(59) MAY 1982

ENVIRONMENTAL MONITORING AT LOVE CANAL INTERAGENCY REVIEW

Comments by:

U.S. Department of Health and Human Services
National Bureau of Standards
U.S. Environmental Protection Agency

Office of Research and Development
U.S. Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

HHS CONSULTANTS REVIEWING EPA LOVE CANAL REPORT

Dr. Steven Aust
Department of Biochemistry
University of Michigan
East Lansing, Michigan 48824

non-scientific data presentation, EPA unconcerned about this.
"very poor science"
"very uneasy about drawing firm conclusions"
"lack of stats. particularly disturbing."

Dr. Richard Browner
School of Chemistry
Georgia Institute of Technology
Atlanta, Georgia 30332

there remains a lingering concern that much of the info. contained in the reports is not fully clarified at this.

Dr. John Doull
Department of Pharmacology and Toxicology
University of Kansas Medical Center
Kansas City, Kansas 66103

"but neither would I endorse or encourage new residents to move into this or any area with the potential problems that could arise as a consequence of living next to a landfill containing large amounts of hazardous materials."

Dr. Joseph Highland
Chairman, Toxicology Chemical Program
Environmental Defense Fund
1525 - 18th Street, N.W.
Washington, D.C. 20036

studies + reviews of studies "inadequate".
"the material presented was clearly inadequate to conduct a proper scientific analysis."

Dr. Robert Metcalf
University of Illinois
Departments of Entomology and
Veterinary Pharmacology
Urbana-Champaign, Illinois 61820

Dr. Samuel Milham
6428 Guerin, S.W.
Olympia, Washington 98502

Dr. Robert A. Neal
Chemical Industry Institute of Toxicology
P.O. Box 12137
Research Triangle Park, North Carolina 27709

Dr. Beverly Paigen
P.O. Box 145
Mount Desert, Maine 04660

Dr. Edo Pellizzari
The Research Triangle Institute
P.O. Box 12194
Research Triangle Park, North Carolina 27709

Dr. Robert Tardiff
National Academy of Sciences
2101 Constitution Avenue, N.W.
Washington, D.C. 20418

Dr. James Whittenberger
Harvard University
665 Huntington Avenue
Boston, Massachusetts 02115

believable if remedial

Health + Human Services.

HHS EVALUATION OF RESULTS OF ENVIRONMENTAL CHEMICAL TESTING PERFORMED BY EPA IN THE VICINITY OF LOVE CANAL

IMPLICATIONS FOR HUMAN HEALTH

MODIFICATION OF THE REPORT OF
SEPTEMBER 15, 1981

For CDC:

Clark W. Heath, Jr., M.D.
Renate D. Kimbrough, M.D.
John A. Liddle, Ph.D.

For NIEHS:

David P. Rall, M.D., Ph.D.
Terri Damstra, Ph.D.
Walter J. Rogan, M.D.
James D. McKinney, Ph.D.

June 14, 1982

In September 1981, we prepared a report evaluating the human health implications of the environmental chemical testing performed by the Environmental Protection Agency (EPA) in the Love Canal area during the summer and fall of 1980. In that report we indicated that our evaluation rested "on the assumption that the methods used by EPA in collecting, storing, and testing specimens were satisfactory." The evaluation of the adequacy and appropriateness of the methods used by EPA has been independently reviewed by the National Bureau of Standards (NBS). The final NBS report regarding the conclusions of that review, together with a revised draft of EPA's detailed report on the total study, were made available to us by EPA on 12 May 1982. In view of the criticisms and concerns expressed in the NBS report, we must modify the tentative conclusions expressed in our earlier report.

The NBS review concludes that EPA did not adequately address the problems of limits of detection and sensitivity of the analytical methods used. In the instances where EPA detected contamination, it is reasonable to conclude that chemicals were present. However, in the instances where EPA reports the absence of contamination (about 90 percent of the values reported), no strict quantitative interpretation is possible, and judgments about the habitability of the area cannot be based on these values. Thus, with the data now available to us, no definite recommendations or conclusions as to the habitability or the potential human health risks of the Love Canal area can be made. The conclusions about the necessity for clean-up of areas shown by EPA to be contaminated still stand.

HHS EVALUATION OF RESULTS OF ENVIRONMENTAL CHEMICAL TESTING PERFORMED BY EPA IN THE VICINITY OF LOVE CANAL

IMPLICATIONS FOR HUMAN HEALTH

FURTHER CONSIDERATIONS CONCERNING HABITABILITY

For CDC: Clark W. Heath, Jr., M.D.
Renate D. Kimbrough, M.D.
John A. Liddle, Ph.D.

For NIEHS: David P. Rall, M.D., Ph.D.
Walter J. Rogan, M.D.

JULY 13, 1982

Transmitted letter
signed and dated
7/13/82 by
James Dickson III, M.D.

On May 12, 1982, the National Bureau of Standards (NBS) made available to the Department of Health and Human Services (HHS) its assessment of the Environmental Protection Agency's (EPA) Love Canal Monitoring project. We reviewed this assessment and pointed out (June 14, 1982) that our earlier statement about habitability of the Love Canal area was predicated on adequate chemical methodology: "Should the NBS review suggest methodologic difficulties in the EPA data set, the health evaluations presented here would require reassessment" (HHS, October 7, 1981). Since the May 12 NBS assessment implied that EPA's technical methods might be inadequate in the area of method detection limits, we felt compelled to withhold judgment about habitability.

Since that time, additional information was provided to HHS by EPA on July 9, 1982, regarding reliability of method detection limits and recovery data for organic compounds measured in environmental specimens from the Love Canal area. EPA assures that levels previously designated as "trace" or "not detected" are most unlikely to have exceeded values in the low parts per billion (ppb) range and in no case would represent a value greater than 1 part per million. We judge that levels of organic chemicals in the low ppb range present minimal health risk, except in the case of TCDD for which levels in the ppb range are clearly of toxicologic significance and which has been identified in storm sewers and related outflow streams in the Love Canal area.

In the meantime, NBS has continued its examination of the technical methods used by EPA in developing the data. Based on the findings of this further review (in part arising from additional information provided by EPA to NBS on June 28, 1982), NBS has indicated by letter to EPA on July 9, 1982, that "the

methods of analysis used by EPA for water, soil and sediments, and air are generally acceptable methods and represent the state of the art." We assume the provisos on this statement from NBS can be met by EPA.

In view of the further information from EPA and of the most recent NBS opinion regarding the methods used by EPA, we feel that the statement concerning habitability of the Love Canal area, as expressed in the NHS evaluation dated October 7, 1981, is accurate. In that evaluation, we stated that "the Love Canal area, outside Area 11, is as habitable as the control areas with which it was compared." Again, as stated in that document, this judgment regarding habitability includes the requirements that Area 11 (the Canal site itself and the land occupied by the two rings of homes surrounding it) be constantly safeguarded against future leakage from the Canal and that cleanup is required for existing contamination of local storm sewers and their drainage tracts.

THE UNIVERSITY OF KANSAS MEDICAL CENTER
COLLEGE OF HEALTH SCIENCES AND HOSPITAL
RAINBOW BOULEVARD AT 39TH • KANSAS CITY, KANSAS 66103

SCHOOL OF MEDICINE
SCHOOL OF NURSING
SCHOOL OF ALLIED HEALTH
UNIVERSITY HOSPITAL

DEPARTMENT OF PHARMACOLOGY
(913) 588-7140

August 21, 1981

Clark W. Heath, Jr., M.D.
Director, Chronic Diseases
Division, CEH
CDC, PHS, HHS
Atlanta, Georgia 30333

Dear Dr. Heath:

In response to your request, I have reviewed the EPA analytical and testing results, the NYSDH environmental testing data, and the other materials provided in preparation for our meeting on August 13, 1981, in Atlanta. In responding to the four questions posed in your letter of August 6, I have focused primarily on the EPA data, although there is consistency in many aspects of the NYSDH and EPA data despite the differences in collection period (prior to versus post-remedial measures) and sampling (air sampling versus multi-media sampling).

The first question is perhaps the most difficult to respond to since it appears from the EPA data and the summary tabulations of the data (pg. 41, 51, 54, 55, 57, 60, 61, 72, 100, 109) that for most of the chemicals analyzed the levels in the declaration area exceed the levels in the control area or in study area 97. The key question here is whether the concentrations measured in the declaration area are significantly different from levels found in other areas. Although I have carried out some calculations using the individual EPA data (2nd book) to attempt to validate and understand the data presented in the summary tables, I do not feel comfortable with this process. During the meeting on August 13, it was suggested that the data in the tables should be presented in a form that would permit the casual reader to more fully understand and evaluate the data. I would agree with this suggestion on the basis that the data as presented appears to be somewhat misleading. Perhaps Dr. Deegan could work with CDC analysts to accomplish this.

The second question asks whether the reported levels are likely to cause adverse health effects. I have focused here primarily on the organics, since the inorganics are highly variable and are probably more closely related to geologic criteria than to material deposited in the canal. Both the EPA data and the NYSDH data indicate that the levels of the organics are low in comparison with TLV values or other criteria used for evaluating risk, and my response to this question is that such cause and effect relationships are unlikely.

The third question asks whether the sampling procedures were adequate. My impression of the EPA data is that the number of control samples is rather small, but since there is rather good consistency in the data from the various media sources, I would conclude that the sampling was adequate, at least in the area of interest (the declaration area). Some concern was expressed at the Atlanta meeting concerning the integrity of the samples during storage prior to analysis (leakage through septems, etc.), and this is certainly a potential problem if it did occur. However, again on the basis of sample consistency, it would appear to me that this does not appear to have been a problem in the EPA data.

The final question asks about the safety of the area for habitation. Since the canal area is obviously heavily contaminated and will remain so for years, the use of this land in such a way as to prevent migration of the buried agents or exposure of populations will present very long-term planning difficulties. On the other hand, the declaration area does not appear to present any clear and evident hazard to residents as long as the contamination of the canal area can be controlled. My concern with making recommendations regarding the habitation of the declaration area derives primarily from a concern about the ability of any legislative or regulatory group to maintain proper control and surveillance of any residential area over extremely long periods of time. Thus, I would not advise residents of this area to move out of the area, but neither would I encourage new residents to move into this or any area with the potential problems that could arise as a consequence of living next to a land-fill containing large amounts of hazardous materials.

The problems of Love Canal are not unique to Niagara Falls, and they involve much more than the toxicologic or adverse health effects evaluations. The benefits side of the risk-benefit equation is even more complex than the risk side of the equation, but it cannot be ignored. In answering questions such as those above, scientists and particularly toxicologists need to distinguish between predictions or conclusions which are based on an evaluation of the toxicity data base for an agent as opposed to opinions or conclusions which are not based on any special expertise. My answer to the last question probably falls in the latter category.

Sincerely yours,

John Doull, M.D., Ph.D.
Professor of Toxicology

JD/mkh

University of Illinois at Urbana-Champaign

INSTITUTE FOR
ENVIRONMENTAL STUDIES

408 South Goodwin Avenue
Urbana, Illinois 61801
(217) 333-4178

Aug. 23, 1981

Clark W. Heath, jr., M.D.
Director, Chronic Diseases Division
Center for Diseases Control
Atlanta GA, 30333

Dear Dr. Heath:

Enclosed please find my report "Threat to Human Health Among Residents of Love Canal Area, Niagara Falls, New York". This is the report requested from my service as a consultant to Center for Diseases Control following the meeting on the above subject held in Atlanta, Georgia on August 13.

I hope that the submission of this report satisfactorily completes my consultant assignment.

Sincerely,

Robert L. Metcalf

Robert L. Metcalf
Professor Biology, Entomology,
Environmental Studies

REPORT TO

CENTER FOR DISEASE CONTROL

ON

THREAT TO HUMAN HEALTH AMONG RESIDENTS OF LOVE CANAL AREA NIAGARA FALLS, NEW YORK

Robert L. Metcalf

Institute for Environmental Studies

University of Illinois, Urbana, Illinois

INTRODUCTION

Analyses of the problems in environmental toxicology around Love Canal in Niagara Falls, New York are complicated by the vast amount of analytical data made available from various aspects of environmental monitoring. Many of the pollutants monitored including heavy metals, polynuclear aromatics, halogenated aliphatics, acrolein, acrylonitrile, benzene, toluene, xylenes, and polychlorinated biphenyls[1]; represent the broad range of chemical pollutants typically found in the urban industrial environment. The amounts detected in Niagara Falls, are more or less typical of urban industrial environments in New Jersey, Louisiana, Texas, Arkansas, and West Virginia (List of Compounds found in Ambient Air, CDC). Without in any way minimizing the undesirability of their presence in the air and water consumed by humans, it is concluded that these "typical" pollutants are not adequate indicators of the possible hazards of Love Canal dumping on the habitability of adjacent residential areas.

Therefore, to properly analyze the environmental toxicology in the residential areas in the vicinity of the Love Canal chemical waste dump, I have concentrated on data indicating the presence of organic chemicals representing typical and persistent toxic waste products from Hooker Chemical Company operations during the years 1942 to 1953. According to data furnished by the company to the New York State Health Department, at least 21,700 tons of such wastes were dumped into Love Canal during this period. Hooker Chemical Company pioneered during and immediately after World War II in the production of a large variety of chlorinated aromatic compounds including 2,4,5-trichlorophenol and chlorobenzenes; benzotrichloride and other chlorinated toluenes; photo-chlorination of benzene to produce lindane and other isomers of hexachlorocyclohexane; and the highly reactive hexachlorocyclopentadiene for Diels-Alder diene syntheses of the insecticides aldrin, chlordane, heptachlor, endosulfan, and mirex.

The toxic chemicals selected as suitable indicators for this evaluation are shown in Table 1 together with available data on TLV values for human industrial exposures to contaminated air and ADI values for contaminated drinking water. In the subsequent Tables 2-7, the available analyses for the maximum detected concentrations of these indicator chemical pollutants in various environmental situations, i.e., human living areas, drinking water, shallow wells, soils, sanitary sewers and sumps are tabulated for the Love Canal dump site (11), for the residential areas immediately adjacent in the West (2, 3), North (4), and East (6, 8), and the miscellaneous control area (99).

Soil: The data in Table 2 for pollution of storm sewer sediments clearly indicate the very extensive pollution of Love Canal (Area 11) with a wide variety of toxic chemicals. These have been transported by leaching in large amounts through the storm sewer system with the worst pollution being found in Area 4 to the North. However, the large ppm quantities of the several pollutants found throughout the adjacent areas suggests a rather massive movement of the sub-surface soils throughout the entire storm sewer system. The serious nature of the contamination of the adjacent aras from this source is clearly shown by the tetrachloro-dibenzo-p-dioxin concentration of 672 ppb recorded in Area 4 together with 20,000 ppb of γ-hexachlorocyclohexane (lindane insecticide). We understand that EPA will undertake to clean up the storm sewer contamination and that capping of the Love Canal area and the provision of a leachate treatment facility should substantially decrease the movement of the toxic pollutants through the storm sewer system.

The data for soil contamination (Table 3) shows evidence of migration of dichlorobenzene to Area 2. Further analytical data for other hazardous pollutants in the "declaration zone" would appear desirable.

