IN THE MATTER of an application for a Certificate of Approval for the Ridge Landfill Corporation Limited site in the Township of Harwich, in the County of Kent,

AND IN THE MATTER of an Environmental Assessment Board Hearing commencing July 14, 1981.

## WITNESS STATEMENT


Name: Frederick Bopp III, Ph.D., P.G.

Position: Project Manager, Geologist, Hydrogeologist, Geochemist

Address: Weston International Inc.
Weston Way
West Chester, PA 19380
USA

Phone: 215-692-3030




I have an interest herein, being an employee of Weston International Inc. carrying on business in Ontario as WESTON DESIGNERS-CONSULTANTS, an international engineering, consulting, environmental, planning, development and design firm retained by the Township of Harwich, a party herein, to provide environmental and other technical and opinion consultation services to the Township of Harwich and the Environmental Assessment Board in these matters.

The evidence presented in this witness statement will be both factual and opinion in nature.

My qualifications and experiences relevant to these matters are set forth in the following biographical, professional profile on page 2.

# Frederick Bopp III, Ph.D.



## Fields of Competence

Groundwater resources evaluation; hydrogeologic evaluation of sanitary landfills and other waste disposal methods; detection and abatement of groundwater pollution; digital modelling of groundwater flow and solute transport; statistical analysis of geological and geochemical data; geochemical prospecting; estuarine geology and geochemistry; trace metal and aqueous geochemistry.

## Experience Summary

Four years of experience in hydrogeology and geochemistry, involving such activities as: quantitative chemical analysis of water and soil; ore assay and ore body evaluation; drilling supervisor; hydrogeologic assessment; pollution detection and abatement; estuarine pollution analysis; application of flow and solute transport computer models; computer programming; project management; teaching environmental geology and geochemistry.

## Credentials

B.A. Geology — Brown University (1966)

M.S. Geology — University of Delaware (1973)
Thesis: "Trace Metals Near Shell Banks in Delaware Bay"

Ph.D. Geology — University of Delaware (1979)
Thesis: "Trace Metal Geochemistry of Upper Delaware Bay"

## Affiliations

Sigma Xi, The Scientific Research Society of North America

Geological Society of America: Hydrology Division

National Water Well Association: Technical Division

American Association for the Advancement of Science

Society for Environmental Geochemistry and Health

Estuarine Research Federation: Atlantic Estuarine Research Society

## Employment History

| | |
|---|---|
| 1979-Present | Weston |
| 1977-1979 | U.S. Army Corps of Engineers<br>Waterways Experiment Station<br>Staff Hydrogeologist |
| 1976-1977 | University of South Florida<br>Department of Geology<br>Visiting Assistant Professor of Geochemistry |
| 1970-1976 | University of Delaware<br>Department of Geology<br>Research and University Fellow |
| 1974-1976 | Earth Quest Associates<br>President and Principal Partner |
| 1974<br>Summer | Weston |
| 1966-1970 | United States Navy<br>Commissioned Officer |

## Key Projects

Flow and solute transport digital model of a heavily-pumped aquifer in southern New Jersey.

Definition and abatement of groundwater contamination from chemical manufacture in the Denver area.

Flow and solute transport digital model of a contaminated groundwater aquifer in the Denver area.

Hydrogeologic impact assessment of on-land dredge spoil disposal in coastal North Carolina.

Hydrogeologic and estuarine impact assessment of phosphoric acid manufacture in the Tampa area.

Geochemical prospecting and ore body analysis in Arizona.

Definition and abatement of groundwater contamination from a hazardous waste site in northern New England.

Definition and abatement of groundwater contamination from plating and foundry wastes in eastern Pennsylvania.

Operational test and evaluation of new naval mine ordnance in southern Florida.

## Publications

Optimum Future Demand Analysis: Final Report on Substudies V and VI, Southern New Jersey Water Resources Study; USAE-WES, Vicksburg, MS, 76 p., 1979.

The Remobilization of Trace Metals from Suspended Sediments Entering the Delaware Estuary: presented at the 27th Annual Meeting, Southeastern Section, Geol. Soc. America, Chattanooga, TN, April 1978.

# Professional Profile

I am a qualified Geologist, Hydrogeologist, Geochemist and have studied and been actively involved in planning, siting, permitting, assessment, and field analysis of hazardous and industrial waste landfills, other landfills, and solid and liquid waste treatment facilities, including their present and potential effects and control.

I am unable to presently reference and identify exhibits which may be part of my evidence, and therefore cannot attach a list of exhibits, since the applicant has only filed "DRAFT" materials until this time.

