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ONONDAGA LAKE
SYRACUSE, SALINA, GEDDES, CAMILLUS, NEW YORK
VOLUME 2 OF 5

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ENVIRONMENTAL SERVICES DIVISION
U.S. ENVIRONMENTAL PROTECTION AGENCY

MARCH 20, 1992
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SUPERFUND CHEMICAL DATA MATRIX

REFERENCE NO. 3

NATIONAL FIELD INVESTIGATIONS CENTER
CINCINNATI

AND

REGION II, NEW YORK

REPORT OF

MERCURY SOURCE INVESTIGATION

ONONDAGA LAKE, NEW YORK

AND

ALLIED CHEMICAL CORPORATION

SOLVAY, NEW YORK

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF ENFORCEMENT AND GENERAL COUNSEL

April 1973

Environmental Protection Agency
Office of Enforcement

Report of Mercury Source Investigation Onondaga Lake, New York and Allied Chemical Corporation Solvay, New York

National Field Investigation Center
Cincinnati, Ohio
and
Region II, New York

April 1973

FOREWORD

In the summer of 1970, the U. S. Department of Justice took legal action against ten chlor-alkali plants to reduce or eliminate discharges of mercury. As of September 1972, only interim stipulated agreements for abatement were in force for most of the companies. This report was prepared in response to a request by the Department of Justice that the technical data on the plants and environs be updated in the following areas:

a) location of sediment deposits and the mercury content,

b) current mercury levels in the effluent, and

c) results of a current in-plant investigation and evaluation.

This report responds to the Department of Justice request.

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SUMMARY AND CONCLUSIONS

In order to obtain up-to-date information on mercury discharges from Allied Chemical Corporation, Solvay, New York and the mercury concentrations in the Onondaga Lake sediments, field surveys were carried out in December 1972. Based on the evaluation of data and facts obtained, the following conclusions may be drawn:

1. The 21-day average mercury discharge by Allied Chemical, as reported by the company to the U. S. Justice Department, has been less than the one-half pound per day maximum permitted by the existing stipulation from each of the two chlor-alkali plants. However, discharges on individual days have exceeded this limit for the west plant and have not been reported.
2. EPA data show that the west plant discharged 1.12 pounds of mercury on the day of sampling, more than double the 0.5 pound per day limitation.
3. The east plant discharged 0.08 pounds of mercury based on EPA sampling.
4. Allied Chemical Corporation is interpreting the existing stipulation to allow omissions of higher discharge values during treatment upsets from its weekly report on mercury discharges.
5. Direct flow measurements on the waste discharges are needed.

6. The one bioassay sample of the discharge from the cast flume was acutely toxic to aquatic life.

7. Winds cause waves and turbid conditions in the waste ponds. Procedures for controlling pond overflows on windy days are not adequate.

8. Allied Chemical Corporation reduced its mercury discharge to the water environment from approximately 22 pounds per day prior to 1970 to less than 1 pound per day. Further reduction is still needed.

9. Steps to reduce mercury have been taken on floor washings, drips and spills, cell room roof runoff, end box ventilation system, wash chamber water, west plant hydrogen, chlorine, and caustic soda.

10. A retort has recently been installed to collect mercury from solid wastes.

11. The company is studying water reduction measures, sulfide treatment for concentrated mercury waste streams, necessity for reducing mercury from the cast plant hydrogen, changing to metal anodes in the mercury cells, and floor and trench linings.

12. More effort is needed with housekeeping practices.

13. The natural background concentration of mercury in Onondaga Lake sediments is less than 0.1 mg/kg on a dry weight basis. More than 90 percent of Onondaga Lake bottom surface sediments are above natural background.

14. The areal distribution of mercury in bottom sediments of Onondaga Lake is not uniform - concentrations vary widely from place to place.

15. The concentration of mercury decreases with sediment depth to background concentrations generally at less than 2 feet below the sediment surface.

16. Highest sediment mercury concentrations are near the two Allied Chemical plant discharges.

17. Most of the Onondaga Lake sediments are very soft (mud-like) and oily, contain a variety of colors, and appear to be predominantly of man-made origin.

18. Comparison of volatile solids and mercury content indicate that three systems of deposition are active and overlap in Onondaga Lake - (1) shore erosion and accretion, (2) introduction and deposition of sediments (including mercury of man origin) in the vicinity of discharges, and (3) redistribution of initially deposited sediments along with primary deposition of less dense organic wastes.

19. Redistribution is now dominant with respect to mercury since discharges have been reduced. Redistribution forces (waves and currents) are active over the entire lake. Flow-through of the lake cannot be considered a prime sediment transporting force.

20. Although nearly all of the lake sediments near the surface contain mercury, differences in analyses and sampling methods between this and earlier surveys and comparison with estimated discharges leave a question as to the precise amount of mercury present.

21. The total volume of sediments containing mercury of levels above background is estimated at seven million cubic yards.

22. The volume and undesirable condition of Onondaga Lake sediments appears to result from a number of discharges and is not wholely attributable to Allied Chemical effluents.

23. Mercury levels in Onondaga Lake fish flesh are significantly higher than background levels in fish.

24. Mercury levels in Onondaga Lake sediments may adversely affect lake biota, but the relationship has not yet been established.

25. New York State water quality standards for Onondaga Lake are not being met as a result of the Allied Chemical Corporation discharges and other sources. Sludge deposits, toxic components and deleterious substances, such as mercury, are among those items prohibited by the standards.

26. A final decision on mercury in the lake sediments must consider the overall lake problems and their relationship to water uses.

RECOMMENDATIONS

1. The goal for the discharge of mercury by Allied Chemical Corporation via the water route should be zero.
2. As an interim, the amount of mercury discharged to the water environment should be reduced to 0.1 pounds per day total for both Allied chlor-alkali plants. This should be applied and monitored daily and include any discharge to the metropolitan treatment plant.
3. The existing waste ponds should be eliminated as the primary method of external treatment for mercury bearing streams from the chlor-alkali plants and a better procedure should be used. Consideration should be given to one treatment system for both plants and should include flow measuring equipment.
4. A flow reduction program for the chlor-alkali plants should be developed and implemented.
5. A stringent housekeeping program should be implemented in the cell buildings. The floor and trenches should be coated with a smooth surface and seal pots and any other flows should not overflow onto the cell room floor. More effort is needed with preventive maintenance of potential leak units. Better methods of cleaning up large spills are needed.
6. Vent gases from the retort should checked for mercury.
7. Flow measuring devices for the waste bed overflow, east flume and west flume, should immediately be made fully operational and used to calculate waste loads to the water environment.

8. On reports to the U. S. Attorney or the Environmental Protection Agency, actual mercury values found should be reported.

9. The method of computation of the amount of mercury discharge and the applicability of the exclusionary clause of paragraph 5. of the interim stipulation should be clarified.

10. The source of acute toxicity in the east flume discharge should be found and corrected.

11. Mercury discharged to the air and to groundwater near the water ponds should continue to be monitored and should be reported to the Environmental Protection Agency.

12. A concerted Federal effort should be given to relating mercury content of fish to that of sediments, preferably in an area with a wide range of sediment mercury content, before a decision is made with respect to the disposition of mercury contaminated Onondaga Lake sediment. However, any stipulation should establish the Allied Chemical Corporation's responsibility for the existing mercury in the sediments.

13. In addition to the mercury problem created by Allied Chemical, a decision should be made regarding responsibility of other sources of pollution for the undesirable condition of the lake sediments.

INTRODUCTION

This investigation has been made to gather further information for the case of the United States of America vs. Allied Chemical Corporation in the United States District Court, Northern District of New York, Civil Action No. 70-CV-256, with respect to mercury discharges to Onondaga Lake.

The only known significant source of the mercury to Onondaga Lake is the Allied Chemical Corporation at Solvay, New York, which has operated one mercury cell chlor-alkali plant since 1946 and a second since 1953. The plants are location near the southwest corner of the lake and discharge to the lake at the plant site and via Ninemile Creek, about 2.5 miles to the northwest.

Existing mercury content of the lake sediments was determined by the U. S. Environmental Protection Agency along with the areal and volumetric extent. Measurements were made of the characteristics of the wastewater discharges of Allied Chemical and plant practices for reducing the mercury content of these discharges were reviewed. Sediments were sampled between December 1 and 3, 1972, while a survey of the Allied Chemical discharges was carried out December 12 and 13, 1972.

In addition to the water route, mercury can be discharged to the environment and reach Onondaga Lake by means of certain plant stack emissions. However, the measurement of the air emissions was beyond the scope of this investigation.

Air emission regulations for mercury from chlor-alkali plants have recently been promulgated by the U. S. Environmental Protection Agency under Section 112 of the Clean Air Act and limit the total emission per plant to 2,300 grams per day.

A comprehensive report entitled, "Onondaga Lake Study", Project No. 11060 FAC 4/71, was recently prepared for the U. S. Environmental Protection Agency by Onondaga County, New York and its consultants. This report reviews the characteristics of Onondaga Lake and problems other than mercury, such as chlorides and oil sludges. Any final decision on mercury in the lake sediments must consider the overall lake problems and their relationship to water uses.

STUDY AREA

Onondaga is a relatively small natural lake in New York with an area of 4.5 square miles. It is located in the southeastern part of the Lake Ontario drainage basin adjacent to the city of Syracuse. It drains northerly to the Seneca River, thence to the Oswego River which enters the south-east corner of Lake Ontario. Oneida Lake to the northeast, also drains to the Oswego River. The Seneca River, Oswego River and Oneida Lake are part of the main route of the New York State Barge Canal. Onondaga Lake is a spur to that system.

The lakes were formed by glacial scour and damming of streams during the Ice Age. They have been in existence for 10,000 years or more and undergoing natural aging processes. Thus, man's activities have affected them for a relatively short period.

Tributary flow to Onondaga Lake totals about 315 cubic feet per second (cfs). The lake, with a volume of five billion cubic feet, thus has a retention or flow-through time of about 180 days. The largest tributary, averaging 145 cfs is Onondaga Creek which flows through the city of Syracuse and enters at the head of the lake. Ninemile Creek has the next largest flow with an annual average of 83 cfs.

Flow-through of the lake is so slow that it cannot be considered a major sediment transporting force. Wind and temperature driven forces dominate and are sufficient to allow fairly uniform distribution of effluents over the lake, particularly during times of lake turnover in spring and fall.

Modification of the topography around Onondaga Lake has been taking place during the last several years. Interstate Highway 690 was constructed along the southwestern shore of the lake. Sections of this highway and related interchanges have been constructed over abandoned tailings piles of Allied Chemical Corporation. A green belt and parks are being developed around the western and northern ends of the lake. The northeast portion has been completed with the northwest portion in process. In developing the park, some of the lowlands are being filled with sediments dredged from the lake itself. Reduction or elimination of pollution would enhance the park development and allow the further development of the water-based recreation.

APPLICABLE STANDARDS AND LIMITATIONS

The present temporary maximum allowable quantity of mercury permitted from the two chlor-alkali plants of Allied Chemical Corporation is spelled out in the Stipulation dated September 14, 1970, between the United States Attorney and the attorneys for Allied Chemical. The stipulation reads as follows:

> It is stipulated by the attorneys for the parties in this action that the plaintiff's application for a preliminary injunction and the trial of the action be adjourned until December 7, 1970, or until such date after that as the Court may fix.
>
> This stipulation and adjournment is made upon these conditions:
>
> 1. The defendant shall, by September 15, 1970, reduce the average total net discharge of mercury from its two chlorine plants in Solvay, New York into the Onondaga Lake or any other navigable water of the United States, or tributary thereof, to an amount not more than the equivalent of eight (8) ounces per day per plant from its said chlorine plants;
>
> 2. The defendant shall thereafter continue to make all efforts further to reduce the total discharge of mercury from its said chlorine plants into the Onondaga Lake, or any other navigable water of the United States, or tributary thereof, and on or before December 1, 1970, defendant shall submit to plaintiff a proposed schedule of future reductions of mercury discharge from said plants;
>
> 3. The defendant shall measure or cause to be measured daily the mercury content of its effluent from its said chlorine plants and no less often than each period of seven consecutive days shall send by mail to the United States Attorney at Federal Building, Syracuse, New York, and also to the Great Lakes Regional Office, Federal Water Quality Administration, 4664 Lake Avenue, Rochester, New York, or its successor in interest, the daily readings covering the seven day period ending on the prior day; the daily average shall be computed for the purposes of Paragraph 1 above upon the basis of a twenty-one (21) consecutive-day period; *

4. The defendant shall permit, at any time that its said chlorine plants are in operation, employees and agents of the plaintiff to enter upon the premises here involved to measure or to cause to be measured daily the mercury content of the effluent being discharged into the Onondaga Lake or any other navigable water of the United States, or tributary thereof;

5. Should the amount of mercury in the defendant's effluent not be reduced to the average total amount set forth in Paragraph 1, or should the amount of mercury at any time exceed such amount (except in isolated cases of accidental discharges), or should the plaintiff decide that its consent to this stipulation should be withdrawn, then the plaintiff may bring on for determination its pending application for a preliminary injunction upon not less than five (5) days' written notice to defendant through its attorneys herein;

6. This stipulation is without prejudice to the claims of either party with respect to any issue in this action, including the demand of plaintiff set forth in Paragraph numbered "2" of plaintiff's prayer for relief set forth in the complaint.

7. This stipulation and any order hereon shall not preclude plaintiff from bringing any future action under the Refuse Act with respect to substances other than mercury or its compounds discharged by the defendant's said plants into the navigable waters of the United States.

New York State has classified the waters of Onondaga Lake for future water use. The eastern end of the lake near Syracuse has been designated Class C. A small section near the mouth of Ninemile Creek also is Class C. See Figure 1. The usage of Class C waters is: Fishing and any other usages except for bathing or as source of water supply for drinking, culinary or food processing purposes. The balance of Onondaga Lake waters have been designated as Class B, which is defined as waters for bathing and any other usages except as a source of water supply for drinking, culinary or food processing purposes.

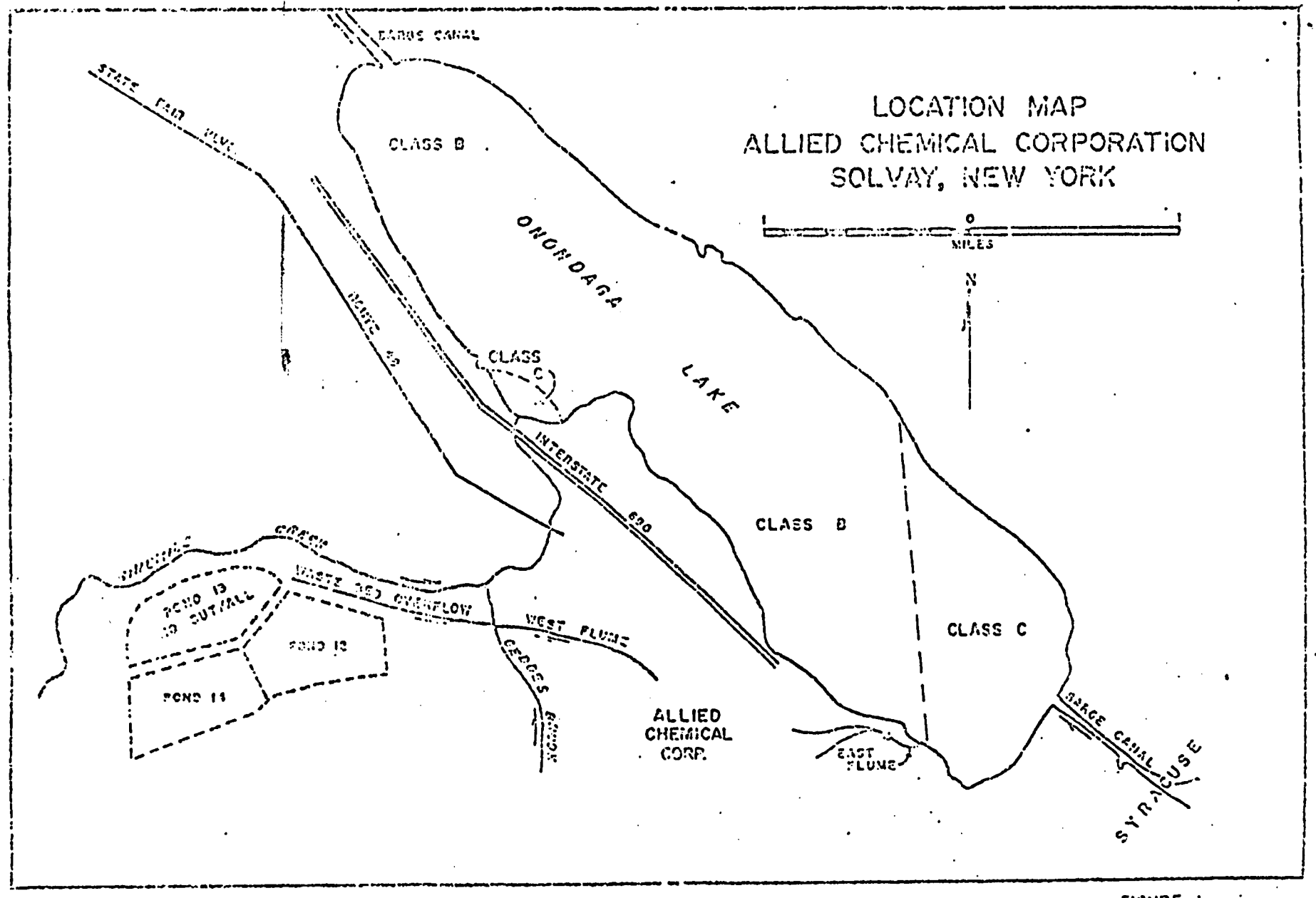

LOCATION MAP
ALLIED CHEMICAL CORPORATION
SOLVAY, NEW YORK
MILES
N
ERIE CANAL
STATE FAIR BLVD
CLASS B
ONONDAGA
LAKE
CLASS C
INTERSTATE 690
CLASS B
CLASS C
CREEK
WASTE ACID OVERFLOW
POND 13
POND 12
POND 14
WEST PLUME
GEORGES BROOK
ALLIED
CHEMICAL
CORP.
EAST PLUME
BARGE CANAL
SYRACUSE

FIGURE 1

It would be appropriate to quote certain sections from New York's Class B and Class C water quality standards as they may apply to Allied Chemical's discharge into Onondaga Lake.

Class B

Toxic Wastes, Deleterious Substances: None alone or in combination with other substances or wastes in sufficient amounts or at such temperatures as to be injurious to fish life, make the waters unsafe or unsuitable for bathing or impair the waters for any other best usage as determined for the specific waters which are assigned to this class.

Sludge Deposits, Floating Solids, Settleable Solids: None which are readily visible and attributable to sewage, industrial wastes or other wastes or which deleteriously increase the amounts of these constituents in receiving waters after opportunity for reasonable dilution and mixture with the wastes discharged thereto.

Class C

Toxic Wastes, Deleterious Substances: None alone or in combination with other substances or wastes in sufficient amounts or at such temperatures as to be injurious to fish life or impair the waters for any other best usage as determined for the specific waters which are assigned to this class.

Sludge Deposits, Floating Solids, Settleable Solids: Same as Class B.

WASTE SOURCE EVALUATION

)Background on Plant

Allied Chemical Corporation at Solvay, New York, produces chlorine, sodium hydroxide, and potassium hydroxide by the mercury and diaphragm cell chlor-alkali processes at its Syracuse Works, Solvay, New York. The hydrogen by-product is utilized in other processes or burned. Pertinent data on the type of processes follow:

	Date Installed		Cathodic Current Density, Amp./m^2
East Plant			
	1927	Allen-Moore diaphragm	415
	1946	Solvay mercury (SD 12)	3213
West Plant (Bridge Street)			
	1953	Solvay mercury (S 60)	3878
	1968	Hooker diaphragm (S 4 B)	1276

The east plant produces 68 tons chlorine per day (30 tons from mercury cells and 38 tons from diaphragm cells) while the larger west plant produces 250 tons per day (100 tons from mercury cells and 150 tons from diaphragm cells).

At present, the external treatment consists of settling any suspended solids in a system of waste ponds. Liquid wastes from the east and Bridge Street plants which contain no suspended solids are released directly to the east and west flumes, respectively. Any flows containing suspended solids and any from which mercury can be precipitated are pumped to the waste ponds. Overflows from the waste ponds and the west flume waters flow to Geddes Brook and then to Ninemile Creek before discharging into Onondaga Lake.

There are three waste streams from the west plant which are discharged to the west flume:

1. A caustic soda solution that is used to neutralize the vent gas in the chlorine line and absorb the residual chlorine.
2. Cooling water from the direct cooling of the chlorine from the mercury cells.
3. Cooling water from indirect cooling of caustic, brine, hydrogen, compressors and chlorine from the diaphragm cells.

The east plant has only one effluent - cooling water used for the direct cooling of the chlorine from all of the cells, both mercury and diaphragm. The vent gases are used in a different process to chlorinate benzene and also to chlorinate the incoming process water from Onondaga Lake.

The process water from the lake is also used for processes other than the chlor-alkali plants and is supplemented by additional water from Ninemile Creek at Amboy. The latter water receives no treatment prior to use.

Beginning in 1970, Allied Chemical initiated several practices in an attempt to reduce the mercury levels in its effluent. Floor washings in the west plant are collected in one of two sumps and pumped to a cone tank where any solids can settle out. From here the contents are pumped through a filter press to a holding tank from which the wastes are pumped to the waste ponds. Roof runoff during rainfalls passes through the same system. Any leakage from the filter press is collected in a sump and pumped to the holding tank. Solids from the

filter press are sent to the retort to collect the mercury. The floor trenches are brushed to the sumps daily while under water. It is planned to add a sodium sulfide treatment system prior to the filter press in the future in order to precipitate the mercury while it is more concentrated. The floor and trenches have deteriorated because of the corrosive nature of the materials handled and company officials stated they have tested numerous coating materials and have not yet found a satisfactory coating.

All east plant floor drainage passes through a trench which also contains several pipelines. The mercury cells are washed down daily. The trench is completely drained and flushed only every three to four months. Drainage is pumped to a triple effect evaporation to recover the potassium values. The concentrated potassium solution passes through a filter before being used for make-up brine. Filter backwash is pumped to a holding tank and is periodically pumped to the waste ponds. Condensate from the vacuum jet on the last effect also goes to the holding tank. Mercury was noticed by EPA personnel in a floor crack near the east plant sump which is an indication that clean-up procedures are not adequate. *

There are no end boxes on the east plant mercury cells because of the nature of the cell design. Condensate from the west plant end box ventilation system drains to one of several seal pots which overflow onto the floor and to the floor sump. Company personnel said that they do not find mercury in the seal pots. When a cell end casting is removed,

it is washed to an upstairs floor drain and this drains through a seal pot to collect the mercury before overflowing across the floor to the first floor trench. Spillage of water over the floor beneath the cells is one of the weaknesses of the Allied housekeeping practice.

Wash chamber water which covers the mercury in the end boxes is pumped through a cyclone separator and a cartridge filter and then is recirculated back to the end boxes.

Chlorine coming off the mercury cells is cooled with water sprayed at the top of a packed tower. As indicated previously, this cooling water, which the company said contains about 0.1 ppb mercury, is discharged to the west flume from the west plant while similar east plant water is used to chlorinate lake intake water and to produce chlorinated benzene. After cooling, the chlorine is dried with sulfuric acid, compressed to liquefy the chlorine and the vent gases are washed with caustic soda before being released to the atmosphere. Company personnel stated that the caustic soda solution discharged contains 15 to 30 ppb mercury and is not sent to the waste beds because the chlorine would poison the sulfide precipitation process. They are looking into a different system to improve the operation.

Vapors from the west plant and box ventilation system are collected in a header and pass through a blower to a scrubber where they are washed with chlorinated brine before being vented to the atmosphere. The brine is then used to make up cell feed.

In the west plant, most of the hydrogen from the denuder passes through a compressor, indirect cooling, demister, dryer and then is

used for fuel at the boiler house. It is planned to insert a charcoal filter for further mercury removal in the future. Condensate from the cooling step flows through a trap onto the floor below the cells. Company officials stated that no liquids come out in the demister. The remainder of the hydrogen is sprayed with chlorinated brine before being vented to the atmosphere. The brine is recirculated for cell feed. In the east plant all hydrogen passes through a heat exchanger and then is vented to the atmosphere.

Because of the low production rate, company personnel said that they may be able to meet the 1,000 grams per day per plant mercury limit in the Environmental Protection Agency air pollution regulations without removing any mercury from the east plant hydrogen emission. They will opt for the 1,300 grams per day per plant for the cell room emissions.

All brine tanks and other tanks containing mercury are diked. Brines spilled and spent brines from the cells are pumped back to the brine make-up area where they are reconstituted. All brines are filtered before use in the cells with the filter solids being pumped to the waste ponds. There is no brine purge.

Recently a retort furnace was placed in operation to recover mercury from certain waste solids. Ashes are drummed and dumped into the waste ponds. After the mercury is condensed in an indirect cooler, the gases are vented to the atmosphere. However, they have not been checked for mercury content. Condensables other than mercury are pumped to the waste pond line.

Caustic soda produced in the mercury cells is filtered using activated carbon deposited on porous carbon filter tubes. Solids backwashed from the filters are sent to the retort.

In discussing water use in the chlor-alkali plants, Allied personnel stated that a program to reduce water use is under study. The conversion to titanium anodes in the mercury cells is also under study.

Mervac vacuum cleaners are used to clean up small droplets of mercury from the cell room floors, but company officials said that if a casting starts to leak, the spill is beyond the capacity of the Mervacs and the mercury must be flushed to the sump system. The rubber lined castings in the west plant are deteriorating and leaks have been occurring several times per month. Diagnostic tests are made daily and if leaks are detected repairs are immediately scheduled.

EPA air pollution regulations require that a number of housekeeping requirements must be met in order for a chlor-alkali plant to qualify for an assumed emission of 1,300 grams per day of mercury from the cell room ventilation system. The cell rooms for both the east and west plants are completely enclosed and are periodically checked for mercury levels. Although Allied Chemical appears to be meeting the majority of the housekeeping requirements, more effort is needed in the area of collecting certain flows and spills that now drain to the floor and in paving the trenches and floors to minimize collection points for mercury.

The waste stream from the soda ash operation contains ammonium polysulfides $(NH_4)_xS_y$ which are used as a corrosion inhibitor. When

this stream is pumped to the waste ponds along with certain wastes from the chlor-alkali plants, the sulfides precipitate the mercury in the line.

Wastes enter the three active ponds at one or more of several locations near the edge. The ponds are operated in parallel. Solids settle out and the liquid is decanted near the center and is discharged to a trench which flows to Geddes Brook and then to Ninemile Creek before entering Lake Onondaga. The newest pond, number 13, does not yet overflow. Strong winds cause waves in the ponds, agitating the sediments, and some of the solids are discharged with the liquid. Under these circumstances, Allied Chemical personnel close the overflow or change the ponds receiving wastes until the winds subside.

The waste pond overflow is not measured directly by plant personnel but is estimated from the pumping figures for wastes pumped to the ponds. It is planned to install flow measuring and proportional sampling equipment on the overflow during the next several months.

Company officials indicated that there are a number of test wells around the waste pond area which are checked twice a year for mercury and chlorides. The officials stated that there has been no groundwater pollution problem as the ponds are self-sealing.

Most of the west flume water results from the barometric condensers for the generator in the boiler plant and the calcium chloride operation. At present, the west flume flow is calculated by adding the several flows being pumped to plants discharging to this flume. A Parshall flume will be installed by May 1973. The west flume discharges to Geddes Brook which in turn flows to Ninemile Creek.

The east flume flows to the southwest end of Onondaga Lake. This flume receives two sewers:

1. The P.A. sewer (picric acid no longer is made) contains wastes from the east chlor-alkali plant, the boiler house and part of the soda ash operations.
2. The main sewer receives effluent from the bulk of the soda ash operations, refined bicarbonate of soda, miscellaneous shops, a neighboring plant (Church and Dwight) that packages bicarbonate of soda, a neighboring barrel plant, and a small amount of town storm runoff.

A Parshall flume has been installed in the east flume but is not fully operational and is not used for official calculations for U. S. Attorney reports.

Construction of a regional tertiary waste treatment plant for metropolitan Syracuse was planned for the spring of 1973 but has not been started because of a lack of funding. The plans call for the Allied waste pond overflow to pass through two additional settling ponds in series before being pumped to the regional system where the line in the overflow will be mixed with the secondary effluent and utilized to precipitate the phosphorus in the sewage. Sludge from the tertiary step along with digested primary and secondary sludge will be pumped to the Allied calcium chloride plant from which it will be added to the wastes being pumped to the present waste beds.

Survey Procedures

In addition to the survey objectives related to mercury, analyses

were performed for a number of chemical constituents in order to obtain data for general purposes. Exploratory bioassays were also carried out.

Twenty-four hour composite samples with equal portions taken each two hours were obtained at each sampling station, except the two flumes where continuous samples were obtained with company equipment.

Sampling stations were set up at seven locations and are indicated in Figure 2:

1. Geddes Brook upstream from the west flume.
2. Ninemile Creek at Amboy water intake.
3. Water intake at Lake Onondaga.
4. East flume.
5. West flume.
6. Ninemile Creek at Route 48.
7. Ditch carrying overflows from waste beds.

In addition to the composite samples, two grab samples were obtained to check for variability of results. One grab was obtained during the night and one in the morning at the end of the sampling period. Alkalinity, pH and chlorine residual were checked in the field on four occasions. The portion of the samples to be used for metal and total organic analyses was preserved by adding concentrated nitric acid. Other analyses were performed on unpreserved samples which were kept in a cool automobile during collection and transportation to the laboratory. All analyses were performed by the EPA Rochester Field Office, Region II. Mercury analyses were performed using the flameless atomic absorption procedure.

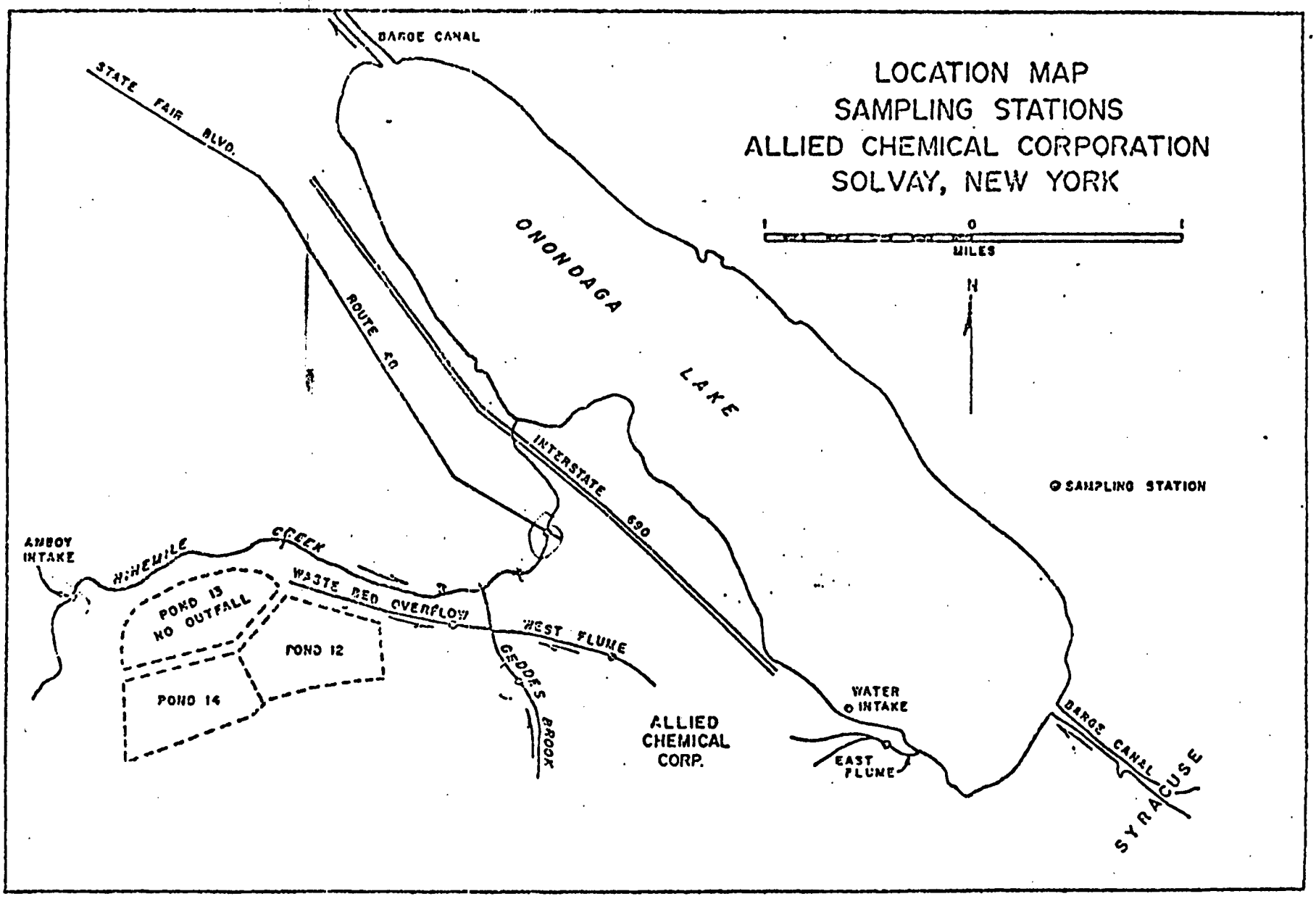

LOCATION MAP
SAMPLING STATIONS
ALLIED CHEMICAL CORPORATION
SOLVAY, NEW YORK
1 0 1
MILES
N
BARGE CANAL
STATE FAIR BLVD.
ROUTE 48
ONONDAGA
LAKE
INTERSTATE 690
SAMPLING STATION
ANBOY INTAKE
HINEMILE CREEK
POND 13
NO OUTFALL
POND 12
POND 14
WASTE BED OVERFLOW
WEST FLUME
GEDDES BROOK
ALLIED CHEMICAL CORP.
WATER INTAKE
EAST FLUME
BARGE CANAL
SYRACUSE

FIGURE 2

The sampling program was carried out under the supervision of Robert Dona, Chief Surveillance Section, Rochester Field Office. Water samples were obtained by William Lewis and Lewis Rawson, Physical Science Technicians from the same office. Information on plant procedures was gathered by Herbert Pahren of NFIC - Cincinnati.

Principal contacts at the Allied Chemical Corporation, Solvay, New York, were Mr. J. L. Rourke, Manager, Technical; Mr. John DeVoe, Superintendent, Environmental Control; and Mr. Daniel Hartong, Environmental Control Chemist.

An evaluation was made of the adequacy of the plant sampling equipment for the east and west flumes. A constant flow pump takes a part of the flow from the channel at a point about 18 inches from the bottom, which is about mid-depth. The flow passes over a splitter which diverts a part into the sample tank with the balance returning to the flume. The stainless steel sampling tanks accumulate the flow until the end of the composite period. A mixer is then turned on and run for at least five minutes. The mixer shaft has two propellers - one near the bottom of the tank and one about mid-depth. While the mixer is running, a sample is dipped from the tank. From a visual observation of the sampling procedure, it appears that the sample is representative of the tank contents. Allied personnel indicated that they twice checked the chemical composition at the end of the flume and compared it to the results from the sampling tank and found no differences.

Rhodamine B dye was added to the P.A. sewer by EPA personnel and the mixing characteristics of the east flume were observed. Excellent

horizontal and vertical mixing resulted in a uniform distribution of dye at the point of sampling. Dye was also added to the main plant sewer with similar results. An oil boom which the company maintains downstream from the main sewer forces any dye near the flume surface to mix as it passes beneath the boom.

The west flume has three moderate bends and two good riffle sections between the sewer from the chlor-alkali plant and the sampling station which aid the mixing of the flume contents. Rhodamine B dye was added by EPA personnel and mixing appeared to be good before the dye was bleached by the chlorine in the flume. Plant personnel said that they checked the west flume with a turbid material and it quickly spread across the flume and mixed well.

Flows for the lake intake water, Amboy intake water, east flume and west flume were furnished by the company and were based on the hours of operation that calibrated pumps were pumping these waters. Waste bed overflow was obtained twice by EPA personnel by measuring the cross sectional area of the drainage ditch and the time for dye to travel a given distance.

Plant flows depend somewhat on the ambient temperature, as it affects cooling water usage, and production levels. In a given 24-hour period, the flows generally would not vary significantly. As an indication of the range of flows over a given period, the following flows, in million gallons per day, were calculated by plant personnel for the period October 29, 1972 to December 2, 1972:

	Minimum	Maximum	Average
Lake intake	76.8	82.7	80.2
East flume	55.1	60.1	57.4
West flume	21.0	28.4	23.8
Waste bed overflow	5.2	10.4	7.8

Plant Survey Results

Concentrations of the various constituents found in the composite samples are summarized in Table 1. The grab sample values are also included. Loadings for the three Allied Chemical waste discharges are tabulated in Table 2. Intake water loadings were subtracted from the gross amounts discharged to the east and west flumes.

EPA mercury results show that a total of 1.2 pounds of mercury were discharged by Allied Chemical Corporation during the 24-hour period from the morning of December 12 to the morning of December 13. Of this, 0.08 pounds were discharged by the east plant via the east flume while 1.12 pounds were discharged from the west plant. Allied stated that to obtain the total from the west plant they add the west flume mercury loadings to those from the waste bed overflow, since most of the mercury contained in the overflow originates with the west plant.

It is interesting to compare the mercury data from the EPA spot check with the formal Allied report for the period. Results contained in Report No. 118 dated December 18, 1972, to the U. S. Attorney from Mr. M. J. Campbell, Director Manufacturing Operations for Allied Chemical Corporation, are tabulated in Table 3. This report is required by item 3 of the stipulation and is sent weekly to the U. S. Attorney and to EPA. While the EPA mercury value of 0.08 pounds from the east plant compares favorably with the 0.10 pounds reported by Allied for

TABLE 1
CONCENTRATION AND RANGE OF SAMPLES

	LAKE INTAKE		EAST FLUME	
	Composite mg/l	Grabs mg/l	Composite mg/l	Grabs mg/l
Mercury	0.0005	<0.0002	0.0007	0.0005-0.0039
Zinc	0.036	0.044	0.031	0.014-0.009
Total solids	3364	3494	3894	3965-3694
Suspended solids	3	12	21	145-32
Dissolved solids	3361	3482	3873	3820-3662
Volatile solids	264	392	362	408-344
Sodium	620	550	686	860-658
Chloride	1550	1455	1707	1694-1619
Calcium	505	490	510	445-575
Sulfate	150	135	174	163-187
COD	19.8	21.0	26.1	25.6-29.4
TOC	6.3	5.9	6.2	6.8-5.0
Organic nitrogen	0.80	0.85	1.55	2.35-0.65
Ammonia nitrogen	2.90	2.95	6.95	6.25-6.25
Nitrate-nitrite N	0.79	0.44	1.25	11.50-1.27
Total phosphorus	0.531	0.457	0.556	0.487-0.451
Dissolved phosphorus	0.392	0.374	0.334	0.279-0.287
pH, units		7.2-7.7		7.1-7.9
Alkalinity		180-184		166-188
Chlorine residual		-		1.5-5.0
Flow, mgd	64.5		46.8	

TABLE 1 (Continued)
CONCENTRATION AND RANGE OF SAMPLES

	AMBOY INTAKE		WEST FLUME	
	Composite mg/l	Grabs mg/l	Composite mg/l	Grabs mg/l
Mercury	0.0009	<0.0002-0.0003	0.0016	0.0008-0.0006
Zinc	<0.005	<0.005-0.005	0.018	0.013-0.030
Total solids	395	434	5260	4870-5906
Suspended solids	7	34	22	15-15
Dissolved solids	388	400	5238	4855-5891
Volatile solids	32	34	296	693-647
Sodium	10	34-7.4	1296	1150-1150
Chloride	16.9	19.8	2584	2205-2674
Calcium	75	90-81	560	520-572
Sulfate	109	100	153	100-145
COD	15.1	18.8	16.6	17.4-14.1
TOC	2.7	3.5-5.6	8.4	9.2-5.1
Organic nitrogen	0.184	0.135	5.575	4.550-0.348
Ammonia nitrogen	0.071	0.040	0.025	0.250-0.017
nitrate-nitrite N	0.080	0.75	0.57	0.58-0.62
Total phosphorus	0.068	0.057	0.484	0.440-0.422
Dissolved phosphorus	0.039	0.023	0.332	0.350-0.437
pH, units		7.6-8.2		7.0-8.3
Alkalinity		172-190		156-166
Chlorine residual		-		1.0-10.0
Flow, mgd	3.28		18.4	

TABLE 1 (Continued)
CONCENTRATION AND RANGE OF SAMPLES

	WASTE BED OVERFLOW		GEDDES BROOK	
	Composite mg/l	Grabs mg/l	Composite mg/l	Grabs mg/l
Mercury	0.0145	0.0545-0.0242	0.0006	0.0023
Zinc	0.023	0.04-0.038	0.011	0.007
Total solids	58,924	44,684-85,479	1,095	884
Suspended solids	446	1,450-244	87	38
Dissolved solids	58,478	43,234-85,235	1,008	846
Volatile solids	14,510	11,246-22,877	58	112
Sodium	7,000	5,140-9,960	140	84
Chloride	26,930	18,202-36,778	169	58.8
Calcium	9,700	7,900-13,700	180	180
Sulfate	532	475-649	309	297
COD	50.7	71.9-80.6	13.5	14.9
TOC	9.5	8.4-9.3	3.4	5.9
Organic nitrogen	0.850	0.650-2.05	9.5	0.135
Ammonia nitrogen	3.55	3.75-4.20	0.250	0.245
Nitrate-nitrite N	1.20	0.82-1.27	1.46	1.39
Total phosphorus	-	-	0.165	0.080
Dissolved phosphorus	-	-	0.055	0.051
pH, units		8.3-11.9		7.7-8.3
Alkalinity		212-900		220-240
Chlorine residual		0		-
Flow, mgd	8			

TABLE 1 (Continued)
CONCENTRATION AND RANGE OF SAMPLES

	NINEMILE CREEK AT ROUTE 48	
	Composite mg/l	Grabs mg/l
Mercury	0.0005	0.0006-0.0015
Zinc	0.010	0.008-0.008
Total solids	3,880	3,348-3,190
Suspended solids	41	20-20
Dissolved solids	3,839	3,328-3,170
Volatile solids	520	68-10
Sodium	550	484-478
Chloride	1,624	1,464-1,470
Calcium	585	540-488
Sulfate	144	136-150
COD	16.7	10.0-43.1
TOC	5.7	4.6-4.3
Organic nitrogen	0.243	6.40-0.130
Ammonia nitrogen	0.322	0.450-0.350
Nitrate-nitrite N	1.34	0.83-0.77
Total phosphorus	0.128	0.119-0.142
Dissolved phosphorus	0.052	0.064-0.015
pH, units		8.0-8.2
Alkalinity		182-190
Chlorine residual		0-0.1
Flow, mgd		

TABLE 2
NET DISCHARGES FROM
ALLIED CHEMICAL CORPORATION
DECEMBER 12-13, 1972

	East Flume lb/day	West Flume lb/day	Waste Bed Overflow lb/day
Mercury	0.08	0.15	0.97
Zinc	0	0	1
Total solids	207,000	366,000	3,930,000
Dissolved solids	200,000	363,000	3,900,000
Suspended solids	7,000	3,000	30,000
Volatile solids	38,000	11,000	970,000
Sodium	26,000	120,000	470,000
Chloride	61,000	200,000	180,000
Calcium	1,900	19,000	650,000
Sulfate	9,400	1,500	35,000
COD	2,500	0	3,400
TOC	0	410	630
Organic nitrogen	290	740	57
Ammonia nitrogen	1,600	0	240
nitrate-nitrite N	180	0	80
Total phosphorus	14	0	-
Dissolved phosphorus	0	0	-

TABLE 3
NET MERCURY CONTRIBUTIONS
POUNDS PER DAY
AS REPORTED BY ALLIED CHEMICAL CORPORATION

Date	East Plant	West Plant
12/11	.08	.18
12/12	.06	.14
12/13	.10	.14
12/14	.09	.09
12/15	.12	.18
12/16	.11	.18
12/17	.10	.18
1-Day Average	.10	.18
11-Day Average 12/27-12/17	.08	.17

the 24-hour period ending December 13, 1972, the Allied 0.14 pounds attributable to the west plant was far below the EPA value of 1.12 pounds. The 0.14 pounds reported by Allied was almost identical to the 0.15 pounds measured by EPA for the west flume. [It appeared that Allied did not include the mercury discharged in the waste bed overflow in the figures reported to the U. S. Attorney.] * Allied personnel were requested to furnish their full calculations for December 13 and 14, 1972. These were furnished and show a discharge of 0.10 pounds mercury per day for the west flume and 0.65 pounds mercury per day for the waste bed overflow for a total of 0.75 pounds mercury from the west plant for December 13, 1972, based on Allied data. In explaining the difference from the value reported to the U. S. Attorney, Mr. DeVoe, in his letter of March 13, 1973, to Mr. Herbert Pahren of EPA, stated: "The net lb./day mercury values reported to the Justice Department include a calculation to eliminate the results of isolated accidental discharges. The values of these accidental discharges are calculated using the average mercury concentration common to the outfall immediately prior and following the actual day of the particular discharge."

During the night of December 12 and 13, a storm passed through the Syracuse, New York area, accompanied by high winds. Winds tend to mix the liquid contained in the waste ponds causing some of the settled solids to be resuspended. When the high winds occur, the Allied procedure calls for the discharge overflow weirs for the waste ponds to be raised or ponds changed so as to prevent turbid wastes near the pond outfall

from being discharged. The effectiveness depends on how alert the Allied personnel are to the problem. It is probable that the relatively high mercury level found by EPA in the waste bed overflow is attributable to suspended solids containing mercury. Allied reported that distribution boxes were changed and boards were added to increase the height of the outlet structure about 3:00 a.m. on the morning of December 13 as the wind increased. However, this action was not sufficient to prevent excessive quantities of mercury from being discharged. In fact, the highest mercury value was obtained with the grab sample obtained on the waste bed overflow at 0850 hours on December 13 after the winds diminished somewhat.

It is recognized that the discharge of the levels of mercury found in the waste bed overflow on December 12 and 13 may be higher than is normally found by Allied. However, when meteorological conditions increase the mercury discharged, this should not be a reason for not reporting the data. Winds occur periodically in the Solvay, New York area and should be taken into consideration when developing a mercury reduction program. In addition, winds are not considered to fall within the "isolated cases of accidental discharges" exception contained in the court stipulation.

The stipulation, cited previously, states that the average amount of mercury from each of the two Allied chlor-alkali plants shall not exceed 8 ounces per day. The daily average is to be computed on the basis of a 21 consecutive day period. The 21-day average has routinely

been below the limit. As shown in Table 3, the 21-day average for the period ending December 17, 1972, was 0.03 pounds mercury per day for the east plant and 0.17 pounds mercury per day for the west plant. Both values are well within the 0.5 pounds per day average permitted by the stipulation. However, while the east plant met the limitation on the day of EPA sampling, the EPA data show that the west plant discharged 1.12 pounds, more than double the 0.5 pound per day limitation.

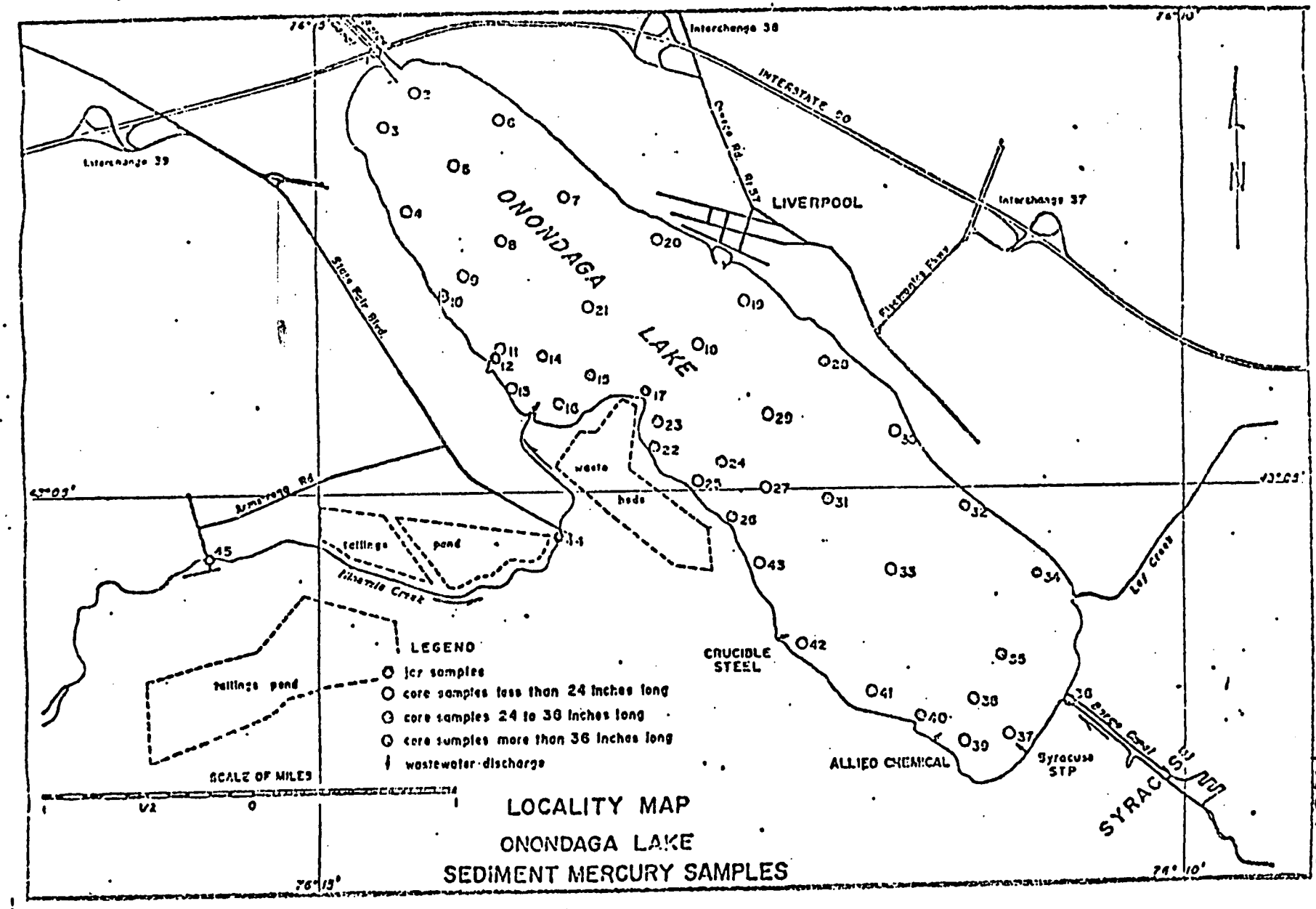
Exploratory bioassays, using Northern Creek chubs, were carried out using water from the east and west flumes, the two intakes, Geddes Brook and Ninemile Creek at Route 48. The samples used for bioassays were grab samples taken at the end of the sampling period. The only sample exhibiting toxic effects was the sample from the east flume where a 10 percent dilution, using Onondaga Lake water as dilution water, killed all of the test fish within 24 hours. A one percent dilution of this effluent showed no lethal effects after 96 hours. At the beginning of the sampling period, a strong organic odor was detected in the east flume but this soon disappeared. Possibly chlorinated benzene is reaching the east flume. As part of its pollution control activities, the company should find the cause of this toxicity and take the necessary corrective steps.

Methods of Investigation

A core sampler was used at all of the 43 Onondaga Lake sampling stations shown in Figure 3. The sampler consisted essentially of a 1.5-inch core tube with a cutting head, plastic liner and check valve attached to sufficient 10-foot lengths of 3/4-inch pipe to reach and penetrate the bottom sediments. The sampler was shoved by hand into the sediment. One sample (ON-29) was taken by dropping a Phleger corer using the same core tube.

As with most core sampling of this type in very soft sediments the cores obtained were generally much shorter than the amount of actual sediment penetration. It is not known how much of the total penetration each core represents. For this report, the most conservative approach, that being the core length at analysis represents from the sediment surface to that depth will be taken. Supporting this approach to some extent is the apparent fact that compression of sediments did not occur within the core tube. If it did, one would expect turbid water above the core; it was always clear. However, sediment compression can occur below the core tube along with complete displacement, so that it is possible for the sampler to retrieve selective portions of the sediment column.

Cores of less than 6 inches in length were placed in glass pint jars. For all others, the core tube liners were sawed off at the top of the core and capped on both ends. No special preservation techniques were



LOCALITY MAP
ONONDAGA LAKE
SEDIMENT MERCURY SAMPLES

FIGURE 3

used other than natural chilling in the near or below freezing temperatures at the time of sampling.

The samples from Ninemile Creek were obtained by dipping a glass pint jar into the sediment just below water level. The samples were retained in the same jars.

All samples were returned to the NFIC-Cincinnati laboratory December 6, 1972, and locked in a freezer until the time of analysis in early January 1973. The frozen cores were sawed into selected sections just prior to analysis. The sections were thawed and mixed and aliquots taken therefrom.

The sampling was conducted from a NFIC-Cincinnati 23-foot boat by Robert Hartley and Julian Bell of NFIC-Cincinnati and Lewis Rawson of the EPA Region II Rochester Field Office. A field description notebook was maintained. Locations were estimated by dead reckoning, rangefinder, landmarks, and water depth.

The mercury analyses were made at NFIC-Cincinnati by the flameless atomic absorption method under the supervision of Donald Sanning by Mr. Sanning, Edward Glick and Mark Millson. Analyses were completed by January 15, 1973. Responsibilities are documented on bench cards and in laboratory notebooks.

Analyses were made, as indicated above, on core segments, and presented as mercury concentrations in milligrams per kilogram (mg/kg) on both a wet and dry weight basis. Percent moisture by weight was also measured. The concentrations, in dry weight, were plotted as midpoints of the core sections and connected in order to interpolate the concentration

at any particular depth within the sediment. From these interpolated data, cross-sections and isoplethic charts of mercury concentration at various sediment depths were prepared. A planimeter was used on the charts to compute volumes of sediment. The amounts of mercury contained therein were then computed.

For the computations of amounts of mercury, a specific gravity of 2.0 for dry sediment was assumed and applied to laboratory-measured percentages of water and sediment (by weight). Varying the specific gravity between 1.5 and 2.5 will still give mercury weight values within 10 percent of those calculated.

Investigation Findings

The sediments of Onondaga Lake are characterized by unusually fine texture and variety of colors. The variety of colors alone is indicative of the predominance of other than natural sediment sources. Colors most often observed were black, gray, light gray, and white. Bright green was observed in a few samples. Photographs are available of all of the samples.

Black sediments, predominant in midlake, ordinarily had an oily odor which was stronger toward the southeast end of the lake. Likely sources of oil are the Crucible Steel Company northwest of the Allied Chemical plant, an oil storage complex along the barge canal at the upstream end of the lake, and the Syracuse sewage treatment plant near the southwest corner of the lake. Several firms in the oil storage area receive petroleum products by pipeline and the U. S. Coast Guard

reported that Hess Oil and Chemical Corporation and Mobile Oil Corporation receive No. 4 and No. 6 oil by barge at the Syracuse terminal but in much lower volumes than in past years.

The white sediments frequently found in the lake are probably not of natural origin. They appear to be derived from the Allied Chemical plant since they are found most often not far from their discharges. Very light gray sediments may be derived from the same sources. Those found along the northeast side of the lake may be from shore fill obtained from the Allied Chemical waste beds.

In the Onondaga Lake Study report previously cited, the oily nature of the black sediments was attributed to "organic decomposition occurring at the sediment-water interface." The same report states that "a common name for the white sediments is lime mud or marl" and they "were composed of primarily the mineral calcite." In the report it is further stated that the significant component of all the lake sediments is calcite "precipitated directly from solution in the lake."

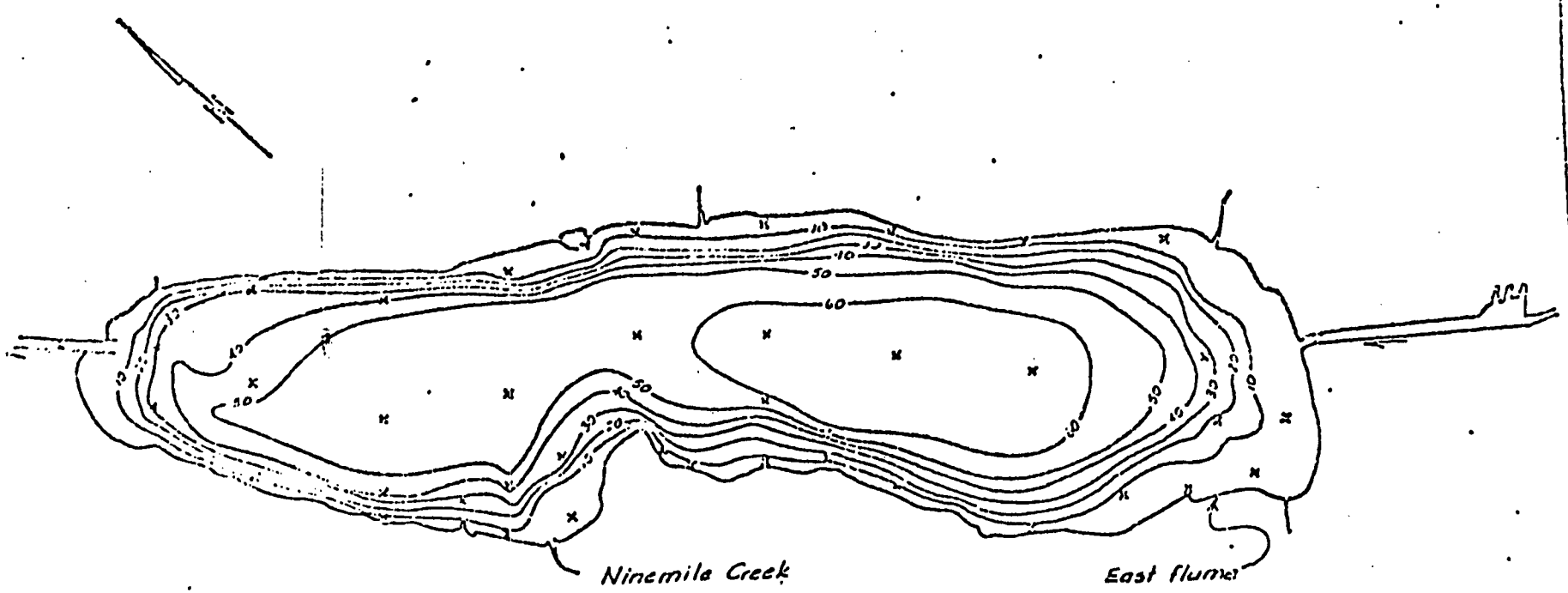
The gray color predominant in many samples in the northwest half of the lake is the most "natural" looking of any of the sediments and may in fact be largely composed of marl.

Sand is very scarce in Onondaga Lake suggesting that it is not abundant in the drainage area. Nearly all sediments are soft, smooth, and clay-like for considerable depths. The bottom of these "muds" was not reached in midlake with penetrations up to 15 feet.

The bottom topography (Figure 4) of Onondaga Lake is simple and smooth, characteristic of a long period of sedimentation of very fine materials. The southeast half of the lake is slightly deeper than the northwest half. The point near the midpoint of the southwest shore may in part be artificial, derived from the building up of waste materials from the Allied Chemical operations. Much of the shore around the northwest half of the lake appears to be eroding while it is artificially protected or maintained around the more heavily populated southeast half.

It is stated in an unpublished report of the EPA Rochester Field Office entitled, "Report of Mercury in Sediments in the Niagara River, Lake Ontario, and St. Lawrence River," (1/1/71) that the net circulation of Onondaga Lake is counterclockwise. One would expect this to appear in sediment data and it does, as discussed later.

Field descriptions of all samples are presented in Table 4, with the sampling locations shown in Figure 3. Analytical results for mercury and moisture content are listed in Table 5, which also indicates the segments into which the cores were cut for analyses. The total lengths of cores indicated in Table 4 are generally greater than indicated in Table 5, the difference being attributed to settling prior to freezing. However, three cores (ON-22, ON-25, and ON-43) were longer at the time of analysis, attributable to freezing expansion of more compacted materials. These three samples all contained white and/or light gray clay.



Contour Interval 10 feet.

x – sediment sample location

MILES

1 1/2 0 1

ONONDAGA LAKE

BOTTOM TOPOGRAPHY

adapted from "Onondaga Lake Study" by Onondaga County

TABLE 4
ONONDAGA LAKE SEDIMENT MERCURY SAMPLES
DECEMBER 1972

tion	Date	Time	Water Depth (ft.)	Core Length (in.)	Field Description
-1	12/1/72	1125	18	24	medium soft light gray smooth clay (3888)
-2	"	1140	32	14	2" black grading to light gray at bottom clay (3899)
-3	"	1215	33	19	soft clay; 10" black on 9" gray
-4	"	1245	9	24	very light gray clay, gritty on top (4500)
-5	12/2/72	0900	49	23	black oily soft clay, some gray (4801) 6' pen.
-6	"	0915	32	23	soft clay, black on [illegible]ck (4802) 5' pen.
-7	"	0930	42	22	soft black clay,
-8	"	0945	60	20	black, soft; oil
-9	"	1000	44	20	black, soft, some gray,
-10	"	1020	4	3	fine sand on white gritty mate. jar sample
-11	"	1045	32	22	soft black over gray clay
-12	"	1100	5	3	same as ON-10, jar sample
-13	"	1115	5	22	1" sand and gravel over soft white material
-14	"	1135	43	42	soft black and gray clay, brown at bottom, 6' pen. (4803)
-15	"	1150	36	61	soft black clay, some gray, 15' pen. (4804)
-16	"	1215	2	34	soft light gray clay, tan on top, 15' pen.
-17	"	1235	5	3	fine sand, 1' pen., jar sample
-18	"	1300	60	21	black, soft, oily, H_2S odor, 10' pen.
-19	"	1320	9	20	1" sand on soft white clay-like material

TABLE 4 (Continued)
ONONDAGA LAKE SEDIMENT MERCURY SAMPLES
DECEMBER 1972

Station	Date	Time	Water Depth (ft.)	Core Length (in.)	Field Description
ON-20	12/2/72	1330	9	20	same as ON-19
ON-21	"	1350	60	20	black oily mud, 10' pen.
ON-22	"	1455	7	35	green sand on light gray on dark sand on clay; 10' pen., turned copper purple
ON-23	"	1515	10	45	2" fine gray sand on soft brown silt, 7' pen.
ON-24	"	1545	60	27	24" black on 3" brown clay, 5' pen.
ON-25	"	1600	8	15	7" dark gray sand on 1" green sand on 7" white clay, 4' pen. to hard material
ON-26	"	1615	17	27	12" black on 15" white, 5' pen. to refusal
ON-27	"	1630	52	27	12" black on 2" green on 2" white on 11" black
ON-28	12/3/72	0820	6	3	fine sand, H_2S odor, 1' pen., jar sample
ON-29	"	0850	60	16	black oil mud
ON-30	"	0915	8	24	light gray soft clay, top 3" sandy
ON-31	"	0945	70	26	22" black oily mud on 4" gray clay
ON-32	"	1000	6	3	gray medium sand, 1' pen., jar sample
ON-33	"	1015	65	24	18" black oily mud on 6" gray clay, 5' pen.
ON-34	"	1040	6	3	sand and light gray gritty material, jar sample
ON-35	"	1100	35	29	black oily mud, 12' pen.
ON-36	"	1115	18	12	black oily mud, 1' pen.
ON-37	"	1130	6	16	black mud, 10" pen. to hard material
ON-38	"	1145	20	27	black oily mud, 10' pen.
ON-39	"	1200	5	23	2" sand on gray clay grading to white, 2' pen.

TABLE 4 (Continued)
ONONDAGA LAKE SEDIMENT MERCURY SAMPLES
DECEMBER 1972

Station	Date	Time	Water Depth (ft.)	Core Length (in.)	Field Description
ON-40	12/3/72	1210	3.5	3	white hard material and sand, jar sample
ON-41	"	1240	12	28	24" black oily mud on 4" white clay, 3' pen.
ON-42	"	1245	5	14	1" sand and gravel on 13" white clay, 2' pen.
ON-43	"	1300	13	23	3" green on 20" white material
ON-44	"	1445	1	--	grab sample light tan silt, Ninemile Creek just upstream from State Fair Blvd. bridge
ON-45	"	1515	1	--	grab sample brown clay, just downstream from bridge on Van Buron Rd. on Ninemile Creek

Note: Numbers in parentheses indicate earlier sampling stations -- July 1970)

TABLE 5
ANALYSES OF ONONDAGA LAKE SEDIMENT SAMPLES
DECEMBER 1-3, 1972

Sample No.	Depth (in.)	Hg mg/kg wet	Hg mg/kg dry	% moisture by wt.	Volatile Solids mg/kg dry
[illegible]-1a	0-6	< 0.1	< 0.1	42.9	31,800
[illegible]-1b	6-12	< 0.1	< 0.1	37.1	23,000
[illegible]-1c	12-22	< 0.1	< 0.1	37.5	35,700
[illegible]-2a	0-6	1.2	4.1	70.7	122,000
[illegible]-2b	6-12	< 0.1	< 0.1	55.2	106,000
[illegible]-3a	0-8	1.4	3.3	57.1	59,200
[illegible]-3b	8-17	0.2	0.4	52.8	92,700
[illegible]-4a	0-6	0.3	0.6	50.1	28,800
[illegible]-4b	6-12	< 0.1	< 0.1	48.8	29,400
[illegible]-4c	12-23	< 0.1	< 0.1	47.6	28,400
[illegible]-5a	0-6	1.6	9.0	82.2	134,000
[illegible]-5b	6-12	0.3	0.8	60.4	102,000
[illegible]-5c	12-19	< 0.1	< 0.1	57.1	134,000
[illegible]-6a	0-6	0.7	2.0	65.2	81,000
[illegible]-6b	6-17	1.1	1.9	41.8	31,000
[illegible]-6c	17-21	1.8	3.4	46.3	101,000
[illegible]-7a	0-6	1.0	3.6	72.5	100,000
[illegible]-7b	6-12	0.4	0.9	55.7	97,400
[illegible]-7c	12-18	< 0.1	< 0.1	53.1	110,000
[illegible]-8a	0-6	1.2	6.1	80.4	135,000
[illegible]-8b	6-12	0.6	1.6	62.2	189,000
[illegible]-8c	12-17	0.2	0.5	60.7	136,000
[illegible]-9a	0-5	2.6	12.1	78.5	
[illegible]-9b	5-10	1.4	3.9	64.4	176,000
[illegible]-9c	10-16	0.5	1.2	59.0	209,000
[illegible]-10	jar sample	12.6	23.6	46.4	42,100
[illegible]-11a	0-6	3.8	13.4	71.6	129,000
[illegible]-11b	6-12	1.0	2.2	54.7	92,500
[illegible]-11c	12-19	0.1	0.2	49.9	120,000
[illegible]-12	jar sample	0.5	0.9	42.6	34,600
[illegible]-13a	0-6	0.1	0.2	44.0	33,400
[illegible]-13b	6-12	< 0.1	< 0.1	42.7	33,100

TABLE 5 (Continued)
ANALYSES OF ONONDAGA LAKE SEDIMENT SAMPLES
DECEMBER 1-3, 1972

Sample No.	Depth (in.)	Hg mg/kg wet	Hg mg/kg dry	% moisture by wt.	Volatile Solids mg/kg dry
M-14a	0-6	7.7	22.9	66.3	63,000
M-14b	6-18	15.9	35.6	55.4	63,000
M-14c	18-30	1.0	2.0	50.4	74,600
M-14d	30-36	0.9	1.7	48.0	100,000
M-15a	0-6	1.0	3.6	72.0	136,000
M-15b	6-12	4.4	8.4	48.0	63,400
M-15c	12-18	3.2	6.4	50.2	65,900
M-15d	18-24	3.2	6.3	49.5	88,600
M-15e	24-30	14.8	28.4	47.9	55,800
M-15f	30-36	47.5	88.8	46.6	53,300
M-15g	36-42	9.0	18.8	52.2	67,900
M-15h	42-48	5.5	11.0	50.2	54,900
M-15i	48-55	6.1	12.9	52.7	68,300
M-16a	0-6	1.7	4.4	61.1	85,800
M-16b	6-12	5.0	9.4	46.7	51,200
M-16c	12-21	22.4	39.0	42.5	52,600
M-16d	21-30	14.2	24.7	42.7	46,300
M-17	jar sample	0.5	0.7	30.4	23,200
M-18a	0-6	3.4	16.5	79.4	137,000
M-18b	6-12	0.4	1.0	61.2	102,000
M-18c	12-19	1.3	3.0	57.2	175,000
M-19a	0-6	0.2	0.4	42.8	34,000
M-19b	6-12	0.4	0.8	51.6	38,100
M-19c	12-21	0.2	0.4	46.1	38,000
M-20a	0-6	<0.1	<0.1	42.7	32,200
M-20b	6-12	4.8	9.5	49.3	56,800
M-20c	12-21	1.9	3.9	50.8	30,000
M-21a	0-6	1.0	6.9	85.6	138,000
M-21b	6-12	1.4	3.5	60.3	95,400
M-21c	12-19	<0.1	<0.1	62.4	132,000
M-22a	0-6	<0.1	<0.1	58.0	91,000
M-22b	6-12	3.8	9.0	57.8	102,000
M-22c	12-18	0.3	0.7	56.8	100,000
M-22d	18-26	0.3	0.8	62.1	102,000
M-22e	26-36	<0.1	<0.1	68.9	93,900

TABLE 5 (Continued)
ANALYSES OF ONONDAGA LAKE SEDIMENT SAMPLES
DECEMBER 1-3, 1972

Sample No.	Depth (in.)	Hg mg/kg wet	Hg mg/kg dry	% moisture by wt.	Volatile Solids mg/kg dry
[illegible]-23a	0-6	0.4	0.7	43.1	46,400
[illegible]-23b	6-12	<0.1	<0.1	47.1	61,600
[illegible]-23c	12-18	6.7	13.7	51.3	77,700
[illegible]-23d	18-30	<0.1	<0.1	44.5	63,700
[illegible]-23e	30-40	0.7	1.2	44.1	72,500
[illegible]-24a	0-6	3.8	24.4	84.4	140,000
[illegible]-24b	6-12	0.4	1.0	61.8	105,000
[illegible]-24c	12-18	0.3	0.8	64.8	134,000
[illegible]-24d	18-26	0.4	0.9	56.6	126,000
[illegible]-25a	0-5	0.8	1.3	39.4	40,500
[illegible]-25b	5-8	<0.1	<0.1	59.5	62,000
[illegible]-25c	8-16	0.3	0.8	72.3	158,000
[illegible]-26a	0-6	1.6	3.3	51.8	134,000
[illegible]-26b	6-11	0.4	0.8	51.0	90,100
[illegible]-26c	11-18	0.1	0.3	69.3	90,700
[illegible]-26d	18-26	<0.1	<0.1	65.4	86,900
[illegible]-27a	0-6	2.6	11.6	77.6	120,000
[illegible]-27b	6-10	0.6	1.6	61.7	92,000
[illegible]-27c	10-16	0.5	1.4	65.3	96,200
[illegible]-27d	16-26	0.2	0.4	52.3	140,000
[illegible]-28	jar sample	1.1	2.0	44.7	36,100
[illegible]-29a	0-7	2.2	8.3	73.4	148,000
[illegible]-29b	7-14	0.2	0.5	61.3	120,000
[illegible]-30a	0-6	0.7	1.3	47.3	29,200
[illegible]-30b	6-12	<0.1	<0.1	50.3	
[illegible]-30c	12-18	0.6	1.2	48.4	45,800
[illegible]-30d	18-23	<0.1	<0.1	52.6	33,700
[illegible]-31a	0-6	2.6	12.0	78.4	140,000
[illegible]-31b	6-12	2.8	18.2	84.6	188,000
[illegible]-31c	12-18	<0.1	<0.1	78.9	113,000
[illegible]-31d	18-24	<0.1	<0.1	60.4	586,000
[illegible]-32	jar sample	0.1	0.2	48.0	27,100
[illegible]-33a	0-6	1.1	4.2	73.8	159,000
[illegible]-33b	6-12	0.3	0.8	61.4	112,000
[illegible]-33c	12-22	0.1	0.2	58.9	130,000

TABLE 5 (Continued)
ANALYSES OF ONONDAGA LAKE SEDIMENT SAMPLES
DECEMBER 1-3, 1972

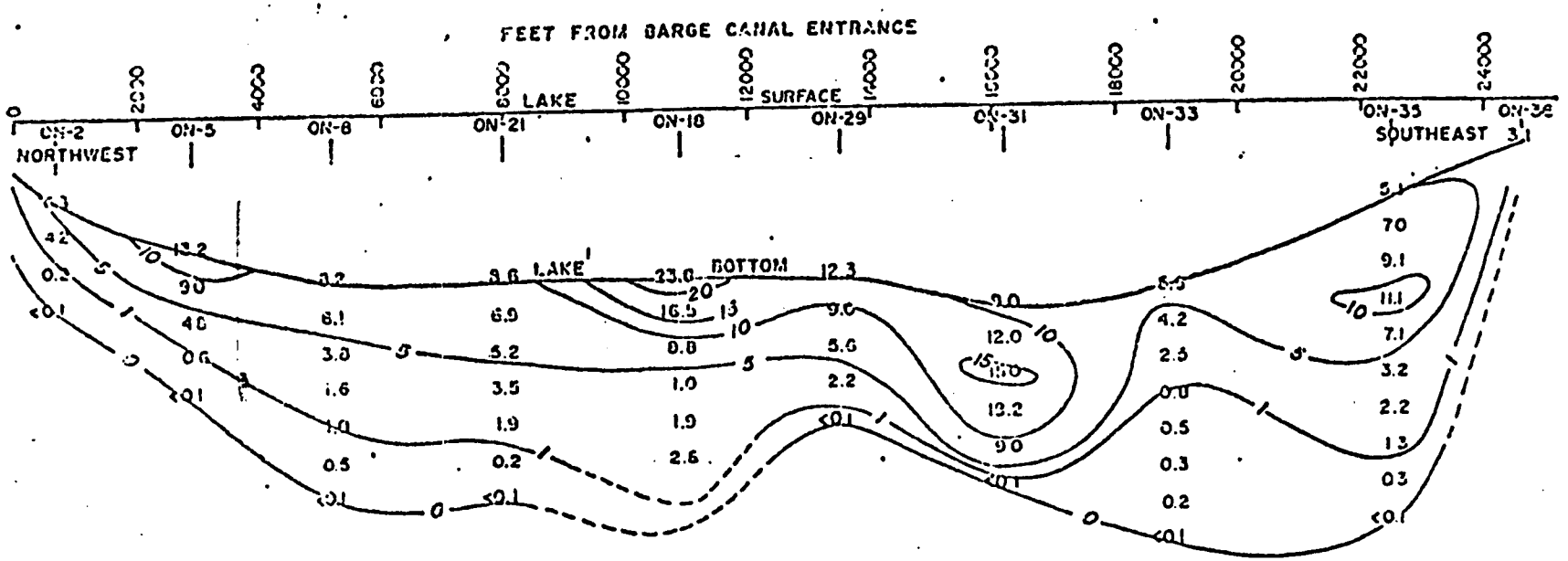
Sample No.	Depth (in.)	Hg mg/kg wet	Hg mg/kg dry	% moisture by wt.	Volatile Solids mg/kg dry
ON-34	jar sample	0.3	0.5	44.8	28,000
ON-35a	0-6	2.2	7.0	68.8	156,000
ON-35b	6-12	4.3	11.1	61.2	144,000
ON-35c	12-18	1.4	3.2	55.5	124,000
ON-35d	18-26	0.5	1.0	50.3	116,000
ON-36	0-10	1.6	3.1	48.7	138,000
ON-37a	0-7	4.6	11.2	58.9	89,300
ON-37b	7-15	0.6	0.8	27.4	64,600
ON-38a	0-6	2.4	8.1	70.3	155,000
ON-38b	6-12	13.3	31.8	58.2	144,000
ON-38c	12-18	1.5	3.1	52.1	107,000
ON-38d	18-24	0.5	1.0	49.3	121,000
ON-39a	0-6	13.5	29.2	53.6	70,900
ON-39b	6-12	2.7	6.3	57.5	83,600
ON-39c	12-22	3.9	10.4	62.4	75,700
ON-40	jar sample	0.7	1.2	39.6	165,000
ON-41a	0-6	4.1	12.6	67.4	159,000
ON-41b	6-12	5.4	12.3	56.2	122,000
ON-41c	12-20	6.1	13.4	54.4	90,000
ON-41d	20-26	0.3	0.6	50.3	73,000
ON-42a	0-7	<0.1	<0.1	45.2	34,800
ON-42b	7-14	<0.1	<0.1	42.4	31,600
ON-43a	0-6	0.1	0.4	75.3	123,000
ON-43b	6-18	0.3	1.2	75.0	117,000
ON-43c	18-24	0.1	0.4	73.2	116,000
ON-44	jar sample	2.0	4.2	52.6	51,700
ON-45	jar sample	0.3	0.5	42.0	42,800

Distribution of Mercury in Sediments

The mercury content of Onondaga Lake sediments decreases with depth within the sediment. Assuming, as discussed earlier, that the core lengths represent the actual sampled sediment thickness, most of the mercury is contained well within the top 2 feet of sediment. A cross-section through the sample points nearest the long axis of Onondaga Lake is shown in Figure 5. The cross-section gives a general picture of the vertical distribution of mercury in midlake. It shows a general decrease in mercury with depth to a concentration of less than 0.1 mg/kg. It can be assumed that the natural background is less than 0.1 mg/kg and that anything greater is not from natural sources.

Figures 6 through 15 show interpolated mercury isopleths, areally, within the sediment at 3-inch intervals down to a sediment depth of 27 inches. Below the 27-inch level, measurable mercury occurs only in the vicinity of the Ninemile Creek outlet. In that area, mercury-contaminated sediments reach a thickness of 4 feet or more (core sample ON-15).

The mercury discharge from the Allied Chemical chlor-alkali plant was reduced in 1970 by more than 97 percent. It might be expected that the reduction would appear in the sediment mercury distribution. However, the amount of sedimentation since that time must have been small and the reduction would not necessarily be shown by the analyses of 6-inch core segments. There is some indication off Ninemile Creek of decreasing mercury concentration toward the surface which may be attributable to discharge reduction. Otherwise, it appears that lateral spreading is



ONONDAGA LAKE LONGITUDINAL CROSS SECTION – MERCURY CONCENTRATIONS

CONCENTRATIONS IN MG/KG DRY WEIGHT. CONCENTRATIONS AT SAMPLE STATIONS INTERPOLATED FROM CORE SEGMENT ANALYSES.

SCALES: HORIZONTAL GIVEN ABOVE

VERTICAL WATER	SEDIMENT
0'	0"
20'	5"
40'	10"

FIGURE 5

actually still increasing the near-surface concentrations throughout most of the lake, with an overall trend toward uniformity. Spreading of the weakly consolidated fine sediments is likely easily accomplished by wave and current activity.

Figures 6 through 15 make it fairly obvious that the prime mercury sources have been the discharges of the Allied Chemical plant via Ninemile Creek and the "East Flume" at the principal plant site at the southwest corner of the lake. High concentrations are persistent in these areas. The largest source appears to be Ninemile Creek. High mercury content in midlake east of the headland on the southwest shore is indicative of transport by lake currents primarily from the Ninemile Creek source area. It also can be interpreted as indicative of the counterclockwise net flow noted earlier.

Table 6 is a compilation, derived from Figures 6 through 15, of sediment volumes and mercury concentrations therein between various levels. Table 7 is a compilation of calculated mercury content in pounds between the same levels. The total estimated mercury content in the lake sediments is about 29,000 pounds. Approximately 40 percent of this quantity is within the upper 6 inches of sediment, 80 percent within the upper 15 inches, and more than 95 percent within the upper 24 inches. Well over one-half of the mercury is contained in sediments with less than 10 mg/kg concentration.

Table 8 summarizes the total volumes of sediment with mercury concentrations greater than specified levels. The table could be used for estimating dredging requirements if it were desired that the

TABLE 6

VOLUMES OF ONONDAGA LAKE SEDIMENT CONTAINING SPECIFIED RANGES OF MERCURY CONCENTRATION

(volumes in millions of cubic feet)

Hg Concentration Range (mg/kg)	Sediment Depth Range in Inches						
	0-3	3-6	6-9	9-12	12-15	15-18	18-24
0-1	2.909	3.432	7.072	12.160	17.635	23.096	53.652
1-5	10.175	13.443	15.054	13.204	9.340	5.282	4.983
5-10	11.384	9.534	5.968	3.715	2.686	1.641	1.910
10-15	4.103	3.193	2.134	1.432	1.015	.807	.985
15-20	1.462	1.238	.865	.433	.239	.134	.478
20-25	.716	.388	.164	.239	.194	.134	.358
25-30	.328	.134	.090	.104	.134	.134	.208
30-35	.104		.015	.060	.104	.104	.090
35-40	.075			.015	.015	.030	.060
40-45	.104						
45-50							
Sediment lbs/ft^3) at sp.gr. = 2.0	28	29.5	33	36	38	39	40

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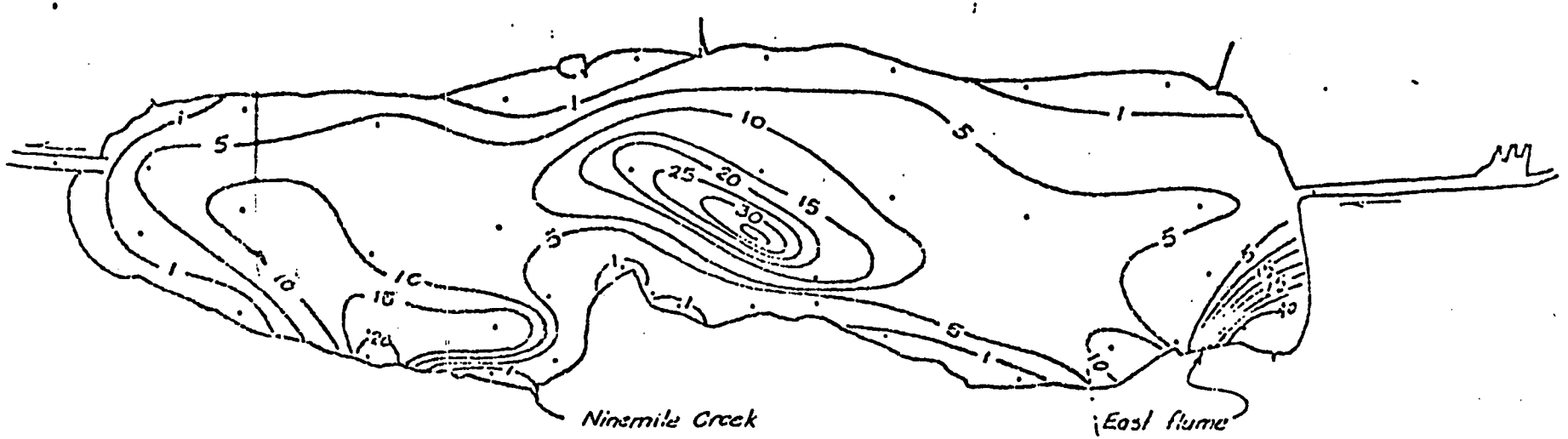
TABLE 7

POUNDS OF MERCURY CONTAINED WITHIN SPECIFIED DEPTH AND CONCENTRATION RANGES

Hg Concentration Range (mg/kg)	Sediment Depth Range in Inches							
	0-3	3-6	6-9	9-12	12-15	15-18	18-24	>24
0-1	8	10	23	44	67	90	215	
1-5	855	1,190	1,490	1,426	1,065	618	598	
5-10	2,390	2,109	1,477	1,002	765	480	573	
10-15	1,436	1,177	882	644	482	401	492	
15-20	716	639	499	273	159	92	335	
20-25	451	258	122	194	166	128	322	
25-30	253	109	82	103	113	144	229	
30-35	95		16	70	128	130	13	
35-40	79			20	21	44	9	
40-45	124							
45-50								
Totals	6,407	5,492	4,591	3,776	2,966	2,127	2,786	est. 1,000

TABLE 8
VOLUMES OF ONONDAGA LAKE SEDIMENT WITH MERCURY
CONCENTRATIONS ABOVE SPECIFIED LEVELS

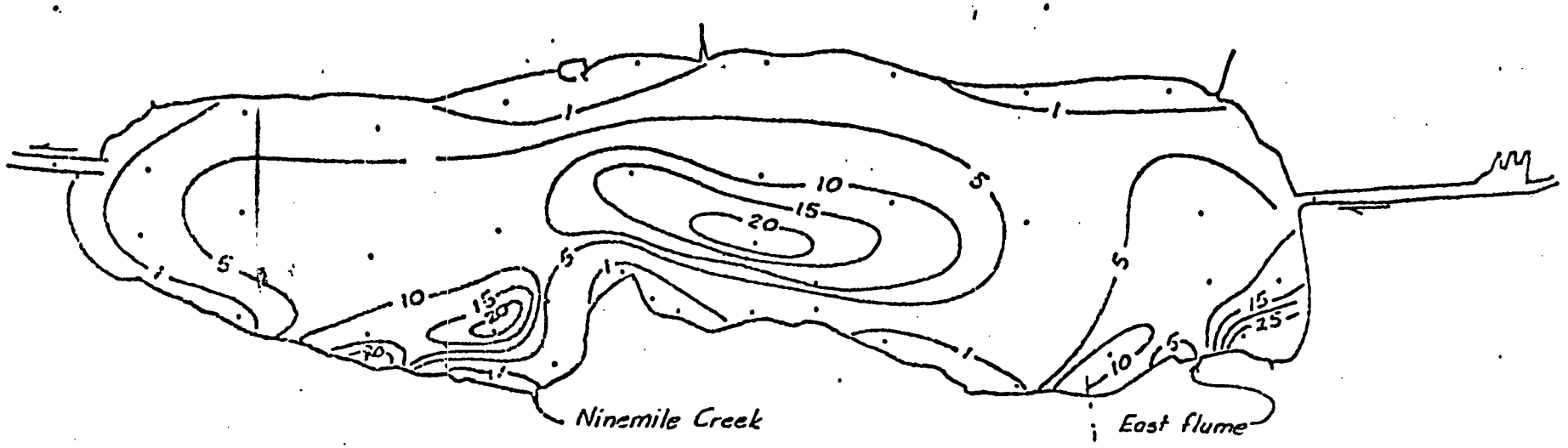
Mercury Concentration mg/kg dry	Cubic Feet	Cubic Yards
> 0.1		est. 7,000,000
> 1	130,938,000	4,850,000
> 5	59,457,000	2,202,000
>10	22,619,000	838,000
>15	8,950,000	331,000
>20	4,101,000	152,000
>25	1,908,000	71,000
>30	775,000	29,000
>35	284,000	11,000
>40	104,000	4,000



ONONDAGA LAKE

MERCURY IN MG/KG DRY WT.
AT SEDIMENT SURFACE
12/1-12/3/72

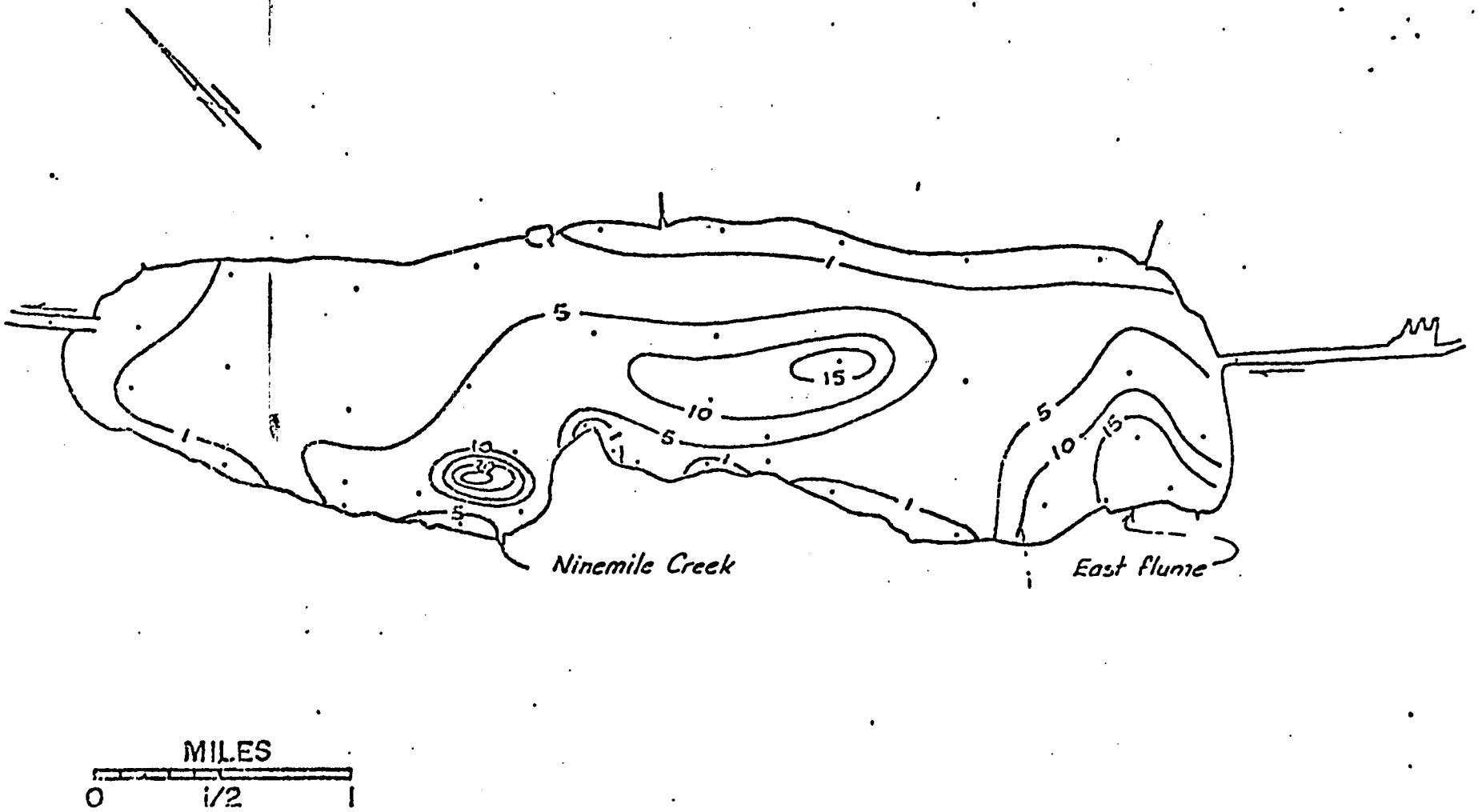
FIGURE 6



ONONDAGA LAKE

MERCURY IN MG/KG DRY WT.
AT 3 INCHES SEDIMENT DEPTH
12/1-12/3/72

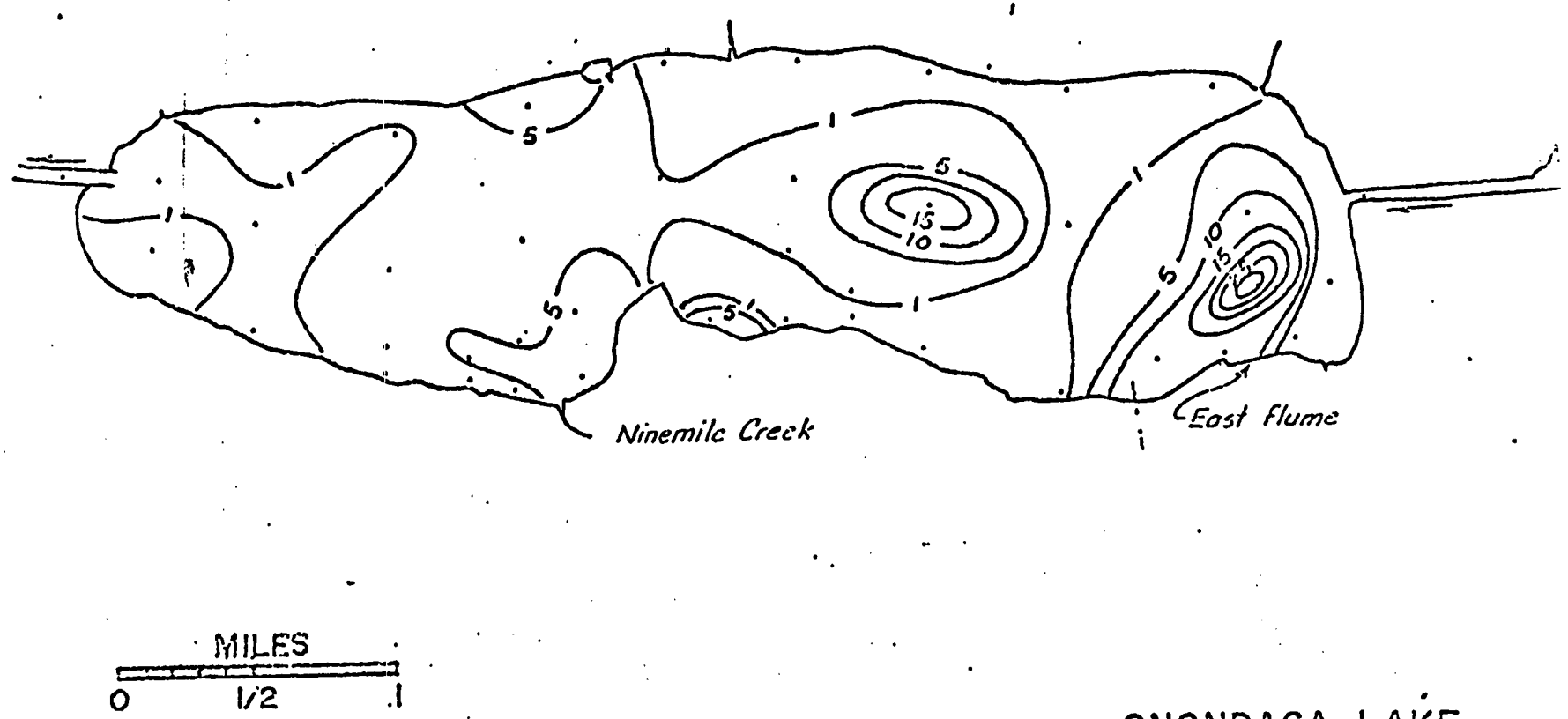
FIGURE 7



ONONDAGA LAKE

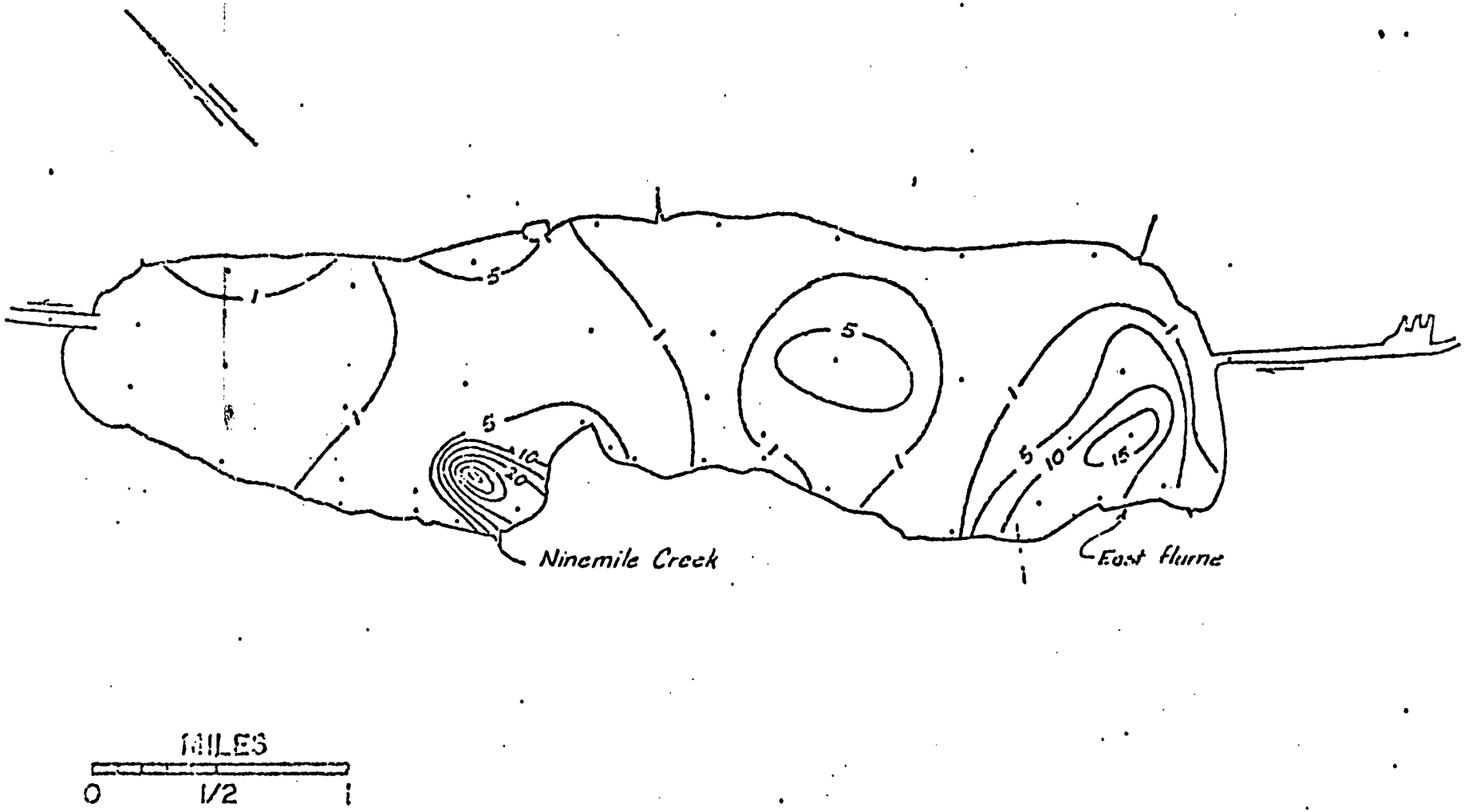
MERCURY IN MG/KG DRY WT.
AT 6 INCHES SEDIMENT DEPTH
12/1-12/3/72