Water: The sump water (Table 4) and shallow well data (Table 5) if representative and reliable appear to indicate substantial ground water pollution only in the Love Canal (Area 11). This is essentially what would be expected because of the relatively deep burial (ca 30 feet) of the 21,700 tons of pollutants. The deep well data is essentially negative for the key chemical pollutants in all sites. The water sampling data for storm and sanitary sewers (Table 6) is, however, indicative of movement of toxic chemicals in water from the Love Canal burial site to the adjacent

declaration areas. The presence of the highly toxic tetrachlorodibenzo-p-dioxin in Area 2 and hexachlorocyclopentadiene in Area 8 is particularly disturbing. Rather large amounts of dichloro-and trichlorobenzenes and γ-hexachlorocyclohexane in storm sewer water of Area 2 and lesser amounts in Areas 4 and 8 also demonstrate the spread of the pollutants from Love Canal into the "declaration area" through water. Thus additional and regular monitoring of storm and sanitary sewer water for the presence of the key pollutants is highly desirable.

Air: The air sampling data from Living Areas (Table 7) is difficult to interpret because of the small number of key pollutants monitored. The data are almost entirely restricted to dichlorobenzenes and chlorotoluenes that are among the most volatile of the key pollutants. The presence of these in Living Areas, however, is greater (at maximum values) in the "declaration areas" 2, 3, 4, 6, 8; than recorded in Area 99. These maximum values especially for dichlorobenzenes are 4.4X greater in Area 6, 6.5X greater in Area 4, 11.5X greater in Area 2, 12.5X greter in Area 3, and 26X greater in Area 8. These substantially increased values must be significant and air monitoring in Living Areas for other volatile key pollutants especially hexachlorocyclopentadiene and hexachlorobutadiene should be made to confirm air movement.

ANSWERS TO QUESTIONS POSED:

Q-1 - Are the concentrations measured in the declaration area significantly different from levels found in other areas of Niagara Falls?

A-1 - As shown in Tables 2-7, concentrations of the specific pollutants associated with the Love Canal waste disposal are relatively very high in the Love Canal Area (11) in storm sewer sediments (Table 2), soil (Table 3), water-sump (Table 4), and water-shallow well (Table 5).

The evidence for leaching and migration away from the Love Canal dump area is strongest with storm sewer sediments where relatively large amounts of important pollutants such as γ-hexachlorocyclohexane, hexachlorobenzene, tetrachlorobenzene, dichlorobenzenes, and trichlorobenzenes were found in Areas 3, 4, and 8 and to a lesser extent in Area 2. Particularly ominous, of course, is the very high level of the extremely toxic tetrachlorodibenzo-p-dioxin (TCDD) found in Area 4. Migration of these substances will undoubtedly be decreased by the remedial construction undertaken but cannot be discounted as a long term source of contamination of the "declaration area" by highly toxic and relatively non-volatible pollutants. Thus, there is reliable evidence of concentrations of key pollutants in areas adjacent to Love Canal significantly higher than in the other areas of Niagara Falls.

Q-2 Do the levels measured represent concentrations that could cause acute or chronic adverse health effects in people living in the Love Canal beyond what might be expected under usual residential conditions in the Niagara Falls area?

A-2 It is impossible to answer this question in the negative. The presence of at least 21,700 tons of hazardous pollutants in the Love Canal and the evidence summarized in A-1 that detectable amounts of these are to be found in the adjacent Areas 2, 3, 4, 6, 8 suggests that people living in these areas will be exposed to trace chemical insults from a variety of highly toxic chemical pollutants for generations. Several of the key chemical pollutants including tetrachlorodibenzo-p-dioxin, hexachlorocyclopentadiene, and hexachlorocyclobutadiene

are extraordinarily toxic. Others such as γ-hexachlorocyclohexane (lindane) and hexachlorobenzene have been strictly regulated or proposed for regulation by the World Health Organization, EPA, OSHA, etc. All of these chemicals are suspect carcinogens. The epidemiological studies of birth defects, abortions, and chromosomal aberrations made in the Love Canal and adjacent areas, while subject to disputations, are significantly disturbing to demand a strongly conservative attitude about promoting the exposure of thousands of persons, especially young children to these trace chemical pollutants over a lifetime.

Comparisons of environmental health standards for air quality i.e. 8-hour TLV-TWA values, and drinking water i.e. ADI values; with maximum air pollution levels and water contaminations recorded for the Love Canal area, are somewhat reassuring. The maximum detected levels for most of the key pollutants for which the data are available are very substantially less than accepted standards. However, tetrachlorodibenzo-p-dioxin, the most toxic of all the pollutants is a notable exception and analytical data are so sketchy for the highly toxic hexachlorocyclopentadiene and hexachlorocyclobutadiene that together with inadequate study and standards for these pollutants the results are virtually meaningless. The use of 8-hour TLV's for air pollutants for evaluation of the 24-hour lifetime exposures that are found in the declaration areas is also very misleading. For lifetime exposures the spectrum of sensitivity of the exposed population including the very young and the aged is much wider than that of an occupationally exposed population. The threat of mutagenic, carcinogenic,

and teratogenic chemicals is very much greater. All of these conditions suggest the need for a safety factor of at least 1000 for the very hazardous chemicals concerned, that should be superimposed upon any considerations of TLV values.

The answer to question 2 is that the concentrations of key pollutants detected in the Love Canal area could cause adverse health effects beyond those in usual residential conditions in the Niagara Falls area.

Q-3 Were sufficient samples taken and analyzed to determine the extent of contamination by particularly hazardous material as to be able to assess their potential threat to human health?

A-3 Although a large number of samples were taken and analyzed and the values obtained seem to be reliable within the present state of the art, sampling and analysis were not rigorous enough to describe adequately the human health threat from the highly toxic key pollutants of Love Canal. The largest gaps in the sampling scheme are for the highly toxic hexachlorocyclopentadiene and hexachlorobutadiene, and tetrachlorodibenzo-p-dioxin. More effort should be expended on routine and regular sampling for the other key pollutants such as lindane, hexachlorobenzene, pentachlorophenol, pentachloronitrobenzene and the more volatile di-,tri-,tetra-chlorobenzenes and phenols, and chlorinated toluenes.

Q-4 Based on available data, can you conclude that the area is not habitable?

A-4 In the writer's opinion the immediate Love Canal (Area 11) should be completely barred to human access. Suggestions that it become a "park area" are irresponsible. It is much more difficult to assess the habitability of the "declaration areas" especially Areas 2; 3; 4; 6; 8 adjacent to Love Canal. Concerns aroused by the

pollutant monitoring and epidemiological studies cannot be erased by the data presently available. Additional monitoring data is important to determine the effects of the remedial capping and barrier construction instituted in the Love Canal and to fill the voids in the analysis of key pollutants as indicated above. The writer does not believe that it would be responsible to advise inhabitants that the area is totally safe. Certainly he would not want to expose himself, his family or his friends to these hazards of chemical pollution through lifetime residence there. There is in addition a measurable hazard in lifetime exposre to the polluted atmosphere of the city of Niagara Falls itself.

Review of EPA Monitoring Program at Love Canal
August 16, 1981
by Dr. Beverly Paigen

Summary

The consultants to CDC were asked to evaluate a subset of the data obtained by EPA's environmental chemical testing program and to answer the following questions:

1. Are the concentrations of chemicals significantly higher than other areas of Niagara Falls?

2. Could these concentrations cause adverse health effects?

3. Were enough samples taken of very toxic chemicals such as dioxin to be able to assess its health threat?

4. Is the area habitable?

The data had several problems in the presentation of material and in the adequacy of measurements. Putting these aside, I believe it was possible to judge that organic chemicals were higher in Love Canal study area (the entire Love Canal neighborhood excluding Rings 1 and 2) than in other areas of Niagara Falls. Organic chemicals were higher in storm sewers, in stream sediments, in sumps, in soil, and in home air. Only in drinking water were organic chemicals similar in Love Canal and control area and this is based on small amount of data.

The data are not adequate to permit an answer to questions 2 and 4 regarding health and habitability for reasons discussed below. In answer to question 3, there were insufficient samples taken to adequately evaluate whether dioxin levels constitute a health threat in the study area even though the small number of samples had surprisingly high levels of dioxin.

Finally, additional analyses of data would be helpful in determining the extent of contamination at Love Canal and these are listed.

I. Adequacy of data

A. Problems for the consultants in reviewing data

The data were difficult to evaluate because of the massive amount of data, the short time to review, the lack of statistical treatment, the inability to read some tables and maps, and the lack of sufficient summary tables and paragraphs. Although I can appreciate the difficulties in assembling and reproducing such large amounts of data, I am not comfortable as a scientist in answering questions concerning public health based on data I cannot read (pp 72-74, 76-78), data with obvious errors (maps on pp 62-70 show stream sediment samples taken where there is no stream), unexplained symbols on maps and tables, and little aggregation of data or statistical analysis (i.e., the entire second book of sampling areas has no summaries at all).

Several points were particularly disturbing. There was no description of control sites (i.e., Packard Avenue may be near another dump site). The EPA program was designed to test for preferential migration (p 8), yet there was no data analysis concerning that hypothesis. The separation into areas 1-11 had some rationale, but there is no discussion of this nor analysis by area.

The picture was further confused when Mr. Deegan of EPA, at the August 13 meeting of consultants, stated that, in his opinion, the data demonstrated no evidence of chemical contamination beyond Ring 1 except for storm sewers and stream sediments. When a consultant asked Mr. Deegan about the soil data on p 41, Deegan replied that table was "no longer operative." The consultant then spent the lunch hour tabulating data by hand from the larger data bases and indicated to Deegan that organic chemicals were frequently found in Love Canal and rarely in control area soils. Mr. Deegan claimed that the differences were "not statistically significant."

As a scientist asked to make a judgment based on data, I simply cannot in good conscience ignore tables of data simply because one person states they are no longer operative nor can I accept one person's statement that the differences are not statistically significant when I am not shown the statistical methods or significance tests and when the data available in hard copy to review lead to the opposite conclusion.

B. Problems with using the data base to answer questions concerning health and habitability

The original plan was to couple the environmental testing programs with a health study. Had that plan been carried out, the two studies taken together could have been used to answer questions of health and habitability. As it stands, the current data base is not appropriate to answer such questions for the following reasons:

1. Love Canal has over 200 chemicals present and only a subset were measured.

2. Little or nothing is known about the toxicology of a large percentage of the chemicals present because they are waste products or process intermediates (for a fuller discussion see Rall et al. "Report of Subcommittee to Evaluate Health Effects Near Hazardous Waste Sites." HHS 1980).

3. Little is known about the synergism or antagonism that might exist in such a complex mixture of chemicals.

4. Even for those chemicals that were measured and for which toxicological data exist, most studies are based on workers or experimental animals. Almost nothing is known concerning the concentrations of chemicals that would be safe for the human fetus; yet adverse reproductive outcomes were the health effect best documented at Love Canal.

The primary ways in which this particular data base could be used to answer questions of health and habitability are two-fold. First, if the levels of one particular chemical were high enough, one could state it was unsafe. Second, if one particular area showed no evidence of chemical contamination, then one could tentatively conclude the area was safe if the sampling was adequate and if the subset of chemicals measured are an adequate reflection of the whole set.

C. Problems with Quality Control

EPA had a good quality control plan for this study with spiked samples, duplicate samples, and inter- and intra-laboratory comparisons. The results of the quality control program are described on pp 111 and following. Several points were made by EPA.

1. The "meaning of trace is obscured by the variance in minimal detection limits among laboratories" (p 119). Trace from one lab could be 30 times higher than trace from another lab (i.e., see tetrachlorobenzene on p 130).

2. Some laboratories performed much better than others ranging from 33 percent acceptable results to 100 percent acceptable results (p 133). These two facts led to a cautionary statement that "users of Love Canal data should be aware of differences in detection limits .... and performance" among laboratories (p 120).

3. The magnitude of the testing program "literally overwhelmed the national capacity for low level chemical analysis" (p 121). Thus many samples were held too long and this fact becomes important for volatiles and semivolatiles. For water many samples arrived with poorly fitted or leaking Teflon cap liners (p 122). Water samples were held too long. Soil samples were held too long and the effect of holding was stated not to be a problem between 4-18 weeks but "losses in the first few weeks are indeterminable at this time" (p 142). For air holding time was not given in the summary data. Mr. Deegan referred the consultants to the full data base in Atlanta, but we could not find holding time there either. Holding time for volatiles in air is quite critical.

4. Some chemical measurements were not to be trusted, i.e., phthalates and methylene chloride in soil and benzene and toluene in air.

5. Reproducibility and accuracy of measurements for metals in soil and sediment were fairly good but were not good for volatiles and semivolatiles (p 148).

6. The reproducibility data for air was calculated in a way that is not familiar to me and which obscured the real differences (p 160). For example: if sample 1 has duplicates a and b and b is 50 percent higher than a; and sample 2 has duplicates a and b and b is 50 percent lower than a; I would calculate that the average difference between duplicate samples was 50%. EPA calculated that the average difference was 0 percent ($\frac{-50+50}{2} = 0$). I would like to see a more conventional analysis of reproducibility.

II. Tentative conclusions based on the data

The data base is not adequate to answer questions of health and habitability but there are several questions that can be answered or could havebeen answered by an environmental monitoring program. The conclusions are only tentative given the problems with presentation of material and quality of data base discussed under I above.

A. Is the Love Canal area contaminated?

The storm sewer, stream sediments, soil, sumps and air in homes in Love Canal are all clearly contaminated compared to the rest of Niagara Falls. Only the drinking water appears to be the same as the rest of Niagara Falls and that is based on very limited data.

EPA did not give any statistical analysis of the data so I examined the data for organic chemicals and simply asked whether each organic chemical was more frequently found in Love Canal samples than in control samples. I then used a simple statistical test, the sign test which has relatively low power, to ask the probability that, for example, out of 13 separate tests, Love Canal was higher than control 13 out of 13 times. This is given by $(1/2)^{13}$ or 0.0001, a significant difference. This is not a sophisticated analysis; it would be possible to use other tests that involve a combination of probabilities (such as Fischer or Wallis). In addition, a strong argument could be made for combining the chemicals into groups such as all trichlorophenols or all BHC or all organics.

For storm sewer sediments, there were 21 Love Canal area samples and 1 control and 14 organic chemicals gave positive readings. In 14/14 cases, Love Canal is higher than control (p 54). For storm sewer water, there were 9 Love Canal samples and 1 control and 13 organic chemicals were detected (p 55). Love Canal was higher than control in 13 out of 13 (12/13 controls were 0). In the sanitary sewers, only 1 Love Canal water sample was taken (no control samples). Twelve organic chemicals were found at levels comparable to or higher than storm sewer water (p 57).

The stream sediments in Love Canal were contaminated but the stream water did not show evidence of contamination. There were 4 Love Canal samples and 5 control samples. For the sediments, 12 out of 12 chemicals were higher in Love Canal; in the stream water only 2 organic chemicals were detected (toluene and heptochlor) and Love Canal was lower than control:

In the sumps, there were 105 Love Canal samples and 6 control area samples (p 51). Love Canal was higher in 9/9 cases (6/9 controls were 0).

