

# **Questions That Regulatory Agencies Staff, Boards and Landfill Applicants and Their Consultants Should Answer About a Proposed Subtitle D Landfill or Landfill Expansion**

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April 1997

It has been found that landfill permitting regulatory agency staff and boards fail to properly implement the groundwater protection requirements of the US EPA Subtitle D regulations for municipal solid waste (MSW) landfilling. Often, landfill applicants, their consultants and regulatory agency staff and boards develop permits for new or expanded landfills without properly evaluating whether the proposed landfill design, operation, closure and post-closure care for a particular landfill will be protective of groundwater resources from pollution by landfill leachate for as long as the wastes in the landfill will be a threat. Frequently, it is assumed that a minimum Subtitle D single composite liner and landfill cover, as well as a set of groundwater monitoring wells located hundreds of feet apart at the point of compliance for groundwater monitoring, will be protective of groundwater resources for as long as the wastes in the landfill will be a threat. However, it is rare that such assumptions are valid. Listed below are questions that should be asked of all regulatory agency staff and boards to ascertain whether the permitting of a new or expanded landfill is in accord with regulatory requirements.

As part of being able to reliably answer these questions, the regulatory agency staff should require that the landfill applicant reliably answer these questions in connection with the proposed development of a new or expanded landfill that conforms to US EPA Subtitle D requirements. Also, the regulatory agency staff and boards should confirm, by independent review, answers to these questions provided by the landfill applicant so that the public can be assured that the proposed landfill or landfill expansion will conform to regulatory requirements of protection of groundwater from MSW leachate pollution for as long as the wastes are a threat.

Since landfill applicants and their consultants, as well as some regulatory agency staff and board members fail to tell the whole truth about the ability of a proposed landfill or landfill expansion to protect groundwater resources, public health and the environment for as long as the wastes in the landfill will be a threat, the answers to these questions should be reviewed in a full public peer review arena where written answers are provided with appropriate documentation and technical support. The answers to the questions should be reviewed by an independent peer review panel of experts in the topic area who have no current or future financial interests in landfill development. The peer review expert panel should provide the regulatory agency boards and the public with their assessment of the reliability of the answers provided by the landfill applicant and their consultants, as well as the agency staff.

Many of these questions are applicable to evaluating whether an environmental impact statement/report (EIS/EIR) provides full disclosure of potential environmental problems associated with a proposed landfill project. They should be addressed in all EIS/EIRs.

Adoption of this approach for reviewing a proposed Subtitle D landfill or landfill expansion will significantly improve the reliability of the information provided to regulatory boards and the public on the potential public health and environmental impacts of a proposed landfill.

### **Importance of Protecting Groundwater Quality**

How important is it to protect groundwater resources in the area where the landfill is proposed to be sited or expanded from pollution by landfill leachate?

Should the people who dispose of garbage today pay the true cost of garbage disposal to protect future generations' groundwater resources from impaired use?

Do US EPA Subtitle D regulations require protection of groundwater resources from impaired use by landfill-derived leachate at the proposed landfill or landfill expansion site for as long as the wastes in the landfill will be a threat?

### **Adequacy of Staff Review of Submitted Materials**

Exhibit 1 is an example of a list of the enclosures that have been submitted to the regulatory agency on the technical deficiencies of the proposed landfill.

Were these materials reviewed by the staff in connection with developing the permitting of the landfill? If not, why not?

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#### **Exhibit 1 List of Enclosures**

- "Review of Regulatory Compliance of the Western Regional Sanitary Landfill Placer County, California"
- "Water Quality Evaluation and Management Solid and Hazardous Waste Landfills"
- "Municipal Solid Waste Landfills and Groundwater Quality Protection Issues"
- "Impact of Municipal and Industrial Non-Hazardous Waste Landfills on Public Health and the Environment: An Overview"
- "Landfills Offer False Sense of Security"
- "Dry Tomb Landfills"
- "Groundwater Pollution by Municipal Landfills: Leachate Composition, Detection and Water Quality Significance"
- "A Groundwater Protection Strategy for Lined Landfills"
- "Detection of the Failure of Landfill Liner Systems"
- "Landfill Leachate Management: Overview of Issues"
- "Landfill Post-Closure Care: Can Owners Guarantee the Money Will Be There?"
- "Landfilling of Solid & Hazardous Waste: Facing Long-Term Liability"
- "'No Guarantee' for Post Closure Care Funding"
- "Municipal Landfill Post-Closure Care Funding: The '30-year Post-Closure Care' Myth"

- "Review of Proposed Landfills: Questions that Should be Answered"
- "Evaluation of the Potential for a Proposed or Existing Landfill to Pollute Groundwaters"
- "Subtitle D Municipal Landfills vs. Classical Sanitary Landfills: Are Subtitle D. Landfills a Real Improvement?"
- "Cost of Groundwater Quality Protection in MSW Landfilling"
- "Geosynthetic Liner Systems for Municipal Solid Waste Landfills: An Inadequate Technology for Protection of Groundwater Quality?"
- "Permitting of New Hazardous Waste Landfills and Landfill Expansions: A Summary of Public Health, Groundwater Resource and Environmental Issues"
- "Municipal Solid Waste Management in Lined, 'Dry Tomb' Landfills: A Technologically Flawed Approach for Protection of Groundwater Quality"
- "Overview of Landfill Post Closure Issues"
- "Comments on Tisinger and Giroud 'The Durability of HDPE Geomembranes'"
- "Recommended Design, Operation, Closure and Post-Closure Approaches for Municipal Solid Waste and Hazardous Waste Landfills"
- "Addressing Justifiable NIMBY: A Prescription for MSW Management"
- "Environmental Impacts of Alternative Approaches for Municipal Solid Waste Management: An Overview"
- "Environmental Ethics: The Whole Truth"
- "'Disposal' of Municipal Solid Wastes"
- "Petition to the State Water Resources Control Board to Review California Regional Water Quality Control Board Waste Discharge Requirements for University of California, Davis Class III Landfill Yolo County Order 96-228 Adopted on August 9, 1996"
- Recent Publications of G. Fred Lee & Anne Jones-Lee
- Lectures and Shortcourses Available from Drs. G. Fred Lee and Anne Jones-Lee
- Recent and Scheduled Presentations of Drs. G. Fred Lee & Anne Jones-Lee
- G. Fred Lee and Anne Jones-Lee Summary of Experience & Activities
- Summary Information

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### **Pollutional Characteristics of MSW Landfill Leachate**

Is the staff familiar with the composition of municipal landfill leachate?

Please examine Exhibit 2 and indicate if you find that the information provided on the composition of MSW leachate is representative of municipal landfill leachate.

Based on the results of the studies of approximately 100 landfills shown in Exhibit 2, do small amounts of municipal landfill leachate represent a significant potential threat to pollute large amounts of groundwater?