FIGURE 8



ONONDAGA LAKE
MERCURY IN MG/KG DRY WT.
AT 9 INCHES SEDIMENT DEPTH
12/1-12/3/72

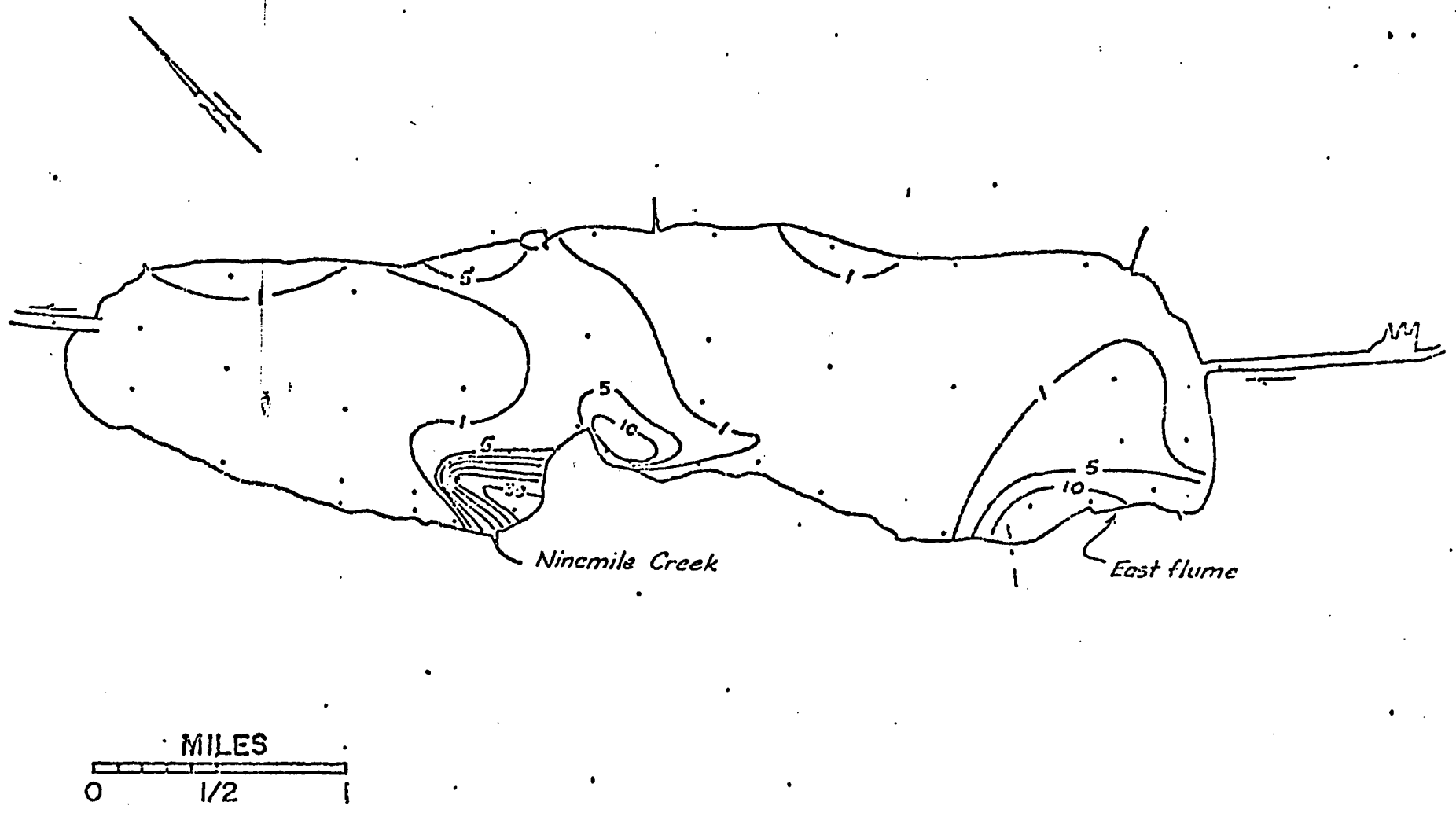
FIGURE 9



ONONDAGA LAKE

MERCURY IN MG/KG DRY WT.
AT 12 INCHES SEDIMENT DEPTH
12/1-12/3/72

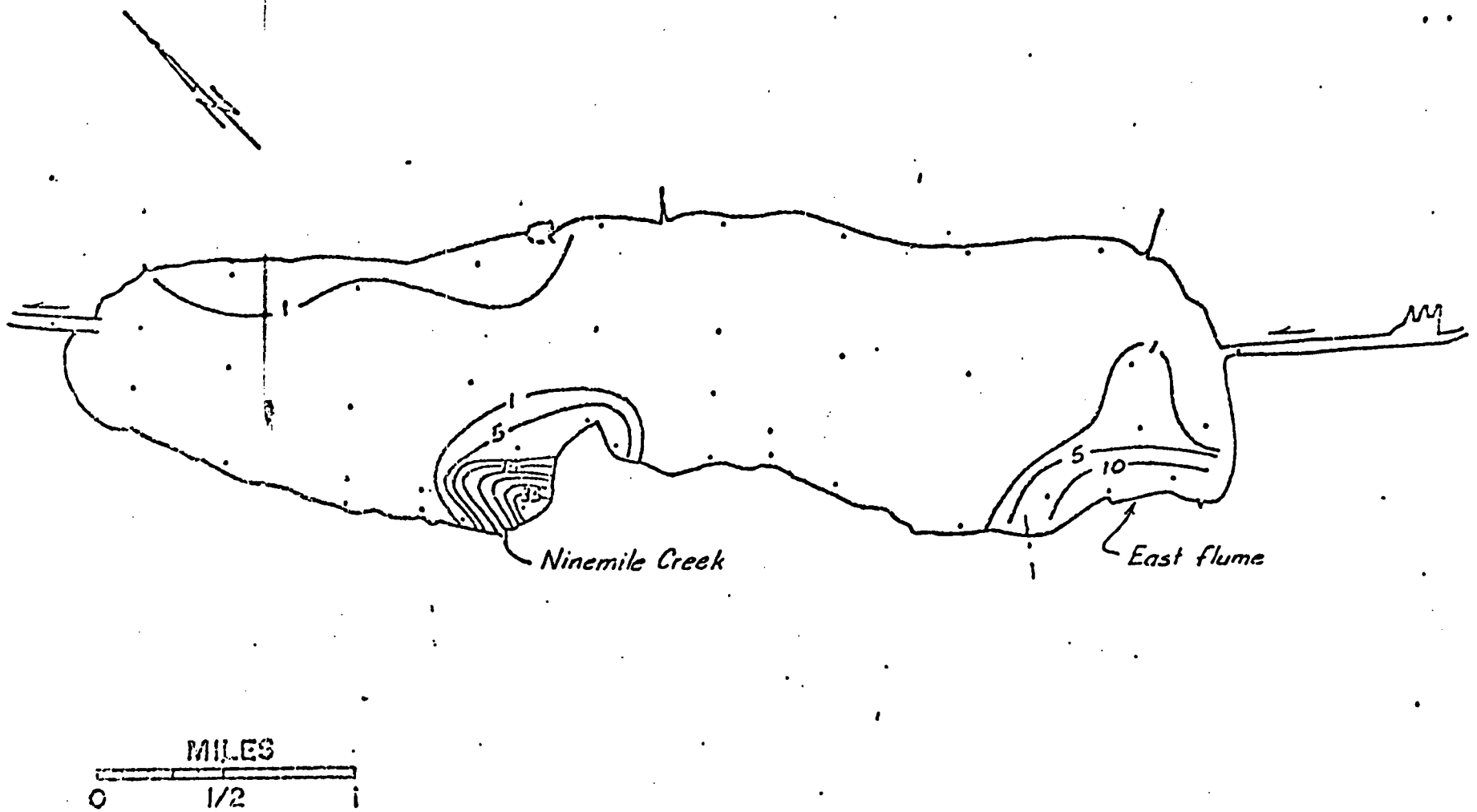
FIGURE 10



ONONDAGA LAKE

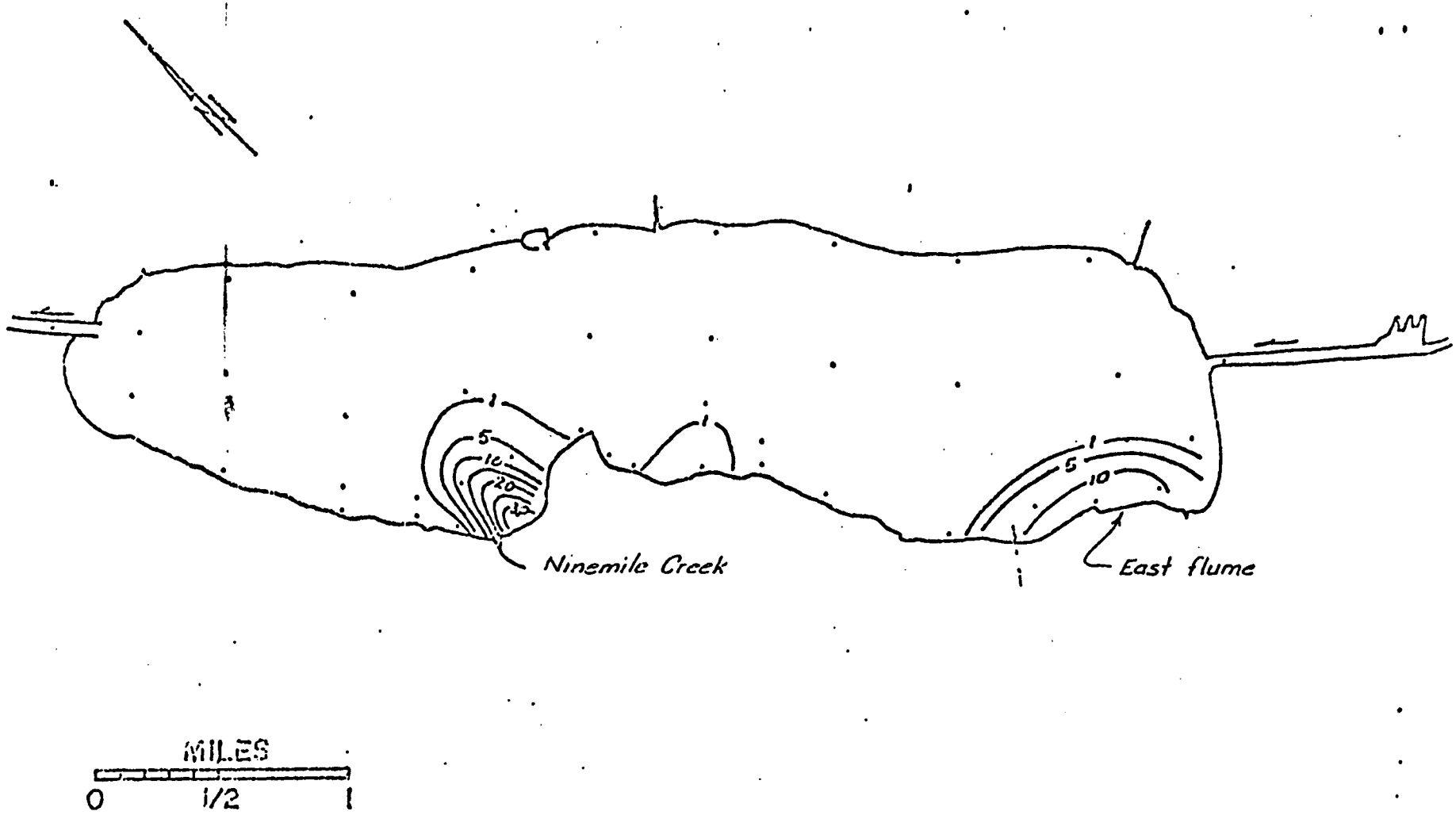
MERCURY IN MG/KG DRY WT.
AT 15 INCHES SEDIMENT DEPTH
12/1-12/3/72

FIGURE 11



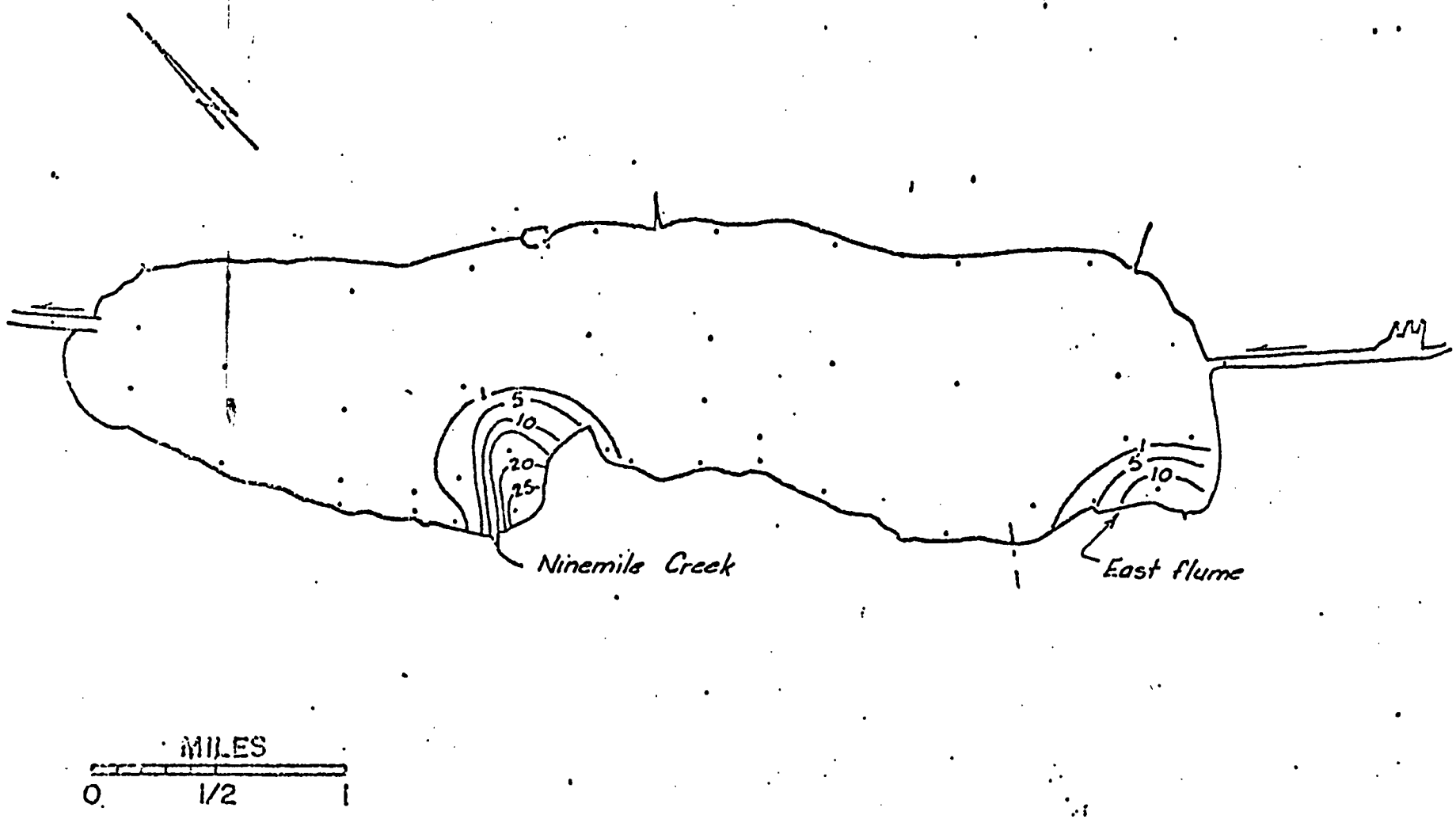
ONONDAGA LAKE
MERCURY IN MG/KG DRY WT.
AT 18 INCHES SEDIMENT DEPTH
12/1-12/3/72

FIGURE 12



ONONDAGA LAKE
MERCURY IN MG/KG DRY WT.
AT 21 INCHES SEDIMENT DEPTH
12/1-12/3/72

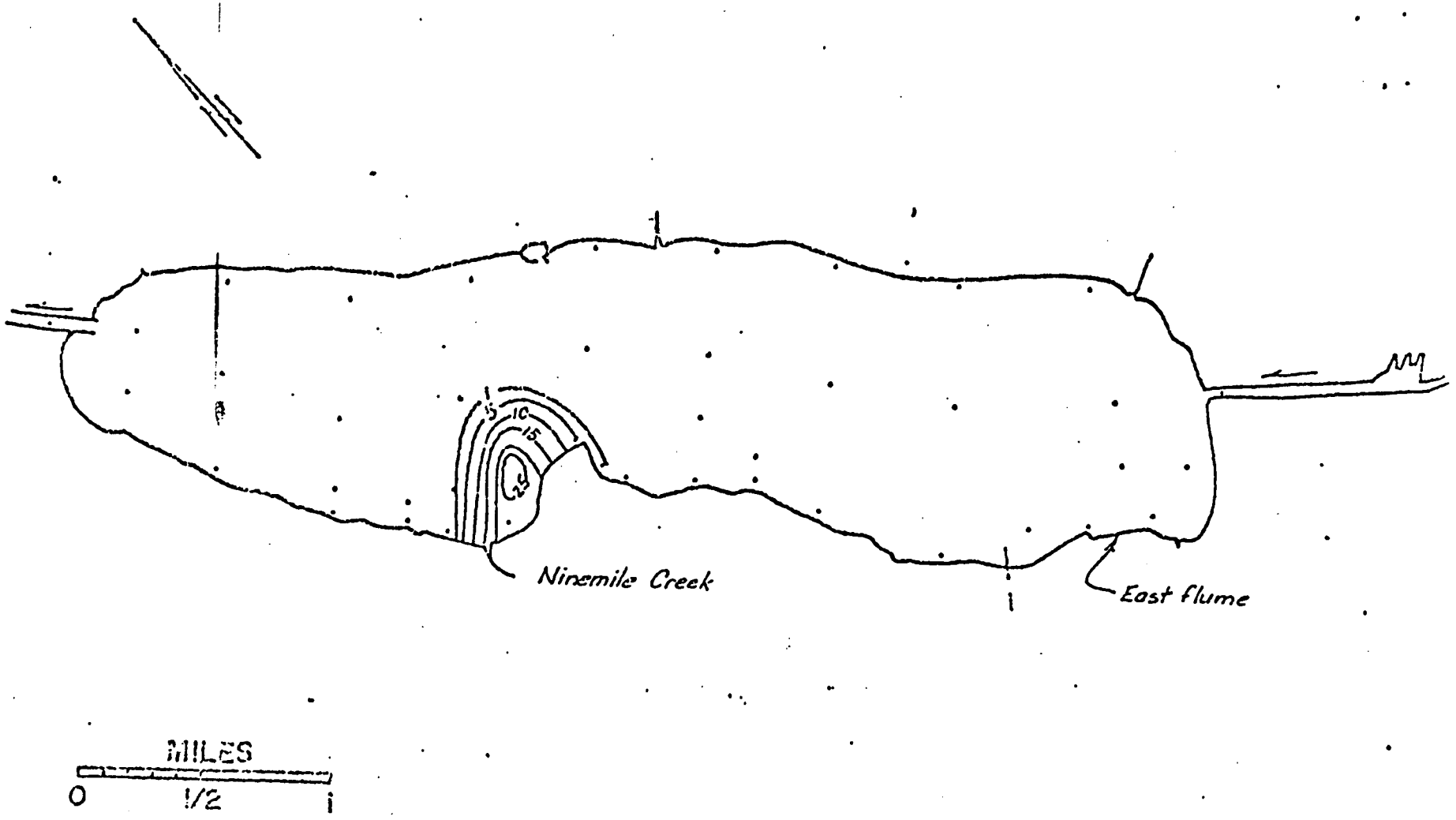
FIGURE 13



ONONDAGA LAKE

MERCURY IN MG/KG DRY WT.
AT 24 INCHES SEDIMENT DEPTH
12/1 - 12/3/72

FIGURE 14



ONONDAGA LAKE
MERCURY IN MG/KG DRY WT.
AT 27 INCHES SEDIMENT DEPTH
12/1-12/3/72

FIGURE 15

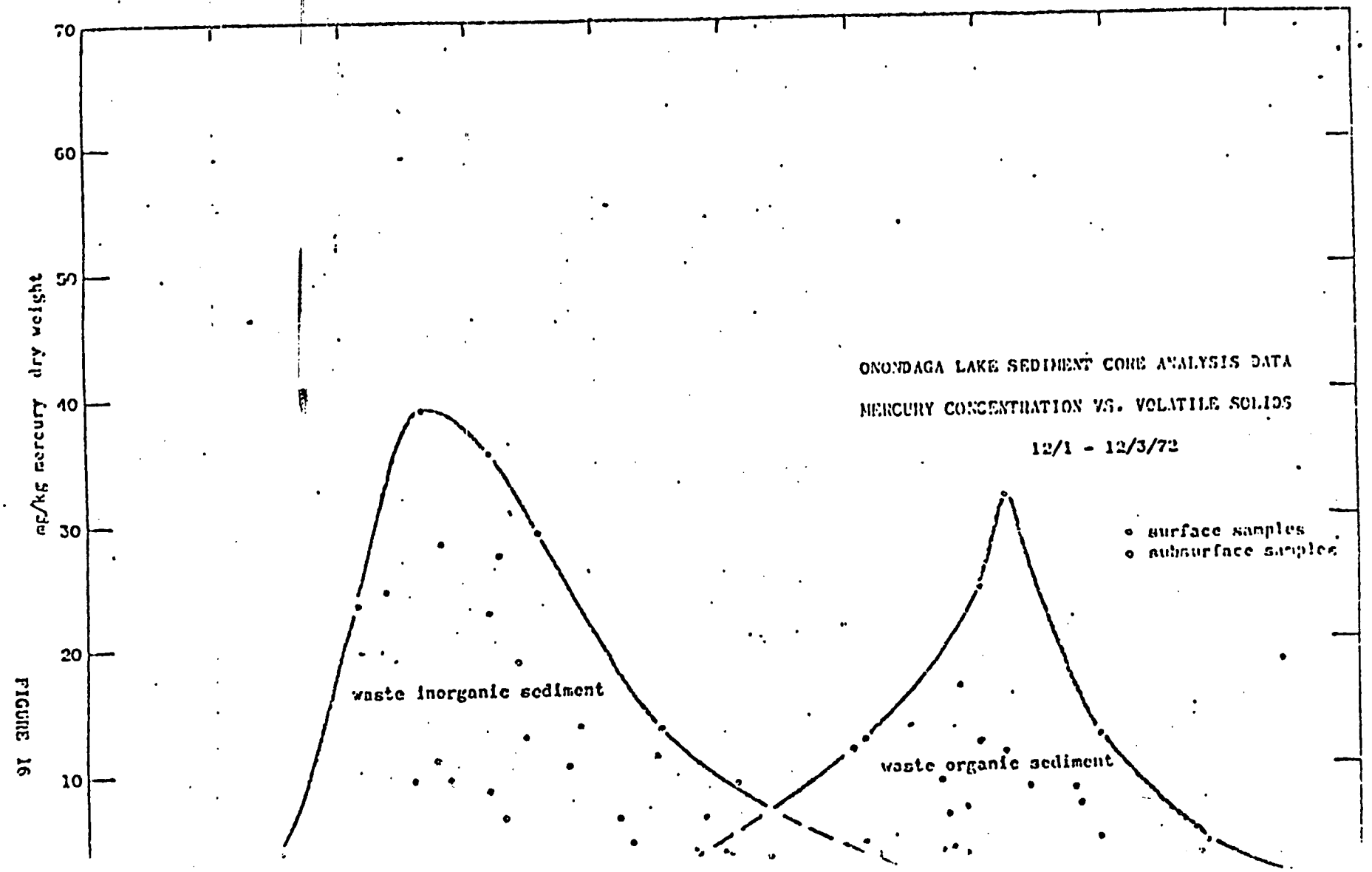

ONONDAGA LAKE SEDIMENT CORE ANALYSIS DATA
MERCURY CONCENTRATION VS. VOLATILE SOLIDS
12/1 - 12/3/72
• surface samples
o subsurface samples
waste inorganic sediment
waste organic sediment
mg/kg mercury dry weight
70
60
50
40
30
20
10

FIGURE 16

sediments contaminated above a specific level be removed from the lake. However, the volumes, if used for that purpose, are very conservative. It is estimated that at as much as 50 percent would have to be added to assure that dredging would accomplish the desired objective. It also must be considered that much of the volume is polluted by other materials from sources other than mercury-bearing wastes.

Volatile Solids vs. Mercury Concentration

Figure 16 is a plot of volatile solids vs. mercury concentration on a dry weight basis for the Onondaga Lake sediment samples. It was suspected that there might be a correlation of mercury with organic content.

There is no definite overall correlation trend between volatile solids and mercury content. However, the pattern exhibits some interesting characteristics. At a volatile solids concentration of less than 40 mg/g (parts per thousand), the mercury was always relatively low. Between about 40 and 80 mg/g the range of mercury concentrations was the broadest and the highest mercury values were found. Relatively low mercury values were again found between 100 and 120 mg/g volatile solids. At concentrations greater than 120 mg/g the range of mercury concentrations again broadened and then lessened again above 160 mg/kg.

Closer examination reveals that those samples containing more than 110 mg/g volatile solids were nearly all described as black or black oily mud or soft clay. These samples would, of course, be expected to be relatively high in organic or volatile content. It is also apparent that most of the higher mercury values (more than 4 mg/kg) in this higher range of volatile solids are in surface samples (top 6

With respect to sediment mercury distribution, it appears that the third system or redistribution is now dominant since the waste source of mercury has been reduced.

Comparison of Data with Earlier Surveys

Onondaga Lake sediments were grab sampled by Rochester Field Office personnel in July 1970 at 14 locations with a Ponar dredge. The analyses were performed by NFIC-Cincinnati and by the Field Office with reasonably comparable results. The data obtained then have been compared with data for the top 6 inches of cores taken during this survey. Table 9 lists the comparative data, using NFIC-C analyses.

The data in Table 9 show very large differences at essentially the same sampling stations. The mercury concentrations in the 1970 Ponar dredge samples are all much higher and average five times higher than the concentrations in the top 6 inches of the 1972 core samples. In contrast a few core samples taken by the Rochester Field Office in September 1970 and analyzed by NFIC-Cincinnati fit very closely with the present cores in mercury content (Table 10). The reason for the large difference between dredge samples and core samples is not apparent. It could be a difference in analytical method, non-comparative sampling, or a loss of mercury from the sediment.

Loss of mercury from sediments to such a degree in such a short time (discussed in next section) would also not be expected from current knowledge of release processes.

The comparable results of NFIC-C and the Rochester Field Office on the 1970 dredge samples suggest that if an error occurred, it is in

74 o F 86.

TABLE 9
COMPARISON OF 7/70 PONAR DREDGE SAMPLES AND 12/72 0-6" CORE SAMPLES
MERCURY ANALYSES - DRY WEIGHT

July 1970		December 1972	
NFO Station No.	Hg mg/kg	NFIC-C Station No.	Hg mg/kg
3988	1.0	ON-1	< 0.1
4800	40.1	ON-4	0.6
4801	15.1	ON-5	9.0
4802	11.4	ON-6	2.0
4803	53.8	ON-11	13.4
4804	42.6	ON-15	3.6
4805	122.9	ON-24	24.4
4806	45.0	ON-29	8.3
4807	33.3	ON-28	2.0
4808	39.2	ON-41	12.6
4809	11.3	ON-32	0.2
4810	107.3	ON-40	1.2
4811	25.5	ON-35	7.0
4812	50.3	ON-39	29.2
Avg.	42.8		8.1

TABLE 10
COMPARISON OF 9/70 CORE SAMPLES AND 12/72 CORE SAMPLES
MERCURY ANALYSES - DRY WEIGHT

September 1970			December 1972		
RFO Station Description	Depth inches	Hg mg/kg	Nearest Station No.	Depth inches	Hg mg/kg
Near northern end of lake	0	11.5	ON-5	0-6	9.0
	9	1.0		6-12	0.8
	18	0.5		12-19	<0.1
Near Ninemile Creek mouth	0	10.4	ON-11	0-6	13.4
	12	1.4		6-12	2.2
	24	<0.3		12-19	0.2
Center southerly part of lake	0	3.7	ON-33	0-6	4.2
	13.5	2.1		6-12	0.8
	27	1.5		12-22	0.2
Near Allied* former discharge (near Crucible Steel)	0	20.6	ON-43*	0-6	0.4
	13.5	2.8		6-18	1.2
	27	2.4		18-24	0.4

*Location about 0.2 mile apart.

the analyses of the 1972 samples. The NFIC-C laboratory analyzed both the 1970 and 1972 samples under the same supervision. The extraction portion of the analytical method changed in the interim from wet digestion to combustion. Samples from other areas run by both methods had shown comparable results. Both the 1970 Ponar dredge samples and the 1972 core samples were analyzed again in May 1973. Most samples showed a slight loss of mercury since the earlier analyses. However the large differences between the 1970 and 1972 samples remained. No source of error has been found in either the 1970 or 1972 analyses.

The difference probably lies in differences in sampling or the way in which samples were handled. The 1972 data are from the top 6-inch segments of cores mixed before analysis. It is possible that only the surface inch or two was retained from the 1970 Ponar dredge samples and that most of the mercury was in that surface layer. Comparability of limited core data from both years supports attributing the differences to method of sampling but also suggests the possibility that the plastic core liner may have absorbed part of the mercury. To further complicate the situation, it is also possible that the sediments within the cores were inadvertently mixed in transit before they were frozen. Low sediment density strengthens this last possibility.

Comparison of Data with Plant Discharges

In a letter to the New York Department of Health from the Allied Chemical plant dated July 21, 1970, the company stated that prior to May 9, 1970, the mercury discharge to Geddes Brook (tributary to Ninemile Creek) averaged 22 pounds per day. The company installed its first mercury cell process in 1946 and a second in 1953. If the

22 lbs/day is applied as the total discharge since 1953 to 1970 (17 years), the total amount of water-wasted mercury would be about 135,000 pounds. If 11 lbs/day is added for the first seven years, the total then amounts to about 165,000 pounds discharged. *

The lake sediments, by taking the conservative approach (noted earlier) from the current survey data, account for only 29,000 pounds of mercury, less than 18 percent of the estimated amount discharged. Thus, a large amount of discharged mercury is unaccounted for. There are six possible explanations: (1) much of the mercury was not deposited in the sediments, (2) mercury has been lost to water and aquatic life leaving the lake, (3) too thin a sediment layer has been used for calculations, (4) error or incomplete recovery in sediment mercury analysis, (5) the estimate of plant discharge is too high, or (6) part of the sediments containing high mercury content have been removed by dredging.

If the unaccounted mercury were not deposited in the sediments and the loss were a uniform percentage over the period of discharge, the concentration in the lake outflow would have ranged from about 5 μg/l in the early years to more than 10 μg/l in the later years of plant operation. ~~Few if~~ any measurements were made on lake water samples during the time of significant discharge. Several have been made since mid-1970 and no values have been found above the reliable detection level of 1 μg/l in 1970 to 0.1 μg/l in 1972. It seems doubtful if mid-lake or outlet water concentrations have ever been

greater than 1 μg/l.

If the unaccounted mercury were deposited in sediments and then lost to the overlying water, the same levels of mercury (5-10 mg/l) would have been expected in the outlet waters over the years. Again, this is very doubtful.

Considerable losses to fish and aquatic life may have occurred but they would have to be removed from the lake to lower the mercury content. Assuming all fish to have one ppm mercury about 47 million pounds of fish per year would have to be removed. It is beyond reason to expect this to have occurred.

As noted earlier, the core samples were much shorter than the sediments penetrated, generally about 1/3 to 1/5 the total penetration. It is possible that the amount of mercury and the sediment volume in which it is contained is 3 to 5 times the amounts calculated herein. These in turn would be much more in line with the total mercury thought to have been discharged. However, this would also indicate 6 to 10 feet of sedimentation in 17 to 24 years. This would not seem probable, because of the lack of a known source for such a tremendous quantity of sedimentation.

Possible error in analysis has been discussed previously. Concentration ranges were confirmed by re-analysis of the 1970 and 1972 samples.

It is also possible that the estimate of the amount of mercury discharged by the Allied Chemical plant is too high. However, considering the lack of earlier concern about mercury discharges, it is likely that the amount is not greatly exaggerated.

Finally, part of the mercury discharges in the past and contained in the sediments was probably already removed by dredging. The lake outlet sediments have been dredged a number of times for barge canal navigation. The oil terminal area has also been dredged in the past. A delta near the mouth of Nineuile Creek was dredged in 1968 in a joint project by Allied and the county. The spoil was deposited in a low area just north of the Creek which is being developed for park purposes. It is doubtful if the lake outlet and terminal sediments ever contained significant amounts of mercury; therefore, this can be discounted. The dredged spoil used for park fill most likely did contain mercury and is the fate of part of the mercury discharged by Allied in the past. However, mercury contamination of lake sediments is quite widespread and only relatively small sections have been dredged in the last few years. It may be concluded that past dredging accounted for a small part of the mercury accumulated in the lake, but it would be difficult to even estimate the quantity so removed.

Mercury Concentrations in Fish

Data on concentrations of mercury in fish from Onondaga Lake are not extensive. Limited analyses by the Food and Drug Administration in 1970 showed high concentrations in fish flesh from the lake, significantly higher than from other waters in the region (Table 11). As a result Onondaga Lake fish were prohibited for human consumption.

The National Field Investigations Center- Cincinnati sampled fish in May 1973 in Onondaga Lake, Oneida Lake 15 miles to the northeast,

TABLE 11
MERCURY CONCENTRATIONS IN FISH

Location Caught	Date (1970)	Type	Mercury* Conc. in mg/kg
Onondaga Lake	5/5	White Perch	0.20
		Yellow Perch	2.48
		White Catfish	4.32
	5/28	Yellow Bullheads	2.64
		Sucker	0.80
		Sucker	1.08
	6/5	Yellow Perch	1.52
	7/6	Carp	2.96
		Bullheads	2.16
Lake Oneida	5/22	Bullheads	0.16
		Bass	0.37
		Carp	0.12
		Carp	0.18
	5/28	Carp	1.22
	6/5	Walleye Pike	0.38
		Ling	0.10
Oswego River (near mouth)	6/26	Sucker	0.49
		Shad	0.21
		Yellow Perch	0.45
		Perch	1.76
		White Perch	0.80

*Analyses by FDA, Buffalo, New York.

and Skaneateles Lake 15 miles south-southwest of Onondaga Lake. The sampling was done by Gerald Kaiser, Thomas Nalepa, and James Steinfeld, Biologists. Types, ages, sizes and flesh mercury concentrations of the fish caught are listed in Tables 12, 13 and 14.

The data in Table 12 show that mercury concentrations in Onondaga Lake fish flesh have apparently decreased since 1970 but are still very high, much higher than those from the other two lakes. Flesh from white perch, the fish caught in greatest numbers from Onondaga Lake, ranged from 0.3 to 4.0 mg/kg mercury with a median of 1.8 mg/kg. Carp ranged from 0.9 to 2.1 mg/kg with a median of 1.5 mg/kg and golden shiners ranged from 0.9 to 1.3 with a median of 1.1 mg/kg. Only 3 of a total of 47 fish showed concentrations below the FDA recommended limit for human consumption of 0.5 mg/kg. *

Comparison of the mercury content of the same species of fish from Onondaga Lake and Oneida Lake could not be made because sufficient numbers of the same species were not caught. Twenty of 26 fish caught in Oneida Lake were yellow perch, none of which were caught in Onondaga Lake.

The mercury concentrations in Oneida yellow perch flesh (Table 13) ranged from 0.2 to 0.5 mg/kg with a median of 0.4 mg/kg. Significantly, 3 of 20 yellow perch were at the FDA recommended limit. Two white perch were caught, one of which was above the limit. Only one walleye and one white sucker were caught. Both were above the limit. Although the mercury content of Oneida Lake fish is high enough to be of concern,

TABLE 12

Onondaga Lake
Mercury Analyses of Fish
May 1973

Species	Age	Length mm	Weight Grams	Sex	Hg in Flesh mg/kg wet wt.
Yellow Bullhead		276	231		0.5
Largemouth Bass	II	219	138		1.0
White Crappie	I	168	65	F	0.9
Walleye	III	408	676	F	0.6
White Bass	II	262	222	M	0.4
White Sucker	I	305	350	F	0.6
" "	I	315	385	M	0.4
" "	II	342	454	F	0.8
Northern Pike	II	352	261		0.8
" "	IV	710	2156		1.8
" "	V	840	2951		1.7
Carp	II	359	1135		0.9
"	III	356	726		1.2
"	III	360	1135		1.4
"	IV	423	1816		1.2
"	V	500	1930		2.0
"	V	503	2156		1.7
"	VI	500	3178		2.1
"	IX	610	3859		1.8
Colden Shiner	II	200	125	F	1.0
" "	II	202	98	F	1.1
" "	II	212	121	M	1.3
" "	II	216	108	F	1.1
" "	II	222	130	F	0.9
" "	II	226	115	M	1.0
" "	II	226	135	F	1.2
" "	II	227	135	F	1.2

TABLE 12 (cont.)

Onondaga Lake
Mercury Analyses of Fish
May 1973

Species	Age	Length mm	Weight Grams	Sex	Hg in Flesh mg/kg wet wt.
White Perch	II	202	169	F	0.3
" "	II	205	134	F	1.3
" "	II	205	142	M	2.3
" "	II	208	158	F	1.4
" "	II	220	190	M	1.1
" "	II	222	191	M	3.0
" "	II	239	240	F	1.5
" "	II	243	290	F	1.4
" "	II	244	242	M	1.7
" "	II	250	289	F	2.0
" "	II	250	295	M	4.0
" "	II	252	291	F	2.3
" "	II	254	284	F	2.2
" "	II	256	302	F	2.4
" "	II	256	338	F	2.3
" "	III	242	130	F	2.0
" "	III	248	269	F	1.2
" "	III	253	284	F	2.3
" "	III	255	272	F	2.5
" "	III	276	395	F	1.6

Table 13

Oneida Lake

Mercury Analyses of Fish

May 1973

Species	Age	Length mm	Weight grams	Sex	Hg in flesh mg/kg wet wt.
Walleye	I	340	390	M	0.7
White Sucker	II	390	908	F	0.5
White Perch	II	245	310	F	0.2
" "	II	280	460	F	0.7
Whitefish	I	280	460	F	0.2
"	III	345	768	F	0.4
Yellow Perch	III	240	205	M	0.4
" "	III	255	230	M	0.5
" "	III	260	260	M	0.4
" "	III	260	265	M	0.3
" "	III	265	260	M	0.4
" "	IV	230	200	M	0.2
" "	IV	230	210	M	0.5
" "	IV	240	200	M	0.5
" "	IV	250	240	M	0.4
" "	IV	250	255	M	0.4
" "	IV	255	255	M	0.3
" "	IV	255	265	M	0.3
" "	IV	260	255	M	0.4
" "	IV	260	265	M	0.3
" "	IV	260	280	M	0.4
" "	IV	265	275	M	0.4
" "	V	250	235	M	0.4
" "	V	260	260	M	0.4
" "	V	260	265	M	0.4
" "	V	260	280	M	0.4

Table 14

Shaneateles Lake

Mercury Analyses of Fish

May 1973

Species	Age	Length mm	Weight grams	Sex	Hg in flesh mg/kg wet wt.
Rock Bass	II	190	120		0.4
" "	III	185	145		0.3
Yellow Perch	II	250	210		0.2
" "	III	277	320		0.2
Chain Pickerel	II	300	160		0.2
" "	II	340	295		0.2
" "	II	346	245		0.3
" "	IV	446	116		0.3

it appears to be far below that of Onondaga Lake. This agrees with the 1970 FDA results.

Only eight fish were caught in Skaneateles Lake, 15 miles south-southwest of Onondaga Lake. Three species were represented, rock bass, yellow perch, and chain pickerel, none of which were found in Onondaga Lake. All of the Skaneateles fish were below the FDA recommended limit of 0.5 mg/kg mercury but all had measurable concentrations from 0.2 to 0.4 mg/kg.

The Skaneateles Lake fish probably show background levels of mercury with a median flesh concentration of 0.26 mg/kg. The Oneida Lake fish (all fish) showed an intermediate level with a median of 0.39 mg/kg. Onondaga Lake fish had far higher levels with a median of 1.55 mg/kg for all fish.

Fish data thus indicate a major source of mercury contamination in Onondaga Lake. Presumably that major source is the Allied Chemical Corporation, the only known significant discharger. Oneida Lake fish data also indicate a source, which may be airborne mercury, still from the Allied Chemical plant to the southwest. Skaneateles fish mercury concentrations are probably natural.

All the lakes drain to the Seneca-Oswego system. It is possible but not likely that ~~some~~ fish migrate between Oneida and Onondaga Lakes. It is even less likely that migration occurs between Skaneateles Lake and the other two lakes.

REFERENCE NO. 4

(1 of 10)

INDUSTRIAL CHEMICALS DIVISION

Allied Chemical Corporation

P. O. BOX 6 • SOLVAY, NEW YORK 13209 • AREA CODE 315 • 468-1611

RECEIVED
JUL 23 1970
N. Y. STATE DEPT. OF HEALTH
SYRACUSE REGIONAL OFFICE

July 21, 1970

Mr. William A. Hicks, P. E.
Regional Director of Public Health Engineering
State of New York
Department of Health
677 South Salina Street
Syracuse, New York 13202

Dear Mr. Hicks:

In keeping with our wish to keep you informed of our mercury containment program, the following summarizes our actions to reduce mercury discharge to the watershed, current level of mercury discharge, and plans for future reduction.

Prior to May 9, 1970, discharge of mercury to Geddes Brook from our Bridge Street operation amounted to about 22 pounds per day. On May 9, a system to send mercury bearing waters from the mercury cell room basement to the waste beds was put into operation. On May 19, mercury containing sluicings from brine filters were routed to the waste beds, and on May 25 the back washings from the mercury cell caustic filters were added to this disposal system. In May and June, a number of improvements to the disposal system were made to virtually eliminate overflows to Geddes Brook. These included installation of a spare sump pump, a surge tank, waste pump ammeters, and various modifications to reduce the hydraulic load on the system. An overflow recorder and alarm were also installed.

The effect of these measures has been to reduce the mercury input to Geddes Brook to a current level of one to two

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MAY 04 REC'D
ACC CORPORATION
REGION II
SENT TO

pounds per day. A definitive program to provide substantial further reductions in mercury discharge has been formulated. Items planned or in progress under this program include:

1. Further process modifications to reduce the volume of liquids handled in the disposal system.

2. Testing of chemical and mechanical treatment methods to recover mercury from wastes now sent to waste beds.

3. Improvement of reliability of mercury disposal system by installation of improved pumps and pump failure alarms.

4. Construction of a brine holding tank to eliminate overflow of brine to the sewer.

5. Installation of a continuous sampler on the main process sewer outfall to the west flume.

6. Continuation of a program to identify and correct miscellaneous sources of mercury contamination.

The items of major importance in this program are scheduled for completion within three months.

Input of mercury to Onondaga Lake via east flume from our Willis Avenue operation amounts to about 0.5 pounds per day. About 80% of this is contained in two waste water streams emanating from the caustic potash evaporation operation.

A plan to eliminate the input from these two streams has been developed. One stage, scheduled for operation in mid-July,

involves installation of a new system to pump one of the two streams to the waste beds. The second stage, to be completed several months later, requires a change in condensing equipment to produce a more concentrated mercury containing waste water which will also be pumped through the new system to the waste beds.

Mercury sent to the waste beds is precipitated as the very insoluble mercuric sulfide by a substantial excess of sulfide in the soda ash process waste. The mercuric sulfide is dispersed in about 800 tons per day of process waste solids and settled on the beds. Mercury bearing boiler fly ash has been sent to our operating waste beds since their startup in 1951. A recent analysis indicates the fly ash carries about one pound per day of mercury to the beds. Excellent retention of mercury in the waste beds is evidenced by the fact that waste bed overflow contains less than 1 ppb mercury, equivalent to less than 0.05 pound per day.

Our containment program has resulted in a substantial reduction in mercury discharged to the watershed, as illustrated by the attached graphs which show daily concentrations and quantities (where calculable) of mercury in our effluents and Nine Mile Creek.

Also attached are copies of our mercury containment programs for the Bridge Street and Willis Avenue operations which give details of progress to date and plans for further action.

We will continue to keep you informed of the results of our efforts to achieve further reductions in the quantity of mercury discharged from our operations.

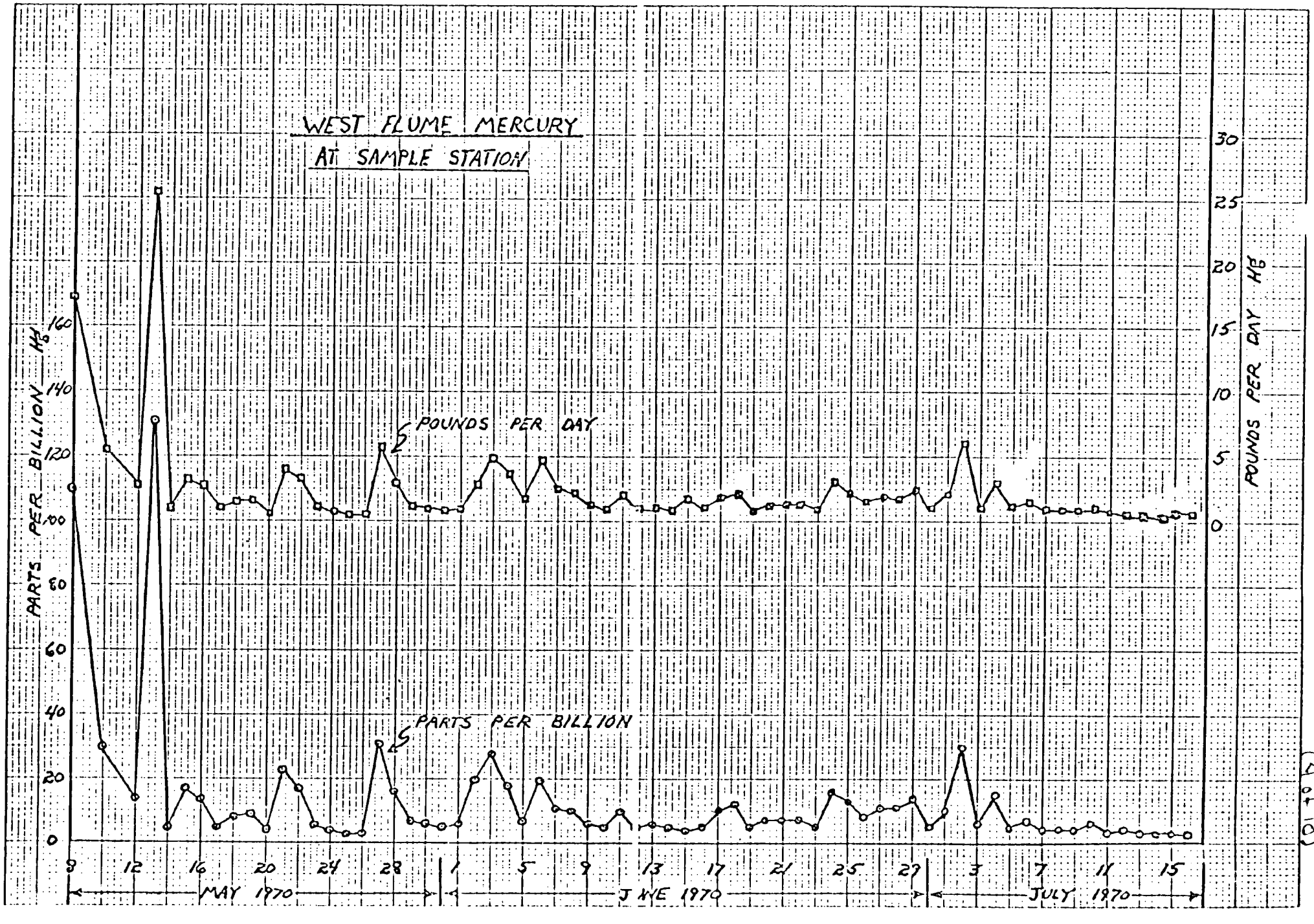
Very truly yours,

J. L. Rourke

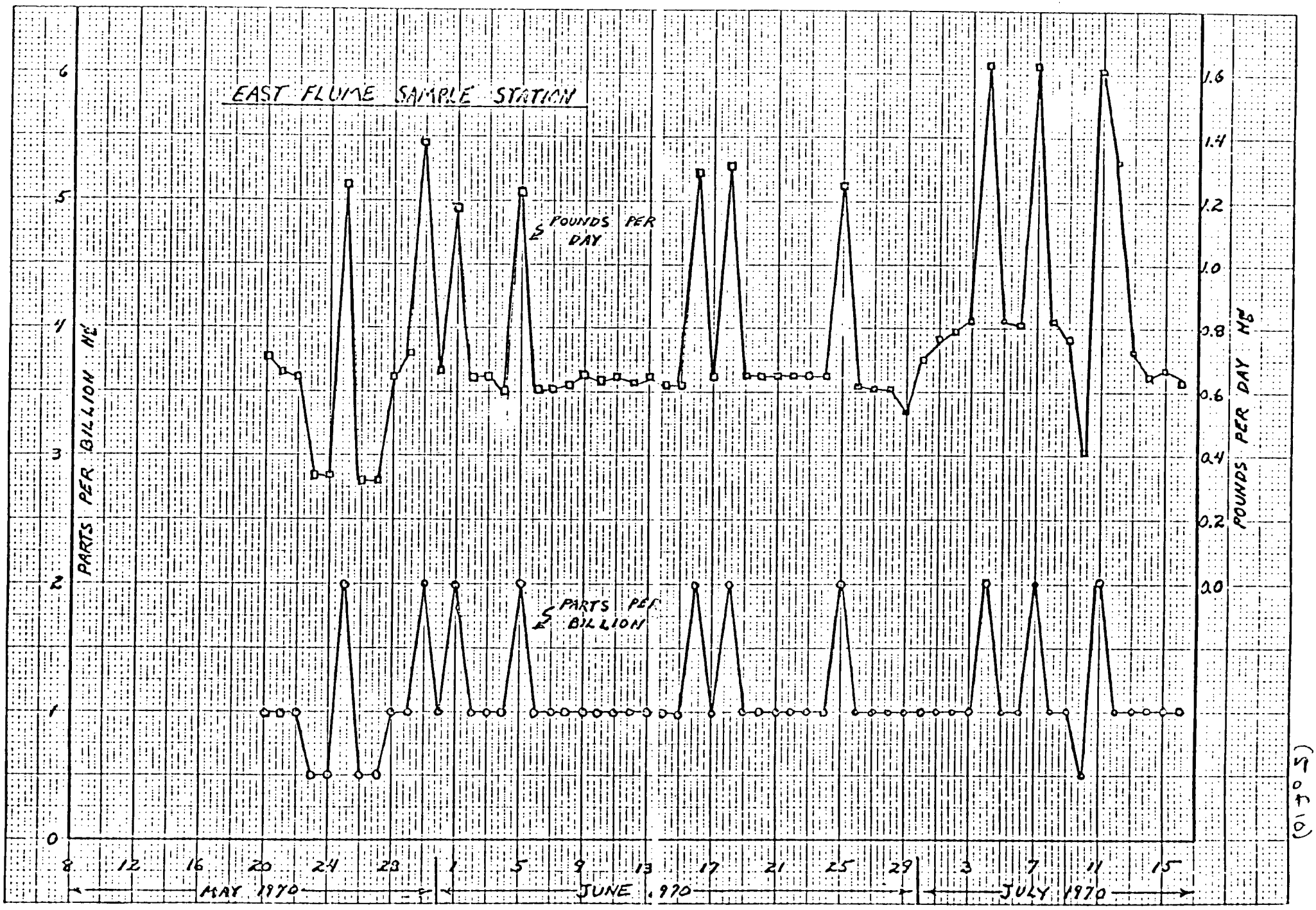
J. L. Rourke
Manager - Technical

Attachments

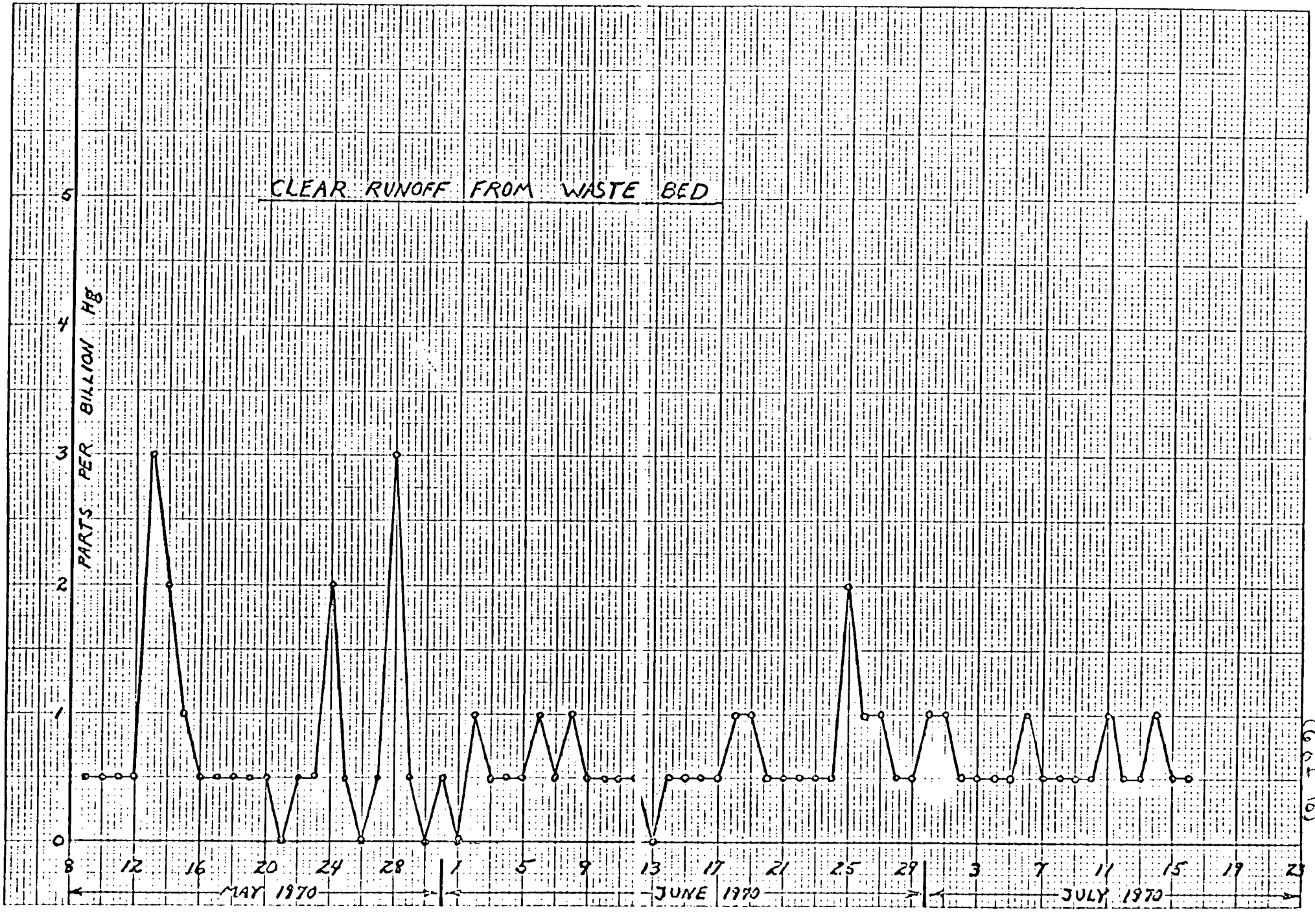
cc: Mr. L. E. Townsend, FWQA, Great Lakes Region
Mr. L. A. Van Den Berg, FWQA, Ohio Basin Region

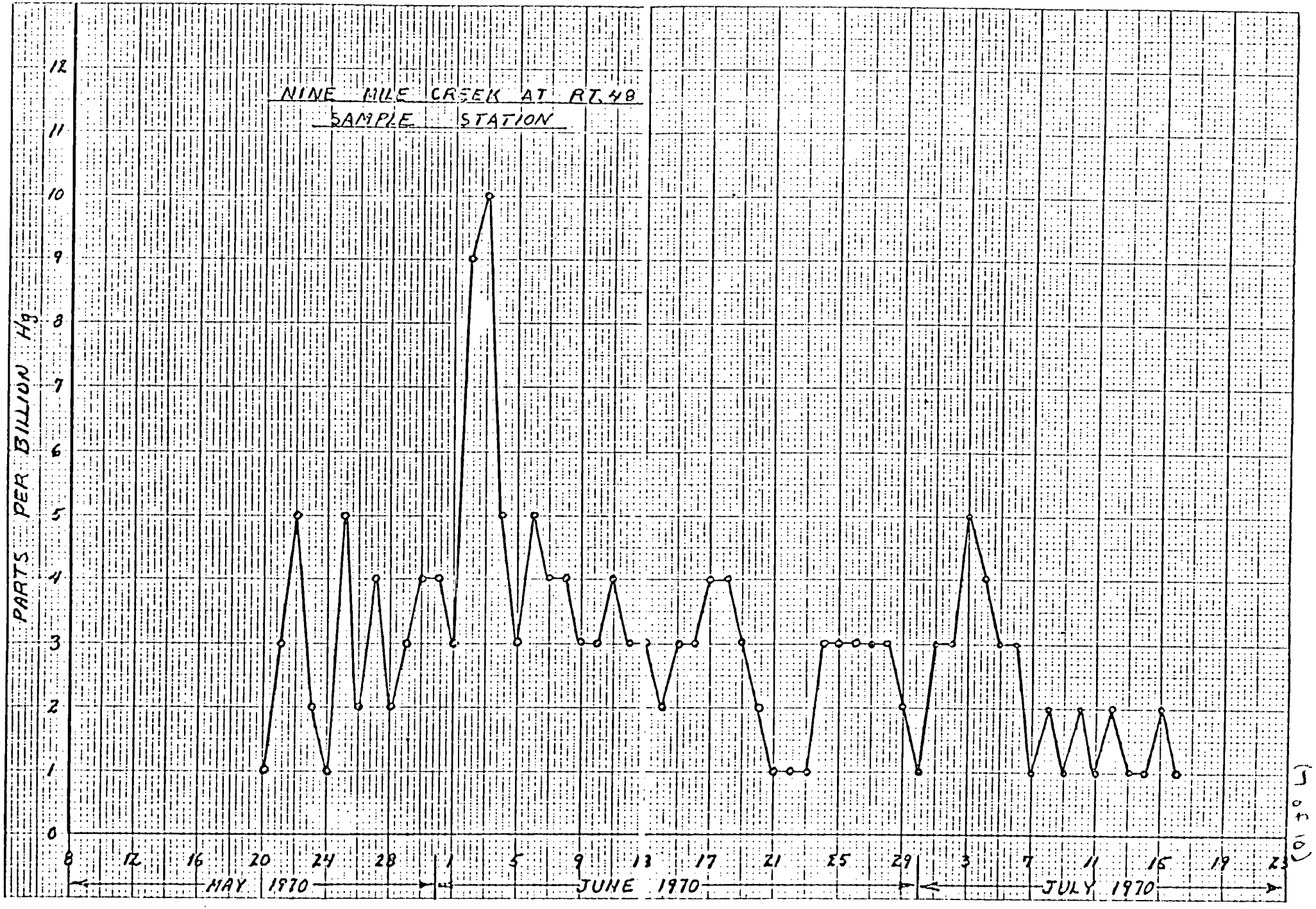

WEST FLUME MERCURY
AT SAMPLE STATION
POUNDS PER DAY
PARTS PER BILLION
PARTS PER BILLION Hg
POUNDS PER DAY Hg
0
20
40
60
80
100
120
140
160
0
5
10
15
20
25
30
8
12
16
20
24
28
1
5
9
13
17
21
25
29
3
7
11
15
MAY 1970
JUNE 1970
JULY 1970

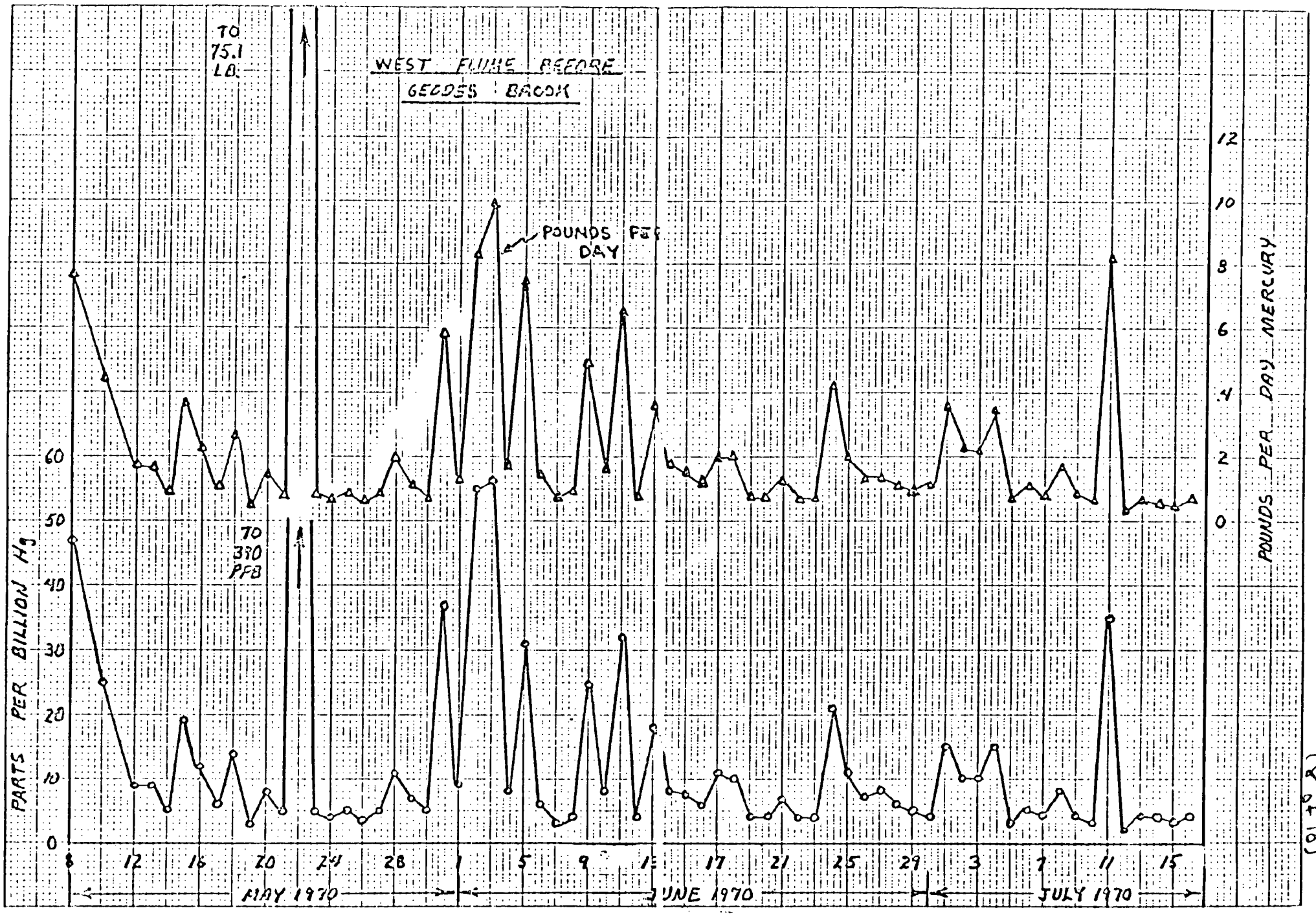
(4 of 10)


EAST FLUME SAMPLE STATION
POUNDS PER DAY
PARTS PER BILLION
PARTS PER BILLION Hg
POUNDS PER DAY Hg
0
1
2
3
4
5
6
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
8
12
16
20
24
28
1
5
9
13
17
21
25
29
3
7
11
15
MAY 1970
JUNE 1970
JULY 1970

(5 of 10)


CLEAR RUNOFF FROM WASTE BED
PARTS PER BILLION Hg
0
1
2
3
4
5
8
12
16
20
24
28
1
5
9
13
17
21
25
29
3
7
11
15
19
23
MAY 1970
JUNE 1970
JULY 1970


NINE MILE CREEK AT RT. 48
SAMPLE STATION
PARTS PER BILLION Hg
0
1
2
3
4
5
6
7
8
9
10
11
12
8
12
16
20
24
28
1
5
9
13
17
21
25
29
3
7
11
15
19
23
MAY 1970
JUNE 1970
JULY 1970


WEST FORK BEFORE
GEODES BROOK
70
75.1
LB.
POUNDS PER
DAY
70
380
PPB
PARTS PER BILLION Hg
POUNDS PER DAY MERCURY
0
10
20
30
40
50
60
0
2
4
6
8
10
12
8
12
16
20
24
28
1
5
9
13
17
21
25
29
3
7
11
15
MAY 1970
JUNE 1970
JULY 1970

(8 of 10)

BRIDGE STREET SECTION -- MERCURY EFFLUENT PROGRAM – 1970

	Completion	6/22	6/29	7/6	7/13	7/20	7/27	8/3	8/10	8/17	8/24	8/31	9/7	9/14	9/21	9/28	10/5
(1) Start-up Waste Solids Systems to CC Plant	Complete 5/8/70																
(2) Pipe Mercury Cell Basement waters to waste solids tank	Complete 5/9/70																
(3) Convert M/C Caustic filter sewer to a sump & pipe to waste solids	Complete 5/26/70																
(4) Convert condensate tank to a waste solids surge tank	Complete 5/27/70																
(5) Put M/C pressure Leaf Filter backwash to waste solids	Complete 5/20/70																
(6) Write SOP for M/C plant start-ups without purging brine to sewer	Complete 6/9/70																
(7) Test Cyclone to remove mercury from basement water				Test Not Successful - Discontinued													
(8) Install overflow recorder and alarm on waste solids tank			Complete														
(9) Replace Durco Waste Solids Pumps with a pump more applicable to pumping asbestos				PUMP SELECTED	BLUE-LINE SUBMITTED		ICD-81 SUBMITTED										
(10) Install ammeters on waste solids pumps	Complete 6/12/70																
(11) Recirculate pump and trap end wash waters - (reduce volume of basement effluent)		ICD-81 SUBMITTED		ICD-81 APPROVAL									INSTALLATION				
(12) Test brine to Coalescor to remove mercury from basement waters		INSTALL UNIT	START TEST			TEST CONCL'D											
(13) Install curbing around sewer in M/C basement.(Prevent overflow of basement water)			Complete														
(14) Treat basement water to improve mercury separation			OBT.MAST.TEST														
(15) Install high level alarm in basement sump				INSTALLATION													
(16) Install spare sump pump in M/C basement			Blueline Submitted		ICD-81 Submitted		Complete										
(17) Complete brine holding tank to eliminate potential overflow of M/C brine to sewer									COMPLETION								
(18) Sample program to identify miscellaneous sources of contamination and recommend correction action		PROGRAM INITIATED			6/8/70	TO BE	CONTINUING										
(19) Minimize M/C basement waters:																	
a. Pipe cation regeneration water to sewer	Complete 4/29/70																
b. Alter float valve to prevent overflow of H_2 closed circuit water tank	Complete 5/1/70																
c. Improve catch pots in floor trenches	Complete 5/27/70																
d. Repipe gland water - H_2 regen. blower		INSTALLATION															
e. Repipe UV Aspirator water		INSTALLATION															
f. Repipe Air conditioner water			INSTALLATION														
g. Improve floor drain catch pots					Complete												
(20) Install end casting vent system - closed circuit on condensate		ENGR.			P&S							Complete					
(21) Test Charples, centrifuge to remove mercury from basement water (controlled by Item 12)			ASSEMBLY				INSTALL UNIT	START TEST									
(22) Install monitoring equipment on main sewer line to west flume		Request Design Info.		Final Design		Blueline Submitted			ICD-81 Submitted								
(23) Test Brink demister for mercury removal from hydrogen stack gas and end casting vent gas.													UNIT AVAIL. FROM MONSANTO				
(24) Improve separator on H_2 nash pump after cooler							EVAL. COMPLETE										
(25) Recycle nash pump seal water on denuder feed water tank						EVAL. COMPLETE											

NOTE: PROGRAM IS DESIGNED TO LIMIT MERCURY OUTFLOW TO LESS THAN 1 LB/DAY. TOTAL REFINEMENT, FOR EXAMPLE - APPARENT MERCURY IN VAT DISCHARGE IS NOT INCLUDED.

WH[redacted] AVE[redacted] – M[redacted] RY [redacted]UEN[redacted]OGRA[redacted] 19[redacted]

	Completion	6/22	6/29	7/6	7/13	7/20	7/27	8/3	8/10	8/17	8/24	8/31	9/7	9/14	9/21	9/28
1. Seal off Sewer Entrance of Amalgam Wash Water	Complete 5/20/70															
2. Divert H_2 Cooler Water to Sewer	Complete 4/19/70															
3. Assign man exclusively for Hg Recov.	" 9/1/70															
4. Increase no. of Hg collection points for recovery man.	" 6/4/70															
5. Install collection pan under mineral jig.				Complete												
6. Mineral jig & sledge mill pad area prep'n.																
A. Permanent wiring.	Complete 6/19/70															
B. Pad painted.	" 6/11/70															
C. Curb installed.				Complete												
D. Position mineral jig & sledge mill				Complete												
7. Use former Benzol line as waste line to CC.																
A. Pump installed		Complete														
B. Wiring installed			Complete													
C. Put into service				Complete												
8. Send Hg bearing liquors thru waste line to CC.								Complete								
9. Hg Cell reguilding program - continuing program.		1	CELL	PER	MONTH	AS	PER	BUDGET								
10. Install Amalgam cleaning system consisting of tanks, pump & cyclone.				Complete												
11. Hg recovery monthly review & inspect.			Status Report					Status Report								
12. Replace barometric with Zaremba surface condenser.								Complete								
13. Impure condensate monitoring (continual)																
14. Evap. Bldg. barometric cond. monitoring.																
15. H_2 gas temperature & cooler water monitoring.																
16. Set up impure condensate for AM washing & filter backwashing.																Complete
17. Weak liquor collector cleaning & inspect.						Complete										
18. Install additional traps in Evaporator Building.							Installation									
19. Test cyclones for Hg recov. at sump loc.																
A. Cyclones ordered		Complete														
B. Testing							Start Test									
20. Back wash water from AM brine filter								Installation								
21. Pressure leaf filter installation - Brine purity.																Installation
22. Recover mercury from Hg reclaiming pad under former amalgam system.						Complete										
23. Recover Hg from wash water effluent areas near mineral jig operation.								Complete								
24. Evaporator Bldg. sump & AM sump cleaning & inspection.			Cleaned & Inspected		Clean & Inspect											
25. Dismantle AM cells over collection																

(10 of 10)

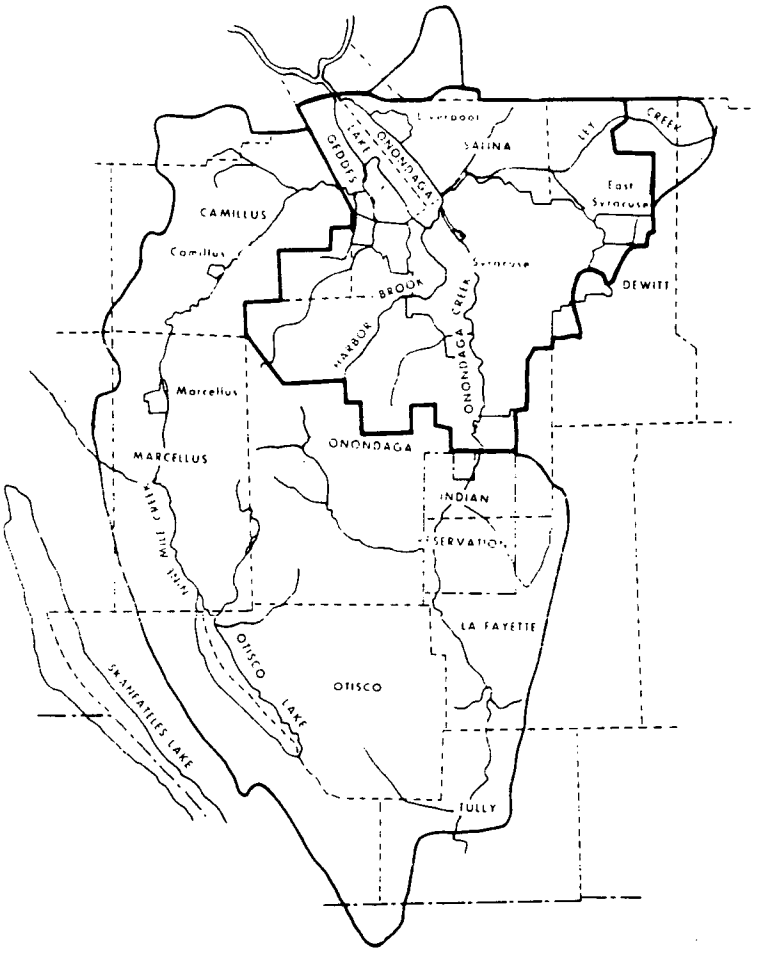
REFERENCE NO. 5

(1 of 8)

ENVIRONMENTAL IMPACT STATEMENT ON WASTEWATER TREATMENT FACILITIES CONSTRUCTION GRANTS FOR THE ONONDAGA LAKE DRAINAGE BASIN

Final

May 1974



U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION II
26 FEDERAL PLAZA
NEW YORK CITY, NEW YORK 10007

It appears that salty ground water may indeed be discharged near the southeastern end of Onondaga Lake. However, the significance of this discharge to the chloride level of Onondaga Lake has not been determined. It is possible that the salt water contributed by ground waters alone causes the high chloride concentrations in Onondaga Lake. These concentrations exceed the maximum 250 mg/l level that was established by the U.S. Public Health Service (1962) to prevent salty tasting drinking waters. The question of chlorides in Onondaga Lake is discussed in Appendix B.

WATER RESOURCES

O'Brien & Gere (1968) estimated that the present water demand in Onondaga County is 350,000 cu m/day (92.5 mgd). This is expected to reach 647,000 cu m/day (171 mgd) by the year 2000. However, in the MSSTP service area, water consumption is not expected to increase significantly.

Onondaga County's main water supply sources are Skaneateles Lake and Otisco Lake, which have safe yields of 165,000 cu m/day (43.5 mgd) and 76,000 cu m/day (20.0 mgd), respectively. Water is being withdrawn from these lakes at or near their maximum safe yields. (O'Brien & Gere, 1973a). Other, smaller sources, primarily wells, are capable of supplying approximately 15,000 cu m/day (4.0 mgd). Thus the total capacity from sources within the county is approximately 255,000 cu m/day (67.5 mgd).

In 1967, Onondaga County completed construction of a water supply system to obtain water from the Oswego intake on Lake Ontario. This system has a capacity of 95,000 cu m/day (25 mgd). It may be expanded to 237,000 cu m/day (62.5 mgd) by construction of additional pumping and treatment facilities. It may be even further expanded by construction of additional intake, pumping, treatment and transmission facilities.

No public water supplies are derived from Onondaga Lake or from the Seneca-Oneida-Oswego River system. Furthermore, there are no plans to use these waterways as sources of public water supplies in the future.

Use of ground water in the area is expected to decline in the future. In fact, it has been recommended that all public well supplies in the county, with the exception of those at Baldwinsville and Tully, be abandoned (O'Brien & Gere, 1968). The following reasons were offered:

1. These sources are or will be located in densely developed areas where the pollution hazard is high; many wells already show evidence of pollution;
2. Rated capacities are inadequate to meet future demands;
3. Present water quality does not compare favorably with that now or potentially available from alternative sources. (O'Brien & Gere,1968).

AIR QUALITY

Available monitoring data reveal that in the vicinity of the MSSTP, ambient air quality standards for suspended particulates were exceeded between 1969 and 1972 (Table 22). Air quality standards for total oxidants were exceeded between 1971 and 1972 (Table 22). Current levels of sulfur oxides, carbon monoxide, and nitrogen dioxide are in compliance with the national standards.

Since there are no emissions from the MSSTP primary treatment plant, the air quality violations must be ascribed to other, primarily industrial, sources in the area. Odors are the main air quality problem presented by sewage treatment plants; there are no Federal, State or local standards for the control of odors. However, the upgraded and expanded MSSTP is not expected to cause any odor problems.

Allied Chemical Corporation

Allied's Syracuse plant is located in the Village of Solvay in Onondaga County, New York. The main plant facilities occupy a site of approximately 1200 ha (3000 acres), southwest of Onondaga Lake. The manufacturing facilities are supplied by a 1200 ha (3000 acre) limestone quarry at Jamesville, N.Y., and a 1200 ha (3000 acre) brine operation at Tully, N.Y. Allied's Syracuse plant is engaged in two distinct manufacturing areas; each area has its particular products and byproducts. Allied also operates its own power plant to supply its facilities.

The first group of manufacturing processes produces soda ash (sodium carbonate - Na_2CO_3) and soda ash derivatives. The soda ash production processes are responsible for the largest wastewater flow in the plant. The synthetic ammonia-soda process, or Solvay Process, is used. Raw materials consumed in this operation include brine, limestone, ammonia, hydrogen sulfide and fuel. Ammonia is recovered for reuse by reacting ammonium chloride, an intermediate product, with excess quantities of lime; the reaction also produces calcium chloride ($CaCl_2$). The wastewaters resulting from this process contain high concentrations of sodium chloride, calcium chloride and lime, as well as natural impurities found in both the limestone and brine raw materials. For each ton of soda ash produced, about one-half ton of salt and one ton of calcium chloride have to be disposed of. These wastes are common to all soda ash plants.

The second group of processes center around the electrolytic decomposition of salt brine (NaCl) to form chlorine and caustic soda (NaOH). Two types of electrolytic cells are used in the process, the mercury cell and the diaphragm cell. Trace amounts of mercury, lead and asbestos enter the

wastewater streams from these operations. In the summer of 1970, the U.S. Department of Justice took legal action to compel Allied to reduce or eliminate its mercury discharge. Allied reduced its mercury discharge from 10.0 kg/day (22 lb/day) to 0.4 kg/day (1 lb/day), as recommended in a stipulation, dated September 14, 1970, between the U.S. Attorney and the attorneys for Allied Chemical Corporation.

The power plant is the third area in which wastes are generated. Boiler feed waters must be treated to remove hardness; during this water treatment operation, sludges are formed. Residual hardness and some treatment chemicals remain in the feed waters and are concentrated during use. The boilers must be cleansed of these impurities. The resultant blowdown waters contain suspended and dissolved solids.

The above description is a simplified representation of a very complex manufacturing operation. The products themselves are the end result of a variety of interrelated processes. Allied currently produces about twenty different chemical products. The wastewaters generated by the manufacturing processes are discussed below.

Allied disposes of its wastewaters at three separate discharge points. Cooling waters from the power plant operation are discharged directly into Onondaga Lake through Discharge Serial No. 001 (east flume). This discharge is disinfected and contains approximately 0.3 mg/l residual chlorine. In addition to cooling water, this discharge contains stormwater runoff from the Syracuse plant and sections of the Village of Solvay. Discharge Serial No. 002 (west flume) contains wastewaters similar to those discharged via the east flume plus sodium chloride, sodium chlorate, and traces of sodium hypochlorite. These salts represent a small percentage of the total salt

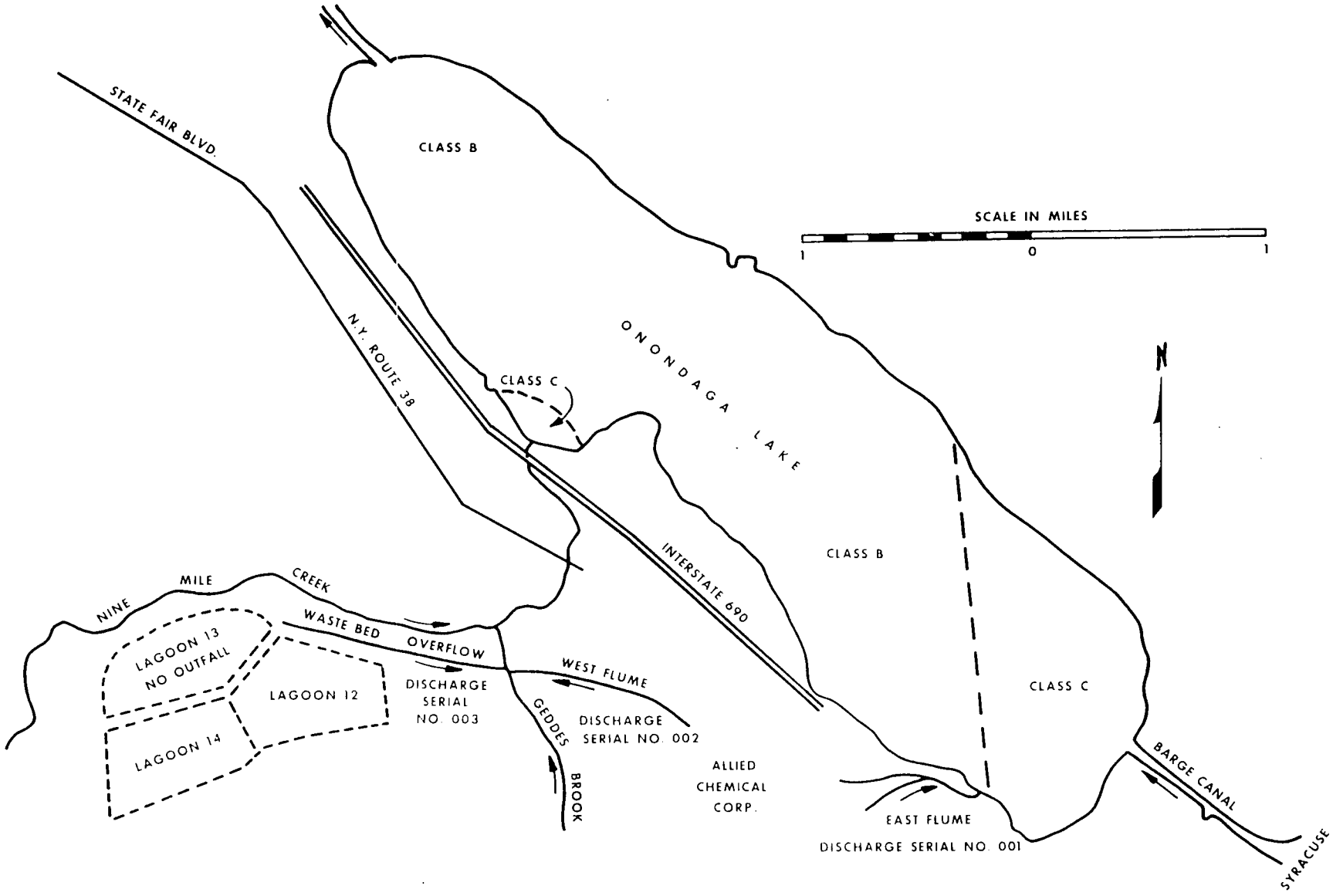
discharged by the plant. Discharge Serial No. 003 contains the overflow from Allied's settling lagoons. Under the proposed water quality management plan, this overflow will be pumped to the advanced waste treatment facilities of the expanded MSSTP. The characteristics of the three discharges are given in Table 27. The locations are shown in Figure 10.

At the Syracuse plant the first step in wastewater treatment is separation of the wastewater streams. Almost every processing area in the plant is sumped, and unintentional spills and floor sweepings are quickly reclaimed. Oil-bearing waters are settled and skimmed before being discharged. Waters contaminated with mercury-bearing solids are filtered before being sent to the settling lagoons.

With the exception of cooling waters, all wastewaters are collected and pumped to one of the three settling lagoons currently being used by Allied. Because certain of the materials in soda ash wastes act as coagulants, the suspended solids removal in the lagoons is good, approaching 99 percent. Dissolved solids, however, remain in solution and are discharged to Geddes Brook.

Allied pumps about 1,000,000 kg (1100 tons) of solids to the lagoons daily. Continual solids deposition results in the filling of the lagoons, thereby exhausting their sedimentation volume. Together the three existing Allied lagoons have a life expectancy of about nine years; new lagoons will be required sometime before 1982. Allied is currently investigating the possibility of additional land purchases and rezoning requirements for the construction of new settling lagoons.

As shown in Table 26, the overflow from the lagoons goes directly into Geddes Brook. The brook is tributary to Nine Mile Creek, which flows



SOURCE U.S. EPA 1973b

LOCATION MAP
ALLIED CHEMICAL CORPORATION DISCHARGE POINTS

Figure 10

(8 of 7)

into Onondaga Lake. When the lagoon overflow, which has a high calcium content, mixes with the waters of Geddes Brook, a calcium carbonate ($CaCO_3$) precipitate is formed. The effect of this is that Geddes Brook is a milky white color by the time it empties into Nine Mile Creek. Although some of the $CaCO_3$ precipitates out of solution and settles as a solid in Geddes Brook and Nine Mile Creek, the rapid rate of flow in both of these streams keeps most of the $CaCO_3$ in suspension until Nine Mile Creek reaches Onondaga Lake. At the juncture of Nine Mile Creek and Onondaga Lake, a delta is formed as the $CaCO_3$ settles out under the quiescent conditions prevailing in the lake. (O'Brien & Gere, 1973a). This precipitation problem is discussed in Appendix D.

REFERENCE NO. 6

Allied Chemical

Industrial Chemicals Division
P.O. Box 1139R
Morristown, New Jersey 07960

JL

find as noted

July 31, 1979

JLR

AUG 7 1979

Mr. George K. Hansen, P.E.
Chief, P.D.E.S. Permit Section
New York State Department of
Environmental Conservation
Room 201
50 Wolf Road
Albany, New York 12233

RE: Allied Chemical Corporation
Industrial Chemicals Division
Syracuse Works, Solvay, New York
SPDES Permit #NY0002275

Dear Mr. Hansen:

Enclosed please find two copies of our renewal application for the subject SPDES Permit, along with our check for $300.00 to cover application fees.

The Syracuse Works has commenced a comprehensive monitoring program to gather representative data for each of the 129 NRDC "Priority Pollutants" which may be detected in our discharges. It is our understanding that such data may be required for our point source sub-category in applications for BAT Permits to be issued under the NPDES Program.

Also, the Plant handles materials which have been or may in the future be classified as hazardous substances under Section 311 of the Federal Water Pollution Control Act. The potential exists for discharge of these materials during start-up, shutdown, equipment malfunction or other events occurring within the scope of the Plant's operation or treatment. During the course of the permit, we will endeavor to develop best engineering estimates of these potential discharges which are excluded from the provisions of Section 311 of the Act, such that a specific identification may be provided in our subsequent application for a BAT NPDES Permit.

Enclosed is a revised copy of the March 1977 Industrial Chemical Survey. As of December 31, 1977 the Willis Avenue Chlorinated Benzene Plant was shut down. The revised survey reflects this change.

Please note that effective June 1, 1980, we will be diverting our major cooling waters from Discharge 002 to our Discharge 001 Thermal Diffuser facility. Also, Discharge 003 will be diverted to the Onondaga County Municipal Sewage Treatment Plant tertiary treatment system in a contracted joint treatment proposal. According to our existing NPDES Permit requirements, therefore, the only stream entering Geddes Brook from Discharge 002 after the June 1, 1980 deadline is a small stream of spent non-contact cooling water from our Bridge Street chlorine producing facility.

We are presently negotiating the sale of the Bridge St. chlorine plant. When the details are finalized appropriate notices will be filed with the DEC.

Should you require further information, please advise.

Sincerely,

C. J. Porter JR

C. J. Porter
Plant Manager

CJP/lal

Enclosure

bcc: J. M. Devoe
C. J. Porter
W. M. Reiter
J. L. Rourke
A. J. Stewart(3)

(3 of 23)

C341 (9-78)

587902

1-2
210

Allied Chemical

ALLIED CHEMICAL CORPORATION
MORRISTOWN, N. J. 07960

THROUGH
THE CHASE MANHATTAN BANK, N.A.
1 CHASE MANHATTAN PLAZA
NEW YORK, N.Y. 10015

DIV.	LOC.
10	825

MO.	DAY	YR.
7	24	79

PAY

$ DOLLARS-CENTS
****$300.00*******

TO THE ORDER OF

New York State Department of
Environmental Conservation
Room 201 50 Wolf Road
Albany, NY 12233

PS Tobold

⑈587902⑈ ⑆021000021⑆ 910⑈3⑈007481⑈

APPLICATION FORM "C" FOR A STATE POLLUTANT DISCHARGE ELIMINATION SYSTEM (SPDES) PERM
INDUSTRIAL OR MINING

(4 of 23)

APPLICANT DATA

APPLICATION TYPE	IF RENEWAL OR MODIFICATION, GIVE PREVIOUS APPLICATION NO., EFFECTIVE DATE, EXPIRATION DATE
☐ New ☒ Renewal ☐ Modification	No. NY- 0002275 Effective Date 1/31/75 Expiration Date 1/31/80

APPLICANT'S NAME (Corporate, Partnership or Individual)	TYPE OF OWNERSHIP
Allied Chemical Corporation, Industrial Chemicals Division	☒ Corporate ☐ Individual ☐ Partnership ☐

APPLICANT'S MAILING ADDRESS (Street, City, State, Zip Code)
P.O. Box 6, Solvay, New York 13209

SEND ALL CORRESPONDENCE TO: (Name, Title and Address)	TELEPHONE NO. (Include Area)
J. L. Rourke, Manager, Environmental Services	315 487-4411

FACILITY NAME	FACILITY LOCATION (Street or Road)	CITY, TOWN OR VILLAGE
Syracuse Works	Milton Avenue	Solvay

COUNTY	GIVE EXPLICIT DIRECTIONS TO LOCATION, If Necessary
Onondaga	See Attached Map #1

NATURE OF BUSINESS OR TYPE OF FACILITY	NO. OF EMPLOYEES	NO. OF
Production of Inorganic Chemicals	1800	3

IF ALL YOUR WASTE IS DISCHARGED TO A PUBLICLY OWNED WASTE TREATMENT FACILITY AND/OR A LICENSED WASTE SCAVENGER AND TO THE BES YOUR KNOWLEDGE YOU ARE NOT REQUIRED TO OBTAIN AN SPDES PERMIT, COMPLETE THIS SECTION ONLY, SIGN APPLICATION AND RETURN.

NAME AND ADDRESS OF MUNICIPALITY RESPONSIBLE FOR RECEIVING WASTE	AND/OR NAME AND ADDRESS OF LICENSED WASTE SCAVENGER
NA	

PRODUCTION DATA (Use additional forms, if necessary)

PRINCIPAL TYPES OF PROCESSING DONE AT THIS FACILITY

Inorganic Chemicals Manufacturing
SIC - 2812 - Alkalies and Chlorine
SIC - 2819 - Industrial - Inorganic Chemicals

PRINCIPAL PRODUCTS AND AMOUNTS PRODUCED PER TIME UNIT	RAW MATERIALS AND AMOUNTS CONSUMED PER TIME UNIT
1. See Attachment 1 (Contains Confidential Information)	1. See Attachment 2
2.	2.
3.	3.
4.	4.
5.	5.

DOES ANY OF YOUR DISCHARGES CONTAIN OR IS IT POSSIBLE FOR ANY DISCHARGE TO CONTAIN ONE OR MORE OF THE FOLLOWING SUBSTANCES AS A RESULT OF YOUR OPERATIONS, ACTIVITIES OR PROCESSES? (See Attachment 3-Note #1a)

☐ Aluminum	☒ Arsenic	☒ Boron	☒ Chromium	☒ Flourides	☒ Lead	☒ Nickel	☒ Selenium	☒
☒ Ammonia	☒ Barium	☒ Cadmium	☒ Copper	☒ Gold	☒ Manganese	☒ Oil & Grease	☒ Silver	☒
☐ Antimony	☒ Beryllium	☒ Chlorine	☒ Cyanide	☒ Iron	☒ Mercury	☒ Phenols	☒ Sulfides	

☐ Corrosion control chemicals (specify) Sodium Sulfite (See Attachment 3-Note #1e) and other compounds (see Attachment 3)
☒ Halogenated organics or halogenated hydrocarbons (e.g. chlorinated, flourinated or brominated) (specify) See Attachment 3
☐ Herbicides or pesticides (specify) See Attachment 3
☐ Radioactivity (specify) Mined raw materials may contain traces of radioactivity
☒ Slimicides, biocides or algaecides (specify) See Attachment 3
☐ Substituted aromatics (e.g. derivatives of benzene, pyridene, biphenyl, naphthalene, coal or petroleum tar, etc.) (specify)
☒ Surfactants (specify) See Attachment 3
☐ None of the above

List the trade names and manufacturer of any chemicals used at this facility which are not listed above and whose specific constituents are not known to you. See Attachment 3

Explanation of above: (Attach additional sheets, if necessary) See Attachment 3 - Note #1

sisid settling pond facility located near the main plant facility. The clear liquid overflow from the basins forms Discharge 003.

Sludge of a hazardous or toxic nature such as mercury treatment plant sludge produced in wastewater treatment is sent to a secure landfill operation as follows: Newco Chemical Waste System, 526 Royal Ave., Niagara Falls, N.Y. 14303 & SCA Services, Inc., P.O. Box 200, Model City, New York 14107

(5 of 23)

CHARGE DATA (Continued) (See Instructions) ATTACH SKETCH SHOWING OUTFALL LOCATIONS See Map 2 & 3

NO. 1	☐ Proposed ☐ Replacement ☒ Existing ☐ Expansion	TYPE OF WASTE Cooling Water	TYPE OF TREATMENT (If none, so state) Thermal Diffusion, Settling Pond Oil Separation & Removal
FLOW 10^6 Gal/Day	ACTUAL FLOW $30 - 70 \times 10^6$ Gal/Day	FREQUENCY OF DISCHARGE ☒ Continuous ☐ Intermittent ☐ Batch	IS FLOW EQUALIZATION PROVIDED? ☒ Yes ☐ No If "Yes", describe in com
OF DISCHARGE 12 Months per year	7 Days per week	24 Hours pe	
CE DISCHARGE ☐ No	If "Yes", Name of Receiving Waters Onondaga Lake	Classification C	Waters Index No. ONT. -66-12-12-P154
RFACE DISCHARGE ☒ No	If "Yes", Name of nearest Surface Water	Distance Ft.	SOIL TYPE / Depth to Wat
NO. 002	☐ Proposed ☐ Replacement ☒ Existing ☐ Expansion	TYPE OF WASTE Cooling Water & Chlorine Vat Discharge	TYPE OF TREATMENT (If none, so state) None
GN FLOW 10^6 Gal/Day	ACTUAL FLOW $5 - 44 \times 10^6$ Gal/Day	FREQUENCY OF DISCHARGE ☒ Continuous ☐ Intermittent ☐ Batch	IS FLOW EQUALIZATION PROVIDED? ☐ Yes ☒ No If "Yes", describe in com
OF DISCHARGE 12 Months per year	7 Days per week	24 Hours p	
E DISCHARGE ☐ No	If "Yes", Name of Receiving Waters Geddes Brook	Classification D	Waters Index No. ONT. -66-12-12-P154-6-2
SURFACE DISCHARGE ☒ No	If "Yes", Name of nearest Surface Water	Distance Ft.	SOIL TYPE / Depth to Wa
L NO. 003	☐ Proposed ☐ Replacement ☒ Existing ☐ Expansion	TYPE OF WASTE Settling Basin Overflow	TYPE OF TREATMENT (If none, so state) Settling & Co-Precipitation with other dissolved chemicals
GN FLOW 10^6 Gal/Day	ACTUAL FLOW $1 - 15 \times 10^6$ Gal/Day	FREQUENCY OF DISCHARGE ☒ Continuous ☐ Intermittent ☐ Batch	IS FLOW EQUALIZATION PROVIDED? ☒ Yes ☐ No If "Yes", describe in co
OD OF DISCHARGE 12 Months per year	7 Days per week	24 Hours p	
E DISCHARGE ☐ Yes ☐ No	If "Yes", Name of Receiving Waters Geddes Brook	Classification D	Waters Index No. ONT. -66-12-12-P154-6-2
SURFACE DISCHARGE ☒ No	If "Yes", Name of nearest Surface Water	Distance Ft.	SOIL TYPE / Depth to Wa
ALL NO.	☐ Proposed ☐ Replacement ☐ Existing ☐ Expansion	TYPE OF WASTE	TYPE OF TREATMENT (If none, so state)
FLOW Gal/Day	ACTUAL FLOW Gal/Day	FREQUENCY OF DISCHARGE ☐ Continuous ☐ Intermittent ☐ Batch	IS FLOW EQUALIZATION PROVIDED? ☐ Yes ☐ No If "Yes", describe in co
RIOD OF DISCHARGE Months per year	Days per week	Hours	
ACE DISCHARGE ☐ Yes ☐ No	If "Yes", Name of Receiving Waters	Classification	Waters Index No.
RFACE DISCHARGE ☐ Yes ☐ No	If "Yes", Name of nearest Surface Water	Distance Ft.	SOIL TYPE / Depth to W

COMMENTS:

- Flow equalization is provided by a holding pond and a level control mechanism within the thermal diffuser pump station.
- Flow equalization is controlled by operational conditions at the settling basins.

I hereby affirm under penalty of perjury that information provided on this form and any attached supplemental forms is true to the best of my knowledge and belief. False statements made herein are punishable as a Class A misdemeanor pursuant to Section 210.45 of the Penal Law.

APPLICANT'S SIGNATURE (See Instructions)	Date	Printed Name	Title
E. A. Regna	7-13-79	Dr. E. A. Regna	Director, Environmental Services

STATE POLLUTANT DISCHARGE ELIMINATION SYSTEM (SPDES)

(6 of 23)

Thermal Discharge And Material
Storage Area Supplement For
Application Form C

(Attach to Application Form)

1. Thermal Discharges

Does the temperature of any of the discharges from this facility exceed 70°F. at any time? [x] YES [ ] NO See Attachment 4

If yes, attach the following information, and specify which outfall(s) it relates to: See Attachment 5

a) Range of measured discharge temperatures

b) Maximum discharge temperature

c) Discharge configuration (that is, whether surface, subsurface, effluent diffuser, etc.)

d) Chemical additives utilized (also see Section 4 on Form C)

2. Material Storage Areas

Is storm runoff or leachate from any material storage area (such as: coal piles, raw material or finished product stockpiles, etc.) discharged to either surface waters or groundwaters? [x] YES [ ] NO See Attachment 5

If "yes", please attach a brief description of types and quantities of materials stored, size of storage area, etc., and show its location and the location of any discharge points on the map required by Section 6 of Form C.

INDUSTRIAL CHEMICAL SURVEY

(7 of 23)

PART I

COMPLETE AND RETURN TO THE ABOVE ADDRESS, ATTENTION: INDUSTRIAL CHEMICAL SURVEY.

NAME: Allied Chemical Corporation		SIC CODE (If known) 2812, 2819	OFFICE USE
MAILING ADDRESS: P.O. Box 1139R	CITY: Morristown	STATE: New Jersey	ZIP CODE: 07960
NAME (If different): Syracuse Works	CONTACT NAME: Mr. A. J. Labuz		TELEPHONE Area (315) 437-407
ADDRESS (If different): P.O. Box 6	CITY: Solvay	STATE: New York	ZIP CODE: 13209

PRINCIPAL BUSINESS OF PLANT: Production of Industrial Chemicals

(If parent company, give name and addresses of all divisions, subsidiaries, etc. located in New York State. A separate questionnaire is to be completed and submitted for each.)

PART II
Discharge Information

1. Does your plant discharge liquid wastes to a municipally owned sanitary sewer system? Sanitary Waste Only — [X] Yes [ ]
   Name of System: Metropolitan Sewage Treatment Plant
2. Is your facility permitted to discharge liquid wastes under a State (SPDES) or Federal (NPDES) permit? — [X] Yes [ ]
   Permit Number: 0 0 0 2 2 7 5
3. Do you discharge liquid wastes in any other manner? — [X] Yes [ ]
   Explain: To settling basins which overflow and form Outfall 003 covered by SPDES. See Attachment 3 Note 1.f. and g.

If any of the above are "Yes":

a. Do you discharge process or chemical wastes – (i.e. water used in manufacturing including direct contact cooling water and scrubber water)? — [X] Yes [ ]
b. Do you discharge non-contact cooling water? — [X] Yes [ ]
c. Do you discharge collected storm drainage only? See Attachment 3 - Note #1 — [ ] Yes [X]
d. Do you discharge sanitary wastes only? — [ ] Yes [X]

4. Does your facility have sources of possible emissions to the atmosphere? — [X] Yes [ ]
5. Enter Location and Facility Code as shown on your Air Pollution Control Application for Permits and Certification (If applicable): 3 1 3 2 0 1 0 2 4 9

6. List Name and Address of Firm (Including yourself) removing wastes other than office and cafeteria refuse.

Name			
Address	City	State	Zip Code
Name			
Address	City	State	Zip Code

See Attachment 6

7. List Location(s) of Landfill(s) owned and used by your facility.

		Active	Inactive
1	Mathews Avenue Landfill, Solvay, New York	[X]	[ ]
2	Settling Basins, Geddes + Camillus, New York	[X]	[X]

8. Does this facility:
   Manufacture Pesticides or Pesticide Product Ingredients? — [X] Yes [ ]
   Produce Pesticides or Pesticide Product Ingredients? — [X] Yes [ ]
   Formulate Pesticides? — [ ] Yes [X]
   Repackage Pesticides? — [ ] Yes [X]

EPA Establishment Number: 2 8 3 8 1 — N Y — 0 1

SUBSTANCES OF CONCERN
(Refer to attached TABLE I)

Complete all information for those substances your facility has used, produced, stored, distributed or otherwise disposed of since January 1, 1971. Do include chemicals used only in analytical laboratory work. Enter the name and code from Table I. If facility uses a substance in any of the Classes A which is not specified in the list, enter it as code class plus 99, e.g. B99 with name, usage, etc.

NAME OF SUBSTANCE	CODE	AVERAGE ANNUAL USAGE	AMOUNT NOW ON HAND	(✓) GAL.	(✓) LB.	PURPOSE OF USE (State whether produced, reacted, ble packaged, distributed, no longer used
reon/Genetron 12,22,114	A05	14563	2870		x	Closed system refrigerant
/chloro Ethylene	A12	846	55	x		Degreaser in machine shop
Paradichlorobenzene	C99	0	0		x	No longer produced
thodichlorobenzene	C00	0	0		x	No longer produced
zene (emulsifiable solvent)	C99	0	0		x	No longer produced
ly Chlorinated Biphenyl*	A21	5	1119	x		Closed system in transfor as coolant and insulator.
benzene	D01	0	0	x		No longer used
sbestos (bulk fiber)	G01	52728	226,000		x	Cathode insulator diaphra cells.
bestos (paper sheeting, roll form)	G01	0	0		x	No longer used
bestos Liners for Allen Moore ells began using 2/75	G01	0	0		x	No longer used
Chlorinated Benzene Products	A18	0	0		x	No longer used
lorine (liquid)	C99	149,400,000	997,480		x	Produced for sale

any usage is the result of replacing PCB oil removed from a transformer for diagnostic analy: to determine transformer condition. "Amount now on hand" includes oil removed from a transfo which was replaced by a non-PCB oil type. This latter material will be incinerated followin EPA approval of an acceptable site and is being stored according to all applicable Federal guidelines.

you use chemicals of unknown composition, list trade name or other identification, name of supplier and complete information.

NAME OF SUBSTANCE	AVERAGE ANNUAL USAGE	AMOUNT NOW ON HAND	(✓) GAL.	(✓) LB.	SUPPLIER	PURPOSE OF US (State whether produced blended, packaged, dis no longer used, e
Drewplex 502	60040	21360		x	Drew Chemical Co.	Water Treatment
tz C-30	37.5	0	x		Betz Laboratory	Slimicide
etz 242	225	110	x		Betz Laboratory	Slimicide
Betz C-5P	600	200		x	Betz Laboratory	Slimicide
katerge E	38100	13,200		x	DMC Chemical Group	Anti-foam agent
lco 600	20800	12,380		x	Nalco Chemical Co.	Water treatment

I hereby affirm under penalty of perjury that information provided on this form is true to the best of my knowledge and belief. False statements mad are punishable as a Class A misdemeanor pursuant to Section 210.45 of the Penal Law.

SIGNATURE (Owner, Partner, or Officer)

DATE June 6, 1979

NAME (Printed or Typed) J. L. Rourke

TITLE Manager, Environmental Services

SUBSTANCES OF CONCERN
(Refer to attached TABLE I)

Complete all information for those substances your facility has used, produced, stored, distributed or otherwise disposed of since January 1, 1971. Do not include chemicals used only in analytical laboratory work. Enter the name and code from Table I. If facility uses a substance in any of the Classes A - which is not specified in the list, enter it as code class plus 99, e.g. 099 with name, usage, etc.

NAME OF SUBSTANCE	CODE	AVERAGE ANNUAL USAGE	AMOUNT NOW ON HAND	(✓) GAL.	(✓) LB.	PURPOSE OF USE (State whether produced, reacted, bler packaged, distributed, no longer used,

To use chemicals of unknown composition, list trade name or other identification, name of supplier and complete information.

NAME OF SUBSTANCE	AVERAGE ANNUAL USAGE	AMOUNT NOW ON HAND	(✓) GAL.	(✓) LB.	SUPPLIER	PURPOSE OF USE (State whether produced, blended, packaged, distr no longer used, etc
etz 403	477	110	x		Betz Laboratory	Slimicide
alco 680	75600	18540		x	Nalco Chemical	Water treatment
alco 75	88800	22880		x	Nalco Chemical	Water treatment
alco 757	9125	360		x	Nalco Chemical	Water treatment
eparan	7500	1500		x	Chemical Sales	Settling agent
mberlite 200	750	0		x	Rohm - Haas	Ion exchange res

I hereby affirm under penalty of perjury that information provided on this form is true to the best of my knowledge and belief. False statements made are punishable as a Class A misdemeanor pursuant to Section 210.45 of the Penal Law.

