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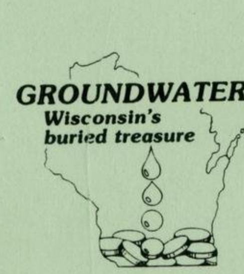

Wisconsin Department of Natural Resources

Volatile Organic Compounds in Groundwater and Leachate at Wisconsin Landfills

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February 1988

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DNR Staff, Interested Consulting Firms,
State Agencies and Individuals

SUBJECT: Volatile Organic Compounds in Groundwater at Wisconsin Landfills

This document is intended to be used by Department staff and others concerned with volatile organic compounds in groundwater. It is the product of a two-year study (1985-87) to gather data on volatile organic compound (VOC) contamination at Wisconsin landfills and to provide VOC monitoring recommendations to the Bureau of Solid Waste Management. As of February 1988, the Bureau does not require periodic VOC sampling of groundwater at new engineered landfills. Most VOC sampling is conducted as either background monitoring at new landfills or in response to contamination problems at specific landfills. The increase in VOC monitoring and detection at landfills across the state and nationwide has caused us to evaluate the need for periodic VOC sampling. This study provides the information needed for this evaluation.

The Department staff sampled 20 municipal and 6 industrial landfills twice over the two year period. We included landfills with clay-lined, zone-of-saturation and natural attenuation designs. The executive summary presents our findings and recommendations.

If you have any questions about the report, please contact Marci A. Friedman at (608) 267-3538 or Jack Connelly at (608) 267-7574.

Sincerely,

Lyman F. Wible

Lyman F. Wible, Administrator
Division of Environmental Standards

LFW:MF:sb/7884R

Enclosure

VOLATILE ORGANIC COMPOUNDS IN GROUNDWATER AND LEACHATE AT WISCONSIN LANDFILLS

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EXECUTIVE SUMMARY

The Wisconsin Department of Natural Resources, Bureau of Solid Waste Management is evaluating the need for periodic volatile organic compound (VOC) sampling at landfills. Currently, we require VOC sampling either to monitor background conditions at new landfills or to investigate contamination problems at a specific landfill. Department staff selected 26 landfills to sample based on design, age and performance. Nine clay-lined, six zone-of-saturation, six retarder or combined retarder and natural attenuation, four natural attenuation and one sludge-lined landfill were sampled. Samples from groundwater, leachate and collection lysimeters samples were analyzed for VOCs.

FINDINGS

The extent of VOC contamination at Wisconsin landfills. We detected VOCs in groundwater at landfills of various ages, designs and locations. Landfills without clay-lined designs comprise the majority of landfills where we detected VOCs in groundwater and appear to be of most concern at the present time. Three collection lysimeter samples contained VOCs. We attributed the VOCs to contamination from glues used in construction or sources other than leachate. Certain parameters appeared more frequently than others in groundwater and leachate. Concentrations of VOCs in leachate were generally greater than in groundwater except in some highly contaminated wells. Groundwater containing VOCs frequently did not contain the same VOC parameters as leachate samples from the same landfill.

The influence of landfill design and waste type. For the eight municipal clay-lined landfills sampled, we found VOCs in one well at an older landfill not built to today's design standards. A second clay-lined landfill had a groundwater sample where two VOCs were found at the detection limit and a sample from a second well that was contaminated by glue used to install a dedicated pump. Because of the leachate collection systems and low permeability clay liners we may not yet be seeing the effects of water infiltrating the liner and recharging the groundwater. Continued long-term monitoring is needed to assess clay liner performance. We detected VOCs more frequently in groundwater samples at zone-of-saturation landfills, retarder or combined retarder and natural attenuation landfills, and natural attenuation landfills. Zone-of-saturation sites where VOCs were detected had areas that were not built to today's design standards. We detected VOCs in groundwater at only one of the six industrial waste landfills sampled. Most industrial waste leachates contained fewer VOC parameters and lower VOC concentrations than municipal landfills.

The relationship between VOCs and indicator parameters. Indicator parameters alone did not reliably indicate the presence of VOCs. Where we detected VOCs in groundwater, however, inorganic parameters such as alkalinity, hardness and specific conductance were often elevated.

Programs in Other States. Several states have either proposed or established requirements for VOC monitoring at landfills.

The need to require VOC monitoring on a regular basis for all municipal landfills. VOC monitoring should be required at a frequency appropriate to each landfill, considering the design of the landfill, the presence of elevated indicator parameters, the goal of the monitoring program and the variability of the data.

RECOMMENDATIONS

The Bureau of Solid Waste should do the following:

1. Require periodic VOC monitoring of leachate and collection lysimeter samples.

2. Require VOC monitoring at selected groundwater points at frequencies chosen on the basis of design, performance, the goal of the monitoring program and the need to confirm variable data.

3. Conduct a study to develop a VOC monitoring strategy and action plan for industrial landfills and small municipal landfills by analyzing VOCs in groundwater and leachate.

4. Develop guidelines for actions to take when low concentrations of VOCs are found in groundwater.

5. Follow up on statewide VOC surveys and VOC monitoring requirements in other states.

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I. INTRODUCTION

This report presents the results of a two-year study (1985-1987) of volatile organic compound (VOC) contamination at 26 Wisconsin landfills (Figure 1). We present data from VOC analyses of groundwater, leachate and collection lysimeter samples. The report also contains tables, figures, appendices and definitions of technical and regulatory terms.

The Bureau of Solid Waste Management designed this study to decide how to approach VOC sampling requirements at Wisconsin landfills. We recognized that while Wisconsin relies primarily on inorganic indicator parameters for routine monitoring, other states require annual or even quarterly VOC sampling at their landfills. Unlike some states Wisconsin has a large number of well constructed clay-lined landfills that have been developed over the past 12 years. But, we did not have a large data base of VOC results from which to make a decision. We structured the study to evaluate whether differences in landfill design should influence our VOC monitoring requirements.

Our results are presented as follows:

A. Research Areas

1 The extent of VOC contamination at Wisconsin landfills

a. At how many landfills and in how many wells, leachate samples, and collection lysimeter samples did we find VOCs?

b. Which VOCs did we detect most frequently in groundwater, leachate, and collection lysimeter samples?

c. What were the VOC concentrations in groundwater, leachate, and collection lysimeter samples?

d. What is the significance of the concentrations found?

2. The influence of landfill design and waste type on the extent of VOC contamination

a. What was the influence of clay-lined landfills on the extent of VOC contamination?

b. What was the influence of zone-of-saturation, retarder, and natural attenuation landfills on the extent of VOC contamination?

c. Was there a difference in VOC contamination between municipal and industrial landfills?

3. The relationship between VOCs and indicator parameters

a. Were inorganic parameters elevated where VOCs were detected?

b. How can inorganic parameters be used to help identify possible VOC contamination?

B. Policy Areas

1. Programs in Other States

   a. Statewide VOC surveys

   b. Monitoring programs

2. The need to require VOC monitoring on a regular basis for all municipal landfills in Wisconsin

   a. What are current solid waste groundwater monitoring requirements in Wisconsin?

   b. How should landfill design influence VOC monitoring frequency?

II. PROCEDURES

A. Landfill Selection

We selected 26 landfills on the basis of design, age, and performance. We evaluated performance based on groundwater quality results. Three types of landfills were selected:

1. Properly constructed clay-lined landfills of various ages with leachate collection systems and, if possible, collection lysimeters.

2. Zone-of-saturation, retarder, and natural attenuation landfills with little evidence of groundwater contamination.

3. Zone-of-saturation, retarder, and natural attenuation landfills with evidence of groundwater contamination.

We selected the landfills after a review of papers published by Bureau of Solid Waste staff (Gordon et al. 1984; Gordon and Huebner 1984; Kmet et al. 1986). We chose other landfills based on staff consultation. These papers report that 28 landfills had leachate collection systems constructed before 1986. We sampled 16 of these landfills. We chose three zone-of-saturation landfills where groundwater data indicated little or no contamination. We chose two zone-of-saturation landfills where known groundwater problems existed. The zone-of-saturation landfills chosen vary widely in design. Three of the landfills use both standard clay liner and zone-of-saturation concepts. Two zone-of-saturation landfills did not use designs up to today's standards.