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**Exhibit 2**  
**Concentration Ranges for Components**  
**of Municipal Landfill Leachate**

| Parameter                                | "Typical" Concentration Range | "Average"* |
|------------------------------------------|-------------------------------|------------|
| BOD <sub>5</sub>                         | 1,000 - 30,000                | 10,500     |
| COD                                      | 1,000 - 50,000                | 15,000     |
| TOC                                      | 700 - 10,000                  | 3,500      |
| Total Volatile Acids (as Acetic Acid)    | 70 - 28,000                   | ---        |
| Total Kjeldahl Nitrogen (as N)           | 10 - 500                      | 500        |
| Nitrate (as N)                           | 0.1 - 10                      | 4          |
| Ammonia (as N)                           | 100 - 400                     | 300        |
| Total Phosphate (PO <sub>4</sub> )       | 0.5 - 50                      | 30         |
| Orthophosphate (PO <sub>4</sub> )        | 1 - 60                        | 22         |
| Total Alkalinity (as CaCO <sub>3</sub> ) | 500 - 10,000                  | 3,600      |
| Total Hardness (as CaCO <sub>3</sub> )   | 500 - 10,000                  | 4,200      |
| Total Solids                             | 3,000 - 50,000                | 16,000     |
| Total Dissolved Solids                   | 1,000 - 20,000                | 11,000     |
| Specific Conductance (umhos/cm)          | 2,000 - 8,000                 | 6,700      |
| pH                                       | 5 - 7.5                       | 63         |
| Calcium                                  | 100 - 3,000                   | 1,000      |
| Magnesium                                | 30 - 500                      | 700        |
| Sodium                                   | 200 - 1,500                   | 700        |
| Chloride                                 | 100 - 2,000                   | 980        |
| Sulfate                                  | 10 - 1,000                    | 380        |
| Chromium (total)                         | 0.05 - 1                      | 0.9        |
| Cadmium                                  | 0.001 - 0.1                   | 0.05       |
| Copper                                   | 0.02 - 1                      | 0.5        |
| Lead                                     | 0.1 - 1                       | 0.5        |
| Nickel                                   | 0.1 - 1                       | 1.2        |
| Iron                                     | 10 - 1,000                    | 430        |
| Zinc                                     | 0.5 - 30                      | 21         |
| Methane Gas                              | 60%                           |            |
| Carbon Dioxide                           | 40%                           |            |

All values mg/L except as noted

\* Based on 83 Landfills Reported by CH2M Hill (1989)

After: Lee et al. (1986)

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### **Threat of the Proposed Landfill to Impair Groundwater Quality**

What is the staff's understanding of how long the wastes in the proposed landfill or landfill expansion will be a threat?

What is the basis for any assessment that the wastes in this landfill will be a threat for less than hundreds to a thousand or more years?

#### **Landfill Liner Issues**

What will be the liner for the proposed landfill?

Is it a minimum Subtitle D single composite liner?

What is your estimate of how long a 60 mil HDPE liner (plastic sheeting) in the proposed landfill liner will function as an effective barrier to prevent leachate from passing through the liner on its way to cause groundwater pollution?

What is the basis for your estimate?

Do you believe the plastic liner for the proposed landfill will be able to prevent leachate from passing through it in sufficient quantities to prevent groundwater pollution by landfill leachate for as long as the wastes in the landfill will be a threat?

Is the staff aware that landfill liner companies only warrant the flexible membrane liners for a period of 20 years?

Does the staff know that this warranty is pro-rated over this period and that the landfill owner/operator must remove the wastes above the defective area so the liner can be fixed?

How does a landfill owner know precisely where a liner is leaking?

Is this warranty of significant value in protecting groundwater from pollution by landfill leachate?

Does this highly limited warranty reflect the fact that landfill liner companies believe the flexible membrane liners they manufacture will protect groundwaters from impaired use for as long as the wastes in the landfill will be a threat?

Is it your position that the plastic sheeting liner and compacted clay layer, i.e. composite liner, in the proposed landfill will be an effective barrier to prevent leachate from passing through it on its way to polluting the groundwaters underlying the landfill for as long as the wastes will be a threat?

## **Subtitle D Regulations**

Is the staff familiar with the part of the US EPA's Subtitle D regulations proposed in 1988 which stated,

"First, even the best liner and leachate collection system will ultimately fail due to natural deterioration, and recent improvements in MSWLF (municipal solid waste landfill) containment technologies suggest that releases may be delayed by many decades at some landfills."

Further, the US EPA in their Criteria for Municipal Solid Waste Landfills (July 1988) stated,

"Once the unit is closed, the bottom layer of the landfill will deteriorate over time and, consequently, will not prevent leachate transport out of the unit."

US EPA, "Solid Waste Disposal Facility Criteria; Proposed Rule," Federal Register 53(168):33314-33422, 40 CFR Parts 257 and 258, US EPA, Washington, D.C., August 30 (1988a).

US EPA, "Criteria for Municipal Solid Waste Landfills, "US EPA Washington D.C., July (1988b).

Do you disagree with the US EPA's reported finding, as part of promulgating Subtitle D, that the single composite liner will eventually deteriorate and allow leachate to pass through it and thereby not be collected in the leachate collection system?

If you do not agree, what is the basis for your disagreement?

What new information has been developed that shows that plastic sheeting liners of the type that are proposed for the landfill will prevent leachate from passing through them for as long as the wastes in the landfill waste management cells will be a threat?

## **Subtitle D Landfill Design Requirements**

Is the staff familiar with US EPA Solid Waste Disposal Criteria Final Rule, October 9, 1991, Subpart D (Subtitle D) requirements for groundwater quality protection §258.40 Design Criteria which requires,

*"(a)(1) The design must ensure that the concentration values listed in Table 1 of this section will not be exceeded in the uppermost aquifer at the relevant point of compliance..."*

Also, the US EPA states in their Subtitle D regulations,

*"For landfills located where ground water is currently used or reasonably expected to be used for drinking water, the performance standard requires States to prevent contamination from exceeding drinking water standards."*

Exhibit 3 presents Table 1 from the US EPA Subtitle D requirements.

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**Exhibit 3**

***"Environmental Protection Agency"***

*NOTE TO SUBPART D: 40 CFR part 239 is reserved to establish the procedures and requirements for State compliance with RCRA section 4005(c)(1)(B).*

**Table 1**

| <b>Chemical</b>                    | <b>MCL (mg/l)</b> |
|------------------------------------|-------------------|
| Arsenic                            | 0.05              |
| Barium                             | 1.0               |
| Benzene                            | 0.005             |
| Cadmium                            | 0.01              |
| Carbon tetrachloride               | 0.005             |
| Chromium (hexavalent)              | 0.05              |
| 2,4-Dichlorophenoxy acetic acid    | 0.1               |
| 1,4-Dichlorobenzene                | 0.075             |
| 1,2-Dichloroethane                 | 0.005             |
| 1,1-Dichloroethylene               | 0.007             |
| Endrin                             | 0.0002            |
| Fluoride                           | 4                 |
| Lindane                            | 0.004             |
| Lead                               | 0.05              |
| Mercury                            | 0.002             |
| Methoxychlor                       | 0.1               |
| Nitrate                            | 10                |
| Selenium                           | 0.01              |
| Silver                             | 0.05              |
| Toxaphene                          | 0.005             |
| 1,1,1-Trichloromethane             | 0.2               |
| Trchloroethylene                   | 0.005             |
| 2,4,5-Trichlorophenoxy acetic acid | 0.01              |
| Vinyl Chloride                     | 0.002             |

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Will the single composite liner specified in the permit for the proposed landfill be expected to meet Subtitle D requirements of preventing exceedances of Table 1 constituents at the point of compliance for groundwater monitoring for as long as the wastes represent a threat at all sites where a landfill could be constructed?

