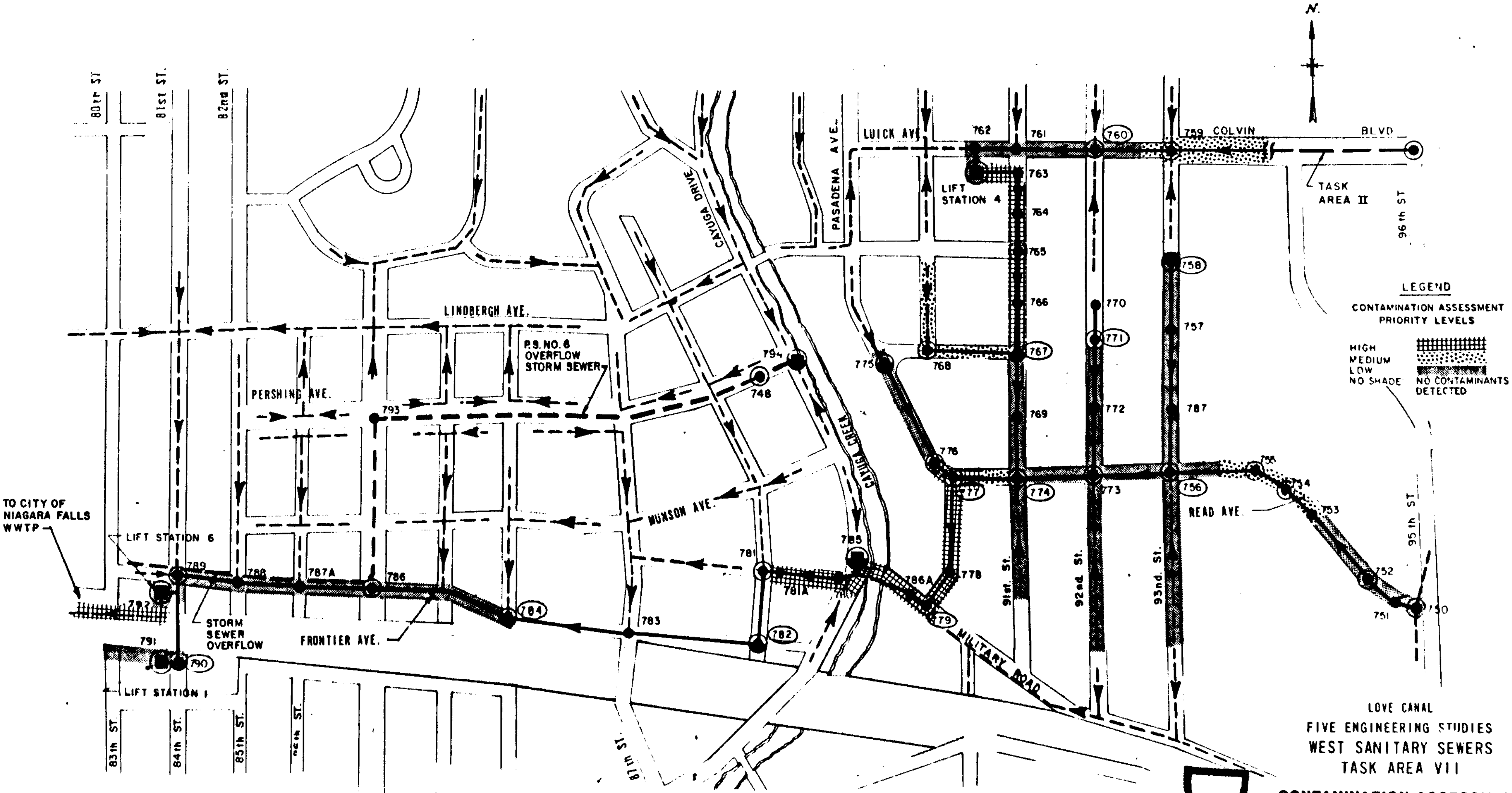
LOVE CANAL
FIVE ENGINEERING STUDIES
WEST STORM SEWERS
TASK AREA VII

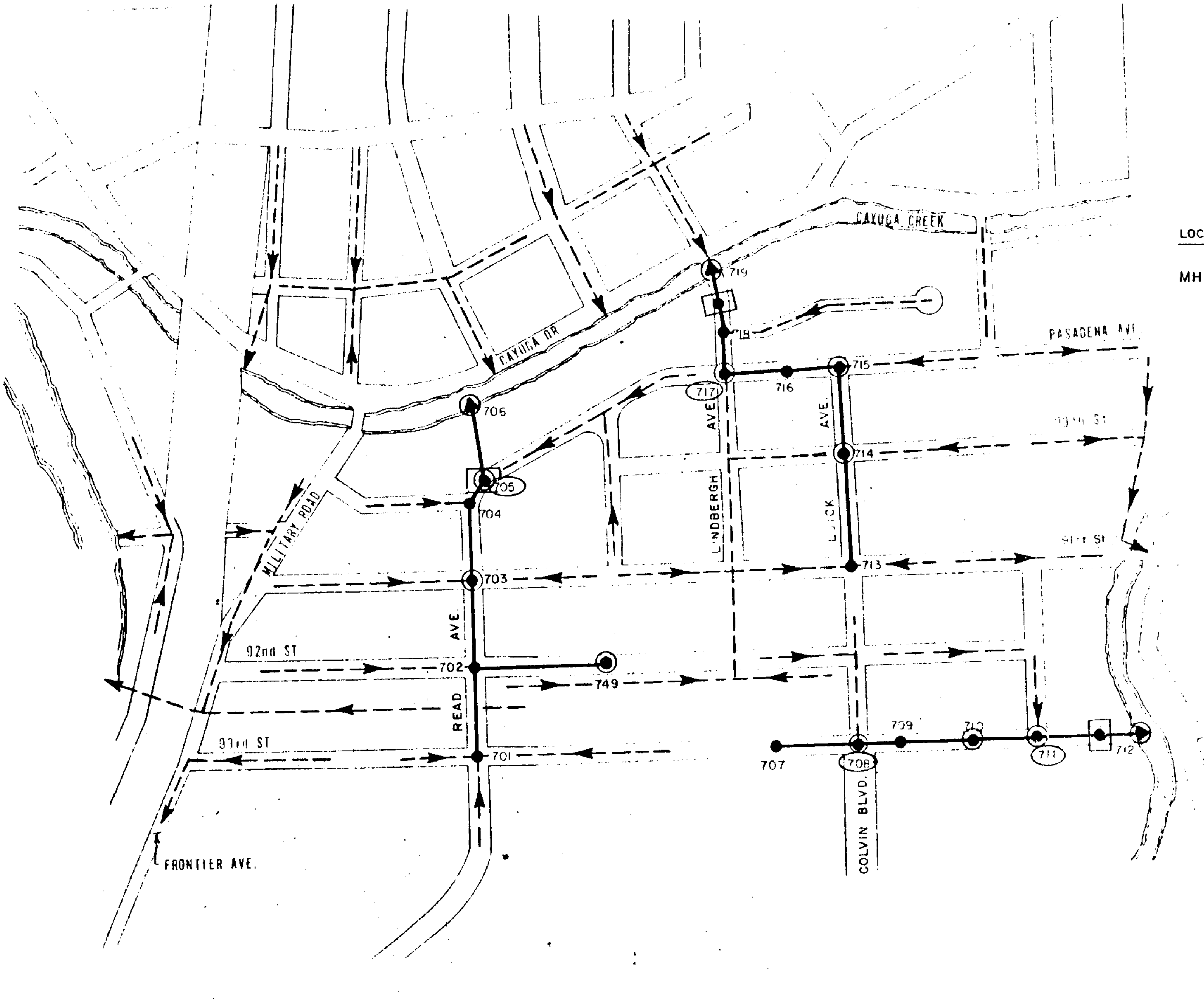
CONTAMINATION ASSESSMENT MAP

FIGURE 6-3



LOVE CANAL
FIVE ENGINEERING STUDIES
WEST SANITARY SEWERS
TASK AREA VII

CONTAMINATION ASSESSMENT MAP



DIOXIN HOT SPOTS

LOCATION	CONCENTRATION (ppb)
MH-712	1.9

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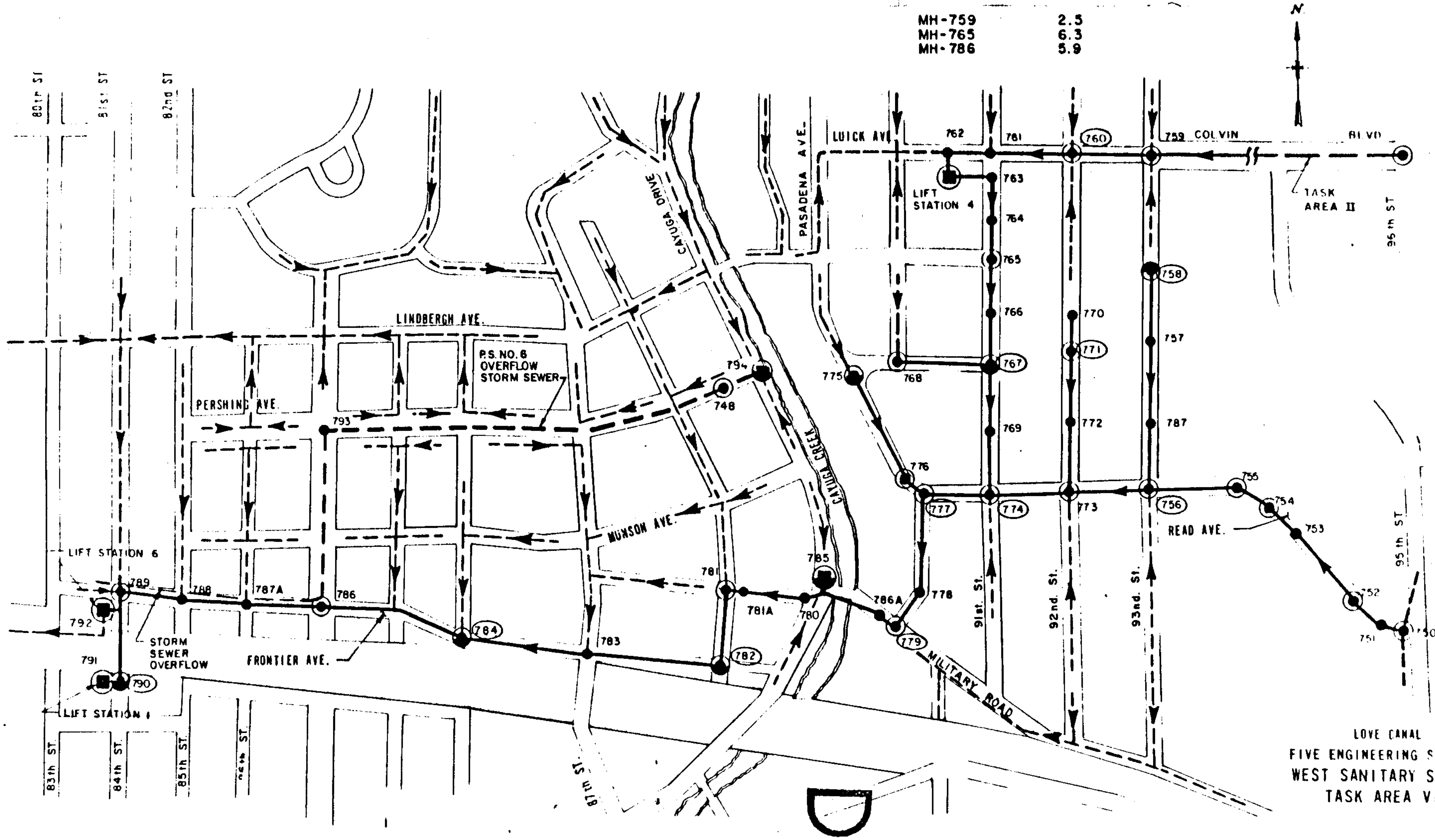
LOVE CANAL
FIVE ENGINEERING STUDIES
WEST STORM SEWERS
TASK AREA VII

FIGURE 6-5

DIOXIN HOT SPOTS

LOCATION	CONCENTRATION (ppb)
MH-759	2.5
MH-765	6.3
MH-786	5.9



LOVE CANAL
FIVE ENGINEERING STUDIES
WEST SANITARY SEWERS
TASK AREA VII

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the results of the quantitative analysis subjected to the contamination assessment scoring methodology (the matrix) previously described in Section 6.2. Samples that did not pass or exceed the qualitative screen are presumed not to be contaminated.

The convention used in preparing the contamination assessment maps is based on the conservative assumption that the analytical results and the associated contamination assessment priority level at each manhole or sampling location are indicative of the level of contamination for the entire sewer reach (to the next manhole). Using the results of the contamination assessment, the upstream and downstream sewer reaches were shaded in each direction from a sampled manhole up to the next manhole or sample location. If the adjacent manhole did not show contamination, the shading was terminated at that manhole. Where samples obtained in adjacent manholes indicated the same level of contamination in each, the shading was continued at that level. For the case where contamination levels differ for adjacent manholes or the subsequent sample manhole, the shading was continued at the appropriate level to a point halfway between each location.

At all sample locations with quantifiable contaminant levels (i.e. low, medium, or high), the detailed analytical results were re-examined to verify the contamination assessment priority level in the context of the sample medium (i.e. sediment, soil, or liquid).

During the Task Area VII sampling program, 16 sewer bedding materials samples, 36 dry weather storm and sanitary sewer sediment samples, 42 dry weather storm and sanitary sewer liquid samples, and 3 storm weather storm sewer liquid samples were collected.

Later in this section, the nature and distribution of contaminants and contamination migration pathways are discussed. Primary migration pathways are defined as those pathways which have or had a known direct connection to a canal area sewer. Secondary migration pathways are those pathways which are not known to be directly connected to a canal area sewer (i.e., surcharged sewers, ground water migration, creek flooding, etc.).

6.3.2 Storm Sewers

6.3.2.1 Nature and Distribution of Contaminants

Four storm sewer sampling locations in this task area exhibited varying degrees of contamination. Four sediment samples showed varying degrees of contamination (two low, one medium, and one high). No liquid samples, either dry weather or storm weather, exhibited any indication of contamination.

The storm sewer sediment samples which exhibited either medium or high degrees of contamination were found in creek sediments at the outfalls of storm sewers on 93rd Street and on Lindbergh Avenue. At the 93rd Street outfall, the sample exhibited a high degree of contamination. This sample contained primarily base-neutral and volatile organics. 2,3,7,8-TCDD (dioxin) was also detected in this sample. The Lindbergh Avenue Outfall sample contained both acid and base-neutral organics.

6.3.2.2 Contamination Migration Pathways

The storm sewers in Task Area VII appear to have become contaminated through two primary migration pathways and one secondary pathway as illustrated on Figure 6-6.

One apparent primary pathway is the pumped overflows from the Lift Station No. 4 to the storm sewer on Luick Avenue which discharges to Cayuga Creek at the Lindbergh Avenue bridge.

The second primary pathway is the use of portable pumps by City utility workers to relieve surcharge conditions in the sanitary sewers by pumping from the sanitary sewers into the storm sewers. The Colvin Boulevard sanitary sewer is occasionally relieved by pumping into any storm sewers which empty into Bergholtz Creek. This explains the source of contamination in the 93rd Street north of Colvin Boulevard.

