July 28, 1978

DRAFT REPORT:

ANALYSIS OF A GROUND WATER CONTAMINATION INCIDENT IN NIAGARA FALLS, NEW YORK

Prepared for:
U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Solid Waste
Contract No. 68-01-3897

Prepared by:
FRED C. HART ASSOCIATES, INC.
527 Madison Avenue
New York, New York 10022

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I. Executive Summary

This document is the Draft Final Report in response to a work-task order performed under Contract No. 68-01-3897 for U.S. EPA Office of Solid Waste. Mr. David Huber is the EPA Project Officer. The subject of the study is a groundwater, surface water and air quality contamination incident involving an abandoned hazardous waste landfill, the Love Canal, in Niagara Falls, New York. The contractor, Fred C. Hart Associates, scheduled, conducted and attended meetings in Niagara Falls, Buffalo and Albany, New York and in Edison, New Jersey to gather data and to interpret all available information relative to the ground-water aspect of the problem. The contractor within the period of performance conducted preliminary and major field investigations, gathered field and local data, collected and analyzed samples and evaluated the problem. The subcontractor, York Research Corporation provided chemical analyses of the samples collected. Dr. D. Dan Rabinowitz provided technical consultation and review.

The Love Canal served as a depository for chemical wastes and other solid and liquid wastes from a variety of municipal and industrial sources. It was filled and covered some twenty-five years ago with no definitive record of its dimensions, of the wastes disposed in the Canal, of the waste contributors, nor of the waste locations. Contamination of the surface of the site and the neighboring properties had been noted by residents and inspectors over the past several years. Contamination of sump pumps, basements and homes has also occurred recently. These problems have resulted from migration of leachate through shallow permeable soil, apparently in a primarily westward direction. Problems also stem from the shallow depth of burial of fill material, periodic saturation of soils to the land surface, and surface water runoff.

Air and water sampling programs have detected high concentrations of wide variety of chemical compound ranging from aliphatics to aromatics and many chlorinated variations of each. The total range of chemicals present on site and present as contaminants in soil, air and water in the surrounding areas has not been determined, but the existing data points to the immediacy and severity of the problem.

Preliminary health studies of local residents indicate problems in three areas: liver function, foetal formation, and success of pregnancy. Further health data are under development.

Specific design of interim and long term measures for clean-up and mitigation of the impacts of this complex problem require fuller investigation than could be accommodated by this contract. Nonetheless, preliminary recommendations have been formulated for further consideration. These include:

1. covering of the fill area with impermeable clay

2. installation of a clay barrier on the east side of the site,

3. installation of a tile drain system on the west side of the site,

4. provision for surface runoff collection,

5. sealing of basements to prevent infiltration of contaminants.

II. Introduction

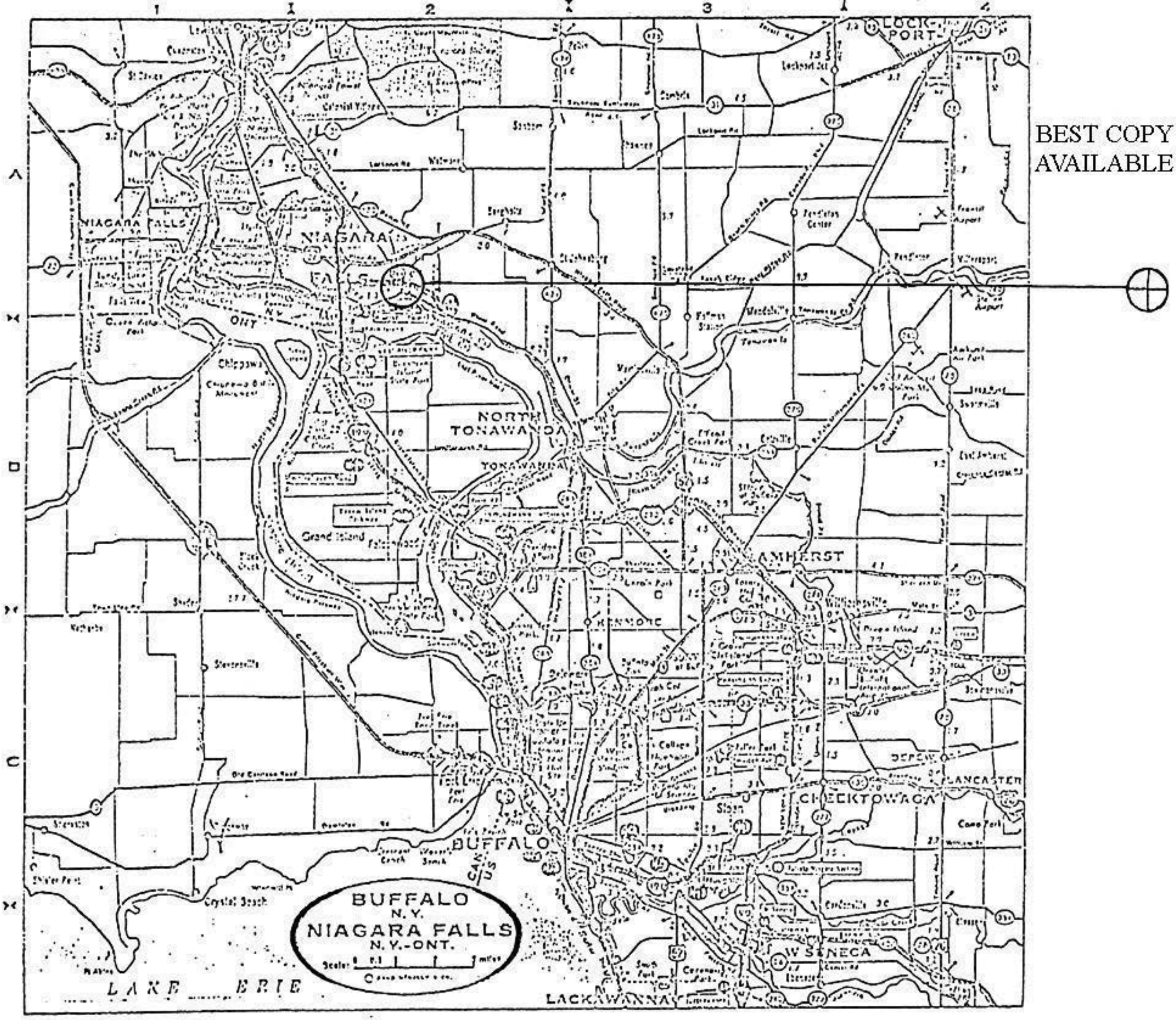
A. Objectives and Scope. This report summarizes the results of the investigation of a groundwater contamination episode resulting from the landfilling of industrial and municipal wastes in the Love Canal in Niagara Falls, New York. The landfill had been owned and operated for a 25 to 30 year period by what was then Hooker Electrochemical Corporation. In 1953, the canal was covered with earth and clay, apportioned and sold to municipal and private owners. The location of the study area is shown in Figures 1 and 2.

The purpose of the study was to evaluate the groundwater impacts stemming from migration of chemical constituents from the landfill into local aquifers. Other purposes included the outline of recommendations for immediate and long-term mitigative actions. The New York State (NYS) Department of Health (DOH) and Department of Environmental Conservation (DEC), the U.S. Environmental Protection Agency headquarters and Region II (EPA), the City of Niagara Falls, Hooker Chemical Co. and the County of Niagara Board of Health have been involved in investigations of the problem and have coordinated efforts to examine both air and water contamination. The above organizations serve as a "project group" As contractor to headquarters EPA (Office of Solid Waste), Fred C. Hart Associates' specific role in studying the problem involved hydrogelogic studies, analytical work and development of suggested measures to mitigate ground-water contamination.

B. Summary of Actions. Over the last seven months the contractor has scheduled and attended meetings, conducted site visits, conducted sampling, analytical and other data gathering efforts and responded to requests for information from the project group. On January 9th, Mr. David Huber, Project Officer and Mr. James A. Rogers of Fred C. Hart Associates travelled to Niagara Falls to gather pertinent information, to visit the site and to attend an organization meeting, held at the DEC Regional Office in Buffalo, New York. In attendence were:

John Beecher	Region 9 DEC, Buffalo
Peter J. Burke, Counsel	Region 9 DEC, Buffalo
Paul R. Counterman	Management Programs DEC, Albany
William Librizzi	EPA Region II, Edison, N.J.
Wayne Pierre	EPA Region II, New York City
David Huber	EPA Office of Solid Waste, Washington
James Rogers	Fred C. Hart Associates, New York City

Throughout the intervening months, contact was maintained with the above representatives and was developed with City officials. On July 14, 1978 Mr. Rogers and Fred C. Hart, President of Fred C. Hart Associates, traveled to Albany to attend a meeting held by the project group as described above. The groups represented were:



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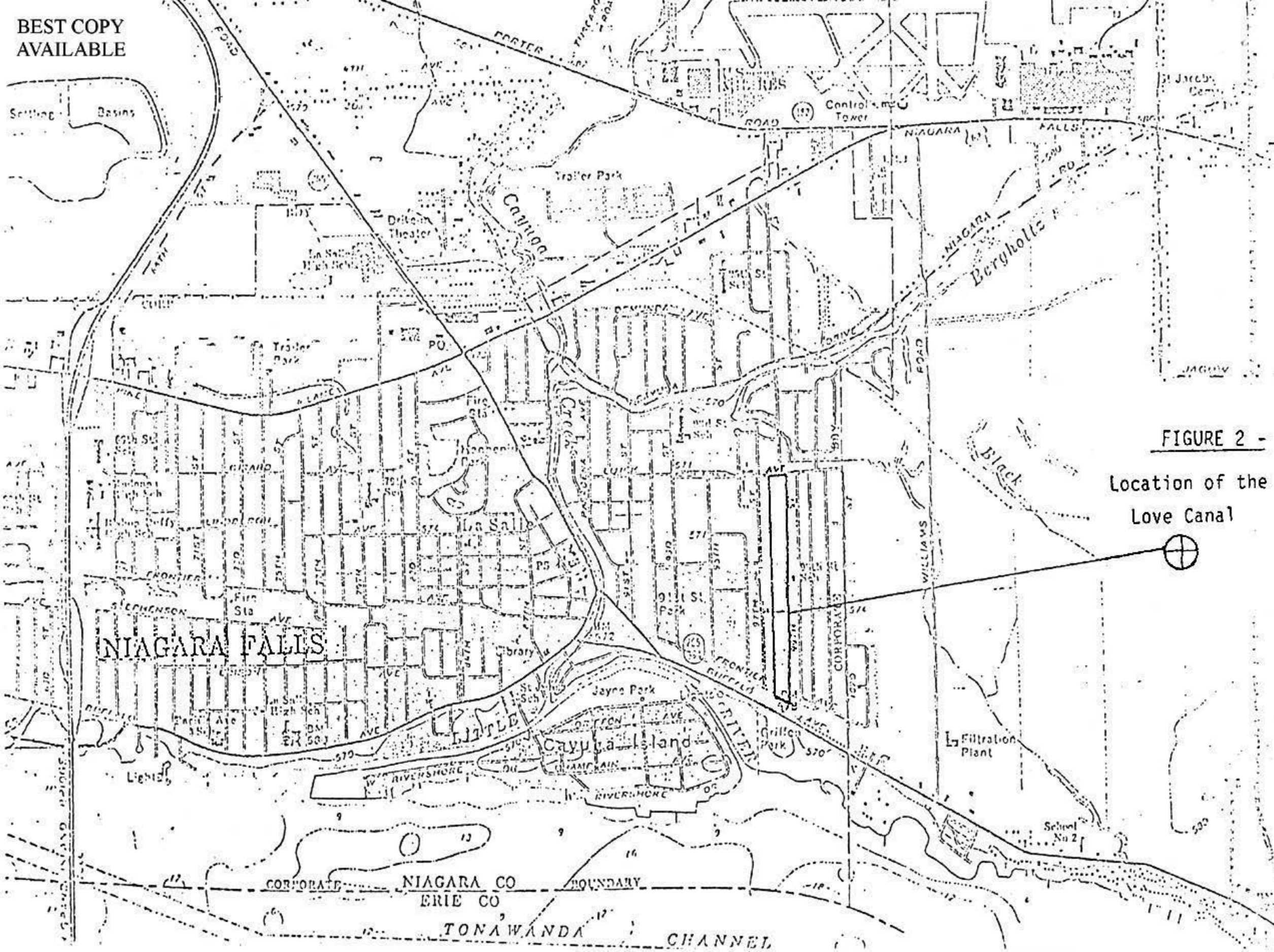

FIGURE 2 -

Location of the Love Canal

State Assemblyman Murphy's Office
U.S. Representative LaFalce's Office
City of Niagara Falls, Mayor's Office,
Counsel, Science Advisor
U.S. EPA Region II, Administrator Beck's Office
U.S. EPA Region II, Office of Toxic Substances
NYS DEC. Commissioner Berle's Office
NYS DEC, Division of Solid Waste Management
and Region 9 Office
NYS DOH Commissioner's Office, Division of
Laboratories and Research
County of Niagara, Department of Health
Consultants and Contractor.