My evidence will be directed to the following matters:

1. sufficiency of the applicant's environmental impact statement and application;

2. insufficiency of the applicant's environmental impact statement and application;

3. matters addressed in the letter dated May 29, 1981 from Tom Cross to Tom Murphy;

4. non-compliance and compliance with regulatory requirements;

5. comparative analysis of state-of-the-art methods, analysis, protocols and designs;

6. deficiencies, assumptions, criteria, adequacy and methodology;

7. necessary quality control and contingency capabilities;

8. continuing analysis, monitoring, responsibility and maintenance;

9. by-laws 5044, 5296, 5613, and 5618 of the Township of Harwich;

10. effect of the proposal on the Township of Harwich and other persons, flora and/or fauna;

11. inaccuracies; and

12. other matters raised upon further information supplied to this Board by the applicant and other persons.

I will also address the following matters as well as matters which Counsel for the Township of Harwich deems appropriate:

The above named witness will attend before the Board and be subject to examination and cross examination if required to do so.



Date: July 13, 1981

Frederick Bopp III, Ph.D., P.G.

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# WITNESS STATEMENT

FREDERICK BOPP III, Ph.D., P.G.



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Adequacy of Groundwater Chemistry Data

This is of concern because of the potential for migrating leachate to contaminate domestic drinking water supplies in the bedrock aquifer. No discussion of the methods of sampling of the wells, preparation of sample bottles, sample storage and transportation, analytical protocols or chain-of-custody documentation was provided.



Only two groundwater wells (Vermey and Sikkema) were sampled within one mile of the landfill, in spite of there being at least fifteen additional wells available for water chemistry sampling within that radius. Both the Vermey and Sikkema wells are ostensibly down-gradient from the site, according to Figure 4. Figure 4 is an invalid map, and, therefore, limiting the groundwater sampling program to the Vermey and Sikkema wells renders the close-in sampling program inadequate.

The analyses reported for groundwater samples (Appendix 3.1) are incomplete for all four wells sampled. The most nearly complete trace metals scan is presented only for the Vermey Well for only one sample--the other three wells never had

even this incomplete list of trace metals anlayzed. An inadequate list of potential industrial organic contaminants was analyzed--only PCB and pesticides analyses were reported, and these are among the least water-soluble compounds potentially to be found within the existing landfill. Analyses of even this short list were not done for any samples, save the first from the Vermey Wells.



Whole classes of organic compounds were omitted from the analytical listing--ie, the chlorinated and non-chlorinated volatile organic solvents such as Trichloroethylene, Tetrachloroethylene, Benzene, Zylene, Chloroform, etc.--in spite of the fact that some of the waste generators have indicated that some of these compounds are entering the landfill.

The groundwater chemical analysis program is inadequate in terms of number and location of wells sampled, as well as in terms of documentation of the sampling program and in terms of the numbers and types of analytes sought.

Required: Detailed information on the sampling and analytical protocols used, as well as chain-of-custody documentation.

Required: Rationale used in selecting the few wells sampled.

Required: Rationale used in selecting the few contaminants analyzed.

Required: More comprehensive ground water quality chemical analysis data.

Accuracy of Interpretation of Hydrogeological Data

This is of concern due to the conclusion, drawn from Figure 4, Hydrogeological Study, that bedrock groundwater flow is to the northeast at the site. Figure 4 is based upon the data in Table 4, Appendix 2.3. The validity of this data is questionable due to the most probable method used to collect the data. For purposes of this witness statement, it will be assumed that the data is correct.

Of the 26 wells used for preparation of the map, nine were missused in the map. Two of the wells, 3960 and 3956 are listed in the data table as "dry" but are contoured as having approximate water levels of 600 feet and 580 feet, respectively. The other seven wells were contoured to have water levels at least five feet different from the tabulated values, as follows:

| Well No. | Contoured Elevation | Tabulated Elevation | Difference[1] |
|---|---|---|---|
| 2652 | 548 | 515 | +33 |
| 2676 | 562 | 606 | -44 |
| 2677 | 574 | 569 | -5 |

| Well No. | Contoured Elevation | Tabulated Elevation | Difference[1] |
|---|---|---|---|
| 2716 | 557 | 611 | -54 |
| 3958 | 605 | 612 | -7 |
| 4697 | 547 | 539 | +8 |
| 6654 | 569 | 556 | +13 |



Footnote 1: + indicates map is contoured higher than the tabulated data, and - indicates the map is contoured lower than the tabulated data.

Recontouring the map yields an apparent groundwater migration direction from the landfill site to the northwest. Due to the lack of well control data in the immediate area around the landfill (17 wells are available within a one mile radius of the landfill, but none were used for the map) there are critical data control gaps on the map. The map is misdrawn, is incomplete, and is, therefore, invalid.