SIGNATURE (Owner, Partner, or Officer) | DATE June 6, 1979

(Printed or Typed) J. L. Rourke | TITLE Manager, Environmental Services

(Refer to attached TABLE I)

Complete all information for these substances your facility has used, produced, stored, distributed or otherwise disposed of since January 1, 1971. Do not include chemicals used only in analytical laboratory work. Enter the name and code from Table I. If facility uses a substance in any of the Classes A - [illegible] not specified in the list, enter it as code class plus 99, e.g. 599 with name, usage, etc.

NAME OF SUBSTANCE	CODE	AVERAGE ANNUAL USAGE	AMOUNT NOW ON HAND	(✓) GAL.	(✓) LB.	PURPOSE OF USE (State whether produced, reacted, bl[illegible] packaged, distributed, no longer used

[illegible] use chemicals of unknown composition, list trade name or other identification, name of supplier and complete information.

NAME OF SUBSTANCE	AVERAGE ANNUAL USAGE	AMOUNT NOW ON HAND	(✓) GAL.	(✓) LB.	SUPPLIER	PURPOSE OF USE (State whether produced, r[illegible] blended, packaged, distri[illegible] no longer used, etc.
[illegible]lgon Ba 11	1825	270	x		Calgon Corp.	Water purificati[illegible]
Solka Floc	91,983	42,000	x		Brown Co.	Pre-coat filter
[illegible] flo Super Cell	733	15,300		x	Johns-Mansville Co.	Pre-coat filter
[illegible]iton B.G. 10	0	0			Rohm - Haas	Experimental Surfactant
[illegible]tz Permacol	220	55	x		Betz Laboratory	Filming agent

I certify affirm under penalty of perjury that information provided on this form is true to the best of my knowledge and belief. False statements made [illegible] are punishable as a Class A misdemeanor pursuant to Section 210.45 of the Penal Law.

SIGNATURE (Owner, Partner, or Officer) | DATE June 6, 1979

Printed or Typed: J. L. Rourke | TITLE Manager, Environmental Services

SUBSTANCES OF CONCERN
(Refer to attached TABLE I)

Complete all information for those substances your facility has used, produced, stored, distributed or otherwise disposed of since January 1, 1978. Do not include chemicals used only in analytical laboratory work. Enter the name and code from Table I, if facility uses a substance in any of the Classes A — [illegible] not specified in the list, enter it as code class plus 99, e.g. 099 with name, usage, etc.

NAME OF SUBSTANCE	CODE	AVERAGE ANNUAL USAGE	AMOUNT NOW ON HAND	(✓) GAL.	(✓) LB.	PURPOSE OF USE (State whether produced, reacted, blended, packaged, distributed, no longer used, etc.)

[illegible] chemicals of unknown composition, list trade name or other identification, name of supplier and complete information.

NAME OF SUBSTANCE	AVERAGE ANNUAL USAGE	AMOUNT NOW ON HAND	(✓) GAL.	(✓) LB.	SUPPLIER	PURPOSE OF USE (State whether produced, reacted, blended, packaged, distributed, no longer used, etc.)
[illegible]rew C-52	165	220	X		Drew Chemical Co.	Water treatment
[illegible]Rubrex 100	20,000	2,245	X		Mobil Oil Co.	Settling agent
[illegible]tz J-12	660	50	X		Betz Laboratory	Slimicide

I hereby affirm under penalty of perjury that information provided on this form is true to the best of my knowledge and belief. False statements made herein are punishable as a Class A misdemeanor pursuant to Section 210.45 of the Penal Law.

SIGNATURE (Owner, Partner, or Officer) | DATE June 6, 1979

PRINTED OR TYPED: J. L. Rourke | TITLE Manager, Environmental Services

THIS PAGE HAS BEEN REMOVED BECAUSE OF CONFIDENTIAL INFORMATION THAT CANNOT BE RELEASED TO THE PUBLIC

Raw Materials, Supplies & Fuels

1. Sodium Carbonate

   Limestone
   Anthracite Coal
   Ammonia
   Hydrogen Sulfide
   Brine (25% NaCl)
   Caustic (weak)(10%)
   Natural Gas

2. Calcium Chloride

   Ammonia distiller waste liquor (impure calcium chloride)
   ($\approx$ 1090 Kg $CaCl_2$/Metric ton of soda ash)
   Liquid Chlorine

3. Chlor-Alkali Plant

   Brine (25% NaCl)
   Asbestos
   Muriatic Acid (31.5% HCl)
   Mercury
   Sulfuric Acid (98%)
   Gluconate #60 (Sodium Gluconate)

4. Ammonium Bicarbonate

   Ammonia
   Liquid CO_2

5. Sodium Sesquicarbonate

   Soda Ash Dissolver from Soda Ash Plant (50% Soda Ash - 50% Sodium Bicarbonate)

6. Sodium Bicarbonate

   Soda Ash Dissolver from Soda Ash Plant ($\approx$ 85% soda ash)
   CO_2 (40%)
   Tri-Calcium Phosphate (free flowing agent)

7. Ammonium Chloride

   Ammonia
   Tricalcium Phosphate
   Filter liquor from Soda Ash Plant ($\approx$ 16% Ammonium Chloride)

8. Sodium Nitrite

   Ammonia
   Soda Ash dissolver from S.A. (Soda Ash and Water)
   Petro-Ag (free flowing agent)

9. Power Section (generation of steam and electricity)

   Bituminous Coal

   Fuel Oil

10. Ancillary Fuel Consumption

   Gasoline
   Diesel Fuel
   Kerosene

11. Miscellaneous laboratory reagents from the Syracuse Works Control Laboratory drains and from the Syracuse Technical Center drains result in trace quantities of these materials entering our Discharge 001.

ATTACHMENT 3

Halogenated Organics *

Methylene Chloride

Methyl Chloride

Chloroform

Trichloroethylene

Tetrachloroethylene

1, 1, 1 Trichloroethane

1, 1, 2 Trichloroethane

1, 2 Dichloroethane

Carbon Tetrachloride

Slimicides & Algaecide		Herbicides & Pesticides		
Betz Laboratories	J-12	Dow	-	Kuron
	D-242	DuPont	-	Hyvar X
	C-5P	Dow	-	Dowpon
	C-30	Dow	-	Formula 40
		DuPont	-	Zelpar
Copper Sulfate		---	-	Chlorine

* Basis data from Discharge Monitoring Reports covering period February, March, April, and May of 1979. Other halogenated organics may be present. Such data are currently being developed as indicated in our transmittal letter.

Trade Name	Manufacturer	Usage
Drewplex 502	Drew Chemical Co.	Water Treatment
Betz C-30	Betz Laboratory	Slimicide
Betz 242	Betz Laboratory	Slimicide
Betz C-5P	Betz Laboratory	Slimicide
Alkaterge E	IMC Chemical Group	Anti-foam agent
Nalco 600	Nalco Chemical Co.	Water Treatment
Betz 403	Betz Laboratory	Slimicide
Nalco 660	Nalco Chemical Co.	Water Treatment
Nalco 75	Nalco Chemical Co.	Water Treatment
Nalco 757	Nalco Chemical Co.	Water Treatment
Separan	Chemical Sales	Settling Agent
Amberlite 200	Rohm & Haas	Ion Exchange Resin
Calgon Ba 11	Calgon Corporation	Water Purification
Solka Floc	Brown Company	Pre-Coat Filter
Hyflo Super Cell	Johns-Manville Co.	Pre-Coat Filter
Triton B.G. 10	Rohm & Haas	Experimental Surfactant
Betz Permacol	Betz Laboratory	Filming Agent
Drew C-52	Drew Chemical Company	Water Treatment
Rubrez 100	Mobil Oil Company	Settling Agent

Note #1

a. Aluminum, barium, copper, iron, lead, manganese, nickel and zinc are not used in the processes, but are present in the materials which are used in the processes (e.g., coal, limestone, brine). Boron, cadmium, gold and tin may possibly be present in raw materials but have not been previously detected.

b. Ammonia, chlorine, mercury are essential raw materials for our processes.

c. Oil and grease are used as lubricants in plant machinery.

d. Slimicides are contained in a closed circuit system but may be present in cooling tower or boiler blowdown.

ATTACHMENT 3 (CONTINUED)

e. Sodium Sulfite is present in boiler feed water blow down in trace quantities.

f. The Syracuse Chemical Plant of Allied Chemical Corporation is situated on land which has been utilized for industrial purposes for over 85 years. Our Outfalls 001 and 002 also receive stormwater runoff from the Village of Solvay as well as from the plant proper. Although decontamination and reclamation have been effected, it is possible that trace concentrations of past products, supplies, and raw materials could find their way into surface runoff and be detected by extremely sensitive analytical techniques. Historical materials have included but are not limited to the following: chlorobenzenes, hydrogen peroxide, coke tar residues, phthalic anhydride, salicylic acid, phenol, cumene, toluene, xylene, benzene, sulfonated coal tars, light oils, ethyl anthroquinone, palladium, potassium and sodium alkaline compounds, picric acid, titanium dioxide, various chlorinated compounds derived from chlorine liquefaction process, carbon tetrachloride, chloroform, methylene chloride, trichloroethylene, trichloroethane, perchloroethylene, cyanide, benzyl chloride, benzaldehyde, benzoic acid, and several chlorinated hydrocarbons produced by the Technical Center for possible market applications.

g. There may be other stormwater discharges that leave the plant other than through Outfalls 001 and 002 but these discharges are not fully defined as to Allied Chemical's contribution or to chemical characterization.

ATTACHMENT 4

On May 9, 1975, the New York State Department of Environmental Conservation (hereafter referred to as "the Agency") recertified water quality limitations and conditions of our NPDES Permit (NY0002275). Further correspondence between the Agency and Allied Chemical explained the need to expand the previously agreed thermal diffuser mixing zone of 6.5 acres or 300 feet radius to 290 acres or 2000 feet radius from point of discharge. These changes were subsequently incorporated in the modified NPDES Permit issued to Allied Chemical on January 17, 1979.

ATTACHMENT 5

1. Thermal Discharges

   A. Range: Outfall 001 - 16°C - 40°C
   Outfall 002 - 7°C - 35°C
   Outfall 003 - 1°C - 34°C

   B. Maximum discharge temperature: 40°C

   C. Discharge Configuration

   Outfall 001 - Effluent Diffuser
   Outfall 002 & 003 - Surface

   D. Chemical additives utilized: none for thermal control

2. Material Storage Areas

   As indicated on our site plan drawing,(Map 2), we have two coal stock piles. One of Bituminous Coal and one of Anthracite. Bituminous coal piles range in size from 10,000 - 100,000 tons depending on time of year. The Anthracite stock pile is approximately 12,000 tons throughout the year.

   Run off from the coal piles are discharged via Outfall 001. In accordance with the NPDES Permit, this run-off is being monitored.

ATTACHMENT 6

1. Allied Chemical Corporation
   P. O. Box 6
   Solvay, New York 13209

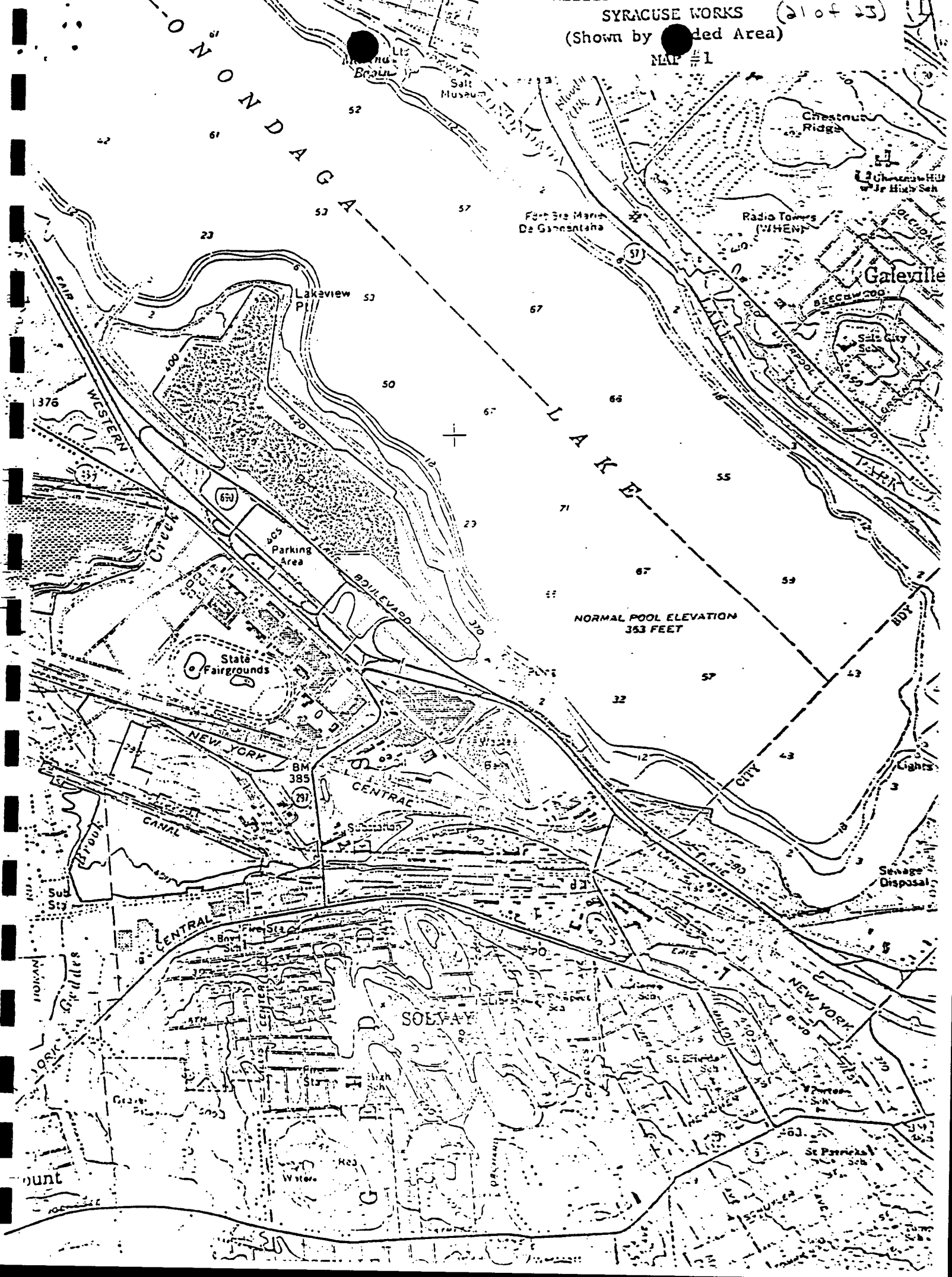
2. D & J Transportation
   107 7th North Street
   Liverpool, New York 13088

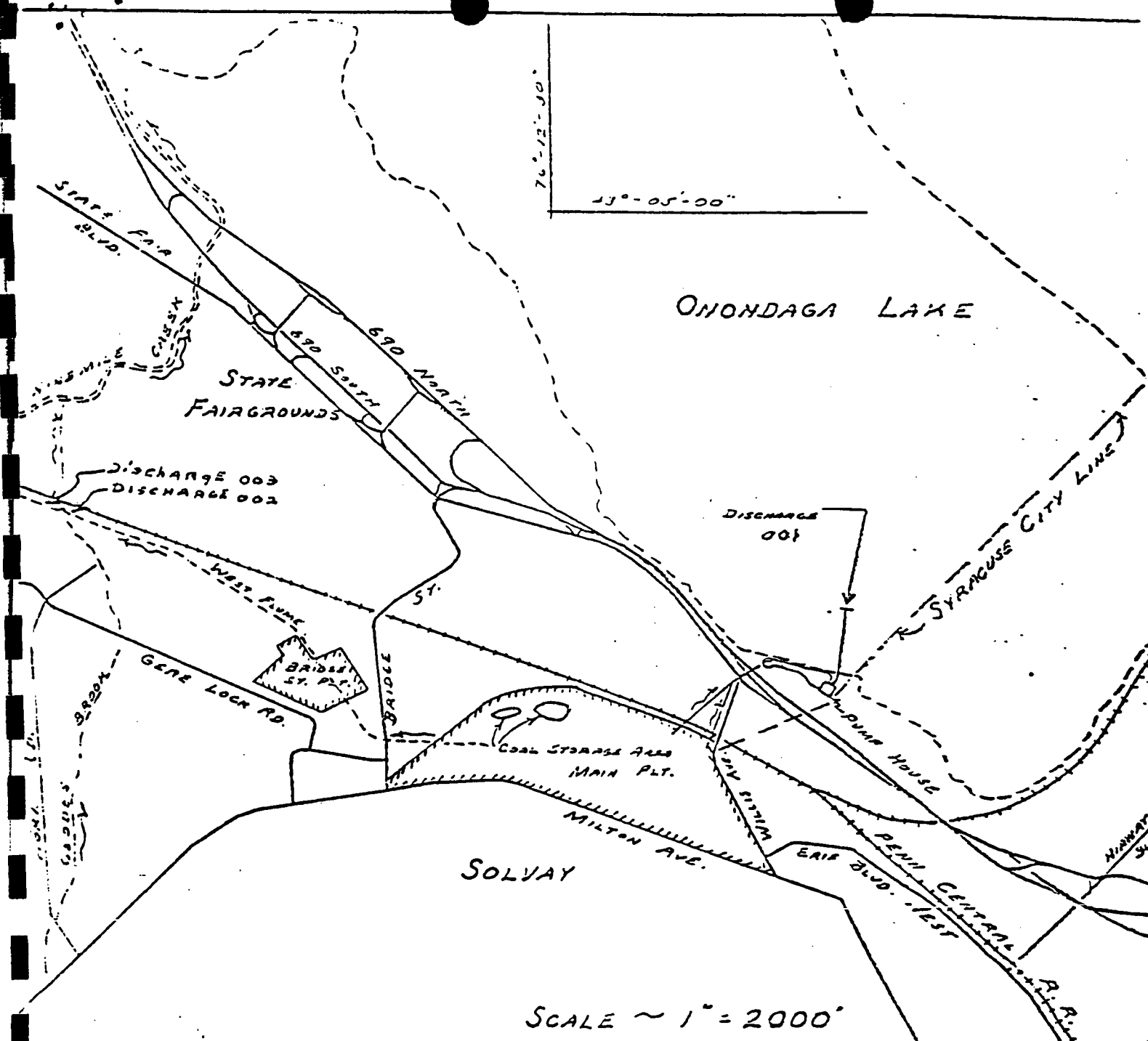
3. Lorber Truck Sales & Service
   1140 Military Road
   Buffalo, New York 14217

4. SCA Chemical Waste Services
   1550 Balmer Road
   Model City, New York 14107

5. Chemical Leaman Tank Lines
   Syracuse, New York

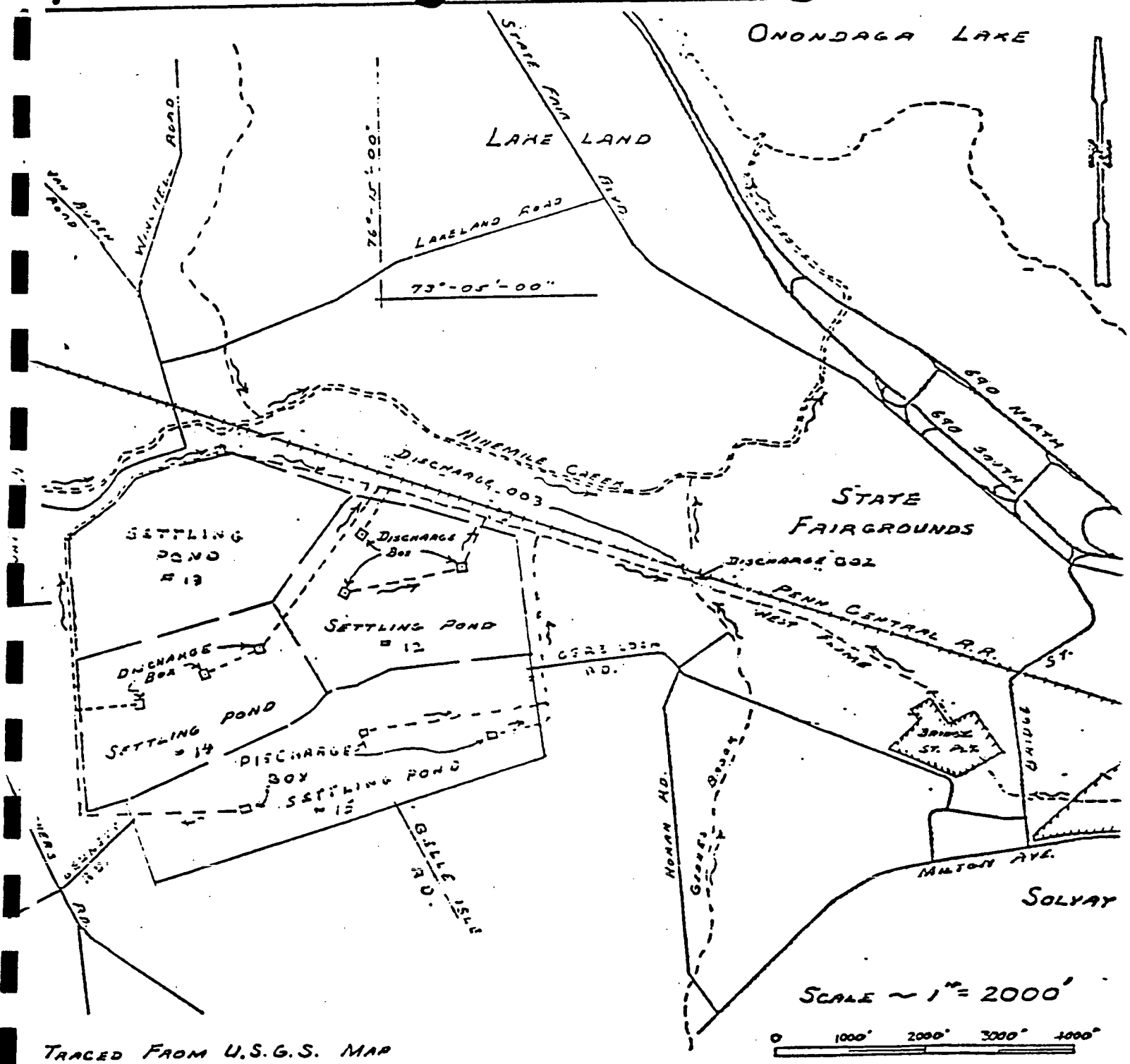
SYRACUSE WORKS (21 of 23)
(Shown by [redacted]ded Area)
MAP #1





TRACED FROM U.S.G.S. MAP.
SYRACUSE WEST QUADRANGLE
N.Y. #AMS 5770 II SW
SERIES V821

EXISTING OUTFALL & DISCHARGE
IN GEDDES BROOK & ONONDAGA LAKE
COUNTY OF ONONDAGA — N.Y.
APPLICATION BY ALLIED CHEMICAL CO
DATE 6-11-71
REVISED 5-30-79
MAP 2



TRACED FROM U.S.G.S. MAP
SYRACUSE WEST & CAMILLUS
N.Y. QUADRANGLES
*AMS 5770 II SW SERIES V821
AMS 5770 III SE SERIES V821

EXISTING OUTFALL & DISCHARGE
IN GEDDES BROOK & NINEMILE CREEK
COUNTY OF ONONDAGA, N.Y.
APPLICATION BY ALLIED CHEMICAL CO.
DATE 6-11-71
SHEET 1 OF 10
MAP 3

TLB/ 6-71

REFERENCE NO. 7

THE IMPACT OF A CHLOR-ALKALI PLANT ON ONONDAGA LAKE AND ADJOINING SYSTEMS*

STEVEN W. EFFLER

Upstate Freshwater Institute, Inc., Box 506, Syracuse, NY 13214, U.S.A.

(Received January 28, 1986; revised August 18, 1986)

Abstract. The pervasive effects an adjoining chlor-alkali plant has had on Onondaga Lake, and the river system that receives the lake discharge, are documented. Effects of the ionic waste discharge of the facility include: (1) ionic enrichment, (2) altered stratification regimes, (3) altered exchange between the lake and river, (4) altered hydrodynamics in the river downstream of the lake, (5) precipitation and deposition of large quantities of calcium carbonate, and (6) altered chemistry of lake sediments regulating P availability. Mercury, benzene, chlorobenzene wastes from the plant have contaminated the sediments and fish of the lake. Deleterious effects of the facility have included: the elimination of fish habitat, exacerbation of the problem of limited O_2 resources of the hypolimnion, contamination of fish flesh, exacerbation of the problem of low transparency of the lake, and severe O_2 depletion in the lower waters of the river system.

1. Introduction

The effects of different industrial operations on adjoining receiving waters are nearly as varied as the myriad of activities and wastes of industry. This paper reports on the impact of a chlor-alkali manufacturer on Onondaga Lake, NY, and waters which receive the discharge from the lake. This case study is particularly valuable and interesting because of: (1) the pervasive impact the industry has had on lake and river processes and water quality, (2) the extensive and costly on-going reclamation program for the lake (e.g., Effler *et al.*, 1981a; Lipe *et al.*, 1983), (3) the high potential resource value of the lake (e.g., Nemerow and Faro, 1970) and the adjoining waters (Babiarz and Pilon, 1979), and (4) the anticipated shut-down of the manufacturing facility in 1986. Presented herein are: (1) descriptions of the effects the chlor-alkali manufacturing operation has had on the lake and downstream systems, and (2) syntheses of these effects into the overall impact this operation has had on the water resources of these systems. Material contained in a number of different investigations, covering a range of disciplines, as well as previously unpublished data, have been utilized in this analysis.

1.1. Onondaga Lake: Setting, Recent History and Present Condition

Onondaga Lake is a small (area of 11.7 km^2, volume of 1.4×10^8 m^3, mean depth of 12 m, maximum depth of 20.5 m) lake located in metropolitan Syracuse, New York. A bathymetric map of the lake is presented in Figure 1(a), which also identifies significant tributaries, other discharges to the lake, the outlet, and other, subsequently presented, features of the system. The lake flushes rapidly, 2.5 to 5.0 times per year (Devan and Effler, 1984). A geographic setting map showing the position of Onondaga Lake with

* Contribution No. 65 of the Upstate Freshwater Institute, Inc.

Water, Air, and Soil Pollution 33 (1987) 85–115.
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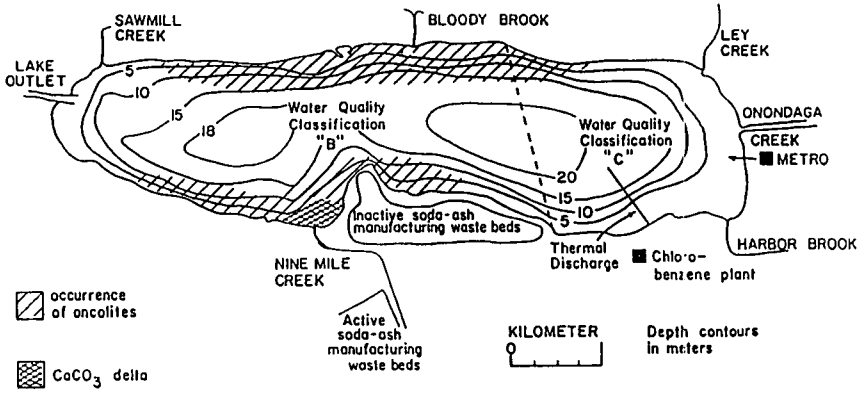

Fig. 1a. Bathymetric map of Onondaga Lake, with tributaries, outlet, and other selected features.

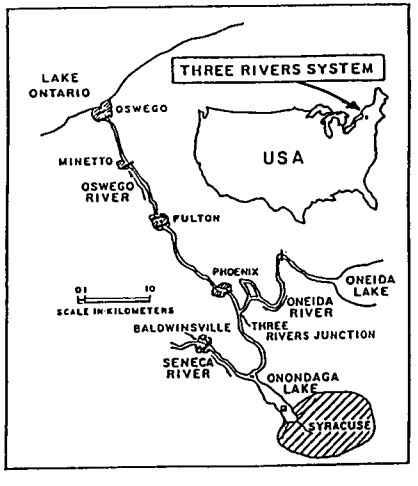

Fig. 1b. Geographic setting map of Onondaga Lake, with respect to Three Rivers System and Lake Ontario, and the United States.

respect to the Three Rivers System and Lake Ontario is presented as Figure 1(b). Discharges from the lake flow into the Seneca River. The Oswego River, formed by the confluence of the Seneca and Oneida Rivers, is the largest fluvial discharge originating within the Lake Ontario drainage basin. The Three Rivers System has been described as particularly well suited for industrial growth (Babiarz and Pilon, 1979), contingent upon it having an adequate waste assimilative capacity.

Onondaga Lake and its immediate surroundings played an important role in the

development of the Syracuse area. Mining of salt from brine springs located proximate to the lake was the major industry of the area during the 1800's. The lake became important to shipping for the region; it was incorporated into the barge canal system in 1918. Recreational use of the lake was particularly great from the late 1800's to the early 1900's (Lipe *et al.*, 1983). The lake had a plentiful cold water fishery, particularly the whitefish (*Coregonus clupeaformis*), that supported significant commercial fishing (Lipe *et al.*, 1983). However, the whitefish were thought to have completely disappeared from the lake by 1898 (Lipe *et al.*, 1983), presumably due to deterioration of water quality and habitat. The lake has been the principle receptacle for the domestic effluents and much of the industrial wastes from the metropolitan area through the early development of the region to the present.

Onondaga Lake is now considered to be polluted (Jackson, 1968; Sze and Kingsburg, 1972; Stewart, 1979) and hypereutrophic (Effler *et al.*, 1981a; Field and Effler, 1983a). Most of the lake has been designated class 'B', the remainder class 'C' (Figure 1(a)). The O_2 standards associated with these New York State designations are a daily average concentration ≥ 5 mg L, and minimum within a 24 hr period of 4 mg L^{-1}. Water quality problems presently preventing swimming are high concentrations of bacteria, indicative of fecal contamination (Friedman *et al.*, 1980), and low transparency (e.g., Devan and Effler, 1984; Effler *et al.*, 1984c). The fish in the lake are generally contaminated with Hg. Fish are usually restricted to portions of the epilimnion of the lake (i.e., warm water fishery) due to severe O_2 depletion (and presence of toxic reduced species (e.g., Effler *et al.*, 1986b)) in subsurface layers. The benthos and aquatic macrophyte populations are extremely small, with low diversity (e.g., Onondaga County, 1971). Manifestations of hypereutrophy include: (1) very high standing crops of phytoplankton (e.g., chlorophyll *a* as high as 170 μg L^{-1} (Field and Effler, 1983a, b)), (2) dominance of chlorococcalean green algae (Sze, 1975); and (3) high concentrations of algal macronutrients. Pollutional loadings to Onondaga Lake include rural and urban runoff, direct discharges of treated municipal sewage and industrial wastewaters, combined sewer overflows and other periodic discharges of untreated sewage, and polluted groundwater.

1.2. Utilization of Onondaga Lake by the Chlor-Alkali Manufacturer

The chlor-alkali manufacturer (limited to alkali manufacturing since 1979) has used the lake to discharge ionic waste and as a source of cooling water since the 1880's. The facility produces soda ash by the Solvay Process. The wastewaters produced from this process contain high concentrations of Cl, Na, and Ca. The production of this waste is nearly stoichiometric with soda ash production; for each kg of soda ash produced approximately 0.5 kg of NaCl and 1.0 kg of $CaCl_2$ is released (USEPA, 1974). The waste is subjected to settling pretreatment in lagoons. Monitoring data for the interval 1970–1980 (Onondaga County, 1971–1981) indicate the average daily load of the ionic waste (effluent from the lagoons) to the lake for that period was 2.5×10^6 kg d^{-1}. The ionic waste entered the lake via Nine Mile Creek (Figure 1(a)) until 1981. A portion of the ionic waste was diverted to the Metropolitan Sewage Treatment Plant (METRO)

from 1981 to 1983 for use in the removal of P (tertiary treatment). The complete diversion of the ionic waste to METRO began in late 1983. Materials settled in the lagoons are disposed of in 'wastebeds' located nearby the lake (e.g., within the watershed of the lake; Figure 1(a)). The waste beds cover an area of approximately 3.6 km^2 and are estimated to have a volume of 0.069 km^3. Input of materials from the wastebeds to the lake via the groundwater is probable, but no estimates of fluxes have been made to date.

Chlorobenzene was also manufactured at the facility (chlorobenzene plant, Figure 1(a)). The waste (Semet residue) was disposed of in nearby lined ponds located within the lake's watershed (Figure 1(a)). Ground water in the vicinity of several of these lagoons has been found to be contaminated with benzene and associated compounds (chlorobenzenes) (Geraghty and Miller, Inc., 1980, 1982), apparently as a result of leakage from the beds. A subsequent study (Geraghty and Miller, Inc., 1982) documented high concentrations of benzene associated compounds in the groundwater between the chlorobenzene plant and the lake, and the presence of these materials in three ground water seeps that discharge to the lake, and in proximate lake sediments. The present loading rate of chlorinated hydrocarbon contamination toward the lake from the chlorobenzene plant via the deep aquifer has been estimated to be 195 g d^{-1} (Groundwater Technology, 1984a). The loading rate of dissolved hydrocarbons via the shallow aquifer has been estimated to be 146 kg d^{-1} (Groundwater Technology, 1984b). The feasibility of recovery of the hydrocarbons from the shallow aquifer has been evaluated (Groundwater Technology, 1984b). The ionic waste used for tertiary treatment at METRO was found to be enriched in chlorobenzene on a single day (31 μg L^{-1} dichlorobenzene and 2.1 μg L^{-1} trichlorobenzene, on 19 February, 1983; Scrudato and Sugatt, 1983).

The alkali plant uses the lake as a source of process cooling water. There are three intakes for withdrawal of lake water. One is in shallow water, at a depth of approximately 3 m below the normal lake level; the other two are in deeper water at a nearly equal, but uncertain depth (10.7 to 12.2 m; personal communication, plant personnel). Withdrawal from the deeper intakes has been preferred because of the colder temperature. However, the upper intake was used more in late summer for a number of years to avoid the corrosive high concentrations of sulfide that developed in the lower waters. In recent years the rate of withdrawal has typically been between 2 and 3 $m^3 s^{-1}$. Heated water was discharged back to the lake via a shore discharge (East Flume (Figure 1(a)), until 1978. Since that time the heated water has been discharged through a multiport diffuser, that extends 900 m offshore (Figure 1(a)), at a depth of 4.6 m.

The chlor-alkali plant discharged Hg waste to Onondaga Lake in the interval 1946 to 1976. Most of this waste emanated from the two Hg cell chlor-lkali processes (first one started in 1946, second in 1953; USEPA, 1973). It is estimated that 75000 kg of Hg were discharged to the lake from 1946 to 1970 (approximately 5 kg d^{-1} from 1946 to 1953, and 10 kg d^{-1} from 1953 to 1970) by the plant (USEPA, 1973). The loading was reduced by more than 95% soon after the U.S. Department of Justice took legal action against the facility (one of 10 chlor-alkali plants) in the summer of 1970; further reductions were subsequently achieved (Lipe *et al.*, 1983). The chlor-alkali plant has been the only known significant source of Hg to the lake (USEPA, 1973).

1.3. Lake Reclamation Efforts/Responses

A number of reclamation measures have been taken since 1970, aimed at recovering the quality and uses of Onondaga Lake, including: (1) County-wide legislation in July 1971 which banned the use of high phosphate detergents, (2) increased maintenance of Syracuse's combined sewer system that resulted in substantial reductions in dry weather loadings from Onondaga Creek and Harbor Brook (Figure 1(a)), (3) reductions in heavy metal loadings from industry, and (4) construction of a tertiary sewage treatment plant (METRO). The design of METRO is unique because of its use of the ionic waste from alkali production to remove P in tertiary treatment (e.g., precipitation with Ca). It has been estimated (Lipe *et al.*, 1983) that $280 million have been invested by the public and private segments of the community to improve the water quality of Onondaga Lake. METRO was upgraded from primary to advanced secondary treatment in 1979, and tertiary treatment in mid-1981. Very little treatment of the ionic waste (approximately 4% reduction in effective solids discharge (Lipe *et al.*, 1983)) is achieved at METRO. Alternatives are now under consideration for the treatment of combined sewer overflows.

A major focus of the program has been the reduction of phytoplankton biomass, and thereby increased transparency and improved oxygen resources of the hypolimnion, by the reduction of external P loading. A 10 fold reduction in external P loading was achieved from 1970 to 1981 (Devan and Effler, 1984) by the reclamation program. However, no significant change in transparency (e.g., Devan and Effler, 1984; Effler *et al.*, 1984c) and the O_2 resources of the hypolimnion (e.g. Effler *et al.*, 1986b) have occurred. More subtle improvements were observed, including (Effler *et al.*, 1981a): the loss of nuisance blue-green algae from the phytoplankton (Sze, 1975), and an increase in the zooplankton population (Meyer and Effler, 1980). The fish of the lake continue to be contaminated with Hg, though concentrations have dropped following reductions in Hg loading from the chlor-alkali manufacturer.

2. Effects of Chlor-Alkali Manufacturing

2.1. Ionic Waste

2.1.1. *Ionic Content of Onondaga Lake*

The ionic content of Onondaga Lake is high; typical yearly average lake concentrations of Cl, Na, and Ca are approximately 1600, 550, and 500 mg L^{-1}, respectively (e.g., Onondaga County, 1981). These three ions presently account for approximately 85 and 90% of the salinity and ionic strength of the lake, respectively (Effler *et al.*, 1986c). The extent to which Onondaga Lake was 'salty' before receiving the ionic waste from alkali manufacturing was described as uncertain in 1971 (Onondaga County, 1971). The

proximity of the brine springs supported the hypothesis that natural (e.g., groundwater) sources contributed significantly to the present ionic content of the lake. However, at least one early publication commented on the strong contrast in salt content between the proximate salt springs and the lake. 'It is singular that this lake, although surrounded almost entirely by salt springs, should itself be perfectly fresh' (Clark, 1849, p. 37). Analyses in the early 1970's (O'Brien and Gere, 1973; Rooney, 1973), based on limited data, indicated the alkali plant's contribution to Cl in the lake was 50 to 60% (i.e., 40 to 50% originated from natural sources).

The results of a more recent and comprehensive analysis of Cl loading to, and export from, the lake for the period 1970 through 1981 (Effler and Driscoll, 1986) indicate lake concentrations are consistent with external surface loads (i.e., contributions from groundwater sources are minor or insignificant). The Cl budget utilized continuous discharge data from all the major tributaries, and lake and stream Cl data, collected 2 mo^{-1} over the 12 yr period. The budget calculations were supplemented by high frequency Cl data from the lake (3 wk^{-1} for 7 mo) and Nine Mile Creek (4 d^{-1} for 11 of 24 mo). Approximately 80 and 70% of the Cl (and presumably Na) and Ca loads originate from the chlor-alkali plant, respectively (Onondaga County, 1971–1982); i.e., the chlor-alkali plant is responsible for a similar (i.e., major) portion of in-lake concentrations of these materials.

The ionic enrichment of the lake strongly affects its physical characteristics and chemistry. This has important implications with respect to the metabolism of the lake, and the water quality of the lake and the downstream systems. The elevated ionic concentrations of the lake are not prohibitive to freshwater life. However, the elevated concentrations have probably exerted some selective pressure on various biological assemblages (e.g., Remane and Schleeper, 1971). For example, the species of zooplankton common in Onondaga Lake (Meyer and Effler, 1980) are known to be tolerant to elevated salinities (oligoholine-tolerant (Remane and Schleeper, 1971)). The effects on the algae composition of the lake are more subtle. The seasonal succession of dominant phytoplankters is typical of an eutrophic lake (Sze and Kingsbury, 1972). However, two characteristically marine species of algae (*Enteromorpha intestinalis* and an unidentified species of *Chaetoceros*) have been found in the lake (Sze and Kingsbury, 1972). The amphipod *Gammarus tigrinus*, which occurs primarily in estuaries, is found in the Seneca (downstream of Onondaga Lake) and Oswego Rivers (Simpson, 1982). This organism has been tentatively identified by the author in Onondaga Lake.

2.1.2. *Density Stratification in Onondaga Lake*

Stratification is the most fundamental characteristic regulating the metabolism of lakes. Early observations (Rand *et al.*, 1971) indicated that Onondaga Lake's stratification regime was unusual as it was chemically, as well as thermally, stratified for much of the year. The seawater equation of state (e.g., Chen and Millero, 1977), which requires paired measurements of temperature (t) and salinity, was found not to be a good estimator of density in Onondaga Lake because of its high equivalent fraction of Ca (Effler *et al.*, 1986c). Effler *et al.* (1986c) developed an equation of state specific to

Onondaga Lake that provided accurate estimates of density based on paired measurements of Cl and t.

Density stratification was characterized in the lake using this equation of state, for a 7 mo period of 1980 (Effler *et al.*, 1986a), based on 54 paired Cl and t profiles (vertical resolution of 1 m), and for a 6 mo period of 1981 (Owens and Effler, 1985), based on 36 paired profiles. Though differences in the stratification regime were observed between the two years, certain reoccurring characteristics were apparent, particularly with regards to the chemical component of stratification. Several of these characteristics are illustrated in the temporal distributions of the total vertical density differences and the chemical component (for the entire water column) that are shown for 1980 in Figure 2.

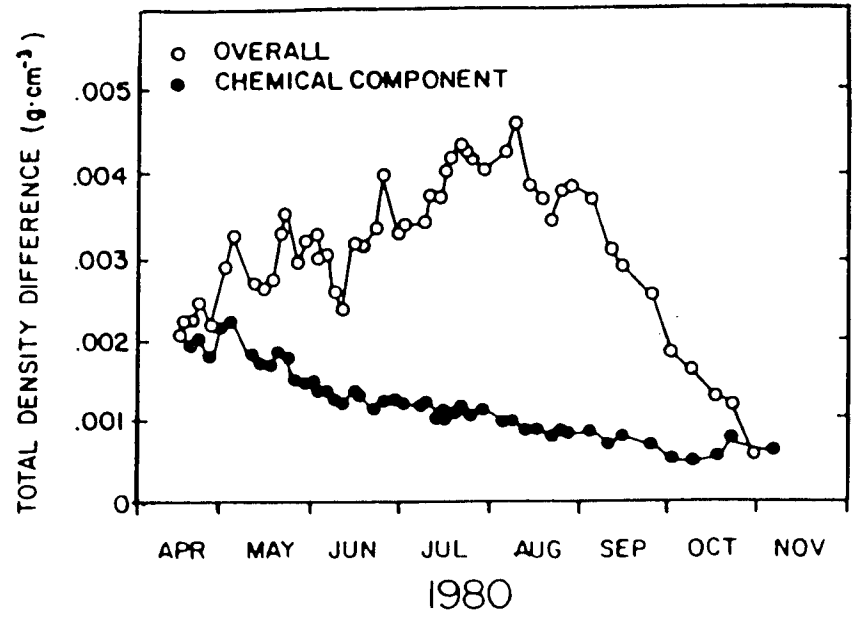

Fig. 2. Temporal distributions of total vertical density differences and the chemical component in Onondaga Lake, 1980 (Effler *et al.*, 1986a).

The chemical component of stratification in the lake is clearly significant. This component decreases in magnitude progressively during the stratification period (a reoccurring phenomenon (Owens and Effler, 1985; Onondaga County, 1971–1984)). The chemical component was more than 50% of the total stratification through early June; it represented 39% of the total density difference for the study period of 1980 (Effler *et al.*, 1986a). The chemical component was also found to most often dictate the depth of the upper mixed layer (Effler *et al.*, 1986a).

Chemical stratification is established in Onondaga Lake by the 'plunging' of the dense (Effler and Owens, 1986a) ionic waste (i.e., enters as an underflow (Figure 3)) to the lower layers of the lake during periods (e.g., spring) of low vertical density gradients

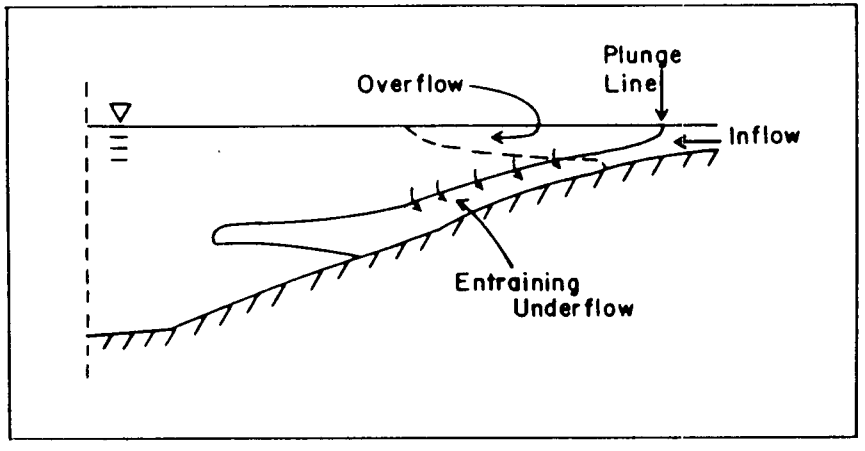

Fig. 3. Basic inflow patterns for entraining underflows and overflows.

(Effler and Owens, 1986a; Owens and Effler, 1985, 1986). The progressive decrease in the chemical component occurs as a result of the subsequent diversion of the chemically enriched underflow to the upper layers, caused by entrainment-based dilution of the underflow and the increase in vertical density gradient following spring (Owens and Effler, 1985, 1986). The increased tendency for plunging during periods of low water-column stability (i.e., low vertical density gradients) causes interrupted and abbreviated turnover periods and extends the duration of stratification (Owens and Effler, 1985, Effler *et al.*, 1986a).

A mathematical model of density stratification was developed and calibrated for Onondaga Lake to quantify the impact of the ionic waste (and cooling water operation) on the stratification regime. The model is a one-dimensional mixed layer model (e.g., Ford and Stefan, 1980; Harleman, 1982; Imberger *et al.*, 1978) which accommodates meteorological, hydrological, and underflow forcing functions (Owens and Effler, 1985). The model simulates with good accuracy the features of the complex stratification of the lake (e.g., the occurrence and timing of turnover, the temperatures of the epilimnion and hypolimnion, the chloride concentrations of the epilimnion and hypolimnion, the depth of the upper mixed layer, and the occurrence of sub-surface maxima in chloride) for the stratification periods of 1980 and 1981, for which there were significant differences in forcing functions (particularly meteorological) and stratification regime. Analyses conducted with the calibrated stratification model indicate the discharge of ionic waste has a major impact on the stratification regime of the lake. The most profound effect is the extension of the period of stratification. The period of stratification was extended by approximately 60% in 1981 because of this discharge (Owens and Effler, 1985). Other impacts identified by the analyses included: increased overall density stratification, increased thermal stratification (e.g., depression of hypolimetic temperatures by several degrees), reduced vertical mixing, and reduced depth of the

upper mixed layer in summer (by approximately 2 m). These findings are not affected greatly by whether an earlier analysis (O'Brien and Gere, 1973; Rooney, 1973) of the contribution of surface discharges to the ionic content of the lake, or the more recent analysis of Effler and Driscoll (1986), is accepted.

The ionic enrichment of the lake also manifests itself through depression of the temperature of maximum density to 3.2 °C (Effler *et al.*, 1986c).

2.1.3. *Exchange Between Onondaga Lake and the Seneca River*

The elevated density of Onondaga Lake compared to that of the Seneca River (Figure 4), that results from the industrial discharge of ionic waste, causes alterations in the hydrodynamics of the outlet and within the river system. For example; inflow of Seneca River water is frequently observed at the outlet (Onondaga County, 1976–1984; Seger, 1980; Stewart, 1978). This usually results in a bi-directional flow regime in the outlet; Seneca River water enters in the top layer, and Onondaga Lake exists in the lower layer. A chloride model was developed to determine exchange between the lake (from various layers) and the river (Owens and Effler, 1986). The net inflow from the river into the lake was approximately 30% of the total for the April through October interval of both 1980 and 1981. Much of the outflow from the lake was from the metalimnion during the periods of river inflow (Owens and Effler, 1986).

The chemically-based density stratification observed in the outlet continues into the Seneca River, and under low (summer) flow conditions, extends downstream to the dam in Phoenix, on the Oswego River (Figure 1(b); Effler, 1982; Effler *et al.*, 1984a), and upstream in the Seneca River to below the Baldwinsville dam (Figure 1(b); Onondaga

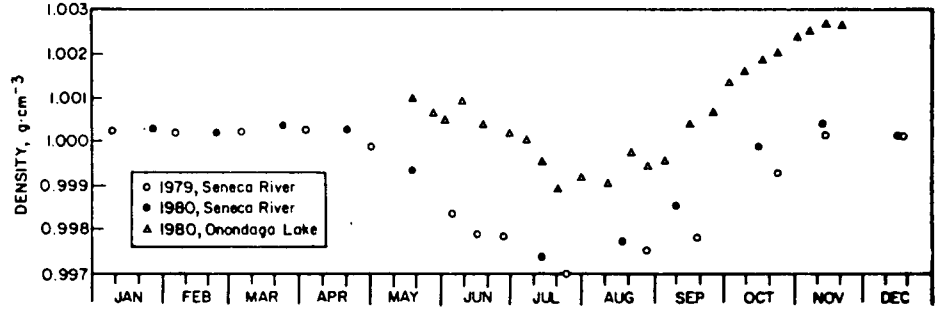

Fig. 4. Seasonal distribution of densities of Onondaga Lake surface water and the Seneca River upstream of the lake inflow (Effler *et al.*, 1984a).

County, 1984b). The longitudinal extent of chemical stratification downstream of the lake, and its magnitude, were found to be dependent on river flow and the difference in density between the lake and river (Effler *et al.*, 1984a). The release of Onondaga Lake water to the river system is highly variable with time, which results in the formation of distinct chloride 'pulses' in the Oswego River (Effler *et al.*, 1984b), that are largely retained until entering Lake Ontario.

The mean annual discharge of chloride from Onondaga Lake for the period 1970–1981 was 7.65×10^5 tonne (Effler *et al.*, 1985a). The alkali plant was the single largest source of Cl to Lake Ontario during that period. The plant contributed 48, 37, and 10% of the U.S. tributary, total tributary, and grand total chloride loading, respectively, to Lake Ontario during the 1970's (Effler *et al.*, 1985a).

2.1.4. *Calcite Oversaturation, Precipitation and Deposition in Onondaga Lake*

The Ca component of the ionic waste discharge from alkali manufacturing demonstrates non-conservative (i.e., reactive) behavior in Onondaga Lake; by inducing oversaturation, precipitation and deposition of $CaCO_3$, mostly in the form of calcite. Oversaturation with respect to calcite *occurs nearly continuously throughout the water-*

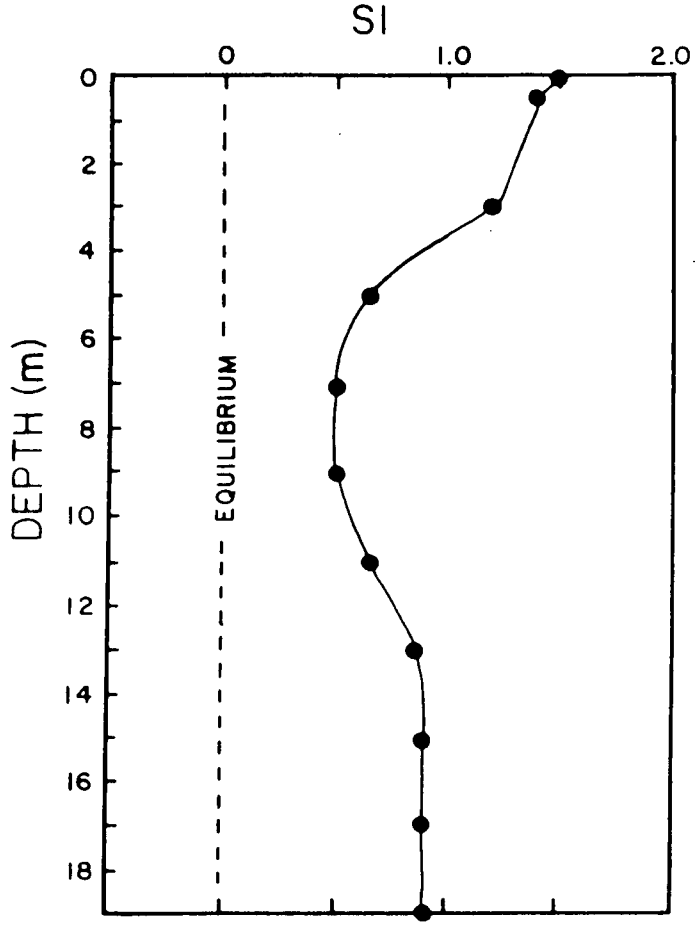

Fig. 5. Typical vertical profile of calcite saturation index in Onondaga Lake, 14 July, 1980.

column of the lake. Vertical differences in the degree of oversaturation occur, as indicated by the typical profile of saturation index (SI) for calcite (SI = log(IAP/K), where IAP is the ion activity product ($\{Ca^{2+}\}\{CO_3^{2-}\}$) and K is the thermodynamic solubility constant for calcite, SI > 0 indicates oversaturation) for 14 July, 1980 (Figure 5), determined with a modified version of the chemical equilibrium model MINEQL. The highly oversaturated condition of the upper waters (Figure 5) results from photosynthetic elevation of pH (Effler and Driscoll, 1985; Wodka *et al.*, 1985); the re-increase in the degree of oversaturation in the lower waters is due to the higher attendant Ca^{2+} concentrations associated with chemical stratification. The continuous oversaturation in Onondaga Lake is extraordinary. Oversaturation with respect to calcite has been documented for shorter periods of time for the epilimnia of a number of hardwater lakes (e.g., Brunskill, 1969; Effler, 1984; Effler *et al.*, 1981b, 1982). Undersaturated conditions were observed in the hypolimnia of these lakes. The extraordinary occurrence of alewife concretions (combustible, chalk-like concretions, composed of Ca-fatty acid compounds) in Onondaga Lake (Dence, 1956; Sondheimer *et al.*, 1966) has been attributed to the conditions of calcite oversaturation in the hypolimnion that persist despite the development of highly anaerobic (e.g., Effler *et al.*, 1986b) conditions (Wilcox and Effler, 1981).

Calcite, formed mostly as a result of the discharge of Ca by the alkali manufacturer, contributes significantly to the particle population of the watercolumn. It was found to be the dominant component of the inorganic particles of the lake (Yin and Johnson, 1984). Further, calcite is a significant component of the turbidity of the lake. Based on a method of partitioning turbidity according to calcite and non-calcite components tested by Effler and Johnson (1986) it is estimated that calcite represented (on average) 22% of the turbidity in the upper waters from mid-May through July of 1985 (Figure 6). The downward flux of precipitated Ca (mostly as calcite), determined from sediment trap collections, is extremely high in the lake (approximately 0.1 mols Ca m^{-2} d^{-1},

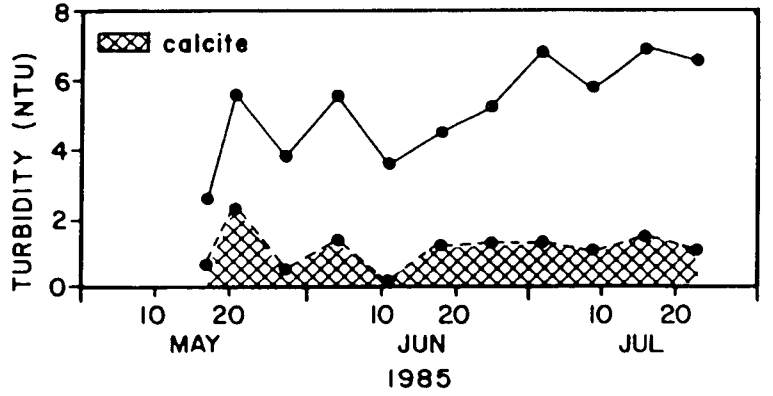

Fig. 6. Temporal distribution of turbidity, and the calcite component of turbidity, in the surface waters of Onondaga Lake, May–July, 1985.

(6 of 16)

from May through September of 1980), and is positively correlated with the level of primary productivity (Effler and Driscoll, 1985). The elevated level of Ca deposition probably also enhances the rate of deposition of a number of other materials. Substantial coprecipitation of P with calcite is considered rare (e.g., Murphy *et al.*, 1983), but is indicated in Onondaga Lake (Wodka *et al.*, 1985). Thirty percent of the particulate P deposited in Onondaga Lake during the sediment trap studies was inorganic (Wodka *et al.*, 1985), presumably coprecepitated with calcite. This mechanism is consistent with the very high value of P retention determined for the lake (Devan and Effler, 1984; Wodka *et al.*, 1985). Wodka *et al.* (1985) hypothesized that calcite forms on the surface of phytoplankton in the productive layers of the lake, as a result of a high pH microenvironment (e.g., Otsuki and Wetzel, 1974) formed in the proximity of active phytoplankton cells. This would increase the effective density of the phytoplankton, and thereby enhance the rate of deposition of these organic particles. Recent analyses with scanning electron microscopy, coupled with energy X-ray spectroscopy, have documented the coating of important zooplankton in the lake with Ca (Garofalo and Effler, 1986). This may also encourage high levels of phytoplankton deposition, by reducing zooplankton grazing pressure.

Using a computerized individual particle analysis technique, Yin and Johnson (1984) determined that approximately 17 000 tonne yr^{-1} of calcite were deposited in Onondaga Lake in 1981. The high rate of deposition of calcite (and associated materials) caused by the industrial discharge manifests itself through extremely high sedimentation rates (5 to 9 cm yr^{-1} in the deepest parts of the lake; determined by Pb-210 dating) for the consolidated sediments of the deep zones of the lake, and by the occurrence of an extensive overlying flocculent layer (> 1 m thick) in these areas (Effler *et al.*, 1979). These sedimentation rates are exceeded only in impoundments with tributaries carrying high sediment loads (e.g., Ritchie *et al.*, 1973). For example, the sedimentation rate of Lake Mendota (0.5 cm yr^{-1}), a hypereutrophic hard water lake (Bortleson and Lee, 1972) is considered high for a natural system. Utilizing the range of sedimentation rates determined for the deep sediments (5 to 9 cm yr^{-1}), hypsographic data for the lake, and a reasonable range of sedimentary focusing (preferential sedimentation in the deeper portions of the lake), it is estimated that the volume of the hypolimnion of Onondaga Lake (below a depth of 10 m) has been reduced by 20 to 40% since the 1880's as a result of the precipitation of calcite induced by the discharge of ionic waste. The thickness of the flocculent layer of the lake is much greater than values reported for other lakes, and is viewed as a manifestation of the very high rate of sedimentation (Effler *et al.*, 1979). The dominant component of the consolidated (Effler *et al.*, 1979) and flocculent (Yin and Johnson, 1984) sediments is calcite. The organic content of both layers is less than 25% (Effler *et al.*, 1979; Honstein *et al.*, 1986).

The character of the near shore sediments has also been greatly altered by the precipitation and deposition of $CaCO_3$. A large $CaCO_3$ delta has formed at the mouth of Nine Mile Creek (Figure 1(a)) due to the earlier discharge of the ionic waste from the settling lagoons (Dean and Eggleston, 1984). The entire bed of the stream from the point of discharge of the lagoons to the lake is covered with the same material (USEPA, 1974).

Much of the near shore zone of the lake (< 2 m), and extending out to depths of more than 10 m (Figure 1(a)), is almost entirely covered with oncolites (ovoid cryptalgal structures) (Dean and Eggleston, 1984). These concretions are composed mostly of calcite (> 90% by weight) and range in size from a few millimeters to as much as 15 cm in diameter (Dean and Eggleston, 1984). The oncolites probably began to form in Onondaga Lake in the 1880's when the ionic waste from alkali manufacturing was introduced (Dean and Eggleston, 1984).

2.1.5. *Ca-P Chemistry of the Flocculent Sediments*

The rate of P deposition (Wodka *et al.*, 1985) and incorporation into the sediments (Devan and Effler, 1984; Effler *et al.*, 1979) of Onondaga Lake is unusually high as a result of the industrial enrichment of Ca in the watercolumn. Thus, a very large reservoir of P exists in the sediments of the lake (e.g., Effler *et al.*, 1979). There is little physical resistance to upward exchange of the fraction of dissolved P contained in the flocculent sediments, as turbulent mixing processes regulate vertical transport through this layer (Effler *et al.*, 1985b). An unusual set of chemical conditions exist in the flocculent sediments of Onondaga Lake with regard to the regulation of pore water P activity, that is yet another manifestation of the industrial discharge of Ca to the lake. A thermodynamically metastable Ca-P mineral (monetite) controls the P activity within the flocculent sediments (Honstein, 1981; Honstein *et al.*, 1986). Thus, P activity is regulated by Ca^{2+} concentration; the relationship is presented in Figure 7. Calcium-P transformations are insensitive to redox potential. As a result of these unusual circumstances, and the existing high concentration of Ca^{2+} in the pore water, the recycle of deposited P back into the overlying waters is very limited; contrary to the 'buffering' action typically observed (e.g. Holdren and Armstrong, 1980; Lee, 1970) for overlying water-sediment interactions.

In most lakes P activity in pore waters is controlled by sorption reactions with Fe (Mortimer, 1941, 1942, 1971). Release of P from the sediments of these lakes is observed upon the development of anaerobic conditions in the overlying water as a result of

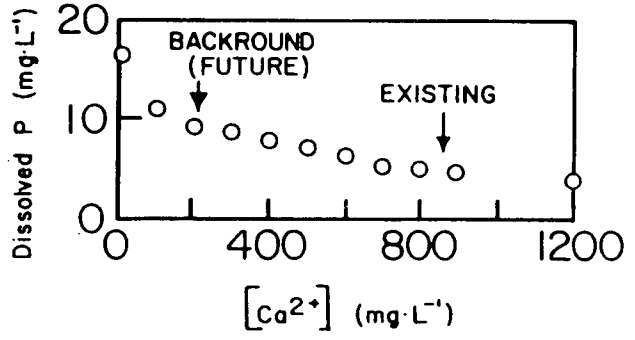

Fig. 7. Phosphorus concentration in the pore water of the flocculent sediments of Onondaga Lake, as a function of pore water concentration of Ca^{2+} (modified from Effler *et al.*, 1985b).

solubilization of Fe precipitates in the sediments (Mortimer, 1941, 1942, 1971). Sedimentary release of P by this mechanism has been shown to be responsible for the failure of certain lakes (e.g., Welsh *et al.*, 1973; Larsen *et al.*, 1981) to respond more positively to P-based reclamation efforts. The very high concentrations of sulfide that develop in the hypoliminon of Onondaga Lake (Effler *et al.*, 1986b) also contribute to the unusual sedimentary P availability conditions, as sulfide probably overwhelms Fe^{2+}, binding it as FeS (Honstein, 1981).

2.2. Cooling Water

The heated (i.e., spent) process cooling water, derived from stratified layers of the lake, is elevated in temperature and salinity compared to the surface waters of Onondaga Lake (Effler and Owens, 1986a). The density of the thermal discharge is generally less than the surface waters of the lake (Effler and Owens, 1986a; i.e., tends to enter the lake as an overflow, e.g., Figure 3). Thus the cooling water operation results in net cycling of water (and associated materials) from stratified layers to the upper layers of the lake when the lower intake is used.

Earlier (Stewart, 1971) measurements indicated rather substantial alterations to thermal stratification occurred in the upper waters of the south basin of the lake (Figure 1(a)), as a result of the shore discharge of the heated water. Much of the south basin failed to freeze during the winter because of this discharge (Stewart, 1971). Mixing of the heated water with the upper waters was improved by the diffuser (1978). Analysis of the performance of the diffuser on a single day indicated that the discharge was incorporated into the upper mixed layer; the largest portion of the plume spread horizontally at a depth of 2 to 3 m (NALCO, 1978). Ice cover has been nearly complete since installation of the diffuser.

Analyses with the calibrated mathematical model of density stratification indicated the use of the lake as a source of cooling water affects the stratification regime of the lake (Owens and Effler, 1985). It partially compensates for the effects of the ionic discharge of the manufacturer by encouraging a deeper upper mixed layer, and by reducing the chemical component of stratification (Owens and Effler, 1985). However, the impact of this use of the lake on its stratification regime is minor by comparison to the impact of the ionic discharge; e.g. the cooling water operation has little effect on the heat content of the lake and on the total water column density difference (Owens and Effler, 1985).

2.3. Mercury and Other Contaminants

2.3.1. *Sediments*

The USEPA (1973) documented the Hg contamination of the sediments of Onondaga Lake based on analysis of 43 core samples (see Figure 8(b) for locations), collected in December of 1970. More than 90% of the surface sediments of the lake were found to be contaminated with Hg (e.g., total Hg concentrations greater than 0.1 mg kg^{-1}); the contamination was limited to the upper 65 cm of (consolidated) sediments (USEPA), 1973). The extent of contamination is great by comparison to other systems (e.g., Hg concentrations in the sediments of Onondaga Lake (USEPA, 1973) exceed the levels observed in the most contaminated areas of the Great Lakes (PLUARG, 1978)), despite the diluting effect of the high sedimentation rate that occurs in the lake (Effler *et al.*, 1979). Mercury was not uniformly distributed in the sediments; as exemplified by the Hg contours determined for sedimentary depths of 7.5 and 30 cm (Figure 8(a) and (b), respectively). The spatial distribution of Hg 'makes it fairly obvious that the prime Hg sources have been the discharges of the chlor-alkali plant via Nine Mile Creek and the East Flume at the plant site at the southwest corner of the lake' (USEPA, 1973; p. 48; e.g., Figure 8(a) and (b)). Transport to mid-lake areas is also indicated (Figure 8(a) and (b)). The estimated total volume of contaminated sediments was 5.3×10^6 m^3; however, it is possible that the volume may be as much as 5 times greater, as substantial compaction may have occurred during the collection of core samples (USEPA, 1973).

Mobilization of Hg from the sediments of Onondaga Lake has been demonstrated; emergent plants, growing in contaminated sediments, were found to be actively releasing Hg to the atmosphere (Kozuchowski and Johnson, 1978). The Hg contamination of fish in the lake is presumably derived from the contaminated sediments (i.e., the chlor-alkali plant discharges (USEPA, 1973)), which indicates that sedimentary Hg is mobilized to the water of the lake.

2.3.2. *Fish Flesh*

Fish may accumulate Hg through consumption of contaminated food and absorption through gills, skin (Norstrom *et al.*, 1976) and the intestinal tract (Phillips, 1977). Following the determination of high concentrations of Hg in fish flesh in Onondaga Lake in 1970 by the Food and Drug Administration (FDA), the New York State Department of Environmental Conservation (NYSDEC) initiated a fish sampling and analysis program to assess the mobility of Hg within the lake's food chain and the safety of fish flesh for human consumption. Substantial temporal variations in fish flesh concentration have occurred since the beginning of the program (Table I). Differences among the species of fish in concentration and temporal trends may reflect differences in metabolism, feeding habits, and trophic level. Migration between the river and lake also affects the observations for certain species (e.g., Walleye (Chiotti, 1981)). Concentrations decreased from the initial high levels of the early 1970's to somewhat lower levels in the mid-1970's. The concentrations in smallmouth bass and white perch decreased further in 1979 to concentrations consistently below 1 ppm (concentrations in walleye pike remained above 1.0 ppm). In 1981, however, Hg concentrations increased in smallmouth bass and walleyes to levels observed in the mid-1970's. Concentrations in 1983 and 1984 were slighly lower than in 1981, but remained substantially above the 1979 observations. The causes of the observed variations are unknown (Sloan and Karcher, 1983), as the processes regulating Hg cycling have not been evaluated.

The data for smallmouth bass have received the greatest attention as this fish population is believed to be the best indicator of trends in Hg levels, because of its localized distribution in the northwest corner of the lake (Sloan, 1984). A direct

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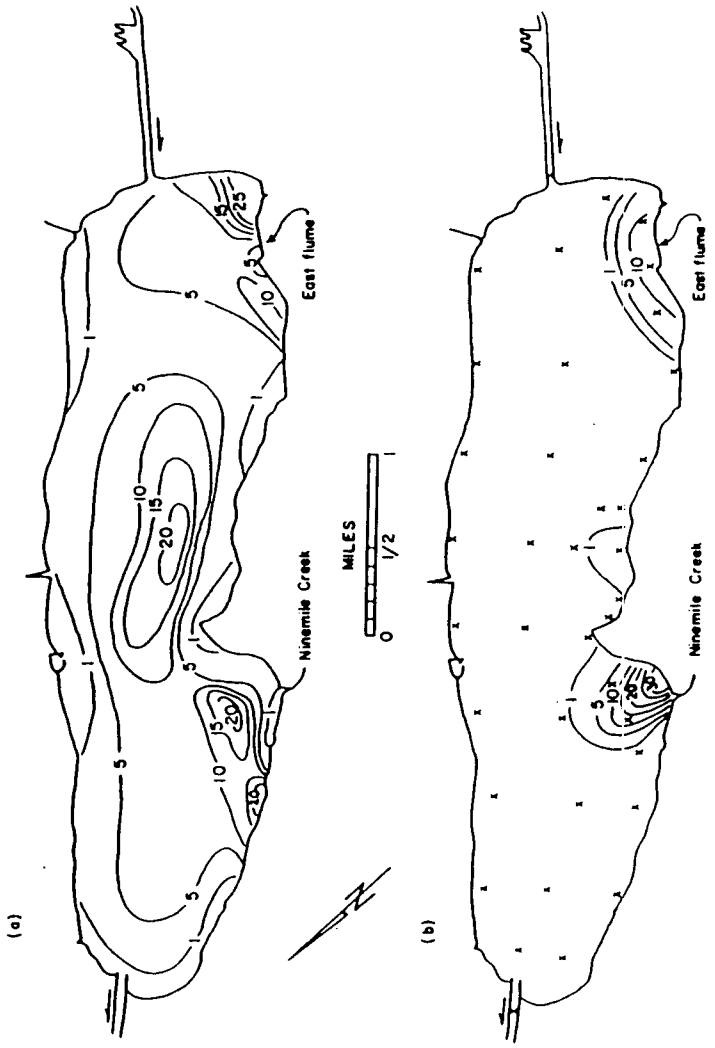

Fig. 8. Contours of total Hg (mg/kg) in the sediments of Onondaga Lake in 1970: (a) depth of 7.5 cm and (b) depth of 30 cm, with core sample locations (USEPA, 1973).

TABLE I

Fish flesh Hg concentrations (ppm, wet weight basis) of selected species from Onondaga Lake (Sloan, 1985)

Year	Smallmouth Bass			White Perch			Walleye Pike		
	No. of fish	Hg concentration		No. of fish	Hg concentration		No. of fish	Hg concentration	
		Range	Average		Range	Average		Range	Average
1972	16	0.61–2.23	1.23	7	0.56–3.55	1.88	–	–	–
1973	–	–	–	60	0.36–2.65	1.29	5	0.37–7.91	4.76
1974	22	0.21–1.40	0.81	30	0.20–2.65	0.90	4	–	1.96
1975	34	0.14–2.04	1.26	51	0.46–2.17	1.37	6	2.28–5.86	3.74
1976	–	–	–	–	–	–	6	0.60–4.07	2.21
1977	–	–	–	–	–	–	18	0.87–4.78	2.16
1978	29	0.24–2.22	0.63	50	0.12–1.50	0.71	1	–	1.39
1979	52	0.38–1.43	0.68	50	0.14–1.50	0.83	34	0.60–3.09	1.30
1980	22	0.70–1.02	0.92	–	–	–	–	–	–
1981	50	0.45–1.78	1.23	48	0.14–1.78	0.91	48	0.65–2.93	1.69
1982	–	–	–	–	–	–	–	–	–
1983	50	0.38–1.86	1.08	–	–	–	–	–	–
1984	50	0.38–1.85	1.03	–	–	–	–	–	–

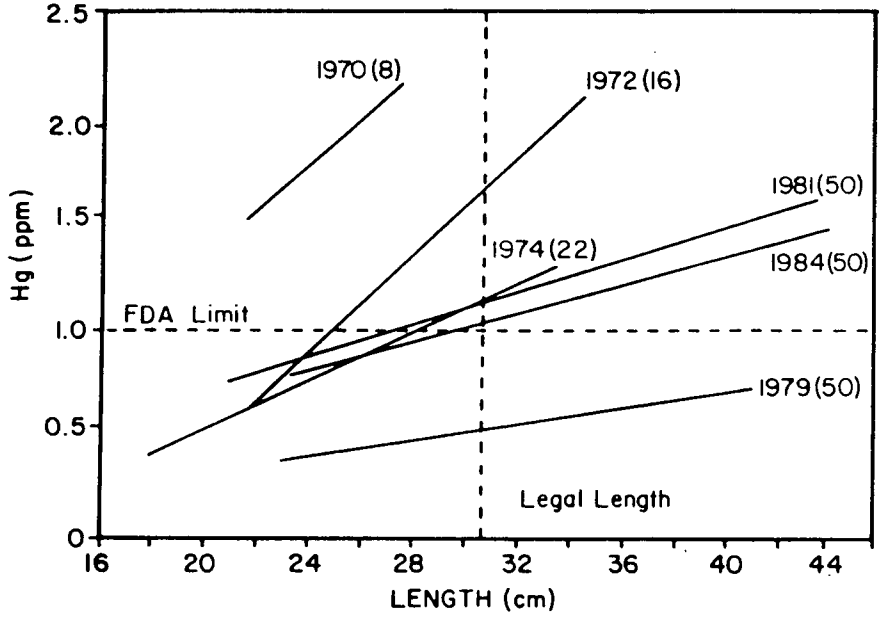

Fig. 9. Mercury concentration (wet weight basis) vs length relationship observed for smallmouth bass in Onondaga Lake, for selected years (from Sloan, 1985).

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relationship between length and concentration of Hg (described by linear regression) occurs in the lake (Sloan and Karcher, 1983). The Hg concentration vs length relationship observed for smallmouth bass for selected years is presented in Figure 9. The dependence of concentration on length was somewhat greater in the early 1970's. The decrease in concentration through the 1970's (to below FDA standards in 1979) and re-increase in the 1980's is apparent.

Analysis of 37 fish samples (composite and individual) collected in 1980 from the lake, performed according to a USEPA interim method, indicated the virtually ubiquitous presence of benzene, chlorobenzene, and dichlorobenzene contaminants in the flesh of a number of species (Hindenlong *et al.*, 1981). Contaminated species included channel catfish, walleye pike, northern pike, smallmouth bass, white perch, white sucker, and gizzard shad. Maximum concentrations (wet weight basis) observed for benzene, chlorobenzene, and dichlorobenzene were 0.2, 0.9, and 0.9 ppm, respectively (Hindenlong *et al.*, 1981). The potential environmental and health risks of this contamination have not been established.

3. Impact of Chlor-Alkali Manufacturing

The impact of chlor-alkali manufacturing on Onondaga Lake and the river system is analyzed here from the perspective of potential resource uses. A matrix of the individual effects, described in previous sections, and the associated impacts on system resources appears in Table II. The facility impacts the fishery and transparency of Onondaga Lake, and the O_2 resources of the Seneca and Oswego Rivers. The impact of this manufacturing operation has clearly been pervasive (Table II), as it has affected a number of fundamental processes that bear on the resources of the systems. Note that the facility has affected a number of processes and characteristics related to trophic state, and therefore interacts with the lake's problem of cultural eutrophication.

3.1. Fishery

The discharges from the chlor-alkali manufacturer have had a deleterious impact on the fishery of Onondaga Lake by eliminating habitat, and contaminating fish flesh.

3.1.1. *Habitat*

The degradation of the fish habitat of the lake by the chlor-alkali facility has two major components: (1) the exacerbation of the problem of limited O_2 resources of the lake, and (2) the blanketing of the lake bottom with calcite precipitate. These components are not totally separable as calcite precipitation contributes to the O_2 problem.

3.1.1.1. *Dissolved oxygen.* Dissolved O_2 is depleted extremely rapidly from the hypolimnion of Onondaga Lake; the 'areal hypolimnetic oxygen deficit' (AHOD) of the lake was between 1.2 and 2.7 g m^{-2} d^{-1} from 1978 through 1981, higher than nearly all values reported in the literature (Effler *et al.*, 1986b). The entire hypolimnion (e.g., bottom 10 m) is anoxic by at least late June of the year (Effler *et al.*, 1986b). The upper

TABLE II

Matrix of effects (v) of chlor-alkali manufacturing and related impacts (+ = positive, − = negative, and ? = uncertain)

Effects	Impacts		
	Fishery	Transparency	River oxygen resources
Ionic waste			
Lake Ionic Content	v(−)	v(−)	v(−)
Altered Stratification	v(−)	v	v
reduced vertical mixing	v(−)	v(+)	
extended period of stratification	v(−)		
plunging inflow	v(−)	v(+)	
interrupted turnover	v(−)		
reduced mixed layer depth	v(−)	v(−)	
secondary stratification	v(−)		
Lake/River Exchange		v(?)	v(−)
bi-directional exchange		v(?)	
metalimnetic lake release			
chemical stratification in river			v(−)
dynamic lake releases			v(?)
Calcite	v(−)	v(−)	
continuous oversaturation	v(−)	v(−)	
turbidity in lake		v(−)	
deposition	v(−)		
deep sediments	v(−)		
near shore	v(−)		
coprecipitation		v(+)	
Ca–P Chemistry of Sediments			
Ca^{2+} regulation of P		v(+)	
Cooling Water			
cycling of hypolimnetic water		v(−)	
alteration of stratification	v(+)		
Mercury			
sediment contamination	v(−)		
fish flesh contamination	v(−)		

boundary of anoxia often occurs above the hypolimnion (e.g. Figure 10). A broad depth interval of O_2 concentrations stressful to fish (e.g., 0 to 4.0 mg L^{-1}) is frequently observed (e.g., Figure 10); at times this interval expands up to 4 m below the surface. Anaerobic conditions develop (mostly in the hypolimnion) following the occurrence of anoxia. Hypolimnetic volume weighted concentrations of sulfide species increase progressively through mid-September to greater than 10 mg L^{-1}; concentrations greater than 20 mg L^{-1} occur proximate to the sediments (e.g., Effler *et al.*, 1986b). The O_2 requirements associated with the existing water quality designations of the lake are violated infrequently in summer (e.g., Sze and Kingsbury, 1972) and frequently in fall.

The loss of O_2 from hypolimnia has generally been related to the level of productivity in the upper layer; e.g., several empirical relationships have been developed to predict

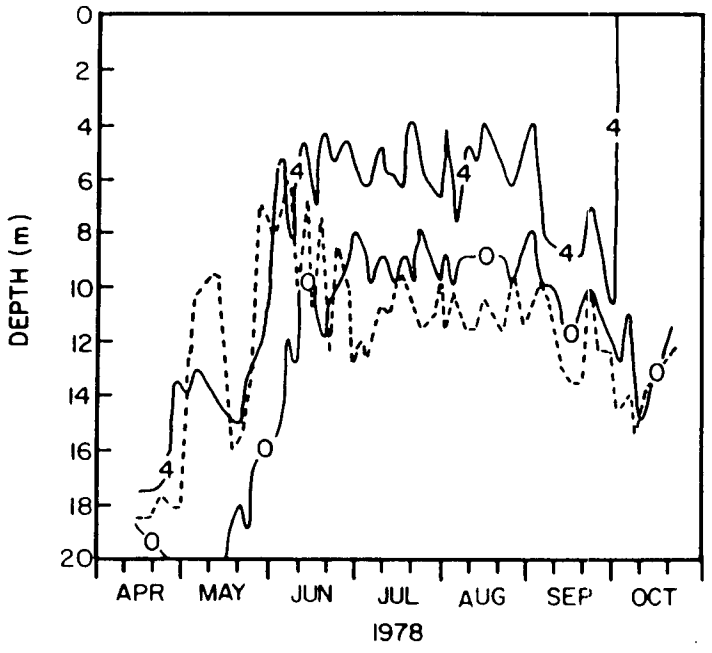

Fig. 10. Isopleths of dissolved oxygen, 0 and 4 mg L^{-1}, for Onondaga Lake, 1978. Dashed line indicates upper boundary of hypolimnion.

AHOD based on trophic state indices (e.g., Cornett and Rigler, 1979; Walker, 1979; Welsh and Perkins, 1979). A conceptual framework for hypolimnetic O_2 dynamics is presented in Figure 11, that can accommodate ecosystem-specific factors, and in particular, some of the individual effects of the chlor-alkali manufacturer. The dynamics of O_2 in the hypolimnion are a function of its volume, the duration of stratification, and the rates of O_2 demanding and supplying processes (Figure 11; note photosynthesis is not a source of O_2 to the hypolimnion of Onondaga Lake because of limited light penetration). The discharge of ionic waste has exacerbated the problem of limited O_2 resources of the lake by altering the stratification regime of the lake and by inducing abnormally high rates of phytoplankton settling and overall sedimentation.

The features of the stratification regime that have been altered by the ionic discharge, and that have deleterious effects on the O_2 resources of the lake include: (1) elevated density stratification, (2) prolonged periods of stratification, (3) the irregular occurrence and abbreviated nature of turnover, and (4) propensity for the formation of secondary stratification. The elevated density stratification results in reduced vertical mixing (e.g., Jassby and Powell, 1975; Effler and Field, 1983), and thus reduced vertical mixing-based inputs of O_2 into the hypolimnion from the overlying oxygenated layers (Figure 11). The extended period of stratification does not affect the rate of O_2 depletion (i.e., AHOD).

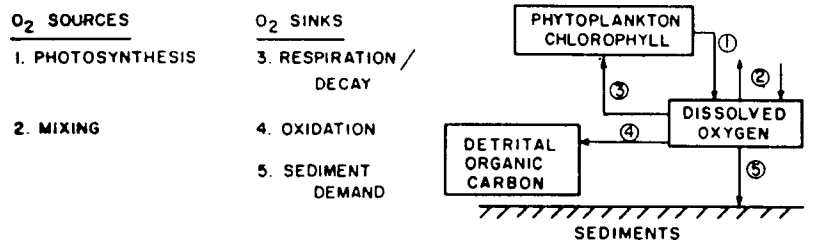

Fig. 11. Conceptual framework for hypolimnetic dissolved oxygen.

However, it prolongs the period of anoxia (Figure 10), thereby increasing the concentration of O_2 demanding reduced chemical species (e.g., sulfide) that develops in the hypolimnion. The high concentrations of O_2 demanding reduced chemical species encourages the depletion of O_2 from depths overlying the hypolimnion (e.g., Figure 10), and is largely responsible for the frequent contravention of dissolved O_2 standards in the lake during fall. The extremely high concentrations of sulfide also play a role in limiting the cycling of P from the sediments. The irregular turnover characteristics (e.g., failure of vernal turnover to occur in some years and the occurrence of restratification following the onset of turnover (Effler *et al.*, 1986b)) caused by the ionic discharges inhibit oxygenation of the lower layers of the lake and stabilization of the deposited organic material. Secondary stratification, along with the high concentrations of O_2 demanding chemicals and reduced vertical mixing, encourages the depletion of dissolved O_2 above the hypolimnion. This effect was probably more severe when cooling water was preferentially withdrawn from the epilimnion in summer, as preferential withdrawal from the deeper intakes compensates in part for the tendency for the formation of secondary stratification (Owens and Effler, 1985).

The high rate of precipitation of calcite induced by the ionic discharge has accelerated the rate of deposition of O_2 demanding material, in the form of phytoplankton, and reduced the volume of the hypolimnion. Both effects exacerbate the O_2 problems of the lake by increasing the rate of O_2 depletion, and subsequent production of reduced chemical species, in the hypolimnion (e.g., Figure 11). Phytoplankton, and related degradation products, are the major sources of organic material reaching the lower waters, as allochthonous organic loadings are small compared to autochthonous production (Freedman *et al.*, 1980). The 'filling-in' of the lake has caused an increase in the rate of O_2 depletion of a magnitude similar to the extent of reduction of the volume of the hypolimnion (20 to 40%), as the volume of the hypolimnion largely dictates its initial O_2 resources (e.g., kg of O_2) upon the onset of stratification (e.g., Martin *et al.*, 1985).

It is likely that O_2 concentrations stressful to most fish (e.g., <4.0 mg L^{-1}) would develop in the hypolimnion of Onondaga Lake before fall turnover due solely to its eutrophic condition (Effler *et al.*, 1986b; i.e., cold-water fishing precluded). However, the ionic waste input undoubtedly reduces the vertical range of fish (and other O_2

sensitive organisms) in the lake, and has a deleterious effect on the temporal features of that range, by expanding the depth interval through which stressful O_2 concentrations occur and by accelerating the rate of O_2 depletion in the hypolimnion.

3.1.1.2. *Calcite sediments.* An active littoral zone and benthic community are important in supporting a healthy fishery. Macrophytes provide valuable habitat for fish by providing conditions conducive to spawning, by encouraging the development of a community of diverse organisms which serve as food for fish, and by providing cover from predators. Macroinvertebrates represent an important source of food for a number of fish. The macrophyte and benthos (e.g., Noble and Forney, 1971) populations of the lake are both depressed by the inappropriate substrate created by calcite deposits, that have accumulated as a result of the ionic discharge. The highly inorganic composition and 'ooze-like' consistency of the sediments in the deeper portions of the lake are probably nearly as limiting to benthos as the existing anoxia. Low organic content and nutrient availability (e.g., Wetzel, 1983) make the deposits of the near-shore zone largely unsuitable for supporting a large population of macrophytes. Light availability (e.g., Field and Effler, 1983b; Effler *et al.*, 1984c) probably limits macrophyte growth in the lake to depths < 2 m. An active littoral community is absent from most of the lake in the near shore zone in depths < 2 m. Oncolites and other $CaCO_3$ deposits instead cover most of these areas (Dean and Eggleston, 1984). The near absence of stream flora and fauna in Nine Mile Creek from the point of discharge below the settling lagoons to the lake is at least in part due to similar substrate limiting conditions.

The interaction between photosynthetic surfaces and calcite precipitation further discourages the development of a littoral zone in the lake. The photosynthetically induced precipitation of $CaCO_3$ on macrophytes in hard water lakes is well known (e.g., Wetzel, 1983). However, the extremely high rate of calcite precipitation on plant surfaces in Onondaga Lake apparently overwhelms macrophytes (i.e., eliminates continued growth by covering photosynthetic surfaces). Dean and Eggleston (1984) have attributed the loss of charophytes (the most common nucleus for the oncolites) from the lake (more than 50 yr ago, probably in the 1880's) in part to this mechanism. Macrophytes (*Myriophyllum* sp.) recently observed in the lake by the author were highly coated with white (presumably calcite) precipitate.

3.1.1.3. *Fish population.* A relatively diverse warm-water fish population exists in Onondaga Lake (e.g., Noble and Forney, 1971; Chiotti, 1981). The species composition has not changed appreciably since state surveys in 1927 and 1946, except for the recently developed large population of white perch (Noble and Forney, 1971). The diversity is somewhat misleading as a number of species (e.g., northern pike and walleye pike (Chiotti, 1981)) do not naturally reproduce in the lake, but migrate into the lake from the Seneca River by way of the outlet. Other fish (e.g., yellow perch, black crappies, and pumpkin seeds) demonstrate only sporadic reproductive success in the lake (Chiotti, 1981). The distribution of fish is not uniform in the lake (Noble and Forney, 1971). The populations are lower in the southern basin; the greatest populations are observed along

the northeastern shore (Noble and Forney, 1971). The distribution probably reflects in part the locations of discharges and the outlet. The fish population in the lake is presently artifically high because of the lack of fishing pressure (Chiotti, 1981). The potential of the lake's fishery to resist fishing pressure is not considered promising because of the lack of appropriate fish habitat (Chiotti, 1981). Improvement in the fishery would be dependent on improvement in the lake O_2 resources (Chiotti, 1981) and development of an active littoral zone.

3.1.2. *Fish Flesh Contamination*

3.1.2.1. *Mercury.* The NYSDEC prohibited human consumption of fish from Onondaga Lake in 1972, as a result of high concentrations of Hg measured in fish flesh collected in 1970 (Table I), which exceeded the standard of 0.5 ppm (wet weight basis; changed to 1.0 ppm in 1979). The concentrations found in fish from Onondaga Lake generally exceed those observed throughout the Great Lakes, and are comparable to those observed in Lake St. Clair, a system that was also contaminated by chlor-alkali discharges (PLURAG, 1978). The contamination in Onondaga Lake presumably occurrs as a result of the mobilization of sedimentary Hg, which originated from the chlor-alkali facility. Fish flesh in the lake was undoubtedly contaminated with Hg before 1970; probably soon after the discharge of Hg from the Hg cell chlor-alkali process started in 1946. Contamination of some fish in the river system has almost certainly occurred as a result of the Onondaga Lake contamination, as certain fish (e.g., walleye pike and northern pike (Chiotti, 1981)) migrate between the lake and the river. The lake was closed to fishing in 1972 by the NYSDEC because of the Hg contamination of fish flesh.

Changes in the Hg contamination of small mouth bass in Onondaga Lake since 1970, with respect to the FDA standard of 1.0 ppm, are illustrated in Figure 12. Substantial

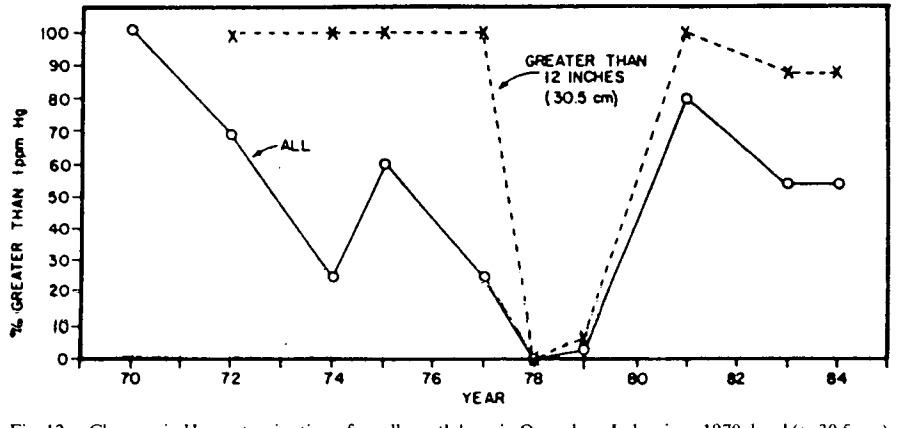

Fig. 12. Changes in Hg contamination of smallmouth bass in Onondaga Lake since 1970, legal (> 30.5 cm) and all sizes.

changes have occurred; the reductions in 1978 and 1979 were particularly dramatic (and remain unexplained). The most recent measurements (Figure 12) indicate only minor improvements have occurred with regard to the acceptability of legal (> 30.5 cm in length) individual fish since the original closure of the lake to fishing. Consideration is being given by the NYSDEC to reopening the lake to fishing. However the fish could not be eaten, as they continue to frequently exceed the FDA standard (e.g., Figure 12). The reopening of the fishery would apparently represent a policy change, as it would not be linked to any progressive trend in the Hg concentration of fish flesh in the lake (e.g., Table I, Figures 9 and 12).

3.2. Transparency

Light is attenuated in water by the processes of absorption and scattering. These processes also control transparency (visibility of submerged objects), as measured with a Secchi disc. Materials in water that attenuate light (and thereby reduce transparency) include: dissolved yellow (organic) substances, phytoplankton, and inanimate particles. Water and dissolved yellow substances absorb light, phytoplankton absorb and scatter light, and inanimate particles mostly scatter light. Transparency is effected preferentially by scattering materials compared to absorbing materials (Effler, 1985). Many lake restoration programs focusing on the reduction of phytoplankton populations through the reduction of nutrient loading may be more appropriately described as being directed at an anticipated attendant improvement in the aesthetic quality of water clarity, as measured by Secchi disc transparency. Effler (1985) has recommended that such programs give careful consideration to the relative contribution of other attenuating (particularly scattering) materials, and their controllability.

The ionic discharges from the chlor-alkali manufacturer have had a deleterious impact on the transparency of Onondaga Lake by inducing the precipitation of calcite; a material that attenuates light through scattering (e.g., Weidemann *et al.*, 1985; Effler *et al.*, 1985c). The chlor-alkali facility may have further impact on the lake's transparency by affecting phytoplankton biomass.

3.2.1. *Existing Conditions*

Transparency exceeded 1.2 m, the swimming safety guideline in New York State, on only 9 of 100 occasions that Secchi disc measurements were made by the author and co-workers in the June to 15 September interval of 1978 (Effler *et al.*, 1984c), 1979, 1980, 1981, 1982, and 1985. Similar conditions have prevailed since at least 1969 (Devan and Effler, 1984), and probably much longer. Substantial temporal variations in transparency occur. Secchi disc values < 0.6 m have been observed, and values of less than 0.8 m are common from late spring through early to mid-summer (e.g., Figure 13). An earlier effort (Field and Effler, 1983b) to partition light attenuation in the lake according to contributing components by an empirical approach (e.g., not according to scattering and absorbing components) indicated that temporal changes in attenuation (and transparency) were regulated mostly by phytoplankton. However, non-phytoplankton

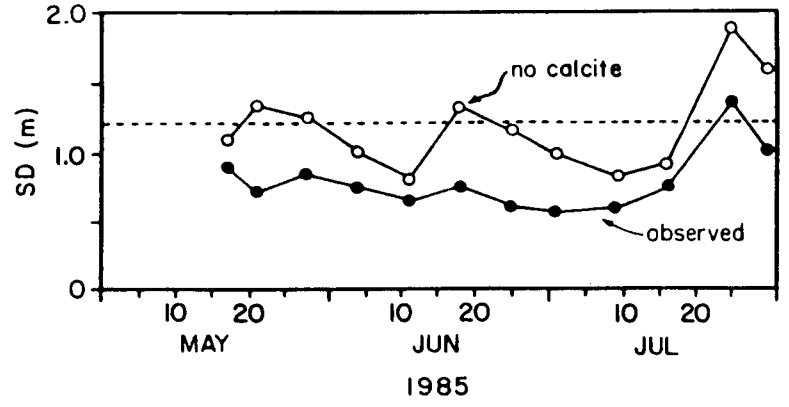

Fig. 13. Secchi disc transparency in Onondaga Lake from May through July of 1985; observed and predicted for absence of calcite.

materials contributed significantly to attenuation (and transparency), and these components also varied with time (Field and Effler, 1983b).

3.2.2. *Calcite*

A mechanistic model framework for light partitioning (i.e., according to scattering and absorption) was subsequently applied to the lake to estimate the contribution of different components to time-averaged conditions (Effler *et al.*, 1984c). Calcite was estimated to represent approximately 8% of the attenuation (Effler *et al.*, 1984c); this corresponds to approximately 15% of the transparency. However, the partitioning was described as speculative (Effler *et al.*, 1984c), in part due to limitations associated with the estimate of the scattering due to calcite. The recent determinations of calcite turbidity (Figure 6) provide a more reliable basis to evaluate the role calcite plays in transparency in the lake, as turbidity has been found to be a good estimator of scattering (DiToro, 1978; Kirk, 1981; Effler and Auer, 1986). Secchi disc transparencies measured in Onondaga Lake for the same interval as presented for turbidity are shown in Figure 13. Also presented are the transparencies that would have occurred in the absence of calcite, calculated with expressions presented by Effler *et al.* (1984c). Clearly the calcite precipitate formed as a result of the ionic waste discharge is a significant component with regard to transparency in the lake, transparency would have been 44% greater in the absence of calcite. The transparency would have been acceptable for swimming (> 1.2 m) on several occasions in the absence of calcite. However, the attenuation regime of the lake may be more dynamic than implied by this analysis (see subsequent discussion).

3.2.3. *Phytoplankton Biomass*

Phytoplankton biomass is the major regulator of transparency in many lakes (e.g., Megard *et al.*, 1979; Field and Effler, 1983b). The amount of biomass present at any

given time is a manifestation of the imbalance in production and loss (e.g., settling, grazing, respiration/death) processes. There are at least four ways in which the chlor-alkali facility may have affected the phytoplankton biomass in Onondaga Lake: (1) by increasing background (i.e., non-phytoplanktonic) light attenuation, (2) by enhancing phytoplankton deposition, (3) by encouraging the formation of secondary stratification, and (4) by altering internal and external P loading. The first two effects would tend to decrease biomass by reducing the availability of light (e.g., Megard *et al.*, 1979; Field and Effler, 1983b) and increasing phytoplankton losses, respectively. However, the shallower upper mixed layer that accompanies secondary stratification encourages higher phytoplankton concentrations in nutrient-rich lakes (Stefan *et al.*, 1976). The overall effect of the alterations in P loading on P availability and phytoplankton growth remains uncertain, largely because of the complex regime created by the facility's activities.

Nutrient (particularly P) availability is a major factor controlling phytoplankton production, that is usually the focus of reclamation efforts for eutrophic systems. The chlor-alkali facility has altered P cycling and loading in a number of ways, associated with its ionic discharge and cooling water operation. The ionic loading from the facility has altered the behavior of P in the lake in at least four important ways (Effler *et al.*, 1985b): (1) it has caused reduced cycling of dissolved P to the upper productive layers from the hypolimnion via diffusivity based transport, as a result of the increased density stratification (Wodka *et al.*, 1983), (2) it has enhanced the chemical reactivity of P in the upper waters of the lake (Wodka *et al.*, 1985), therby reducing the relative availability of this nutrient to phytoplankton, (3) as a result of this reactivity, it has accelerated the rate of removal of P from the productive layers of the lake (Devan and Effler, 1984; Wodka *et al.*, 1985), and (4) it has encouraged the development of a rather unusual mineral phase in the flocculent sediments, which limits P availability (Figure 7; Honstein, 1981; Honstein *et al.*, 1985). Taken individually and together, these features of P behavior are highly non-conservative in nature, and therefore may be beneficial in limiting phytoplankton biomass, as they reduce the availability of P and limit its internal cycling (Effler *et al.*, 1985b).

Unfortunately, the P loading to the upper productive layers that accompanies the cooling water operation of the chlor-alkali manufacturer counteracts the benefits of reduced P availability and cycling that have been attributed to the ionic waste. The load apparently has two components (Effler and Owens, 1986b): (1) the elevated concentrations that develop in the hypolimnion of the lake (e.g., Wodka, 1981) associated with stabilization processes, and (2) an external in-plant component from the facility. Minor reductions in P loading to the productive layers accompany the plunging inflow phenomenon in the spring and fall of the year (Effler and Owens, 1986b). The estimated P loading associated with the cooling water operation is compared to the total loading from all other external sources (Devan and Effler, 1984) for the May through August interval of 1981 (tertiary treatment was operational from mid-May to mid-September) in Figure 14. The cooling water load was greater than the sum of all other loads in July, and was more than 60% of the loading from all other external sources for the entire

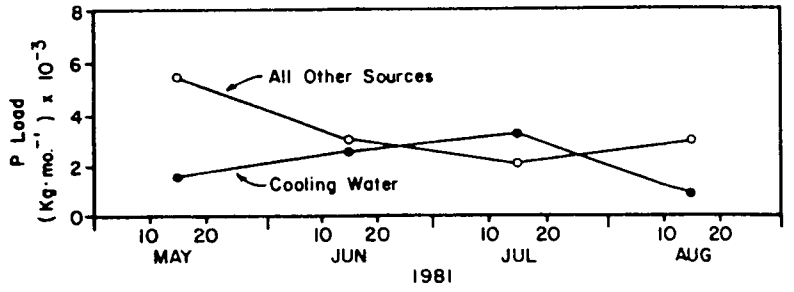

Fig. 14. Comparison of P loading to the epilimnion of Onondaga Lake from cooling water discharge to that from all other sources, May–August, 1981.

interval. The timing of the cooling water load is unfortunate as it doubtlessly contributes to maintaining phytoplankton growth following the rapid loss of P from the water column that occurs after spring turnover (e.g., Wodka, 1981; Wodka *et al.*, 1983, 1985).

Synthesis of the various effects of the chlor-alkali facility on P cycling/loading and phytoplankton biomass has been confounded by the complexity of the regime. Clearly simple P models (e.g., Dillon and Rigler, 1974, 1975) are inappropriate because a number of assumptions implicit in their application are contravened as a result of the effects of the facility. A more sophisticated mechanistic model is necessary to quantify the overall impact of the facility on P cycling and phytoplankton biomass in the lake.

3.3. Oxygen Resources of the Seneca and Oswego Rivers

The chemical stratification in the Seneca and Oswego Rivers, that occurs routinely in summer (mostly as a result of the discharge of ionic waste by the alkali manufacturing facility) is accompanied by the development of substantial dissolved O_2 stratification (vertical differences >3 mg L^{-1}) downstream of the lake outlet (Effler *et al.*, 1984a). Conditions approaching anoxia have been observed in the lower layer of the Seneca River between the lake outlet and the Three Rivers junction (Figure 1(b)); dissolved O_2 concentrations <4.0 occur routinely in summer (Effler *et al.*, 1984a). Oxygen stratification in large slow moving rivers is not unusual, however, the degree observed in the Seneca River is extraordinary, and is a manifestation of the attendant chemical stratification (Effler 1984a). The lower layer is Onondaga Lake water. Chemical stratification encourages depletion of O_2 from the lower layer by: (1) isolating high concentrations of organic material (mostly in the form of phytoplankton) in the lower layer (beyond the limits of the trophogenic zone (Effler, 1982; Effler 1984a)), and (2) inhibiting vertical mixing-based O_2 input from the overlying layer (Effler 1984a).

The occurrence of severe O_2 depletion in the lower waters of the river has not been interpreted to contravene existing standards applied to that section of the river (classified 'B'), as the surface waters meet the requirements. The distributions of fish and benthos are no doubt affected in the portion of the river where severe depletion of dissolved O_2 occurs in the lower waters.

6. Summary

The use of Onondaga Lake for the disposal of wastes and as a source of cooling water by an adjoining chlor-alkali plant has altered many fundamental processes and characteristics of the lake and the river system that receives the lake's discharge. The effects of the activities of this industry on these systems has been pervasive, as the alterations include: (1) ionic enrichment of the lake and the Seneca and Oswego Rivers downstream of the lake, (2) extraordinary hydrodynamic features of lake stratification, exchange between the lake and Seneca River, and stratification in the Seneca and Oswego Rivers, (3) precipitation of large quantities of $CaCO_3$ (mostly as calcite) and related materials, (4) regulation of sedimentary P availability by concentrations of Ca^{2+}, and (5) contamination of sediments and fish flesh.