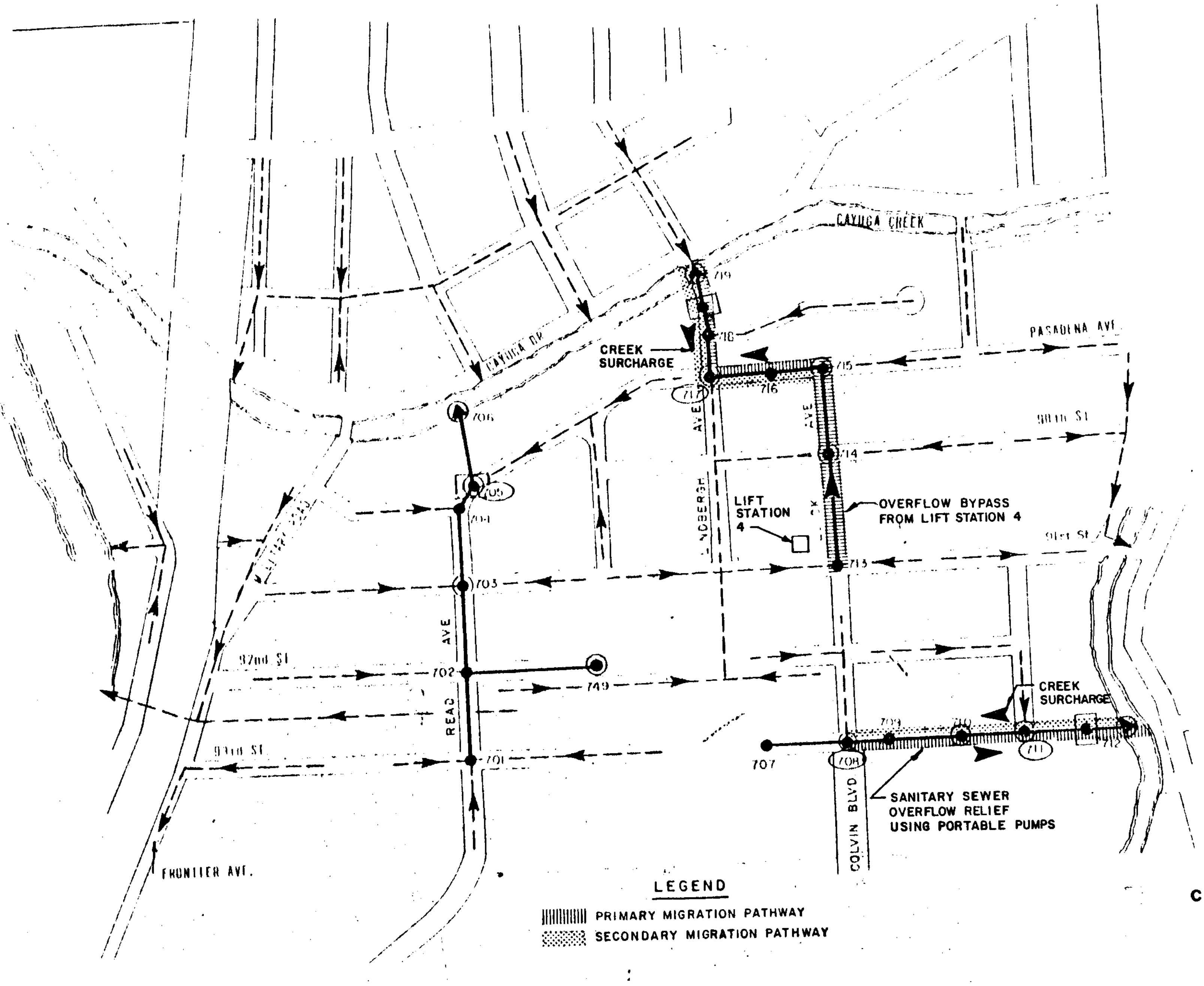
The secondary pathway may be caused by high water levels in Bergholtz Creek which surcharge the storm sewers adjacent to the Creek. Because the sediment in the creek has been found to be contaminated, the possibility exists that high water levels in the creek could transport creek sediment into the storm sewers near the outfall.

6.3.3 Sanitary Sewers and Lift Stations

6.3.3.1 Nature and Distribution of Contaminants

Nineteen sanitary sewer sampling locations exhibited varying degrees of contamination. Nineteen sanitary sewer sediment material samples showed varying degrees of contamination (nine low, four medium,

FIGURE 6-6



LOVE CANAL
FIVE ENGINEERING STUDIES
WEST STORM SEWERS
TASK AREA VII

CONTAMINANT MIGRATION PATHWAYS

and five high). No liquid sample exhibited any indication of Love Canal-related contamination; however, the liquid sample at MH 756 exhibited low levels of phthalate contamination.

The sanitary sewer sediment samples (MH Nos. 776, 773, 774, 756, 787, 752, 750, 760, and 791) which were designated as low priority contained only of metals and pthalates at concentrations similar to those detected in the "upstream" samples in Black and Bergholtz Creek. The samples which exhibited these low levels of contamination were distributed throughout the task area.

The sanitary sewer sediment samples which exhibited medium or high contamination assessment priority levels were primarily found along the main interceptor route in the task area. At Lift Station Nos. 4 and 6, chlorobenzenes, polynuclear aromatic hydrocarbons (PAH) and BHC isomers were found. MH 779 had the second highest score in the matrix of all the samples in the entire study area (all task areas). Several volatile compounds (such as chlorobenzene and tolulene), PAH's, several isomers of dichlorobenzene, BHC and a variety of other organics were found. At MH 777, chemicals similar to those found in MH 779 were identified, although at lower concentrations. The other sanitary sewers on the main interceptor route that exhibited Love Canal-related contaminants were at MH 786, MH 759 and MH 765. 2,3,7,8-TCDD (dioxin) was detected at MH 786 and MH 765, as indicated on the "hot spot" map. The sanitary sewer sediment samples not on the main interceptor route that exhibited medium or high levels of contamination were found at MH 768, MH 754, and MH 755.

6.3.3.2 Contamination Migration Pathways

Based upon the results of the contamination assessment and physical findings, the contaminated sanitary sewers in Task Area VII appear to have become contaminated via one primary migration pathway and several secondary pathways as illustrated on Figure 6-7.

The primary pathway is a direct connection to the canal area sanitary sewers originating from 97th and 99th Streets exiting at Colvin Boulevard and the Wheatfield Avenue sanitary sewer exiting the canal area at 100th Street from 101st Street to 91st Street following east then north along 101st Street to Colvin Boulevard. All Love Canal Area Sanitary sewers flow west into Task Area VII on Colvin Boulevard. This major sewer interceptor extends to Lift Station No. 6 at 91st Street and Luick Avenue. This pathway is believed to be responsible for contamination levels found in sanitary sewer sediments on the following streets:

- Colvin Boulevard
- 91st Street between Luick Avenue and Read Avenue
- Read Avenue between 91st and Pasadena Avenue
- Pasadena Avenue between Read Avenue and Military Road
- Mang Avenue between Cayuga Drive and 88th Street

FIGURE 6-7

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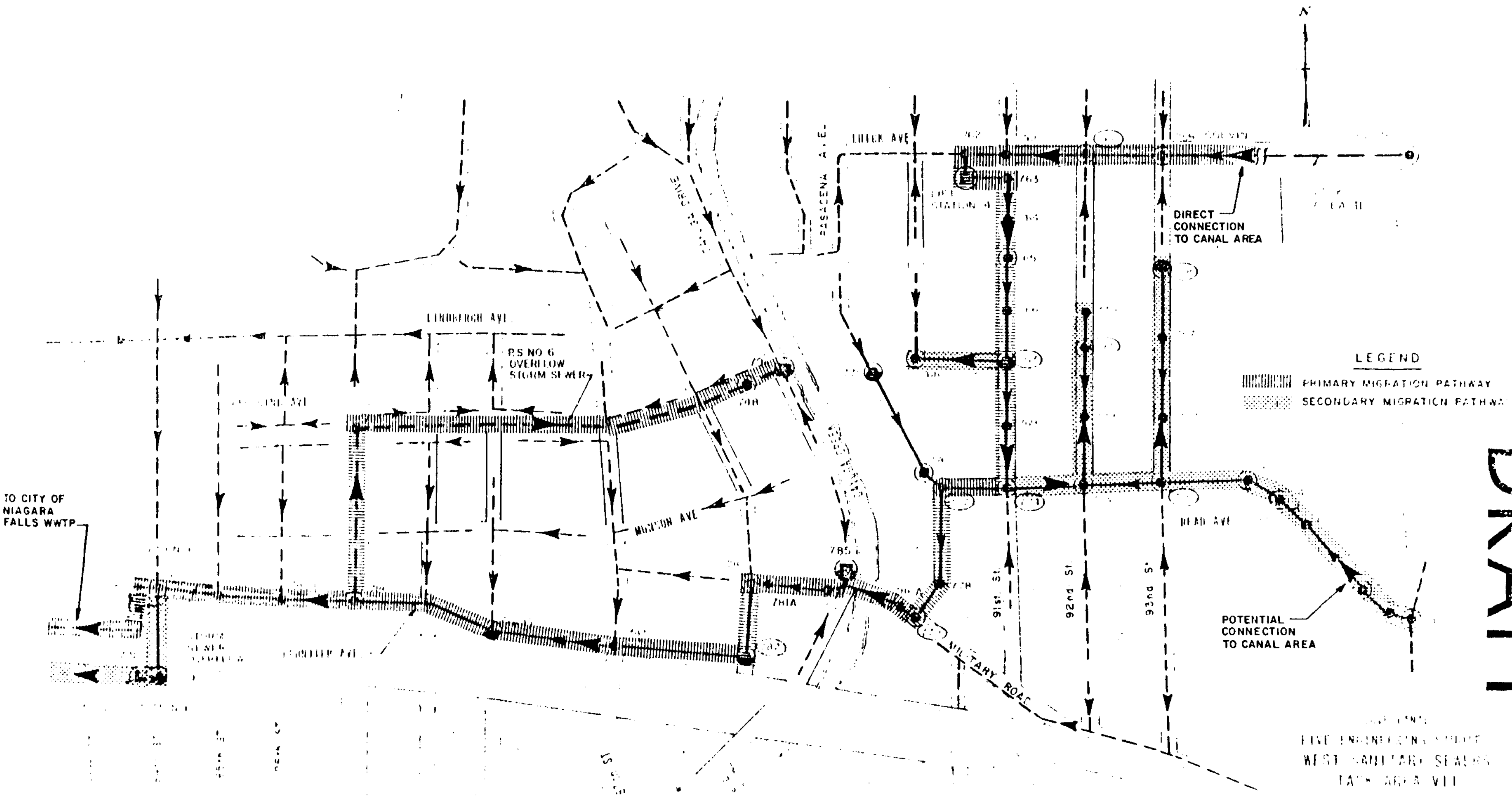

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LINE ENGINEERING STUDY
WEST SANITARY SEWERS
TASK AREA VII

CONTAMINANT MIGRATION PATHWAYS

- 88th Street between Mang Avenue and Frontier Avenue
- Frontier Avenue between 88th Street and Pump Station No. 6 at 81st Street.
- Lift Station Nos. 4, 6, 1 and associated overflows.

A secondary migration pathway is apparently caused by sewer surcharging or backing up along the main sanitary sewer interceptor. This is a fairly common occurence throughout the study area, and particularly in the area of 90th to 94th Streets between Luick Avenue and Read Avenue. These surcharge conditions are most pronounced during high ground water and rainfall periods. Based upon previous infiltration/inflow studies performed by the City, and discussions with City Department of Utilities personnel this surcharging is believed to be primarily caused by illegal household drainage connections to the sanitary sewers and excessive ground water infiltration. This surcharging can explain contamination found on Jayne Place and Pasadena Avenue.

Other potential causes of surcharging are:

- Root intrusion.
- Structural problems (i.e., collapsed pipe or joint misalignment).
- Severe sediment deposition.
- Improper construction (i.e., no slopes or reverse slopes).

Based on discussions with the City Department of Utility personnel, root intrusion along Read Avenue between 91st and 92nd Streets is believed to be the cause of surcharging in sanitary sewers along 92nd and 93rd Streets south of Colvin Boulevard and Read Avenue, east of 91st Street.

There is uncertainty, however, to the source of contamination in one portion of the sanitary sewers in Task Area VII. The sewer sediments on Read Avenue between 93rd Street and 96th Street were found to exhibit contamination in several locations. While is it possible for the sewers to surcharge from Manhole 773 (at 91st and Read Avenue) to Manhole 750 (at Read Avenue and 96th Street), consideration must be given to the possibility of contamination entering along this sanitary sewer reach from a source or sources on 96th Street or within the Griffon Manor area. This possibility is substantiated by low to medium contamination levels found in the storm sewers on 96th Street (Task Area IV) and low levels of contaminants recently detected in soils along the proposed containment wall alignment adjacent to the western curb of 97th Street. Sewer maps for this area do not present adequate information to determine if any direct connections exist which may originate in or immediately adjacent to the canal area (such as old septic systems or house laterals).

It is likely that contaminated sediment exists beyond the limits of the study area because high levels of contamination were found in Lift Station No. 6 and quantifiable amounts of dioxin were found in MH 786. The main sewer interceptor flowing away from Lift Station No. 6 extends along Frontier Avenue to 74th Street, then north on 74th Street to

Girard Avenue, west on Girard Avenue to 66th Street and north on 66th Street to John Avenue. Downstream of the manhole at 66th Street and John Avenue, the sewers become a combined (i.e, storm and sanitary) system with industrial wastewater contributions from the heavily industrialized corridor located east of I-290 between Pine Avenue and Buffalo Avenue. Beyond this point, it would be difficult to identify any contaminants as being of Love Canal origin.

6.3.4 Bedding Materials

The bedding materials were found to have low levels of contamination in several locations throughout the task area. The contaminants found in the bedding material (i.e., heavy metals, methylene chloride, and phthalates) are not believed to be Love Canal-related contaminants such as those found throughout the sanitary sewers in sediments. This contamination may be caused by localized exfiltration of contaminated liquid, broken pipes, and leaking joints.

However, considering the types of contaminants, their concentrations, their ubiquitous nature, and their extremely low exposure potential, bedding materail samples are not considered to be of concern and have not been assigned any contamination assessment priority ratings.

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7.0 REMEDIAL ALTERNATIVES

7.1 General

Sewer rehabilitation alternatives suitable for levels of contamination identified in previous sections range from relatively simple remedial activities to complex combinations of several methods. An alternative or combination of alternatives suitable for one task area or sewer reach may not be the best action for another. Each of the unit operations which together could comprise a remedial alternative is described below. An evaluation of these remedial actions is presented in Section 8.

7.2 No Action

In areas of limited or no contamination and limited or no migration potential, indicative of no significant environmental impacts, the "no action" alternative may be appropriate.

7.3 Monitor

Periodic sampling of storm and sanitary sewer flows and sediments at strategic locations, must be required subsequent to any remediation in affected storm and all sanitary sewers in the Study Area. Such post-remediation monitoring of sewers will be necessary in order to:

- Ascertain the efficacy of sewer remediation.
- Determine if contaminant migration from the canal containment area to the sewers is occuring in the future.

- Determine if contaminant migration from sources outside the canal containment area is occurring in the future.

- Act as an early warning system to detect substantial contaminant accumulation in the sewers. This would allow for protection against the health and environmental impacts of the release of and exposure to these contaminants in the event of a remediation failure or incomplete remedial response.

As an alternative to physical remediation measures, periodic sampling could be performed at selected storm and sanitary sewer reaches and storm sewer outfalls to the creeks and river to monitor movement of contaminants. This would obviously result in the continued migration of toxic pollutants away from the study area. Migration would continue, until such time that the source(s) of these contaminants has been eliminated and naturally-occurring phenomenon, such as sediment transport and to a lesser extent volatilization, purge contaminants from the sewers. While the rate of contaminant transport is difficult, if not impossible, to ascertain and is beyond the scope of this study, there was evidence of contaminant migration from the Canal area nearly six years ago. It is not unreasonable to assume that this migration will continue for an extended period of time even after all sources of contamination have been eliminated.

The acceptability of this alternative for the storm sewers must be evaluated in the context of the potential impacts of this continued migration on the receiving water bodies in Task Area VII (i.e. Bergholtz Creek and Cayuga Creek). This alternative for the sanitary sewers may similarly impact upon Cayuga Creek and the Niagara River due to the existence of several sanitary and combined sewer overflows and bypasses along the sewer route to the City's Wastewater Treatment Plant located on Buffalo Avenue (see Figure 3-1).

7.4 Abandonment In Place

Where contaminated storm or sanitary sewer sediment is found to have moved only a short distance from the canal, it may be appropriate to cut off and/or plug that sewer line and abandon it. This option is most appropriate in areas not needed to support any current or future demand.

Construction worker safety considerations for this alternative would include the use of respiratory protection for workers in manholes and/or trenches, hard hats and boots, goggles, and disposal coveralls.

The environmental impact of abandonment in place is that any contaminants present could migrate from their present locations and enter the surface or groundwater in the area. Additional hazards to construction workers excavating in-situ contaminants in the future would also be posed by this alternative.