Field work and site investigations were conducted June 7, 8 and 9, 1978. These actions included drilling of holes into the water table aquifer with a power auger, the collection of groundwater and surface water samples and attendance at meetings with the city.

A summary of events and actions taken is provided in the Appendix.

III. History and Background

A. Ownership History. Love Canal was planned originally as an all-American shipping canal on the United States side of Niagara Falls in New York State to compete with the Welland Canal in Canada. As a promotional activity, it succeeded in making money, but as a canal, it was never completed. It was sold to Hooker Electrochemical Company sometime in the 1930's. Neither the date nor the price are certain. The canal was then utilized for the disposal of wastes. Hooker sold the filled chemical dump for $1.00 in 1953 to the Board of Education City of Niagara Falls. The deed advised the grantee (Board of Education) that the premises had been filled with chemical wastes and that

> "the grantee assumes all risk and liability in use thereof" and that "no claim, suit, action or demand of any nature whatsoever shall ever be made by the grantee, its successor or assigns... for injury to a person or persons, including death...or loss of or damage to property caused by...the presence of said industrial wastes...(E)ach subsequent conveyance of the aforesaid lands shall be made subject to the foregoing provisions and conditions." 7/2/53 registered, 7/6/53 filed.

The Board sold portions to the City government (3.53 acres) and to a private developer (5.98 acres) who had never seen the property and kept 6.58 for its own uses.

B. Background. The 16 acre landfill site is bounded by Colvin Boulevard to the north, Frontier Avenue and the LaSalle Expressway to the south, 97th Street to the west, and 99th Street to the east. These boundaries are not exact since the canal may extend further north and south. The Niagara River is located about 1/4 mile southwest of the southernmost portion of the site. Cayuga Creek, Black Creek and Bergholtz Creek flow around the site on three sides, within 200 yards to a mile distant. The landfill is bordered by single-family residences on 97th and 99th Streets, while the portion of the landfill, located between Read Avenue and Wheatfield Avenue, is used as the official playground of the 99th Street elementary school. The school itself is located over the Canal, while only a far eastern section, which houses the boilers, is located below ground. No school basement has been excavated from the Canal landfill.

The exact contents of the landfill are not known. However, it is known that the Hooker Chemical Company disposed of a variety of drummed chemical wastes including chemical residues, process sludges (Hot Cake) and fly ash. The site was also utilized by the City of Niagara Falls for disposal of City solid waste. Figure 3 indicates the approximate locations of wastes according to a 1977 report[1]. However checks of the validity of these locations have revealed that the drummed wastes are

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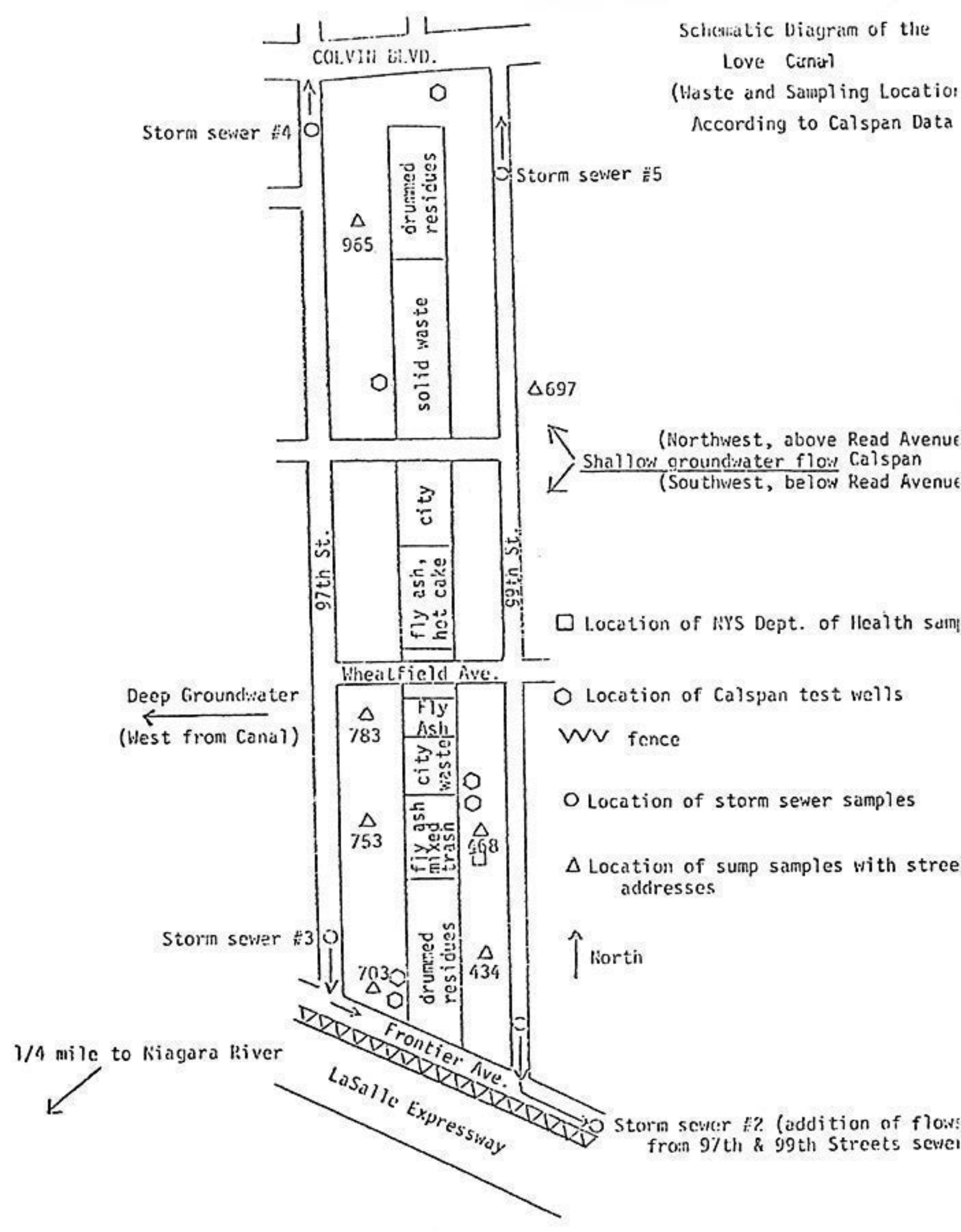
1. Calspan Corporation, Buffalo, New York (8/77).


Schematic Diagram of the
Love Canal
(Waste and Sampling Location
According to Calspan Data
COLVIN BLVD.
Storm sewer #4
Storm sewer #5
drummed residues
965
solid waste
697
(Northwest, above Read Avenue
Shallow groundwater flow Calspan
(Southwest, below Read Avenue
97th St.
99th St.
city
fly ash, hot cake
Location of NYS Dept. of Health samp
Wheatfield Ave.
Deep Groundwater
(West from Canal)
783
Fly Ash
city waste
Location of Calspan test wells
fence
753
fly ash mixed trash
968
Location of storm sewer samples
Location of sump samples with stree
addresses
Storm sewer #3
703
drummed residues
434
North
Frontier Ave.
1/4 mile to Niagara River
LaSalle Expressway
Storm sewer #2 (addition of flows
from 97th & 99th Streets sewer

not confined to the areas indicated, but are spread along the length of the Canal. Two other chemical manufacturers have been contacted about the possibilities of their disposal of waste in the Canal. The Army is also looking into possible contributions from plants operated by the Defense Department.

The drums are buried to a probable depth of ten feet. However, it is reported that in 1957, 3 disposal pits were dug to a maximum depth of 36 feet. The surface cover, sealing the Canal ranges in thickness from zero to six feet, with an average thickness of 3.5 to 4 feet, it is reported. As the drums have deteriorated, the soil has settled so that the surface of the landfill has become very irregular, with potholes, depressions, and some drums appearing at the surface.

In April of 1977, the City of Niagara Falls contracted with the Calspan Corporation of Buffalo, New York, to assess the extent of the contamination problem at the Love Canal, and to propose recommendations for control of the spread of contaminants and for disposal of the drummed and released wastes in the Canal. Calspan, in its studies during the Spring and the Summer of 1977, sampled the basements of residences and sewers to gather information on the extent, the movement and the concentration of contaminants. The firm also examined groundwater flow direction locally through a test well drilling program. This effort did not address deep groundwater flow nor surficial flow outside the canal boundaries.

As part of the 1977 study, Calspan installed six 6" diameter monitoring wells in May, 1977. The deepest wells extend to bedrock; however, the majority of the wells range in depth from 3.3 ft. to 10 ft. The shallow wells, located in the southern portion of the landfill site, confirmed the existence of a water table within 2 to 3 feet of the surface. Movement of the groundwater in the shallow or perched water table was determined to be in a southwest direction below Read Avenue and northwest above it.

Movement of the groundwater in the bedrock aquifer was undetermined by Calspan wells, although it was hypothesized that movement is generally from east to west. This hypothesis was based on "possible infiltration of water from the Niagara River into the deep permanant water table." This conclusion was also drawn in a 1952 U.S.G.S. report:

> "Pumping of some wells adjacent to the river lowers the water table to below river level producing a flow of water from the river toward the wells through solution channels and other openings."[1]

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1. "Water Resources of the Buffalo-Niagara Falls Region," C.W. Reck and E.T. Simmons; U.S.G.S. Circular 173, 1952.

C. History of the Problem. Organic contaminants can be seen on the surface of the Canal cover. In several places, the contaminants have moved with ponded surface water into backyards. Area residents have experienced unpleasant odors outdoors, especially in the summer, and in their cellars, especially after rains. Basement sump pumps have also been affected by oily liquids. Chemical constituents, travelling either with the near-surface groundwater or over the surface to the basement walls and down the walls, have found their way into many basements adjacent to the canal. Air sampling performed by the State has shown that many compounds have volatilized and are present in the homes.

During construction of the LaSalle Expressway, noxious fumes, corrosive waters and oily materials were encountered, according to State personnel and local residents. When Read Avenue was installed some 13 years ago, drums were exposed during excavation work, which allowed the release of noxious fumes and oily liquids, causing several work stoppages. Noxious fumes and hazardous liquid chemicals were detected in various storm sewers, mostly to the west of the site, and at the outfall which collected flow from both the 97th and 99th Street sewer lines. In addition to these problems, land subsidence in the grammar school playground occurs regularly, and the holes are periodically filled with soil. School personnel reported to the County Health Department that school children handled waste phosphorous and received burns.

D. Analytical Work. Several sampling and monitoring studies have been performed at the Love Canal site during the past two years. It is known that a variety of chemical compounds are present on site and have been detected in homes and in groundwater. It is clear that air contamination of the home environments is not limited to the southern third of the Canal area or to those homes on the western boundary but extends to Colvin Boulevard on both sides of the Canal from Frontier Avenue.