What was the technical basis used to select the spacing of the monitoring wells at the point of compliance for the proposed landfill or landfill expansion?

Should a site-specific evaluation be made by the landfill permitting agency to determine if a minimum Subtitle D liner would be expected to be protective of groundwater resources as required by Subtitle D at the point of compliance for groundwater monitoring for as long as the wastes in the landfill will be a threat?

Is the staff familiar with US EPA Subtitle D Subpart E--Ground-Water Monitoring and Corrective Action §258.51 Ground-water monitoring systems which states,  
*"(a) A ground-water monitoring system must be installed that consists of a sufficient number of wells, installed at appropriate locations and depths, to yield ground-water samples from the uppermost aquifer (as defined in §258.2) that:*

*(2) Represent the quality of ground water passing the relevant point of compliance specified by Director of an approved State under §248.40(d) or at the waste management unit boundary in unapproved States."*

and §258.53 Ground-water sampling and analysis requirements,  
*"(c) The sampling procedures and frequency must be protective of human health and the environment."*

and §258.54 Detection monitoring program,  
*"(a) Detection monitoring is required at MSWLF units at all ground-water monitoring wells defined under §258.51(a)(1) and (a)(2) of this part. At a minimum, a detection monitoring program must include the monitoring for the constituents listed in appendix I to this part."*

and §258.55 Assessment monitoring program,  
*"(a) Assessment monitoring is required whenever a statistically significant increase over background has been detected for one or more of the constituents listed in the appendix I to this part or in the alternative list approved in accordance with §258.54(a)(2).*

*(b) Within 90 days of triggering an assessment monitoring program, and annually thereafter, the owner or operator must sample and analyze the ground water for all constituents identified in appendix II to this part."?*

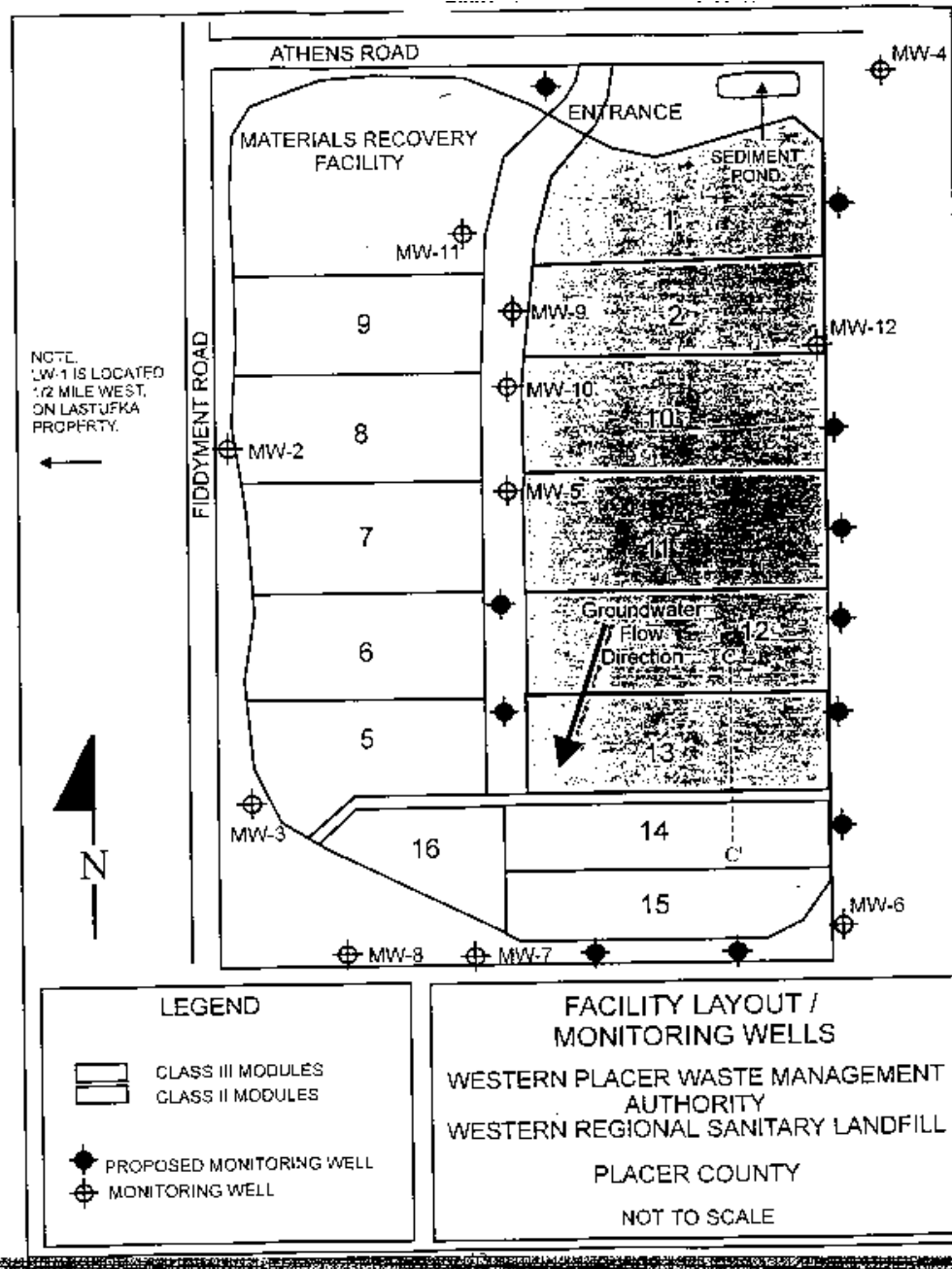
Do these sections of Subtitle D requirements prohibit a landfill from causing a statistically significant increase in the concentrations of constituents presented in appendices I and II of Subtitle D at the point of compliance for groundwater monitoring for a Subtitle D landfill?



## **Groundwater Monitoring**

Exhibit 4 presents an example of a plan for a municipal solid waste landfill site which shows the position of monitoring wells as allowed by a California regional water quality control board. This monitoring well array is typical of that allowed by regulatory agencies permitting Subtitle D landfills throughout the US. Would this array of monitoring wells comply with Subtitle D requirements providing a sufficient number of monitoring wells which will collect samples that represent the groundwater quality passing the point of compliance?

### **Exhibit 4 Facility Layout/Monitoring Wells of WRSL, Placer County, CA**



Where is the point of compliance for the landfill shown in Exhibit 4?

What are the Subtitle D requirements with respect to the ability of the groundwater monitoring system for the proposed landfill to detect leachate-polluted groundwaters at the point of compliance?

What is the spacing between the monitoring wells?

Should a map of the site contain a scale showing the approximate distances so that reviewers of the map can determine the spacing between the monitoring wells?

Assume that the map is one inch equals 100 feet. Is the spacing between the monitoring wells along the downgradient edge of the waste management unit, i.e. point of compliance - hundreds of feet apart?

