UNITED STATES DISTRICT COURT
WESTERN DISTRICT OF NEW YORK

UNITED STATES OF AMERICA,
THE STATE OF NEW YORK,

Plaintiffs,

- vs - Civil No. 79-989

HOOKER CHEMICALS & PLASTICS CORP.;
OXY CHEMICAL CORPORATION; HOOKER CHEMICAL CORPORATION; OCCIDENTAL PETROLEUM INVESTMENT CO.; OCCIDENTAL PETROLEUM CORPORATION;
THE TOWN OF LEWISTON; THE TOWN OF NIAGARA,
(HYDE PARK LANDFILL),

Defendants.

BRIEF OF
THE ECUMENICAL TASK FORCE OF THE NIAGARA FRONTIER, INC.
AMICUS CURIAE
AND
POLLUTION PROBE,
OPERATION CLEAN - NIAGARA
AMICI CURIAE

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Dated: Buffalo, New York
June 30, 1981

On the Brief:

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I. INTRODUCTION

This brief is submitted by The Ecumenical Task Force of the Niagara Frontier, Pollution Probe, and Operation Clean-Niagara for the review of the Court.

Its purpose is to assist the Court in reaching a decision whether to approve the proposed settlement agreement for Hyde Park Landfill.

We have attempted to evaluate the technical viability of the remedial program and have reviewed and incorporated underlying data to substantiate our findings wherever possible.

From our review we have found the agreement fundamentally defective and unable to accomplish its intended purpose of providing protection for human health and the environment.

II. OVERVIEW

The main issues raised by the proposed agreement which we sought to examine and present are the following:

1. Will the containment strategy proposed in Addendum I isolate the hazardous wastes contained in Hyde Park Landfill from the surrounding environment, and protect against human exposure to its contents?

2. Does the Court have sufficient information to reach a decision whether to approve the proposed agreement?

3. What is the public interest in this case, and what segments of the public will be most affected by judicial approval?

4. Have the Environmental Protection Agency (EPA) and the State accurately and completely presented the facts to the Court, and should a presumption of Public Agency Expertise attach to their recommendations?

5. Should this Court approve the proposed settlement?

After review of data, independent investigation, consultation with our experts, as our financial and human resources permitted, we must advise the Court that:

- there is no question that the 'materials' contained in Hyde Park Landfill are extremely toxic, with tremendous potential for lethal consequences in extremely small doses;

- there is no question that tetrachlorodibenzo-p-dioxin (hereafter "TCDD"), mirex, and other highly toxic chemicals are leaking into the Niagara River and Lake Ontario;

- there is no question that TCDD and other toxins are accumulating in the food chain;

- there is no question that these wastes are affecting a public water supply;

- there is no question that Hyde Park Landfill is a source of these exposures.

Based upon the analysis below, approval of the settlement proposed by the parties will ensure the perpetuation of each problem listed.

The data reveals that wastes in Hyde Park Landfill were placed in direct contact with the highly fractured bedrock, and that the chemical pit has no solid bottom.

It appears that it is necessary to remove and re-entomb the wastes in a secure clay vault, if the parties insist upon using containment technology rather than destruction technology. While landfilling in general is an unsatisfactory and short-term solution, doing so under conditions designed to effectively contain the wastes is (perhaps) the best of a series of unsatisfactory choices.

III. THE REMEDIAL STRATEGY PROPOSED IS INADEQUATE TO ACHIEVE ISOLATION OF CHEMICAL WASTES FROM THE ENVIRONMENT

Analysis of the settlement agreement, along with hydrogeologic and leachate sampling data, by two independent consultants[1], has revealed fundamental error in the interpretation of the hydrogeologic character of the site and a misunderstanding of the limitations inherent in the remedial strategy proposed by the parties.

The data also confirms that the Lockport Dolomite underlying the landfill is a highly permeable bedrock with vertical fractures and horizoneal bedding plains intersecting, in random fashion, and acting as conduits for groundwater to reach the Niagara Gorge and enter the Niagara River.

Conestoga Rovers data (prepared for Hooker) indicates that the chemicals have been deposited directly on top of the permeable bedrock. Moreover, highly toxic organic wastes have already contaminated the bedrock aquifer to a depth of fifty feet and at least 500 feet beyond the site within the aquifer.* (see also Anderson - Report - Addendum at p. 2.)

According to Anderson (at Report - p. 20) groundwater velocities in the bedrock are about 10,000 times faster than in the glacial till soils. In addition, the quantity of leachate that can potentially move down into the bedrock is 200,000 times greater than outflow into the soil (at a worst case scenario). Giving the parties all benefit of the doubt, the potential quantity of leachate outflow into the rock could be 200 times greater than outflow through the clay soil side walls of the fill.

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1. Grant Anderson and Dr. Edward Kleppinger, see Affidavit of each annexed herein.

* Since the data we received pursuant to N. Y. Freedom of Information Law request was at times highly edited, data evidencing even more widespread contamination may be in the possession of the parties.

This, in turn, increases the downward water pressure on the leachate as it accumulates to follow the path of least resistance and move down through the bedrock fractures and bedding plains, intermingling with and contaminating groundwater, then flushing through the conduits in to the River. (see Kleppinger Affidavit at pp. 7, 8.)

The parties to the proposed settlement agreement misinterpreted such very basic hydrogeologic determinations as the directions in which the groundwater is flowing, and the direction of the vertical hydraulic gradient.

If the flow of groundwater on a site is not accurately contoured, a monitoring or purge well system will not be correctly designed. The improper placement of wells is dangerous because it will allow contaminants to by-pass the wells in their travels from a waste site.

Well reading could then erroneously indicate that no migration has occurred, while substantial quantities of contaminants flow out unchecked. An error of that fundamental nature would subvert the entire remedial goal.

The correct calculation of the direction of the vertical gradient is of utmost importance in designing a proper remedial strategy. The vertical gradient will, in this case, dictate whether groundwater moves up into the till or downward into the bedrock. Here since the gradient is steeply downward, the groundwater (and leachate) move downward.

Since the groundwater moves downward into the bedrock, and the bedrock has conduits which transmit substantial amounts of groundwater unattenuated toward the river, it becomes obvious that the focus in any remedial action must be the bedrock. (see Kleppinger Affidavit at pp. 6,7; also Anderson - Repoirt at p. 21)

Kleppinger and Anderson share the opinion that waste removal and re-entombment is the only viable option (aside from removal and incineration) for effective remediation.

Kleppinger specifically explains, upon review of the data, that no practical method exists for sealing off the porous bedrock at this site for the life of the hazard. (see Kleppinger Affidavit at p. 5, #29).

Richard H. Johnston of the U.S. Geological Survey who is an authority on groundwater flow in the Lockport Dolomite, revealed that large conduits through which water flows run parallel to the river, and act as four mile long drains. He indicated that "all the chemicals that got into the bedrock would sooner or later end up in Lake Ontario."

The parties focus their attention on controlling groundwater flow in the overburden. The only absolute commitments made in the proposed agreement with respect to attempting to achieve containment of the wastes, were (1) to cap the landfill, and (2) to place a tile drain collection system in the overburden. There is no absolute commitment to undertake any remedial work in the bedrock, even though it is the most vulnerable stratum, given the circumstance at Hyde Park.

Yet the parties knew or should have known since 1979 from the Conestoga Rovers data that for at least two years prior to finalizing negotiations, that EPA Priority Pollutants had migrated deeply into the rock and beyond the Hooker site.

As amici, we bring to the Court's attention the serious and unresolved questions raised above.

IV. THE NATURE AND MAGNITUDE OF THE IMMINENT AND SUBSTANTIAL HAZARD TO HUMAN HEALTH AND THE ENVIRONMENT

If the remedial strategy proposed in the agreement is not successful in isolating the wastes, the chemical contents of the Hyde Park landfill site will continue to migrate into the Niagara River and Lake Ontario. It is critical for the Court to consider the impact of the wastes buried at Hyde Park on these two major multi-use waterbodies, and on the five million people who depend on the Lake's integrity for their water supply.

The Hyde Park landfill site contains over 80,000 tons of toxic chemicals. Among the chemicals buried at the site are mirex, lindane, chlorobenzene, chlorotoluene, endosulfan and other organic chemicals well-known for their toxic potential. Many of these chemicals if released into the environment will cause severe degradation of the ecosystem.

However, it is not feasible to attempt a comprehensive evaluation of the total hazard represented by the diverse chemicals in this site. For the purposes of illustrating the critical need to control and contain the chemicals moving away from the Hyde Park landfill, we have chosen to describe the activities and the toxicity of one chemical, 2,3,7,8-tetrachlorodibenzo-p-dioxin, or TCDD, as it is commonly known.

Because of its tremendous toxicity and the volume of the chemical known to be in the landfill, TCDD must be regarded as the chemical of the greatest concern in this landfill site. TCDD is the most toxic isomer of dioxin, and is known to be the most toxic chemical ever synthesized. It is estimated to be 100,000 to a million times more toxic than mirex, which has also caused severe contamination problems in Lake Ontario.

TCDD is a contaminant produced in the manufacturing of trichlorophenol. In the Hyde Park landfill there are 3,300 tons of trichlorophenol wastes, described as still bottoms. These contaminated still bottoms "cleaned" or removed from the trichlorophenol contain extremely high concentrations of TCDD.

Trichlorophenol wastes buried in the Hyde Park landfill are conservatively estimated to contain concentrations of 40 parts per million of TCDD. Based on this estimate, the Hyde Park landfill contains a minimum of 264 pounds of pure TCDD available for contamination of the environment. However, the more realistic estimate of the dioxin residing in the landfill site is believed to be 2,000 pounds or approximately one ton. (See Hallett affidavit, at p. 8) In relation to the 80,000 tons of waste buried at the site, one ton may seem insignificant. However, the extreme toxicity of TCDD makes its isolation from the environment imperative.

While this one ton represents one of the largest deposits of dioxin in the world, it has been calculated that the total amount which has thus far infiltrated Lake Ontario through the Niagara River is less than one pound. Still, even this minute quantity of dioxin has already contaminated fish and wildlife around Lake Ontario to dangerously high levels as will be shown below.

The presence of TCDD has been documented in The Canadian Wildlife Service Study (See Hallett affidavit, Exhibit "B") conducted by Dr. Douglas J. Hallett. This report measures the contaminant levels in herring gulls from colonies on Lake Ontario. TCDD was detectable in these gulls at levels ranging from 48 to 68 parts per trillion.

In addition, the high levels of TCDD in Lake Ontario were found to be consistent throughout the Lake, indicating widespread contamination. This study also points to the probable contamination of fish, particularly alewives and smelt, that provide the substance of the herring gull diet.

Although the studies generated on fish from the Great Lakes are still not definitive at this point in time, some species of fish taken from Lake Ontario in 1980 have been reported to have detectable levels of TCDD over 5 parts per trillion. These levels of dioxin in fish and herring gulls provide indisputable evidence of the contamination of Lake Ontario by TCDD and prove its ability to accumulate in the food chain.

The primary concern that has precipitated this amicus evaluation is fear that, if a proper course of remediation is not undertaken, highly toxic chemicals from Hyde Park will continue to migrate to the Niagara River. Water contaminated with TCDD, running from the landfill site through Bloody Run Creek to the Niagara River, already contributes to the levels detectable in Lake Ontario. At the levels detectable in the sediments of Bloody Run Creek, TCDD is sufficiently soluble to be moving into the river. TCDD is also readily soluble in certain solvents known to be in the landfill site, including toluene and the lesser chlorinated benzenes. Because of this degree of solubility, TCDD can be easily mobilized in surface or groundwater.

Although Bloody Run Creek presently brings contaminants to the Niagara River, the much more significant route of entry that is not adequately addressed in the proposed agreement is the fractures and bedding plains in the Lockport dolomite underlying the chemical wastes. These fractures are capable of moving contaminants to the river by acting as virtual pipelines through the bedrock.

It is also evident from the material data reviewed for this brief that groundwater is already moving contaminants away from the site in the direction of the Niagara Gorge. (See Anderson affidavit at p. 7) Bore hole logs indicating contaminated water in the bedrock as deep as 50 feet demonstrate that these contaminants have already migrated off-site. Grant Anderson estimated that contaminants carried in the groundwater through highly fractured bedrock could reach the Niagara River over a short period of time, or as little as one year.

It is estimated by Hallett that if as little as one shovel-full (3 pounds or 1200 grams) of dioxin were to reach the Niagara River over a period of six months, the present levels of TCDD would rise to a level that would jeopardize the survival of certain species of wildlife.

These levels could also contaminate drinking water to a degree that would increase the risk of cancer to the 5 million residents drawing their water from Lake Ontario.

With macrocontaminants that pose a threat at extremely low levels, it is difficult to consistently measure the levels present in raw or treated water. The levels of contamination in the water can only be estimated by reference to the concentrations that are measurable in the fish and herring gulls. Based on an established bioaccumulation factor, the concentration of TCDD in the water would be 10,000 to 100,000 times lower than the levels detectable in fish and herring gulls. This means that although the levels of TCDD in the water elude detection, the concentrations believed to be currently contaminating drinking water are in the order of 1×10^{-4} to 1×10^{-5} parts per trillion. (See Hallett affidavit at p. 9)

The levels that we assume are present from these calculations fall into the areas of risk set out by the draft Environmental Protection Agency Water Quality Criteria for the ingestion of dioxin through water. Levels in this range, according to the EPA, would result in an increased risk of one additional cancer in a population of 100,000 to one million.

Although it is impossible to predict the effects of dispersing the chemicals from the Hyde Park landfill site further into Lake Ontario, the consequences of further contamination of these water bodies suggest a tragedy of immense proportions. Unlike other episodes or accidents involving dioxin, the Hyde Park landfill site represents a unique and unparalleled environmental risk, where a deposit of dioxin of that magnitude lies in close proximity to a major waterbody.

The further contamination of the Niagara River and Lake Ontario would add to the burden of contaminants already carried by the water, the fish and the wildlife.

The studies that have been conducted on laboratory animals should serve as an incentive to avoid any experimentation with the exposure of human health to the effects of dioxin. The underlying intention of conducting laboratory experiments on animals is to study the toxicity of certain chemicals and to predict the effects on human health. By extrapolating from the observed effects on primate species closely related to man, it can be concluded that TCDD could pose extremely grave hazards to animals and humans exposed to it.

In Dr. Allen's experiments rhesus monkeys were chosen as the test animal because they are more closely related to humans on the biogenetic chain than other species. Their responses to dioxin exposure would most closely relate to human diseases and intoxication. (See Allen affadavit at p. 2)

In exposing these animals to TCDD-contaminated fats through their feed, Dr. Allen discovered that TCDD was an extremely toxic compound producing a variety of effects including hair loss, facial swelling, thickening of the stomach wall and anaemia. Eventually, after a certain exposure, the animals died in direct relation to the amount of TCDD ingested.

During experiments conducted in the 1970's Dr. Allen fed the test animals fat contaminated with levels of 500 parts per trillion of TCDD. The test animals showed signs of intoxication after three months of exposure.

Dr. Allen's experiments involve the feeding of rhesus monkeys with feed contaminated with much lower levels of 50 parts per trillion of TCDD. In these experiments the animals developed similar symptoms of intoxication but over a longer period of time. However, the animals developed these symptoms after the same total body intake level -- approximately one microgram per kilogram of body weight. In other words, the same level of toxicity developed at a level of accumulation proportionate to body weight. This suggests that a critical level could be reached through the accumulation of TCDD in the body where the signs of toxicity would begin to manifest themselves. (37 p.5 A)

Although individual human exposures may never be as high as the 500 parts per trillion level or even the 50 parts per trillion level, these studies strongly suggest that chronic low dose exposure can produce injurious effects over a period of time.

Since these studies were partially inspired by the desire to investigate what the effects would be of ingesting TCDD-contaminated fish, these studies are particularly relevant for an evaluation of the potential risks posed by the contamination of waters by dioxin. Since fish are known to accumulate TCDD in their fat tissue and fish from Lake Ontario already show detectable levels, it is imperative that this Court consider carefully the implications of ineffective remediation.

In summary, the Court must realize that although we have focussed our attention on TCDD, to the exclusion of other toxins contained in this site, we do not wish the Court to underestimate the significance of the hazard posed by other chemicals buried in this site. We believe that the key to controlling further chemical migration from this site lies in removal of the wastes, followed by destruction, or reburial in a properly prepared site.

V. THE REMEDIAL PROGRAM SET FORTH IN THE PROPOSED SETTLEMENT DOES NOT MEET THE STANDARD OF ADEQUACY AND REASONABLENESS

The Court must determine that the terms and conditions of the proposed settlement agreement "are reasonable and adequate to resolve the issues raised in this action and constitute appropriate programs to restore and protect the environment." In addition, the Court must find that the programs are "designed to protect against endangerment to human health or the environment in and about Hyde Park Landfill-Bloody Run area."[1]

There is a dearth of environmental case law in which judicial examination of consent decrees resulted in the development of specific interpretations of the adequacy and reasonableness standard. Therefore, amici have turned to look at other fields such as antitrust and civil rights law where the public interest is many times affected by judicial approval of proposed decrees, and where legal, technical, and factual scrutiny of proposed contracts was common. It is within those fields that judicial factors for review have emerged.

Among the factors evaluated by Courts in determining reasonableness are consistency of the agreement with the statutory goals under which the action was brought,[2] unenforceability or vagueness,[3] requirement for extensive judicial supervision,[4] bargaining away of police power by the State[5] and breach of public policy.

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[1]Proposed "Stipulation and Judgment Approving Settlement Agreement (p.1)

[2]Boyd v. U.S. et al, 345 F supp 790 (1972)

[3]U.S. v. Automobile Manufacturers Association, Inc. et al, 307 F Supp 617 (1969(, affm'd 1970

[4]U.S. v. Automobile Manuf., supra

[5]U.S. v. Reserve Mining, 7ERC 1096

Consistency between the agreement and the statutory goals must be evaluated in the context of the factual situation, and the remedy proposed, after examination of the statute under which the lawsuit was brought.

The first claim for relief cited in the federal complaint in U.S. v Hooker et al Civ. #79-989 (Hyde Park) was Section 7003 of the Resource Conservation and Recovery Act (hereafter "RCRA"), 42 U.S.C. 6973. That Section was specifically designed to empower the U.S. Environmental Protection Agency (hereafter "EPA") to take whatever action is necessary against a disposer of hazardous waste upon receipt of evidence that such activity may create "an imminent hazard to health or the environment."

The second claim for relief was predicated upon Section 504 of The Clean Water Act, 33 U.S.C. 1364, which authorizes EPA to bring suit against any person causing or contributing to an alleged pollution source, upon receipt of evidence that the pollution source is presenting an imminent and substantial endangerment to health of persons.

It is evident from the data generated by the parties that contamination of groundwater deep into the bedrock has already occurred beyond the site. The chemical mixture migrating from the landfill through the bedrock aquifer contains highly toxic chemicals, including known and suspected carcinogens; (See Anderson affidavit - Exhibit "B" at p.2).

If Richard Johnston, authority on the behavior of groundwater in Lockport dolomite, is correct in his belief that all chemicals which find their way into the bedrock will eventually end up in Lake Ontario, then any remedial program must at the bottom line provide for the effective sealing off of those wastes from the bedrock below. (Kleppinger affidavit at p. 4). This opinion is supported by Anderson's conclusion that in developing remedial strategy emphasis must be placed on protecting the bedrock now. (Anderson affidavit Exhibit "B" at p. 21 para. 9).

We cannot emphasize strongly enough that the ramifications of this case will have drastic and far reaching consequences. It is evident to all of our independent consultants, none of whom has a personal stake in this matter, that while we accept that there are many variables which still must be determined, it is appallingly clear that the patchwork remedial proposals put forward by the parties will not correct the problem. In that sense, this is a simple case.

We recognize that this settlement need not be the best settlement possible, but only that it be reasonably calculated to achieve its basic goals.

In this case, we submit that the remedial strategy proposed cannot work to effectuate discontinuation of the imminent hazard and pollution source which precipitated the litigation. We feel that the most scrupulous and intensive scrutiny of the underlying facts by the Court is necessary before a proper determination can be made.

While it has been held that a presumption of validity exists where a consent decree is proposed by a private defendant and a government agency, the Court in U.S. v. City of Alexandria et al, 614 F. 2d 1358 (5th Cir. 1980) indicated that the presumption could be overcome if the decree contained provisions which were unreasonable, illegal, unconstitutional or against public policy. In reversing the District Court disapproval of a consent decree in that case, the Alexandria court noted that the lower court heard no evidence prior to reaching its decision and there had been no arguments raised in the record supporting the District Court's refusal to sign the agreement.

So too, the Hyde Park Landfill agreement contains a remedial program which will, if approved, allow the hazard source to continue polluting the environment, in violation of RCRA and The Clean Water Act.

Where there is a dispute as to fundamental facts, no decision should be rendered without careful judicial scrutiny.

The Court in In Re Traffic Executive Association, Eastern Railroads et al v. The Long Island Railroad Co. et al 627 F.2d 631 (2nd. Cir. 1980), denied a petition directing the lower court to approve a proposed settlement of a class action on the basis that the lower court judge properly exercised his discretion in disapproving the agreement where he had misgivings as to its adequacy, even though no objections had been raised. The appellate court stated the settlement disapproval did not make the case extraordinary even for lack of objection, in that "a substantial lack of response from absentee class members appears to be the norm rather than the exception." (p. 634) The Court also emphasized that a Judge "should explore the facts sufficiently to make a proper assessment" and that he was required to exercise his "independent judgement to protect the interests of class absentees, regardless of their apparent indifference." (at p. 634)

The main parties to this case are advocating judicial approval, and intervenor status has not been granted to any individual or group to date. But the breadth and depth of the substance of public comments received by the Court should alert the Court that there are fundamental issues of grave concern to residents of the immediate Hyde Park community and Western New York, as well as from those Canadian and Americans who use the Niagara River and Lake Ontario as a source of drinking water, food, and recreation.

Since there was no factual record, the Court did not offer any substantive guidelines as to what constituted unreasonableness.

In the Hyde Park situation, inadequacy permeates the entire agreement in that the governmental parties did not responsibly define or apparently understand the hydrogeologic setting or conditions which facilitated the migration of toxic wastes off-site and into the Niagara River. Although our experts advise us that it is not improper to omit many details of a proposed remediation strategy in the planning stage, it is still necessary to design a coherent and specific program, which defines a clear performance standard.

Here the single most important requirement for abatement of the hazard is achieving separation of the landfilled wastes from the bedrock aquifer on which it rests and into which leachate flows.

Since the vertical gradient within the landfill is downward, leachate will percolate through the 15 acre area of the landfill and down into the underlying bedrock. Yet the parties who claim expertise have not recognized the largest remedial problem, that of contaminants moving out from the bottom of the site.

According to our consultants, the program set forth in the agreement is absolutely not viable, and the technical reasoning behind the proposal is based upon misinterpretation of the parties' own data.

The 8th Circuit Court of Appeal in In re International House of Pancakes Franchise Litigation 487 F. 2d 3036 (1973) affirmed a lower Court order disapproving a proposed settlement agreement between the parties in a multi-district class action, finding that the lower Court had not abused its discretion where the proposal incorporated the very franchise provision which violated the statute.

The Court recognized the necessity in certain types of actions for a trial judge to protect the rights of absentee members of a class, recognizing that in certain types of suits there may be those who will be affected by the result of a case, but who are unable or unwilling to speak on their own behalf either from uncertainty, ignorance or lack of financial or other resources.

There appears to be expressed in this case a public policy of reviewing a proposed settlement agreement to review the protection it affords to those who are affected by the decision but have not spoken on their own behalf. An analogy can be drawn between non-responsive class members whose rights the judge sought to protect in his evaluation of the adequacy of the agreement, and in the Hyde Park case, those segments of the public who will be materially affected by the adequacy of the remediation program and the health and safety protections implemented during remedial work.

In determining adequacy and reasonableness, the Court must examine the adverse health impacts which have been and will continue to be suffered by the public as a result of the migration of chemical leachate into the Niagara River and Lake Ontario, and as a result of exposure to airborne contaminants which have been known to emanate from the Hyde Park Landfill site.

It is clear that highly toxic organic chemicals, including TCDD, many of which are known or suspected carcinogens and teratogens, are migrating from the landfill and are now present in Lake Ontario. TCDD in particular is moving up the food chain in alarming concentrations.

Studies have shown TCDD to be present in fish taken from Lake Ontario over 5 ppt and in herring gulls up to 68 ppt. While we know that TCDD is present in the water of Lake Ontario, it is at such low levels, i.e. below 1 ppt, that our detection equipment is not able to quantify its presence.

Yet the concentration in which TCDD is found in fish in the water of Lake Ontario and in herring gulls who consume these fish indicates that as dioxin moves up the food chain its presence becomes more pervasive and its potential toxicity to the exposed species increases over time.

Dr. Douglas Hallett of Environment Canada notes that in addition to its toxicity, TCDD causes cancer, birth defects and chromosomal abnormalities (see Hallett affidavit at p. 11, para. 40).

Other studies done by Dr. James Allen on primates indicate that there is a critical exposure level to TCDD which can be lethal, and that lower dose exposures over a longer period of time will not avoid adverse health impacts. He also describes the lethal health effects suffered by primates after prolonged exposure. (See Allen affidavit at p. 5).

We cannot emphasize too strongly the necessity for the Court to refuse approval unless it is convinced that the proposal will effectively prevent the continued accumulation of dioxin and other chemicals into the Niagara River and Lake Ontario, given the potential consequences to humans and other species from prolonged exposure.

"The Court may properly consider whether or not the rights of persons not parties to the action are jeopardized and whether the consent decree on the whole, is against the public interest." U.S. v. Automobile Manufacturers Association Inc. et al, 307 F. Supp. 617, (U.S. Dist. Ct. 1969), 90 S.C.T 1105 aff'd 1970.

The Court in U.S. v. Automobile Manufacturers Association, Inc. et al, supra, in deciding to approve a consent decree in an anti-trust action first determined that

1. the consent agreement provided the government with substantially all the relief which could be obtained if the case were tried and won and
2. that the settlement brings assured results and
3. that the settlement was in fact in the public interest.

It appears from the data that the remedial strategy proposed by the parties is doomed to failure, and that viable alternative remedial technologies such as waste removal and re-entombment exist which will abate the source of the chemical migration.

Although there are no cases setting standards for review of environmental consent decrees, the landmark case of the Village of Wilsonville et al v SCA Services, Inc. #52885 (Opinion filed May 22, 1981), Supreme Court, Illinois involved the efforts of a town to compel a hazardous waste disposal site which was contaminating its community to discontinue its operations, dig up the waste and haul them away.

We submit that this case provides an excellent guideline for the court's assistance in rendering a decision on the proposed Hyde Park agreement.

The case was brought by the Village of Wilsonville in 1977 after officials determined that the site operations constituted a hazard to the health of citizens of its village, the county, and the State. A similar action brought by the Attorney-General of Illinois against SCA Services was brought and subsequently joined with the initial action. After a lengthy trial, during which extensive technical examination was heard on behalf of the parties, the trial court judgement permanently enjoined the defendant from operating its hazardous waste disposal site, and ordered restoration and reclamation of the land.

SCA Services, Inc. appealed, and the Appellate Court unanimously upheld the trial court's decision. The Supreme Court of Illinois affirmed the lower courts' decisions and remanded the case to the Circuit Court to enable it to retain jurisdiction for supervision of enforcement of its order. The situational similarity with respect to the position taken by the defendant SCA, with the support and advocacy of the State of Illinois EPA and U.S. EPA, parallels the position taken by the parties advocating approval of Hyde Park Landfill Settlement Agreement in the instant case. Many of the arguments put forward by the Illinois Attorney General on behalf of Wilsonville and the other plaintiffs coincided with the technical and health concerns raised by the public and herein.

The materials deposited at the Wilsonville site included highly toxic organic wastes, identical in many cases, to the wastes buried in Hyde Park Landfill. The on-site permeability below the ground surface at Wilsonville made isolation of wastes on a long term basis impossible because of the existence of abandoned mine shafts which acted like pipes or conduits for transmission of contaminated waste water.

In Hyde Park Landfill chemicals are deposited on top of highly fractured bedrock, where the vertical fractures and horizontal bedding plains in combination facilitate movement of chemical wastes into the River.

In addition the Court in <u>Wilsonville</u> found that although 14 monitoring wells were designed and functioning to detect liquids seeping through the soil, the Court found that because of the distance between the wells, materials could by-pass any two wells and avoid interception. At Hyde Park Landfill, the difficulty in intercepting contaminants is exacerbated by the nature of groundwater movement in fractured bedrock where both horizontal and vertical migration can occur simultaneously. Also at Hyde Park the contaminants move through the bedrock in random fashion and a truly effective monitoring system would be extremely difficult to design and expensive to operate. (see Kleppinger affidavit

p. 5).

It is interesting to note that along with SCA and Illinois EPA, U.S. EPA as amicus strongly urged that the case be remanded to the Circuit Court so that alternatives to closure of the site and removal of the waste materials could be considered. The U.S. EPA, addressing the dangers of removal, specifically urged the court that:

> "Heavy equipment may damage drums, releasing wastes and possibly causing gaseous emissions, fires, and explosions. Repackaging and transporting damaged drums also risks releasing wastes. Workers performing the exhumation face dangers from contact with or inhalation of wastes; these risks cannot be completely eliminated with protective clothing and breathing apparatus. Nearby residents may also be in danger." (p. 21)

Rejecting U.S. EPA's position the Wilsonville court noted that the reasons given by U.S. EPA in support of the position that the site should remain open, includes some of the same hazards which the plaintiffs raised as reasons in favour of closing the site.

The Wilsonville Court refuted a claim by defendant SCA that the lower Courts refused to consider the practicability of removing and relocating the wastes which had been deposited at the site. SCA conceded that it was possible to excavate the site and haul the materials elsewhere but disputed the technical and scientific reasonableness of doing so. The Court specifically noted that the lower courts had given serious consideration to available remedies and concluded that removal of the wastes and reclamation of the site was the best and safest alternative.

U.S. EPA further urged the Court to consider the possible alternative remedies to closure and assured the Court that:

> "a proper cap of low permeability can ensure that little or no rainwater can infiltrate the site, and thus that little leachate will be formed...Groundwater monitoring can generally detect any migration of waste constituents, and counterpumping of contaminated groundwater (or other measures) can protect against further migration."

The Court, in citing this argument, observed that U.S. EPA made no suggestion regarding resolution of the fundamental problem; that is, how the location of the disposal site above an abandoned tunneled mine and the effects of subsidence can be overcome.

In the case now before this Court, identical remedial strategies have been represented as adequate to protect against further migration. Yet in the Hyde Park case, both Dr.Kleppinger and Mr. Anderson independently concluded after reviewing data generated by the parties, that none of the parties had identified or addressed the fundamental problem of how to seal off the wastes from the fractured bedrock.

The Wilsonville Court attacked SCA's contention that error occurred in the lower courts when they failed to defer to the expertise of Illinois EPA and U.S. EPA and failed to give weight to permits issued by Illinois EPA. The Court directly stated that:

> "This assertion has no merit...because the data relied upon by Illinois EPA in deciding to issue a permit to the defendant, data which have been proved at trial to be inaccurate...The Illinois EPA as well as the US EPA adopted this inaccurate conclusion in deciding to issue a permit to the defendant."

We submit that in the Hyde Park case no presumption of expertise should attach to the public agencies or their 44 experts given that the data reveals that the remedial program cannot work.

The Court should disapprove this agreement given the fundamental flaws manifested in the terms and conditions of the proposed settlement.

VI. THE COURT SHOULD ORDER A HEARING TO ASCERTAIN ALL MATERIAL FACTS PRIOR TO REACHING A DECISION.

The proposed settlement agreement is replete with error, omission, and ill-conceived programs.

The crux of the agreement is the remedial plan designed to abate imminent hazard and in the case of Hyde Park Landfill, to achieve total isolation of the land-buried wastes.

Our expert witnesses share the opinion that the remediation strategy was conceived in partial ignorance of the hydrogeologic conditions of the Hyde Park site. Both Dr. Kleppinger and Mr. Anderson are disturbed by the apparent lack of integrated consideration and analysis of the total problem, and lack of effort at reaching a coherent and specific proposal which is tailored to the characteristics of that terrain and its hydrogeologic behavior, as demonstrated in the Conestoga-Rovers borings and other data.