A summary of the studies conducted presents the following outline of work:

U.S. EPA Region II	Home Environment Air Sampling (2/78)
NYS DEC	Ambient Air Monitoring (6/78)
NYS DOH	Home Environment Air Sampling (6/78)
NYS DEC	Surface Water and Soil Sampling (9/77 and 12/77)
Calspan Corporation	Home Environment Air and Water Sampling (4/77)
Fred C. Hart Associates	Surficial Groundwater (6/78)

Due to variations in analytical techniques, the certainty of identification of organic contaminants is often in question. For instance, chlorinated hydrocarbons are often reported as equivalent parts of lindane with certain analytical techniques. Nevertheless, many chlorinated hydrocarbons and aromatics have been positively identified with

large scale GC-EC units and a new technique utilizing high pressure liquid chromatography (HPLC) with scanning ultraviolet. The study using HPLC was conducted by NYSDOH.

During the Calspan analysis of sewer and sump water, the following hazardous constituents were detected and measured:

Polychlorinated Biphenyls	(PCBs)
Hexachlorobenzene	
Hexachlorocyclopentadiene	(C-56), a pesticide precursor

Gas chromatography (GC) with an electron capture unit (EC) provided the analytical data. Sampling results showed that hazardous constituents were more highly concentrated on the western border of the Canal along 97th Street between Wheatfield Avenue and Frontier Avenue which abuts the LaSalle Arterial.

Several sampling and analytical efforts in recent months by EPA Region II, by the NYS DEC and be Fred C. Hart Associates have not detected either PCB's or C-56. Many other aromatics, chlorinated aromatics and aliphatics and heavier straight chain olefins and paraffins have, however, been detected. A list of the chemical compounds detected in air and water around and in the canal is included in the Appendix. This list is not all-inclusive since the presence of many more constituents at lower concentrations is possible within the greatly variable waste mass buried in the landfill. The more common contaminants have been identified and measured in the analytical work. Several of the chemical compounds detected are listed on the U.S. Environmental Protection Agency's list of priority Toxic Substances, as established by the NRDC Consent Decree in 1976, and identified as potentially carcinogenic, teratogenic, and/or mutagenic.

An analysis performed by the Division of Laboratories and Research, N.Y.S. Department of Health, on samples of ponded water on the Love Canal submitted by DEC on 9/26/77 showed probabilities of presence of two or more chemicals: trichlorophenol and lindane analogues. The laboratory utilized analytical techniques which employed hexane extracts in a GC-MS (mass spectrometer) with a computer link which gave a "probability of presence" value. The results of that sampling and analysis effort are to be found in the Appendix. Found in sample #11088, which was analyzed using a "stripper adsorption resin" and then the GC-MS unit, were the following: hexane, methyl cyclopentane, benzene, toluene, chlorobenzene, benzylchloride, dichlorobenzene, ortho-dichlorotoluene, trichloro-benzene and tetrachlorobenzene.

An EPA analysis (Contract No. 68-02-2764) conducted in February detected the presence of forty (40) different chemicals, including isomers, in basement air samples of homes around the Canal. The results are included in the Appendix. The State Department of Health performed the analyses for Region II EPA under DEC guidance for sampling. Additional sampling work performed by the Department of Health in June showed the presence of xylenes as well as some of the above mentioned

compounds. This more comprehensive study in homes at the northern end as well as the southern end of the Canal determined that contamination was present in many homes along 97th and 99th Streets. The results have been summarized and placed in the Appendix.

The results of the sampling and analysis of groundwater performed by Fred C. Hart Associates is discussed in the section on site investigations.

E. Health Information. NYSDOH studies of residents along the canal indicate problems in the areas of foetal malformations, miscarriages and liver function. Health effects are apparently more notable in the area south of Wheatfield Avenue. This information was presented at a meeting of the project group on July 14. Health effects data are included in the Appendix.

F. Jurisdiction. In 1976, the U.S. Environmental Protection Agency determined that NYS DEC had jurisdiction over the landfill since existing state legislation more adequately covered the situation. The Resource Conservation and Recovery Act of 1976 (RCRA) had not yet been passed nor had policies and regulations been established on the Federal level for complete management of hazardous wastes. In 1976 and 1977, U.S. Congressman John LaFalce, (D) from Niagara Falls pressed for Federal funds for study and cleanup due to rising constituent concern. In 1977 the NYS DEC reconsidered its role in the matter and determined that under existing state laws, clean up could not possibly occur for at least 2 years and perhaps even 3 years due to court action and legal battles over culpability and liability for the site and its contamination. In view of this State analysis of its legal position, DEC requested EPA assistance. The City of Niagara Falls tried to come up with answers in 1977 with its own study by Calspan, described previously.

Due to the State request, to the Calspan study results and to Congressman LaFalce's concern, EPA Administrator, Douglas Costle responded to the situation. He said to Mr. LaFalce in a letter of December 13, 1977 that hazardous waste regulations of U.S. EPA have been delayed for 2 years due to two unresolved issues: 1) liability for clean-up of non-removable hazardous substances, the issue in this case, and 2) determination of the discriminator that would differentiate between the lower or higher civil penalty rates for the discharge of non-removable substances. Thus, the EPA involvement in certain non-removable hazardous waste situations had been suspended for a period of time until the issues could be resolved, as they eventually were under Section 311 of the Water Act amendments and by decision by the Administrator. Mr. Costle told Representative LaFalce that EPA was preparing a monitoring study to determine what final action should be taken on chemicals surfacing in Niagara County. This current study would assist in this regard.

At the meeting on January 9, 1978, the U.S. EPA Region II agreed that its surveillance and laboratory section in Edison, New Jersey would respond to the requests of NYS DEC to perform the air quality monitoring

and analysis. New York DEC then agreed to perform the water quality monitoring analyses in homes, including analysis of sump pump liquids and solids and surface waters. The groundwater situation and other geohydrological parameters were investigated by Fred C. Hart Associates.

At the County level, the Niagara County Health Commissioner has recommended on several occasions that the City fill in pot-holes created by decomposition or leaching of chemicals from corroded drums and subsequent subsidence around the drums. However, the health impact aspects of the situation have only recently been assessed by the Health Board. Recently State House passed legislation under the Public Health law Section I Article 13 to which a new title, Title 12, Toxic Substances has been added. It specifically addresses the Love Canal incident in Sections 1385 to 1389. A copy of Title 12 has been included in the Appendix.

On June 21, 1978, the State Health Commissioner, Dr. Robert Whelan, issued an Emergency Health Declaration under the Public Health Law, Section 1303. Concluding the Declaration was the following:

NOW, THEREFORE, I DO HEREBY ORDER AND DIRECT:

That the President of the Niagara County Board of Health convene the Board of Health of the County of Niagara and that said Board, together with the Niagara County Health Commissioner, take the following definite actions:

a. Take adequate and appropriate measures to cause the removal from the Love Canal Chemical Waste Landfill site of all chemicals, pesticides and other toxic material which lie exposed or visible on the surface of the site.

b. Take appropriate and adequate measures to limit accessibility to the site by the installation of suitable fencing or other effective means, together with periodic surveillance and monitoring, to assure that access to the site is properly restricted or limited.

c. Take all other appropriate and necessary corrective action to abate the public health nuisance now existing at the Love Canal Chemical Waste Landfill site.

d. Make an initial report to the undersigned Commissioner of Health, not later than 15 days from the date of service of this Order, concerning the progress made in implementing the order and directions herein given and, thereafter, report on a monthly basis as to such progress.

In early June, previous to the Health Declaration, a snowfence was erected along Wheatfield and Frontier Avenues. Signs were posted advising the hazard of the Canal. Some pot-holes had been filled at the time the Declaration was issued.

IV. Environmental Setting

A. Bedrock Geology. The Lockport Dolomite is the uppermost bedrock formation in the vicinity of the Love Canal landfill site. The Lockport Dolomite is not exposed at the surface in the site area, but is exposed along the Niagara Escarpment to the north, along the gorge walls of the Niagara River, and along excavations of sufficient depth. The dolomite is composed of flat lying beds of calcium and magnesium carbonate. This is about 150 feet thick and 40 feet below the land surface.

According to Johnston (1964) groundwater in the Lockport Dolomite occurs in three types of openings: (1) bedding joints which occurs in at least seven important water bearing zones, (2) vertical joints, and (3) small solution cavities. Of these, the bedding joints or planes, expanded locally through solution by groundwaters through geologic time, are the most important. The planes transmit nearly all the water moving through the formation.

Of the seven principal water-bearing bedding joints, one occurs about 40 feet from the uppermost layer of the Lockport Dolomite. It is possible to trace the planes laterally for distances of 1 to 4 miles as was discovered by excavation for the Niagara Power Project.

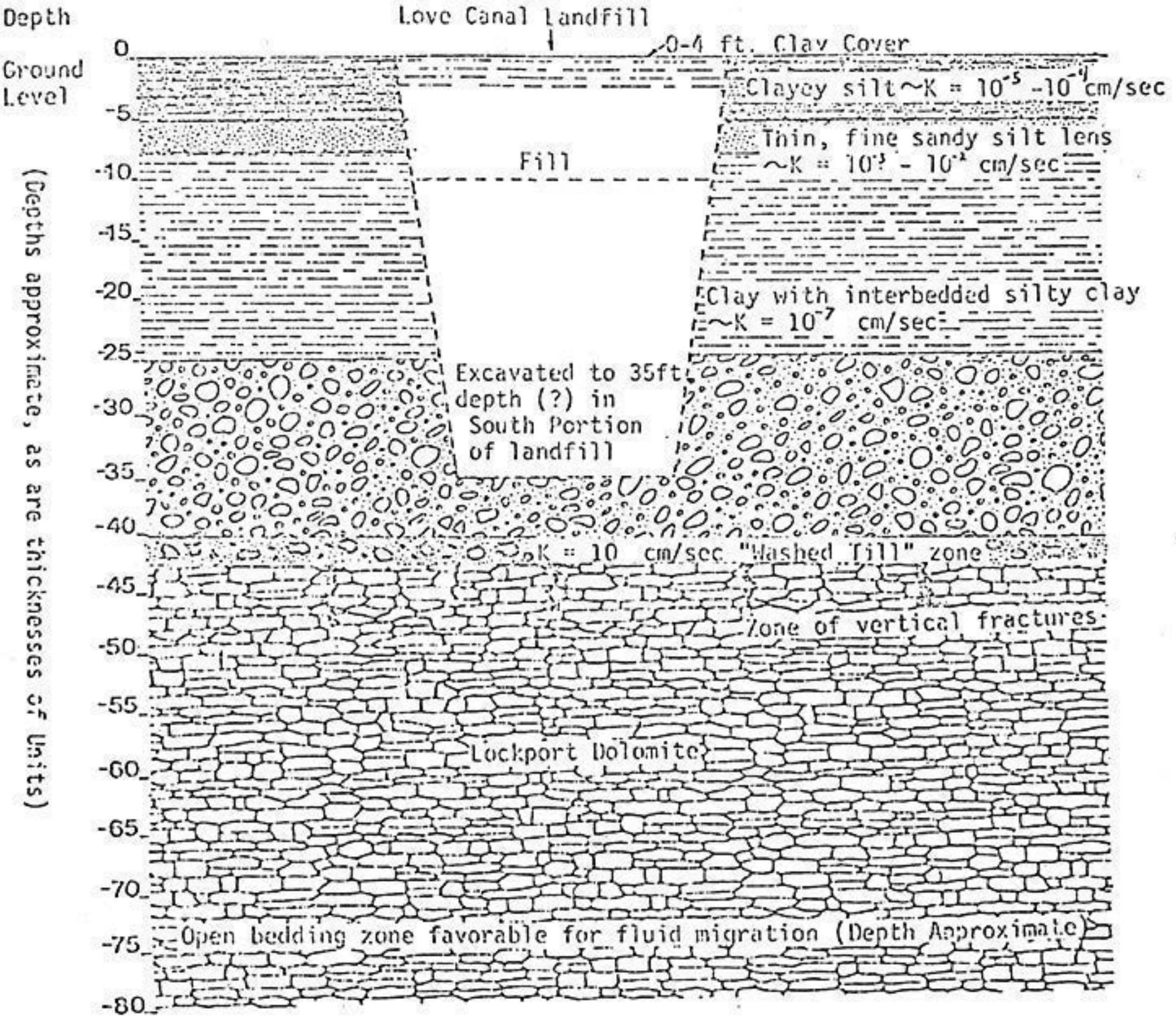
Regarding the other water bearing zones, both the vertical joints and solution cavities are not important water bearing features. The vertical joints are prominent in outcrops but appear to gradually narrow and seal with depth. They may, however, serve as conduits for vertical water movement through the upper bedrock, into whichever bedding zone lies below. The water transmitting ability of these vertical joints is unknown due to the lack of local deep wells. Except for these horizontal bedding joints and vertical joint-systems, the Lockport Dolomite is extremely impermeable.