We listed the design, age, design capacity, and approximate waste volume (including daily cover) for each of the 26 landfills (Table 1). We used the license number to identify the landfill throughout the report.

B. Environmental Sampling

We designed a sampling program to collect samples from upgradient and downgradient monitoring wells, leachate, and collection lysimeters, and to check sample accuracy and replicability. As a result, we could compare data from downgradient wells with upgradient wells and leachate. We could compare data among landfills and catch errors caused by contaminated distilled water or bailers, verify the compounds detected, and assess sample variability over time. The study included one upgradient and three or four downgradient groundwater monitoring wells per landfill. We sampled a total of 125 wells, 21 leachate points and 7 collection lysimeters.

Staff familiar with the landfills selected upgradient and downgradient wells. They selected downgradient wells, both where indicator parameters were elevated, and where these wells appeared to show no impact. We developed sampling guidelines that emphasized measures to prevent contaminating and aerating samples (Appendix A). Sampling staff generally followed Department guidelines although different equipment, conditions and people may have increased variability. The Wisconsin State Laboratory of Hygiene screened all the samples using gas chromatography/mass spectroscopy (GC/MS) using a head space technique for analysis. Concentrations of chemicals detected above the report limit by GC/MS analysis were quantitated using EPA approved methods 601 and 602. The reporting limit used is listed on the sample laboratory sheet (Appendix B).

In most cases, each of the sampling crews collected a bailer blank of distilled water and one duplicate groundwater sample per landfill. At most of the landfills, staff collected two sets of samples on two dates, generally three months apart.

C. Data Summary and Analysis

We extracted a file of samples where volatile organic compounds (VOCs) were detected from the computer data file (Appendices D through G). We then constructed a series of tables using Lotus 1-2-3 software designed to answer the questions outlined in the introduction.

Landfill Descriptions. We organized the landfills first by waste type and then by design (Table 1). We used a set of guidelines to categorize the landfills by design factors. In cases where one part of a landfill was constructed with a clay-liner and another with a less stringent engineering design, the landfill was classified by the facility design used upgradient of the monitoring wells sampled. In cases where the zone-of-saturation design was used for part of a facility and another design was used for other parts, the landfill was put in the zone-of-saturation category. Landfills in the category "retarder or combined retarder and natural attenuation" did not have leachate collection systems and had bases constructed of either native or imported soils. For natural attenuation landfills, no attempt was made to differentiate among varying geologic environments. Some of the natural attenuation landfills were constructed in native coarse-grained soils.

Data on design, age, design capacity, and waste volume filled (as of January 1987) was obtained from previous department publications (Gordon and Huebner 1984; Gordon et.al. 1984; Kmet et. al. 1986) and from Department staff estimates. The current waste volume includes the combined volume of refuse and daily and intermediate cover.

We tabulated the number of wells sampled and the number of wells with VOCs for each landfill (Table 2). We identified landfills with leachate and collection lysimeter samples and noted the landfills with VOC detects in collection lysimeter samples. All but one leachate sample had VOCs, so we did not tabulate the number of VOC detects.

VOC Distributions. We listed the VOCs detected in the groundwater, leachate, collection lysimeter and field blank analyses (Table 3). To show the distribution of related compounds and breakdown products, we organized the parameters by chemical groups. We summarized the number and percentage of landfills that detected each parameter found in groundwater, leachate, collection lysimeter and field blank samples. The percentage is based on the 26 landfills sampled.

We arranged the compounds detected in order of increasing specific gravity (Table 4). Our State Laboratory of Hygiene does not use analytical techniques that differentiate between cis and trans isomers of 1,2 dichloroethylene or ortho and para isomers of xylene. For the purpose of our data analysis, we used specific gravity and solubility data for o-xylene and trans-1,2-dichloroethylene. The solubilities in water and the detection frequencies of these compounds in groundwater and leachate samples are shown for comparison.

Next we arranged the parameters detected in groundwater from Wisconsin landfills by their percent detection (Table 5) and compared them with data from Minnesota and Massachusetts landfills (Nelson and Book 1986 and Massachusetts Department of Environmental Quality Engineering 1986). We then compared the parameters detected most frequently in leachate with the parameters detected in groundwater (Table 6).

Maximum Concentrations. We listed these maximum values for each well at each landfill for groundwater, leachate, and the collection lysimeters (Tables 7 and 8). We illustrated the maximum concentrations detected for each parameter on the logarithmic scale of the bargraphs (Figures 2 to 9). Collection lysimeter data are not presented on the histograms because of the small sample size. We then compared the groundwater quality values with NR 140 groundwater standards (Table 9), as well as the VOCs in groundwater with those in leachate (Table 10). Groundwater standards are presented here for comparison purposes and not as they would be used in a regulatory application. In a regulatory application the enforcement standards (ES) would apply only at wells located at or beyond the design management zone (DMZ), a regulatory boundary. The preventive action limits (PALs) would apply at all points where groundwater is monitored.

Significance. To attempt to evaluate the significance of the concentrations detected, we listed the number of VOCs with concentrations greater than 10 ug/l. The Wisconsin State Laboratory of Hygiene lists detection limits of less than 10 ug/l for most VOCs analyzed (Table 11). We selected 10 ug/l as an arbitrary cutoff to compare wells with low and high levels of VOCs.

Waste Type. We looked for differences in the type, concentration or frequency of VOCs detected in wells at municipal and industrial landfills (Tables 2, 7 and 8).

Indicator Parameters. We prepared a list of monitoring wells where VOCs were detected in groundwater for each landfill (Table 11). We then obtained historical data from the Bureau of Solid Waste Management's groundwater monitoring files. For each indicator parameter sampled, we indicated if current values were above background values or above the groundwater standards set by NR 140, Wis. Adm. Code. The Department is currently calculating PALs for indicator parameters at each landfill in the state. For landfills where indicator PALs have not yet been calculated, we compared the monitoring data to background values and made a qualitative judgment as to whether or not the data from the well were above background concentrations.

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III. RESULTS

A. Research Areas

This section presents the results of the Wisconsin study and answers the research questions around which the report is organized. We discuss programs in other states in the section titled Policy Areas.

1. The extent of VOC contamination at Wisconsin landfills

   a. At how many landfills and in how many wells, leachate samples and collection lysimeters did we find VOCs?

   We sampled 20 municipal and 6 industrial landfills. The industrial landfills consisted of four paper mill landfills, one foundry landfill and one landfill accepting miscellaneous industrial wastes (Table 1). Although none of the 26 landfills are licensed to accept hazardous waste, all municipal waste streams contain household quantities of hazardous waste that are exempt from existing EPA regulation and contribute VOCs and other organic contaminants to the landfill. In addition, older landfills may have accepted hazardous wastes before the current regulations went into effect in 1981.

   Of the 26 landfills sampled, we detected VOCs in the groundwater at 12 (Table 2). Of the 125 groundwater wells sampled we detected VOCs in 29. We detected VOCs in leachate at 18 of the 19 sampled landfills with leachate collection systems. We sampled collection lysimeters at seven landfills and detected VOCs in three.

   b. Which VOC parameters did we detect most frequently in groundwater, leachate, and collection lysimeter samples?

   Compounds were organized into chemical groups to show the distribution of related compounds and breakdown products (Table 3). The percentages are based on the number of samples from each source (groundwater 26, leachate 19, collection lysimeters 7). Tetrahydrofuran was most frequently detected in collection lysimeter samples. It is routinely found in glues used to seal the collection pipe to the plastic membrane in the collection lysimeter. The 10 most frequently detected compounds in groundwater and the 10 most frequently detected compounds in leachate (12 compounds total) are listed below:

HALOMETHANES	TRICHLOROFLUOROMETHANE (groundwater only) TETRAHYDROFURAN (leachate only)
CHLORINATED ETHANES	CHLOROETHANE 1,1-DICHLOROETHANE 1,1,1-TRICHLOROETHANE
CHLORINATED ETHYLENES	1,2-DICHLOROETHYLENE (groundwater only) TRICHLOROETHYLENE TETRACHLOROETHYLENE
AROMATIC AND HALOGENATED HYDROCARBONS	ETHYLBENZENE (leachate only) BENZENE TOLUENE XYLENE

There does not appear to be a relationship between the specific gravity of a compound and the percent detected (Table 4). Tetrachloroethylene, a heavy molecular weight compound was detected 30% of the time. The lighter compounds benzene and toluene were also detected frequently (27% and 23% of the time respectively). In landfill #2051, where several wells had very high VOC concentrations, compounds with higher specific gravity were found in a deep piezometer and in shallow water table observation wells.