The discharges from the chlor-alkali manufacturer have had a deleterious impact on the lake's fishery and transparency (i.e. swimming), and the O_2 resources of the Seneca River. The facility has impacted the fishery by eliminating habitat and contaminating fish flesh. It has impacted transparency by inducing the precipitation of calcite. The facility may further impact transparency by affecting phytoplankton biomass. It has also stressed the O_2 resources of the lower layer of portions of the Seneca and Oswego Rivers.

The closure of the chlor-alkali facility will cause dramatic changes in a number of features of Onondaga Lake and the river system. A number of changes can probably be accurately anticipated, others are highly uncertain and unquantifiable, while others cannot be anticipated from the available information.

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References

Babiarz, P. and Pilon, K.: 1979, *Water Quality Management on the Eastern Oswego River Basin*, Central New York Regional Planning and Development Board, Syracuse, New York.
Bortleson, G. C. and Lee, G. F.: 1972, *Envir. Sci. Tech.* **6**, 799.
Brunskill, G. J.: 1969, *Limnol. Oceanogr.* **14**, 839.
Chen, C. T. and Millero, F. J.: 1977, *Nature* **266**, 707.
Chiotti, T. L.: 1981, *Onondaga Lake Survey Report 1980 and 1981*, N.Y.S. Department of Environmental Conservation, Cortland, New York.
Clark, J. V. H.: 1849, *Onondaga*, Stoddard and Babcock, Syracuse, New York.
Cornett, R. J. and Rigler, F. H.: 1979, *Science* **205**, 580.
Dean, W. E. and Eggleston, J. R.: 1984, *Sediment. Geol.* **40**, 217.
Dence, W. A.: 1956, *Copeia* **3**, 155.
Devan, S. P. and Effler, S. W.: 1984, *J. Env. Eng. Div. ASCE* **110**, 93.
Dillon, P. and Rigler, F.: 1974, *Limnol. Oceanogr.* **19**, 767.

Dillon, P. and Rigler, F.: 1975, *J. Fish. Res. Bd. Can.* **32**, 1519.
DiToro, D. M.: 1978, *Wat. Res.* **12**, 1059.
Effler, S. W. (ed.): 1982, *A Preliminary Water Quality Analysis of the Three Rivers System*, The Upstate Freshwater Institute, Inc.
Effler, S. W.: 1984, *J. Great Lakes Res.* **10**, 3.
Effler, S. W.: 1985, *J. Env. Eng. Div. ASCE* **111**, 448.
Effler, S. W. and Auer, M. T.: 1986, *Water Resour. Bulletin* (in review).
Effler, S. W. and Driscoll, C. T.: 1985, *Envir. Sci. Tech.* **19**, 716.
Effler, S. W. and Driscoll, C. T.: 1986, *Water, Air, and Soil Pollut.* **27**, 29.
Effler, S. W. and Field, S. D.: 1983, *J. Freshwat. Ecol.* **2**, 273.
Effler, S. W. and Johnson, D. L.: 1986, *Water Resour. Bull.* in press.
Effler, S. W. and Owens, E. M.: 1986a, *Water, Air, and Soil Pollut.* **28**, 105.
Effler, S. W. and Owens, E. M.: 1986b, *J. Env. Eng. Div. ASCE* (in review).
Effler, S. W., Rand, M. C., and Tamayo, T.: 1979, *Water, Air, and Soil Pollut.* **12**, 117.
Effler, S. W., Field, S. D., Meyer, M. A., and Sze, P.: 1981a, *J. Env. Eng. Div. ASCE* **107**, 191.
Effler, S. W., Field, S. D., and Wilcox, D. A.: 1981b, *J. Freshwat. Ecol.* **1**, 141.
Effler, S. W., Field, S. D., and Quirk, M.: 982, *Freshwat. Bio.* **12**, 139.
Effler, S. W., McCarthy, J. M., Simpson, K. W., Unangst, F. J., Schafran, G. C., Schecher, W. D., and Khalil, M. T.: 1984a, *Water, Air, and Soil Pollut.* **21**, 335.
Effler, S. W., Perkins, M. G., and Field, S. D.: 1984b, *Water, Air, and Soil Pollut.* **23**, 69.
Effler, S. W., Wodka, M. C., and Field, S. D.: 1984c, *J. Env. Eng. Div. ASCE* **110**, 1134.
Effler, S. W., Devan, S. P., and Rodgers, P.: 1985a, *J. Great Lakes Res.* **11**, 53.
Effler, S. W., Driscoll, C. T., Wodka, M. C., Honstein, R., Devan, S. P., Jaran, P., and Edwards, T.: 1985b. *Water, Air, and Soil Pollut.* **24**, 121.
Effler, S. W., Johnson, D. L., Perkins, M. G., and Brooks, C. M.: 1985c, *A Selective Limnological Analysis of Otisco Lake*, publication of the Upstate Freshwater Institute, Inc., Syracuse, New York.
Effler, S. W., Owens, E. M., Schimel, K.: 1986a, *Water, Air, and Soil Pollut.* **27**, 247.
Effler, S. W. Perkins, M. G., and Brooks, C. M.: 1986b, *Water, Air, and Soil Pollut.* **29**, 93.
Effler, S. W., Schimel, K., and Millero, F. J.: 1986c, *Water, Air and Soil Pollut.* **27**, 169.
Field, S. D. and Effler, S. W.: 1983a, *J. Env. Eng. Div. ASCE* **109**, 830.
Field, S. D. and Effler, S. W.: 1983b, *Arch. Hydrobiol.* **98**, 409.
Ford, D. E. and Stefan, H. G.: 1980, *J. Hydraul. Div. ASCE* **108**, 302.
Freedman, P. L., Canale, R. P., and Pendergast, J. F.: 1980, *J. Env. Eng. Div. ASCE* **106**, 335.
Garofalo, J. and Effler, S. W.: 1986, *Envir. Sci. Tech.* (in review).
Geraghty and Miller, Inc.: 1980, 'Hydrogeologic Investigation at Allied Chemical Corporation Syracuse Works Solvay, New York', submitted to Allied Chemical Solvay, New York.
Geraghty and Miller, Inc.: 1982, 'Groundwater Quality Conditions at the Former Willis Avenue Plant', submitted to Allied Chemical Solvay, New York.
Groundwater Technology: 1984a, 'Hydrogeologic Investigation Allied Chemical an Allied Corporation Company Willis Avenue and Lakeshore Area Solvay, New York', submitted to Allied Chemical Solvay, New York.
Groundwater Technology: 1984b, 'Shallow Aquifer Hydrogeologic Investigation Allied Chemical an Allied Corporation Company Willis Avenue and Lakeshore Area Solvay, New York', submitted to Allied Chemical Solvay, New York.
Harleman, D. R. F.: 1982, *J. Hydraul. Div. ASCE* **108**, 302.
Hindenlong, D. M., Rudewicz, P., and Smith, D. E.: 1981, *Analysis of Onondaga Lake Fish Samples for Benzene and Chlorobenzene*, Allied Chemical Corporation Memorandum to R. S. Price.
Holdren, G. C. and Armstrong, D. E.: 1980, *Envir. Sci. Tech.* **14**, 79.
Honstein, R. L.: 1981, 'An Assessment of Mechanisms by Which Phosphorus may be Regulated Within the Sediments of Onondaga Lake, New York', Masters Thesis, Syracuse University, Syracuse, New York.
Honstein, R. L., Driscoll, C. T., Effler, S. W., and Johnson, D. L.: 1986, *Water, Air, and Soil Pollut.* (accepted).
Imberger, J., Patterson, J., Hebbert, B., and Loh, I.: 1978, *J. Hydraul. Div. ASCE* **104**, 725.
Jackson, D. F.: 1968, 'Onondaga Lake, New York – An Unusual Algal Environment', in D. F. Jackson (ed.), *Algae, Man, and the Environment*, Syracuse University Press, Syracuse, New York.
Jassby, A. and Powell, T.: 1975, *Limnol. Oceanogr.* **20**, 530.
Kirk, J. T. O.: 1981, *Austral. J. Mar. Freshwat. Res.* **32**, 533.

Kozuchowski, J. S. and Johnson, D.: 1978, *Nature* **274**, 468.
Larsen, D. P., Schults, D. W., and Malereg, K. W.: 1981, *Limnol. Oceanogr.* **26**, 740.
Lee, G. F.: 1970, *Factors Affecting the Transfer of Materials Between Water and Sediments*, The University of Wisconsin Water Resources Center, Madison, Wisconsin.
Lipe, W. C., Haley, J. J., and Ripberger, R. R.: 1983, 'Report of the Onondaga Lake Subcommittee to the Onondaga County Legislature Committee on Public-Works', Onondaga County, New York.
Martin, S. C., Effler, S. W. DePinto, J. V., Trama, F. J., Rodgers, P. W., Dobi, J., and Wodka, M. C.: 1985, *Jour. Env. Eng. Div. ASCE* **111**, 647.
Megard, R. O., Combs, W. S., Smith, P. D. and Knoll, A. S.: 1979, *Limnol. Oceanogr.* **24**, 1038.
Meyer, M. A. and Effler, S. W.: 1980, *Envir. Poll. (Ser. A)* **23**, 131.
Mortimer, C. H.: 1941, *J. Ecol.* **29**, 280.
Mortimer, C. H.: 1942, *J. Ecol.* **30**, 147.
Mortimer, C. H.: 1971, *Limnol. Oceanogr.* **16**, 387.
Murphy, T. P., Hall, K. J., and Yesake, I.: 1983, *Limnol. Oceanogr.* **28**, 58.
NALCO ENVIRONMENT SCIENCES CO.: 1978, 'Thermal Plume in Onondaga Lake Near Allied Chemical Plant Solvay, New York', Report to Allied Chemical Company Solvay, New York, Northbrook, Illinois.
Nemerow, N. L. and Faro, R. C.: 1970, *San. Eng. Div. ASCE* **96**, 665.
Noble, R. L. and Forney, J. L.: 1971, 'Fish Survey of Onondaga Lake-Summer, 1969', in *Onondaga Lake Study*, Water Pollution Control Research Series, Report 11060.
Norstrom, R. J., McKinnon, A. E., and Freitas, A. S. W. de: 1976, *J. Fish. Res. d. Canada* **33**, 248.
O'Brien and Gere Engineers, Inc.: 1973, *Environmental Assessment Statement, Syracuse Metropolitan Sewage Treatment Plant and the West Side Pump Station and Force Main*, Onondaga County, Syracuse, New York.
Onondaga County: 1971, 'Onondaga Lake Study', *Water Quality Office, United States Environmental Protection Agency*, Water Pollution Control Research Series, Report 11060.
Onondaga County: 1971, 1972, 1973, 1974, 1975, 1976, 1977, 1978, 1979, 1980, 1981, 1982, 1983, 1984a, *Onondaga Lake Monitoring Program*, Annual publication, Onondaga County, New York.
Onondaga County: 1984b, *Three Rivers Study, Water Quality Assessment, Phase I*, Department of Drainage and Sanitation, Onondaga County, New York.
Otsuki, A. and Wetzel, R. G.: 1974, *Arch. Hydrobiol.* **73**, 14.
Owens, E. M. and Effler, S. W.: 1985, 'A Stratification Model for Onondaga Lake, N.Y.', submitted to Central New York Regional Planning and Development Board, Syracuse, New York.
Owens, E. M. and Effler, S. W.: 1986, *Water, Air, and Soil Pollut.* (in review).
Phillips, D. J. H.: 1977, *Environ. Poll.* **13**, 231.
Pollution from Land Use Activities Reference Group (PLUARG): 1978, *Environmental Strategy for the Great Lakes System*, Final Report of the International Joint Commision, Windsor, Ontario.
Rand, M. C.: 1971, 'Section 10-Chemical Considerations', in *Onondaga Lake Study*, Water Pollution Control Research Series, Report 11060.
Remane, A., and Schleeper, C.: 1971, *The Biology of Brackish Water*, Wiley and Sons, New York.
Ritchie, J. C., McHenry, J. R., and Gill, A. C.: 1973, *Limnol. Oceanogr.* **18**, 254.
Rooney, J.: 1973 (cited by United States Environmental Protection Agency, 1974. Environmental Impact Statement on Wastewater Treatment Facilities Construction Grants for the Onondaga Lake Drainage Basin). Memorandum.
Scrudato, R. J. and Sugatt, R. H.: 1983, 'State Pollutant Discharge Elimination System (SPDES): Toxic Loadings to the Oswego River Drainage Basin, North Central, New York', submitted to the Legislative Commission on Science and Technology, New York State.
Seger, E. S.: 1980, 'The Fate of Heavy Metals in Onondaga Lake', Masters Thesis, Clarkson College, Potsdam, New York.
Simpson, K. W.: 1982, 'Macroinvertebrate Survey of the Seneca-Oswego River System – 1972 and 1978: Environmental Health Report No. 14', submitted to the New York State Department of Environmental Conservation.
Sloan, R.: 1984, 'Contaminant Conditions in Onondaga Lake Smallmouth Bass', Abstract from the Onondaga Lake Symposium, Liverpool, New York.
Sloan, R.: 1985, personal communication.
Sloan, R. and Karcher, R.: 1983, 'Temporal Changes in Mercury Concentrations of Onondaga Lake Fish', Abstract from New York Chapter, American Fisheries Society, Annual Meeting, Rome NY.

Sondheimer, E., Dence, W. A., Mattick, L. R., and Silverman, S. R.: 1966, *Science* **152**, 221.
Stefan, H. G., Skoglund, T., and Megard, R. O.: 1976, *J. Env. Eng. Div. ASCE* **102**, 1201.
Stewart, K. M.: 1971, 'Section 9 – Temperature and Transparency', in *Onondaga Lake Study*, Water Pollution Control Research Series, Report 11060.
Stewart, K. M.: 1978, *Verh. Theor. Angew. Limnolog.* **20**, 496.
Stewart, K. M.: 1979, Book review of: *Lakes of New York State, Amer. Scientist* **67**, 480.
Sze, P.: 1975, *Phycologia* **14**, 197.
Sze, P. and Kingsbury, J. M.: 1972, *J. Phycol.* **8**, 25.
United States Environmental Protection Agency: 1973, 'Report of Mercury Source Investigation Onondaga Lake, New York and Allied Chemical Corporation, Solvay, New York', National Field Investigations Center, Cincinnati and Region II, New York.
United States Environmental Protection Agency: 1974, 'Environmental Impact Statement on Waste Water Treatment Facilities Construction Grants for the Onondaga Lake Drainage Basin', New York.
Walker, W. W.: 1979, *Wat. Resour. Res.* **15**, 1463.
Wiedemann, A. D., Bannister, T. T., Effler, S. W., and Johnson, D. L.: 1985, *Limnol. Oceanogr.* **30**, 1078–1083.
Welsh, E. B. and Perkins, M. A.: 1979, *J. Wat. Pollut. Contr. Fed.* **51**, 2823.
Welsh, E. B., Rock, C. A., and Krull, J. D.: 1973, 'Long-Term Lake Recovery Related to Available Phosphorus', in Middlebrooks, Falkenborg, and Maloney (eds.), *Modeling the Eutrophication Process*, Ann Arbor Science Co., Ann Arbor, Michigan, pp. 15–32.
Wetzel, R. G.: 1983, *Limnology* (2nd edition), Saunders College Publishing, Philadelphia, Pennsylvania.
Wilcox, D. A. and Effler, S. W.: 1981, *Environ. Pollut. Ser. 8* **2**, 203.
Wodka, M. C.: 1981, 'Vertical Phosphorus Transport in Onondaga Lake', Masters Thesis, Syracuse University, Syracuse, New York.
Wodka, M. C., Effler, S. W., Driscoll, C. T., Field, S. D., and Devan, S. P.: 1983, *Jour. Env. Eng. Div. ASCE* **109**, 1403.
Wodka, M. C., Effler, S. W., and Driscoll, C. T.: 1985, *Limnol. Oceanogr.* **30**, 833.
Yin, C., and Johnson, D. L.: 1984, *Limnol. Oceanogr.* **24**, 1193.

(16 of 16)

REFERENCE NO. 8

NUS CORPORATION AND SUBSIDIARIES — **TELECON NOTE**

CONTROL NO.:	DATE: 4/30/91	TIME: 1340

DISTRIBUTION: Onondaga Lake Mercury Sediments file

BETWEEN:	OF:	PHONE:
Lee Flocke	NYSDEC Region 7	(315)426-7400

AND: Joann Wagner (NUS)

DISCUSSION:

(i.e., the open-air portion), and the west flume (from the LCP plant to where it discharged to Geddes Brook) to be approx. 5,000 feet. I asked whether the wastebed overflow was also an open ditch. Mr. Flocke said that this overflow was actually a collection of overflows from the various waste ponds in that area. The overflows were collected via a "drop inlet" and channeled into a "circumferential ditch." The combined wastebed overflow discharged to Geddes Brook via an open drainage ditch until approx. 1981, when it was attempted to reroute this discharge to the Syracuse Metropolitan Sewage treatment plant. Because of the caking problems that the wastebed discharge caused to the sewage treatment system, successful rerouting did not occur until about 1986.

I also asked Mr. Flocke whether there was more to reference No. 1 of the Phase II report than just the one page of the Kernan Davis memo that was included with my copy. He checked his copy, which had only one page also, but gave me Kernan Davis's phone number [(518)457-0740] so that I could find out whether there are more pages to the memo than what was included in the Phase II report.

ACTION ITEMS:

Joann L. Wagner 4/30/91

NUS CORPORATION AND SUBSIDIARIES (1) **TELECON NOTE**

CONTROL NO.:	DATE: 5/3/91	TIME: 0920

DISTRIBUTION: Onondaga Lake Mercury Sediments File

BETWEEN: Lee Flocke	OF: NYSDEC Region 7	PHONE: (315) 426-7400

AND: Joann Wagner (NUS)

DISCUSSION:

Mr. Flocke returned my call from yesterday. I asked him whether the "drop inlets" which he had talked about during our previous conversation were the same thing as the discharge boxes shown on some sketches included with one of Allied's SPDES permit applications. He said he wasn't familiar with the term discharge box, but they were probably the same thing. The inlets - or discharge boxes - consisted of wooden timbers constructed at the base of the settling ponds (or waste beds) to which additional timbers were added as the elevation of the material in the waste beds rose. The boxes discharged to underground pipes which conveyed the overflow from the waste beds to the circumferential (or peripheral) ditch. The ditch was/is unlined. The waste ponds themselves were dug into the existing material with bulldozers to such a depth that groundwater was encountered. Mr. Flocke said that from interviews with former

ACTION ITEMS:

Allied employees, the bulldozers continued digging until the water level nearly made them inoperable, usually with the water being 3 to 4 feet deep. He said that perched water table conditions now exist in the areas covered by the waste beds. I asked about the apparent absence of any outfall from waste bed No. 13 as indicated in the 1974 EIS for the wastewater

(continued)

NUS CORPORATION AND SUBSIDIARIES (2) **TELECON NOTE**

CONTROL NO.:	DATE: 5/3/91	TIME: 0920

DISTRIBUTION: Onondaga Lake Mercury Sediments file

BETWEEN: Lee Flocke	OF: NYSDEC Region 7	PHONE: (315) 426-7400

AND: Joan Wagner (NUS)

DISCUSSION:

treatment plant and the sketch with the SPDES permit (former says no outfall for lagoon 13, latter shows no discharge boxes in settling pond 13). He found that odd, as there should have been some sort of release point for material in that unit. He said that the discharge boxes continue to collect waste bed effluent, ~~and~~ 5/3/91 which is ~~then~~ sent to the Metropolitan Sewage Treatment Plant (as per diversion implemented in early 1980s) for phosphorous removal of treatment plant wastes before discharge to Onondaga Lake. Mr. Flocke said that a one-time sampling event showed Metro to be the second-largest contributor of mercury into the lake, with Nine Mile Creek being the largest. The source of the mercury from Metro is not known, but could be the waste bed material. He also informed me that the N.Y. State Attorney General is negotiating an RI/FS with Allied Chemical with respect to ~~the waste~~ lake clean-up 5/23/91

ACTION ITEMS:

~~Tests~~, a draft copy of which he has but does not have authority to release yet. He said it might contain information helpful to our NPL effort, and suggested I contact the Attorney General, Norman Speigel, in NYC. Mr. Flocke will send me a copy of the entire Blasland & Bouck 1989 Hydrogeologic Assessment of the Waste Beds if there is an extra copy lying around; otherwise, he will have section 4.3 copied and sent to me.

NUS 067 REVISED 0685

Joan L. Wagner 5/3/91

NUS CORPORATION AND SUBSIDIARIES ① **TELECON NOTE**

CONTROL NO.:	DATE: 5/23/91	TIME: 1150

DISTRIBUTION:
Onondaga Lake Mercury Sediments file

BETWEEN: Lee Flocke	OF: NYSDEC Region 7	PHONE: (315) 426-7400

AND: Joann Wagner (NUS)

DISCUSSION:
Mr. Flocke returned my call from yesterday. He said he didn't send Appendix C of the 1989 Blasland & Bouck report because it is too voluminous. I asked whether he could send copies of just the wells & borings installed by Blasland & Bouck; he suggested that I get my own copy of the entire report from them (i.e., Blasland, Bouck, & Lee). He said Tyler Gass would be the person from whom to request authorization to release a copy of it. I also asked Mr. Flocke about the conflicting dates I was finding of when Allied sold its chlor-alkali operations to LCP; he said the correct year is 1979. Allied Chemical ceased production of soda ash in 1986; LCP shut down the chlor-alkali plant (Bridge Street facility) in 1988 at NYSDEC's request. LCP had to either shut down voluntarily or face a Summary Abatement order to cease its discharges of mercury. The East Plant (aka Willis Avenue Plant) had been shut down and dismantled prior to when Mr. Flocke began working for the NYSDEC in 1978. I asked what kind of administrative/enforcement actions had been taken against either Allied or LCP. He said that 3 civil complaints had been issued: one was for the waste beds; one for the tar beds (aka Semet residue),

ACTION ITEMS:

NUS CORPORATION AND SUBSIDIARIES (2) **TELECON NOTE**

CONTROL NO.:	DATE: 5/23/91	TIME: 1150

DISTRIBUTION:

Onondaga Lake mercury Sediments file

BETWEEN:	OF:	PHONE:
Lee Flocke	NYSDEC Region 7	(315) 426-7400

AND: Joann Wagner (NUS)

DISCUSSION:

which is contained in an 8- to 10-acre pond and which probably isn't (according to Mr. Flocke) a significant problem because the pond is lined with Solvay process waste, which is relatively impermeable; and one for the Willis Avenue Plant "as expanded" to include plumes from the company's Chlorobenzene plant and other areas at the Main Plant, such as leaking underground pipes that conveyed feedstocks, for example, to other buildings on Allied's property. I asked whether a Consent Order had ever been issued ~~for~~ 5/23/91 with respect to the mercury sediments problem: he said no, that instead a RCRA closure plan was supposed to address problems associated with the West Plant (the LCP site) such as contaminants in the West Flume sediments and in groundwater, but the RCRA closure has not been pursued. For more information on the RCRA aspect, I could

ACTION ITEMS:

talk to Mike McPeck (same office & phone number as above). A draft RI/FS has been submitted addressing cleanup of the lake (ionic loading problem) and a natural resources damage suit; these issues are being pursued by the N.Y. Attorney General's office. The RI/FS has not been designated as releasable to the public yet.

Joann L. Wagner 5/23/91

REFERENCE NO. 9

Office Copy
1 of 26
Fol

ENGINEERING INVESTIGATIONS AT INACTIVE HAZARDOUS WASTE SITES

PHASE II INVESTIGATION

Mercury Sediments-
Onondaga Lake

City of Syracuse

Site No. 734030

Onondaga County

VOLUME 1

New York State
Department of
Environmental Conservation
50 Wolf Road, Albany, New York 12233
Thomas C. Jorling, *Commissioner*

Division of Hazardous Waste Remediation
Michael J. O'Toole, P.E., *Director*

ENGINEERING INVESTIGATIONS AT INACTIVE HAZARDOUS WASTE SITES IN THE STATE OF NEW YORK

PHASE II INVESTIGATIONS
ONONDAGA LAKE
NYS SITE NUMBER 734030
ONONDAGA COUNTY
NEW YORK

VOLUME 1

PREPARED FOR:

DIVISION OF HAZARDOUS WASTE REMEDIATION
NEW YORK STATE
DEPARTMENT OF ENVIRONMENTAL CONSERVATION
50 WOLF ROAD
ALBANY, NEW YORK 12233-0001

AUGUST 1989

ONONDAGA LAKE
PHASE II REPORT
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SECTION I

SECTION I

EXECUTIVE SUMMARY

SITE BACKGROUND

The Onondaga Lake site is located in the City of Syracuse, and the Towns of Salina and Geddes, Onondaga County, New York (Figure I-1). The eastern end of the Lake borders the City of Syracuse and the Lake extends approximately 4.5 miles in a northwest direction. The approximate surface area of the Lake is 4.5 square miles. The site is shown on the USGS Syracuse West, NY 7-1/2 minute quadrangle map. The land surrounding the Lake is owned by Onondaga County, New York State, the City of Syracuse, Allied Corporation and others.

The industries surrounding Onondaga Lake have discharged large volumes of waste from industrial processes into the Lake from the late 1800s to the present, with extensive reductions beginning in the 1970s. Mercury and salts comprised the bulk of these wastes with discharges of aromatic hydrocarbons, solvents and PCBs noted to a lesser degree. It is estimated that during the period from 1946 to 1970, 75,000 kg of mercury were discharged to the Lake by the two Allied Chemical Corporation chlor-alkali plants in Solvay, New York (USEPA, 1973). Onondaga Lake has also received large volumes of raw sewage during most this century (Andrews, 1985).

Onondaga Lake was once a major commercial and recreational resource in the Syracuse area. As the contamination of the Lake worsened, various activities were diminished or eliminated. There were indications that commercial fishing was threatened as early as 1885 according to a series of articles by Andrews in the Syracuse Post Standard in October, 1985 (Andrews 1985). The resort industry began to decline in the late 1800s. The Lake was closed to public swimming in the 1920s (OCDDS, 1988), and to public fishing in 1970 (NYSDEC, 1987). In 1986, the Lake was reopened to fishing on a catch and release basis only (NYSDEC, 1987).

PHASE II INVESTIGATION

The primary focus of this investigation was for mercury contamination of Onondaga Lake. Data were gathered with the completion of a Hazard Ranking System (HRS) score as one of the desired end results. Surface water and sediment sampling for the Phase II investigation at the Onondaga Lake site was initially conducted in September, 1986. Additional sampling was conducted in September, 1987. All field work was performed by NYSDEC personnel. Aliquots of the surface water samples were analyzed for temperature, electrical conductivity, pH, and dissolved oxygen. All sediment samples were lithologically classified in the field. The 1986 water and sediment samples were analyzed for mercury. The 1987 water and sediment samples were

analyzed for Hazardous Substance List (HSL)* organic (volatiles, semivolatiles, pesticide/PCBs) compounds, metals, and cyanide.

Forty-three sediment cores were collected from various locations beneath Onondaga Lake. The cores were subdivided into segments for analysis. Eight sediment grab samples were collected from various tributaries and an industrial discharge point. In all, 225 sediment samples were analyzed.

For this assessment, and the completion of an HRS score, various sampling locations within the Lake or from several tributaries of the Lake had to be designated as upgradient or downgradient, as the case may be, for assessment purposes of relative contaminant concentrations in the entire Lake/Tributary setting.

Forty-three percent of the 217 sediment samples taken from the Lake contained concentrations of mercury which exceeded typical background concentrations for New York State soils of 0.02 to 0.5 mg/kg (USGS, 1984). Sixty-nine percent of the 85 samples taken from the top 6 inches of Lake sediment contained concentrations of mercury exceeding the background range. The highest concentration of mercury detected was 85.37 mg/kg. The concentrations of mercury in the first 6 inches of sediment throughout nearly the entire Lake exceed these background values, with two distinct high concentration plumes evident.

In addition to mercury, twenty other HSL inorganic constituents were detected in the sediment samples. Fourteen of the inorganics were present downgradient (in or near the Lake) at concentrations which were more than three times the upgradient concentrations (which is a measurement tool suggested by the Environmental Protection Agency (EPA) for usage in completing the HRS scoring to define the presence of a contaminant): arsenic, barium, cadmium, chromium, cobalt, copper, iron, lead, manganese, nickel, sodium, vanadium, zinc, and cyanide. Five metals were detected at concentrations exceeding the naturally occurring ranges for New York State soils: barium, cadmium, chromium, cobalt, and lead.

Fifty-six HSL organic compounds were detected in the sediment samples. Twenty-two organic compounds were present downgradient at concentrations which were more than three times the upgradient concentrations. These compounds included benzene, chlorobenzene, ethylbenzene, xylenes, and various other chemicals belonging to several classes of compounds, including polynuclear aromatic hydrocarbons (PAHs), pesticides, and PCBs. These organic and inorganic analyses results indicate significant contamination of the Lake sediments.

Onondaga Lake is classified primarily as a Class B Lake, although parts of it are Classified Class C. Class B waters are designated for bathing, and any other usages except drinking and food processing, while Class C waters are designated for fishing, and any other usages except for

---

*The Hazardous Substance List (HSL) at the time of this field study (1986 and 1987) was a list of one hundred thirty (130) organic compounds (volatiles, semi-volatiles, pesticides/PCBs) and twenty-four (24) metals plus cyanide that the Department utilized for screening a suspected inactive hazardous waste site.

bathing, drinking, and food processing. In order to assess the analytical results, the concentrations of various chemicals in the Lake water samples are compared to applicable Class B or C standards or guidance values.

Twelve surface water samples were collected from Onondaga Lake, and nine surface water samples were collected from various influent streams to the Lake. Four HSL organic compounds (methylene chloride, chloroform, tetrachloroethene, toluene) were detected in the Lake water samples. None of the compounds were present in the Lake at concentrations which were more than three times the upgradient concentrations. The concentrations of organic compounds did not exceed applicable Class B standards or guidance values (Figure III-1).

Thirteen HSL inorganics were detected in the Lake water samples. The concentrations of copper and sodium were present in two separate downgradient samples at concentrations which were more than three times the upgradient concentrations. The concentrations of aluminum in all samples exceeded the Class B standard, while the concentrations of mercury in three samples at two locations, W-2 and W-3, exceeded the Class B guidance value.

Sixteen HSL inorganics including cyanide were detected in the influent water samples. Six metals were present at concentrations which were more than three times the background concentrations: barium, chromium, lead, mercury, nickel, and sodium. The concentrations of six analytes exceeded the Class B standards or guidance values in one or more samples. Concentrations of aluminum, iron, lead, zinc, and cyanide exceeded the applicable standards in one or more samples, while mercury exceeded the guidance value in one sample.

The extent of the mercury contamination in Onondaga Lake has been well characterized by the Phase II investigation. High concentrations and wide distribution of mercury are apparent in the top six inches of Lake sediments. Beneath the upper two feet of Lake sediment, the mercury contamination appears to be much less extensive, with the bulk of the sediments having mercury concentrations near background levels (0.02 to 0.5 ppm). Based on the mercury analyses conducted as part of the Phase II investigation, the estimated volume of sediment containing mercury concentrations over 1.0 mg/kg is approximately seven million cubic yards.

Contamination of sediments by other metals, cyanide, and organic compounds was detected. The extent of this contamination is much less defined than the mercury contamination, because of the limited number of samples collected and analyzed for other than mercury. Elevated concentrations of various metals and organic compounds were detected at all three locations S-14, S-29, S-38 (Figure III-1) where samples were taken. These locations also had elevated mercury concentrations.

Contamination of the Lake water by most HSL analytes does not appear to be severe. Although copper and sodium were detected at concentrations greater than three times the upgradient concentrations; neither of these metals exceeded the applicable standards or guidance values.

HAZARD RANKING SYSTEM SCORE

In an attempt to establish the relative risk associated with this site, the Hazard Ranking System (HRS) was applied. As currently used by the NYSDEC, the HRS is one of the tools utilized to evaluate inactive hazardous waste sites in New York State. This model takes into account the types of wastes at the site, receptors, and transport routes to calculate a numerical score for the site. As stated in 40 CFR Subpart H Section 300.81, the HRS was developed for evaluating the relative potential of uncontrolled hazardous disposal facilities to cause human health or safety problems or ecological and environmental damage. It is assumed by the EPA that a uniform application of the ranking system in each state will permit EPA to identify releases of hazardous substances that pose the greatest hazard to human health and/or the environment.

Under the HRS, three numerical scores are computed to express the relative risk or danger from the site. These scores take into account the population at risk, the potential for contamination of drinking water supplies, for direct human contact, for destruction of sensitive ecological systems and other appropriate factors. The three scores are:

- S_M - reflects the potential for harm to humans or the environment from migration of a hazardous substance away from the facility by routes involving groundwater, surface water and air. It is a composite of separate scores for each of the three routes (S_{GW} = groundwater route score, S_{SW} = surface water route score, and S_A = air route score).
- S_{FE} - reflects the potential for harm from substances that can explode or cause fires.
- S_{DC} - reflects the potential for harm from direct contact with hazardous substances at the facility (i.e., no migration need be involved).

Based on the results of this and previous studies, the HRS scores for the Onondaga Lake site have been calculated as follows:

$S_M = 21.26$	$S_{GW} = 32.30$
$S_{FE} = 0$	$S_{SW} = 17.62$
$S_{DC} = 62.5$	$S_A = 0$

Hazard Ranking Score:

$$HRS = S_M = \frac{\sqrt{(S_{GW})^2 + (S_{SW})^2 + (S_A)^2}}{1.73} = 21.26$$

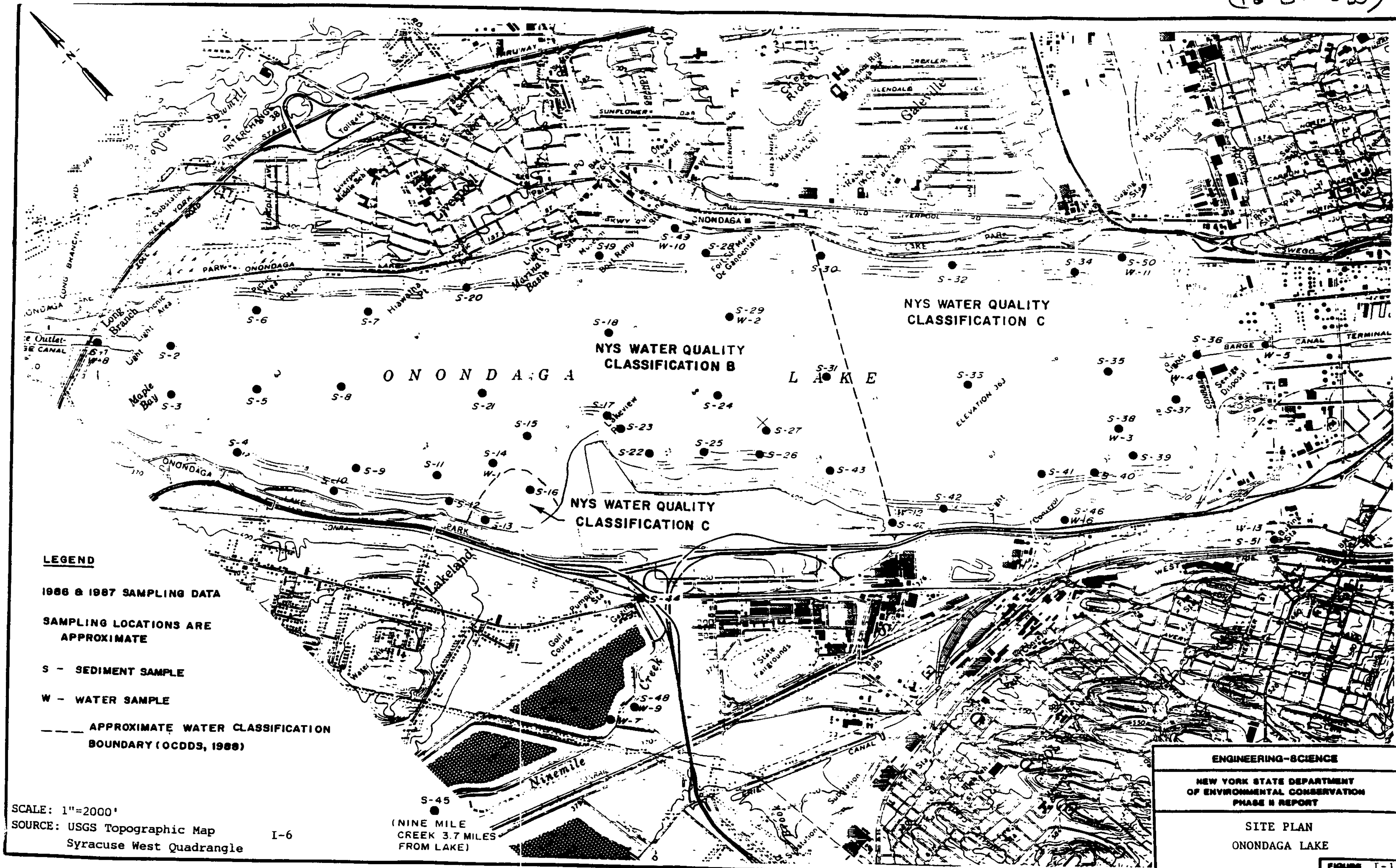
RECOMMENDATIONS

The available evidence indicates that mercury contamination of Onondaga Lake is and will continue to be a serious impediment to the full recreational and commercial utilization of the Lake. Ongoing restrictions and monitoring programs will continue to be necessary to assure that the public is adequately protected.

Remedial alternatives should be considered. The existing data are sufficient to characterize the distribution of mercury in the sediments. However, it will be necessary to further characterize contamination of sediments by PCBs, PAHs, pesticides and metals other than mercury before any remediation plans are formulated. This will allow a more complete assessment of contamination associated with Onondaga Lake sediments than is possible within the scope of this Phase II investigation.

The data from other studies should be considered in the development of remediation plans. One such study, the development of a mathematical model of Onondaga Lake by the Upstate Freshwater Institute, is currently in progress. Also, a clearer picture of mercury cycling in the Lake, particularly the role of sulfides in the trapping of mercury in the sediments will be necessary.

A comprehensive multi-discipline evaluation and approach must be taken with the review and exchange of data concerning this Lake. All potential components must be exposed and evaluated prior to the formulation of remedial plans and should be directed by a comprehensive remedial investigation/feasibility study.


N
ONONDAGA LAKE
NYS WATER QUALITY CLASSIFICATION B
NYS WATER QUALITY CLASSIFICATION C
NYS WATER QUALITY CLASSIFICATION C
S-1 W-8
S-2
S-3
S-4
S-5
S-6
S-7
S-8
S-9
S-10
S-11
S-12
S-13
S-14 W-1
S-15
S-16
S-17
S-18
S-19
S-20
S-21
S-22
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S-26
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S-29 W-2
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S-35
S-36 W-5
S-37
S-38 W-3
S-39
S-40
S-41
S-42
S-43
S-43 W-10
S-46 W-16
S-48 W-9
W-7
S-50 W-11
S-51 W-13
W-4
W-12
S-45
(NINE MILE CREEK 3.7 MILES FROM LAKE)
Maple Bay
Long Branch
Liverpool
Galeville
Lakeland
Ninemile
Creek
State Fairgrounds
Golf Course
Marina Basin
ELEVATION 363
LEGEND
1986 & 1987 SAMPLING DATA
SAMPLING LOCATIONS ARE APPROXIMATE
S - SEDIMENT SAMPLE
W - WATER SAMPLE
APPROXIMATE WATER CLASSIFICATION BOUNDARY (OCDDS, 1988)
SCALE: 1"=2000'
SOURCE: USGS Topographic Map
Syracuse West Quadrangle
ENGINEERING-SCIENCE
NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION PHASE II REPORT
SITE PLAN
ONONDAGA LAKE
FIGURE I-1

(13 of 265)

SECTION II

SECTION II

PURPOSE

The objective of a Phase II investigation is to determine if hazardous wastes have been disposed of in the site, if contaminants exist in the various mediums (air, groundwater, surface water or soils) and whether or not threats to human health or the environment exist. Information gathered relative to the above will allow the Department to reclassify the site or if warranted delist it.

This Phase II study was specifically designed to investigate mercury levels in Onondaga Lake surface water and sediments. The presence of other hazardous substances in the surface water and sediments was also assessed on a less intensive basis. Samples taken from the Onondaga Lake site indicate contamination present in the form of aromatic hydrocarbons, metals, salts, solvents, and PCBs.

SECTION III

SECTION III

SCOPE OF WORK

INTRODUCTION

Surface water and sediment sampling for the Phase II investigation at the Onondaga Lake site was initially conducted in September, 1986. Additional sampling was conducted in September, 1987. Field work was performed by NYSDEC personnel, in accordance with the February 28, 1986 NYSDEC work plan. The work plan was later revised by NYSDEC.

The work plan originally included the installation of four monitoring wells, two upgradient and two downgradient. These wells were intended to screen both a shallow and a bedrock aquifer. Because of the size of the Onondaga Lake site, the number of wells was considered inadequate and this task was eliminated from the scope of work (Demick, 1987).

PHASE II SITE INVESTIGATION

The scope of the Phase II investigation is summarized herein and the field investigation tasks are described below. All field work was performed by NYSDEC personnel, using procedures described in the project work plan.

Field Activities - September, 1986

Surface Water Sampling - A total of four surface water samples were collected from two different depths at each of two locations (Table III-1 and Figure III-1). Sample aliquots were analyzed in the field for pH, temperature and specific conductance; the samples were then transported to a NYSDEC laboratory where they were analyzed for mercury using the NYSDEC Superfund and Contract Laboratory Protocols (January 1985).

Sediment Sampling - A total of 202 sediment samples were collected. Each sample of lake sediment consisted of a 3- to 6-inch segment of a core which was up to 54 inches long. Up to six segments per core were sampled. There were 40 core sampling locations (Table III-1 and Figure III-1). Thirty-eight of the sampling locations were distributed throughout Onondaga Lake, one was in the lake outlet, and one was at the mouth of a tributary (Onondaga Creek via the Barge Canal Terminal). Sediment cores were collected using the following sampling methods: 1) Wildco core sampler, 2) Piston core sampler, or 3) Vibracorer core sampler. An outline of the method used at each sampling location is presented in Table III-2. Generally, the hand-core (Wildco core sampler) method was used where the water depth was quite shallow, while the piston core and vibracore sampling methods were employed in deeper water. All sediment samples were

lithologically classified in the field (see "Field Notes" in the Appendix) and then transported to a NYSDEC laboratory for analysis of mercury concentrations using the NYSDEC Superfund and Contract Laboratory Protocols (January, 1985). A complete listing of the 1986 analytical results is presented in Section IV.

Field Activities - September and November, 1987

Surface Water Sampling - A total of eighteen water samples were collected from thirteen sampling locations. (Table III-1 and Figure III-1). Samples were taken from up to three different depths at each location. Sample aliquots were analyzed in the field for pH, temperature, and specific conductance; the samples were analyzed by Recra Environmental, Incorporated for Hazardous Substance List (HSL) organic compounds (volatiles, semivolatiles, and pesticide/PCBs), HSL metals and cyanide using the NYSDEC Superfund and Contract Laboratory Protocols (January 1985).

Sediment Sampling - A total of 23 samples were taken from 11 sampling locations; 3 locations were in Onondaga Lake while 8 locations were at the tributaries around the lake (Table III-1 and Figure III-1). Each sample of lake sediment was taken from a 3- to 6-inch segment of a core which was up to 54 inches long. Up to six segments per core were sampled. Grab samples of sediment were taken from the tributaries. Samples were analyzed by Recra Environmental, Incorporated, for Hazardous Substance List (HSL) organic compounds, HSL metals and cyanide using the NYSDEC Superfund and Contract Laboratory Protocols (January 1985).

A complete listing of the 1987 analytical results is presented in the Appendix of this report. The field procedures for the 1986 and 1987 sampling events are described in the field notes which are presented in the Appendix of this report.

The Phase II sampling locations were intended to duplicate those from the study of Onondaga Lake sediments conducted by the United States Environmental Protection Agency (USEPA) in 1973. Each Phase II sample location was precisely referenced to a fixed datum to allow duplication of these locations in the future, if desired.

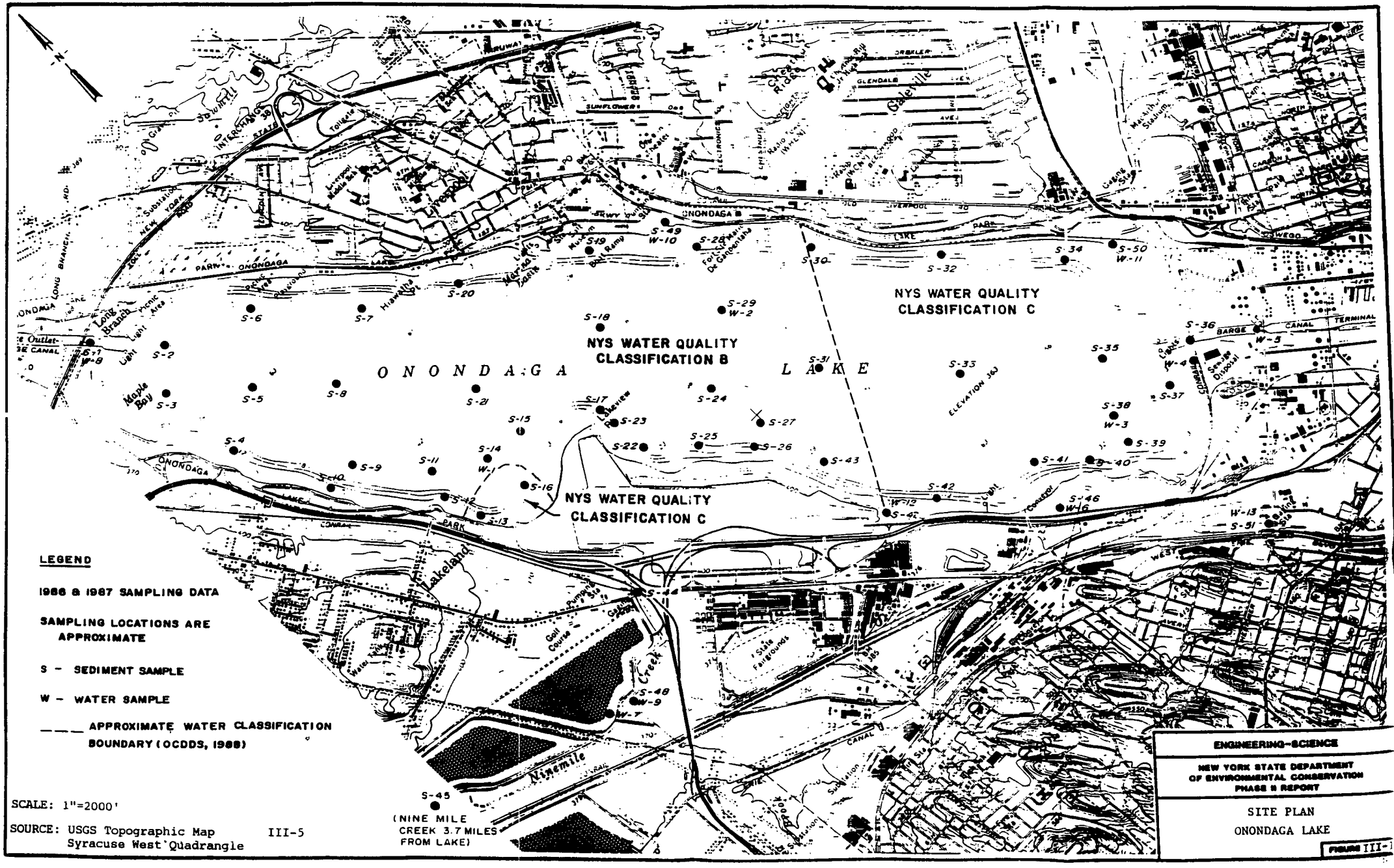
TABLE III-1
SAMPLING AND ANALYSIS SUMMARY

Year	Sample Type	Source	Sampling (a) Location	Number of Samples Collected (b)	Analyses
1986	Sediment Core	Lake Outlet	S-1	5	Mercury
	Sediment Core	Lake	S-2 to S-13 S-15 to S-28 S-30 to S-37 S-39 to S-43	60 73 41 23	Mercury
	Surface Water	Lake	W-1, W-2	4	Mercury
1987	Sediment Core	Lake	S-14, S-29, S-38	15	HSL Organics, HSL Metals, Cyanide
	Sediment Grab	Influent Streams	S-44 to S-51	8	HSL Organics, HSL Metals, Cyanide
	Surface Water	Lake	W-1 to W-3	6	HSL Organics, HSL Metals, Cyanide
	Surface Water	Lake Outlet	W-8	2	HSL Organics, HSL Metals, Cyanide
	Surface Water	Influent Streams	W-4 to W-7 W-9 to W-13	5 (c) 5	HSL Organics, HSL Metals, Cyanide

(a) See map, Figure III-1
(b) One to six samples were collected from different depths at each location.
(c) Includes a duplicate of one sample

Table III-2
Sediment Sampling Methods
Onondaga Lake

Sampling Location	Sampling Method	Sampling Location	Sampling Method
S- 1	Vibra-core	S-23	Hand-core
S- 2	Piston-core	S-24	Piston-core
S- 3	Piston-core	S-25	Hand-core
S- 4	Vibra-core	S-26	Hand-core
S- 5	Piston-core	S-27	Piston-core
S- 6	Piston-core	S-28	Hand-core
S- 7	Piston-core	S-29	Piston-core
S- 8	Piston-core	S-30	Hand-core
S- 9	Piston-core	S-31	Piston-core
S-10	Vibra-core	S-32	Hand-core
S-11	Piston-core	S-33	Piston-core
S-12	Hammered	S-34	Hand-core
S-13	Hammered	S-35	Piston-core
S-14	Piston-core	S-36	Hammered
S-15	Piston-core	S-37	Hand-core
S-16	Hammered	S-38	Piston-core
S-17	Hand-core	S-39	Hammered
S-18	Piston-core	S-40	Hammered
S-20	Vibra-core	S-41	Piston-core
S-21	Piston-core	S-42	Hammered
S-22	Hand-core	S-43	Piston-core



SCALE: 1"=2000'

SOURCE: USGS Topographic Map Syracuse West Quadrangle

SECTION IV

SECTION IV

SITE ASSESSMENT

SITE HISTORY

The Onondaga Lake site is located in the City of Syracuse, and the Towns of Salina and Geddes, Onondaga County, New York (Figure IV-1). The eastern end of the lake borders the City of Syracuse and the lake extends approximately 4.5 miles in the northwest direction. The approximate surface area of the lake is 4.5 square miles.

Early commercial activity in the vicinity of Onondaga Lake included the mining of salt, ice-cutting, and fishing. Recreational use of the lake peaked during the late 1800s to the early 1900s, with many resorts surrounding it (Effler, 1987; Andrews, 1985). Lake activities included fishing, boating and swimming. The resort industry began to decline in the late 1800s. Many species of fish disappeared from the lake between 1884 and 1900, and ice-cutting was banned in 1901 because of impurities in the water (Andrews, 1985). The lake was closed to public swimming in the 1920s (OCDDS, 1988), and to public fishing ir. 1970 (NYSDEC, 1987). In 1986, the lake was reopened to fishing on a catch and release basis only (NYSDEC, 1987).

According to a series of articles by Andrews in the Syracuse Post Standard in October, 1985, the U.S. Fishing Commission in 1885 reported a one-year decline in the commercial fish harvest from Onondaga Lake of 95 % (Andrews, 1985). A perch kill was noted in 1897, and whitefish, a commercially valuable species, was extirpated by 1898 (Andrews, 1985). The fish species composition of the lake has not changed appreciably since state surveys in 1927 and 1946, except for increases observed in the white perch population (Effler, 1987). At least eighteen species of fish currently exist in Onondaga Lake, including: walleye, northern pike, smallmouth bass, bluegill, channel catfish, yellow perch, and carp (NYSDEC, 1987).

In 1884 a soda ash producer, Solvay Process Company, was established along the south shore of Onondaga Lake (Andrews, 1985). Solvay Process later became the Allied Chemical Corporation (Andrews, 1985). Other manufacturing industries soon followed. Today, land ownership around the lake is divided among Onondaga County, the City of Syracuse, New York State, Allied Corporation, Crucible Inc., Marley's Division of Abe Cooper, and Niagara Mohawk (Andrews, 1985). To varying extents, the industries surrounding Onondaga Lake have discharged waste from industrial processes into the lake from at least the 1800s to the present. Mercury and salts comprised the bulk of these wastes with discharges of aromatic hydrocarbons, solvents and PCBs noted to a lesser degree.

In 1968, under a joint project by Allied and Onondaga County, a delta near the mouth of Ninemile Creek was dredged. The dredged spoil was deposited in a low area north of the creek which was being developed for recreational purposes (USEPA, 1973). This area was not investigated as part of this study as it is not within the Scope of this Phase II Investigation. However, this area should be evaluated as part of the comprehensive remedial investigation/feasibility study.

In 1970, as a result of the growing awareness of the contamination problem, the U.S. Justice Department pursued legal action against industry around Onondaga Lake, calling for an immediate reduction or elimination of mercury discharge into the lake (USEPA, 1973). In response, the U.S. Environmental Protection Agency (USEPA) conducted an investigation of mercury concentrations in the sediments of Onondaga Lake and its tributaries, and of the effluent from industrial dumping areas to the lake (Figure IV-2). The field investigation was conducted during December 1972. The report included the following findings:

- Prior to 1970, Allied Chemical Corporation discharged approximately 22 pounds of mercury per day to Onondaga Lake.
- More than 90 percent of the sediments sampled contained mercury concentrations above natural background levels.
- The highest concentrations of mercury occurred in the upper 2 feet of sediment.
- The highest concentrations of mercury formed an elongated north-south trending configuration near the southern end of the lake.
- The total volume of sediments containing mercury in concentrations above natural background levels was estimated at seven million cubic yards.
- The mercury concentrations in fish flesh exceeded Food and Drug Administration (FDA) standards.

The response to this investigation was the immediate reduction of mercury discharges into the lake. However, the mercury contamination of fish from Onondaga Lake has been an ongoing concern. The conclusions from a New York State Department of Environmental Conservation Report (NYSDEC, 1987) were as follows. In 1970, mercury concentrations in the flesh of fish from the lake were well above FDA standards (0.5 ppm) in effect at that time, and would have exceeded the current action level of 1.0 ppm. Since 1970, mercury concentrations in fish flesh have declined, but in the early 1980s concentrations again increased to levels exhibited in the mid-1970s. The 1985 and 1986 data indicate relatively stable mercury concentrations, but at levels above those considered protective of public health and natural resources.

According to a series of articles by Andrews in the Syracuse Post Standard in October, 1985, as of 1985, potential dischargers of chemicals into Onondaga Lake, either directly or indirectly, were identified as: Allied Industrial Laundry, Pass & Seymour, Crucible Specialty Metals,

Allied Chemical Company, LCP, Coyne Textile Services, General Electric Company, Unifirst Corporation, Crouse-Hinds Company, Syracuse China, Fischer Guide Division of General Motors, Carrier Corporation, Roth Brothers Metal Company, Oberdorfer Foundries, Bristol-Meyers Company, General Super Plating, and Oil City companies (Andrews, 1985). Oil City is an area of Syracuse at the southeast end of Onondaga Lake, which is the location of petroleum product storage for regional distribution.

Allied Chemical Corporation sold its chlor-alkali plant to Linden Chemicals and Plastics, Inc. (LCP) in 1979 (NYSDEC, 1987). As of 1985, LCP had a permit to discharge slightly less than half an ounce of mercury per day into the lake (Andrews, 1985). LCP closed its plant in 1988 to halt the release of up to a pound of mercury per day into tributaries of Onondaga Lake (Cappon, 1988).

Onondaga Lake has also received large volumes of raw sewage during most of this century (Andrews, 1985). Since 1981, the Metropolitan Syracuse Sewage Treatment Plant has been providing tertiary treatment (OCDDS, 1988). However, significant pollutant loadings have historically been discharged into three tributaries of the lake during wet weather conditions from combined sewer overflows (CSO), street runoff, and upland sources (OCDDS, 1988). It is estimated that as of 1985, improvements in the system have resulted in at least an 80 % reduction in CSO (OCDDS, 1988).

REGIONAL SETTING

Regional Geology

The Onondaga Lake site is located in Onondaga County, near the geographical center of New York State. The county occurs within two physiographic provinces: 1) the Erie-Ontario Plain in the northern section of the county, and 2) the Allegheny Plateau in the southern section of the county. These two distinct provinces are separated by the east-west trending Onondaga Limestone Escarpment. The Onondaga Lake site occurs within the Erie-Ontario Lowlands physiographic province. Onondaga Lake is one of a group of lakes in the area formed by glacial scour and damming of streams during the last ice age. These lakes have been in existence for 10,000 years or more (USEPA, 1973).

All of the unconsolidated materials present in Onondaga County are derived from glacial activities which acted on the Silurian and Devonian bedrock formations found in the area. The last glacial event affecting the area occurred approximately 10,000 years ago during the last glacial retreat, which deposited the parent material from which many present-day sediments have been derived.

The bedrock which underlies and outcrops throughout the county consists of Silurian sandstones, shales and limestones in the Erie-Ontario Plain region, and Upper Silurian and

Devonian interbedded shales and limestones in the Allegheny Plateau region. In both regions, bedrock is generally gently sloping to the south at approximately 20 - 30 feet per mile (USDA, 1977). The Erie-Ontario Plain contains formations from the Clinton (red sandstones, shales and thin limestones), Lockport (dolomite) and Salina Groups (Camillus Shale, Manlius Limestone, Helderberg Limestone, Dristomy Sandstone and Onondaga Limestone). The Allegheny Plateau region contains formations from the Salina (Onondaga Limestone, Marcellus Shale) and Hamilton groups (Skaneateles Shale). The age of the bedrock units in Onondaga County increases northward towards Lake Ontario. The bedrock that underlies all of Onondaga Lake is the Vernon shale. This unit overlies the Lockport Dolomite and is comprised of thick argillaceous shale; red at the base, becoming gray to black toward the top (Hopkins, 1914).

Overlying the bedrock are deposits of glacial till, glacial outwash, alluvial deposits, and lacustrine sediments. As the ice advanced into the area, hills were smoothed and valleys were deepened. The result was a mass of glacial till that was deposited as the glaciers receded. Till is found up to 30 feet thick in the lowlands of the Erie-Ontario Plain region, and is about five feet thick at the higher elevations of the Allegheny Plateau region. Glacial outwash sediments were deposited along the front and sides of the receding glacier. Rivers collected runoff and deposited sand and gravel layers, while glacial meltwater lakes deposited wedges of clay and silt.

Regional Hydrology

Most of Onondaga County is located within the Lake Ontario drainage basin. Surface water draining from Onondaga County eventually flows into Lake Ontario, except for a few minor tributaries located in the southern part of the county that drain to the Susquehanna River to the south. From Lake Ontario, water flows to the Atlantic Ocean via the St. Lawrence River.

Onondaga Lake receives drainage from Ley, Onondaga and Ninemile Creeks and their tributaries. Onondaga Lake drains to the north into the Seneca River, which flows north into the Oswego River, and eventually Lake Ontario. The lake has a mean depth of 12 meters, with a maximum of 20.5 meters, and flushes 2.5 to 5 times per year (Effler, 1987). The deepest portions of the lake occur in two separate depressions known as the "north basin" and "south basin" (Effler, 1987; OCDDS, 1988).

The aquifer of concern at the Mercury Sediments - Onondaga Lake Site is the overburden aquifer. Although municipal water systems supply the bulk of the population with water derived from surface water resources, some individual wells do exist in the vicinity of the Lake. This aquifer consists of well-sorted glacial outwash sands and gravels. Semi-confined conditions exist in parts of this aquifer resulting from localized deposits of less permeable lacustrine silts and clays, which overlie the outwash deposits. The thickness of this aquifer probably ranges from 20 to 40 feet. However, in the valley of Nine Mile Creek, the overburden thickness may be up to 100 feet in a buried canyon. Other such deep deposits, known as buried valleys, may also exist in additional locations in the vicinity of Onondaga Lake (NYSDEC, 1989).

The overburden aquifer is recharged by infiltration from precipitation, from streams and from bedrock groundwater flow. If a well near the lake were to be heavily pumped, some proportion of water inflow to the well would probably be supplied from the Lake. Because the Lake's water surface is at a lower static head than is found in nearby wells, the Lake does not recharge this aquifer under non-pumping conditions. During periods of flood, some recharge from the Lake may occur (NYSDEC, 1989).

SITE GEOGRAPHY

Topography

The Onondaga Lake site is located in the City of Syracuse and the Towns of Salina and Geddes, Onondaga County, N.Y. (Figure IV-1). The Lake is approximately 4.5 square miles in area, bordered by the City of Syracuse to the southeast. Surface water flows into the lake primarily via Nine Mile Creek, Onondaga Creek, Ley Creek, Harbor Brook, Bloody Brook, Sawmill Creek, and Tributary 5A. The net circulation of the lake is in a counterclockwise direction (USEPA, 1973). Water flows out of the lake through the lake outlet to the Seneca River, thence to the Oswego River, northward to Lake Ontario.

The land surface around the perimeter of the lake is generally level and flat. Away from the lake, the topography rises gradually to the north, east and west. To the south, as one approaches the boundary separating the Erie-Ontario Plain region and the Allegheny Plateau region, the topography rises sharply to 600 feet above mean sea level (AMSL). The approximate elevation of Onondaga Lake is 363 feet AMSL (USGS, 1973-1978).

Onondaga Lake has New York State surface water designations of Class B and Class C, depending on location. Class B provides protection for bathing and other uses except for drinking and food processing, and Class C provides protection for fishing and other uses except bathing, drinking, and food processing. The southeastern most portion of the lake (approximately one-third of the surface area) and a small area around the mouth of Ninemile Creek are designated as Class C, while the remainder of the lake is designated as Class B (Figure I-1).

Soils

Along the western, southern and eastern borders of Onondaga Lake, the soils are classified as made land (chemical waste) and urban land (USDA, 1977). Urban land is the designation given to soils that have been grossly altered or obscured due to urbanization. Often, identification of the soils is not possible. Urban land includes downtown districts that are mostly covered by buildings and pavement, and includes parking lots, shopping complexes and industrial parks. Much of the northern shore of the lake has soils that represent cut and fill areas, where low-lying areas have been filled for construction and development purposes.

Made land mainly consists of chemical waste beds, which contain waste generated from the Allied Chemical Corporation industrial processing plants adjacent to the lake. This material

was pumped into diked beds and allowed to settle, and the beds were eventually dewatered to allow vegetation to be established. Chemical composition of these beds is about 68% calcium carbonate, 1% calcium chloride, 11% silicon dioxide, 12% calcium oxide, 7% magnesium oxide and 2% calcium sulfate. The material has a silt-like texture and has little structural development. It is moderately well drained on higher terraces and poorly drained near lake level.

The oldest expanse of waste beds occupy an area along the southwest shore of Onondaga Lake (Figure IV-1). These beds extend for approximately 2.8 miles, and range in width from approximately 130 feet to 3032 feet (USDA, 1977). Part of this complex of beds, east of the New York State Fair Grounds, was begun in 1916. Process waste has not been added to this part since about 1950 (Alexander, 1973). Currently, Interstate 690, parking lots, and various industrial facilities are located over parts of these beds. Another set of waste beds at the former Amboy airport (Alexander, 1973) are located within 2 miles of the lake, to the southwest (Figure IV-1). These beds were active from about 1950 up until approximately 1986 (Alexander, 1973; Effler, 1987). In addition, much older beds of Solvay Process wastes lie buried beneath the land surface along the southern shore of the Lake. Some have been incorporated into the extensive land filling along the route of Interstate 690, on the western shore. The total surface area of all waste beds is approximately 1.38 square miles, and the total volume is approximately 0.016 cubic miles (Effler, 1987).

SITE CONTAMINATION ASSESSMENT

Waste Characterization

Onondaga Lake has received domestic effluent and much of the industrial wastes from the Syracuse metropolitan area from the early development of the region to the present (Effler, 1987). Of primary concern is the presence of mercury in the lake, particularly in the sediments. It is estimated that during the period from 1946 to 1970, 75,000 kg of mercury were discharged to the lake by the two Allied Chemical Corporation chlor-alkali plants in Solvay, New York (USEPA, 1973). The mercury was conveyed to the lake mainly by two flumes, known as the "east flume" and the "west flume". The east flume discharged directly to the lake, while the west flume discharged to Geddes Brook, which flows into Ninemile Creek, a tributary of the lake. The mercury loading to the lake from the Allied plants was reduced by more than 95 % soon after the U.S. Department of Justice took legal action against the facilities in 1970 (Effler, 1987).

The cycling of mercury in natural aquatic systems is complicated and poorly understood. It is well known, however, that mercury in an aquatic system can assume a variety of forms and undergo several important biological or chemical transformations. The solubility of elemental mercury in water is 56 ug/L (USEPA, 1987). Mercury's major removal mechanism from a natural water system is adsorption onto the surfaces of particulate phases and subsequent settling to the sediment (USEPA, 1979). Biotransformation to methylmercury takes place in the water and sediments to varying degrees depending on conditions (USEPA, 1979; Stolzenberg et al., 1986) For example, divalent mercury is the form that is methylated, and under anaerobic conditions

sulfide may limit the availability of this form (Stolzenberg et al., 1986). The extent to which methylmercury is produced is of concern, as this is the most toxic form to humans and other animals, is highly stable, and tends to bioaccumulate (Stolzenberg et al., 1986; USEPA, 1987).

Waste generated by Allied's manufacturing of chlorobenzene was disposed in lined ponds on Allied's property (Effler, 1987). Benzene and associated compounds have been detected in 1) the groundwater between the plant and the lake, 2) groundwater seeps that discharge to the lake, and 3) proximal lake sediments (Geraghty and Miller, Inc., 1982). The loading rate of dissolved hydrocarbon contamination to the lake via groundwater has been estimated to be 146 kg per day (Groundwater Technology, 1984a and 1984b).

The following subsections summarize the results of the Phase Ii investigation sampling and analysis tasks. Concentrations downstream or downgradient of the site in excess of three times the upgradient concentration may indicate a release from a contaminant source located on-site as suggested by the Environmental Protection Agency (EPA) for usage in completing the HRS scoring.

For purposes of this study, locations considered to be upgradient of Onondaga Lake are several tributaries of the lake including: 1) Bloody Brook, 2) Ley Creek, and 3) Ninemile Creek near Amboy, 3.7 miles upstream of the lake. These sample locations are less urbanized/industrialized and are less likely to have received discharges from the industrial areas located south of the lake. Samples from these locations have also been used for comparison with samples from other influent (to the lake) sources, although in some cases they are not hydrologically "upgradient" of these sources; however, they are considered upgradient samples for relative comparison purposes.

The assumed downgradient locations for this study are those in Onondaga Lake, or in tributaries which are downstream from suspected waste sources. These include: 1) those that are known to have received or suspected of having received significant discharges from industries south of the lake in the past (or are close to such sources), and 2) those that pass through highly urbanized or industrialized areas. The tributaries or influent sources which were sampled and are considered to be downgradient are as follows: 1) the outfall at the Metropolitan Treatment Plant, 2) Ninemile Creek near or downstream of the confluence with Geddes Brook, 3) Geddes Brook, 4) Tributary 5A, 5) the East Flume, 6) Harbor Brook, and 7) Onondaga Creek (Barge Canal Terminal).

The analytical surface water results of this Phase II investigation have also been compared to applicable New York state standards or guidance values. Standards and guidance values are provided for the applicable surface water classification. Onondaga Lake is classified primarily as a Class B lake, although part of it is classified Class C. Class B waters are designated for bathing and any other usages except drinking and food processing, while Class C waters are designated for fishing and any other usages except for bathing, drinking, and food processing. Standards that have been promulgated for surface water appear in 6 NYCRR Parts 701 and 702. These regulations also provide authority for the use of guidance values when a standard does not exist for a given water classification. Sediment results have been compared to the upgradient sediment

sample results and published, naturally-occurring ranges in New York State or conterminous United States soils.

Sediment Contamination Assessment

Forty sediment cores were collected from various locations beneath Onondaga Lake during September, 1986 and analyzed for mercury (Table III-1 and Figure III-1). Three additional lake sediment cores were collected during September, 1987 (Table III-1 and Figure III-1). Eight sediment grab samples were collected from various tributaries and an industrial flume (sample W-6) during November, 1987 (Table III-1 and Figure III-1). The samples collected in 1987 were analyzed for HSL organic compounds and HSL inorganics including cyanide. The cores ranged in length from 17 to 54 inches and were divided into 3 to 6-inch core segments. Four to six segments per core were selected and analyzed for mercury (Table IV-1).

In the previous EPA study, the natural background concentration of mercury in Onondaga Lake sediments was said to be less than 0.1 mg/kg on a dry weight basis (USEPA, 1973). The naturally-occurring concentration range of mercury in New York State soils is 0.02 to 0.5 mg/kg (USGS, 1984). Grab samples of sediments taken upgradient of the lake from the following tributaries contained concentrations of mercury below 0.5 mg/kg: Ninemile Creek (3.7 miles from the lake), Bloody Brook (outlet to lake), and Ley Creek (outlet to lake). For the purposes of this report, sediments with concentrations of mercury in excess of 0.5 mg/kg are considered to be "contaminated". The Phase II analyses show that sixty-nine percent of the samples from the upper six inches of lake sediment currently exceed 0.5 mg/kg.

Table IV-2 shows the number of samples contained within specified depth and mercury concentration ranges. Seventy-six percent of the samples from the 0- to 3-inch depth range exceeded 0.5 mg/kg, and 17 percent of the samples exceeded 5 mg/kg, with a maximum value of 85.37 mg/kg. Sixty-three percent of the samples from the 3- to 6-inch depth range exceeded 0.5 mg/kg, and 33 percent of the samples exceeded 5 mg/kg, with a maximum value of 53.57 mg/kg. At 12 to 42 inches sediment depth, 27 percent of samples exceeded 0.5 mg/kg, and less than seven percent exceeded 5 mg/kg. Below 48 inches depth, only one sample exceeded 0.5 mg/kg.

Tables IV-3 through IV-6 present the sediment results from Onondaga Lake and its tributaries. Figures IV-3 through IV-8 (constructed from data on Tables IV-1 and IV-3 through IV-6) illustrate the lateral and vertical mercury distribution in the lake sediments. Based on the Phase II data, it appears that the mercury is concentrated in two plumes in the first 6 inches of sediments, with concentrations decreasing markedly below 12 inches. The highest concentration of mercury measured was 85.37 mg/kg in the 0- to 3-inch range at the southeast corner of the lake, near the east flume outlet (Figure IV-3). This is where the southernmost plume appears to originate

The two mercury plumes in the 0- to 3-inch depth range are shown in Figure IV-3. The first plume, as defined by the 10 ppm isoconcentration line, extends from the southeast corner of the lake toward the northwest for approximately 2.6 miles, and is approximately 4,500 feet wide.

The second plume, as defined by the 10 ppm isoconcentration line, is approximately 1.2 miles long and 3000 feet wide, and extends northwest from a point near the outlet of Ninemile Creek. The locations of the mercury plumes indicate the east flume and the west flume (via Ninemile Creek) as the primary points of discharge. This finding is consistent with that of a previous report (USEPA, 1973). The concentration gradients and plume orientations may be attributed to: 1) the volume of mercury discharged, 2) the points of discharge, 3) the time over which the discharges took place, 4) sediment deposition over time, 5) water currents, and 6) benthic topography.

Twenty other HSL inorganics (in addition to mercury) were detected in the 1987 sediment samples (Tables IV-3 and IV-4). Fourteen of the inorganics were present downgradient (in or near the lake) at concentrations which were more than three times the upgradient concentrations: arsenic, barium, cadmium, chromium, cobalt, copper, iron, lead, manganese, nickel, sodium, vanadium, zinc, and cyanide. Five metals were detected at concentrations exceeding the naturally occurring ranges for New York State soils: barium, cadmium, chromium, cobalt, and lead.

Fifty-six HSL organic compounds were detected in the 1987 sediment samples (Tables IV-5 and IV-6). About forty-two of these compounds were detected at levels below the contract-required detection limits, or can be attributed to laboratory contamination based on their presence in blank samples. Twenty-two organic compounds were present downgradient (in or near the lake) at concentrations which were more than three times the upgradient concentrations (upgradient = S-45, S-49, and S-50, Table IV-6). These compounds included: benzene, chlorobenzene, ethylbenzene, xylenes, and various others belonging to several classes of compounds which include polynuclear aromatic hydrocarbons (PAHs), pesticides, and polychlorinated biphenyls (PCBs).

Surface Water Contamination Assessment

Four surface water samples were collected from Onondaga Lake during September, 1986, and analyzed for mercury. Eight surface water samples were collected from Onondaga Lake, and nine surface water samples were collected from various influent streams during November, 1987. The samples from 1987 were analyzed for HSL organic compounds and HSL inorganics including cyanide.

Four HSL organic compounds were detected in the lake water samples (Table IV-7). All of these compounds were detected at levels below the contract-required detection limits or can be attributed to laboratory contamination due to their presence in laboratory blank samples. None of the compounds were present at concentrations which were more than three times the upgradient concentrations. None of the compounds exceeded the Class B guidance values.

Thirty HSL organic compounds were detected in the influent water samples (Table IV-8). All of the compounds were detected at levels below the contract-required detection limits or can be attributed to laboratory contamination due to their presence in laboratory blank samples. None of the compounds were present at concentrations which were more than three times the upgradient concentrations. The concentration of gamma-BHC (Lindane) in the East Flume (W-6)

exceeded the Class B standard, while the concentration of alpha-chlordane (an insecticide) in Geddes Brook (W-9) exceeded the Class B guidance value. The origin of these chemicals is unknown. Geddes Brook drains higher elevations to the south, and there may be sources of these chemicals located upstream. LCP Chemicals is believed to have discharged microbiocides into Geddes Brook (Andrews, 1985).

Thirteen HSL inorganics were detected in the lake water samples (Table IV-9). The concentrations of copper and sodium were present in two separate downgradient samples at concentrations which were more than three times the upgradient concentrations. This indicates potential releases of metals to surface waters. The concentrations of aluminum in all samples exceeded the Class B standard, while the concentrations of mercury in three of eight samples exceeded the Class B guidance value.

Sixteen HSL inorganics including cyanide were detected in influent water samples (Table IV-10). Six metals were present at concentrations which were more than three times upgradient: barium, chromium, lead, mercury, nickel, and sodium. Six analytes exceeded the Class B standards or guidance values in one or more samples. Concentrations of aluminum, iron, lead, zinc, and cyanide exceeded the applicable standards in one or more samples, while mercury exceeded the guidance value in sample W-9.

Contamination Assessment Discussion

The foregoing results for mercury in Onondaga Lake sediments were expected, and confirm the results of previous reports, particularly those of the EPA (USEPA, 1973). The extent of the mercury contamination in Onondaga Lake has been well characterized by the Phase II investigation. High concentrations and wide distribution of mercury are apparent in the top six inches of lake sediments. Beneath the upper two feet of lake sediment, the mercury contamination appears to be much less extensive, with these sediments generally having mercury concentrations near background levels (0.02 to 0.5 ppm).

The EPA calculated a value of 4.85 million cubic yards of sediment containing mercury concentrations over 1 ppm (USEPA, 1973). Based on the mercury analyses conducted as part of the Phase II investigation, the estimated volume of sediment containing mercury concentrations over 1.0 ppm is approximately 7 million cubic yards. A polar planimeter was used on Figures IV-3 to IV-8 to calculate this total based on the contoured data. Linear interpolation between ranges was used to estimate the quantity of mercury-contaminated sediments. The estimate of 7 million cubic yards is 44 % higher than the EPA estimate. Among the possible reasons to account for this discrepancy are: 1) differences in sample collection and analysis, and data interpretation methods, 2) spreading of existing contamination during the intervening years, and 3) significant additional discharges.

Contamination of sediments by other metals, cyanide, and organic compounds was found, although it is not as well characterized as the mercury contamination. Sampling and analyses for these other parameters was conducted at only three locations in the lake. Elevated concentrations

of various metals were detected at all three sampling locations in the lake. It is noteworthy that the metals which were detected at elevated levels near the mouth of Ninemile Creek tended to be found at greater sediment depths. Tributary 5A exhibited the most extensive sediment contamination by metals other than mercury of any of the influent streams sampled. It also exhibited the most extensive sediment contamination by organic compounds (PAHs) of any of the influent streams sampled, followed by Harbor Brook. Tributary 5A drains the facilities of Crucible Specialty Metals.

Contamination of sediments with elevated concentrations of organic compounds was also detected at all three sampling locations in the lake. PAHs were detected at the approximate center of the lake (S-29), below 3 inches sediment depth, while 4,4'-DDD and Aroclor 1248 were detected at elevated concentrations at the sediment surface (0 to 6 inches) at this location. Elevated concentrations of PCBs were also detected at the southeast corner of the lake (S-38), but at sediment depths below 1 foot. Aldrin was detected at an elevated concentration at the sediment surface of S-38.

The sources of the pesticides in lake sediment samples are uncertain. These pesticides are persistent and could have been released in the past from farms, suburban, or urban areas which are upgradient of the site. The presence of PCBs at sampling location S-29 is consistent with documented discharges of PCBs into Ley Creek by Fisher Guide Division of General Motors (Andrews, 1985). The source of PCBs detected at the southeast corner of the lake may be the same, although this assumption is complicated by the counterclockwise circulation of the lake.

Mercury was detected in three of the lake water samples, and a sample from Geddes Brook at concentrations exceeding the Class B guidance value. Another report indicated periodic elevations (above the guidance value) in mercury concentration in lake water over the years 1983 to 1986 (OCDDS, 1988). In general, though, contamination of the lake water by most HSL analytes does not appear to be severe. Copper and sodium were detected at concentrations greater than three times the respective upgradient values. Neither of these metals exceeded applicable standards or guidance values. There was a clear trend toward decreasing specific conductance, as well as decreasing concentrations of both sodium and chloride beginning in early 1986 as compared to the six previous years (OCDDS, 1988). In fact, a reduction in loading rates of chlorides, sodium, and calcium of approximately 3,000,000 pounds per day in 1986 was attributed to the closure of the remaining Allied Chemical Corporation plant in Solvay that same year (OCDDS, 1988).

It is apparent from the data that the sediments of Onondaga Lake are substantially more contaminated than the water in terms of the HSL analytes assessed. This is not surprising in view of: 1) the efforts that have been made to curtail discharges to the lake over the last eighteen years, 2) the rapid flushing of the lake (2.5 to 5 times per year according to Effler, 1987), and 3) the tendency of most of the analytes to deposit and remain in the sediments or be released from the sediments at a low rate.

The available evidence indicates that mercury contamination of Onondaga Lake is and will continue to be a serious impediment to the full recreational and commercial utilization of the lake. Ongoing restrictions and monitoring programs will continue to be necessary to assure that the public is protected. Remedial alternatives should be considered. It will be necessary to further characterize contamination of sediments by PCBs, PAHs, pesticides, and metals other than mercury before any remediation plans are formulated.

TABLE IV-I

1986 SAMPLING RESULTS

Site Name: Onondaga Lake
Submitted by: Michele Galvin
Date Reported January 27, 1987

Sample #	Sample Location	Date Collected	Date Digested	Date Analyzed	% Dry Mass	PPM Hg-Dry Mass Basi
786256-01	S-01-00-03	09/15/86	10/24	12/8/86	54.09	0.35
786256-02	S-01-03-06	"	10/24	12/8/86	49.95	0.39
786256-03	S-01-12-18	"	10/24	12/8/86	61.50	<0.5
786256-04	S-01-24-30	"	10/24	12/8/86	60.28	<0.5
786256-05	S-01-36-41	"	09/23	12/18/86	59.96	<0.5
786256-06	S-02-~~01-06~~ 00-03	"	10/27	12/8/86	25.84	05.88
786256-07	S-02-03-06 WB 11/22/88	"	11/03	12/8/86	28.68	11.59
786256-08	S-02-12-18	"	10/22	12/8/86	42.72	<0.5
786256-09	S-02-24-30	"	10/22	12/8/86	49.32	<0.5
786256-10	S-02-36-39	"	10/22	12/8/86	52.91	<0.5
786256-11	S-03-00-03	"	10/27	12/8/86	69.35	0.93
786256-12	S-03-03-06	"	10/27	12/8/86	58.84	0.59
786256-13	S-03-12-18	"	10/27	12/8/86	46.05	<0.5
786256-14	S-03-24-30	"	10/27	12/8/86	48.80	<0.5
786256-15	S-03-36-39	"	12/23	12/23/86	47.12	<0.5
786256-16	S-04-00-03	"	10/08	12/11/86	53.33	<0.5
786256-17	S-04-03-06	"	10/08	12/11/86	56.88	0.17
786256-18	S-04-12-18	"	10/08	12/11/86	53.62	<0.5
786256-19	S-04-24-30	"	09/17	12/10/86	46.82	<0.5
786256-20	S-04-36-42	"	09/17	12/10/86	46.11	<0.5
786256-21	S-04-48-54	"	09/17	12/10/86	56.90	<0.5
786256-22	S-05-00-03	"	12/23	12/23/86	23.22	1.84
786256-23	S-05-03-06	"	12/23	12/23/86	20.24	49.28
786256-24	S-05-12-18	"	12/23	12/23/86	32.55	1.16
786256-25	S-05-24-30	"	12/23	12/23/86	37.84	0.16
786256-26	S-05-36-37	"	12/23	12/23/86	41.67	0.21
786256-27	S-06-00-03	"	09/29	12/10/86	27.45	18.18
786256-28	S-06-03-06	"	09/29	12/10/86	47.36	0.37
786256-29	S-06-12-18	"	09/29	12/10/86	48.11	0.17
786256-30	S-06-24-30	"	09/29	12/10/86	51.27	<0.5
786256-31	S-06-36-42	"	09/29	12/10/86	55.27	<0.5
786256-32	S-07-00-03	"	10/27	12/8/86	23.63	02.81
786256-33	S-07-03-06	"	10/27	12/8/86	20.65	24.0
786256-34	S-07-12-18	"	10/27	12/8/86	33.58	1.16

TABLE IV-I

(continued)

Site Name: Onondaga Lake
Submitted by: Michele Galvin
Date Reported January 27, 1987

Sample #	Sample Location	Date Collected	Date Digested	Date Analyzed	% Dry Mass	PPM Hg-Dry Mass Basis
786256-35	S-07-24-30	09/15/86	10/27	12/8/86	40.51	<0.5
786256-36	S-07-36-42	"	10/27	12/8/86	42.29	<0.5
786256-37	S-08-00-03	"	10/09	12/11/86	23.92	20.34
786256-38	S-08-03-06	"	10/24	12/8/86	37.92	0.24
786256-39	S-08-12-18	"	10/24	12/8/86	38.83	<0.5
786256-40	S-08-24-30	"	11/03	12/8/86	41.06	<0.5
786256-41	S-08-36-42	"	10/24	12/8/86	44.91	<0.5
786256-42	S-09-00-03	"	10/02	12/16/86	24.59	02.33
786256-43	S-09-03-06	"	10/02	12/18/86	24.00	28.99
786256-44	S-09-12-18	"	10/02	12/16/86	36.46	0.23
786256-45	S-09-24-30	"	10/02	Lab Accident	39.27	
786256-46	S-09-36-42	"	10/02	12/16/86	44.13	<0.5
786255-01	S-10-00-03	"	10/16	12/15/86	53.59	<0.5
786255-02	S-10-03-06	"	10/16	12/15/86	50.93	<0.5
786255-03	S-10-12-18	"	09/29	12/18/86	55.07	<0.5
786255-04	S-10-24-30	"	09/29	12/18/86	56.41	<0.5
786255-05	S-10-36-42	"	09/29	12/18/86	63.49	<0.5
786255-06	S-10-48-53	"	09/29	12/18/86	63.78	<0.5
786256-47	S-11-00-03	"	09/23	12/12/86	30.53	11.27
786256-48	S-11-03-06	"	09/25	12/18/86	33.24	28.99
786256-49	S-11-12-18	"	09/25	12/12/86	41.22	0.23
786256-50	S-11-24-30	"	09/23	12/16/86	46.76	<0.5
786256-51	S-11-36-41	"	09/25	12/16/86	49.24	<0.5
786256-52	S-12-00-03	"	11/08	12/09/86	60.76	02.82
786256-53	S-12-03-06	"	10/28	12/09/86	60.06	01.20
786256-54	S-12-12-18	"	10/28	12/09/86	51.24	<0.5
786256-55	S-12-24-30	"	10/28	12/09/86	57.78	<0.5
786256-56	S-12-36-37	"	10/28	12/09/86	54.82	<0.5
786256-57	S-13-00-03	"	10/06	12/15/86	51.38	01.08
786256-58	S-13-03-06	"	10/06	12/15/86	51.82	<0.5
786256-59	S-13-12-18	"	12/23	12/23/86	50.81	<0.5
786256-60	S-13-24-30	"	12/23	12/23/86	53.47	<0.5
786256-61	S-15-00-03	"	09/17	12/10/86	44.16	02.04
786256-62	S-15-03-06	"	09/17	12/10/86	47.20	01.05

TABLE IV-1

(continued)

Site Name: Onondaga Lake
Submitted by: Michele Galvin
Date Reported January 27, 1987

Sample #	Sample Location	Date Collected	Date Digested	Date Analyzed	% Dry Mass	PPM Hg-Dry Mass Bas
786256-63	S-15-12-18	9/15/86	09/19	12/10/86	43.94	33.33
786256-64	S-15-24-30	"	09/17	12/10/86	43.73	08.42
786256-65	S-15-36-42	"	11/03	12/09/86	52.29	0.36
786256-66	S-16-00-03	"	12/23	12/23/86	63.73	02.71
786256-67	S-16-03-06	"	12/23	12/23/86	58.44	01.09
786256-68	S-16-12-18	"	12/23	12/23/86	51.93	01.42
786256-69	S-16-24-30	"	12/23	12/23/86	58.62	01.59
786256-70	S-16-36-40	"	12/23	12/23/86	60.79	01.14
786256-71	S-17-00-03	"	09/29	12/18/86	68.96	0.62
786256-72	S-17-03-06	"	09/29	12/18/86	72.25	0.38
786256-73	S-17-12-18	"	09/29	12/18/86	68.54	0.52
786256-74	S-17-24-30	"	09/29	12/18/86	67.78	0.58
786256-75	S-17-36-40	"	09/25	12/18/86	69.74	0.37
786256-76	S-18-00-03	"	10/07	12/16/86	24.96	01.64
786256-77	S-18-03-06	"	10/07	12/16/86	21.58	53.57
786256-78	S-18-12-18	"	10/06	12/16/86	35.48	01.87
786256-79	S-18-24-30	"	10/07	12/16/86	40.17	< 0.5
786256-80	S-18-36-41	"	10/06	12/16/86	41.50	< 0.5
786256-81	S-19-00-03	"	09/17	12/10/86	52.85	< 0.5
786248-02	S-19-03-06	"	09/17	12/10/86	52.82	< 0.5
786248-03	S-19-12-18	"	09/17	12/10/86	60.80	< 0.5
786248-04	S-19-24-30	"	09/17	12/10/86	62.80	< 0.5
786248-05	S-19-36-42	"	09/19	12/10/86	38.69	< 0.5
786256-81	S-20-00-03	"	10/22	12/08/86	66.54	0.58
786256-82	S-20-03-06	"	10/22	12/08/86	64.42	0.62
786256-83	S-20-12-18	"	11/03	12/09/86	63.29	0.14
786256-84	S-20-24-30	"	10/22	12/09/86	65.80	< 0.5
786256-85	S-20-36-42	"	09/29	12/18/86	57.95	< 0.5
786256-86	S-21-00-03	"	10/06	12/16/86	26.11	02.07
786256-87	S-21-03-06	"	10/06	12/18/86	28.86	01.45
786256-88	S-21-12-18	"	10/06	12/18/86	31.75	04.11
786256-89	S-21-24-30	"	10/06	12/16/86	38.62	0.68
786256-90	S-21-36-41	"	10/06	12/16/86	42.08	0.22
786256-91	S-22-00-03	"	09/25	12/18/86	24.89	< 0.5

TABLE IV-I

(continued)

Site Name: Onondaga Lake
Submitted by: Michele Galvin
Date Reported January 27, 1987

Sample #	Sample Location	Date Collected	Date Digested	Date Analyzed	% Dry Mass	PPM Hg-Dry Mass Bas
786256-92	S-22-03-06	9/15/86	09/24	12/18/86	19.08	< 0.5
786256-93	S-22-12-18	"	09/23	12/12/86	33.12	0.28
786256-94	S-22-24-30	"	09/24	12/18/86	23.59	<0.5
786256-95	S-22-36-42	"	09/24	12/18/86	23.67	<0.5
786256-96	S-2248-54	"	09/24	12/18/86	29.17	<0.5
786256-97	S-23-00-03	"	09/29	12/18/86	48.55	0.56
786256-98	S-23-03-06	"	09/29	12/18/86	54.73	0.78
786256-99	S-23-12-18	"	09/29	12/18/86	57.98	< 0.5
786256-100	S-23-24-30	"	09/25	12/18/86	60.70	<0.5
786256-101	S-23-36-42	"	09/25	12/18/86	56.32	<0.5
786256-102	S-24-00-03	"	10/09	12/11/86	22.98	01.54
786256-103	S-24-03-06	"	10/09	12/11/86	20.61	14.29
786256-104	S-24-12-18	"	10/09	12/11/86	36.53	0.85
786256-105	S-24-24-30	"	10/15	12/12/86	39.38	< 0.5
786256-106	S-24-36-42	"	10/09	12/11/86	44.75	< 0.5
786256-107	S-25-00-03	"	09/29	12/18/86	45.66	01.10
786256-108	S-25-03-06	"	09/29	12/18/86	33.41	0.54
786256-109	S-25-12-18	"	09/29	12/18/86	33.01	< 0.5
786256-110	S-25-24-30	"	09/29	12/18/86	36.40	< 0.5
786256-111	S-25-36-42	"	09/29	12/18/86	33.67	<0.5
786256-112	S-25-48-54	"	09/29	12/18/86	32.90	<0.5
786256-113	S-27-00-03	"	10/08	12/11/86	25.38	03.17
786256-114	S-27-03-06	"	10/08	12/11/86	22.22	32.00
786256-115	S-27-12-18	"	10/08	12/12/86	33.93	0.27
786256-116	S-27-24-30	"	10/08	12/11/86	38.99	< 0.5
786256-117	S-27-36-42	"	10/08	12/11/86	40.69	01.85
786256-118	S-27-48-54	"	10/08	12/11/86	44.44	< 0.5
786248-06	S-28-00-03	"	09/17	12/10/86	62.86	01.27
786248-07	S-28-03-06	"	09/17	12/10/86	58.94	01.46
786248-08	S-28-12-18	"	09/19	12/10/86	61.68	<0.5
786248-09	S-28-24-30	"	09/19	12/10/86	62.96	<0.5
786256-119	S-30-00-03	"	09/25	12/18/86	58.63	01.60
786256-120	S-30-03-06	"	09/25	12/18/86	47.34	<0.5
786256-121	S-30-12-18	"	09/24	12/18/86	53.59	<0.5

(57 of 65)

TABLE IV-I

(continued)

Site Name: Onondaga Lake
Submitted by: Michele Galvin
Date Reported January 27, 1987

Sample #	Sample Location	Date Collected	Date Digested	Date Analyzed	% Dry Mass	PPM Hg-Dry Mass Ba
786256-122	S-30-24-30	9/15/86	09/25	12/18/86	52.82	<0.5
786257-01	S-30-36-42	"	09/25	12/18/86	57.10	<0.5
786256-123	S-31-00-03	"	10/15	Lab Accident	30.42	
786256-124	S-31-03-06	"	10/09	12/12/86	31.55	0.29
786256-125	S-31-12-18	"	10/09	12/12/86	40.32	<0.5
786256-126	S-31-24-30	"	10/09	12/12/86	41.56	<0.5
786256-127	S-31-36-42	"	10/09	12/12/86	48.10	<0.5
786256-128	S-31-48-50	"	10/15	12/12/86	47.21	<0.5
786256-129	S-33-00-03	"	10/02	12/18/86	14.69	50.00
786256-130	S-33-03-06	"	10/02	12/18/86	19.40	37.04
786256-131	S-33-12-18	"	10/02	12/18/86	33.76	01.35
786256-132	S-33-24-30	"	10/08	12/11/86	41.68	0.22
786256-133	S-33-36-42	"	10/08	12/16/86	44.18	<0.5
786256-134	S-33-48-51	"	10/08	12/11/86	43.07	<0.5
786256-135	S-35-00-03	"	11/03	12/08/86	36.31	01.72
786256-136	S-35-03-06	"	10/28	12/08/86	29.70	02.42
786256-137	S-35-12-18	"	10/28	12/08/86	32.15	08.57
786256-138	S-35-24-30	"	10/28	12/08/86	34.75	10.13
786256-139	S-35-36-42	"	10/28	12/08/86	45.05	08.70
786256-140	S-35-48-51	"	10/28	12/08/86	44.98	02.64
786255-07	S-36-00-03	"	09/17	12/11/86	31.58	0.62
786255-08	S-36-03-06	"	09/19	12/11/86	63.14	0.40
786255-09	S-36-12-18	"	09/17	12/11/86	61.17	0.14
786255-10	S-36-24-30	"	10/16	12/15/86	54.76	01.03
786256-141	S-39-00-03	"	10/24	12/09/86	36.94	85.37
786256-142	S-39-03-06	"	10/24	12/08/86	51.43	14.56
786256-143	S-39-12-18	"	11/03	12/08/86	45.90	15.31
786256-144	S-39-24-27	"	10/24	12/09/86	45.24	16.48
786255-11	S-40-00-03	"	10/16	12/15/86	38.72	02.25
786255-12	S-40-03-06	"	10/16	12/15/86	33.25	01.37
786255-13	S-40-12-17	"	10/16	12/15/86	38.82	0.50
786256-145	S-41-00-03	"	09/17	12/12/86	28.33	03.23
786256-146	S-41-03-06	"	09/19	12/12/86	25.09	13.56
786256-147	S-41-12-18	"	09/19	12/12/86	39.30	0.22

TABLE IV-I

(continued)

Site Name: Onondaga Lake
Submitted by: Michele Galvin
Date Reported January 27, 1987

Sample #	Sample Location	Date Collected	Date Digested	Date Analyzed	% Dry Mass	PPM Hg-Dry Mass Ba
786256-148	S-41-24-30	9/15/86	09/17	12/12/86	38.48	0.88
786256-149	S-41-36-42	"	09/17	12/12/86	34.33	<0.5
786255-14	S-42-00-03	"	10/16	12/15/86	49.49	<0.5
786255-15	S-42-03-06	"	10/16	12/15/86	53.81	<0.5
786255-16	S-42-12-18	"	10/16	12/15/86	51.34	<0.5
786255-17	S-42-24-30	"	10/16	12/15/86	56.16	<0.5
786255-18	S-42-36-42	"	10/16	12/15/86	53.30	<0.5
786255-19	S-42-48-54	"	10/16	12/15/86	55.47	<0.5
786256-150	S-43-00-03	"	10/22	12/08/86	34.55	01.07
786256-151	S-43-03-06	"	10/22	12/08/86	31.13	21.92
786256-152	S-43-12-18	"	10/22	12/08/86	30.58	0.32
786256-153	S-43-24-30	"	10/22	12/08/86	43.53	0.73
786256-154	S-43-36-41	"	10/22	12/08/86	37.87	0.25
786258-01	S-37-00-03	9/18/86	09/22	12/10/86	74.39	<0.5
786258-02	S-37-03-06	"	09/22	12/10/86	75.96	<0.5
786258-03	S-37-12-18	"	09/22	12/10/86	73.06	<0.5
786258-04	S-37-24-30	"	09/22	12/10/86	59.80	<0.5
786258-05	S-37-36-42	"	09/22	12/11/86	61.04	<0.5
786258-06	S-26-~~03-06~~ 00-03	"	09/22	12/11/86	25.11	<0.5
786258-07	S-26-03-06 WB 11/22/95	"	09/22	12/11/86	30.00	<0.5
786258-08	S-26-12-18	"	09/22	12/11/86	28.09	<0.5
786258-09	S-26-24-30	"	09/23	12/11/86	29.50	<0.5
786258-10	S-26-36-42	"	09/22	12/11/86	34.70	<0.5
786258-11	S-26-48-54	"	09/22	12/11/86	58.52	<0.5
786258-12	S-34-00-03	"	09/24	12/11/86	54.47	<0.5
786258-13	S-34-03-06	"	09/23	12/11/86	55.87	<0.5
786258-14	S-34-12-18	"	09/23	12/11/86	61.40	<0.5
786258-15	S-34-24-30	"	09/23	12/11/86	63.09	<0.5
786258-16	S-34-36-42	"	09/24	12/11/86	53.03	<0.5
786258-17	S-32-00-03	"	09/22	12/11/86	42.27	0.22
786258-18	S-32-03-06	"	09/22	12/11/86	59.39	01.49
786258-19	S-32-12-18	"	09/23	12/11/86	56.95	01.72
786258-20	S-32-24-30	"	09/23	12/11/86	57.01	0.16
786258-21	S-32-36-42	"	09/23	12/11/86	62.75	<0.5

TABLE IV-1

(continued)

Site Name: Onondaga Lake
Submitted by: Michele Galvin
Date Reported January 27, 1987

Sample #	Sample Location	Date Collected	Date Digested	Date Analyzed	% Dry Mass	PPM Hg
* SAMPLES WERE SUBMITTED AS WATER, THERFORE NO DRY WEIGHT WAS DETERMINED.						
** THE FOLLOWING SAMPLES 786259-01 thru 04 WERE SUBMITTED AS WATER SAMPLES.						
786259-01	W-01-05-05	9/18/86		12/16/86		<0.5
786259-02	W-01-13-13	"		12/16/86		<0.5
786259-03	W-03-02-02	"		12/16/86		<0.5
786259-04	W-03-04-04	"		12/16/86		<0.5

TABLE IV-2
NUMBER OF SAMPLES (LAKE ONLY) OCCURRING WITHIN SPECIFIED
DEPTH AND CONCENTRATION RANGES (1986 AND 1987 SAMPLES)
ONONDAGA LAKE SITE

Mercury concentration Range (mg/kg)		Sediment Depth Ranges (inches)					
greater than or equal to	less than	0 - 3	3 - 6	12 - 18	24 - 30	36 - 42	48 - 54
	0.5	10	16	27	30	32	9
0.5	5	25	13	13	8	4	1
5	10	1	1	1	1	1	
10	15	1	4		1		
15	20	1	1	1	1	1	
20	25	1	1				
25	30		2				
30	35		1	1			
35	40		1				
40	45		1				
45	50	1	1				
50		2	1				

TABLE IV-3
ONONDAGA LAKE
1987 LAKE SEDIMENT SAMPLE RESULTS
HSL INORGANICS (mg/kg)
SAMPLES COLLECTED 9/22/87

ANALYTE (a)	NATURALLY OCCURRING RANGE IN NYS SOILS (b)	Sample Location (c) S-14 (0-3")	S-14 (3-6")	S-14 (12-18")	S-14 (24-30")	S-14 (36-41")	S-29 (0-3")	S-29 (3-6")	S-29 (12-18")	S-29 (24-30")	S-29 (36-42")
Aluminum		5690	2700	3080	5170	12400	14500	9620	7800	11900	18600
Antimony	<1-10	---	1.77	---	---	---	---	---	---	---	---
Arsenic	0.1-100	5.28	2.82	4.25	6.04	13.8	19.1	15.7	12.1	18.5	14.4
Barium	10-500	66.6	80.6	37.8	88.0	108	448	390	298	189	195
Cadmium	0.01-7 (d)	1.60	0.81	0.79	2.10	2.44	62.0	62.3	16.6	1.69	---
Calcium		288000	359000	344000	378000	307000	282000	197000	256000	21600	144000
Chromium	1-2000	17.2	11.1	13.0	47.6	47.9	1070	920	232	26.2	27.0
Cobalt	<3-70	9.18	---	---	---	12.2	26.4	---	---	---	---
Copper	1-700	30.5	18.0	28.2	56.8	65.6	451	340	173	164	50.1
Iron		7710	4340	4750	8410	17500	28700	18700	17900	23600	26800
Lead	<10-700	53.7	41.3	40.8	110	107	511	314	183	151	95.9
Magnesium		8150	4250	4540	7550	18500	11200	7040	5550	10600	13100
Manganese	<2-7000	357	305	281	338	469	352	223	238	378	673
Mercury	0.02-0.5	2.0	1.01	0.63	1.82	2.12	48.0	40.9	1.29	2.64	0.697
Nickel	<5-7000	13.8	8.06	17.3	26.8	38.6	257	223	105	26.9	29.8
Potassium		1340	626	701	1030	2610	3190	1810	1350	2090	3550
Silver		---	---	---	1.53	8.72	22.4	16.3	5.23	3.37	---
Sodium		1380	1450	1890	2300	2030	7260	8160	6910	11100	11900
Vanadium		23.9	14.3	18.5	17.0	17.0	70.0	65.4	23.9	52.9	21.7
Zinc	<5-3500	92.0	65.9	82.9	185	185	1020	696	2040	561	170
Cyanide		---	---	---	---	---	---	---	---	---	---

FOOTNOTES:

(a) Only HSL analytes that were detected are presented.
(b) USGS Professional Paper 1270 (1984): New York State Soils.
(c) Depth (in meters) at which water sample was taken is shown in parentheses. Upgradient = Ninemile Creek near Amboy, Bloody Brook, and Ley Creek; see Table IV-4.
(d) Booz, Allen & Hamilton, Inc. (1983): Range in U.S. Soils.