7.5 Television Inspection and Other Physical Inspection Methods

7.5.1 Television Inspection (see Figure 7-1)

While it is not an actual remediation measure, television inspection is a valuable diagnostic tool used prior to any type of sewer system repair or replacement. Television inspection is normally used to locate sources of infiltration such as offset joints, root intrusions,

FIGURE 7-1

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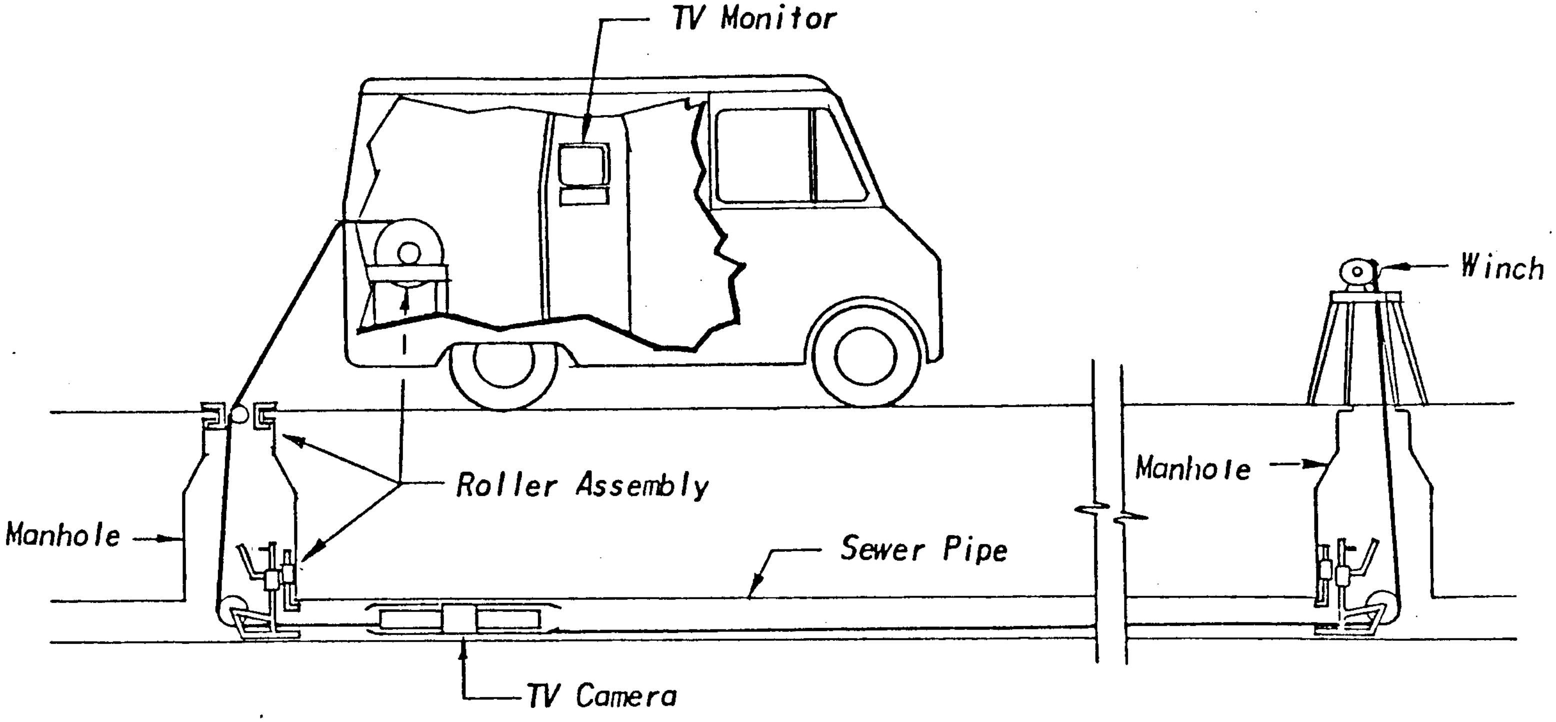

Typical Arrangement for Television Inspection of Sewer Lines

(Source: USEPA, 1975)

broken or collapsed pipe, leaky laterals and service connections, etc. A television camera specifically designed for this service is pulled through the pipe section to be examined on a sled and the problem areas located with respect to the manholes via the footage counter on the T.V. cable feeder. The camera can be stopped at any time so that still photographs may be taken of the monitoring screen. Usually the entire inspection is recorded on videotape for subsequent playback and review.

Prior to any remedial sewer repairs it is usually necessary to televise the sewers to locate specific problem areas and determine the extent of repairs which will likely be necessary. Television inspection may also be used to document causes of sewer surcharging and to verify that sewers which have been blocked off in the past are not active pathways of migration.

Environmental impacts of television inspection are temporary and minimal and can be mitigated by following proper safety and decontamination procedures. Use of half-face respirators, disposable gloves, shoe covers and outer garments would be appropriate for the television crews.

7.5.2 Other Physical Inspection Methods

Two other methods are commonly used to determine if illegal connections exist or determine the water flow direction. These methods are smoke testing and dye testing. Smoke testing involves forcing smoke via gasoline-powered blowers into confined sections of sewer and visually locating any smoke escaping from the sewer. Dye testing involves the injection of dye into the flow stream to determine the flow pathway.

7.6 Sewer Cleaning

The methods used to remove accumulated sediment and other deposits from existing sewer lines are well established. Available sewer cleaning techniques include power rodding, hydraulic scouring and flushing, bucket dredging, suction cleaning with pumps or vacuums, chemical treatment, or a combination of these methods. Access to sewer lines for interior cleaning and repair is most commonly made through manholes.

The choice of cleaning techniques for rehabilitating contaminated sewer lines depends on a number of variables including:

- Depth of deposition
- Degree of root intrusion
- Degree of cleanliness required
- Extent of contamination
- Chemical and physical nature of the contaminants
- Costs and availability of different cleaning services
- Ease of access to contaminated areas
- Immediacy of any potential public health hazards
- Specific legal issues that may complicate a given cleanup strategy.

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Interior cleaning of contaminated pipes will facilitate the location of structural deficiencies such as cracks, joint failures, and collapsed pipes which ultimately may require repair to prevent infiltration of contaminated soil and groundwater and eliminate surcharging. Cleaning must also be performed before television inspection and grouting of sewers. Figures 7-2 through 7-4 illustrate the various methods of cleaning.

7.6.1 Mechanical and Hydraulic Cleaning

Mechanical cleaning is effective in removing obstacles such as roots, stones, corrosion nodules, grease and sludges from sewers. In the case of sewer lines infiltrated by contaminated runoff or leachate, interior scouring may be necessary to loosen or remove solidified masses of chemical residues or contaminated sediment which are then flushed or dredged from the line. Mechanical cleaning techniques include the use of power rodding machines (i.e. "snakes"), which pull or push scrapers, augers, and brushes through the obstructed line.

Hydraulic flushing of contaminated lines can be achieved by running high-pressure cleaning nozzles into sewer lines through manholes and flushing out contaminated sections of the sewer. This technique is often used after mechanical devices have cleared the line of solid debris or loosened contaminated sediments and sludges coating the inner surface of the pipe.

The mechanical cleaning techniques have the advantage of removing heavy root intrusions and being able to penetrate or remove blockages from the line without using the large quantities of water required for the hydraulic equipment. The hydraulic flushers, however,

FIGURE 7-2

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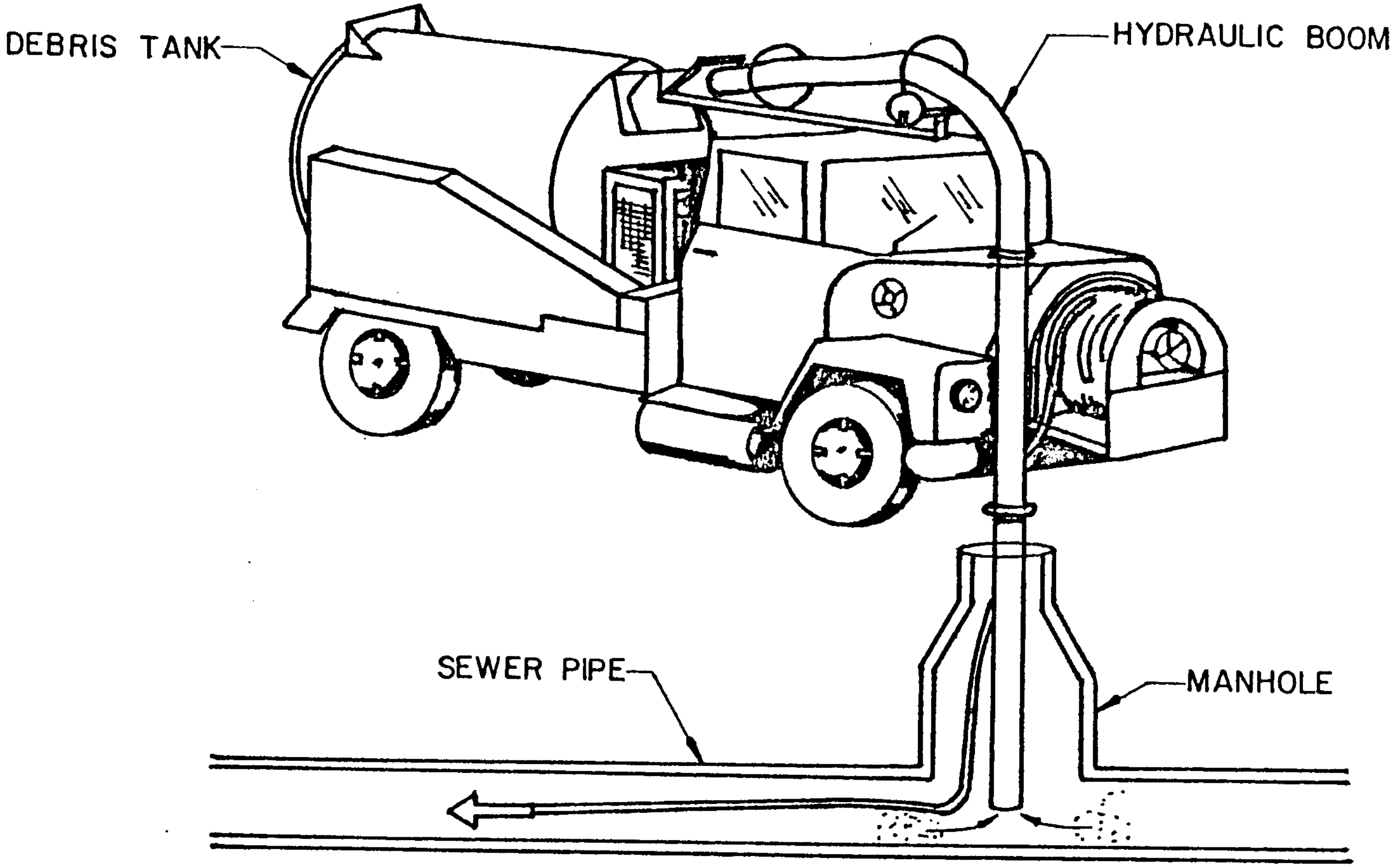

BACKFLUSHING AND VACUUMING - SIMULTANEOUS OPERATIONS

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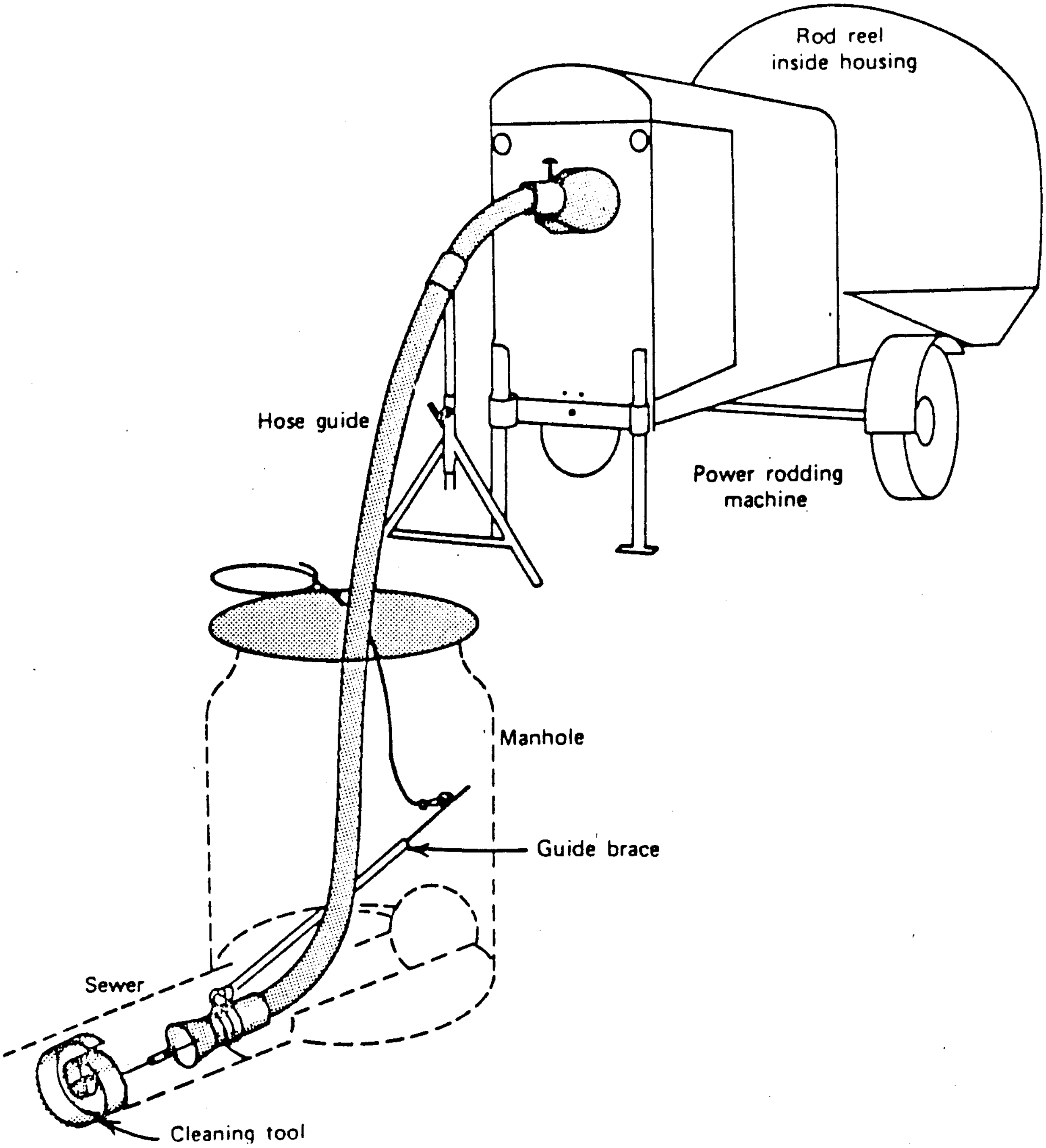
FIGURE 7-3

POWER RODDING MACHINE

(Source: Hammer, 1975)



are more useful for moving the loosened debris to the manhole for removal from the system.

7.6.2 Bucket Dredging and Suction Equipment

A bucket machine can be used to dredge grit or sediment from a sewer line. Power winches are set up over adjacent manholes with cable connections to both ends of the collection bucket, which is pulled through the sewer until loaded with debris. The same technique can be used to pull "sewer balls" or "porcupine scrapers" through obstructed pipes.

The main advantage of using bucket cleaning equipment is that this method can remove heavy accumulations of solids from the manhole and deposit them into disposal vehicles without using flushing water. One of the main disadvantages is that significant amounts of solids and water from the manhole can be splashed or sprayed on workers and the area adjacent to the manhole.

Suction devices such as pumps or vacuum trucks also may be used to remove accumulated solids from the manholes. These devices can also be used to remove flushing water associated with hydraulic cleaners. Manholes provide easy access for the setup and operation of such equipment.