B. Near-Surface Geology: Unconsolidated Sediments. Overlying the Lockport Dolomite is a sequence of unconsolidated silts, clays, and fine sands deposited during the close of the Pleistocene glaciation. Additionally, prior to the deposition of these lake sediments, a heterogeneous layer of glacial till was deposited by the ice-sheet directly on top of the Lockport Dolomite. This till is composed of a poorly-sorted mixture of gravel, boulders, silt, and clay. The till is of relatively low permeability due to the clay mixture, except for a "wasted fill" zone at the top four feet of the Lockport, in which a large portion of the "fines" were washed out.

Permeability values for these unconsolidated lake silts and clays are variable, and range from extremely low (less than 10^{-2} gpd/sq ft or less than 10^{-7} to 10^{-8} cm/sec.) for the clays to moderate for the sandy silt material (less than 10^{-2} gpd/sq ft or less than 10^{-3} to 10^{-2} cm/sec).

Drilling and excavation programs conducted by Conestoga-Rovers and Calspan indicate a sequence of material underlying the site, as depicted in Figure 4.

Figure 4: Generalized Site Stratigraphic Section



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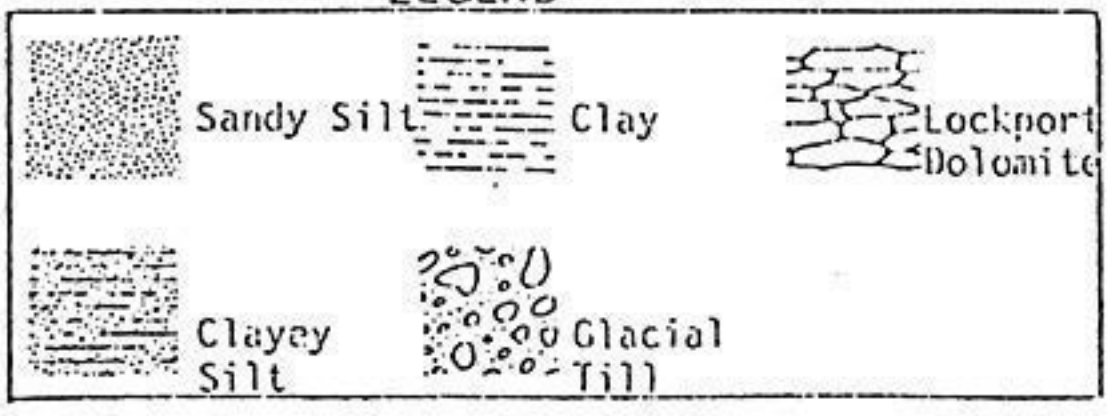


Sources:

CALSPAN REPORT (1977)
Johnston, R.H. (1964)

V. Field Investigations

A. Testing and Sampling Program. No sampling was conducted on the preliminary site investigation made by Hart Associates in January, 1978 due to blizzard conditions. However, a sampling program was designed according to the data needs of Region II EPA and NYS DEC. The program was conducted on June 7, 8 and 9, 1978.

The field program was undertaken to examine the extent of contaminant migration from the Canal through the shallow aquifer and into the environment. A total of 7 auger holes were completed and groundwater samples were collected. Surface water samples were also collected. Location of sample points are shown in Figure 5 and analytical results are presented in Table 1.

The power driven auger used in the drilling had a seven horsepower gasoline engine, a flexible drive train which was nine feet long, and two auger bits, one 6 inches and the other 9 inches in diameter. Three-feet long extension rods were attached as the drilling progressed. When water was struck the holes were drilled about 1 foot past the water table boundary. Two of the holes did not yield water. Drilling stopped when hard red clay was reached because the auger could not penetrate this layer. The drill bits were cleaned after each hole.

Drilling with the auger showed that the dense, red clay layer began at 6 to 7 feet below land surface. Above that layer was a relatively permeable water bearing layer of sandy clay to clayey sand, which was determined to be from one to three feet thick. Heavier gray-brown, silty clay overlay the water bearing layer (2 to 3 feet thick) and above this layer of fill and soil extended for approximately 2 feet. In several locations, solid waste fill was encountered which prevented augering at that position.

Samples were taken by lowering a clean sample bottle on a line into the hole. The 1/2 liter samples were filled, brought to the surface where the first sample was discarded in order to rinse the bottle, lowered and filled again. The contents were immediately preserved with 2 drops of concentrated Sulfuric Acid (H_2SO_4) and then placed into an ice chest where a temperature below 4° Celsius was maintained. The samples were transferred to York Research Corporation laboratories for analysis. Results of the analyses are presented in Table 1. The samples were initially analyzed for Total Organic Carbon (TOC) content. Two samples which had the largest TOC values were susequently analyzed for chlorinated organics, using a gas chromatograph with a flame ionization detector. The retention times of one of the predominant peaks in the chromatograph suggested the presence of 1.2,4 trichlorobenzene or other chlorinated aromatics. The report from York Research is included in the Appendix for reference.

B. Results. The analytical results indicate that a concentration of up to 80 ppm trichlorobenzene is present in the surficial groundwater west of the Love Canal. The migration distance and the concentration

URE 5 -

ed C. Hart Assoc.
mpling Locations

X = Sample Locations

* = Future Locations

Vertical scale foreshortened

NORTH

(creek in pipe)

Colvin Boulevard

56th Street

97th Street

99th Street

100th Street

101st Street

LOVE CANAL

99th St. School

Read Avenue

Wheatfield Avenue

Chemical Waste Zone

Fenced-in area

Frontier Avenue

LA SALLE EXPRESSWAY

Buffalo Avenue

001

002

003

004

005

006

007

008

009

010

011

012

Sample Numbers, Location & Analytical Results on Samples
Taken June 9, 1978, Love Canal Vicinity

FCHA #	York #	TOC mg/l	TCIB * ppm	Location
001	21791	+		Buffalo Avenue, due South of Love Canal
002	21792	52		Frontier Ave. at 96th St.
003	21793	112		Wheatfield Ave. at 96th St.
004	21794	129	50-80	Read Ave. at 96th St.

006	21796	36		Black Creek at 96th St.
007	21797	34		Black Creek at 102nd St.

010	21800	+		Read Ave. & 97th St.
011	21806	132	50-80	Frontier Ave. & 97th St.
012	21801	42		Wheatfield Ave. at 97th St.

* 1,2,4 - Trichlorobenzene

+ Saturated Clay Samples, not analyzed since other data indicated contamination.

range suggest that a large leachate plume exists west of the Canal. Further sampling and analytical work should be done to fully assess the extent of this plume.

Total organic carbon does not necessarily indicate the presence of contaminants. It is a preliminary indicator of the presence of organic material in the sample and suggests directions for further, refined analytical work to detect organic chemical constituents. In groundwater generally, TOC is expected to remain below 30 mg/l. Values obtained in this analytical effort of TOC indicate that more organic material than normal was found in local surficial groundwater. Further analyses indicated that a chlorinated hydrocarbon was present in those two samples with the highest TOC values.

A summary of results from other analytical studies (see Appendix) shows the links among: wastes in the Canal, ponds of materials on-site, contaminants off-site on the surface and in basements and contaminants in the groundwater. Chemicals are in suspension or solution in the groundwater environment, are moving from the Canal into the environment and are causing environmental and health impacts.

The contamination of the shallow groundwater poses a significant problem. Since the water table fluctuates and often comes up to the surface the contaminants can migrate laterally through surficial strata and also travel as surface runoff. In either manner, contaminants can be carried to sewers and distributed over the ground surface. Continued human exposure to the chemicals can thus take place. The migrating groundwater will carry the chemicals into basements of homes within the extent of the leachate plume. Volatilization of contaminants in basements could continue, resulting in hazards to health. The spread of contaminants in the surface and near surface environment increases the risk of exposure and the threat to human health. As long as chemicals remain in the surficial groundwater zone, they will pose contamination problems.

C. Groundwater movement. As a result of this potentially expanding problem, interest has focused on the movement of contaminanted groundwater away from the Love Canal landfill to neighboring properties. The information collected during previous investigations and from the shallow augering and water sampling program conducted by Fred C. Hart Associates suggest a hypothesis of groundwater migration, which should be viewed in consideration of the following:

1. The clayey cover installed on site is not continuous and therefore does not provide a continuous impermeable cover. Thicknesses generally vary from zero to four feet. An average infiltration value cannot be known without testing. This infiltration value is useful to determine a groundwater budget, and the quantities of leachate generated.

2. Permeability of the upper sandy silt layer is as yet unassessed through lab or field tests. However, the ease of water entry into auger test holes drilled by Hart Associates, as well as observed soil texture suggests relatively high permeabilities.

During the time the auger holes were installed, field personnel attempted to bail the holes dry, however, water entered the holes too quickly to enable this. It is thus suggested that permeabilities are greater than 10^{-5} cm/sec.

3. In a flat terrain such as found in the Love Canal area, groundwater gradient is low and direction of shallow groundwater travel cannot be thoroughly assessed without installation of additional shallow auger holes.

With these provisos in mind, the following evaluation is provided:

1. The generalized regional flow gradient of the shallow groundwater is westerly, resulting in westward movement of contaminants and consequent manifestation of problems in basements of homes to the west of the fill. Data available at the time of FCHA field studies suggested westerly flow of groundwater resulting in the focus on examining the extent of contamination in that direction. All field data available to date indicates that the groundwater gradient is very low. The water table may periodically be slightly higher within the fill area than in areas to the east as well as the west. Such a situation could reflect greater local surficial permeability of the fill than adjacent areas and may occur during, or shortly after storm events. Even a slight "mounding" of water within the fill could result in migration of contaminants in all directions from the fill. That possibility has not been fully explored.

2. The water table is apparently at higher elevation than the potentiometric surface of the deep aquifer, thus, over a period of time, vertical seepage of ground water can occur through relatively impermeable strata, such as the clay, found at approximately to 40 feet in depth. It is very possible that contaminants have seeped through the clays and may be found in the bedrock aquifer. It is also possible that the clays were totally breached by excavation of the canal, thus providing ready access of contaminants to the bedrock. As well, there may be permeable zones within the clay, allowing lateral migration of contaminants within the 7 to 40 foot depth zone. These possibilities require further investigations.

The State plans to install deep well(s) to examine lithology, and to assess the chemical condition of water in the bedrock aquifer. Barring inordinate delays in implementating this program, FCHA will be present during drilling operations and provide an appropriate update to this report.

VI. Recommendations

A. Site Decommissioning. Previous sections have demonstrated a number of serious problems associated with the disposal of toxic industrial wastes at the Love Canal site. Specifically, these health and safety hazards result from subsurface migration of hazardous pollutants, surface migration of hazardous pollutants, localized surface subsidence, and localized and off-site air emissions. To mitigate these problems, a preliminary engineering concept has been developed. In essence, the preliminary recommendation consists of provision of an on-site clay cover, provision of an upgradient clay barrier on the east boundary of the site, provision of a tile drain leachate collection system on the downgradient, west boundary of the site, provision for a surface runoff collection system, and subsurface sealing of the basements of affected homes.