(1/2 of 2)

TABLE IV-3 (continued)
ONONDAGA LAKE
1987 LAKE SEDIMENT SAMPLE RESULTS
HSL INORGANICS (mg/kg)
SAMPLES COLLECTED 9/22/87

ANALYTE (a)	NATURALLY OCCURRING RANGE IN NYS SOILS (b)	Sample Location (c) S-38 (0-3")	S-38 (3-6")	S-38 (12-18")	S-38 (24-30")	S-38 (36-42")
Aluminum		8370	10200	10900	15700	11200
Antimony	<1-10	---	---	---	---	---
Arsenic	0.1-100	7.87	10.4	18.8	18.8	14.8
Barium	10-500	210	231	420	371	623
Cadmium	0.01-7 (d)	14.6	10.9	46.0	45.8	46.5
Calcium		282000	225000	141000	104000	161000
Chromium	1-2000	112	117	680	476	671
Cobalt	<3-70	11.7	12.7	13.0	17.8	---
Copper	1-700	106	113	460	407	406
Iron		12400	16000	21000	21700	20000
Lead	<10-700	135	157	674	498	971
Magnesium		9180	10900	11700	14500	12800
Manganese	<2-7000	293	279	333	363	310
Mercury	0.02-0.5	3.05	6.04	2.97	3.42	19.0
Nickel	<5-7000	35.0	38.1	104	107	131
Potassium		1650	1910	1810	2240	1950
Silver		3.50	4.57	26.9	19.3	29.3
Sodium		1260	1780	2600	2540	3790
Vanadium		30.0	32.0	44.1	36.6	70.2
Zinc	<5-3500	255	374	1520	1060	969
Cyanide		---	---	17.8	11.4	3.11

FOOTNOTES:

(a) Only HSL analytes that were detected are presented.
(b) USGS Professional Paper 1270 (1984): New York State Soils.
(c) Depth (in meters) at which water sample was taken is shown in parentheses. Upgradient = Ninemile Creek near Amboy, Bloody Brook, and Ley Creek; see Table IV-4.
(d) Booz, Allen & Hamilton, Inc. (1983): Range in U.S. Soils.

TABLE IV-4
ONONDAGA LAKE
1987 TRIBUTARY SEDIMENT SAMPLE RESULTS
HSL INORGANICS (mg/kg)
SAMPLES COLLECTED 11/10/87

ANALYTE (a)	NATURALLY OCCURRING RANGE IN NYS SOILS (b)	Sample Location (c)							
		S-45 (d) (Nine/Am)	S-49 (d) (Bldy Brk)	S-50 (d) (Ley Crk)	S-44 (Nine/Blvd)	S-46 (E Flume)	S-47 (Trib 5A)	S-48 (Ged Brk)	S-51 (Hrbr Brk)
Aluminum		4860	6830	3460	10100	4030	6100	4380	10200
Arsenic	0.1-100	2.8	3.8	2.7	6.3	7.7	16	5.2	7.7
Barium	10-500	45	100	46	84	140	7670	99.7	196
Cadmium	0.01-7 (e)	---	10	2.9	---	1.2	---	---	2.0
Calcium		185000	144000	112000	200000	367000	140000	373000	67800
Chromium	1-2000	7.0	21	19	18	27	2252	9.0	59
Cobalt	<3-70	4.2	4.1	2.8	3.8	7.2	1500	---	12
Copper	1-700	17	70	28	37	100	422	30.4	167
Iron		10300	11200	12200	13700	9690	104000	8710	17800
Lead	<10-700	38	88	39	40	92	253	43	665
Magnesium		29800	21800	8470	13300	11500	9020	10500	16200
Manganese	<2-7000	495	344	275	600	374	1550	317	324
Mercury	0.02-0.5	---	0.13	---	13	1.94	1.08	21.1	1.01
Nickel	<5-7000	8.5	9.6	8.4	19	19	1570	18.6	32
Potassium		1450	2180	657	2980	1100	1360	1480	2100
Silver		---	16	---	---	---	2.7	---	1.0
Sodium		282	411	556	2670	1930	833	1860	831
Vanadium		7.0	15	9.7	15	19	3000	9.8	30
Zinc	<5-3500	39	240	92	103	221	475	172	346
Cyanide		---	---	---	---	---	2.5	---	---

FOOTNOTES:

(a) Only HSL analytes that were detected are presented.
(b) USGS Professional Paper 1270 (1984): New York State Soils.
(c) Nine/Am = Ninemile Creek near Amboy, 3.7 miles from lake; Bldy Brk = Bloody Brook; Ley Crk = Ley Creek; Nine Blvd = Ninemile Creek near State Fair Blvd.; E Flume = East Flume; Trib 5A = Tributary 5A; Ged Brk = Geddes Brook; Hrbr Brk = Harbor Brook.
(d) Background or upgradient samples.
(e) Booz, Allen & Hamilton, Inc. (1983): Range in U.S. Soils.

1987 LAKE SEDIMENT SAMPLE RESULTS
HSL ORGANIC COMPOUNDS (ug/kg)
SAMPLES COLLECTED 9/22/87

	Sample Location (b)									
COMPOUND (a)	S-14 (0-3")		S-14 (3-6")		S-14 (12-18")		S-14 (24-30")		S-14 (36-41")	
Methylene Chloride	14	B	560	BE	19	B	23	B	15	B
Acetone	98		88		61		120		47	B
Chloroform	5	J	---		8	J	9	J	---	
2-Butanone	---		---		---		---		---	
Benzene	15		14		13		21		13	
Tetrachloroethene	---		---		---		---		6	J
Toluene	1300	BE	4	BJ	4	BJ	4	BJ	3	J
Chlorobenzene	8	J	8	J	16		33		18	B
Total Xylenes	13		---		---		---		---	
1,3-Dichlorobenzene	---		---		53	J	---		---	
1,4-Dichlorobenzene	---		---		---		120	J	---	
4-Methylphenol	240	J	---		---		---		---	
1,2,4-Trichlorobenzene	---		---		---		---		---	
Naphthalene	---		---		---		---		---	
4-Chloroaniline	---		---		---		---		---	
2-Methylnaphthalene	---		---		5	J	---		---	
Acenaphthylene	---		---		---		---		---	
Acenaphthene	---		---		---		---		---	
Dibenzofuran	---		---		---		---		---	
Diethylphthalate	75	BJ	79	BJ	71	BJ	63	BJ	67	BJ
Fluorene	---		---		---		---		---	
Phenanthrene	110	J	38	J	94	J	110	J	85	J
Anthracene	30	J	---		22	J	---		---	
Di-n-Butylphthalate	3500	B	3200	B	3500	B	3800	B	3500	B
Fluoranthene	210	J	---		190	J	180	J	170	J
Pyrene	280	J	---		200	J	200	J	160	J
Benzo(a)Anthracene	120	J	25	J	91	J	87	J	77	J
Chrysene	160	J	40	J	140	J	120	J	110	J
bis(2-Ethylhexyl)Phthalate	910	B	360	BJ	1100	B	1800	B	680	B
Benzo(b)Fluoranthene	350	J	---		270	J	240	J	---	
Benzo(a)Pyrene	---		---		110	J	97	J	---	
Indeno(1,2,3-cd)Pyrene	---		---		---		---		---	
Dibenz(a,h)Anthracene	---		---		---		---		---	
Benzo(g,h,i)Perylene	---		---		---		---		---	
4,4'-DDD	---		---		---		---		---	
4,4'-DDT	---		---		40		---		---	
Aroclor-1248	---		---		---		---		---	

FOOTNOTES:

(a) Only HSL compounds that were detected are presented.
(b) Upgradient = Ninemile Creek near Amboy, Bloody Brook, and Ley Creek, see Table IV-6.

DATA QUALIFIERS:

B: This flag is used when the analyte is found in the blank as well as a sample. It indicates possible/probable blank contamination and warns the data user to take appropriate action.
E: Indicates that the value is an estimate.
J: Indicates the presence of a compound that meets the identification criteria but the result is less than the specified detection limit but greater than zero.
---: Indicates that the compound was analyzed for but not detected. Refer to Appendix for detection limit.

1987 LAKE SEDIMENT SAMPLE RESULTS
HSL ORGANIC COMPOUNDS (ug/kg)
SAMPLES COLLECTED 9/22/87

	Sample Location (b)									
COMPOUND (a)	S-29 (0-3")		S-29 (3-6")		S-29 (12-18")		S-29 (24-30")		S-29 (36-42")	
Methylene Chloride	45	B	41	B	21	B	23	B	53	B
Acetone	110	B	290	B	100	B	320		180	B
Chloroform	30	BJ	50	B	8	BJ	---		---	
2-Butanone	---		---		---		140		---	
Benzene	51		37		11	J	---		---	
Tetrachloroethene	---		---		---		---		---	
Toluene	28	BJ	22	BJ	---		3	BJ	---	
Chlorobenzene	220		300		---		---		---	
Total Xylenes	97		170		37		67		---	
1,3-Dichlorobenzene	---		---		---		---		---	
1,4-Dichlorobenzene	120	J	250	J	---		---		---	
4-Methylphenol	83	J	110	J	200	J	140	J	57	J
1,2,4-Trichlorobenzene	47	J	110	J	---		---		---	
Naphthalene	81	J	200	J	560	J	590	J	200	J
4-Chloroaniline	860	J	---		---		---		---	
2-Methylnaphthalene	99	J	430	J	350	J	430	J	84	J
Acenaphthylene	110	J	280	J	600	J	480	J	72	J
Acenaphthene	---		290	J	270	J	250	J	81	J
Dibenzofuran	60	J	200	J	140	J	130	J	97	J
Diethylphthalate	720	BJ	160	BJ	76	BJ	82	BJ	75	BJ
Fluorene	1900	J	8800		1300		---		170	J
Phenanthrene	580	J	1900	J	2200		3200		520	J
Anthracene	180	J	550	J	730	J	1300		260	J
Di-n-Butylphthalate	11000	B	11000	B	3100	B	3200	B	3100	B
Fluoranthene	840	J	2000		3100		3100		950	J
Pyrene	1100	J	2800		4000		6200		1500	
Benzo(a)Anthracene	510	J	870	J	1600		2000		710	J
Chrysene	640	J	1300	J	2200		2300		700	J
bis(2-Ethylhexyl)Phthalate	25000	B	28000	B	8100	B	3800	B	---	
Benzo(b)Fluoranthene	1600	J	2800		4300		2000		1200	
Benzo(a)Pyrene	---		1000	J	1600		1300		730	J
Indeno(1,2,3-cd)Pyrene	300	J	910	J	1300		900	J	---	
Dibenz(a,h)Anthracene	---		---		590	J	---		---	
Benzo(g,h,i)Perylene	---		---		1000	J	1300		---	
4,4'-DDD	110		200		---		---		---	
4,4'-DDT	---		---		---		---		---	
Aroclor-1248	1700		1600		---		---		---	

FOOTNOTES:

(a) Only HSL compounds that were detected are presented.
(b) Upgradient = Ninemile Creek near Amboy, Bloody Brook, and Ley Creek, see Table IV-6.

DATA QUALIFIERS:

B: This flag is used when the analyte is found in the blank as well as a sample. It indicates possible/probable blank contamination and warns the data user to take appropriate action.

E: Indicates that the value is an estimate.

J: Indicates the presence of a compound that meets the identification criteria but the result is less than the specified detection limit but greater than zero.

---: Indicates that the compound was analyzed for but not detected. Refer to Appendix for detection limit.

ONONDAGA LAKE
1987 LAKE SEDIMENT SAMPLE RESULTS
HSL ORGANIC COMPOUNDS (ug/kg)
SAMPLES COLLECTED 9/22/87

(47 of 265)

COMPOUND (a)	Sample Location (b) S-38 (0-3")		S-38 (3-6")		S-38 (12-18")		S-38 (24-30")		S-38 (36-42")	
Methylene Chloride	19	B	20	B	26	B	17	B	25	B
Acetone	44	B	120	B	780	BE	260	B	140	B
Carbon Disulfide	---		---		70		---		---	
Chloroform	16	B	---		---		6	BJ	---	
Benzene	17		28		160		150		280	
Tetrachloroethene	8	J	---		16	J	---		---	
Toluene	5	BJ	7	BJ	59		39		58	B
Chlorobenzene	70		110		1100	BE	580	BE	740	E
Ethylbenzene	---		---		27		15		23	
Total Xylenes	20		37		220		79		330	
1,4-Dichlorobenzene	---		78	J	---		---		---	
4-Methylphenol	34	J	---		---		---		---	
1,2,4-Trichlorobenzene	25	J	46	J	---		---		---	
Naphthalene	140	J	190	J	---		---		170	J
4-Chloroaniline	120	J	290	J	---		---		---	
2-Methylnaphthalene	70	J	130	J	29	J	---		49	J
Acenaphthylene	170	J	240	J	---		---		---	
Acenaphthene	53	J	---		---		---		---	
Dibenzofuran	39	J	90	J	---		---		---	
Diethylphthalate	100	BJ	92	BJ	---		---		---	
Fluorene	320	J	1100		63	J	---		400	J
Phenanthrene	370	J	470	J	150	J	200	J	210	J
Anthracene	160	J	170	J	---		49	J	---	
Di-n-Butylphthalate	4500	B	2200	B	---		---		---	
Fluoranthene	670	J	630	J	---		310	J	310	J
Pyrene	1100		2600		180	J	---		290	J
Benzo(a)Anthracene	400	J	860	J	93	J	---		160	J
Chrysene	550	J	1100		170	J	150	J	220	J
bis(2-Ethylhexyl)Phthalate	3200	B	5500	B	380	BJ	410	BJ	---	
Benzo(b)Fluoranthene	900	J	1500		170	J	260	J	290	J
Benzo(a)Pyrene	390	J	860	J	62	J	---		---	
Indeno(1,2,3-cd)Pyrene	390	J	600	J	---		---		---	
Benzo(g,h,i)Perylene	---		900	J	---		---		---	
Aldrin	47		---		---		---		---	
Aroclor-1248	---		---		5800		4300		7600	
Aroclor-1254	---		---		1800		1900		3600	

FOOTNOTES:

(a) Only HSL compounds that were detected are presented.
(b) Upgradient = Ninemile Creek near Amboy, Bloody Brook, and Ley Creek, see Table IV-6

DATA QUALIFIERS:

B: This flag is used when the analyte is found in the blank as well as a sample. It indicates possible/probable blank contamination and warns the data user to take appropriate action.
E: Indicates that the value is an estimate.
J: Indicates the presence of a compound that meets the identification criteria but th result is less than the specified detection limit but greater than zero.
---: Indicates that the compound was analyzed for but not detected. Refer to Appendix for detection limit.

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. .E IV-6
ONONDAGA LAKE
1987 TRIBUTARY SEDIMENT SAMPLE RESULTS
HSL ORGANIC COMPOUNDS (ug/kg)
SAMPLES COLLECTED 11/10/87

COMPOUND (a)	Sample Location (b) S-45 (c) (Nine/Am)	S-49 (c) (Bldy Brk)	S-50 (c) (Ley Crk)	S-44 (Nine/Blvd)	S-46 (E Flume)	S-47 (Trib 5A)	S-48 (Ged Brk)	S-51 (Hrbr Brk)
Methylene Chloride	10 B	230 B	25 B	24 B	NA	45 B	370 B	23 B
Acetone	---	---	---	---	NA	---	730	140
Carbon Disulfide	---	---	2 J	---	NA	13	5	---
1,2-Dichloroethene(Total)	---	---	0.6 J	---	NA	---	---	0.3 J
Chloroform	7	0.2 J	0.2 J	8 B	NA	1 J	44 B	2 J
1,2-Dichloroethane	---	---	---	---	NA	---	---	---
2-Butanone	---	---	---	---	NA	7 J	---	21
1,1,1-Trichloroethane	---	2 J	---	---	NA	---	---	---
Bromodichloromethane	2 J	---	---	3 J	NA	---	---	---
Trichloroethene	---	0.3 J	1 J	---	NA	---	2 J	0.2 J
1,1,2,2-Tetrachloroethane	---	---	---	---	NA	---	1 J	---
Dibromochloromethane	0.5 J	---	---	1 J	NA	---	---	---
Benzene	---	0.2 J	---	---	NA	3 J	---	0.5 J
Tetrachloroethene	---	0.1 J	---	---	NA	---	---	0.9 J
Toluene	1 BJ	1 BJ	1 BJ	2 BJ	NA	2 BJ	2 BJ	3 J
Chlorobenzene	---	---	---	---	NA	0.4 J	0.2 J	---
Ethylbenzene	---	0.3 J	0.1 J	---	NA	0.4 J	0.3 J	0.5 J
Total Xylenes	---	1 J	---	---	NA	3 J	2 J	3 J
2-Chlorophenol	---	4 J	5 J	---	---	---	6 J	---
1,3-Dichlorobenzene	---	---	---	---	---	---	---	---
1,4-Dichlorobenzene	65 BJ	94 BJ	59 BJ	130 BJ	290 BJ	160 BJ	120 BJ	---
Benzyl Alcohol	---	---	---	---	---	---	7 J	---
1,2-Dichlorobenzene	---	---	---	---	67 J	---	---	---
4-Methylphenol	---	---	---	---	---	---	---	24 J
Benzoic Acid	---	---	91 J	---	---	---	---	---
1,2,4-Trichlorobenzene	---	---	---	---	30 J	---	---	320 J
Naphthalene	---	24 J	10 J	---	30 J	1400 J	---	320 J
2-Methylnaphthalene	3 J	11 J	6 J	---	21 J	590 J	---	250 J
Acenaphthylene	5 J	14 J	10 J	---	12 J	170 J	---	78 J

FOOTNOTES:

(a) Only HSL compounds that were detected are presented.
(b) Nine/Am = Ninemile Creek near Amboy, 3.7 miles from lake; Bldy Brk = Bloody Brook; Ley Crk = Ley Creek; Nine Blvd = Ninemile Creek near State Fair Blvd.; E Flume = East Flume; Trib 5A = Tributary 5A; Ged Brk = Geddes Brook; Hrbr Brk = Harbor Brook.
(c) Upgradient location.

DATA QUALIFIERS:

B: This flag is used when the analyte is found in the blank as well as a sample. It indicates possible/probable blank contamination and warns the data user to take appropriate action.
J: Indicates the presence of a compound that meets the identification criteria but the result is less than the specified detection limit but greater than zero.
---: Indicates that the compound was analyzed for but not detected. Refer to Appendix for detection limit.
NA: Not available.

TABLE . (continued)
ONONDAGA LAKE
1987 TRIBUTARY SEDIMENT SAMPLE RESULTS
HSL ORGANIC COMPOUNDS (ug/kg)
SAMPLES COLLECTED 11/10/87

	Sample Location (b)															
COMPOUND (a)	S-45 (c) (Nine/Am)		S-49 (c) (Bldy Brk)		S-50 (c) (Ley Crk)		S-44 (Nine/Blvd)		S-46 (E Flume)		S-47 (Trib 5A)		S-48 (Ged Brk)		S-51 (Hrbr Brk)	
Acenaphthene	5	J	28	J	7	J	---		13	J	1200	J	---		650	J
Dibenzofuran	4	J	26	J	6	J	---		11	J	1100	J	1	J	440	J
Diethylphthalate	12	BJ	6	J	16	BJ	---		20	BJ	---		7	BJ	---	
Fluorene	8	J	38	J	10	J	---		15	J	1600	J	---		830	J
N-Nitrosodiphenylamine	---		---		---		82	BJ	---		---		---		230	BJ
Phenanthrene	94	J	350		87	J	99	J	130	J	13000		18	J	8700	
Anthracene	19	J	83	J	20	J	---		21	J	3000	J	---		1300	
Di-n-Butylphthalate	20	BJ	30	J	32	BJ	---		48	BJ	83	BJ	28	BJ	---	
Fluoranthene	170	J	670		190	J	230	J	270	J	16000		32	J	8700	
Pyrene	140	J	510		180	J	190	J	230	J	12000		27	J	7800	
Butylbenzylphthalate	---		10	J	---		---		---		---		---		---	
Benzo(a)Anthracene	85	J	310	J	84	J	160	J	110	J	6600		17	J	890	J
Chrysene	90	J	350		110	J	150	J	160	J	6300		21	J	4100	
bis(2-Ethylhexyl)Phthalate	83	J	380		450		---		340		790	J	60	J	---	
Di-n-octylphthalate	4	BJ	10	J	4	BJ	---		---		---		3	BJ	---	
Benzo(b)Fluoranthene	130	J	610		180	J	250	J	280	J	1000	J	45	J	5400	
Benzo(a)Pyrene	72	J	310	J	84	J	98	J	84	J	5600		---		3200	J
Indeno(1,2,3-cd)Pyrene	42	J	210	J	56	J	---		120	J	3500		---		1700	J
Dibenz(a,h)Anthracene	19	J	79	J	25	J	---		40	J	930	J	---		580	J
Benzo(g,h,i)Perylene	48	J	210	J	60	J	---		130	J	3700		---		1700	J
beta-BHC	108	B	86	JB	55	JB	---		---		---		78	B	---	
gamma-BHC (Lindane)	---		---		---		---		---		---		---		---	
alpha-Chlordane	---		---		---		---		---		---		---		---	
gamma-Chlordane	---		---		---		---		---		350	J	24	J	410	J

FOOTNOTES:

(a) Only HSL compounds that were detected are presented.
(b) Nine/Am = Ninemile Creek near Amboy, 3.7 miles from lake; Bldy Brk = Bloody Brook; Ley Crk = Ley Creek; Nine Blvd = Ninemile Creek near State Fair Blvd.; E Flume = East Flume; Trib 5A = Tributary 5A; Ged Brk = Geddes Brook; Hrbr Brk = Harbor Brook.
(c) Upgradient location.

DATA QUALIFIERS:

B: This flag is used when the analyte is found in the blank as well as a sample. It indicates possible/probable blank contamination and warns the data user to take appropriate action.
J: Indicates the presence of a compound that meets the identification criteria but the result is less than the specified detection limit but greater than zero.
---: Indicates that the compound was analyzed for but not detected. Refer to Appendix for detection limit.

TABLE IV-7
ONONDAGA LAKE
1987 LAKE WATER SAMPLE RESULTS
HSL ORGANIC COMPOUNDS (ug/L)
SAMPLES COLLECTED 9/22/87

COMPOUND (a)	NYS GUIDANCE VALUES (b)	Sample Location (c)							
		W-1 (4 M)	W-1 (14 M)	W-2 (4 M)	W-2 (11 M)	W-2 (16 M)	W-3 (3 M)	W-8 (3 M)	W-8 (3 M dup)
Methylene Chloride		5 B	4 BJ	5 B	7 B	4 BJ	20 B	4 BJ	5 B
Chloroform		---	---	---	0.9 J	---	---	---	0.4 J
Tetrachloroethene	1	---	0.7 J	---	---	0.4 J	---	0.6 J	---
Toluene		---	---	---	0.5 BJ	1 BJ	---	---	0.3 B

FOOTNOTES:

(a) Only HSL compounds that were detected are presented.
(b) Referenced from: "Ambient Water Quality Standards and Guidance Values" for Class B waters, 6 NYCRR Parts 701 and 702, NYSDEC, 7/24/85, as amended through 4/1/87. All units are ug/L.
(c) Depth at which water sample was taken is shown in parentheses. Upgradient = Bloody Brook and Ley Creek, see Table IV-8.

DATA QUALIFIERS:

B: This flag is used when the analyte is found in the blank as well as a sample. It indicates possible/probable blank contamination and warns the data user to take appropriate action.
J: Indicates the presence of a compound that meets the identification criteria but the result is less than the specified detection limit but greater than zero.
---: Indicates that the compound was analyzed for but not detected. Refer to Appendix D for detection limit.

TABLE IV-8
ONONDAGA LAKE
1987 INFLUENT WATER SAMPLE RESULTS
HSL ORGANIC COMPOUNDS (ug/L)
SAMPLES COLLECTED 11/10/87

COMPOUND (a)	NYS STANDARDS/ GUIDANCE VALUES (b)		Sample Location (c) W-10 (d) (Bldy Brk)		W-11 (d) (Ley Crk)		W-4 (Metro)		W-5 (Ondga Crk)		W-5 (dup)		W-6 (East Flume)		W-7 (Nine/Ged)		W-9 (Ged Brk)		W-12 (Trib 5A)		W-1 (Hrbr
Vinyl Chloride			---		---		---		---		---		---		---		---		---		1
Methylene Chloride			2	BJ	3	BJ	81	B	4	BJ	3	BJ	3	BJ	2	BJ	3	BJ	3	BJ	3
Acetone			---		---		740	E	8	J	---		---		---		---		---		---
Carbon Disulfide			---		---		0.3	J	---		---		---		---		---		---		---
1,2-Dichloroethene(Total)			1	J	6	J	0.2	J	1	J	0.7	J	---		---		---		---		2
Chloroform			0.5	J	0.8	J	3	J	0.3	J	0.1	J	1	J	0.2	J	1	J	15		0.2
1,1,1-Trichloroethane			0.5	J	0.8	J	0.4	J	0.5	J	---		---		---		---		---		---
Bromodichloromethane			0.2	J	---		0.4	J	---		---		0.2	J	---		0.2	J	3	J	---
Trichloroethene	11	G	2	J	4	J	0.4	J	0.8	J	0.7	J	0.09	J	0.2	J	2	J	---		---
Benzene	6	G	---		---		0.1	BJ	0.2	BJ	---		0.2	BJ	0.4	BJ	---		---		---
Tetrachloroethene	1	G	---		---		0.6	J	1	J	1	J	0.5	J	---		---		---		---
Toluene			0.7	BJ	0.7	BJ	2	BJ	0.8	BJ	0.7	BJ	0.7	BJ	0.7	BJ	0.7	BJ	0.8	BJ	0.8
Chlorobenzene	5		---		---		---		---		---		---		1	J	---		---		---
Ethylbenzene			---		---		0.3	J	---		---		---		---		---		---		---
Total Xylenes			---		---		1	J	1	J	---		---		---		0.8	J	---		---
1,4-Dichlorobenzene	5		4	BJ	4	BJ	4	BJ	2	BJ	0.2	BJ	9	BJ	4	BJ	4	BJ	2	BJ	0.2
Benzyl Alcohol			---		---		---		---		---		---		---		---		---		0.8
1,2-Dichlorobenzene	5		---		---		---		---		---		4	J	---		---		---		---
1,2,4-Trichlorobenzene	5		---		---		---		---		---		0.2	J	---		---		---		---
Naphthalene			---		---		---		0.4	BJ	---		0.4	J	---		---		0.4	J	0.4
Acenaphthene			0.2	J	---		---		---		---		---		---		---		---		---
Dibenzofuran			0.4	J	---		---		---		---		---		---		---		---		---
Phenanthrene			0.4	J	---		---		---		---		---		---		---		---		---
Di-n-Butylphthalate			0.4	J	0.4	J	---		---		---		---		0.2	J	0.6	J	0.4	J	0.4
Fluoranthene			0.4	J	---		---		---		---		---		---		---		---		---
Butylbenzylphthalate			---		---		---		---		---		---		---		---		---		2
bis(2-Ethylhexyl)Phthalate	0.6		---		2	BJ	2	BJ	0.04	J	---		1	BJ	0.9	BJ	---		0.9	BJ	---
Di-n-octylphthalate			0.04	J	0.1	J	---		---		---		0.2	J	---		0.1	BJ	0.2	J	---
gamma-BHC (Lindane)	0.01	*	---		---		---		---		---		0.06	J	---		---		---		---
alpha-Chlordane	0.002	G	---		---		---		---		---		---		---		0.6	J	---		---

FOOTNOTES:

(a) Only HSL compounds that were detected are presented.
(b) Referenced from: "Ambient Water Quality Standards and Guidance Values" for Class B waters, 6 NYCRR Parts 701 and 702, NYSDEC, 7/24/85, as amended through 4/1/87. The value presented is the standard except where noted by "G", in which Case it is the guidance value. An "*" denotes the standard for the sum of BHC isomers. All units are ug/L.
(c) Bldy Brk = Bloody Brook; Ley Crk = Ley Creek; Metro = Outfall at Metropolitan Treatment Plant; Ondga Crk = Onondaga Creek; Nine/Ged = Ninemile Creek, upstream of confluence with Geddes Brook; Ged Brk = Geddes Brook; Trib 5A = Tributary 5A; Hrbr Brk = Harbor Brook.
(d) Upgradient location.

DATA QUALIFIERS:

B: This flag is used when the analyte is found in the blank as well as a sample. It indicates possible/probable blank contamination and warns the data user to take appropriate action.
E: Indicates that the value is an estimate.
J: Indicates the presence of a compound that meets the identification criteria but the result is less than the specified detection limit but greater than zero.
---: Indicates that the compound was analyzed for but not detected. Refer to Appendix for detection limit.

TABLE IV-9
ONONDAGA LAKE
1987 LAKE WATER SAMPLE RESULTS
HSL INORGANICS (ug/L)
SAMPLES COLLECTED 9/22/87

ANALYTE (a)	NYS STANDARDS/ GUIDANCE VALUES (b)		Sample Location (c)							
			W-1 (4 M)	W-1 (14 M)	W-2 (4 M)	W-2 (11 M)	W-2 (16 M)	W-3 (3 M)	W-8 (3 M)	W-8 (3 M dup)
Aluminum	100		320	400	260	340	280	290	310	290
Barium			[70]	[110]	[80]	110	[90]	[100]	[80]	[90]
Calcium			211000	204000	202000	196000	211000	202000	168000	165000
Chromium	899	*	---	---	---	---	[5]	---	---	---
Copper	55	*	---	[6]	42	[6]	---	[8]	[6]	[9]
Iron	'300		[70]	150	[90]	[70]	110	120	80	120
Magnesium			28200	29600	28100	27900	29300	28100	27100	27700
Manganese			30	197	44	88	372	52	63	63
Mercury	0.2	G	---	---	0.5	---	0.4	0.5	---	---
Nickel	374	*	---	[20]	[20]	---	---	---	---	---
Potassium			11700	11900	11800	12300	10600	11200	11500	10700
Sodium			280000	300000	290000	330000	270000	290000	290000	290000
Zinc	30		---	---	[7]	[5]	---	---	---	[10]

FOOTNOTES:

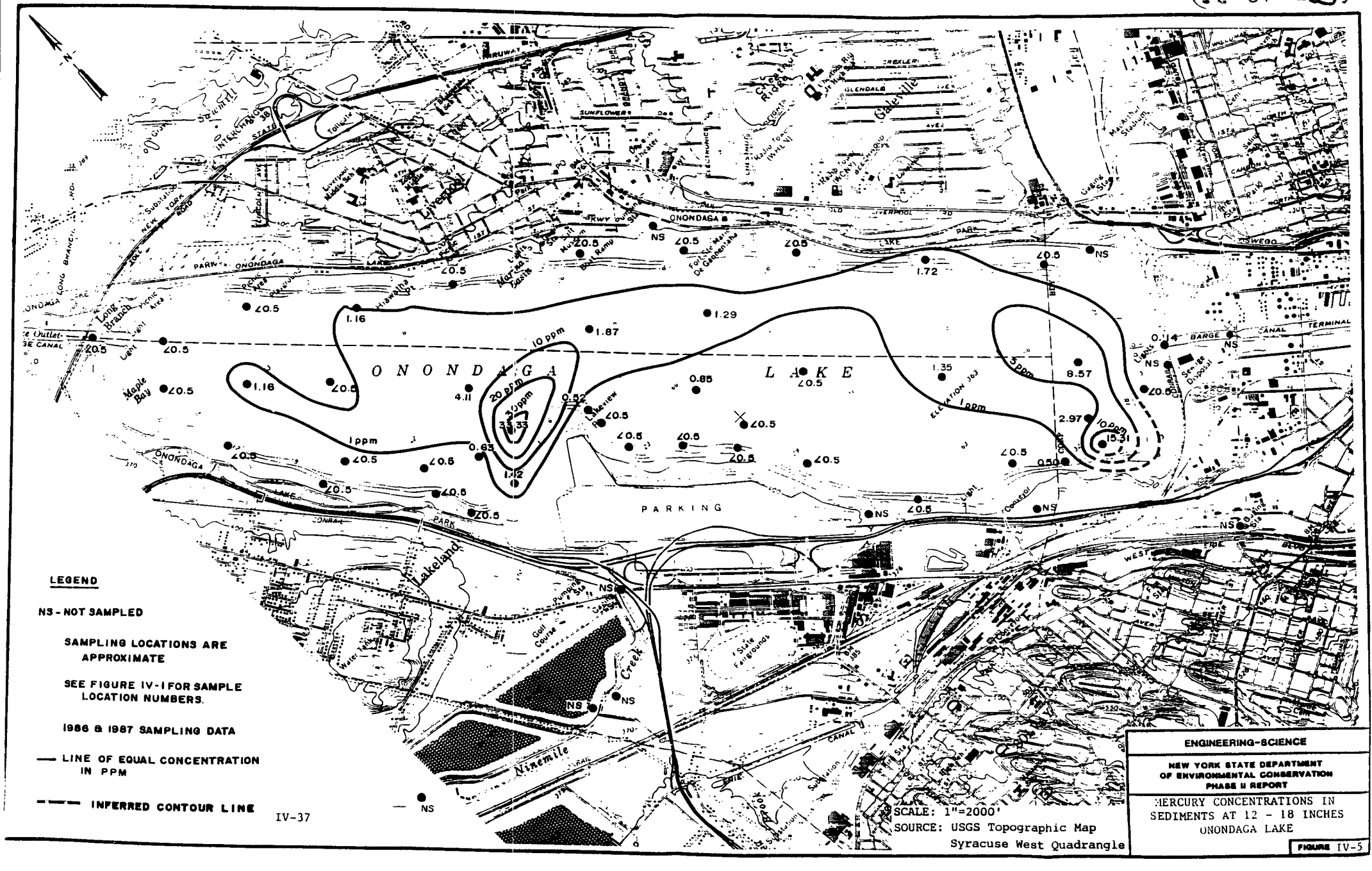
(a) Only HSL analytes that were detected are presented. If the result is a value greater than or equal to the instrument detection limit but less than the contract-required detection limit, the value is reported in brackets (e.g., [10]).
(b) Referenced from: "Ambient Water Quality Standards and Guidance Values" for Class B waters, 6 NYCRR Parts 701 and 702, NYSDEC, 7/24/85, as amended through 4/1/87. The value presented is the standard except where noted by "G", in which Case it is the guidance value. An "*" denotes a standard calculated based on a water hardness of 601 mg/L. All units are ug/L.
(c) Depth at which water sample was taken is shown in parentheses. Upgradient = Bloody Brook and Ley Creek, see Table IV-10.

TABLE IV-10
ONONDAGA LAKE
1987 INFLUENT WATER SAMPLE RESULTS
HSL INORGANICS (ug/L)
SAMPLES COLLECTED 11/10/87

ANALYTE (a)	NYS STANDARDS/ GUIDANCE VALUES (b)		Sample Location (c) W-10 (d) (Bldy Brk)	W-11 (d) (Ley Crk)	W-4 (Metro)	W-5 (Ondga Crk)	W-5 (dup)	W-6 (East Flume)	W-7 (Nine/Ged)	W-9 (Ged Brk)	W-12 (Trib 5A)	W-13 (Hrbr Br
Aluminum	100		380	340	260	660	1050	[180]	350	380	350	270
Antimony			---	---	---	---	---	---	---	---	---	10
Barium			[80]	[90]	[40]	130	[160]	[60]	[130]	[70]	670	[60]
Calcium			145000	78000	97400	142000	114000	56300	415000	260000	77400	233000
Chromium	899	*	[6]	---	29	---	---	[5]	---	---	78	---
Copper	55	*	[10]	[8]	21	[9]	[7]	---	[5]	---	14	---
Iron	300		540	650	620	780	830	170	610	460	990	350
Lead	31	*	13	7.0	---	10	5.0	19	15	20	10	40
Magnesium			26200	23300	18100	33400	30100	25000	47900	36700	15400	52700
Manganese			81	139	105	71	82	30	101	69	122	37
Mercury	0.2	G	---	---	---	---	---	---	---	1.0	---	---
Nickel	374	*	---	---	[30]	---	---	---	---	---	80	---
Potassium			4940	5760	14300	5980	5900	19800	11600	7320	7070	5890
Sodium			69000	110000	97000	410000	380000	590000	215000	400000	180000	120000
Zinc	30		358	29	99	158	205	109	228	89	61	251
Cyanide	5.2		---	---	15	---	---	27	---	---	13	---

FOOTNOTES:

(a) Only HSL analytes that were detected are presented. If the result is a value greater than or equal to the instrument detection limit but less than the contract-required detection limit, the value is reported in brackets (e.g., [10]).
(b) Referenced from: "Ambient Water Quality Standards and Guidance Values" for Class B waters, 6 NYCRR Parts 701 and 702, NYSDEC, 7/24/85, as amended through 4/1/87. The value presented is the standard except where noted by "G", in which case it is the guidance value. An "*" denotes a standard calculated based on a water hardness of 601 mg/L. All units are ug/L.
(c) Bldy Brk = Bloody Brook; Ley Crk = Ley Creek; Metro = Outfall at Metropolitan Treatment Plant; Ondga Crk = Onondaga Creek; Nine/Ged = Ninemile Creek, upstream of confluence with Geddes Brook; Ged Brk = Geddes Brook; Trib 5A = Tributary 5A; Hrbr Brk = Harbor Brook.
(d) Background or upgradient samples.



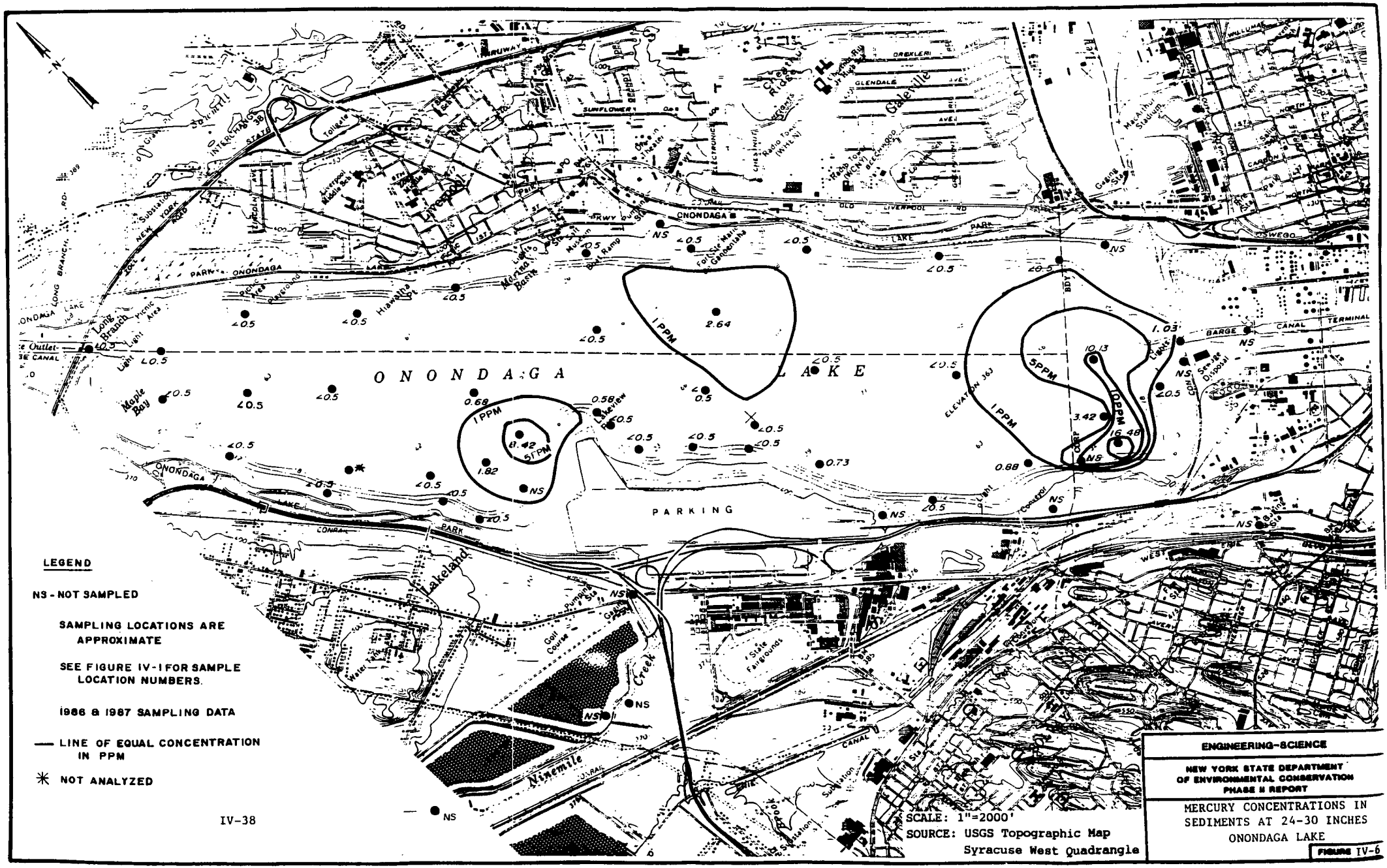
ENGINEERING-SCIENCE

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
PHASE II REPORT

MERCURY CONCENTRATIONS IN SEDIMENTS AT 12 - 18 INCHES
ONONDAGA LAKE

FIGURE IV-5

(59 of 265)



LEGEND

NS - NOT SAMPLED

SAMPLING LOCATIONS ARE APPROXIMATE

SEE FIGURE IV-1 FOR SAMPLE LOCATION NUMBERS.

1986 & 1987 SAMPLING DATA

— LINE OF EQUAL CONCENTRATION IN PPM

✳ NOT ANALYZED

SCALE: 1"=2000'

SOURCE: USGS Topographic Map Syracuse West Quadrangle

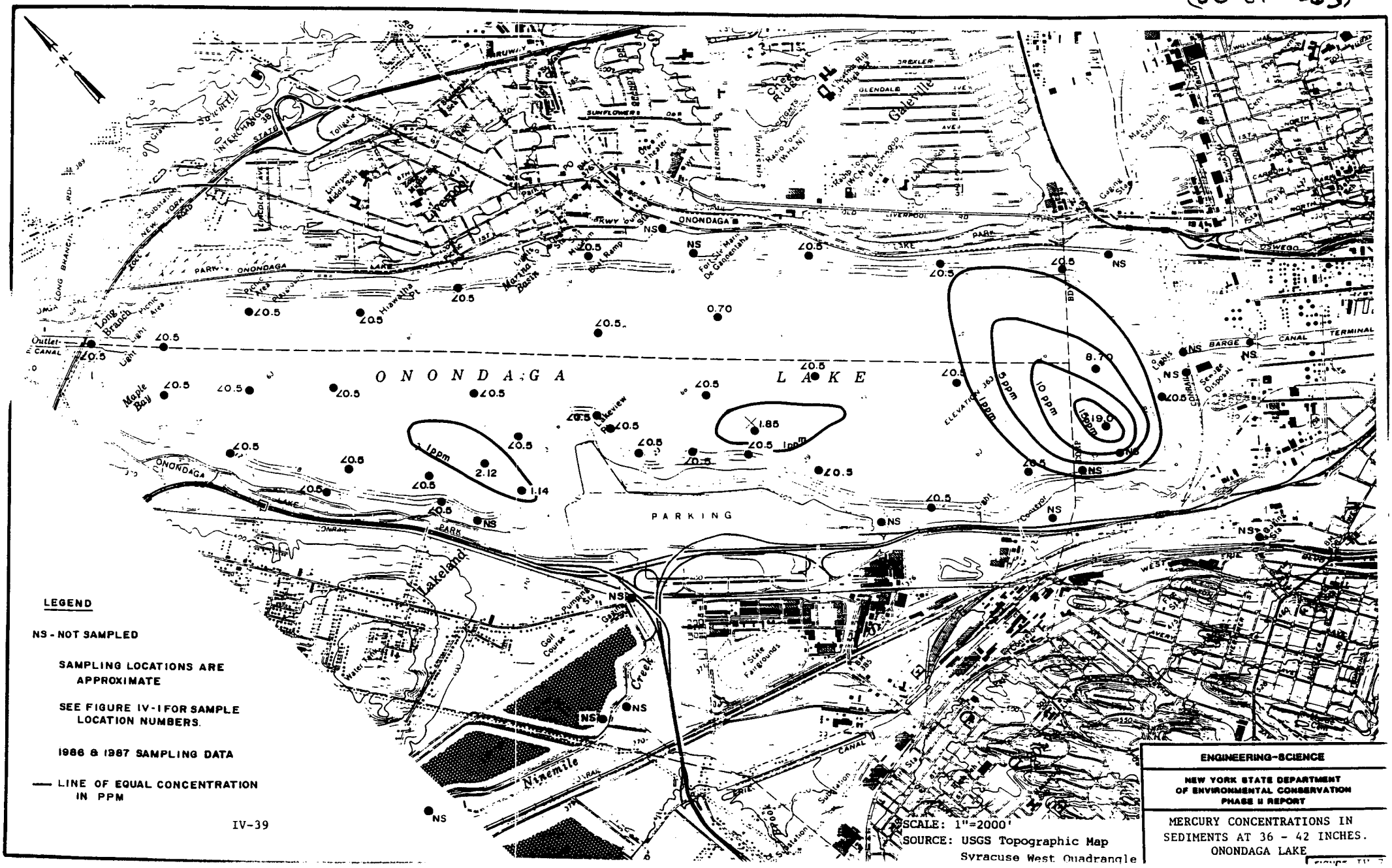
ENGINEERING-SCIENCE

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
PHASE II REPORT

MERCURY CONCENTRATIONS IN SEDIMENTS AT 24-30 INCHES ONONDAGA LAKE

FIGURE IV-6

(60 of 255)

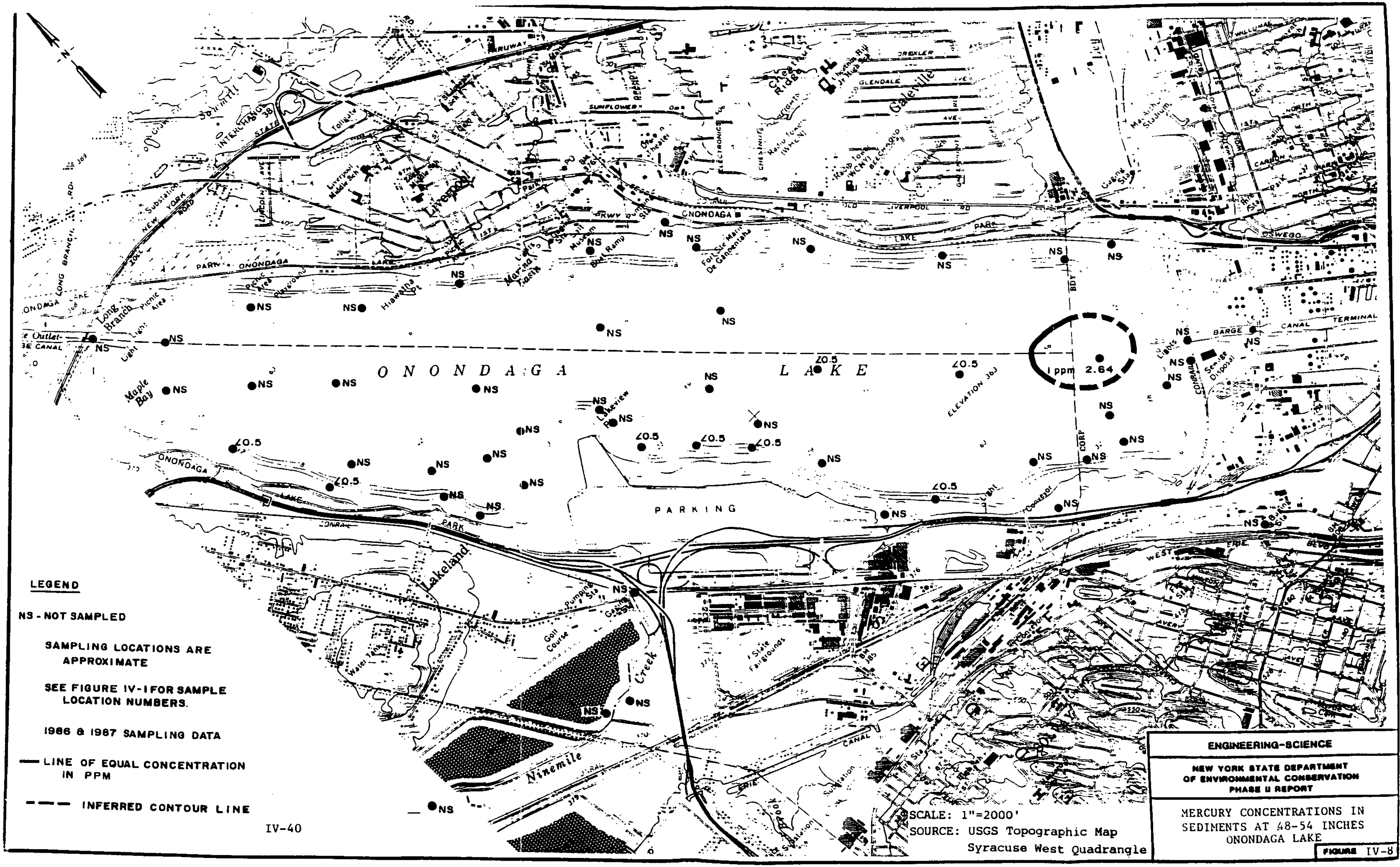


ENGINEERING-SCIENCE

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
PHASE II REPORT

MERCURY CONCENTRATIONS IN SEDIMENTS AT 36 - 42 INCHES. ONONDAGA LAKE

FIGURE IV-7



LEGEND

NS - NOT SAMPLED

SAMPLING LOCATIONS ARE APPROXIMATE

SEE FIGURE IV-1 FOR SAMPLE LOCATION NUMBERS.

1986 & 1987 SAMPLING DATA

— LINE OF EQUAL CONCENTRATION IN PPM

– – – INFERRED CONTOUR LINE

SCALE: 1"=2000'
SOURCE: USGS Topographic Map
Syracuse West Quadrangle

ENGINEERING-SCIENCE

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION PHASE II REPORT

MERCURY CONCENTRATIONS IN SEDIMENTS AT 48-54 INCHES ONONDAGA LAKE

FIGURE IV-8

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SECTION V

NARRATIVE

SECTION V

FINAL APPLICATION OF THE HAZARD RANKING SYSTEM

NARRATIVE SUMMARY

The Onondaga Lake site is located in the City of Syracuse and the Towns of Salina and Geddes, Onondaga County, N.Y (Figure V-1). The lake is approximately 4.5 square miles in size. From the late 1800s to the present industrial process wastes have been discharged into the lake. These wastes consist of predominantly mercury and salts with lesser amounts of aromatic hydrocarbons, solvents, and PCBs. Municipal wastewater effluent is still discharged into the lake, which also receives periodic raw sewage overflows from several municipal pumping stations. The primary sources of these wastes were the facilities which operated in the vicinity of the lake, and discharged wastes to the lake or its tributaries.

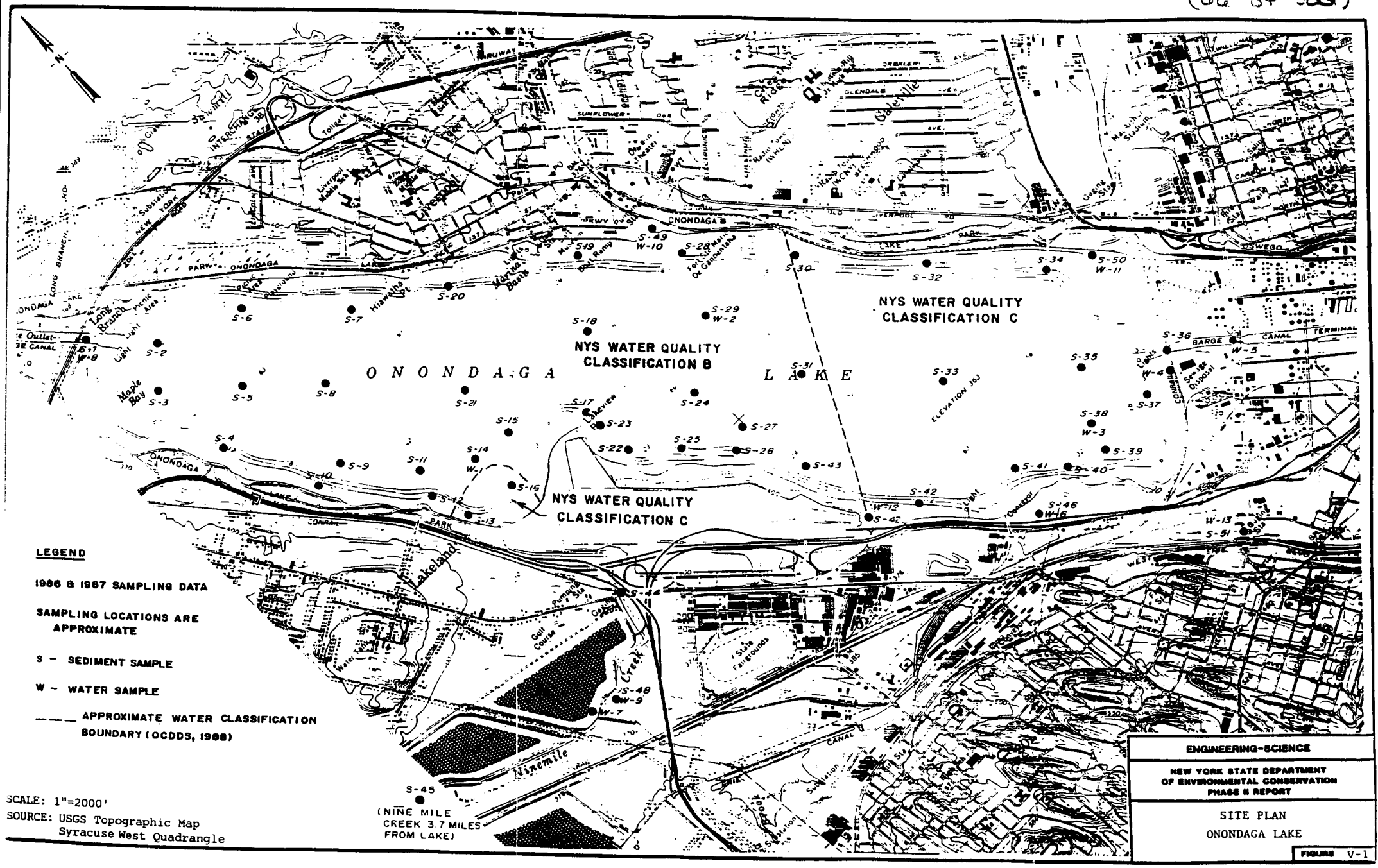
In 1973 the USEPA completed a study of the sediments in Onondaga Lake and concluded that between 1946 and 1970, 75,000 kg of mercury had been discharged to the lake by the two Allied Chemical Corporation chlor-alkali plants in Solvay, N.Y. The EPA report also concluded that the total volume of sediments containing mercury at concentrations above natural background levels was approximately seven million cubic yards. The mercury concentrations in fish flesh exceeded FDA standards.

This NYSDEC Phase II investigation included sampling and analysis of surface water and sediment from Onondaga Lake and its tributaries. Sixty-nine percent of the samples from the upper six inches of lake sediment exceed the naturally-occurring range of mercury in New York State soils. Thirty-six HSL organic and inorganic compounds were present in downgradient sediment samples at concentrations in excess of three times the upgradient concentrations. Seven HSL metals were present in downgradient surface water samples at concentrations in excess of three times the upgradient concentrations.

Surface water from Onondaga Lake is not used as a drinking water source. However, the aquifer of concern (overburden) serves as the drinking water source for an estimated 707 people within a 3-mile radius of the site.

LOCATION

(66 of 255)



ENGINEERING-SCIENCE

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
PHASE II REPORT

SITE PLAN
ONONDAGA LAKE

FIGURE V-1

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MRS WORKSHEETS

Facility Name: Onondaga Lake Date: 11-18-88

Ground Water Route Work Sheet					
Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 45	1	0	45	3.1
If observed release is given a score of 45, proceed to line 4. If observed release is given a score of 0, proceed to line 2.					
2 Route Characteristics					3.2
Depth to Aquifer of Concern	0 1 2 3	2	6	6	
Net Precipitation	0 1 2 3	1	2	3	
Permeability of the Unsaturated Zone	0 1 2 3	1	3	3	
Physical State	0 1 2 3	1	3	3	
Total Route Characteristics Score			14	15	
3 Containment	0 1 2 3	1	3	3	3.3
4 Waste Characteristics					3.4
Toxicity/Persistence	0 3 6 9 12 15 18	1	18	18	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1	3	8	
Total Waste Characteristics Score			21	26	
5 Targets					3.5
Ground Water Use	0 1 2 3	3	9	9	
Distance to Nearest Well/Population Served	0 4 6 8 10 12 16 18 20 24 30 32 35 40	1	12	40	
Total Targets Score			21	49	
6 If line 1 is 45, multiply 1 x 4 x 5 If line 1 is 0, multiply 2 x 3 x 4 x 5			18,522	57,330	
7 Divide line 6 by 57,330 and multiply by 100			S_{gw} = 32.30		

GROUND WATER ROUTE WORK SHEET

Facility Name: Onondaga Lake Date: 11/18/88 (69 of 76)

Surface Water Route Work Sheet					
Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 45	1	45	45	4.1
If observed release is given a value of 45, proceed to line 4. If observed release is given a value of 0, proceed to line 2.					
2 Route Characteristics					4.2
Facility Slope and Intervening Terrain	0 1 2 3	1	0	3	
1-yr. 24-hr. Rainfall	0 1 2 3	1	2	3	
Distance to Nearest Surface Water	0 1 2 3	2	6	6	
Physical State	0 1 2 3	1	3	3	
Total Route Characteristics Score			11	15	
3 Containment	0 1 2 3	1	3	3	4.3
4 Waste Characteristics					4.4
Toxicity/Persistence	0 3 6 9 12 15 18	1	18	18	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1	3	8	
Total Waste Characteristics Score			21	26	
5 Targets					4.5
Surface Water Use	0 1 2 3	3	6	9	
Distance to a Sensitive Environment	0 1 2 3	2	6	6	
Population Served/ Distance to Water Intake Downstream	0 4 6 8 10 12 16 18 20 24 30 32 35 40	1	0	40	
Total Targets Score			12	55	
6 If line 1 is 45, multiply 1 x 4 x 5 If line 1 is 0, multiply 2 x 3 x 4 x 5			11,340	64,350	
7 Divide line 6 by 64,350 and multiply by 100			S_{sw} = 17.62		

SURFACE WATER ROUTE WORK SHEET

Facility Name: Onondaga Lake Date: 11/18/88

Air Route Work Sheet					
Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	5.1
Date and Location:					
Sampling Protocol:					
If line 1 is 0, the S_a = 0. Enter on line 5. If line 1 is 45, then proceed to line 2.					
2 Waste Characteristics					5.2
Reactivity and Incompatibility	(0) 1 2 3	1	0	3	
Toxicity	(0) 1 2 3	3	0	9	
Hazardous Waste	(0) 1 2 3 4 5 6 7 8	1	0	8	
	Total Waste Characteristics Score		0	20	
3 Targets					5.3
Population Within 4-Mile Radius	0 9 12 15 18 21 (24) 27 30	1	24	30	
Distance to Sensitive Environment	0 1 2 (3)	2	6	6	
Land Use	0 1 2 (3)	1	3	3	
	Total Targets Score		33	39	
4 Multiply 1 x 2 x 3			0	35,100	
5 Divide line 4 by 35,100 and multiply by 100			S_a = 0		

AIR ROUTE WORK SHEET

Facility Name: Onondaga Lake Date: [illegible]/88

Fire and Explosion Work Sheet					
Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Containment	1 3	1	1	3	7.1
2 Waste Characteristics					7.2
Direct Evidence	0 3	1	0	3	
Ignitability	0 1 2 3	1	0	3	
Reactivity	0 1 2 3	1	0	3	
Incompatibility	0 1 2 3	1	0	3	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1	0	8	
Total Waste Characteristics Score			0	20	
3 Targets					7.3
Distance to Nearest Population	0 1 2 3 4 5	1	4	5	
Distance to Nearest Building	0 1 2 3	1	2	3	
Distance to Sensitive Environment	0 1 2 3	1	3	3	
Land Use	0 1 2 3	1	3	3	
Population Within 2-Mile Radius	0 1 2 3 4 5	1	5	5	
Buildings Within 2-Mile Radius	0 1 2 3 4 5	1	5	5	
Total Targets Score			22	24	
4 Multiply 1 x 2 x 3			0	1,440	
5 Divide line 4 by 1,440 and multiply by 100			S_{FE} = 0		

FIRE AND EXPLOSION WORK SHEET

Facility Name: Onondaga Lake Date: 11/18/88

Direct Contact Work Sheet					
Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Incident	(0) 45	1	0	45	8.1
If line 1 is 45, proceed to line 4 If line 1 is 0, proceed to line 2					
2 Accessibility	0 1 2 (3)	1	3	3	8.2
3 Containment	0 (15)	1	15		8.3
4 Waste Characteristics Toxicity	0 1 2 (3)	5	15	15	8.4
5 Targets					8.5
Population Within 1-Mile Radius	0 1 2 3 4 (5)	4	20	20	
Distance to a Critical Habitat	(0) 1 2 3	4	0	12	
Total Targets Score			20	32	
6 If line 1 is 45, multiply 1 x 4 x 5 If line 1 is 0, multiply 2 x 3 x 4 x 5			13,500	21,600	
7 Divide line 6 by 21,600 and multiply by 100			S_{DC} = 62.5		

DIRECT CONTACT WORK SHEET

Facility Name: Onondaga Lake Date: 11/18/88

Worksheet for Computing S_M

	S	S^2
Groundwater Route Score (S_{gw})	32.30	1043.29
Surface Water Route Score (S_{sw})	17.62	310.46
Air Route Score (S_a)	0	0
$S_{gw}^2 + S_{sw}^2 + S_a^2$		1353.75
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2}$		36.79
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2} / 1.73 = S_M =$		21.26

WORK SHEET FOR COMPUTING S_M

NRC
DOCUMENTATION
RECORDS

DOCUMENTATION RECORDS
FOR
HAZARD RANKING SYSTEM

INSTRUCTIONS: The purpose of these records is to provide a convenient way to prepare an auditable record of the data and documentation used to apply the Hazard Ranking System to a given facility. As briefly as possible summarize the information you used to assign the score for each factor (e.g., "Waste quantity = 4,230 drums plus 800 cubic yards of sludges"). The source of information should be provided for each entry and should be a bibliographic-type reference that will make the document used for a given data point easier to find. Include the location of the document and consider appending a copy of the relevant page(s) for ease in review.

FACILITY NAME: Mercury Sediments - Onondaga Lake

LOCATION: Onondaga Lake, Onondaga County, New York

GROUND WATER ROUTE

1. OBSERVED RELEASE **Assigned Value = 0**

Contaminants detected (5 maximum):

No groundwater samples taken.

Rationale for attributing the contaminants to the facility:

No groundwater samples taken.

***

2. ROUTE CHARACTERISTICS

Depth to Aquifer of Concern **Assigned Value = 3**

Name/description of aquifer(s) of concern:

Overburden aquifer. Outwash sand and gravel deposits. (NYSDEC, 1989).

Depth(s) from the ground surface to the highest seasonal level of the saturated zone [water table(s)] of the aquifer of concern:

Surface of Onondaga Lake is hydraulically connected with the aquifer of concern. (NYSDEC, 1989).

Depth from the ground surface to the lowest point of waste disposal/storage:

Wastes were discharged directly into the lake and its tributaries. Water table is at or above the level of waste disposal. (USGS, 1973-1978; Effler, 1987).

Net Precipitation **Assigned Value = 2**

Mean annual or seasonal precipitation (list months for seasonal):

Mean annual precipitation is 40 inches. (Climatic Atlas of the United States, U.S. Department of Commerce, National Climatic Center, Asheville, NC, 1979).

Mean annual lake or seasonal evaporation (list months for seasonal):

Mean annual lake evaporation is 27 inches. (Climatic Atlas of the United States, U.S. Department of Commerce, National Climatic Center: Asheville, NC, 1979).

Net precipitation (subtract the above figures):

Net precipitation is 13 inches (40 inches - 27 inches). (Climatic Atlas of the United States, U.S. Department of Commerce, National Climatic Center, Asheville, NC, 1979).

Permeability of Unsaturated Zone **Assigned Value = 3**

Soil type in unsaturated zone:

There is no unsaturated soil zone in Onondaga Lake. Soils surrounding the lake are artificial fill, made land and urban land, all having high permeabilities. (USDA, 1977).

Permeability associated with soil type:

Sand and gravel units have permeability of $>10^{-3}$ cm/sec. (USEPA, 1984b).

Physical State **Assigned Value = 3**

Physical state of substances at time of disposal (or at present time for generated gases):

Liquid, sludge. (NYSDEC Inactive Hazardous Waste Disposal Site Report, 1987).

***

3. CONTAINMENT **Assigned Value = 3**

Containment

Method(s) of waste or leachate containment evaluated:

None; waste directly discharged to tributaries supplying the lake, and to the lake itself. (NYSDEC Inactive Hazardous Waste Disposal Site Report, 1987).

Method with highest score:

No containment receives a score of 3. (USEPA, 1984).

4. WASTE CHARACTERISTICS

Toxicity and Persistence **Assigned Value = 18**

Compound(s) evaluated:

Samples (surface water and sediment) were analyzed for HSL organics, metals, and cyanide. (NYSDEC, 1987b).

Compound with highest score:

Mercury has a toxicity/persistence score of 18. (USEPA, 1984).

Hazardous Waste Quantity **Assigned Value** = 3

Total quantity of hazardous substances at the facility, excluding those with a containment score of 0 (Give a reasonable estimate even if quantity is above maximum):

Approximately 83 tons of mercury. (Effler, 1987).

Basis of estimating and/or computing waste quantity:

Approximately 11 lbs of mercury per day from 1946 to 1953 and 22 lbs/day from 1953 to 1970. (Effler, 1987).

***

5. TARGETS

Ground Water Use **Assigned Value** = 3

Use(s) of aquifer(s) of concern within a 3-mile radius of the facility:

There are private wells located northwest of Onondaga Lake within a three mile radius. No municipal water supplies exist in this area (Letteney, 1988).

Distance to Nearest Well **Assigned Value (Matrix)** = 12

Location of nearest well drawing from aquifer of concern or occupied building not served by a public water supply:

There are private wells located on Walters Road. (Letteney, 1988).

Distance to above well or building:

The wells on Walters Road are approximately 1.5 miles from the Onondaga Lake Boundary (Letteney, 1988).

Population Served by Ground Water Wells Within a 3-Mile Radius

Identified water-supply well(s) drawing from aquifer(s) of concern within a 3-mile radius and populations served by each:

Residences on Herman, Walters, Winchell and Van Buren Roads draw off private wells in this area. Approximately 186 homes x 3.8 people/home = 707 people. (Lettenay, 1988; and USEPA, 1986).

Computation of land area irrigated by supply well(s) drawing from aquifer(s) of concern within a 3-mile radius, and conversion to population (1.5 people per acre):

There is no irrigated land within 3 miles (Nemecek, 1988; Gilligan, 1989).

Total population served by ground water within a 3-mile radius:

Approximately 707 people.

SURFACE WATER ROUTE

1. OBSERVED RELEASE **Assigned Value** = 45

Contaminants detected in surface water at the facility or downhill from it (5 maximum):

	W-10*	W-11*	W-2
Copper	10	8	42
Sodium	69000	110000	330000

(Recra Environmental, 1987).

* Upgradient locations

Rationale for attributing the contaminants to the facility:

Downgradient concentrations were greater than three times the upgradient concentrations. (Recra Environmental, 1987).

***

2. ROUTE CHARACTERISTICS

Facility Slope and Intervening Terrain **Assigned Value** = 0

Average slope of facility in percent:

Site comprises the boundaries of Onondaga Lake. Approximate surface elevation - 363 feet above mean sea level. Average slope 0%. (USGS, 1973-1978).

Name/description of nearest downslope surface water:

Site is a surface water body - Onondaga Lake. Lake drains into the Barge Canal at the north end of the lake, eventually discharging to Lake Ontario. (USDA, 1977).

Average slope of terrain between facility and above-cited surface water body in percent:

Elevation Lake Ontario = 245 feet above mean sea level. Elevation Onondaga Lake = 363 feet above mean sea level. Lake Ontario is approximately 30 miles "downstream" of Onondaga Lake (outlet to outlet). Average slope 0-1%. (USGS, 1973-1978).

Is the facility located either totally or partially in surface water?

Totally. The site comprises all of Onondaga Lake.

Is the facility completely surrounded by areas of higher elevation?

The facility is surrounded by areas of higher elevation, except for the lake outlet at the northwest end. (USGS, 1973-1978).

1-Year 24-Hour Rainfall in Inches **Assigned Value** = 2

2.1" (USDOC, 1963).

Distance to Nearest Downslope Surface Water **Assigned Value** = 3

0 feet. Site is surface water in Onondaga Lake basin. Discharge of Onondaga Lake follows the Barge Canal to the Seneca River north to the Oswego River north to Lake Ontario. (USDA, 1977).

Physical State of Waste **Assigned Value** = 3

Liquid, sludge. (NYSDEC Inactive Hazardous Waste Disposal Site Report, 1987).

***

3. CONTAINMENT

Containment **Assigned Value** = 3

Method(s) of waste or leachate containment evaluated:

None, waste discharged directly to tributaries supplying the lake. (NYSDEC Inactive Hazardous Waste Disposal Site Report, 1987).

Method with highest score:

No containment receives a score of 3. (USEPA, 1984).

4. WASTE CHARACTERISTICS

Toxicity and Persistence **Assigned Value** = 18

Compound(s) evaluated

Surface water samples were analyzed for HSL organics, metals, and cyanide. (Recra Environmental, 1987).

Compound with highest score:

Mercury has a Toxicity/Persistence score of 18. (USEPA, 1984b).

Hazardous Waste Quantity **Assigned Value** = 3

Total quantity of hazardous substances at the facility, excluding those with a containment score of 0 (Give a reasonable estimate even if quantity is above maximum):

Approximately 83 tons of mercury. (Effler, 1987).

Basis of estimating and/or computing waste quantity:

Approximately 11 lbs of mercury per day from 1946 to 1953 and 22 lbs/day from 1953 to 1976. (Effler, 1987,)

***

5. TARGETS

Surface Water Use **Assigned Value** = 2

Use(s) of surface water within 3 miles downstream of the hazardous substance:

Industrial plants use surface water for process cooling water (Effler, 1987). Recreation, boating activities (USGS, 1973-1978).

Is there tidal influence?

No. The site is not a body of water affected by tides, although there may be seasonal fluctuation of water level. (USGS, 1973-1978).

Distance to a Sensitive Environment **Assigned Value** = 3

Distance to 5-acre (minimum) coastal wetland, if 2 miles or less:

The site is not located near the coast. (USGS, 1973-1978).

Distance to 5-acre (minimum) fresh-water wetland, if 1 mile or less:

There is a large wetland (more than 5 acres) adjacent to the western shore of the lake. (Cotterill, 1987).

Distance to critical habitat of an endangered species or national wildlife refuge, if 1 mile or less:

There are no federally designated critical habitats of endangered species located within New York State. (Ozard, NYSDEC Wildlife Resources Center, 1988).

Population Served by Surface Water **Assigned Value** = 0

Location(s) of water-supply intake(s) within 3 miles (free-flowing bodies) or 1 mile (static water bodies) downstream of the hazardous substance and population served by each intake:

There are no surface water supply intakes within 1 mile of the lake that serve drinking water supply sources. There are, however, surface water intakes, both deep and shallow in Onondaga Lake, they supply various industries with process cooling water. (NYSDOH, 1982; Effler, 1987).

Computation of land area irrigated by above-cited intake(s) and conversion to population (1.5 people per acre):

Not applicable. No surface water supply intakes.

Total population served:

N.A.

Name/description of nearest of above water bodies:

N.A.

Distance to above-cited intakes, measured in stream miles:

N.A.

AIR ROUTE

1. OBSERVED RELEASE

Contaminants detected: **Assigned Value** = 0

Air quality monitoring upwind and downwind of the lake was not performed.

Date and location of detection of contaminants:

Not applicable.

Methods used to detect the contaminants:

Not applicable.

Rationale for attributing the contaminants to the site:

Not applicable.

***

2. WASTE CHARACTERISTICS

Reactivity and Incompatibility **Assigned Value** = 0

Most reactive compound:

No reactive compound with the potential to impact the air pathway is known to exist on-site. (NYSDEC Inactive Hazardous Waste Disposal Site Report, 1987; Effler, 1987).

Most incompatible pair of compounds:

No incompatible compounds with the potential to impact the air pathway are known to exist on-site. (NYSDEC Inactive Hazardous Waste Disposal Site Report, 1987; Effler, 1987).

Toxicity **Assigned Value** = 0

Most toxic compound:

Since there are no substances that can reasonably be expected to be transported away from the facility via the air route, a score of 0 is assigned.

Hazardous Waste Quantity — Assigned Value = 0

Total quantity of hazardous waste:

There is no existing situation exhibiting the potential to release hazardous waste into the air pathway. (NYSDEC Inactive Hazardous Waste Disposal Site Report, 1987; Effler, 1987).

Basis of estimating and/or computing waste quantity:

Not applicable. See comment above.

***

3.TARGETS

Population Within 4-Mile Radius — **Assigned Value** = 24

Circle radius used, give population, and indicate how determined:

0 to 4 mi 0 to 1 mi 0 to 1/2 mi 0 to 1/4 mi

Population within 1-mile radius of Onondaga Lake is 35,171. (1980 Population Census).

Distance to a Sensitive Environment — **Assigned Value** = 3

Distance to 5-acre (minimum) coastal wetland, if 2 miles or less:

Not applicable. Site is not located near the coast. (USGS, 1973-1978).

Distance to 5-acre (minimum) fresh-water wetland, if 1 mile or less:

There are several 5-acre fresh water wetlands around the lake. The wetlands are concentrated on the northern and southern ends of the lake with several to the southwest. (Cotterill, 1987).

Distance to critical habitat of an endangered species, if 1 mile or less:

There are no federally established critical habitats of endangered species in New York State. (Ozard, NYSDEC Wildlife Resources Center, 1988).

Land Use

Assigned Value = 3

Distance to commercial/industrial area, if 1 mile or less:

0.0 miles. Site is surrounded by commercial/industrial areas. (USGS, 1973-1978).

Distance to national or state park, forest, or wildlife reserve, if 2 miles or less:

Greater than 2 miles (USGS, 1973-1978).

Distance to residential area, if 2 miles or less:

Approximately 50 feet. (USGS, 1973-1978).

Distance to agricultural land in production within past 5 years, if 1 mile or less:

There is agricultural land approximately 0.9 miles from the site. (USDA, 1988).

Distance to prime agricultural land in production within past 5 years, if 2 miles or less:

There is prime agricultural land approximately 0.9 miles from the site. (USDA, 1988).

Is a historic or landmark site (National Register or Historic Places and National Natural Landmarks) within the view of the site?

There are no historic or landmark sites within view of the site. (US Department of the Interior, National Registry of Historic Places, 1983).

FIRE AND EXPLOSION

1. CONTAINMENT **Assigned Value = 1**

Hazardous substances present:

There are no substances or situations present on the site that would create a fire or explosion. (NYSDEC Inactive Hazardous Waste Disposal Site Report, 1987; Effler, 1987).

Type of containment, if applicable:

Not applicable.

***

2. WASTE CHARACTERISTICS

Direct Evidence **Assigned Value = 0**

Type of instrument and measurements:

No measurements of the potential for fire or explosion were taken on site.

Ignitability **Assigned Value = 0**

Compound used:

No ignitable compounds are present at this site. (NYSDEC Inactive Hazardous Waste Disposal Site Report, 1987).

Reactivity **Assigned Value = 0**

Most reactive compound:

No reactive compounds are present at this site. (NYSDEC Inactive Hazardous Waste Disposal Site Report, 1987).

Incompatibility **Assigned Value = 0**

Most incompatible pair of compounds:

No incompatible pairs of compounds are present at this site. (NYSDEC Inactive Hazardous Waste Disposal Site Report, 1987).

Hazardous Waste Quantity **Assigned Value** = 0

Total quantity of hazardous substances at the facility:

No hazardous substances or situations present at this site that would cause a fire or explosion. (NYSDEC Inactive Hazardous Waste Disposal Site Report, 1987; Effler, 1987).

Basis of estimating and/or computing waste quantity:

Not applicable. See above comment.

***

3. TARGETS

Distance to Nearest Population **Assigned Value** = 4

Between 51-200 feet. (USGS, 1973-1978).

Distance to Nearest Building **Assigned Value** = 2

Between 51-200 feet. (USGS, 1973-1978).

Distance to Sensitive Environment **Assigned Value** = 3

Distance to wetlands:

There are several wetlands located around the lake. The wetlands are concentrated on the northern and southern edges of the lake, with a couple to the southwest. (Cotterill, 1987).

Distance to critical habitat:

There are no federally designated critical habitats of endangered species located within New York State. (Ozard, NYSDEC - Wildlife Resources Center, 1988).

Land Use **Assigned Value** = 3

Distance to commercial/industrial area, if 1 mile or less:

Metropolitan Syracuse Sewage Treatment Plant is located approximately 100 feet from Onondaga Lake. (USGS, 1973-1978).

Distance to national or state park, forest, or wildlife reserve, if 2 miles or less:

Greater than 2 miles (USGS, 1973-1978).

Distance to residential area, if 2 miles or less:

Approximately 50 feet. (USGS, 1973-1978).

Distance to agricultural land in production within past 5 years, if 1 mile or less:

There is agricultural land approximately 0.9 miles from the site. (USDA, 1988).

Distance to prime agricultural land in production within past 5 years, if 2 miles or less:

There is prime agricultural land approximately 0.9 miles from the site. (USDA, 1988).

Is a historic or landmark site (National Register or Historic Places and National Natural Landmarks) within the view of the site?

There are no historic or landmark sites within view of the site. (US Department of the Interior, Register of Historic Places, 1983).

Population Within 2-Mile Radius **Assigned Value** = 5

82,012 people (US Population Census, 1980).

Buildings Within 2-Mile Radius **Assigned Value** = 5

Unknown - can estimate number of houses as follows: 82,012 people / 3.8 people per house = 21,582 houses.

DIRECT CONTACT

1. OBSERVED INCIDENT **Assigned Value = 0**

Date, location, and pertinent details of incident:

No known observed incident was discovered during the Phase II investigation. There is a sport fishing "eat none" health advisory against eating fish from the lake (NYSDEC Inactive Hazardous Waste Disposal Site Report, 1987; OCDDS, 1988).

***

2. ACCESSIBILITY **Assigned Value = 3**

Describe type of barrier(s):

No known barriers to lake except that much of lake property boundary is privately owned. (NYSDEC Inactive Hazardous Waste Disposal Site Report, 1987; USGS, 1973-1978).

***

3. CONTAINMENT **Assigned Value = 15**

Type of containment, if applicable:

No containment. (NYSDEC Inactive Hazardous Waste Disposal Site Report, 1987; USGS, 1973-1978).

***

4. WASTE CHARACTERISTICS

<u>Toxicity</u> **Assigned Value = 3**

Compounds evaluated:

Samples were analyzed for HSL organics, metals, and cyanide. (Recra Environmental, 1987; NYSDEC Mobile Analytical Laboratory, 1986).

Compound with highest score:

Mercury has a toxicity score of 3. (Sax, 1984).

5. TARGETS

Population within one-mile radius **Assigned Value = 5**

35,171 people. (US Population Census, 1980).

Distance to critical habitat (of endangered species) **Assigned Value = 0**

There are no critical habitats of endangered species located in NYS. (Ozard, NYSDEC - Wildlife Resources Center, 1988).

Site Inspection Report

EPA

POTENTIAL HAZARDOUS WASTE SITE
SITE INSPECTION REPORT
PART 1 - SITE LOCATION AND INSPECTION INFORMATION

I. IDENTIFICATION

01 STATE	02 SITE NUMBER
NY	

II. SITE NAME AND LOCATION

01 SITE NAME (Legal, common, or descriptive name of site)	02 STREET, ROUTE NO., OR SPECIFIC LOCATION IDENTIFIER
Onondaga Lake	

03 CITY	04 STATE	05 ZIP CODE	06 COUNTY	07 COUNTY CODE	08 CONG DIST
Syracuse	NY		Onondaga	67	27

09 COORDINATES LATITUDE	LONGITUDE
43 05 00.0	076 12 30.0

10 TYPE OF OWNERSHIP (Check one)
☐ A. PRIVATE ☐ B. FEDERAL _____ ☒ C. STATE ☐ D. COUNTY ☐ E. MUNICIPAL
☐ F. OTHER _____ ☐ G. UNKNOWN

III. INSPECTION INFORMATION

01 DATE OF INSPECTION	02 SITE STATUS	03 YEARS OF OPERATION
11/25/88 (MONTH DAY YEAR)	☐ ACTIVE ☒ INACTIVE	_____ / _____ (BEGINNING YEAR / ENDING YEAR) ☒ UNKNOWN

04 AGENCY PERFORMING INSPECTION (Check all that apply)
☐ A. EPA ☐ B. EPA CONTRACTOR _____ (Name of firm) ☐ C. MUNICIPAL ☐ D. MUNICIPAL CONTRACTOR _____ (Name of firm)
☒ E. STATE ☐ F. STATE CONTRACTOR _____ (Name of firm) ☐ G. OTHER _____ (Specify)

05 CHIEF INSPECTOR	06 TITLE	07 ORGANIZATION	08 TELEPHONE NO.
			( )

09 OTHER INSPECTORS	10 TITLE	11 ORGANIZATION	12 TELEPHONE NO.
			( )
			( )
			( )
			( )
			( )

13 SITE REPRESENTATIVES INTERVIEWED	14 TITLE	15 ADDRESS	16 TELEPHONE NO
			( )
			( )
			( )
			( )
			( )
			( )

17 ACCESS GAINED BY (Check one)	18 TIME OF INSPECTION	19 WEATHER CONDITIONS
☐ PERMISSION ☐ WARRANT		

IV. INFORMATION AVAILABLE FROM

01 CONTACT	02 OF (Agency/Organization)	03 TELEPHONE NO.
Carl Hoffman	NYSDEC	(518) 457-9538

04 PERSON RESPONSIBLE FOR SITE INSPECTION FORM	05 AGENCY	06 ORGANIZATION	07 TELEPHONE NO.	08 DATE
George H. Moreau		ES	315-451-9560	11/25/88 (MONTH DAY YEAR)

EPA

POTENTIAL HAZARDOUS WASTE SITE
SITE INSPECTION REPORT
PART 2 - WASTE INFORMATION

I. IDENTIFICATION	
01 STATE	02 SITE NUMBER

II. WASTE STATES, QUANTITIES, AND CHARACTERISTICS

01 PHYSICAL STATES (Check all that apply)

- ☐ A. SOLID
- ☐ B. POWDER, FINES
- ☒ C. SLUDGE
- ☐ D. OTHER _____ (Specify)
- ☐ E. SLURRY
- ☒ F. LIQUID
- ☐ G. GAS

02 WASTE QUANTITY AT SITE (Measures of waste quantities must be independent)

TONS 83

CUBIC YARDS _____

NO. OF DRUMS _____

03 WASTE CHARACTERISTICS (Check all that apply)

- ☒ A. TOXIC
- ☐ B. CORROSIVE
- ☐ C. RADIOACTIVE
- ☒ D. PERSISTENT
- ☐ E. SOLUBLE
- ☐ F. INFECTIOUS
- ☐ G. FLAMMABLE
- ☐ H. IGNITABLE
- ☐ I. HIGHLY VOLATILE
- ☐ J. EXPLOSIVE
- ☐ K. REACTIVE
- ☐ L. INCOMPATIBLE
- ☐ M. NOT APPLICABLE

III. WASTE TYPE

CATEGORY	SUBSTANCE NAME	01 GROSS AMOUNT	02 UNIT OF MEASURE	03 COMMENTS
SLU	SLUDGE	83 tons	mercury contaminated sluc	
OLW	OILY WASTE			
SOL	SOLVENTS			
PSD	PESTICIDES			
OCC	OTHER ORGANIC CHEMICALS			
IOC	INORGANIC CHEMICALS			
ACD	ACIDS			
BAS	BASES			
MES	HEAVY METALS			

IV. HAZARDOUS SUBSTANCES (See Appendix for most frequently cited CAS Numbers)

01 CATEGORY	02 SUBSTANCE NAME	03 CAS NUMBER	04 STORAGE/DISPOSAL METHOD	05 CONCENTRATION	06 MEASURE OF CONCENTRATION
MES	Mercury	7439-97-6	direct discharge	unknown	

V. FEEDSTOCKS (See Appendix for CAS Numbers)

CATEGORY	01 FEEDSTOCK NAME	02 CAS NUMBER	CATEGORY	01 FEEDSTOCK NAME	02 CAS NUMBER
FDS			FDS		
FDS			FDS		
FDS			FDS		
FDS			FDS		

VI. SOURCES OF INFORMATION (Cite specific references, e.g., state files, sample analysis, reports)

Effler, 1987. The impact of a Chlor-Alkali Plant on Onondaga Lake and adjoining systems. Water Air Soil Pollut 33:85-115

EPA

POTENTIAL HAZARDOUS WASTE SITE
SITE INSPECTION REPORT
PART 3 - DESCRIPTION OF HAZARDOUS CONDITIONS AND INCIDENTS

I. IDENTIFICATION	
01 STATE	02 SITE NUMBER

II. HAZARDOUS CONDITIONS AND INCIDENTS

01 ☒ A. GROUNDWATER CONTAMINATION — 02 ☐ OBSERVED (DATE: _____) ☒ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED: _____ 04 NARRATIVE DESCRIPTION

Lake sediments are contaminated with mercury, Lake is in hydraulic connection with the Baldwinsville aquifier.

01 ☒ B. SURFACE WATER CONTAMINATION — 02 ☒ OBSERVED (DATE: 1987) ☐ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED: 0 04 NARRATIVE DESCRIPTION

Water samples from Onondaga Lake had more than 3 times the upgradient concentrations of copper and sodium

01 ☐ C. CONTAMINATION OF AIR — 02 ☐ OBSERVED (DATE: _____) ☐ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED: _____ 04 NARRATIVE DESCRIPTION

no evidence

01 ☐ D. FIRE/EXPLOSIVE CONDITIONS — 02 ☐ OBSERVED (DATE: _____) ☐ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED: _____ 04 NARRATIVE DESCRIPTION

no evidence

01 ☐ E. DIRECT CONTACT — 02 ☐ OBSERVED (DATE: _____) ☐ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED: _____ 04 NARRATIVE DESCRIPTION

no evidence, however eating fish from the lake is prohibited

01 ☒ F. CONTAMINATION OF SOIL — 02 ☒ OBSERVED (DATE: 1987) ☐ POTENTIAL ☐ ALLEGED
03 AREA POTENTIALLY AFFECTED: 4.5 sq. miles (Acres) 04 NARRATIVE DESCRIPTION

Sediments in lake bottom are contaminated with mercury

01 ☐ G. DRINKING WATER CONTAMINATION — 02 ☐ OBSERVED (DATE: _____) ☐ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED: _____ 04 NARRATIVE DESCRIPTION

no evidence

01 ☐ H. WORKER EXPOSURE/INJURY — 02 ☐ OBSERVED (DATE: _____) ☐ POTENTIAL ☐ ALLEGED
03 WORKERS POTENTIALLY AFFECTED: _____ 04 NARRATIVE DESCRIPTION

no evidence

01 ☐ I. POPULATION EXPOSURE/INJURY — 02 ☐ OBSERVED (DATE: _____) ☐ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED: _____ 04 NARRATIVE DESCRIPTION

no evidence

EPA

POTENTIAL HAZARDOUS WASTE SITE
SITE INSPECTION REPORT
PART 3 - DESCRIPTION OF HAZARDOUS CONDITIONS AND INCIDENTS

I. IDENTIFICATION
01 STATE | 02 SITE NUMBER

II. HAZARDOUS CONDITIONS AND INCIDENTS (Continued)

01 ☐ J. DAMAGE TO FLORA — 02 ☐ OBSERVED (DATE: _____) ☐ POTENTIAL ☐ ALLEGED
04 NARRATIVE DESCRIPTION

no evidence

01 ☒ K. DAMAGE TO FAUNA — 02 ☐ OBSERVED (DATE: _____) ☐ POTENTIAL ☐ ALLEGED
04 NARRATIVE DESCRIPTION (Include name(s) of species)

Several studies have documented elevated levels cf mercury in fish. Eating fish is prohibited.

01 ☒ L. CONTAMINATION OF FOOD CHAIN — 02 ☐ OBSERVED (DATE: _____) ☐ POTENTIAL ☐ ALLEGED
04 NARRATIVE DESCRIPTION

Several studies have documented elevated levels of mercury in fish. Eating fish is prohibited.

01 ☒ M. UNSTABLE CONTAINMENT OF WASTES (Spills/Runoff/Standing liquids, Leaking drums) — 02 ☐ OBSERVED (DATE: _____) ☐ POTENTIAL ☐ ALLEGED
03 POPULATION POTENTIALLY AFFECTED: _____ 04 NARRATIVE DESCRIPTION

Wastes directly discharged to lake system

01 ☐ N. DAMAGE TO OFFSITE PROPERTY — 02 ☐ OBSERVED (DATE: _____) ☐ POTENTIAL ☐ ALLEGED
04 NARRATIVE DESCRIPTION

no evidence

01 ☐ O. CONTAMINATION OF SEWERS, STORM DRAINS, WWTPs — 02 ☐ OBSERVED (DATE: _____) ☐ POTENTIAL ☐ ALLEGED
04 NARRATIVE DESCRIPTION

no evidence

01 ☐ P. ILLEGAL/UNAUTHORIZED DUMPING — 02 ☐ OBSERVED (DATE: _____) ☐ POTENTIAL ☐ ALLEGED
04 NARRATIVE DESCRIPTION

Discharge of wastes directly into lake system by local industries may have violated state permits

05 DESCRIPTION OF ANY OTHER KNOWN, POTENTIAL, OR ALLEGED HAZARDS

III. TOTAL POPULATION POTENTIALLY AFFECTED: _____

IV. COMMENTS

V. SOURCES OF INFORMATION (Cite specific references, e. g., state files, sample analysis, reports)

(Effler, 1987)
NYSDEC,1987-Hazardous Waste Disposal site report

EPA

POTENTIAL HAZARDOUS WASTE SITE
SITE INSPECTION
PART 4 - PERMIT AND DESCRIPTIVE INFORMATION

I. IDENTIFICATION	
01 STATE	02 SITE NUMBER

II. PERMIT INFORMATION

01 TYPE OF PERMIT ISSUED (Check all that apply)	02 PERMIT NUMBER	03 DATE ISSUED	04 EXPIRATION DATE	05 COMMENTS
☐ A. NPDES				
☐ B. UIC				
☐ C. AIR				
☐ D. RCRA				
☐ E. RCRA INTERIM STATUS				
☐ F. SPCC PLAN				
☐ G. STATE (Specify)				
☐ H. LOCAL (Specify)				
☐ I. OTHER (Specify)				
☐ J. NONE				

III. SITE DESCRIPTION

01 STORAGE/DISPOSAL (Check all that apply)	02 AMOUNT	03 UNIT OF MEASURE
☐ A. SURFACE IMPOUNDMENT		
☐ B. PILES		
☐ C. DRUMS, ABOVE GROUND		
☐ D. TANK, ABOVE GROUND		
☐ E. TANK, BELOW GROUND		
☐ F. LANDFILL		
☐ G LANDFARM		
☐ H. OPEN DUMP		
☐ I. OTHER direct discharge (Specify)		

04 TREATMENT (Check all that apply)

- ☐ A. INCENERATION
- ☐ B. UNDERGROUND INJECTION
- ☐ C. CHEMICAL/PHYSICAL
- ☐ D. BIOLOGICAL
- ☐ E. WASTE OIL PROCESSING
- ☐ F. SOLVENT RECOVERY
- ☐ G. OTHER RECYCLING/RECOVERY
- ☐ H. OTHER _____ (Specify)

05 OTHER

☐ A. BUILDINGS ON SITE

4.5 sq. miles

06 AREA OF SITE

_____ (Acres)

07 COMMENTS

Wastes from local industries were directly discharged to the lake system via tributaries to Onondaga Lake

IV. CONTAINMENT

01 CONTAINMENT OF WASTES (Check one)

☐ A. ADEQUATE, SECURE ☐ B. MODERATE ☒ C. INADEQUATE, POOR ☐ D. INSECURE, UNSOUND, DANGEROUS

02 DESCRIPTION OF DRUMS, DIKING, LINERS, BARRIERS, ETC.

Waste beds along lake and tributaries potentially leaking to groundwater and Onondaga Lake

V. ACCESSIBILITY

01 WASTE EASILY ACCESSIBLE: ☒ YES ☐ NO

02 COMMENTS

VI. SOURCES OF INFORMATION (Cite specific references, e.g. state files, sample analysis, reports)

Effler, 1987

NYSDEC, 1987

EPA

POTENTIAL HAZARDOUS WASTE SITE
SITE INSPECTION REPORT
PART 5 - WATER, DEMOGRAPHIC, AND ENVIRONMENTAL DATA

I. IDENTIFICATION

01 STATE	02 SITE NUMBER

II. DRINKING WATER SUPPLY

01 TYPE OF DRINKING SUPPLY (Check as applicable)

	SURFACE	WELL
COMMUNITY	A. ☐	B. ☒
NON-COMMUNITY	C. ☐	D. ☒

02 STATUS

ENDANGERED	AFFECTED	MONITORED
A. ☐	B. ☐	C. ☐
D. ☐	E. ☐	F. ☐

03 DISTANCE TO SITE

A. greather than 3 (mi)

B. 1.5 (mi)

III. GROUNDWATER

01 GROUNDWATER USE IN VICINITY (Check one)

☐ A. ONLY SOURCE FOR DRINKING ☒ B. DRINKING (Other sources available) COMMERCIAL, INDUSTRIAL, IRRIGATION (No other water sources available) ☐ C. COMMERCIAL, INDUSTRIAL, IRRIGATION (Limited other sources available) ☐ D. NOT USED, UNUSEABLE

02 POPULATION SERVED BY GROUND WATER _____

03 DISTANCE TO NEAREST DRINKING WATER WELL 1.5 (mi)

04 DEPTH TO GROUNDWATER	05 DIRECTION OF GROUNDWATER FLOW	06 DEPTH TO AQUIFER OF CONCERN	07 POTENTIAL YIELD OF AQUIFER	08 SOLE SOURCE AQUIFER
0 (ft)	N-NW	0 (ft)	unknown (gpd)	☐ YES ☒ NO

09 DESCRIPTION OF WELLS (Including usage, depth, and location relative to population and buildings)

About 186 residences within 3 miles of lake utilize private wells for drinking water.

10 RECHARGE AREA		11 DISCHARGE AREA	
☐ YES ☐ NO	COMMENTS	☐ YES ☐ NO	COMMENTS

IV. SURFACE WATER

01 SURFACE WATER USE (Check one)

☐ A. RESERVOIR, RECREATION DRINKING WATER SOURCE ☐ B. IRRIGATION, ECONOMICALLY IMPORTANT RESOURCES ☒ C. COMMERCIAL, INDUSTRIAL ☐ D. NOT CURRENTLY USED

02 AFFECTED/POTENTIALLY AFFECTED BODIES OF WATER

NAME:	AFFECTED	DISTANCE TO SITE
Onondaga Lake	☒	(mi)
	☐	(mi)
	☐	(mi)

V. DEMOGRAPHIC AND PROPERTY INFORMATION

01 TOTAL POPULATION WITHIN

ONE (1) MILE OF SITE	TWO (2) MILES OF SITE	THREE (3) MILES OF SITE
A. 35,171 NO. OF PERSONS	B. 82,012 NO. OF PERSONS	C. 168,080 NO. OF PERSONS

02 DISTANCE TO NEAREST POPULATION .01 (mi)

03 NUMBER OF BUILDINGS WITHIN TWO (2) MILES OF SITE 21,582

04 DISTANCE TO NEAREST OFF-SITE BUILDING .01 (mi)

05 POPULATION WITHIN VICINITY OF SITE (Provide narrative description of nature of population within vicinity of site, e.g., rural, village, densely populated urban area)

City of Syracuse is located at southeast end of lake. Industrial/residential areas to west, residential areas to north,east.

EPA

POTENTIAL HAZARDOUS WASTE SITE
SITE INSPECTION REPORT
PART 5 - WATER, DEMOGRAPHIC, AND ENVIRONMENTAL DATA

I. IDENTIFICATION

01 STATE	02 SITE NUMBER

VI. ENVIRONMENTAL INFORMATION

01 PERMEABILITY OF UNSATURATED ZONE (Check one)

☐ A. $10^{-6} - 10^{-8}$ cm/sec ☐ B. $10^{-4} - 10^{-6}$ cm/sec ☐ C. $10^{-4} - 10^{-3}$ cm/sec ☒ D. GREATER THAN 10^{-3} cm/sec

02 PERMEABILITY OF BEDROCK (Check one)

☐ A. IMPERMEABLE (Less than 10^{-6} cm/sec) ☐ B. RELATIVELY IMPERMEABLE ($10^{-4} - 10^{-6}$ cm/sec) ☒ C. RELATIVELY PERMEABLE ($10^{-2} - 10^{-4}$ cm/sec) ☐ D. VERY PERMEABLE (Greater than 10^{-2} cm/sec)

03 DEPTH TO BEDROCK	04 DEPTH OF CONTAMINATED SOIL ZONE	05 SOIL pH
20-50 (ft)	1 (ft)	unknown

06 NET PRECIPITATION	07 ONE YEAR 24 HOUR RAINFALL	08 SLOPE: SITE SLOPE	DIRECTION OF SITE SLOPE	TERRAIN AVERAGE SLOPE
13 (in)	2.1 (in)	less than 1 %	N	less than 1 %

09 FLOOD POTENTIAL

SITE IS IN NA YEAR FLOODPLAIN

10 ☐ SITE IS ON BARRIER ISLAND, COASTAL HIGH HAZARD AREA, RIVERINE FLOODWAY

11 DISTANCE TO WETLANDS (5 acre minimum)

ESTUARINE: A. _____ (mi)

OTHER: B. less than .01 (mi)

12 DISTANCE TO CRITICAL HABITAT (of endangered species)

none in NYS _____ (mi)

ENDANGERED SPECIES: _____

13 LAND USE IN VICINITY

DISTANCE TO:

COMMERCIAL/INDUSTRIAL	RESIDENTIAL AREAS; NATIONAL/STATE PARKS, FORESTS, OR WILDLIFE RESERVES	AGRICULTURAL LANDS: PRIME AG LAND	AGRICULTURAL LANDS: AG LAND
A. less than .01 (mi)	B. less than .01 (mi)	C. _____ (mi)	D. _____ (mi)

14 DESCRIPTION OF SITE IN RELATION TO SURROUNDING TOPOGRAPHY

Site is a lake surrounded bt generally level topography. Lake is fed by several tributaries with generally low gradients and flows. Outlet to lake leads to Seneca River and Lake Ontario. Flow in lake is counterclockwise.