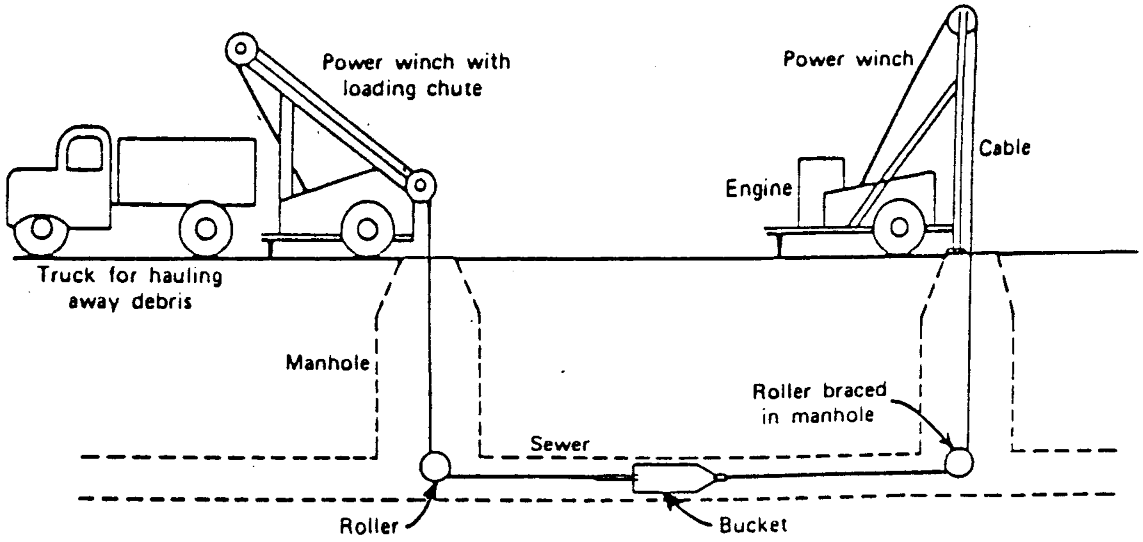
7.6.3 Vapor Control

Vapor control may be required in conjunction with the above cleaning alternatives in sewer lines having high concentrations of volatile contaminants in the sediment. This measure is very expensive, but may be necessary to minimize the exposure risk to workers and

FIGURE 7-4

SCHEMATIC OF BUCKET MACHINE CLEANING

(Source: Hammer, 1975)



area residents during sewer cleaning operations. Control enclosures incorporating granular activated carbon adsorption equipment would be set up over the affected manholes. Contaminated gases volatilized during cleaning operations would be adsorbed on the activated carbon, thus preventing release to the ambient atmosphere. Temporary vapor barriers also would be installed to prevent migration of contaminated vapor from the cleaning area.

7.6.4 Residuals Treatment, Handling and Disposal

As previously stated, cleaning equipment other than bucket machines does not remove materials from manholes and catchbasins, therefore a vacuum or pumping system is needed to complement most cleaning methods. The options for ultimate disposal of residual solids and any wash water generated from the cleaning operation, include dewatering at the leachate treatment facility with on-site disposal of solids in the canal area or hauling to a permitted commercial waste processor for dewatering and secure burial.

7.6.4.1 On-Site Disposal

On-site disposal requires separation of the liquid/solid fraction using a filter press, clarifiers, or pressure filters prior to treatment of the liquid fraction using the leachate treatment plant. The separation of the liquid and solids is mandated by the limitations of the leachate treatment facility to handle solids. Problems with the air lift pump in the plant claifier and plugging of the carbon itself could be expected without some type of solids removal pretreatment. All solids removed would be drummed for disposal beneath the existing clay cap at the canal site.

7.6.4.2 Off-Site Disposal

Off-site disposal would entail use of tank trucks or similar equipment to transport all material, solid and liquid to a local commercial waste processing facility for dewatering, treatment of the liquid fraction using granular activated carbon and drummed disposal of the residual solids at a permitted and NYSDEC approved hazardous waste disposal facility. Prior to burial, the residual solids must be sufficiently dewatered so that there is no free water with the solids and the solids concentration must be 20 percent or greater.

7.7 Sewer Repair

7.7.1 Grouting

One method of in-place repair is to grout fractured or leaky joints to seal them from groundwater infiltration and sewage exfiltration.

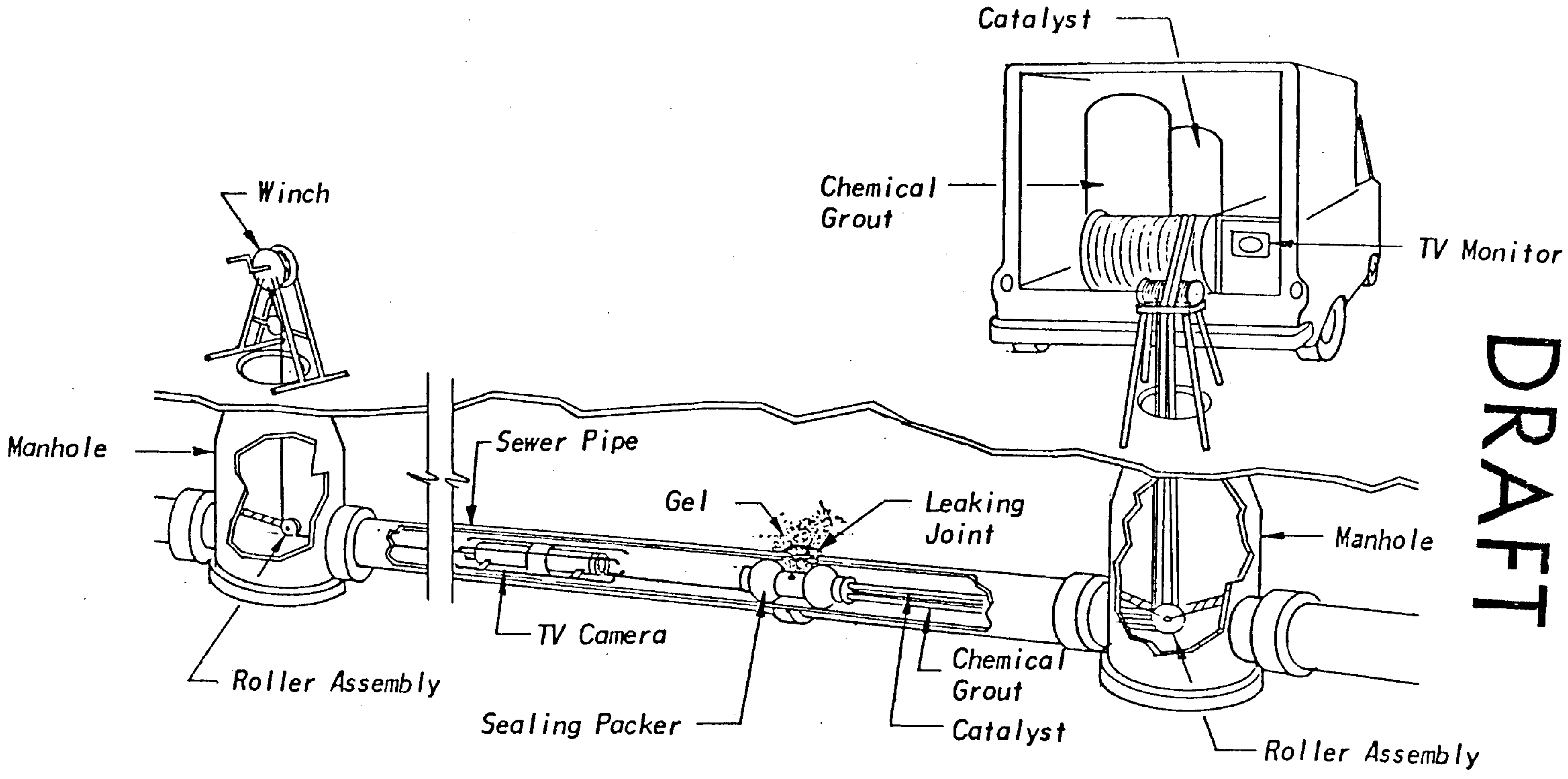
Chemical grouts for sealing sewer lines are generally acrylamide resins or silica gels, which are applied to leaking joints from the interior following detection by television inspection. A sealing packer is pulled through the sewer line ahead of the closed circuit camera, which is used to position the packer. The sealing packer is then inflated at each end leaving an open pocket in the area of the joint. Chemical grout is then pumped into the open space under pressure and the central portion of the packer is inflated, thereby forcing the grout through the break or opening into the surrounding soil and sealing the leak. After the grout has had time to set, the ends of the packer are deflated and the operation repeated at the next leaky joint. The joints repaired in this manner are usually air tested before and after the grouting operation by forcing low pressure air into the space between the ends of the sealing packer and observing the drop in pressure. If the pressure drop exceeds established limits indicating that the grout has not taken, the grouting operation is repeated until a successful test result is achieved. Grouting and testing of lines simultaneously in this manner is known as "test and seal." A typical grouting operation is illustrated on Figure 7-5.

Environmental impacts of grouting are low as all of the grouting work is performed below grade without the need to excavate and disturb the surrounding area. The grouts are inert upon curing and would not be expected to contaminate the sewers via leaching of base compounds. There is an exposure potential to the grout catalyst from volatilization during the mixing of the grout; however, the airborne concentration would be low. Use of half-face respirators and protective clothing would mitigate any adverse impact.

7.7.2 Pipe Relining

Relining is another method of sealing that can inhibit infiltration and exfiltration in pipelines. Interior lining of sewers can be performed in addition to chemical grouting to ensure a high level of pipeline integrity and low future risk of groundwater or leachate

FIGURE 7-5



Typical Arrangement for Chemical Grouting
(Source: USEPA, 1975)

infiltration. Large sections of badly cracked or deteriorating sewer lines can be relined with high density polyethylene piping, a technique commonly called slip-lining. Lengths of polyethylene pipe are fused together above ground and pulled into place within the pipeline from strategically located excavations along the existing sewer (see Figure 7-6). Normally a sewer length of 2 to 3 manhole sections can be lined from a single excavation. Connection of the house service lines to the new liner is then accomplished using a remote cutting tool or by excavating to install a more conventional saddle joint.

7.8 Removal and Replacement

Removal and/or replacement of sewer lines consists of excavation under carefully controlled conditions to expose and remove contaminated piping and bedding material for disposal at a permitted and NYSDEC-approved hazardous waste landfill. This option is necessary when the degree of bedding contamination is sufficiently high to preclude the no-action alternative or when structural damage prevents the proper operation of the recommended remedial measure. Replacement is also required if the removed pipeline is needed for current or future service. Removal and/or replacement is the most expensive remedial option, but in some cases may be the only choice to assure protection of the environment and public health.

This alternative has the most significant short-term impact on the environment as it involves excavation in residential neighborhoods, disruption of traffic patterns, and would create airborne dust and noise from construction equipment.

Mitigating measures include the use of haul vehicle covers to minimize dust during transportation of contaminated soils, use of protective clothing by construction workers,

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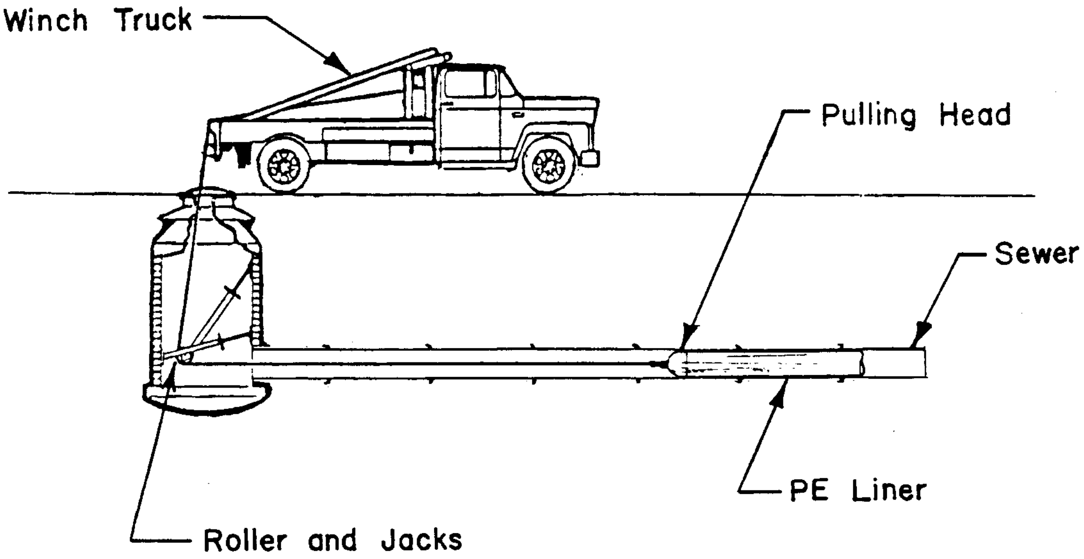
INTERIOR RELINING WITH PE
(Source: USEPA, 1982)



requiring sound limiting devices such as mufflers on all construction equipment, and dust control measures such as street sweeping and soil wetting on a frequent basis during excavation.

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8.0 EVALUATION OF ALTERNATIVES

8.1 Preliminary Screening of Alternatives

A matrix analysis of the remedial alternatives is presented as Table 8-1. The alternatives listed in the left-hand column are arranged from top to bottom in increasing order of complexity, i.e., no action is the least complex and removal and replacement is the most complex. The criteria used for rating the alternatives (highly effective, moderately effective, not effective or not applicable) were established based on the actual physical findings discovered during the sampling program.

Where more than one remedial measure was assigned the same score for a particular sewer condition, other factors must be included in evaluating the alternatives. These factors include long and short-term environmental impacts, cost effectiveness, worker and community safety, public acceptability, future rehabilation plans for the area, scheduling constraints and impact of other remedial activity.

This preliminary evaluation of each alternative is intended to indicate the relative assessment of the usefulness of each alternative. The suitability of each approach has been evaluated in the context of a particular application within the task area. Section 8.2 provides a detailed evaluation of each alternative with respect to the environmental impacts, cost effectiveness and other factors referenced above and provides the unit costs used in the evaluation.

8.2 Detailed Evaluation

Each of the matrix elements will be discussed below in terms of their specific applicability to problems in Task Area VII. Some alternatives will be eliminated from further con-

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TABLE 8-1

REMEDIAL ALTERNATIVE MATRIX

REMEDIAL ALTERNATIVES / REASONS FOR SEWER REMEDIATION	Small to Medium Amts. of Sediment Accumulation in pipe (i.e. < 2 in)	Medium to Large Amts. of Sidiment Accumulation in Pipe	Sediment Accum. in Manhole or Drop Inlet	Root Intrusion/Blockage	Slightly Moderately damaged Sewers (i.e. cracked pipe or offset joint)	Severely Damaged Sewers (i.e. broken or collapsed pipe)	Leaking Joints	Location of Suspected or known cross connections, Contaminant sources, and/or Srructural problems	Remediation of Contaminated Sewer Bedding Material	NOTES (SEE NEXT PAGE)
No Action	-	-	-	-	-	-	-	-	-	None
Monitoring Only	-	-	-	-	-	-	-	-	-	None
Physical Inspection/ Testing Methods										
a. Television	-	-	-	-	-	-	-	x	-	3, 14
b. Dye Testing	-	-	-	-	-	-	-	o	-	None
c. Smoke Testing	-	-	-	-	-	-	-	o	-	None
Sewer Cleaning										
a. Hydraulic	x	o	x	-	-	-	-	-	-	1, 5, 8, 10
b. Power Rodding	o	o	-	x	-	-	-	-	-	4, 6, 11
c. Bucket Cleaning	o	x	-	o	-	-	-	-	-	2, 3, 7, 11, 14
Sewer Repair										
a. Grouting	-	-	-	-	-	-	o	-	o	14, 3
b. Slip Lining	-	-	-	-	x	-	x	-	o	12, 14
Remove and Replace Sewer	x	x	x	x	x	x	x	-	x	10, 12

Legend:

x - Highly effective
o - Moderately effective
\- - Not effective or not applicable

Notes:
1. Require large quantities of flushing water.
2. Can cause pipe damage.
3. Cannot be used in damaged pipe, offset joints, protruding service laterals.
4. Cannot transport heavy solids.
5. Can clean manhole walls and bench.
6. Best for dislodging roots and blockages.
7. Best for dislodging, transporting and removing sand, gravel, rocks, bricks, and roots.
8. Best for dislodging and transporting sludge, mud, sand and gravel.
9. Manhole access not critical.
10. Generates large quantity of contaminated residuals which must be properly handled, treated and diposed of.
11. Requires hydraulic flushing as final step to assure high degree of cleanliness.
12. Requires excavation.
13. Long-term effectiveness not proven.
14. Requires that sewer be threaded via flushing or rodding machine prior to starting.