The maximum concentrations of the compounds detected in this study were all much lower than their solubilities. Solubility values are textbook values derived from pure single compound solutions. In multi-compound systems, such as in contaminated groundwater, these compounds may exhibit synergistic effects. The high solubility values mean the VOC compounds we detected would be dissolved in the groundwater. The groundwater flow system would control the compound's movement in the aquifer.

The 10 parameters found most frequently in groundwater in the Wisconsin study were also found frequently in studies conducted in Minnesota and Massachusetts (Table 5). These studies are discussed later in the report. In addition, the Minnesota study reported methylene chloride among the most frequently detected parameters in groundwater. About 42% of the Minnesota landfills sampled had received or were suspected of having received hazardous waste (Nelson and Book 1986). When we compared data from the Minnesota and Wisconsin studies, we found that more than twice as many landfills were sampled in the Minnesota study than in the Wisconsin study. Most of the Minnesota landfills were unengineered. In the Wisconsin study we chose a smaller number of landfills, over half of which were engineered.

c. What were the VOC concentrations in groundwater, leachate and collection lysimeter samples?

Concentrations of VOCs in leachate were generally greater than in groundwater. At highly contaminated wells at three landfills, however, groundwater VOC concentrations exceeded typical leachate concentrations (landfill #2484 - 1,2-dichloroethylene, chlorobenzene, toluene; landfill #2680 - tetrachloroethylene; landfill #2051 - toluene) (Figures 2-9).

Halomethanes and Miscellaneous Compounds. We detected halomethanes and miscellaneous compounds more frequently and in higher concentrations in leachate than in groundwater (Table 8 and Figures 2 and 3). Tetrahydrofuran was detected in only three groundwater samples (Table 3). One sample (landfill #3023) was contaminated by glue used in pump installation. Another well (landfill #3023) was highly contaminated with these compounds. We detected halomethanes and miscellaneous compounds most frequently in wells with the highest concentrations of VOCs and the greater number of VOC parameters detected (landfills #2680 and #2051) (Table 7). Tetrahydrofuran was also detected at high concentrations at three collection lysimeters.

Chlorinated Ethanes. We detected 1,1-dichloroethane more frequently and in higher concentrations than 1,2-dichloroethane in groundwater (Figure 4). NR 140 groundwater standards for 1,2-dichloroethane are less than the detection limit (Table 9). Wherever 1,2-dichloroethane was detected in groundwater, it exceeded enforcement standard values.

Chlorinated Ethylenes. We detected 1,2-dichloroethylene more frequently and in higher concentrations than 1,1-dichloroethylene in groundwater (Figure 6). We did not detect 1,1-dichloroethylene in any of the leachate samples, although we did detect 1,2-dichloroethylene (Figure 7). NR 140 enforcement standards for 1,1-dichloroethylene and 1,2-dichloroethylene are less than the detection limit, and enforcement standards for tetrachloroethylene are at the detection limit (Table 9). This means wherever these compounds were detected in groundwater, the compounds attained or exceeded NR 140 enforcement standard values. Vinyl chloride was detected in one collection lysimeter at a concentration of 1.5 ug/l.

Aromatic and Halogenated Hydrocarbons. Most aromatic and halogenated hydrocarbons were detected much more frequently in leachate than in groundwater (Table 7 and 8, Figures 8 and 9). Concentrations were often higher in leachate than in groundwater. Again, we detected aromatic and halogenated hydrocarbons most frequently in wells with the highest concentrations of VOCs and the greatest number of VOCs detected (landfills #2484, #611, #2680, #2051) (Table 7). A very low (1.2 ug/l) concentration of toluene was detected in one collection lysimeter sample.

NR 140 groundwater enforcement standards and PALs for benzene are below its detection limit. Wherever benzene was detected, it exceeded the enforcement standard and PAL values. Groundwater enforcement standards and PALs for 1,4-dichlorobenzene, toluene and xylene are substantially above their detection limits. Concentrations of 1,4-dichlorobenzene in groundwater or leachate samples did not exceed enforcement standards or PALs. Two of 10 groundwater samples exceeded NR 140 enforcement standard values for toluene, two were between the PAL and the enforcement standard and the other six did not attain or exceed the PAL. One of seven groundwater samples attained or exceeded PAL values for xylene and none attained or exceeded enforcement standard values (Table 9).

Groundwater standards do not apply to leachate but they can be used to compare leachate quality with groundwater quality. We noted that, although toluene and xylene were detected more frequently in leachate samples than in groundwater samples, the concentrations detected were often below groundwater standards. We detected toluene in all 21 leachate samples. Enforcement standards were attained or exceeded in 11 samples and values were below the PAL in eight samples. The remainder of the sample values were between the PAL and the ES. We detected xylene in 19 leachate samples. Of these, the PAL was attained or exceeded in six samples and none exceeded enforcement standards.

We detected VOCs in both groundwater and leachate at seven landfills (Table 10). Data from landfill #2484 was not used because it was not representative. At only two of these five landfills (#3023 and #2568) were the same VOCs detected in groundwater and in leachate. Both these landfills had only one or two parameters detected in groundwater. At the other three landfills, leachate samples had VOC parameters not detected in groundwater. In the following cases we detected parameters in groundwater that were not detected in leachate:

Landfill	Parameter
2569	1,1,1-trichloroethane, trichlorofluoromethane, chloroform
2637	1,1-dichloroethane, 1,1,1-trichloroethane, 1,2-dichloroethylene, trichloroethylene, tetrachloroethylene
140	1,2-dichloroethane, benzene
2695	chloroethane, vinyl chloride, 1,2-dichloroethylene, benzene methylethylketone

The parameters detected belong to various chemical groups. These data show that it may be misleading to use VOC parameters in leachate to identify the source of groundwater contamination. Similarly, the collection lysimeter samples contained VOC parameters not detected in leachate. We detected trace concentrations of toluene (landfill #2974) and vinyl chloride (#1940) in collection lysimeter samples but not in leachate for those landfills. We detected tetrahydrofuran in the collection lysimeter at site #2974 but not in leachate for that landfill. We detected tetrahydrofuran both in the collection lysimeter and in leachate at landfill #2892, but there was no waste over the collection lysimeter.

d. What is the significance of the concentrations found?

At two landfills (#2821 and #2637) 1,1,1-trichloroethane; 1,4-dichlorobenzene; bromodichloromethane and chloroform were detected in distilled water and bailer blanks. We detected 1,1,1-trichloroethane in the groundwater at landfill #2637. The other three parameters were not present in any other groundwater or leachate analysis for either landfill. The results indicate that groundwater data containing the same contaminants as the field blanks are not useable. Where blanks are contaminated guidelines are needed for interpreting VOC results.

Tetrahydrofuran was the only contaminant detected in groundwater samples at landfills #3023 and #2568 and collection lysimeters at landfills #2974, #1940 and #2892. The owner of landfill #3023 reported that glue was used to install the dedicated well wizard pump in the well. The lysimeter sampled at landfill #2892 did not have waste above it. The landfill owner reported that glue used to install the lysimeter at landfill #2974 contained tetrahydrofuran. Glue containing tetrahydrofuran was likely used in lysimeters at landfills #1940 and #2892 as well.

VOCs were detected in groundwater samples from 29 wells at 12 landfills (Table 7). In eight of these wells, all VOCs detected were below 10 ug/l (Table 11). There are a number of VOC parameters that have been detected for which groundwater standards have not yet been established.