The entire site should be covered with an impermeable clay cover consisting of approximately two feet of compacted clayey material with a maximum permeability of 10^{-7} cm/sec. The clay cover should be graded at a minimum slope of 3% towards the outside boundaries of the site. A minimum of six inches of sandy loam should be placed above the clay to prevent the clay layer from drying and cracking and to provide an adequate soil base for a short rooted grass cover. The clay cover will prevent precipitation and surface runoff from infiltrating into the site, will minimize toxic air emissions, and will provide adequate cover for wastes which are currently exposed. A total of 55,000 cubic yards of clay and 13,500 cubic yards of sandy loam will be required.

Installation of a clay subsurface barrier along the east, north and south boundaries of the site should also be completed. This will divert the westward movement of near surface ground water away from the site and will minimize ground water intrusion into the site, under the assumption of westerly flow. The clay barrier should extend into the low permeability clay layer beneath the shallow silty layer previously identified. Based upon current data, average depth of the barrier will be approximately seven feet. Minimum width of the compacted clay barrier will be two feet. Approximately 3,700 feet of clay barrier will be constructed, requiring approximately 6,050 cubic yards of clay. Figure 6 presents a typical section through the clay barrier.

Along the western boundary of the site, a tile drain system should be constructed to collect leachate from the Canal, and to create a depression in the shallow water table to capture groundwater from areas west of the drain. If further field tests and monitoring indicate that the occurrence of an on-site groundwater "mound" is more frequent than the supposed westerly flow, it may be prudent to consider installation of the drains on both the west and east boundary of the site, though such a measure could substantially increase the volume of discharge that must be disposed of in an appropriate manner. Tile drain should be

separate from the surface water collection system, and the collected leachate should be discharged by gravity, if possible, to the adjacent City sanitary system for treatment at the City physical/ chemical treatment plant. Approximately 3,200 feet of tile drain will be constructed, requiring 2,700 cubic yards of gravel fill. The connection(s) to the sanitary system will require additional design analysis. Figure 6 presents a typical section of the proposed tile drain system.

To prevent surface runoff from the site from entering the subsurface ground water system and the tile drain system, and to prevent surface runoff complications on adjacent properties, a surface runoff collection scheme should be employed. Essentially, this requires construction of a shallow clay-lined ditch around the perimeter of the site. The collection system will route surface runoff from the highly impermeable site surface cover to the adjacent storm system. Approximately 7,000 feet of ditch will be constructed and and connection to the storm system will require installation of at least one catchment basin and 200 feet of pipe. Additional design analyses will be required to finalize the connection details. Figure 6 presents a typical detail of the proposed surface drainage system.

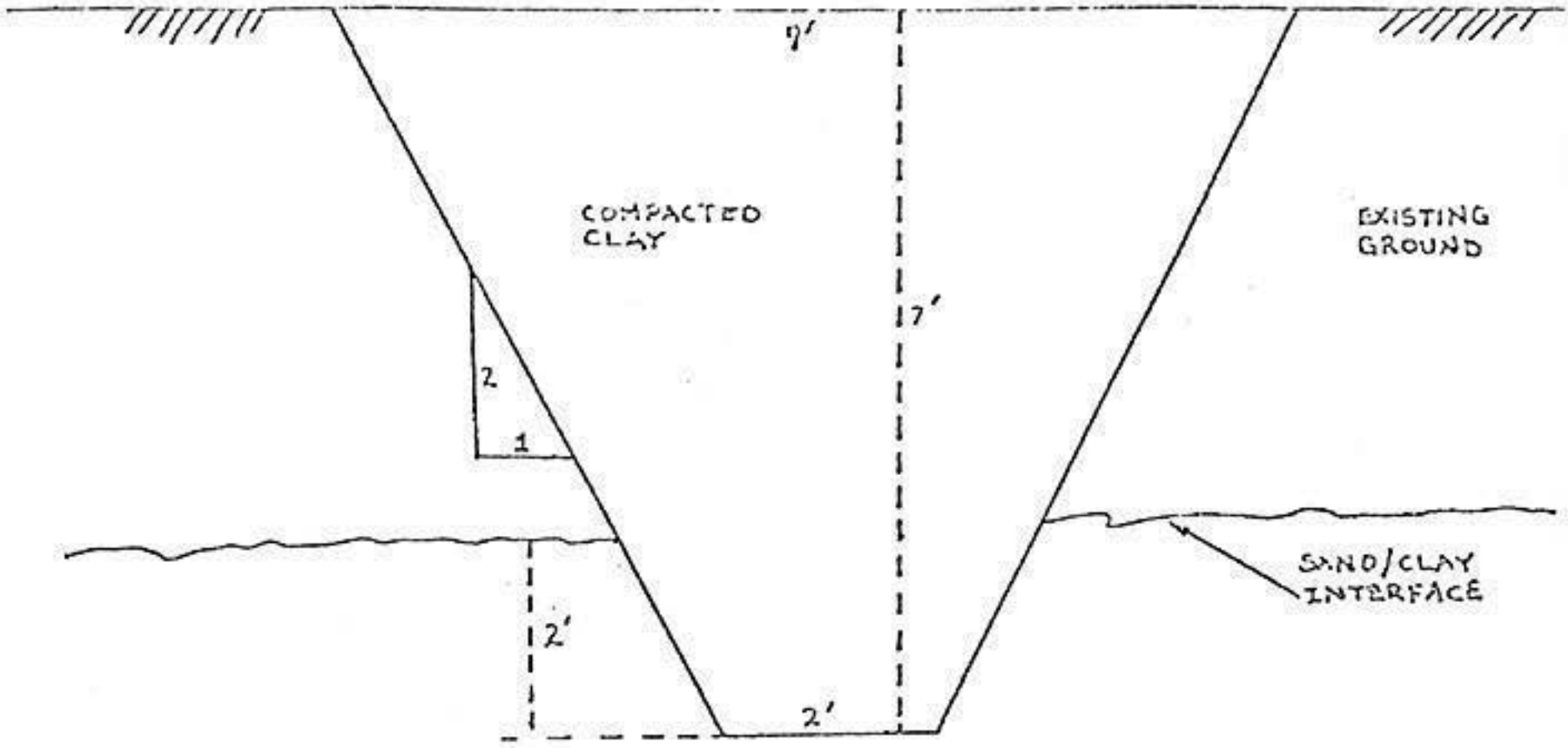
Data collected by the City of Niagara Falls indentified approximately 20 homes where contaminants were infiltrating and volatilizing in cellars in the area of the Love Canal. Further investigation may identify additional homes with this problem. The Calspan Corporation report "Characterization and Abatement of Ground Water Pollution from Love Canal Chemical Landfill, Niagara Falls, New York" presents a recommended detail for sealed sump pump installations. For the purposes of the following cost analysis, it has been assumed that approximately thirty homes may require such modifications. The sealing of basement walls and floors with an epoxy paint to prevent intrusion of contaminants may also be appropriate. Alternative abatement measures may, however, preclude these actions.

In summary, total capital costs required for the potential site decontamination measures are as follows:

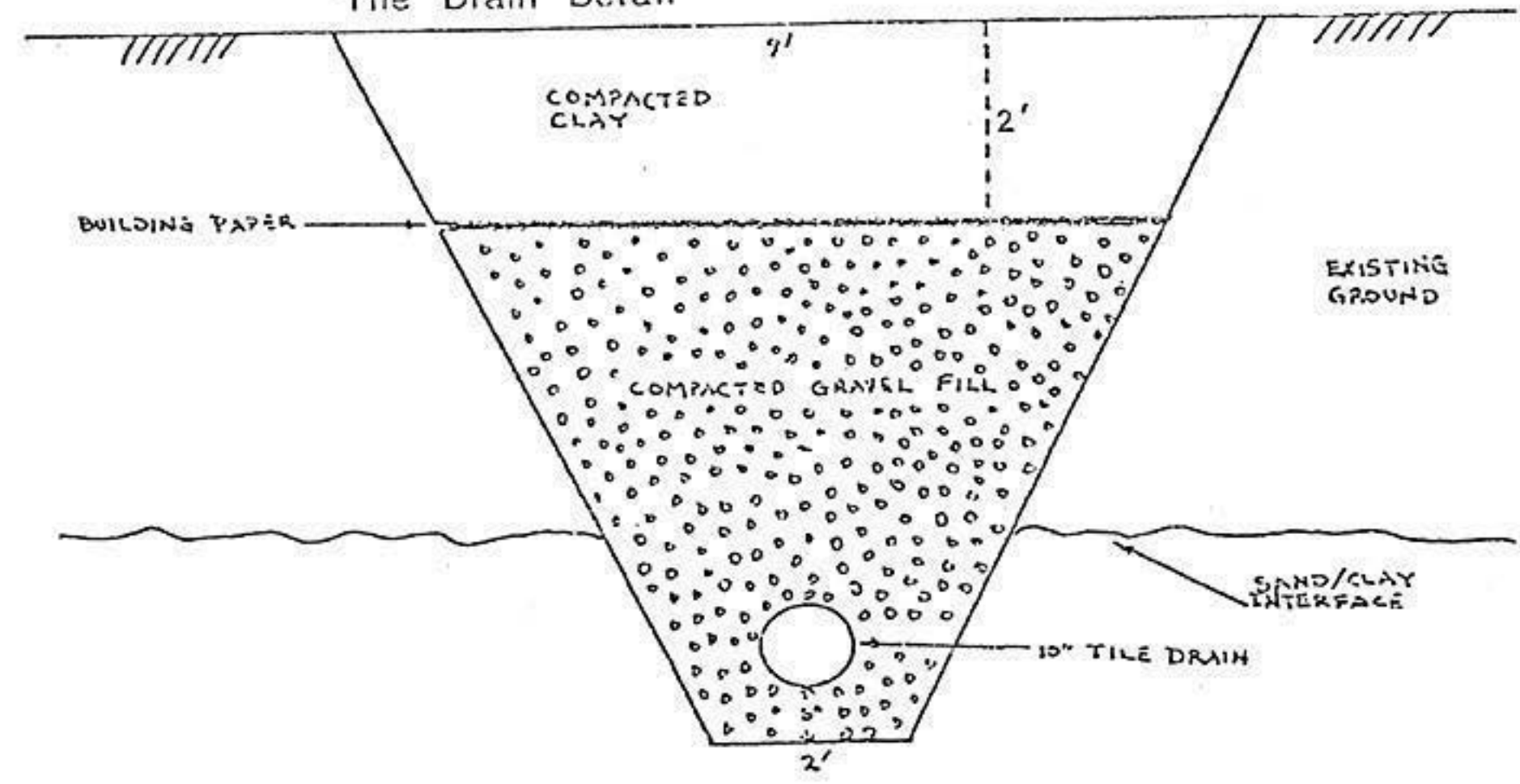
On-Site Well Construction	$ 15,000
Clay/Loam Cover With Seeding*	$315,000
Upgradient Clay Barrier	$ 32,000
Downgradient Tile Collection System	$ 31,000
Surface Runoff Collection System	$ 4,000
Basement Sealing	$ 41,000
Further Analyses, Testing and Design	$ 80,000
Contingency @ 10%	$ 52,000
TOTAL: approx.	$570,000

* NOTE: Delivered clay prices assumed as $4.00 per cubic yard and delivered loam prices as $3.00 per cubic yard.