In the soils, there were 113 Love Canal samples and 8 control samples (p 41). Love Canal soils were higher in 12/12 organic chemicals. All 12 control samples were 0.

In drinking water, there were 31 Love Canal samples and 5 control samples. A total of 7 organic chemicals were detected; Love Canal samples were higher in 3 and control samples were higher in 4. Thus there was no apparent difference in Love Canal and control, a result that is not surprising since the same municipal water is supplied to both areas.

The data given for shallow aquifer wells and deep aquifer wells was not sufficient to permit an evaluation.

There were over 100 Love Canal samples of outdoor air (p 72) and over 80 Love Canal samples of basement air (p 73). However, there were no controls and so one cannot determine whether Love Canal is different than Niagara Falls.

For living area air, there were over 400 Love Canal samples and 30 controls (p 74). After eliminating benzene and toluene based on information in the quality control section; 11 out of 12 organic chemicals were higher in Love Canal homes than in control homes. The exception is p dichlorobenzene, which is completely missing from the table on p 75 causing me to wonder if there is an error. All of the air data were difficult to evaluate because they were almost unreadable.

In conclusion the data show that Love Canal is clearly higher in organic chemical contamination than the control area in storm sewer, stream sediments, sumps, soils, and living area air. No determination could be made for sanitary sewers, basement air, or outside air since no control data exist. Drinking waster was the same for both Love Canal and control and indeed comes from the same municipal source. Surface water, surprisingly, did not show any evidence of contamination although the sediments did. Perhaps this is because organic chamicals would tend to stay in sediments or be released into air, but would not be dissolved in water.

B. How far has the contamination occurred?

Since the data indicate that Love Canal is contaminated, it becomes relevant to determine how far contamination has occurred. Unfortunately, no analysis by area was given. The areas of particular concern are 5 and 1 which are the extreme edges of the neighborhood and where the greatest percentage of current residents are located. Both areas 1 and 5 have a few houses on swales or streams and these appear to be giving quantifiable levels of chemicals. I would like to see an analysis with and without those houses.

C. By what routes did contamination occur?

No analyses were presented that would permit such a determination, but it may be possible. I would like to see an analysis by 1) area, 2) wet/dry, 3) swale/non-swale, and 4) air in home with and without sumps. Several homes in the area have flooding in the yard from storm sewers. Are the soils, air, or sumps higher in such homes? Is there any correlation between positive readings in soil and air or sumps in the home?

D. Has remedial work resulted in a reduction in contamination?

Mr. Deegan stated that back flushing of chemicals from the soil was occurring to a greater extent than expected. This is an important finding and I would like to see the data.

I would also like to see a comparison of homes done by both New York State and Love Canal to compare soil, air, and sumps.

E. Is there correspondence between the geochemical evidence of contamination and the adverse health effects?

The adverse reproductive outcomes found by New York State should be compared to the geochemical data.

III. Questions posed by CDC

A. Are the concentrations of chemicals significantly higher than in other areas of Niagara Falls?

As discussed above, the answer is yes.

B. Could these concentrations cause adverse health effects?

Due to the limitations of the data base discussed above, I do not believe this question can be answered.

C. Were enough samples taken of very toxic chemicals such as dioxin to be able to assess its health threat?

Only 4 soil samples in the study area were tested for dioxin and all 4 were negative. This is an insufficient number of samples. Eleven storm sewer sediment samples were taken and all had dioxin levels.

D. Is the area habitable?

As discussed above, I do not believe this particular data base permits an answer to that question.

However, as a parent of young children, I would not want to live in any Love Canal house that 1) was along a stream with contaminated sediments, 2) had a history of basement or yard flooding from backed up storm sewers, or 3) had a sump pump. Any of these situations could lead to periodic exposures much higher than those detected by the EPA monitoring programs.

IV. Further Analyses

The following information would be useful in a further evaluation of the data base.

1. Holding time for air.
2. Evaluation by area.
3. All positive readings for organic chemicals on a map by media and with various media combined.
4. List of organic chemicals not likely to be found in consumer products.
5. Map of control sites and other dumps in Niagara Falls.
6. Statistical evaluation of data.
7. Readable tables of data for air.
8. Analysis by wet/dry.
9. Correlation of chemical data with adverse reproductive outcomes.
10. Discussion of p dichlorobenzene--the only chemical found more often in control than in Love Canal.
11. Readable figures for daily variation in air readings.
12. Comparison of New York and EPA data for some locations.

V. Final questions

The most striking thing about the EPA monitoring program was the high percentage of negative findings and the low levels of chemicals found compared to New York data.

The question that comes to me is whether exposure at Love Canal is periodic in nature and whether the health impact may occur by transitory exposure to higher levels than those found by EPA. According to Vianna et al, the peak in adverse reproductive outcomes occurred in the mid-sixties

when as many as 50 percent of all pregnancies on 99th Street ended in miscarriage. In the mid-sixties, basements were being dug for the homes on 97th Street. Perhaps the exposure of large amounts of contaminated soil to the air on 99th Street resulted in a transitory high exposure for residents on 99th Street and beyond. Consistent with this hypothesis is the peak of adverse reproductive outcomes claimed by the Love Canal residents during the remedial construction in 1979 and 1980. Perhaps Love Canal may be habitable as long as no digging occurs. Another peak exposure may have occurred following the unusually heavy precipitation in 1977. This exposure caused the residents to organize and to seek help and it was this type of exposure that the remedial work was designed to prevent.

MICHIGAN STATE UNIVERSITY

DEPARTMENT OF BIOCHEMISTRY · BIOCHEMISTRY BUILDING EAST LANSING · MICHIGAN · 48824

August 19, 1981

Dr. Clark W. Heath, Jr.
Director
Chronic Diseases Division
Center for Environmental Health
Center for Disease Control
Department of Health and Human Services
Atlanta, GA 30333

Dear Dr. Heath:

This letter constitutes my assessment of human health implications of environmental data from the Love Canal area. I would like to present a general assessment of the data and the meeting of August 13 before I address the specific questions in your letter of August 6, 1981.

In general, I believe this study was fairly well conducted and that the results do not convey reasons for alarm. However, I am particularly disturbed by two observations that may, unfortunately, be related. The first involves the non-scientific manner in which the data was presented, and the second concerns the fact that the EPA officials were apparently unconcerned about the first. The callous nature of EPA officials towards the environment they have the obligation to protect is exemplified by their attitude toward those asked to give recommendations to the agency. I can think of no better way to start any EPA activity on a more sure road to its downfall.

First of all there are many examples of very poor science. The PCB data was presented as ppb of a certain Aroclor mixture, which is scientifically unsound. If this was the only feasible method then it should be explained. If peak matching was used to see if the environmental pattern was the same as an Aroclor, what was the confidence level? Is it possible that no PCB would be reported if the GC elution pattern did not fit any of the standard Aroclor GC patterns? This is an example of the lack of adequate explanations also. Tables and graphs should always be able to stand alone such that they can be readily understood by the reader. We never did get an explanation of some tables and maps. I feel very uneasy about drawing any firm conclusions from the data presented or from the discussions held in Atlanta.

Another example of poor science is the lack of sufficient controls and definitions of controls. The lack of sufficient explanations and definitions is apparent throughout the report. The only aspect of the report adequately addressed is the quality assurance. First of all the samples were not described. Secondly, no examples of raw data were provided. Composites were uninterpretable. The maps and tables were not adequately described, difficult to read, and frequently impossible to interpret. Then, at the meeting, we were told to disregard some of the tables, presumably because they were in error. But when asked to explain the error Dr. Deegan could not do so.

I would have preferred to see examples of raw data, examples of data handling, summary tables, and statistics. The lack of statistics was particularly disturbing. Any statistics should have been accompanied by a rationale for using the particular statistical method. This data is going to come under very close and complete scrutiny. And, various people will be looking for various things. This was pointed out at the meeting by the consultants. Some wanted to see raw data while at the other end of the spectrum some only wanted summary tables. In order to satisfy each and every consultant it is necessary to provide at at least examples of all aspects of the data.

I will now reply specifically to your questions in the letter of August 6.

1. Are the concentrations measured significantly different from levels found in areas of Niagra Falls?

I am assuming that the question refers to areas 1-10 as compared to area 99, and that "significantly different" does not mean statistically significantly different. Certain chemicals certainly appear more frequently in areas 1-10 than they do in area 99. However, the levels of most do not seem to be disturbingly high. It would appear that the migration of chemicals did not occur to a great extent beyond area 11. I would recommend a thorough evaluation of the data and the site such that migration to any area beyond area 11 be identified and that remedial action be taken.

2. Do the levels measured represent concentrations that could cause acute or chronic adverse health effects in people living in the Lovel Canal area beyond what might be expected under usual residential conditions in the Niagra Falls area?

If the remedial action which has and is being taken is as effective as it appears to be, there would seem to be very little chance for acute or chronic adverse health effects for people living in areas 1 through 10. However, the data should be carefully analyzed and an on-site evaluation made to determine if any migration avenues extended outside of area 11. I make this comment with reference to the identification of obvious migration routes. The sand lenses must be thoroughly investigated to determine their extent.

3. Were sufficient samples taken and analyzed to determine the extent of contamination by particularly hazardous material and to be able to assess their potential threat to human health?

The number of samples taken seems to be sufficient but it may be impossible to guarantee that no small but excessively contaminated "hot spots" don't exist. This statement is made, however, in light of very little explanation of sampling locations. It is my understanding that an attempt was made to sample areas which would be most likely to be contaminated but the fact cannot be guaranteed. Another serious fault with the study is the lack of sufficient control samples. The number of times chemicals were found in control samples is indeed less than the number of finite levels in the declaration area samples but the number of control samples was much less.

The particularly hazardous substance of concern is most probably TCDD and the number of analyses for this compound is limited. However, an area of contamination was found and it must be dealt with. Fortunately, the area is not one normally contacted

by people living in the area. I am speaking specifically of the storm sewer system. But its contamination must be noted and corrective action must be taken to prevent indirect exposure to TCDD.

It must be noted that some concern should be expressed considering the number of chemicals in this area. Although the levels do not seem alarmingly high, an inappropriate mixture may exist. With the possible presence of both initiators and promotors the likelihood of carcinogenesis may be increased.

4. Based on available data, can you conclude that the area is not habitable?

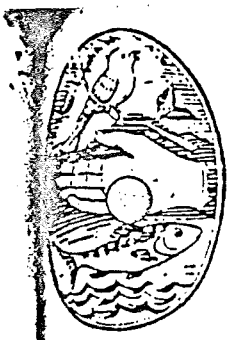
I cannot conclude that areas 1 through 10 are not habitable, although I must admit that part of my inability to make this conclusion stems from having very little definitive data or a complete analysis of the data. This hesitancy also stems from a lack of confidence in analyses of environmental samples. It would have been desirable to be able to assess the ability to duplicate data in all samples. This would be particularly important for soil samples where recovery may be variably affected by binding of the chemicals to the soil. However, my confidence in this conclusion is strengthened by the absence of any highly contaminated samples. Also, the biota did not reveal the presence of any bioaccumulated substances.

Finally, there were some very positive results of the study. The best example of this is the fact that the theory that chemicals may have readily moved via the old swails seems unproven. Also, there does not seem to be evidence for at least major migrations by dump trucks. No excessively contaminated "hot spots" were found. Finally, the "natural" barriers to migration seemed quite effective. I am speaking primarily of the barriers provided by streets and the installation of sewers. It also seems apparent that the leachate system that was installed is in fact effective.

Sincerely,

Steven D. Aust
Professor of Biochemistry

SDA/cmc



ENVIRONMENTAL DEFENSE FUND

August 21, 1981

Dr. Clark W. Heath
Director
Chronic Diseases Division
Center for Environmental Health
Centers for Disease Control
Atlanta, Georgia 30333

Dear Dr. Heath:

Let me begin by again thanking you for the opportunity to participate in the recent workshop held at CDC on August 13, 1981 to assess the human health implications of environmental data from the Love Canal area. The rest of this letter will serve as my report on that meeting.

Before discussing in detail the conclusions I reached, I think it is necessary to briefly describe my feelings as I approached the evaluation of the data presented to me. The Love Canal problem has received enormous notoriety and if one word could generally characterize both the scientific studies performed and the review of these studies, that word would have to be "inadequate." While health and environmental assessments at Love Canal have been numerous, many questions remain about the adequacy of the scientific methods used and the quality of the data generated. Likewise, the review of data, such as presented in the Lewis Thomas Report, can be heavily criticized as cursory in nature and inadequate in scope. Therefore, I approached the review of the data presented to me with the belief that the efforts we were undertaking had to provide a scientifically critical review of the data collection methodology, the data analysis techniques and the conclusions reached.

1525 18th Street, N.W. Washington, DC 20036 202-833-1484
OFFICES IN: NEW YORK, NY (NATIONAL H); WASHINGTON, DC; BERKELEY, CA; DENVER, CO

It was clear from the outset of Dr. John Deegan, Jr.'s presentation that he did not expect us to carefully review the data but rather to rely heavily on his personal conclusions in order to establish our conclusion as a panel. In fact, one of Dr. Deegan's assistants, when speaking to me, stated that it was EPA's belief that we would "trust" what they said and answer the four questions posed based on EPS's data review. Since I do not believe it is our role as scientists to merely accept what we are told, I approached the assignment given us by asking three basic questions. These questions were:

1) Are the data and analysis presented clear, accurate and if so, what do they show?

2) How accurately does the picture created by the data reflect the current situation at Love Canal and how likely is that picture to remain constant in the future?

3) Can the four questions posed be answered based on the data presented and if so, how would I answer them?

My comments are presented below in answer to these three questions.

To begin to answer the first question, are the data clearly and accurately presented, one need go no further than the printed material we received. As Dr. Whittenberger noted early in our discussion, the data were often in an unreadable and unintelligible form and certainly not in standard, proper scientific format. Moreover, once the material was deciphered, it was evident that we had been presented selected segments of the raw data base, rather than a compilation or summary of all the data that had been gathered. The rationale offered for this presentation by Dr. Deegan was that EPA hoped to avoid biasing the conclusions of the reviewers. While I appreciate his concern, the material presented was clearly inadequate to conduct a proper scientific analysis.

In response to criticisms of the format, Dr. Deegan suggested that any reviewer who wished could refer to the entire raw data base in order to conduct his or her own analysis. Such a suggestion could not be taken seriously, given the amount of time it would have taken for any individual to have made sense out of the vast amounts of raw data that had been collected. If any further analysis of these data is deemed necessary, I would suggest that the data be provided to us in a completely revised format, a format similar to that

used in the publication of a peer reviewed article. To avoid biasing the conclusions of the reviewers, the data could be presented clearly and accurately, statistical analyses could be provided and the reviewers left to draw their own conclusions.

The problems that arise in analyzing segments of raw data often presented in an illegible manner are demonstrated by the following two examples. Dr. Deegan, in making his presentation, provided the review panel with his personal view of the meaning of the data. One conclusion that Dr. Deegan drew was that the extent and level of chemical contamination in the declaration area was no higher than in the control area. Referring to page 41 of the document entitled "Environmental Monitoring at Love Canal, 1980" which had been distributed to us, I question the veracity of that conclusion. Reviewing the data, I found that the presence of organic chemicals in the declaration area far exceeded their presence in the control area. In all cases, the levels of chemical contamination in the declaration area exceeded those in the control area and thus I found it difficult to reconcile the data with Dr. Deegan's conclusion.