VOCs can be used to detect groundwater contamination because they are highly mobile, poorly attenuated, and can be detected in low concentrations. As with inorganic parameters, reliable background values must be established and other contamination sources minimized to yield useful data.

VOCs are often detected in low concentrations in groundwater at landfill sites. Bailer blanks and trip blanks can identify contamination from sampling equipment or the laboratory. Contamination from well construction is more difficult to identify, particularly in older wells where VOCs contained in glues, solvents, and drilling fluids (including water) were rarely documented.

Interpreting the significance of VOC results is difficult because sample contamination or volatilization can easily lead to erroneous conclusions. Because groundwater VOC standards are set low (ppb) even a minute amount of sampling contamination can produce results which exceed the standards. VOCs can be lost due to volatilization while collecting samples and results much lower than actual field conditions can be produced.

To further complicate matters, the inherent error of the laboratory analysis at or near the detection limit is sometimes as great as 30 to 50% (D. Weir, pers. com. 1987). In this regard, VOCs' behavior differ from inorganic indicator parameters. A small amount of sampling contamination in inorganic sampling may not cause groundwater standards exceedances.

If a compound is detected one can be relatively sure it is there, especially when the blanks do not contain the detected compounds. But, if the concentration of the compound is near the detection limit, it is difficult to determine the actual value.

2. The influence of landfill design and waste type on the extent of VOC contamination

   a. What was the influence of clay-lined landfills on the extent of VOC contamination?

Of the eight clay-lined municipal landfills we sampled, VOCs were detected in groundwater samples in three wells at two landfills (Table 2). At landfill #3023 (operating 2 years) one groundwater sample was apparently contaminated by a glue used to install a dedicated pump. In the other groundwater sample, VOCs were not detected during the first sampling but were found at the detection limit during the second sampling round. Landfill #2569 has been operating 12 years. Several VOCs were detected at this landfill during both sampling rounds.

Clay-lined landfills minimize the amount of leachate that can travel to the groundwater by collecting the leachate. Low permeability clay liners also slow down the travel time of any leachate not collected. The Department's usual specification for clay liner permeability is a maximum of 1×10^{-7} cm/sec. Given a vertical gradient of 1.4 and an effective clay porosity of 0.03, the estimated travel time through a five-foot clay liner would be one year. Recent liner construction documentation shows that many liners have lower permeabilities (about 1×10^{-8} cm/sec). Given the same vertical gradients and effective porosities, the estimated travel time could increase to ten years.

Some of the landfills sampled may have been constructed too recently for us to assume we have sampled groundwater that was recharged with water passing through the clay liner. To evaluate how effectively clay-lined landfills prevent VOCs from reaching the groundwater, continued study of these landfills is needed as they approach the age where water has likely infiltrated through the liner.

VOCs were detected in leachate at all eight clay-lined landfills. Of the five collection lysimeter samples taken at these landfills, only one contained VOCs and the only compound found was tetrahydrofuran. This was most likely the result of using glue in lysimeters to connect the collection pipe to the plastic membrane.

b. What was the influence of zone-of-saturation, retarder and natural attenuation sites on the extent of VOC contamination?

Of the five zone-of-saturation landfills sampled, we detected VOCs in the groundwater at three sites (Table 2). They were the three oldest and largest zone-of-saturation landfills in the state with design capacities of 3.0 to 4.6 million cubic yards of waste. Groundwater from one of the wells at landfill #2568 may have been contaminated by glue during well construction. Of the four landfills at which leachate was sampled, all leachate samples contained VOCs.

We detected VOCs in groundwater at all three of the retarder or combined retarder and natural attenuation sites we sampled. Leachate taken from the lined portion of landfill #2637 contained VOCs.

Of the four natural attenuation landfills we sampled, three had detectable levels of VOCs in groundwater. The fourth landfill (#057) contained no VOCs in groundwater, had one of the smallest waste volumes, and is one of the oldest landfills sampled.

c. Was there a difference in VOC contamination between municipal and industrial landfills?

Of the six industrial waste landfills sampled, we detected VOCs in groundwater at only one landfill, a recycling paper mill. Industrial leachates were tested at three paper mill landfills, one foundry landfill and one landfill accepting miscellaneous industrial waste. In leachate from landfill #2873, containing paper mill waste, we detected only a low concentration of toluene (Table 8). In leachate from landfill #2488, containing paper mill waste, we detected only toluene and ethylbenzene. In leachate from landfill #2695, containing recycling paper mill waste, we detected a wide range of volatile organics similar to those detected in municipal leachates. In leachate from landfill #1940, a landfill accepting miscellaneous industrial waste, we detected fewer parameters and a lower concentration of parameters than leachate from other sampled municipal landfills. In leachate from landfill #2974, containing foundry waste, we detected no VOCs.

VOCs were detected in collection lysimeter samples at industrial sites. Solvents used during construction, however, are probably responsible for at least some of the VOCs found in the collection lysimeter samples.

3. The relationship between VOCs and indicator parameters

a. Are inorganic parameters elevated where VOCs are detected?

For each well where VOCs were detected, we compared indicator parameters with VOCs (Table 11). Chloride is used to indicate when contamination may be occurring because it is not easily attenuated and often moves at the front of an advancing leachate plume. Despite this, in almost all cases where we detected VOCs in groundwater, chloride concentrations were at background levels. Although well MW-29 at landfill #2680 had elevated levels of VOCs, it did not have chloride concentrations above background. Even though well TW-25 at landfill #2051 had chloride concentrations above the PAL, values were generally less than 150 mg/l. These chloride values are not very high considering the extremely elevated concentrations of VOCs and other indicator parameters, including COD. Other wells in which chloride was elevated included well P-6B at landfill #2484, wells DH-5 and DH-17 at landfill #2695, and well MW-12R at landfill #2680.

Where VOCs were detected in the groundwater, alkalinity, hardness and specific conductance values were most often elevated. NR 140 PALs have been calculated for landfills #2051 and #2565. Wells where VOCs were detected at landfill #2051 exceeded the PAL values for alkalinity, specific conductance and hardness while those at landfill #2565 did not. Wells where VOCs were detected at landfills #611, #2484, #2680, #140, #2054 and #2695 had alkalinity, hardness and specific conductance concentrations above background for some wells but not for others.

COD concentrations were the most difficult to interpret. COD concentrations are often elevated after well construction. This interference can actually persist for months or years. COD values are also often erratic, reflecting the changes in water quality or sampling methods. COD values at landfill #2051 exceeded the PAL value for at least one well. COD values at landfills #2695, #2054, #2637, and, #2484 appeared above background for some of the wells. It was difficult to correlate VOCs and COD at landfills where COD values were either erratic or appeared to be background. Wells at landfills #3023, #2568 and #2565 contained VOCs but did not show elevated indicator parameters.

b. How can inorganic parameters be used to help identify possible VOC contamination?

The results of this study show that we cannot rely solely on monitoring for indicators to detect groundwater contamination because there are cases where the groundwater contains VOCs but does not have elevated indicator parameters. We are, however, likely to detect VOCs at wells where groundwater has elevated indicator parameters.

B. Policy Areas

1. Programs in Other States

We sent a questionnaire to 14 state regulatory agencies asking for information on five topics: sampling of VOCs at landfills in their states, monitoring requirements for VOCs, the extent of VOC contamination around their landfills, the influence of design, geologic environment and waste type on the presence of VOCs and the relationship between VOCs and indicator parameters (Appendix C). The agencies chosen were selected because of our knowledge of their solid waste programs, previous work on this topic, geographic location, or previous personal contacts. This was a preliminary survey and we suggest a more detailed followup be conducted since several states are expanding their VOC monitoring. We obtained the most detailed responses to our survey on the topics of statewide VOC surveys and monitoring requirements. We discuss these topics here.

a. Statewide VOC Sampling. We asked the states if they had conducted statewide sampling of VOCs at landfills. Staff from Minnesota, Massachusetts, Connecticut and California responded as follows:

   The Minnesota Pollution Control Agency (MPCA) sampled approximately 60 sanitary landfills. Their study concluded that neither landfill size nor urban or rural location influence the number of VOCs detected (Nelson and Book 1986). They found VOCs at landfills in all geologic settings but found more compounds in coarse-grained environments. They also found more VOC compounds at sites with known or suspected hazardous waste than those that did not receive these wastes. An earlier study (Sabel and Clark 1983) found some VOCs to be ubiquitous in leachate and found good correlation among parameters found in leachate data from Minnesota, Wisconsin and New York. They also obtained similar but less consistent data from analyzing leachate-contaminated groundwater. The goal of their research was to develop a list of volatile organic compounds to be analyzed at Minnesota municipal solid waste landfills.