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sideration, while others will be combined to give maximum effectiveness and utility to remedial action.

8.2.1 No Action

As previously discussed, this alternative is acceptable only in sewers with no past or present contaminant indications, and where no upstream sections were contaminated.

The no action alternative is potentially applicable to most of Task Area VII's storm sewers with the following exceptions: 93rd Street (MH 712-708, 1000 lf), Luick Avenue (MH 713-715, 750 lf), Pasadena Avenue (MH 715-717, 450 lf) and Lindberg Avenue (MH 717-719, 400 lf). The no action alternative is not applicable for most of Task Area VII's sanitary sewers.

The long and short-term environmental impacts of no action include the possible migration of contaminants into the local ground and surface waters and subsequent exposure to local residents. This alternative could also cause contamination or recontamination of downstream areas such as the creeks and river which may be remediated in the future. Public acceptance of no action would certainly be unfavorable and revitalization plans for the neighborhood would be negatively impacted by this alternative.

Mitigating measures to reduce the negative impacts associated with no action include the use of public information campaigns to educate the local citizens to the degree of potential hazard posed, and the use of periodic monitoring to substantiate the acceptability of no action.

8.2.2 Monitor

Monitoring as a solitary remedial measure is not considered acceptable based on the levels of contamination in Task Area VII discussed in Section 6.3. These contaminants should be removed from the system to prevent further migration throughout the storm and sanitary sewer and subsequent discharge either directly or indirectly to surface or ground water in the area.

A long-term monitoring program to verify the effectiveness of the remedial actions, however, will be necessary.

Specific monitoring locations for Task Area VII include Lift Station Nos. 4 and 6 for the sanitary sewers. The lift stations were chosen as monitoring locations since all sanitary sewers originating at or near the canal area are tributary to them. Additionally, the lift station wet wells are collection points for sediments and sludges which can be readily sampled.

No storm sewer sample locations were chosen for monitoring because no direct connections to the canal area exist from the Task Area VII storm sewers. The storm sewers in Task Area VII can become contaminated only by deliverate overflow bypassing from the sanitary sewers.

Environmental impacts associated with monitoring are similar to those for no action and include continued migration of contamination as well as possible exposure to these contaminants by workers cleaning sewers and taking samples. Problems with adverse public reaction to monitoring as a separate remedial alternative, possible negative impact (contamination) on related downstream clean-up activities and concern about what and where contamination may be detected in the future as a result of monitoring would also inhibit future rehabilitation of the area.

Mitigating measures to protect the health and safety of cleaning and or monitoring crews include use of respiratory and dermal protection, such as disposable footwear and outergarments, and general safety protocol for working in sewer and manholes.

No costs have been developed for the monitoring program because monitoring for storm and sanitary sewers should be included in the entire Love Canal area monitoring program being undertaken by the NYSDEC.

8.2.3 Abandon in Place

Abandonment in place is an effective measure following cleaning of the sewers to remove contaminants and prevent possible future contaminant migration. Pipes taken out of service should necessarily be replaced with new facilities to meet existing or future demand. As there are currently residents living throughout Task Area VII, it would not be possible to abandon storm or sanitary sewers without replacing the sewers or moving the existing residents.

At the present time, no decision has been made concerning future land use in any portion of the Declaration Area within Task Area VII. Because the possibility exists for future use of the portion of the Declaration Area within Task Area VII, it would be impractical to abandon any sewers at this time.

Abandonment in place, if not preceded by cleaning, would allow contamination to remain at its present location for an intermediate time period.

Future excavation for utilities in the area and abandoned sewers could potentially cause exposure of construction crews to any remaining contaminants. Also, infiltration and exfiltration through leaking joints or cracked or broken pipe could liberate contaminants in the future. Safety measures for construction crews working in the vicinity of abandoned Love Canal Sewers should include use of respiratory protection for workers in manholes or trenches, hard hats, boots, goggles, and disposable coveralls.

The costs for abandoning the sewers in place are very site specific depending on location number and size of pipes, manholes, catch basins, etc., and the method used to abandon the facilities, i.e., sandbags, concrete plugs, etc.

8.2.4 Television Inspection and Other Physical Inspection Methods

Inspection by closed circuit television has the advantage of being easily accomplished while providing additional information and a permanent record of the sewer system. Television inspection is also an excellent method of verifying the effectiveness of repair or cleaning operations.

In Task Avea VII, television inspection will be used to seek additional information concerning potential or unknown connections to sanitary sewers on Read Avenue and

95th Street (MH 756-750, 1350 lf) and along 96th Street (sewers which flow into MH 750, approximately 1100 lf).

Related techniques for detection of cross-connections between storm and sanitary sewers for tracing the origins and terminal points of sewers not shown on the drawings are smoke and dye testing. Smoke testing involves forcing smoke into sewers via gasoline-powered blowers which straddle the manholes. Smoke emissions along the route of the pipe help to indicate alignment, pipe breaks, leaky laterals, and connection points to other pipes and manholes.

Dye testing is often used to verify the results of smoke tests. Liquid dye tracer compounds are poured into the manholes or catch basins, etc., and flushed into the pipes using water. The downstream manholed are simultaneously observed for signs of dye indicating a connection.

There is no environmental impact of television inspection other than possible contamination of the equipment and the clothing of the television crew members. Use of appropriate decontamination procedures for equipment such as swabbing with an organic solvent, and use of respirators, gloves, goggles, and disposable garments by personnel performing the work would mitigate the impact of possible exposure. It is not anticipated that use of television inspection or any physical inspection methods will cause negative public reactions, nor interfere with scheduling constraints, revitilization plans, or other remedial activity.

There are no significant long term environmental impacts of smoke or dye testing. Short term impacts include possible momentary smoke inhalation due to basements filling with smoke via sanitary sewer house laterals, and possible dyeing of short sections of the creeks from discharge of dyed waters via storm sewer outfalls. Both the dye and the smoke, however, are nontoxic, and nonstaining, and are not hazardous to human, animal or plant life.

The costs for television inspection have been estimated at $1.40/l.f. This cost was developed by contacting Buffalo area television inspection contractors. Smoke and dye testing are estimated to cost $0.25/l.f. and $0.10/l.f., respectively, based on past studies.

8.2.5 Sewer Cleaning

Three sewer cleaning alternatives (hydraulic flushing, bucket cleaning, and power rodding) were evaluated in Section 7.

High pressure hydraulic flushing is the most easily implemented of the three alternatives. In Task Area VII which does not have large quantities of sediment or root intrusion, this alternative has been judged to be the most effective. A major concern with this alternative is the large quantities of cleaning water which will have to be disposed.

In areas to be cleaned, power rodding or bucket cleaning may have to be used if excessive root intrusion or sediments are found.

The environmental impacts of sewer cleaning vary, depending on the method and equipment used and location being cleaned. The impact of using either flushing

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machines or power rodding equipment is more significant than bucket machines from the standpoint of the quantities of residuals to be disposed of as both methods rely on the use of flushing water to complete the operation. Bucket machines have a potentially larger impact on the surrounding area if proper operation procedures are not followed. If the bucket machines are used to transport debris from the manhole directly to a disposal vehicle, splashing of liquid, solids and slurries onto crew members and adjacent areas could occur. The impact of using any cleaning method which does not remove all sediment (in this case bucket cleaning) would also be quite significant since some of the contaminants would be left in the sewer and could subsequently migrate to downstream locations causing contamination or recontamination at those locations.

Mitigating measures to offset the negative impact of sewer cleaning on cleaning crew workers include use of respiratory and dermal protection, goggles, gloves, boots, and disposable coveralls, etc.

Mitigating measures to avoid leaving contamination in the pipes following cleaning includes using hydraulic flushing following bucket cleaning or power rodding to assure that the pipes are completely scoured.

This need to supplement mechanical cleaning methods with flushing techniques despite the large volume of presumably contaminated washwater generated is overwhelming justification for recommending use of hydraulic flushing as the primary cleaning mode.

It is not anticipated that any of the cleaning methods evaluated if properly implemented, would create problems in regard to public acceptance. Each cleaning alternative would positively impact on revitalization of the area because the contamination would be removed.

All hydraulic cleaning must be performed in the summer or fall due to infiltration problems in the springtime and ice-related problems during the winter months. Additionally, the sequence and scheduling of cleaning storm sewers should be coordinated with cleanup activity in the creeks and in the Niagara River to preclude the possibility of recontamination.

Hydraulic cleaning has been estimated at $5.50/L.F. Bucket cleaning and power rodding are significantly more expensive than hdyraulic cleaning and would cost approximately $7.50/L.F.

Costs of sewer cleaning were obtained from both western New York and nationwide sewer cleaning contractors and from the 1982 EPA manual on Remedial Action at Hazardous Waste Sites. These costs were than averaged to obtain representative costs for this project.

8.2.6 Sewer Repair and Replacement

Three sewer repair alternatives (sliplining, grouting and replacement) were evaluated in Section 7. Removal and replacement is considered the most feasible alternative for damaged sewers in Task Area VII because of its reliability and long term effectiveness.

If pipes are damaged and broken the potential for large quantities of exfiltration is possible. This exfiltration could possibly contaminate the bedding material. The removal and replacement option would assure that any contaminated bedding material was removed from the site.

Sliplining is considered unfeasible because of the large number of house laterals in the area. At each house lateral location, the sewer would have to be excavated and the house lateral reconnected to the sewer. Additionally the slip lining option would not remove the contaminated bedding material from the site.

Grouting is considered infeasible because it cannot be expected to produce a longterm solution. There is always the possibility of the grout cracking or becoming loose. Grouting is also ineffective in sealing longitudinal cracks.

Removal and replacement of the structurally-damaged sewer is the most effective method of sewer rehabilitation. This alternative removes all contamination from the site. This alternative has the longest expected life of any rehabilitation option.

No adverse environmental impacts would be created by this option. All contamination would be removed from the site if this option is chosen. All contaminated excavated material should be disposed at a NYSDEC approved hazardous waste facility.

The removal and replacement option would not interfere with the operation of any other remedial task.

For estimating purposes, the costs for removal and replacement of 10 to 15-inch diameter sewers (similar to those found in the study area) has been at $100/l.f. This cost was developed by review of recent bid tabulations in the Niagara Falls area. The cost for disposal for contaminated excavated material has been estimated at $100/cubic yard. This cost was developed through discussion with local hazardous waste disposal facility operators.

8.2.7 Residuals Disposal

The residuals disposal alternatives evaluated include onsite and offsite disposal. Input to evaluation of the alternatives was generated from discussions with NYSDEC personnel, local hazardous waste disposal firms, and contractors experienced in cleaning storm sewers on 97th and 99th Streets in the winter of 1982-1983. It is environmentally sound to consider onsite dewatering and disposal, however the need to erect dewatering facilities, the limited capacity of the existing leachate treatment plant, worker safety concerns from multiple handling cycles, and severe scheduling difficulties, make onsite disposal unfeasible. Accordingly, offsite disposal at one of several local hazardous waste faciltiies is considered the best method of residuals handling.

The feasibility of segregation of liquid and solid wastes from sewers to be cleaned which were not sampled was also evaluated. By segregating and testing these wastes prior to final disposal, it would be possible to determine if the wastes were indeed hazardous, thereby requiring treatment of the flushing water and burial of the solids in a secural burial facility. If testing determined that these wastes were not hazardous, the liquid could be discharged to the sanitary sewers and solids landfilled in a sanitary landfill, both at signifi-

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cant unit costs savings. Based on the total cost savings for estimated quantity of material involved, however, segregation of the wastes is not cost effective.

The recommended method of residuals disposal at a NYSDEC approved hazardous waste landfill should not create any adverse environmental impacts. These landfills have been created for the specific purpose of providing a long term, controlled, and environmentally-safe area for the disposal of hazardous wastes.

The possibility exists that workers transporting this waste could become contaminated if direct contact is made with these wastes. However, if proper handling and protective procedures are followed, no contamination should occur. The waste transporting firm selected to do the work should be a NYSDEC approved hazardous waste transporter and should follow all of the application regulations.

The costs of residual disposal have been estimated at $0.35/gallon. These costs have been developed through discussions with hazardous waste landfill operators in the vicinity of Niagara Falls. The costs for residual transportation has been estimated at $1.40/l.f. This costs was developed through discussions with sewer cleaning and waste hauling time in the vicinity of Niagara Falls.

8.2.8 Vapor Control

Vapor control will not generally be required during remedial activities, since only isolated pockets of volatile contaminants were detected in the Task Area VII. It was estimated that if gross volatilization of contam-

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inants were to occur during cleaning in these isolated areas, the airborne contaminant concentrations would not exceed permissible exposure limits established by the Occupational Safety and Health Administration for prolonged exposure. Further, all workers involved in remedial activities will be equipped with respiratory and dermal protection to minimize the risk of exposure to airborne contamination. Based on the above, no provision for vapor curtains or scrubbers need be included in the remedial action plan. However, portable volatile organic meters should be used for continuous monitoring. If excessive volatilization does occur, then the need for vapor controls will be reassessed.

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9.0 RECOMMENDATIONS

9.1 General

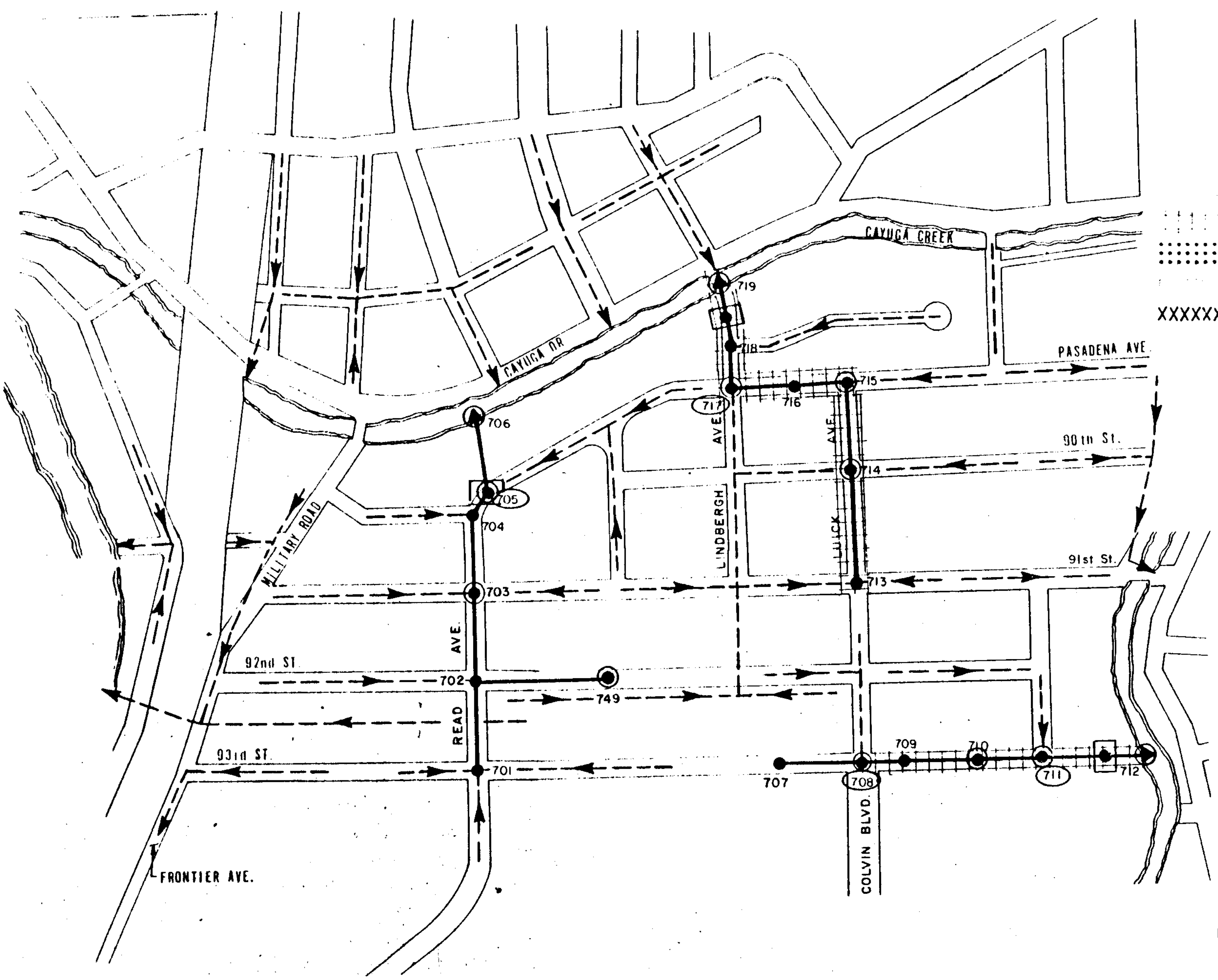
Figures 9-1 and 9-2 illustrate the recommended remediation plan for the storm and sanitary sewers, respectively in Task Area VII. As shown on the figures, the primary recommendation is to utilize hydraulic flushing techniques to remove all contaminated sediments from the storm and sanitary sewers.