Upon questioning, Dr. Deegan indicated that the table presented on page 41 was inoperative and really should not be referred to for data analysis. Rather, he suggested that the large compendium of data by areas within the declaration area and for the control area be referred to instead. In a few minutes, during the lunch hour, I reviewed the data in these tables. For each area I counted the number of organic chemicals found in soil samples and compared these findings to the control area. The results are presented below.

Area	Number of Organic Contaminants Found in Soil
Control	2
Area 1	11
Area 2	16
Area 3	14
Area 4	20
Area 5	6
Area 6	3
Area 7	16
Area 8	2
Area 9	34
Area 10	10
Area 11	30

In all cases, it is clear that the number of organic chemical contaminants found in soil in each area of the declaration area exceeds the number of such chemicals found in the control area. When presented with this conclusion, Dr. Deegan suggested that a statistical analysis of this data showed the apparent differences to be insignificant. Unfortunately, neither this statistical analysis nor any other analysis were provided in the materials we received. Consequently, it is impossible to judge whether the differences are insignificant or in fact indicate a significant contamination of the declaration area compared to the control area.

In further discussion of this issue, Dr. Deegan indicated that the statistical analysis that had been performed evaluated each chemical individually for its presence in the declaration area and the control area. It is my scientific judgment that a number of these chemicals should have been considered together because they are likely to have emanated from a single source. For example, alpha, beta and gamma BHC and lindane, if found, should all have been considered together. The failure to find all four in one soil sample is easily explained by the fact that these chemicals may have diffused widely from the point source from which they emanated and the soil sample taken was extremely limited and likely therefore to have missed a number of chemical constituents. If a further review of this data is to take place, I would suggest that proper data analysis be presented so that the reviewers can evaluate the method of data analysis and the conclusions reached.

A similar confusion arises in an evalution of the data on organic air pollutants found in the control area and in the declaration area. Again, after Dr. deegan presented his conclusion that the extent and level of chemical contamination found in the declaration area and control area were no different, I quickly compared the levels of o-dichlorobenzene measured in living areas in both the control area and the declaration area. The results of that comparison are presented below.

Area	Mean Level Found (ug/m3)
Control	none reported
Area 1	28.4
Area 2	9.3
Area 3	13.1
Area 4	4.9
Area 5	4.6
Area 6	6.5

Area 7	6.4
Area 8	29.4
Area 9	6.5
Area 10	4.1
Area 11	5.1

As in the case of the soil analysis previously presented, it is clear that in every area of the declaration area, living area air was more highly contaminated with o-dichlorobenzene than in the control area. In fact, by referring to the large compendium of data provided to us, one would conclude that o-dichlorobenzene was not found at all in the control area.

Dr. Deegan quickly corrected this misunderstanding by referring to page 74 of the document entitled "Environmental Monitoring at Love Canal, 1980." He noted that in sampling for o-dichlorobenzene this chemical had been detected at the detection limit in 10% of the cases, as compared with 43.4% of the cases in the declaration area. I failed to make this comparison, largely because the table provided is illegible. When questioned whether the incidence of o-dichlorobenzene contamination in the declaration area was statistically significant compared to the control area, Dr. Deegan reported it was. Consequently, it was hard to understand how he reached a conclusion that the control area and the declaration area were equally contaminated. Dr. Deegan quickly pointed out that for p-dichlorobenzene the reverse pattern of contamination was observed. He suggested that it therefore might be appropriate to consider evacuating the control area. Such sarcastic statements have no place in a proper scientific disucssion.

I am left with the conclusion that there is a great deal of ambiguity about the meaning of the data collected by EPA. The data analysis referred to above certainly suggests that chemical contamination of the declaration area exceeds contamination in the control area. While this was not Dr. Deegan's conclusion, it will remain mine until I can be shown that these and similar analyses are in some way inappropriate or incorrect.

An additional point to consider is the quality of data presented to us and the conclusions that can be drawn from it. I remain quite concerned that the quality control experienced in these studies is less than adequate. This is not to suggest that the methodologies chosen by EPA are less than state-of-the-art. At this point in time I have not personally reviewed the appropriateness of each test methodology employed by EPA, and must rely upon conclusions of experts like Dr. Browner that, in terms of analytical techniques, the methods selected by EPA are appropriate. However, Dr. Browner in his-

discussion of this issue alluded to the fact that he could make no judgment about the sampling procedures used by EPA nor the adequacy of the treatment of the samples prior to analysis. The materials presented to us clearly indicate that there was a significant variability in the analytic capabilities of the laboratories employed to conduct the environmental analysis at Love Canal. Moreover, several significant questions still remain regarding the effect of unusually long storage periods prior to sample analysis. For example, on page 142 of the document entitled "Environmental Monitoring at Love Canal, 1980" there is a discussion of the effect of holding times on the analysis for volatile organic chemicals. The report states that "only minimal loss of purgeable organics" occurred when the holding time for analysis was 18 weeks after collection rather than 4 to 5 weeks. It is unclear what the term "minimal loss" really means, and I would wish to see data regarding the number of chemicals analyzed and what percentage of loss that actually occurred. Furthermore, and perhaps more important, is the conclusion stated in the report that "losses, if any, in the first few weeks are indeterminable at this time." Therefore, the magnitude of loss of volatile organic chemicals that occurred during the first 4 to 5 weeks of storage is unknown and it is highly likely that under certain holding conditions a significant portion of volatile organics would have been lost.

One final point needs to be made in discussing the analysis of the data presented to us and that concerns the number and identity of the control areas chosen. In presenting his review of the data, Dr. Deegan indicated that different numbers of samples were taken for analysis from different environmental media. For example, if my notes are correct, of 19 sites selected for surface water sampling, 14 samples were taken from within the declaration area and 5 from the control area. Similarly, of 79 different sites sampled for groundwater analysis, 68 were from within the declaration area and 11 were from the control area. The ratio of samples obtained from the test area (areas 1 through 11) to the control area (number 99) suggests that the sampling pattern heavily favored the collection of samples from within the Love Canal area. While I am not a statistician, I believe that a skewing of sample selection so heavily toward the experimental neighborhood may make the study relatively insensitive compared to a study where a better balance between samples collected from the experimental area and the control area is achieved. In further discussions of this data I would like an analysis by a statistician as to the significance of the effect of the sampling pattern on the sensitivity of the study.

In addition, I believe we need a much better explanation of how the control areas were selected, for what criteria they were matched compared to the Love Canal declaration area, and whether in fact any of these sites themselves were contaminated. Dr. Paigen raised the point that one of the sites, namely Control Site C (see page 4 of the document "Environmental Monitoring at Love Canal, 1980"), the site in the vicinity of 7320 Packard Avenue is in close proximity to, or actually overlaps, a known hazardous waste dumpsite. If this is true, then a thorough analysis needs to be provided to assure us that the control site is clearly distinct from the area known to be a chemical dumpsite and that no contamination from that site would be detected in sampling at the control area. Moreover, nowhere in the materials presented are we informed as to which values for control readings come from which of the control sites. I would find it very helpful to know where the control data comes from, especially after learning more about the nature of each of these control sites and their appropriateness to serve as controls for the Love Canal declaration area.

Whether one concurs with the conclusions reached by Dr. Deegan or finds that the data suggest something entirely different, the question of rehabitation necessitates a judgment on how predictive the current picture is for the future. This issue was addressed by several of the participants in the working group, including Dr. Doull, Dr. Kim, Dr. Pellizzari and myself. Dr. Pellizzari commented that we are only looking at a "microcosm of the total reality." Dr. Kim cautioned that it might be advisable to continue monitoring for some time into the future, before making a judgment on the habitability of the site. He questioned the advisability of predicting future conditions based on our current knowledge.

I strongly concur with the sentiments of those participants noted above because I too have great reservations about the applicability of the current data to predicting the future situaton at Love Canal. As one example of the possible changing nature of the conditions at the Canal, I offer the observation I have made on visits to several other dumpsites where clay caps have been used as part of the remedial cleanup plan.

At the Kin Buc dump in New Jersey and Gratiot landfill in Gratiot County, Michigan, clay caps were put in place, topsoil applied, and the area seeded. Within 12 to 18 months, both caps showed significant deterioration resulting from subsidance and erosion. There is no guarantee even in the short term, no

less in perpetuity, that the cap at Love Canal will be properly maintained. There are no funds designated for long term maintenance. Consequently, the cap at Love Canal may deteriorate with time. Dr. Kim has already reported that when cracks developed in the current cap prior to sodding, one could detect the escape of volatile organic chemicals. I believe, therefore, that any discussion of the possible future uses of the Love Canal area must address concerns such as the maintenance of the cap and explore the likelihood for changes in the nature of the conditions that exist today.

Finally, we must ask whether the four questions we addressed can be answered based on the available data, and if so, how we would answer them. The first question asks "Are the concentrations measured significantly different from levels found in other areas of Niagara Falls?" This question is difficult to answer, based on the available data. The analysis presented above suggests that the number of chemical contaminants and, in many cases, the level of contamination in the Love Canal declaration area exceed those in the control area. However, since we were not provided with adequate descriptive information about the control areas, it is impossible to conclude whether they are representative of the Niagara Falls area in general. In order to properly answer this question one would have to have a more complete analysis of the data collected and would need more extensive information on the control areas and their relationship to other areas in the Niagara Falls vicinity.

Question #2 asks "Do the levels measured represent concentrations that would cause acute or chronic adverse health effects in people living in the Love Canal area above what might be expected under usual residential conditions in the Niagara Falls area?" I suggest that this is an impossible question for anyone to answer because of our very limited knowledge of the toxicological effects of lifetime low level exposures to a wide variety of chemical toxins. Moreover, in many cases, the toxicological risk posed by exposure to many of the chemicals reportedly disposed of in Love Canal is unknown. Therefore, it is impossible to make an accurate judgment about the likelihood of health impairment if exposure to these chemicals occurs. In addition, in order to answer this question one would have to assume that the data generated in the control areas are representative of the conditions in the general Niagara Falls area. At this point we certainly don't know that to be a fact.

As discussed at the workshop meeting, there is an another element of information that needs to be considered in attempting to judge the toxicological risk of habitation of the

Love Canal area. That element is the data generated on the adverse health effects that have already resulted from living at Love Canal. It is the conclusion of both the State of New York and Dr. Beverly Paigen that an increased incidence of adverse birth outcomes resulted from residing in the Love Canal community. In addition, Dr. Paigen's work also suggests that other forms of health impairment (i.e., the incidence of asthma) were elevated in the Love Canal community. The available health effects data has been criticized for various scientific inadequacies. The environmental data we have been asked to review is, in my judgment, flawed in a variety of respects as well. Consequently, the best judgment that can be made about the risk to human health from residing in Love Canal would be a judgment based on both the evidence we have from environmental monitoring and from health effects testing.

Even if we were able to accurately predict the adverse health consequence of exposure to all the chemicals in the various environmental media, we would be hard pressed to determine whether the reported level of chemical contamination is accurate or is predictive of future conditions. With regard to the current situation, it is unclear from the data presentation what margin of error exists for the reported levels of chemical contamination. Further analyses would have to be provided in order for anyone to feel confident in judging the true magnitude of current contamination reported within the declaration area.

Concerning future patterns of contamination, it is my belief that, based on the data before us, we are unable to predict with any accuracy what the future will be. Disruption of the clay cap as noted above might lead to far greater contamination of the declaration area. Suggestions voiced at the workshop that the area designated by EPA as Area 11 might become a park or a public playground indicate that the integrity of the clay cap in that area might be at far greater risk than merely from erosion, subsidance and lack of maintenance. Any activity that would have people using the canal site as a playground or park would most surely jeopardize the integrity of the clay cap.

Moreover, even Dr. Deegan noted that for certain environmental media, contamination within the declaration area far exceeded that in the control area. Most notably Dr. Deegan spoke about the contamination of sewer lines and sediments. While Dr. Deegan alluded to the fact that EPA had just announced plans for the cleanup of the sewer lines and sediments, it should be remembered that this announcement of cleanup is not new. Under the pevious Administration, the Regional Administrator for Region II announced a program that was also going to clean up the sewer lines. However, that

program was not undertaken. Consequently, one should not assume that the promise of cleanup programs means that cleanup will occur. Finally, on this same point it should be noted that while Dr. Deegan stated that the barrier drain system was operating as designed and "the material was moving back faster than it had ever moved out," there is no documentation for such a statement in the materials presented to us. This is a significant point because previous reports about the functioning of the barrier drain system were less optimistic about its working success.

The third question posed was "Were sufficient samples taken and analyzed to determine the extent of contamination by particularly hazardous materials and to be able to assess the potential threat to human health?" At the workshop, you attempted to have the consultants answer this question with respect to dioxin contamination. In my judgment, insufficient discussion took place about this question . Differences of opinion were voiced as to the potential threat posed by dioxin exposure, but the direct intent of the question (i.e., the sampling or review of the sampling regime) was not discussed.

I agree with those who expressed concern over the high levels of dioxin in soil samples taken in the Love Canal declaration area. As one participant noted, it certainly is difficult to explain to the public that parts per billion levels in soil are an insignificant risk when the Commissioner of Health of the State of New York has warned people against eating fish contaminated with parts per trillion of the same chemical. Obviously, the exposure that may result from eating fish contaminated with dioxin as opposed to living in an area with dioxin-contaminated soil is not the same. However, it should be remembered that young children, for example, often play in soil and very young children may in fact ingest soil.

The last question posed to the consultants was "Based on available data, can you conclude that the area is not habitable?" This question might as well have been asked in the following way: "Based on available data, can you conclude that the area is habitable?" Had the latter question been posed, I think the answer clearly would have been "No." The environmental monitoring data presented to us is, in my judgment, an insufficient data base on which to conclude that the Love Canal declaration area is habitable and that individuals should be encouraged to move back in. Because the question is worded as it is, any belief that the data base we have to rely on is inadequate would force one to answer the

question in the negative. The conclusion that most likely would be drawn from that response is that the respondant believes that the declaration area should be rehabitated. I certainly do not believe that the evidence we were asked to consider allows one to conclude that the Love Canal declaration area is a safe place to live. I strongly believe that CDC and the Department of Health and Human Services would be making a grave error if they concluded from a review of this data that the Love Canal declaration area was safe to live in, and that individuals should be encouraged to relocate there. At best, our judgment must be that the data base presented to us, taken alone, is insufficient to reach a conclusion on habitability that would be scientifically supportable. If forced to offer a more definitive opinion, then one would have to say that no one should be encouraged to relocate in the Love Canal area based on what we know today.

I recognize that a number of families in the declaration area have chosen to stay rather than to move out. That is clearly their choice to make. I believe we have a responsibility as scientists to -- as best as we can -- explain the significance of the data that have been gathered, and to be honest and straightforward about the numerous uncertainties that exist. If these individuals continue to choose to stay, that is their right. Providing such advice is clearly different from actively supporting a conclusion that the declaration area should be reinhabited.