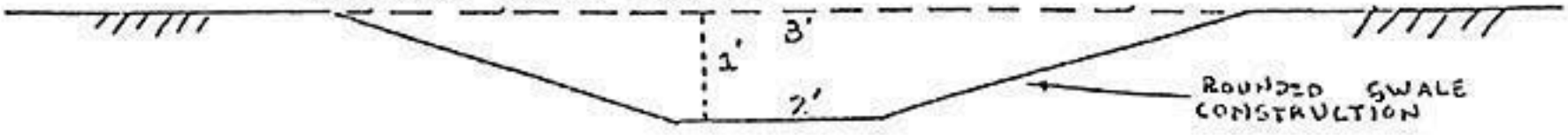
Clay Barrier Detail



Tile Drain Detail



Surface Drain Detail



B. Recommended Continued Analysis and Monitoring. The work completed to date has provided a general outline of the problems and potential solutions for the Love Canal site. However, significant quantities of data are as yet unavailable. In that light, it is recommended that continued testing and analysis be completed in the following areas:

1. Determinations of the exact boundaries of the canal and of the extent of waste deposition, particularly along the north and south boundaries where more recent construction has occurred;

2. Geophysical investigation of the east and west boundary conditions to determine the depth and consistency of the lower clay layers, to assist in design of the clay barrier and tile drain systems;

3. Further chemical identification and quantification of chemical constituents in leachate plume.

4. Further investigation of the areal extent of the downgradient leachate plume, and the investigation of upgradient input into Canal;

5. Determinations of the in-site soil permeability around Canal in both the surficial and deeper layers;

6. Further analyses of potential mitigative measures including substitution of a clay barrier east of the canal with a tile drain, as recommended for the western boundary, feasibility of leachate storage and collection, requirements for adjacent homes basement sealing, etc.;

7. Analyses of potential health effects of identified and yet-to-be-identified leachate constituents;

8. Determination of possible deep aquifer contamination in conjunction with NYSDEC well drilling program.

9. Preparation of preliminary plans, outline specifications, and a detailed cost estimate to be followed by final plans and specifications for actual implementation of the mitigation program.

During and following site decommissioning, a testing program should be established to monitor on-site conditions and changes in the extent and severity of the contamination problem. The monitoring program should include testing of both the shallow and deep ground water aquifers both on-site and off-site at representative locations. The monitoring should initially occur frequently, and should continue until substantial decreases in identified toxic pollutants have been recorded for an extended period.

APPENDIX A

LIST OF KNOWN CONTAMINANTS

APPENDIX A

LIST OF KNOWN CONTAMINANTS

Chloroform
Benzene*
Trichloroethylene*
Tetrachloroethylene*
Toluene*

Chlorobenzene*
Chlorotoluene
Xylene, isomers
Trichlorobenzene, isomers*
Dichlorobenzene, isomers*

Trichlorophenol*
Lindane*
Pentachlorobenzene*
Trichlorotoluene, isomers
Tetrachlorotoluene

Chlorobenzaldehyde
Dichlorobenzaldehyde
1, 1- Oxybis methylene, bis benzene
1, 1- Thiobis methylene, bis benzene

Dimethylbutane
Hexane
Methylcyclopentane
Cyclohexanol
Benzyl Chloride

Methylbenzoate
Dichlorotoluene, isomers
Tetrachlorobenzene
Dichloroethylene*
Carbon tetrachloride*

Pentachloroethane*
Pentachlorobutadiene
1, 3- Hexachlorobutadiene*
Bromotoluene, isomers
Bromochlorotoluene, isomers

Chloronaphtalene isomer*
1, 2- Dichloropropane*
Chlorobenzoic Acid
Hexylbenzoate

* On EPA list of Toxic Chemicals as per Consent Decree NRDC vs. Train.

APPENDIX B

SUMMARY OF ACTIONS

Appendix B

Summary of Actions Taken

1930's	Canal purchased by Hooker Electrochemical Corporation for use as a chemical waste landfill.
July 1953	Hooker sells the Love Canal to the Board of Education City of Niagara Falls.
1970's	Residents complain of chemical smells, fumes from Canal and in basements.
1976	U.S. Environmental Protection Agency (EPA) determines that the New York State Department of Environmental Conservation (NYSDEC) has jurisdiction over the Canal.
10/76	Resource Conservation and Recovery Act (RCRA) passed giving EPA authority to control hazardous wastes.
1976-77	U.S. Congressman LaFalce (D-Niagara Falls) presses for Federal funds to clean-up landfill.
Early 1977	NYSDEC reconsiders its role, estimates 3 year legal battle under State law and requests EPA assistance.
4/77	City of Niagara Falls hires Calspan to perform research study on possible solutions.
9/77	NYSDEC/DOH conducts sampling of surface water.
12/77	NYSDEC takes additional water, soil and sludge samples from the Love Canal.
12/77	EPA Administrator Costle suspends EPA involvement in incidents of discharge of non-removable hazardous substances due to the unresolved issues in regulations of liability and penalty discriminators. However, Costle said that a monitoring study would be conducted and section 311 Regulations would be promulgated.
1/78	Fred C. Hart Associates and EPA Office of Solid Waste travel to Buffalo and Niagara Falls to attend research kick-off meeting and conduct site visit.
2/78	EPA Contract No. 68-02-2764 detects a large range of chemicals in air of basements of homes.

2/78	Love Canal sump samples show high concentrations of several contaminants.
5/78	Conestoga Rovers Associates hired by the City of Niagara Falls to perform geohydrologic study for development of short term options.
6/78	NYSDOH declares a Health Emergency around the Love Canal.
6/78	Fred C. Hart Associates performs shallow aquifer analysis: augering of shallow wells, collection of samples and chemical analyses.
6/78	Presentation of Conestoga-Rovers Report.
6/78	NYSDOH/DEC complete full scale air studies. Health and epidimeological studies performed by NYSDOH.
7/78	A meeting of all participants in Love Canal Project was held at NYSDOH offices in Albany to discuss all available data and to critique Conestoga-Rovers Report. Participants also discuss range of solutions.
7/78	A meeting was held with NYSDEC Commissioner Berle, with Region II EPA representatives Eric Outwater and William Librizzi, with NYSDEC representatives Dr. Leo Hetling and Robert Collin and with Fred C. Hart Associates to discuss long-term solutions to the Love Canal incident.

APPENDIX C

PUBLIC HEALTH LAW AMENDMENT

Title 12 - Toxic Sustances

Section 1385 Legislative Intent

Section 1386 Contracts

Section 1388 Power of the Commissioner - Emergencies

Section 1389 Reports

Section 1385 Legislative Intent

Sites formerly operated as landfill to dispose of toxic substances are exposing the citizens of the State to unnecessary hazards the duration and extent of which is unknown. To develop a plan for the alleviation of these conditions, it is necessary to conduct a study to determine the extent of such hazards. The potential hazard believed to exist at a specific landfill site in t County of Niagara has precipated the need for immediate action to authorize the Department of Health to undertake such study and to conduct a pilot program to evaluate the effect of individual correc systems in effected residences.

Section 1386 Duties of the Commissioner

The Commissioner of Health shall conduct a study of both the long and the short term effects of health hazards associated with exposure to toxic sustances emanating from certain landfills.

Section 1387 Contracts

The Commissioner of Health is authorized to enter into conti and agreements with individuals, corporations, and municipalities t perform the study herein directed to alleviate the specific hazard which the general public and members thereto may be exposed as th result of toxic substances emanating from landfills.

Section 1388 Powers of the Commissioner - Emergencies

In case of great and imminent peril to the health of the general public from such hazards as may be identified as resulting from exposure to toxic substances emanating from landfills, the Commissioner may declare the existence of an emergency and take such measures and such acts as he may deem responsibly necessary and proper for the preservation and protection of the public health

Section 1389 Reports

The Commissioner of Health shall make an initial report to the Governor and the Legislature on or before September 15, 1978 of the progress, and a further report to the Governor and the Legisl on or before April 1, 1981.

Section 2 - Appropriation

The sum of $500,000, or so much thereof as may be necessar is hereby appropriated to the Department of Health from any monie in the State Treasury in the General Fund to the credit of the State Purposes Fund not otherwise appropriated for its expenses including personal services, maintenance and operation in carrying out the provisions of this act. Such monies shall be made payable out of the State Treasurery after audit by and on the warrant of t Comptroller upon vouchers certified or appoved by the Commissione of Health.

Section 3

This act shall take effect immediately.

APPENDIX D

AGENDA OF PROJECT GROUP MEETING (7/14/78)

Agenda for Meeting on Love Canal

I. Introduction of All Participants - Haughie

II. Report on Epidemiologic Survey of Love Canal Residents

(a) Available data - Vianna
(b) Additional information likely to be available by August 1

III. Report on Air Sampling of Love Canal homes

(a) Basis for selection of indicator organics - N. Kim
(b) Description of sampling procedures } Richards
(c) Presentation of data } Bush
(d) Survey monitoring data - S. Kim
(e) Conclusions
(f) Remaining questions

(i) air levels in adjacent houses
(ii) effects of changes in season, weather, etc. } Bush, Richards

IV. Sump Venting Design - Calspan modification

(a) Current rationale for venting
(b) Recommended venting procedure

EPA - Librizzi
DEC - Hetling

V. Fred C. Hart Studies (Librizzi)

(a) Migration and infiltration extension
(b) Extent of area involved in landfill
(c) Additional workscope being explored (Hetling & Librizzi)

VI. Comments on Rovers Report

(a) Need for additional environmental data for engineering plan

EPA - Librizzi
DEC - Hetling

(b) Limitation of remedial plan to South portion

EPA - Librizzi
DEC - Hetling

(c) Any suggested modifications of plan

EPA - Librizzi
DEC - Hetling

(d) Response of Rovers to critique - Rovers

VII. Current Niagara Falls plan for remedial site action

(a) Initiation of engineering design - Rovers
(b) Time table for initiation and completion of site activities - Rovers
(c) Leachate disposal - Clifford
(d) Precautions on site to limit hazard to residents during trenching, etc. - Clifford

VIII. Identification of chemical materials likely to be present in landfill

(a) Efforts by Hooker - Hooker
(b) U.S. Army disclaimer - Axelrod
Ventry statements

IX. Public perception of hazard and remedial activities - Clifford

(a) Public meeting to present new data
(b) Discussion of remedial activities

X. Preparation of final report for Governor - Haughie

(a) Assigned responsibilities
(b) Data for submission

XI. Schedule next meeting - Haughie

APPENDIX E

ANALYTICAL RESULTS OF SURFICIAL GROUND WATER SAMPLING PROGRAM

YORK RESEARCH CORPORATION
One Research Drive — Stamford, Conn. 06901

CERTIFIED REPORT TRANSMITTAL

DATE SENT: July 11, 1978

METHOD: First Class Mail

COMPANY NAME AND ADDRESS: Fred C. Hart Associates
527 Madison Ave.
New York, N.Y. 10022

ATTENTION: Jim Rodgers

REPORT NUMBER: 3-9559-04 ADDITIONAL COPIES

DISPOSITION OF UNITS:

DATE:

METHOD:

The above referenced report is enclosed. Copies of this report and supporting data will be permanently retained in our files in the event they are required for future reference.

If there are any questions concerning this report, please do not hesitate to contact the writer.

Naturally, as in the past, our staff will be pleased to quote on any future requirements you may have.

Very truly yours,

YORK RESEARCH CORPORATION

Kathryn K. Wahl

Kathryn K. Wahl, Manager
Laboratory Services

Environmental Consultants

3-9559-04 Fred C. Hart Associates July 11, 1978

Various water samples were taken in Niagara, N.Y. by Mr. J. Rodgers of Fred C. Hart Associates. The samples were submitted to York Research Corporation Laboratory and a preliminary analysis for total organic carbon was performed. The results of the analysis are listed below:

Sample No.	Total Organic Carbon (ppm) (TOC)
21792	52
21793	112
21794	129
21796	36
21797	34
21801	42
21806	132

The samples which had the highest TOC values, #'s 21794, 21806 were further examined by Gas Chromatography. A 5 ul aliquots of the samples were injected into a Hewlett-Packard, Model 5734A Gas Chromatograph flame ionization detector under the following conditions.