   The Massachusetts Department of Environmental Quality Engineering, Division of Solid and Hazardous Waste prepared a summary of VOC values in groundwater and in leachate (Massachusetts DEQE 1986). We presented the results of the parameters most frequently detected in the Minnesota and Massachusetts studies earlier in the report (Tables 5 and 6).

   The Connecticut Department of Environmental Protection reported that out of 140 permitted landfills they have monitoring data for 120 (J. Dziuba, pers. com. 1987). Groundwater monitoring at about 75% of those landfills includes quarterly sampling for VOCs and several constituents have been detected. Their staff assumes all their municipal solid waste landfills have at some time accepted wastes containing VOCs. They have no landfills that are lined with natural or artificial materials.

The California Waste Management Board reported that statewide sampling of organic contaminants in groundwater at all landfills in California are just beginning at all landfills in California (K. Amundson, pers. com. 1987).

b. Monitoring Programs. We asked the states if they required periodic monitoring at landfills. Minnesota, New York, Pennsylvania, Massachusetts and Connecticut either have or are developing requirements for VOC monitoring. Staff from agencies in Ohio, Illinois, Colorado, California, Washington, Michigan and Oklahoma reported that they either required periodic VOC monitoring only for selected landfills or that they did not require VOC monitoring at all.

The Minnesota Pollution Control Agency (MPCA) Solid and Hazardous Waste Division is proposing monitoring requirements for landfills where the state has not yet established site specific monitoring requirements in the facility permit (D. Jakes, pers. com. 1986). The requirement would be for three rounds of VOCs and one round of a list of 21 inorganic parameters (including dissolved metals) each year. The MPCA already samples for VOCs at selected landfills.

The New York State Department of Environmental Conservation, Division of Solid and Hazardous Waste requires annual baseline scans at all permitted landfills (N. Nosenchuck, pers. com. 1987). Their standard groundwater baseline scan includes over 30 indicator parameters and a complete priority pollutant scan. Some parameters may be deleted during subsequent scans based on the initial results. They do not require routine quarterly VOC monitoring at the present time because of the cost to municipalities and local governments. They may include VOCs in future routine monitoring programs because of the mobility and persistence of VOCs in groundwater.

The Pennsylvania Department of Environmental Resources, Bureau of Solid Waste Management requires quarterly VOC monitoring for one year prior to waste deposition and annually thereafter for all existing and new facilities (J. Hassen, pers. com. 1987).

The Massachusetts Department of Environmental Quality Engineering DEQE has been requiring periodic VOC analyses in recent plan approvals (J. Doucett, pers. com. 1987). Massachusetts DEQE requires groundwater monitoring for inorganic and organic parameters. At the present time, these requirements are contained in a Department policy rather than in legislation. They anticipate rewriting their 1971 solid waste rules in 1987 and will include a general requirement for groundwater monitoring although a guidance manual will contain the specifics. Massachusetts DEQE approves few new landfills. Most work involves landfill expansions and closures. The monitoring program is designed to obtain information on background monitoring and field conditions. The program includes quarterly monitoring for indicator parameters, an extended list of inorganic parameters (including metals) and the 31 VOCs in the priority pollutant list plus acetone, methylethylketone, methylisobutylketone, and xylene. After the initial groundwater analysis, a priority pollutant screen is performed on a site specific basis. The Massachusetts DEQE then sets subsequent monitoring requirements based on the results.

The Connecticut Department of Environmental Protection has implemented VOC monitoring, through permit modifications, at about 75% of the 120 municipal solid waste facilities that monitor groundwater (J. Dziuba, pers. com. 1987). Quarterly monitoring of VOCs is usually required at all groundwater monitoring points.

The Ohio Environmental Protection Agency, Division of Solid and Hazardous Waste Management reported that some landfills are monitored for VOCs through hazardous waste regulations and state enforcement actions (T. Krichbaum, pers. com. 1987). The Illinois Environmental Protection Agency reported that some landfills are required to monitor VOCs (H. Chappel, pers. com. 1987). The Colorado Department of Health, Waste Management Division reported that many selected landfills are monitored quarterly for VOCs (K. Mesch, pers. com. 1987). The California Waste Management Board reported that selected landfills are monitored for VOCs (K. Amundson, pers. com. 1987). The Washington Department of Ecology monitors VOCs primarily under the Superfund program (J. Knudson, P. Kmet, pers. com. 1987). The Michigan Department of Natural Resources, Groundwater Quality Division has monitored VOCs at some older unlined landfills and permeable soil landfills (T. Work, pers. com. 1987). The Oklahoma State Department of Health, Waste Management Service has conducted 20 scans for organics since 1985 (C. Varga, pers. com. 1987). About 35 to 40% of their landfills have groundwater monitoring.

2. The need to require VOC monitoring on a regular basis for all municipal landfills in Wisconsin

   a. What are current solid waste groundwater monitoring requirements in Wisconsin?

   VOC Monitoring. At the present time, the proposed Wisconsin solid waste rules (NR 508) require background sampling of

VOCs at monitoring wells at all new landfills (including expansions of existing sites). Periodic VOC monitoring is required on a case by case basis at existing landfills where groundwater contamination is known to be present. We do not require routine scans for VOCs at existing landfills without evidence of groundwater contamination. Periodic priority pollutant scans on leachate are required on a case by case basis.

Other Monitoring. The proposed solid waste rules (NR 508) and the present Bureau of Solid Waste Management practice requires quarterly monitoring for a set of indicator parameters and background monitoring for a selected set of public health and welfare parameters. A typical municipal landfill would be required to sample quarterly for specific conductance, pH, COD, alkalinity, hardness, chloride, and dissolved iron. Other parameters would be added depending on the waste type disposed or evidence of groundwater contamination. Periodic scans for other public health parameters (As, Ba, Cd, Cr, Pb, Se, Ag) or public welfare parameters (sulfate, fluoride, copper) are sometimes required where indicator parameters show evidence of groundwater contamination.

b. How should landfill design influence VOC monitoring frequency?

Landfills constructed with 5-foot clay-liners according to specifications in proposed solid waste code series NR 500 are designed to slow the movement of contaminants through the liner. Since many newer landfills are designed to collect over 80% of the leachate generated, the volume of leachate anticipated to leave through the liner is very small. Because of the low permeability clay liner and the efficient leachate collection system, there may be less need for intensive VOC monitoring of these landfills during the early years of operation. VOC monitoring at new landfills should focus on periodic, long-term monitoring of selected wells including monitoring after landfill closure. For example, of 20 wells at a landfill, two downgradient and two crossgradient wells might be required to monitor VOCs annually.

Older landfills, with designs not conforming to proposed specifications, may have a greater potential for groundwater contamination. Since VOCs are often more mobile than other indicator parameters, selected wells should be tested annually even where the wells show no indication of inorganic contamination. For example, of 15 wells at a landfill, three downgradient wells might be required to monitor for VOCs annually.

Groundwater with elevated concentrations of indicator parameters also often contains VOCs (although not all groundwater samples containing VOCs show elevated indicators). All wells with elevated indicators should be sampled for VOCs annually.

Where VOC results are highly variable, analyses conducted more frequently than annually (semiannually, quarterly, etc.) should be required for a defined time period to investigate the source of the variability.

Where groundwater contamination investigations are being performed, VOC analyses should be required more frequently than annually to establish field conditions. If appropriate, after a period of time, a less frequent schedule can be established.