VII. SOURCES OF INFORMATION (Cite specific references, e.g., state files, sample analysis, reports)

Effler 1987
EPA,"Atlas of Four Selected Aquifiers in New York" ,1984

EPA

POTENTIAL HAZARDOUS WASTE SITE
SITE INSPECTION REPORT
PART 6 - SAMPLE AND FIELD INFORMATION

I. IDENTIFICATION	
01 STATE	02 SITE NUMBER

II. SAMPLES TAKEN

SAMPLE TYPE	01 NUMBER OF SAMPLES TAKEN	02 SAMPLES SENT TO	03 ESTIMATED DATE RESULTS AVAILABLE
GROUNDWATER			
SURFACE WATER	21	NYSDEC, Recra Environmental, Inc	now
WASTE			
AIR			
RUNOFF			
SPILL			
SOIL	222	NYSDEC,Recra Environmental,Inc.	now
VEGETATION			
OTHER			

III. FIELD MEASUREMENTS TAKEN

01 TYPE	02 COMMENTS
Ph	
Conductivity	
Temp.	

IV. PHOTOGRAPHS AND MAPS

01 TYPE ☐ GROUND ☐ AERIAL

02 IN CUSTODY OF _____ (Name of organization or individual)

03 MAPS ☐ YES ☐ NO

04 LOCATION OF MAPS _____

V. OTHER FIELD DATA COLLECTED (Provide narrative description)

VI. SOURCES OF INFORMATION (Cite specific references, e.g., state files, sample analysis, reports)

NYSDEC,1987-Analytical Results for Onondaga Lake

EPA

POTENTIAL HAZARDOUS WASTE SITE
SITE INSPECTION REPORT
PART 7 - OWNER INFORMATION

I. IDENTIFICATION	
01 STATE	02 SITE NUMBER

II. CURRENT OWNER(S)				PARENT COMPANY (If applicable)			
01 NAME County of Onondaga		02 D+B NUMBER		08 NAME		09 D+B NUMBER	
03 STREET ADDRESS (P.O. Box, RFD #, etc.)		04 SIC CODE		10 STREET ADDRESS (P.O. Box, RFD #, etc.)		11 SIC CODE	
05 CITY	06 STATE	07 ZIP CODE		12 CITY	13 STATE	14 ZIP CODE	
01 NAME City of Syracuse		02 D+B NUMBER		08 NAME		09 D+B NUMBER	
03 STREET ADDRESS (P.O. Box, RFD #, etc.)		04 SIC CODE		10 STREET ADDRESS (P.O. Box, RFD #, etc.)		11 SIC CODE	
05 CITY	06 STATE	07 ZIP CODE		12 CITY	13 STATE	14 ZIP CODE	
01 NAME Allied Corporation		02 D+B NUMBER		08 NAME		09 D+B NUMBER	
03 STREET ADDRESS (P.O. Box, RFD #, etc.)		04 SIC CODE		10 STREET ADDRESS (P.O. Box, RFD #, etc.)		11 SIC CODE	
05 CITY	06 STATE	07 ZIP CODE		12 CITY	13 STATE	14 ZIP CODE	
01 NAME Crucible Steel		02 D+B NUMBER		08 NAME		09 D+B NUMBER	
03 STREET ADDRESS (P.O. Box, RFD #, etc.)		04 SIC CODE		10 STREET ADDRESS (P.O. Box, RFD #, etc.)		11 SIC CODE	
05 CITY	06 STATE	07 ZIP CODE		12 CITY	13 STATE	14 ZIP CODE	

III. PREVIOUS OWNER(S) (List most recent first)				IV. REALTY OWNER(S) (If applicable; list most recent first)			
01 NAME		02 D+B NUMBER		01 NAME		02 D+B NUMBER	
03 STREET ADDRESS (P.O. Box, RFD #, etc.)		04 SIC CODE		03 STREET ADDRESS (P.O. Box, RFD #, etc.)		04 SIC CODE	
05 CITY	06 STATE	07 ZIP CODE		05 CITY	06 STATE	07 ZIP CODE	
01 NAME		02 D+B NUMBER		01 NAME		02 D+B NUMBER	
03 STREET ADDRESS (P.O. Box, RFD #, etc.)		04 SIC CODE		03 STREET ADDRESS (P.O. Box, RFD #, etc.)		04 SIC CODE	
05 CITY	06 STATE	07 ZIP CODE		05 CITY	06 STATE	07 ZIP CODE	
01 NAME		02 D+B NUMBER		01 NAME		02 D+B NUMBER	
03 STREET ADDRESS (P.O. Box, RFD #, etc.)		04 SIC CODE		03 STREET ADDRESS (P.O. Box, RFD #, etc.)		04 SIC CODE	
05 CITY	06 STATE	07 ZIP CODE		05 CITY	06 STATE	07 ZIP CODE	

V. SOURCES OF INFORMATION (Cite specific references, e.g., state files, sample analysis, reports)

(103 of 265)

EPA

POTENTIAL HAZARDOUS WASTE SITE
SITE INSPECTION REPORT
PART 8 - OPERATOR INFORMATION

I. IDENTIFICATION	
01 STATE	02 SITE NUMBER

II. CURRENT OPERATOR (Provide if different from owner)			OPERATOR'S PARENT COMPANY (If applicable)		
01 NAME	02 D+B NUMBER		10 NAME	11 D+B NUMBER	
03 STREET ADDRESS (P.O. Box, RFD #, etc.)	04 SIC CODE		12 STREET ADDRESS (P.O. Box, RFD #, etc.)	13 SIC CODE	
05 CITY	06 STATE	07 ZIP CODE	14 CITY	15 STATE	16 ZIP CODE
08 YEARS OF OPERATION	09 NAME OF OWNER				

III. PREVIOUS OPERATOR(S) (List most recent first; provide only if different from owner)			PREVIOUS OPERATORS' PARENT COMPANIES (If applicable)		
01 NAME	02 D+B NUMBER		10 NAME	11 D+B NUMBER	
03 STREET ADDRESS (P.O. Box, RFD #, etc.)	04 SIC CODE		12 STREET ADDRESS (P.O. Box, RFD #, etc.)	13 SIC CODE	
05 CITY	06 STATE	07 ZIP CODE	14 CITY	15 STATE	16 ZIP CODE
08 YEARS OF OPERATION	09 NAME OF OWNER DURING THIS PERIOD				
01 NAME	02 D+B NUMBER		10 NAME	11 D+B NUMBER	
03 STREET ADDRESS (P.O. Box, RFD #, etc.)	04 SIC CODE		12 STREET ADDRESS (P.O. Box, RFD #, etc.)	13 SIC CODE	
05 CITY	06 STATE	07 ZIP CODE	14 CITY	15 STATE	16 ZIP CODE
08 YEARS OF OPERATION	09 NAME OF OWNER DURING THIS PERIOD				
01 NAME	02 D+B NUMBER		10 NAME	11 D+B NUMBER	
03 STREET ADDRESS (P.O. Box, RFD #, etc.)	04 SIC CODE		12 STREET ADDRESS (P.O. Box, RFD #, etc.)	13 SIC CODE	
05 CITY	06 STATE	07 ZIP CODE	14 CITY	15 STATE	16 ZIP CODE
08 YEARS OF OPERATION	09 NAME OF OWNER DURING THIS PERIOD				

IV. SOURCES OF INFORMATION (Cite specific references, e.g., state files, sample analysis, reports)

EPA

POTENTIAL HAZARDOUS WASTE SITE
SITE INSPECTION REPORT
PART 9 - GENERATOR/TRANSPORTER INFORMATION

I. IDENTIFICATION	
01 STATE	02 SITE NUMBER

II. ON-SITE GENERATOR

01 NAME	02 D+B NUMBER
Allied Chemical	
03 STREET ADDRESS (P.O. Box, RFD #, etc.)	04 SIC CODE
05 CITY	06 STATE / 07 ZIP CODE

III. OFF-SITE GENERATOR(S)

01 NAME	02 D+B NUMBER	01 NAME	02 D+B NUMBER
03 STREET ADDRESS (P.O. Box, RFD #, etc.)	04 SIC CODE	03 STREET ADDRESS (P.O. Box, RFD #, etc.)	04 SIC CODE
05 CITY	06 STATE / 07 ZIP CODE	05 CITY	06 STATE / 07 ZIP CODE
01 NAME	02 D+B NUMBER	01 NAME	02 D+B NUMBER
03 STREET ADDRESS (P.O. Box, RFD #, etc.)	04 SIC CODE	03 STREET ADDRESS (P.O. Box, RFD #, etc.)	04 SIC CODE
05 CITY	06 STATE / 07 ZIP CODE	05 CITY	06 STATE / 07 ZIP CODE

IV. TRANSPORTER(S)

01 NAME	02 D+B NUMBER	01 NAME	02 D+B NUMBER
03 STREET ADDRESS (P.O. Box, RFD #, etc.)	04 SIC CODE	03 STREET ADDRESS (P.O. Box, RFD #, etc.)	04 SIC CODE
05 CITY	06 STATE / 07 ZIP CODE	05 CITY	06 STATE / 07 ZIP CODE
01 NAME	02 D+B NUMBER	01 NAME	02 D+B NUMBER
03 STREET ADDRESS (P.O. Box, RFD #, etc.)	04 SIC CODE	03 STREET ADDRESS (P.O. Box, RFD #, etc.)	04 SIC CODE
05 CITY	06 STATE / 07 ZIP CODE	05 CITY	06 STATE / 07 ZIP CODE

V. SOURCES OF INFORMATION (Cite specific references, e.g., state files, sample analysis, reports)

EPA

POTENTIAL HAZARDOUS WASTE SITE
SITE INSPECTION REPORT
PART 10 - PAST RESPONSE ACTIVITIES

I. IDENTIFICATION
01 STATE | 02 SITE NUMBER

II. PAST RESPONSE ACTIVITIES

01 ☐ A. WATER SUPPLY CLOSED — 02 DATE _____ 03 AGENCY _____
04 DESCRIPTION

01 ☐ B. TEMPORARY WATER SUPPLY PROVIDED — 02 DATE _____ 03 AGENCY _____
04 DESCRIPTION

01 ☐ C. PERMANENT WATER SUPPLY PROVIDED — 02 DATE _____ 03 AGENCY _____
04 DESCRIPTION

01 ☐ D. SPILLED MATERIAL REMOVED — 02 DATE _____ 03 AGENCY _____
04 DESCRIPTION

01 ☐ E. CONTAMINATED SOIL REMOVED — 02 DATE _____ 03 AGENCY _____
04 DESCRIPTION

01 ☐ F. WASTE REPACKAGED — 02 DATE _____ 03 AGENCY _____
04 DESCRIPTION

01 ☐ G. WASTE DISPOSED ELSEWHERE — 02 DATE _____ 03 AGENCY _____
04 DESCRIPTION

01 ☐ H. ON SITE BURIAL — 02 DATE _____ 03 AGENCY _____
04 DESCRIPTION

01 ☐ I. IN SITU CHEMICAL TREATMENT — 02 DATE _____ 03 AGENCY _____
04 DESCRIPTION

01 ☐ J. IN SITU BIOLOGICAL TREATMENT — 02 DATE _____ 03 AGENCY _____
04 DESCRIPTION

01 ☐ K. IN SITU PHYSICAL TREATMENT — 02 DATE _____ 03 AGENCY _____
04 DESCRIPTION

01 ☐ L. ENCAPSULATION — 02 DATE _____ 03 AGENCY _____
04 DESCRIPTION

01 ☐ M. EMERGENCY WASTE TREATMENT — 02 DATE _____ 03 AGENCY _____
04 DESCRIPTION

01 ☐ N. CUTOFF WALLS — 02 DATE _____ 03 AGENCY _____
04 DESCRIPTION

01 ☐ O. EMERGENCY DIKING/SURFACE WATER DIVERSION — 02 DATE _____ 03 AGENCY _____
04 DESCRIPTION

01 ☐ P. CUTOFF TRENCHES/SUMP — 02 DATE _____ 03 AGENCY _____
04 DESCRIPTION

01 ☐ Q. SUBSURFACE CUTOFF WALL — 02 DATE _____ 03 AGENCY _____
04 DESCRIPTION

EPA

POTENTIAL HAZARDOUS WASTE SITE
SITE INSPECTION REPORT
PART 10 - PAST RESPONSE ACTIVITIES

I. IDENTIFICATION	
01 STATE	02 SITE NUMBER

II PAST RESPONSE ACTIVITIES (Continued)

01 ☐ R. BARRIER WALLS CONSTRUCTED — 02 DATE _____ — 03 AGENCY _____
04 DESCRIPTION

01 ☐ S. CAPPING/COVERING — 02 DATE _____ — 03 AGENCY _____
04 DESCRIPTION

01 ☐ T. BULK TANKAGE REPAIRED — 02 DATE _____ — 03 AGENCY _____
04 DESCRIPTION

01 ☐ U. GROUT CURTAIN CONSTRUCTED — 02 DATE _____ — 03 AGENCY _____
04 DESCRIPTION

01 ☐ V. BOTTOM SEALED — 02 DATE _____ — 03 AGENCY _____
04 DESCRIPTION

01 ☐ W. GAS CONTROL — 02 DATE _____ — 03 AGENCY _____
04 DESCRIPTION

01 ☐ X. FIRE CONTROL — 02 DATE _____ — 03 AGENCY _____
04 DESCRIPTION

01 ☐ Y. LEACHATE TREATMENT — 02 DATE _____ — 03 AGENCY _____
04 DESCRIPTION

01 ☐ Z. AREA EVACUATED — 02 DATE _____ — 03 AGENCY _____
04 DESCRIPTION

01 ☒ 1. ACCESS TO SITE RESTRICTED — 02 DATE _____ — 03 AGENCY NYSDOH
04 DESCRIPTION
swimming restricted

01 ☐ 2. POPULATION RELOCATED — 02 DATE _____ — 03 AGENCY _____
04 DESCRIPTION

01 ☒ 3. OTHER REMEDIAL ACTIVITIES — 02 DATE _____ — 03 AGENCY NYSDEC
04 DESCRIPTION

Eating fish prohibited

III. SOURCES OF INFORMATION (Cite specific references, e.g., state files, sample analysis, reports)

EPA FORM 2070-13 (7-81)

EPA

POTENTIAL HAZARDOUS WASTE SITE
SITE INSPECTION REPORT
PART 11 - ENFORCEMENT INFORMATION

I. IDENTIFICATION	
01 STATE	02 SITE NUMBER

II. ENFORCEMENT INFORMATION

01 PAST REGULATORY/ENFORCEMENT ACTION ☐ YES ☒ NO

02 DESCRIPTION OF FEDERAL, STATE, LOCAL REGULATORY/ENFORCEMENT ACTION

III. SOURCES OF INFORMATION *(Cite specific references, e.g., state files, sample analysis, reports)*

REFERENCES

HRS REFERENCES*

ONONDAGA LAKE SITE

1. NYSDEC, 1989. Internal memo from Kernan Davis, dated July 7, 1989.
2. USGS, 1973-1978. USGS 7-1/2 Minute Quadrangle Topographic Maps: Baldwinsville, 1973; Brewerton, 1973; Camillus, 1978; Syracuse West, 1978.
3. Effler, 1987. The Impact of a Chlor-Alkali Plant on Onondaga Lake and Adjoining Systems. Water Air Soil Pollut. 33:85-115.
4. USDOC, 1979. "Climatic Atlas of the United States", U. S. Department of Commerce.
5. USEPA, 1984. "Uncontrolled Hazardous Waste Site Ranking System, A User's Manual (HW-10)".
6. NYSDEC, 1987a. Inactive Hazardous Waste Disposal Site Report for Onondaga Lake.
7. NYSDEC, 1987b. Results for Mercury Analyses of Onondaga Lake Water and Sediment dated January 22, 1987.
8. Letteney, 1988. Onondaga County Department of Health, letter dated October 31, 1988.
9. USEPA, 1986. Geohydrology of the Glacial-Outwash Aquifer in the Baldwinsville Area, Seneca River, Onondaga County, N.Y. Water-Resources Investigations Report 85-4094.

10a. Nemecek, 1988. USDA Soil Conservation Service, personal correspondence dated November 17, 1988.

10b. Gilligan, 1989. Telephone conversation with Kevin Gilligan, dated July 27, 1989.

11. Recra Environmental, Inc. 1987. Analytical Results for Onondaga Lake.
12. USDA, 1977. Soil Survey of Onondaga County, U.S. Department of Agriculture.
13. USDOC, 1963. U.S. Department of Commerce "Rainfall Frequency Atlas of the U.S.", Technical Paper No. 40.
14. Cotterill, 1987. NYSDEC Letter to E. Dobson (ES) dated July 1, 1987.
15. Ozard, 1988. Conversation with NYSDEC on April 14, 1988.
16. NYSDOH, 1982. NY State Department of Health Atlas of Community Water System Sources.

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*All these references were used for HRS Documentation, while some of them were also used as General References.

17. US Census, 1980. Due to volume of material copies have not been included.

18. USDA, 1988. Soil Conservation Service letter dated November 22, 1988.

19. USDOI, 1983 - National Register of Historic Places Annual Listing of Properties.

20. Federal Register, 1983. U.S. Department of Interior National Park Service National Registry of Natural Landmarks.

21. Sax, 1984, Dangerous Properties of Industrial Materials 6th Ed. Van Nostrand Reinhold Company, New York.

22. OCDDS, 1988. 1986 Onondaga Lake Monitoring Program, April 1988.

GENERAL REFERENCES**

ONONDAGA LAKE

23. Alexander, 1973. The Ecology of Onondaga County and Vicinity. State University of New York at Syracuse.

24. Andrews, 1985. Series of articles in the Syracuse Post Standard, October 14-17, 1985. Copies not included.

25. Cappon, 1988. "LCP's Pollution Problems Aren't Limited to Geddes Plant", Syracuse Post Standard, July 14, 1988.

26. Geraghty and Miller, Inc. 1982. Groundwater Quality Conditions at the Former Willis Avenue Plant, submitted to Allied Chemical, Solvay, NY. April 1982.

27. Groundwater Technology, 1984a. Hydrogeologic Investigation. Allied Chemical, an Allied Corporation Company, Willis Avenue and Lakeshore Area, Solvay, NY. Submitted to Allied Chemical, Solvay, NY. March 1984.

28. Groundwater Technology, 1984b. Shallow Aquifer Hydrogeologic Investigation. Allied Chemical an Allied Corporation Company, Willis Avenue and Lakeshore Area, Solvay, NY. Submitted to Allied Chemical, Solvay, NY. December 1984.

29. Hopkins 1914. Geology of the Syracuse Quadrangle, New York State Science and Museum Bulletin 171, July 15, 1914.

30. NYSDEC, 1987c. An Overview of Mercury Contamination in the Fish of Onondaga Lake, Technical Report 87-1 (BEP), July 1987.

31. Stolzenburg, T. R., R. R. Stanforth, and D. G. Nichols, 1986. Journal AWWA 78:45, January 1986.

32. USEPA, 1973. Report of Mercury Source Investigation Onondaga Lake, NY and Allied Chemical Corporation Solvay, NY, USEPA, April, 1973.

33. USEPA, 1979. Water-Related Environmental Fate of 129 Priority Pollutants. December 1979.

34. USEPA, 1987. Mercury Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. Biological Report 85 (1.10), April 1987.

**These references were not used for HRS Documentation. See also "HRS References" above.

35. USGS, 1984. Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States, Professional Paper 1270.

New York State Department of Environmental Conservation

MEMORANDUM

I: General Distribution
OM: Kernan Davis, Associate Engineering Geologist,
Division of Hazardous Waste Remediation
BJECT: The Baldwinsville Aquifer - A Clarification of the Issues

TE: 7 July 1989

In May of 1986, as part of an effort to establish a sound scientific foundation for decisions regarding the many issues surrounding the closing of the Allied Chemical facilities in the area of Onondaga Lake, Syracuse, New York, the issue of the proper designation the Baldwinsville Aquifer came up. At that time, there was some confusion and controversy regarding the proper designation of that aquifer as a "Primary Water Supply Aquifer" or as a "Principal Aquifer". I drafted a memorandum, asking the Division of Water to clarify a confusing report, issued by US/EPA in 1984, Atlas of Four Selected Aquifers in New York. Some readers were mistakenly taking the Baldwinsville Aquifer to be a Primary Aquifer! That memo was not found in our files.

When asked about the Baldwinsville Aquifer issue today, Mr. Alan C. Tedrow, P.E., Chief of the Groundwater Management Section of the Bureau of Water Quality Management of the Division of Water, indicated that he considers the so-called "Baldwinsville Aquifer" to be part of an extensive Principal Aquifer.

The only Primary Water Supply Aquifer in the Syracuse area is "The Senceca River Aquifer", which is situated in the vicinity of the Village of Baldwinsville, and which is a subdivision of the "Baldwinsville Aquifer", situated next to and beneath the Senceca River.

The 1981 New York State Department of Health's Report on Groundwater Dependence in New York State, considered to be the most authoritative document on the subject, clearly shows that The Seneca River Aquifer is not in the Onondaga Valley drainage basin. Therefore, the Mercury Sediments - Onondaga Lake Site could not affect said Primary Water Supply aquifer.

It is ill-advised to use the nomenclature, "Baldwinsville Aquifer" when referring to any aquifers surrounding and underlying Onondaga Lake. Just say "an aquifer" or "the lake-side aquifer".

One should also be aware that it was from these lake-side aquifers that the Native Americans and the European-Americans took brine for the making of salt and that the natural lake sedimentary deposits in this vicinity are rich in "marl", a calcite deposit. Mercury, on the other hand, is a very rare mineral in central New York.

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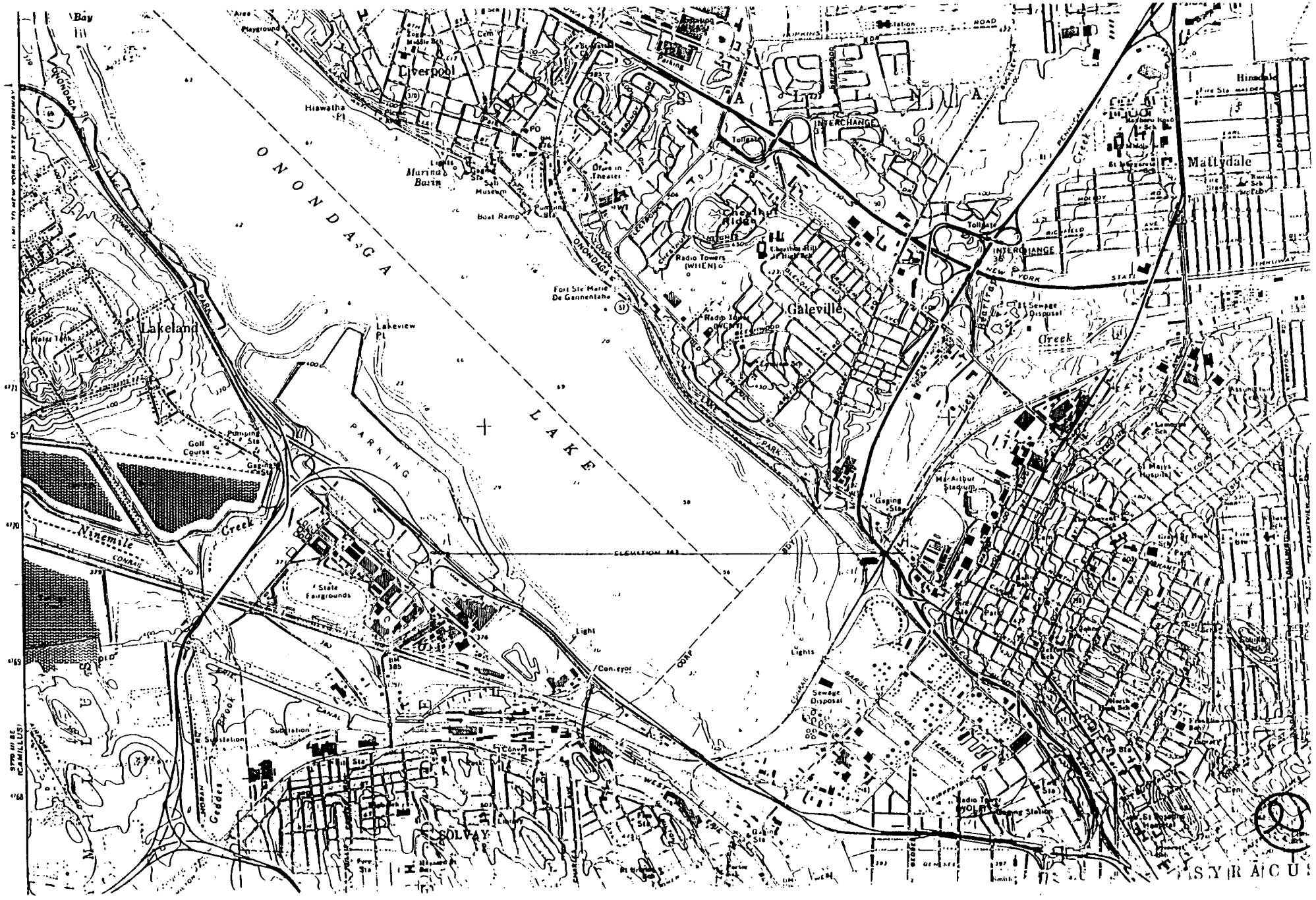

ONONDAGA
LAKE
Liverpool
Hiawatha Pt
Marina Basin
Boat Ramp
Lakeland
Lakeview Pt
Golf Course
Ninemile Creek
State Fairgrounds
Light
Conveyor
Substation
SOLVAY
Galeville
Cheathut Ridge
Radio Towers (WHEN)
Fort Ste Marie De Gannentaha
Mattydale
Hinsdale
INTERCHANGE
Tollgate
Sewage Disposal
MacArthur Stadium
Gaging Sta
Lights
Creek
SYRACUS

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THE IMPACT OF A CHLOR-ALKALI PLANT ON ONONDAGA LAKE AND ADJOINING SYSTEMS*

Steven W. Effler
Upstate Freshwater Institute, Inc.
Box 506, Syracuse, NY 13214, U.S.A.

*Contribution No. 65 of the Upstate Freshwater Institute, Inc.

(Friedman et al., 1980), and low transparency (e.g. Devan and Effler, 1984; Effler et al., 1984c). The fish in the lake are generally contaminated with Hg. Fish are usually restricted to portions of the epilimnion of the lake (i.e. warm water fishery) due to severe oxygen depletion (and presence of toxic reduced species (e.g. Effler et al., 1986b)) in subsurface layers. The benthos and aquatic macrophyte populations are extremely small, with low diversity (e.g. Onondaga County, 1971). Manifestations of hypereutrophy include: (1) very high standing crops of phytoplankton (e.g. chlorophyll a as high as 170 $\mu g \cdot L^{-1}$ (Field and Effler, 1983)), (2) dominance of chlorococcalean green algae (Sze, 1975); and (3) high concentrations of algal macronutrients. Pollutional loadings to Onondaga Lake include rural and urban runoff, direct discharges of treated municipal sewage and industrial wastewaters, combined sewer overflows and other periodic discharges of untreated sewage, and polluted groundwater.

1.2. UTILIZATION OF ONONDAGA LAKE BY THE CHLOR-ALKALI MANUFACTURER

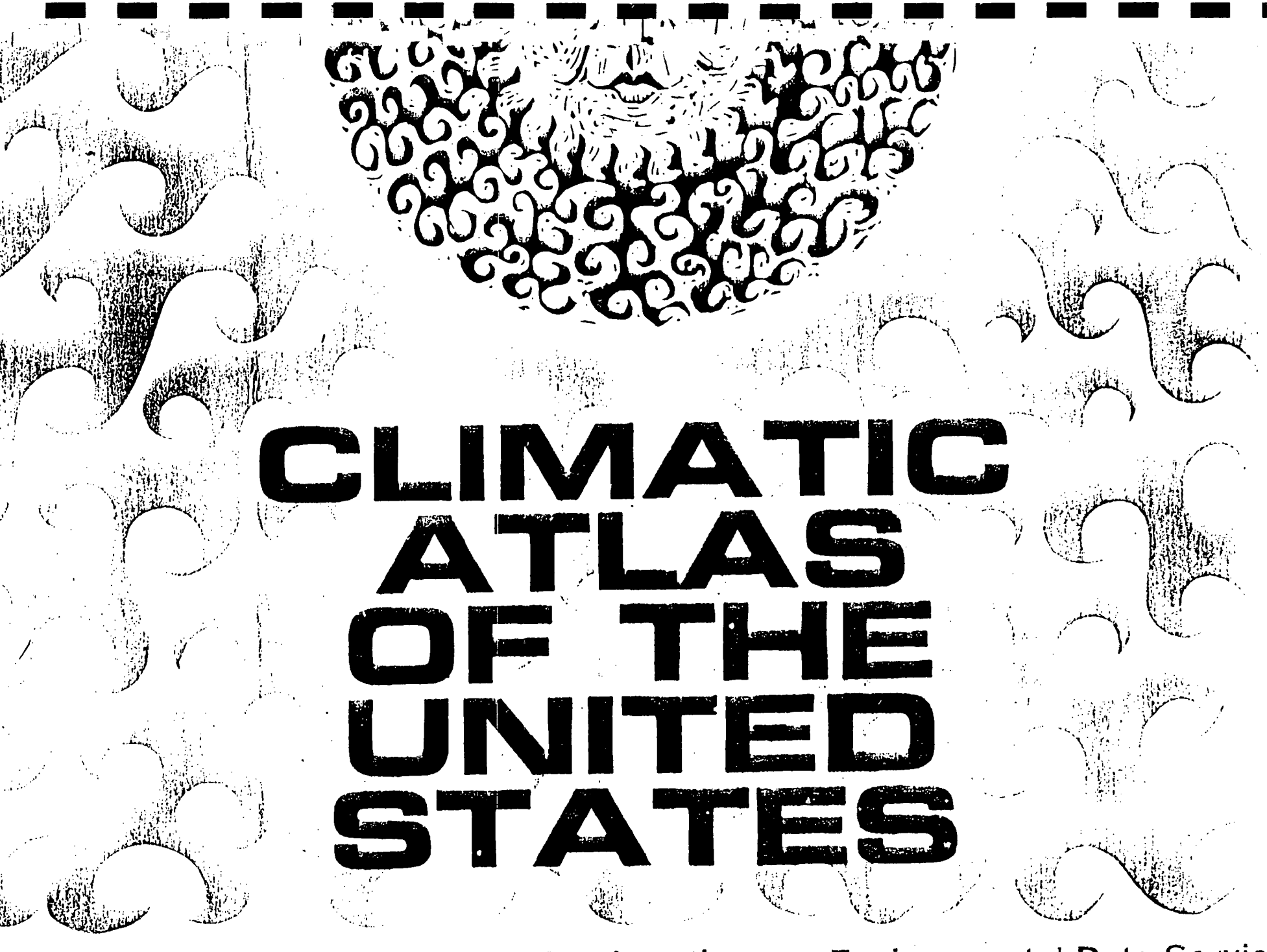
The chlor-alkali manufacturer (limited to alkali manufacturing since 1979) has used the lake to discharge ionic waste and as a source of cooling water since the 1880's. The facility produces soda ash by the Solvay Process. The wastewaters produced from this process contain high concentrations of Cl, Na, and Ca. The production of this waste is nearly stoichiometric with soda ash production; for each kg of soda ash produced approximately 0.5 kg of NaCl and 1.0 kg of $CaCl_2$ is released (United States Environmental Protection Agency (USEPA), 1974). The waste is subjected to settling pretreatment in lagoons. Monitoring data for the interval 1970-1980 (Onondaga County, 1971-1981) indicate the average daily load of the ionic waste (effluent from the lagoons) to the lake for that period was 2.5×10^6 $kg \cdot d^{-1}$. The ionic waste entered the lake via Nine Mile Creek (Figure 1a) until 1981. A portion of the ionic waste was diverted to

the Metropolitan Sewage Treatment Plant (METRO) from 1981 to 1983 for use in the removal of phosphorus (tertiary treatment). The complete diversion of the ionic waste to METRO began in late 1983. Materials settled in the lagoons are disposed of in "wastebeds" located nearby the lake (e.g. within the watershed of the lake; Figure 1a). The waste beds cover an area of approximately 3.6 km^2 and are estimated to have a volume of 0.069 km^3. Input of materials from the wastebeds to the lake via the groundwater is probable, but no estimates of fluxes have been made to date.

Chlorobenzene was also manufactured at the facility (chlorobenzene plant, Figure 1a). The waste (Semet residue) was disposed of in nearby lined ponds located within the lake's watershed (Figure 1a). Ground water in the vicinity of several of these lagoons has been found to be contaminated with benzene and associated compounds (chlorobenzenes) (Geraghty and Miller, Inc., 1980; 1982), apparently as a result of leakage from the beds. A subsequent study (Geraghty and Miller, Inc., 1982) documented high concentrations of benzene associated compounds in the groundwater between the chlorobenzene plant and the lake, and the presence of these materials in three ground water seeps that discharge to the lake, and in proximate lake sediments. The present loading rate of chlorinated hydrocarbon contamination toward the lake from the chlorobenzene plant via the deep aquifer has been estimated to be 195 $g \cdot d^{-1}$ (Groundwater Technology, 1984a). The loading rate of dissolved hydrocarbons via the shallow aquifer has been estimated to be 146 $kg \cdot d^{-1}$ (Groundwater Technology, 1984b). The feasibility of recovery of the hydrocarbons from the shallow aquifer has been evaluated (Groundwater Technology, 1984b). The ionic waste used for tertiary treatment at METRO was found to be enriched in chlorobenzene on a single day (31 $\mu g \cdot L^{-1}$ dichlorobenzene and 2.1 $\mu g \cdot L^{-1}$ trichlorobenzene, on 19 February, 1983; Scrudato and Sugatt, 1983).

The alkali plant uses the lake as a source of process cooling water. There are three intakes for withdrawal of lake water. One is in shallow water, at a depth of approximately 3m below the normal lake level; the other two are in deeper water at a nearly equal, but uncertain depth (10.7-12.2 m; personal communication, plant personnel). Withdrawal from the deeper intakes has been preferred because of the colder temperature. However, the upper intake was used more in late summer for a number of years to avoid the corrosive high concentrations of sulfide that developed in the lower waters. In recent years the rate of withdrawal has typically been between 2 and 3 $m^3 \cdot s^{-1}$. Heated water was discharged back to the lake via a shore discharge (East Flume (Figure 1a)), until 1978. Since that time the heated water has been discharged through a multiport diffuser, that extends 900 m offshore (Figure 1a), at a depth of 4.6 m.

The chlor-alkali plant discharged Hg waste to Onondaga Lake in the interval 1946 to 1976. Most of this waste emanated from the two Hg cell chlor-alkali processes (first one started in 1946, second in 1953; United States Environmental Protection Agency, 1973). It is estimated that 75,000 kg of Hg were discharged to the lake from 1946 to 1970 (approximately 5 $kg \cdot d^{-1}$ from 1946 to 1953, and 10 $kg \cdot d^{-1}$ from 1953 to 1970) by the plant (United States Environmental Protection Agency, 1973). The loading was reduced by more than 95% soon after the U.S. Department of Justice took legal action against the facility (one of 10 chlor-alkali plants) in the summer of 1970; further reductions were subsequently achieved (Lipe et al., 1983). The chlor-alkali plant has been the only known significant source of Hg to the lake (United States Environmental Protection Agency, 1973).



CLIMATIC ATLAS OF THE UNITED STATES

nvironmental Science Services Administration . Environmental Data Service

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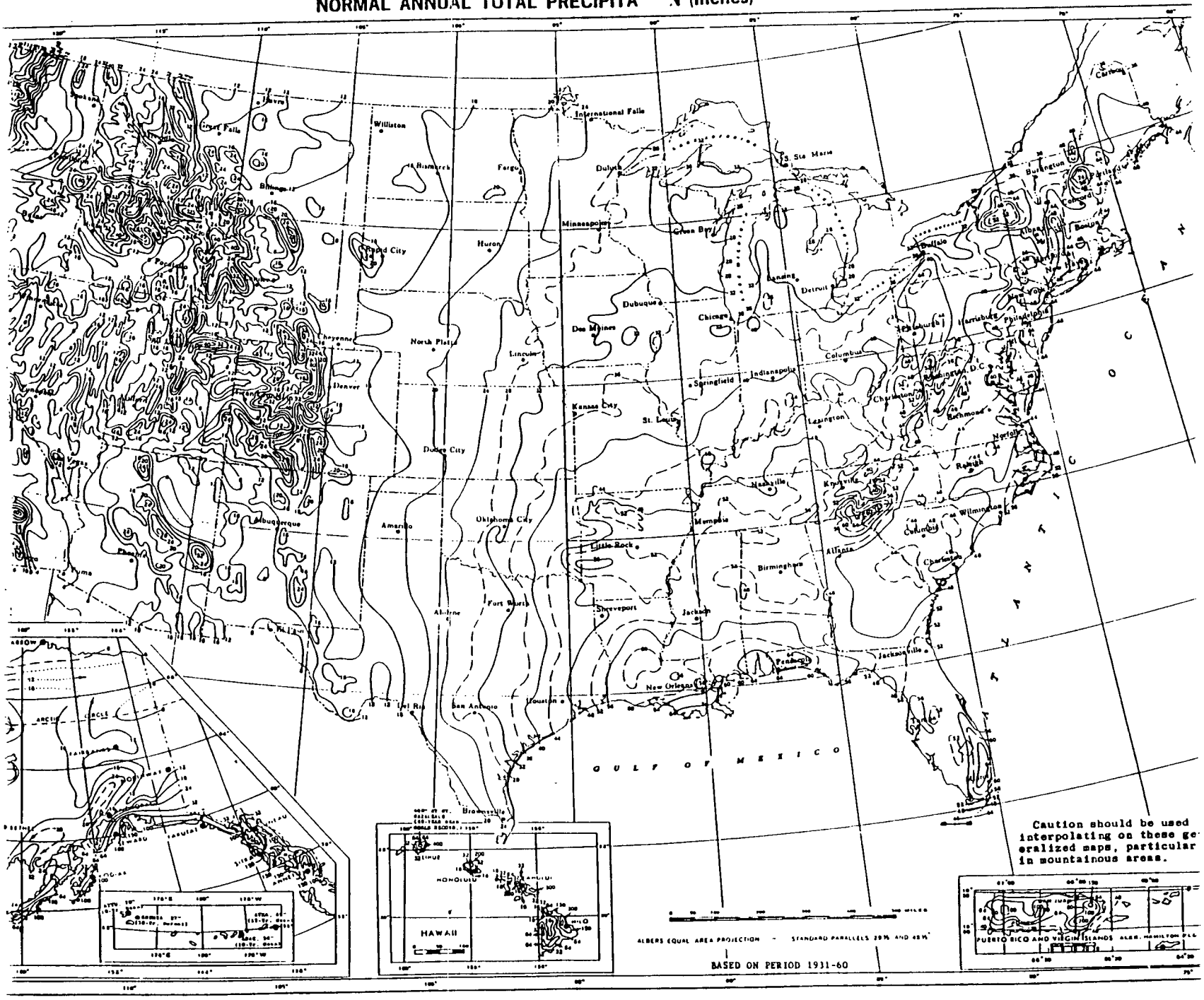
(4)

NORMAL ANNUAL TOTAL PRECIPITA N (Inches)



Caution should be used interpolating on these ge eralized maps, particular in mountainous areas.

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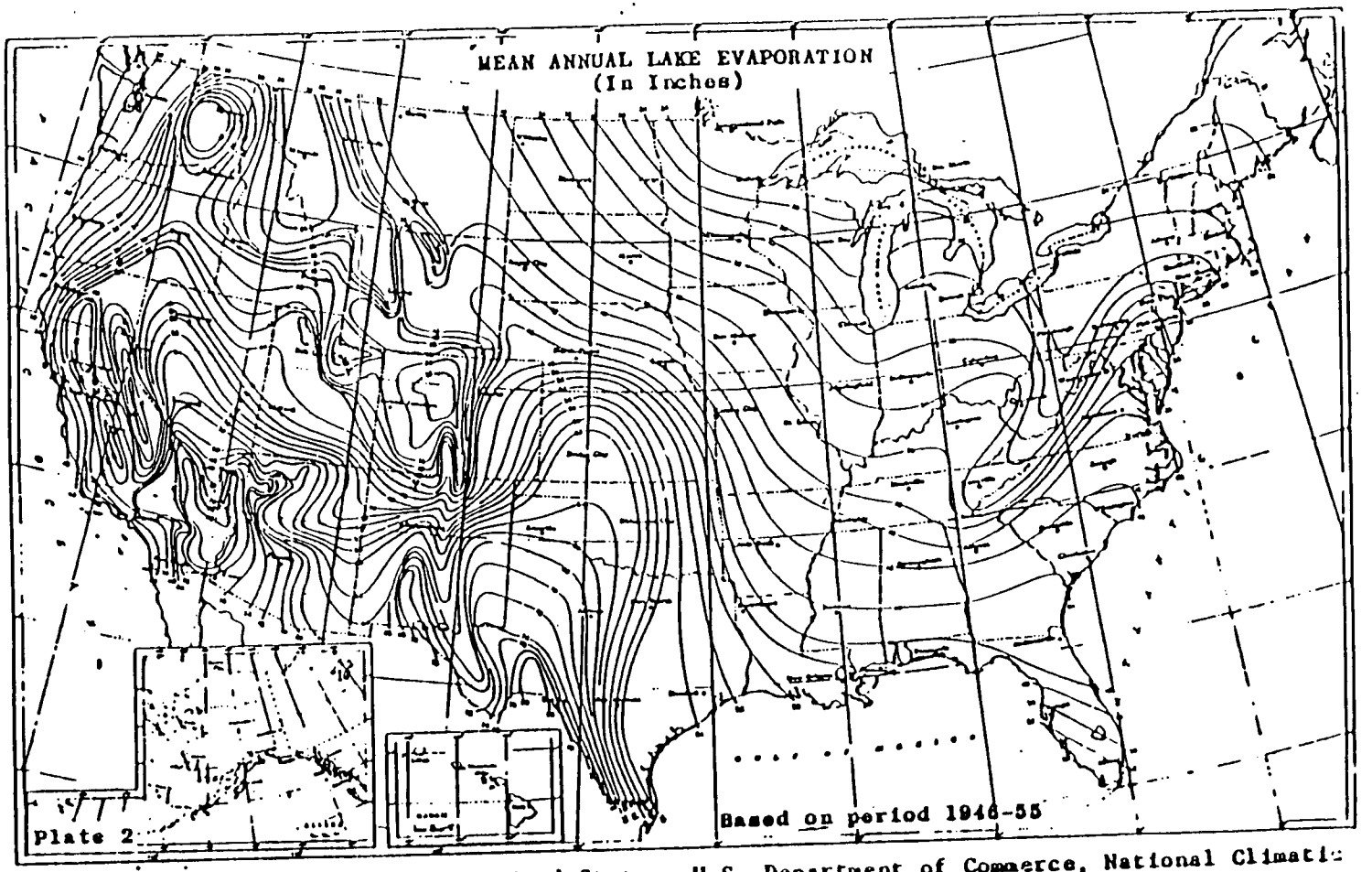
(4)



Source: Climatic Atlas of the United States, U.S. Department of Commerce, National Climatic Center, Ashville, N.C., 1979.

FIGURE 4
MEAN ANNUAL LAKE EVAPORATION
(IN INCHES)

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(4)

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Uncontrolled Hazardous Waste Site Ranking System

A Users Manual

(HW-10)

Originally Published in
the July 16, 1982, *Federal Register*

United States
Environmental Protection
Agency

1984

TABLE 2

PERMEABILITY OF GEOLOGIC MATERIALS*

Type of Material	Approximate Range of Hydraulic Conductivity	Assigned Value
Clay, compact till, shale; unfractured metamorphic and igneous rocks	$<10^{-7}$ cm/sec	0
Silt, loess, silty clays, silty loams, clay loams; less permeable limestone, dolomites, and sandstone; moderately permeable till	$10^{-5} - 10^{-7}$ cm/sec	1
Fine sand and silty sand; sandy loams; loamy sands; moderately permeable limestone, dolomites, and sandstone (no karst); moderately fractured igneous and metamorphic rocks, some coarse till	$10^{-3} - 10^{-5}$ cm/sec	2
Gravel, sand; highly fractured igneous and metamorphic rocks; permeable basalt and lavas; karst limestone and dolomite	$>10^{-3}$ cm/sec	3

*Derived from:

Davis, S. N., Porosity and Permeability of Natural Materials in Flow-Through Porous Media, R.J.M. DeWest ed., Academic Press, New York, 1969

Freeze, R.A. and J.A. Cherry, Groundwater, Prentice-Hall, Inc., New York, 1979

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
DIVISION OF HAZARDOUS WASTE REMEDIATION
INACTIVE HAZARDOUS WASTE DISPOSAL REPORT

(6) (125 of 255)

IFICATION CODE: 2a REGION: 7 SITE CODE: 734030
EPA ID:

IE OF SITE : Mercury Sediments - Onondaga Lake
REET ADDRESS:
N/CITY: COUNTY: ZIP:
acuse Onondaga

TE TYPE: Open Dump- Structure- Lagoon- Landfill- Treatment Pond-
IMATED SIZE: Acres

ITE OWNER/OPERATOR INFORMATION:
RENT OWNER NAME....:
RENT OWNER ADDRESS.: ,
NER(S) DURING USE...:
TRATOR DURING USE...:
ERATOR ADDRESS.....:
RIOD ASSOCIATED WITH HAZARDOUS WASTE: From 1946 To 1970

E DESCRIPTION:
liments in nine mile creek, Geddes Brook and portions of Onondaga Lake ontain mercury discharged from Chloro-alkali manufacturing plants cated on the western shore of the lake. Mercury cells used to produce lorine were originally placed on line in 1946 at the east plant and 53 at the Bridge Street plant. Approximately 20 lbs/day of mercury s being discharged from the 2 plants prior to 1970. The amount of ury deposited is unknown, although tests conducted on sediment ies in 1972 indicated 90% contained mercury above natural, back-round concentrations. Phase II study underway. Core samples taken in te Summer 1986, the results are still pending. Additional surface ter samples were taken too, and the analytical results are also nding.

AZARDOUS WASTE DISPOSED: Confirmed-X Suspected-

TYPE	QUANTITY (units)
mercury	unknown

TA IV-

1986 SAMPLING RESULTS

Site Name: Onondaga Lake
Submitted by: Michele Galvin
Date Reported January 27, 1987

Sample #	Sample Location	Date Collected	Date Digested	Date Analyzed	% Dry Mass	PPM Hg-Dry Mass Basis
786256-01	S-01-00-03	09/15/86	10/24	12/8/86	54.09	0.35
786256-02	S-01-03-06	"	10/24	12/8/86	49.95	0.39
786256-03	S-01-12-18	"	10/24	12/8/86	61.50	<0.5
786256-04	S-01-24-30	"	10/24	12/8/86	60.28	<0.5
786256-05	S-01-36-41	"	09/23	12/18/86	59.96	<0.5
786256-06	S-02-~~01-06~~ 00-03	"	10/27	12/8/86	25.84	05.88
786256-07	S-02-03-06 WB 11/22/88	"	11/03	12/8/86	28.68	11.59
786256-08	S-02-12-18	"	10/22	12/8/86	42.72	<0.5
786256-09	S-02-24-30	"	10/22	12/8/86	49.32	<0.5
786256-10	S-02-36-39	"	10/22	12/8/86	52.91	<0.5
786256-11	S-03-00-03	"	10/27	12/8/86	69.35	0.93
786256-12	S-03-03-06	"	10/27	12/8/86	58.84	0.59
786256-13	S-03-12-18	"	10/27	12/8/86	46.05	<0.5
786256-14	S-03-24-30	"	10/27	12/8/86	48.80	<0.5
786256-15	S-03-36-39	"	12/23	12/23/86	47.12	<0.5
786256-16	S-04-00-03	"	10/08	12/11/86	53.33	<0.5
786256-17	S-04-03-06	"	10/08	12/11/86	56.88	0.17
786256-18	S-04-12-18	"	10/08	12/11/86	53.62	<0.5
786256-19	S-04-24-30	"	09/17	12/10/86	46.82	<0.5
786256-20	S-04-36-42	"	09/17	12/10/86	46.11	<0.5
786256-21	S-04-48-54	"	09/17	12/10/86	56.90	<0.5
786256-22	S-05-00-03	"	12/23	12/23/86	23.22	1.84
786256-23	S-05-03-06	"	12/23	12/23/86	20.24	49.28
786256-24	S-05-12-18	"	12/23	12/23/86	32.55	1.16
786256-25	S-05-24-30	"	12/23	12/23/86	37.84	0.16
786256-26	S-05-36-37	"	12/23	12/23/86	41.67	0.21
786256-27	S-06-00-03	"	09/29	12/10/86	27.45	18.18
786256-28	S-06-03-06	"	09/29	12/10/86	47.36	0.37
786256-29	S-06-12-18	"	09/29	12/10/86	48.11	0.17
786256-30	S-06-24-30	"	09/29	12/10/86	51.27	<0.5
786256-31	S-06-36-42	"	09/29	12/10/86	55.27	<0.5
786256-32	S-07-00-03	"	10/27	12/8/86	23.63	02.81
786256-33	S-07-03-06	"	10/27	12/8/86	20.65	24.0
786256-34	S-07-12-18	"	10/27	12/8/86	33.58	1.16

SITE CODE: 734030

(6)

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ICAL DATA AVAILABLE:
Surface Water-X Groundwater- Soil- Sediment-X None-

VENTION OF STANDARDS:
water- Drinking Water- Surface Water- Air-

ACTION:

State- Federal-
Negotiation in Progress- Order Signed-

IAL ACTION:

sed- Under design- In Progress- Completed-

E OF ACTION:

CHNICAL INFORMATION:
TYPE: not applicable
DWATER DEPTH: not applicable

SMENT OF ENVIRONMENTAL PROBLEMS:

hing ban was placed on Onondaga Lake in 1970 because of mercury
mination of the fish.

SSMENT OF HEALTH PROBLEMS:

um	Contaminants Available	Migration Potential	Potentially Exposed Population	Need for Investigation
ace Soil				
nwater				
ace Water				

th Department Site Inspection Date :

ICIPAL WASTE ID:

TABLE -I

(continued)

Site Name: Onondaga Lake
Submitted by: Michele Galvin
Date Reported January 27, 1987

Sample #	Sample Location	Date Collected	Date Digested	Date Analyzed	% Dry Mass	PPM Hg-Dry Mass Basis
786256-35	S-07-24-30	09/15/86	10/27	12/8/86	40.51	<0.5
786256-36	S-07-36-42	"	10/27	12/8/86	42.29	<0.5
786256-37	S-08-00-03	"	10/09	12/11/86	23.92	20.34
786256-38	S-08-03-06	"	10/24	12/8/86	37.92	0.24
786256-39	S-08-12-18	"	10/24	12/8/86	38.83	<0.5
786256-40	S-08-24-30	"	11/03	12/8/86	41.06	<0.5
786256-41	S-08-36-42	"	10/24	12/8/86	44.91	<0.5
786256-42	S-09-00-03	"	10/02	12/16/86	24.59	02.33
786256-43	S-09-03-06	"	10/02	12/18/86	24.00	28.99
786256-44	S-09-12-18	"	10/02	12/16/86	36.46	0.23
786256-45	S-09-24-30	"	10/02	Lab Accident	39.27	
786256-46	S-09-36-42	"	10/02	12/16/86	44.13	<0.5
786255-01	S-10-00-03	"	10/16	12/15/86	53.59	<0.5
786255-02	S-10-03-06	"	10/16	12/15/86	50.93	<0.5
786255-03	S-10-12-18	"	09/29	12/18/86	55.07	<0.5
786255-04	S-10-24-30	"	09/29	12/18/86	56.41	<0.5
786255-05	S-10-36-42	"	09/29	12/18/86	63.49	<0.5
786255-06	S-10-48-53	"	09/29	12/18/86	63.78	<0.5
786256-47	S-11-00-03	"	09/23	12/12/86	30.53	11.27
786256-48	S-11-03-06	"	09/25	12/18/86	33.24	28.99
786256-49	S-11-12-18	"	09/25	12/12/86	41.22	0.23
786256-50	S-11-24-30	"	09/23	12/16/86	46.76	<0.5
786256-51	S-11-36-41	"	09/25	12/16/86	49.24	<0.5
786256-52	S-12-00-03	"	11/08	12/09/86	60.76	02.82
786256-53	S-12-03-06	"	10/28	12/09/86	60.06	01.20
786256-54	S-12-12-18	"	10/28	12/09/86	51.24	<0.5
786256-55	S-12-24-30	"	10/28	12/09/86	57.78	<0.5
786256-56	S-12-36-37	"	10/28	12/09/86	54.82	<0.5
786256-57	S-13-00-03	"	10/06	12/15/86	51.38	01.08
786256-58	S-13-03-06	"	10/06	12/15/86	51.82	<0.5
786256-59	S-13-12-18	"	12/23	12/23/86	50.81	<0.5
786256-60	S-13-24-30	"	12/23	12/23/86	53.47	<0.5
786256-61	S-15-00-03	"	09/17	12/10/86	44.16	02.04
786256-62	S-15-03-06	"	09/17	12/10/86	47.20	01.05

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TAB. IV-I

(continued)

Site Name: Onondaga Lake
Submitted by: Michele Galvin
Date Reported January 27, 1987

Sample #	Sample Location	Date Collected	Date Digested	Date Analyzed	% Dry Mass	PPM Hg-Dry Mass Basis
786256-63	S-15-12-18	9/15/86	09/19	12/10/86	43.94	33.33
786256-64	S-15-24-30	"	09/17	12/10/86	43.73	08.42
786256-65	S-15-36-42	"	11/03	12/09/86	52.29	0.36
786256-66	S-16-00-03	"	12/23	12/23/86	63.73	02.71
786256-67	S-16-03-06	"	12/23	12/23/86	58.44	01.09
786256-68	S-16-12-18	"	12/23	12/23/86	51.93	01.42
786256-69	S-16-24-30	"	12/23	12/23/86	58.62	01.59
786256-70	S-16-36-40	"	12/23	12/23/86	60.79	01.14
786256-71	S-17-00-03	"	09/29	12/18/86	68.96	0.62
786256-72	S-17-03-06	"	09/29	12/18/86	72.25	0.38
786256-73	S-17-12-18	"	09/29	12/18/86	68.54	0.52
786256-74	S-17-24-30	"	09/29	12/18/86	67.78	0.58
786256-75	S-17-36-40	"	09/25	12/18/86	69.74	0.37
786256-76	S-18-00-03	"	10/07	12/16/86	24.96	01.64
786256-77	S-18-03-06	"	10/07	12/16/86	21.58	53.57
786256-78	S-18-12-18	"	10/06	12/16/86	35.48	01.87
786256-79	S-18-24-30	"	10/07	12/16/86	40.17	<0.5
786256-80	S-18-36-41	"	10/06	12/16/86	41.50	<0.5
786256-81	S-19-00-03	"	09/17	12/10/86	52.85	<0.5
786248-02	S-19-03-06	"	09/17	12/10/86	52.82	<0.5
786248-03	S-19-12-18	"	09/17	12/10/86	60.80	<0.5
786248-04	S-19-24-30	"	09/17	12/10/86	62.80	<0.5
786248-05	S-19-36-42	"	09/19	12/10/86	38.69	<0.5
786256-81	S-20-00-03	"	10/22	12/08/86	66.54	0.58
786256-82	S-20-03-06	"	10/22	12/08/86	64.42	0.62
786256-83	S-20-12-18	"	11/03	12/09/86	63.29	0.14
786256-84	S-20-24-30	"	10/22	12/09/86	65.80	<0.5
786256-85	S-20-36-42	"	09/29	12/18/86	57.95	<0.5
786256-86	S-21-00-03	"	10/06	12/16/86	26.11	02.07
786256-87	S-21-03-06	"	10/06	12/18/86	28.86	01.45
786256-88	S-21-12-18	"	10/06	12/18/86	31.75	04.11
786256-89	S-21-24-30	"	10/06	12/16/86	38.62	0.68
786256-90	S-21-36-41	"	10/06	12/16/86	42.08	0.22
786256-91	S-22-00-03	"	09/25	12/18/86	24.89	<0.5

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TABI v-I

(continued)

Site Name: Onondaga Lake
Submitted by: Michele Galvin
Date Reported January 27, 1987

Sample #	Sample Location	Date Collected	Date Digested	Date Analyzed	% Dry Mass	PPM Hg-Dry Mass Basis
786256-92	S-22-03-06	9/15/86	09/24	12/18/86	19.08	< 0.5
786256-93	S-22-12-18	"	09/23	12/12/86	33.12	0.28
786256-94	S-22-24-30	"	09/24	12/18/86	23.59	< 0.5
786256-95	S-22-36-42	"	09/24	12/18/86	23.67	< 0.5
786256-96	S-2248-54	"	09/24	12/18/86	29.17	< 0.5
786256-97	S-23-00-03	"	09/29	12/18/86	48.55	0.56
786256-98	S-23-03-06	"	09/29	12/18/86	54.73	0.78
786256-99	S-23-12-18	"	09/29	12/18/86	57.98	< 0.5
786256-100	S-23-24-30	"	09/25	12/18/86	60.70	< 0.5
786256-101	S-23-36-42	"	09/25	12/18/86	56.32	< 0.5
786256-102	S-24-00-03	"	10/09	12/11/86	22.98	01.54
786256-103	S-24-03-06	"	10/09	12/11/86	20.61	14.29
786256-104	S-24-12-18	"	10/09	12/11/86	36.53	0.85
786256-105	S-24-24-30	"	10/15	12/12/86	39.38	< 0.5
786256-106	S-24-36-42	"	10/09	12/11/86	44.75	< 0.5
786256-107	S-25-00-03	"	09/29	12/18/86	45.66	01.10
786256-108	S-25-03-06	"	09/29	12/18/86	33.41	0.54
786256-109	S-25-12-18	"	09/29	12/18/86	33.01	< 0.5
786256-110	S-25-24-30	"	09/29	12/18/86	36.40	< 0.5
786256-111	S-25-36-42	"	09/29	12/18/86	33.67	< 0.5
786256-112	S-25-48-54	"	09/29	12/18/86	32.90	< 0.5
786256-113	S-27-00-03	"	10/08	12/11/86	25.38	03.17
786256-114	S-27-03-06	"	10/08	12/11/86	22.22	32.00
786256-115	S-27-12-18	"	10/08	12/12/86	33.93	0.27
786256-116	S-27-24-30	"	10/08	12/11/86	38.99	< 0.5
786256-117	S-27-36-42	"	10/08	12/11/86	40.69	01.85
786256-118	S-27-48-54	"	10/08	12/11/86	44.44	< 0.5
786248-06	S-28-00-03	"	09/17	12/10/86	62.86	01.27
786248-07	S-28-03-06	"	09/17	12/10/86	58.94	01.46
786248-08	S-28-12-18	"	09/19	12/10/86	61.68	< 0.5
786248-09	S-28-24-30	"	09/19	12/10/86	62.96	< 0.5
786256-119	S-30-00-03	"	09/25	12/18/86	58.63	01.60
786256-120	S-30-03-06	"	09/25	12/18/86	47.34	< 0.5
786256-121	S-30-12-18	"	09/24	12/18/86	53.59	< 0.5

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(continued)

Site Name: Onondaga Lake
Submitted by: Michele Galvin
Date Reported January 27, 1987

Sample #	Sample Location	Date Collected	Date Digested	Date Analyzed	% Dry Mass	PPM Hg-Dry Mass Basis
786256-122	S-30-24-30	9/15/86	09/25	12/18/86	52.82	<0.5
786257-01	S-30-36-42	"	09/25	12/18/86	57.10	<0.5
786256-123	S-31-00-03	"	10/15	Lab Accident	30.42	
786256-124	S-31-03-06	"	10/09	12/12/86	31.55	0.29
786256-125	S-31-12-18	"	10/09	12/12/86	40.32	<0.5
786256-126	S-31-24-30	"	10/09	12/12/86	41.56	<0.5
786256-127	S-31-36-42	"	10/09	12/12/86	48.10	<0.5
786256-128	S-31-48-50	"	10/15	12/12/86	47.21	<0.5
786256-129	S-33-00-03	"	10/02	12/18/86	14.69	50.00
786256-130	S-33-03-06	"	10/02	12/18/86	19.40	37.04
786256-131	S-33-12-18	"	10/02	12/18/86	33.76	01.35
786256-132	S-33-24-30	"	10/08	12/11/86	41.68	0.22
786256-133	S-33-36-42	"	10/08	12/16/86	44.18	<0.5
786256-134	S-33-48-51	"	10/08	12/11/86	43.07	<0.5
786256-135	S-35-00-03	"	11/03	12/08/86	36.31	01.72
786256-136	S-35-03-06	"	10/28	12/08/86	29.70	02.42
786256-137	S-35-12-18	"	10/28	12/08/86	32.15	08.57
786256-138	S-35-24-30	"	10/28	12/08/86	34.75	10.13
786256-139	S-35-36-42	"	10/28	12/08/86	45.05	08.70
786256-140	S-35-48-51	"	10/28	12/08/86	44.98	02.64
786255-07	S-36-00-03	"	09/17	12/11/86	31.58	0.62
786255-08	S-36-03-06	"	09/19	12/11/86	63.14	0.40
786255-09	S-36-12-18	"	09/17	12/11/86	61.17	0.14
786255-10	S-36-24-30	"	10/16	12/15/86	54.76	01.03
786256-141	S-39-00-03	"	10/24	12/09/86	36.94	85.37
786256-142	S-39-03-06	"	10/24	12/08/86	51.43	14.56
786256-143	S-39-12-18	"	11/03	12/08/86	45.90	15.31
786256-144	S-39-24-27	"	10/24	12/09/86	45.24	16.48
786255-11	S-40-00-03	"	10/16	12/15/86	39.72	02.25
786255-12	S-40-03-06	"	10/16	12/15/86	33.25	01.37
786255-13	S-40-12-17	"	10/16	12/15/86	38.82	0.50
786256-145	S-41-00-03	"	09/17	12/12/86	28.33	03.23
786256-146	S-41-03-06	"	09/19	12/12/86	25.09	13.56
786256-147	S-41-12-18	"	09/19	12/12/86	39.30	0.22

TABLE I

(continued)

Site Name: Onondaga Lake
Submitted by: Michele Galvin
Date Reported January 27, 1987

Sample #	Sample Location	Date Collected	Date Digested	Date Analyzed	% Dry Mass	PPM Hg-Dry Mass Basis
786256-148	S-41-24-30	9/15/86	09/17	12/12/86	38.48	0.88
786256-149	S-41-36-42	"	09/17	12/12/86	34.33	<0.5
786255-14	S-42-00-03	"	10/16	12/15/86	49.49	<0.5
786255-15	S-42-03-06	"	10/16	12/15/86	53.81	<0.5
786255-16	S-42-12-18	"	10/16	12/15/86	51.34	<0.5
786255-17	S-42-24-30	"	10/16	12/15/86	56.16	<0.5
786255-18	S-42-36-42	"	10/16	12/15/86	53.30	<0.5
786255-19	S-42-48-54	"	10/16	12/15/86	55.47	<0.5
786256-150	S-43-00-03	"	10/22	12/08/86	34.55	01.07
786256-151	S-43-03-06	"	10/22	12/08/86	31.13	21.92
786256-152	S-43-12-18	"	10/22	12/08/86	30.58	0.32
786256-153	S-43-24-30	"	10/22	12/08/86	43.53	0.73
786256-154	S-43-36-41	"	10/22	12/08/86	37.87	0.25
786258-01	S-37-00-03	9/18/86	09/22	12/10/86	74.39	<0.5
786258-02	S-37-03-06	"	09/22	12/10/86	75.96	<0.5
786258-03	S-37-12-18	"	09/22	12/10/86	73.06	<0.5
786258-04	S-37-24-30	"	09/22	12/10/86	59.80	<0.5
786258-05	S-37-36-42	"	09/22	12/11/86	61.04	<0.5
786258-06	S-26-~~03-06~~ 00-03	"	09/22	12/11/86	25.11	<0.5
786258-07	S-26-03-06 WB 11/22/88	"	09/22	12/11/86	30.00	<0.5
786258-08	S-26-12-18	"	09/22	12/11/86	28.09	<0.5
786258-09	S-26-24-30	"	09/23	12/11/86	29.50	<0.5
786258-10	S-26-36-42	"	09/22	12/11/86	34.70	<0.5
786258-11	S-26-48-54	"	09/22	12/11/86	58.52	<0.5
786258-12	S-34-00-03	"	09/24	12/11/86	54.47	<0.5
786258-13	S-34-03-06	"	09/23	12/11/86	55.87	<0.5
786258-14	S-34-12-18	"	09/23	12/11/86	61.40	<0.5
786258-15	S-34-24-30	"	09/23	12/11/86	63.09	<0.5
786258-16	S-34-36-42	"	09/24	12/11/86	53.03	<0.5
786258-17	S-32-00-03	"	09/22	12/11/86	42.27	0.22
786258-18	S-32-03-06	"	09/22	12/11/86	59.39	01.49
786258-19	S-32-12-18	"	09/23	12/11/86	56.95	01.72
786258-20	S-32-24-30	"	09/23	12/11/86	57.01	0.16
786258-21	S-32-36-42	"	09/23	12/11/86	62.75	<0.5

TABLE -V-I

(continued)

Site Name: Onondaga Lake
Submitted by: Michele Galvin
Date Reported January 27, 1987

Sample #	Sample Location	Date Collected	Date Digested	Date Analyzed	% Dry Mass	PPM Hg
* SAMPLES WERE SUBMITTED AS WATER, THERFORE NO DRY WEIGHT WAS DETERMINED.						
** THE FOLLOWING SAMPLES 786259-01 thru 04 WERE SUBMITTED AS WATER SAMPLES.						
786259-01	W-01-05-05	9/18/86		12/16/86		<0.5
786259-02	W-01-13-13	"		12/16/86		<0.5
786259-03	W-03-02-02	"		12/16/86		<0.5
786259-04	W-03-04-04	"		12/16/86		<0.5

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ONONDAGA COUNTY DEPARTMENT OF HEALTH
DIVISION OF ENVIRONMENTAL HEALTH

Mailing Address
P.O. Box 190, Syracuse, New York 13215-0190
Location
4894 Onondaga Road

Nicholas J. Pirro
County Executive

James R. Miller, M.D., M.P.H.
Commissioner of Health

Guala, P.E.,
Assistant Commissioner

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October 31, 1988

Mr. William Bradford, M.S.
Engineering - Science, Incorporated
290 Elwood Davis Road
Liverpool, New York 13088

Re: Groundwater usage in the vicinity of Onondaga Lake

Dear Mr. Bradford:

The purpose of this letter is to respond to your questions regarding groundwater usage in the vicinity of Onondaga Lake. Enclosed is a map outlining a three mile distance around the lake. The pink shaded roads show the areas where people use private wells. Please note that the majority of residences on private wells (approximately 150) are on Hayes Road in the Town of Lysander. This road will receive public water within a year. The other shaded areas contain at the most, a couple of dozen residences. We have no knowledge as to the depths of these wells.

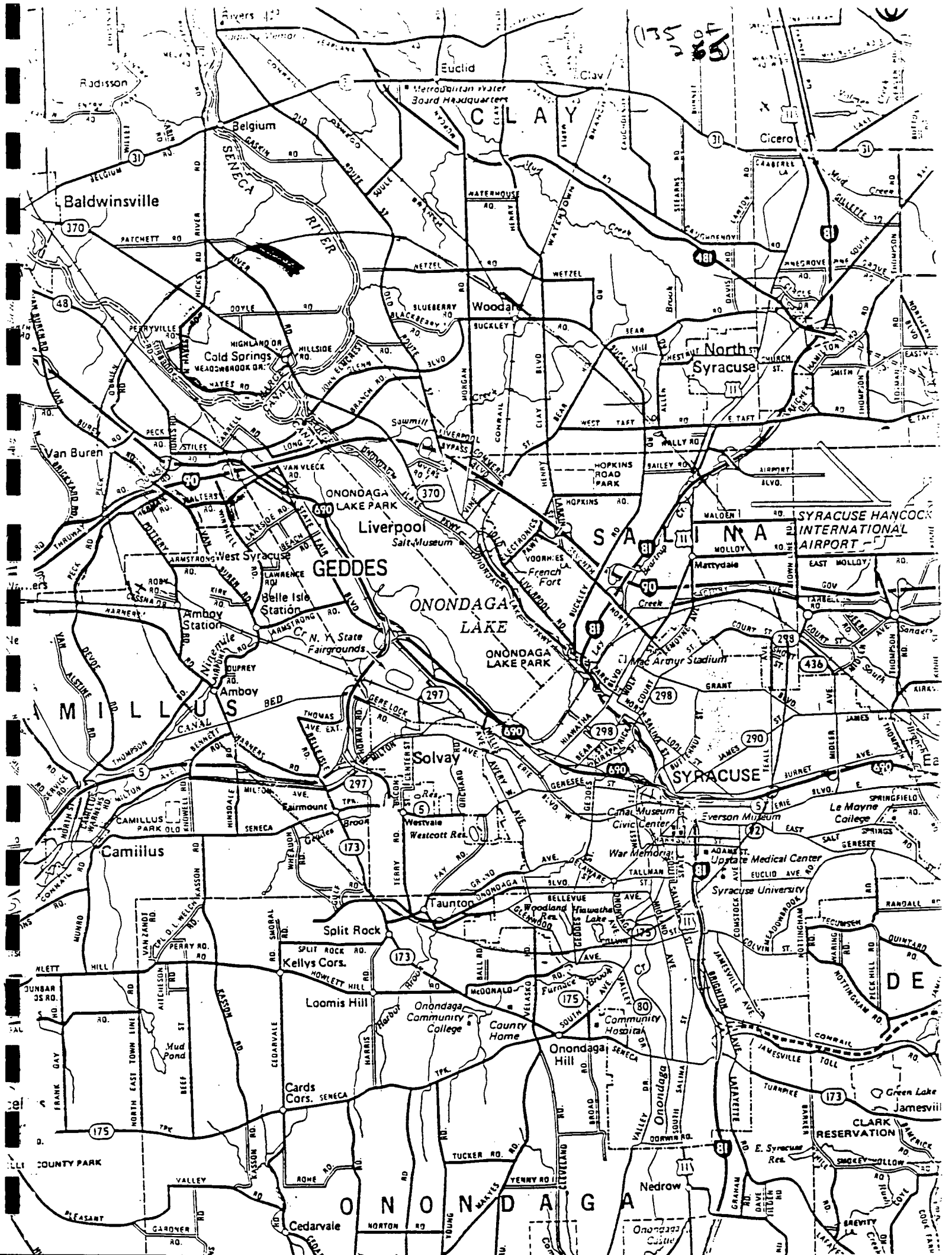
I am currently taking Jeffrey Banikowski's position at the Onondaga County Health Department. If you have any questions on this matter or any other, please do not hesitate to call me at 469-6955.

Very truly yours,

Lisa A. Letteney

Lisa A. Letteney,
Public Health Engineer I
Environmental Risk Assessment

LAL/nc
Enc.



Rivers
Euclid
Clay
Radisson
Metropolitan Water Board Headquarters
CLAY
Belgium
Cicero
Baldwinsville
SENECA RIVER
Woodard
Cold Springs
North Syracuse
Van Buren
ONONDAGA LAKE PARK
Liverpool
Salt Museum
HOPKINS ROAD PARK
SALINA
SYRACUSE HANCOCK INTERNATIONAL AIRPORT
West Syracuse
GEDDES
French Fort
Mattydale
Belle Isle Station
Amboy Station
ONONDAGA LAKE
N. Y. State Fairgrounds
ONONDAGA LAKE PARK
Mac Arthur Stadium
Amboy
MILLUS
Solvay
SYRACUSE
Fairmount
Westvale
Westcott Res.
Canal Museum
Civic Center
Everson Museum
Le Moyne College
CAMILLUS PARK
Camillus
War Memorial
Upstate Medical Center
Syracuse University
Taunton
Woodland Res.
Hiawatha Lake
Split Rock
Kellys Cors.
Loomis Hill
Onondaga Community College
County Home
Community Hospital
Onondaga Hill
Mud Pond
Cards Cors.
Green Lake
Jamesville
CLARK RESERVATION
E. Syracuse Res.
COUNTY PARK
Nedrow
ONONDAGA
Cedarvale
Onondaga Castle

GEOHYDROLOGY OF THE GLACIAL-OUTWASH AQUIFER IN THE BALDWINSVILLE AREA, SENECA RIVER, ONONDAGA COUNTY, NEW YORK

(136 of 265)

By

Timothy S. Pagano, David B. Terry, and Arlynn W. Ingram

WATER-RESOURCES INVESTIGATIONS REPORT 85-4094

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Timothy S. Pagano and D

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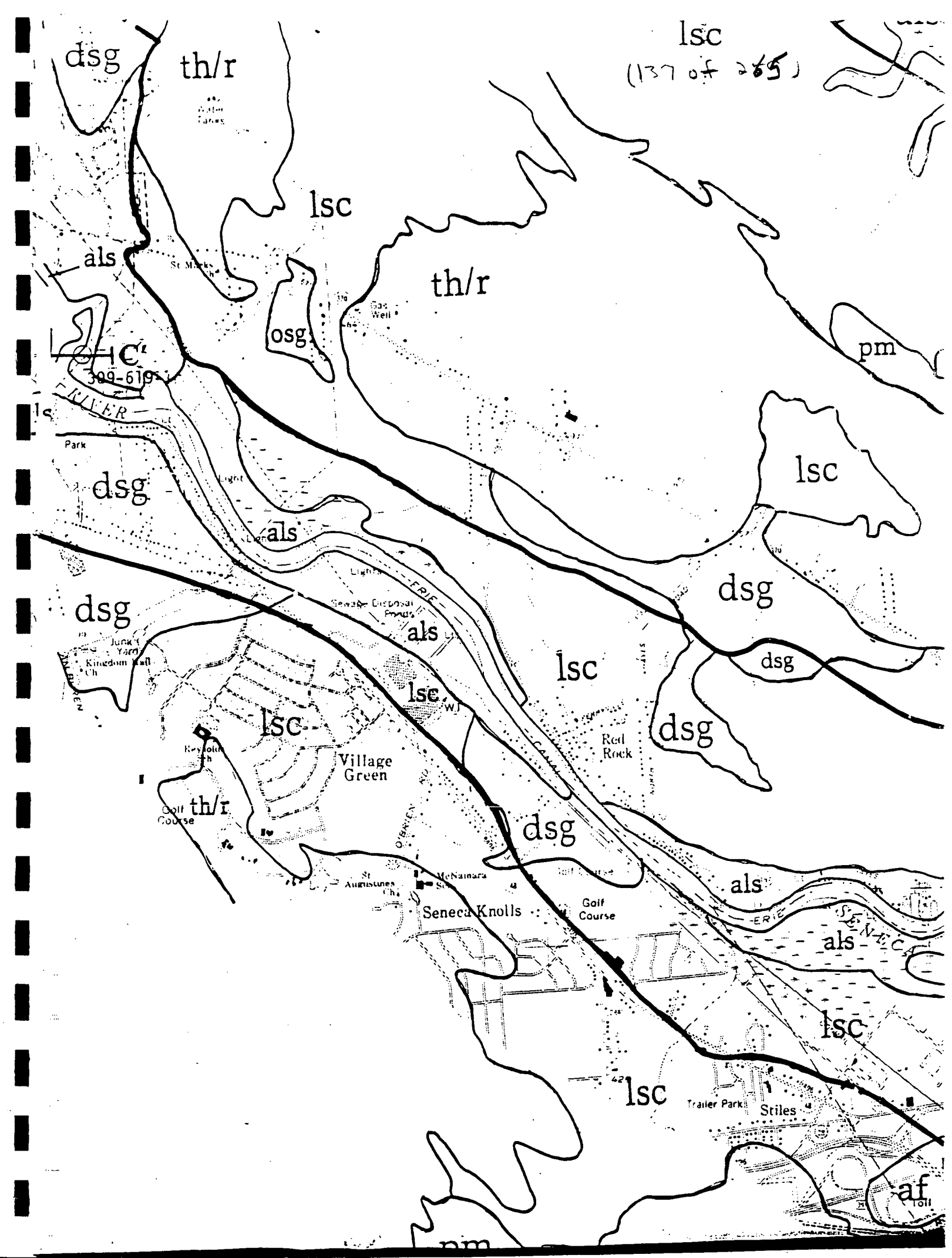
Sheet 6. Well Yield
Timothy S. Pagano and

Sheet 7. Land Use
Arlynn W. Ingram



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Park
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Sewage Disposal Ponds
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lsc
lsc
Village Green
Red Rock
dsg
th/r
Golf Course
dsg
St Augustines Ch
McNamara
Seneca Knolls
Golf Course
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als
lsc
lsc
Trailer Park
Stiles
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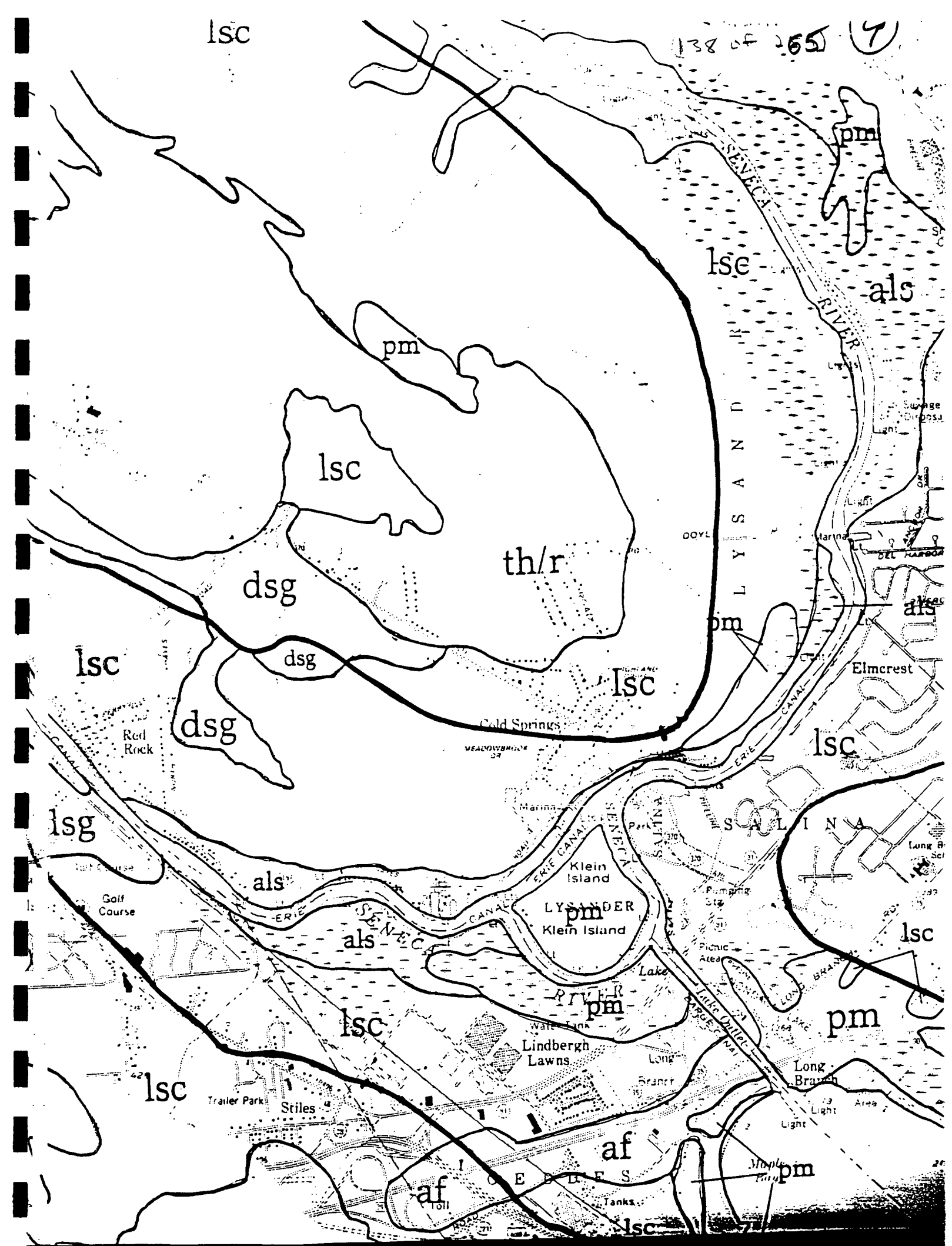
pm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Elmcrest
lsc
Cold Springs
Red Rock
lsg
als
Golf Course
Klein Island
LYSANDER
Klein Island
pm
als
lsc
pm
lsc
Lindbergh Lawns
Long Branch
Trailer Park
Stiles
af
af
pm
lsc
SENECA RIVER
LYSANDER
SALINA
ERIE CANAL
Lake Outlet
Long Branch
Marina
Pumping Sta
Picnic Area
Tanks

(100)

(139 of 265

ES ENGINEERING-SCIENCE
INTERVIEW FORM

Interviewee/Code Russell Nemecek / Water Quality Management Agency

Title-Position ~~Planning Department - Onondaga County Soil Conservation Service~~

Address ~~4876 Onondaga Road~~ 1100 Civic Center 421 Montgomery St

City Syracuse State NY Zip 13202

Phone (315) ~~469-5034~~ 425-2616 Residence Period _____ to _____

Location _____ Interviewer MARK CHAUVIN

Date/Time 11-17-88 /

Subject: IRREGATION WELLS WITHIN 3-MILE RADIUS OF ONONDAGA LAKE.

Remarks: There are no irregation wells or surface-water intakes supplying water for farmland irrigation located within a 3-mile radius of Onondaga Lake.

To the best of my knowledge, this is true. ~~However, we have no precise information~~ ~~Point However there is no precise information~~

I agree with the above summary of the interview: _____

Signature: Russell Nemecek

Comments: _____

ENGINEERING-SCIENCE COMPANIES

(10 b)

MEMORANDUM TO FILE

(140 of 265)

JOB NO. S4012.05

FILE DESIGNATION Onondaga Lake

DATE 7/27/89 TIME 16:55

PHONE CALL FROM Kevin Gilligan PHONE NO. (315) 422-1152

PHONE CALL TO W. Bradford PHONE NO.

CONFERENCE WITH

PLACE

SUBJECT Use of groundwater for irrigation in the vicinity of Onondaga Lake

Mr. Gilligan is an attorney with the firm of Costello, Cooney & Fearon, 100 E. Washington St, Syracuse

Mr. Gilligan informed me that Pope's Grove Golf Course does not use groundwater for irrigation. They installed a well with the intention of using it for this purpose, but found the water was contaminated. As a result they only use public water. Furthermore, the Pope family (owners) has retained this law firm to pursue legal action against Allied (the PRP).

Mr. Gilligan handles environmental affairs for the firm.

SIGNED W. Bradford

ES D. 12 2/8

Form I

W-10

U.S. EPA Contract Laboratory Program
Sample Management Office
P.O. Box 818 - Alexandria, VA 22313
703/557-2490 FTS: 8-557-2490

EPA Sample No.
SH8773403010

Date 12/8/87

INORGANIC ANALYSIS DATA SHEET

LAB NAME RECRA ENVIRONMENTAL, INC. CASE NO. 87-1525

SOW NO. LAB RECEIPT DATE 11/10/87

LAB SAMPLE ID. NO. SH8773403010 (9093) QC REPORT NO. 87-1525QC

Elements Identified and Measured

Concentration: Low _____ Medium _____

Matrix: Water X Soil _____ Sludge _____ Other _____

(ug/L) or mg/kg dry weight (Circle One)

1.	Aluminum	380 *		A	13.	Magnesium	26,200		A
2.	Antimony	5 U	N	F	14.	Manganese	81		A
3.	Arsenic	5 U	N	F	15.	Mercury	0.2 U		CV
4.	Barium	[80]		A	16.	Nickel	20 U		A
5.	Beryllium	5 U		A	17.	Potassium	4,940		A
6.	Cadmium	5 U		A	18.	Selenium	5 U		F
7.	Calcium	145,000		A	19.	Silver	3 U	N	A
8.	Chromium	[6]		A	20.	Sodium	69,000		A
9.	Cobalt	20 U		A	21.	Thallium	5 U	N	F
10.	Copper	[10]		A	22.	Vanadium	30 U		A
11.	Iron	540		A	23.	Zinc	358 *	N	A
12.	Lead	13 *		F	Percent Solids (%)		NR		
Cyanide		10 U							

Footnote: For reporting results to EPA, standard result qualifiers are used as defined on Cover Page. Additional flags or footnotes explaining results are encouraged. Definition of such flags must be explicit and contained on Cover Page, however.

Comments: CV - cold vapor

Lab Manager _____

Form I

(142 of 265) W-11

120 (11)

U.S. EPA Contract Laboratory Program
Sample Management Office
P.O. Box 818 - Alexandria, VA 22313
703/557-2490 FTS: 8-557-2490

EPA Sample No.
SH8773403011

Date 12/8/87

INORGANIC ANALYSIS DATA SHEET

LAB NAME RECRA ENVIRONMENTAL, INC.

CASE NO. 87-1525

SOW NO.

LAB RECEIPT DATE 11/10/87

LAB SAMPLE ID. NO. SH8773403011 (9094)

QC REPORT NO. 87-1525QC

Elements Identified and Measured

Concentration: Low _____ Medium _____

Matrix: Water X Soil _____ Sludge _____ Other _____

ug/L or mg/kg dry weight (Circle One)

1.	Aluminum	340 *		A	13.	Magnesium	23,300		A
2.	Antimony	5 U	N	F	14.	Manganese	139		A
3.	Arsenic	5 U	N	F	15.	Mercury	0.2 U		CV
4.	Barium	[90]		A	16.	Nickel	20 U		A
5.	Beryllium	5 U		A	17.	Potassium	5,760		A
6.	Cadmium	5 U		A	18.	Selenium	5 U		F
7.	Calcium	78,000		A	19.	Silver	3 U	N	A
8.	Chromium	5 U		A	20.	Sodium	110,000		A
9.	Cobalt	20 U		A	21.	Thallium	5 U	N	F
10.	Copper	[8]		A	22.	Vanadium	30 U		A
11.	Iron	650		A	23.	Zinc	29 *	N	A
12.	Lead	7.0 *		F	Percent Solids (%)		NR		
Cyanide		10 U							

Footnote: For reporting results to EPA, standard result qualifiers are used as defined on Cover Page. Additional flags or footnotes explaining results are encouraged. Definition of such flags must be explicit and contained on Cover Page, however.

Comments: CV - cold vapor

Lab Manager _____

IFB Amend. One

(143 of 265) 61 (11)
W-2

Form I

U.S. EPA Contract Laboratory Program
Sample Management Office
P.O. Box 818 - Alexandria, VA 22313
703/557-2490 FTS: 8-557-2490

EPA Sample No.
SH877340300 21

Date _____

INORGANIC ANALYSIS DATA SHEET

LAB NAME Recra Environmental Inc

CASE NO. 87-1234A

SOW NO. _____

Lab Receipt Date 9/23/87

LAB SAMPLE ID. NO. SH877340300 21 (8371)

QC REPORT NO. 87-1234AQC

Elements Identified and Measured

Concentration: Low _____ Medium _____

Matrix: Water ✓ Soil _____ Sludge _____ Other _____

ug/L or mg/kg dry weight (Circle One)

1.	Aluminum	260		A	13.	Magnesium	28,100		A
2.	Antimony	5u	N	F	14.	Manganese	44		A
3.	Arsenic	5u	N	F	15.	Mercury	0.5		CV[1]
4.	Barium	[80]		A	16.	Nickel	[20]		A
5.	Beryllium	2u		A	17.	Potassium	11,800		A
6.	Cadmium	5u		A	18.	Selenium	5u	N	F
7.	Calcium	202,000		A	19.	Silver	3u	N	A
8.	Chromium	5u		A	20.	Sodium	290,000		A
9.	Cobalt	30u		A	21.	Thallium	5u	N	F
10.	Copper	42		A	22.	Vanadium	5u		A
11.	Iron	[90]		A	23.	Zinc	[7]	N	A
12.	Lead	5u		F		Precent Solids (%)	NA		
	Cyanide	10u							

Footnotes: For reporting results to EPA, standard result qualifiers are used as defined on Cover Page. Additional flags or footnotes explaining results are encouraged. Definition of such flags must be explicit and contained on Cover Page, however.

Comments: [1] CV = cold vapor technique

Lab Manager _____

(144 of 365)

(11)

62

Form I

W-2

U.S. EPA Contract Laboratory Program
Sample Management Office
P.O. Box 818 - Alexandria, VA 22313
703/557-2490 FTS: 8-557-2490

EPA Sample No.
SH87734030022

Date _____

INORGANIC ANALYSIS DATA SHEET

LAB NAME Recra Environmental Inc

CASE NO. 87-1234A

SOW NO. _____

Lab Receipt Date 9/23/87

LAB SAMPLE ID. NO. SH87734030022 (8369)

QC REPORT NO. 87-1234AQC

Elements Identified and Measured

Concentration: Low _____ Medium _____

Matrix: Water ✓ Soil _____ Sludge _____ Other _____

ug/L or mg/kg dry weight (Circle One)

1.	Aluminum	340		A	13.	Magnesium	27900		A
2.	Antimony	5U	N	F	14.	Manganese	85		A
3.	Arsenic	5U	N	F	15.	Mercury	0.2U		CV
4.	Barium	110		A	16.	Nickel	20U		A
5.	Beryllium	2U		A	17.	Potassium	12300		A
6.	Cadmium	5U		A	18.	Selenium	5U	N	F
7.	Calcium	196,000		A	19.	Silver	3U	N	A
8.	Chromium	5U		A	20.	Sodium	330000		A
9.	Cobalt	30U		A	21.	Thallium	5U	N	F
10.	Copper	[6]		A	22.	Vanadium	50U		A
11.	Iron	[70]		A	23.	Zinc	<5]	N	A
12.	Lead	5U		F		Precent Solids (%)	NR		
	Cyanide	10U							

Footnotes: For reporting results to EPA, standard result qualifiers are used as defined on Cover Page. Additional flags or footnotes explaining results are encouraged. Definition of such flags must be explicit and contained on Cover Page, however.

Comments: CV = cold vapor technique

Lab Manager _____

(145 of 285) (12)

SOIL SURVEY OF

Onondaga County, New York

United States Department of Agriculture
Soil Conservation Service
In cooperation with
Cornell University Agricultural
Experiment Station

(146 of 265) (12)

Limestone cap the thicker Moscow Formations. This nestone layer is too thin and too buried to be of much influence on soil formation except in the immediate vicinity of the outcrops.

Along the southern edge of the county and at the highest elevations are soils common to the northern edge of the Allegheny Plateau. These are the Arnot and Lordstown soils where arenaceous, coarse, blocky shale and bedded, flaggy, olive to dark olive-gray sandstone of the Ithaca Formation are close to the surface. Manlius soils formed where the more fissile shale of the Genesee Formation is close to the surface. Deeper soils in this area, Mardin and Volusia soils, have a fragipan.

Physiography

Onondaga County is situated in the center of upstate New York. Because of its location, it borders on several physiographic regions. The county is divided in half by two major physiographic provinces—the Erie-Ontario Plain to the north and the Allegheny Plateau to the south. The demarcation line separating these two provinces is an east-west escarpment formed by the Onondaga Limestone.

The northern half of Onondaga County is typified by the Erie-Ontario Plain. West of a line from Syracuse through Baldwinsville and Little Utica are low-lying till plains, drumlins, several outwash plains, and numerous small areas of lacustrine origin. Relief in this area ranges from 380 feet to 425 feet above sea level in the lacustrine deposits and from 425 feet to 00 feet on the till plains to the highest drumlins and hills. All of the hills, and particularly the well-formed drumlins, show molding both in form and direction by the force of the glacier that overran the county.

To the east is the largest part of the Erie-Ontario Plain within the county. It has typical lake-plain topography. Elevations range from 370 feet near Onondaga Lake and Oneida Lake to more than 450 feet on the low hills or ridges of glacial till scattered throughout the plain. Some of these hills barely extended above the surface of glacial Lake Iroquois when it occupied this part of the county. In this area are several shallow basins and low spots in the glacial lake bottom that developed muck accumulations. The largest is Cicero Swamp, which is about 5 square miles in area. Except for the low-lying, islandlike hills, the muck areas, and some small sand and gravel deposits, most of the soil materials in this part of the county are lacustrine silts and clays.

The southern half of the county, beginning at the limestone escarpment, is typical of the northernmost extension of the Allegheny Plateau. Elevations rise abruptly several hundred feet at the escarpment south of Syracuse. Elevation increases to the south, ranging from 600 feet at the northern edge to 1,600 feet, except near the Cortland County line where hilltops range from 1,600 feet to more than 2,000 feet. The highest point, 2½ miles south of Fabius, is 2,060 feet above sea level. The southern half of the county has rolling till uplands between deep, U-shaped, steep-sided valleys that extend through the plateau to the south.

In a broad band of lower elevations south of the Escarpment, the soils are similar to those in the Finger Lakes Section in Cayuga and Seneca Counties. In Onondaga County, slopes are steeper and more rolling with fewer nearly level or more gently sloping areas than they are to the west in Cayuga and Seneca Counties.

The hilly area, 3 to 5 miles wide north of the Cortland County line, is more typical of the Allegheny Plateau. Valleys in this area broaden or merge with the valleys from the north. They have steep and very steep valley sides that are often rocky. Valley floors are at elevations of 1,300 feet and are higher than the northern part of the plateau south of the escarpment.

Drainage

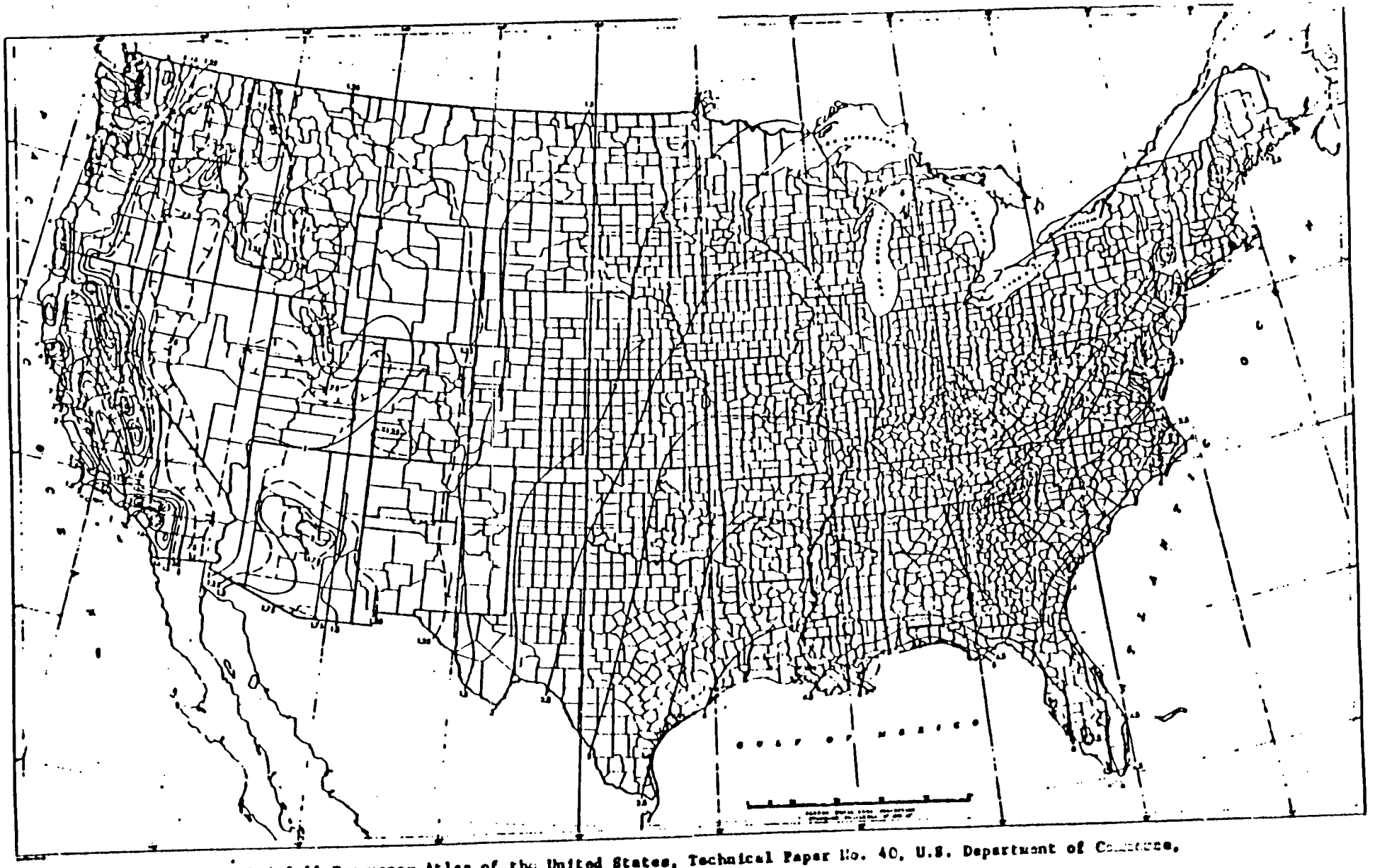
All of the drainage from Onondaga County eventually flows into Lake Ontario, except for five small watersheds near the southern edge of the county that drain south to the Susquehanna River. These are Cold Brook near the southwestern edge of the county; the west branch of Tioughnioga River near Tully; Labrador Creek south of Apulia; Fabius Creek south of Fabius; and the west branch of Tioughnioga Creek.

Much of the southwestern part of the county drains into Skeaneateles or Otisco Lakes. Skaneateles Creek flows north from Skaneateles Lake to the Seneca River, and Nine Mile Creek flows from Otisco Lake into Onondaga Lake, which outlets into the Seneca River. The central part of the county drains into Onondaga Creek which also flows north into Onondaga Lake. East of the Onondaga drainage area to the Madison County line, drainage is into Butternut and Limestone Creeks. They flow to the north. Butternut Creek joins Limestone Creek about 1½ miles north of Minoa. Limestone Creek joins Chittenango Creek immediately north of North Manlius. Chittenango Creek, which is the northeastern boundary of Onondaga County, drains a narrow area along the creek, including the east end of Cicero Swamp, and then flows into Oneida Lake. The Oneida River is the outlet for Oneida Lake. It flows westerly and forms part of the northern boundary of the county.

A few minor streams in the northern part of the county drain directly into Oneida Lake or the Seneca, Oneida, and Oswego Rivers. The Oswego River begins at the junction of the Oneida and the Seneca Rivers at Three Rivers and flows north into Lake Ontario. Mud Creek, which drains Peat Swamp and the western half of Cicero Swamp, is a slow, sluggish stream which flows into the Oneida River at Oak Orchard. Ox Creek drains the northwestern part of the county around Beaver Lake and flows north through Oswego County into the Oswego River. Carpenters Brook, White Bottom Creek, and Dead Creek are the major streams that flow directly into the Seneca River. These streams come from springs in the Onondaga Limestone and the Camillus Shale, and have white marl streambeds.

Vegetation

Prior to settlement, Onondaga County, with the exception of a few fresh water marshes, was heavily forested with mixed hardwoods and conifers. Beech,



Source: Rainfall Frequency Atlas of the United States, Technical Paper No. 40, U.S. Department of Commerce, U.S. Government Printing Office, Washington, D.C., 1963.

FIGURE 8
1-YEAR 24-HOUR RAINFALL
(INCHES)

00-17-1 (5/76)
Formerly GA-4

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

TRANSMITTAL SLIP

TO Liz Dobson

FROM Jean Cotterill

DATE 7/1/87

RE: Freshwater Wetlands - City of Fulton - Onondaga Lake

Enclosed are copies of wetland maps with all wetlands highlighted in blue. I may have gotten carried away, but I wasn't sure at what point to stop. Also enclosed is a copy of the scale.