Is this typical of groundwater monitoring wells for Subtitle D landfills at the point of compliance?

Are there a sufficient number of monitoring wells located such that they provide assurance of earliest possible detection of leachate releases from the waste management unit?

How can the staff be certain that the monitoring wells spacing and location will provide assurance of detection of leachate releases from the waste management unit and thereby provide for the assurance of earliest possible detection of releases from the waste management unit?

Was a site-specific evaluation conducted to determine whether the proposed monitoring well spacing and location would have a high probability of detecting landfill leachate-polluted groundwaters at the point of compliance for as long as the wastes in the landfill will be a threat?

If not, why not?

Does the staff agree that a site-specific evaluation is an appropriate requirement in order to evaluate whether the groundwater monitoring system has the potential to comply with Subtitle D requirements?

If not, why not?

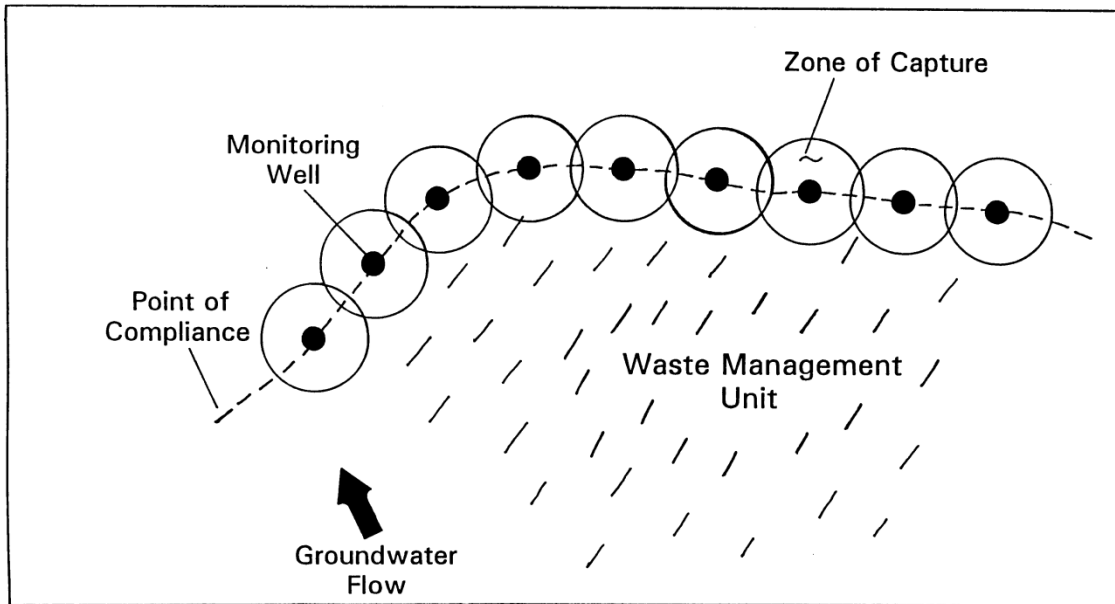
How was the groundwater monitoring system designed for the proposed landfill or landfill expansion?

Was a site specific evaluation made to ensure that the well spacing and location would detect leachate polluted groundwaters when they first reach the point of compliance?

Did the staff review the paper, "A Groundwater Protection Strategy for Lined Landfills," published by Dr. G. Fred Lee and Dr. Anne Jones-Lee, in Environmental Science and Technology, concerning the problems of trying to monitor groundwater pollution by leakage through plastic-sheeting lined landfills?

Exhibit 5 is adapted from the Parsons and Davis paper showing an array of monitoring wells along the downgradient edge of a waste management unit which displays zones of capture of these wells, indicating that the monitoring wells zones of capture should overlap in order to prevent leachate from passing between the monitoring wells and fail to be detected by them.

**Exhibit 5**  
**Zones of Capture of Standard Monitoring Wells Must Overlap**  
**to Detect Leakage from Lined Landfills (after Parsons and Davis, 1992)**

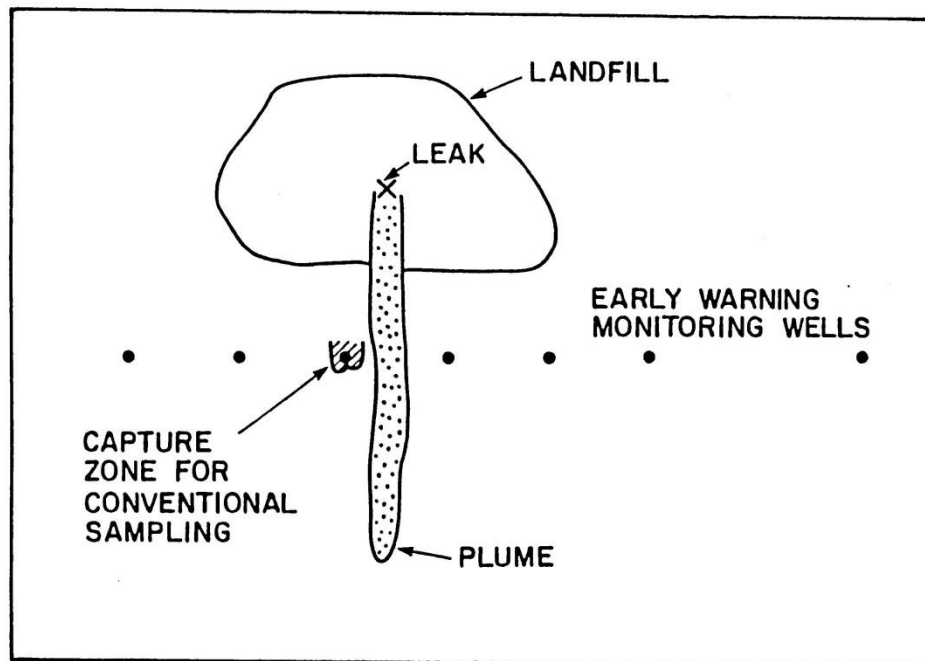


Do you agree with Parsons and Davis' suggested approach that the zones of capture of the monitoring wells and the well spacing should be such that there is a low probability of leachate-polluted groundwaters from passing the point of compliance without being detected?

If not, why not?

Exhibit 6 is a figure developed by Dr. John Cherry of the University of Waterloo from his 1990 paper which indicates that lined landfills produce finger plumes of leachate of a few meters width at the point of compliance for groundwater monitoring.

**Exhibit 6**  
**Pattern of Landfill Leakage - Groundwater Contamination from**  
**Lined Landfills (After Cherry, 1990)**



Does the staff agree that Dr. Cherry has properly assessed this situation?

If not, why not?

What are the zones of capture of the groundwater monitoring wells that the staff has proposed for use at the proposed landfill?

Is there a high probability that with the proposed monitoring well spacing of hundreds of feet apart and zones of capture of the monitoring wells of about one foot on each side, that leachate-polluted groundwaters that occur from leaks near the downgradient edge of the waste management unit, could pass by the point of compliance and not be detected by the monitoring well array that the staff have proposed?

Does the monitoring well array proposed by the staff for the proposed landfill provide assurance of the earliest possible detection of releases from the waste management unit?