It should be emphasized that as amici we rely wholly upon the data provided to us by the parties. It was on the basis of information generated by those who apparently misunderstood the significance of their own investigations that we now apprise this Court that our evaluation of the Agreement's viability leads us to conclude that the agreement must be disapproved.

We would respectfully suggest that the Court order a plennary fact finding hearing where the representations of the parties, so easy to put forward in an uncontested forum, will be subjected to the truth finding process of cross-examination.

Technological jargon and scientific issues can provide a disguise for incompetence and bias under the talisman of expertise. Agency experts offer many practical conclusions daily which are founded on weak or erroneous data. Those errors in judgement would go undisclosed absent the opportunity to cross-examine or to challenge the empirical premises of so-called expert opinion.

In our opinion there is no issue in this case so complex that it cannot be understood by the average citizen if presented in a manner to demystify its content. However, if the Court determines that a fact finding hearing specifically addressing any or all of the concerns we have raised is necessary to assist it in its decision-making process we would suggest that the Court might wish, to appoint on its own motion, and independent hydrogeologist. We respectfully submit that Richard H. Johnston, of the U.S. Geological Survey, who is a foremost authority on the behavior and characteristics of groundwater flow in Lockport dolomite in the Niagara Region be appointed.

VII. DELAY - A NON-ISSUE

The Court should not feel pressured to render a decision in the case prior to ascertaining all of the facts because of the argument advanced by the parties that delay in reaching a decision does not allow remediation to begin until approval is granted. The issue of delay as put forward by the parties is a "red herring" in two respects. First, over half the work cited to be undertaken with any specificity in the agreement is comprised of testing, sampling and monitoring. Section 3013 of the Resource Conservation and Recovery Act (RCRA) was specifically enacted to give EPA the power to compel the waste discharger to undertake exactly the kind of testing and monitoring specified in the agreement, even without pending litigation. Although this case is in litigation, if the governmental parties were concerned about immediately effectuating the isolation of wastes from the environment, section 3013 could have been used by the EPA in the past year to accomplish much of what is proposed in the agreement.

Secondly, under the new Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), EPA, through the President, can have direct access to the Hazardous Substances Response Fund for all types of assessment costs in ascertaining potential damage claims. Also under liability provision s 107(a)(4)(c) others, for example, the New York State Attorney-General, can claim damages for injury to, destruction of, or loss of natural resources, including the reasonable costs incurred in assessing such injuries.

If either of the public agencies is concerned that more testing and damage assessment cannot wait for a factually complete judicial determination of their proposed agreement, either or both can utilize these provisions.

More important, there has already been enough data generated to determine that the program the parties seek to so quickly implement would be a tragic and ineffective commitment of financial resources. It is far more important for the court to thoroughly ascertain the facts before rendering its decision.

The firm technological commitment contained in the agreement does not provide substantially more protection for the site than the collection systems already in place. In addition, the remedial plan proposed is not structured to address the real problems.

Given the public interest which is affected so strongly by the outcome of the case, the Court should not accept the unsubstantiated assertions of Hooker, EPA, or the State. One major problem with an "agreement to agree later" is that when each disagreement occurs over Hooker's future obligations, (as we believe is inevitable as the agreement is now constructed) this Court will be faced with waves of litigation..

VIII. THE AIR MONITORING PROGRAM HAS NOT BEEN DESIGNED WITH THE UNQUALIFIED INTENT OF PROTECTING HUMAN HEALTH

The Health and Safety Plan, contained in the proposed settlement agreement sets forth the two-fold goal of (1) providing extraordinary precautions to protect the health of on-site personnel and (2) protecting human health and the environment outside the immediate area of remedial activities by controlling the airborne dispersion of particulates during those activities.

However, if the parties to the proposed agreement are seeking to minimize human exposure to chemicals emanating from the landfill site, they must establish and incorporate into the settlement agreement stringent detection limits and sampling procedures.

It is our position that the Court should require the parties to monitor for the lowest detction limits technologically feasible, setting a performance standard and establishing, for the first time, the principle of preventable exposure. This would be consistent with the alleged purpose of the Plan in Addendum V.

Where an imminent hazard exists in the environment, and complete isolation from its effects is not possible, the most desirable and reasonable goal would be to require a monitoring level of the lowest possible concentration of exposure to contaminants.

We believe that the Court should take the initiative to ensure that any unnecessary risk or preventable exposure to the public within the zone of individuals sought to be protected under RCRA and the Clean Water Act would not ensue from the approval of this agreement.

This principle is being violated by the unacceptably high levels of risk created by the failure of the agreement to set the lowest possible detection limits. Expediency and convenience to the parties (See Response to Comment 102) does not justify the involuntary exposure of human beings affected by these decisions.

The representation to the Court that field gas chromatograph/mass spectroscopy units used for the measurement of air do not exist, is an overt admission of disinterest in the protection of public health.

Field units incorporating gas chromatograph/mass spectroscopy capabilities are available for the sensitive monitoring required to detect organic chemicals in air, soil and leachate. These units (see Sciex letter, Appendix I) would be particularly appropriate for a site where complex mixtures of organic chemicals contaminate the air. A similar unit was used to detect airborne contaminants present at the Love Canal site for the New York State Department of Health.

With the use of such sophisticated equipment, surrogate parameters would become unnecessary and the chemicals of most concern such as TCDD could be monitored at the Hyde Park site. (See Hallett affidavit at p.10.)

Use of limited indicator parameters instead of broad spectrum testing should only occur where a constant ratio between concentrations of indicator agents and all other known chemicals contained in the landfill has been firmly established.

The selection of trichlorophenol and hexachlorobenzene as surrogates for TCDD is totally unacceptable without clear data demonstrating a constant ratio between concentrations of those particular indicator agents and of TCDD.

The government in its Response to Public Comments represents (at p.94, top) that "there is firm evidence from the field measurements and from knowledge of the source of dioxin, that these chemicals are appropriate surrogates in this case." The single ratio calculation contained in the background data to the settlement agreement provides no support for this assertion.

IX. THE AGREEMENT WILL NOT ADEQUATELY PROTECT THE NIAGARA RIVER FROM CONTAMINATION AND WILL RESULT IN BREACHES OF INTERNATIONAL OBLIGATIONS UNDER THE 1909 BOUNDARY WATERS TREATY AND 1978 GREAT LAKES WATER QUALITY AGREEMENT

The proposed settlement agreement does not touch upon the international obligations assumed by both the United States and Canada under the 1909 Boundary Waters Treaty, which expressly prohibits pollution of boundary waters causing injury to property or health of persons on either side of the border; nor with obligations assumed by both countries under the 1978 Great Lakes Water Quality Agreement.

The 1909 Boundary Waters Treaty, 36 Stat. 2448 (1910), T.S. No. 548 (effective May 13, 1910) is part of the law of the United States. Article IV is the relevant section dealing with the pollution of boundary waters. It states "it is further agreed that the waters herein defined as boundary waters and waters flowing across the boundary shall not be polluted on either side to the injury of health or property on the other". Both Lake Ontario and the Niagara River are Boundary Waters as defined under the Treaty.

The 1978 Great Lakes Water Quality Agreement, signed by Canada and the United States, pursuant to the 1909 Boundary Waters Treaty is designed to prevent future, and abate existing pollution of the Great Lakes Basin ecosystem.

Article II states that the policy of the Parties is that:

(a) the discharge of toxic substances in toxic amounts be prohibited, and

(b) the discharge of any or all persistent toxic substances be virtually eliminated.

Annex 12 entitled 'Persistent Toxic Substances', states in section 2(a)(ii) that the philosophy adopted for control of inputs of persistent toxic substances shall be zero discharge.

Annex I lists specific objectives for chemicals including persistent toxic substances, such as mirex, which are found in the Hyde Park landfill. Annex I, I(A)(1)(b) states that the concentration for 'Unspecified Organic Compounds' in water or aquatic organisms should be substantially absent, i.e. less than detection levels as determined by the best scientific methodology available. This would include the dioxin found in the Hyde Park landfill.

The International Joint Commission in its The Seventh Annual Report on Great Lakes Water Quality to Canada and the United States, October 1980, Ottawa and Washington, D.C., clearly stated that as a result of the leaking landfill sites on the Niagara River serious degradation of the water quality had occurred, and is still occurring.

The joint Government Response to Public Comments on the Stipulation and Judgement Approving Settlement Agreement tries to rely on the Canada/Ontario Review Board and the International Joint Commission's Special Report on Pollution in the Niagara River as being evidence that conditions in the Niagara River are satisfactory and that approval has been given to this settlement. It is our submission that these references have been taken out of context and that the IJC continues to be extremely concerned about the quality of the Niagara River.

The 1981 Special Report on the Pollution in the Niagara River notes that while average annual water quality conditions generally met the Specific Objectives of the 1978 Agreement, approximately 10% of the samples exceeded Specific Objectives (p.3). The Report notes that:

> "a number of organic compounds have been found in the Niagara River for which specific objectives for the protection of fish and other biota and/or health implications have not been defined. While the significance of their presence cannot therefore be assessed, their very existence in the boundary waters is a matter for concern under the Great Lakes Water Quality Agreement under Annex 12 and the Specific Objective that they be at less than detection levels. Furthermore, the combined or synergistic effects of these substances are largely unknown". (p.2)

More importantly, the IJC, in the Special Report recommended that:

> "Governments prevent any additional discharges to the Niagara River that would increase the input of those substances for which the Specific Objectives under the 1978 Great Lakes Water Quality Agreement (including the objective for unspecified organic substances) are exceeded or likely to be exceeded."

Although one of the major thrusts of the agreement is alleged to be the protection of the Niagara River, the Niagara River will remain vulnerable to the infiltration of toxic chemicals despite the avowed intentions of the proposed settlement _if_ the agreement does not incorporate a containment technology that will guarantee the security of the river. It must be kept in mind that not only is the integrity of the Niagara River jeopardized by the leaching of chemicals from this site, but Lake Ontario is also ultimately receiving unacceptably high inputs of toxic chemicals entering from the Niagara River.

From the hydrogeological evaluations done by Dr. Kleppinger and Mr. Anderson it is apparent that the agreement does not seal off adequately the more crucial pathways that run underground to the Niagara River. Fractures and bedding plains characteristic of the Lockport Dolomite geological formation can carry contaminants from the site for miles underground. Based on data from Hooker's own consultants, toxic chemicals have been detected 50 feet below the rock surface and in a well drilled over 500 feet northwest of the site. This indicates that chemicals are moving through the rock to the Niagara River (Anderson Affidavit, p.9, para. 52).

Furthermore, breaches of the 1978 Great Lakes Water Quality Agreement are already taking place, and any further migration will endanger the health of the approximately 6 million Canadians and Americans living on the shores of these water bodies. What is especially significant, according to Dr. Hallett, is that if only "one shovelful" (3 lbs) of the 3,300 tons of "trichlorophenol still bottoms" containing TCDD were mobilized into the Niagara River over as short a period as 6 months, the levels of TCDD in the water column and biota of Lake Ontario would likely be elevated between 10 and 100 times the present levels". (Hallett Affidavit. p.10, para. 34). The Court in determining whether this settlement should be approved must take into account the magnitude of the harm to public health and the environment that would result from further migration of dioxin and other chemicals into the Niagara River and Lake Ontario.

If the settlement with its proposed remedial strategies is approved in its present form, there will be continued violations of international obligations and agreements as well as violations of RCRA and the Clean Water Act.

X. CONCLUSION

It is our recommendation, based upon the advice of our experts, that the problems manifest in the agreement should result in disapproval; or in the alternative, a fact finding hearing should be held to ascertain the validity of the material representations made by the parties.

Respectfully Submitted,

Toby Vigod

TOBY VIGOD

Barbara Morrison

BARBARA MORRISON

Dated: 30 June 1981

IN THE UNITED STATES DISTRICT COURT
FOR THE WESTERN DISTRICT OF NEW YORK

UNITED STATES OF AMERICA
THE STATE OF NEW YORK

Plaintiffs,

- vs -

Civil Action No. 79-989

HOOKER CHEMICALS & PLASTICS CORP.; OXY CHEMICAL CORPORATION; HOOKER CHEMICAL CORPORATION; OCCIDENTAL PETROLEUM INVESTMENT CO.; OCCIDENTAL PETROLEUM CORPORATION; THE TOWN OF LEWISTON; THE TOWN OF NIAGARA, (Hyde Park Landfill)

AFFIDAVIT OF
EDWARD W. KLEPPINGER

Defendants.

STATE OF NEW YORK)
COUNTY OF ERIE) ss.
CITY OF BUFFALO)

Edward W. Kleppinger, being duly sworn, hereby deposes and says:

1. My office is at 407 "N" Street, S.W., Washington, D.C. 20024.

2. As a private consultant in the field of environmental management, with specific expertise in the area of hazardous waste control, I provide scientific and technical counsel to both industry and the federal government.

3. I am a chemist by education, and taught chemistry at the university level after receiving my doctoral degree in 1965 from the University of Toledo.

4. I served as Director of Environmental Quality at International Telephone and Telegraph, and was responsible for the development and implementation of the company's pollution control program.

5. In 1976 I managed a hazardous waste treatment and disposal site, which handled waste streams from over one hundred generators.

6. I have acted as a technical consultant to the United States Environmental Protection Agency (hereafter "EPA") and the United States Attorney in evaluating the viability of proposed control technology in the first application of the Resource Conservation and Recovery Acts (hereafter "RCRA") S 7003 imminent hazard authority. I have subsequently conducted additional evaluations for EPA to determine the existence of an imminent hazard under RCRA.

7. On behalf of EPA, I participated in the evaluation of stabilization technology for Love Canal, and for the Salisbury Laboratory hazardous waste disposal site in Iowa.

8. In October of 1980, I participated at EPA's request in an environmental impact assessment seminar prepared for the Indian Government, and I was asked to address health impact assessment.

9. My private consulting work includes corporate environmental investigations for insurance purposes, and due diligence investigations of corporations which may become involved in merger or acquisition proceedings.

10. I first became specifically familiar with Hyde Park Landfill in 1978, as a result of my participation in a merger due diligence evaluation to determine undisclosed environmental problems of Occidental Petroleum and its subsidiaries on behalf of Mead Corporation.

11. My investigation of Hyde Park Landfill at that time included discussions with residents, scientists, State and County Officials, and evaluation of internal documents obtained through legal discovery (and which were later publicly released by federal and state authorities).

12. In February of 1981, I was asked by the Ecumenical Task Force to review and evaluate the proposed settlement agreement providing for remedial activity at Hyde Park Landfill, because of my personal knowledge of that site.

13. I prepared an initial analysis of the adequacy of the containment technology proposed, but indicated that a review of relevant data was necessary.[1]

14. At that time I concluded that the Court should disapprove the proposed settlement without prior independent and objective judicial scrutiny of the scientific and technological components of the agreement. That was predicated upon my initial conclusion that the containment program proposed would not work. Yet in the case of Hyde Park, it is imperative that a viable remedial strategy be selected because of the extreme toxicity of the wastes, in particular TCDD.

15. This affidavit is prepared in response to a request of the Ecumenical Task Force for my professional evaluation of the adequacy of the remedial strategy proposed for Hyde Park Landfill.

16. In preparing this analysis, I reviewed numerous documents and data, and conferred with government officials and private consultants (please see listing of all data reviewed at attachment "A" annexed hereto and made a part hereof).

17. A review of hydrogeologic data confirmed that Hyde Park Landfill was installed on highly fractured bedrock which is extremely permeable, and that wastes were deposited in <u>direct</u> contact with the bedrock.

18. Since it is clear that the parties intend to rely primarily on a containment strategy, such a strategy can not utilize the existing site nor attempt to leave the chemicals within this landfill.

19. Hydrogeologic data on and around the Hyde Park Landfill site, prepared by Conestoga-Rovers for Hooker Chemicals and Plastics Corp. (hereafter "Hooker") confirms that (1) the fractured Lockport dolomite is highly permeable and (2) reveals unequivocally that contaminants have already migrated downward into the bedrock at least 40 feet and 500 feet from the landfill.

[1] Letter dated March 6, 1981 from Dr. Edward W. Kleppinger to Barbara Morrison, and filed with the Court as Appendix "A" to Preliminary Comments of the Ecumenical Task Force.

20. The data indicate the presence of significant void spaces in the bedrock where, when wells were drilled into the rock, most of the wells were reported to have "lost circulation" of the drilling water. This simply means that the water used in drilling the wells was not recovered at the well surface, but rather disappeared downward through spaces and cracks in the permeable and fractured bedrock.

21. Leachate in Hyde Park Landfill will exhibit the same general behavior.

22. A void space is merely a hole in the bedrock, some of which are integral to the initial geologic development of the rock, and some of which occur when acids dissolve certain chemical constituents of the rock.

23. Lockport dolomite is a fractured bedrock, and the fractures exist both in the vertical and horizontal direction. The horizontal fractures are called bedding plains, which act as channels through which leachate will flow.

24. While some flow patterns in the bedding plains can be ascertained at a particular point in time, the direction of flow can dramatically change during the hazard life of the toxic wastes.

25. Unless every channel for leachate movement is sealed off for the life of the hazard (i.e., in perpetuity), leachate will continue to enter Lake Ontario either through movement to the conduits of the New York State Power Authority to the east, toward the Niagara River gorge to the south, or toward the power project (PASNY) to the north.

26. It is my professional opinion after review of the data that no practical method exists for sealing off the underlying porous bedrock at this site for the life of the hazard.

27. It is therefore my further conclusion that the contamirants buried at Hyde Park must be removed and re-entombed in a properly constructed clay vault which can be sealed off from the surrounding environment.

28. Another serious problem in attempting to monitor groundwater flow in the Lockport dolomite arises because of the interconnected and random nature (i.e., mazelike) of the horizontal and vertical fractures in the rock. That is, there is no assurance that any combination of monitoring wells would intercept, test or reclaim all potentially contaminated conduits (vertical and horizontal fractures).

29. This problem is well illustrated in EPA's Procedures Manual for Ground Water Monitoring of Solid Waste Disposal Facilities (SW-611, Dec. 1980) where groundwater is shown flowing within the rock fractures in two separate directions (at page 51, figure 10). It should also be noted that (at page 50, figure 9, supra) if a monitor well is not located at the junction in the right corner above monitor well C it will fail to intercept the flow traveling along that fracture line. (Please see figures 9 and 10 appended hereto as attachment "B" and "C" respectively and made a part hereof.)

30. The EPA procedures manual warns that there is no assurance that the wells will intercept the contaminant plume since groundwater flow patterns are not always predictable in fractured rock.

31. It appears that the parties have misplaced the groundwater collection system on the wrong side of the landfill, that is, to the west. If flow is toward the PASNY conduits, they would have to be located to the east of the landfill.

32. The Government in its Joint Response to Public Comments discusses the requirement for a leachate collection system, and cites the requirement for a leachate collection system in the overburden and a purge well system in the upper fifteen feet of the bedrock. They claim that "these two systems have been located in such a manner as to completely intercept the groundwater flow through and beneath the landfill." (at page 80) This representation demonstrates a complete lack of understanding of the geohydraulic behavior of the Lockport dolomite. For example, the purge well system located 15 feet below the top of bedrock will only collect leachate which intersects the system. No contamination below 15 feet would be intercepted.

33. In addition, the parties consideration of possible use of a grout curtain surrounding the fill and not placed down as far as the Rochester shale, indicates a complete lack of understanding of the major direction and method of migration of contaminants from the landfill. The leachate will, even with a grout curtain, continue to move down into the highly fractured rock within the landfill.

34. The above is deduced from the basic law of physics that water does not run uphill. Certainly groundwater in solution cavities in fractured bedrock will not move uphill. The capillary action which in some situations might overcome the downward force of gravity is absent in this situation.

35. It should be noted that within the existing landfill there is a groundwater mound created in the center when groundwater cannot escape laterally. So it decreases toward the sides as the pressure is relieved. This hydrostatic head (sometimes 10 to 20 feet) created at the landfill center increases the rate at which contaminated leachate is forced into the underlying porous bedrock. The higher the pressure, the more leachate is forced down into the rock. The Hyde Park Landfill would have a relatively high hydrostatic head. More leachate can escape from a landfill resting primarily on bedrock than in a situation where a containment vessel with a secure bottom will temporarily capture the leachate until the collection system would pump the liquid, thus relieving the hydrostatic head.

36. A leachate collection system used in conjunction with a larger containment system which is integrally developed to accomplish waste isolation is not what is required here, but rather an effective leachate collection system. In my professional opinion the approach of the parties does <u>not</u> provide a viable system. I believe that such a system cannot be provided within this landfill because the wastes are directly in contact with the Lockport dolomite.

37. It is my conclusion and my professional opinion that if a containment strategy is to be selected to isolate these wastes from the environment, removal of all wastes and re-entombment in a secure clay vault (even adjacent to this site) but with a properly prepared clay bottom is absolutely unavoidable.

38. The limited capping and tile drain installation plan constitutes a patchwork approach. Installation of purge wells and/or grout curtains does not alter the fundamental defects in the plan.

39. On June 9, 1981, I contacted Richard H. Johnson of the United States Geological Survey and author of Ground Water in the Niagara Falls Area, New York with Emphasis on the Water Bearing Characteristics of the Bedrock, Bulletin GW-53 (1964), published by the State of New York Conservation Department, Water Resources Division. His frequently cited work is considered to be the seminal study of groundwater in the Niagara region.

40. I conferred with Johnston for the purpose of obtaining his professional opinion on the ability of fractured Lockport dolomite to serve as a secure bottom for the hazardous wastes at Hyde Park Landfill.

41. I described the location of the landfill, the type and amount of material contained within it, the fact that the fill was either cut to bedrock or practically to bedrock with a minimal or intermittent clay layer, and the proposed containment plan.

42. I then asked Johnston whether, based upon his extensive knowledge of the behavior of Lockport dolomite, the fractured rock could effectively contain the landfilled chemicals. I also inquired as to whether it was possible to seal off the Lockport dolomite to effectively intercept leachate.

43. Johnston first advised me that the fractured bedrock absolutely could not secure the wastes, and that he did not believe it was possible to seal off the dolomite. He then advised me that all chemicals which got into the bedrock would sooner or later end up in Lake Ontario.

44. He explained that there are conduits parallel to the river through which water flows to the PASNY project, and that from my description of the location of the site, that he believed the groundwater to be flowing toward the conduits. They begin north of the Hooker "S" area dump on the upper Niagara River and end between the discharge power plant and the pump storage lagoon in the PASNY power channel.

45. According to Johnston, the PASNY conduits are as deep as 140 feet and approximately four miles long. While they are concrete lined, they have drains on their outside lining against the bedrock (emphasis supplied). He explained that any drainage leaking into the area between the concrete lining and the cut walls of the bedrock would eventually get into the canal through seepage holes and water weepage.

46. Note where ice has accumulated and heavy water flow occurs from some areas of bedding plains, while in immediately adjacent areas, there is no flow out. Likewise, if monitoring wells drilled into one point in the bedding plains of the dolomite, water (and perhaps contaminants) would be recovered, whereas a few inches away no water might be recovered (and thus no contaminants). The import of this is that if no contamination shows in the purge well in one bedding plain, one cannot assume that others are also uncontaminated. (In Johnson, Ground Water in the Niagara Falls Area, figure 7, page 24, not appended because complex weepage systems not xeroxable.)

47. Johnston further indicated that there is a 6 foot head loss between the river and the canal so the conduits in effect act as 4 mile long drains.

48. Johnston advised me that "anything put into the bedrock will eventually find its way to the canal".

49. I specifically asked Johnston what he would do with the wastes on the basis of the information furnished. I did not through this point express any preference with respect to remedial action. Johnston advised me that he would "dig it up and haul it away".

50. A clay cap is an important component of any secure landfill design, in that it can limit or decrease the rate of rainwater infiltration into the landfill.

51. But before a decision can be reached as to the viability of capping, the secureness of the bottom at the landfill site must be examined. If a naturally secure geologic bottom exists, or one can be provided by engineering means, only then can a reasonable projection of containment success be made, assuming adequate construction, safeguards, and long-term perpetual care and monitoring.

52. It is important to recognize that clay is not impermeable. It is simply less permeable than other materials such as sand. Clay will transmit significant amounts of water when the area of clay is extensive and when the hydraulic head across the clay is significant.

53. Quantitative calculations can be made with respect to the amount of water that could infiltrate the clay cap on an annual basis, after obtaining data on clay permeability, cap thickness, and the hydraulic head across the clay layer. I would very roughly estimate to an order of magnitude that between tens and hundreds of thousands gallons of water per year will infiltrate the 15 acre landfill.

54. This estimate assumes perfect clay and perfect technical performance over all 15 acres. As a practical matter, that is highly unlikely. Visualize the landfill as a glass with water dripping in continuously. As the water accumulates in the glass, water would follow the path of least resistance and move downward and out of the bottom of the glass. Likewise, in Hyde Park landfill the water percolated through the hazardous wastes in the landfill creating leachate and spills downward through the bottom.

55. Clay is only effective in limiting quantitative infiltration and retains its integrity as a surface barrier only for so long as it is not allowed to dry out and develop cracks and fissures, which allow rain to fall directly into the fill.

56. As part of the Mead Paper Corporation's merger due diligence evaluation of Occidental Petroleum and its subsiduaries in 1978, in which I was a participant, we investigated an old Hooker hazardous waste facility at Montague, Michigan.

57. My investigation revealed that in the Montague case, wastes were disposed of on a sandy soil , and the Michigan Department of Natural Resources (hereafter "DNR") required removal of the wastes and replacement into a secure clay vault which was constructed to accomplish environmental isolation.

58. It should be noted by the Court that Hooker's consultant, Conestoga-Rovers, insisted almost two years in lengthy negotiation with the State, that capping and pumping would constitute adequate remedial technology, similar to what is proposed in this case. DNR rejected this approach, because no adequate engineering controls could be provided to seal the site on the bottom and because the toxicity of the chemicals required effective isolation of waste.

59. The Hyde Park situation is strategically similar to Montague in terms of hydrogeologic problems, as well as the types of wastes requiring containment.

60. In the Government Responses to Public Comments, at p.33, a distinction is drawn between the two sites with respect to composition and quantity of wastes. This demonstrates a lack of familiarity with the Montague problem, since a majority of the chemicals are identical to those at Hyde Park Landfill.

61. Although Hooker never reported the presence of TCDD during the course of our investigation, it was subsequently discovered to be a component of the wastes at Montague.

62. The quantity of waste at Hyde Park is roughly equal to that at Montague. Hooker estimated the waste at 422,000 cu. yds., and DNR at 500,000 cu. yds. Hyde Park Landfill has roughly 489,000 cu. yds. (15 acres x 20 feet high divided by 27 for conversion from cubic feet to cubic yards).

63. The government misconceives the waste removal program, in that it would be unnecessary to excavate significant quantities of bedrock, but only enough to intercept all the potentially contaminated bedding plains and to provide counter-pumping which would reverse groundwater flow and collect materials which had migrated into the bedding plains.

64. Furthermore, the risk of exposure during excavation, transportation, and reburial can be limited by practicing the same techniques being used in Montague to control revolitalization of various toxic organic chemicals while the re-entombment takes place. Also, the limited number of residents who are potentially exposed could be re-located if necessary to effectuate proper remedial strategy.

65. The government's suggestion that the Montague situation did not involve a landfill constitutes a misrepresentation of the problem. In fact, numerous pits or fills of various depths contained wastes partially below and partially above ground level. Hyde Park Landfill also contains wastes partially below and partially above ground level. It is important not to lose sight of the main reason for re-entombment in Montague, which was simply that covering over the problem with a clay cap and pumping contaminants offers no real solution.

66. I met with Jack Bails,Director of Environmental Enforcement at the Michigan Department of Natural Resources on June 18, 1981 and inquired as to

(1) Hooker's compliance with the Montague Consent decree, and

(2) Hooker's success in effectuating its remedial responsibilities.

67. Bails advised me that Hooker, as part of its Settlement decree with the State of Michigan, was required to design and set up a purge well system on the edge of White Lake to monitor for contaminants.

68. Hooker is out of compliance with performance requirements and has been for a period in excess of one year.

69. Hooker was advised by DNR on June 8, 1981 that "aquifer characteristics have not been adequately determined nor has there been reliable definition of the rate of discharge of groundwater to White Lake through the contaminated zone of the aquifer. Thus the existing purge well system has been designed incorrectly" and that "It is apparent that substantial quantities of chlorinated hydrocarbons are escaping the influence of the purge well system." (see letter from Howard A. Tanner to John R. Nichter, dated June 8, 1981 appended hereto with attached memo as attachment "D" and made a part hereof.)

70. If the only alternative to removing the waste from Hyde Park Landfill now is to allow its highly toxic components to continue to leach into Lake Ontario over the next few generations, then re-entombment becomes extremely practical.

71. The details of a remedial strategy cannot be finalized until the complete dimensions of the problem are determined. But at this point, it can be ascertained with certainty that the containment strategy which has been selected in this case will ultimately fail to contain the waste.

72. No remedial program will effectuate containment of these wastes without requiring removal as a fundamental part of that strategy.

Sworn to Before me
on this 30th day of June, 1981

Barbara Morrison

NOTARY

State of New York
Qualified in Erie County
My commission expires 3/30/83

EDWARD W. KLEPPINGER

Kleppinger -- Attachment "A"

List of Materials Reviewed by Dr. Kleppinger

1. Federal Complaint in U.S. vs. Hooker et al. Civil No. 79-989 (Hyde Park Landfill).

2. Proposed Settlement Agreement, Stipulation and Judgement Approving Settlement Agreement.

3. Comments on Proposed Settlement Agreement.

4. Response to Public Comments On the Stipulation and Judgement Approving Settlement Agreement.

5. Mead Report by Fred C. Hart and Company 11. Hyde Park Dump pp 40-69.

6. Sampling locations, Health Effects, Environmental Effects, Management Status, Hyde Park Chemical Landfill, Oct. 17, 1978, Toxic Substances Coordinating Unit pp. 3-5, reference: Mr. Charles Goddard, Div. of Solid Waste Management, N.Y. State Dept. of Envir. Cons., 50 Wolf Rd., Albany, N.Y. 12233, Ph. AC 418-457-6605.

7. Letter of Oct. 24, 1979, Re: Information Submittal Regarding TCDD Contamination of Soils in Drainage near the Hyde Park Landfill. To Chief, Office of Toxic Substances, Region II, USEPA Edison, N.J. 08817.

8. Site Study, Bloody Run, Jan. 1979, 978-538 by Conestoga-Rover & Assoc.

9. Letter to F.T. Olotka from Frank Echelberger, Subject: Air Sampling - Hyde Park Landfill, Sept. 25, 1979.

10. State of NY Conservation Report, Water Resource Comm., Ground Water in the Niagara Falls NY. Area with Emphasis on the Water Being Characteristic with the Bedrock by Richard H. Johnston.

11. Various Chemical Analyses, Appendix A., Stratigraphic Logi and Comments, Soil Sampling Stations in Bloody Run and North of Hyde Park Landfill.