Required: Rationale for not using more of the available data control near the landfill.

Required: Assumptions used for revising tabulated data in drawing Figure 4.

Required: Additional well control data.

Required: Redraw the map of the bedrock aquifer potentiometric surface to reflect the available data more accurately.

Adequacy of Hydrogeological Data

Adequacy of hydrogeological data is of concern due to the projected directions of movement of contaminants which may enter the bedrock aquifer. One would normally expect that mounding of groundwater in the shallow aquifers would accelerate the downward migration of shallow groundwaters, thereby causing a mound to form in the bedrock aquifer under the landfill. Such a mound in the bedrock aquifer could establish a roughly radial flow regime in the bedrock aquifer, and such a mound would make all the wells in the area subject to contamination.

The potential for a radial flow regime in the bedrock aquifer apparently was never investigated. Of the 26 wells listed in Table 4, Appendix 2.3 of the Hydrogeological Study, only three wells plot within one mile of the center of the existing landfill dumpsite. There are 17 known wells available within that same mile radius which are not shown on the data.

An additional problem with the data used is the method of collection. All of the wells examined in the area of the landfill have piston pumps installed in them permanently.

There is no provision at any of those wells for being able to measure depths to water, and it would appear that this is the case at the rest of the wells listed in the aforecited Table 4.

My best estimate of how the data was obtained is from original drilling records. Very likely these records provide an estimate of casing elevation from a topographic map, and a single taped measurement of water depth at some undetermined and probably highly variable time interval after actual drilling was completed.



With drilling completion dates ranging from December 1951 to June 1978, the water level data for bedrock, the contour map derived therefrom, and any conclusions based thereon should be considered completely invalid.

Required: Complete description of method of collection of hydrogeological data.

Required: Rationale for not using any of the 17 known wells listed above within one mile of the site.

Lateral Migration of Leachate

The lateral migration of leachate is of concern because of the potential for movement of contaminants off-site and subsequent discharge either to surface waters or to groundwater wells.

The report uses a gradient of 0.003 to compute a lateral migration rate for the fractured till of 3 feet per year- that gradient was explicitly selected "away from the influence of the existing landfill."

Figure 5 in the report indicates that gradients within the fill area range up to 0.4. This higher gradient should be used for calculation of leachate travel times.

Groundwater mounded within the existing landfill might attain elevations of as much as 685 feet- more than twenty feet higher than shown as inferred contours on Figure 5.

The report appears to be in error in the assignment of porosity to the fractured till.

Required: Rationale for the selection of 0.01 as the porosity for fractured till

Required: Rationale for drawing the "inferred contours" on Figure 5

Required: Data control on water levels within the existing filled areas.

Adequacy of Surface Water Chemistry Data

This is of concern because of the potential discharge of contaminants to the drain networks, its ultimate discharge to navigable waterways of the Province of Ontario, and its potential impact upon livestock grazing in and near the drain system.

No discussion of the methods of sampling the wells, preparation of sample bottles, sample storage and transportation, analytical protocols or chain-of-custody documentation was provided.

Only two drainage ditch locations appear to have been sampled, on the Duke Drain upstream of the existing site, and on the Howard Drain downstream of the existing site. Figure 2 of the Hydrogeological Study indicates that four surface water sites were sampled, and the method of data presentation makes it unclear which of the three Howard Drain sites were sampled. The sample site labelled 3 on the Howard Drain, as plotted on Figure 2, places the sample site upstream of the confluence of the Duke and Howard Drains. Both of the other Howard Drain sample sites, labelled "MOE" and "Gartner Lee" are both well downstream of the existing landfill site. No samples are reported on the Duke Drain adjacent to the existing site, in spite of the fact that several

tile drains were observed to be discharging to the Duke Drain along the reach to the southeast of the existing fill operation. No samples were taken from the Lewis Drain to the northwest of the site, in spite of the facts that:

1) several leachate breakouts were observed by Provincial Offenses Officers on the northwest side of the landfill, and

2) at least one tile drain from the proposed Area B has been observed to be discharging to the upper end of the Lewis Drain.



The analysis reported for surface water samples (Appendix 3.1) are incomplete for all sites sampled. Incomplete trace metals scans are presented for all the samples.

An inadequate list of potential industrial organic contaminants was analysed-- only PCB and pesticide analyses were reported, and these are among the least water-soluble compounds potentially to be found within the existing landfill. Analyses of even this short list were not done for any samples.