Is there significant probability that the concentrations of the constituents listed in Table 1 (Exhibit 3) will be exceeded in the groundwaters at the point of compliance for groundwater monitoring for the proposed landfill?

If not, why not?

Should the staff/board be proactive in groundwater quality protection, or must pollution occur before the regulatory agency will act to protect groundwater resources?

Are there locations where a site-specific evaluation would show that a minimum Subtitle D landfill should not be constructed at that location because,

- the liner system will not prevent leachate from leaving the landfill and entering the groundwater system underlying the landfill for as long as the wastes represent a threat;
- the proposed groundwater monitoring system does not have a high reliability of complying with Subtitle D requirements of *a sufficient number of wells to yield ground-water samples from the uppermost aquifer that represent the quality of ground water passing the relevant point of compliance?*

Should the implementation of Subtitle D requirements of groundwater quality protection require a site-specific evaluation of the expected performance of the landfill containment system components (liner and cover) and groundwater monitoring system reliability (monitoring well spacing and zones of capture) to protect "*human health and the environment*" for as long as the wastes in the landfill will be a threat?

Could pollution-impaired use of groundwaters occur by proposed MSW landfill leachate-derived constituents that are not on US EPA Subtitle D Table 1 and appendices I and II lists?

Is the staff familiar that a large number of unregulated chemicals (unconventional pollutants) are present in municipal landfill leachate?

Could there be hazardous or otherwise deleterious chemicals in the unregulated chemicals in leachate that do not now have drinking water MCLs?

Is it appropriate to assume, as the US EPA is doing in their Subtitle D regulations, that because all drinking water MCLs are met as set forth in Table 1 that a groundwater polluted by landfill

leachate is safe to consume considering the presence of unregulated hazardous or otherwise deleterious chemicals in MSW leachate?

### **Post-Closure Care Period**

Does Subtitle D only limit groundwater protection to 30 years after closure of a landfill?

Are you familiar with Subtitle D, Subpart F Closure and Post-Closure Care requirements which state:

*"§258.61 Post-closure care requirements.*

*(b) The length of the post-closure care period may be:*

*(2) Increased by the Director of an approved State if the Director of an approved State determines that the lengthened period is necessary to protect human health and the environment."*

Will the wastes in a Subtitle D "dry tomb" landfill be a threat after the landfill has been closed for 30 years?

If no, what will happen to the heavy metals, inorganic salts and persistent organics that are present in the wastes that will cause them not to be a threat?

Will they still be available to be leached from the wastes and, for some of the organics, produce landfill gas?

Given that the wastes after a 30-year post-closure period will still be a threat to cause groundwater pollution through leachate generation and develop landfill gas, does the staff believe that the Board will allow the landfill owner/operator to no longer maintain and to continue to provide post-closure care required by Subtitle D at the proposed landfill?

Since wastes will be a threat forever, will post-closure care be required forever?

Are Subtitle D landfills significantly better than the unlined landfills with respect to their ultimate protection provided for groundwater quality?

If so, how?

Is it better to postpone groundwater pollution so future generations will have to address it rather than requiring that those who generate the wastes address the problems associated with the landfill during the time that the wastes are generated?

Subtitle D, Subpart D -- Design Criteria states,  
*"§258.40 Design criteria*

*(a) New MSWLF units and lateral expansions shall be constructed:*

*(1) In accordance with a design approved by the Director of an approved State or as specified in §258.40(e) for unapproved States. The design must ensure that the concentration values listed in Table 1 of this section will not be exceeded in the uppermost aquifer at the relevant point of compliance, as specified by the Director of an approved State under paragraph (d) of this section, or*

*(2) With a composite liner, as defined in paragraph (b) of this section and a leachate collection system that is designed and constructed to maintain less than a 30-cm depth of leachate over the liner.*

*(b) For the purposes of this section, composite liner means a system consisting of two components; the upper composite must consist of a minimum 30-mil flexible membrane liner (FML), and the lower component must consist of at least a two-foot layer of compacted soil with a hydraulic conductivity of no more than  $1 \times 10^{-7}$  cm/sec. FML components consisting of high density polyethylene (HDPE) shall be at least 60-mil thick. The FML component must be installed in direct and uniform contact with the compacted soil component.*

*(c) When approving a design that complies with paragraph (a)(1) of this section, the Director of an approved State shall consider at least the following factors:*

*(1) The hydrogeologic characteristics of the facility and surrounding land;*

*(2) The climatic factors of the area; and*

*(3) The volume and physical and chemical characteristics of the leachate.*

*(d) The relevant point of compliance specified by the Director of an approved State shall be no more than 150 meters from the waste management unit boundary and shall be located on land owned by the owner of the MSWLF unit. In determining the relevant point of compliance State Director shall consider at least the following factors:*

*(1) The hydrogeologic characteristics of the facility and surrounding land;*

*(2) The volume and physical and chemical characteristics of the leachate;*

*(3) The quantity, quality, and direction, of flow of ground water;*

*(4) The proximity and withdrawal rate of the ground-water users;*

*(5) The availability of alternative drinking water supplies;*

*(6) The existing quality of the ground water, including other sources of contamination and their cumulative impacts on the ground water, and whether the ground water is currently used or reasonably expected to be used for drinking water;*



*(7) Public health, safety, and welfare effects;..."*

Did the staff perform the site-specific evaluations specified in the above quoted section from Subtitle D regulations as part of developing the permit for the proposed landfill?

If not, why not?

If this evaluation was conducted, what was the conclusion with respect to each of the listed items that led the staff to believe that a single composite liner of the type that the staff proposed for the landfill would prevent any of the constituents listed in Table 1 from exceeding the drinking water MCLs at the point of compliance for groundwater monitoring for as long as the wastes represent a threat?

In developing the permit for the landfill, did the staff assume, without conducting the evaluation required in Subtitle D, that a minimum Subtitle D liner system, landfill cover and the proposed groundwater monitoring system would comply with the Subtitle D groundwater protection requirements of preventing pollution by Subtitle D Table 1 constituents that exceed a drinking water MCL at the point of compliance for groundwater monitoring for as long as the wastes represent a threat?

Have the staff properly developed the permit for the landfill based on Subtitle D requirements for site-specific evaluations?

### **Lysimeters**

Is the purpose of the vacuum cup lysimeters that are installed under each of the landfill waste management unit cells that of providing early warning of leakage through the liner?

How many lysimeters will be placed under each landfill cell? What is the total area of each landfill cell?

What is the zone of capture of each lysimeter, i.e. how far does a lysimeter sample into the vadose zone underlying a waste management unit?

Is it possible that leaks through the liner system which will develop would not be sampled by the lysimeters that the staff have proposed in the permit for the landfill?

Will the lysimeters that have been proposed provide a reliable, effective warning system for leakage through the liner?