12. Table 4, Hyde Park 2nd Phase Organic, Date Samples Jan. 26, 1979.

13. Appendix B, Priority Pollutant Analysis of Soil Samples Collected for Bloody Run and Niagara Gorge.

14. New York State Dept. of Health, Results of Examination.

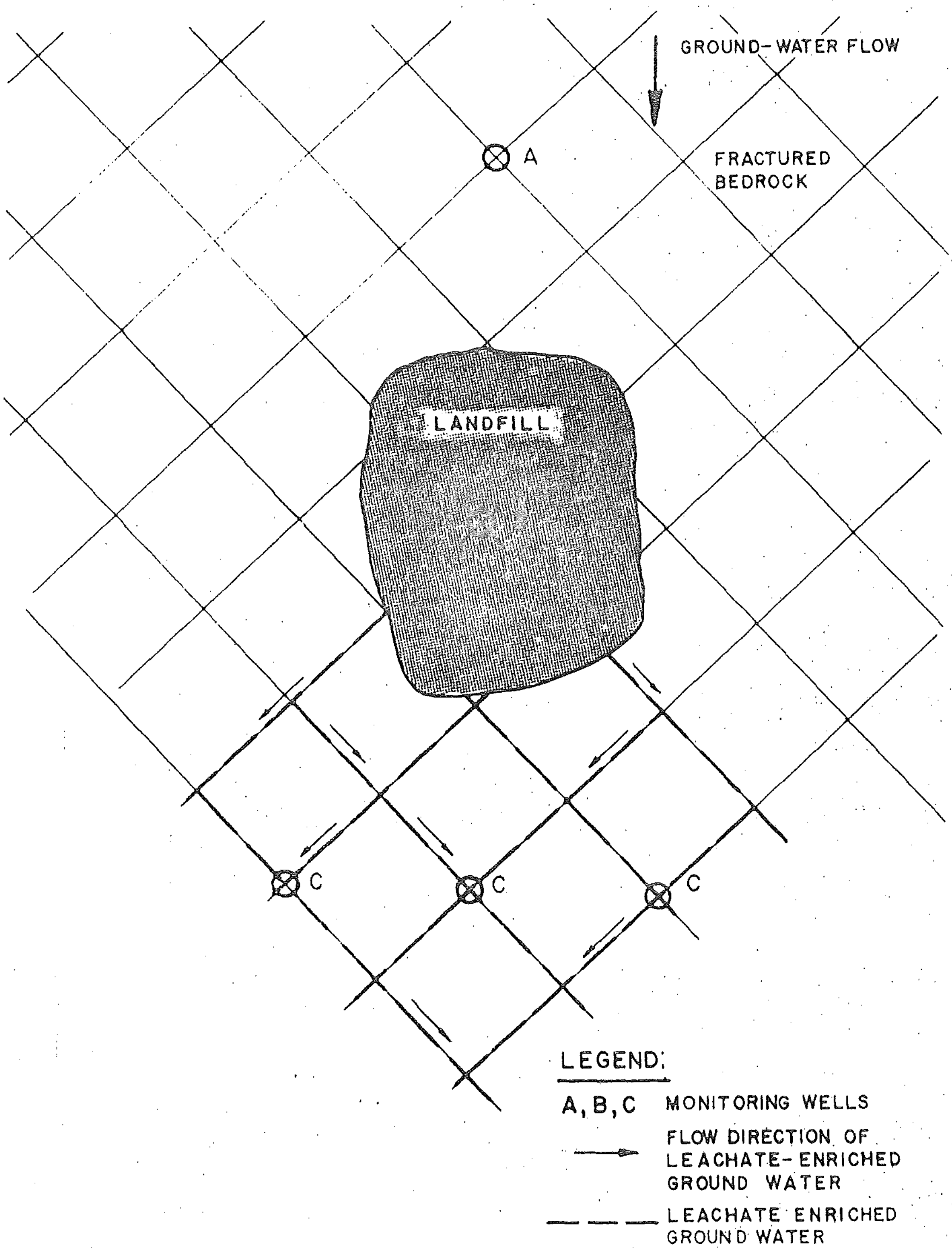


FIGURE 9. MONITORING NETWORK FOR AQUIFERS WITH FRACTURE POROSITY - AREAL FLOW PATTERNS.

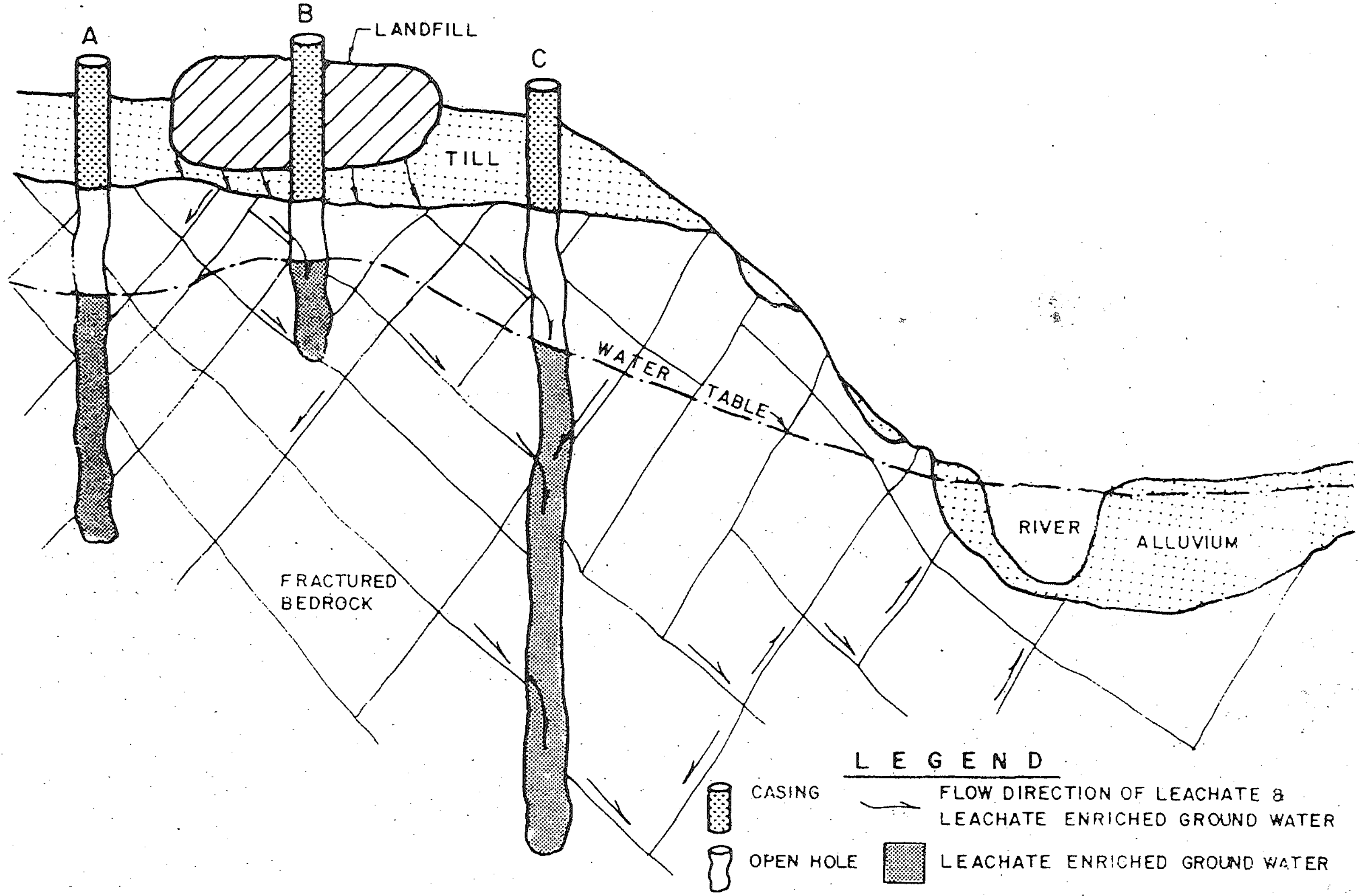


FIGURE 10: MONITORING NETWORK FOR AQUIFERS WITH FRACTURE POROSITY - VERTICAL FLOW PATTERNS

Kleppinger -- Attachment "C"

Kleppinger -- Attachment "D"

STATE OF MICHIGAN

WILLIAM G. MILLIKEN, Governor

DEPARTMENT OF NATURAL RESOURCES

STEVENS T. MASON BUILDING
BOX 30028
LANSING, MI 48909
HOWARD A. TANNER, Director

James Truchan
Dr. ... File
... white
... Johnson

RECEIVED
... 1981
ENVIRONMENTAL ENFORCEMENT DIVISION

June 8, 1981

CERTIFIED MAIL

Hooker Chemicals & Plastics Corporation
P. O. Box 728
Niagara Falls, New York 14302

ATTN: Mr. John R. Nichter, Program Manager
Special Environmental Operations

Item	Page	Paragraph	Requirement
52	14	XV A	Submit plans and specifications for a groundwater purge system.

Gentlemen:

This is to acknowledge your April 27, 1981 letter which responded to my letter of April 8, 1981. You have indicated that the additional conditions outlined in my letter are not acceptable to Hooker Chemicals & Plastics Corporation. In addition, you request that the Department of Natural Resources specifically describe the technical deficiencies that exist in the purge well system.

My April 8, 1981 letter approved the concept to intercept groundwater contamination by utilization of purge wells placed within the zone of contamination in a line perpendicular to the direction of contaminant flow and was written expressly with the intent of resolving the technical deficiencies we perceive in the design of the system.

Technical deficiencies in the purge well design are related to incorrect assumptions used by Hooker's consultant in design of the system. The data necessary to correctly design the system were outlined in the Consent Judgment.

Correct design of a purge well system necessitates utilization of the following design criteria in the order listed:

1. Definition of the vertical and horizontal extent of contamination entering White Lake (Item 60) has not been determined. The extent of contamination where it is critical, at the shore of White Lake, has not been defined by your consultant.

2. Reliable coefficients of permeability and transmissivity have not been provided. To obtain reliable estimates of these aquifer characteristics it is necessary to run complete pump test and aquifer analysis. The direction of groundwater flow and the groundwater gradient can be utilized along with these data on aquifer characteristics to generate estimates of flow through the cross sectional area of the aquifer. This area is then used as the basis for design of the purge well system. Aquifer characteristics have not been adequately determined nor has there been reliable definition of the rate of discharge of groundwater to White Lake through the contaminated zone of the aquifer. Thus the existing purge well system has been designed incorrectly.

3. Chemical monitoring and observation wells are necessary during or prior to this phase to determine effectiveness of the purge system. Purge wells have been installed but this monitoring and observation network has not been completely installed to date. However, without these wells there is no data to confirm that the existing rate of pumping does in fact halt all flow of contaminated groundwater to White Lake.

Data collected for chemical analysis from White Lake shoreline wells L-A through L-J indicates that increasing amounts of chlorinated hydrocarbons are being discharged to White Lake (note attached May 5, 1981 memo from Gene Mogg to the Hooker Order Compliance Team [HOCT]). Levels of chlorinated hydrocarbons in these wells should be decreasing if the purge well system has been effectively halting the flow of contaminated groundwater to White Lake. It is apparent that substantial quantities of chlorinated hydrocarbons are escaping the influence of the purge well system. The attached March 26, 1981 memo from James Heinzman to Jack Bails details our estimation of groundwater movement based strictly on information provided by your consultant. Analysis of existing data on the hydrogeologic conditions indicates that the purge well system may at best be 60 percent efficient in capturing contaminated groundwater flowing to White Lake. The increased amounts of chlorinated hydrocarbons in wells L-A through L-J and the technical design deficiencies which have been cited all indicate the present purge well system is inadequate.

The demonstration period required by the Consent Judgment began as of April 8, 1981. The design necessary to demonstrate the effectiveness of the purge well system is outlined in my approval letter sent on that date. If appropriate action is not taken by Hooker Chemicals & Plastics Corporation within 30 days to resolve the deficiencies that have been outlined in my April 8, 1981 letter and in this letter, the matter will be referred to the Attorney General for enforcement action.

Sincerely,

Howard A. Tanner

Howard A. Tanner
Director

blind copy sent to [illegible].

Attachments

Ce

M[illegible]CHIGAN [illegible]PARTMENT OF NATURAL R[illegible]SOURCES

INTEROFFICE COMMUNICATION

350 Ottawa Avenue, N. W.
Grand Rapids, MI 49503

RECEIVED
MAY 0[illegible] 1981
WQC COMPLIANCE

TO: H.O.C.T.

FROM: C[illegible] E. Mogg, Water Quality Divison

DATE: [illegible] 5, 1981

SUBJECT: Hooker Chemicals - Plastics (H.C.P.)
Consent Judgment

Hooker Chemical Company's shoreline monitoring wells (MW) were sampled again on March 12, 1981. The attached report compiles the previous data since staff began quarterly sampling of these wells in May, 1980.

During previous sampling it was believed that MW "A" was missing. However, during our March 12, 1981 sampling it was discovered that MW "D" had been submerged during our previous sampling. We (as well as H.C.P. staff) had been sampling wells "C", "B" and "A", but were designating them wells "D", "C" and "B" in our reports. The data and MW designation in the attached report is correct and all previous reports should be discarded or corrected, This error does not require any corrections to the maps showing the locations of the shoreline monitoring wells.

The data shows that the concentrations of chlorinated hydrocarbon in the affected wells is continuing to increase. Thus the concentration of chlorinated hydrocarbon discharging into White Lake must also be increasing. This continues to make the effectiveness of the Hooker purge well system to halt the flow of chlorinated hydrocarbon into White Lake questionable.

Also, routine (monthly) monitoring of White Lake at the outlet to Lake Michigan has on occasions (during ice cover) shown the presence of carbon tetrachloride and perchloroethylene.

CM:bjc
attachment

IN THE UNITED STATES DISTRICT COURT
FOR THE WESTERN DISTRICT OF NEW YORK

UNITED STATES OF AMERICA,
THE STATE OF NEW YORK

Plaintiffs,

- vs -

Civil Action No. 79-989

AFFIDAVIT OF
GRANT ANDERSON

HOOKER CHEMICALS & PLASTICS CORP.; OXY CHEMICAL CORPORATION; HOOKER CHEMICAL CORPORATION; OCCIDENTAL PETROLEUM INVESTMENT CO.; OCCIDENTAL PETROLEUM CORPORATION; THE TOWN OF LEWISTON; THE TOWN OF NIAGARA, (Hyde Park Landfill).

Defendants.

PROVINCE OF ONTARIO, CANADA)
REGIONAL MUNICIPALITY OF)
HALDIMAND-NORFOLK) ss:
TOWN OF DUNNVILLE)

Grant Anderson, being duly sworn, deposes and swears on personal knowledge that:

1. I live at 48 Summerfeldt Crescent, Unionville, Province of Ontario, Canada.

2. I am a full partner in the firm of Gartner Lee Associates Limited, Consulting Engineering Geologists and Hydrogeologists. (See Curriculum Vitae annexed hereto as Exhibit "A".)

3. I am a hydrogeologist by profession, with a Bachelor of Science in Engineering Geology from Queen's University in Kingston, Ontario. I have also taken graduate courses in hydrogeology from the University of Waterloo in Waterloo, Ontario, Princeton University in New Jersey, and the University of Missouri in Missouri.

4. I have extensive experience in hydrogeology, specializing in applying terrain evaluation, engineering geology and hydrogeological principles to earth science problems. Since 1970 our firm has been involved in over 200 studies dealing with contaminant-related problems resulting from waste disposal activities, including liquid industrial, domestic, hazardous, toxic, sewage sludge, low level and high

level radioactive wastes.

5. I am presently the project director for the Ontario Waste Management Corporation. My responsibilities include the assessment of a site at South Cayuga, Ontario, to determine whether it is a suitable location for the disposal of treated hazardous liquid industrial wastes.

6. I have been involved with a number of projects in Canada where there has been a problem of contamination of either creeks or groundwater aquifers. Part of my involvement has been to recommend remedial measures to correct those contaminant problems. These measures have ranged from the design of purge well systems to the design of toe drain leachate collection systems.

7. This affidavit was prepared in response to the request of Pollution Probe and the Canadian Environmental Law Association for my professional evaluation of the hydrogeology of the Hyde Park Landfill and the proposed technology in the Settlement Agreement. I have submitted a report to Environment Canada entitled "Hydrogeological Review of Hyde Park Landfill." (see Report annexed hereto as Exhibit "B" and made a part hereof.)

8. In coming to my conclusions I have reviewed the January 19, 1981 Stipulation and Judgement Approving Settlement Agreement, the April 3, 1981 Government Response filed in this Court to Public Comments on the Stipulation and Judgement Approving Settlement Agreement, the comments of the Ecumenical Task Force, the original Complaint filed by the Environmental Protection Agency, material obtained by the Ecumenical Task Force pursuant to the New York Freedom of Information Law, and other relevant data. (see list of materials reviewed annexed hereto as Exhibit "C" and made a part hereof.)

9. To determine remedial measures necessary for a site like Hyde Park, the procedure must be ~~to first~~ determine the character of the wastes and their toxicity.

10. In the case of Hyde Park, these wastes are some of the most toxic wastes known to man. As such, remedial action has to be carefully designed around that understanding of their characteristics.

11. A basic understanding of the hydrogeological characteristics of the site is necessary in order to design the best remedial measures. These hydrogeological characteristics include the setting of the site, the character of the waste, the quantity of the leachate produced, the characteristics of the leachate, the direction that the leachate is moving and the impact the leachate has on the groundwater and surface water environment.

12. The key is to determine how much leachate is being produced at the site and where it is going. Once that is quantified, then it can be determined where remedial measures can be applied most effectively.

13. To determine groundwater flow, it is necessary to know two basic things -- the water table and the piezometric surface of any underlying deeper aquifers that exist below a disposal site.

14. The water table is at the top of the zone of saturation. To determine where the water table is located, a hole can be dug in a field and left open. If it extends below the water table, then the hole would fill with water to the level of the water table. This is called the top of the zone of saturation and establishes the level of the water table. (This could be measured using a stand-pipe.)

15. The piezometric surface is the pressure gradient of the water that allows you to determine in which direction the water is flowing. A hole is drilled at exactly the same location in a field as the first hole, going further down through the soil and into the rock. If a pipe were installed in the rock and sealed with bentonite or concrete, and if the water level in the rock were measured, it would likely be a different level than the water table. When water moves it uses up energy and the energy lost by that movement is reflected by a pressure change in the water. The comparison of the water level in the pipe that has its bottom in the rock to the water table determines the vertical gradient. By knowing this gradient, and other hydraulic properties of the soil/rock, it can be determined in which direction the water is moving, and at what rate.

GEOLOGIC SETTING OF SITE

16. The analysis of the hydrogeology of the Hyde Park landfill site done by Conestoga Rovers does not address the quantity of the water moving vertically as opposed to laterally.

17. The Hyde Park landfill is situated on a thin glacial till deposit which over lies the Dolomite bedrock of the Lockport Formation.

18. The Lockport Dolomite formation, or similar, extends from Niagara Falls to Tobermory through Southern Ontario. I am familiar with this formation from having assessed landfills on the top of the Niagara Escarpment, located within the Lockport Dolomite formation.

19. To determine the hydrogeological characteristics of the site, observation wells are drilled to gather information on the type and depth of the overburden soils on the site, the depth of the bedrock and the characteristic of the bedrock. After retrieving this information from these wells, a pipe is placed in the hole and depending on the type of pipe and the depth of its placement, the measurement of the piezometric surface in the rock and the measurement of the water table can be obtained. Chemical analyses can be done on these water samples to determine whether contamination of that water has taken place or not.

20. In the Government Response to Public Comments, Response #113, states that the piezometric head on the bedrock aquifer is above the top of the bedrock beneath the landfill. This implies that the vertical gradient was upwards. This is totally inaccurate. According to an appendix to a report prepared by Conestoga-Rovers in 1980, the water table is about 20 feet higher than the piezometric surface in the bedrock. This means that groundwater is moving downward with a very steep vertical gradient of .57 downwards into the fractured bedrock.

21. I strongly disagree with the assumption in the agreement that the wastes are placed on clays which separate the chemicals from the bedrock aquifer. The data I have reviewed indicates that this is not the case.

22. Of the 22 observation wells drilled by Conestoga-Rovers, only one well was placed through the waste itself. They tried to put another well in the waste, but it was destroyed during construction according to the bore hole logs (reference to O.W. 9-78 and 10-78, p. 3, Exhibit "B").

23. It is my opinion that the chemical wastes have been deposited in direct contact with the bedrock. This is illustrated by observation well 10-78 (see p.8, Exhibit "B") which was placed right on the bedrock surface to a depth of 29 feet. This is the well that was destroyed during construction. However, the well log indicates that there is chemical waste down to 25 feet. From 25 feet down to bedrock at 29 feet, the material is permeable and contaminants could move freely into the rock.

24. Of even more concern is observation well 9-78, drilled near the north central portion of the site through the chemicals (see p.7, Exhibit "B"). That log states that from 0 to 5 feet, there exists coarse gravel fill and black chemical residue; from 5 to 10 feet stiff silty clay and black chemical residue; 10 to 15 feet soft silty clay, some $1\frac{1}{4}$" stones, black organic like residue and light sugarlike crystals (probably chemical); from 10 to 20 feet, the log describes black chemical residue with medium sand and metal barrels; from 20 to 26 feet there is black chemical slurry (a mixture of solids and liquids) with medium sand.

25. At 26 feet the augers could not penetrate further. Conestoga-Rovers interpreted this refusal as "probably concrete rubble". It is difficult to accept that this is concrete rubble rather than bedrock considering that the bedrock elevation at this point is 580.3 feet above sea level compared to observation well 10-78 which has bedrock at 583.2 feet, just roughly 3 feet higher in elevation.

26. Considering the highly toxic nature of the wastes, it is important to take the worst case interpretation and assume that the refusal was bedrock rather than concrete rubble. This is important because the bedrock underlying the wastes is very permeable and water moves through it very quickly.

27. Observation well 11-79, 13-79, shows that the upper 15 feet of the bedrock is very fractured with solutioned cavities.

28. During the drilling of observation well 11-79 voids (spaces between the different layers) were encountered from 6.8 feet to 28 feet. (See p.9 Exhibit "B".) From 7.5 to 7.8 feet a void of .3 feet was encountered. These wells indicate that the bedrock is able to move contaminated water in open cavities for miles unattenuated. (P.21 Exhibit "B", #10.)

GROUNDWATER FLOW

29. It is my opinion that the groundwater flow system cannot be accurately analyzed from the data on which the proposed settlement agreement is based. Conestoga-Rovers drilled a number of observation wells along a line of cross section in the Hyde Park Bloody Run Area (reference to Map A-1, annotated as A-A' Exhibit "B"). The number of observation wells were limited to holes drilled along that line of cross section through the wastes.

30. On the basis of that information, Conestoga-Rovers drew curved contour lines of a number of basic data points including: curved lines of depth to bedrock, curved lines of water table configuration and curved lines of the piezometric surface of the bedrock.

31. In my opinion there is no justification for drawing the line curved when there are only points along a straight line. In order to determine which way the contour lines curve, it is necessary to drill observation wells aerially distributed adjacent to the wells drilled along the straight line. Conestoga-Rovers should have drilled more holes around the site, through the site, and adjacent to the site, so that they would have had a number of points with which to get their data to draw accurate contours.

32. It is important to accurately determine groundwater flow through the use of properly drawn contour lines in order to know whether to protect the groundwater in the soil or the groundwater in the rocks. A comparison must be made between the amount of water going down into the rock and the amount of water moving laterally into the soil. This calculation is fundamental to deciding what remedial measures are needed.

33. Observation well 11-79 also indicates how permeable the rock is and how quickly leachate can move downward. The flushing water used to drill this hole no longer reached the surface after a depth of 11 feet. This means that at first the water came up to the ground surface because the rock and the soil would not let the water flow through the formation that indicates that water was moving fairly slowly initially, but after 11 feet all the water went gushing out through the rock downward.

34. I have seen no analysis that has tried to calculate how much water goes down into the rock versus how much goes laterally through the soil. On the basis of my analysis, I have calculated that the majority of the leachate and contamination in the Hyde Park site moves vertically downwards into the rock (see p.10 Exhibit "B").

35. In my opinion, the groundwater flow direction, referred to in the agreement as being the northwest (page 5) is inaccurate. The flow is not only in a northwesterly area with flow (in the shallow bedrock zone at least) moving westerly, northerly and possibly easterly away from the site.

36. The northerly direction would take the leachate to Niagara University area approximately parallel to Bloody Run Creek. The easterly direction would flow at a right angle to Bloody Run Creek, beneath what is called New Road immediately north of the site. The northwesterly direction would take it directly to the Niagara River.

37. It is very significant that the groundwater flow has been misinterpreted or misunderstood because of its importance in designing the remedial strategy.

PROPOSED REMEDIAL ACTION

38. One of the few definite commitments in the proposed settlement agreement is the installation of the overburden barrier collection system. This system primarily collects the contaminated groundwater moving laterally into the soil. I have calculated that there is approximately 200,000 times more contaminated groundwater going down into the rock than there is into the overburden. The emphasis should not be on the overburden barrier system when most of the contamination can go into the rock and move out through the rock towards the Niagara River (see p.17 Exhibit "B").

39. From my analysis showing that as much as 200 thousand times as much water can go down through the rock as moves laterally through the soils, it is my opinion that the groundwater flow into the rock and out through the rock to the Niagara Gorge would represent the most significant avenue for chemicals to get through the Niagara Gorge and to reach the Niagara River and not by way of Bloody Run Creek.

40. I have also calculated the groundwater velocity and determined that the velocity of contaminants in the rock will be about 10,000 times faster than in the soil.

41. Considering the velocity of the water moving through the rock, it is likely that water can go out from the site out to the gorge within a year.

42. I have seen no data that considers the possibility of these contaminants being present along the face of the gorge remote from the point at which Bloody Run Creek spills over the gorge.

43. Therefore, it is obvious that the overburden barrier drain system will not prevent the most significant release of contaminants. The overflow of chemicals to the bedrock is the most critical aspect of contamination requiring remedial action at this site.

44. The possibly proposed bedrock barrier collection system, made up of 11 purge wells along the west end of the landfill, is intended to remove leachate from the bedrock and to create a hydraulic trap so that leachate cannot flow past the wells.

45. However, the locations of the 11 purge wells in this proposed collection system are based on the wrong assumption that groundwater is flowing only in a northwesterly direction.

46. Because groundwater is moving in a northerly and northeasterly direction in addition to northwesterly, it would be necessary to put wells all the way along the north and east edge of the landfill at spacings similar to those along the west end of the landfill.

47. I have calculated that with the additional wells around the north and east edge of the site, using the same spacings, approximately 60,000 gallons of leachate must be pumped daily in order to collect all of the leachate produced on the site. Pumping this amount of leachate would create a hydraulic trap and prevent water from flowing past those wells and away from the landfill site.

48. The adequacy of a purge well system and its effectiveness is related to the economics of that system and the length of time it has to operate. As long as the wastes are there, chemicals will move slowly out of the bottom of the site. They must be collected in perpetuity.

49. If a purge well is used, considerable dilute quantities of leachate (60,000 gallons per day) will have to be collected, transported and treated forever.

50. In my opinion, Addendum I to the agreement is naive in suggesting that the collection system would be discontinued if water quality from the purge well outfall meets plume definition levels. This leachate will necessarily be dilute because all the clean groundwater from around the site is coming into the system to dilute the leachate. To properly monitor, it is necessary to monitor the groundwater that has percolated through the waste between the waste and the purge well.

51. My concern that chemicals are in direct contact with the rock and moving away from the site is reinforced by the data from observation well 18-79 (see p.2 Addendum Exhibit "B"). The groundwater taken from 50 feet below the bedrock surface shows, for example, trichloroethylene in concentrations of 500 ppb. This concentration exceeds the 10 ppb plume definition level set for trichloroethylene (see proposed Settlement Agreement Addendum I, p. 27). Other hazardous chemicals including benzene, chloroform and toluene have also been measured at extremely high concentrations at this well.

52. These toxic chemicals were detected 50 feet below the rock surface and in a well drilled over 500 feet northwest of the site. This indicates that chemicals have already moved 50 feet below the rock surface and are moving through the rock to the Niagara River.

53. I cannot determine how far these chemicals have gone or what the concentrations are below 50 feet because there are no observation wells far enough away from the site. The proposed agreement does not address the collection of contaminants below a 15 foot level.

54. Placing a 3 foot clay cap on the landfill is only a short term solution. The clay cap does not totally eliminate precipitation from infiltrating. It merely minimizes the amount of infiltration. Therefore, leaching of the chemicals into the groundwater will take place over a much longer period of time.

55. It is my conclusion that the toxic chemicals buried at the Hyde Park landfill have to be removed from this environment. There are only two alternatives to consider: either by removal of the approximately 15 acres of concentrated wastes which could be done in a few years, or the pumping, storing, handling and treatment of 15 acres of dilute leachate 5 feet deep every 240 days for thousands of years.

56. Given the requirement to handle over 60,000 gallons of dilute leachate daily in perpetuity, it is my opinion that the removal of all the contaminated soil and chemical wastes for safe disposal at a properly designed site or destruction where feasible is the only reasonable option available.

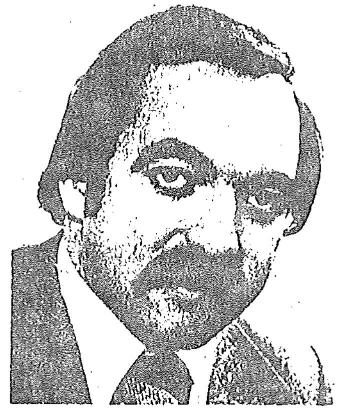
57. Finally, having reviewed the proposed settlement agreement and supporting technical data, I am of the opinion that it does not seriously consider either of the two options seriously.

SWORN before me at the Town of Dunnville, in the Regional Municipality of Haldimand-Norfolk, this 29th day of June, 1981.	))))	Grant Anderson

A Notary Public in and for the Province of Ontario.
My Commission is for life.

Gartner Lee Associates Limited

E. GRANT ANDERSON
B.Sc., P.Eng.
Consulting Hydrogeologist



Profile

Mr. Anderson has specialized in applying terrain evaluation, engineering geology and hydrogeological principles to solving many earth science problems. Studies have dealt with regional and detailed impact assessments of most waste disposal practices including liquid industrial, domestic, hazardous, toxic and sewage sludge wastes. In addition, resource evaluation, dewatering and route alignment studies have been completed. He has developed a number of pioneering field techniques which have resulted in the applications of unique analysis for complex geological systems. Mr. Anderson has presented papers at a number of conferences across Canada and lectured at universities and government sponsored seminars.

Experience

1966-1970 — B.Sc., Queen's University, Engineering Geology
1970-1972 — Engineering Geologist, Terra Scan Limited
1972-1975 — Engineering Geologist, Gartner Lee Associates Limited
1973-1975 — Credit to Masters, University of Waterloo — Ground Water Geology and Advanced Hydrogeology
1975-Present — Associate, Gartner Lee Associates Limited
1976 — Audit, University of Waterloo, Field Techniques in Hydrogeology
1977 — Extension Course, University of Missouri-Rolla, Ground Water Analysis and the Design of Dewatering Systems
1978 — Designated Consulting Engineer, Ontario

Affiliations

• Association of Professional Engineers of Ontario • International Association of Hydrogeologists, Canadian National Chapter • National Water Well Association • Canadian Geotechnical Society • International Society for Soil Mechanics and Foundation Engineering • Geological Association of Canada

Exhibit "B"

Gartner Lee Associates Limited

Consulting Engineering Geologists and Hydrogeologists

Toronto - Buttonville Airport ■ Markham, Ontario ■ L3P 3J9 ■ 416-297-4600

HYDROGEOLOGICAL REVIEW
OF
HYDE PARK LANDFILL
SUMMONS AND AGREEMENT

PREPARED FOR:

ENVIRONMENT CANADA

GLAL 81-73

JUNE 17, 1981

Gartner
Lee
Associates Limited

Consulting
Engineering
Geologists and
Hydrogeologists

Toronto-Buttonville Airport ■ Markham, Ontario ■ L3P 3J9 ■ 416-297-4600

June 17, 1981.

Environment Canada,
Ontario Region,
55 St. Clair Avenue East,
Toronto, Ontario.
M4T 1M2

Attention: Dr. R. W. Slater,
Regional Director General

Dear Sir:

Re: Hydrogeological Review of Hyde Park Landfill - (GLAL 81-73)

We are pleased to submit our review of the hydrogeological aspects of the Summons and Agreement for the Hyde Park Landfill.

I will be out of town for the week of June 22, 1981, but would be pleased to discuss this review with you later this week or when I return.

Yours very truly,

GARTNER LEE ASSOCIATES LIMITED

Grant Anderson

E. Grant Anderson, P.Eng.,
Consulting Hydrogeologist.

EGA:jcm
Enclosure.

TABLE OF CONTENTS

HYDE PARK - BLOODY RUN LANDFILL
HYDROGEOLOGIC REVIEW

1) GEOLOGIC SETTING OF SITE:

This 15 acre± chemical disposal site was developed by excavating and filling pits or cells within glacial silt and clay till soils. Wastes were dumped in bulk and in 45 gallon drums. Excavations were made utilizing a drag line type of operation. Historical airphotos of the site suggest that it was likely a low wet area with the water table near the ground surface prior to landfilling.