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IV. CONCLUSIONS

This report has presented the results of a two-year study (1985-1987) of volatile organic compound (VOC) contamination at 26 Wisconsin landfills. The Bureau of Solid Waste Management conducted the study to evaluate the extent of VOC contamination at landfills and whether differences in landfill design should influence our VOC monitoring requirements.

We selected landfills based on design, age and performance as indicated by groundwater quality results. We sampled upgradient and downgradient monitoring wells, leachate, and collection lysimeters on two dates and collected bailer blanks and duplicate samples for quality assurance. We made the following conclusions:

A. Research Areas

1. The extent of VOC contamination at Wisconsin landfills

   Twelve out of 26 sampled landfills contained VOCs in groundwater. VOCs were detected in 18 of 19 leachate samples and three of seven collection lysimeter samples. We did not believe the detects in the collection lysimeter samples represented leachate.

   The following list of parameters were detected most frequently in groundwater and leachate: chloroethane; 1,1-dichloroethane; 1,1,1-trichloroethane; 1,2-dichloroethylene; trichloroethylene; tetrachloroethylene; benzene; ethylbenzene; toluene; xylene; trichlorofluoromethane; and tetrahydrofuran. These parameters were also found frequently in studies conducted in Massachusetts and Minnesota. The solubilities of the compounds are greater than the concentration found in groundwater. There does not appear to be a relationship between specific gravity and detection frequency.

   Samples from collection lysimeters most frequently contained tetrahydrofuran. This compound is routinely used in glues to seal the collection pipe to the plastic membrane and is probably the reason for these detections.

   Concentrations of VOCs in leachate were generally greater than in groundwater. In some highly contaminated wells, however, groundwater VOC concentrations exceeded typical leachate concentrations.

   We detected aromatic and halogenated hydrocarbons, halomethanes and miscellaneous compounds much more frequently and in higher concentrations in leachate than in groundwater. Where we detected these compounds in groundwater, they occurred most frequently in wells with the highest concentrations of contaminants and the greatest number of VOCs. We detected 1,1-dichloroethane and 1,2-dichloroethylene more frequently than 1,2-dichloroethane and 1,1 dichloroethylene.

NR 140 groundwater enforcement standards for 1,2-dichloroethane, 1,1-dichloroethylene and benzene are below the Wisconsin State Laboratory of Hygiene detection limit. Wherever those compounds were detected in groundwater, they exceeded the enforcement standard. The groundwater enforcement standard for toluene was exceeded in two samples. The preventive action limit (PAL) for xylene was exceeded in one sample. The groundwater standard for 1,4-dichlorobenzene was not attained or exceeded in any of the samples collected. Other VOC compounds detected do not have NR 140 enforcement standards at this time.

Frequently, groundwater containing VOCs did not contain the same VOC parameters as leachate samples from the same landfill. Collection lysimeter samples also contained VOC parameters not detected in leachate.

The significance of low levels of VOCs is difficult to determine. Where blank samples are contaminated, VOC data for other wells are questionable. The accuracy of laboratory analyses near the detection limit are variable. If a compound is detected in the sample, but not in the blank, one can be relatively sure it is there. But, if the concentration of the compound is near the detection limit, it is difficult to determine the actual value.

2. The influence of landfill design and waste type on the extent of VOC contamination

Six of eight clay-lined landfills did not have VOCs in downgradient groundwater samples but did contain VOCs in leachate. VOCs detected in three collection lysimeters do not appear to be the result of landfill leachate. These landfills range from 2 to 12 years old. Continued periodic monitoring is needed to assess the long-term effects of clay-lined landfills on groundwater quality.

At all three retarder and natural attenuation landfills and three of five zone-of-saturation landfills, we found groundwater containing VOCs. The zone-of-saturation landfills where VOCs were detected ranged from 9 to 16 years old and were not constructed using current design standards. VOCs need to be sampled at more retarder and natural attenuation landfills to determine the effect of these sites on groundwater quality.

Four of the five industrial waste leachates sampled contained fewer VOC parameters with lower concentrations than municipal leachates. More sampling of industrial landfills is needed to determine what factors influence the presence of VOCs in industrial leachates.

3. The relationship between VOCs and indicator parameters

At landfills where VOCs were detected in groundwater, inorganic parameters such as alkalinity, hardness and specific conductance values were often elevated. With a few exceptions, chloride concentrations were at background levels despite the presence of VOCs. No correlation between COD values and VOC detections was found, although elevated COD sporadically appeared in some samples containing VOCs. Indicator parameters alone did not reliably indicate the presence of VOCs. It appears, however, that we are more likely to detect VOCs in groundwater by monitoring for VOCs at wells where groundwater has elevated concentrations of parameters such as alkalinity, hardness, and specific conductance.

B. Policy Areas

1. Programs in other states

Several states surveyed have either proposed or established requirements for VOC monitoring at landfills.

2. The need to require VOC monitoring on a regular basis for all municipal landfills in Wisconsin

VOC monitoring should be required at a frequency appropriate to each landfill. The design of the landfill, the presence of elevated indicator parameters, the goal of the monitoring program and the variability of the data are factors to be considered when choosing an appropriate VOC monitoring program for a specific landfill.

We have little data on either leachate from small municipal landfills or the effect of small municipal landfills on VOC contamination in groundwater.

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V. RECOMMENDATIONS

As a result of this study we recommend the Bureau of Solid Waste do the following:

A. Require periodic VOC monitoring of leachate at a frequency selected on the basis of landfill size, leachate quality, and treatment.

B. Require periodic VOC monitoring of collection lysimeter samples at a frequency selected on the basis of elevated indicator parameters in groundwater monitoring wells or collection lysimeters or increased liquid volumes obtained in collection lysimeters.

C. Require periodic VOC monitoring at selected groundwater points at the following frequency:

   1) Every two to five years for all landfills constructed with designs conforming to proposed solid waste code series NR 500.

   2) Annually at operating landfills not conforming to proposed solid waste code series NR 500.

   3) Annually at any landfill, regardless of design, where inorganic parameters are elevated or where VOCs have been detected in groundwater.

D. Require VOC monitoring for a limited time period at an increased frequency (semiannually or quarterly) at any landfill to define contamination or to confirm variable VOC data.

E. Develop a VOC monitoring strategy and action plan for industrial and small municipal landfills by analyzing VOCs in groundwater and leachate.

F. Continue to compare results of VOC analyses with indicators to further define their relationship for future monitoring requirements.

G. Address the VOC contamination observed at the landfills in this study through existing regulatory programs under solid waste management (NR 500-520 Wis. Adm. Code), hazardous waste management (NR 181, Wis. Adm. Code) and groundwater management (NR 140, Wis. Adm. Code).

H. Develop guidelines for actions to take when low concentrations of VOCs are found in groundwater.

I. Continue to gather information on sampling results and VOC monitoring requirements in other states.

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REFERENCES

Gordon, M. E. and P. M. Huebner. 1984. An Evaluation of the Performance of Zone of Saturation Landfills in Wisconsin pp. 411-410 in Proceedings of the Seventh National Groundwater Quality Symposium, Las Vegas, Nevada.

Gordon, M. E., P. M. Huebner and P. Kmet. 1984. An Evaluation of the Performance of Four Clay-Lined Landfills in Wisconsin pp. 399-460 in Proceedings of the Seventh Annual Madison Conference on Municipal and Industrial Waste.

Kmet, P., G. Mitchell and M. Gordon. 1986. Leachate Collection System Design and Performance - Wisconsin's Experience pp. 564-598 in Proceedings of the Ninth Annual Madison Conference on Municipal and Industrial Waste.

Massachusetts Department of Environmental Quality Engineering. 1986. Compounds detected most frequently in Massachusetts Solid Waste Landfill Leachate and in Groundwater at Massachusetts Solid Waste Landfills. Unpublished Report.

Nelson, B. R. and P. R. Book. 1986. Monitoring for Volatile Organic Hydrocarbons at Minnesota Sanitary Landfills pp. 72-77 in Proceedings of the Ninth Annual Madison Conference on Municipal and Industrial Waste.

Sabel, G. V. and T. P. Clark. 1983. Volatile Organic Compounds as Indicators of Municipal Solid Waste Leachate Contamination pp. 108-125 in Proceedings of the Sixth Annual Madison Conference on Municipal and Industrial Waste.