### **Comments by Staff**

One of the two areas that the staff chose to comment on with respect to the extensive comments that were provided to them on the deficiencies in the proposed landfill was,

*"1. The ultimate failure of minimum Subtitle D liner systems will allow leachate to enter groundwater. New landfill units should be constructed with a double composite liner. Staff agree that a double composite liner will provide greater protection of groundwater than the single composite liner specified in the tentative permit. Staff have not observed that single composite liners beneath Subtitle D landfills have failed to contain wastes. There is ample evidence that unlined landfills leak wastes to groundwater. However, the single composite liner standard, which was implemented through RCRA Subtitle D has resulted in the construction of a significant number of single composite-lined landfills. Although the time period for observing of these single composite-lined landfills is short, they are functioning well."*

What is the basis for stating that the Subtitle D landfill liner systems that have been installed since 1993 are **"functioning well"**?

How does the staff know that the minimum Subtitle D liner systems that have been installed are functioning well?

What conditions would have to exist to be able to determine that the Subtitle D liner systems that have been installed since 1993 are not functioning well?

Did the staff review the report that was submitted in the packet of materials as back-up to the comments on the deficiencies in the proposed permit for the proposed landfill entitled, "Detection of the Failure of Landfill Liner Systems," dated April 1996 developed by Drs. Lee and Jones-Lee?

Does the staff agree with the assessment presented in that report that there is little possibility that minimum Subtitle D landfills would, at this time, be demonstrating the inevitable failure of the liner system to prevent leachate from passing through them for as long as the wastes in the landfill will be a threat?

Did the staff, in their comment above, provide the Board with a reliable assessment of what is known and to be expected with respect to the performance of minimum Subtitle D landfill liner systems to prevent leachate from passing through them for as long as the wastes in the landfill represent a threat that can cause groundwater pollution, as required in Subtitle D?

Is the staff aware that New York, New Jersey, Pennsylvania, Michigan, Florida, Arizona, Oregon, Kentucky, Arkansas and possibly other states will not allow a minimum Subtitle D lined landfill to be constructed over vulnerable groundwaters such as those that exist under the proposed landfill site within their state?

Is the staff aware that these states require at least a double composite-lined system for municipal solid waste landfills located over vulnerable groundwater?

Is the staff aware that several of these states, particularly Michigan, have addressed the problems of trying to monitor landfill liner leakage that can lead to groundwater pollution by landfill leachate by requiring that a double composite liner be used where the lower composite liner is a leak detection system for the upper liner?

Is the Michigan Rule 641 approach which sets forth the requirement of a double composite liner as a more reliable approach for detecting leakage through liners than the approach that the staff have adopted for the proposed landfill?

Is it appropriate to assume that the hydraulic gradient underlying a landfill will be the hydraulic gradient that exists in perpetuity, i.e. for as long as the wastes in the landfill will be a threat?

Is it possible that the adjacent property owner could install a production well for either domestic or agricultural water supply that would change the hydraulic gradient and, therefore, the rate of groundwater movement underlying the proposed landfill?

Could a change in the hydraulic gradient lead to a greater probability that leachate generated through leakage through the minimum Subtitle D liner system would pass the point of compliance without being detected by the monitoring wells spaced hundreds of feet apart that have zones of capture of only one foot?

What provisions exist that prevent adjacent property owners from utilizing the groundwaters under their property for domestic or other water supply purposes and thereby changing the hydraulic gradient and therefore the rate at which off-site pollution of groundwaters occurs that is not detected by the monitoring well system proposed by the staff?

The second comment selected by the staff covering the many issues that were raised on the significant technical deficiencies in the proposed permit for the landfill was:

*"2. The minimum Subtitle D, Chapter 15 approach to closure is insufficient. A single composite barrier is required in the cover system for areas overlying compositely lined areas (module 13 and subsequent modules). This single composite barrier exceeds the minimum requirements of Subtitle D. The minimum RCRA Subtitle D requirement does not require a  $1 \times 10^{-6}$  cm/sec clay barrier layer. A four foot thick cover is required over unlined modules. This cover consists of two feet of foundation material, one foot of clay and a foot of topsoil to support vegetation. As long as the clay layer is properly maintained and repaired during the closure/post-closure period, this cover will provide protection of landfilled wastes from infiltration of significant amounts of precipitation. The landfill owner must protect the clay barrier layer from erosion, desiccation and differential settlement which can affect the integrity of the clay barrier layer in the cover."*

Did the staff review the report developed by Dr. G. Fred Lee and Dr. Jones-Lee that was submitted to the staff entitled, "Overview of Landfill Post-Closure Issues," as well as several other papers and reports included in the submitted materials which discussed the inability of a minimum Subtitle D landfill cover of the type proposed by the staff for the landfill to prevent leachate generation that will ultimately lead to groundwater pollution?

Is the desiccation cracking of clay layers in landfill covers well known in the literature?

Did the staff review the materials that were submitted on the state of Wisconsin's experience with an experimental landfill cover at the Omega Hills site which was published in a US EPA

report in 1990 covering landfill covers, where in a three-year period one-half inch wide desiccation cracks occurred to a depth of over three feet in the landfill cover?

Does the staff contend that visual inspection of the surface topsoil layer of a landfill that the landfill operator will be able to maintain the integrity of the cover for the closed waste management units so that the designed permeability of the cover will be maintained in perpetuity, i.e. as long as the wastes represent a threat?

If so, how will the landfill operator be able to learn of the desiccation cracks that will occur within the first season after the landfill cover is installed since these cracks will only occur in the low permeability layer which lies below the topsoil layer and the drainage layer?

Is the statement in the permit that the landfill owner must maintain the low permeability character of the cover a superficial requirement that cannot be achieved with the approaches that are normally used for cover inspection?

In the materials that were submitted to the staff was information that several companies have developed leak detection systems for landfill covers. It was suggested a leak detectable cover should be required in closing filled waste management units to prevent moisture from entering the landfill and thereby generating leachate that will lead to groundwater pollution.

Does the staff feel that it is appropriate to require that this readily available technology be specified in permits for all landfill closures that take place in the state?

Is it a fact that the landfill covers specified in the proposed landfill permit will not achieve Subtitle D's overall groundwater protection performance standards of preventing moisture from entering the wastes that leads to leachate generation and the impairment of groundwaters by landfill-derived constituents for as long as the wastes in the landfill will be a threat?

If not, why not?

### **Landfill Liner Organic Solvent Permeation**

Is the staff familiar with the permeation of organic chemicals through HDPE liners?

What is the permeation process?

Can solvents, such as those used for paint removal that can be purchased at any hardware store and that can be legally disposed of in an MSW landfill waste stream by homeowners can, when the container rusts out, pass through the wastes down to the liner and through the intact liner causing groundwater pollution?

Does the staff know how much groundwater pollution above drinking water MCLs for carcinogens can occur by a half gallon of the solvents that can be purchased by homeowners and disposed of in their household waste?

Would the staff be surprised to learn that this could be millions of gallons of groundwater.

Is the staff aware that many of these solvents are suspected human carcinogens and are regulated as carcinogens by the US EPA?

A discussion was provided, in the materials that were submitted, to reference to the work of Sakti and others at the University of Wisconsin, Madison on solvent permeation of HDPE liners where it was indicated that they found that a three-inch thick HDPE liner would only retard solvents passing through the liner, which does not contain any holes, for a period of 25 years.

Does the staff have any information that would show that Sakti et al. as well as others' assessment of the solvent permeation situation is incorrect?