Soil borings carried out by Conestoga-Rovers around the site indicate that the area is characterized by an upper glacial silty clay till on surface. Sandwiched between this till and the underlying bedrock is a weathered bedrock zone intermixed with sand and till. The depth of the glacial till overlying the bedrock varies from about 5 feet± (O.W.-7-78) east of the site to 30 feet (O.W.1-78) north west of the site and 16 feet (O.W.13-79) immediately west of the site. (See Map A-1 - Observation Well Locations and borehole logs on following page.) The elevation of bedrock east of the site is 603.7 feet, (O.W.7-78) west of the site bedrock is confirmed at 582.4 feet (O.W.13-79) and north west of the site bedrock is confirmed at 563.1 feet (O.W.1-78). These data indicate that bedrock underlying most of the chemical fill is at about elevation 582 feet or higher by extrapolation between O.W.7-78 and O.W.13-79.

Two wells were drilled through the waste. These were wells O.W.9-78 and 10-78. O.W.10-78 was destroyed during construction and is not shown on Map A-1. However O.W.9-78 met refusal on assumed concrete rubble at elevation 580.3 feet and O.W.10-78 hit refusal at elevation 583.2 feet on bedrock. Both of these well records (attached) indicate that chemical wastes have been filled in direct contact with the underlying bedrock.

The underlying bedrock is known locally as the Lockport Dolomite. At this site, it is about 100 feet thick. It is generally described as massive to thin bedded dolomite. The upper 15 feet of the rock is very fractured and solutioned cavities are reportedly common. (Refer to logs of O.W.11-79 and 13-79). Below this

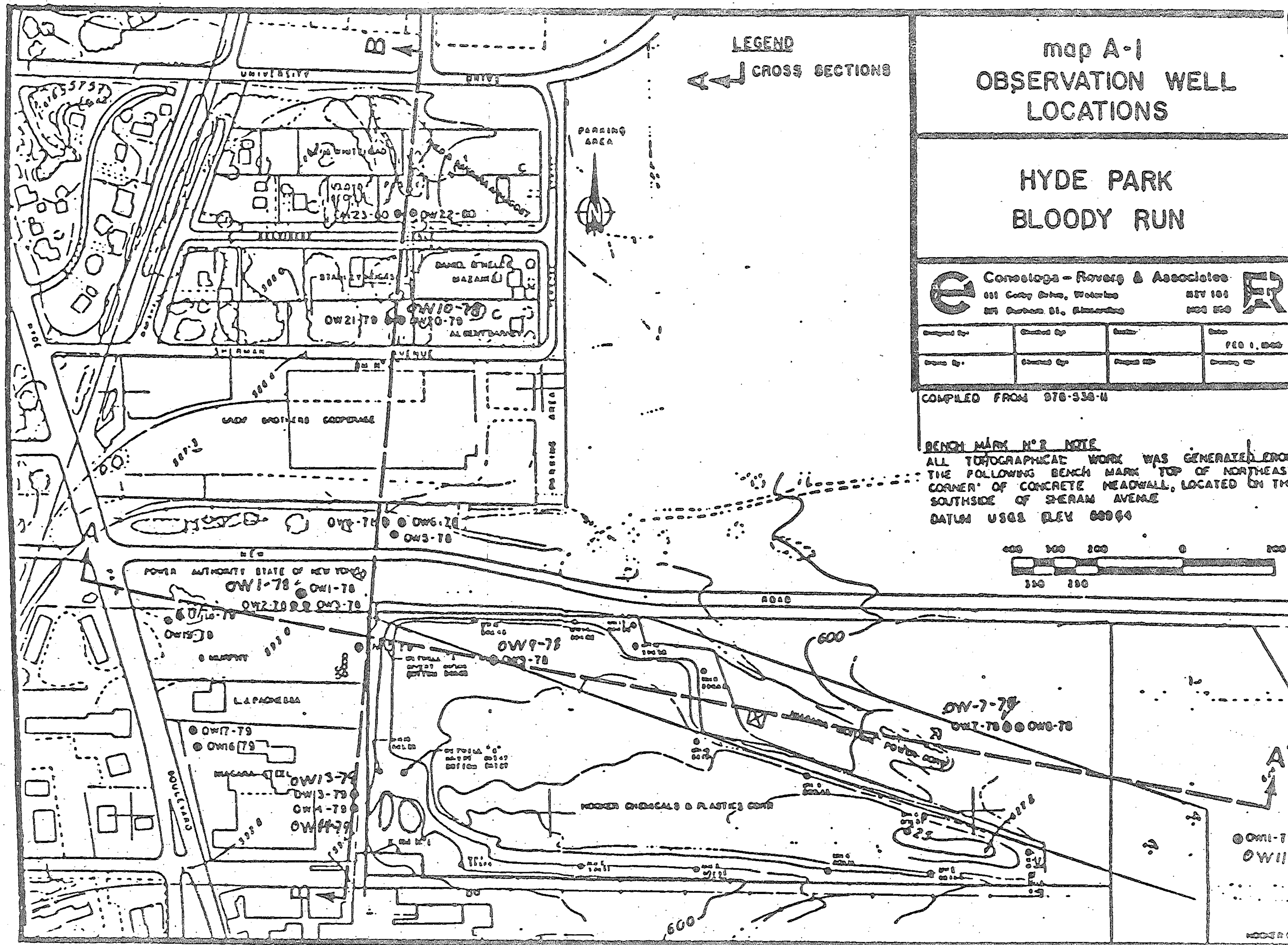

map A-1
OBSERVATION WELL LOCATIONS
HYDE PARK
BLOODY RUN
LEGEND
CROSS SECTIONS
Conestoga - Rovers & Associates
COMPILED FROM
BENCH MARK N°2 NOTE
ALL TOPOGRAPHICAL WORK WAS GENERATED FROM THE FOLLOWING BENCH MARK TOP OF NORTHEAST CORNER OF CONCRETE HEADWALL, LOCATED ON THE SOUTHSIDE OF SHERAM AVENUE
DATUM USGS ELEV
PARKING AREA
UNIVERSITY
AVENUE
ROAD
BOULEVARD
POWER AUTHORITY STATE OF NEW YORK
HOOKER CHEMICALS & PLASTICS CORP.
OW1-78
OW2-78
OW3-78
OW6-78
OW9-78
OW-7-78
OW8-78
OW10-79
OW11-79
OW13-79
OW14-79
OW15-79
OW16-79
OW17-79
OW20-79
OW21-79
OW22-80
OW23-80
600
A
A'
B

TABLE 1

OBSERVATION WELL INSTALLATIONS (1)

HYDE PARK LANDFILL

DATE ? WELL NO.	WELL CASING ELEV.	GROUND ELEVATION (feet)	DEPTH OF INSTALLATION BELOW GROUND (feet)	LOCATION OF INSTALLATION
OW 1-78	596.99	596.2	49.9	Bedrock
OW 2-78	597.19	596.1	25.2	Overburden
OW 3-78	597.77	596.3	34.0	Interface
OW 4-78	596.01	594.5	42.1	Bedrock
OW 5-78	596.29	594.6	29.3	Interface
OW 6-78	596.05	594.6	15.2	Overburden
OW 7-78	613.80	612.5	20.8	Bedrock
OW 8-78	614.08	612.4	7.0	Interface
OW 9-78	610.66	609.2	26.0	Overburden
OW 10-78 (2)	616.66	615.1	29.0	Interface
OW 11-79	626.20	622.2	28.0	Bedrock
OW 13-79	597.94	598.4	36.2	Bedrock
OW 14-79	593.03	598.3	16.0	Interface
OW 15-79	600.26	597.8	20.5	Overburden
OW 16-79	596.03	596.6	51.5	Bedrock
OW 17-79	596.06	596.6	29.5	Interface
OW 18-79	599.14	596.7	85.5	Bedrock
OW 19-79	599.02	596.6	33	Interface
OW 20-79	590.57	587.8	45.4	Bedrock
OW 21-79	590.77	587.6	25.0	Interface
OW 22-80		588.5	43.3	Bedrock
CW 23-80		588.6	23.3	Interface

(1) DATUM = USGS (2) Well Destroyed During Construction

OW 7-78

From	To (Feet)	
0 (609.7 - 605.5)	4	Red-brown dry silty loam with clay traces, no stones
4 (605.5 - 604.9)	4.6	Stiff dry silty clay and crushed grey stone Blowcounts 68/6" 100/1"
4.6 (604.9 - 603.7)	5.8	Weathered bedrock fragments in dark grey coarse sand matrix - no spoon sample
5.8 (603.7 - 601.4)	8.1	Medium grey, coarse grained weathered dolomite, horizontal bedding, fractures and solution voids
8.1 (601.4 - 595.9)	13.6	Light-medium grey, medium grained dolomite fractured, with pores, horizontal bedding
13.6 (595.9 - 591.5)	18	Light grey, medium grained dolomite, horizontal beds, darker horizontal bands with dark specks, fractures
18 (591.5 - 588.9)	20.6	Light grey, coarse-medium grained dolomite, horizontal beds and darker bands, less fractured.

BOREHOLE LOGS AND BLOWCOUNTS

OW 1-78

From	To (Feet)		Description
0 (593.4	1.5 − 591.9)	Blowcounts	Silty sand, some cinders, 3/4" stone medium brown to dark brown clay at spoon tip 4/6" 5/6" 10/6"
1.5 (591.9	5.0 − 588.4)		Medium brown, stiff silty clay till, 1/16" - 1/8" stone, some fill material, glass, cinders etc.
5.0 (588.4	10.0 − 583.4)	Blowcounts	Dark brown to black silty organics, grey clay 3/6" 2/6" 2/6"
10 (583.4	15 − 578.4)	Blowcounts	Light brown silty clay 4/6" 9/6" 10/6"
15 (578.4	20 − 573.4)	Blowcounts	Light brown clay 5/6" 5/6" 6/6"
20 (573.4	25 − 568.4)	Blowcounts	Stiff light brown clay till, some 1/8" stones 4/6" 7/6" 7/6"
25 (568.4	30 − 563.4)	Blowcounts	Stiff reddish-light brown clay till 2/6" 2/6" 4/6"
30 (563.4	30.3 − 563.1)		Light brown dry clay, with bluish-grey rounded stones and crushed rock fragments
30.3 (563.1	30.8 − 562.6)		Light grey dolomite rock
30.8 (562.6	36.5 − 556.9)	Blowcounts	Dark grey shale with stiff clay, washed coarse grey sand and dark grey rock fragments 6/6" 37/6" 81/6" 50/1"
36.5 (556.9	37.9 − 555.5)		Grey, coarse grained dolomite, horizontal bedding planes, fractured with solution voids
37.9 (555.5	38.1 − 555.3)		Clay streak
38.1 (555.3	47.7 − 545.7)		Grey, coarse grained dolomite, horizontal bedding planes, fractured solution voids, dark grey horizontal and oblique streaks, several small clay seams, crystals within solution voids
47.7 (545.7	50.2 − 543.2)		Grey medium grained dolomite, horizontal bedding planes, fractures, solution voids, more porous, many horizontal and oblique thin streaks

OW 13-79 Date Installed - September 17, 18, 19, 1979
Machine - CME 55
Crew - Joe Jensen, Leo Jensen

Soil Log
Depth (feet)

FROM	TO	Sample No.	N	DESCRIPTION
0	1.5	--	--	Stone cover
1.5	3.0	1	5/6/7	Brown and gray silt and fine sand - roots - odorous
4.5	6.0	2	6/10/15	Medium brown silt and fine sand with - traces of clay - gravel - clean
9.5	11.0	3	5/6/6	Medium to reddish brown clayey silt with - black residue - odorous
14.5	16.0	4	5/7/15	Medium brown silt and sand (fine to coarse) - slight odor
16.2	36.2	--	--	Bedrock - dolomite 16.2 - 25 solid 25 - 30 badly pitted Seams 19.0 - 19.1 23.7 - 23.9 25.0 - 25.2 Lost all water 33.0

NOTES:

- The well pulled up 4 feet when the temporary casing was pulled out. The well was driven back down excpet for 18 inches. The well was checked to insure that it was in operating condition after this incident.

- At a drilled depth of 25 feet, the flushing water no longer came to the surface.

- The top of the well was set below ground elevation to eliminate interference with private roadway.

Top of sand - 30.0' below ground surface
Top of bentonite plug - 28.5' below ground surface
Total pipe length installed - 33.9'

OW 9-78

From	To (Feet)		
0 (606.3 -	5 601.3)		Coarse gravel fill and black chemical residue
5 (601.3 -	10 596.3)	Blowcounts	Stiff silty clay and black chemical residue 3/15" 1/3"
10 (596.3 -	15 591.3)	Blowcounts	Soft silty clay, some 1/4" stones, black organic-like residue and light coloured sugar-like crystals 9/6" 5/6" 1/6"
15 (591.3 -	20 586.3)	Blowcounts	Black chemical residue with medium sand, metal barrels 7/6" 31/6" 100/2"
20 (586.3 -	26 580.3	Blowcounts	Black chemical slurry with medium sand 28/6" 75/5"
26 (580.3)			Refusal - probably concrete rubble

OW 10-78 WELL DESTROYED DURING CONSTRUCTION

From	To (Feet)		
0 (612.2 -	5 607.2)		Grey gravel
5 (607.2 -	10 602.2)	Blowcounts	Medium sand with black chemical residue and 1" - 1¼" stones 9/6" 11/6" 23/6"
10 (602.2 -	15 597.2)	Blowcounts	Silty gravel with clay and black chemical traces 2/6" 6/6" 3/6"
15 (597.2 -	20 592.2)	Blowcounts	Sample lost 2/6" 1/6" 1/6"
20 (592.2 -	25 587.2)	Blowcounts	Black medium sand and red-brown clay 9/6" 11/6" 13/6"
25 (587.2 -	29 583.2)		Rock fragments, till
29 (583.2)			Refusal

OW 11-79

Date Installed	- September 10, 11, 12, 13, 1979
Machine	- GME 45C - Augered, Cored, 3 1/2" ream
Crew	- Roger Logel, Pete Pietrzak
Machine	- CME 55 - 6" Ream
Crew	- Joe Jensen, Leo Jensen

Soil Log
Depth (feet)

FROM	TO	Sample No.	N	DESCRIPTION
0	0.1	1	5/11/15	Topsoil
0.1	1.3	1	5/11/15	Fill - Medium brown silt, fine sand and vegetation
1.3	1.5	1	5/11/15	Reddish-brown silty clay (encountered rock at 4 feet - augered through)
1.5	4.9	--	--	Reddish-brown silty clay (encountered rock at 4 feet - augered through)
4.9	5.9	--	--	Rock - cored through
5.9	6.6	2	$30/\frac{100}{0.2}$	Reddish-brown fine sand and silt
6.6	6.8	2	$30/\frac{100}{0.2}$	Medium brown fine sand and silt
6.8	28.0			Bedrock - dolomite - voids encountered from 7.5 to 7.8 10.8 to 11.1 22.4 to 22.6 23.2 to 23.5

NOTES:

- The original auger hole encountered rock at 4.9 feet. In an attempt to get around this, the hole was moved 4 feet to the east. However, the same rock layer was encountered.
- Water was used as the flushing medium druing the coring and reaming operations.
- The flushing water no longer reached the surface after a depth of 11 feet.

Top of sand - 21.0' below ground surface
Top of bentonite plug - 19.5' below ground surface
Total pipe length installed - 32'

15 foot zone, vertical fractures are less frequent but horizontal fractures (bedding planes) are common for the remaining vertical distance to the underlying Rochester Shale about 100 feet below the top of the Lockport Dolomite.

In summary, chemical wastes have been deposited in direct contact with very solutioned and fractured bedrock. The previously existing glacial silt and clay tills were breached during drag line excavations prior to filling with bulk chemicals and drums.

2) <u>GROUND WATER FLOW:</u>

Generally speaking, two ground water flow systems exist at this site. These are

a) Ground Water Flow in Overburden (Soils)

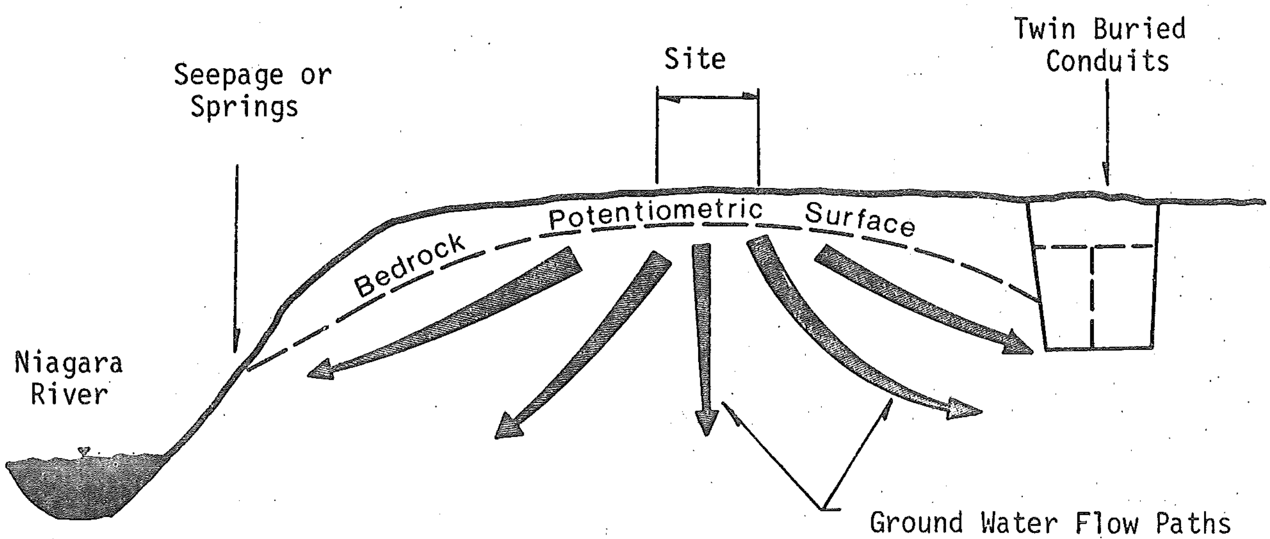
b) Ground Water Flow in Bedrock

The velocity of ground water movement is defined by $v = \frac{ki}{n}$

where
- v = velocity
- k = hydraulic conductivity
- i = gradient
- n = effective porosity

The quantity (Q) of ground water movement is defined by $Q = kiA$ where A is the cross sectional area of flow.

No quantitative analysis of ground water flow was available in the information packet accompanying the agreement. However, preliminary calculations can be carried out once one has a basic understanding of flow directions. According to the agreement, ground water flows to the north west (page 5) towards the Niagara Gorge in the bedrock. No technical data supports this flow direction. In fact, data indicates that the landfill is, in fact, located in a ground water recharge area with flow (in the shallow bedrock zone at least) moving westerly, northerly and easterly away from the site. These radial flow directions are influenced by the Niagara Gorge to the west, the twin buried conduits to the east and the open canal to the north. (See Figure 14, page 54 in Ground Water in the Niagara Falls Area, New York by R.H. Johnston). The location of the landfill has been imposed onto the "Present Condition" of the figure. If a cross section were drawn between the Niagara Gorge, through the site and to the Conduit the following condition would exist.



SCHEMATIC CROSS SECTION SHOWING
GROUND WATER FLOW BETWEEN CONDUITS AND
THE NIAGARA GORGE

Not to Scale

It is apparent that immediately below the site, ground water movement is vertically downwards and radiates both east and west of the site. This is a typical example of a ground water recharge area.

Knowing that the chemicals are deposited directly on top of the bedrock, we can compare the quantity of contaminated ground water moving into the rock to the quantity of contaminated ground water moving into the soil adjacent to the site. To simplify the calculation we will assume that flow takes place through a unit area and that the gradient in the rock and glacial till is the same. (In actual fact the gradient in the rock will be greater by at least one order of magnitude and the total area of flow out the bottom of the 15 acre site is greater than the area of flow through the side walls of the fill around the entire site by a factor of 20.) Thus the

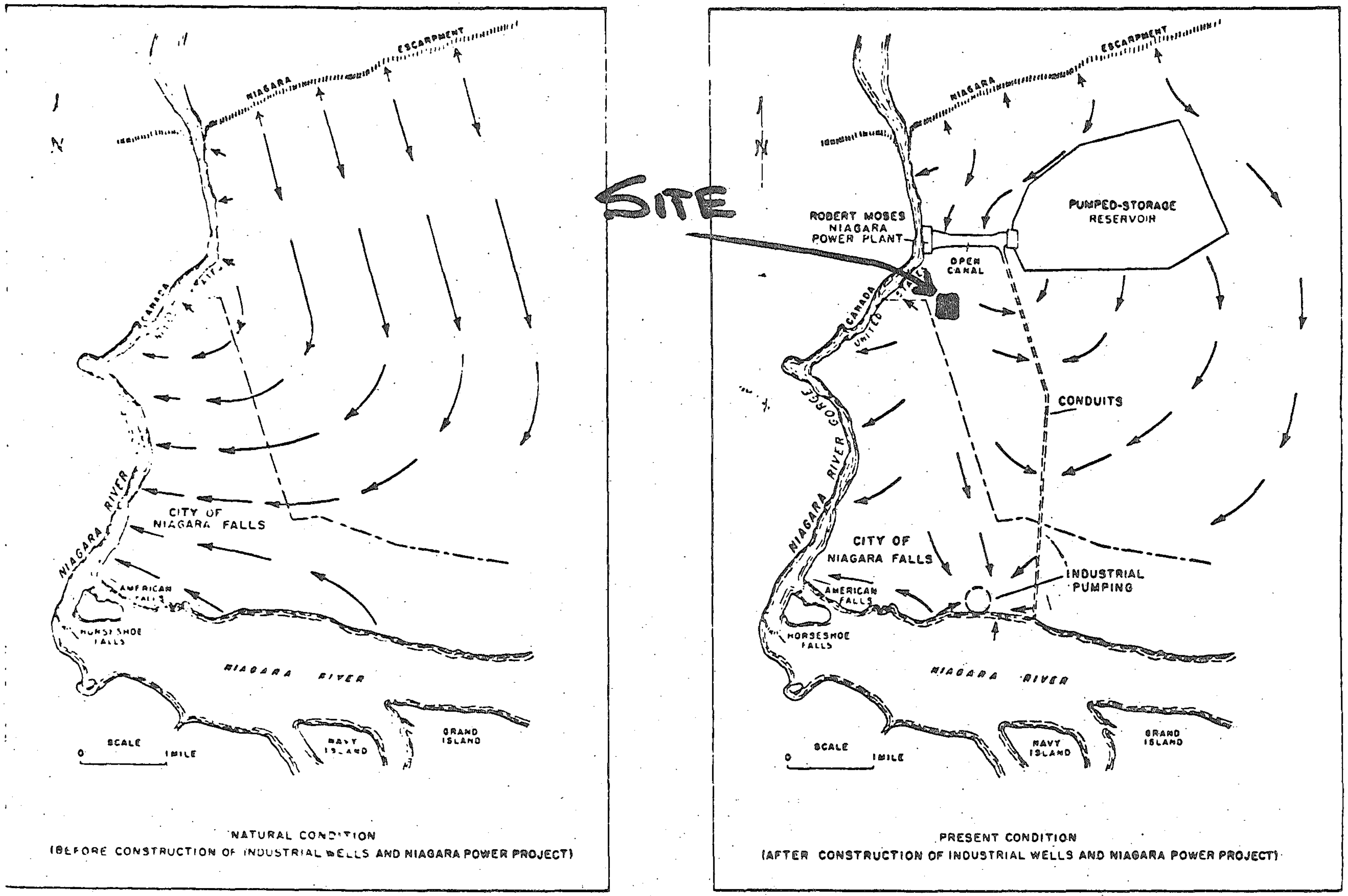


Figure 14.--Inferred direction of ground-water movement in the upper water-bearing zones of the Lockport Dolomite in the vicinity of Niagara Falls.

quantity of flow in the rock compared to the quantity of flow in the soil is proportional to the permeability of the rocks and soil. The permeability of the soil is 10^{-7} cm/sec and the permeability of the rock will be at least 10^{-4} cm/sec. Therefore, at least 1000 times more contaminated ground water would move downwards into the rock than would move into the adjacent soil.

Even if we assume that the permeability of the rock and soil are the same (this is the same as assuming clay till under the site and waste is not in contact with rock) but use the realistic gradient and area data previously bracketed, we calculate that 200 times as much contaminated ground water will move downwards as will move laterally through the soil.

These very basic, but fundamental understandings of ground water movement are of paramount importance in assessing the adequacy of any remedial measures proposed at this site.

In a similar manner some very basic calculations on ground water velocity reveal that the velocity of contaminants in the rock will be about 10,000 times faster than in the soil.

In summary, the chemical wastes are resting on the very permeable Lockport Dolomite bedrock aquifer. Conservative calculations indicate that at least 200 times more leachate will move vertically into the rock than laterally through the soil. Velocity of the contaminants in the rock will be 10,000 times faster than in the soil. Once in the rock, contaminants will move through open bedding planes and vertical fractures that form conduits for movement westerly, easterly, northerly and vertically downwards in the bedrock. These contaminants will eventually reach the Niagara River.

3) COMMENTS ON PROPOSED REMEDIAL ACTIONS:

Any proposed remedial concept has to be based on an understanding of the hydrogeology of the site. We have seen no indication in the background data reviewed by us that such an understanding was utilized to conceive the alternative schemes.

3.1 CAPPING OF DRAINAGE SWALES AND PERIPHERAL AREAS

The proposed capping option generally provides for a study to delineate the extent of contamination in the very shallow (upper 2 foot) soil zone. Capping will only minimize infiltration of precipitation and not totally eliminate it. In addition, capping may isolate the waste, temporarily from direct contact by humans or animals. However, there are a number of fundamental geotechnical problems associated with capping drainage swales and lands adjacent to these swales. These problems are related to the long term integrity of the cap.

As a first consideration, the foundation conditions over which the cap is constructed will be variable. The presence of organic soils (topsoil) is expected in some areas. Since these soils are susceptible to differential frost heaving -- and under compaction of the cap, differential settlements might occur -- there is a good likelihood that heaving and cracking of the cap seal will result. Also, some preparation of the surface by means of excavation will be required, necessitating removal and disposal of contaminated soils.

It is our opinion that capping of swales or creeks without removal of the contaminants will only serve as a very short term measure to isolate wastes from exposure to animals or humans. Capping will not prevent release of contaminants to the Niagara River via the ground water system. In addition, the cap itself will be subject to not only frost heave and settlement problems, but surface erosion of sediments will occur with time. Removal of the wastes and replacement with clean fill is the only reasonable option to ensure that contaminants are not released to the Niagara River.

3.2 CAPPING THE LANDFILL SITE

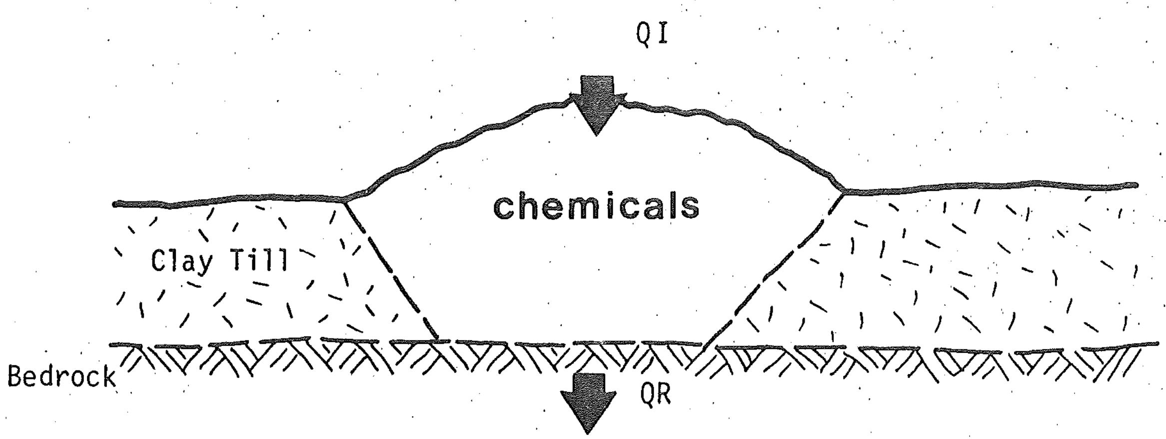
Placing a three foot clay cap on the landfill is again only a short term solution. This cap will not stop the formation of leachate, but only slow down its production and migration through the system. Leachate is formed at sites such as this by the downward percolation of precipitation through the waste. If the amount of precipitation allowed to enter the waste is decreased -- say by a clay cap -- then the leaching action is slowed and the amount of leachate produced is decreased. Thus, it takes longer to completely leach the landfill. This approach to contaminant control is in conflict with the philosophy of leachate collection.

For example, it makes more sense to expedite leaching to get all the contaminants out of the site into the collection system as quickly as possible in order to decrease maintenance time and expense. In contrast, capping at the site will likely result in lower rates of release to the environment. However, the same amount of waste (loading) will ultimately reach the Niagara River. Capping of the wastes will only increase the migration over a longer period of time. As such, capping alone is not an acceptable remedial option since it does not preclude release to the environment. This is of particular importance when considering very stable wastes of this nature that easily accumulate in the environment.

3.3 OVERBURDEN BARRIER SYSTEM

This proposed option consists conceptually of a tile drain located about 10 feet below ground surface around the periphery of the landfill. Normally, such a system is required when leachate springs emanate from the toe of the landfill and discharge to surface waters.

Capping of the landfill is intended to reduce infiltration. If precipitation infiltrates the landfill at a rate less than the ground water outflow through the bottom, then leachate will not mound and come to ground surface. Thus, there would be no need for a toe drain overburden leachate collection system. It is a simple fundamental calculation required to determine this need. The diagram below illustrates the basic components of the calculations.



SCHEMATIC OF WATER BUDGET THROUGH WASTE

If QI > QR leachate mounds and comes to surface

QI - the quantity of precipitation infiltration can be determined from the rule of thumb used by hydrogeologists. That is 12 inches of infiltration on the average over a year would equate to about 1/2 imperial gallon per minute (IGPM) per acre of fill on the average. Capping should reduce infiltration to less than 6" of precipitation or about 0.25 IGPM per acre.

QR the potential quantity of leachate outflow through the bottom of the fill into the bedrock can be calculated using the formula

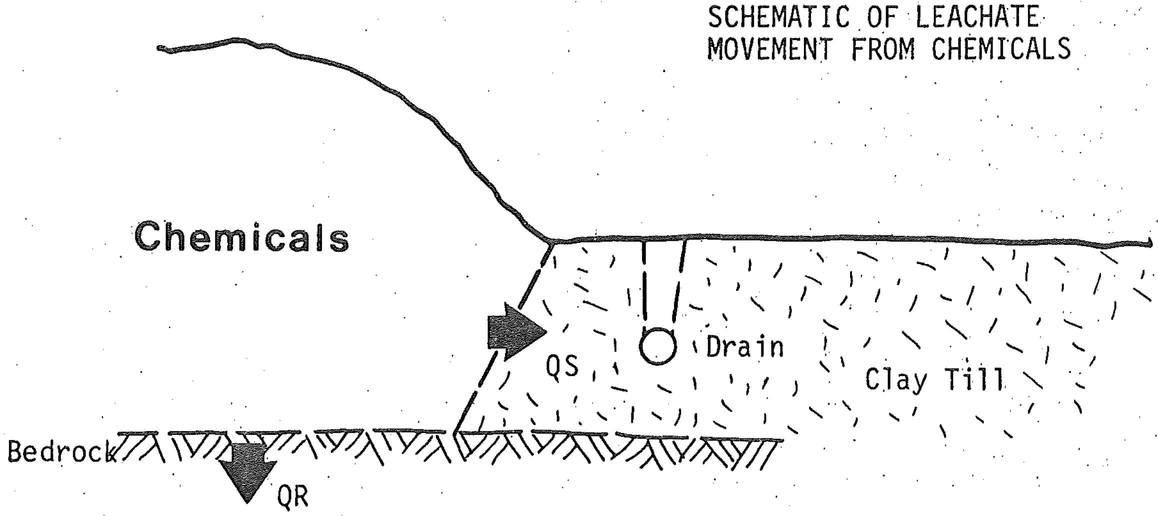
$$QR = kiA \quad \text{where } k = 10^{-4} \text{ cm/sec}$$
$$i = 0.5 \text{ (recharge gradient)}$$
$$A = 43{,}560 \text{ sq. ft. (1 acre)}$$

changing the units and substituting into the equation, QR = 106 IGPM/acre. It is obvious that the potential leachate outflow will exceed the potential precipitation inflow by a factor of 400 times.