As shown on Figure 9-1, several of the storm sewers in Task Area VII are recommended for remediation. The storm sewers recommended for remediation have become contaminated due to overflow bypassing from the main interceptor sewer which collects all the wastewater flows from the Declaration Area. This overflow bypassing occurs at Lift Station No. 4, Lift Station No. 6, and at 93rd Street and Colvin Boulevard. The storm sewer which is used for discharging overflow bypasses from Lift Station No. 1 to Cayuga Creek is also recommended for cleaning and shown on Figure 9-2.

As shown on Figure 9-2, most of the sanitary sewers in Task Area VII are recommended for remedial action due to the sporatic but widespread contamination throughout the task area. Several streets which are quite a distance from the main interceptor sewer, discussed in earlier sections, have not been recommended for remedial action because it is very unlikely that the sewers could have surcharged to such an extent. The main interceptor route from Lift Station No. 6 to the manhole at the intersection of 66th Street and John Avenue is also recommended for cleaning.

Television inspection is recommended for the sewers in one area. The sanitary sewer segments on Read Avenue between

FIGURE 9-1



LOVE CANAL
FIVE ENGINEERING STUDIES
WEST STORM SEWERS
TASK AREA VII

REMEDIAL ACTION PLAN

FIGURE 9-2

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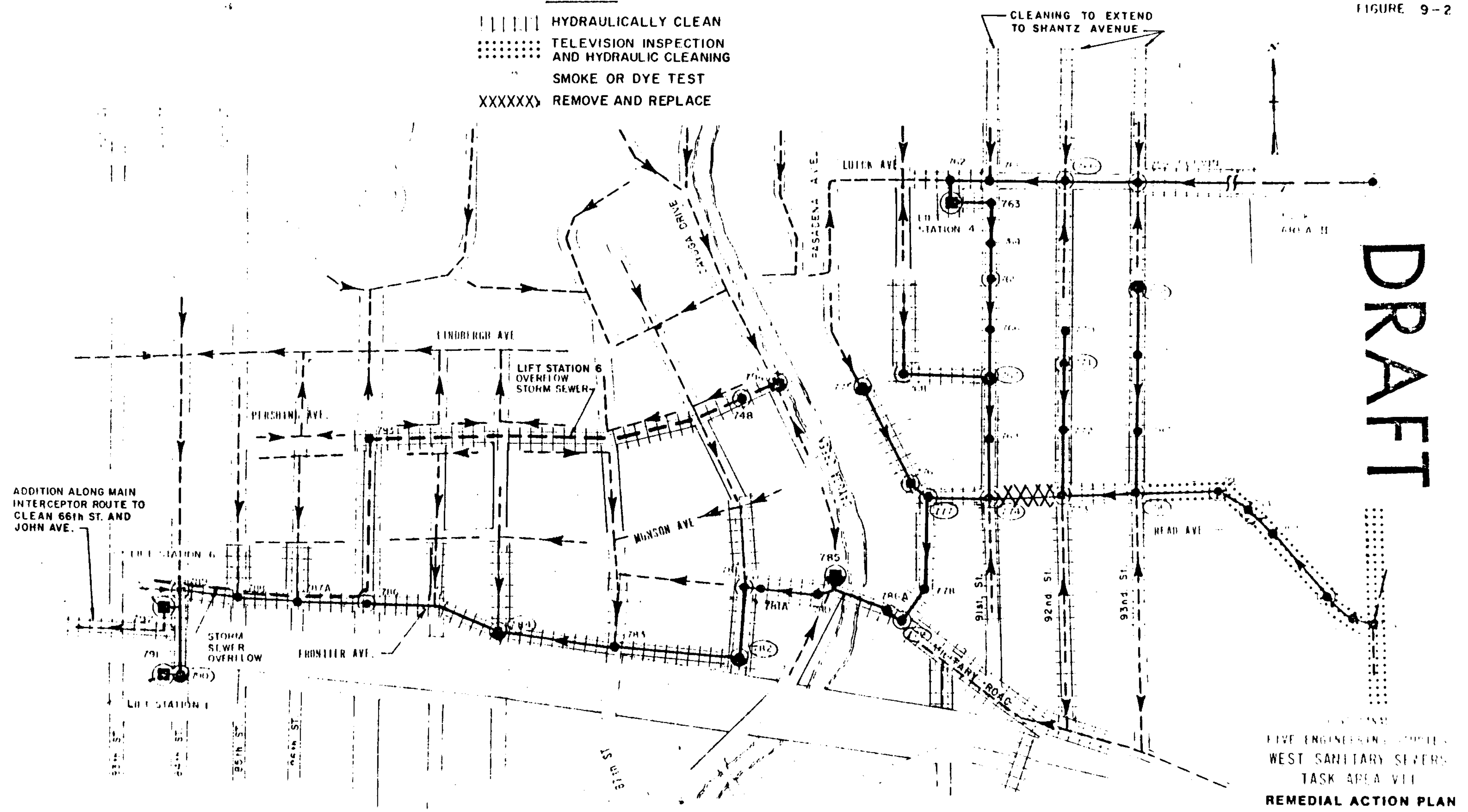

FIVE ENGINEERING COMPLEX
WEST SANITARY SEWERS
TASK AREA VII
REMEDIAL ACTION PLAN

MH 774 and 773 have been recommended for replacement. Lift Station Nos. 1, 4, and 6 should also be cleaned.

9.2 Detailed Engineering Description

9.2.1 General

The cleaning of the sewer system should be accomplished utilizing a high velocity water flushing machine which uses both the nozzle pressure (up to 15,000 psi) to remove encrusted debris combined with the force of the flow to transport the debris to the collection manhole. The debris is actually loosened on the initial pass of the cleaning jet while traveling upstream from the collection manhole and transported to the collection manhole on the return trip while the flusher is being reeled back in. The upstream and downstream manholes should be plugged during the entire cleaning operation to assume that no debris is transported away from the designated collection manhole. The collection manholes should be established in the field at a distance of 500 to 1000 feet downstream of the flushing equipment to allow for convenient removal of flushing water while at the same time providing additional storage capacity to prevent surcharging of the sewers caused by flushing operations.

Contaminated waste material flushed from the lines should be collected and removed by using specific pipeline intersections as "catch manholes." Catch manholes are isolated from the rest of the system by the use of inflatable sewer plugs. Waste material would be transferred from the catch manhole to transport vehicles by using submersible pumps and vacuum nozzles. The estimated daily output for this method of hydraulic cleaning is 1000 linear feet per day.

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Special precautions should be followed by the cleaning contractor to prevent the surcharging of sewers into house laterals. This problem should receive special consideration during the design phase of the remedial activities.

An estimated 6 to 7 gallons of liquid and sediment waste per linear foot is produced by sewer hydraulic cleaning. Transport vehicles should haul the waste to a NYSDEC approved and permitted hazardous waste treatment facility for dewatering. Residual solids should be buried in a NYSDEC-approved secure landfill and liquid filtrate should be treated by NYSDEC approved techniques.

Personnel employed to implement the remedial action plan should follow strict personal safety and decontamination protocols similar to those presently being used for remedial activity inside Rings 1 and 2. Workers should be equipped with appropriate respiratory and dermal protection, (particularly when cleaning the lift stations) and should be trained to work in hazardous environments. Additionally, all confined environments in which men will be working should be continuously monitored for oxygen, hydrogen sulfide combustibles and volatile chemicals. These meters should also be used to monitor the air during the removal and replacement operations on Read Avenue.

9.2.2 Storm Sewers

An estimated 2,800 lf of storm sewer in Task Area VII is recommended for cleaning at the locations identified in Figure 9-1. No areas of the Task Area II storm sewers have been recommended for inspection by television.

9.2.3 Sanitary Sewers and Lift Stations

An estimated 26,000 lf of sanitary sewer in Task Area VII is recommended for cleaning at the locations identified in Figure 9-1. Additionally 2,400 lf of sanitary sewer should be inspected by television.

The main interceptor from Lift Station No. 6 to the intersection of 66th Street and John Avenue should also be cleaned. Although no samples were taken along this route, it is likely that Love Canal-related contaminants are present in the sediments within this sewer because the main interceptor route was contaminated in a number of locations upstream of Lift Station No. 6.

The source of contamination is unknown in the sanitary sewer on Read Avenue between 93rd Street and 96th Street. Therefore, the section of sewer, from MH 756 to MH 750, should be televised. Additionally, the sanitary sewers on 95th Street, which enter MH 750, should be televised to determine if unknown connections to the canal area exist.

During the sampling period, the sanitary sewer on Read Avenue between MH 774 and MH 773 was blocked due to structural damage, root intrusion, or some other problem. This conclusion was made because MH 773 and the sewers upstream of this manhole were surcharged during the sampling period. At the same time, MH 774 and the sewers downstream of MH 774 were not surcharged. As shown on Figure 9-2, the recommendation has been made to remove and replace the portion of sewer between MH 774 and MH 773. This recommendation has been made by using the conservative assumption that the blockage is caused by severe structural damage. Before this sewer is actually removed, an attempt should be made to clean the blockage by hydraulic flushing or other cleaning techniques.

During the removal and replacement of the sanitary sewer between MH 774 and MH 773, special excavation procedures will have to be followed. It is recommended that the trench material excavated to a depth of one foot above the pipe crown be considered as ordinary fill material. The material excavated from one foot above the pipe crown to one foot below the pipe invert should be considered as hazardous material and diposed at a NYSDEC approved hazardous waste disposal facility. The pipe material should also be considered as a hazardous material. Any contaminants which may have exfiltrated from the sewer should be contained within the soil to be excavated.

Other isolated sections of structurally deficient sewers within the task area detected during cleaning activities should be removed and replaced if the damaged sewer prevents proper application of the recommended remedial measures.

Lift Station Nos. 1, 4, and 6 should also be hydraulically cleaned to remove all the grit in the wet wells. This will require taking the lift stations out of service for a short period of time to empty the wet wells and remove the grit. The flow can be pumped around each lift station using portable pumps. Cleaning can be performed using a water jet or long handle brooms and brushes. Any cleaning equipment that cannot be properly cleaned should be disposed of as a hazardous waste. It is estimated that 5 gallons of wastewater will be produced for each square foot cleaned.

During the hydraulic cleaning and removal and replacement of the sewers and lift stations in Task Area VII, vapor controls are not expected to be required. Most of the contaminants in Task Area VII found are nonvolatile.

9.3 Estimated Cost of Remedial Action

Costs estimates (initially developed in Section 8.2) for the various elements of the remedial action plan for Task Area VII are summarized in Table 9-1. Unit costs are based on quotations obtained from sewer cleaning and waste disposal contractors in the Western New York area.

The cost of hydraulic cleaning has been estimated at $5.50/lf. This hydraulic cleaning is a common procedure and can be accomplished by a number of local contractors. For estimating purposes, it has been assumed that vapor controls will not be necessary.

Television inspection has been estimated at $1.50/lf. Television inspection is a common procedure and can be accomplished by a number of local contractors. This task should be included in the same contract as the hydraulic cleaning thereby giving overall coordination responsibility to one contractor.

Cleaning for the lift stations has been estimated at $8,000/each. This includes all labor and rental of hazardous monitoring equipment and bypass pumping equipment.

Waste transportation includes pumping the wastewater from the manholes to transport vehicles which will take the wastewater to the hazardous waste disposal facilities. This task should be performed by the hydraulic cleaning contractor. This task should not be bid separately because this would only

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TABLE 9-1

RECOMMENDED REMEDIATION COSTS TASK AREA VII

Item	Quantity	Unit Cost	Total
Hydraulic Cleaning	28,800 lf	$5.50/lf	$158,400
T.V. Inspection	2,400 lf	$1.50/lf	3,600
Cleaning Residuals Transportation	28,800 lf	$1.40/lf	40,320
Cleaning Residuals Disposal (7 gal/lf)	201,600 gal.	$0.35/gal.	70,560
Removal and Replace Sanitary Sewer	300 lf	$100/lf	30,000
Dispose of Hazardous Excavated Material (0.5 cy/lf)	150 cy	$110/cy	16,500
Clean Lift Stations	3 ea.	$8000/ea.	24,000
Lift Station Cleaning Residuals Transportation	7,500 $ft.^2$	$1.00/$ft.^2$	7,500
Lift Station Cleaning Residuals (5 gal/ft^2) Disposal	2,500/$ft.^2$/ea.	$0.35/gal.	13,200
		Subtotal	$364,080
Engineering, Contingency, Legal Administrative @ 30 percent			109,220
		Total	$473,300

create coordination and responsibility problems among contractors. This cost has been estimated at $1.40/lf.

For waste disposal, only the costs for liquid wastes have been considered. Discussions with hazardous waste disposal operators have indicated that the quantities of solids from sewer cleaning operations will be minimal in comparision with the cost of treating the residual wastewater. The cost for wastewater disposal has been estimated at $.35/gal. This price includes the cost of the residuals solids disposal.

9.4 Implementation Scheduling

The remediation of storm and sanitary sewers in Task Area VII should begin as soon as possible to minimize further migration and dispersion of the contaminants.

Cleaning of the storm sewers is of higher priority than the sanitary sewers because any contamination in the storm sewers can potentially migrate to the Niagara River. Before remediation begins some of the contamination in the sanitary sewer will likely be transported to the City of Niagara Falls Wastewater Treatment Plant, although there is a remote possibility that some of the contaminated sanitary sewer sediment could enter Bergholtz or Caguya Creek through lift station bypasses in Task Area VII.

The scheduling of storm cleaning operations in Task Area VII will not interfere with sewer cleaning operation in any other task area.

The sanitary sewers in Task Area VII should be cleaned after the sanitary sewers in other task areas because Task Area VII is downstream of the other task areas. However,

remediation of the storm and sanitary sewers shoul
before the remediation of Black and Bergholtz Creek

Hydraulic flushing involves the handling of la
ties of water, therefore, hydraulic flushing should
scheduled during the winter months (November-March)
the potential working hazards created by ice, cold w
and poor visibility.

During the spring months (March-April), infiltra
the sewers is greatest due to spring thaw and a high g
water table. Since it will be necessary to dispose of
residual wastewater during the hydraulic clearing oper
extraneous flows due to infiltration will increase the t
disposal cost.

Based on the timing discussed above, the hydraulic flush
operation should be undertaken from May through October.