What consideration was given to the permeation of organic solvents through the HDPE liner in developing permits for the proposed landfill?

If none, why not?

Does Subtitle D require that the staff consider whether the proposed landfill containment system will prevent groundwater pollution by the waste constituents for as long as the wastes in the landfill will be a threat?

If not, why not?

Have the staff, in developing the proposed landfill permits, properly implemented Subtitle D requirements of determining whether the proposed landfill liner cover systems will protect groundwaters from pollution by waste-derived constituents for as long as the wastes are a threat?

### **Appropriateness of Development of Permits for MSW Landfills**

Is it true that since Subtitle D was promulgated in 1991 that the staff have assumed that the minimum prescriptive design landfill liner and cover standards set forth in Subtitle D of a single composite liner would meet Subtitle D's overall groundwater protection performance standard of preventing impairment of use of groundwaters by waste-derived constituents for as long as the wastes in the landfill represent a threat?

Where does it state in Subtitle D that the groundwater protection performance standard can be assumed to be achieved by constructing the minimum Subtitle D liner system at all sites where landfills could be located?

Must the staff make a site-specific evaluation of each proposed landfill or landfill expansion to ensure that no impairment of the beneficial uses of surface water or groundwater beneath or adjacent to the landfill occurs throughout this post-closure period for as long as the wastes in the landfill represent a threat.

### **Breakthrough Times for Clay Liners**

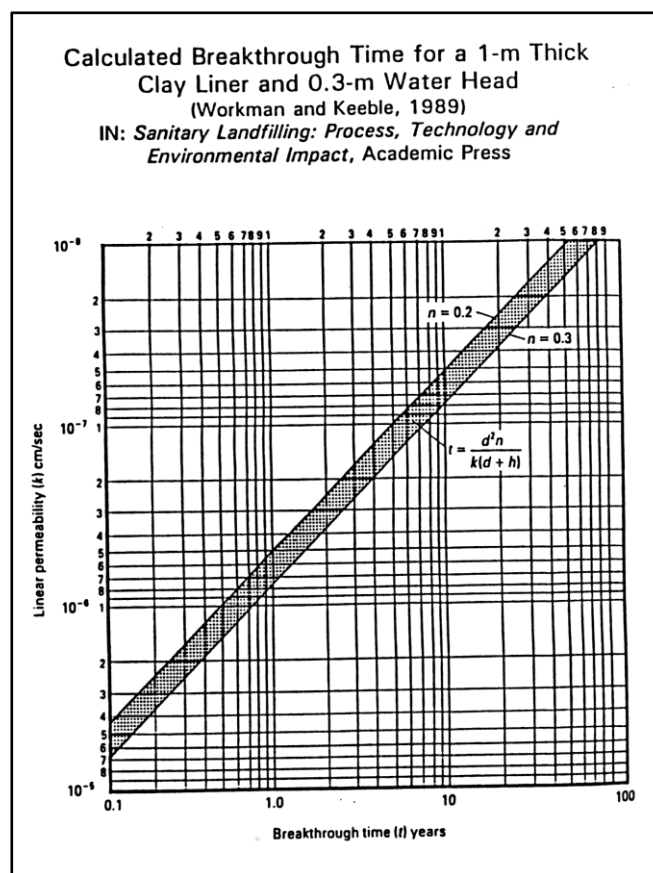
Exhibit 7 is a nomograph based on a Darcy's Law calculation developed by Workman and Keeble that was discussed in the materials submitted to the staff on the technical deficiencies of the proposed permit for the landfill which shows breakthrough times for various permeabilities of clay liner systems.

What is the thickness of the clay in the composite liner that is recommended for the proposed landfill?

Is this clay liner specified to be two feet thick with a permeability of less than  $1 \times 10^{-7}$  cm/sec?

Based on the nomograph presented in Exhibit 7, how long would it take leachate, once it has penetrated the plastic sheeting layer, to pass through the compacted clay layer underlying the plastic sheeting layer in the composite liner?

Exhibit 7



Does this nomograph show that leachate penetration of this clay layer through holes that develop in the plastic sheeting layer could occur within about seven years?

## **Desiccation Cracking of the Clay Layer of a Composite Liner**

Is the staff familiar with the approach that is used to develop a clay liner with respect to compaction of the liner with a moisture content slightly wet of the optimum of the moisture density relationship?

Does the compaction of a clay liner require the addition of moisture to the clay in order to achieve optimum compaction?

Is the staff familiar with the desiccation cracking of clay layers underlying flexible membrane liners in a composite liner?

Does the moisture that is used to enable optimum liner compaction leave this clay layer, through unsaturated transport, and does the drying of this layer lead to desiccation cracks in the layer?

Will the desiccation cracks that occur in the clay layer underlying the flexible membrane liner provide pathways through the clay where leaks that develop in the flexible membrane liner can penetrate the clay layer in less than the predicted rate of about seven years?

Did the staff review this issue in the materials that were provided to them on the proposed deficiencies of the single composite liner recommended by the staff as being suitable for the proposed landfill?

What provisions were taken by the staff in developing their recommended permit for the proposed landfill which includes a single composite liner, to address the desiccation cracking of the clay layer underlying the flexible membrane liner in the composite liner?

## **Leachate Component Attenuation**

Statements are made by landfill applicants, their consultants and regulatory agency staff who want to gain approval for a particular landfill that the clay layer in a composite liner and the natural geological strata represents additional barriers due to attenuation of constituents in the clay and the underlying geological strata.

Is the staff familiar with the attenuation processes that occur for municipal landfill leachate components in clay layers?

Is it appropriate to assume that all municipal solid waste MSW landfill leachate components that are a threat to groundwater pollution will be attenuated, i.e. prevented from transport, in passing through the underlying clay layer in a composite liner and through the natural geological strata at the landfill site?

Are there components in municipal solid waste leachate that are not attenuated to any significant extent by clays or natural geological strata and thereby move at about the same rate as water, eventually leading to groundwater pollution by the waste-derived constituents?

Should the staff become familiar with attenuation issues for municipal landfill leachate before they advise the Board that attenuation is an important mechanism for preventing leachate-derived constituents from polluting groundwaters under the proposed landfill?

Did the staff mislead the Board in its attempt to support the permit for the proposed landfill when it stated that the leachate components that pass through the plastic sheeting liner would be attenuated and therefore would not be a threat to pollute groundwaters?

### **Final Questions**

Will the recommended permit for the proposed landfill comply with Subtitle D requirements of protecting groundwaters from impaired use for as long as the wastes in the landfill will be a threat?

Does the current regulatory approach, in which it is assumed by the staff that a minimum Subtitle D landfill liner system consisting of a thin plastic sheeting layer and two feet of clay or equivalent, provide for groundwater quality protection for as long as the wastes are a threat?

Is it appropriate to assume that a minimum Subtitle D composite liner will comply with Subtitle D's performance standards of protecting groundwaters from impaired use for as long as wastes represent a threat at a site where it already has been demonstrated that groundwaters are vulnerable to pollution by landfill leachate based on the pollution of groundwaters by existing waste management units located in that area?