Based on this analysis we can only conclude that the overburden barrier system will not be functional in collecting the most significant component of leachate movement away from this site. It is of paramount importance that the contaminants leaving the bottom of the site be collected as the primary line of defence to ensure that dioxin is not released to the environment.

This point can be further emphasized when one considers the fact that the proposed overburden barrier drain is located within natural clay soils outside the fill (see sketch below and Figure 7 in the agreement).

SCHEMATIC OF LEACHATE MOVEMENT FROM CHEMICALS



Calculations given in Section 2 of this brief indicate that outflow to the bedrock QR is a minimum of 1000 times greater than flow through the soils (QS). This uses a permeability in the soil of 10^{-7} cm/sec and some simplifying assumptions concerning gradients that give all benefit of doubt to the proponent (Hooker Chemical). In actual fact using realistic gradients it can be shown that outflow through the rock could be as much as 200,000 times greater than flow through the clay till.

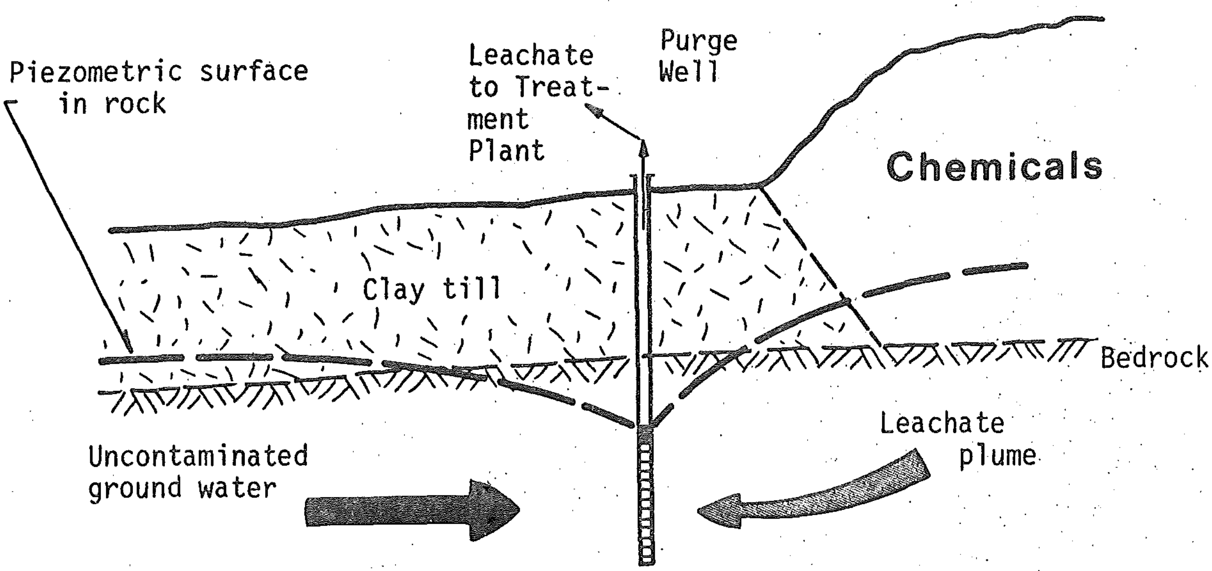
It could be argued that the clay is very fractured and 10^{-7} cm/sec is an unreasonable permeability to use in the equations. If we use a permeability for fracture flow of 10^{-4} cm/sec outflow in the rock would still exceed flow to the drain in the overburden by a factor of 200.

It is obvious that the overburden barrier drain system will not prevent the most significant release of contaminants to the environment and that outflow of chemicals to the bedrock is the most critical aspect of contamination requiring remedial action at this site.

3.4 BEDROCK BARRIER COLLECTION SYSTEM

The proposed bedrock barrier collection system consists of about 11 wells drilled into the Lockport Dolomite along the west end of the chemical fill. The proposed locations are obviously based on a wrong assumption of the ground water flow direction as evidenced on Figure 11 of the agreement and discussed in detail in Section 2 of this Brief. This would mean that wells would have to be similarly spaced along the north and east sides of the fill, ultimately requiring a total of about 30 wells.

However, an examination of this concept should and can be made now based on existing data, prior to ratifying the agreement. An understanding of this proposed concept is very important and the following diagram illustrates the essential components of the system that make it work.



SCHEMATIC OF GROUND WATER AND LEACHATE FLOW TO A PURGE WELL

The purge well serves two primary functions. It removes leachate from the bedrock and it creates a hydraulic trap such that leachate cannot flow past the well.

To determine if such a system is feasible, even to consider as a concept, some basic calculations can be made. It is critical to understand the quantity of diluted leachate that will require collection, handling and treatment.

To create the hydraulic trap, all water must flow to the wells that are within the potential contaminant plume. A parameter frequently used to describe an aquifer's capability to yield water is its specific capacity. This is defined as yield per unit drawdown and expressed as gallons per minute per foot of drawdown. A reasonable specific capacity for an operating system in the Lockport Dolomite is 0.3 gpm/foot of drawdown for each well. If a 5 foot drawdown is required to insure a hydraulic trap between all wells, then each well would have to pump continuously at about 1.5 gpm. If 30 wells are utilized then the total continuous production of leachate requiring treatment would be 45 gpm or about 65,000 gallons per day. This would fill a 1/4 acre pond that is 5 feet deep every 4 days.

There is an inference in the agreement that leads us to believe that such a system may have to be operated only for a short period of time. For example in Addendum III - Maintenance Program paragraph F of the agreement indicates that any of the barrier systems can be terminated if "a) over a period of four consecutive years no specific chemical parameter listed in paragraph F of Addendum III has been detected at more than 10 ug/L in liquids collected by such system or component thereof."

These criteria may very easily be met on the basis of dilution alone in the purge well system when one considers that leachate production at the landfill is likely only 1/10 of the total volume of water collected (at the most) by the purge well system. These criteria are absolutely absurd at a site of this nature when one considers the basic simple alternative of monitoring the quality of the leachate plume between the waste and the purge well. This leads us to believe that this agreement is based on a very poor understanding of the fundamental hydrogeologic setting of this site.

We must reiterate that as long as the chemicals are present at this location, they will slowly percolate to the water table and migrate. If a purge well system is used, considerable dilute quantities of leachate (65,000 gallons per day) will have to be collected, transported and treated forever. We cannot emphasize enough that the words forever or in perpetuity mean just that. There are no short term solutions by leaving the wastes at this location and it is only naive and totally unreasonable to have an agreement that considers a short term (35 years) maintenance as an option. This site if left in place will require management in perpetuity.

4) CONCLUSIONS:

Based on our review of all available data in addition to the agreement and subsequent comments the following conclusions are made.

1. The Hyde Park Landfill contains large quantities of organic chemicals that are among the most toxic of all man-made compounds.

2. These chemicals have been deposited directly on top of the Lockport Dolomite bedrock in excavations draglined through glacial clay till soils.

3. The Lockport Dolomite is fractured, solutioned and generally a very permeable rock formation that transmits large quantities of water very quickly through it. Movement is through openings (both vertical and horizontal) that are reported by Conestoga Rovers to be as much as 0.3 feet wide. The areal extent of these openings is reported to be in terms of 3 or 4 miles.

4. The chemical dump is located over a ground water recharge area. As such ground water potential gradients are vertically down below the site into the bedrock and subsequently radiate outwards westerly, northerly and easterly from the site.

5. The quantity of leachate that can potentially move down into the rock is 200,000 times greater than outflow into the soil at a maximum worst case scenario. Giving all benefit of the doubt, the potential quantity of outflow into the rocks could be as low as 200 times greater than outflow through the clay soil side walls of the fill. This illustrates the need to place priority on protecting the bedrock aquifer as the primary remedial measure at this location.

6. Ground water velocities in the bedrock are about 10,000 times faster than in the glacial till soils.

7. Contamination of sediments adjacent to the site appears to be caused by the direct runoff of chemicals from the site onto the adjacent lands and subsequent infiltration and not by sub-surface movement of contaminants through the soil for the main part. Capping of these contaminated soils is considered only a short term measure to prevent infiltration of precipitation and isolation from the human environment. Structural failures (cracking and differential heaving) are inevitable with subsequent release of contaminants to the environment.

8. Capping of the chemicals with clay is again only an interim measure which will minimize infiltration of precipitation and thus leaching of chemicals from the wastes. Considering the very stable nature of these chemicals and their ability to bio-accumulate in the environment, they will still pose a very serious threat to the environment over a very long period of time. Capping alone will not prevent release of chemicals to the environment.

9. The proposed overburden barrier system, which is the only system that is described as a definite requirement in the agreement, does not appear to serve any useful function when one considers point (5) of these conclusions. The agreement is lacking in foresight in this particular area as it is obvious now that emphasis must be placed on protecting the rock.

10. Once organic chemicals enter the rock they can migrate quickly for miles unattenuated. This stems from the fact that water is moving in open cavities much the same as water moves through a pipe.

11. A purge well system concept proposed is ill conceived on the basis of a misinterpretation of the ground water flow system. About 3 times as many wells would be required to achieve the goal of hydraulic trap and total leachate collection. Over 60,000 gallons per day of leachate contaminated ground water would require treatment.

12. The agreement suggests that there is a possibility of only operating this purge well system for a short term on the basis of monitoring the outflow from the system and then stopping once certain criteria are met. (Section 3.4). This reflects a basic misunderstanding of the hydrogeologic aspects of such a system again shedding considerable doubt on whether all parties to the agreement have a basic understanding of the fundamental hydrogeologic setting.

13. The agreement indicates that a maintenance period of only 35 years may be required. In our opinion, given the nature of the wastes and the site setting, this is naive and perpetual care will be required.

14. Given the requirement to handle over 60,000 gallons of dilute leachate daily <u>in perpetuity</u>, we are of the opinion that removal of all the contaminated soil and chemical wastes for safe disposal at a properly designed site or destruction where feasible is the only reasonable option available to all parties.

ADDENDUM LETTER

JUNE 18, 1981

Gartner Lee Associates Limited

Consulting Engineering Geologists and Hydrogeologists

Toronto-Buttonville Airport ■ Markham, Ontario ■ L3P 3J9 ■ 416-297-4600

June 18, 1981.

Environment Canada,
Ontario Region,
55 St. Clair Avenue, East,
Toronto, Ontario.
M4T 1M2

Attention: Dr. R. W. Slater,
Regional Director General

Dear Sir:

Re: Addendum to Hydrogeological Review of Hyde Park Landfill, June 17, 1981

Subsequent to issuing the above noted report-brief we received what appeared to be the appendix of a hydrogeological report prepared by Conestoga Rovers in the spring of 1980. We are somewhat horrified that the U.S. Attorney General's office does not have the report that accompanies this appendix as it is likely the most pertinent document used in negotiating the agreement from a hydrogeological point of view. Not having the report, we have evaluated the appendix in light of our brief and offer the following further comments.

1) There was nothing in this appendix that would change any of the interpretations, calculations or conclusions outlined in the brief.

2) The technical data contained in the appendix confirms our calculations and indicates that we have been very conservative in our calculations and indeed have given reasonable benefit of the doubt to Hooker Chemical wherever practicable.

3) Chemical analysis of water samples taken from the bedrock confirm that this site is in a ground water recharge area

continued ..

with ground water trying to move downwards. This is proved positively by vertical gradients downwards of .57 in the data provided in the Appendix. Considerable effort is expended in the agreement around whether it will be necessary to collect contaminated ground water in the bedrock from the upper 15 foot zone or deeper. You need only consider the chemistry of the ground water taken from O.W.18-79. This well is about 500 feet west of the site and the well screen is about 50 feet below the rock surface. The chemistry is as follows:

Chlorides (ppm)	190
Phenol (ppb)	14,000
Chloroform (ppb)	1,000
Trichloroethylene (ppb)	500
Tetrachloroethylene (ppb)	900
Benzene (ppb)	270
Chlorobenzene (ppb)	1,200
Ethyl benzene (ppb)	370
Toluene (ppb)	3,200

Surely, it is clear that this zone in the bedrock, 50 feet below the bedrock surface, is extremely contaminated now. This data clearly indicates that all parties to the agreement are not fully aware of the facts as they stand at this time, otherwise there would be no dissertations concerning the "if" question and the "how" could have been dealt with more directly.

Although there are numerous technical concerns that we have regarding both the agreement and the supporting technical data, our severe time constraints will not permit us to itemize and discuss them at this time. We have chosen to try and put into perspective the key factors that must be considered prior to making a decision on the agreement. Apart from all of the complex technical issues some very simple facts remain. These are:

a) There are very toxic organic chemicals disposed in direct contact with a very permeable bedrock aquifer. This aquifer has already started to receive these

continued ..

chemicals at least 50 feet below the rock surface 500 feet away from the chemical dump.

b) These chemicals will be removed from the dump in one of two ways; either by slowly leaching out over the next, literally, thousands of years or by physically removing the entire dump. There are no other alternatives to consider in this case.

c) If it is decided to let them leach out over the next thousands of years, the chemicals will definitely reach the Niagara River unless intercepted by a purge well system. Thus, very large quantities of dilute leachate would have to be treated forever.

d) No matter which of the two alternatives noted in (b) are chosen, the end result has to be the same. The chemicals have to be removed from this environment. You can either get them by removing 15 acres of concentrated wastes which could be done in a few years or you can pump, store, handle and treat 15 acres of dilute leachate 5 feet deep every 240 days for thousands of years. These are the only choices available.

Having reviewed the agreement and supporting technical data we are of the opinion that it does not seriously consider either of these options and as such should <u>not</u> be ratified.

Respectfully submitted,

GARTNER LEE ASSOCIATES LIMITED

John J Gardner

for E. Grant Anderson, P.Eng.
Consulting Hydrogeologist.
Principal.

EGA:jcm

Exhibit "C"

List of Materials Reviewed by Grant Anderson

1. Federal Complaint in U.S. vs. Hooker et al. Civil No. 79-989 (Hyde Park Landfill).

2. Proposed Settlement Agreement, Stipulation and Judgement Approving Settlement Agreement.

3. Comments on Proposed Settlement Agreement.

4. Response to Public Comments On the Stipulation and Judgement Approving Settlement Agreement.

5. Excerpts from Mead Report by Fred C. Hart and Company
11. Hyde Park Dump pp 40-69

6. Sampling locations, Health Effects, Environmental Effects, Management Status, Hyde Park Chemical Landfill, Oct. 17, 1978, Toxic Substances Coordinating Unit pp. 3 - 5, reference: Mr. Charles Goddard, Div. of Solid Waste Management, N.Y. State Dept. of Envir. Cons., 50 Wolf Rd., Albany, N.Y. 12233, Ph. AC 518-457-6605.

7. Hyde Park Chemical Landfill, Niagara Falls, New York, Information Dossier 78.13, October 17, 1978, Toxic Substances Coordinating Unit, Division of Pure Waters, New York State Department of Environmental Conservation, 50 Wolf Road, Albany, N.Y. 12233.

8. Hyde Park, Hydroscience (Report HK 180)

9. Letter and Analyses
   From:John C. Mahon, P.E., Regional Engineer, Water/Solid Waste Program
   To: Mr. Thomas Johnston, Hooker Chemical and Plastics Corp., 345 Third Street, Box 728, Niagara Falls, N.Y. 14320

10. Memorandum from NY State Dept. of Environ. Conservation To Mr. Beecher From Paul Foersch, Feb. 6, 1979.

11. Sheet entitled Issues in Responses that Must be Answered.

12. Hooker Chemicals and Plastics Corporation, Hyde Park Landfill, Form N45 s/80, Letter to Mr. John Judy, July 30, 1971 from Ernest R. Gedeon, Exhibit "A" Letter to John Judy, Re: Unsatisfactory Operation of Hooker Disposal Site, Town of Niagara.

13. Assorted Newspaper Clippings.

14. Letter of Oct. 24, 1979, Re: Information Submittal Regarding TCDD Contamination of Soils in Drainage near the Hyde Park Landfill. To Chief, Office of Toxic Substances, Region II, USEPA Edison, N.J. 08817.

15. Letter and Analyses from John C. Mahon to Mrs. Joan E. Gipp, Councilwomen, Nov. 2, 1979.

16. Letter to Mr. Raymond Tyson, Niagara Gazette from John R. Komansky, H.E.W, Jan 7, 1980 TA 79.22.

16. Niagara Frontier, Inactive Waste Disposal Sites, Hyde Park Landfill, Bloody Run, 102nd Street Landfill, "S" Area Landfill, Site Condition and Proposed Remedial Action, Feb. 6, 1980, Prepared by Frank D. Neruda, U.P., Special Environmental Programs,

17. United Steelworker of America, Letter of March 19, 1979 to Anthony Ruhlwin, M.D., from Michael J. Wright, M.S. and Christine Oliver, M.D., M.P.H.

18. Memo to Rae Tyson from Jim Green, Oct. 12, 1979; letter to Mr. James Green from Rae Tyson, October 10, 1979, Hooker Chemical News Release.

19. Letter to Patrick J. Berrigan from Philip J. Landrigan, HEW, Sept. 13, 1979.

20. Telex from Rae Tyson.

21. Memorandum, Nov. 4, 1955, J. Wilkenfold, Study of Residue Disposal System, marked Confidential.

22. Niagara Frontier Inactive Waste Disposal Sites, Hyde Park/ Bloody Run, S-Area and 10snd St., Site Condition and Proposed Remedial Measure, Feb. 6, 1980, Francis D. Neruda.

23. Town of Niagara ledger, p. 21, 1955 date put in ledger.

24. Site Study, Bloody Run, Jan 1979, 978-538 by Conestoga-Rover & Assoc.

25. Letter to Mrs. Joan E. Gipp re: Roosevelt Drive - Hyde Park Development - Lewiston (T), Nov. 2, 1979.

26. Letter to F.T. Olotka from Frank Echelberger, Subject: Air Sampling - Hyde Park Landfill, Sept. 25, 2979.

27. Niagara County Health Department Memorandum, July 10, 1979 To Mr. Stand Gubner from Mr. George Amery.

28. Application for Treatment or Disposal of an Industrial or Hazardous Waste Stream, Hooker Specialty Chemicals, Sept. 10, 1979.

29. Niagara County Health Dept. Memorandum, May 17, 1979 to Robert Armbrent from Ernest R. Gedeon Re: Application for Certificate to Operate Source at Hooker Chemical Co.

30. Letter to Robert Armbrent from G.M. Dworzanski, Aug. 29, 1979.

31. Certified Letter, Oct. 24, 1979, From P.O. Nees to Chief, Office of Toxic Substances. Also Copy Stamped "Received Oct. 26."

32. State of NY Conservation Report, Water Resource Comm., Ground Water in the Niagara Falls NY. Area with Emphasis on the Water Being Characteristic with the Bedrock by Richard H. Johnston.

33. Various Chemical Analyses, Appendix A., Stratigraphic Logi and Comments, Soil Sampling Stations in Bloody Run and North of Hyde Park Landfill.

34. Table 4, Hyde Park 2nd Phase Organic, Date Sampled Jan 26, 1979.

35. Appendix B, Priority Pollutant Analysis of Soil Samples Collected for Bloody Run and Niagara Gorge.

36. New York State Dept. of Health, Results of Examination.

37. State of New York Dept. of Health, Memorandum, Sept. 15, 1978, To Dr. Leo Hetling from Dr. Art Richards.

UNITED STATES DISTRICT COURT
WESTERN DISTRICT OF NEW YORK

UNITED STATES OF AMERICA,
THE STATE OF NEW YORK,

Plaintiffs,

- vs - Civil Action No: 79-989

HOOKER CHEMICALS & PLASTICS CORP.; OXY CHEMICAL CORPORATION; HOOKER CHEMICAL CORPORATION; OCCIDENTAL PETROLEUM INVESTMENT CO.; OCCIDENTAL PETROLEUM CORPORATION; THE TOWN OF LEWISTON; THE TOWN OF NIAGARA; (Hyde Park Landfill),

Defendants.

AFFIDAVIT

I, DOUGLAS J. HALLETT, a resident of the Township of West Carleton, Province of Ontario, make oath and say as follows:

1. I have been employed by Environment Canada for 6.5 years, presently I am the Senior Adviser, Scientific Programs, Federal Department of the Environment, Ontario Region and a Research Scientist with the Canadian Wildlife Service, Federal Department of the Environment. My research responsibilities include investigating previously unknown contaminants in the Great Lakes Food chain. Presently I am Chairman of the Federal Interagency Committee on TCDD and other chlorinated dioxins and furans and have been a member of various International Joint Commission Great Lakes Water Quality Board Committees on environmental contaminants for over 5 years. I have published over 37 scientific papers on environmental contaminants analysis, toxicology, and environmental significance and made over 75 presentations at scientific conferences and synposia on environmental contaminants matters. (See curriculum vitae annexed hereto as Exhibit "A" and made a part hereof.)

2. This affidavit was prepared in response to the request of Pollution Probe and the Canadian Environmental Law Association for my professional evaluation of certain scientific and technological aspects of the settlement proposed for the Hyde Park landfill site by the Parties (Civil Action No: 79-989). I am making this affidavit in my professional capacity and not as a representative or employee of the Canadian government. However, this affidavit is made with the full knowledge and permission of the Department of Environment.

3. I have reviewed the January 19, 1981 Stipulation and Judgement of this Court Approving Settlement Agreement, the April 3, 1981 Government response filed in this Court to Public Comments on the Stipulation and Judgement Approving

Settlement Agreement, the comments of the Ecumenical Task Force, the original complaint filed by the Environmental Protection Agency, all filed in this Court, and other relevant data in coming to my conclusions.

4. In December 1980 a report of my research concerning the discovery of 2,3,7,8 tetrachlorodibenzo-para-dioxin (hereafter referred to as "TCDD") in Great Lakes resident fish eating birds (Herring Gulls) was released by the Canadian Department of Environment and reported through the Department of External Affairs to the U.S. Department of State. (Appended as Exhibit B and attached hereto).

5. Only 2,3,7,8 - TCDD was found of a possible 22 tetrachlorodioxins.

6. In 1980 concentrations of TCDD ranged from 43 to 86 ppt (parts per trillion fresh weight Herring Gull tissue) in Saginaw Bay Herring Gull colonies, from 44 to 68 ppt in Lake Ontario colonies, and from 9 to 14 ppt in colonies on the other Great Lakes.

7. Levels of TCDD in archived Lake Ontario Herring Gull eggs collected in 1971-72 ranged from 800 to 1200 ppt. TCDD concentrations declined at a constant rate in Lake Ontario Herring Gull eggs collected from 1974 to 1980 falling 10 times in concentration from 502 ppt to 68 ppt.

8. It was concluded from this study that the two areas where TCDD levels were elevated (i.e. Saginaw Bay and Lake Ontario) were closely associated with the past production and disposal of 2,4,5 - trichlorophenol wastes. Although many chlorinated dioxins similar in structure to TCDD are created in chemical processes such as the low temperature (less than 700°C) incineration of industrial waste and municipal garbage

the specific compound 2,3,7,8 TCDD is a characteristic undesirable by-product in only one industrial process, the production of 2,4,5 - trichlorophenol from 1,2,4,5 - tetrachlorobenzene.

9. Hooker Chemicals and Plastics Corporation at Niagara Falls, N.Y. (hereafter referred to as Hooker) was the only known major producer of 2,4,5 - trichlorophenol in the Lake Ontario Basin area. (U.S. EPA report 600/2-80-197, 1980).

10. The decline of TCDD observed in Lake Ontario Herring Gulls starting in 1974, coincides with the cessation of 2,4,5 - trichlorophenol production by Hooker in 1974.

11. TCDD levels have been reported to be detectable (over 5 ppt) in some species of Lake Ontario fish collected in 1980. In July 1981, enough data will be available to assess whether or not Lake Ontario fish contain levels of TCDD at levels high enough to be considered a health hazard.

12. TCDD, mirex, and α and B-BHC's (lindane derivatives) are all present in the Hyde Park landfill site as well as chlorobenzenes, chlorotoluenes, and thiodan or endosulfan. Residues of all of these compounds have been found in the Lake Ontario ecosystem.

13. Mirex, and BHC's along with TCDD are of particular environmental concern because of their ability to bio-concentrate in aquatic food chains. These compounds concentrate in the fat or lipid of algae, increasing in concentration in fish eating algae, and further increasing in fish eating fish. Large carnivorous fish and Herring Gulls represent the top of the Lake Ontario food chain and have

bioaccumulated some of the highest concentrations of these compounds found anywhere. Humans are also ultimately at the top of this food chain and bioaccumulate these residues after consumption of contaminated water or fish.

14. TCDD and mirex residues in Lake Ontario can be traced directly to the manufacturing and disposal activities of Hooker as the major source of entry into Lake Ontario.

15. Mirex is known to have been manufactured in the Great Lakes Basin area only by Hooker at Niagara Falls, N.Y. The only other source in the Lake Ontario area, considered to be relatively minor, has been traced to a deposit of mirex in the Oswego River at Armstrong Cork Company. This company purchased a quantity of mirex, but did not use the substance in its products.

16. TCDD might appear to be a very minor residue in the Hyde Park landfill sites. It is present in the 3300 reported tons of "still bottoms" from the 2,4,5 - trichlorophenol production (pg. 9, Summons and Complaint for Injunctive Relief).

17. However, TCDD in my opinion is the chemical of greatest concern in this landfill because it is much more toxic than any of the other chemicals of concern in this dump site. TCDD is 100,000 to 1,000,000 times more acutely toxic than mirex or the BHC - lindane derivatives.

18. TCDD, mirex and α and B-BHC's are all known mammalian carcinogens (cancer-causing agents (IARC, 1974)). However, while recognizing that the other contaminants are also present in the Hyde Park landfill are hazardous, TCDD in my opinion deserves primary attention.

19. TCDD is a known mammalian carcinogen (Kociba, R.J., Keyes, D.G., Beyer, J.E., Carreon, R.M., Wade, C.F., Dittenber, D.A., Laknins, R.P. Frauson, L.E., Park, C.N., Barnard, S.D., Hummel, R.A., and Hamiston, C.G. Toxicol Appl. Pharmacology. Vol. 46., pg 279-303, 1978),a teratogen (causes birth defects) (Courtney K.D. and Moore, A., Toxicol. Appl. Pharmacology. Vol. 20., pg 396-403, 1971), and a weak mutagen (Wassom, J.S., Hugg, J.E., and Loprieno, N. Mutation Research. Vol. 47., pg. 141-160, 1977/1978).

20. It has the highest acute toxicity of any industrial contaminant produced having an acute lethal dose which kills 50% of all animals exposed ranging from 600 ppt in guinea pigs and 70,000 ppt in rhesus monkeys.

21. On feeding first generation rats at rates as low as 10 ppt TCDD per day chronic reproductive effects including decreased litter size, increased numbers of stillbirths, and altered growth occurred in the second and third generation rats produced sequentially from the first generation which were dosed of the 10 ppt/day rate for 90 days. Chronic toxicity due to low dosage exposure to these compounds over periods as long as 30 to 40 years, or during key periods of development in children or neonates is the primary toxicological concern.

22. Prior to the decline of TCDD and mirex residues in Lake Ontario Herring Gulls (which exactly parallel each other and coincide with the cessation of production of these substances by Hooker Chemical Co.), these birds were experiencing reproduction rates 80-83% below normal.

23. Toxicological symptoms of organochlorine poisoning caused by these two potent chemicals and/or others such as chlorinated benzenes and certain PCB isomers were also observed. These include porphyria (a liver disease specifically caused by organochlorines) chick edema disease, and teratogenic effects (birth defects) such as cross bills in gull chicks.

24. Other resident fish-eating bird species had become absent entirely from the Lake Ontario area. These species exhibited greater sensitivity to organochlorine contaminants than Herring Gulls and could not reproduce at all.

25. Contrary to argument that TCDD is insoluble in water and will not move in underground aquifers or aboveground streams, TCDD is soluble in water at concentrations of 0.20 ug/L to 0.60 ug/L or 200 to 600 parts per billion. (Isensee, A.R. and G.E. Jones. Environ. Science and Technology, Vol. 9., pg. 688 to 672, 1975.) Therefore, TCDD is sufficiently soluble in water that significant amounts can be mobilized in ground water and surface water. Evidence for this phenomenon is visible where TCDD has been mobilized to the extent that concentrations reach as high as 200,000 ppt in Bloody Run Creek sediments. Water from Bloody Run Creek which has been and continues to be contaminated with TCDD has reached the Niagara River and Lake Ontario.

26. None of the estimates of the toxic effects of TCDD take into account that TCDD may potentiate the toxic effects of other contaminants present in the site which are leaching as well. (TCDD has been shown to promote the formation of tumors in animals previously exposed to carcinogens (Pitot, H.C., T. Goldsworthy, H.A. Campbell, and A. Poland. Cancer Research, Vol. 40, pg 3616 to 3620, 1980). None of the estimates of toxic effects of the chemicals in the landfill site, particularly TCDD and mirex, take into account that these chemicals might have synergistic effects with other environmental contaminants present in the Niagara River or Lake Ontario ecosystem.

27. TCDD is readily soluble in the basic toluenes, and lesser chlorinated benzenes known to be present in the Hyde Park landfill site. The mixture of TCDD with these chemicals will enhance its solubility in water and therefore enhance its mobilization in aquifers, and surface water.

28. Hyde Park is the largest known deposit of these "trichlorophenol still bottoms" in the world, a reported 3,300 tons (Summons and Complaint for Injunctive Relief pg.9). TCDD is present as an undesirable contaminant in the production of 2,4, 5 - trichlorophenol from 1,2,4,5, tetrachlorobenzene. TCDD is removed or "cleaned" from the product prior to the subsequent use of trichlorophenol for the manufacture of herbicides such as 2,4,5 - T or disinfectants such as hexachlorophene. This is accomplished by stirring the trichlorophenol reaction mixture with organic solvents such as toluene which are then decanted and subseqently distilled leaving a residue of "still bottoms" containing extremely high concentrations of TCDD.

29. Such "still bottoms" have been estimated to contain as low as 40 ppm (parts per million) of TCDD (Vertac Inc., Jacksonville, Arkansas USEPA 600/2-80-197, 1980) and as high as 400 ppm TCDD (T. Whiteside, The New Yorker Magazine, 1979).

30. The Hyde Park landfill therefore contains an estimated minimum deposit of 3,300 tons X 40 ppm = more than 264 lbs of pure TCDD. In my view the more realistic estimates range about 2,000 lbs (T. Whiteside, The New Yorker Magazine, 1976).

31. The total amount of mirex calculated to be present in Lake Ontario today including all sediments, the water column, fish and biota is only 2,000 to 3,000 kg. (R. Thomas. International Association of Great Lakes Research, 1981, NYS 1978, PLURAG 1978). Mirex and TCDD bioaccumulate from water into fish and Herring Gulls at roughly the same rate (approximately 10,000 times). The relative concentrations of TCDD are approximately 100,000 times lower in fish and Herring Gulls in Lake Ontario than mirex levels. Therefore, the estimated total amount of TCDD that has entered Lake Ontario to date is only between 30 to 300 grams or roughly between 1 ounce and 1 pound of TCDD.

32. This small amount of TCDD has resulted in bioaccumulation of levels as high as 1200 ppt in 1972 Lake Ontario Herring Gulls.

33. With present technology it is just barely possible to routinely measure raw water and drinking water for the presence of macro contaminants such as mirex and PCBs in Lake Ontario at concentrations of 1 ppt. Using a conservative bioconcentration factor of 10,000 to 100,000 for TCDD from water to Lake Ontario fish and gulls (presently at 20 to 50 ppt) one can estimate a present Lake Ontario water concentration of 1×10^{-4} to 1×10^{-5} ppt. It is impossible to measure TCDD (or determine the direct biological effects) of such concentrations at this time. However, that is not to say that because we cannot measure the presence of TCDD at this time in water does not mean that it does not pose a hazard at this time. Extrapolations of measurable concentrations in biota such as Herring Gulls and fish will provide our best available estimates of water concentrations for some time to come.

34. Of utmost concern is that if one shovel full (3 lbs or 1200 grams) of the 3,300 tons of "trichlorophenol still bottoms" containing TCDD were mobilized into the Niagara River over as short a period as 6 months, the levels of TCDD in the water column and biota of Lake Ontario would likely be elevated between 10 and 100 times the present levels. Levels in Herring Gulls would likely surpass the 1972 record of 1200 ppt and reproduction would begin to fail as it did in the past. It is presently uncertain whether existing levels of TCDD in Lake Ontario fish are safe for human consumption.