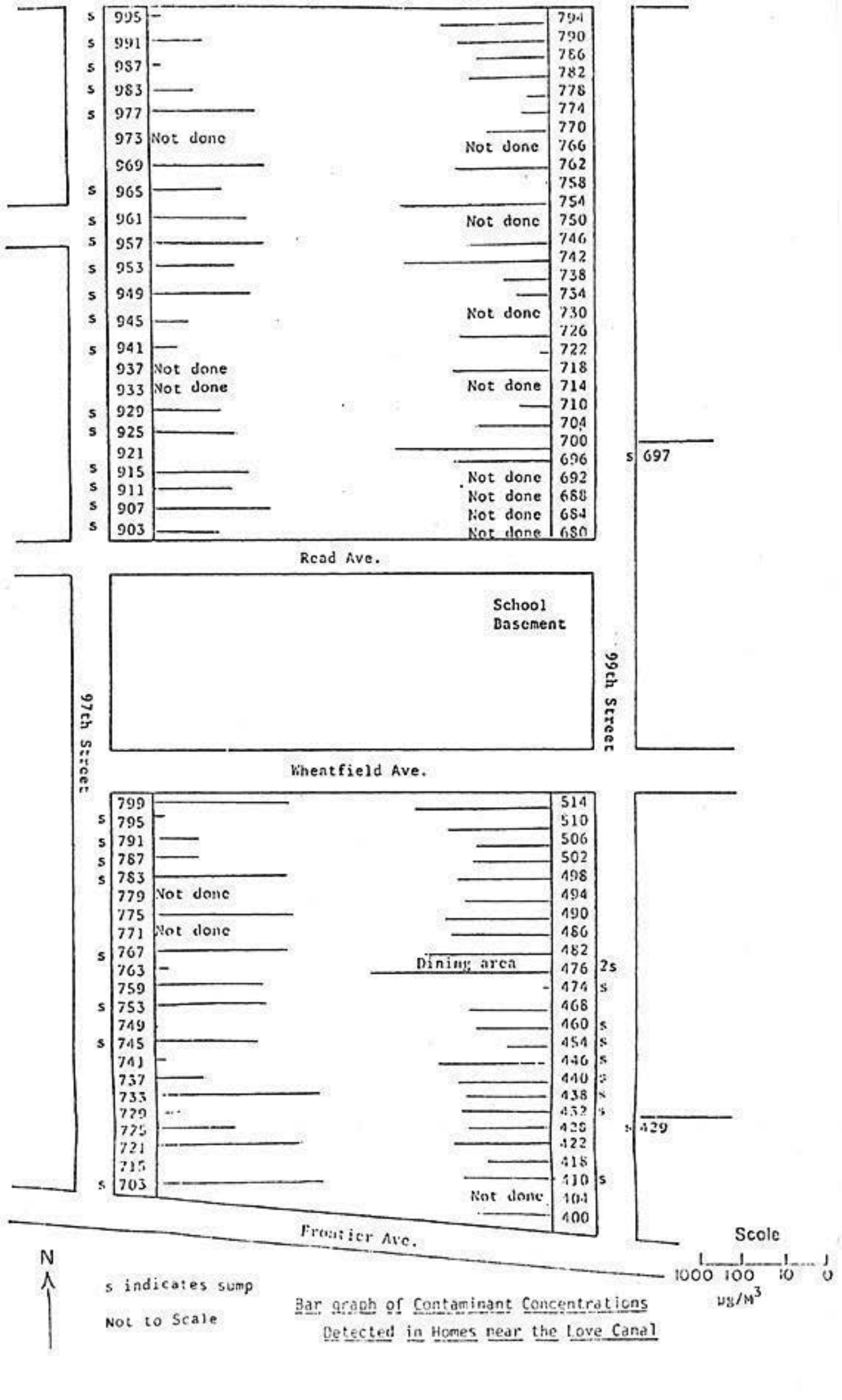
Column:	0.1% SP-1000/Carbopack C, 6' x i/8" S.S.
Column Temperature:	125° (4') to 190° @ 8'/min.
Carrier Gas:	He @ 20 ml/min.
Detector @ °C:	FID (A) @ 200°C
Injector @ °C:	on column @ 250°C

A qualitative standard consisting of water spiked with approximately 0.008% each of Benzene, Toluene, and 1,2,4 trichlorobenzene was prepared for comparitive purposes.

Scans of the two samples indicated major peaks in the region of 1,2, 4 trichlorobenzene. No benzene or toluene was detectable. The peaks represent a concentration of approximately 80 ppm. The scans generated during the study are included for your reference.

Additional analyses on the samples will be performed pending your review of the data submitted and your instructions for parameters to analyze.

York Research Corporation
One Research Drive, Stamford, Connecticut 06906 · Telephone: (203) 325-1371 · TWX: 710-474-3947



Bar graph of Contaminant Concentrations
Detected in Homes near the Love Canal

Sample Numbers, Location & Analytical Results on Samples
Taken June 9, 1978, Love Canal Vicinity

FCHA #	York #	TOC mg/l	TCIB * ppm	Location
001	21791	+		Buffalo Avenue, due South of Love Canal
002	21792	52		Frontier Ave. at 96th St.
003	21793	112		Wheatfield Ave. at 96th St.
004	21794	129	50-80	Read Ave. at 96th St.

006	21796	36		Black Creek at 96th St.
007	21797	34		Black Creek at 102nd St.

010	21800	+		Read Ave. & 97th St.
011	21806	132	50-80	Frontier Ave. & 97th St.
012	21801	42		Wheatfield Ave. at 97th St.

* 1,2,4 - Trichlorobenzene

+ Saturated Clay Samples, not analyzed since other data indicated contamination.

DIVISION OF LABORATORIES AND RESEARCH

Water
Air
Gen
Circ
File

MEMORANDUM

November 22, 1977

To: Mr. J. Beecher, Encon Buffalo Regional Office

From: Dr. R. Dell'Acqua and Dr. Art Richards

Subject: Hyde Park (Hooker) and Chem-Trol Samples - 9/26/77

We have obtained preliminary data on the Hooker and Chem-Trol samples as submitted by your office. The identification of each (collected 9/26/77) is as follows:

771701099 - Hooker (Hyde Park Landfill) Culvert Northwest Property Line 1010

771701100 - Hooker (Hyde Park Landfill) Ditch Northwest Property Line Adjacen to Fence

771701101 - Hooker (Hyde Park Landfill) Conduit Northeast Proper ty Line 1020

771701102 - Chem-Trol South Standpipe Landfill #5

771701103 - Chem-Trol 70 ft. South and 10 ft East of South Well

771701103 - Hooker Pond in Yard at 460 99th St. 1515

Because of the complex nature of these samples it was decided that a qualitat screening procedure would be employed by using gas chromatography-mass spectr metry. Thus Dr. Dymerski and Mr. John Rankin prepared either hexane extracts or eluates from a "stripping" adsorbtion resin. These extracts and eluates were then subjected to gas chromatography-mass spectroscopy. The fact that some compounds are not reported which you may expect to be present in these preparations reflects only that the mass spectrometer may not be sufficiently sensitive to identify compounds at lesser concentrations. The report of the mass spectral analysis is enclosed. The letter A designates the hexane extracts while the letter B indicates the eluates from the "stripping" appa: Please note the probability assignments as given by the computer. No compou were identified in 1100, 1101 and 1102 under the conditions employed.

The second portion of the investigation was to carry out a hexane extraction to determine PCB's and/or Mirex using gas chromatography with electron captu detection. These results are being reported in the usual routine fashion.

The third portion of our investigation will relate to our attempting to quan the compounds reported to be present by mass spectral data with a high proba assignment. We are obtaining standards for this work and hopefully will be able to give you additional quantitative information.

naz
Enclosure

Scan #	Identification	Source	Probability
7	N.I.		
10	Isobutyl Benzoate	Cyphernetics	.215
20	N.I.		
29	N.I.		
73	Phenyl Benzoate	Cyphernetics	.971
73	Benzil	Incos	
323	Methyl-thiochromanone dioxide		.327

Sample #1103A

6	Ethyl Naphthoate	Cyphernetics	.152
9	N.I.		
29	Dichloro Toluene	Cyphernetics	.175
74	N.I.		
335	N.I.		
351	Nonanone		.211
461	Trimethyl silyl arsinate		.208

Sample #1108A

1	Trichlorophenol	Cyphernetics	.252
8	"	"	.205
14	"	"	.176
76	N.I.		
118	N.I.		
205	Lindane	Cyphernetics	0.400

Sample #1103B

Scan #	Identification	Source	Probability
29	Heptylhydroperoxide	Incos	.339
49	3(2-methoxyethylamino) phthalide	Incos	.152
68	Trichloroethylene	Cyphernetics	.141
68	Methyl N-(1-phenylethyl) carbamate	Cyphernetics	.148
110	Isopentylbenzene	Incos	.103
187	Chlorotoluene	Incos	.777
211	Dichlorobenzene	Incos	.500
220	B-Benzoyl-A-Methyl propionic acid	Incos	.380
237	Dichlorotoluene	Incos	.372
251	Trichlorobenzene	Incos	.861
260	"	Incos	.748
280	3-phenyl-3-hydroxy-cyclopentene	Incos	.363
280	Methyl naphthalene	Incos	.189
289	Tetrachlorobenzene	Incos	.273
308	Dimethylnaphthalene	Incos	.677

Sample #1108B

2	Dimethylbutane	Cyphernetics	.416
10	Hexane	Incos	~1.000
19	Methyl cyclopentane	Incos	.750
29	Benzene	Incos	.993
89	Toluene	Incos	~1.000
126	Chlorobenzene	Incos	~1.000
146	Cyclohexanol	Cyphernetics	.405
167	Benzyl chloride	Incos	.824
184	Dichlorobenzene	Incos	~1.000
191	"	Incos	~1.000
208	Methyl benzoate	Incos	.647
216	o, dichlorotoluene	Incos	.864
230	Trichlorobenzene	Incos	~1.000
278	Tetrachlorobenzene	Incos	.816

MEMORANDUM

TO: File via Mr. McMahon
FROM: Mr. Beecher
SUBJECT: Hooker Chemical - Love Canal - Niagara Falls (C)
12-1-77 Sampling of Exposed Chemicals
DATE: December 5, 1977

Four samples of exposed chemicals, three samples of exposed sludges and two samples of ponded water were taken from the Love Canal site, bound by 97th St., 99St, Frontier Ave. and Colvin Blvd in the City of Niagara Falls, Niagara County on December 1, 1977.

1. Exposed fiber pak located about 100 feet south of curb on Wheatfield Avenue and 60 feet west of fence behind house No. 506 - 99th St.

2. Exposed fiber pak located 3 feet south-southwest of sample 1. Sample appears similar to 1.

3. Exposed sludge located 20 feet west and 5 feet north of sample 1.

4. Ponded water about 20 feet diameter north of sample 1 and west of 506 & 510 - 99th St.

5. Ponded water extending into unfenced yard of 460-99th St. (approximate midpoint between Frontier and Wheatfield).

6. Exposed chemicals located 13 feet north of curb on Read and 2¼ feet east of light pole about equidistant from 99th and 97th Streets.

7. Exposed chemical located 6 feet west of sample 6 and appears to be similar to 6. Five other exposed containers were within ten feet of samples 6 & 7 but not sampled.