Is it appropriate to conclude that the proposed permit conditions for the landfill will protect groundwaters in the vicinity of the landfill from being polluted by landfill leachate for as long as the wastes in the landfill will be a threat?

If not, why not?

Is it appropriate to conclude that the groundwater monitoring approach proposed in the permit has a low probability of detecting leachate-polluted groundwaters at the point of compliance before pollution beyond this point occurs?

If not, what is the expected reliability of these monitoring systems to detect leachate polluted groundwaters when it first reaches the point of compliance?

### **Professional Ethics Issues**

Exhibit 8 is the cover page of a paper that discusses the significant professional ethics problem that exists today in landfill permitting where landfill applicant consultants and in some cases regulatory agency staff do not tell the board and public the whole truth about the ability of a landfill liner system and groundwater monitoring system for a particular landfill to protect groundwaters from impaired use for as long as the wastes in the landfill will be a threat.



Do you agree that there is a significant professional ethics problem in the landfill development field today with respect to the permitting of municipal solid waste landfills?

Does the staff understand that if a consultant who normally works on behalf of landfill applicants discusses the whole truth about the inevitable failure of the landfill liner and cover systems and the inability of the groundwater monitoring system to detect this failure in leachate-polluted groundwaters they will not obtain future work from landfill applicants?

Does the staff know that the American Society of Civil Engineers and the National Society for Professional Engineers have codes of ethics that require, with respect to matters of public health and safety, a civil engineer and a professional engineer to provide the public with the whole truth concerning the ability of a particular project, such as a landfill, to protect public health, groundwater resources and the environment from adverse impacts for as long as the wastes in the landfill will be a threat?

#### Exhibit 8

## ENVIRONMENTAL ETHICS: THE WHOLE TRUTH

**D**o engineers working on issues concerning the impacts of chemical constituents on public health or the environment have a professional obligation to tell the whole truth? The obvious answer is yes. Unfortunately, this is often not being done today.

The field of environmental quality management has become immersed in the adversarial (legal) system for "resolving disputes" among parties with different interests—a system significantly different from the traditional engineer/scientist (E/S) approach to addressing complex environmental issues. In the adversarial system, one side presents the strongest possible technical discussion on behalf of the client; it is left to the other side to bring out the weaknesses in the technical position. While such an approach is considered appropriate in the courtroom, the problem is that it is routinely followed by E/Ss in proceedings such as appearances before regulatory boards supporting or opposing proposed projects. Engineering and other technical reports commonly do not present a disinterested discussion of technical issues and information pertinent to the protection of public health and the environment.

When the responsible, competent E/S—who is charged to tell the truth complete with caveats, qualifiers, uncertainties and unanswered questions—presents the "whole" story to the client/employer, he or she is then frequently faced with a situation in which the client or employer wants only positive project-supportive information revealed and detracting information omitted. To be useful to the client/employer, the "expert" E/S must testify or otherwise make authoritative presentation of those selected facts and information in technical reports at hearings or other review-board proceedings.

Some professionals justify doing this on the grounds that they have to "play the game." The realities of maintaining a client, securing future work, and holding and advancing one's position in a firm, along with inadequate funding to conduct quality and necessary work compel some E/Ss to exaggerate, diminish or otherwise manipulate the whole truth—despite the fact that the codes of ethics of both ASCE and the National Society of Professional Engineers emphasize the importance of full disclosure on matters of public health and safety.

One way to help neutralize the effects of the adversarial system may be to incorporate a requirement with project applications for funding independent, disinterested technical review to be presented to the regulatory agency, decision makers and public. This approach is being followed in the siting of three large landfills to serve the Greater Toronto area.

It would provide considerable impetus for project consultants and advocates to be more forthcoming with reliable information on potentially adverse project impacts if they were faced

with exposure of the technical unreliability (failure to tell the whole truth) of their positions in a full peer-review public arena. Such a review could also help address "not-in-my-backyard" concerns if individuals, communities and interest groups had a mechanism for independent review and reporting of technical information they felt they could trust. To fund this peer-review process, a percentage of the cost of any proposed project with potentially significant public-health or environmental-quality implications could be made available.

While environmental impact statements (or, in California, environmental impact reports) should by law provide the vehicle for full technical disclosure of potential problems associated with the project, such documents rarely provide reliable in-depth review of complex technical issues, especially as they relate to chemical constituents in the environment. Every project applicant should be required to conduct plausible worst-case-scenario evaluations for projects involving management of chemical constituents in the environment.

Such evaluations must include consideration of the nature, transport, fate and effects of chemical constituents under plausible worst-case conditions; the ability of the project's monitoring system to detect impending public-health and environmental-quality impairment under plausible worst-case conditions; the actions that would be taken in response to such detection; the magnitude of harm to public health and environmental quality that could result from inadequate response actions to plausible worst-case conditions; the magnitude and source of funding available for corrective action required under plausible worst-case conditions for as long as the wastes and/or chemicals represent a threat; and the adequacy of the public-health and environmental-protection regulatory standards or other requirements applicable to the project, as well as potential future changes in those standards. The plausible worst-case-scenario evaluation would be provided for peer review of the project.

Adoption of this approach would provide the public, the regulatory community and officers of the courts with a much better understanding of the potential consequences of undertaking a particular project or activity. It would also be a major step in reversing the tide of unethical practices that have become common among engineers and scientists in the environmental-quality-management field today.

[This Forum is condensed from a more comprehensive review of the topic, available from the authors at tel. 916/753-9630; fax 916/753-9956.]

G. Fred Lee, P.E.

Anne Jones-Lee

G. Fred Lee & Associates

El Macero, Calif.

Do you agree that Drs. Lee and Jones-Lee's suggested approach as discussed in this paper (Exhibit 8) of requiring a full, public, independent peer review of controversial technical issues concerning a proposed landfill is an appropriate approach to follow to better ensure that future generations' groundwaters will not be polluted by landfill leachate than is being followed today in the permitting of landfills?

Does the staff feel that the independent peer review approach is an appropriate approach to take with respect to protecting public health, the environment and the public's interests?

Do you agree that regulatory agency staff typically understand the significant problems that exist today of permitting landfills that will not protect groundwaters from pollution by landfill leachate for as long as the wastes represent a threat?

Does this problem exist in your regulatory agency?

Who in the agency is responsible for continuing the policy of having the staff recommend permits for landfill liners and covers and groundwater monitoring systems that, based on what is well-established in the professional literature, obviously will not be protective of groundwater resources associated with the landfill for as long as the wastes represent a threat?

What needs to be done to change the current landfill permitting situation so that true groundwater quality protection can be achieved in the landfilling of municipal solid wastes at the proposed landfill?

Based on our discussions of issues, is it appropriate to require that the people who deposit wastes in the landfill pay the true cost of protecting groundwaters from impaired use for as long as the wastes in the landfill will be a threat?

Will the permit that is recommended by the staff for the proposed landfill provide protection of groundwater resources from impaired use for as long as the wastes represent a threat?

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References as:

Lee, G. F., "Questions that Regulatory Agencies, Staff, Boards and Landfill Applicants and Their Consultants Should Answer About a Proposed Subtitle D Landfill or landfill Expansion," Report G. Fred Lee & Associates, El Macero, CA (1997)