APPENDIX A
SUMMARY OF ANALYSIS

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VII-4026B
Location ID: MH-711
CompuChem #: 2260

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	222	Methylene Chloride	6,200	2,000	153
Acid	LS	Cyclotetrasiloxane, Octamethyl-	400	EC	718
	LS	Unknown	380	EC	1256
Base/Neutral/ Pesticide	413	BIS (2-Ethylhexyl) Phthalate	3,600	200	1524

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	120	1.0
104	Cadmium, Total	1.6	1.0
105	Chromium, Total	8.6	1.0
106	Copper, Total	11	1.0
107	Lead, Total	16	1.0
109	Nickel, Total	13	1.0
112	Thallium, Total	14	1.0
113	Zinc, Total	27	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VII-1008S
Location ID: MH-712
CompuChem #: 2184

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	222	Methylene Chloride	4,900	2,000	154
Acid	LS	1,2-Benzenedicarboxylic-acid,Butyl2-Methyl-propylester	13,000	EC	1487
Base/Neutral/ Pesticide	413	BIS (2-Ethylhexyl) Phthalate	100,000	4,000 [1]	1531
	431	Fluoranthene	6,800	4,000 [1]	1307
	445	Pyrene	5,600	4,000 [1]	1337
	LS	1,2-Benzenedicarboxylic-acid,2-Butoxyethylbutylester	600,000	EC	1387
	LS	Unknown	19,000	EC	1632

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	7.7	1.0
105	Chromium, Total	12	1.0
106	Copper, Total	15	1.0
107	Lead, Total	39	1.0
109	Nickel, Total	3.3	1.0
112	Thallium, Total	3.8	1.0
113	Zinc, Total	70	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#: VII-1005S
Location ID: MH-714
CompuChem #: 1988

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	LS	Benzene,1,2,3-Trichloro-	6,600	EC	661
Acid	LS	Benzene,1,4-Dichloro-	2,200	EC	758
	LS	Unknown	1,800	EC	871
	LS	Benzene,1,2,4-Trichloro-	1,400	EC	928
	LS	Unknown	2,200	EC	1319
	LS	Hexathiepane	200	EC	1386
Base/Neutral/ Pesticide	446	1,2,4-Trichlorobenzene	39,000	28,000 [1]	795

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	11	1.0
105	Chromium, Total	3.5	1.0
106	Copper, Total	4.1	1.0
107	Lead, Total	19	1.0
109	Nickel, Total	2.5	1.0
112	Thallium, Total	3.6	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#: VII-1001S
Location ID: MH-715
CompuChem #: 1985

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	207	Chlorobenzene	18,000	2,000	717
	222	Methylene Chloride	7,200	2,000	161
	225	Toluene	2,400	2,000	681
	LS	1,4-Dioxane	170,000	EC	386
	LS	Ethane,1,2-Dimethoxy-	15,000	EC	460
	LS	Ethane,1,1'-Oxybis/2-Methoxy-	160,000	EC	835
Acid	LS	Unknown	3,600	EC	501
	LS	Benzene,1,4-Dichloro-	6,200	EC	759
	LS	Unknown	5,600	EC	871
	LS	Benzene,1,2,4-Trichloro-	2,200	EC	884
	LS	Benzene,1,2,4-Trichloro-	8,400	EC	928
Base/Neutral/ Pesticide	413	BIS (2-Ethylhexyl) Phthalate	8,000	4,000 [1]	1551
	422	1,4-Dichlorobenzene	5,600	4,000 [1]	676
	446	1,2,4-Trichlorobenzene	12,000	4,000 [1]	807
	LS	Benzene,2,4-Dichloro-1-Methyl-	4,800	EC	762
	LS	Unknown	4,400	EC	772

[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#: VII-1001S
Location ID: MH-715
CompuChem #: 1985

ORGANICS, Cont'd.

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Base/Neutral/ Pesticide	LS	Benzenamine,3,4-Dichloro-	6,400	EC	973
	LS	Unknown	7,600	EC	1627
	LS	Unknown	5,600	EC	2491

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	12	1.0
104	Cadmium, Total	1.2	1.0
105	Chromium, Total	10	1.0
106	Copper, Total	37	1.0
107	Lead, Total	30	1.0
109	Nickel, Total	6.6	1.0
112	Thallium, Total	6.6	1.0
113	Zinc, Total	70	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VII-1003S
Location ID: MH-719
CompuChem #: 1987

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	207	Chlorobenzene	55,000	2,000	725
	225	Toluene	3,700	2,000	690
Acid	LS	Benzene, 1,3-Dichloro-	30,000	EC	785
	LS	Benzene, 2,4-Dichloro-1-Methyl-	14,000	EC	898
	LS	Unknown	14,000	EC	960
	LS	Benzene, 2, 4-Dichloro-1-(Chloromethyl)-	7,400	EC	1076
	LS	Unknown	7,800	EC	1099
Base/Neutral/ Pesticide	420	1,2-Dichlorobenzene	18,000	4,000[1]	697
	421	1,3-Dichlorobenzene	60,000	4,000[1]	672
	422	1,4-Dichlorobenzene	92,000	4,000[1]	678
	433	Hexachlorobenzene	9,200	4,000[1]	1144
	434	Hexachlorobutadiene	14,000	4,000[1]	832
	446	1,2,4-Trichlorobenzene	72,000	4,000[1]	809
	LS	Benzene, 1-Chloro-2-Methyl-	77,000	EC	625
	LS	Benzene,2,4-Dichloro-1-Methyl-	110,000	EC	765

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[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#: VII-1003S
Location ID: MH-719
CompuChem #: 1987

ORGANICS, Cont'd.

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Base/Neutral/ Pesticide	LS	Benzene,2,4-Dichloro-1-(Chloromethyl)-	42,000	EC	891
	LS	Benzene,2,4-Dichloro-1-(Chloromethyl)-	45,000	EC	900
	LS	Benzene,1,2,3,5-Tetrachloro-	46,000	EC	915

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	1.8	1.0
105	Chromium, Total	2.4	1.0
106	Copper, Total	7.6	1.0
107	Lead, Total	12	1.0
113	Zinc, Total	22	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VII-2017S
Location ID: MH-750
CompuChem #: 2117

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile		None Detected			
Acid	LS	Unknown	1,220	EC	1186
	LS	Unknown	540	EC	1258
	LS	Unknown	3,200	EC	1494
	LS	Unknown	1,800	EC	1500
	LS	Unknown	1,580	EC	1507
Base/Neutral/ Pesticide	413	BIS (2-Ethylhexyl) Phthalate	1,700	400 [1]	1552
	422	1,4-Dichlorobenzene	480	400 [1]	676
	LS	Eicosane	600	EC	1569
	LS	Eicosane	600	EC	1661
	LS	Unknown	800	EC	1772
	LS	Unknown	4,400	EC	2395
	LS	Unknown	1,100	EC	2500

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[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#: VII-2017S
Location ID: MH-750
CompuChem #: 2117

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	28	1.0
104	Cadmium, Total	1.3	1.0
105	Chromium, Total	10	1.0
106	Copper, Total	110	1.0
107	Lead, Total	35	1.0
109	Nickel, Total	9.1	1.0
112	Thallium, Total	13	1.0
113	Zinc, Total	68	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VII-2016S
Location ID: MH-752
CompuChem #: 2075

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	222	Methylene Chloride	4,200	2,000	153
	225	Toluene	6,000	2,000	648
Acid	LS	Benzene,1,2,3,5-Tetrachloro-	31,000	EC	1109
	LS	Dodecanoicacid	38,000	EC	1221
	LS	Tetradecanoicacid	120,000	EC	1361
	LS	Unknown	660,000	EC	1494
	LS	Unknown	72,000	EC	1595
Base/Neutral/ Pesticide	413	BIS (2-Ethylhexyl) Phthalate	13,000	4,000 [1]	1552
	LS	1-Hexadecene	23,000	EC	1277
	LS	Unknown	200,000	EC	2409
	LS	Unknown	92,000	EC	2510
	LS	Unknown	48,000	EC	2527
	LS	Unknown	34,000	EC	2960

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[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#: VII-2016S
Location ID: MH-752
CompuChem #: 2075

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	3.0	1.0
105	Chromium, Total	4.8	1.0
106	Copper, Total	70	1.0
107	Lead, Total	5.9	1.0
109	Nickel, Total	6.1	1.0
112	Thallium, Total	3.6	1.0
113	Zinc, Total	69	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VII-2015S
Location ID: MH-754
CompuChem #: 2074

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	222	Methylene Chloride	9,300	2,000	161
	225	Toluene	4,800	2,000	683
Acid	LS	Dodecanoicacid	43,000	EC	1240
	LS	Unknown	200,000	EC	1387
	LS	2-Heptadecanone	11,000	EC	1458
	LS	Unknown	270,000	EC	1540
Base/Neutral/ Pesticide	413	BIS (2-Ethylhexyl) Phthalate	5,600	4,000 [1]	1552
	422	1,4-Dichlorobenzene	4,400	4,000 [1]	677
	431	Fluoranthene	6,400	4,000 [1]	1320
	444	Phenanthrene	6,400	4,000 [1]	1181
	445	Pyrene	4,800	4,000 [1]	1351
	LS	Tridecane	14,000	EC	869
	LS	2-Propanamine,2-Methyl-	53,000	EC	994
	LS	Pentacosane	30,000	EC	1493
	LS	Tridecane,2-Methyl-	42,000	EC	1908
	LS	Unknown	17,000	EC	2397

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[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#: VII-2015S
Location ID: MH-754
CompuChem #: 2074

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	5.4	1.0
105	Chromium, Total	3.0	1.0
106	Copper, Total	150	1.0
107	Lead, Total	14	1.0
109	Nickel, Total	2.5	1.0
113	Zinc, Total	79	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VII-2014S
Location ID: MH-755
CompuChem #: 2073

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	225	Toluene	17,000	10,000	649
Acid	LS	Pentadecane	36,000	EC	1206
	LS	Hexadecane	36,000	EC	1279
	LS	Octadecane	38,000	EC	1350
	LS	Tetradecanoicacid	42,000	EC	1412
	LS	Unknown	100,000	EC	1558
Base/Neutral/ Pesticide	403	Anthracene/Phenanthrene	2,000	2,000 [1, 2]	1165
	413	BIS (2-Ethylhexyl) Phthalate	23,000	2,000 [1]	1525
	422	1,4-Dichlorobenzene	2,200	2,000 [1]	658
	444	Phenanthrene/Anthracene	2,000	2,000 [1, 2]	1165
	LS	Unknown	26,000	EC	915
	LS	Heptadecane,2,6,10,14-Tetramethyl-	22,000	EC	952
	LS	Pentadecane	28,000	EC	974
	LS	Heptadecane	30,000	EC	1082
	LS	Unknown	28,000	EC	2321

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

[2] Indistinguishable isomers.

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VII-2014S
Location ID: MH-755
CompuChem #: 2073

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	7.6	1.0
104	Cadmium, Total	1.0	1.0
105	Chromium, Total	3.0	1.0
106	Copper, Total	340	1.0
107	Lead, Total	25	1.0
109	Nickel, Total	3.7	1.0
113	Zinc, Total	85	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VII-2011L
Location ID: MH-756
CompuChem #: 2062

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/l)	Detection Limit (ug/l)	Scan Number
Volatile		None Detected			
Acid	LS	Unknown	1,100	EC	1241
	LS	Dodecanoicacid	880	EC	1248
	LS	Unknown	1,300	EC	1387
	LS	Unknown	240	EC	1450
	LS	Unknown	2,600	EC	1517
Base/Neutral/ Pesticide	413	BIS (2-Ethylhexyl) Phthalate	680	10	1524
	LS	Unknown	46	EC	1083
	LS	Unknown	54	EC	1784
	LS	Unknown	81	EC	2300
	LS	Unknown	53	EC	2388

INORGANICS

Compound Number	Compound	Conc. (mg/l)	Detection Limit (mg/l)
	None Detected		

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VII-2011S
Location ID: MH-756
CompuChem #: 2088

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile		None Detected			
Acid	LS	Unknown	38,000	EC	1189
	LS	Dodecanoicacid	26,000	EC	1224
	LS	Tetradecanoicacid	170,000	EC	1367
	LS	Hexadecanoicacid	58,000	EC	1508
Base/Neutral/ Pesticide	413	BIS (2-Ethylhexyl) Phthalate	6,000	6,000 [1]	1552
	LS	Unknown	17,000	EC	1757
	LS	Unknown	32,000	EC	1772
	LS	Tetradecane,4-Ethyl-	18,000	EC	2072
	LS	Pentacosane	32,000	EC	2278
	LS	Unknown	28,000	EC	2394

INORGANICS

INSUFFICIENT SAMPLE MATERIAL AVAILABLE TO PERFORM INORGANICS ANALYSIS.

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[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#: VII-2019S
Location ID: MH-759
CompuChem #: 2120

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile		None Detected			
Acid	LS	Tetradecanoicacid	170,000	EC	1372
	LS	Unknown	210,000	EC	1522
	LS	Unknown	130,000	EC	1541
	LS	Unknown	28,000	EC	1579
Base/Neutral/ Pesticide	413	BIS (2-Ethylhexyl) Phthalate	1,100	200	1551
	433	Hexachlorobenzene	280	200	1142
	446	1,2,4-Trichlorobenzene	960	200	807
	LS	Tridecane	3,400	EC	869
	LS	1-Pentanamine,N-Ethyl-	4,800	EC	993
	LS	Unknown	2,200	EC	1100
	LS	Unknown	3,500	EC	1199
	LS	Octadecane	1,700	EC	1280

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VII-2019S
Location ID: MH-759
CompuChem #: 2120

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
105	Chromium, Total	9.8	1.0
106	Copper, Total	8.2	1.0
107	Lead, Total	4.4	1.0
113	Zinc, Total	19	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VII-2018S
Location ID: MH-760
CompuChem #: 2119

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile		None Detected			
Acid	LS	Butanoicacid	11,000	EC	618
	LS	Unknown	8,200	EC	659
	LS	Pentanoicacid	11,000	EC	695
	LS	Phenol,2-Methyl-	10,000	EC	821
	LS	Benzeneaceticacid	11,000	EC	1010
Base/Neutral/ Pesticide	413	BIS (2-Ethylhexyl) Phthalate	280	200	1529
	LS	Unknown	2,800	EC	561
	LS	Unknown	3,200	EC	567
	LS	1H-Indole	2,200	EC	869
	LS	Unknown	2,800	EC	1405
	LS	Unknown	2,700	EC	2349

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
104	Cadmium, Total	1.0	1.0
105	Chromium, Total	10	1.0
106	Copper, Total	140	1.0
107	Lead, Total	8.8	1.0
113	Zinc, Total	58	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VII-4031B
Location ID: MH-760
CompuChem #: 2259

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile		None Detected			
Acid	LS	Unknown	74	EC	667
	LS	Unknown	220	EC	735
	LS	Unknown	95	EC	1285
	LS	Unknown	96	EC	1409
Base/Neutral/ Pesticide	413	BIS (2-Ethylhexyl) Phthalate	1600	200	1551
	LS	2-Pentanone,4-Hydroxy-4-Methyl-	390	EC	516

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	36	1.0
104	Cadmium, Total	2.1	1.0
105	Chromium, Total	10	1.0
106	Copper, Total	18	1.0
107	Lead, Total	21	1.0
109	Nickel, Total	13	1.0
112	Thallium, Total	9.6	1.0
113	Zinc, Total	35	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Page 1 of 2

Malcolm-Pirnie ID#: VII-2007S
Location ID: MH-765
CompuChem #: 2014

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile		None Detected			
Acid	LS	Unknown	3,200	EC	1226
	LS	Unknown	3,700	EC	1426
	LS	Unknown	1,600	EC	1438
	LS	Unknown	8,100	EC	1522
	LS	Unknown	64,000	EC	1540
Base/Neutral/ Pesticide	433	Hexachlorobenzene	4,000	4,000 [1]	1143
	LS	Benzene,1,2,3,5-Tetrachloro-	14,000	EC	947
	LS	Unknown	7,000	EC	981
	LS	Benzene,Pentachloro-	34,000	EC	1035
	LS	Unknown	8,400	EC	2392
	LS	Unknown	8,800	EC	2500

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[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#: VII-2007S
Location ID: MH-765
CompuChem #: 2014

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
104	Cadmium, Total	5.9	1.0
105	Chromium, Total	2,8	1.0
106	Copper, Total	14	1.0
107	Lead, Total	10	1.0
109	Nickel, Total	5.7	1.0
112	Thallium, Total	2.2	1.0
113	Zinc, Total	130	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VII-4032B
Location ID: MH-767
CompuChem #: 2274

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile		None Detected			
Acid	LS	Unknown	230	EC	836
Base/Neutral/ Pesticide	413	BIS (2-Ethylhexyl) Phthalate	360	200	1552

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	29	1.0
104	Cadmium, Total	1.9	1.0
105	Chromium, Total	9.7	1.0
106	Copper, Total	2.6	1.0
107	Lead, Total	18	1.0
109	Nickel, Total	12	1.0
112	Thallium, Total	8.2	1.0
113	Zinc, Total	32	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VII-2008S
Location ID: MH-768
CompuChem #: 2015