I hope these comments will be useful to CDC in making recommendation to EPA regarding the meaning of the environmental assessment data. At the workshop you stated that the final report that will be prepared by the Department of Health and Human Services for EPA will have our letters to you attached as appendicies. I believe it is essential that our comments be included because I want to be sure that the views of all consultants are clearly and accurately presented.

As I indicated at the meeting, I would be happy to participate in another meeting if that would be useful to CDC. I would, however, request that if such a meeting is to take place, we be provided with more time to review any data we will be expected to discuss. Again, thank you for the opportunity to participate in the workshop and to serve as an expert consultant to CDC on this matter.

Sincerely,

Joseph Highland /ec

Joseph Highland, Ph.D.
Chairman
Toxic Chemicals Program

c

RESEARCH TRIANGLE INSTITUTE
POST OFFICE BOX 12194
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27709

CHEMISTRY AND LIFE SCIENCES GROUP

August 27, 1981

Dr. Clark W. Heath, Jr.
Director, Chronic Diseases Division
Center for Health
Centers for Disease Control
1600 Clifton Road, N.E.
Atlanta, Georgia 30333

Dear Dr. Heath:

Enclosed is a copy of the review on the EPA Love Canal Study. I enjoyed the opportunity to provide some assistance to you in this program and hope that it will be helpful to the overall goals. If I can be of any further help please give me a call at (919)541-6579.

Sincerely,

E. D. Pellizzari, Ph.D.
Director for Analytical
Sciences Division

EDP/mlu

Enclosures (as stated)

qualified available

REVIEW OF EPA LOVE CANAL STUDY

E. D. Pellizzari

Research Triangle Institute

Research Triangle Park, North Carolina

Introduction

The emphasis of this review was directed toward assessing the study design and analytical methodology employed for acquiring information concerning toxic chemicals in the various media. The primary questions to be addressed in the review were expanded to provide more in depth probes to the viability of the study design and results. These aspects are debated below.

Purpose of the Review

The major thrust of this review is to address the following primary questions:

(1) Were sufficient samples taken and analyzed to determine the extent of contamination by particularly hazardous materials and to be able to assess their potential threat to human health?

(2) Are the concentrations measured significantly different from levels found in other areas of Niagara Falls?

(3) Do the levels measured represent concentrations that could cause acute or chronic adverse health effects in people living in the Love Canal area beyond what might be expected under usual residential conditions in the Niagara Falls area?

(4) Based on available data is the area not habitable?

Specific Issues Reviewed

The primary interrogatives not only have far reaching ramifications but also contain subtle, detailed issues that need examination prior to drawing any valid conclusions. Some specific issues are enumerated and addressed here as part of this review.

(1) Was the study design adequately structured to meet the main objectives implicit in the primary questions?

Based upon readily accessible information the implied intention of the study was to determine whether a significantly greater risk of exposure to chemicals from the Love Canal site exists now or in the future for inhabitants of the declaration area as compared to inhabitants of other areas within Niagara Falls, NY. In essence the design should be a probability study. To demonstrate significant differences between a "test case" and a "control case" sufficient, representative, experimental data from both cases need to be acquired. The problem becomes predicting what is "sufficient" when initially setting up the study design. This is particularly difficult if the samples analyzed yield many non-detectable values. Probability functions can be used to decide upon "representative" data. Also, what constitutes significant, i.e., is the purpose to measure differences between the two areas that are greater than factor of two or an order of magnitude.

The monitoring of ambient air for volatile chemicals occurred at 62 sites in the declaration area and 4 sites in the "control" area over a two month period. Both outdoor and indoor (living room and basement) ambient air was sampled as

12 hr integrated samples (two/day). Unoccupied premises were sampled which had been closed to enhance the possibility of elevated levels of chemicals. Although sufficient numbers of samples were collected during the period of September and October, 1980 at each site, more sites designated in the "control" area would have been desirable, especially when testing for significant differences between the declaration and control area. The degree of representativeness of the four sites in Niagara as constituting a "control" might be questioned.

Monitoring of water was primarily through "grab" sampling instead of integration with time. Drinking water was obtained from pre- and post- municipal treatment systems serving the communities designated as the declaration and control areas. This is an indirect approach. Acquiring drinking water samples from each home selected for air monitoring may have revealed whether any small ruptures in water lines existed in contaminated areas. Nevertheless, the likelihood of such an occurence probably is small. Ground water was taken from about 170 wells, including shallow and deep aquifers from the declaration and control areas. In this case their were more sampling sites from the control area (15) than in the air sampling design. Water samples from storm sewars (28 sites), sumps in basements (54 sites) and creeks/rivers (19 sites: 14 declaration, 5 control) were also collected. The rationale for selection of sampling sites within each area was not clearly stated in the report provided, nor whether the objectives were achieved.

Sediments were collected from 19 streams, 3 sumps and 24 storm sewers. One sediment sample from the Leachate Treatment Facility was also taken. Soils were taken from 171 locations (9 in control area) as 6 ft. vertical cores.

The major exposure route is postulated to be ambient air, since vaporization of surface chemicals would lead to their inhalation. The importance of soil and sediment cannot be over emphasized since they can provide historical (time integrated) documentation of fate and transport of chemicals. The number of sediment samples examined probably are representative of the streams and sewers; however, an insufficient number of sumps were selected. Sediments from sumps in both occupied and unoccupied homes in the declaration area should have been included in the study, particularly since previous evidence is suggestive that major pollution of basement air came from the basements sumps.

Soil also can be a major route in "pica" exposure in young children. Moreover, it can be a sink for chemical emission (fallout) and subsequently involved in dynamics of transport. Vertical cores were not analyzed in sections. As such, considerable dilution could occur from such compositing to the extent that any chemicals potentially present as a small discrete zone (say at the ground surface) were diluted below the detection limits of the techniques employed.

(2) Was the most exhaustive list of toxic chemicals potentially occurring at Love Canal sought in the study design?

The selection of methods for sampling and analysis of air, water, soil, sediment and biota obviously should be based upon the best available technology. The techniques employed, however, essentially limited the study design to a finite list of target compounds. One should be cognizant of the fact that comprehensive monitoring for all chemicals in the five matrices was not conducted nor is it possible with the current analytical methods in the analyst's arsenal of tools. This may be inappropriately gleaned as a serious limitation of this study. The technical approach employed emphasized quantification of target compounds. Nevertheless, an equally important aspect should have been the determination of any "unknown" chemicals that may be present. The qualitative identification of as many chemicals as possible with state-of-the-art technology would increase ones confidence that the chance of potential exposure to toxic chemicals is minimal if the findings are not significant. This feature of the study was short changed since state-of-the-art technology (see below) was employed for only some of the environmental media.

(3) Were the sampling methods selected for the various environmental media - air, water, soil, biota, sediments - viable for the purposes intended to support the study design?

In as much as its possible to assess this facet of the study it appears that the sampling techniques employed were adequate. One minor exception on soils was noted above, however. More detailed discussion on the documentation of accuracy of sampling will be discussed under Quality Control/ Assurance (QC/QA) below.

(4) Were the analytical methods that were employed state-of-the-art?

The methods chosen for sampling and analysis of ambient air for toxic organic vapors were in this case state-of-the-art. Neither method (Tenax-GC/MS or Polyurethane foam - GC/ECD and HPLC/EC) is a "standard method". Also, the application of these complimentary methods still do not yield a comprehensive picture of the ambient air composition. The full potential of either method was not realized in this study. The Tenax-GC/MS method lends itself to assessing sampling accuracy by the use of deuterated surrogate chemicals. This feature was not exploited (To be discussed further under QC/QA). The polyurethane foam technique (PUF-GC/ECD) employed antiquated pack column gas chromatography. The use of capillary column technology would have improved the limits of detection for the target compounds (halogenated aromatics including PCBs and polychlorinated naphthalenes) as well as ensured more specificity to isomer identification and quantification. Thus, collection with polyurethane foam is at the frontier of the scientist's capability while packed column gas chromatographic analysis is at least a decade outdated.

Similar criticisms can be made of the use of the Federal Register Methods for analysis of water samples. The strength of these methods rests with the degree of validation (both intra and interlaboratory) that each has been subjected to over the past several years. Nevertheless, the use of selective detectors with gas chromatography is limited to quantification.

Broad spectrum analysis (identification of non-targeted chemicals) should have been given more emphasis to decrease the chances of missing important chemicals in this study. Capillary column GC/MS should have been employed rather than packed column technology, again to increase the accuracy of identification and the breadth of analysis capability.

Similar deficiencies can be cited for the methods employed for analysis of soils, sediments and biota.

(5) Were experienced and reliable research/service laboratories employed for the sampling and analysis of air, water, soil, sediment and biota?

Analysis of air samples were performed by two laboratories with no prior experience with the Tenax-GC/MS method. This was evident in the Quality Assurance sample results which appeared to be less precise during the first few weeks of analysis by one laboratory. Laboratories performing analysis using the PUF-GC/ECD method were experienced with the technique.

All other laboratories had several years prior experience in performing priority pollutant analysis in water samples and to a lesser extent in soil, sediment and biota.

(6) Were their sufficient Quality Control and Assurance practices imposed on the sampling, sample analysis, and data analysis to ensure the integrity of the analytical data reported?

The QC/QA practices employed were extensive and one of the relatively stronger features of this study. Unfortunately, "Standard Reference Materials" are not available from the National Bureau of Standards. Thus, reliance was on performance

evaluation solutions, controls, blanks, etc., to assess the sample preparation and analysis steps.

Quality assurance applied to the sampling and storage step for each environmental matrix was limited to the use of spiked sampling devices (containers) for determining recovery (i.e., accuracy). No internal standards were used to assess potential malfunctions of the sampling step and subsequently storage, work-up and analysis. This is a serious limitation of all methods. A small percentage (~ 10%) of the samples should have included internal standards during sampling. For example, deuterated benzene (d_6), d_5-chlorobenzene, etc., could have been added to the ambient air sampling device (protocol: Tenax-GC/MS) to monitor the accuracy of sampling and analysis without interfering with endogeneous chemical analysis. The use of isotopic compounds would more closely mimic the endogeneous compounds than the use of spiked, unsampled devices. The isotopic concept is well documented and widely accepted by analytical chemists in many different areas of research.

Much of the QC/QA practices were devoted to establishing precision. As such criteria were used to establish "out-of-control" guidelines. This aspect of the study is well done and substantially documented. Somewhat disappointing were the number of data points classified as out-of-control and thus not usable. Storage times exceeded recommended maximum holding times for water, soil, and sediment. This may have accounted for the high rejection level. More important, a substantial

quantity of data for water samples could not be accounted for (by this reviewer) on the basis of samples collected. This problem needs to be clearly rectified.

(7) Is the overall quality of the data adequate to support the study objectives?

For the most part the precision of this data appears to be plus or minus a factor of two (2 σ) for the sampling and analysis techniques employed for each environmental medium except soil which is somewhat larger. To determine whether a significant difference exists between the declaration and control areas this level of precision can be one of the limiting factors. The accuracy for each S/A method is more difficult to discern, in fact no definitive statement should be made since internal standards were not employed as surrogates.

(8) Does the data appear to be consistant across all environmental media studied?

An estimated 90% of the 400,000 measurements performed yielded results below the detectable limits of each method. This is the most important observation to be cited of the data, i.e., its consistency across all environmental media. Such overwhelming negative evidence suggests that the conclusions to be drawn will be substantially founded. It is highly improbable that all S/A methods employed were inferior and incapable of detecting the target chemicals if present.

(9) Does the data provide any insight to significant differences between the declaration and control areas?

Even though the statistical frequency tests between the two areas are not significant, the sample size employed in the control area may have been too small since the number of values reported below the detection limits was large (possibly skewed data).

Conclusions

The following responses are offerred to the primary questions raised concerning this study:

(1) More sites representative of the "control" area in Niagara Falls should have been selected in this study for making comparisons to the declaration area.

(2) Data available for review did not indicate that significant differences in concentrations of the target compounds between the declaration area and other areas of Niagara Falls; however, this conclusions is subject to the qualifications cited in (1).

(3) If a clustering health effect phenomenon was presently latent in the declaration area it is not clear how the statistical design of this study would have detected this possibility. The results of this study design suggest at best the minor differences in concentrations between the declaration and control area would have to cause acute or chronic adverse health effects at an elevated rate in the Love Canal area relative to Niagara Falls.

(4) Based on the available data from this study design the area appears to be habitable. More importantly, the data should be reanalyzed to determine whether any one household might be considered at a greater risk (risk assessment analysis) rather than comparing statistical means, medians, geometric means between the two areas and extrapolating potential risk to the entire area. Perhaps each location (household) in the declaration area should be individually evaluated.

Finally, this reviewer strongly recommends that the Final Report on the Love Canal be written in acceptable scientific format with one additional peer review of the report prior to its release. In its present form it is unacceptable for release.

NATIONAL RESEARCH COUNCIL
ASSEMBLY OF LIFE SCIENCES
2101 Constitution Avenue Washington, D. C. 20418

CUTIVE DIRECTOR
)N TOXICOLOGY AND
NTAL HEALTH HAZARDS

August 26, 1981

Clark W. Heath, Jr., M.D.
Director, Chronic Diseases
Division
Center for Environmental Health
Centers for Disease Control
Atlanta, GA 30333

Qualified
habitable

Dear Dr. Heath:

I am responding to your letter of August 6th requesting review of monitoring data from the Love Canal. I have reviewed the entire package of data and offer my conclusions in the format stated in your letter:

1. Are the concentrations measured significantly different from levels found in other areas of Niagara Falls?

The data indicate that the concentrations of some organic and inorganic substances are higher in the soil and sewer sediment in the Love Canal area than in other areas of Niagara Falls. However, for purposes of assessing risks to human health, it is unclear from these data whether human exposure is significantly different from one population to the other.

2. Do the levels measured represent concentrations that could cause acute or chronic adverse health effects in people living in the Love Canal area?

The levels measured in the various media would not be expected to produce acute toxicity unless, for example, large quantities of contaminated soil would be consumed (an unlikely prospect). On the other hand, the risk of chronic injury is real for exposure to the carcinogens and mutagens because the risks are assumed to have no measureable population threshold. The risks from these substances are associated not only with concentration level but also with duration of exposure. Since there is no longitudinal information about exposure, risk estimation is necessarily uncertain.

3. Were sufficient samples taken and analyzed to determine the extent of contamination by particularly hazardous materials and to be able to assess their potential threat to human health?

There is little doubt that the sampling was exhaustive geopgraphically and that all media were analyzed extensively. These data provide an adequate picture of contamination in the area at the time of sampling. However, to assess risks to human health, two assumptions are required: First, the concentrations in media such as soil represent a measure of exposure of humans (for sewer sediment this is difficult to conceptualize); and second, the exposure presently assumed will continue for a large portion of the lifespan of the residents (longitudinal data would be advisable to address this issue). While perhaps impractical, data from actual human exposures would be the most reliable to make assessments of risks to human health. If those direct exposure data were available, an exposure algorithm could be constructed to estimate total body burden. This information could then be used to estimate risk.

4. Based on available data, can the area be considered "not habitable?"

From these data, I would conclude that some form of clean-up or containment is required so as to minimize possible exposure from, for example, contaminated soils. However from these data alone it is not possible for me to conclude that health hazards of such unusual proportions exist to make this area "uninhabitable." There are societal and legal considerations that must be taken into account in judging habitability.