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DEFINITIONS

Clay-Lined Landfill - A landfill constructed with a 5-foot compacted clay liner of low permeability, a granular drainage blanket on the base and sidewalls and a leachate collection system. The clay liner is constructed above the water table.

Collection Basin Lysimeter - A device that is constructed with a geomembrane for monitoring the unsaturated zone beneath a clay liner. Referred to here as "collection lysimeter".

Design Capacity - The volume of solid waste and daily and intermediate cover approved for disposal.

Design Management Zone - The Design Management Zone (DMZ) is a regulatory boundary defined in the Wisconsin Groundwater Quality Rules (NR 140). The DMZ is located 150 feet from the waste (new site) or at the property boundary, whichever is less. For an old site, the DMZ is located 300 feet from the waste or at the property boundary, whichever is less.

Indicator Parameter - In this report, parameters monitored frequently to indicate the presence of leachate, including specific conductance, pH, hardness, alkalinity, dissolved iron, pH, chloride and sulfate. Note: Indicator parameter has a more narrow definition in NR 140 Wis. Adm. Code.

Field Blank - A quality control sample taken to document if sampling procedures have contaminated a sample. The sampling device is rinsed thoroughly and a sample of rinse water is put through the device, collected and analyzed.

Leachate Collection System - A system capable of collecting and removing leachate from a solid waste facility. Generally composed of a series of interconnected PVC pipes, manholes and pumping stations.

Natural Attenuation Landfill - An unlined landfill generally constructed on native soils with no leachate collection system. Natural attenuation landfills exist in both coarse and fine-grained soil environments.

NR 140 Wis. Adm. Code - Wisconsin Groundwater Quality Rules. NR 140 establishes two sets of standards for given parameters that are applied to groundwater. Enforcement standards are based on federal numbers, and preventive action limits (PALs) are set at a certain percent of the enforcement standards. Enforcement standards only apply in wells beyond a certain distance from the waste while PALs apply at all wells. NR 140 describes action which should be taken if groundwater exceeds either of these standards.

NR 181 Wis. Adm. Code - Wisconsin Hazardous Waste Management Rules

NR 500 to 520 Wis. Adm. Code - Wisconsin Solid Waste Management Rules (Revision of NR 180 Wis. Adm. Code) effective February 6, 1988.

Retarder Landfill - A landfill constructed with a reworked base of generally fine-grained materials that does not meet the thickness or quality specifications for a clay-lined landfill.

VOC Scan and Quantification - For purposes of this study, a VOC scan consists of running the sample through a mass spectrometer and then quantifying the compounds detected with a gas chromatograph. Parameters reported vary according to the regulatory list used. This study uses a list prepared by the Wisconsin State Laboratory of Hygiene (Appendix G).

Zone-of-Saturation Landfill - A landfill where the base grade is located below the water table in a natural clay soil environment and is designed and operated to maintain inward groundwater gradients.

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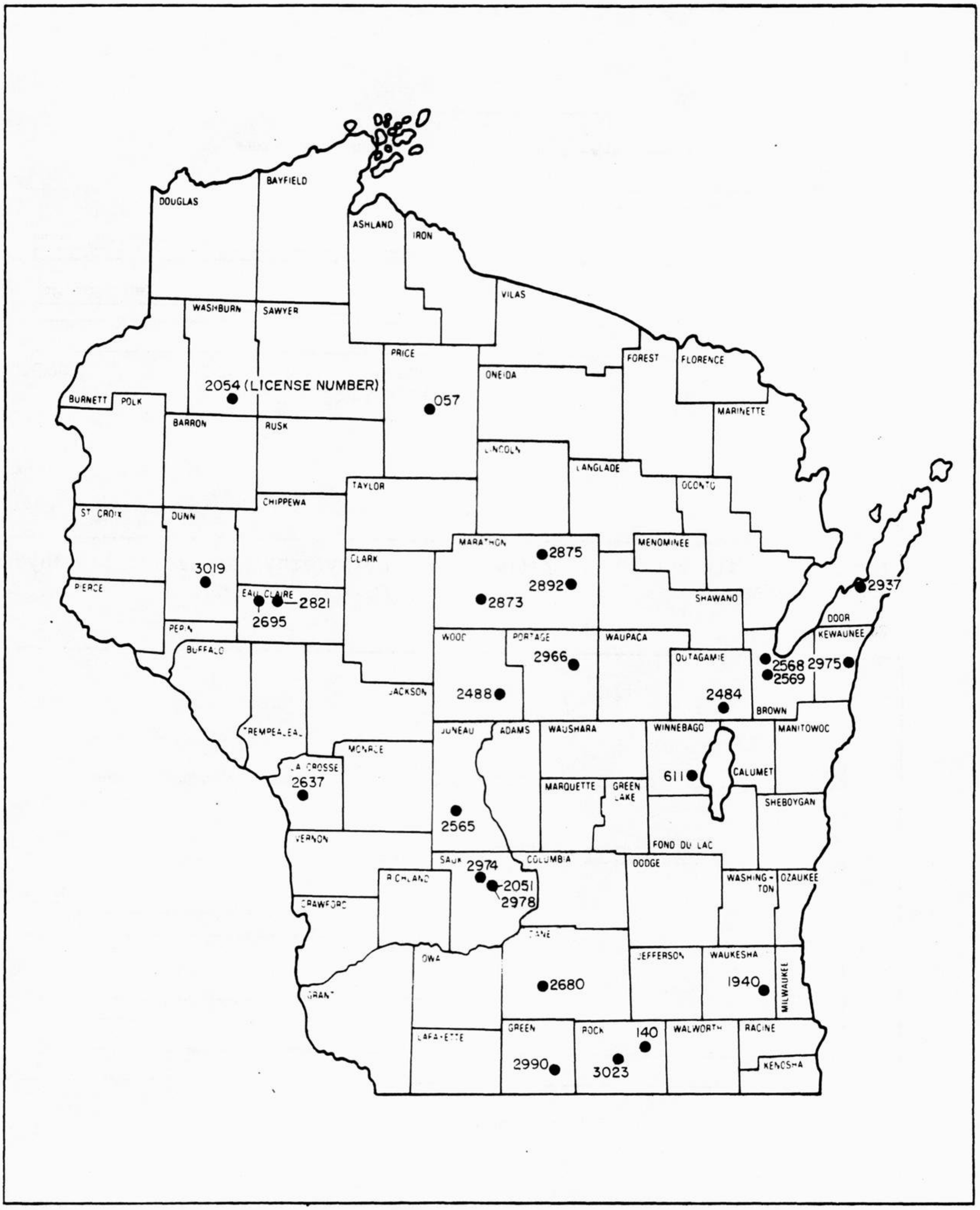

Figure 1. Geographic distribution of landfills chosen for this study.