FOR ACTION AS INDICATED:

- ☐ Please Handle
- ☐ Prepare Reply
- ☐ Prepare Reply for _____ Signature
- ☐ Information
- ☐ Approval
- ☐ Prepare final/draft in _____ Copies
- ☐ Comments
- ☐ Signature
- ☐ File
- ☐ Return to me
- ☐ _____
- ☐ _____

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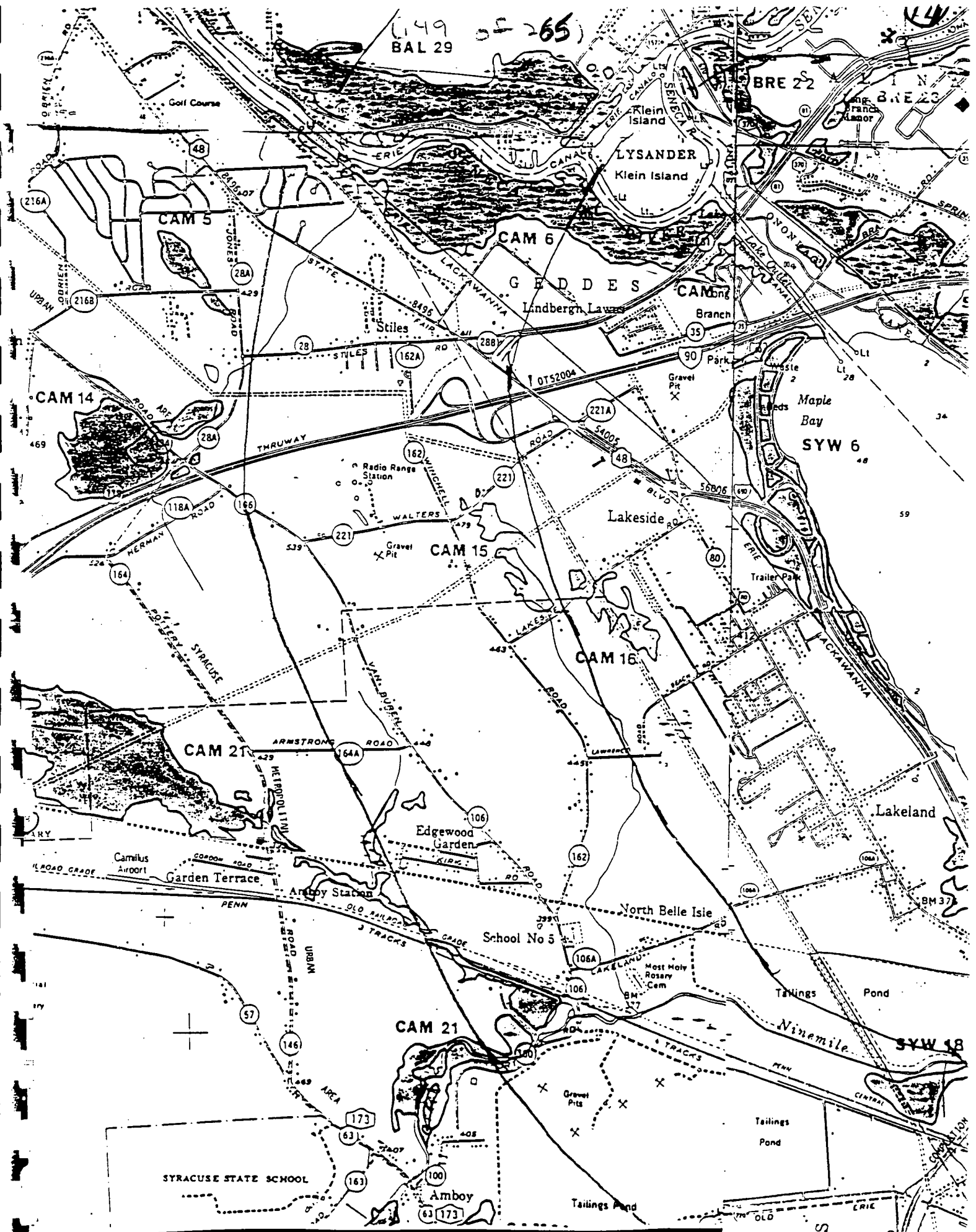
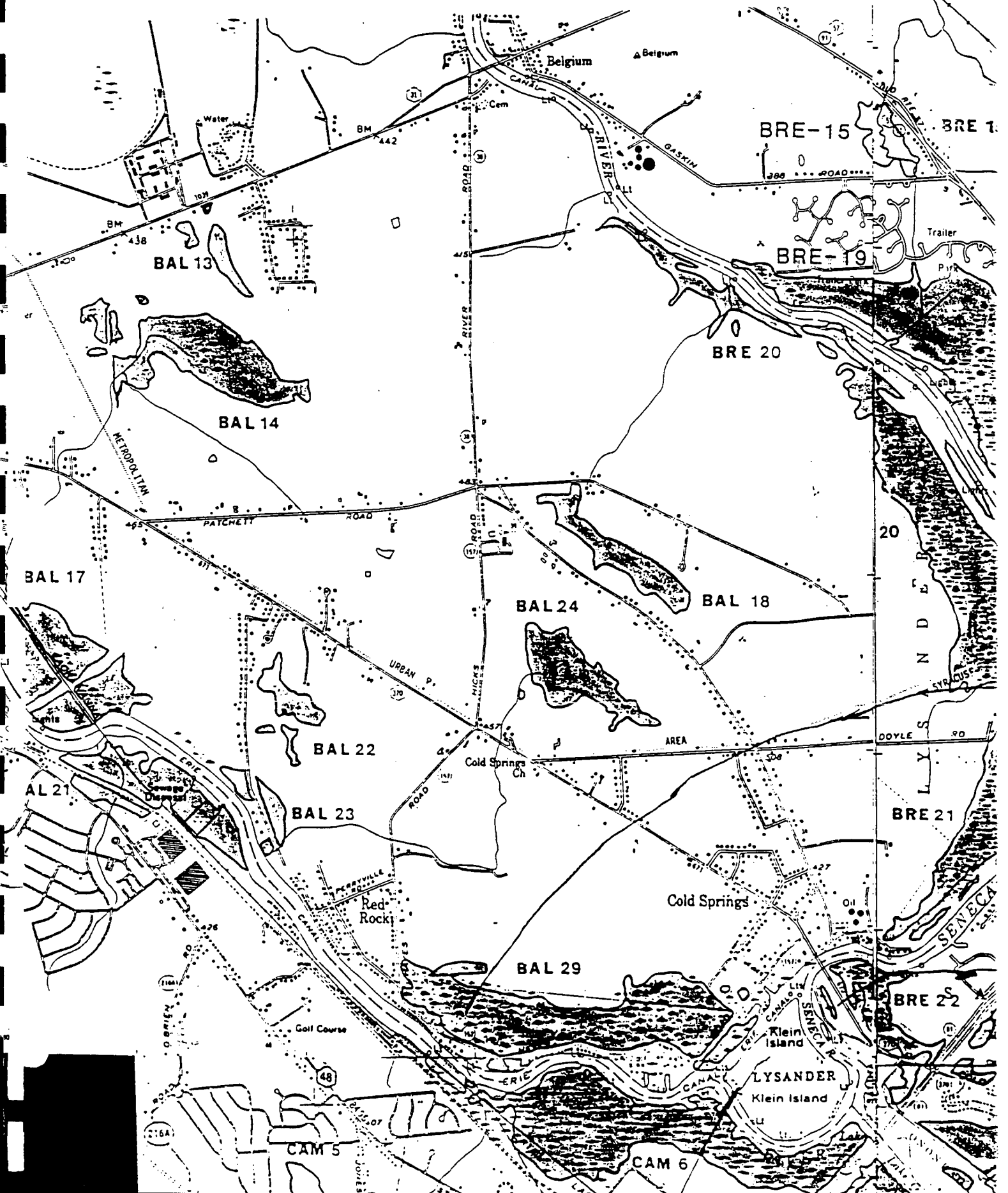
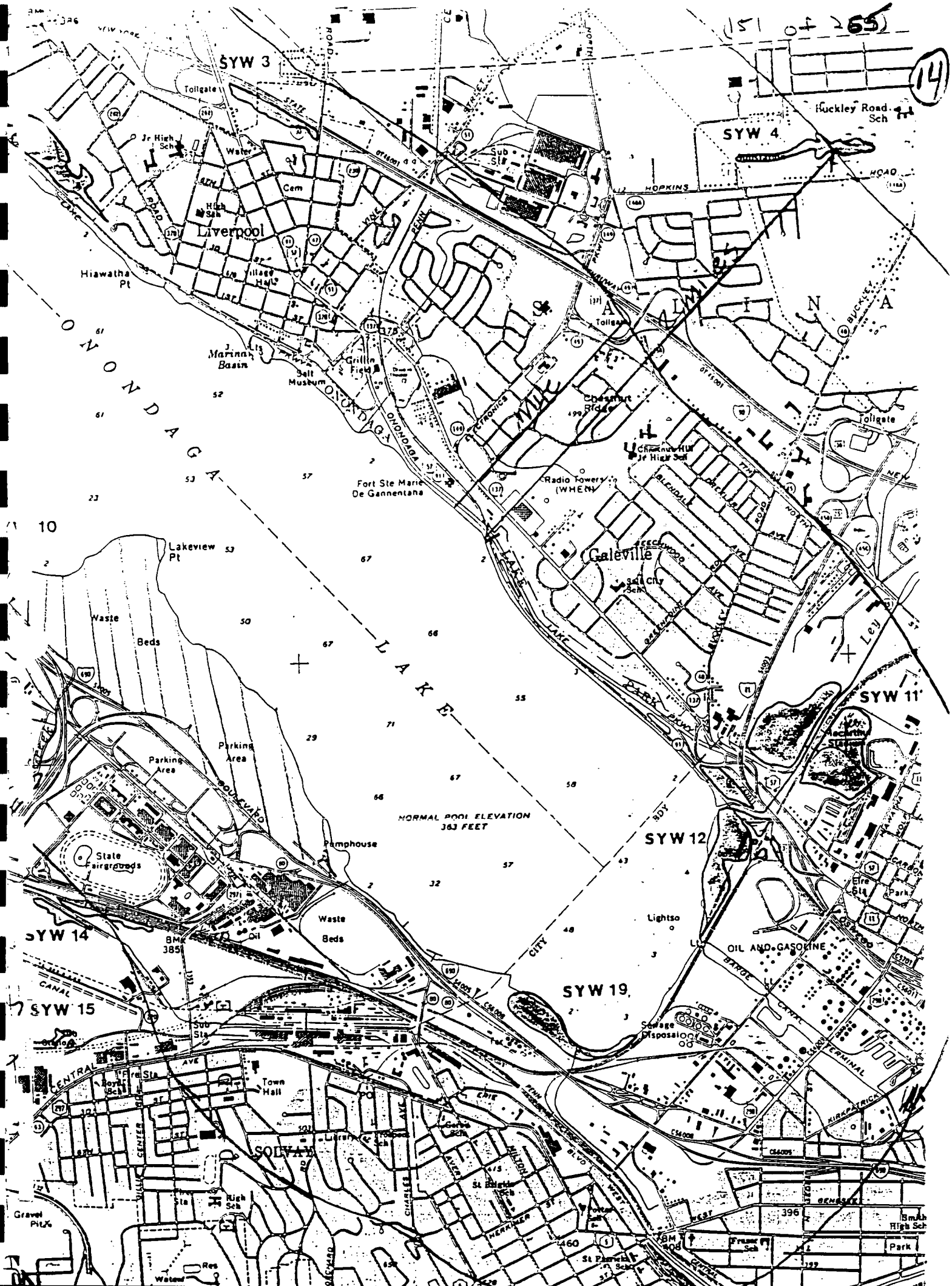
(14)

(149 of 265)



[redacted]


Belgium
Belgium
Cem
Water
BM 442
BM 438
BRE-15
BRE 1
GASKIN ROAD
RIVER
Trailer
BRE-19
BAL 13
BRE 20
BAL 14
METROPOLITAN
PATCHETT ROAD
20
BAL 17
BAL 24
BAL 18
URBAN
HICKS ROAD
SYRACUSE
AREA
DOYLE RD
BAL 22
Cold Springs Ch
AL 21
Sewage Disposal
BAL 23
BRE 21
PERRYVILLE RD
Red Rock
Cold Springs
Oil
SENECA
BAL 29
BRE 22
Golf Course
Klein Island
LYSANDER
Klein Island
CAM 5
CAM 6



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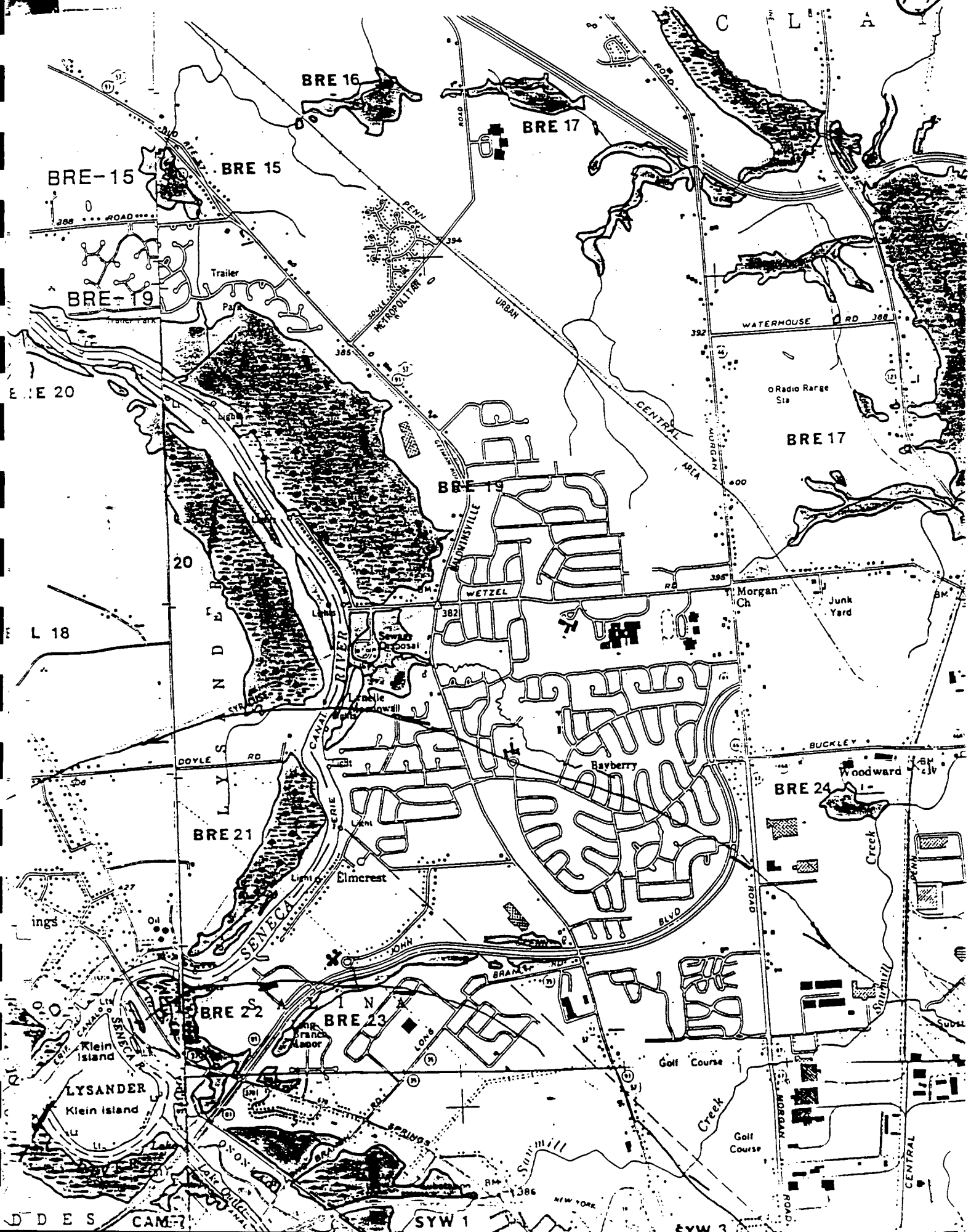
14
SYW 3
SYW 4
SYW 11
SYW 12
SYW 14
SYW 15
SYW 19
Tollgate
Jr High Sch
Water
Cem
High Sch
Liverpool
Village Hall
Hiawatha Pt
Marina Basin
Salt Museum
Grillin Field
ONONDAGA LAKE
Fort Ste Marie De Gannentaha
Chestnut Ridge
Chestnut Hill Jr High Sch
Radio Towers (WHEN)
Galeville
Salt City Sch
Buckley Road Sch
HOPKINS ROAD
Lakeview Pt
Waste Beds
Parking Area
State Fairgrounds
Pumphouse
NORMAL POOL ELEVATION 363 FEET
Lightso
OIL AND GASOLINE
Sewage Disposal
Town Hall
SOLVAY
Gravel Pit
Smith High Sch
Park

(152 of 265)

14



C L A Y
BRE 16
BRE 17
BRE-15
BRE 15
BRE-19
Trailer
Park
PENN
URBAN
CENTRAL
AREA
METROPOLITAN
WATERHOUSE RD
Radio Range Sta
BRE 17
BRE 19
BALDWINSVILLE
WETZEL RD
Morgan Ch
Junk Yard
20
L 18
Sewage Disposal
RIVER
CANAL
ERIE
DOYLE RD
BUCKLEY
Bayberry
Woodward
BRE 24
BRE 21
Elmcrest
SENECA
JOHN BLVD
BRANCH RD
BRE 22
BRE 23
Long Branch Manor
Klein Island
LYSANDER
Klein Island
Golf Course
Golf Course
Creek
Sawmill
SPRINGS
NEW YORK
CAM 7
SYW 1
SYW 3

(15)

INTERVIEW FORM

INTERVIEWEE/CODE John W. Ozard /

TITLE - POSITION Senior Wildlife Biologist

ADDRESS WRC New York State DEC

CITY Delmar STATE NY ZIP 12054

PHONE (518) 439-7488 RESIDENCE PERIOD _____ TO _____

LOCATION phone conversation INTERVIEWER W. Bradford

DATE/TIME 4/14/88 / 11:00 AM

SUBJECT: Critical habitats in New York state.

REMARKS: There are no federally designated critical habitats of endangered species located within New York state.

I AGREE WITH THE ABOVE SUMMARY OF THE INTERVIEW: John W. Ozard

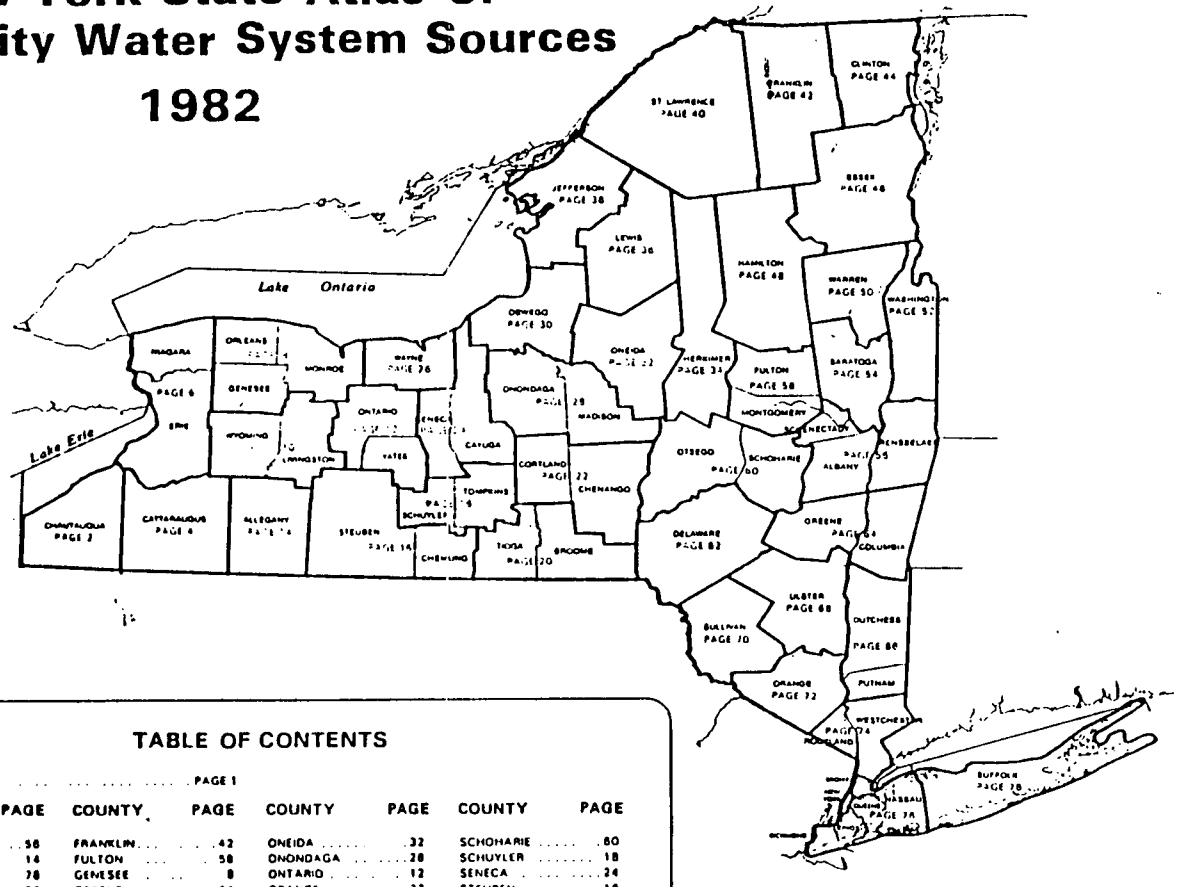
SIGNATURE: JOHN W. OZARD

COMMENTS:

New York State Atlas of Community Water System Sources

1982

NEW YORK STATE
DEPARTMENT OF HEALTH



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COUNTY	PAGE	COUNTY	PAGE	COUNTY	PAGE	COUNTY	PAGE
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BRONX	78	GENESEE	8	ONTARIO	12	SENECA	24
BROOME	20	GREENE	64	ORANGE	72	STEUBEN	16
CATTARAUGUS	4	HAMILTON	48	ORLEANS	8	SUFFOLK	78
CAYUGA	24	HERKIMER	34	OSWEGO	30	SULLIVAN	70
CHAUTAUQUA	2	JEFFERSON	38	OTSEGO	60	TIOGA	20
CHEMUNG	16	KINGS	76	PUTNAM	66	TOMPKINS	18
CHENANGO	22	LEWIS	36	QUEENS	76	ULSTER	68
CLINTON	44	LIVINGSTON	10	RENSSELAER	56	WARREN	50
COLUMBIA	64	MADISON	28	RICHMOND	76	WASHINGTON	52
CORTLAND	22	MONROE	8	ROCKLAND	74	WAYNE	26
DELAWARE	82	MONTGOMERY	58	ST LAWRENCE	40	WESTCHESTER	74
DUTCHESS	66	NASSAU	76	SARATOGA	54	WYOMING	10
ERIE	6	NEW YORK	76	SCHENECTADY	58	YATES	12
ESSEX	46	NIAGARA	6				

LEGEND

BOUNDARIES AND PLACES

International
State
County
Town
Indian Reservation
City
Village
Unincorporated Place
Federal Reservation
Built-up Area (Over 25 000 population including any contiguous city or village)

CLASSIFICATION OF POPULATED PLACES

100 000 or more — YONKERS
50,000 to 100 000 — Levittown
12,500 to 50 000 — Poughkeepsie
2,500 to 12 500 — Hampton
250 to 2 500 — Rensselaerville
250 or less

TRANSPORTATION

Highways
- Divided Highways
  - Full Control of Access
  - Partial or No Control of Access
- Undivided Highway
- Interchange
- Touring Route (State U S Interstate) or State Parkway
- Touring Route Markers
  - State U S Interstate

Railroads
- Operating Line
- Service Discontinued
- Operator
- Owner (If Other than Operator)
- Company Having Trackage Rights

Airports (Open to the Public, Military)
- Runway under 4000'
- Runway over 4000'

Rest Areas
- Food, Gas Rest Rooms
- Gas, Rest Rooms
- Rest Rooms
- Parking Only

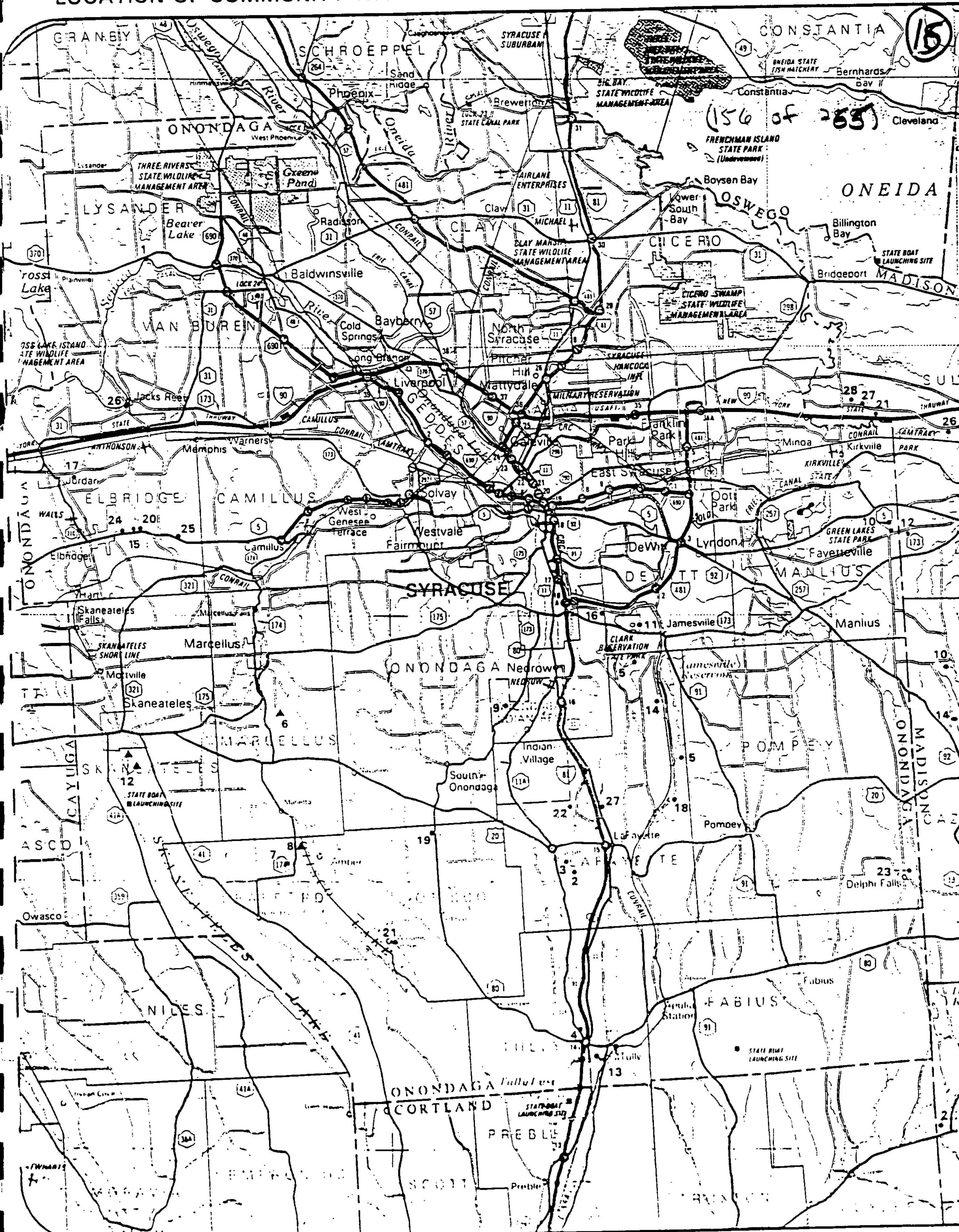
RECREATION FACILITIES

- State or National Recreation Area
- State Campground
- State Boat Launching Site
- State Canal Park
- State Fish Hatchery
- Other State Recreation Site

..DAGA COUNTY

.OMMUNITY WATER SYSTEM	POPULATION	SOURCE
Community		
B: ·insville Village.	6500. . .	.Wells
ff, Haynes Spring.	.35. . .	.Wells (Spring)
·diff, Tooke Spring.	.100. . .	.Wells (Spring)
st Side Spring.	.52. . .	.Wells (Springs)
East Syracuse Village.	3900. . .	.Wells, East Syracuse Reservoir (Springs)
Marcellus Village.	1870. . .	.Rockwell Spring
·-tropolitan Water Board (See No 5 Oswego Co, Page 30).	NA	
untain Glen Water Company Inc.. . .	250. . .	.Wells (Spring)
Onondaga County Water Authority. .	130000. . .	.Otisco Lake
Onondaga Indian Reservation.	.750. . .	.Wells (Springs)
yridge Community Inc.	.50. . .	.Wells
uthwood Jamesville Water District. .	NA. . .	.Wells
racuse City.	170105. . .	.Skaneateles Lake
Tully Village.	1065. . .	.Wells
cipal Community		
..ack's Breezy Acres.	.54. . .	.Wells
Champion Home Communities.	.288. . .	.Wells
Cliffside Mobile Homes.	270. . .	.Wells
'gewood Trailer Park.	36. . .	.Wells
een Valley Mobile Manor.	.129. . .	.Wells
Lords Hill Apartments.	.126. . .	.Wells
Mobile Manor Mobile Home Park.	66. . .	.Wells
Otisco Lake Drive-Inn & Trailer Park.	.15. . .	.Wells
irc Du Bois.	120. . .	.Wells
'easant Valley Mobile Court.	222. . .	.Wells
Rolling Wheels.	300. . .	.Wells
Smith Trailer Park.	.60. . .	.Wells
'illiams Trailer Park.	36. . .	.Wells
illowwood Apartments.	.128. . .	.Wells

LOCATION OF COMMUNITY WATER SYSTEM SOURCES-1982



SCALE 1

US CENSUS DATA, 1980

US Census Data used in the HRS scoring was obtained from various County Planning Offices. This data was not obtained from a report. The raw census data combined with County Planning Maps was used to estimate the population within 1, 2, 3, and 4 miles of the Phase II site being investigated. Because of the voluminous amount of data used, the data is not provided in this Appendix.

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(13)

United States
Department of
Agriculture

Soil
Conservation
Service

4876 Onondaga Road
Syracuse, NY 13215
Phone 315/469-5034

November 22, 1988

Engineering-Science, Inc.
William Bradford, M.S.
290 Elwood Davis Road
Liverpool, NY 13088

Mr. Bradford,

Enclosed are soil maps with information on farmland near Onondaga Lake as you requested.

There was only one area where there is agricultural land in production within the past five years within one mile of the Lake. It is on map #21 and is also prime farmland.

Additionally there are numerous areas of prime farmland soils in production within the past five years that all between one and two miles from the Lake. All prime farmland is shaded in red.

If you should have any questions on this information please call me at 469-5034.

Paul Webb

Paul Webb
District Conservationist
Syracuse Field Office

W/f

enc.

(159 of 265) (19)

ONAL REGISTER OF HISTORIC PLACES

ANNUAL LISTING OF PROPERTIES

UARY 1979 THROUGH DECEMBER 1982

U.S. DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

JULY 1983

(160 of 265) (2)

federal register

Tuesday
March 1, 1983

Part III

Department of the Interior

National Park Service

National Registry of Natural Landmarks

(161 of 265)

Dangerous Properties of Industrial Materials

Sixth Edition

N. IRVING SAX

Assisted by:

Benjamin Feiner/Joseph J. Fitzgerald/Thomas J. Haley/Elizabeth K. Weisburger

VAN NOSTRAND REINHOLD COMPANY
New York

Clear colorless liquid. mp: 5.51°, bp: 80.093°-80.094°, flash p: 12°F (CC), d: 0.8794 @ 20°, autoign. temp.: 1044°F, lel: 1.4%, uel: 8.0%, vap. press: 100 mm @ 26.1°, vap. d: 2.77, ulc: 95-100.

SYNS:

(6)ANNULENE
BENZEEN (DUTCH)
BENZEN (POLISH)
BENZOL
BENZOLENE
BENZOLO (ITALIAN)
BICARBURET OF HYDROGEN
CARBON OIL
COAL NAPHTHA
CYCLOHEXATRIENE
FENZEN (CZECH)
MINERAL NAPHTHA
MOTOR BENZOL
NCI-C55276
PHENYL HYDRIDE
PYROBENZOLE

TOXICITY DATA: 3

	CODEN:
skn-rbt 15 mg/24H open MLD	AIHAAP 23,95,62
eye-rbt 88 mg MOD	AMIHAB 14,387,56
eye-rbt 2 mg/24H SEV	28ZPAK -,23,72
cyt-rat-scu 12 gm/kg/12D-I	GTPZAB 17(3),24,73
mnt-mus-ipr 500 uL/kg	ENMUDM 2,43,80
cyt-mus-orl 100 uL/kg	ENMUDM 2,43,80
cyt-mus-ipr 100 uL/kg	ENMUDM 2,43,80
dlt-mus-ipr 5 mg/kg	TPKVAL 15,30,79
cyt-rbt-scu 8400 mg/kg	PSDTAP 15,275,74
scu-mus TDLo:2700 mg/kg/(13D preg):TER	AMBNAS 17,285,70
ihl-hmn TCLo:100 ppm/10Y-I:CAR	TRBMAV 37,153,78
orl-rat TDLo:52 gm/kg/52W-I:CAR	MELAAD 70,352,79
skn-mus TDLo:1200 gm/kg/49W-I:NEO	BJCAAI 16,275,62
scu-mus TDLo:600 mg/kg/17W-I:ETA	KRANAW 9,403,32
par-mus TDLo:670 mg/kg/19W-I:ETA	KLWOAZ 12,109,33
ihl-hmn TC:400 ppm/8Y-I:ETA	BLOOAW 52,285,78
ihl-man TC:2100 mg/m3/4Y-I:CAR	NEJMAG 271,872,64
orl-rat TD:10 gm/kg/52W-I:CAR	MELAAD 70,352,79
orl-hmn TDLo:130 mg/kg:CNS	AHYGAJ 31,336,1897
ihl-hmn LCLo:20000 ppm/5M	29ZUA8 -,-,53
ihl-hmn TCLo:210 ppm:BLD	27ZXA3 -,341,63
ihl-rat TCLo:670 mg/m3/24H (15D pre/1-22D preg)	HYSAAV 33,327,68
ihl-rat TCLo:56600 ug/m3/24H (1-22D preg)	HYSAAV 33,112,68
ihl-rat TCLO:50 ppm/24H (7-14D preg)	JHEMA2 24,363,80
ihl-rat TCLO:150 ppm/24H (7-14D preg)	JHEMA2 24,363,80
scu-mus TDLo:1100 mg/kg (12D preg)	TOXID9 1,125,81
scu-mus TDLo:2700 mg/kg/(13D preg) TFX:TER	AMBNAS 17,285,70
orl-mus TDLo:9 gm/kg (6-15D preg)	TJADAB 19,41A,79
orl-mus TDLo:12 gm/kg (6-15D preg)	TJADAB 19,41A,79
orl-rat TD:10 gm/kg/52W-I TFX:CAR	MELAAD 70,352,79
ihl-hmn TCLo:100 ppm:CNS	INMEAF 17,199,48
unk-man LDLo:194 mg/kg	85DCAI 2,73,70
orl-rat LD50:3800 mg/kg	TXAPA9 19,699,71
ihl-rat LC50:10000 ppm/7H	28ZRAQ -,113,60
ipr-rat LDLo:1150 mg/kg	TXAPA9 1,156,59
orl-mus LD50:4700 mg/kg	HYSAAV 32,349,67
ihl-mus LC50:9980 ppm	JIHTAB 25,366,43
ipr-mus LD50:990 ug/kg	AGGHAR 18,109,60
orl-dog LDLo:2000 mg/kg	HBAMAK 4,1313,35
ihl-dog LCLo:146000 mg/m3	HBTXAC 1,324,56
ihl-cat LCLo:170000 mg/m3	HBTXAC 1,324,56
ivn-rbt LDLo:88 mg/kg	JTEHD6 -(Suppl.2),45,77
ipr-gpg LDLo:527 mg/kg	HBTXAC 1,42,56
scu-frg LDLo:1400 mg/kg	HBAMAK 4,1313,35
ihl-mam LCLo:20000 ppm/5M	AEPPAE 138,65,28

Aquatic Toxicity Rating: TLm96:100-10 ppm WQCHM* 2,-,74. Carcinogenic Determination: Human Suspected IARC** 7,203,74.

TLV: Air: 10 ppm DTLVS* 4,37,80. *Toxicology Review:* ARPAAQ 11,434,31; EVHPAZ 11,163,75; AEHLAU 22,373,71; PAREAQ 4,1,52; FNSCA6 2,67,73; MUREAV 47(2),75,78; AMSVAZ 118,354,44; ZHPMAT 166,113,78; JTEHD6 -(suppl.2),69,77; PHRPA6 41,1357,26; CTOXAO 11,531,77; BNYMAM 54, 413,78; KRANAW 9,403,32; 27ZTAP 3,22,69. OSHA Standard: Air: TWA 10 ppm; CL 25 ppm; Pk 50 ppm/10M/8H (SCP-U) FEREAC 39,23540,74. DOT: Flammable Liquid, Label: Flammable Liquid FEREAC 41,57018,76. Occupational Exposure to Benzene recm std: Air: CL 10 ppm/60M NTIS**. Currently Tested by NTP for Carcinogenesis by Standard Bioassay Protocol as of December 1980. "NIOSH Manual of Analytical Methods" VOL 1 127, VOL 3 S311. Reported in EPA TSCA Inventory, 1980. EPA TSCA 8E NO:12770027-Followup Sent as of April, 1979.

THR: Poisoning occurs most commonly through inhal of the vapor, though benzene can penetrate the skin, and poison in that way. Locally, benzene has a comparatively strong irr effect, producing erythema and burning, and, in more severe cases, edema and even blistering. Exposure to high conc of the vapor (3000 ppm or higher) may result from failure of equipment or spillage. Such exposure, while rare in industry, may result in acute poisoning, characterized by the narcotic action of benzene on the CNS. The anesthetic action of benzene is similar to that of other anesthetic gases, consisting of a preliminary stage of excitation followed by depression and, if exposure is continued, death through respiratory failure. The chronic, rather than the acute form, of benzene poisoning is important in industry. It is a recog leukemogen. There is no specific blood picture occurring in cases of chronic benzol poisoning. The bone marrow may be hypoplastic, normal, or hyperplastic, the changes reflected in the peripheral blood. Anemia, leucopenia, macrocytosis, reticulocytosis, thromocytopenia, high color index, and prolonged bleeding time may be present. Cases of myeloid leukemia have been reported. For the supervision of the worker, repeated blood examinations are necessary, including hemoglobin determinations, white and red cell counts and differential smears. Where a worker shows a progressive drop in either red or white cells, or where the white count remains below 5,000 per cu mm or the red count below 4.0 million per cu mm, on two successive monthly examinations, he should be immediately removed from exposure. Following absorption of benzene, elimination is chiefly through the lungs, when fresh air is breathed. The portion that is absorbed is oxidized, and the oxidation products are combined with sulfuric and glycuronic acids and eliminated in the urine. This may be used as a diagnostic sign. Benzene has a definite cumulative action, and exposure to relatively high conc is not serious from the point of view of causing damage to the blood-forming system, provided the exposure is not repeated. On the other hand,

SYN: MERCURY NUCLEATE, SOLID (DOT)

TOXICITY DATA: 3

DOT: Poison B, Label: Poison FEREAC 41,57018,76. Occupational Exposure to Inorganic Mercury recm std: Air: TWA 0.05 mg(Hg)/m3 NTIS**.

THR: A poison. See also mercury compounds.

Disaster Hazard: When heated to decomp it emits tox fumes of Hg.

MERCUROPHEN

CAS RN: 17140737 NIOSH #: OW 4550000

mf: $C_6H_4HgNO_4 \cdot Na$; mw: 377.70

Brick-red odorless powder. Sol in hot H_2O.

TOXICITY DATA: 3	CODEN:
ivn-rat LDLo:8 mg/kg	12VXA5 8,661,68
ims-rat LDLo:12 mg/kg	12VXA5 8,661,68
ivn-rbt LDLo:4 mg/kg	12VXA5 8,661,68

Occupational Exposure to Inorganic Mercury recm std: Air: TWA 0.05 mg(Hg)/m3 NTIS**.

THR: HIGH ivn, ims. See also mercury compounds. Poison.

Disaster Hazard: When heated to decomp it emits very tox fumes of NO_x and Hg vapors.

MERCUROPHYLLINE

CAS RN: 8012348 NIOSH #: OV 8650000

SYNS:

MERCUPURIN
MERCUZANTHIN

TOXICITY DATA: 3-2	CODEN:
ivn-hmn TDLo:28 mg/kg:CNS	JAMAAP 117,1806,41
scu-mus LD50:163 mg(Hg)/kg	JPETAB 105,336,52
ivn-mus LD50:1410 mg/kg	JPETAB 99,149,50
ivn-cat LDLo:250 mg/kg	JPETAB 99,149,50
ivn-rbt LDLo:177 mg/kg	JPETAB 99,149,50

Occupational Exposure to Inorganic Mercury recm std: Air: TWA 0.05 mg(Hg)/m3 NTIS**.

THR: A hmn CNS. HIGH scu, ivn. MOD ivn. See also mercury compounds.

Disaster Hazard: When heated to decomp it emits tox fumes of Hg.

MERCUROUS CHLORIDE

CAS RN: 7546307 NIOSH #: OV 8750000

mf: Cl_2Hg_2; mw: 472.09

White, odorless, tasteless, heavy powder or crystals. Sunlight causes it to decomp into mercuric chloride and metallic Hg. Insol in H_2O, alc and ether. Protect from light. Subl @ 400°; d: 7.150.

SYNS:

MERCURY(I) CHLORIDE
C.I. 77764
CALOMEL
CALOMELANO (ITALIAN)
CHLORURE MERCUREUX (FRENCH)
CLORURO MERCUROSO (ITALIAN)
KALOMEL (GERMAN)
MERCUROCHLORIDE (DUTCH)
MERCURY MONOCHLORIDE
MERCURY PROTOCHLORIDE
MILD MERCURY CHLORIDE
QUECKSILBER(I)-CHLORID (GERMAN)
SUBCHLORIDE OF MERCURY

TOXICITY DATA: 3	CODEN:
mrc-bcs 50 mmol/L	MUREAV 77,109,80
orl-rat LD50:210 mg/kg	WRPCA2 9,119,70

Toxicology Review: SDGTB3 1(2),177,71; RREVAH 42,103,72; 27ZTAP 3,91,69. Occupational Exposure to Inorganic Mercury recm std: Air: TWA 0.05 mg(Hg)/m3 NTIS**. Reported in EPA TSCA Inventory, 1980.

THR: MUT data. HIGH orl. See also mercury compounds.

Disaster Hazard: When heated to decomp it emits very tox fumes of Cl^- and Hg.

Human Tox: Excessive doses may cause Hg poisoning.

Antidote: BAL (Dimercaprol). If laxation from oral mercurous chloride should not occur, saline laxative must be administered to prevent possibility of Hg poisoning.

Med Incomp: Bromides, iodides, alkali chlorides, sulfates, sulfites, carbonates, hydroxides, lime water, acacia, ammonia, golden antimony sulfide, cocaine, cyanides, copper salts, hydrogen peroxide, iodine, iodoform, Pb salts, silver salts, soap, sulfides.

MERCURY

CAS RN: 7439976 NIOSH #: OV 4550000

af: Hg; aw: 200.59

Silvery liquid, metallic element. mp: −38.89°, bp: 356.9°, d: 13.546, vap. press: 1 mm @ 126.2°. vap press: @ 25° = 2×10^{-3} mm.

SYNS:

COLLOIDAL MERCURY
KWIK (DUTCH)
MERCURE (FRENCH)
MERCURIO (ITALIAN)
MERCURY, METALLIC (DOT)
NCI-C60399
QUECKSILBER (GERMAN)
QUICK SILVER
RTEC (POLISH)

TOXICITY DATA: 3	CODEN:
ihl-rat TCLo:890 ng/m3/24H (16W male)	GISAAA 45(3),72,80
ihl-rat TCLo:7440 ng/m3/24H (16W male)	GISAAA 45(3),72,80
ipr-rat TDLo:400 mg/kg/14D-I:ETA	ZEKBAI 61,511,57
ihl-wmn TCLo:150 ug/m3/46D:GIT	AEHLAU 33,186,78
ihl-wmn TCLo:150 ug/m3/46D:CNS	AEHLAU 33,186,78
ihl-rbt LCLo:29 mg/m3/30H	AMIHBC 7,19,53

TLV: Air: 0.05 mg(Hg)/m3 (skin) DTLVS* 4,254,80.

Toxicology Review: AJOGAH 126(3),390,76; JTEHD6 2(3),491,77; TRBMAV 33(1),85,75; PHJOAV 213(5781),159,74; JDSCAE 58(12),1767,75; CPEDAM 13,783,74; QURBAW 7(1),75,74; AEMBAP 48,463,74; JAVMA4 164(3),277,74; 31ZNAA 2,365,73; AEMBAP 40,239,73; CTOXAO 5(2),151,72; BIOGAL 41(7),208,75; ADTEAS 5,51,72; RREVAH 42,103,72; FOREAE 7,313,42; NISIA9 27(9),942,74; MIBUBI 9(4),321,75; STEVA8 2(4),341,74; ENVRAL 13,36,77; 85CVA2 5,63,70; JOCMA7 2,337,60; PEXTAR 12,102,69; PDTNBH 6,204,77.

OSHA Standard: Air: CL 1 mg/10m3 (SCP-N) FEREAC 39,23540,74. DOT: ORM-B, Label: None FEREAC 41,57018,76. Occupational Exposure to Inorganic Mercury recm std: Air: TWA 0.05 mg(Hg)/m3 NTIS**. "NIOSH Manual of Analytical Methods" VOL 1

145,165,167, VOL 4 S199*, VOL 5 175#. Reported EPA TSCA Inventory, 1980.

THR: A hmn GIT, CNS. An exper ETA. HIGH ihl. See also mercury compounds. Reacts violently with acetylene, NH_3, BPI_2, Cl_2, ClO_2, CH_3N_3, Na_2C_2, nitromethane, (butyne diol + acid).

Incomp: Acetylenic compounds; ammonia; boron diiodophosphide; ethylene oxide; metals; methyl azide; methylsilane, oxygen; oxidants; tetracarbonylnickel, oxygen.

For further information see Vol. 1, No. 3 of *DPIM Report.*

MERCURY AMIDE CHLORIDE

CAS RN: 10124488 NIOSH #: OV 7020000
mf: ClH_2HgN; mw: 252.07

White pulverulent lumps or powder.

SYNS:

AMINOMERCURIC CHLORIDE
MERCURIC AMMONIUM CHLORIDE, SOLID
MERCURIC CHLORIDE, AMMONIATED
MERCURY AMINE CHLORIDE
MERCURY AMMONIATED
WHITE MERCURY PRECIPITATED
WHITE PRECIPITATE

TOXICITY DATA:

Aquatic Toxicity Rating: TLm96:under 1 ppm WQCHM* 3,-,74. *Toxicology Review:* SDGTB3 1(2),177,71; 27ZTAP 3,15,69. DOT: Poison B, Label: Poison FEREAC 41,57018,76. Occupational Exposure to Inorganic Mercury recm std: Air: TWA 0.05 ng(Hg)/m3 NTIS**. Reported in EPA TSCA Inventory, 1980.

THR: A poison. See also mercury compounds.

Disaster Hazard: When heated to decomp it emits very tox fumes of Cl^-, NO_x and Hg.

MERCURY(II)-o-ARSENATE

CAS RN: 7784374 NIOSH #: OV 7040000
mf: $AsHO_4 \cdot Hg$; mw: 340.52

Yellow powder; mp: decomp. Insol in H_2O, sol in HCl or HNO_3.

SYN: MERCURIC ARSENATE

TOXICITY DATA: 3

Aquatic Toxicity Rating: TLm96:under 1 ppm WQCHM* 3,-,74. Occupational Exposure to Inorganic Mercury recm std: Air: TWA 0.05 mg(Hg)/m3 NTIS**. Occupational Exposure to Inorganic Arsenic recm std: Air: CL 2 ug/m3/15M NTIS**.

THR: A poison. See also mercury and arsenic compounds.

Disaster Hazard: When heated to decomp it emits very tox fumes of Hg and As.

MERCURY(I) AZIDE

mf: Hg_2N_6; mw: 485.22

THR: Explodes on heating in air. HIGH tox. See also azides, mercury compounds.

Disaster Hazard: When heated to decomp it emits very tox fumes of NO_x and Hg.

MERCURY(II) AZIDE

mf: HgN_6; mw: 284.65

THR: High friction sensitivity; brisance on explosion. HIGH tox. See also mercury compounds, azides.

Disaster Hazard: When heated to decomp it emits very tox fumes of Hg and NO_x.

MERCURY(II) BENZOATE

CAS RN: 583153 NIOSH #: OV 7060000
mf: $C_{14}H_{10}O_4 \cdot Hg$; mw: 442.83

White crystalline powder; odorless. mp: 165°. Very sol in NaCl soln; slightly sol in alc. Protect from light.

SYNS:

MERCURIC BENZOATE
MERCURIC BENZOATE, SOLID (DOT)

TOXICITY DATA: 3

Aquatic Toxicity Rating: TLm96:under 1 ppm WQCHM* 3,-,74. DOT: Poison B, Label: Poison FEREAC 41,57018,76. Occupational Exposure to Inorganic Mercury recm std: Air: TWA 0.05 mg(Hg)/m3 NTIS**.

THR: A poison. See also mercury compounds.

Disaster Hazard: When heated to decomp it emits tox fumes of Hg.

MERCURY(I) BROMIDE (1:1)

CAS RN: 10031182 NIOSH #: OV 7410000
mf: BrHg; mw: 280.50

White-yellow tetrg cryst or powder; odorless. d: 7.307; vap d: 19.3. Darkens on exposure to light. Sublimes @ approx 390° (decomp); Insol in H_2O, alc, ether; decomp by hot HCl or alkali bromides. Protect from light.

SYN: MERCUROUS BROMIDE, SOLID (DOT)

TOXICITY DATA: 3

Aquatic Toxicity Rating: TLm96:under 1 ppm WQCHM* 3,-,74. DOT: Poison B, Label: Poison FEREAC 41,57018,76. Occupational Exposure to Inorganic Mercury recm std: Air: TWA 0.05 mg(Hg)/m3 NTIS**.

THR: A poison. See also mercury compounds and bromides.

Disaster Hazard: When heated to decomp it emits very tox fumes of Br^- and Hg.

MERCURY(II) BROMIDE (1:2)

CAS RN: 7789471 NIOSH #: OV 7415000
mf: Br_2Hg; mw: 360.41

White crystals or cryst powder. Sensitive to light; mp: 237°; bp: 322° (sublimes); d: 6.109 @ 25°; vap press: 1 mm @ 136.5°; sublimes @ higher temp; very sol in hot alc, methanol, HCl, HBr, alkali bromide solns; slightly sol in chloroform.

SYNS:

MERCURIC BROMIDE
MERCURIC BROMIDE, SOLID (DOT)

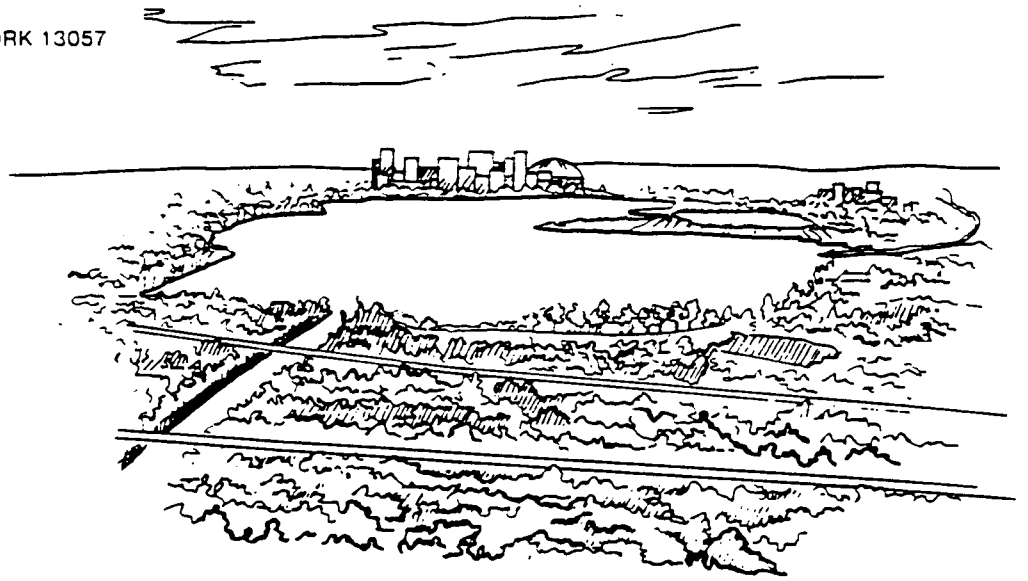
(165 of 265) (22)

ONONDAGA COUNTY, NEW YORK
DEPARTMENT OF DRAINAGE AND SANITATION

MOFFA & ASSOCIATES
CONSULTING ENGINEERS

EAST SYRACUSE, NEW YORK 13057

REPORT



1986
ONONDAGA LAKE MONITORING PROGRAM

APRIL 1988

Engineers. The latter firm was responsible for performing the detailed analysis and report preparation for the period of January, 1981 to December, 1985. Data analysis and report preparation responsibilities were transferred to the firm of Moffa and Associates in 1986. The OCDDS has performed data collection and reduction duties since January of 1982. This report specifically addresses the monitoring program conducted from January through December of 1986.

1.02 Authorization

The 1986 Onondaga Lake Monitoring Program Report was prepared under the Engineering Agreement between the OCDDS and Moffa and Associates Consulting Engineers dated June 9, 1986. All services performed under this agreement were funded solely by Onondaga County.

1.03 Description of Study Area

Onondaga Lake is located immediately northwest of the City of Syracuse in Onondaga County, New York. Due to its proximity to the urbanized areas of Syracuse, Onondaga Lake has served as a convenient receiving water body for numerous municipal and industrial discharges. It is unfortunate that these discharges have, over the years, resulted in the disappearance of the once popular resort area which existed along the western shoreline of the Lake, in addition to the excellent fishery which existed in the Lake. The Lake was closed to public swimming by the New York State Health Department in the 1920's due to high concentrations of bacteria, while high mercury content of several fish species resulted in the closing of the Lake to public fishing in 1970. The Lake has subsequently been opened in 1986 to sport fishing on a catch and release basis.

(23)

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The Ecology of Onondaga County and Vicinity

The Past, Present, and Future of its Ecosystems

by

Maurice M. Alexander

Department of Forest Zoology

State University of New York
College of Environmental Science and Forestry
Syracuse, New York

1973

The Old Solvay Waste Beds

One of the visible scars in the Syracuse environment, other than industrial air pollution and the inner city slums, is the man-made hill to the west of Onondaga Lake that is referred to as the Old Solvay Waste Beds. It is of interest ecologically both from the standpoint of a solid waste disposal problem and an illustration of primary ecological succession. It is a field laboratory for study of both these features.

Solvay Process

Solvay Process is a well known and rather inexpensive method of producing soda ash and related chemicals. These include sodium bicarbonate, calcium chloride, caustic soda and many others. The process was developed in 1865 and the Solvay Plant was constructed in 1886. This location is of importance because of the abundant supply of salt in the Tully Valley and limestone in the Split Rock and Jamesville vicinity. The industry has done much for the economy of the Syracuse area. Other than the air pollution problem that accompanies many industries, the one drawback involves a voluminous waste product that has no known use. This presents us with a hugh disposal problem in a suburban area where priorities in land use can be questioned.

The Waste Beds

The Solvay waste beds have been growing in size and effect for over 80 years. The first beds were located along the south shore of Onondaga Lake, an area now developed for roads and industry. In 1916 the large complex of beds east of the State Fair Grounds was begun. Some of this has been obliterated by industry, super-highways and parking lots.

Deposition in these beds continued until after World War II. Solvay Process purchased the old Amboy Airport in 1950 and the use of it for storing waste began soon thereafter. About 1180 acres are now occupied. This can be broken down into 700 acres of active bed, 200 acres of roads and parking lots, and 280 acres left as waste land. The accompanying map (Fig. 13) shows the latter area as it is divided into compartments and dated for the last deposits of wastes. The hatched areas indicate steep slopes between compartments.

The Waste Material

Much of the waste material is a suspension in water of very light and ultra-fine particles. It is pumped from the plant in 12-inch pipes, hot from the reaction processes. Distribution boxes channel the material around the perimeter of a compartment. From these channels it spreads out over the cell. The coarser material settles in the perimeter channels and

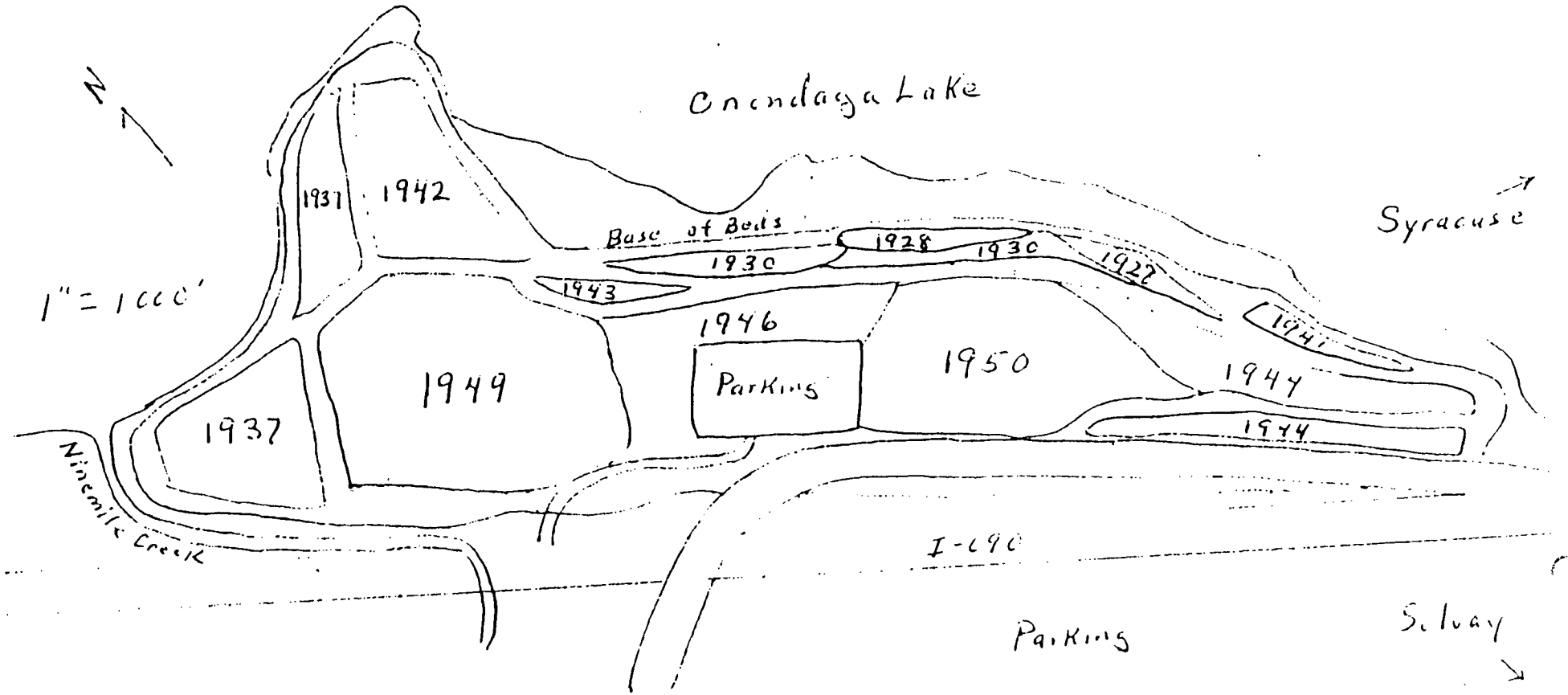

Fig. 13 - Old Waste Beds, Solvay Process

hardens. The sand (SiO_2) settles first inside the edges. The top slopes toward the center of the cell and the drainage. Two or more compartments are used alternately so that time is allowed for evaporation and leaching. Beds should be no higher than 70 feet because of the weak bondage of the material. The uniform size of these tiny round particles prevents compaction as would occur with most fill material. A "blow-out" can occur in the side of the dike, and permit a large segment to flow from the bed. One large blow-out has occurred at which time the main road was covered as well as part of the State Fair Grounds. Smaller ones are visible today. Side slopes vary from 40 to 90% grade. There is a slow but steady movement of material into Onondaga Lake. The rate is difficult to determine. Onondaga Lake has an elevation of 364 feet and the top of the beds are at 434 feet. This gives the top an elevation of 70 feet and an open exposure to the winds.

The chemical analysis of the material is as follows:

Chemical	Fresh	After drained
$CaCO_3$	50%	68%
$Ca(OH)_2$	11	
$CaCl_2$	11	1
NaCl	9	
SiO_2	5.5	11
CaO	4.5	12
MgO	4	7
$CaSO_4$	2.5	1
Al_2O_3 and Fe_2O_3	2	
	100	100

The characteristics of this new soil are (1) high water-holding capacity, (2) low air permeability, (3) unstable surface, and (4) alkaline. After a few years of weathering and leaching, the upper layers are a powdery silt with some crusting. The pH is between 8 and 10, and soluble salts amount to 2 to 3½%. As these salts drop to 1% and the pH to 8, conditions for specialized forms of life are present.

Ecological Development

Salt-tolerant plants with wind-blown seeds are the first to come in. Ecological succession is not secondary but a specialized form of primary succession. The series of abandoned beds with their dates of abandonment gives us a picture of the slow development of biotic communities.

The penetration of the material by plant roots improves aeration and salts are reduced. There is a gradual deepening of the weathered layer with time. The accompanying illustration (Fig. 14) shows the changes that take place in time on these waste beds.

This illustration and other information used here regarding plant development are taken from a graduate thesis of John Hewlett, 1955-56. He states: "The alkalinity of the waste and the predominance of calcium carbonate tends to render phosphorous almost totally unavailable to plants. This in turn prevents the accumulation of nitrogenous material and prolongs the shortage of nitrogen as a nutrient.

LCP's Pollution Problems Aren't Limited to Geddes Plant

By PATRICIA CAPPON

In a West Virginia river town weary of unemployment, one local official thinks of LCP Chemicals Inc. as a blessing in hard times.

"We've just been devastated in this Ohio Valley and we are tickled to death to have LCP here," says Marshall County Assessor Alfred Clark.

But when environmental officials there and in five other states talk of LCP's plants — including the one in Geddes — they describe a company with a troubled history of mercury pollution.

Even though LCP's plant in Moundsville, W.Va., flushed out its own wastewater treatment system to try to solve the problem, small amounts of mercury from the plant have continued to leak into the Ohio River.

"The problem is chronic," said James Waycaster, a spokesman for the state's Department of Natural Resources. "They're still looking for the source, but it's kind of like trying to find a short in your car."

LCP Chemicals' lingering use of an industrial process abandoned years ago by some chlorine manufacturers has also created wastewater pollution problems at the company's plants in Georgia, Maine and North Carolina, at a former plant in New Jersey and at the now-closed plant in Geddes.

LCP's environmental record in other states illustrates the enormity of its difficulties with the mercury-cell process and may offer clues to the approach the company will take to resolve serious mercury and chlorine pollution problems at its Geddes plant.

Ron Burkett, LCP's environmental corporate manager, said Tuesday the company was preparing a response to questions about its companywide environmental record. He could not be reached for comment Wednesday.

In other states, officials are quick to point out that LCP has made concerted and costly efforts to address environmental complaints by improving wastewater treatment facilities and replacing aging equipment. The company is currently abiding by its discharge permits in all those states, state officials say.

There are many parallels with Geddes, but one major difference. In no case in the other states did the pollution problems reach the point where state officials pushed the company to the brink of a state-imposed shutdown.

LCP voluntarily shut down its Geddes plant June 28 and has remained closed to halt pollution that state officials said released up to a pound of mercury a day into tributaries of Onondaga Lake. The plant laid off most of its workers Wednesday for an indefinite period.

Mercury is dangerous because its compounds can make their way into the food chain. Scientists have discovered mercury in eggs, fish, grain and meat. When ingested, mercury can cause brain damage.

LCP's recurrent plant problems come at a time of decline in the amount of chlorine manufactured nationally by the mercury-cell process. As of Jan. 1, 17 percent of the chlorine manufactured in the United States was done through the mercury-cell process, down from 22 percent to 24 percent in the mid-1970s.

"There's no question about it; the mercury-cell process is kind of a dinosaur that is dying out," said Paul Leming, a chemicals analyst for Morgan Stanley & Co. "It's an environmental headache that no one wants."

In the mercury-cell process that LCP employs, mercury is used to conduct electricity in the use of salt from the Tully brine wells to produce chlorine and caustic soda.

In the mercury-free "diaphragm" process, which LCP also uses, pure brine is fed to cells that operate like batteries in reverse. That is, they consume electrical power to produce chemicals (chlorine) rather than consuming chemicals to give electricity.

In the past five years, three

(Continued on Page B-3)

Mercury Discharges State-by-State

LCP Chemicals has had mercury pollution problems in several plants besides its Geddes operation. Here is a plant-by-plant rundown:

West Virginia

LCP's plant in Moundsville is one of the cornerstones of a fragile economy, county officials say. The plant is one of the top five manufacturers in Marshall County, population 40,000.

James Waycaster, a spokesman for the state Department of Natural Resources, said the mercury leaking from the plant into the Ohio River has been a "chronic" problem, but added that it poses no danger to the environment because the quantities are so small.

He also said the company has cooperated with the state agency, and is one of the few companies that provides complete information about its organic wastes.

(Continued on Page B-3)

Market Strong for LCP's Product

(Continued from Page B-1)

chlorine plants that relied on the mercury-cell process have shut down entirely. LCP's plant in Linden, N.J., was one of them, one official said.

Twenty-one of the 51 chlorine plants in the nation are still using the mercury-cell process, according to The Chlorine Institute Inc. in Washington, D.C. LCP operates six of the 21.

Dow Chemical Co., the industry's largest producer, converted all of its plants to the mercury-free process more than 20 years ago.

"When the mercury scare first surfaced in the mid-1960s, our top management put out the edict," said Tim Burdon, marketing manager for Dow's chlor-alkali product line.

LCP generates about 4 percent of the 12,000 metric tons of chlorine the nation's industry is capable of producing, making it the sixth largest producer of chlorine.

LCP has refused to comment on its finances. But theoretically, LCP should be sharing in a bull market for chlorine and caustic soda. Industry analysts describe this period as a golden age for manufacturers because demand is so high.

"When times are good, everybody is making money hand over fist, and times are good right now in the chemical industry," Leming said.

During the shutdown, LCP has been supplying at least one local customer with caustic soda from its plants in West Virginia and Georgia.

General Chemical Co. in Solvay, a 42-employee, sodium nitrite manufacturer which relies on LCP for 80 percent of the caustic soda it uses, is receiving most of it from LCP and is buying some from a company in Niagara Falls, plant manager David Tusinski said this week.

A State-by-State Look at LCP

(Continued from Page B-1)

Georgia

Last winter, LCP's plant in Brunswick, Ga., released excessive levels of mercury into an estuary of the Turtle River, which in turn flows into the Atlantic Ocean.

The company has had "some minor problems with spillage," according to Mike Creason, environmental program manager for the state's industrial wastewater program.

LCP is permitted to discharge some mercury. The state's Environmental Protection Agency ordered the company to stop the excess, and the problem has since subsided because the company is replacing old equipment in the aging plant, Creason said.

Maine

Geoffrey Kany, an engineer in Maine's Bureau of Water Quality Control, calls the Penobscot River a churning "monster" with a powerful enough current to dilute pollutants.

LCP's Orrington plant has "occasionally" violated its permit to discharge mercury-laden wastewater into the river, Kany said. Although worrisome, LCP's mercury discharges have had little effect on water quality, he said.

North Carolina

Ground water beneath LCP's property in Riegelwood, N.C., has been contaminated by leakage from holding ponds that LCP once used to dump its waste, including mercury. The contamination landed the property on the state's list of hazardous waste sites.

Although those ponds have been dug up, treated with chemicals to neutralize the toxics, then sealed over, the company must still come up with a plan to remove the mercury from the ground water.

"We've worked with them and they've done a relatively good job," said Doug Holyfield, supervisor of hazardous waste compliance for the state's Department of Human Resources.

New Jersey

Before the company's plant in Linden, N.J., closed, two mercury-contaminated sludge lagoons had been placed on the state's list of hazardous waste sites. The company has spent at least $200,000 for studies and cleanup, officials said, and the site has since been removed from the list.

Ohio

The company's plant in Ashtabula, Ohio, near Lake Erie received unrestrained praise from state environmental officials. In fact, officials there called the company "one of the better companies in the northeastern part of the state."

"They have an excellent record of complying with mercury limits," said Carol Porter, a spokeswoman for the Ohio Environmental Protection Agency.

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GROUND-WATER QUALITY CONDITIONS
AT THE FORMER WILLIS AVENUE PLANT
ALLIED CHEMICAL COMPANY
SOLVAY, NEW YORK

April 1982

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Consulting Ground-Water Geologists and Hydrologists
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HYDROGEOLOGIC INVESTIGATION

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SOLVAY, NEW YORK

Submitted to:

ALLIED CHEMICAL
SOLVAY, NEW YORK

Submitted by:

GROUNDWATER TECHNOLOGY
Division of Oil Recovery Systems, Inc.

March, 1984

Prepared by:

Barbara P. Linkiewicz
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Senior Hydrogeologist

SHALLOW AQUIFER HYDROGEOLOGIC INVESTIGATION

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New York State Museum

JOHN M. CLARKE, Director

Museum Bulletin 171

THE GEOLOGY OF THE SYRACUSE QUADRANGLE

BY

THOMAS CRAMER HOPKINS

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ALBANY
THE UNIVERSITY OF THE STATE OF NEW YORK
1914

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LOCKPORT LIMESTONE

Overlying the Rochester-Clinton shale is the Lockport limestone, known in the older reports as the Niagara limestone. It consists of a very dark colored, in places black, dolomitic limestone and associated shales. It contains numerous small geodic cavities lined with calcite and dolomite crystals.

This limestone forms a rather broad belt across the Syracuse quadrangle. The rock is more resisting to the action of the weather than the shales above and below and hence is characterized by a slight topographic relief. This relief is even less than one might expect from the difference in the rocks, which is probably due in part to the leveling action of the ice during the glacial period and the inequalities of the glacial deposits; possibly also the area was nearly base-leveled before the advent of the glacier.

The outcrops of the Lockport limestone, while not numerous owing to the heavy glacial covering, are more extensive than that of the underlying shales. The best exposure on the Syracuse area is at the quarry on the South Bay electric road about one mile south of Oneida lake. The greater part of the rock here is a nearly black dolomite. The upper layer is evenly bedded, varies from 1 to 2 feet in thickness, has a finely crystallized, even texture and is a fairly good building stone. The layers immediately underlying the top bed are more thinly bedded and interlaminated with black carbonaceous shale. At a depth of 4 to 6 feet the limestone occurs in rough irregular masses with no regular lamination or grain. In the bottom portion of the quarry the shale prevails over the limestone.

On the White farm immediately south of the quarry the rock has been removed over an area several acres in extent. It has been nearly all used for foundations, culverts and bridge piers. Its extended local use is due rather to the fact that it is the only rock obtainable for building purposes between the plateau south of Syracuse and the Medina sandstone area some miles to the north.

A similar rock at or near the same horizon as that at the quarry mentioned above has been quarried to a limited extent for local use at the village of Cicero, two and a half miles southwest of the barge canal at Oak Orchard on the Oneida river, and in the bank of the Seneca river a half mile south of Three River point. There is another quarry in this rock two and a half miles northwest of Baldwinsville and another on the western border of the village of Lysander. Both of these localities are on the Baldwinsville

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Technical Report 87-1 (BEP)
Division of Fish and Wildlife

AN OVERVIEW OF MERCURY CONTAMINATION IN THE FISH OF ONONDAGA LAKE

by

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New York State Department of Environmental Conservation

July - 1987

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Potential Health Effects of Mercury in Water Supply Wells

Thomas R. Stolzenburg, Robert R. Stanforth, and David G. Nichols

The cycling of mercury in the environment and in well water was studied to determine the seriousness of the threat to human health of the elemental mercury sometimes contained in water well equipment. Modeling of mercury cycling indicated that, because of unfavorable conditions, mercury in well water is highly unlikely to be methylated to the toxic methylmercury form. More important, aquatic organisms, such as fish and shellfish, that can concentrate methylmercury and could be consumed by humans are not present in well water.

Metallic mercury is sometimes used in equipment in drinking water supply wells. In some situations, this mercury may be accidentally introduced into the well, creating a potential for contamination. In reviewing possible sources of mercury in drinking water, the US Environmental Protection Agency (USEPA) suggested that there may be "some instances of well contamination from mercury-sealed well pumps."[1] In light of well-documented cases of mercury contamination in surface waters, an evaluation of possible human health effects resulting from the use in drinking water supply systems of equipment containing metallic mercury was conducted. In particular, the aquatic cycling of mercury under conditions likely to occur in groundwater and the human health effects of different chemical forms of mercury were investigated.

Toxicity of mercury

To evaluate the possible danger from mercury in drinking water, knowledge of previous mercury poisoning incidents is helpful. Because of the long history of industrial use of mercury, its toxic properties are well known. The toxicity and mode of entry of mercury into the human body depend on which chemical form is present.

Mercury poisonings caused by exposure to inorganic mercury, mainly through inhalation of elemental or mercuric mercury fumes, have usually been work-related (in mining, felt hat manufacturing, and other industries that use elemental mercury).[2]

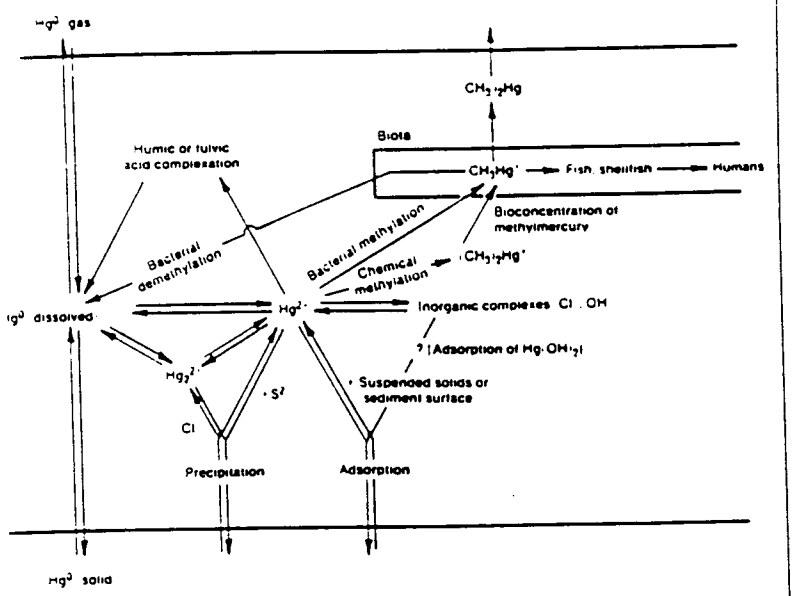
Recently, highly publicized cases of mercury contamination have involved alkyl organomercurials, especially methylated mercury. Methylmercury attacks the brain and nervous system and can cross the placenta to attack the fetus.[2,3] Such poisoning has limited reversibility, in contrast to the effects of inorganic mercury poisoning, which are alleviated when exposure is reduced.

Four cases of methylmercury contamination of the aquatic environment are well-known: Minamata and Niigata, Japan; Lake St. Clair, Michigan–Ontario; and the English–Wabigoon river system in northwestern Ontario.[2,3] In all cases, contamination was caused by long-term industrial discharge of mercury-contaminated wastewater. In Japan, methylmercury was released directly in the wastewater discharge and caused severe cases of human poisoning. Inorganic mercury was the primary form of the element released in the incidents in the United States and Canada. This inorganic mercury was then methylated in the receiving waters, probably by bacteria in the sediments.

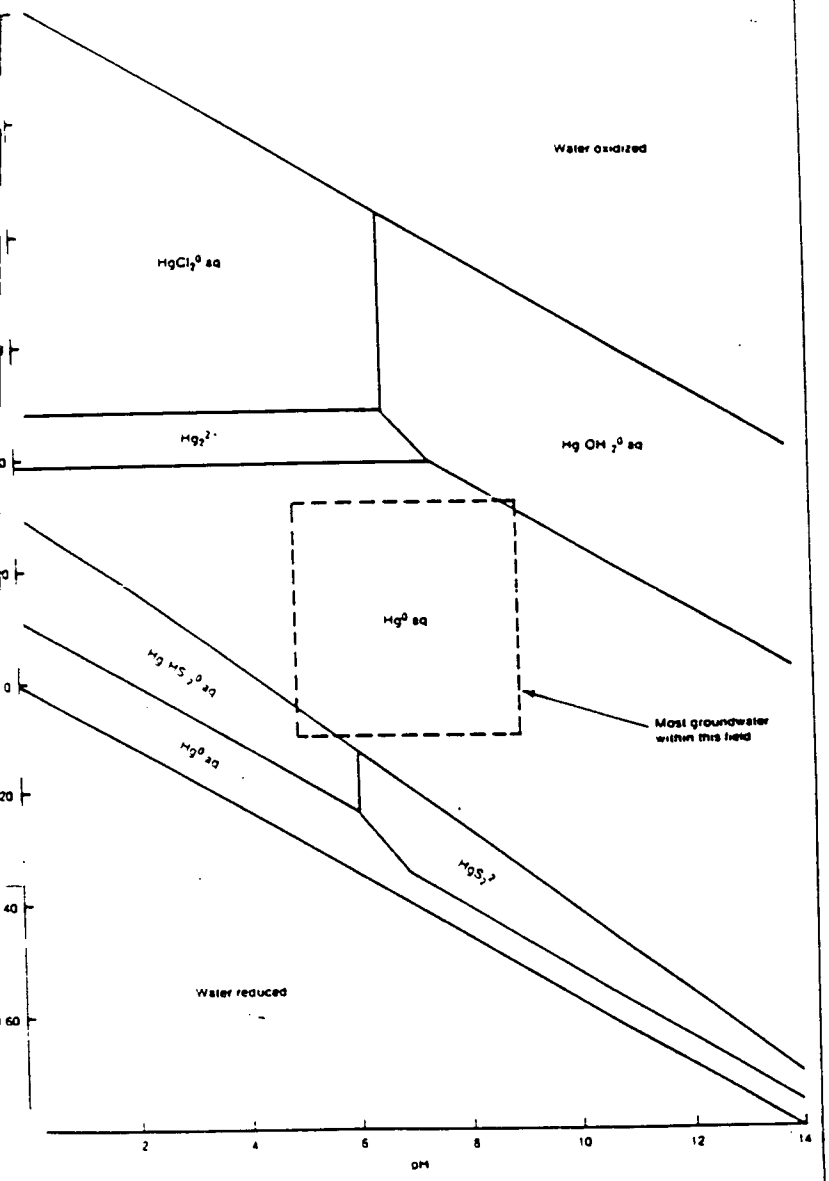
Methylmercury in water becomes concentrated in fish and shellfish, and human poisoning appears to result from eating the contaminated food rather than through direct intake of contaminated water. The people most affected by the contamination incidents were those who depended heavily on fish or shellfish as a food supply—for example, residents of Minamata and Niigata.

In the early 1970s, methylmercury was found to be the predominant form of the element in fish, even in those from uncontaminated areas of the ocean.[4] Methylmercury formation and bioaccumulation were demonstrated to occur naturally and were not limited to contaminated areas. Tuna and swordfish, for example, are especially high in methylmercury. Known cases of methylmercury poisoning, however, are limited to areas where industrial discharge of methylmercury has led to very high methylmercury concentrations in fish.

Ingestion of elemental mercury does not cause the symptoms associated with methylmercury poisoning. In fact, miners of the centuries-old mercury mine at Almaden, Spain, were known to drink elemental mercury to treat constipation. Although this procedure is not medically recommended, it demonstrates that



Schematic diagram of the cycling of mercury in the environment



ur 2. Stability fields for aqueous mercury species at various Eh and pH values *ride and sulfur concentrations of 1 mM each were used in the calculation.*[5] *m Eh-pH ranges for groundwater are also shown*[6])

direct intake of elemental mercury poses a relatively insignificant health threat compared with the ingestion of methylmercury.

Cycling of mercury in the environment

The aqueous chemistry of mercury in the environment is complex because of its stability in three oxidation states, complexation with a variety of ligands, strong adsorptive character, and complex interactions with organic or biological material. A diagram of the cycling of mercury in natural waters is shown in Figure 1. The diagram is broken into three levels: solid, water, and air. Conversion of mercury from one form to another occurs in the water, i.e., in sediment-pore water or the water column, rather than in the solid phase. The biota, e.g., bacteria and fish, are shown as an insert in the water phase.

Oxidation states. Mercury (Hg) can exist in three oxidation states: 0 (elemental), I (mercurous), and II (mercuric). Figure 2[5] shows the stability ranges for the three oxidation states on an Eh-pH diagram. The Eh is a measure of the oxidation-reduction potential, with an increasing Eh value indicating more oxidizing conditions. Chloride and sulfur are included in the diagram at environmentally common concentrations (1 m*M* each) to show their influence on mercury speciation. Those solute species that are stable under the Eh-pH conditions represented are indicated by the delineated areas in the figure. The limits of the diagram show where the water itself is decomposed. Also shown are Eh-pH conditions commonly found for groundwater.[6] Over the Eh-pH range of most groundwaters, elemental mercury is the stable form.

Oxygen rapidly reacts with elemental mercury to form mercuric mercury.[7] Thus, in reoxygenated groundwater or in surface waters, mercuric ion should be the predominant form. Elemental mercury is also oxidized by chlorine, so in drinking water that is chlorinated before use, mercury should be in the oxidized form.

Saturation concentrations. The concentration of elemental mercury [Hg(0)] in solution may be controlled by its solubility. Glew and Hames[7] found a saturation concentration of about 60 μg Hg(0)/L at 77°F (25°C), with a strong temperature dependence, and derived equation 1 to describe the solubility of Hg(0) in air-free water. At 122°F (50°C), the saturation concentration is 100 μg/L, and at 167°F (75°C) it is almost 200 μg/L. The often repeated solubility of 25 μg/L at 77°F (25°C) is based on early, incorrect studies.

$$\log \mathrm{Hg}(0) = -118.04 + 4715.2/T + 42.03 \log_{10} T \quad (1)$$

in which Hg(0) is mercury solubility in μg/L and *T* is temperature in K. Dissolu-

tion kinetics are very rapid, so water in direct contact with metallic mercury will probably be saturated.[8]

Mercuric mercury [Hg(II)] is quite soluble under aerobic conditions, with solubility greatly increased by the presence of complexing anions, especially hydroxide and chloride. If no chloride is present, the solubility of Hg(II) will be approximately 200 mg/L at pH values commonly encountered in natural waters. However, because other processes reduce mercury concentrations in aerobic waters, the solubility of mercuric salts (except for the sulfide) does not usually control mercury concentrations in natural waters. Under anaerobic conditions, sulfide may limit the solubility of Hg(II) to very low levels.

Mercurous mercury [Hg(I)] has a small stability region in the Eh-pH diagram presented in Figure 2. Wollast et al[9] state that mercurous mercury is unlikely to occur in the natural environment. If the free mercuric ion concentration is rapidly removed from solution through complexation or adsorption, Hg(I) dismutates, i.e., splits into elemental and mercuric mercury. Since these are common occurrences in the aqueous environment, the stability of Hg(I) in natural systems is probably low.

Bacterial absorption and conversion. Methylmercury formation requires the presence of a suitable methylating agent, i.e., a chemical or biochemical process capable of adding the methyl group to the mercury. Although methylating agents can be produced either by microorganisms or by humans, the principal agents are bacterial. Bacteria can absorb and convert inorganic mercury into several important products. Of greatest interest in this work is the ability of several types of bacteria to methylate mercury to form methylmercury or dimethylmercury. Of the several bacterial methylating agents known, methylcobalamin, a vitamin B_{12} analogue, is believed to be the most active.

Bacterial methylation has been observed under both aerobic and anaerobic conditions.[10] The rate of methylation depends on the activity of methylating bacteria and on the availability of mercury to the bacteria. Bacterial activity depends on the bacterial population, food supply (i.e., carbon and nutrient concentrations), and temperature. Since Hg(II) is the species that is methylated, the availability of mercury for methylation depends on Hg(II) concentration. This concentration is influenced by redox conditions, presence of complexing agents, sulfide concentration, and pH.

Several studies have shown that bacteria can demethylate mercury in the same type of environments as those in which methylation occurs, e.g., sediments.[10] Both methylation and demethylation of mercury can be assumed to occur in bacteria-rich environments. The net methylmercury concentration will depend on the relative rates of methylation and demethylation.

In the environment, net methylation occurs most rapidly under moderately anaerobic conditions.[11] Presumably, both bacterial activity and Hg(II) availability are optimized under these conditions. Under strong reducing conditions, formation of mercuric sulfide probably limits the concentration of soluble Hg(II). Under aerobic conditions, net methylation is slower than under anaerobic conditions. Olson and Cooper suggested that this may be due to an increased rate of methylmercury demethylation rather than to a decreased rate of methylmercury formation.[12]

Whether monomethylmercury or dimethylmercury is formed is a function of pH. Monomethylmercury is favored at a pH of less than 8, whereas dimethylmercury is formed at a pH greater than 8. Since dimethylmercury is volatile, it is usually lost from an aquatic system as soon as it is formed.

A few nonbiologically produced methylating agents have also been shown to be significant, e.g., other methylated metals, especially lead and zinc. Alkyl lead, for example, has been implicated as the methylating agent in the St. Clair River mercury contamination incident.[10] Under most conditions, however, bacterial methylation is of more concern.

TABLE 1

Concentrations of mercury and methylmercury in natural waters

Water	Total Mercury Concentration *ng/L*	Methylmercury Concentration *ng/L*	Reference
Mississippi River	50 (average)	Below detection*	14
Florida Everglades	80 (average)	Below detection	14
Great Lakes		<0.24	15
Mercury-polluted lakes			15
Lake St. Clair		0.6	
Clay Lake, Kenora, Ont., in Wabigoon River system		0.5 (central lake) 1.0 (near shore)	
Pincky Lake		1.7	
Survey of natural waters (excluding one site near mercury deposits)	10-6000		4
Seawater	10-2000		13

*<0.1 ng/L

TABLE 2

*Assumed maximum safe daily human intake of methylmercury from various food sources**

Source	Amount Consumed	Intake of Methylmercury *μg/d*
Water	2 L/d	0.28
Freshwater fish	1.72 g/d	22.5
Coastal-estuarine fish	4.78 g/d	19.5
Open-ocean fish	12.2 g/d	158.0
Total		200

*Used by USEPA in developing current water quality criteria for human health

Bioaccumulation. Methylmercury can be absorbed from water by organisms and binds strongly to organic detritus. Thus fish and other organisms accumulate methylmercury to higher concentrations than the concentrations in surrounding waters. Methylmercury concentrations in water are generally very low (in the nanogram-per-litre [10^{-6} mg/L] range or less), even in areas of mercury contamination (Table 1). The total mercury concentrations of surface waters, on the other hand, are often in the hundreds-of-nanograms-per-litre range. Thus, methylmercury constitutes only a small fraction of the total mercury content of most natural waters.

The mercury in fish and shellfish, however, is almost completely in the form of methylmercury. This indicates that fish selectively retain methylmercury instead of inorganic mercury, mostly because methylmercury is much more lipophilic than inorganic mercury.[13] Because of the large bioaccumulation of methylmercury, the intake of methylmercury by humans is primarily through the food chain rather than directly through drinking water.[13,14]

Cycling of mercury in well water

Well water presents a simpler aquatic environment than does surface water, which makes modeling of the mercury cycle in well water easier. Since oxygen concentrations in well water are gener-

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ally low, dissolved mercury tends to remain as Hg(0) rather than being oxidized to Hg(II). Winograd and Robertson have challenged the prevailing opinion that deep groundwater has a low oxygen content and give several examples of oxygenated deep groundwater.[15] Whether these instances are exceptions or the norm has yet to be established. For modeling purposes, the groundwater is assumed to be deoxygenated. This assumption has little effect on the modeled concentrations of methylmercury in the pumped water but simplifies the mercury cycle, since only the reactions involving elemental mercury and methylation need to be considered. Although methylation involves the mercuric ion, it can still occur under conditions in which Hg(0) is the predominant form. The only Hg(0) reaction of concern is the dissolution of mercury from liquid mercury to the overlying water.

Methylmercury formation and contamination. For mercury that has been accidentally introduced into a well to pose a hazard to human health, at least two steps would have to occur: (1) the mercury would have to be methylated, and (2) the methylmercury would have to be bioconcentrated by aquatic organisms, and those organisms would have to be consumed by humans. Both of these steps are highly unlikely in drinking water wells.

Biological methylation is controlled by three factors: (1) the presence of methylating bacteria, (2) sufficient substrate, and (3) mercury in the mercuric form. It is favored by conditions of active bacterial growth and high organic content, such as those in sediments or sewage lagoons. Large municipal drinking water supply wells generally have very low bacterial populations, much lower and much less diverse than those of sediments or sewage lagoons. Furthermore, growth of whatever bacteria may be present is slowed by the unfavorable bacterial environment (the low organic and nutrient content) of the well water. Well water is thus not a favorable environment for methylation.

Methylation also depends on the mercury concentration, which may reach levels of 40 to 50 μg/L at the bottom of the well immediately next to the metallic mercury pool (at water temperatures of 68°F [20°C]). Such levels, however, are far below the mercury concentrations of 1 to 100 mg/L used in experiments with natural sediments during which methylation was observed. Methylation, therefore, is extremely unlikely to be significant in wells because of the low bacterial population and the low dissolved mercury concentration.

Extremely low concentrations of methylmercury could theoretically be transferred directly from well water to the human consumer. However, these amounts of methylmercury are not of major concern because a significant health threat exists only when dissolved methylmercury is bioaccumulated by organisms and these organisms are consumed.

In the event that aerobic conditions exist in the groundwater, some of the mercury might be present in the Hg(II) form, which is more amenable to methylation. However, the likelihood of methylation would remain small since two other conditions would still have to be met: the presence of methylating bacteria and of a growth substrate. In addition, in order for a consumer to be exposed to a significant dose of methylmercury, an organism that has bioaccumulated the methylmercury would have to be ingested.

This last point was exemplified during development of the USEPA's current water quality criteria for human health.[14] The agency assumed that methylmercury ingested by humans came from two sources: from the water itself and from fish living in the water. The USEPA used an average bioaccumulation factor to estimate the distribution of methylmercury between the fish and the water and used an average daily consumption of both fish and water. To set the safe daily intake of methylmercury from water, it was estimated that 99 percent of methylmercury ingestion results from fish consumption and only 0.1 percent from drinking the water (Table 2). Thus, for aquatic methylmercury to be of concern to human health, a bioaccumulator is necessary to concentrate the methylmercury. Such bioaccumulators are not commonly present in municipal water supply wells.

Conclusions

According to the analysis presented here, metallic mercury in water supply well equipment does not pose a threat to human health. Because of low mercury concentrations and unfavorable conditions for methylation, the methylation of inorganic mercury dissolved in well water is highly unlikely. Even if a small amount of methylmercury is formed, there are no fish or shellfish present to concentrate the methylmercury to the point at which it would be a threat to human health.

Acknowledgments

This work was supported by the Byron Jackson Division of Borg-Warner Corporation. The authors thank Frank D'Itri for reviewing the report on which this article is based.

References

1. USEPA. National Revised Primary Drinking Water Regulations: Advanced Notice of Proposed Rulemaking. *Fed. Reg.*, 48:194:45513 (Oct. 5, 1983).
2. D'ITRI, P.A. & D'ITRI, F.M. *Mercury Contamination: A Human Tragedy*. Wiley-Interscience, New York (1977).
3. SMITH, W.E. & SMITH, A.M. *Minamata*. Holt, Reinhardt, & Winston, New York (1978).
4. GAVIS, J. & FERGUSON, J.F. The Cycling of Mercury Through the Environment. *Water Res.*, 6:989 (1972).
5. HEM, J.D. Chemical Behavior of Mercury in Aqueous Media. *Mercury in the Environment*. USGS Prof. Paper 713 (1970).
6. DAVIS, S.N. & DEWIEST, R.J.M. *Hydrogeology*. John Wiley & Sons, New York (1966).
7. GLEW, D.N. & HAMES, D.A. Aqueous Nonelectrolyte Solutions. Part X. Mercury Solubility in Water. *Can. Jour. Chem.*, 49:3114 (1971).
8. ANDREN, A.W. Personal communication (1981).
9. WOLLAST, R.; BILLEN, G.; & MACKENZIE, F.T. Behavior of Mercury in Natural Systems and Its Global Cycle. *Ecological Toxicology Research* (A.D. McIntyre and C.F. Mills, editors). Plenum Press, New York (1975).
10. BEUER, K. & JERNELOV, A. Methylation of Mercury in Aquatic Environments. *The Biogeochemistry of Mercury in the Environment* (J.O. Nriagu, editor). Elsevier/North-Holland Biomedical Press, New York (1979).
11. BISOGNI, J.J. JR. Kinetics of Methylmercury Formation and Decomposition in Aquatic Environments. *The Biogeochemistry of Mercury in the Environment*. (J.O. Nriagu, editor). Elsevier/North-Holland Biomedical Press, New York (1979).
12. OLSON, B.H. & COOPER, R.C. Comparison of Aerobic and Anaerobic Methylation of Mercuric Chloride by San Francisco Bay Sediments. *Water Res.*, 10:113 (1976).
13. D'ITRI, F.M. ET AL. An Assessment of Mercury in the Environment. Natl. Acad. Sci., Washington, D.C. (1978).
14. USEPA. Ambient Water Quality Criteria for Mercury. EPA-440/5-80-058. Washington, D.C. (1980).
15. WINOGRAD, I.J. & ROBERTSON, F.N. Deep Oxygenated Ground Water: Anomaly or Common Occurrence? *Science*, 216:1227 (1982).

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(185 of 265)

NATIONAL FIELD INVESTIGATIONS CENTER CINCINNATI

AND

REGION II, NEW YORK

REPORT OF

MERCURY SOURCE INVESTIGATION

ONONDAGA LAKE, NEW YORK

AND

ALLIED CHEMICAL CORPORATION

SOLVAY, NEW YORK

NYS IHWS ID# 734030

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF ENFORCEMENT AND GENERAL COUNSEL

April 1973

(33)
(186 of 265)

EPA-440/4-79-029a
December 1979

WATER-RELATED ENVIRONMENTAL FATE OF 129 PRIORITY POLLUTANTS

Volume I:

Introduction and Technical Background, Metals and Inorganics, Pesticides and PCBs

by

Michael A. Callahan, Michael W. Slimak,
Norman W. Gabel, Ira P. May, Charles F. Fowler, J. Randall Freed,
Patricia Jennings, Robert L. Durfee, Frank C. Whitmore, Bruno Maestri,
William R. Mabey, Buford R. Holt, and Constance Gould

EPA Contract No. 68-01-3852
EPA Contract No. 68-01-3867

Project Officer: Donald J. Ehreth
Monitoring and Data Support Division (WH-553)
Office of Water Planning and Standards
Washington, D.C. 20460

OFFICE OF WATER PLANNING AND STANDARDS
OFFICE OF WATER AND WASTE MANAGEMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

14. MERCURY

14.1 Statement of Probable Fate

Mercury's major removal mechanism from a natural water system is adsorption onto the surfaces of particulate phases and subsequent settling to the bed sediment. The overwhelming majority of any dissolved mercury is removed in this manner within a relatively short time, generally in the immediate vicinity of the source. Much smaller portions of the dissolved mercury are ingested by the aquatic biota or transported by current movement and dilution. Secondary transformations of mercury in the sediments can occur; these include precipitation as HgS and methylation by bacteria. Since the mercury itself is not destroyed, these inorganic and organic forms of mercury may then release ionic or metallic mercury into the water column as part of a recycling process. Resuspension of sediments by turbulence or the activity of benthic organisms can also release these compounds of mercury directly into the water column. The primary sink for mercury released to the environment is thus the sediments.

14.2 Identification - Geochemistry of Mercury

Mercury is able to exist in the natural environment in three oxidation states: as the native element itself, in the +1 (mercurous) state, and in the +2 (mercuric) state. The nature of the species which will occur in a given assemblage, or predominate in solution, depends upon the redox potential and pH of the environment.

It is difficult to estimate the abundance of mercury in the earth's crust. Fleischer (1970) reported that concentrations vary between 5 and 1000 ppb in common natural materials. Considerably higher concentrations have been measured in specific formations in mercury-rich regions of the world. Erickson (1960) estimated that about 10^{10} metric tons of rock are weathered each year. Using an average mercury content for rocks of 80 ppb, this would mean that about 800 metric tons of mercury are released from rock every year. Since typical soils do not contain higher concentrations of mercury than does its underlying rock, some of this weathered mercury must reach the aquatic environment.

Mercury has an atomic weight of 200.59, a melting point of -38.87°C, and a boiling point range of 356-358°C. At 20°C, its specific gravity is 13.546 and its vapor pressure is 0.0012 torr (Weast 1977). The solubility of metallic mercury in pure water has been determined by Sanemasa (1975) to be 19.2 μg/l and 81.3 μg/l at 5°C and 30°C, respectively.

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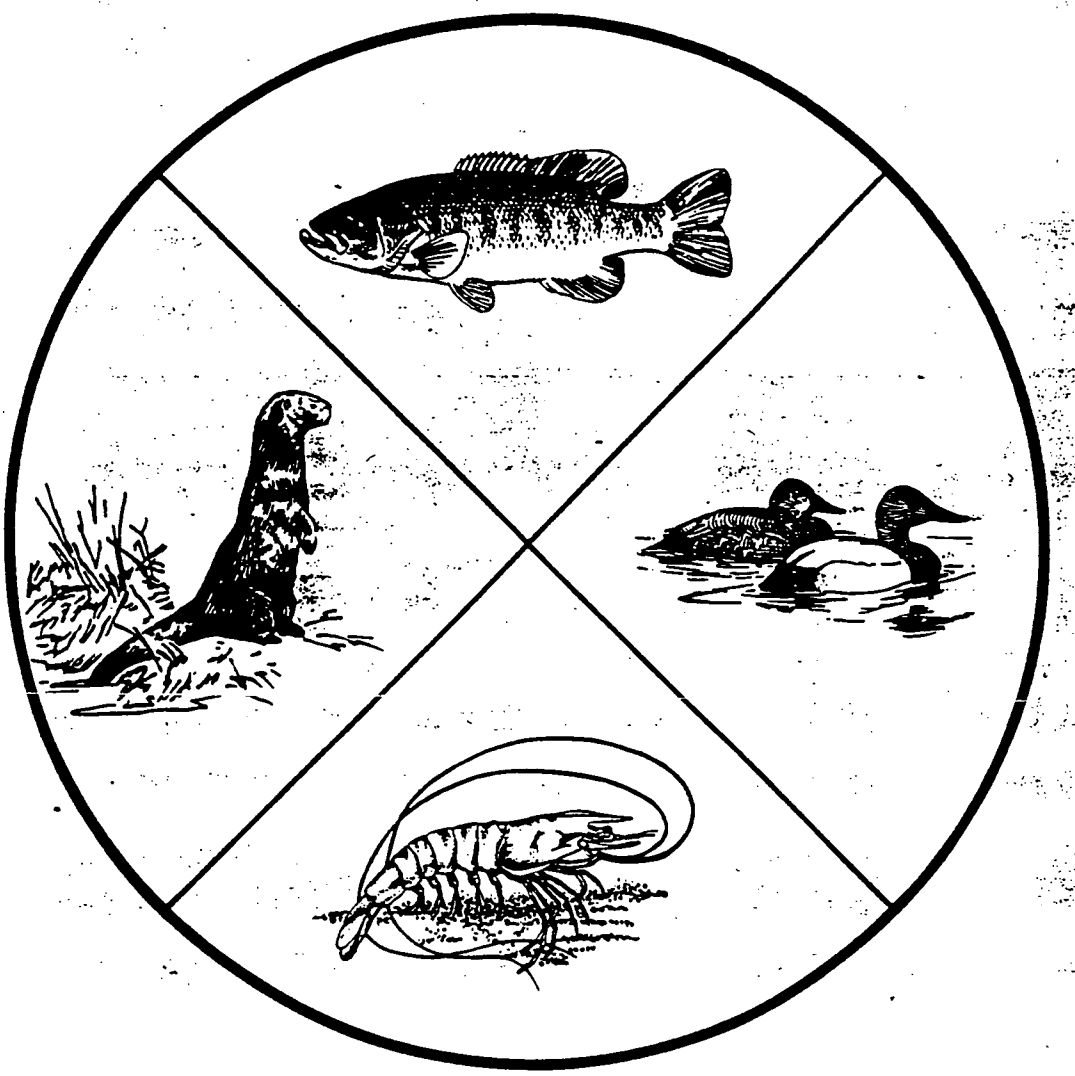
BIOLOGICAL REPORT 85(1.10)
APRIL 1987

CONTAMINANT HAZARD REVIEWS
REPORT NO. 10

MERCURY HAZARDS TO FISH, WILDLIFE, AND INVERTEBRATES: A SYNOPTIC REVIEW



Fish and Wildlife Service

U.S. Department of the Interior

CHEMICAL PROPERTIES

Mercury, a silver-white metal that is liquid at room temperature and is highly volatile, can exist in three oxidation states: elemental mercury (Hg^0), mercurous ion (Hg_2^{2+}), and mercuric ion (Hg^{2+}). It can be part of both inorganic and organic compounds (EPA 1980; Clarkson et al. 1984; Table 3). All mercury compounds interfere with thiol metabolism, causing inhibition or inactivation of proteins containing thiol ligands and ultimately leading to mitotic disturbances (Das et al. 1982; Elhassani 1983). The mercuric species is the most toxic inorganic chemical form, but all three forms of inorganic Hg may have a common molecular mechanism of damage in which Hg^{2+} is the toxic species (Clarkson and Marsh 1982; Figure 1).

Chemical speciation is probably the most important variable influencing ecotoxicology of Hg, but Hg speciation is difficult, especially in natural environments (Boudou and Ribeyre 1983). Mercury compounds in an aqueous solution are chemically complex. Depending on pH, alkalinity, redox, and other variables, a wide variety of chemical species are liable to be formed, having different electrical charges and solubilities. For example, $HgCl_2$ in solution can speciate into $Hg(OH)_2$, Hg^{2+}, $HgCl^+$, $Hg(OH)^-$, $HgCl_3^-$, and $HgCl_4^{2-}$; anionic forms predominate in saline environments (Boudou and Ribeyre 1983). In the aquatic environment, under naturally occurring conditions of pH and temperature, Hg may also become methylated by biological or chemical processes, or both (Beijer and Jernelov 1979; EPA 1980; Ramamoorthy and Blumhagen 1984; Figure 1) -- although abiological methylation is limited (Callister and Winfrey 1986). Methylmercury is the most hazardous mercury species due to its high stability, its lipid solubility, and its possession of ionic properties that lead to a high ability to penetrate membranes in living organisms (Beijer and Jernelov 1979).

All mercury discharged into rivers, bays, or estuaries as elemental (metallic) mercury, inorganic divalent mercury, phenylmercury, or alkoxyalkyl mercury can be converted into methylmercury compounds by natural processes (Jernelov 1969). The mercury methylation in ecosystems depends on mercury loadings, microbial activity, nutrient content, pH and redox condition, suspended sediment load, sedimentation rates, and other variables (NAS 1978; Compeau and Bartha 1984; Berman and Bartha 1986; Callister and Winfrey 1986; Jackson 1986). The finding that certain microorganisms are able to convert

Table 3. Some properties of mercury and its compounds.[a]

Property	Elemental mercury	Mercurous chloride	Mercuric chloride	Methylmercury chloride
Empirical formula	Hg	Hg_2Cl_2	$HgCl_2$	CH_3HgCl
Molecular weight	200.59	472.09	271.52	251.09[c]
Chlorine, %	0	15.02	26.12	14.12[c]
Mercury, %	100	84.98	73.88	79.89[c]
Melting point, °C	-38.87	sublimes at 400-500	277	170[c]
Density	13.534	7.15	5.4	4.063[c]
Solubility, mg/l (ppm)				
In water	0.056	2.0	74,070	~1,016[d]
In benzene	2.387[b]	insol.	5,000	~6,535[e]

[a] All data from Merck Index (1976), except where indicated.
[b] Spencer and Voigt (1968).
[c] Weast and Astle (1982).
[d] Eisler (unpubl.), 72 hour equilibrium value.
[e] Eisler (unpubl.), 24 hour equilibrium value.

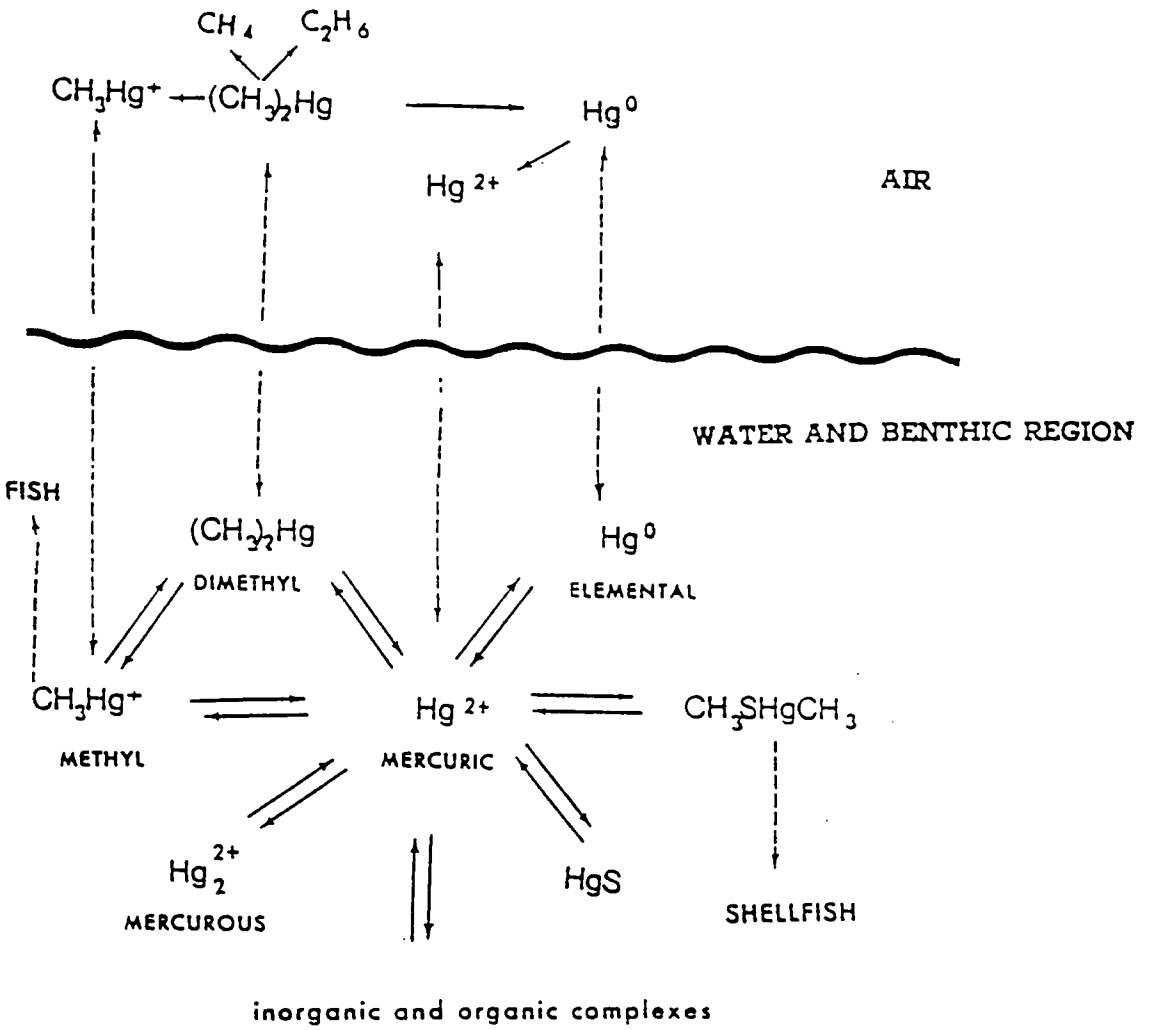


Figure 1. Major transformations of mercury in the environment (modified from Beijer and Jernelov 1979).