35. Bearing in mind the extreme danger presented by the migration of these chemicals from this site, what can be done with the existing landfill?

36. First and foremost, the TCDD in this site is, in my opinion the most potent toxin present. Relative to the proposed settlement, in determining the extent of migration of TCDD deposited in the Hyde Park site by probing for traces, the presence of TCDD cannot be predicted by analysing for a surrogate chemical such as trichlorophenol or hexachlorobenzene. The ratio of TCDD to trichlorophenol or hexachlorobenzene in the still bottom wastes is unknown. Trichlorophenol is far more soluble in water and will be mobilized in water at a much higher rate, is far less toxic than TCDD, and is known to have entirely different properties than TCDD in soils, and aqueous ecosystems.

37. Therefore, the absence or presence of trichlorophenol or hexachlorobenzene in these probes will not in any way accurately reflect the presence or absence of TCDD. TCDD is of utmost concern and should be analysed as TCDD.

38. The landfill site will remain extremely hazardous far longer than the 35 years indicated in the present agreement and may survive as a threat to the environment indefinitely if left untreated. There are no distinct microbial degradation routes known for either mirex or TCDD. Nor would these chemicals be subject to ulta violet irradiation (sunlight) or sufficient heat to break them down into less toxic forms while they are buried in the landfill site.

39. The bulk of the chemicals at Hyde Park, if not removed, will persist indefinitely with the exception of a small percentage that may continue to leach into the Niagara River if the site is not properly contained.

40. The chemicals in this site, particularly TCDD, must be regarded in the long-term as extremely hazardous. In addition to being extremely toxic, TCDD is also a carcinogen a teratogen and a weak mutagen. Mirex and α- and B-BHC are also animal carcinogens. Carcinogenicity, teratogencity and mutagenicity are also the properties of concern for human exposure to radionuclides (BEIR, The Advisory Committee on the Biological Effects of Ionizing Radiation, "The Effects of Populations of Exposure to Low Levels of Ionizing Radiation" National Academy of Sciences, National Research Council Washington, D.C., 1972) and are the reasons for the extensive precautions being taken for the disposal of radioactive wastes.

41. The principles for containment of the chemical in this site should therefore be the same as those for radioactive waste if containment of the waste is the chosen plan of action. The US Nuclear Regulatory Commission Proposed Criteria call for impervious containers and sites which are stable from erosion or earth quakes for a least 1000 years.

42. Radioactive waste sites and containers are chosen to minimize possible human tampering with the containment as well as to minimize environmental erosion. Provisions must ensure that extremely hazardous materials such as TCDD and mirex in the Hyde Park landfill site, be not mishandled by future generations who could expose themselves and Lake Ontario to a serious situation of chemical contamination.

43. At the present time the toxic contaminants are not in a contained impervious to the environment and are in a site which could be readily tampered with by present and future generations.

44. An impervious container should be developed immediately for containing the leachate presently being removed from the site.

45. The better long-term option is to destroy the chemicals in the landfill.

46. Of the chemicals known to be present in the site, TCDD and mirex are the most stable to incineration. At temperatures of 800°C TCDD is stable for 20 seconds. Mirex, being used as a fire retardant, is heat resistant but breaks down in heat more readily than TCDD.

47. Incineration of organochlorines at temperatures lower than 700°C or procedures using extremely short residence times in the incinerator will simply volatalize the chemicals into the atmosphere for deposition elsewhere, or will create additional potent toxins such as other chlorinated dioxins.

48. Several industrial incinerators are available in the U.S.A. which will effectively incinerate these organochlorines.

49. Organochlorines and contaminated earth can also be incinerated efficiently in rotary kilns such as cement kilns at 2000°C.

50. TCDD and related compounds can also be degraded chemically by oxidative degradation with ruthenium tetroxide although this technique has never been applied to TCDD on a large scale.

51. In conclusion either the TCDD and other hazardous chemicals must be removed and enclosed in an impervious container and maintained indefinitely in a fashion similar to radioactive waste or, better, destroyed through available incinerators or kilns which have been checked and proven to destroy TCDD and the other organochlorine contaminants in this site.

SWORN before me at the City of Toronto, in the Municipality of Metropolitan Toronto, this 25th day of June, 1981.

Douglas J. Hallett

Douglas J. Hallett

Toby Vigod

A COMMISSIONER, ETC.

Hallett - Exhibit "A"

Curriculum Vitae

Dr. Douglas J. Hallett. PhD. MSc. BSc.
Mailing Address: RR#2 Woodlawn, Ontario Canada KOA 3MO

Education:- PhD. 1977. University of Ottawa,
Biology and Chemistry, Ottawa, Canada.
Thesis: Effect of Fenitrothion, anorganophosphorus pesticide on non-target forest plants and animals.
Formation, detection, and effect of toxic and non-toxic metabolites.

MSc. 1972 McMaster University, Virology and Biochemistry
Hamilton, Ontario, Canada.
Thesis: Studies on RNA and RNA complexes produced by Vesicular Stomatitis Virus in mouse L. Cells

BSc. 1970 McMaster University
Animal Physiology, Hamilton, Ontario, Canada
Thesis: Physiological Effects of Amphetamines on the Gerbil.

Professional Distinctions and Memberships

1. 1973 Vice-President: Graduate Students Association University of Ottawa.
2. International Association of Great Lakes Research
3. American Association for the Advancement of Science
4. American Chemical Society
5. Society for Environmental Chemistry and Toxicology.

Federal and International Environmental Committees

1. Chairman: Federal Interagency Committee on TCDD, Chlorinated Dioxins, and Chlorinated Dibenzofurans
2. Chairman: Environmental Contaminants Committee.
3. Member: Toxic Substances Committee International Joint Commission, Great Lakes Science Advisory Board.
4. Member: Aquatic Ecosystems Objectives Committee International Joint Commission, Great Lakes Science Advisory Board.
5. Analytical Capability Committee, Ontario Region

Present Position: Senior Advisor, Scientific Programs, Ontario Region Dept. of Environment.
Assignment: Develop and Manage a Canadian Interagency and Federal- Provincial Great Lakes Contaminants Program.

Past Position: (1975 to present). Research Scientist.
Canadian Wildlife Service, Dept. of Environment, Ontario Region.
Assignment: Determination of spatial and temporal trends in

Environmental comtaminants found in Great Lakes Herring Gulls. Identification of previously unidentified environmental contaminants.

Presentations:
Some 52 scientific papers have been presented at international scientific meetings and symposia

Publications - Reviewed

1. Galet, H., D. Hallet, and L. Prevec. 1976. Analysis of In Vitro Transcription Products of Intracellular Vesicular Stomatitis Virus RNA Polymerase, J. of Virology 19, No. 2, Pg. 467-474.

2. Hallett D., R. Greenhalgh, P. Weinberger, and R. Prasad. The Absorption of Fenitrothion During Germination of Stratified and Non-Stratified White Pine Seeds and Identification of Metabolites Formed. Canadian Journal of Forestry 5, No. 1, Pg. 84-89.

3. Hallett, D.J., R. Greenhalgh,P. Weinberger and R. Prasad. 1976. The Uptake and Metabolism of Fenitrothion by Germinating White Pine, White Spruce, and Yellow Birch. J. of Environmental Science and Health, Part B., Pesticides, Food Contaminants, and Agricultural Wastes. 12(1), 53-69.

4. Hallett, D.J., R.J. Norstrom, F.I. Onuska, M.E. Comba, and R. Sampson. 1976. Mass Spectral Confirmation and Analysis by the Hall Detector of Mirex and Photomirex in Herring Gulls form Lake Ontario. Journal of Agriculture and Food Chemistry, 24: 1189-1193.

5. Hallett, D.J., R.J. Normstom, F.I. Onuska, M.E. Comba. 1977. Mirex, Chlordane, Dieldrin, DDT, and PCB's: Metabolites and Photoisomers in L. Ontario Herring Gulls. In Fate of Pesticides in Large Animals, Academic Press. G.W. Ivie and H.W. Dorough, editors. pp. 183-192.

6. Hallett, D.J., K.S. Khera, D.R. Stoltz, Ih. Chu, D.C. Villeneuve, and G. Trivett. 1978. Photomirex: Synthesis and Assessment of Acute Toxicity, Tissue Distribution, and Mutagenicity. Journal of Agriculture and Food Chemistry, 26, pg. 388.

7. Gilman, A.P., D.J. Hallett, G.A. Fox, L.J. Allan, W.J. Learing, and D.B. Peakall. 1978. Effects of Injected Organachlorines on Naturally Incubated Herring Gull Eggs. J. Wildlife Management, 42: 3.

8. Norstrom, R.J., D.J. Hallett, and R.A. Sonstegard. 1978. Comparative Accumulation of Organochlorine Residues by L. Ontario Coho Salmon (Onchorhyncus kisutch) and Herring Gulls (Larus argentatus) Use of These Species as Indicators of Lake-wide Contamination. J. Fisheries Research Board. 35:1, 1401-1409.

9. Greenhalgh, R., D. Hallett, and P. Weinberger. The Metabolism of Fenitrothion by Pine Seedlings, and the Analysis of S-methyl Fenitrothion. Presented at the Third International Congress on Pesticide Chemistry (IUPAC) July 1974, Helsinki, Finland.

10. Hallett, D., P. Weinberger, R. Greenhalgh and R. Prasad. Recovery of Fenitrothion and its Metabolites from Germinating White Pine Seeds. Presented at the Canadian Federation of Biological Societies Meeting, June 1974, McMaster University, Hamilton, Ontario, Proceedings 17, p. 101. 1975.

11. Hallett, D.J., P. Weinberger, R. Greenhalgh, and R. Prasad. 1975. The Uptake and Metabolism of Fenitrothion by Germinating Forest Tree Seedlings, Seventh Eastern Canada Symposium on Pesticide Residue Analysis, Toronto, Ontario, May 1975.

12. Hallett, D.J., P. Weinberger, R. Greenhalgh and R. Prasad. April 1975. Metabolism of the Insectides, Fenitrothion by Seeds and Seedlings of Picea Glauca (Moench/Voss), Pinus Strobus L. and Betula Alleghaniezsis. Britt., Second FAO/IUFRO World Technical Consultation on Forest Diseases and Insects. New Delhi, India.

13. Hallett, D.J., R.J. Norstrom, F.I. Onuska, M.E. Comba, and R. Sampson. 1975. Determination of PCB's and Mirex in Lake Ontario Herring Gulls. International Conference on Environmental Sensing and Assessment, Proceedings 7, 7 September, 1975, Las Vegas Nevada.

14. Gilman, A.P., Hallett, D.J., Fox, G.A. Allan, L.J., Learning, W.J., and Peakall, D.B. J. Wildlife Management42: (3) Effects of Injected Organchlorines on Naturally Incubated Herring Gull Eggs.

15. Gilman, A.P., D.J. Hallett, G.A. Fox, L.J. Allan W.J. Learing and D.B. Peakall. Effects of injecting several organochlorine compounds into naturally incubated Herring Gull eggs. CWS Symposium on Fish-Eating Birds of the Great Lakes and Environmental Contaminants.

16. Hallett, D.J., R.J. Norstrom, F.I. Onuska, and M.E. Comba. Analysis of Polynuclear Aromatic Hydrocarbons and Organochlorine Pollutants in Great Lakes Herring Gulls by High Resolution Gas Chromatography. Proceedings: Second International Symposium on Glass Capillary Chromatograph, Hindelang, Germany, May 1977.

17. Gilman, A.P., D.B. Peakall, D.J. Hallett, G.A. Fox and R.J. Norstrom. The Herring Gull as a Monitor of Great Lakes Contamination. Proceedings of Symposium on Environmental Pollution, Storrs Connecticut, June 1977. Nat. Acad. Sci.

18. Hallett, D.' P. Weinberger, and R. Prasad. A Preliminary Study on the Fate of Fenitrothion in Forest Seeds. 1. Determination of Residues in Eastern White Pine and Their Effects on Amino Acid Metabolism. Information Report CC-X-50. Chemical Control Research Institute, Environment Canada, Ottawa, Ontario, 1973.

19. Hallett, D., P. Weinberger, R. Greenhalgh and R. Prasad.The Fate of Fenitrothion in Forest Trees V. The Formation of Metabolites in Pinus strobus L. and Their Detection by Gas. Chromatography and Mass Spectroscopy. Information Report CC-X-78. Chemical Control Research Institute, Environment Canada. Pickering Place, Ottawa, Ontario, February 1974.

20. Hallett, D., P. Weinberger, R. Greenhalgh and R. Prasad. 1975. Comparative Uptake and Metabolism of Fenitrothion by Three Species of Forest Tree Seedlings and One Species of a Rodent. CCRI Information Report CC-X-107.

21. Fox, G.A., A.P. Gilman, D.J. Hallett, R.J. Norstrom, F.I. Onuska, and D.B. Peakall. 1975. Herring Gull Productivity and Toxic Chemicals in the Great Lakes in 1975. CWS Manuscript Report #34.

22. Peakall. D.B., G.A. Fox., A.P. Gilman., P.J. Hallett, R.J. Norstrom. The Herring Gull as a Monitor of Great Lakes Contamination Proceedings. International Symposium on the Analysis of Hydrocabions and Halogenated Hydrocarbons. Pleuun Press, 1980.

23. Norstrom, R.J., D.J. Hallett, F.I. Onuska, and M.E. Comba. Mirex and its degradation products in Great Lakes Herring Gulls, Environmental Science and Technology, Dec. 1979.

24. Peakall, D.B., D.J. Miller, R.G. Butler, W.B. Kinter, and D.J. Hallett, Effects of injested crude oil on Black Guillenots Ambio 9 (1), 1980.

25. Mineau, P.D.V. Weseloh, and D.J. Hallett. Contamination par les substances organochlorees et. reproduction de goeland argente, 1974 a 1978, proceedings "Les contaminants daus l'euvironment Conference, Quebec, Canada, 1979.

26. Weseloh D.V., P. Mineau, and D.J. Hallett Organochlorine contaminants and trends in reproduction in Great Lakes Herring Gulls 1974-1978. Proceedings 44th North American Wildlife Conference, Toronto, Canada.

27. A.P. Gilman, D.P. Peakall, D.J. Hallett, G.A. Fox, and R.J. Norstrom. Herring Gulls (Larus argentatus) as monitors of contamination in the Great Lakes. 1979. In animals as Monitors of Environmental Pollutants. National Academy of Sciences.

28. Norstrom, R.J., A.P. Gilman, and D.J. Hallett. Totally organically-bound chlorine and bromine in L. Ontario Herring Gull eggs, 1977, by instrumental neutron activation and chromatographic methods (Submitted to Sci. Total Environ.).

29. Hallett, D.J., Onuska, F.I., and Comba, M.E. Aliphatic and Aromatic Components of Weathered and unweathered Southern Louisiana Crude Oil. Submitted to Environ. Pollut.

30. Hallett. D.J., Shear H. Weseloh, D.V. and Mineau, P. Surveillance of Wildlife Kyoto, Japan 1980 (reviewed and accepted).

31. Miller, D.S., Hallett, D.J. and Peakall, D.B. Which components of crude oil are toxic to young seakirds. Environ. Pollut. (Submitted).

32. Ellenton, J.A. and Hallett, D.J. Mutagencity and Chemical Analysis of Aliphatic and Aromatic Fractions of Prudhoe Bay Crude Oil and Fuel Oil No. 2. J. Toxicol. and Environ. Health. (Submitted).

33. Peakall, D.B., Hallett, D.J. Bead, J.R., Foureman, G.L., and Miller, D.S. Toxicity of Prudhoe Bay Crude Oil and its Aromatic Fractions to Nestling Herring Gulls. Environmental Research. (Submitted).

34. Hallett, D.J. and Norstrom, R.J. TCDD (2, 3, 7, 8 - Tetrachlorodibenzo-p-dioxin) in Great Lakes Herring Gulls. Science. (Submitted).

35. Hallett, D.J. and Perrin, E. Polychlorinated Bidenzodioxins: Aquatic Ecosystem Objective Scientific Rationale and objective development written for the Aquatic Ecosystems Objectives Committee, reviewed and accepted by the IJC Great Lakes Water Quality. See Aquatic Ecoysystems Objectives Committee Report, November, 1980.

36. Hallett, D.J., Norstrom, R.J., Onuska, F.I. and Comba, M.E. Chlorinated benzenes in Great Lakes Herring Gulls. Chemosphere. (Submitted).

37. Hodson, P., Borghman, U., Chau Y.K. Wang, P. Neraga, Hallett, D.J. Lead: Aquatic Ecosystem Objective written for the Aquatic Ecoysystem Objectives Committee, reviewed and accepted by the Science Advisory Board and accepted by the International Joint Commission on Great Lakes Water Quality. See Aquatic Ecosystem Objectives Committee Report, November, 1980.

38. Hallett, D.J. and Hutter, M.P. Plenary discussion paper: Environmental Fate of Chlorinated Dioxins and Related Compounds, prepared as co-chairman of Environmental Fate Section of Workshop on Impact of Chlorinated Dioxins and Related Compounds on the Environment. Rome, Italy, 1980.

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Hallett - Exhibit "B"

TCDD (2,3,7,8 - Tetrachlorodibenzo-p-dioxin) in Great Lakes Herring Gulls

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ABSTRACT

Pooled samples of 10 Herring Gull (*Larus argentatus*) eggs collected in 1980 from each of 12 colonies scattered throughout the Great Lakes and one colony on the Atlantic Coast in the Bay of Fundy were analyzed by high resolution gas chromatography/low resolution mass spectrometry for tetrachlorodibenzo-p-dioxin isomers. Only 2,3,7,8-TCDD was found. It ranged from 43 to 86 ng/kg in Saginaw Bay colonies, from 44 to 68 ng/kg in Lake Ontario colonies, and from 9 to 14 ng/kg in colonies on the other Great Lakes. The Bay of Fundy colony had a level of approximately 3 ng/kg. Levels of TCDD in archived Lake Ontario eggs collected in 1971-72 were in the order of 1 μg/kg (ppb). TCDD levels declined exponentially in Lake Ontario eggs with a half-life of 2.2 yr from 1974-1980.

Ultra-trace quantities of chlorinated dibenzo-p-dioxins have recently attracted the attention of analytical chemists and toxicologists due to the extreme toxicity of the 2,3,7,8-tetrachloro-isomer, hereinafter referred to as TCDD. TCDD has been recognized in Europe and North America as an ultra-trace (ng/kg) contaminant in soils, sediments, plants and animals. It is particularly found in areas subjected to production, industrial accidents or industrial disposal of 2,4,5-trichlorophenol used in the formulation of herbicides 2,4,5-T and fenoprop and the disinfectant hexachlorophene. Examples include Seveso, Italy (1, 2), the Love Canal at Niagara Falls, N.Y. (3) and Saginaw Bay near Midland, Michigan (4). TCDD persists and bioaccumulates in ecosystems which have been subjected to repeated dosages of herbicide formulations such as Silvex or Agent Orange, which contain 2,4,5-T (4-6). Examples include rangeland studies (4), experimental plots, including U.S. airforce bases (5) and South Vietnam (6). TCDD has also been found in activated sludge and flyash (7) although in low relative amounts ($<10\%$) to other TCDD isomers. Other TCDD isomers have not been found to be present in environmental samples.

There has been, however, no systematic study of TCDD contamination in aquatic ecosystems, in which organochlorine contaminants often accumulate to high levels. Herring Gulls have been used successfully as indicators of organochlorine contaminants in Great Lakes aquatic ecosystems (8, 9, 10). An early attempt in 1973 to find chlorinated dibenzodioxins in Herring Gull eggs was unsuccessful (11). However, unconfirmed reports on the finding of TCDD in Lake Ontario fish prompted us to analyse Herring Gull eggs from the Great Lakes for TCDD and other tetrachloro dioxin isomers recently developed, using more sensitive techniques.

We report here the levels of 2,3,7,8-TCDD determined in pools of 10 eggs collected in May 1980 from Herring Gull colonies in each of the Great Lakes (Fig. 1): two in L. Superior, one in L. Michigan, three in L. Huron, two in L. Erie, and four in L. Ontario, including one colony in north central L. Ontario for which archived samples were available retrospectively to 1971, and one colony on the Atlantic coast in the Bay of Fundy. A pooled sample of breast muscle from 5 adult Herring Gulls from Saginaw Bay was also analysed. Samples were analysed for TCDD isomers by high-resolution capillary chromatography/low resolution mass spectrometry (12).

All Herring Gull egg and muscle samples analysed contained detectable levels ($>$ 2-3 ng/kg) of TCDD (Table 1). No other compounds present demonstrated the correct ion abundance ratios for m/z 320, 322 and 324, characteristic of the molecular ion of TCDD isomers. The identity of TCDD was determined by retention time of an authentic standard on three different capillary columns (methylsilicone, SE-54 and OV-17). On all three columns, TCDD was well-resolved from the 1,2,3,4-; 1,3,6,8-; and 1,3,7,9-TCDD isomers. TCDD isomer interferences with 2,3,7,8-TCDD on methylsilicone and OV-17 columns are completely different (13). Since only one peak was present in the TCDD region of the chromatogram for at least one (usually all three) of the ions measured, these results constitute isomer specific analysis of great certainty. High resolution mass spectral analysis (resolution 20,000, 10% valley) confirmed the structure of TCDD. This degree of resolution is twice that required to distinguish between TCDD and tetrachlorobiphenyl-methyl ethers, or tetrachlorobenzyl- phenyl ethers, which have the same molecular weight and ion abundance ratios, and are potential interferences in analysis of gull samples (14). Confirmatory analyses on selected samples were also performed through U.S. Environmental Protection Agency, and U.S. Fish and Wildlife Service.

Recovery studies were carried out using 1,2,3,4- and 2,3,7,8-TCDD spiked to chicken eggs at the 0, 10 and 50 ng/kg level just prior to the extraction stage. The recoveries were: 50 ng/kg, 80-100% (1,2,3,4-TCDD), 94% (2,3,7,8-TCDD); 10 ng/kg, 84-86% (1,2,3,4-TCDD), 66-67% (2,3,7,8-TCDD). Although the recoveries were reproducible, no correction factors were applied to the analytical results. Repeatability of analysis of naturally contaminated samples was 13% at the 50 ng/kg level (Muggs Isl., L. Ontario) and 17% at the 10 ng/kg level (Middle Isl., L. Erie).

Eggs from colonies on Lakes Erie, Huron (except Saginaw Bay), Superior and Michigan contained 9-14 ng/kg of TCDD. These colonies are highly contaminated with other organochlorines, particularly PCBs. The ratio of TCDD to PCB (Table 1) was relatively constant, ranging from 3 to 7 x 10^{-7}, in this Great Lakes "baseline" concentration group. It is noteworthy that the ratio in the Bay of Fundy was consistent with the Great Lakes baseline, although the former area is relatively uncontaminated and remote from major potential industrial, agricultural or silvicultural sources of TCDD. The major exogenous source of PCBs in the Great Lakes is atmospheric deposition (14). Our data therefore suggest that TCDD, like PCBs, may be a ubiquitous contaminant, cycling at ultratrace levels between various components of the air, water, sediment and biota of the biosphere.

The TCDD/PCB ratio was approximately 7 times higher in Saginaw Bay and approximately 3 times higher in Lake Ontario than the "baseline" ratio in the other colonies. Both are clearly localized areas of elevated TCDD contamination. The elevated levels in Saginaw Bay gulls corroborate the finding of 2,3,7,8-TCDD in fish collected in 1978 from the

Saginaw and Tittabawassee river system (4), since the Channel Shelter Island colony is situated at the mouth of the Saginaw River. Dow Chemical Co. in the Midland and Bay City, Michigan area is situated on the Saginaw-Tittabawassee river system and has been a major producer of 2,4,5-trichlorophenol and 2,4,5-trichlorophenoxy acid herbicides. The possible influence of this point source of TCDD is reflected in relatively high TCDD levels in eggs from the Little Charity Island colony 50 km from the mouth of this river system. Gulls at Chantry Island, on the opposite shore of Lake Huron were not highly contaminated, indicating that lake-wide distribution of TCDD has not occurred.

The low variability (Relative SD 16%) of TCDD levels in the four Lake Ontario colonies in 1980 suggests that lake-wide contamination of the fish species (mainly alewives and smelt) which comprise the main aquatic portion of the Herring Gull's diet in the Great Lakes (16) has occurred. Combustion of organic compounds at temperatures below 1000°C in the presence of chlorine-containing compounds, such as during the incineration of municipal garbage, has been shown to yield chlorinated dioxins (5, 17). However, the 2,3,7,8-TCDD isomer is a relatively minor constituent (< 10%) of the tetrachloro isomers produced, and no isomer other than 2,3,7,8-TCCD was found in gull eggs. It would also be unusual for widely distributed atmospheric sources such as refuse incinerators to have contaminated only Lake Ontario. Another possible source of TCDD to Lake Ontario is application of herbicides to agricultural and forest lands, but neither 2,4,5-T nor fenoprop herbicides have been used extensively in Ontario in recent years (18). Spraying of 2,4,5-T in Vietnam and on experimental plots has resulted in detectable levels of TCDD in biota, but only when the application rate was far in excess of usual agricultural practice (4,6,7). Fish levels in Vietnam were only in the 10 ng/kg range, similar to the baseline concentrations which we detected in Great Lakes Herring Gulls outside of Lake Ontario and Saginaw Bay. Some formulations of the herbicide 2,4-D have recently been shown to contain μg/kg levels of 1,3,6,8- and 1,3,7,9-TCDD (19). Since 2,4-D has been used in much larger quantities than 2,4,5-T in the Great Lakes basin and since these isomers of TCDD were not found in the gulls, it appears that waste disposal or major accidents during the manufacturing of 2,4,5-trichlorophenol are the likely sources of the higher levels of TCDD found in Lake Ontario. Hooker Chemical Co. at Niagara Falls, N.Y. manufactured 2,4,5-trichlorophenol and it is known from studies on mirex in gull eggs and fish that widespread contamination of Lake Ontario can occur from such a point source in the Niagara River (10, 20).

The retrospective study of TCDD levels in eggs from 1971 to 1980 at Scotch Bonnet Island in Lake Ontario is shown in the insert of Fig. 1. Levels decreased throughout this period from 800 - 1,300 ng/kg in the early 1970's to 68 ng/kg in 1980. Most organochlorine residues in Lake Ontario also decreased during this period, presumably due to restrictions on use (9). Prior to 1975 the TCDD/PCB ratio was 45 to 52 x 10^{-7} (except for a low result of 18 x 10^{-7} in 1973). From 1976 onwards the ratio has stayed roughly the same (15 to 24 x 10^{-7}), indicating that both contaminants were being cleared from the ecosystem at similar rates. The data from this later period have a good fit to an exponential decay model (r^2 = 0.9886, log-linear regression) with a half-life of 2.2 years. This half-life is identical to that found for mirex in Lake Ontario as determined from similar Herring Gull egg data (9). It is encouraging that TCDD levels in Lake Ontario gull eggs will likely decline to the "baseline" level of ca. 10 ng/kg within 5-7 years. TCDD levels in fish relative to those in gull eggs have yet to be established, but we expect the rate of decline in fish to be similar.

We shall continue to monitor Herring Gull populations for TCDD in the Great Lakes. On a more widespread basis, we intend to test the hypothesis that 2,3,7,8-TCDD is a ubiquitous contaminant by comparing its relative abundance to such global contaminants as PCBs in a range of Canadian biota.

References

1. Hay, A. Nature 262, 636 (1976).
2. Hay, A. Disasters 1, 289 (1977).
3. Esposito, M.P., H.M. Drake, J.A. Smith and T.W. Owens. U.S. Environmental Protection Agency Report No. EPS-600/2-80-156, June 1980.
4. Harless, R.L. and R.G. Lewis. Proceedings of the Workshop "Impact of Chlorinated Dioxins and Related Compounds on the Environment", October 22-24, 1980, Rome, Italy (in press).
5. Young, A.L. and C.E. Thalken, ibid.
6. Baughman, R. and M. Meselson. Environ. Health Perspectives 5, 27 (1973).
7. Lamparski, L.L. and T.J. Nestrick. Anal. Chem. 52, 2045 (1980).
8. Gilman, A.P., D.B. Peakall, D.J. Hallett, G.A. Fox, and R.J. Norstrom in _Animals as Monitors of Environmental Contaminants_ (National Academy of Sciences, Wash., D.C., 1979), pp. 280-289.
9. Weseloh, D.V., P. Mineau, and D.J. Hallett. Trans. 44th North American Wildl. and Nat. Resour. Conf., Wildl. Manage. Inst., Washington, D.C., 543 (1979).
10. Norstrom, R.J., D.J. Hallett, and R.A. Sonstegard. J. Fish, Res. Bd. Can. 35, 1401 (1978).

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TABLE 1

LEVELS OF 2,3,7,8-TCDD IN POOLED[1] 1980 GREAT LAKES

HERRING GULL EGGS

LAKE - COLONY (Colony No. in Fig. 1)	N[2]	2,3,7,8-TCDD[3] (ng/kg)	RELATIVE ABUNDANCE (%) TO BASE PEAK[4] m/z 324	m/z 320	PCB[5] (mg/kg)	TCDD/PCB x10[7]
L. SUPERIOR						
GRANITE ISL (1)	6	11 ± 2.3	46	79	21	5
AGAWA ROCK (2)	4	10 ± 1.3	45	73	ND	ND
L. MICHIGAN						
BIG SISTER ISL. (3)	3	9 ± 1.0	47	71	25	3
SAGINAW BAY						
CHANNEL SHELTER (4)	4	86 ± 2.5	49	77	32	27
(muscle)	4	90 ± 7.2	48	80	41	22
L. CHARITY ISL. (5)	4	43 ± 3.6	49	76	ND	ND
L. HURON						
CHANTRY ISL. (6)	3	14 ± 2.4	50	75	19	7
L. ERIE						
MIDDLE ISL. (7)	2	13 ± 0.7	46	77	ND	ND
(repeat analysis)	4	11 ± 0.6	49	71	35	3
PORT COLBOURNE (8)	2	9 ± 0.5	44	73	34	3

TABLE 1 (cont'd)

L. ONTARIO						
MUGGS ISL. (9)	5	50 ± 2.6	47	76	ND	ND
(repeat analysis)	3	44 ± 1.0	46	74	39	11
PRESQU'ILE (10)	3	64 ± 3.8	49	77	39	17
SCOTCH BONNET ISL. (11)	5	68 ± 4.1	47	76	42	16
SNAKE ISL. (12)	7	55 ± 4.7	44	75	42	13
BAY OF FUNDY						
KENT ISL.	3	3 ± 0.3[6]	54	73	5	6
CHICKEN EGG	3	< 2	ND	ND		ND

[1] No. of eggs in pool was 10

[2] N is number of replicate injections of each sample

[3] Results on a fresh weight basis calculated from m/z 322 using a 1,2,3,4,-TCDD internal standard; mean ± SD of replicate injections, uncorrected for recovery;

ND = not determined. Repeat analysis of colony (7) and (9) eggs began with a second 100 g subsample

[4] Base peak is m/z 322; experimental relative abundances for 2,3,7,8-TCDD were 49% (m/z 320) and 77% (m/z 324)

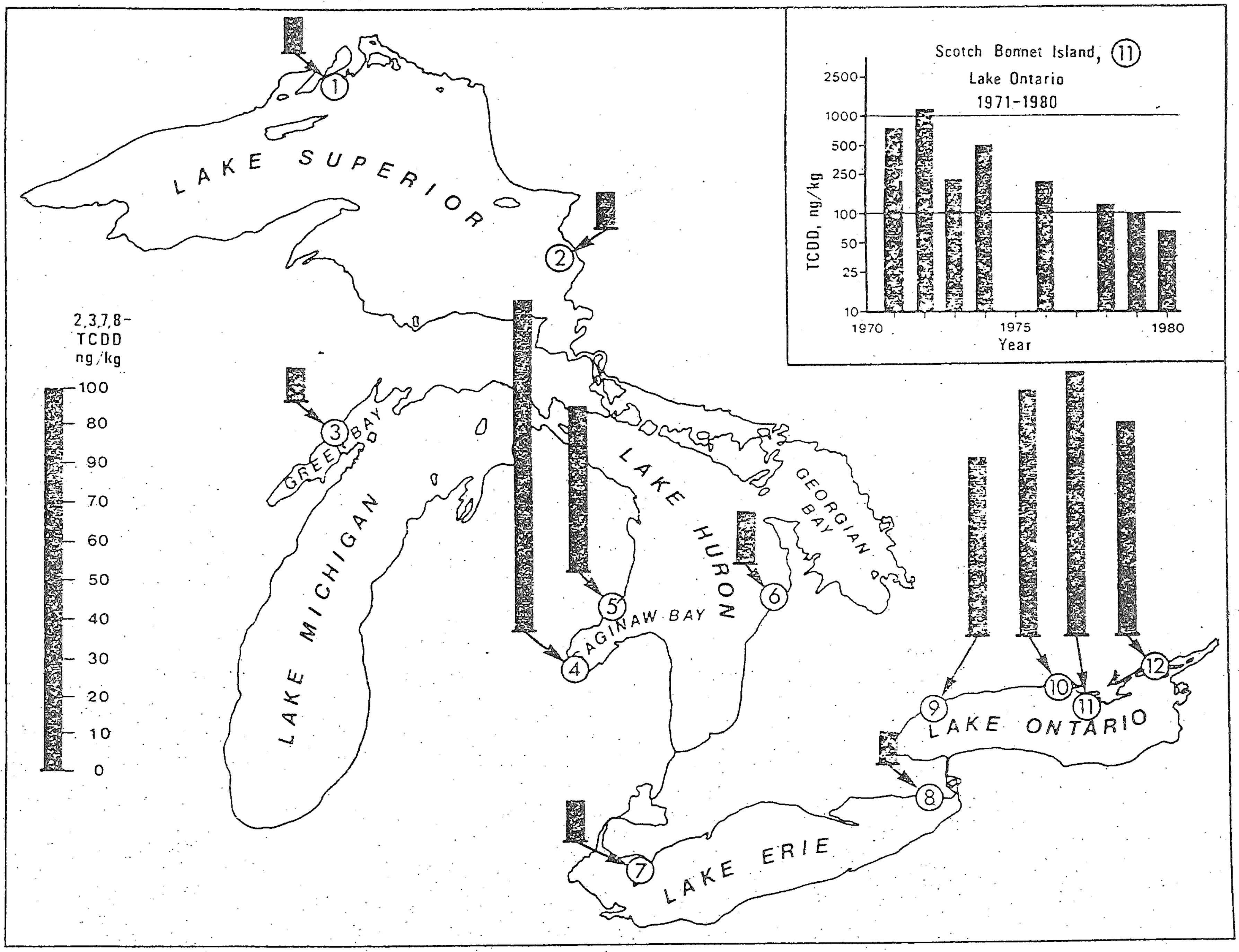
[5] Results calculated as Aroclor 1254

[6] Due to closeness to detection limit the accuracy of this result is likely poor. TCDD was confirmed by retention time, but not by high resolution GC/MS

FIGURE LEGEND

Fig. 1 Sites of Herring Gull colonies from which eggs were collected in 1980. Colony names can be identified from the numbers in parentheses in column 1, Table 1, which correspond to those shown on the map. Levels (ng/kg fresh weight) of 2,3,7,8-TCDD in pools of 10 eggs are indicated by the height of the bars next to each colony.