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile		None Detected			
Acid	LS	Unknown	2,200	EC	738
	LS	Phenol,2-Methyl-	2,700	EC	837
	LS	Unknown	3,400	EC	1206
	LS	Unknown	2,200	EC	1379
Base/Neutral/ Pesticide	413	BIS (2-Ethylhexyl) Phthalate	11,000	4,000 [1]	1530
	431	Fluoranthene	4,400	4,000 [1]	1307
	445	Pyrene	4,000	4,000 [1]	1337
	LS	Unknown	4,800	EC	1799
	LS	Unknown	31,000	EC	2323
	LS	Unknown	20,000	EC	2420

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[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#: VII-2008S
Location ID: MH-768
CompuChem #: 2015

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	3.2	1.0
105	Chromium, Total	4.9	1.0
106	Copper, Total	110	1.0
107	Lead, Total	34	1.0
109	Nickel, Total	2.2	1.0
113	Zinc, Total	72	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VII-2005S
Location ID: MH-773
CompuChem #: 2008

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile		None Detected			
Acid	LS	Unknown	3,000	EC	716
	LS	Phenol,2-Methyl-	5,200	EC	815
	LS	1,2,4-Trithiolane	3,800	EC	858
	LS	Unknown	4,000	EC	935
	LS	Unknown	7,200	EC	1182
Base/Neutral/ Pesticide	413	BIS (2-Ethylhexyl) Phthalate	7,600	4,000 [1]	1548
	421	1,3-Dichlorobenzene	4,000	4,000 [1]	670
	422	1,4-Dichlorobenzene	15,000	4,000 [1]	675
	426	Di-N-Butyl Phthalate	5,600	4,000 [1]	1233
	446	1,2,4-Trichlorobenzene	20,000	4,000 [1]	806
	LS	Unknown	17,000	EC	1145
	LS	Heptadecane	16,000	EC	1096
	LS	Hexadecane	12,000	EC	1044
	LS	Eicosane	14,000	EC	1236
	LS	Pentacosane	12,000	EC	1279

[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#: VII-2005S
Location ID: MH-773
CompuChem #: 2008

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
105	Chromium, Total	1.3	1.0
106	Copper, Total	3.0	1.0
107	Lead, Total	14	1.0
113	Zinc, Total	33	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VII-2009S
Location ID: MH-774
CompuChem #: 2118

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile		None Detected			
Acid	LS	2-Propanamine,2-Methyl-	7,400	EC	1183
	LS	Unknown	7,200	EC	1222
	LS	Hexadecanoicacid	98,000	EC	1493
	LS	Unknown	150,000	EC	1499
	LS	Unknown	8,200	EC	1594
Base/Neutral/ Pesticide	413	BIS (2-Ethylhexyl) Phthalate	6,000	4,000 [1]	1545
	LS	Unknown	7,200	EC	1503
	LS	Hexatriacontane	4,400	EC	1903
	LS	Unknown	27,000	EC	2391
	LS	Unknown	11,000	EC	2497

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[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#: VII-2009S
Location ID: MH-774
CompuChem #: 2118

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	5.20	1.0
105	Chromium, Total	4.10	1.0
106	Copper, Total	210	1.0
107	Lead, Total	54	1.0
109	Nickel, Total	3.8	1.0
113	Zinc, Total	170	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VII-4029B
Location ID: MH-774
CompuChem #: 2261

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile		None Detected			
Acid	LS	Unknown	170	EC	1240
Base/Neutral/ Pesticide	413	BIS (2-Ethylhexyl) Phthalate	2,600	200	1550
	LS	Unknown	1,600	EC	1053
	LS	Heptadecane	280	EC	1096
	LS	Unknown	300	EC	1145
	LS	Eicosane	260	EC	1192
	LS	Eicosane	200	EC	1236

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	21	1.0
104	Cadmium, Total	1.0	1.0
105	Chromium, Total	6.2	1.0
106	Copper, Total	6.5	1.0
107	Lead, Total	12	1.0
109	Nickel, Total	7.9	1.0
112	Thallium, Total	6.6	1.0
113	Zinc, Total	20	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VII-2003S
Location ID: Mh-776
CompuChem #: 2007

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile		None Detected			
Acid	LS	Cyclohexane	15,000	EC	327
	LS	Cyclotrisiloxane, Hexamethyl-	6,000	EC	531
	LS	Cyclotetrasiloxane, Octamethyl-	2,800	EC	726
	LS	Unknown	2,200	EC	1034
	LS	Unknown	3,800	EC	1388
Base/Neutral/ Pesticide	LS	Unknown	9,000	EC	1316

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	5.7	1.0
105	Chromium, Total	9.4	1.0
106	Copper, Total	38	1.0
107	Lead, Total	76	1.0
109	Nickel, Total	2.8	1.0
113	Zinc, Total	97	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VII-2002S
Location ID: MH-777
CompuChem #: 2006

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile		None Detected			
Acid	611	2,4,6-Trichlorophenol	560	500	1087
	LS	Benzene,1,2,4-Trichloro-	1,800	EC	927
	LS	Benzene,1,2,3,5-Tetrachloro-	2,200	EC	1066
	LS	Unknown	8,000	EC	1113
	LS	Unknown	5,000	EC	1225
	LS	Unknown	1,700	EC	1485
Base/Neutral/Pesticide	413	BIS (2-Ethylhexyl) Phthalate	4,000	4,000 [1]	1552
	433	Hexachlorobenzene	6,000	4,000 [1]	1142
	434	Hexachlorobutadiene	6,000	4,000 [1]	831
	446	1,2,4-Trichlorobenzene	37,000	4,000 [1]	807
	702	Alpha-BHC	6,400	4,000 [1]	1132
	704	Gamma-BHC	5,200	4,000 [1]	1165
	705	Delta-BHC	4,000	4,000 [1]	1187

[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#: VII-2002S
Location ID: MH-777
CompuChem #: 2006

ORGANICS, Cont'd.

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
	LS	Benzene,2,4-Dichloro-1 -(Chloromethyl)-	22,000	EC	890
	LS	Benzene,1,2,3,5-Tetrachloro-	25,000	EC	914
	LS	Unknown	72,000	EC	948
	LS	Unknown	40,000	EC	1035
	LS	Unknown	21,000	EC	2395

INORGANICS

INSUFFICIENT SAMPLE MATERIAL AVAILABLE TO PERFORM INORGANICS ANALYSIS.

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VII-2001S
Location ID: MH-779
CompuChem #: 2005

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	207	Chlorobenzene	78,000	10,000	682
	225	Toluene	35,000	10,000	648
	LS	1,4-Cyclohexadiene,1-Methyl-4-(1-Methylethyl)-	8,300	EC	717
	LS	Unknown	3,800	EC	785
	LS	Unknown	15,000	EC	815
Acid	LS	Benzene,2,4-Dichloro-1-Methyl-	38,000	EC	873
	LS	Benzene,1,2,4-Trichloro-	82,000	EC	936
	LS	Unknown	38,000	EC	1072
	LS	Unknown	90,000	EC	1119
	LS	Unknown	66,000	EC	1231
Base/Neutral/ Pesticide	403	Anthracene/Phenanthrene	10,000	4,000 [1, 2]	1160
	413	BIS (2-Ethylhexyl) Phthalate	10,000	4,000 [1]	1523
	420	1,2-Dichlorobenzene	34,000	4,000 [1]	678
	421	1,3-Dichlorobenzene	52,000	4,000 [1]	653
	422	1,4-Dichlorobenzene	98,000	4,000 [1]	659

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

[2] Indistinguishable isomers.

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VII-2001S
Location ID: MH-779
CompuChem #: 2005

ORGANICS, Cont'd.

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Base/Neutral/ Pesticide	433	Hexachlorobenzene	82,000	4,000 [1]	1126
	434	Hexachlorobutadiene	76,000	4,000 [1]	815
	444	Phenanthrene/Anthracene	10,000	4,000 [1, 2]	1160
	446	1,2,4-Trichlorobenzene	310,000	4,000 [1]	791
	702	Alpha-BHC	56,000	4,000 [1]	1115
	704	Gamma-BHC	43,000	4,000 [1]	1148
	LS	Benzene,1,2-Dichloro-4-Methyl-	64,000	EC	747
	LS	Benzene,1,2,3,5-Tetrachloro-	76,000	EC	899
	LS	Unknown	68,000	EC	929
	LS	Benzene,Pentachloro-	96,000	EC	1017

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

[2] Indistinguishable isomers.

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VII-2001S
Location ID: MH-779
CompuChem #: 2005

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	1.6	1.0
104	Cadmium, Total	2.2	1.0
105	Chromium, Total	48	1.0
106	Copper, Total	38	1.0
107	Lead, Total	8.4	1.0
113	Zinc, Total	27	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VII-2022S
Location ID: MH-786
CompuChem #: 2183

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	222	Methylene Chloride	4,800	2,000	154
Acid	LS	Unknown	1,400	EC	580
	LS	Ethanol,2-(Dimethylamino)-	1,300	EC	1189
	LS	Unknown	1,400	EC	1224
	LS	Unknown	3,000	EC	1365
	LS	Unknown	19,000	EC	1498
Base/Neutral/ Pesticide	413	BIS (2-Ethylhexyl) Phthalate	300	200	1542
	446	1,2,4-Trichlorobenzene	300	200	799
	LS	Benzene,1,2,4-Trichloro-	320	EC	799
	LS	Unknown	1,100	EC	1109
	LS	Unknown	820	EC	1130
	LS	Unknown	2,000	EC	2388
	LS	Unknown	1,100	EC	2491

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VII-2022S
Location ID: MH-786
CompuChem #: 2183

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	4.0	1.0
104	Cadmium, Total	3.6	1.0
105	Chromium, Total	31	1.0
106	Copper, Total	75	1.0
107	Lead, Total	56	1.0
109	Nickel, Total	3.7	1.0
112	Thallium, Total	3.3	1.0
113	Zinc, Total	87	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VII-2012S
Location ID: MH-787
CompuChem #: 2087

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile		None Detected			
Acid	LS	Undecane	9,700	EC	1013
	LS	Unknown	150,000	EC	1230
	LS	Unknown	220,000	EC	1375
	LS	Unknown	630,000	EC	1477
	LS	Unknown	360,000	EC	1520
Base/Neutral/ Pesticide	413	BIS (2-Ethylhexyl) Phthalate	2,300	400 [1]	1552
	LS	Octane,2,6-Dimethyl-	4,600	EC	703
	LS	Unknown	5,600	EC	1194
	LS	2-Heptadecanone	8,800	EC	1199
	LS	Unknown	4,000	EC	1278
	LS	Unknown	7,400	EC	1837

INORGANICS

INSUFFICIENT SAMPLE MATERIAL AVAILABLE TO PERFORM INORGANICS ANALYSIS.

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[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#: VII-3004S
Location ID: MH-791
CompuChem #: 2273

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile		None Detected			
Acid	LS	Unknown	1,100	EC	1178
	LS	Unknown	1,300	EC	1256
	LS	Unknown	1,100	EC	1304
	LS	Unknown	1,300	EC	1320
	LS	Hexadecanol	2,400	EC	1437
Base/Neutral/ Pesticide	413	BIS (2-Ethylhexyl) Phthalate	3,200	400 [1]	1552
	LS	Unknown	2,400	EC	1054
	LS	1-Dodecanol	2,100	EC	1188
	LS	1-Hexadecyne	2,500	EC	1270
	LS	1-Heptadecanol	2,900	EC	1277
	LS	Unknown	1,700	EC	1373

[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#: VII-3004S
Location ID: MH-791
CompuChem #: 2273

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
105	Chromium, Total	2.1	1.0
106	Copper, Total	31	1.0
107	Lead, Total	8.4	1.0
113	Zinc, Total	64	1.0

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VII-3001S
Location ID: 91st & Luick
CompuChem #: 2248

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile		None Detected			
Acid	LS	Dodecane	48,000	EC	956
	LS	Tridecane	44,000	EC	1045
	LS	Tetradecane	43,000	EC	1127
	LS	Hexadecane	30,000	EC	1175
	LS	Pentadecane	36,000	EC	1204
Base/Neutral/ Pesticide	403	Anthracene/Phenanthrene	9,200	2,000 [1, 2]	1165
	405	Benzo (A) Anthracene/ Chrysene	4,600	2,000 [1, 3]	1534
	413	BIS (2-Ethylhexyl) Phthalate	18,000	2,000 [1]	1523
	418	Chrysene/Benzo (A) Anthracene	4,600	2,000 [1, 3]	1534
	421	1,3-Dichlorobenzene	3,800	2,000 [1]	653
	422	1,4-Dichlorobenzene	14,000	2,000 [1]	659
	431	Fluoranthene	3,800	2,000 [1]	1301
	433	Hexachlorobenzene	7,400	2,000 [1]	1127
	444	Phenanthrene/Anthracene	9,200	2,000 [1, 2]	1165

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

[2, 3] Indistinguishable isomers.

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VII-3001S
Location ID: 91st & Luick
CompuChem #: 2248

ORGANICS, Cont'd.

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Base/Neutral/ Pesticide	445	Pyrene	4,400	2,000 [1]	1331
	446	1,2,4-Trichlorobenzene	29,000	2,000 [1]	792
	702	Alpha-BHC	9,400	2,000 [1]	1116
	704	Gamma-BHC	4,800	2,000 [1]	1149
	705	Delta-BHC	3,400	2,000 [1]	1171
	LS	Octadecane	12,000	EC	1130
	LS	Octadecane	18,000	EC	1178
	LS	Eicosane	18,000	EC	1223
	LS	Heneicosane	21,000	EC	1265
	LS	Pentacosane	16,000	EC	1308

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	20	1.0
104	Cadmium, Total	2.9	1.0
105	Chromium, Total	28	1.0
106	Copper, Total	430	1.0
107	Lead, Total	130	1.0
109	Nickel, Total	13	1.0
112	Thallium, Total	3.0	1.0
113	Zinc, Total	560	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#: VII-3003S
Location ID: P.S. #6
CompuChem #: 2249

ORGANICS

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Volatile	LS	Cyclopentane,1-Ethyl-3-Methyl-,Trans-	16,000	EC	713
	LS	Unknown	61,000	EC	766
Acid	LS	Tetradecane	44,000	EC	1128
	LS	Unknown	46,000	EC	1195
	LS	Pentadecane	46,000	EC	1206
	LS	Heptadecane	50,000	EC	1349
	LS	Octadecane	42,000	EC	1415
Base/Neutral/ Pesticide	403	Anthracene/Phenanthrene	16,000	2,000[1, 2]	1171
	413	BIS (2-Ethylhexyl) Phthalate	12,000	2,000[1]	1531
	415	Butyl Benzyl Phthalate	3,400	2,000[1]	1419
	420	1,2-Dichlorobenzene	2,200	2,000[1]	681
	422	1,4-Dichlorobenzene	5,600	2,000[1]	661
	439	Naphthalene	7,000	2,000[1]	802
	444	Phenanthrene/Anthracene	16,000	2,000[1, 2]	1171
	445	Pyrene	4,800	2,000[1]	1337

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

[2] Indistinguishable isomers.

MALCOLM-PIRNIE
SUMMARY OF ANALYSIS

Malcolm-Pirnie ID#: VII-3003S
Location ID: P.S. #6
CompuChem #: 2249

ORGANICS, Cont'd.

Fraction	Compound Number	Compound	Conc. (ug/kg)	Detection Limit (ug/kg)	Scan Number
Base/Neutral/ Pesticide	446	1,2,4-Trichlorobenzene	7,400	2,000 [1]	794
	LS	Unknown	70,000	EC	855
	LS	Unknown	10,000	EC	687
	LS	Unknown	99,000	EC	715
	LS	Unknown	110,000	EC	864
	LS	Unknown	92,000	EC	965

INORGANICS

Compound Number	Compound	Conc. (ug/g)	Detection Limit (ug/g)
102	Arsenic, Total	6.7	1.0
104	Cadmium, Total	1.1	1.0
105	Chromium, Total	8.6	1.0
106	Copper, Total	170	1.0
107	Lead, Total	49	1.0
109	Nickel, Total	4.3	1.0
113	Zinc, Total	150	1.0

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

APPENDIX B
REFERENCES

APPENDIX B

LOVE CANAL REFERENCE DOCUMENTS

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"A" - Remote Sensing Program

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

"C" - Sampling Plan to Define Chemical Migration

"D" - Comment on Love Canal Pollution Abatement Program

"E" - Love Canal Remedial Action Project - Project Statement Conestoga - Rovers, August 1978.