8. Exposed sludge between Reed and Colvin near North End - 80 feet west of rear fence of 770 (or 774 - house not numbered) - 99th St. Broken in transit

9. Exposed sludge about equidistant 99th & 97th Street west of vacant lot No. 750 - 99th Street.

JLB:dd

Table ESTIMATED LEVELS OF BENZENE AND HALOGENATED ORGANIC VAPORS IN AIR OF HOUSEHOLD BASEMENTS AND SCHOOL ROOM IN NIAGARA, NY[a]

EPA Contract No. 68-C2-2764

Chemical	Sampling/Location							
	L1	L2	L3	L4	L5	L6	L12A	B[c]
benzene	13,896[b]	73,785	4,194	6,286	T(39)	522,698	976	5.6
dichloroethylene	<263	<334	<294	<263	T(79)	T(334)	T(334)	<10
methylene chloride	1,534	<714	1,300	1,334	11,556	9,428	4,000	3.6
chloroform	1,670	834	464	684	13,484	8,584	2,668	22
1,1,1-trichloroethane	3,656	506	412	400	3,890	1,000	<334	<5
carbon tetrachloride	200	496	T(83)	5,038	562	704	<95	<2
trichloroethylene	1,224	2,920	270	5,344	1,374	15,880	T(116)	<5
tetrachloroethylene	6,346	10,652	3,342	5,386	51,992	37,442	<163	<7
pentachloroethane	<19	<53	<19	<17	<10	<36	<116	<5
pentachlorobutadiene	<22	<63	<23	<20	T(10)	<43	<140	<6
1,3-hexachlorobutadiene	<22	114	<23	26	100	414	<140	<6
chlorobenzene	1,940	4,232	1,000	3,674	2,778	<107	<348	<15
dichlorobenzene isomer	2,044	4,400	154	2,940	8,914	100,476	<186	<8
dichlorobenzene isomer	260	2,442	76	2,106	6,024	51,600	<186	<8
dichlorobenzene isomer	<30	<63	418	3,654	2,294	34,686	<186	<8
trichlorobenzene isomer	642	10,084	72	56	26	27,228	<140	<6
trichlorobenzene isomer	58	1,010	T(23)	1,306	3,424	2,370	<140	<6
trichlorobenzene isomer	<22	<63	<23	1,066	580	3,686	<140	<6

(continued)

Chemical	Sampling/Location							
	L1	L2	L3	L4	L5	L6	L12A	B[c]
tetrachlorobenzene isomer	16	1,832	<23	280	214	2,400	<140	<6
tetrachlorobenzene isomer	12	9,600	62	360	406	17,142	<140	<6
tetrachlorobenzene isomer	<22	<63	<23	<20	<10	<43	<140	<6
pentachlorobenzene isomer	<22	494	T(23)	18	30	250	<140	<6
chlorotoluene isomer	2,552	14,990	1,754	4,586	3,022	226,514	<116	<5
chlorotoluene isomer	3,820	<53	<19	<17	<8	223,042	<116	<5
dichlorotoluene isomer	8,836	20,926	<19	5,240	7,428	158,628	<116	<5
dichlorotoluene isomer	3,956	6,316	86	5,320	2,318	98,428	<116	<5
dichlorotoluene isomer	<19	<53	48	314	<8	109,872	<116	<5
trichlorotoluene isomer	634	206	46	134	1,644	6,886	<116	<5
trichlorotoluene isomer	3,336	3,790	62	1,786	4,908	42,286	<116	<5
trichlorotoluene isomer	<19	1,810	T(19)	<17	466	43,700	<116	<5
trichlorotoluene isomer	1,142	842	T(19)	594	160	25,936	<116	<5
trichlorotoluene isomer	<19	<53	<19	60	<8	<36	<116	<5
tetrachlorotoluene isomer	148	168	<27	<15	56	<18	<116	<7
tetrachlorotoluene isomer	58	<26	<27	16	<8	970	<116	<7
chlorobenzaldehyde isomer	<26	180	<19	746	34	4,058	<116	<5
dichlorobenzaldehyde isomer	<26	<63	<23	<20	<10	950	<140	<6
bromotoluene isomer	25	T(53)	<19	134	66	4,372	<116	<5

(continued)

Chemical	Sampling/Location							
	L1	L2	L3	L4	L5	L6	L12A	B[c]
bromochlorotoluene isomer	T(19)	<53	<19	80	28	1,542	<116	<5
chloronaphthalene isomer	78	84	<31	<27	<13	3,414	<186	<8
1,2-dichloropropane	1,406	<53	<19	<17	<8	<36	<116	<5
total halogenated organics	59,489	172,713	13,760	58,968	127,778	1,786,636	7,644	

[a]See Monthly Technical Progress No. 6 (March 14, 178, EPA Contract 68-02-2764) for sampling protocol.

[b]Values are in ng/m^3, T = trace, ( ) or < indicates limit of detection.

[c]Values are ng/cartridge.

New York State Department of Environmental Conservation

MEMORANDUM

TO: Mr. Gitlen
FROM: Mr. Kadlec
SUBJECT: Love Canal Sampling Data

DATE: April 5, 1978

On April 4, 1978, I received a call from Ron Rude of the Health Department Laboratories. He gave me additional sampling results for the Love Canal Sump samples, collected on February 7 & 8, 1978.

The analyses requested for these samples are described in my memo to Dr. Nehling of March 3, 1978. We now have complete results for PCB, mirex, benzene, toluene, hexachlorocyclohexane, endosulfan, trichloroethylene, and perchloroethylene. PCB, mirex, and endosulfan could not be detected in any of the samples. Results for the other parameters are summarized on the attached table.

Analyses for dichlorobenzene, trichlorobenzene, and monochlorobenzotrifluoride have not yet been done.

LJK/sm

cc: Mr. Pagano
Mr. T. Pleasant
Dr. Nehling
Mr. McMahon
Mr. Ruddard

Parameter								
Benzene (ppb)	N/D	60	1,100	N/D	N/D	900	1,300	3,300
Toluene (ppb)	N/D	80	23,000	N/D	N/D	12,000	13,000	31,000
Hexachlorocyclohexane (ppb)								
Alpha isomer	0.08	70	600	0.03	N/D	N/D	250	N/D
Beta isomer	0.18	N/D	N/D	0.06	0.05	N/D	70	N/D
Gamma isomer (Lindane)	N/D	140	600	N/D	N/D	160	170	70
Delta isomer	0.13	70	N/D	N/D	N/D	N/D	120	N/D
Trichloroethylene (ppb)	N/D	190	750	N/D	N/D	300	250	500
Perchloroethylene (ppb)	N/D	375	190	N/D	N/D	325	125	1,000
1,1,1-Trichloroethane (ppb)(1)	N/D	N/D	225	N/D	N/D	N/D	N/D	N/D
Chloroform (ppb)(1)	N/D	120	N/D	N/D	N/D	75	4,550	230
Carbon Tetrachloride (ppb)(1)	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
Bromodichloromethane(1)	N/D	N/D	N/D	N/D	N/D	N/D	35	N/D

1) - Analyses done gratis by Health Department

2) - N/D: Not specifically detected. Limit of detectability may vary widely between samples, because of interferences.

Compound	% Confidence	Retention Time	Concentra ((g/l)
Toluene	>90	1.33	250
Chlorobenzene	>90	1.85	10
Chlorotoluene	>90	4.18	75
Dichlorobenzene (2 isomers)	>90	5.79, 6.77	3
Dichlorotoluene (2 isomers)	>90	13.23, 14.27	52
Trichlorobenzene (2 isomers)	>90	15.40, 16.65	3
α,R,R trichlorotoluene (4 isomers)	>90	18.66, 19.95, 20.11, 20.77	34
Tetrachlorobenzene	>90	21.83	5
α,R,R, tetrachlorotoluene (2 isomers)	>90	24.21	1
Pentachlorobenzene	>90	25.29	2.5
1,1' Biphenyl-2 ethyl ($C_{14}H_{14}$)	>90	25.81	<1
Hexylbenzoate	>90	27.75	2
Benzene, 1,1'-oxybis (methylene)bis ($C_{14}H_{14}O$)	>90	28.18	6
Hexachlorobicycloheptadiene	>90	30.59	3
Chlorobenzoic Acid	70	31.58	2
Benzene, 1,1'-thiobis (methylene) bis ($C_{14}H_{14}S$)	80	35.97	1

α indicates chlorination on the methyl group.

R indicates chlorination on the ring.

Postscript

Upon completion of the steam distillation step, the sample was extracted with hexane and then with methylene chloride. Gas chromatographic examination of these extracts show that the steam distillation was approximately 100% efficient.

Fred Rubel w/2 way memo 4/12/78

APPENDIX G

AVAILABLE PRELIMINARY HEALTH RESULTS

INSURANCE

Homeowners Policy: Generally provides full coverage if the house is damaged or destroyed by fire or extended coverages, e.g. - lightning, windstorm, hail, etc. (regardless of whether a house is either vacant or unoccupied).

In reading the policy terms, it is important to know the insurance definition of "VACANT", i.e. VACANT means that a house has no furnishings.

I. Most homeowners policies exclude:

a) Coverage for vandalism and malicious mischief if the premises are vacant over 30 days.

b) Freezing of plumbing or heating systems unless due care and diligence is taken to maintain proper heat or drain systems in which case full coverage is maintained.

c) Glass breakage if premises VACANT over 30 days.

Homeowners policies limit coverage for personal property away from insured premises to ten per cent of dwelling coverage subject to a minimum of $1,000.

It is advisable for those insured who temporarily relocate with their furnishings to obtain either a tenant's policy or a personal property floater to fully protect their furnishings and personal property.

II. Most fire policies contain a provision which excludes coverage if the home is either VACANT or unoccupied for 60 days.

It is important in above instance to notify your company or agent and request a rider which will extend coverage beyond 60 days if either vacancy or unoccupancy is imminent.

In all cases, it is recommended that you contact either your agent or company to determine whether vacancy or unoccupancy affects your coverage.

APPENDIX H

HEALTH EMERGENCY DECLARATION (6/21/78)

STATE OF NEW YORK DEPARTMENT OF HEALTH

In the Matter of

THE LOVE CANAL CHEMICAL WASTE LANDFILL SITE
LOCATED IN THE CITY OF NIAGARA FALLS,
NIAGARA COUNTY, STATE OF NEW YORK

ORDER

WHEREAS, the Commissioner of Health of the State of New Y among other things, is directed by the Public Health Law to ta' cognizance of the interests of health and life of the People o the State, and of all matters pertaining thereto and to exerci: the functions, powers and duties of the Department of Health p: scribed by law and to enforce the Public Health Law; and

WHEREAS, Subdivision four of section 1303 of the Public Health Law provides as follows:

"Whenever the commissioner shall by notice to the presidin officer of any local board of health, direct him to convene suc local board to take certain definite proceedings which the commissioner shall be satisfied that the action recommended is necessary for the public good, and is within the jurisdiction of such board of health, such presiding officer shall convene such board of health, which shall take the action directed"; and

WHEREAS, section 1304 of the Public Health Law provides:

"The local health officer of a health district having no local board of health and each county health commissioner shall have authority equal to a board of health to investigate and abate public nuisances which may affect health."; and

WHEREAS, investigation by the Commissioner of Health of the State of New York and those acting by and on his behalf has disclosed that certain hazardous chemical wastes heretofore deposited at that certain site known as the "Love Canal Chemical Waste Landfill" located in the City of Niagara Falls, County of Niagara and State of New York constitute a public nuisance and an extremely serious threat and danger to the health, safety and welfare of those using it, living near it or exposed to the conditions emanating from it, consisting, among other things, of chemical wastes lying exposed on the surface in numerous places and pervasive, pernicious and obnoxious chemical vapors and fumes affecting both the ambient air and the homes of certain residents living near such site; and

WHEREAS, the undersigned State Commissioner of Health, pursuant to the statutory authority conferred upon him, heretofore did direct the Niagara County Health Commissioner to take certain actions deemed necessary to alleviate and lessen, for the public good, the dangers and hazards posed at the aforesaid landfill site to those affected by it; and

WHEREAS, it appears that the Niagara County Health Commissioner took some, but not all, of the actions so directed to be taken to alleviate and lessen such hazards and dangers; and

WHEREAS, it appears that certain actions are still necessary for the public good,

NOW, THEREFORE, I DO HEREBY ORDER AND DIRECT:

That the President of the Niagara County Board of Health convene the Board of Health of the County of Niagara and that said Board, together with the Niagara County Health Commissioner, take

a. Take adequate and appropriate measures to cause the removal from the Love Canal Chemical Waste Landfill site of all chemicals, pesticides and other toxic material which lie exposed or visible on the surface of the site.

b. Take appropriate and adequate measures to limit accessibility to the site by the installation of suitable fencing or other effective means, together with periodic surveillance and monitoring, to assure that access to the site is properly restricted or limited.

c. Take all other appropriate and necessary corrective actions to abate the public health nuisance now existing at the Love Canal Chemical Waste Landfill site.

d. Make an initial report to the undersigned Commissioner of Health, not later than 15 days from the date of service of this Order, concerning the progress made in implementing the orders and directions herein given and, thereafter, report on a monthly basis as to such progress.

ROBERT P. WHALEN, M.D.
Commissioner of Health
State of New York

6/21/78

TO: Dr. Francis J. Clifford
Niagara County Health Commissioner
Niagara County Health Department
5467 Upper Mountain Road
Lockport, N.Y. 14094

Ralph W. Lewis, D.V.M.
President, Niagara County Board of Health
5467 Upper Mountain Road
Lockport, N.Y. 14094