Inset: Retrospective analysis of gull egg pools from Scotch Bonnett Island, Lake Ontario, for 2,3,7,8-TCDD. Bar height is proportional to the logarithm of the TCDD level (ng/kg fresh weight).



Scotch Bonnet Island, 11
Lake Ontario
1971-1980
TCDD, ng/kg
2500
1000
500
250
100
50
25
10
1970
1975
1980
Year
2,3,7,8-
TCDD
ng/kg
100
80
90
70
60
50
40
30
20
10
0
LAKE SUPERIOR
GREEN BAY
LAKE MICHIGAN
LAKE HURON
SAGINAW BAY
GEORGIAN BAY
LAKE ONTARIO
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IN THE UNITED STATES DISTRICT COURT
FOR THE WESTERN DISTRICT OF NEW YORK

UNITED STATES OF AMERICA,
THE STATE OF NEW YORK,

Plaintiffs,

Civil Action No. 79-989

- vs -

HOOKER CHEMICALS & PLASTICS CORP.; OXY CHEMICAL CORPORATION; HOOKER CHEMICAL CORPORATION; OCCIDENTAL PETROLEUM INVESTMENT CO.; OCCIDENTAL PETROLEUM CORPORATION; THE TOWN OF LEWISTON; THE TOWN OF NIAGARA, (Hyde Park Landfill),

Defendants.

AFFIDAVIT OF JAMES R. ALLEN

STATE OF NEW MEXICO)
COUNTY OF LOS ALAMOS) ss:
CITY OF LOS ALAMOS)

Dr. James R. Allen, being first duly sworn, deposes and says:

1. I reside at Box 178, Mars Hill, North Carolina.

2. I am an environmental Toxicologist and Pathologist by profession, and serve as a private consultant. (See curriculum vitae annexed hereto as Exhibit " A ".)

3. From 1969 to 1980 I held the position of Professor in the Department of Pathology and concurrently in the Department of Food, Microbiology and Toxicology at the University of Wisconsin in Madison, Wisconsin. I was also a Senior Scientist in the Regional Primate Research Centre at the University of Wisconsin [illegible].

4. I have [illegible] into the [illegible] related halogenated hydrocarbons on experimental animals, focusing upon the impacts [illegible] rhesus monkeys.

5. Because of my expertise in this area, I have served as consultant to the National Institute of Environmental Health Sciences, the National Institute of Occupational Safety and Health, the Environmental Protection Agency and the World Health Organization.

6. I was also requested to consult with the Italian Government with respect to an accident in Seveso, Italy, in 1976, involving the release of between two and eleven pounds of 2,3,7,8- tetrachlorodibenzo-p-dioxin (hereinafter referred to as "TCDD") into the atmosphere.

7. This affidavit is prepared specifically to elucidate the severe health consequences of low dose exposure to TCDD in primates, including humans. I have reviewed the proposed Hyde Park settlement for the Ecumenical Task Force and wish to emphasize the need to achieve complete isolation of TCDD from human and environmental exposure.

8. Early in the course of my research, I selected an experimental animal that would closely relate to human diseases and intoxication.

9. In my laboratory, we eliminated a variety of species including rats, mice, and chickens, in attempting to determine the most desirable experimental animal model for the study of human diseases.

10. Research revealed that the rhesus monkey most closely simulated what would occur in the human population at certain exposure levels. Since they are primates, they are more closely related to humans on the biogenetic chain than other species.

11. That choice proved to be particularly accurate with respect to intoxicants such as the polychlorinated biphenyls (PCBs), the dioxins and other halogenated compounds.

12. The rhesus monkey is able to assimilate, metabolize, eliminate and store intoxicants in the body in a manner very similar to human processes.

13. Since 1957 I have studied dioxins and other related compounds to determine the toxicological effects on non-human primates, with particular emphasis on the TCDD isomer of dioxin.

14. My first specific report was published in 1967 in the American Journal of Veterinary Research, and was the first report on the effects of dioxins and other closely related compounds on primates. (Reference to Allen, J.R. and Carstens, L.A.: Light and Electron Microscopic Observations in the Macaca mulatta monkeys fed toxic fat. Amer. J. Vet. Res., 28: 1513-1526, 1967.)

15. In 1967, analytical capabilities were not sufficiently sophisticated to determine the exact concentration of TCDD in the toxic feed to which the experimental animals were exposed. However, we did know that the largest concentration of dioxin in the fats being fed to these monkeys was TCDD.

16. I discovered that TCDD was an extremely toxic compound which produced a variety of adverse effects in the test animals, including hair loss, eyelash loss, facial swelling, and acute subcutancous edema and gastrointestinal disturbances including ulcerations and hyperplasia (thickening of the stomach wall).

17. There was a decrease in the bone marrow of the animals, and they became extremely anaemic. Because of the anaemia they were extremely susceptible to infection and other illness.

18. There was a decrease in all circulating blood components of the monkeys, their white blood cells, which help to resist infection. Other alterations included a decrease in lymph node size which increased their susceptibility to infection.

19. The response of the animals varied due to a variance in the concentration of the toxic fat in their diet from 0.125% to about 10%.

20. Although their food intake was maintained throughout the period, the animals' condition continued to worsen and they eventually died.

21. The level of exposure related directly to the survival of the animals. The higher the dose of toxic fat, the more rapidly death occurred. The lower the dose, the longer the animals survived.

22. The monkeys who were exposed to concentrations of only .5% lived in excess of one year, while the others who were exposed to higher levels, died within a short period of time. The test animals were between the ages of 5 to 10 years with a life expectancy of 20 to 30 years.

23. This research published in 1967, revealed that these compounds were extremely toxic to primate species closely related to man and it suggested that injurious effects might occur in man if exposed to these compounds.

24. By the 1970s analytical procedures had developed to the point of detection of TCDD at levels of parts per trillion. Previously only levels of dioxin in the parts per million or parts per billion range were detectable. However, it should be noted that many dioxins, and TCDD in particular, are extremely toxic to animals with parts per trillion exposure.

25. At this point pure TCDD was obtainable for our research.

26. I participated in a study undertaken by the University of Wisconsin Regional Primate Research Centre to determine what the effects of ingestion of levels of TCDD, similar to those found in fish, would have on non-human primates. The experimental animals in this study were fed diets containing 500 parts per trillion of TCDD. (reference to Allen, J.R., Barsotti, D.A., Van Miller, J.P., Abrahamson, L.J. and Lalich, J.J.: Morphological changes in monkeys consuming a diet containing low levels of 2,3,7,8-tetrachlorodibenzo-p-dioxin. Food Cosmet. Toxicol. 15: 401-410, 1977.)

27. The TCDD level of 500 parts per trillion was selected on the basis of studies of fish taken from Vietnam where levels of dioxin in fish ranging from 67 to 800 parts per trillion were detected.

28. In approximately three months time, the test animals demonstrated signs of intoxication including swollen eyelids, and hair loss. In addition, the monkeys showed early signs of anaemia with a decrease in the red blood cell components.

29. Within a period of six months the female monkeys showed irregularities in their menstrual cycle, either by the absence of menstruation or difficult menstruation. Also there was a general alteration of the reproductive cycle of the female.

30. I attempted to breed these monkeys during the course of the study, but of eight animals, only one was able to conceive and to maintain full term pregnancy. The control group of eight animals all conceived and gave birth to normal infants.

31. After six months definite signs of intoxication, including stomach ulcerations, thickened stomach walls, swollen eyelids, loss of eyelashes, hair loss and alterations of many of the organs throughout the body, occurred in test animals. These alterations included changes in the bone marrow, and in the morphological features of many tissues throughout the body suggesting the neoplastic or cancer-producing potential of these particular cells.

32. In this experiement signs of intoxication occurred at three months once total consumption of TCDD had reached one microgram per kilogram of body weight of the test animals.

33. After the animals had consumed approximately two micrograms per kilogram of body weight, some animals died. Five of the eight animals died after seven to twelve months exposure from intoxication of approximately two to two and a half micrograms of TCDD per kilogram of body weight.

34. This study revealed that extremely low levels of exposure will produce morbidity, mortality and reproductive abnormalities in the non-human primates.

35. Although individual human exposures may not reach the test levels of 500 parts per trillion and although one low level of exposure would not necessarily be injurious, injurious effects can occur over time after repeated low dosage exposure.

36. TCDD is a lipophilic compound. Once the material is ingested into the body it goes to the liver and is subsequently deposited in fatty tissues throughout the body where it bioaccumulates.

37. In a subsequent study which is ongoing, non-human primates fed 50 ppt of TCDD developed the same symptoms in about twenty months that test animals in the earlier study developed after three months when fed 500 ppt of TCDD. What is important here is that the total intake level was the same in each study -- one microgram of TCDD per kilogram of body weight. In other words, the same level of toxicity developed at one microgram of TCDD per kilogram of body weight whether this exposure occurred over three months or twenty months, at a level of accumulation proportionate to body weight. This suggests that there is a critical level which might be reached in non-human primates where toxicity would be manifested.

James R Allen

James R. Allen

SUBSCRIBED AND SWORN TO
before me this 29th day
of June, 1981.

Marguerite K. Cantrell
Notary Public

OFFICIAL SEAL
Signature: Marguerite K. Cantrell
MARGUERITE K. CANTRELL
NOTARY PUBLIC - NEW MEXICO
NOTARY BOND FILED WITH SECRETARY OF STATE
My Commission Expires 8-11-84

CURRICULUM VITAE

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(608) 592-4012

Personal Data

Born December 13, 1927 in Mars Hill, North Carolina; attended grade and high school in Mars Hill. Married to Christie Ann Smith, we have four sons. I am six feet tall, 165 lbs., excellent health.

Education

B.S. degree	Mars Hill College, Mars Hill, N.C. (1946-1948) University of Tennessee, Knoxville, TN. (1948-1950)
M.S. degree	University of Tennessee, Knoxville, TN. (1951) Major - Nutrition
D.V.M. degree	University of Georgia, Athens, GA. (1955) School of Veterinary Medicine
Ph.D. degree	University of Wisconsin, Madison, WI. (1959-1961) Medical School, Department of Pathology

Military Service

U.S. Navy Hospital Corps, December, 1944 to October, 1946.
Hospital Apprentice, 1st Class - Honorable Discharge, 1946.

Major Scientific Endeavors

Toxicological and Biochemical Pathology, Chemically Induced Carcinogenesis, Comparative Toxicology of Halogenated Hydrocarbons, In Vitro/In Vivo Metabolism of Enviromental Intoxicants

Special Advisory Appointments

Consultant to the National Insitute of Environmental Health Sciences, 1976 to 1980.

Consultant to the National Insitute of Occupational Safety and Health, 1976 to 1980.

Member of the Wisconsin Department of Natural Resources PCB Advisory Council, 1976 to 1979.

Consultant to the Italian Government in regards to the TCDD accident in Seveso, Italy, 1976.

Member of the Research Council, Committee on Polychlorinated Biphenyls, National Academy of Science, 1978 to 1979.

Invited Participant to the New York Academy of Science's Hydrocarbon Converence, New York City, 1978.

Consultant to the Health Protection Branch, Government of Canada, 1978.

Member of the Ad Hoc Committee, Training Grant Review, National Institute of Environmental Health Sciences, 1978 to 1979.

Member of the Working Group on the Evaluation of the Carcinogenic Risk of Chemicals to Man: Organo-Chlorine Pesticides Team, World Health Organization, Lyon, France, 1978.

Member of the Advisory Committee on Health Related Effects of Herbicides, The Veterans Administration, 1979 to 1980.

Consultant to a number of firms in private industry regarding various toxicologic problems, 1974 to 1980.

Consultant to the Environmental Protection Agency, Washington, D.C.., 1978 to 1980.

Member of the Toxicology Study Section, National Institutes of Health, 1979 to 1980.

Associate Editor of the Journal of Toxicology and Environmental Health, 1978 to 1980.

Member, Scientific and Technical Advisory Board, Ecumenical Task Force to Address the Love Canal Disaster, 1980 -.

Professional License

Licensed to practice Veterinary Medicine and Surgery in the States of Florida and North Carolina.

Academic and Professional Honors

Burr Beach Award for research as a graduate student from the Wisconsin Veterinary Medical Association

Graduated cum laude from the University of Georgia, Athens, GA.

U.S. Public Health Service, Postdoctoral Research Fellowship from the National Institute of Health to the Department of Pathology, University of Wisconsin Medical School (1959-1961)

Listed in "Who's Who in the Midwest" and "Who's Who in American Universities"

Considered "Board Eligible" by the American College of Veterinary Pathologist (1961)

Professional Experience

Consulting Toxicologist and Pathologist	J.R. Allen Associates, Inc. 57 Hamilton Dr. Novato, CA. 94947 Box 222 Lodi, WI. 53555 (1975 to present)
Professor	Department of Pathology University of Wisconsin Madison, WI. 53706 (1969-1980)
Senior Scientist	Regional Primate Research Center, University of Wisconsin, Madison, WI. 53706 (1969-1980)
Professor	Department of Food Microbiology and Toxicology, University of Wisconsin Madison, WI. 53706 (1969-1980)

Administer primarily National Institutes of Health grants in excess of 500 thousand dollars annually; supervise approximately 30 personnel including 7 to 8 post-doctoral fellows and 10 to 12 graduate students. Research endeavors include in vitro/in vivo metabolism of several halogenated hydrocarbons and their metabolites in fetal, neonatal, infant, and adult animal species and humans in clinical situations. These studies have had a pronounced influence in dictating levels of safe exposure to the regulatory agencies. Other scientific work involves hepatocellular metabolism, cardiovascular toxicology, carcinogentic effect of halogenated biphenyls and dioxins employing in vitro procedures with mannalian cells, cardiac metabolism, teratological effects and reproductive influence of food contaminants and various chemical intoxicants. Operate a modern, fully-equipped bio-chemistry laboratory. Responsible for the diagnostic and clinical gross anatomic, light microscopic, and ultrastructural pathology of numberous animal species involved in research projects from many sources. Perform over 300 necropsies annually on several species of non-human primates. Supervise annually autopsies of over 50 humansat the Medical School. Actively involved in the operation of portions of the Primate Research Center and the operation of portions of the Primate Research Center and Biotron which maintain over 1,500 primates, and require my expertise in performing services in veterinary medicine, surgery, radiology, etc. Responsible for the ongoing education and evaluation of graduate and post-doctoral students in the Department of Pathology.

Associate Professor ,	Department of Pathology, University of Wisconsin Medical School, Madison, WI. 53706 (full time 1966-1969);
Project Associate and Unit Chief	Regional Primate Research Center, University of Wisconsin, Madison, WI. 53706 (full time 1966-1969)
Assistant Professor ,	Department of Pathology, University of Wisconsin Medical School, Madison, WI. 53706 (full time 1962-1966);
and Project Associate	Regional Primate Research Center, University of Wisconsin, Madison, WI. 53706 (full time 1962-1966)

Expanded administrative responsibilites regarding the operation of the Primate Medicine Unit and the Experimental Pathology Unit at the Primate Research Center, and regarding the ongoing research program which required continued submission of grant proposals, constant publication of the results or research projects, co-ordination of the efforts of the research staff and graduate students, and numerous presentations before the scientific community regarding the latest findings of our research endeavors.

Assistant Professor	Veterinary Pathology Department, School of Veterinary Medicine, University of Georgia, Athens, GA. (full time 1961-1962)

Responsible for a coordinated series of lectures to undergraduate and graduate students regarding general and systemic veterinary pathology.

Studied several naturally occurring intoxicating chemicals; especially those from the plant, Crotalaria spectabilis, which contains pyrrolizidine alkaloids implicated in accidental poisonings in man, marked toxicity in avian species, etc.

N.I.H. Postdoctoral Research Fellow (U.S. Public Health Service)

Department of Pathology, University of Wisconsin Medical School, Madison, WI. 53706
(full time 1959-1961)

Pursued a course curriculum and research program toward the Ph.D degree in Pathology. Performed over 100 autopsies at the University of Wisconsin Hospitals and investigated the effect of "toxic fat" in avian species.

Director of Field Service

Research Division, Central Soya Company, Inc., Fort Wayne, Indiana
(full time 1955-1959)

Responsible for all experimental and field-related research work involving the efficacy and safety evaluation of feed additives (eg. antibiotics), growth stimulants, vitamin/ mineral preparations, etc. in commerical poultry and livestock situations. As the Chief Veterinarian-in-Charge, I was responsible for nation-wide "problem solving" regarding the development of new company products; this was completely integrated with ongoing basic research.

Research Assistant

Department of Biochemistry/ Nutrition, University of Tennessee, Knoxville, TN.
(part time 1950-1951)

While completing requirements for a M.S. degree in Nutrition, I assisted in the evaluation of various levels of fluorine upon the digestibility of diets. This research was important due to the environmental contamination by fluorine resulting in unspecified toxicity primarily in cattle at that time.

Membership in Professional Societies and Organizations

Society of Experimental Biology and Medicine
American Association of Pathologists and Bacteriologist *
American Society for Experimental Pathology (F.A.S.E.B.) *
* merged to form: American Association of Pathologists
International Academy of Pathology

American Society for Cell Biology
American Association for the Advancement of Science
Midwest Society of Electron Microscopists
Electron Microscope Society of America
American Veterinary Medical Association
New York Academy of Science
International Study Group for Research in Cardiac Metabolism **
** name changed to: International Society for Heart Research
American Heart Association
Forum for the Advancement of Toxicology
American Association for Cancer Research
Society of Toxicology
American College of Toxicology (application pending)

Honor Society Membership

Phi Sigma - National Honor Society of Biology

Phi Kappa Phi - National Scholastic Honor Society

Phi Zeta - National Honor Society in Veterinary Medicine

Scientific Publications

On the following pages are listed approximately 220 references to scientific articles published from about 1960 to the present; they are generally listed in chronological order with the latest at the end of the list.

PUBLICATIONS:

Allen, J.R. and Hobbs, C.S.: The effects of various levels of fluorine upon the digestibility of diets. Agric. Res. Bull., Univ. of Tennessee, 1954.

Allen, J.R., Childs, C.R. and Cravens, W.W.: Crotalaria spectabilis toxicity in chickens. Proc. Soc. Exp. Biol. Med., 104: 434-436, 1960.

Allen, J.R.: Effects of "toxic fat" in chickens. Fed. Proc., 19: 235, 1960.

Allen, J.R.: The role of "toxic fat" in the production of hydropericardium and ascites. (Doctoral Dissertation, Univ. of Wisconsin), June, 1961, Dissert. Abstr., 22: 433, 1961.

Allen, J.R. and Lalich, J.J.: The effects of toxic fat on spermatogenesis. Fed. Proc., 20: 433, 1961.

Allen, J.R. and Lalich, J.J.: Response of chickens to prolonged feeding of crude "toxic fat". Proc. Soc. Exp. Biol. Med., 109: 48-51, 1962.

Allen, J.R., Lalich, J.J. and Schmittle, S.M.: Crotalaria spectabilis induced cirrhosis in turkeys. Lab. Invest., 12: 512-517, 1963.

Allen, J.R.: Crotalaria spectabilis toxicity studies in turkeys. Avian Diseases, 7: 318, 1963.

Allen, J.R. and Lalich, J.J.: Monocrotaline induced cirrhosis in experimental animals. Fed. Proc., 22: 546, 1963.

Wolf, R.C., Allen, J.R. and Van Lancker, J.L.: Protection of rhesus monkeys against lethal doses of X-irradiation. Bone Marrow Transplantation and Irradiation Protection Conference. Blood, 22: 499, 1963.

Allen, J.R.: 1,1,3-tricyano-2-amino propene induced changes in growth and endocrine development in the rat. Fed. Proc., 23: 147, 1964.

Allen, J.R.: The role of toxic fat in the production of hydropericardium and ascites in chickens. Amer. J. Vet. Res., 25: 1210-1219, 1964.

Allen, J.R., Van Lancker, J.L. and Wolf, R.C.: Protection of experimental animals against lethal doses of X-irradiation. Proceedings of the Annual Conference for Veterinarians. University of Georgia, 1964.

Allen, J.R., Van Lancker, J.L. and Wolf, R.C.: The use of bone marrow transplants in the protection of rhesus monkeys against total body X-irradiation. Amer. J. Vet. Res., 25: 1740-1745, 1964.

Allen, J.R., Carstens, L.A. and Knezevic, A.L.: Crotalaria spectabilis intoxication in rhesus monkeys. Amer. J. Vet. Res., 26: 753-757, 1965.

Carstens, L.A. and Allen, J.R.: Ultrastructural observations on the fetal monkey liver. J. Cell Biol., 31: 19A, 1966.

Allen, J.R., Carstens, L.A. and Olson, B.E.: Veno-occlusive disease in Macaca speciosa monkeys. Amer. J. Path., 50: 653-667, 1967.

Allen, J.R. and Carstens, L.A.: Light and electron microscopic observations in Macaca mulatta monkeys fed toxic fat. Amer. J. Vet. Res., 28: 1513-1526, 1967.

Schmidt, M.J. and Allen, J.R.: Effects of 1,1,3,-tricyano-2-amino-propene on the pre- and postnatal development of rats. Lab. Invest., 17: 255-264, 1967.

Carstens, L.A. and Allen, J.R.: Ultrastructural changes in the liver of monkeys receiving total body irradiation. Fed. Proc., 26: 576, 1967.

Allen, J.R. and Carstens, L.A.: Ultrastructural observations on the fetal monkey liver and heart. Proceedings of the Annual Meeting of the American Veterinary Medical Association, Dallas, 1967.

Allen, J.R. and Carstens, L.A.: Ultrastructural modifications in the fetal monkey heart. J. Cell Biol., 35: 159A, 1967.

Carstens, L.A. and Allen, J.R.: Fine structural observations on embryonic myocardial binding sites. J. Cell Biol., 35: 22A, 1967.

Allen, J.R. and Carstens, L.A.: Ultrastructural changes in partially hepatectomized irradiated rat livers. Fed. Proc., 26: 576, 1967.

Barrett, T.J. and Allen, J.R.: Hematological changes in newly acquired Macaca speciosa monkeys. Proceedings of the Amer. Assoc. for Lab. Animal Science, Washington, D.C., 1967.

Allen, J.R. and Ahlgren, S.: A comparative study on the hematological changes in the Macaca mulatta monkey and on the human female during pregnancy. Amer. J. Obst. and Gyn., 100: 894-903, 1968.

Loh, P.M. and Allen, J.R.: Effects of partial hepatectomy upon livers of rhesus monkeys. Fed. Proc., 27: 66, 1968.

Allen, J.R., Carstens, L.A. and Ross, S.M.: Ultrastructural changes in the kidney following Crotalaria spectabilis intoxication. Proceedings of the Annual Meeting of the American Veterinary Medical Association, Boston, 1968.

Carstens, L.A. and Allen, J.R.: Ultrastructural changes in the lymph nodes of monocrotaline intoxicated rats. Fed. Proc., 27: 192, 1968.

Allen, J.R. and Carstens, L.A.: Sequential ultrastructural changes in the hepatic vessels of monkeys with veno-occlusive disease. Amer. J. Path., 52: 13A, 1968.

Allen, J.R. and Carstens, L.A.: Monocrotaline induced Budd-Chiari syndrome in monkeys. Amer. J. Digest. Dis., 16: 111-121, 1971.

Lalich, J.J. and Allen, J.R.: Protein overload nephropathy in rats subjected to unilateral nephrectomy. II. Ultrastructural evaluations. Arch. Path., 91: 372-382, 1971.

Chapman, W.L. and Allen, J.R.: The fine structure of the fetal and neofetal monkey (M. mulatta) thymus. Zeitschrift fur seleforschung and mekriskopische anatomia, 114: 220-233, 1971.

Allen, J.R. and Carstens, L.A.: Monocrotaline induced biochemical and ultrastructural changes in the hepatic endoplasmic reticulum. Amer. J. Path., 62: 80A, 1971.

Paik, S.K., Carstens, L.A. and Allen, J.R.: Three dimensional ultrastructural evaluation of the monkey heart. Fed. Proc., 30: 2730, 1971.

Allen, J.R. and Carstens, L.A.: Modifications of pyrrolizidine alkaloid toxicity by altering hepatic microsomes. Proc. Elect. Micr. Soc. Amer., Claitor's Publishing Division, 1971, pp. 550-551.

Lalich, J.J., Paik, W.C.W. and Allen, J.R.: Production of arterial hemosiderosis in monkeys following the ingestion of β-aminopropionitrile. Lab. Invest., 25: 302-308, 1971.

Lalich, J.J., Allen, J.R. and Paik. W.C.W.: Myocardial fibrosis in smooth muscle hyperplasia in coronary arteries of allylamine-fed rats. Amer. J. Path., 66: 225-234, 1972.

Allen, J.R.: Cor pulmonale: A sequela to monocrotaline intoxication in the infant monkey. Amer. J. Path., 66: 94A, 1972.

Frazee, W.J., Chesney, C.F. and Allen, J.R.: Effects of altered hepatic drug-metabolizing enzyme activities on the antimitotic action of monocrotaline in the liver of rats. Fed. Proc., 31: 611, 1972.

Engblom, J.F., Carstens, L.A. and Allen, J.R.: Antioxidant induced ultrastructural and biochemical changes in the liver of monkeys. Amer. J. Path., 66: 35A, 1972.

Allen, J.R., Jenny, J.M. and Chesney, C.F.: Pulmonary hypertension in young Macaca arctoides monkeys: A sequela to monocrotaline intoxication. Proceedings of the National Conference on Research Animals in Medicine, Washington, D.C., January 28-30, 1972.

Norback, D.H. and Allen, J.R.: Chlorinated triphenyl induced extensions of the hepatic endoplasmic reticulum. Proc. Soc. Exp. Biol. Med., 139: 1127-1131, 1972.

Norback, D.H. and Allen, J.R.: Chlorinated aromatic hydrocarbon induced modifications of hepatic endoplasmic reticulum: concentric membrane arrays. Environmental Health Perspectives, 1: 137-143, 1972.

Allen, J.R. and Abrahamson, L.J.: Enzymatic changes in the liver of rats fed chlorinated biphenyls, triphenyls and DDT. Proceedings of the American Chemical Society Meetings, 12: 97-111, 1972.

Allen, J.R. and Chesney, C.F.: Effect of age on development of cor pulmonale in nonhuman primates following pyrrolizidine alkaloid intoxication. Exp. Molec. Pathol., 17: 220-232, 1972.

Allen, J.R., Chesney, C.F. and Frazee, W.J.: Modifications of pyrrolizidine alkaloid intoxication resulting from altered hepatic microsomal enzymes. Toxicol. Appl. Pharmacol., 23: 470-479, 1972.

Chesney, C.F. and Allen, J.R.: Spontaneous osteogenic sarcoma in stump-tail (Macaca arctoides) monkeys. J. Natl. Cancer Inst., 49: 139-146, 1972.

Kerr, G.R., Tyson, I.B., Allen, J.R., Wallace, J. and Scheffler, G.: Deficiency of thyroid hormone and development of the fetal rhesus monkey. I. Effects on physical growth, skeletal maturation and biochemical measures of thyroid function. Biology of the Neonate, 21: 282, 1972.

Norback, D.H. and Allen, J.R.: Decreased cholesterol composition of hepatic microsomal membranes in rat following chlorinated triphenyl ingestion. J. Cell Biol., 55: 189A, 1972.

Allen, J.R. and Engblom, J.F.: Ultrastructural and biochemical changes in the livers of monkeys given butylated hydroxytoluene (BHT) and butylated hydroxyanisole (BHA). Food Cosmet. Toxicol., 10: 769-779, 1972.

Allen, J.R. and Norback, D.H.: Polychlorinated biphenyl and triphenyl induced gastric mucosal hyperplasia in primates. Science, 179: 498-499, 1973.

Chesney, C.F. and Allen, J.R.: Animal model of human disease: cardio-pulmonary disease. Pulmonary hypertension, cor pulmonale and endocardial fibroelastosis in monocrotaline-intoxicated nonhuman primates. Amer. J. Path., 70: 489, 1973.

Hsu, I.C., Chesney, C.F. and Allen, J.R.: Chronic effects of monocrotaline pyrrole on hepatic mitosis and DNA synthesis. Proc. Soc. Exp. Biol. Med., 142: 1133-1136, 1973.

Chesney, C.F., Allen, J.R. and Hsu, I.C.: Effect of monocrotaline, a pyrrolizidine alkaloid, on regenerating rat liver. Res. Comm. Chem. Path. Pharmacol., 5: 859-862, 1973.

Allen, J.R., Abrahamson, L.J. and Norback, D.H.: Biological changes in primates produced by a polychlorinated biphenyl and triphenyl. Fed. Proc., 32: 236, 1973.

Allen, J.R.: Biological effects of the antioxidants BHT and BHA. Annual Report of the Food Research Institute of University of Wisconsin-Madison, 1972, p. 82.

Abrahamson, L.J. and Allen, J.R.: The biological response of infant non-human primates to a polychlorinated biphenyl. Environmental Health Perspectives, 2: 81-86, 1973.

Allen, J.R., Abrahamson, L.J. and Norback, D.H.: Biological effects of polychlorinated biphenyls and triphenyls on subhuman primates. Environmental Research, 6: 344-354, 1973.

Chesney, C.F. and Allen, J.R.: Resistance of the guinea pig to pyrrolizidine alkaloid intoxication. Toxicol. Appl. Pharmacol., 26: 385-392, 1973.