Whole classes of organic compounds were omitted from the analytical listing-- i.e., the chlorinated and non-chlorinated volatile organic solvents such as trichloroethylene, tetrachloroethylene, benzene, zylene, chloroform, etc. in spite of the fact that some of the waste generators have indicated that some of these compounds are entering the landfill.

The surface water chemical analysis program is inadequate in terms of number and location of sites sampled, as well as in terms of documentation of the sampling program and in terms of the numbers and types of analytes sought.

Required: Detailed information on the sampling and analytical protocols used, as well as chain-of-custody documentation

Required: Rationale used in selecting the few sites sampled

Required: Rationale used in selecting the few contaminants analyzed

Required: More comprehensive Surface Water Quality Chemical Analysis Data.

Sources of Hydrochemical Data

The method of collection of hydrochemical data is of concern since there are several laboratories providing data, and there is no apparent method of cross-comparing data derived from the several sources.



The hydrogeological study presents hydrochemical data from five mutually independent sources: 1) Gartner Lee Associates Limited; 2) Enviroclean Limited; 3) the Ontario Research Foundation and Diversified Research Laboratories; 4) the Ministry of the Environment; and 5) an unidentified laboratory which provided tritium analyses. There are no sampling procedures, bottle preparation protocols, analytical protocols, quality assurance procedures, or chain of custody documentation for any of these sources of laboratory data.

Required: Provide detailed information as listed below for each of the five laboratories:

a. sampling procedures
b. sample bottle preparation protocols
c. analytical protocols
d. quality assurance procedures
e. chain of custody documentation

Adequacy of Proposed Monitoring Programs

This is of concern due to the potential long-term impact to the environment of the proposed landfill operation, and the desire of the local populace to have their health and safety protected from that long-term impact.



The proposed monitoring plan is set forth conceptually in pages 31-34 of the Design and Operations Report. There are numerous omissions and several discrepancies in the proposed plan, and these are discussed below.

General

a. The plan calls for installation of groundwater and gas monitors to be installed in the fill, but specifies that they will be installed prior to landfilling. This is a physical impossibility.

b. The plans do not specify how long the monitoring plan will be in effect, nor who will take it over after that period of time.

Well Water Quality

a. The plan indicates that an inventory of all existing groundwater wells in the surrounding area is complete, and that baseline water quality data has been analyzed over the last two years. However, no fewer than 15 additional wells exist within one mile of the landfill, and none of these is included in the background data bank.

b. The plan does not specify either how many groundwater monitor wells are to be monitored, or what compounds are to be analyzed.

c. The plan does not specify either how many wells are to be monitored in which aquifers, or what compounds are to be analyzed.

Leachate Production

a. The plan does not specify what a "reasonable area of fill" is prior to installation of leachate monitors.

Leachate Characteristics

a. The plan does not specify how many standpipes will be installed in the filled areas, nor does it specify the construction of these standpipes.

b. The plan does not specify which analytes will be selected in order to define the characteristics of the leachate.



Leachate Movement

a. The plan contains no specifics concerning how many monitors will be emplaced to ascertain whether or not leachate is moving.

b. The plan makes no provision for computing how much leachate is moving, nor how fast it is moving.

c. The plan does not specify what actions will be taken to counter the movement of leachate.

Surface Water Monitoring

a. There is no indication of how many surface water monitoring stations will be sampled, nor what their locations are, nor what analytes will be monitored.

Methane Gas Generation and Movement

a. There is no indication of how many gas monitors will be installed, nor their locations or construction specifications, nor how they will be monitored.

Required: Submit a comprehensive monitoring plan for review prior to a decision as to permitting for the landfill.

Adequacy of Proposed Plan for Locating and Removing Existing Tile Drains

This is of concern because existing tile drains may provide conduits for the transport of leachate in the fractured till zone to discharge points at surface water drain systems.

The entire plan for existing tile drains is contained under iii) of Section 4.3, Site Operations- Area A, and reads as follows: "Excavate and remove existing under drains, that intersect the cell area, to the limit of landfilling and backfill with compacted clay material."



This statement is so ambiguous that one cannot determine whether the drains are being removed within cells, or are being removed between the property boundaries and the cell limits. The latter of these cases is obviously the desired course of action.

No mention is made of tile drains known to be present in Area B, presently discharging to the Lewis Drain. Area C is a former farm, now lying fallow, and presumably has been tile drained in the past-- No mention of this is made with respect to Area C.

No indication is provided as to how the old drains will be located, and no specifics are provided for the method of their removal. Clearly the proposed consideration for tile drain removal is completely inadequate.

Required: Provide clarification as to which segment of the tile drains is to be removed

Required: Provide details concerning the method of locating and removing the existing tile drains

Required: Expand the proposed plan to include Areas B and C.