I appreciate the opportunity to respond to your request.

Sincerely yours,

Robert G. Tardiff

Robert G. Tardiff, Ph.D.
Executive Director

HARVARD UNIVERSITY
SCHOOL OF PUBLIC HEALTH

s L. WHITTENBERGER, M.D.
ssor of Physiology
nes Stevens Simmons Professor of Public Health

665 HUNTINGTON AVENUE
BOSTON, MASSACHUSETTS 02115

August 19, 1981

habitable if remedial measures taken

ark W. Heath, Jr., M.D.
rector, Chronic Diseases Division
nter for Environmental Health
nters for Disease Control
lanta, GA 30333

ar Clark:

fore attempting to answer the questions posed in your letter of August 6, 1981, wish to comment in general about the meeting and about the materials provided the consultants. Overall it was one of the more frustrating experiences I've d as a consultant. On trying to read the draft report prior to the meeting, I nd so many graphs and tables that were illegible or uninterpretable that I ve up trying to form any conclusions from the submitted material.

would have been very helpful to have had in advance some of the comparison bles that some of us tried to construct for ourselves by searching through the ntout during the meeting. For example, I thought it would be interesting to pare one air pollutant measurement in the living areas of the homes sampled each of the geographic areas studied. Eventually I had a simple table showing t the chemical was present in all geographic areas except for the control a. It was annoying to be told repeatedly, in answer to questions, that "the a are all there on the table for you to examine." I was informed later that had made additional comparison tabulations which had not been accepted by . If this is true, I wonder about the reasons. I can respond better if I e a scientific presentation in essentially the form presented for publication a peer-reviewed journal - the objectives, a statement of hypotheses to be ted, the study design, the methods in detail, including sampling strategy, results, and the author's interpretations. I don't accept the author's erpretations unless he has persuaded me that he has used the best possible hods and analysis. I had the feeling that most such information came out e-meal at the meeting, and we would have had a more fruitful day if these es had been presented clearly at the beginning, or if we had had better ormation in advance.

age 17 of the EPA report is reference to "two comparison volumes." These never identified so far as I know, although they contain data for Area 97, h is an interesting comparison area in some of the tables. The air monitoring for Area 98 might also be of interest.

ever additional comments I have about the study will come in my attempts to er the questions.

stion 1: Are the concentrations measured significantly different from levels nd in other areas of Niagara Falls?

he more I reflect on this question, the more I wonder what it means. If taken iterally, the answer is no, because many of the "concentrations measured" were ound in "other areas of Niagara Falls." Presumably the intent was to compare ither Area 11 (the Canal) or the Declaration Area (Areas 1 through 10), with he "control area" (Area 99). Since Niagara Falls has so many hazardous waste mps, active or inactive, and since the control areas were defined in terms of roximity to known dump sites, the concept of "control area" is questionable in iagara Falls, since dissemination or translocation of chemicals from dump sites certain to have occurred by various construction activities as well as by tural processes. There are high concentrations of inorganics in sampling sites many parts of Niagara Falls, including metals like arsenic, lead, mercury, and dmium. My conclusion is that the Study Area (which does not include Area 11), not significantly different from other areas of Niagara Falls, provided that e takes into account that storm sewers and outfall sediments can have high ncentrations of contaminants from Love Canal.

Do the levels measured represent concentrations that could cause acute or ronic adverse health effects in people living in the Love Canal area beyond at might be expected under usual residential conditions in the Niagara Falls ea?

ain, I assume the question refers to the Study Area, excluding Area 11. Con- dering contamination of air in living area and contamination of drinking water, think residents of the Study Area are not at greater risk than might be expected der usual residential conditions in Niagara Falls.

Were sufficient samples taken and analyzed to determine the extent of contami- ion by particularly hazardous materials and to be able to assess their ential threat to human health?

noted at the meeting on August 13, 1981, the sampling and analytical methods d by EPA and its subcontractors were "state of the art" and probably as well ried out as is possible in a study of this magnitude and complexity. EPA has n very sensitive to quality control issues since their problems with CHESS large program of epidemiologic studies of air pollution several years ago) their problems with pesticide testing; I believe they took quality control sures seriously in this study and did as well as anyone could do considering number of subcontractors and the state of development of specific methods. hink sufficient samples were taken except possibly for the control area. four houses had air sampling because it was so difficult to persuade pants to vacate their houses for 3 months. If the data were consistent for ven house sampled repeatedly, for a week, for example, it might have been er to have more houses sampled for much briefer periods. However, I don't this as a strong criticism of the EPA study.

Based on available data, can you conclude that the area is not habitable?

sume again that we are talking about residential areas outside the rings of es that were largely evacuated in 1978, and assume further that remedial ures will be continued to prevent further dissemination of chemicals still ined in the Canal, or previously deposited in storm sewers or outfalls.

der these assumptions, I believe residence in the Study Area would be no more zardous than in other residential areas of Niagara Falls.

summary, I think EPA has done a very good study under difficult circumstances. my opinion, the study is an adequate basis for judging the habitability of e areas neighboring Love Canal. Unfortunately, the findings are not directly levant to assessment of human exposures pre-1978, since the study was performed ter remediation. I believe that neighborhoods 200 ft. or more from the old nal are just as habitable as other residential areas in Niagara Falls, provided medial measures are continued, to contain the residual hazardous wastes.

Sincerely,

James L. Whittenberger

James L. Whittenberger, M.D.

JW:mc

GEORGIA INSTITUTE OF TECHNOLOGY
ATLANTA, GEORGIA 30332

CHEMISTRY

August 19, 1981

Dr. Clark W. Heath, Jr., M.D.
Director, Chronic Diseases Division
Center for Disease Control
Atlanta, GA 30333

Dear Dr. Heath:

Following the meeting held at CDC on August 13, to review health hazard data on the Love Canal, I am enclosing my comments and recommendations on the material considered.

General:

The format of the analytical data presentation made effective comparison between the various Tables difficult. Consequently, it was not really possible prior to the meeting to give a rigorous treatment to the data and arrive at any firm conclusions. In addition, the lack of appropriate units to the primary computer print-out of data made evaluation of these dimensionless numbers impossible.

During the course of the meeting, and also subsequent to the meeting, the meaning and implications of the results contained in the reports have become clearer, as a result of questions and discussions raised at the time. Nevertheless, there remains a lingering concern that much of the information contained in the reports is not fully clarified at this time.

While the position of EPA towards the data, namely a desire to present raw values, with minimum interpretation by them is understandable, it is probably not a helpful position for arriving at an informed opinion. Consequently it is recommended that EPA provide a report based on the available material, but more in the form of a scientific paper. This could concentrate on a Results and Discussion Section which would explain the data contained in the Tables, provide statistical treatment where appropriate and discuss the implications of the data in the light of the statistical treatment. As with my scientific paper, the discussion of the data would be open to question and clarification by the review group. It is felt that in the absence of such a report the magnitude of the task facing the consultant group in reviewing this material will result in unclear recommendations to HHS.

A meeting to review the total data, with as long a lead time as possible, would be most helpful.

In the light of the foregoing reservations regarding comprehension of the data, the following comments should only be considered as tentative and subject to review.

1. Quality of Analytical Data.

The procedures used for sampling and chemical analysis, including QA and QC testing appear to be of the highest quality. While certain discrepancies certainly exist between various laboratories, these are typical for trace organic analysis at these low levels. With the proviso that the EPA procedures of running duplicates for only 10% of samples is unacceptable to many analytical chemists, the overall quality of the data can reasonably be considered to be excellent.

2. Comparison of Concentrations of Various Chemicals with Niagara Falls Area 99.

In general, the data appear to indicate no significant pattern of contamination for the toxic species examined in the Love Canal area compared to the surrounding district, with the exception of the immediate vicinity of the Canal (Area 11). Area 11 appears to show significant soil contamination compared to Area 99. Many of the chemicals found at significant levels in air samples (e.g. benzene) probably cannot be attributed to migration from the canal site, as there is no evidence of dumping these chemicals there.

3. Toxic Hazards of Pollutants to Area Residents.

At the present time, with the remedial action that has been taken, there appears to be little hazard to homes outside Area 11. Such conclusions, however, could be vitiated by any reduction in the quality of the pollution containment and monitoring procedures that are currently in effect. In particular, the clay cap over the site will need constant attention and maintenance to ensure that no adverse leakage takes place, if settling occurs as water is drawn from the treatment plant.

4. Habitability of Love Canal Area.

Area 11 should probably be considered permanently closed to human habitation or general ingress, and the present houses removed. The potential for future exposure to toxic materials seems to involve too high a risk to be justifiable.

Surrounding portions of the study area (Areas 1-10) appear to offer no greater health risk than that experienced by the general population of Niagara Falls, due to prevailing air pollution levels.

I hope that these comments are of some value to you in considering the response of HHS to the EPA study.

Yours sincerely,

Richard F. Browner

Richard F. Browner
Associate Professor
of Chemistry

RFB/jap

"This report represents the opinion of the author. It carries no official endorsement by the Georgia Institute of Technology".

SPELLMAN
Governor

ALAN J. GIBBS
Secretary

STATE OF WASHINGTON

DEPARTMENT OF SOCIAL AND HEALTH SERVICES

Olympia, Washington 98504

August 17, 1981

Clark W. Heath, Jr., M.D.
Director, Chronic Diseases Division
Center for Environmental Health
Centers for Disease Control
Atlanta, Georgia 30333

Dear Dr. Heath:

Before giving formal responses to the questions you pose about the Love Canal dump site, I would like to have the EPA raw sampling data summarized and interpreted as in the format of a scientific article.

I have come to some preliminary conclusions after perusing the raw data, reading the available published studies, and listening to the presentations and discussion at the Atlanta meeting.

Since the EPA sampling was done in August-October 1980, one year after the site had been capped, these samples represent historical remnants of Love Canal pollutants.

It is currently impossible to reconstruct the pollution situation at earlier times. Thanks to the nature of the soil and terrain, most of the pollutants dumped in the Canal did not migrate very far. The only exception to this is the contamination of storm sewers, catchment basins, waterways and streams draining Ring I homes. The capping of the Canal and the installation of the barrier drain system and treatment plant seem to be working to prevent further pollution.

With the exception of the anecdotal reports of gross contamination of a dozen Ring I and II houses, and sampling results adjacent to sand lenses, there is surprisingly little objective evidence that serious chemical pollution of the environment occurred. There is currently no good evidence that this pollution has caused human health impairment. The pollutant levels measured are far below those causing acute effects and probably could not be linked to chronic health effects if, indeed, such effects were demonstrated.

The EPA sampling effort was extensive and seems to be state of the art.

If the integrity of the clay cap and covering turf can be maintained and the barrier drain system properly operated, I see no reason why the

area cannot be rehabilitated. With the exception of the dozen or so obviously contaminated houses, I'd go as far as having no objection to the other houses in the area being reoccupied.

When the summarized EPA sampling data are available, I'd like to see them.

Thanks for giving me the opportunity to offer advice.

Sincerely,

Sam Milham

Samuel Milham, Jr., M.D.
Head, Epidemiology Section LB-15
Health Services Division

SM:em

EMIC INDUSTRY INSTITUTE OF TOXICOLOGY

IDENT, ROBERT A. NEAL, PH.D.
PRESIDENT, DIRECTOR OF RESEARCH, JAMES E. GIBSON, PH.D.
ETARY AND ADMINISTRATIVE MANAGER, DONALD A. HART, ED.D.

CIIT

P. O. BOX 12137
RESEARCH TRIANGLE PARK,
NORTH CAROLINA 27709
(919) 541-2070

August 18, 1981

Clark W. Heath, Jr., M.D.
Director, Chronic Disease Division
Center for Environmental Health
Center for Disease Control
Atlanta, GA 30333

Dear Dr. Heath:

Given the heterogeneity of the group who reviewed the EPA monitoring data, it is clear that there will not be a consensus concerning what these data mean relative to a health risk to the residents of the Love Canal area. I think it is quite clear that the analytical data was generated in as scientifically a rigorous manner as is possible. All of the analytical chemists present at the meeting were of that opinion, including Stephen Kim of the New York State Department of Health. The validity of these analytical data is also suggested by their general concordance with the data generated earlier by the New York Department of Health. Some of the panel members had difficulty evaluating the EPA analytical data in the form in which they were presented. I had less difficulty in that regard, primarily because I had spent considerable time comparing the data from the various sampling regions of the declaration area with the control data. It is my opinion that, with the exception of the canal area itself (including some ring one houses), the analytical data do not indicate that residents of the declaration area are exposed to levels of chemicals by way of air, water or soil which are, in a practical sense, different than exposure, by those same routes, of people living in the control areas. It is also highly unlikely since they are, in general, much lower than allowable concentrations in the industrial work environment, that persons in the control areas are experiencing any significant health risk from exposure to the levels of various chemicals detected in the EPA monitoring. It can be argued that persons in the declaration area are exposed to toxic chemicals, as a result of their presence in the Love Canal, which were not monitored for by the New York Department of Health or EPA. However, I do not believe that argument has any merit in a practical sense. The EPA monitoring examined for compounds of known and unknown toxicity which they knew had been disposed of in the Love Canal. Hypothetically, there are compounds in the Love Canal which were not examined for in the EPA monitoring and for which there is no toxicology data base. However, unless these compounds posses considerable volatility, the persons in the declaration area are not likely to be exposed to them. I say this because, with the exception of about 10% of the houses in ring one and the effluent

of some storm sewers adjacent to the canal, there is no evidence of migration of chemicals from the immediate area of the canal. In addition, the human health monitoring or the animal studies which have been done on site have not yet produced any evidence of adverse health effects or the potential for adverse health effects in residents of the declaration area. I repeat that it can, and has been, argued that persons living in the declaration area may be exposed to chemicals which have not yet been identified in the monitoring program. It is further argued that these chemicals may have an adverse health effect. My answer to this is that there comes a time when we must stop delaying decisions relative to the health risks to persons in the declaration area based on unknown and improbable eventualities. I believe the time for decision making in this regard has come. Based on the analytical data, the results of human health monitoring and on-site animal studies it is my opinion that no practical health risk exists for persons living in the declaration area (excluding the immediate area of the canal and ring one houses). The finding of low birth weight children in the "wet" vs. "dry" areas of the declaration area is offered as an argument that adverse health effects are occurring. I do not find these data at all convincing. First of all, the numbers are small. Secondly, there is no evidence that there was movement of chemicals from the canal into these areas. Finally, the fact that the incidence of low birth weight babies of families living in ring one and ring two houses was not significantly different from control incidences suggest the effect seen in the "wet" area is either a spurious result or unrelated to living in close proximity to Love Canal.

With those general comments as a background, let me direct some remarks to the specific questions you posed in your letter of August 6.

Question 1

As I indicated above, the raw data from the EPA analytical monitoring does not suggest that the compounds which were monitored for were in higher concentrations in the declaration as compared to the control areas of Niagara Falls (excluding some ring one houses and the immediate area of the canal).