Allen, J.R. and Abrahamson, L.J.: Morphological and biochemical changes in the liver of rats fed chlorinated biphenyls. Arch. Env. Contam. Toxicol., 1: 265-280, 1973.

Chesney, C.F. and Allen, J.R.: Monocrotaline-induced pulmonary vascular lesions in nonhuman primates. Cardiovasc. Res., 7: 508-518, 1973.

Branen, A.L., Richardson, T., Goel, M.C. and Allen, J.R.: Lipid and enzyme changes in the blood and liver of monkeys given butylated hydroxytoluene (BHT) and butylated hydroxyanisole (BHA). Food Cosmet. Toxicol., 11: 797-806, 1973.

Chesney, C.F. and Allen, J.R.: Endocardial fibrosis following monocrotaline-induced pulmonary hypertension in nonhuman primates. Amer. J. Vet. Res., 34: 1577-1581, 1973.

Flick, D.F., Firestone, D., Ress, J. and Allen, J.R.: Studies of the chick edema disease. 10. Relative toxicity of chick edema factors in the chick, chick embryo and monkeys. Poultry Sci., 52: 1637-1641, 1973.

Norback, D.H. and Allen, J.R.: Biological responses of the nonhuman primate, chicken, and rat to chlorinated dibenzo-p-dioxin ingestion. Environmental Health Perspectives, 5: 233-240, 1973.

Chesney, C.F. and Allen, J.R.: Urinary bladder carcinoma in a rhesus monkey (Macaca mulatta): A literature review and case report. Lab. Animal Sci., 23: 716-719, 1973.

Paik, S.K. and Allen, J.R.: A new multiple specimen table for freeze-etching. Proceedings of the Electron Microscopy Society of America. Claitor's Publishing Division, Baton Rouge, J. Arceneaux, ed., pp. 94-95, 1973.

Allen, J.R. and Carstens, L.A.: Long-term effects on monkeys of limited exposure to the polychlorinated biphenyls. Amer. J. Path., 74: 24A, 1974.

Allen, J.R.: Composition and functional changes in the endoplasmic reticulum of hepatic cells exposed to polychlorinated biphenyls. J. Cell Biol., 59: 6A, 1973.

Hsu, I.C., Allen, J.R. and Chesney, C.F.: Identification and toxicological effects of dehydroretronecine, a metabolite of monocrotaline. Proc. Soc. Exp. Biol. Med., 144: 834-838, 1973.

Kerr, G.R., Waisman, H.A., Allen, J.R., Wallace, J. and Scheffler, G.: Malnutrition studies in Macaca mulatta. II. The effect on organ size and skeletal growth. Amer. J. Clin. Nutrit., 26: 620, 1973.

Allen, J.R., Norback, D.H. and Hsu, I.C.: Tissue modifications in monkeys as related to absorption, distribution and excretion of polychlorinated biphenyls. Arch. Environ. Contam. Toxicol., 2: 86-95, 1974.

Chesney, C.F. and Allen, J.R.: Oxidative phosphorylation and respiration by liver mitochondria from polychlorinated biphenyl intoxicated rats. Biochem. Pharmacol., 23: 1577-1582, 1974.

Norback, D.H., Van Miller, J.P. and Allen, J.R.: Tetrachlorodibenzo-p-dioxin localization within the hepatic ER. J. Cell Biol., 63: 247A, 1974.

Allen, J.R., Carstens, L.A. and Barsotti, D.A.: Residual effects of short-term, low-level exposure of nonhuman primates to polychlorinated biphenyls. Toxicol. Appl. Pharmacol., 30: 440-451, 1974.

Allen, J.R. and Carstens, L.A.: Biological effects of the polychlorinated biphenyls in nonhuman primates. Proceedings of the International Symposium on Recent Advances in the Assessment of the Health Effects of Environmental Pollution, 1: 385-397, 1974.

Hsu, I.C., Shumaker, R.C. and Allen, J.R.: Tissue distribution of tritium-labeled dehydroretronecine. Chem-Biol. Interactions, 8: 163-170, 1974.

Chesney, C.F., Allen, J.R. and Hsu, I.C.: Right ventricular hypertrophy in monocrotaline pyrrole treated rats. Exp. Mol. Path., 20: 257-268, 1974.

Hsu, I.C., Shumaker, R.C. and Allen, J.R.: Toxicological effects of dehydro-retronecine — a metabolite of the pyrrolizidine alkaloids. Fed. Proc., 33: 640, 1974.

Chesney, C.F., Hsu, I.C. and Allen, J.R.: Modifications of the in vitro metabolism of the hepatotoxic pyrrolizidine alkaloid, monocrotaline. Res. Comm. Chem. Path. Pharmacol., 8: 567-570, 1974.

Allen, J.R. and Hsu, I.C.: Antimitotic effects of dehydroretronecine pyrrole. Proc. Soc. Exp. Biol. Med., 147: 546-550, 1974.

Allen, J.R.: Response of rats and nonhuman primates to polychlorinated biphenyl exposure. Fed. Proc., 34: 1675-1679, 1975.

Hsu, I.C. and Allen, J.R.: Synthesis of a tritium-labelled pyrrolizidine alkaloid - disenecioyl retronecine. J. Lab. Cmpds., 11: 71-76, 1975.

Hsu, I.C., Van Miller, J.P., Seymour, J.L. and Allen, J.R.: Urinary metabolite of 2,5,2',5'-tetrachlorobiphenyl in the nonhuman primate. Proc. Soc. Exp. Biol. Med., 150: 185-188, 1975.

Hsu, I.C., Robertson, K.A., Shumaker, R.C. and Allen, J.R.: Binding of tritiated dehydroretronecine to macromolecules. Res. Comm. Chem. Path. Pharmacol., 11: 99-106, 1975.

Shumaker, R.C., Hsu, I.C. and Allen, J.R.: Localization and tissue effects of tritiated dehydroretronecine in young rats. J. Path., 110: 21-28, 1976.

Allen, J.R.: Effects of long term exposure to antioxidants on female nonhuman primates. Arch. Environ. Health, 31: 47-50, 1976.

Hsu, I.C., Robertson, K.A. and Allen, J.R.: Tissue distribution, binding properties and lesions produced by dehydroretronecine in the nonhuman primate. Chem-Biol. Interactions, 12: 19-28, 1976.

Van Miller, J.P., Marlar, R.J. and Allen, J.R.: Tissue distribution and excretion of ^3H tetrachlorodibenzo-p-dioxin in nonhuman primates and rats. Food Cosmet. Toxicol., 14: 31-34, 1976.

Shumaker, R.C., Robertson, K.A., Hsu, I.C. and Allen, J.R.: Neoplastic transformation in tissues of rats exposed to monocrotaline and dehydroretronecine. J. Natl. Cancer Inst., 56: 787-790, 1976.

Barsotti, D.A., Marlar, R.J. and Allen, J.R.: Reproductive dysfunction in rhesus monkeys exposed to low levels of polychlorinated biphenyls (Aroclor 1248). Food Cosmet. Toxicol., 14: 99-103, 1976.

Seymour, J.L., Peterson, R.E. and Allen, J.R.: Tissue distribution and biliary excretion of 2,5,2',5'-tetrachlorobiphenyl (TCB) and 2,4,5,2',4',5'-hexachlorobiphenyl (HCB) in male and female rats. Society of Toxicology Abstracts, p. 155, 1976.

Norback, D.H., Seymour, J.L. and Allen, J.R.: Metabolic study of ^3H 2,4,5,2',4',5'-hexachlorobiphenyl and ^3H 2,5,2',5'-tetrachlorobiphenyl in rats. Amer. J. Path., 82: 36A, 1976.

Barsotti, D.A., Carstens, L.A. and Allen, J.R.: The association of transplacental and mammary movement of PCBs with infant morbidity and mortality. Amer. J. Path., 82: 21A-22A, 1976.

Seymour, J.L., Schmidt, S.P. and Allen, J.R.: In vitro generation of a chemically reactive metabolite of 2,5,2',5'-tetrachlorobiphenyl by rhesus monkey liver microsomes. Proc. Soc. Exp. Biol. Med., 152: 621-625, 1976.

Shumaker, R.C., Seymour, J.L. and Allen, J.R.: Disenecioyl dehydroretronecine-synthesis and acute hepatic toxicity of a pyrrolizidine alkaloid pyrrole analog. Res. Comm. Chem. Path. Pharmacol., 14: 53-61, 1976.

Norback, D.H., Seymour, J.L., Knieriem, K.M., Peterson, R.E. and Allen, J.R.: Biliary metabolites of 2,5,2',5'-tetrachlorobiphenyl in the rat. Res. Comm. Chem. Path. Pharmacol., 14: 527-533, 1976.

Allen, J.R. and Seymour, J.L.: In vitro generation by rhesus monkey liver microsomes of an active metabolite of 2,5,2',5'-tetrachlorobiphenyl capable of binding to macromolecules. Fed. Proc., 35: 504, 1976.

Allen, J.R. and Norback, D.H.: Pathobiological response of primates to polychlorinated biphenyl exposure. Proceedings of the National Conference of PCBs, EPA-560-16-75-004, pp. 43-49, 1976.

Allen, J.R., Carstens, L.A. and Abrahamson, L.J.: Response of rats exposed to polychlorinated biphenyls for fifty-two weeks. I. Comparison of tissue levels of PCB and biological changes. Arch. Environ. Contam. Toxicol., 4: 409-419, 1976.

Allen, J.R. and Barsotti, D.A.: The effects of transplacental and mammary movement of PCBs on infant rhesus monkeys. Toxicology, 6: 331-340, 1976.

Peterson, R.E., Seymour, J.L. and Allen, J.R.: Distribution and biliary excretion of polychlorinated biphenyls in rats. Toxicol. Appl. Pharmacol., 38: 609-619, 1976.

Allen, J.R., Marlar, R.J., Chesney, C.F., Helgeson, J.P., Kelman, A., Weckel, K.G., Traisman, E. and White, J.W. Jr.: Teratogenicity studies on late blighted potatoes in nonhuman primates (Macaca mulatta and Saguinus labiatus). Toxicology, 15: 17-23, 1977.

Shumaker, R.C., Raczniak, T.J., Johnson, W.D. and Allen, J.R.: Pulmonary heart disease induced by disenecioyl dehydroretronecine - a semi-synthetic pyrrolizidine alkaloid pyrrole. Proc. Soc. Exp. Biol. Med., 154: 57-59, 1977.

Raczniak, T.J., Chesney, C.F. and Allen, J.R.: Oxidative phosphorylation and respiration by mitochondria from normal, hypertrophied and failing rat hearts. J. Molec. Cell Cardiol., 9: 215-223, 1977.

Van Miller, J.P. and Allen, J.R.: Chronic toxicity of 2,3,7,8-tetrachlorodibenzo-p-dioxin in rats. Fed. Proc. 36: 396, 1977.

Allen, J.R. and Norback, D.H.: Carcinogenic potential of the polychlorinated biphenyls. Cold Spring Harbor Conferences on Cell Proliferation, Vol. 4, Origins of Human Cancer, edited by H.H. Hiatt, J.D. Watson and J.A. Winsten, Book A, Incidence of Cancer in Humans, pp. 173-186, 1977.

Allen, J.R., Barsotti, D.A. and Van Miller, J.P.: Reproduction dysfunction in nonhuman primates exposed to dioxins. Toxicol. Appl. Pharmacol., 41: 177, 1977.

Allen, J.R., Barsotti, D.A., Van Miller, J.P., Abrahamson, L.J. and Lalich, J.J.: Morphological changes in monkeys consuming a diet containing low levels of 2,3,7,8-tetrachlorodibenzo-p-dioxin. Food Cosmet. Toxicol. 15: 401-410, 1977.

Robertson, K.A., Johnson, W.D. and Allen, J.R.: Dehydroretronecine induced skin tumores in mice. Cancer Res., 18: 213, 1977.

Bushnell, P.J., Bowman, R.E., Allen, J.R. and Marlar, R.J.: Chronic lead poisoning impairs scotopic vision in young rhesus monkeys. Science, 196: 333-335, 1977.

Robertson, K.A., Seymour, J.L., Hsia, M.T. and Allen, J.R.: Covalent interaction of dehydroretronecine, a carcinogenic metabolites of the pyrrolizidine alkaloid monocrotaline, with cysteine and glutathione. Cancer Res., 37: 3141-3144, 1977.

Hsia, M.T.S., Bairstow, F.V.Z., Shih, L.C.T., Pounds, J.G. and Allen, J.R.: 3,4,3',4'-tetrachloroazobenzene: a potential environmental toxicant. Res. Comm. Chem. Path. Pharmacol., 17: 225-236, 1977.

Van Miller, J.P., Lalich, J.J. and Allen, J.R.: Increased incidence of neoplasms in rats exposed to low levels of 2,3,7,8-tetrachlorodibenzo-p-dioxin. Chemosphere, 6: 625-632, 1977.

Sun, P.S., Hsia, M.T.S., Chu, F.S. and Allen, J.R.: Inhibition of yeast alcohol dehydrogenase by dehydroretronecine. Food Cosmet. Toxicol., 15: 419-422, 1977.

Allen, J.R. and Van Miller, J.P.: Health implications of 2,3,7,8-tetrachlorodibenzo-p-dioxin exposure in primates. In: Pentachlorophenol, edited by K. Ranga Rao, Plenum Press, New York, pp. 371-379, 1978.

Allen, J.R. and Lambrecht, L.: Responses of rhesus monkeys to polybrominated biphenyls. Society of Toxicology Abstracts, pp. 243-244, 1978.

Raczniak, T.J., Chesney, C.F. and Allen, J.R.: Ultrastructure of the right ventricle after monocrotaline-induced cor pulmonale in the nonhuman primate (Macaca arctoides). Exp. Molec. Pathol., 28: 107-118, 1978.

Preston, B., Seymour, J.L., Kordes, J., Hsia, M.T. and Allen, J.R.: Effects of microsomal stimulators on the in vitro metabolism of 2,5,2',5'-tetrachlorobiphenyl (TCB), a component of carcinogenic polychlorinated biphenyl mixtures. Cancer Res., 19: 200, 1978.

Allen, J.R. and Abrahamson, L.J.: Comparative liver responses of rats fed polychlorinated biphenyl mixtures and tetrachlorobiphenyl and hexachlorobiphenyl isomers. Fed. Proc., 37: 320, 1978.

Norback, D.H., Britt, J., Hsia, M.T. and Allen, J.R.: Identification of metabolites of 2,5,2',5'-tetrachlorobiphenyl (TCB) and 2,4,5,2',4',5'-hexachlorobiphenyl (HCB) in rhesus monkey bile. Fed. Proc., 37: 299, 1978.

Lin, F.S., Hsia, M.T. and Allen, J.R.: Acute toxic effect of a tetrachlorobiphenyl on the rat liver plasma membrane. Fed. Proc., 37: 320, 1978.

Raczniak, T.J., Johnson, W.D., Preston, B.D., Voss, K.A., Allen, J.R. and Lalich, J.J.: Alteration in the active transport system of cultured human endothelial cells exposed to dehydromonocrotaline. Fed. Proc., 37: 900, 1978.

Allen, J.R., Van Miller, J.P. and Seymour, J.L.: Absorption, tissue distribution and excretion of ^{14}C ethylenethiourea by the rhesus monkey and rat. Res. Comm. Chem. Path. Pharmacol., 20: 109-115, 1978.

Pounds, J.G., Marlar, R.J. and Allen, J.R.: Metabolism of lead-210 in infant and adult rhesus monkeys (Macaca mulatta). Bull. Environm. Contam. Toxicol., 19: 684-691, 1978.

Shumaker, R.C., Hsia, M.T.S., Seymour, J.L. and Allen, J.R.: Synthesis of tritiated senecioyl dehydroretronecine, a pyrrolizidine alkaloid pyrrole. J. Lab. Cmpds. Radiopharm., 15: 227-232, 1978.

Lambrecht, L.K., Barsotti, D.A. and Allen, J.R.: Responses of nonhuman primates to a polybrominated biphenyl mixture. Environ. Health Persp., 23: 139-147, 1978.

Bairstow, F., Hsia, M.T., Norback, D.H. and Allen, J.R.: Toxicity of Firemaster FF-1 and 2,2',4,4',5,5'-hexabromobiphenyl in cultures of C3H/10T 1/2 mammalian fibroblasts. Environ. Health Persp., 23: 321-327, 1978.

Johnson, W.D., Robertson, K.A., Pounds, J.G. and Allen, J.R.: Dehydroretronecine-induced skin tumors in mice. J. Natl. Cancer Inst., 61: 85-89, 1978.

Bowman, R.E., Heironimus, M.P. and Allen, J.R.: Correlation of PCB body burden with behavioral toxicology in monkeys. Pharmacol. Biochem. Behavior, 9: 49-56, 1978.

Hsia, M.T.S., Lin, F.S.D. and Allen, J.R.: Comparative mutagenicity and toxic effects of 2,5,2',5'-tetrachlorobiphenyl and its metabolites in bacterial and mammalian test systems. Res. Comm. Chem. Path. Pharmacol., 21: 485-496, 1978.

Allen, J.R., Lambrecht, L.K. and Barsotti, D.A.: Effects of polybrominated biphenyls on nonhuman primates. J. Amer. Vet. Med. Assoc., 173: 1485-1489, 1978.

Allen, J.R. and Abrahamson, L.J.: Responses of rats exposed to polychlorinated biphenyls for fifty-two weeks. II. Compositional and enzymatic changes in the liver. Arch. Environm. Contam. Toxicol., 8: 191-200, 1979.

Norback, D.H., Mack, E., Blomquist, K.A. and Allen, J.R.: Metabolic study of 2,4,5,2',4',5'-hexachlorobiphenyl in rhesus monkeys. Toxicol. Appl. Pharmacol., 45: 331, 1979.

Barsotti, D.A., Abrahamson, L.J. and Allen, J.R.: Hormonal alterations in female rhesus monkeys fed a diet containing 2,3,7,8-tetrachlorodibenzo-p-dioxin. Bull. Environm. Contam. Toxicol., 21: 463-469, 1979.

Hargraves, W.A. and Allen, J.R.: The in vitro binding of 2,2',5,5'-tetrachlorobiphenyl metabolites to rat liver microsomal proteins. Res. Comm. Chem. Path. Pharmacol., 25: 33-52, 1979.

Allen, J.R., Barsotti, D.A., Lambrecht, L.K. and Van Miller, J.P.: Reproductive effects of halogenated aromatic hydrocarbons on nonhuman primates. New York Acad. Sci. Annals, 320: 419-427, 1979.

Lin, F.S.D., Hsia, M.T.S. and Allen, J.R.: Acute hepatotoxicity of a tetrachlorobiphenyl - changes in the hepatocyte ultrastructure and plasma membrane-bound enzymes. Arch. Environ. Contam. Toxicol., 8: 321-334, 1979.

Allen, J.R., Van Miller, J.P., Barsotti, D.A. and Carstens, L.A.: Toxicological responses of nonhuman primates to 1,2,3,6,7,8-hexachlorodibenzo-p-dioxin (HCDD). Toxicol. Appl. Pharm., 47: 179, 1979.

Schantz, S.L., Barsotti, D.A. and Allen, J.R.: Toxicological effects produced in nonhuman primates chronically exposed to fifty parts per trillion 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). Toxicol. Appl. Pharm., 47: 180, 1979.

Stadnicki, S.S., Lin, F.S.D. and Allen, J.R.: The toxicity and mutagenicity of 2,5,2',5'-tetrachlorobiphenyl (TCB) and its metabolites, TCB-phenol and TCB-arene oxide on cells in culture. Fed. Proc., 38: 995, 1979.

Allen, J.R., Barsotti, D.A. and Carstens, L.A.: Residual effects of polychlorinated biphenyls on adult nonhuman primates and their offspring. Fed. Proc., 38: 1119, 1979.

Preston, B.D., Van Miller, J.P., Moore, R.W. and Allen, J.R.: Dibenzofuran-free Aroclor 1254 as a promoter of diethylnitrosamine (DENA) hepatocarcinogenesis in rats. J. Natl. Cancer Inst., 20: 153, 1979.

Allen, J.R., Robertson, K.A., Johnson, W.D. and Carstens, L.A.: Toxicological effects of monocrotaline and its metabolites. Symposium on Pyrrolizidine Alkaloids: Toxicity, Metabolism and Poisonous Plant Control Measures, Nutrition Research Institute, Oregon State University, Corvallis, pp. 37-42, 1979.

Raczniak, T.J., Shumaker, R.C., Allen, J.R., Will, J.A. and Lalich, J.J.: Pathophysiology of dehydromonocrotaline-induced pulmonary fibrosis in the beagle. Respiration, 37: 252-260, 1979.

Stadnicki, S.S., Lin, F.D.S., and Allen, J.R.: DNA single strand breaks caused by 2,2',5,5'-tetrachlorobiphenyl and its metabolites. Res. Comm. Chem. Path. Pharmacol., 24: 313-327, 1979.

Stadnicki, S.S. and Allen, J.R.: Toxicity of 2,2',5,5'-tetrachlorobiphenyl and its metabolites, 2,2',5,5'-tetrachlorobiphenyl-3,4-oxide and 2,2',5,5'-tetrachlorobiphenyl-4-ol to cultured cells _in vitro_. Bull. Environm. Contam. Toxicol., 23: 788-796, 1979.

Forgue, S.T., Preston, B.D., Hargraves, W.A., Reich, I.L. and Allen, J.R.: Direct evidence that an arene oxide is a metabolic intermediate of 2,2',5,5'-tetrachlorobiphenyl. Biochem. Biophys. Res. Comm. 91: 475-483, 1979.

Carstens, L.A., Barsotti, D.A. and Allen, J.R.: Exposure of infant rhesus macaques (_Macaca mulatta_) to polychlorinated biphenyl (PCB). In: _Animals as Monitors of Environmental Pollutants_, pp. 339-345, 1979.

Allen, J.R., Barsotti, D.A., and Van Miller, J.P.P Pathology of rhesus macaques (_Macaca mulatta_) exposed to tetrachlorodibenzo-_p_-dioxin (TCDD). In: _Animals as Monitors of Environmental Pollutants_, pp. 346-355, 1979.

Allen, J.R., Barsotti, D.A. and Carstens, L.A.: Residual effects of polychlorinated biphenyls on adult nonhuman primates and their offspring. J. Toxicol. Environ. Health, In press.

Preston, B.D. and Allen, J.R.: 2,2',5,5'-tetrachlorobiphenyl: isolation and identification of metabolites generated by rat liver microsomes. Drug Metab. Dispo., Accepted.

Shumaker, R.C., Lalich, J.J. and Allen, J.R.: Toxicity of the acid moieties of pyrrolizidine alkaloid pyrroles. J. Exp. Path. Toxicol., Accepted.

Bushnell, P.J., Bowman, R.E. and Allen, J.R.: Experimental low level lead intoxication in the infant rhesus monkey: dose-effect relationships for blood lead intoxication. Toxicol. Appl. Pharmacol., Submitted.

Allen, J.R., Hargraves, W.A., Hsia, M.T. and Lin, F.S.D.: Comparative toxicology of chlorinated compounds on mammalian species. Pharmac. Ther., 7: 513-549, 1979.

Barsotti, D.A., Abrahamson, L.J., Marlar, R.J. and Allen, J.R.: The effects of climate controlled housing on the reproductive potential of the rhesus monkey. J. Reprod. Fert., In press.

Barsotti, D.A. and Allen, J.R.: Health implications of Aroclor 1016 on nursing rhesus monkey infants. Toxicol. Appl. Pharm., In press.

Allen, J.R., et al: IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans: Polychlorinated biphenyls and Polybrominated biphenyls. Volume 18, International Agency for Research on Cancer, World Health Organization, Lyon, France, 1978.

Allen, J.R., et al.: Polychlorinated Biphenyls; A report prepared by the Commission on National Resources, National Research Council, National Academy of Science, Washington, D.C., 1979.

Forgue, S.T., Preston, B.D., Hargraves, W.A., Reich, I.L. and Allen, J.R.: Direct evidence that an arene oxide is a metabolic intermediate of 2,2',5,5'-tetrachlorobiphenyl. Toxicol. Appl. Pharm. (accepted).

Preston, B.D., Van Miller, J.P., Moore, R.W. and Allen, J.R.: Promoting effects of polychlorinated biphenyls (Aroclor 1254) and polychlorinated dibenzofuran-free Aroclor 1254 on diethylnitrosamine-induced hepatic tumorigenesis in the rat. J. National Cancer Institute (accepted)

Allen, J.R., Barsotti, D.A. and Van Miller, J.P.: Toxicological effects of Aroclor 1016 on nonhuman primates. Environmental Toxicology Division, Office of Research and Development, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina 27711

Allen, J.R., Barsotti, D.A., Van Miller, J.P., Schantz, S.L. and Carstens, L.A.: Pathobiological effects of 2,3,7,8-tetrachlorodibenzo-p-dioxin on nonhuman primates. Laboratory of Environmental and Toxicological Chemistry (submitted)

appendix 1

SCIEX T.M.

SCIEX INC.

55 GLENCAMERON ROAD, #202, THORNHILL, ONTARIO, CANADA L3T 1P2

TELEPHONE: (416) 881-4646/(416) 223-9077 • TELEX: 06-964722

17 June, 1981

Ms. Anne Wordworth
Pollution Probe
12 Madison Avenue
Toronto, Ontario
M5S 1A1

Dear Ms. Wordworth:

This is in reply to your letter dated June 15 and I shall couch my reply as answers to the specific questions that you raise.

Q. How similar is this unit to gas chromatograph/mass spectroscopy equiment generally used for laboratory analysis of organic chemicals?

A. Our equipment, which we term the TAGA™ 6000 (See information attached) is mass spectrometer based, but differs from conventional gas chromatograph mass spectroscopy in the following ways:

i) it has been ruggedized for field use
ii) is available in a mobile vehicle as a fully integrated system
iii) it has been designed to provide extremely sensitive, yet extremely rapid analysis. It does this in many cases by eliminating the gass chromatograph from the inlet of the mass spectrometer and carries out the initial separation by a pre-mass spectrometer separator; thus you could think of this as a mass spectrometer/mass spectrometer approach as opposed to a gas chromatograph/mass spectrometer approach. This means that the chemical class separation step which typically takes 30 minutes in the case of a gas chromatograph, is shortened to a millisecond or less. This provides a unique analytical capability and will provide answers to complex mixture analysis problems within seconds.

Q. Can the unit be used to test for the presence of tetrachlorodioxins in the air? If so, at what detection limit? How accurate would the reading be? How long would it take to make a determination as to the presence of these dioxins in air?

Could this unit also be used to detect tetrachlorodioxins in soils or in leachate if the samples were properly prepared?

Does the unit have the capability to test for trichlorophenol, hexachlorobenzene, monochlorobenzene and monochlorotoluene? If so, what are the lowest detection limits possible in air and in soild with proper preparation of samples?

A. I will answer the previous three questions by referring to the attached appendix. This appendix shows you our estimated detection limits, accuracy, precision and time for analysis for air, water and soil samples. In the case of soil, we show two approaches, one is a rapid direct approach and the other is a more conventional approach, which includes a lengthy sample preparation stage. The figures given for this preparation stage we believe could be shortened by orders of magnitude with further development which we are currently carrying out. The Appendix shows these numbers for the following compounds as per your request:

a) Tetrachlorodioxin (TCDD)
b) 2,3,7,8-TCDD
c) Trichlorophenol
d) Hexachlorobenzene
e) Monochlorobenzene
f) Monochlorotoluene
g) PCB's, both in ambient and stack gas

Q. What other general parameters does the unit test for? Can heavy metals be detected?

A. The instrumented van of course can be equipped with meteorological sensors as well as spatial information sensors if required. However, the TAGA™ 6000 is a chemical analytical instrument. With regards our ability to analyze heavy metals, we have demonstrated a prototype heavy metal analyzer that is a simple clip-on module for our TAGA™ 6000. This is being engineered for commercial availability.

Q. Can the unit be used to monitor incinerators for the detection of residual emissions that might result from incomplete combustion?

A. Most definitely. SCIEX has pioneered the use of mass spectrometry for this work. We had an instrument connected to the St. Lawrence stack for six months for the development and demonstration of exactly this task. SCIEX has pioneered the linkage of a sensitive mass spectrometer to combustion incinerators. Measurements have been made of polycyclic hydrocarbons, PCB's, acid compounds and our published dioxin detection methodology could easily be transferred to such a system.

I hope these answers are sufficient. If you require further amplification in any area please contact me directly.

Yours sincerely,

N.M. Reid, Ph.D.
Executive Vice President and
Managing Director

nrm/nh

Enc.

APPENDIX

1. TOTAL TCDD

SAMPLE		DETECTION LIMIT	ANALYSIS TIME
a) Air		20 ng/TCDD/m^3 air or 2 ppt	2 - 5 minutes
b) Water, Leachate		1 μg TCDD/L water or 1 ppt	1 - 10 hr sample preparation + 2-5 minutes analysis
c) Soil, sediment			
Direct Method	(a)	1 mg TCDD/Kg soil or 1 ppm	2 - 5 minutes
Extraction Method	(b)	1 μg TCDD/Kg soil or 1 ppt	1 - 10 hr sample preparation + 2-5 minutes analysis
Fish and other biota		1 μg TCDD/Kg soil or 1 ppt	10-20 hr sample preparation + 2-5 minutes analysis

ACCURACY

Using 2 fragment ion species specific to TCDD, TCDD can be distinctively separated from common interfering chemicals such as DDE and PCBs. Accuracy and precision to 10 - 20%.

APPENDIX

2. 2,3,7,8-TCDD by capillary GC/MS/MS

	SAMPLE	DETECTION LIMIT	ANALYSIS TIME
a)	Air	50 μg/TCDD/m^3 air or 4 ppt	10 hr sample clean-up + 20-60 min analysis
b)	Water, Leachate	1.3 μg TCDD/L water or 1.3 ppt	10 hr sample clean-up + 20-60 minute analysis
c)	Soil, sediment	1.3 μg TCDD/Kg soil or 1.3 ppt	5-15 hr sample clean-up + 20-60 min analysis
	Fish, biota	1.3 μg TCDD/Kg body weight or 1.3 ppt	10-20 hr sample clean-up + 20-60 min analysis

PRECISION OR ACCURACY to 10 - 20%

2,3,7,8-TCDD can be unequivocally determined

APPENDIX

3. CHLORINATED AROMATICS IN AIR

TRICHLOROPHENOL : Real Time

5 ppt or 40 ng/m^3 air

4. HEXACHLOROBENZENE :

Real Time — 30 ppb or 345 μg/m^3 air

2 min integration: — 0.3 ppb or 3 μg/m^3 air

5. MONOCHLOROBENZENE: Real Time

0.6 ppb or 2.7 μg/m^3 air

6. MONOCHLOROTOLUENE: Real Time

0.5 ppb 2.6 μg/m^3 air

CHLORINATED AROMATICS IN SOIL

No work has been done to this date, but hexachlorobenzene, monochlorobenzene and monochlorotoluene should behave similarly to PCBs.

- ca. 1 ppm (1 mg/Kg) detection limit by direct soil analysis
- ca. 1 ppb (1 μg/Kg soil) by solvent extraction followed by MS/MS analysis

ANALYSIS TIME:

Air - Real Time - 3 minutes

Soil - 1-8 hr sample preparation for solvent extraction - MS/MS analysis

- or 5 min by direct soil desorption

APPENDIX

7. PCBs IN AMBIENT AIR

	DETECTION LIMIT
Monochlorobiphenyl	8.1 ng/m^3 air or 1.0 ppt
Dichlorobiphenyl	4.2 ng/m^3 air or 0.4 ppt
Trichlorobiphenyl	3.9 ng/m^3 air or 0.4 ppt
Tetrachlorobiphenyl	2.4 ng/m^3 air or 0.2 ppt
Pentachlorobiphenyl	11.1 ng/m^3 air or 0.8 ppt

8. PCBs IN STACK GAS

Monochlorobiphenyl	299 ng/m^3 or 38.9 ppt
Dichlorobiphenyl	264 ng/m^3 or 29.0 ppt
Trichlorobiphenyl	339 ng/m^3 or 32.0 ppt
Tetrachlorobiphenyl	282 ng/m^3 or 23.7 ppt
Pentachlorobiphenyl	179 ng/m^3 or 13.4 ppt
Hexachlorobiphenyl	181 ng/m^3 or 12.2 ppt