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Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States

By HANSFORD T. SHACKLETTE *and* JOSEPHINE G. BOERNGEN

U.S. GEOLOGICAL SURVEY PROFESSIONAL PAPER 1270

An account of the concentrations of 50 chemical elements in samples of soils and other regoliths

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1984

APPENDIX

LABORATORY ANALYTICAL DATA

(1987 Results Only)

SEE VOLUME 2

(194 of 265)

ENGINEERING INVESTIGATIONS AT INACTIVE HAZARDOUS WASTE SITES

PHASE II INVESTIGATION

Mercury Sediments - Onondaga Lake

Site No. 734030

City of Syracuse

Onondaga County

VOLUME 2 (Continued)

New York State Department of Environmental Conservation

50 Wolf Road, Albany, New York 12233
Thomas C. Jorling, Commissioner

Division of Hazardous Waste Remediation
Michael J. O'Toole, P.E., Director

(195 of 285)

01

SAMPLE DATA SUMMARY PACKAGE

DEC 0 2 1987

RECEIVED
DEC 11 1987
TECHNICAL SERVICES & RESEARCH
DIVISION OF WATER

CASE NARRATIVE

Laboratory Name: Recra Environmental, Inc.
Case Number: 87-1525

Samples Identifications*:

Soil Matrix

SH8773403044	V	S	P	M
SH8773403045	V	S	P	M
SH8773403046	—	S	P	M
SH8773403047	V	S	P	M
SH8773403048	V	S	P	M
SH8773403048 MS				
SH8773403048 MSD				
SH8773403049	V	S	P	M
SH8773403050	V	S	P	M
SH8773403051	V	S	P	M

Aqueous Matrix

SH8773403004	V	S	P	M	SH8773403009	V	S	P	M
SH8773403005	V	S	P	M	SH8773403010	V	S	P	M
SH8773403006	V	S	P	M	SH8773403011	V	S	P	M
SH8773403007	V	S	P	M	SH8773403012	V	S	P	M
SH8773403007 MS					SH8773403013	V	S	P	M
SH8773403007 MSD					SH8773403061	V	S	P	M
Field Blank					Trip Blank	V			

* Sample identifications contained in the data package consist of the last three (3) digits of the above identification numbers.

Contract Number: C001741
Sample Receipt: November 10, 1987

Volatile Data

- Volatile sample and standard areas are listed on the corresponding data system printouts.
- During the volatile data transfer of sample SH8773403046, a software error resulted in the loss of the data file. The sample was not re-analyzed since the holding time had been exceeded.

Semi-Volatile Data

- Chromatogrpahically, Benzo(b)fluoranthene and Benzo(k)fluoranthene coelute. The reported value is therefore an "and/or" value.
- Semi-volatile sample and standard areas are listed on the corresponding raw data worksheets.
- Surrogate 2-Fluorophenol for the aqueous samples has low recovery due to a slight retention time shift on the scan delay.

Pesticide Data

- Pesticide/PCB compounds confirmed by two dissimilar GC columns were not confirmed by GC/MS due to insufficient concentration in the final sample extracts.

"Release of the data contained in this hardcopy data package has been authorized by the Laboratory Manager or his designee, as verified by the following signature."

Dr. Arun K. Bhattacharya

December 10, 1987

1A
VOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.
050

Lab Name: RECRA ENVIRONMENTAL, INC. Contract: C001741

Lab Code: FINNMAT Case No.: 87-1525 SAS No.: - SDG No.: -

Matrix: (soil/water) SOIL Lab Sample ID: 050

Sample wt/vol: 5.33 (g/mL) G Lab File ID: 5198

Level: (low/med) LOW Date Received: 11 10 87

% Moisture: not dec. 27.2 Date Analyzed: 11 17 87

Column: (pack/cap) PACK Dilution Factor: 1.0

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
74-87-3	Chloromethane	10	U
74-83-9	Bromomethane	10	U
75-01-4	Vinyl Chloride	10	U
75-00-3	Chloroethane	10	U
75-09-2	Methylene Chloride	25	B
67-64-1	Acetone	10	U
75-15-0	Carbon Disulfide	2	J
75-35-4	1,1-Dichloroethene	5	U
75-34-3	1,1-Dichloroethane	5	U
540-59-0	1,2-Dichloroethene (total)	0.6	J
67-66-3	Chloroform	0.2	J
107-06-2	1,2-Dichloroethane	5	U
78-93-3	2-Butanone	10	U
71-55-6	1,1,1-Trichloroethane	5	U
56-23-5	Carbon Tetrachloride	5	U
108-05-4	Vinyl Acetate	10	U
75-27-4	Bromodichloromethane	5	U
78-87-5	1,2-Dichloropropane	5	U
10061-01-5	cis-1,3-Dichloropropene	5	U
79-01-6	Trichloroethene	1	J
124-48-1	Dibromochloromethane	5	U
79-00-5	1,1,2-Trichloroethane	5	U
71-43-2	Benzene	5	U
10061-02-6	trans-1,3-Dichloropropene	5	U
75-25-2	Bromoform	5	U
108-10-1	4-Methyl-2-Pentanone	10	U
591-78-6	2-Hexanone	10	U
127-18-4	Tetrachloroethene	5	U
79-34-5	1,1,2,2-Tetrachloroethane	5	U
108-88-3	Toluene	1	BJ
108-90-7	Chlorobenzene	5	U
100-41-4	Ethylbenzene	0.1	J
100-42-5	Styrene	5	U
1330-20-7	Xylene (total)	5	U

1E
VOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

EPA SAMPLE NO.
050

Lab Name: RECRA ENVIRONMENTAL, INC. Contract: C001741

Lab Code: FINNMAT CASE NO.: 87-1525 SAS No.: - SDG No.: -

Matrix: (soil/water) SOIL Lab Sample ID: 050

Sample wt/vol: 5.33 (g/mL) G Lab File ID: 5198

Level: (low/med) LOW Date Received: 11/10/87

% Moisture: not dec. 27.2 Date Analyzed: 11/17/87

Column: (pack/cap) PACK Dilution Factor: 1.0

Number TICs found: 6

CONCENTRATION UNITS:
(ug/L or ug/Kg) UG/KG

	CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.	-	UNKNOWN	1:58	21	B
2.	-	UNKNOWN	2:56	120	
3.	-	UNKNOWN	5:48	120	B
4.	-	ALKYL ALIPHATIC	19:18	31	
5.	-	ALKYL ALIPHATIC	26:12	8	
6.	-	UNKNOWN	35:48	16	
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1B
SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.
050

Lab Name: RECRA ENVIRONMENTAL, INC. Contract: C001741

Lab Code: FINNMAT Case No.: 87-1525 SAS No.: - SDG No.: -

Matrix: (soil/water) SOIL Lab Sample ID: 050

Sample wt/vol: 30.11 (g/mL) G Lab File ID: 1038E

Level: (low/med) LOW Date Received: 11/10/87

% Moisture: not dec. 27.2 dec. ____ Date Extracted: 11/13/87

Extraction: (SepF/Cont/Sonc) SONC Date Analyzed: 11/25/87

GPC Cleanup: (Y/N) Y pH: 7.8 Dilution Factor: 1.0

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
108-95-2	Phenol	330	U
111-44-4	bis(2-Chloroethyl)ether	330	U
95-57-8	2-Chlorophenol	5	J
541-73-1	1,3-Dichlorobenzene	330	U
106-46-7	1,4-Dichlorobenzene	59	BJ
100-51-6	Benzyl alcohol	330	U
95-50-1	1,2-Dichlorobenzene	330	U
95-48-7	2-Methylphenol	330	U
108-60-1	bis(2-Chloroisopropyl)ether	330	U
106-44-5	4-Methylphenol	330	U
621-64-7	N-Nitroso-di-n-propylamine	330	U
67-72-1	Hexachloroethane	330	U
98-95-3	Nitrobenzene	330	U
78-59-1	Isophorone	330	U
88-75-5	2-Nitrophenol	330	U
105-67-9	2,4-Dimethylphenol	330	U
65-85-0	Benzoic acid	91	J
111-91-1	bis(2-Chloroethoxy)methane	330	U
120-83-2	2,4-Dichlorophenol	330	U
120-82-1	1,2,4-Trichlorobenzene	330	U
91-20-3	Naphthalene	10	J
106-47-8	4-Chloroaniline	330	U
87-68-3	Hexachlorobutadiene	330	U
59-50-7	4-Chloro-3-methylphenol	330	U
91-57-6	2-Methylnaphthalene	6	J
77-47-4	Hexachlorocyclopentadiene	330	U
88-06-2	2,4,6-Trichlorophenol	330	U
95-95-4	2,4,5-Trichlorophenol	1600	U
91-58-7	2-Chloronaphthalene	330	U
88-74-4	2-Nitroaniline	1600	U
131-11-3	Dimethylphthalate	330	U
208-96-8	Acenaphthylene	10	J
606-20-2	2,6-Dinitrotoluene	330	U

1C
SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.
050

Lab Name: RECRA ENVIRONMENTAL, INC. Contract: C001741

Lab Code: FINNMAT Case No.: 87-1525 SAS No.: - SDG No.: -

Matrix: (soil/water) SOIL Lab Sample ID: 050

Sample wt/vol: 30.11 (g/mL) G Lab File ID: 1038E

Level: (low/med) LOW Date Received: 11/10/87

% Moisture: not dec. 27.2 dec. ____ Date Extracted: 11/13/87

Extraction: (SepF/Cont/Sonc) SONC Date Analyzed: 11/25/87

GPC Cleanup: (Y/N) Y pH: 7.8 Dilution Factor: 1.0

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
99-09-2	3-Nitroaniline	1600	U
83-32-9	Acenaphthene	7	J
51-28-5	2,4-Dinitrophenol	1600	U
100-02-7	4-Nitrophenol	1600	U
132-64-9	Dibenzofuran	6	J
121-14-2	2,4-Dinitrotoluene	330	U
84-66-2	Diethylphthalate	16	BJ
7005-72-3	4-Chlorophenyl-phenylether	330	U
86-73-7	Fluorene	10	J
100-01-6	4-Nitroaniline	1600	U
534-52-1	4,6-Dinitro-2-methylphenol	1600	U
86-30-6	N-Nitrosodiphenylamine (1)	330	U
101-55-3	4-Bromophenyl-phenylether	330	U
118-74-1	Hexachlorobenzene	330	U
87-86-5	Pentachlorophenol	1600	U
85-01-8	Phenanthrene	87	J
120-12-7	Anthracene	20	J
84-74-2	Di-n-butylphthalate	32	BJ
206-44-0	Fluoranthene	190	J
129-00-0	Pyrene	180	J
85-68-7	Butylbenzylphthalate	330	U
91-94-1	3,3'-Dichlorobenzidine	660	U
56-55-3	Benzo(a)anthracene	84	J
218-01-9	Chrysene	110	J
117-81-7	bis(2-Ethylhexyl)phthalate	450	
117-84-0	Di-n-octylphthalate	4	BJ
205-99-2	Benzo(b)fluoranthene	180	J
207-08-9	Benzo(k)fluoranthene	330	U
50-32-8	Benzo(a)pyrene	84	J
193-39-5	Indeno(1,2,3-cd)pyrene	56	J
53-70-3	Dibenz(a,h)anthracene	25	J
191-24-2	Benzo(g,h,i)perylene	60	J

(1) - Cannot be separated from Diphenylamine

1F
SEMIVOLATILE ORGANICS ANALYSIS DATA SHEET
TENTATIVELY IDENTIFIED COMPOUNDS

EPA SAMPLE NO.
050

Lab Name: RECRA ENVIRONMENTAL, INC. Contract: C001741

Lab Code: FINNMAT Case No.: 87-1525 SAS No.: - SDG No.: -

Matrix: (soil/water) SOIL Lab Sample ID: 050

Sample wt/vol: 30.11 (g/mL) G Lab File ID: 1038E

Level: (low/med) LOW Date Received: 11/10/87

% Moisture: not dec. 27.2 dec. ____ Date Extracted: 11/13/87

Extraction: (SepF/Cont/Sonc) SONC Date Analyzed: 11/25/87

GPC Cleanup: (Y/N) Y pH: 7.8 Dilution Factor: 1.0

Number TICs found: 20

CONCENTRATION UNITS:
(ug/L or ug/Kg) UG/KG

	CAS NUMBER	COMPOUND NAME	RT	EST. CONC.	Q
1.	-	METHYL CYCLOPENTANOL ISOMER	5:14	450	
2.	-	ALKYL SUBSTITUTED COMPOUND	5:34	410	B
3.	-	ALKYL OXYGENATED COMPOUND	5:56	530	B
4.	-	ALKYL OXYGENATED COMPOUND	6:04	1200	
5.	-	BENZENEDICARBOXYLIC ALKYL ESTER	20:06	330	B
6.	-	UNKNOWN	21:48	14500	
7.	-	LONGCHAIN ALIPHATIC	22:35	1800	B
8.	-	LONGCHAIN ALIPHATIC	27:29	7300	
9.	-	LONGCHAIN ALIPHATIC	28:29	400	
10.	-	LONGCHAIN ALIPHATIC	29:33	17200	
11.	-	ALKYL LONGCHAIN ALIPHATIC	30:29	930	
12.	-	ALKYL LONGCHAIN ALIPHATIC	31:35	7800	
13.	-	LONGCHAIN ALIPHATIC	31:47	490	
14.	-	LONGCHAIN ALIPHATIC	34:11	3100	
15.	-	UNKNOWN	34:27	1040	
16.	-	UNKNOWN	35:07	550	
17.	-	ALKYL SUBSTITUTED COMPOUND	37:46	730	
18.	-	ALKYL SUBSTITUTED COMPOUND	38:07	460	
19.	-	ALKYL SUBSTITUTED COMPOUND	38:53	1140	
20.	-	ALKYL SUBSTITUTED COMPOUND	39:08	1700	
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1D
PESTICIDE ORGANICS ANALYSIS DATA SHEET

EPA SAMPLE NO.
050

Lab Name: RECRA ENVIRONMENTAL, INC. Contract: C001741

Lab Code: _____ Case No.: 87-1525 SAS No.: - SDG No.: -

Matrix: (soil/water) SOIL Lab Sample ID: SS239

Sample wt/vol: 30.1 (g/mL) G Lab File ID: _____

Level: (low/med) LOW Date Received: 11/10/87

% Moisture: not dec. 27 dec. - Date Extracted: 11/13/87

Extraction: (SepF/Cont/Sonc) SONC Date Analyzed: 11/20/87

GPC Cleanup: (Y/N) Y pH: 7.8 Dilution Factor: 0.1

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/KG	Q
319-84-6	alpha-BHC	110	U
319-85-7	beta-BHC	55	JB
319-86-8	delta-BHC	110	U
58-89-9	gamma-BHC (Lindane)	110	U
76-44-8	Heptachlor	110	U
309-00-2	Aldrin	110	U
1024-57-3	Heptachlor epoxide	110	U
959-98-8	Endosulfan I	110	U
60-57-1	Dieldrin	220	U
72-55-9	4,4'-DDE	220	U
72-20-8	Endrin	220	U
33213-65-9	Endosulfan II	220	U
72-54-8	4,4'-DDD	220	U
1031-07-8	Endosulfan sulfate	220	U
50-29-3	4,4'-DDT	220	U
72-43-5	Methoxychlor	1100	U
53494-70-5	Endrin ketone	220	U
5103-71-9	alpha-Chlordane	1100	U
5103-74-2	gamma-Chlordane	1100	U
8001-35-2	Toxaphene	2200	U
12674-11-2	Aroclor-1016	1100	U
11104-28-2	Aroclor-1221	1400	U
11141-16-5	Aroclor-1232	1400	U
53469-21-9	Aroclor-1242	1100	U
12672-29-6	Aroclor-1248	1100	U
11097-69-1	Aroclor-1254	2200	U
11096-82-5	Aroclor-1260	2200	U

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Form I

U.S. EPA Contract Laboratory Program
Sample Management Office
P.O. Box 818 - Alexandria, VA 22313
703/557-2490 FTS: 8-557-2490

EPA Sample No.
SH8773403044

Date 12/8/87

INORGANIC ANALYSIS DATA SHEET

LAB NAME RECRA ENVIRONMENTAL, INC.

CASE NO. 87-1525A

SOW NO.

LAB RECEIPT DATE 11/10/87

LAB SAMPLE ID. NO. SH8773403044 (9110)

QC REPORT NO. 87-1525AQC

Elements Identified and Measured

Concentration: Low _____ Medium _____

Matrix: Water _____ Soil X Sludge _____ Other _____.

ug/L or mg/kg dry weight (Circle One)

1.	Aluminum	10,100		A	13.	Magnesium	13,300		A
2.	Antimony	0.95 U	N	F	14.	Manganese	600		A
3.	Arsenic	6.3	N	F	15.	Mercury	13		CV
4.	Barium	84		A	16.	Nickel	19		A
5.	Beryllium	0.95 U		A	17.	Potassium	2,980		A
6.	Cadmium	0.95 U		A	18.	Selenium	0.95 U	N	F
7.	Calcium	200,000		A	19.	Silver	0.95 U	N	A
8.	Chromium	18		A	20.	Sodium	2,670		A
9.	Cobalt	3.8		A	21.	Thallium	0.95 U		F
10.	Copper	37		A	22.	Vanadium	15 *		A
11.	Iron	13,700		A	23.	Zinc	103	N	A
12.	Lead	40		A	Percent Solids (%)		53.8		
Cyanide		0.93 U							

Footnote: For reporting results to EPA, standard result qualifiers are used as defined on Cover Page. Additional flags or footnotes explaining results are encouraged. Definition of such flags must be explicit and contained on Cover Page, however.

Comments: CV - cold vapor

Lab Manager _____

Form I

U.S. EPA Contract Laboratory Program
Sample Management Office
P.O. Box 818 - Alexandria, VA 22313
703/557-2490 FTS: 8-557-2490

EPA Sample No.
SH8773403045

Date 12/8/87

INORGANIC ANALYSIS DATA SHEET

LAB NAME RECRA ENVIRONMENTAL, INC. CASE NO. 87-1525A

SOW NO. _____ LAB RECEIPT DATE 11/10/87

LAB SAMPLE ID. NO. SH8773403045 (9111) QC REPORT NO. 87-1525AQC

Elements Identified and Measured

Concentration: Low _____ Medium _____

Matrix: Water _____ Soil X Sludge _____ Other _____

ug/L or mg/kg dry weight (Circle One)

1.	Aluminum	4,860		A	13.	Magnesium	29,800		A
2.	Antimony	0.70 U	N	F	14.	Manganese	495		A
3.	Arsenic	2.8	N	F	15.	Mercury	0.10 U		CV
4.	Barium	45		A	16.	Nickel	8.5		A
5.	Beryllium	0.70 U		A	17.	Potassium	1,450		A
6.	Cadmium	0.70 U		A	18.	Selenium	0.70 U	N	F
7.	Calcium	185,000		A	19.	Silver	0.70 U	N	A
8.	Chromium	7.0		A	20.	Sodium	282		A
9.	Cobalt	4.2		A	21.	Thallium	0.70 U		F
10.	Copper	17		A	22.	Vanadium	7.0 *		A
11.	Iron	10,300		A	23.	Zinc	39	N	A
12.	Lead	38		A	Percent Solids (%)		73.2		
Cyanide		0.68 U							

Footnote: For reporting results to EPA, standard result qualifiers are used as defined on Cover Page. Additional flags or footnotes explaining results are encouraged. Definition of such flags must be explicit and contained on Cover Page, however.

Comments: CV - cold vapor

Lab Manager _____

Form I

U.S. EPA Contract Laboratory Program
Sample Management Office
P.O. Box 818 - Alexandria, VA 22313
703/557-2490 FTS: 8-557-2490

EPA Sample No.
SH8773403046

Date 12/8/87

INORGANIC ANALYSIS DATA SHEET

LAB NAME RECRA ENVIRONMENTAL, INC. CASE NO. 87-1525A

SOW NO. _____ LAB RECEIPT DATE 11/10/87

LAB SAMPLE ID. NO. SH8773403046 (9112) QC REPORT NO. 87-1525AQC

Elements Identified and Measured

Concentration: Low _____ Medium _____

Matrix: Water _____ Soil X Sludge _____ Other _____

ug/L or mg/kg dry weight (Circle One)

1.	Aluminum	4,030		A	13.	Magnesium	11,500		A
2.	Antimony	1.2 U	N	F	14.	Manganese	374		A
3.	Arsenic	7.7	N	F	15.	Mercury	1.94		CV
4.	Barium	140		A	16.	Nickel	19		A
5.	Beryllium	1.2 U		A	17.	Potassium	1,100		A
6.	Cadmium	1.2		A	18.	Selenium	1.2 U	N	F
7.	Calcium	367,000		A	19.	Silver	1.2 U	N	A
8.	Chromium	27		A	20.	Sodium	1,930		A
9.	Cobalt	7.2		A	21.	Thallium	1.2 U		F
10.	Copper	100		A	22.	Vanadium	19 *		A
11.	Iron	9,690		A	23.	Zinc	221	N	A
12.	Lead	92		A	Percent Solids (%)		42.8		
Cyanide		1.2 U							

Footnote: For reporting results to EPA, standard result qualifiers are used as defined on Cover Page. Additional flags or footnotes explaining results are encouraged. Definition of such flags must be explicit and contained on Cover Page, however.

Comments: CV - cold vapor

Lab Manager _____

Form I

U.S. EPA Contract Laboratory Program
Sample Management Office
P.O. Box 818 - Alexandria, VA 22313
703/557-2490 FTS: 8-557-2490

EPA Sample No.
SH8773403047

Date 12/8/87

INORGANIC ANALYSIS DATA SHEET

LAB NAME RECRA ENVIRONMENTAL, INC. CASE NO. 87-1525A

SOW NO. _____ LAB RECEIPT DATE 11/10/87

LAB SAMPLE ID. NO. SH8773403047 (9113) QC REPORT NO. 87-1525AQC

Elements Identified and Measured

Concentration: Low _____ Medium _____

Matrix: Water _____ Soil X Sludge _____ Other _____

ug/L or mg/kg dry weight (Circle One)

1.	Aluminum	6,100		A	13.	Magnesium	9,020		A
2.	Antimony	1.1 U	N	F	14.	Manganese	1,550		A
3.	Arsenic	16	N	F	15.	Mercury	1.08		CV
4.	Barium	7,670		A	16.	Nickel	1,570		A
5.	Beryllium	1.1 U		A	17.	Potassium	1,360		A
6.	Cadmium	1.1 U		A	18.	Selenium	1.1 U	N	F
7.	Calcium	140,000		A	19.	Silver	2.7	N	A
8.	Chromium	2,252		A	20.	Sodium	833		A
9.	Cobalt	1,500		A	21.	Thallium	1.1 U		F
10.	Copper	422		A	22.	Vanadium	3,000 *		A
11.	Iron	104,000		A	23.	Zinc	475	N	A
12.	Lead	253		A	Percent Solids (%)		46.2		
Cyanide		2.5							

Footnote: For reporting results to EPA, standard result qualifiers are used as defined on Cover Page. Additional flags or footnotes explaining results are encouraged. Definition of such flags must be explicit and contained on Cover Page, however.

Comments: CV - cold vapor

Lab Manager _____

Form I

U.S. EPA Contract Laboratory Program
Sample Management Office
P.O. Box 818 - Alexandria, VA 22313
703/557-2490 FTS: 8-557-2490

EPA Sample No.
SH8773403048

Date 12/8/87

INORGANIC ANALYSIS DATA SHEET

LAB NAME RECRA ENVIRONMENTAL, INC. CASE NO. 87-1525 A

SOW NO. _____ LAB RECEIPT DATE 11/10/87

LAB SAMPLE ID. NO. SH8773403048 (9114, 9115) QC REPORT NO. 87-1525AQC

Elements Identified and Measured

Concentration: Low _____ Medium _____

Matrix: Water _____ Soil X Sludge _____ Other _____

ug/L or mg/kg dry weight (Circle One)

1.	Aluminum	4,380		A	13.	Magnesium	10,500		A
2.	Antimony	0.98 U	N	F	14.	Manganese	317		A
3.	Arsenic	5.2	N	F	15.	Mercury	21.1		CV
4.	Barium	99.7		A	16.	Nickel	18.6		A
5.	Beryllium	0.98 U		A	17.	Potassium	1,480		A
6.	Cadmium	0.98 U		A	18.	Selenium	0.98 U	N	F
7.	Calcium	373,000		A	19.	Silver	0.98 U	N	A
8.	Chromium	9.0		A	20.	Sodium	1,860		A
9.	Cobalt	3.9 U		A	21.	Thallium	0.98 U		F
10.	Copper	30.4		A	22.	Vanadium	9.8 *		A
11.	Iron	8,710		A	23.	Zinc	172	N	A
12.	Lead	43		A	Percent Solids (%)		51.1		
Cyanide		0.98 U							

Footnote: For reporting results to EPA, standard result qualifiers are used as defined on Cover Page. Additional flags or footnotes explaining results are encouraged. Definition of such flags must be explicit and contained on Cover Page, however.

Comments: CV - cold vapor

Lab Manager _____

Form I

U.S. EPA Contract Laboratory Program
Sample Management Office
P.O. Box 818 - Alexandria, VA 22313
703/557-2490 FTS: 8-557-2490

EPA Sample No.
SH8773403049

Date 12/8/87

INORGANIC ANALYSIS DATA SHEET

LAB NAME RECRA ENVIRONMENTAL, INC.

CASE NO. 87-1525A

SOW NO.

LAB RECEIPT DATE 11/10/87

LAB SAMPLE ID. NO. SH8773403049 (9116)

QC REPORT NO. 87-1525AQC

Elements Identified and Measured

Concentration: Low _____ Medium _____

Matrix: Water _____ Soil X Sludge _____ Other _____

ug/L or mg/kg dry weight (Circle One)

1.	Aluminum	6,830		A	13.	Magnesium	21,800		A
2.	Antimony	0.68 U	N	F	14.	Manganese	344		A
3.	Arsenic	3.8	N	F	15.	Mercury	0.13		CV
4.	Barium	100		A	16.	Nickel	9.6		A
5.	Beryllium	0.68 U		A	17.	Potassium	2,180		A
6.	Cadmium	10		A	18.	Selenium	0.68 U	N	F
7.	Calcium	144,000		A	19.	Silver	16	N	A
8.	Chromium	21		A	20.	Sodium	411		A
9.	Cobalt	4.1		A	21.	Thallium	0.68 U		F
10.	Copper	70		A	22.	Vanadium	15 *		A
11.	Iron	11,200		A	23.	Zinc	240	N	A
12.	Lead	88		A	Percent Solids (%)		74.2		
Cyanide		0.68 U							

Footnote: For reporting results to EPA, standard result qualifiers are used as defined on Cover Page. Additional flags or footnotes explaining results are encouraged. Definition of such flags must be explicit and contained on Cover Page, however.

Comments: CV - cold vapor

Lab Manager _____

Form I

U.S. EPA Contract Laboratory Program
Sample Management Office
P.O. Box 818 - Alexandria, VA 22313
703/557-2490 FTS: 8-557-2490

EPA Sample No.
SH8773403050

Date 12/8/87

INORGANIC ANALYSIS DATA SHEET

LAB NAME RECRA ENVIRONMENTAL, INC. CASE NO. 87-1525A

SOW NO. _____ LAB RECEIPT DATE 11/10/87

LAB SAMPLE ID. NO. SH8773403050 (9117) QC REPORT NO. 87-1525AQC

Elements Identified and Measured

Concentration: Low _____ Medium _____

Matrix: Water _____ Soil X Sludge _____ Other _____

ug/L or mg/kg dry weight (Circle One)

1.	Aluminum	3,460		A	13.	Magnesium	8,470		A
2.	Antimony	0.69 U	N	F	14.	Manganese	275		A
3.	Arsenic	2.7	N	F	15.	Mercury	0.096 U		CV
4.	Barium	46		A	16.	Nickel	8.4		A
5.	Beryllium	0.69 U		A	17.	Potassium	657		A
6.	Cadmium	2.9		A	18.	Selenium	0.69 U	N	F
7.	Calcium	112,000		A	19.	Silver	0.69 U	N	A
8.	Chromium	19		A	20.	Sodium	556		A
9.	Cobalt	2.8		A	21.	Thallium	0.69 U		F
10.	Copper	28		A	22.	Vanadium	9.7 *		A
11.	Iron	12,200		A	23.	Zinc	92	N	A
12.	Lead	39		A	Percent Solids (%)		72.8		
Cyanide		0.69 U							

Footnote: For reporting results to EPA, standard result qualifiers are used as defined on Cover Page. Additional flags or footnotes explaining results are encouraged. Definition of such flags must be explicit and contained on Cover Page, however.

Comments: CV - cold vapor

Lab Manager _____

Form I

U.S. EPA Contract Laboratory Program
Sample Management Office
P.O. Box 818 - Alexandria, VA 22313
703/557-2490 FTS: 8-557-2490

EPA Sample No.
SH8773403051

Date 12/8/87

INORGANIC ANALYSIS DATA SHEET

LAB NAME RECRA ENVIRONMENTAL, INC.

CASE NO. 87-1525A

SOW NO.

LAB RECEIPT DATE 11/10/87

LAB SAMPLE ID. NO. SH8773403051 (9118)

QC REPORT NO. 87-1525AQC

Elements Identified and Measured

Concentration: Low _____ Medium _____

Matrix: Water _____ Soil X Sludge _____ Other _____

ug/L or mg/kg dry weight (Circle One)

1.	Aluminum	10,200		A	13.	Magnesium	16,200		A
2.	Antimony	0.83 U	N	F	14.	Manganese	324		A
3.	Arsenic	7.7	N	F	15.	Mercury	1.01		CV
4.	Barium	196		A	16.	Nickel	32		A
5.	Beryllium	0.83 U		A	17.	Potassium	2,100		A
6.	Cadmium	2.0		A	18.	Selenium	0.83 U	N	F
7.	Calcium	67,800		A	19.	Silver	1.0	N	A
8.	Chromium	59		A	20.	Sodium	831		A
9.	Cobalt	12		A	21.	Thallium	0.83 U		F
10.	Copper	167		A	22.	Vanadium	30 *		A
11.	Iron	17,800		A	23.	Zinc	346	N	A
12.	Lead	665		A	Percent Solids (%)		59.2		
Cyanide		0.85 U							

Footnote: For reporting results to EPA, standard result qualifiers are used as defined on Cover Page. Additional flags or footnotes explaining results are encouraged. Definition of such flags must be explicit and contained on Cover Page, however.

Comments: CV - cold vapor

Lab Manager _____

Field Notes

(213 of 265)

Keuffel & Esser Company

ONONDAGA LAKE

#734030

82 0020

Weatherproof Field Book

Perforated pages

96 pages

4 5/8" x 7 1/4"

Keuffel & Esser Co. Morristown, N. J. 07960 Made in U.S.A.

CURVE FORMULAS

$T = R \tan \frac{1}{2} I$

$T = \frac{50 \tan \frac{1}{2} I}{\text{Sin.} \frac{1}{2} D}$

$\text{Sin.} \frac{1}{2} D = \frac{50}{R}$

$\text{Sin.} \frac{1}{2} D = \frac{50 \tan \frac{1}{2} I}{T}$

$R = T \cot. \frac{1}{2} I$

$R = \frac{50}{\text{Sin.} \frac{1}{2} D}$

$E = R \text{ ex. sec } \frac{1}{2} I$

$E = T \tan \frac{1}{2} I$

$\text{Chord def.} = \frac{\text{chord}^2}{R}$

$\text{No. chords} = \frac{I}{D}$

Tan. def. = ½ chord def.

The square of any distance, divided by twice the radius, will equal the distance from tangent to curve, very nearly.

To find angle for a given distance and deflection.

Rule 1. Multiply the given distance by .01745 (def. for 1° for 1 ft.) and divide given deflection by the product.

Rule 2. Multiply given deflection by 57.3, and divide the product by the given distance.

To find deflection for a given angle and distance. Multiply the angle by .01745, and the product by the distance.

GENERAL DATA

Right Angle Triangles. Square the altitude, divide by twice the base. Add quotient to base for hypotenuse.

Given Base 100, Alt. $10.10^2 \div 200 = .5$. $100 + .5 = 100.5$ hyp.

Given Hyp. 100, Alt. $25.25^2 \div 200 = 3.125$; $100 - 3.125 = 96.875$ = Base.

Error in first example, .002; in last, .045.

To find Tons of Rail in one mile of track: multiply weight per yard by 11, and divide by 7.

Leveling. The correction for curvature and refraction, in feet and decimals of feet is equal to $0.574\,d^2$, where d is the distance in miles. The correction for curvature alone is closely, $\frac{2}{3}d^2$. The combined correction is negative.

Probable Error. If d_1, d_2, d_3, etc. are the discrepancies of various results from the mean, and if Σd^2 = the sum of the squares of these differences and n = the number of observations, then the probable error of the mean =

$$\pm 0.6745 \sqrt{\frac{\Sigma d^2}{n(n-1)}}$$

MINUTES IN DECIMALS OF A DEGREE

1'	.0167	11'	.1833	21'	.3500	31'	.5167	41'	.6833	51'	.8500
2	.0333	12	.2000	22	.3667	32	.5333	42	.7000	52	.8667
3	.0500	13	.2167	23	.3833	33	.5500	43	.7167	53	.8833
4	.0667	14	.2333	24	.4000	34	.5667	44	.7333	54	.9000
5	.0833	15	.2500	25	.4167	35	.5833	45	.7500	55	.9167
6	.1000	16	.2667	26	.4333	36	.6000	46	.7667	56	.9333
7	.1167	17	.2833	27	.4500	37	.6167	47	.7833	57	.9500
8	.1333	18	.3000	28	.4667	38	.6333	48	.8000	58	.9667
9	.1500	19	.3167	29	.4833	39	.6500	49	.8167	59	.9833
10	.1667	20	.3333	30	.5000	40	.6667	50	.8333	60	1.0000

INCHES IN DECIMALS OF A FOOT

1-16	3-32	⅛	3-16	¼	5-16	⅜	7-16	½	9-16	¾	⅞
.0052	.0078	.0104	.0156	.0208	.0260	.0313	.0417	.0521	.0625	.0729
1	2	3	4	5	6	7	8	9	10	11
.0833	.1667	.2500	.3333	.4167	.5000	.5833	.6667	.7500	.8333	.9167

(214 of 265) (1)

9/5/86 Onondaga Lake

Slight windy rain in morning SHP gage 2.65 @ 0950
intermittent sunshine with showers throughout day temp in 60's
Vibrate, Longbucket, Denton - DEC

5-18 HAND Core - Pounded with rubber mallet
water depth 9 ft start 1035 am

48" Recovery

0-6" LIGHT GRAY SILTY SAND (THICK)
Sample Jarred Prior 6-12" LIGHT GRAY SILTY SAND (THICK)
5:30 pm 12-18" LIGHT GRAY SILTY SAND TENDING TO MED GRAY
6:30 pm 18-24" LIGHT GRAY SILTY SAND TENDING TO MED GRAY
9/5/86 24-30" LIGHT GRAY SILTY SAND TENDING TO MED GRAY
30-36" LIGHT GRAY SILTY SAND TENDING TO MED GRAY
36-42" LIGHT GRAY SILTY SAND TENDING TO MED GRAY
42-48" LIGHT GRAY SILTY SAND TENDING TO MED GRAY

5-28 HAND Core - Pounded with rubber mallet
start 1030 am
WATER DEPTH 3½ ft

36" RECOVERY

0-6" 10 ppb Photo Vac Jar DARK BROWN/DARK GRAY SAND
Samples Jarred Prior 6-12" 25 ppb Photo Vac Jar COARSE LIGHT GRAY GRAVELLY MIX WITH SILTY SAND
4:30 pm 12-18" 5 ppb Photo Vac Jar LIGHT GRAY GRAVELLY MIX WITH SILTY SAND
5:30 pm 18-24" 128 ppb Photo Vac Jar MIX WITH SILTY SAND LIGHT GRAY GRAVELLY
9/5/86 24-30" 158 ppb Photo Vac Jar MIX WITH SILTY SAND LIGHT GRAY GRAVELLY
30-36" MIX WITH SILTY SAND AND SHELL TYPE FRAGMENTS

9/8/86 calm, sunny + clear temps in high 60's
VITALE, ~~[illegible]~~, DONLON - DEC
Sampled point 17, 23, 22, 25 + 30 with hand cores

S-17 Hand core pounded with mini-sledge @ 15:45 pm
Water Depth 3'
approx 42" core length pounded 6'
sandy (brown)

S-23 Hand core pounded with mini-sledge @ 16:30 pm
Water Depth 11½'
approx 54" core length pounded 5'
sandy (brown) upper ½-1' to light grey sandy silty clayish

S-22 Hand core pounded with mini sledge @ 18:00
Water Depth 8½'
approx 56" core length pounded 5½'
sandy with greenish patches in upper 3'
whiteish chalky sandy silt

S-25 Hand core pounded with mini sledge @ 18:30
Water Depth 7½'
60" core length pounded 5½'
sandy (brown) upper ½-1' whiteish chalky material in lower 4-4½'

S-30 Hand core pounded with mini-sledge @ 19:00 hrs
water depth 8'
approx 48" core length pounded 5'
upper 2" sandy (brown) remainder light grey silty sand / clayish

9/9/86 Staff gage at 7:30 - 3.15'
VITALE, BROWN, DONLON - DEC
sunny, clear, calm, temps in 70's ~~[illegible]~~

S-18 Piston core taken - no weights 14' Triggerline
at 10:00 hrs
water depth 55'
approx 42" core length black (thick) clayish silt ~~[illegible]~~
~~[illegible]~~

S-24 Piston core taken - no weights 14' Triggerline
at 11:00 hrs
water depth 60'
approx core length 42" - Black (thick) clayish silt

S-27 Piston core taken - no weights 14' Triggerline
at 12:15 hrs
water depth 54'
approx 60" core length - Black (thick) clayish silt with green + white intermixed

staff gage at 12:30 HRS 3.00

S-8 Piston core taken at 60 pounds weight
14½' trigger line at 15:00 HRS
water depth 54'
approx 48" core length - black (thick) clayish silt ~~with green and white intermixed~~

S-5 Piston core taken - 60 pounds weight -
Trigger line 14' at 15:30 HRS
water depth 49'
approx core length 42" - black (thick) clayish silt

S-7 Piston core taken - 60 pounds weight
14' Trigger line at 16:00 HRS
water depth 42'
approx core length 42" - black (thick) clayish silt

S-3 Piston core taken - 60 pounds weight
13½' Trigger line at 17:00 HRS
water depth 33'
approx core length 48" - upper 1½ brown sandy silt tending toward light grey sandy silt.

S-2 Piston core taken - 60 pounds weight
13½' Trigger line at 18:00 HRS
water depth 29'
approx core length 42" - upper 1½' sandy silt, lower 1½'-2' light grey sandy silt

S-6 Piston core taken 60 pound weights
13½' Trigger line at 18:30 HRS
water depth 29'
approx core length 42" - silty sand with lenses of light grey silty/clay

9/10/86 staff gage at 8:45 HRS - 2.80
VITALE, BROWN, DONLON - DEC
slight to strong wind cloudy, temps in 60's occasional showers

S-41 Piston core taken - 60 pound weights
13½' trigger line at 10:45 HRS
water depth 29'
approx core length 48" - heavy black clayish silt with white mixed in lower 24" (heavy oil smell)

S-33 Piston core taken - 60 pound weights
13½ trigger line at 11:30 HRS
water depth 59'
approx core length 48" - heavy black clayish silt (oil smell)

S-31 Piston core taken - 60 pound weights
13½' trigger line at 12:10 HRS
water depth 62'
approx core length 48" - heavy black clayish silt

S-43 Piston core taken - 60 pound weights
13½' trigger ~~length~~ line at 12:45 HRS
water depth 31'
approx core length 48" - black clayish silt in
upper 12"; lower 36" mixed to full white
chalky material.

staff gage at 14:45 HRS 2.70

S-9 Piston core taken - 60 pound weights
13½' trigger ~~length~~ line at 15:45 HRS
water depth 44'
approx core length 48" - black (thick) clayish
silt

S-11 Piston core taken - 60 pound weights.
13½' trigger ~~length~~ line at 16:15 HRS
water depth 36'
approx core length 36" upper 24" black clayish silt
lower 12" dark-medium grey clay

S-15 Piston core taken - 60 pound weights
13½' trigger ~~length~~ line at 16:50 HRS
water depth 32½'
approx core length 48" - black-dark grey clayish silt
in upper 36". lower 12" dark brown clayish silt

S-21 Piston core taken - 60 pound weight
13½' trigger line at 17:35 HRS
water depth 55½'
approx core 44" - black clayish silt

S-35 Piston core taken - 60 pound weight
13½' trigger line at 18:30 HRS
water depth 31½'
approximate core length 52" - black clayish silt
(heavy oil smell and sheen)

VITALE, BROWN, DONLON - DEC
9/11/86 Staff gage at 08:30 HRS 2.55
warm, cloudy, rain, windy in morning
warm cloudy windy in afternoon
Staff gage at 13:30 HRS 2.50

S-1 Broken Hand Corer in morning on this location
Vibracore taken at 15:30 HRS
water depth 14½'
approx core length 42" - sandy gravel to 6", lower 36"
white to light grey clay
Range - From Thruway overpass supports
EAST 83' - WEST 112'
Drawn 5½'

S-4 Vibracore taken at 15:00 HRS
water depth 9'
approx core length 56" - upper 12" sandy
feeding to light grey to white clay
driven 5'

S-10 Vibracore taken at 15:35 HRS
water depth 4'
approx core length 56" - upper 6" sandy -
remainder whitish grey clay
Taken 25' toward shore from bouy
driven 5'

S-13 manually pounded core liner taken at 17:30 HRS
pounded 5'
water depth 6'
approx core length 3½' upper 6" sandy (brown)
remainder whitish to light grey clay

S-16 manually pounded core liner taken at 18:00 HRS
water depth 2'
approx core length 36" - upper 1" sandy brown
remainder dark gray silt

S-12 Manually pounded core liner w/fingers taken
at 18:30 HRS
water depth 5½'
approx core length 36" - upper 1" sandy (brown)
bottom 2" grey silt

S-20 Vibracore taken at 19:15 HRS
water depth 9'
approx core length 42" - upper 18" sandy (brown)
lower 24" dark grey silt
driven 5½'

9/12/86 Staff gage at [illegible]
Windy + rain Vitale, Brown, Dunlon - DEC

S-36 Manually pounded core liner taken at 10:00 HRS
water depth 6'
approx core length 36" - upper 12" dark grey
sand - lower 24" dark grey sandsilt
driven 6'

S-42 Manually pounded core line taken at 11:30 HRS
water depth 14'
approx core length 60" - upper 48" gravelly (grey)
remainder light grey silt
driven 5½'

S-40 Manually pounded core liner taken at 12:30 HRS
Water depth 3'
Approx core length 18" - upper 6" Gravelly
lower 12" white silty w/some green
very tight and difficult to drive.

S-39 Manually pounded core liner taken at 13:30 HRS
water depth 4½'
Approx core length 30" - upper 24" Gravelly
sand (Brown-grey) - lower 6" dark grey silty clay
~~pounded~~
High winds Forced work to cease

9/15/86 Rainy + calm
staff gage 2.70 at 10:30 HRS
VITALE, DANA, DONLON - DEC

S-26 Hand core taken at 14:00 HRS
Driven 5'
Water depth 16'
Approx core length 56" - Top 3" Sandy brown
(Dark Grey) Lower portion white marl

S-32 Hand core taken at 15:00 HRS
Driven 5'
Water depth 6'.
[illegible] 42". Light grey upper 6"

S-34 Hand core taken at 15:30 HRS pounded 5'
water depth 4½'
Approx core length 36" - GRAVEL TOP 2" TO 4"
sand ~~to~~ 36"

S-37 Hand core taken at 16:00 HRS pounded 5'
Water depth 4½'
Approximate core length 42" - Light grey on top to
Dark grey silty material

S-38 Piston corer taken with 60 pounds with 13½ trigger line
at 16:45 HRS
Water depth 20½'
Approx core length 54" - Heavy black muck (silty)

9/16/86 VITALE, DANA, DONLON - DEC

S-29 Piston corer taken with 60 pounds - 13½'
trigger line at 10:30 HRS.
Water depth 60'
Approx core length 54" Heavy black muck (silty)

S-14 Piston corer taken with 60 pounds - 13½'
trigger line at 11:45 HRS
water depth 43'
Approx core length 54" Heavy black muck (silty)

(12)

(220 of 255) (13)

9/16/96 TRIBUTARY SURFACE WATER + SEDIMENT SAMPLES TAKEN BY REYNOLDS + LACKEY INC

5-45 11:00 AM 5-45-00-00 — Sediment sample upstream of Allied Waste Beds on Nine Mile Creek

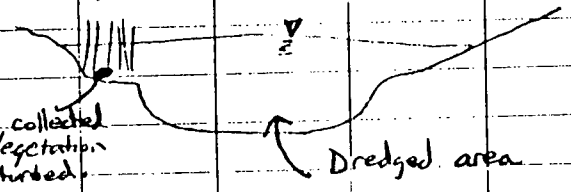
11:45 AM 4W-07-00-00 — Water sample upstream of Geddes Brook on Nine Mile Creek. Collected approx 100' upstream of confluence on Northern Bank, about 3' from shoreline

SH4 12:00 Noon 5-44-00-00 — Sediment sample on Nine Mile Creek. Taken from south side of bridge on State Fair Blvd, near center of stream channel.

SH7, 4W-12 12:20 PM 5-47-00-00 4W-12-00-00 — Samples collected from Trib 5A approx. 125' upstream from ℄ State Fair Blvd., just downstream of steel catwalk, from west bank. Visible Oil Sheen. (Chrome laminated peeled off trowel when cleaning), after collected sediment sample.

S-46, W-6
12:40 PM
S-46-00-00
W-06-00-00

Samples collected from East Flume about 10' upstream of locked gate across road to pump station. Samples taken from south bank about 5' from shore. Bottom of flume did not appear to have been dredged this close to shore. Depth = ~1.5'



S-49, W-10
1:45 PM
S-49-00-00
W-10-00-00

Samples collected from Bloody Brook, approx. 30' East of bridge on Onondaga Lake Parkway, from North bank in ~ 1' water.

S-48, W-9
2:40 PM
S-48-00-00
W-09-00-00

Samples collected from Geddes Brook, downstream of Confluence of West Flume, just West of NYS Route 5 overpass. Sample collected from south bank of Brook

W-4
3:15 PM
W-04-00-00

Sample collected from ISCO sampler in shed over outfall line at Metro STP.

W-5
3:25 PM
W-05-00-00

Sample collected from North side of Hiawatha Blvd. bridge over Onondaga Creek (Barge Canal) - inlet to Lake.

W-11, S-50
3:55 PM
W-11-00-00
S-50-00-00

Samples collected from Ley Creek @ Park Street. Water collected from center of Park Street bridge on West (downstream) side. Sediment collected from North bank ~30' West of bridge, about 2' from shore in ~2.5' of water.

(16)

9/16/06 Water samples collected from Onondaga Lake by Longobucco + Dunlop DEC

Sta 38 (sediment) at approx 14:00 hrs

water site station W-3

air D.O. 13.0
air Temp 4.5

Depth (m)	Temp (°C)	D.O. (ppm)	Conductivity (umoh)
0	12.0	10.4	2350
1	12.0	9.4	2400
2	12.0	9.0	2450
3	12.1	11.4	2450
4	12.1	10.5	2460
5	12.1	9.6	2480
6	12.3	9.0	2480
7	12.2	8.0	2450
~~8~~			

W-03-02-02 Sample collected from 2m 38-2m
W-03-04-04 " " " 4m 38-4m

Sta 29 (sediment) at approx 14:30 hrs

water site station W-2

air temp 8°C

Depth (m)	Temp (°C)	D.O. (ppm)	Conductivity (umoh)
0	12.9	10.2	2500
1	12.9	10.8	2500
2	12.9	13.6	2500
3	13.0	12.2	2500
4	13.0	12.2	2500
5	13.0	11.3	2500
6	13.0	10.7	2500
7	13.0	9.8	2500
8	12.9	9.2	2500
9	12.9	8.8	2500
10	12.9	8.6	2500
11	12.9	5.3	2500
12	11.2	2.5	2500
13	6.1	1.6	3000
14	3.7	1.6	3010
15	3.2	1.6	3010
16	3.0	1.6	3010
17	2.8	1.6	3010
18	2.2	1.5	3010

W-02-04-04 Sample collected from 4m
W-02-13-13 Sample collected from 13m
W-02-16-16 Sample collected from 16m

(18)

Station 14 (sediment) at approx 15:30 hrs
water site station W-81

Depth (m)	Temp (°C)	D.O (mg/l)	Conductivity (µmoh)
0	12.2	10.3	2900
1	12.5	10.1	2910
2	12.4	9.8	2910
3	12.9	9.8	2910
4	12.8	10.0	2920
5	12.9	10.0	2920
6	12.8	9.8	2900
7	13.0	9.6	2900
8	12.9	9.6	2900
9	13.0	9.6	2900
10	12.9	9.6	2880
11	13.0	9.4	2880
12	9.9	2.0	3210
13	9.1	1.1	3300
14	9.0	0.7	3100
15	8.3	0.6	3100

W-03-05-05 Sample collected from 5m
W-03-13-13 Sample collected from 13m

Station 18 (sediment) at approx 16:00 hrs
water site station W-8

Depth (m)	Temp (°C)	D.O. (mg/l)	Conductivity (µmoh)
0	12.0	11.0	1040
1	12.1	10.5	1100
2	12.4	9.5	2100
3	12.2	9.1	2500
4	12.4	8.9	2500
5	12.3	8.8	2500

W-08-01-01 Water sample taken from 1m
W-08-04-04 Water sample taken from 4m

9/22/87 Samples collected by Vitale, Langevin, Dunn of DEC

Sta 38 (sediment)
water site station W-3 Air temp 14°C

Depth (m)	Temp °C	(D.O. mg/l)	Conductivity
0	18.0	8.3	1850
1	17.7	6.5	2230
2	17.5	5.5	2240
3	17.5	5.3	2230
4	17.5	5.2	2230
5	17.5	5.2	2230
6	17.3	5.6	2230
6.5	17.3	5.0	2230

Samples Collected at 1130 hrs
1 sample at 3m - SH8773403003

S-38 Piston core taken with 60 lbs + 13½' Rigid line
at 12.00 hrs
Water depth 6½ meters
Approx core length 46" "HEAVY BLACK" muck (silty)

Sta 29 (sediment)
water site station W-2 Air temp 15°

Depth (m)	Temp °C	(D.O. mg/l)	Conductivity
0	17.4°	9.4	2280
1	17.5°	9.3	2280
2	17.3°	7.5	2240
3	17.2°	6.8	2250
4	17.1°	6.5	2220
5	17.0°	6.0	2230
6	17.0°	5.5	2230
7	17.0°	5.1	2230
8	17.0°	4.7	2300
9	16.8°	4.0	2380
10	16.7°	2.9	2450
11	13.7°	0.6	2340
12	10.5°	0.0	2000
13	9.5	0.0	1910
14	9.1	0.0	1900
15	9.0	0.0	1900
16	8.8	0.0	1900
17	8.7	0.0	1910
18	8.5	0.0	1800
19	8.5	0.0	1800

Samples collected at 1300 hrs
4 meters - SH8773403021
11 meters SH8773403022

(22)

S-29 Piston core taken at 14:00 Hrs with
60 lbs + 12' trigger line
water depth at 18 meters
approximate core length 48" - Thick Black muck (silty

Station 14 (sediment)
Water site station W-1

Air Temp 15

Depth (m)	Temp (°C)	D.O (ppm)	Conductivity
0	17.4	10.0	2260
1	17.5	9.2	2280
2	17.2	7.8	2280
3	17.5	6.9	2280
4	17.3	6.7	2300
5	17.2	5.7	2290
6	17.1	5.6	2360
7	17.1	5.4	2360
8	17.0	5.4	2360
9	16.5	1.7	2310
10	16.0	1.7	2340
11	16.1	1.7	2390
12 bottom	16.1	4.3	2500
13	12.9	0.8	1940
14	12.5	0.7	1940
15	12.0	0.4	1920
		0.5	1910

Samples Collected at 1630 Hrs
4 meters SH87734030011 MATRIX SPIKE MATRIX DUP
14 meters SH87734030012

S-14 Piston core taken at 17:30 Hrs at depth
of 12 m - 60 lbs 12½' Trigger line
approximate core length 48" Heavy Black muck with light grey mixed in spots (silty)

Sediment Station
water site station W-8 at approx 18:30 Hrs
Air Temp 14.1°

Depth	Temp (°C)	D.O (ppm)	Conductivity
0	17.0	9.5	1930
1	17.2	8.5	2210
2	16.9	6.8	2280
3	17.0	5.0	2300
4	16.8	4.2	2300
5	16.8	4.5	2300

Samples collected at approx 18:30 Hrs
3 meters SH87734030008

Duplicate sample TAKEN SH87734030060

Core S-38 recovery 46"
collected 9/22/87

This sample is to be sent for full HSL analysis

0-3" sample # SH87234030381
charcoal grey organic muck, oily smell
pudding like consistency

3-6" sample # SH87234030382
charcoal grey organick muck, oily smell
thick pudding consistency

6-12" reference sample
charcoal grey organic muck, oily smell
thick pudding consistency

12-18" sample # SH87234030383
charcoal grey organic muck, thick pudding
consistency + leaves

18-24" reference sample
charcoal grey organics muck tending toward a
more stiff clayey muck, oily smell (heavy)

24-30" sample # SH87234030384
semi-stiff charcoal grey clayey muck - heavy oil smell

30-36" reference sample
charcoal grey organic muck - semi stiff with
pale green tint on lower section - pudding like
(thick) consistency

36-42" sample # SH87234030385
mix of light green tinting toward off white and
back to a darker green pudding like muck

42-46" reference sample
mixture of charcoal grey, pale green, medium
green and dark green along with off white
marly type material, thick pudding consistency

(29)

Core S-29 recovery 48"
collected 9/22/87

This sample to be sent for full HSL analysis

0-3" sample # SH877340302 91
charcoal grey organic muck - pudding like consistency

3-6" sample # SH877340302 92
charcoal grey organic muck - stiffer than above sample. some clay.

6-12" reference sample
dark grey to black organic clayey muck

12-18" sample # SH877340302 93
dark grey to black clayey muck

18-24" reference sample
dark grey to black clayey muck

24-30" sample # SH877340302 94
dark grey to black clayey muck

30-36" reference sample
dark grey to black clayey muck

36-42" sample # SH877340302 95 matrix spike + matrix dup.
dark grey to black clayey muck

42-48" reference sample
dark grey to black clayey muck

core S-14 recovery 41"
collected 9/22/97

This sample to be sent for full HSL analysis

0-3" sample # SH877340301 41
charcoal grey organic muck - thin pudding like consistency.

3-6" sample # SH877340301 42
charcoal grey organic muck - pudding like consistency

6-12" reference sample
dark grey to black with greenish grey organic muck mixed - pudding like consistency

12-18" sample # SH877340301 43
dark grey to black with slight greenish grey muck - thick pudding consistency - heavy oil smell.

18-24" reference sample
dark grey to black thick pudding like organic muck

24-30" sample # SH877340301 44
dark grey to black thick pudding like organic muck

30-36" reference sample
black thick pudding consistency organic muck.

36-41" sample # SH877340301 45
black organic muck - thick pudding like consistency.

Samples processed
paperwork regarding samples performed
packed into coolers with ice
driven to RICON Environmental, Inc
relinquished to Len Kasperek @ 17:08 HE 9/23/97

I advised Ken Kasperek of contents of coolers. the desired analysis for field blanks. the presence of a sample section of the lexan core which was used for collection of the sediment samples and the suffix designation of MS + MD to represent the samples collected as matrix spike and matrix spike duplicate respectively.

David Vitale

11/10/87 VITALE, LOSO, COOK -- DEC

BLOODY BROOK 10:15 SH8773403049 SEDIMENT SH8773403010 WATER	ONONDAGA LAKE PARKWAY ~~OLD LIVERPOOL~~ RD - JUST DOWNSTREAM OF PUMP STATION SOUTH OF 370 BRIDGE (ONONDAGA LAKE PARKWAY)
LEY CREEK 10:30 SH8773403050 SEDIMENT SH8773403011 WATER	AT PARK ST. WATER COLLECTED FROM CENTER OF BRIDGE. SEDIMENT COLLECTED APPROX 30' WEST (DOWNSTREAM) SIDE. SEDIMENT COLLECTED ON SOUTH SIDE OF BANK WEST OF BRIDGE APPROX 3' FROM BANK IN APPROX 2 1/2' OF WATER.
METRO STP 10:55 SH8773403004 WATER	COLLECTED AT SAMPLING POINT IN PARKING LOT AFTER TERTIARY A+B MIXTURE AFTER CLORINATION BEFORE ISCO LINE.

ONONDAGA CREEK (BARGE CANAL) INLET 11:15 SH8773403005 WATER SH8773403061	COLLECTED FROM NORTH SIDE OF HIAWATHA BLVD BRIDGE OVER ONONDAGA CREEK (DUPLICATE)
HARBOR BROOK 11:40 SH8773403013 WATER SH8773403061 SEDIMENT	WATER: COLLECTED FROM NORTH SIDE OF HIAWATHA BLVD BRIDGE OVER HARBOR BROOK, SHEEN DETECTED ON WATER SURFACE. SEDIMENT COLLECTED FROM 20' NORTH OF BRIDGE ON WEST BANK APPROX 2½' FROM BANK IN 2' OF WATER
TRIB 5A 12:20 SH8773403012 WATER SH8773403047 SEDIMENT	SAMPLES COLLECTED FROM TRIB 5A APPROX 125' UPSTREAM FROM ℄ OF STATE FAIR BLVD, JUST DOWNSTREAM FROM STEEL CATWALK FROM WEST BANK. OIL SHEEN VISIBLE ON WATER + SOIL SURFACE. WATER WARM
EAST FLUME 1200 HRS SH8773403006 ~~WATER~~ SH8773403046 SEDIMENT	SAMPLES COLLECTED 10' UPSTREAM FROM LOCKED GATE ACROSS RUNS TO PUMP STATION. SAMPLES TAKEN ABOUT 5' FROM SOUTH BANK ON THE EDGE OF THE VEGETATION. WATER WARM
GEDDES BROOK 1245 HRS SH8773403009 WATER SH8773403048 SEDIMENT	SAMPLES COLLECTED FROM GEDDES BROOK, DOWNSTREAM OF WEST FLUME, JUST WEST OF NYS 5 OVERPASS. SEDIMENT SAMPLE COLLECTED FROM SOUTH BANK OF BROOK APPROX 2' FROM BANK.
NINE MILE CREEK 1305 HRS SH8773403044 SEDIMENT	Sediment sample on Nine Mile Creek. Taken from south side of bridge on State Fair Blvd. under center of bridge 2' from west bank.

(34)

NINE MILE CREEK - APPROX
13:30 HRS
SH877240304S
SEDIMENT

SAMPLE TAKEN UPSTREAM FROM ALLIED WASTE BEDS. 20' NORTH OF WARNERS ROAD BRIDGE ON WEST SIDE OF CREEK APPROX 3' FROM BANK IN APPROX 2½' OF WATER

NINE MILE CREEK
UPSTREAM OF GEDDES BROOK
14:30 HRS
SH877340300 7
WATER

SH877340300 7MS
SH877340300 7MD
MATRIX SPIKE + MATRIX DUP
COLLECTED

WATER SAMPLE UPSTREAM OF GEDDES BROOK APROX 40' UPSTREAM OF CONFLUENCE OF GEDDES BROOK + NINE MILE CREEK OF BANK 3' FROM THE BANK.

PROCESSED PAPERWORK ON SAMPLES.
PACKED COOLERS
TAPED
EVIDENCE TAPE SEALED - CHAIN OF CUSTODY FORM
20:00 HRS DELIVERED TO RECRA ENVIRONMENTAL INC.
RELINQUISHED TO SAL RANDAZO

CURVE FORMULAS

$T = R \tan \frac{1}{2} I$	$R = T \cot. \frac{1}{2} I$	Chord def. $= \frac{\text{chord}^2}{R}$
$T = \frac{50 \tan \frac{1}{2} I}{\text{Sin.} \frac{1}{2} D}$	$R = \frac{50}{\text{Sin.} \frac{1}{2} D}$	No. chords $= \frac{I}{D}$
$\text{Sin.} \frac{1}{2} D = \frac{50}{R}$	$E = R \text{ ex. sec } \frac{1}{2} I$	
$\text{Sin.} \frac{1}{2} D = \frac{50 \tan \frac{1}{2} I}{T}$	$E = T \tan \frac{1}{4} I$	Tan. def. $= \frac{1}{2}$ chord def.

The square of any distance, divided by twice the radius, will equal the distance from tangent to curve, very nearly.

To find angle for a given distance and deflection.

Rule 1. Multiply the given distance by .01745 (def. for 1° for 1 ft.) and divide given deflection by the product.

Rule 2. Multiply given deflection by 57.3, and divide the product by the given distance.

To find deflection for a given angle and distance. Multiply the angle by .01745, and the product by the distance.

GENERAL DATA

RIGHT ANGLE TRIANGLES. Square the altitude, divide by twice the base. Add quotient to base for hypotenuse.

Given Base 100, Alt. $10.10^2 \div 200 = .5$. $100 + .5 = 100.5$ hyp.

Given Hyp. 100, Alt. $25.25^2 \div 200 = 3.125$; $100 - 3.125 = 96.875 =$ Base.

Error in first example, .002; in last, .045.

To find Tons of Rail in one mile of track: multiply weight per yard by 11, and divide by 7.

LEVELING. The correction for curvature and refraction, in feet and decimals of feet is equal to $0.574 d^2$, where d is the distance in miles. The correction for curvature alone is closely, $\frac{2}{3} d^2$. The combined correction is negative.

PROBABLE ERROR. If d_1, d_2, d_3, etc. are the discrepancies of various results from the mean, and if Σd^2 = the sum of the squares of these differences and n = the number of observations, then the probable error of the mean $= \pm 0.6745 \sqrt{\frac{\Sigma d^2}{n(n-1)}}$

MINUTES IN DECIMALS OF A DEGREE

1'	.0167	11'	.1833	21'	.3500	31'	.5167	41'	.6833	51'	.8500
2	.0333	12	.2000	22	.3667	32	.5333	42	.7000	52	.8667
3	.0500	13	.2167	23	.3833	33	.5500	43	.7167	53	.8833
4	.0667	14	.2333	24	.4000	34	.5667	44	.7333	54	.9000
5	.0833	15	.2500	25	.4167	35	.5833	45	.7500	55	.9167
6	.1000	16	.2667	26	.4333	36	.6000	46	.7667	56	.9333
7	.1167	17	.2833	27	.4500	37	.6167	47	.7833	57	.9500
8	.1333	18	.3000	28	.4667	38	.6333	48	.8000	58	.9667
9	.1500	19	.3167	29	.4833	39	.6500	49	.8167	59	.9833
10	.1667	20	.3333	30	.5000	40	.6667	50	.8333	60	1.0000

INCHES IN DECIMALS OF A FOOT

1-16	3-32	1/8	3-16	1/4	5-16	3/8	1/2	5/8	3/4	7/8
.0052	.0078	.0104	.0156	.0208	.0260	.0313	.0417	.0521	.0625	.0729

1	2	3	4	5	6	7	8	9	10	11
.0833	.1667	.2500	.3333	.4167	.5000	.5833	.6667	.7500	.8333	.9167

(232 of 265) (1)

9/12/86 3:30 p.m. Dick Dana

Onondaga Yacht Club Dave Vitale

Core S-28 Recovery - 36" collected and jarred on 9/5

top 3" of 6" core transferred to a second bottle

- 0-3" (00-03) medium sand } ½" yellow pebble some whitish mat'l
- 3-6" (03-06) medium sand with silt
- 6"-12" (Reference Sample) (06-12) light gray silty medium sand
- 12-18" (12-18) sandy silty gravel (< ¼") very light gray
- 18-24" (Reference Sample) (18-24) very light gray sandy silty gravel with white gastropod shells & yellow mollusks
- 24-30" (24-30) same, but only 1 gastropod, no mollusks
- 30-36" (30-36) (Reference Sample) medium-gray silty sandy gravel 1 large shattered shell (?)

(2)

Core S-19 recovery 48"; collected 9/5/86
bottled 9/5/86

Today we split 0-6" into 0-3" and 3-6".

-0-3" (00-03)
light gray gravelly sand w/ white gastropods

03-06
light gray sand, trace gravel w/ white gastropods

-06-12 (reference sample)
light gray silty sand

-12-18
sandy silt with gastropod shells
medium gray

-18-24 (reference sample)
medium gray silt + sand (50:50)
with gastropods

24-30'
medium gray coarse sand with many gastropods (10%)

30-36 (reference sample)
light gray ~~clayey~~ silt w/ little sand, little gravel, trace clay.

36-42
coarse sand and fine sand (50:50) w/ little silt + trace clay

42-48 (reference sample)
coarse sand w/ little silt and trace clay

Core S-36 recovery 35"; collected 9/12/86
Photo #13

00-03
dark gray muck with leaves and sticks
Sewage odor (from near "Metro" sewage treatment plant)

03-06
dark gray organic rich medium sand. Trace sticks.

06-12 (reference sample)
Same as 03-06

12-18
Same

(4)

18-24 (reference sample)
silty sandy muck
dark gray

24-30
silty sandy muck
dark gray

30-35 (reference sample)
silty sand muck
dark gray

Core S-40 recovery 17"
collected 9/12/86
Photo #17

00-03
semifriable slabs 1/2" thick
by up to 1" in diameter,
surrounded by of white
marl with green (algae ?)
+ green algae layer on top (1/4")

03-06 light gray
semifriable chunks up to 1"
diameter, surrounded by white
marl.

(234 of 265) (5)

06-12 (reference sample)
light gray
sandy, silty marl with
"salt & pepper" look due to
light gray + black sand

12-17
light gray sandy silty marl
with semi friable chunks

Core S-42 recovery 56"
collected 9/12/86
Photo #19

00-03
medium gray-green medium
sand with many small shells

03-06
medium gray green medium
sand, trace silt

06-12 (reference sample)
same as above

12-18
ditto
18-24 (reference sample)
ditto
24-30
ditto
many 1/8" shells (few larger too)
30-36 (reference sample)
ditto
36-42
42-48 (reference sample)
48-54
54-56 (reference sample)
silty medium gray, green
medium sand

Core S-10 recovery 53"
collected 9/11/86
Photo #20

00-03
large > 1/2" gastropod on top
medium to light gray silty

03-06
ditto
06-12 (reference sample)
medium sand, medium gray,
~~little~~ some silt
12-18
ditto
18-24 (reference sample)
ditto
24-30
ditto
30-36
ditto → grading to gravelly at bottom
36-42
medium sand (med gray) with
~~42-48~~ some gravel, ~~some~~ little silt.
42-48
ditto
48-53
medium sand medium gray,
with some silt.

(8)

9/13/86 7:30 am Dick Dana
Onondaga Yacht Club Dave Vitale

Core S-9 recovery 48"
collected 9/10/86
Photo #23

00-03
charcoal gray organic muck - pudding-like consistency.

03-06
ditto

06-12 (reference sample)
ditto

12-18
ditto

18-24 (reference sample)
charcoal gray organic muck with some clay. More solid + less pudding-like.

24-30
ditto

30-36 (reference sample)
ditto

36-42
ditto

(236 of 265) (9)

Core S-33 recovery: 51"
collected 9/10/86
Photo #24

00-03
liquid transition layer between water and muck. Black organics

03-06
black muck-organic; pudding-like consistency (loose pudding)

06-12 (reference sample)
ditto (regular pudding)

12-18
ditto

18-24 (reference sample)
ditto (stiff pudding)
tar-like smell

24-30
ditto, brown clayey streaks here + there.

30-36 (reference sample)
organic rich charcoal gray clay with some silt.

36-42
ditto

42-48 (reference sample)
ditto

(10)

Core S-27 recovery 54"
collected 9/9/86
Photo #25

~~00-03~~ From 18" down whole core shows marly ($CaCO_3$(?)) mottling.

00-03
charcoal gray organic muck; pudding-like consistency

03-06
ditto

06-12 (reference sample)
ditto with at least one semi friable "chunk" 1/16" x 1/4"

12-18
~~mixture of~~ ditto mottled with light gray - off white marly substance

18-24 (reference sample)
light gray marly substance with streaks of organic black muck

24-30
50:50 mixture of charcoal

(237 of 265) (11)

light gray marly substance (Marly substance is consistency of spackling compound).

30-36 (reference sample)
charcoal gray organic muck (pudding-like consistency).

36-42 ditto ~~organic rich brown gray clay~~.

42-48 (reference sample)
organic rich brown gray clay

48-54
medium brown gray clay with some organics.

(12)

Core S-4 recovery 55"
collected 9/11/86
Photo # 26

00-03
medium to coarse medium gray sand with some silt; "salt + pepper" coloring; numerous small (<⅛") shells (mainly whole gastropods)

03-06
ditto

06-12 (reference sample)
ditto

12-18
medium gray medium sand, trace silt
some visible shells, but not as many as above

18-24 (reference sample)
ditto

24-30
~~ditto~~ medium gray medium sand, some ~~silt~~ silt, some ~~[illegible]~~ shells visible.

30-36 (reference sample)
ditto

36-42
ditto

42-48 (reference sample)

48-54
ditto

54-55 (reference sample)
ditto

Core S-41 recovery 47"
collected 9/10/86
Photo # 28

00-03
1" of fringe water with organic muck (black) 2" of ~~black~~ ~~[illegible]~~ charcoal gray organic muck. (2" above this section were also fringe but settled rapidly during sawing with hand saw, so it was discarded) pudding-like consistency.

03-06
ditto strong oily smell

06-12
ditto mixed with dark gray organic muck. Strong oily smell.

(14)

12-18
ditto mixed with some off-white marly sediments

18-24 (reference sample) (?)
mixture of pale green, black, and off white, with traces of orange, muck

24-30
ditto w/ no orange

30-36 (reference sample)
~~ditto w/ no orange~~ ditto w/ no orange

~~36-42~~

36-42
mostly ~~w/~~ off-white marl w/ black + pale green secondary

42-47
~~Same~~ ditto, with ~~some~~ trace yellow

(239 of 265) (15)

Core S-15

recovery ~~47~~ 41"
collected 9/10/86
Photo # 1

00-03
charcoal gray organic muck; padding - like consistency

03-06
ditto

06-12 (reference sample)
ditto ~~trace~~ little brown gray specks of clay

12-18
ditto

18-24 (reference sample)
charcoal gray organic muck; (stiff padding)

24-30
ditto

30-36 (reference sample)
~~ditto~~ (s
clayey organic muck (much stiffer than above)

36-42
~~ot~~ muddy clay

42-47 (reference sample)
[illegible] brown silty clay

(16) 35

Core S - [illegible]

recovery: 51"
collected 9/10/86
Photo # 2

00-03
charcoal gray organic muck; pudding like consistency.
03-06
ditto
06-12 (reference sample)
ditto w/ medium ~~strong~~ clay streak.
12-18
charcoal gray organic muck; pudding-like consistency
18-24 (reference sample)
ditto
27-30
ditto
30-36 (reference sample)
ditto
36-42
ditto
42-48 (reference sample)
ditto with ~~[illegible]~~ stick seeds
48-51
ditto with strong oily odor (or gunpowder (?))

(240 of 265) (17)

Core S - 12

recovery: 37"
collected 9/11/86
Photo #

00-03
medium gray sand w/some gravel, up to ½" diameter ~~[illegible]~~
03-06
ditto
06-12 (reference sample)
silty gravelly sand - medium gravel w/shells
12-18
medium gravel sand w/some silt w/shells
18-24 (reference sample)
ditto with putrid odor w/shells
24-30
ditto
30-36 (reference sample)
ditto w/ trace clay
36-37
ditto w/ trace clay

Core S-31 recovery: 50"
collected 9/10/86
Photo #5

00-03
charcoal gray organic muck
chunk of what appeared to
be yellow sand (like pudding)

03-06
charcoal gray organic muck;
pudding - like consistency

06-12 (reference sample)
stiff pudding - like, charcoal
gray organic muck.

12-18
ditto

18-24 (reference sample)
~~clayey~~ charcoal gray clayey
muck.

24-30
ditto

30-36 (reference sample)

36-42
ditto

42-45 (reference sample)

45-50
ditto

Core S-24 recovery = 45"
collected 9/9/86
Photo #6

00-03
charcoal gray muck
"soupy" pudding consistency

03-06
charcoal gray muck
pudding - like consistency

06-12 (reference sample)
ditto

12-18
ditto

18-24 (reference sample)
ditto

24-30
ditto

30-36 (reference sample)
~~of muddy~~ gray clay with
some silt

36-42
ditto

42-45 (reference sample)

Core S-8

recovery 44"
collected 2/9/86
Photo # 5

00-03
charcoal gray organic muck, pudding like consistency

03-06
ditto

06-12 (reference sample)
organic rich clay - charcoal gray

12-18"
ditto

18-24 (reference sample)
ditto

24-30
ditto

30-36 (reference sample)
dark gray clay

36-42
ditto

42-44 (reference sample)
ditto

Core S	Photo #
1	8 6
11	9 6
22 a	10 6
22 b closeup	11 6
18	12 6
2	13 6
13	14 6
25	15 6
17	16 6
23	17 6
16	18 6
15	19 6
7	20 6
30	21 6
3	22 6
12	23 6
20	24 6
6	25 6
43	26 6
39	27 6
31	28 6

Core S-39 recovery: 27"
collected 9/12/86
Photo # 28 (6)

00-03
healthy green algae growth on top of sediment; live sand shrimp. Directly under algae is semi friable 1/8" layered white + medium gray "pad". green, off white marl and dark gray muck

03-06
off white marl (spackling compound ~~plaster~~ like consistency

06-12 (reference sample)
ditto with large ~~12-18~~ 1/8" layer of semi friable material.

12-18 ~~off w~~
off white marl; ~~plaster~~ spackling compound consistency

18-24 (reference sample)
ditto plus unidentifiable 2" x 2" med gray fine grained ~~[illegible]~~ rock

~~24-27~~

24-27 ditto

Core S-1 recovery 41"
collected 9/11/86
Photo # 86

00-03
fine to medium, medium gray sand w/ shells

03-06
ditto

06-12 (reference sample)
top 3" grades down from med to coarse med gray sand
bottom 3" is gravel (> 1/4") ~~with~~ (< 1/2") with some coarse sand)

12-18
light gray marl ~~with~~ and ~~some~~ gravel (marly concretions of some sort)

18-24 (reference sample)
ditto

24-30
sandy marl with little gravel ~~some~~ and shells

30-36 (reference sample)
light gray sandy marl
grading down to silty
marl

36-42
light gray silty marl

Core S-11 recovery 41"
collected 9/10/86
Photo #96

00-03
charcoal gray organic muck
pudding-like consistency

03-06
ditto

06-12 (reference sample)
mottled dark gray and brown
organic rich clay

12-18
ditto

18-24 (reference sample)
medium brown gray clay

24-30
ditto

30-36
ditto

(244 of 265)

Core S-22 recovery 54"
collected 9/9/86
Photo #14

00-03
bright olive green muck

03-06
ditto

06-12 (reference sample)
off white marl

12-18 grading down to white marl
pale yellow-white marl

18-24 (reference sample)
off white marl with slight
green tint

24-30
off white marl

30-36 (reference sample)
ditto

36-42
ditto

42-48 (reference sample)
ditto

48-54
ditto

(26)

Core S-18

recovery: 41"
collected 9/9/86
Photo # 126

00-03
charcoal gray organic muck
pudding - little consistency
03-06
ditto
06-12 (reference sample)
ditto
12-18
ditto
18-24 (reference sample)
~~ditto~~ dark gray organic rich
clay
24-30
ditto
30-36 (reference sample)
ditto
36-41
ditto

Core S-21

(245 to 265) (27)
recovery 41"
collected 9/10/86
Photo # 136

00-03
charcoal gray organic muck
loose pudding consistency
03-06
ditto
pudding-like consistency
06-12 (reference sample)
~~12~~ ditto
12-18
ditto
18-24 (reference sample)
ditto
24-30
ditto
30-36 (reference sample)
dark brownish gray organic
~~36~~ rich clay
36-41
ditto

(28)

Core S-13

recovery 36"
collected 9/11/86
Photo # 146

00-03
greenish medium gray ~~medium~~
silty medium sand
03-06
light gray sandy mud with shells
06-12 (reference sample)
ditto
12-18
ditto
18-24 (reference sample)
light gray sandy medium sand
with shells
24-30
ditto
30-36 (reference sample)
ditto

(246 of 265) (29)

Core S-16

recovery 40"
collected 9/11/86
Photo # 186

00-03
dark gray sand w/ some silt
little clay
03-06
dark gray clay
06-12 (reference sample)
ditto
12-18
silty clay, dark gray
18-24 (reference sample)
dark gray clay upper 3"
silty clay, dark gray
lower 3"
24-30"
slightly stiff (trace silt?)
dark gray clay
30-36 (reference sample)
same as above
36-40" ditto

(30)

Core S-5

recovery - 37"
collected 9/9/86
Photo # 196

00-03
~~[illegible]~~ charcoal gray organic muck
pudding-like consistency
03-06
ditto
06-12 (reference sample)
ditto
12-18
ditto
18-24 (reference sample)
clayey muck, dark gray
24-30
dark gray clay
30-36 (reference sample)
ditto
36-37
ditto

(247 or 265) (31)

Core S-7

recovery - 42"
collected 9/9/86
Photo # 206

00-03
charcoal gray organic muck
pudding like consistency
03-06
ditto
06-12 (reference sample)
ditto with off white marl
patch
12-18
ditto without patch
18-24 (reference sample)
ditto grading down into
clayey muck, dark
gray
24-30
ditto
30-36 (reference sample)
ditto
36-42
dark gray clay

(32)

Core S-3

recovery: 39"
collected 9/9/86
Photo # 226

00-03
gravelly muck - charcoal gray
03-06
~~ditto~~ gravelly, mucky clay, dk gray
06-12 (reference sample)
top 2" gravelly clay, dk gray
bot 4" dk gray clay
12-18
dk gray clay w/ little silt
18-24 (reference sample)
dk gray silty clay w/ brown mottling
24-30
ditto
30-36 (reference sample)
ditto
36-39 ditto

(248 of 265) (33)

Core S-2

recovery 39
collected 9/9/86
Photo # 236

00-03
medium gray silty muck
03-06
ditto
06-12 (reference sample)
silty clay, dark gray
12-18
ditto
18-24 (reference sample)
ditto
24-30
ditto
30-36 (reference sample)
medium gray clay
36-39
ditto

(34)

Core S-43 recovery 41"
collected 9/10/86
Photo # 266

00-03
medium gray clayey muck

03-06
dark gray organic muck

06-12 (reference sample)
interlayer charcoal gray organic muck and off white marl

12-18
interlayered medium gray and off white marl

18-24 (reference sample)
off white marl, mottled with black, olive, pale green, turquoise!
very bottom 1/2" is charcoal gray organic muck

24-30
top 1" charcoal gray organic muck
bottom 5" white marl

30-36 (reference sample)
stiff, crumbly white marl

(35)

(249 of 265)

Core S-20 recovery 42"
collected 9/11/86
Photo # 246

00-03
medium to coarse, medium gray sand with shells

03-06
ditto

06-12 (reference sample)
ditto

12-18
ditto

18-24 (reference sample)
top 2" ditto
bottom 4" ~~silty~~ med gray sand w/ ~~[illegible]~~ little silt

24-30
medium gray medium sand with shells, bottom 2" silty

30-36 (reference sample)
top 2" silty medium gray medium grained sand
bot 4" medium grained sand, medium gray

36-42
ditto

(36)

Core S-6 recovery 42"
collected 9/9/84
Photo # 256

00-03
charcoal gray organic muck
pudding-like consistency
03-06
top 1" organic rich clay
bot 5" medium gray clay
06-12 (reference sample)
medium gray to dark gray
clay
12-18
ditto
18-24 (reference sample)
ditto
24-30
ditto
30-36 (reference sample)
ditto
36-42
ditto

Core S-25 recovery: 59"
collected 9/8/86
Photo # 156

00-03
dark gray medium to
coarse sand
03-06
off white marl
06-12 (reference sample)
ditto
12-18
white marl
18-24 (reference sample)
ditto
24-30
ditto, stiff, crumbly
30-36 (reference sample)
white marl
36-42
ditto
42-48 (reference sample)
ditto
48-54
54-59 (reference sample)

(38)

Core S-17 recovery 40"
collected 9/8/56
Photo # 166

00-03
dark gray medium sand
03-06
ditto
06-12 (reference sample)
ditto
12-18
ditto
18-24 (reference sample)
ditto
24-30
ditto
30-36 (reference sample)
ditto
36-40
ditto ~~top 3½"~~
~~bottom 2½", light gray fine sand~~

(39)

Core S-23 recovery 42"
collected 9/7/56
Photo # 114

00-03
medium gray medium grained sand w/ pt shells
03-06
ditto
06-12 (reference sample)
ditto
12-18
ditto, top 2½" grained
bot 3½" w/ pt gray fine sand
18-24 (reference sample)
ditto
24-30 ~~ditto~~
medium gray fine sand
30-36
ditto
36-42
clay with trace silt
medium gray

(40)

Core S-30 recovery: 47"
Collected 9/8/86
Photo # 216

00-03
medium to coarse medium gray sand
03-06
medium gray sandy clay
06-12 (reference sample)
clayey sandy silt, light gray
12-18
ditto
18-24 (reference sample)
ditto
24-30
9/14/86 ditto
30-36 reference
ditto with little gravel (small gravel)
36-42
light gray, clayey, sandy silt
42-47 (reference sample)
ditto

~~Core S-38~~ recovery collected

Samples delivered to SARATOGA LAB by D. VITALE on 9/14/86 @ 23:30 HRS - 173 SEDIMENT

(42)

9/15/86 6:15 pm Dave Vitale
Dirk Dunn

Onondaga Yacht Club

Core S-38 recovery 50"
collected 9/15/86
Foo clark for photo

~~[illegible]~~
These cores to be sent
for full analyses:

00-03 (split into 2 bottles)
charcoal gray organic muck;
pudding like consistency, oily smell
03-06 (2 bottles)
ditto, thick pudding - cultable
06-12 (reference sample)
ditto
12-18" (2 bottles)
ditto with coarse organic matter
(stides & leaves?)
18-24 (reference sample)
ditto top 5"
bot 1" clayey mucks + charcoal gray
24-30 (2 bottles)
clayey muck; charcoal gray
quite stiff, putrid smell.

30-36 (reference sample)
pale green organic muck
~~pudd~~ with pod of charcoal
gray organic muck
pudding - like consistency
36-42 (2 bottles)
top 1" ~~[illegible]~~
medium green muck
next 2" off white muck
bot 3" medium green muck
42-48" (reference sample)
mixture of pale green
medium green & dark green
muck
48-50" (2 bottles)
mixture of pale green and
off white ~~[illegible]~~ marl (?)

(44)

Core S-37 recovery: 46 4
collected 9/15/86
too dark for photo

00-03
dark gray medium grained
sand
03-06
ditto
06-12 (reference sample)
ditto
12-18
ditto
18-24 (reference sample)
ditto
24-30
ditto
30-36 (reference sample)
ditto
36-42
ditto
46-46 (reference sample)
ditto

(254 of 265) (45)

Core S-26 recovery 57 4
collected 9/15/86
too dark for photo

00-03
off white, speckled green ~~mud~~
03-06
ditto
06-12 (reference sample)
ditto - no green specks
12-18
ditto
18-24 (reference sample)
ditto
24-30
ditto
30-36 (reference sample)
ditto, stiff & crumbly
36-42
ditto
42-48 (reference sample)
ditto
48-54
ditto
54-57 (reference sample)
ditto, very stiff & crumbly
bean and or feta cheese
consistency

(46)

Core S - 34

recovery: 42"
collected 9/15/86
too dark for photo

00-03
top 3" is gradation from 1/2" gravel down to medium sand, ~~bottom 2" is~~ both medium gray, little silt

03-06
coarse sand and fine gravel
rotten eggs smell

06-12 (reference sample)
ditto

12-18
ditto

18-24 (reference sample)
ditto

24-30
ditto

30-36 (reference sample)
medium gray medium grained sand

36-42
ditto

~~Core S~~

Core S - 32

recovery: 46"
collected 9/15/86
too dark for photo

00-03
sandy olive green marl

03-06
med gray med grained sand

06-12 (reference sample)
ditto

12-18
ditto

18-24 (reference sample)
ditto

24-30
ditto

30-36 (reference sample
top 5" ditto
bot 1" ~~silty~~ sand with little gravel + some silt

36-42
~~[illegible]~~ sand with some silt + trace gravel, medium gray

42-46" (reference sample
medium gray medium sand with ~~little~~ some silt and trace clay

9/16/86 2 pm Dave Vitale
Dick Dana
Onondaga Yacht Club

Core S-29 recovery: 54"
collected 9/16/86
no camera available
lent to TRR

00-03 (split into 2 bottles)
charcoal gray organic muck
(pudding like consistency (loose)
03-06 (2 bottles)
~~dit~~ charcoal gray clayey organic
mud, stiffer than 00-03
06-12 (reference sample)
dark gray organic rich clay
12-18 (2 bottles)
ditto
18-24 (reference sample)
ditto
24-30 (2 bottles)
ditto
30-36 (reference sample)
ditto
36-42 (2 bottles)
42-48 (reference sample)
ditto

~~S-14~~ Core S-14 recovery: 50"
collected 9/16/86
no camera avail.

00-03 (split into 2 bottles)
charcoal gray organic muck
(loose pudding like consistency)
03-06 (2 bottles)
ditto (pudding like)
06-12 (reference sample)
very dark grayish green organic
muck (pudding like consistency)
12-18 (2 bottles)
ditto + oily smell
18-24 (reference sample)
ditto, no oily smell
24-30 (2 bottles)
ditto
30-36 (reference sample)
ditto
36-42 (2 bottles)
top 3" ditto
bot 3" black organic muck
42-48" (reference samples)
black organic muck
48-50" (2 bottles)
top 1" ditto
bot 1" olive green organic muck

(257 cont 265) (51)

(50) Cooler #1 (blue with white top)

All of S14, S-29, S-38 except for:

S-38-36-42 (Seal Bottles)
S-14-03-06
S-29-00-03
S-14-00-03
S-38-03-06
S-29-12-18

Cooler #2 (New Cran Coleman)

(A) The above 6 sediment samples plus

(B) W-05-00-00 (Metal Bottles)
W-09-00-00
W-12-00-00
W-11-00-00
W-04-00-00
W-07-00-00
W-10-00-00
W-06-00-00

(C) All tributary sediment samples

S-44-00-00 (2 bottles)
S-45-00-00 "
S-46-00-00 "
S-47-00-00 "
S-48-00-00 "
S-49-00-00 "
S-50-00-00 "

Cooler #3 (Versa Cooler)

~~W-08-04-04~~ (B/N Bottles)
W-02-04-04
W-02-13-13
W-02-16-16
W-02-13-13
W-02-16-16
W-02-04-04
W-08-01-01
W-08-01-01
~~W-08-04-04~~
W-04-00-00
W-09-00-00
~~W-10-00-00~~

(52)

W-11-00-00
W-06-00-00
~~W-04-00-00~~
W-12-00-00
W-05-00-00
W-05-00-00
W-07-00-00
~~W-07-00-00~~
~~W-06-00-00~~
~~W-11-00-00~~
W-12-00-00
~~W-9-00-00~~
W-10-00-00
W-08-04-04
~~W-08-04-04~~
W-03-04-04
W-01-13-13
W-03-02-02
W-01-05-05
W-08-01-01
W-02-16-16
W-02-13-13
W-08-04-04

B/N metals

SARATOGA Cooler #5 (Playmate)

Cooler #3

(258 of 265) (53)
(small white top blue)

Cooler #4

~~W-08-04-04~~
W-07-0000
W-08-0404
W-11-00-00
W-09-00-00
W-10-00-00
W-06-00-00
W-04-00-00
W-08-04-04

(B/N Bottles)

~~VOA Bottles~~

Also in Cooler #3

VOA Bottles

W-02-16-16
W-02-04-04
W-02-13-13
W-11-00-00
W-05-00-00
W-09-00-00
W-06-00-00
W-08-04-04

(54)

W-02-167 6
W-02-04-04
W-11-00-00
W-07-00-00
W-08-01-01
W-08-04-04
W-12-00-00
W-12-00-00
W-06-00-00
W-07-00-00
~~W-0-00~~-0
W-08-01-01
W-02-13-13
W-10-00-00
W-09-00-00
W-05-00-00
W-04-00-00
W-10-00-00
W-04-00-00

4 COOLERS
MAILED FEDERAL EXPRESS TO
RICRA RESEARCH - JIM PLOSCYCA
ON 9/17/96 @ 5:30 PM

321 pounds

(59 of 365) (55)

Remaining Samples delivered to
SARATOGA LAB ON 9/12/96 @ 12:30 PM

2) SEDIMENT : 4 WATER

(260 - 265)

ork State Department of Environmental Conservation
oad, Albany, New York 12233

AUG 24 1988

Thomas C. Jorling
Commissioner

Mr. David Johnson, P.E.
Project Manager
Engineering Science, Inc.
290 Elwood Davis Road
Liverpool, NY 13088

Dear Mr. Johnson:

Re: Mercury Sediment - Onondaga Lake
Site I.D. #734030

Enclosed are copies of the two final sample data summary packages for the Mercury Sediments - Onondaga Lake site, #734030. This data has been reviewed by our Quality Assurance Section and is considered to be valid.

The following is a listing of the sample identification numbers and their corresponding locations:

	Sample ID No.	Sample Point		Matrix
9/22/87	SH87734030141	S-14	(0-3")	Sediment
	SH87734030142	S-14	(3-6")	Sediment
	SH87734030143	S-14	(12-18")	Sediment
	SH87734030144	S-14	(24-30")	Sediment
	SH87734030145	S-14	(36-41")	Sediment
	SH87734030291	S-29	(0-3")	Sediment
	SH87734030292	S-29	(3-6")	Sediment
	SH87734030293	S-29	(12-18")	Sediment
	SH87734030294	S-29	(24-30")	Sediment
	SH87734030295	S-29	(36-42")	Sediment
	SH87734030381	S-38	(0-3")	Sediment
	SH87734030382	S-38	(3-6")	Sediment
	SH87734030383	S-38	(12-18")	Sediment
	SH87734030384	S-38	(24-30")	Sediment
	SH87734030385	S-38	(36-42")	Sediment
	SH87734030011	W-1	(4 meters)	Water
	SH87734030012	W-1	(14 meters)	Water
	SH87734030021	W-2	(4 meters)	Water
	SH87734030022	W-2	(11 meters)	Water
	SH87734030023	W-3	(16 meters)	Water
	SH8773403008	W-8	(3 meters)	Water
	SH8773403060	W-8	(3 meter Duplicate)	Water
11/10/87	SH8773403045	S-45	(Nine Mile Creek-Amboy)	Sediment
	SH8773403007	W-7	(Nine Mile Creek-Up of Geddes)	Water
	SH8773403044	S-44	(Nine Mile Creek)	Sediment

David Johnson, P.E.

Sample ID No.	Sample Point		Matrix
SH8773403047	S-47	(Tributary 5A)	Sediment
SH8773403012	W-12	(Tributary 5A)	Water
SH8773403046	S-46	(East Flume)	Sediment
SH8773403006	W-6	(East Flume)	Water
SH8773403049	S-49	(Bloody Brook)	Sediment
SH8773403010	W-10	(Bloody Brook)	Water
SH8773403048	S-48	(Geddes Brook)	Sediment
SH8773403009	W-9	(Geddes Brook)	Water
SH8773403004	W-4	(Metro Sewage Treat. Plant)	Water
SH8773403005	W-5	(Barge Canal Inlet-Onondaga Creek)	Water
SH8773403050	S-50	(Ley Creek)	Sediment
SH8773403011	W-11	(Ley Creek)	Water
SH8773403061	W-5	(Duplicate of SH8773403005)	Water
SH8773403013	W-13	(Harbor Brook)	Water
SH8773403051	S-51	(Harbor Brook)	Sediment

The sampling points correspond to the locations designated on the map previously supplied to you.

This information should now supply you with all the data which you require to prepare the draft Phase II for this site.

If you have any questions regarding this data or the site, you may contact me at (518) 457-9538.

Sincerely,

David Vitale

David Vitale
Bureau of Hazardous Site Control
Division of Hazardous Waste
Remediation

Enclosures

-rk State Department of Environmental Conservation
:lf ıd, Albany, New York 12233

Thomas C. Jorling
Commissioner

SEP 12 1988

Mr. David Johnson, P.E.
Project Manager
Engineering Science, Inc.
290 Elwood Davis Road
Liverpool, NY 13088

Dear Mr. Johnson:

Re: Mercury Sediments - Onondaga Lake
Site I.D. NO. 734030

Enclosed is the final list of lake stations which includes the new locations for stations S-14, S-29 and S-38. In addition is a listing of the state plane coordinates for these sites.

This should provide you with the final data required from our office to complete your draft Phase II report. If you have any questions, you may contact me at (518) 457-9538.

Sincerely,

David Vitale

David Vitale
Bureau of Hazardous Site Control
Division of Hazardous Waste
Remediation

Enclosures

TABLE A. Sample Collection Data for 1986 Onondaga Lake Sediment Coring.

Sta.	Date	Time	Zero line	Vert. ∠(°'")	Horiz. ∠(°'")	Range (ft)	Water Depth (ft)	Corer	Core Length (in)
2	9/9	1800	C to LK	90-02-30	68-12-30	4113	29	P	39
3	9/9	1700	C to LK	–	55-19-10	4630	33	P	39
4	9/11	1500	P to LV	–	289-36-40	4795	9	V	55
5	9/9	1530	C to LK	90-22-20	37-39-30	3200	49	P	37
6	9/9	1830	C to LK	90-12-20	68-38-50	2053	29	P	42
7	9/9	1600	C to LK	90-30-20	327-14-40	986	42	P	42
8	9/9	1500	C to LK	–	4-34-30	2531	54	P	44
9	9/10	1545	P to RT	–	255-45-40	2363	44	P	48
10	9/11	1535	P to LV	–	283-33-20	2440	4	V	53
11	9/10	1615	P to RT	90-29-20	303-33-25	1000	32	P	41
12	9/11	1830	P to LV	–	31-38-10	203	6	H	37
13	9/11	1730	P to LV	–	101-47-30	969	6	H	36
14	9/22/87		P to RT	–	35-40-00	1704	33	P	47
15	9/10	1650	P to RT	–	0-20-10	2700	2	H	40
16	9/11	1800	P to LV	–	77-08-30	2056	3	H	40
17	9/8	1545	G to JG	–	309-58-05	4215	55	P	41
18	9/9	1000	G to JG	90-21-30	321-25-00	2442	9	H	48
19	9/5	1030	G to JG	90-01-50	6-16-40	1324	9	V	42
20	9/11	1915	C to LK	–	275-55-25	2753	56	P	41
21	9/10	1735	P to RT	–	333-20-10	3020	9	H	54
22	9/8	1800	G to JG	90-32-45	296-54-15	4964	12	H	42
23	9/8	1630	G to JG	90-33-05	304-56-05	4480	60	P	45
24	9/9	1100	G to JG	90-00-00	272-52-20	3825	8	H	59
25	9/8	1830	G to JG	90-03-30	281-55-00	5059	15	V(?)	57
26	9/15	1400	H to SJ	–	238-52-10	3348	54	P	54
27	9/9	1215	G to JG	89-58-50	264-54-40	5064	4	H	36
28	9/5	1130	G to JG	90-04-45	218-22-15	1156			
29	9/22/87		G to JG	–	250-53-18	2448	8	H	47
30	9/8	1900	G to JG	90-04-10	209-03-25	3777	62	P	50
31	9/10	1210	H to SJ	–	277-37-30	3529	6	H	46
32	9/15	1400	M to SH	–	127-07-50	2054	59	P	51
33	9/10	1130	H to SJ	–	332-33-00	3212	5	H	42
34	9/15	1530	M to SH	–	350-40-35	850	32	P	51
35	9/10	1830	M to SH	–	16-41-00	3138	5	H	46
*37	9/15	1600	M to SH	–	3-53-00	–			
			G to JG	–	219-24-40				
38	9/22/87		M to SH	–	24-58-36	4492	5	H	27
39	9/12	1330	H to SJ	–	23-06-35	5128			

(263 of 265)

TABLE A.

Sta.	Date	Time	Zero line	Vert.∠(°'")	Horiz.∠(°'")	Range (ft)	Water Depth (ft)	Corer	Core Length (in)
40	9/12	1230	H to SJ	-	25-15-40	4200	3	H	17
41	9/10	1045	H to SJ	-	20-45-20	2966	29	P	47
42	9/12	1130	H to SJ	-	29-01-10	766	14	V	56
43	9/10	1245	H to SJ	-	245-20-45	2003	31	P	41
**1	9/11	1430	112' to western abutment of thruway bridge over outlet 83' to eastern abutment of thruway bridge over outlet				15	V	41
**36	9/12	1000	90' to western abutment of railroad bridge over inlet 87' to eastern abutment of railroad bridge over inlet				6	V	35

Abbreviations

C - China
P - Pleasant
G - Griffin
M - Mercury
H - Hores
LK - Lakeland Water Tower
LV - Liverpool Water Tower (more southerly with pointed top)
RT - WHEN Radio Tower (most northerly)
JG - John Glenn Standpipe
SJ - St. John the Baptist Church Spire
SH - Sacred Heart Church Spire (eastern spire with gold cross)

* A range could not be obtained from either Mercury or Griffin — therefore, two angles were provided.

** Ranges and angles could not be obtained for Stations 1 and 36 — however, by using a rangefinder, distances to bridge abutments from the sampling locations were obtained.

NYSDEC REAL PROPERTY SERVICES REGION 7

PRELIMINARY STATE PLANE COORDINATES (NAD 1927)-1986 ONONDAGA LAKE SEDIMENT CORING STATIONS (COMPUTED USING DATA SUPPLIED BY BUREAU OF TECHNICAL SERVICES AND RESEARCH)

PC CAD VERSION 1.018 HOUSEMAN & ASSOCIATES (713) 890-5160

DATE 09-25-1987 TIME 10:36:17
PROJECT ONONDAGA LAKE HAZARDOUS WASTE FILE 7-34-370
DATA FILE 4 ALLOCATED FILE SIZE 2000 POINTS 20 LOTS PER BLK

LIST POINTS

POINT	BEARING	DISTANCE	POINT	NORTHING	EASTING	ELEVATION	OBJECT
			102	1134221.5615	591922.4431	0.000	STATION 2
			103	1133414.8213	591163.4527	0.000	STATION 3
			104	1131445.7041	591149.8020	0.000	STATION 4
			105	1132204.3305	592569.2984	0.000	STATION 5
			106	1133462.2593	593837.5425	0.000	STATION 6
			107	1131708.9794	595544.3699	0.000	STATION 7
			108	1130997.1356	593840.6050	0.000	STATION 8
			109	1129520.8498	592836.3303	0.000	STATION 9
			110	1129244.3188	592061.1172	0.000	STATION 10
			111	1128080.8887	593991.9763	0.000	STATION 11
			112	1127297.6180	593646.2399	0.000	STATION 12
			113	1126460.5628	594028.2835	0.000	STATION 13
			114	1127304.5478	595154.5210	0.000	STATION 14 (9/22/87)
			115	1127263.9805	596151.6549	0.000	STATION 15
			116	1126247.6524	595252.7582	0.000	STATION 16
			117	1126234.3712	597760.3776	0.000	STATION 17
			118	1127549.2075	599111.1160	0.000	STATION 18
			119	1128899.6350	600255.2424	0.000	STATION 19
			120	1130574.3810	597511.8806	0.000	STATION 20
			121	1128634.8916	596130.0137	0.000	STATION 21
			122	1124952.3482	597769.1483	0.000	STATION 22
			123	1125770.4743	597737.0991	0.000	STATION 23
			124	1124793.2019	599905.2721	0.000	STATION 24
			125	1124037.9358	598707.9801	0.000	STATION 25
			126	1122996.3735	599711.9965	0.000	STATION 26
			127	1123421.8300	600072.0650	0.000	STATION 27
			128	1127307.2770	602029.2250	0.000	STATION 28
			129	1125851.8793	601367.1208	0.000	STATION 29 (9/22/87)
			130	1125415.7571	603875.0062	0.000	STATION 30
			131	1123341.0820	601974.0181	0.000	STATION 31
			132	1123333.7533	605809.3312	0.000	STATION 32
			133	1121035.1165	604077.7917	0.000	STATION 33
			134	1121339.0159	607678.3890	0.000	STATION 34
			135	1119170.4110	606582.3670	0.000	STATION 35
			137	1117903.1275	607409.4251	0.000	STATION 37 (CORRECTED 3/30/87)
			138	1118015.6842	605794.8726	0.000	STATION 38 (9/22/87)
			139	1117331.2981	605480.5398	0.000	STATION 39
			140	1117667.5973	604598.2420	0.000	STATION 40
			141	1118534.1304	603676.9012	0.000	STATION 41
			142	1119477.7929	601677.7308	0.000	STATION 42
			143	1121844.7399	600465.8899	0.000	STATION 43