Question 2

Again, as noted above, the analytical data currently available do not indicate that persons living in the declaration area are exposed qualitatively or quantitatively to chemicals which are, in a practical sense, different from the exposure of people living in control areas of Niagara Falls.

Question 3

In my opinion, sufficient sampling for known substances of high toxicity have been performed. The results of this sampling do not suggest the presence

of sufficient amounts of these substances in areas outside of some ring one houses and the immediate canal area, which pose a health risk to people living in these areas.

Question 4

In my opinion, people living outside of the ring one houses are not exposed to levels of the chemicals present in the Love Canal which pose any significant health risk. Further, the lack of significant migration of chemicals from the canal (excluding some ring one houses and storm sewers adjacent to the canal) in the 30 plus years of the presence of significant amounts of chemicals in the canal does not suggest the possibility of future exposure of persons living in the declaration area from chemicals present in the immediate area of the canal. The fact that additional safeguards against migration of chemicals from the canal by various routes, including storm sewers, have been put in place, adds additional assurance that significant migration is highly unlikely in the future.

Sincerely,

Robert A. Neal
President

RAN:eam

Source EPA
Love Canal
Monitoring
Report 1982

CHAPTER 5
SUMMARY AND CONCLUSIONS

The EPA multimedia environmental monitoring program conducted at Love Canal provided a substantial amount of information on the extent and degree of environmental contamination in the Declaration Area that resulted directly from the migration of contaminants from the former canal. In general, the monitoring data revealed that except for residual contamination in certain local storm sewer lines and portions of creeks located near the outfalls of those storm sewers, the occurrence and concentration levels of chemicals found in the Declaration Area (in each media monitored) were comparable to those found at nearby control sites. The monitoring data also revealed that contamination that had most likely migrated directly from Love Canal into residential areas was confined to relatively localized portions of ring 1 in the Canal Area (that is, near certain unoccupied houses located adjacent to the former canal). In addition, comparative data from other locations in the United States (presented in Appendix B of this Volume) revealed that the observed occurrence and concentration levels of those chemicals monitored in the residential portions of the Declaration Area and elsewhere were comparable. Furthermore, comparisons of the concentration levels of environmental contaminants found in the residential portions of the Declaration Area with existing EPA standards revealed that no environmental standards were violated.

A review of all of the environmental monitoring data collected at Love Canal also revealed that no evidence was obtained which demonstrated that residential portions of the Declaration Area exhibited measurable environmental contamination that was directly attributable to the presence of contaminants that had migrated from the former canal. In addition, it is unlikely that undetected Love Canal-related contamination exists in the residential portions of the Declaration Area, because the targeted substances monitored and the sampling locations selected for monitoring purposes were intentionally directed (based on the best available evidence) to maximize the probability of detecting contaminants that had migrated from the former canal.

The absence of Love Canal-related environmental contamination in the Declaration Area, other than that which was mentioned previously, conformed with the results and implications of the hydrogeologic investigations conducted in the general Love Canal area. Specifically, the well-defined multimedia pattern of environmental contamination found in shallow system ground-water samples, in soil samples, and in sump samples collected at certain locations in ring 1 of the Canal Area, was in full agreement with (and corroborated) the hydrogeologic program results.

The following points highlight the major findings of the EPA multimedia environmental monitoring program conducted at Love Canal.

- The hydrogeologic program results demonstrated that there is little potential for migration of contaminants from Love Canal into the Declaration Area. These findings conformed fully with the results of the multimedia environmental monitoring program. Furthermore, the close correspondence of the multimedia monitoring data to the implications of the geological and hydrological characteristics of the site minimized the likelihood that potential limitations inherent in the state-of-the-art analytical methods used during the study resulted in artifactual or fallacious conclusions regarding the extent and degree of environmental contamination at Love Canal.

- The results from the hydrogeologic program suggested that the barrier drain system, which was installed around the perimeter of Love Canal in 1978 and 1979, is working as designed. In particular, the outward migration of contaminants through more permeable overburden soil has been contained, and the movement of nearby shallow system ground water is towards the drain. Consequently, contaminated shallow system ground water beyond the barrier drain will be drawn towards Love Canal, intercepted by the barrier drain system, and decontaminated in the Leachate Treatment Facility. Previously reported EPA testing of the effectiveness of the Leachate Treatment Facility demonstrated an operating efficiency of greater than 99 percent removal of all monitored organic compounds in the influent leachate. Discharged liquids from the facility are transported through the sanitary sewer system to the City of Niagara Falls wastewater treatment plant for additional treatment.

- Except for some apparently isolated pockets of shallow system ground-water contamination located immediately adjacent to the former canal, no general pattern of contamination

was found in the shallow system. Furthermore, no significant shallow system ground-water contamination attributable directly to migration from Love Canal was found outside of ring 1 in the Canal Area.

- Low level, widespread contamination was observed throughout the bedrock aquifer. However, ground-water samples from the bedrock aquifer located in the Lockport Dolomite did not reveal a pattern of contamination that had migrated directly from Love Canal.

- No Love Canal-related patterns of contamination were found in soil samples collected in the Declaration Area. Patterns of soil contamination attributable to contaminants having migrated from Love Canal were found in ring 1 of the Canal Area, and were associated with known or suspected preferential transport pathways in the soil, and with the occurrence of shallow system ground-water contamination.

- No evidence of Love Canal-related contamination that had migrated preferentially through former swales into the Declaration Area was found, nor were "wet" area residences found to have higher concentrations of contamination than "dry" residences.

- Evidence of residual contamination that had most likely migrated from Love Canal was present in sump samples collected in a few residences located immediately adjacent to the former canal (that is, within ring 1).

- Evidence of residual contamination that had most likely migrated from Love Canal was found in those storm sewer lines which originated near Love Canal in the Canal Area.

- Evidence of residual contamination that had most likely migrated from Love Canal was present in the sediments of certain creeks and rivers sampled near to those storm sewer outfalls of sewer lines originating near the former canal.

- Results from monitoring activities in the residential portions of the Declaration Area revealed that the contamination present was comparable to that at the control sites, to concentrations typically found in the ambient environment, and to concentrations found in other urban locations. In general, no environmental contamination that was directly attributable to the migration of contaminants from Love Canal was found in the Declaration Area (outside of the previously mentioned storm sewer lines and creeks).

Finally, a review of the results from the entire Love Canal environmental monitoring study revealed that: (1) except for contamination present in sediments of certain storm sewers and of certain local surface waters, the extent and degree of environmental contamination in the area encompassed by the emergency declaration order of May 21, 1980 were not attributable to Love Canal; (2) the short-term implications of ground-water contamination are that a continued effective operation of the barrier drain system surrounding Love Canal will contain the lateral migration of contaminants through the overburden, and the long-term implications are that little likelihood exists for distant ground-water transport of contaminants present in the Canal Area; and (3) a review of all of the monitoring data revealed that there was no compelling evidence that the environmental quality of the Declaration Area was significantly different from control sites or other areas throughout the United States for which monitoring data are available.

APPENDIX A
LISTS OF SUBSTANCES MONITORED AT LOVE CANAL

The following two tables contain lists of substances that were routinely determined in samples collected during the EPA Love Canal multimedia environmental monitoring program. Table A-1 contains a list of targeted organic and inorganic substances that were determined in water, soil, sediment, and biological samples. In Table A-2, a list is presented of targeted organic and inorganic substances that were determined in air samples.

TABLE A-1. SUBSTANCES MONITORED IN LOVE CANAL WATER/SOIL/SEDIMENT/BIOTA SAMPLES

Volatiles-Method 624 Analytes (Medium: Water/Soil/Sediment/Biota)	
Methylene chloride	trans-1,3-Dichloropropene
Chloromethane	Benzene
1,1-Dichloroethene	Acrolein
Bromomethane	Acrylonitrile
1,1-Dichloroethane	Dibromochloromethane
Vinyl chloride	1,1,2-Trichloroethane
cis-1,2-Dichloroethene	Bromoform
Chloroethane	1,1,2,2-Tetrachloroethane
trans-1,2-Dichloroethene	Benzyl chloride
Trichlorofluoromethane	o-Xylene
Chloroform	m-Xylene
1,2-Dichloroethane	p-Xylene
1,2-Dichloroethene	Tetrachloroethene
1,1,1-Trichloroethane	Toluene
Carbon tetrachloride	2-Chlorotoluene
Bromochloromethane	3-Chlorotoluene
Bromodichloromethane	4-Chlorotoluene
2,3-Dichloropropene	Chlorobenzene
1,2-Dichloropropane	Ethyl benzene
Trichloroethene	1,2-Dibromoethane

(continued)

TABLE A-1 (continued)

Phenols and Base/Neutrals-Method 625 Analytes
(Medium: Water/Soil/Sediment/Biota)

2-Chlorophenol
3-Chlorophenol
4-Chlorophenol
2-Nitrophenol
Phenol
2,4-Dimethylphenol
2,4-Dichlorophenol
2,3,5-Trichlorophenol
2,4,6-Trichlorophenol
4-Chloro-3-methylphenol
2,4-Dinitrophenol
2-Methyl-4,6-dinitrophenol
Pentachlorophenol
4-Nitrophenol
Hexachloroethane
1,4-Dichlorobenzene
1,3-Dichlorobenzene
1,2-Dichlorobenzene
Bis(2-chloroethyl)ether
Bis(2-chloroisopropyl)ether
N-nitrosodi-n-propylamine
Hexachlorobutadiene
1,2,3-Trichlorobenzene
N-nitrosodimethylamine
1,2,4-Trichlorobenzene
1,3,5-Trichlorobenzene
Nitrobenzene
Naphthalene
Isophorone
Bis(2-chloroethoxy)methane
Hexachlorocyclopentadiene
(C-56)
2-Chloronaphthalene
Acenaphthylene
Acenaphthene
Dimethylphthalate
2,6-Dinitrotoluene
Fluorene
1,2-Diphenylhydrazine
4-Chlorophenylphenylether
2,4-Dinitrotoluene
2,4-Dichlorotoluene
Diethylphthalate
N-nitrosodiphenylamine
Hexachlorobenzene
4-Bromophenylphenylether
Phenanthrene
Anthracene
Di-n-butyl phtalate
Fluoranthene
Pyrene
Benzidine
Butylbenzylphthalate
Di(2-ethylhexyl)phthalate
Chrysene
Di-n-octylphthalate
Benzo(a)anthracene
Benzo(k)fluoranthene
Benzo(b)fluoranthene
Benzo(a)pyrene
3,3-Dichlorobenzidine
Indeno(1,2,3-dc)pyrene
Dibenzo(a,h)anthracene
Benzo(g,h,i)perylene
Pentachloronitrobenzene
2,4,6-Trichloroaniline
4-Chlorobenzotrifluoride
(Trifluoro-p-chlorotoluene)
1,2,3,4-Tetrachlorobenzene
1,2,4,5-Tetrachlorobenzene
Tetrachlorotoluenes
(18 position isomers--ring and methyl substitution)

(continued)

TABLE A-1 (continued)

Aroclors (PCBs) and Pesticides-Methods 608 and 625 Analytes (Medium: Water/Soil/Sediment/Biota)	
α-BHC	Endosulfan sulfate
β-BHC	DDD
δ-BHC	Chlordane
γ-BHC (Lindane)	DDT
Heptachlor	Toxaphene
Aldrin	Aroclor 1221
Mirex	Aroclor 1254
Endosulfan I	Aroclor 1016
Heptachlor epoxide	Aroclor 1232
DDE	Aroclor 1242
Endrin	Aroclor 1248
Endosulfan II	Aroclor 1260
Dieldrin	

Inorganics (Medium: Water/Soil/Sediment/Biota) and Fluoride and Nitrate (Medium: Water)	
Antimony	Mercury
Arsenic	Nickel
Barium	Selenium
Beryllium	Silver
Cadmium	Thallium
Chromium	Zinc
Copper	Fluoride
Lead	Nitrate

Note: 2,3,7,8-Tetrachlorodibenzo-p-dioxin was quantitatively determined in a select number of samples.

TABLE A-2. SUBSTANCES MONITORED IN LOVE CANAL AIR SAMPLES

Volatiles
(Source: TENAX)

Quantitative Analysis	Qualitative Analysis
Benzene	Chloroform
Carbon tetrachloride	1,2-Dichloroethane
Chlorobenzene	2,4-Dichlorotoluene
o-Chlorotoluene	o-Chlorobenzaldehyde
p-Chlorotoluene	p-Chlorobenzaldehyde
1,2-Dibromoethane	Benzyl chloride
o-Dichlorobenzene	(α-Chlorotoluene)
p-Dichlorobenzene	1,1-Dichloroethane
1,1,2,2-Tetrachloroethylene	1,1-Dichloroethylene
Toluene	(Vinylidene chloride)
	1,2-Dichloroethane (EDC)
	1,2-Dichloroethylene
	Dichloromethane
	Phenol
	o-Xylene
	m-Xylene
	p-Xylene

Pesticides and Other Compounds
(Source: PFOAM)

Quantitative Analysis	Qualitative Analysis
γ-BHC (Lindane)	Hexachloro-1,3-butadiene
Hexachlorobenzene	1,2,4,5-Tetrachloro-benzene
Hexachlorocyclopentadiene (C-56)	α,α,2,6-Tetrachloro-toluene
1,2,3,4-Tetrachlorobenzene	Pentachloro-1,3-butadiene
1,2,3-Trichlorobenzene	Pentachloronitrobenzene (PCNB)
1,2,4-Trichlorobenzene	1,2,3,5-Tetrachloro-benzene
1,3,5-Trichlorobenzene	α-Benzenehexachloride (α-BHC)
2,4,5-Trichlorophenol	Heptachlor
Pentachlorobenzene	

(continued)

TABLE A-2 (continued)

Inorganics (Source: HIVOL)
Quantitative Analysis
Antimony
Arsenic
Beryllium
Cadmium
Copper
Lead
Nickel
Zinc

Note: 2,3,7,8-Tetrachlorodibenzo-p-dioxin was quantitatively determined in a select number of samples.

EPA Observations on the Review of the National Bureau of Standards of the Love Canal Monitoring Program

Abstract

The NBS Review highlighted many technical aspects that must be considered in detail when employing state-of-the-art analytical methods for the first time in operational programs, particularly programs being carried out under severe time constraints. NBS considered the methods used by EPA to have been the best that were available for the study. The Review underscored the importance of determining the detection limits and the precision and accuracy of these methods.

The Review identified many issues that were not adequately addressed in the initial drafts of documents provided to NBS by EPA. However, the Review did not identify any technical limitations, deficiencies in laboratory performance, inadequacies in quality assurance activities, or other shortcomings in methodological approaches or procedures that would affect the conclusions of the monitoring program. The deficiencies in the early drafts have been corrected, and the revisions of these documents incorporate or respond to all suggestions and questions raised by NBS.

General

During the fall of 1981, EPA requested the National Bureau of Standards (NBS) to review and critique a number of initial drafts of a variety of technical documents prepared during 1980 and 1981 in support of the Love Canal Monitoring Program. The NBS comments are set forth in the May 1982 report "Review of Material Presented by EPA on the Analysis for Organic Chemicals in the EPA Love Canal Monitoring Study" which also identifies the EPA draft documents that were considered. The Review identified many issues that were not adequately addressed in these initial drafts and greatly assisted EPA in preparing the final documentation to support the study. The NBS comments were particularly useful in EPA's effort to document more fully the technical basis for the conclusions presented in EPA's final report of the study "Environmental Monitoring at Love Canal," May 1982, and in particular, in helping to ensure the completeness and clarity of the associated quality assurance documentation. In this regard, the initial drafts of Appendices C, D, and E of Volume I of the final report which describe the quality assurance program have been substantially rewritten to incorporate many suggestions of NBS.