Required: Details of containment of leachate from reaching surrounding drains and tile beds to the site

Truck Loading Computations

This is of concern due to the potential impacts of elevated truck traffic upon local traffic patterns, road maintenance schedules and ambient air quality.



Assuming an 8 hour workday for receiving refuse (two additional hours per day were assumed for compaction and emplacement of daily cover), this translates to one truck either entering or leaving the site at intervals ranging from 21 minutes down to 5 minutes, although bunching may occur.

There appears to be no assessment provided in the application of the impact of this truck loading upon the following: 1) local traffic patterns, 2) local land use, 3) repair schedules for local roads, especially for Concession Road 4 (principal access to Areas A and B) which is gravel, 4) local ambient air quality, 5) school bus routing and stops, and 6) local farm traffic.

Required: Provide an assessment of the impact of truck loadings upon the following:

a. local traffic patterns
b. local land use
c. repair schedules for local roads
d. local ambient air quality
e. school bus routing and stops
f. local farm traffic

Volumetric Analysis of Leachate Requiring Control, Transportation and Treatment

This is of concern because leachate is to be transported and treated by unspecified methods at unnamed facilities, and because the currently proposed level of 54,000 imperial gallons per day appears to be low. On our calculation of increased infiltration, and with 260 work days per year, there would be 24 truck loads of leachate per day. If a sewage treatment plant is acceptable for treatment and disposal of this hauled leachate, the nearest plant in Blenheim may not have the available capacity.



The 48 truck trips represented by the generation of this volume of leachate translates to one tanker truck every ten minutes, and this truck loading factor has not been taken into account in the report traffic analysis.

Required: Provide adequate details of the leachate transport and treatment plan proposed

Required: Recompute the planned for volume of leachate

Required: If disposal is to be by truck hauling, include these truck loading factors into the traffic analysis

Required: Specify the amount of time leachate will be handled under the closure and post-closure period, and specify who is to take over leachate management after that period.

Vertical Migration of Leachate

Vertical migration of leachate is of concern because of the potential for present or future groundwater contamination. The hydrogeological study indicates that regional groundwater flow is to the northeast from the site, as illustrated in Figure 4 of the Hydrogeological Study. That figure shows bedrock aquifer elevations to range from a high of about 600 feet above mean sea level (MSL datum is assumed, because the report does not specify the datum) to a low of about 545 feet in the region encompassed by Charing Cross, Blenheim and Cedar Springs. Site specific water levels, as contoured on Figure 5 of the Hydrogeological Study indicate water level elevations ranging from a high of about 660 feet to a low of about 645 feet. These maps indicate that the vertical gradient driving landfilled fluids toward the bedrock aquifer is at least 100 feet, although the report does not mention this.



Such a steep gradient would appear toindicate that a vertical migration rate of 0.2 feet per year for the dense till is low by at least an order of magnitude. If there exist within

the dense till lenses of coarse grained materials, then the estimated vertical migration rate could be low by an additional one or two orders of magnitude.

Most of the boring logs indicate the presence of coarse grained materials in the till, and two refer to the presence of sand seams at various depths. Only four borings on the site penetrated to depths in excess of 16.5 feet. The report indicates the presence of one large pocket of sand and gravel material at the surface.



Required: Verify that the vertical gradient is 100 feet or more.

Required: Recompute the vertical migration rate for leachate.

Required: Provide some assurance that additional sand and gravel lenses are not present beneath the site.

Climate and Water Budget Estimates

The water budget computations are of concern because of the potential for generation of leachate by the landfill. The rate of filling of landfill cells with leachate was computed on the basis of the water budget calculations for potential evapotranspiration. Actual evapotranspiration losses are inevitably smaller that potential, thereby allowing for a higher infiltration rate that than computed, as well as a more rapid leachate generation rate.



The computational method employed is apparently that of Thornthwaite, although the method is not specified. The Thornthwaite procedure includes a number of highly restrictive and often subjective assumed values for input to the basic equation, including those of: 1) field capacity of the wastes; 2) grade of land; 3) surficial soil type; 4) depth of root penetration; 5) coefficient of surface runoff.

Additional assumptions for applicability of the Thornthwaite water balance computation include: 1) a single, continuous land use; 2) no disturbance of surface soils; 3) constancy of input variables such as runoff and precipitation rates. In the

water balance computation supporting the application, changes in land use and configuration were apparently not taken into account.

Required: Specify water balance computational method and assumptions

Required: Recast the water balance computations in terms of having open excavations, bare land, and then recompute the leachate generation rate.