The NBS has extensive experience in the development of high precision scientific measurements, in general, with a long-standing interest in advancing the scientific frontiers of analytical methods. Furthermore, NBS had not been involved in monitoring activities at Love Canal and therefore was in a position to bring an independent perspective to a review of EPA's monitoring efforts. This combination of research experience, interest, and fresh perspective resulted in many useful observations in the NBS Review and complements internal EPA reviews which drew on EPA's more extensive experience in conducting environmental monitoring programs.

As recognized in the NBS Review, the analytical methods used by EPA were at the state-of-the-art. In some instances, the Love Canal effort was advancing the state-of-the-art. For example, the methods for air and water analyses had not previously been subjected to multi-laboratory validation studies. With regard to the analysis of soil and sediment, the initial weeks of the study were devoted to determining, through abbreviated multi-laboratory tests, which method of several options would be most appropriate. For analysis of water as well as soil and sediment samples, fused silica capillary columns were used on a significant scale for the first time.

In view of EPA's regulatory mission and the need to respond promptly to complex technical issues at Love Canal, there was no opportunity to conduct a methods evaluation program and to determine in advance the full capabilities of the methods to be used. Rather, it was necessary to determine and document those capabilities during the study. Despite the uncertainties inherent in using methodologies that had not been thoroughly tested, NBS and EPA agree that the methods that were employed were the most appropriate given the objectives of the study.

Use of relatively new methods on a large scale strained the manpower skills of contractor laboratories throughout the country. Given the limited experience with these technologies, EPA technical specialists devoted substantial efforts to ensure that the participating laboratories immediately achieved an acceptable level of performance. In general, the contractor laboratories responded very well to this unprecedented technical challenge as indicated by the relatively low rate of data rejection, the few instances of laboratory performance that required major corrective action, and the general consistency of data generated by many laboratories.

The Love Canal program was the most extensive environmental monitoring program ever undertaken at a single site. It included the analysis of more than 6,000 environmental samples and of an equal number of quality assurance/quality control samples, involving a total of about 150,000 individual measurements. The effort was of necessity compressed into an 80-day sampling period and an analytical phase that lasted about six months. It was clear from the outset that there was to be no opportunity to collect additional samples nor to conduct repeat analyses. Thus, the primary emphasis during the initial months was to ensure that samples were collected properly and analyses performed satisfactorily. Procedures were established to ensure that these efforts were technically sound. The procedures were set forth in the contractual requirements involving the prime contractor and the subcontractors.

From the outset attention was directed to the complete documentation of the program, including further elaboration of procedures set forth in contract requirements when necessary. However, time pressures frequently required actions before all documentation had been completed, and in these cases frequent consultations between EPA and contractor technical specialists were essential in clarifying the details of technical approaches. As reflected several times in the NBS Review, the written procedures supplemented by technical consultations achieved their objective. For example, instances of unacceptable laboratory performance were uncovered and prompt corrective actions taken. A number of contamination problems were identified and adjustments made. In a few cases, excessive holding times for samples prior to analysis were discovered and the implications promptly evaluated. Given this focus on the real-time operational aspects of the program, the early drafts provided by EPA to NBS needed substantial improvement to complete the written documentation supporting the effort.

Response to Specific Concerns of NBS

As suggested above, most of the specific concerns raised by the NBS Review can be traced to shortcomings in the initial drafts prepared in 1980 and 1981 that were provided to NBS by EPA. The documents prepared since that time have been substantially modified, and they incorporate many NBS suggestions. The Review also expressed general concerns over the limitations of the analytical methods to detect extremely low levels of organic chemicals and the possible impact of these limitations on the study's conclusions. As explained in Volume 1, EPA considers the technical capabilities of the methods adequate to fully support the conclusions presented. Finally, NBS raised several issues concerning performance of the contractor laboratories and the problems inherent in coordinating a multi-laboratory program. EPA considers that the overall performance of the laboratories was quite good and that while there were complex coordination problems, many benefits were derived from obtaining complementary data from multiple laboratories as well as from several environmental media.

The principal issues raised in the NBS Review are set forth in the main body of the Review. Elaboration of some issues and identification of several other issues are contained in Appendix A of the Review. Summarized below are all the issues raised in the main body of the Review (pages 1 to 10 of the Review) with a brief EPA commentary on each issue. In several cases the commentaries also address additional issues raised in Appendix A. Whenever appropriate the commentary identifies the section of Volume 1 of the EPA final report which contains additional information on the topic.

1. "EPA's stated goals and objectives, as they applied to the analysis for organic chemicals . . . were not . . . quantitatively explicit. EPA did not define at the outset . . . the limits of detection or the precision and accuracy required . . ." (Page 5 of NBS Review)

Since the analytical methods had not been previously subjected to multi-laboratory validation studies, data were not available to make a priori determinations of precision and accuracy or limits of detection. These determinations were made using the multi-laboratory data generated during the Program, and the procedures and determinations are documented in Appendices C, D, and E of Volume 1. Existing Federal Register methods provided general guidance for water analysis, but they were based on packed columns, not the fused silica capillary columns (FSCC) used in this study.

2. ". . . the requirement for the identification of the 20 most abundant non-targeted substances was generally not met." (Page 5)

A principal reason that the laboratories did not identify many non-target compounds is that they were generally not present in the samples at detectable levels. Specifically, the audit showed that in about 73 percent of the water/soil/sediment samples non-target compounds were not present. In the great majority of the cases when non-target chemicals were found to be present but not reported, they were present at only trace levels, and the sample was heavily contaminated with target compounds. The reporting omissions did not affect project findings.

3. "The quantitation limits realized by water monitoring laboratories . . . varied by more than a factor of ten. Few laboratories reported quantitation limits as good as those reported by the EPA laboratory . . . Comparisons of quantitation limits with data provided by EPA from other studies indicated that the contract laboratories were not uniformly performing at the state of the art. . . ." (Page 5)

For GC/MS methods the detection limits were all in the range of 1 to 50 micrograms per liter, and nearly all were less than 30 micrograms per liter. For certain pesticides, the limit of detection was in the low nanograms per liter range. These values are representative of the current technology limitations in analytical chemistry. Indeed, the range is very acceptable since it is comparable to the range obtained in other studies. (See, for example, Environmental Science and Technology, Volume 15, Number 12, December, 1981, pages 1426-35.) Given the different missions of EPA and contractor laboratories, it is not surprising that the EPA laboratory with its highly specialized staff achieved a higher level of performance. We are unaware of other published studies that had used fused silica capillary columns which indicated different ranges of quantitation.

4. "EPA has not fully used its quality assurance data to derive estimates of precision, accuracy, and limits of detection. EPA has not incorporated estimates . . . into its validated data base." (Page 5)

As set forth in Appendices C, D, and E of Volume 1, EPA has fully used its quality assurance data to derive estimates of precision, accuracy, and uncertainty. However, so few replicates had positive results, estimates of precision and accuracy were based on results obtained from analyses of performance evaluation samples and/or laboratory control standards.

5. "Unless ... 'none detected' (values) are accompanied by estimates of uncertainty, they are incomplete and of limited usefulness." (Page 5)

The procedure for determining the method detection limit, which is set forth in Environmental Science and Technology, Volume 15, Number 12, December, 1981, pages 1426-35, provides a high degree of assurance that positive identifications are real identifications. Under this procedure the probability is less than 1% that a value reported as "none detected" (which includes both trace and below detectable values) is greater than twice the method detection limit. This represents the worst case situation.

6. "EPA has not explicitly related included or excluded (target) substances to specific (selection) criteria." (Page 6)

Criteria for selecting target compounds are stated in Volume 1 and were (a) chemicals known to have been deposited in Love Canal, (b) the priority pollutants previously defined by EPA as exhibiting toxic properties in water, and (c) other chemicals of toxicological concern believed to be present in the area as a result of studies by New York State and analyses of leachate material. These target compounds included chemicals with a wide variety of physical and chemical properties that influence their rates of migration through different environmental media.

7. "For some individual substances, alternative analytical methods might have been more suitable (for example . . . other than TENAX for benzene and toluene)". (Page 6)

Given the magnitude of the effort, it was not feasible to tailor individual methods to very many individual chemicals. The contamination problems associated with TENAX had not been documented prior to the Love Canal effort. Nevertheless, even anticipating such contamination, TENAX was the best method then available. Future research efforts should take into account this limitation in the use of TENAX. The limitations of TENAX are further discussed in Appendix E of Volume 1.

8. "Some ambiguity existed in the analytical protocols." (Page 6)

We are unaware of ambiguities. To insure that the written protocols did not raise ambiguities, EPA technical specialists met with representatives of the laboratories at the outset of the effort to review the protocols in detail.

9. "Program design did not anticipate the possibility that a significant fraction of the samples might not contain any detectable levels of analytes." (Page 6)

EPA clearly anticipated that a larger number of samples would contain measurable levels of contaminants. However, the same procedures would have been employed had there been greater awareness that most of the positive findings would be near the levels of detection. In interpreting the data when very low levels are encountered, greater reliance must be placed on the consistency of the data and on possible patterns of contamination. In this effort the data obtained from the different media were consistent and were in accordance with the findings of the hydrogeological investigations.

10. "The quality assurance plans . . . vary in detail from one laboratory to another. The variations in detail could lead to difficulties in comparing data obtained from different laboratories and different media." (Page 6)

All laboratories were required to satisfy a minimally acceptable quality assurance program specified by EPA. All laboratories met this requirement. As would be expected, a number of the laboratories imposed more stringent requirements of their own. Since all laboratories had satisfied the minimum requirements, comparisons of results were possible.

11. "The Quality Assurance Plan . . . did not require the use of control charts." (Page 7)

The contractual arrangements required the use of quality control charts, and they were used.

12. "The Quality Assurance Plan did not address how the quality assurance data would be used to qualify the environmental data." (Page 7)

The criteria and procedures for qualifying data are set forth in detail in Appendices C, D, and E of Volume 1.

13. "Estimates of the limits of detection are critical to the conclusions which can be drawn when the majority of samples contain no measurable concentration of analytes. The Quality Assurance Plan did not anticipate such a possibility." (Page 7)

See 9 above.

14. "Laboratories were not uniformly performing at the state of the art." (Page 7)

See 3 above.

15. "Laboratories did not generally identify non-targeted substances." (Page 7)

See 2 above.

16. "In isolated instances, contamination of the samples during sample collection or analysis may have obscured possible trends and patterns." (Page 7)

Field and laboratory blanks were analyzed together with the environmental samples to determine whether accidental contamination was introduced during the sample collection or the laboratory analytical procedures. In a few instances these blanks indicated such accidental contamination, and corrections were made in the data on those environmental samples which were subjected to the same accidental contamination. While it is conceivable that additional accidental contaminants may have been present in a few samples, it is highly unlikely that undetected accidental contamination occurred to the extent that trends and patterns of contamination were obscured. The trends and patterns observed were consistent among all media and were consistent with the physical and chemical properties of the chemicals which affect their migration rates.

17. "The quality control limits set in the Quality Assurance Plan widened during the study." (Page 7)

The quality control limits did not change. The use of fused silica capillary columns required different limits than the limits for packed columns specified in Method 625. Appropriate control limits were established at the outset and uniformly applied throughout the program.

18. "The estimation of precision and accuracy . . . has not been adequately documented. Only a portion of the . . . data has been used in arriving at these estimates. The estimates are generally unconfirmed and estimates for some of the analytes have not been given." (Page 8)

See 4 above.

19. "The estimation of the limits of detection and quantitation are . . . not adequately documented." (Page 8)

The data are available in project files. While not considered essential for inclusion in this report, they are publicly available and will be reported in the scientific literature at a later date. The limits of detection and quantitation derived from actual sample analyses are discussed in Appendices C, D and E.

20. "The rejection of data has neither been clearly described nor adequately justified." (Page 8)

See 12 above.

21. "There is no evidence of . . . monthly on-site visits as prescribed in the Quality Assurance Plan." (Page 8)

All participating laboratories were initially audited through on-site visits. Subsequent visits were generally unnecessary because the prime contractor, through daily review of quality control data, took timely action via telephone when questions arose. When additional visits were needed, they were conducted. In addition to the reviews by the prime contractor, the data were further examined and qualified by EPA through a deliberately designed redundant system of data review, including analysis of surrogate compound recoveries for each sample.

22. "No audit of the air or biota monitoring programs was performed." (Page 9)

The results of the biota monitoring program were not a significant factor in reaching the study conclusions. Therefore, a diversion of limited resources to audit the GC/MS tapes generated during the program was not warranted. The Love Canal compounds likely to be detected in air were well identified from analyses of the head space in liquid samples taken from the French Drain and were on the target list. An audit of the air program did not seem warranted in view of the unlikelihood that additional Love Canal chemicals would be detected and the consistency of the data that had been reported.

23. "The claim that missed compounds were predominantly in heavily contaminated samples is not supported." (Page 9)

Documentation is contained in project files and is publicly available. Individual sample analyses from the data audit are too cumbersome for inclusion in the report. Appendix F of Volume 1 presents a summary of results.

24. "The implications of the audit to the conclusions of the study are not discussed . . . For the samples audited, most laboratories did not identify non-targeted substances." (Page 9)

See 2 above.

25. "The measured values . . . in the validated data base are not accompanied by estimates of their uncertainty." (Page 9)

See 4 above.

26. "Recovery factors have not been given nor confirmed for most analytes in water and in soil and sediment samples." (Page 9)

Recovery factors for laboratory control standards are set forth in Appendices C and D of Volume 1. Performance evaluation standards for organic chemicals in soil and sediments were not available, and therefore recovery factors for analytes in soil and sediment could not be estimated. Recovery factors are not essential in determining patterns and trends.

27. "Examples selected to support the conclusions of the study have not always been confirmed as being truly typical of the data in general." (Page 9)

Since it was not feasible to include all of the voluminous data in the descriptions of the findings of the study, examples were used to assist in supporting and clarifying the findings. The criteria used in selecting examples are set forth in Volume 1. For example, compounds of varying solubility and migratory propensity were included in the graphical presentations to help ensure that any significant migration patterns would not be overlooked. Also, in some discussions examples were chosen to represent each of the analytical categories (pesticides, volatiles, semi-volatiles, inorganics). In one case, the highly toxic compound dioxin was given special attention.

28. "EPA has not addressed explicity how . . . conclusions are influenced by the limitations in its analytical data." (Page 9)

See 9 above.

29. "Nowhere . . . are . . . results presented which give . . . indication of whether . . . (chemicals which might serve as) tracers migrated through the subsurface area." (Page 14)

Compounds which are more soluble in water such as phenols, nitrates, fluorides and many volatile organics did not indicate patterns of subsurface migration as would have been expected if such migration had, in fact, occurred.

EMSL-LV: 07-01-82