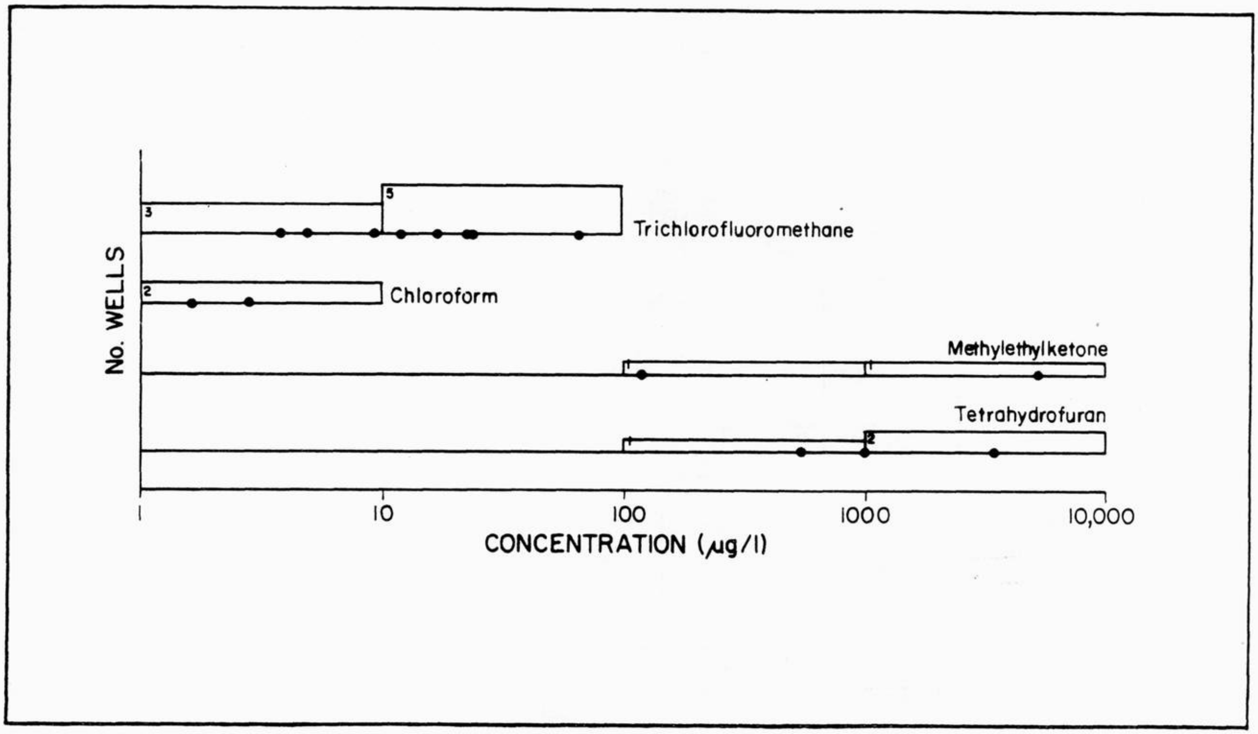

Figure 2. Distribution of halomethanes, methylethylketone and tetrahydrofuran in groundwater.

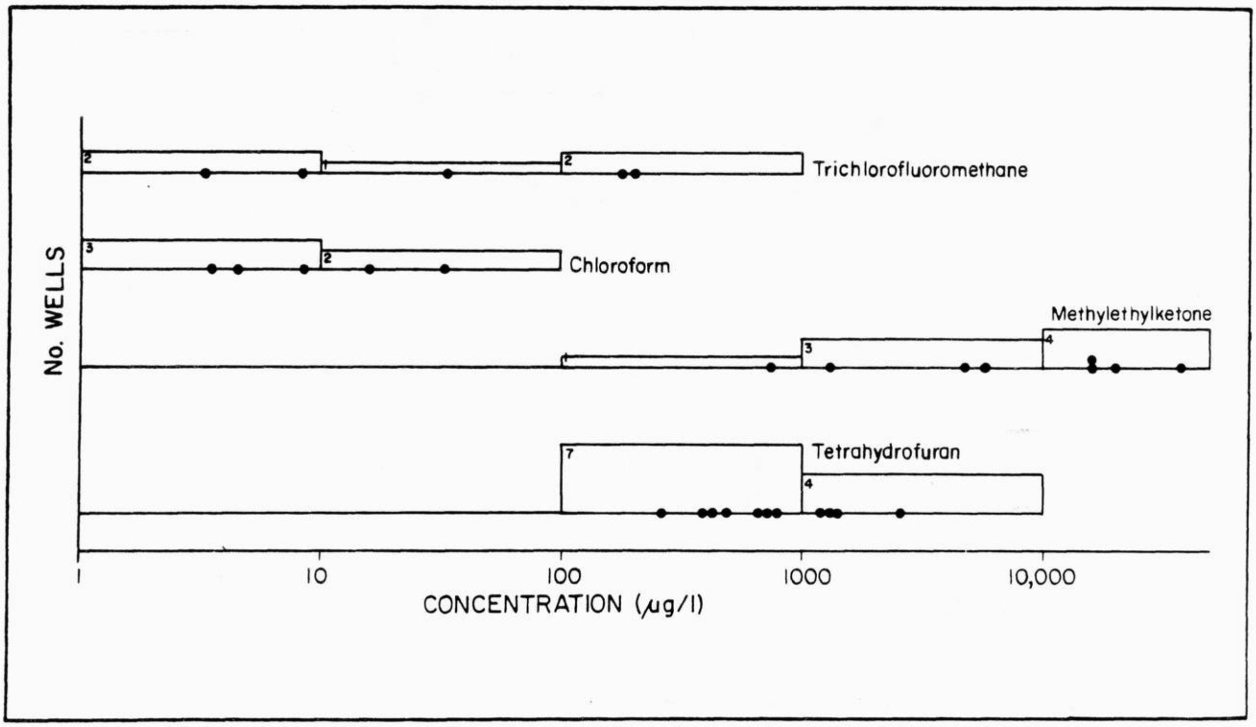

Figure 3. Distribution of halomethanes, methylethylketone and tetrahydrofuran in leachate.

* The height of the bar corresponds to the number in the left hand corner. Number in the left hand corner represents the number of wells detecting the compound.

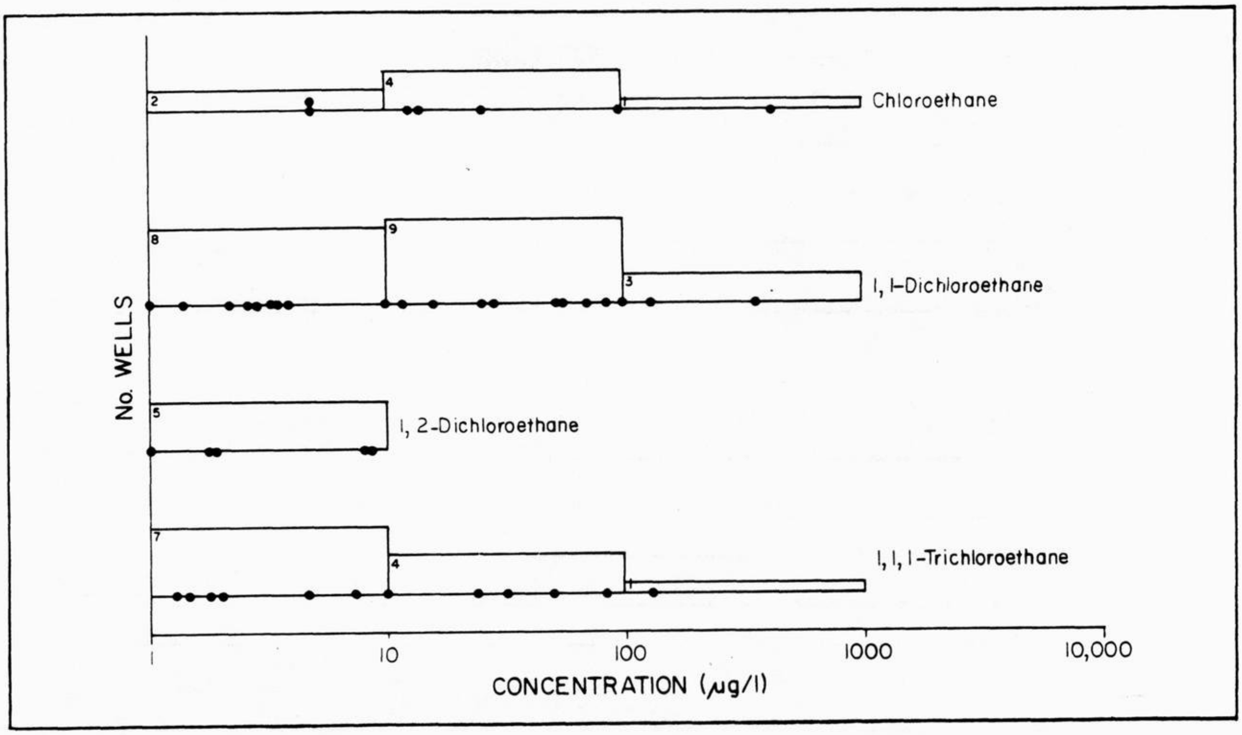

Figure 4. Distribution of chlorinated ethanes in groundwater.

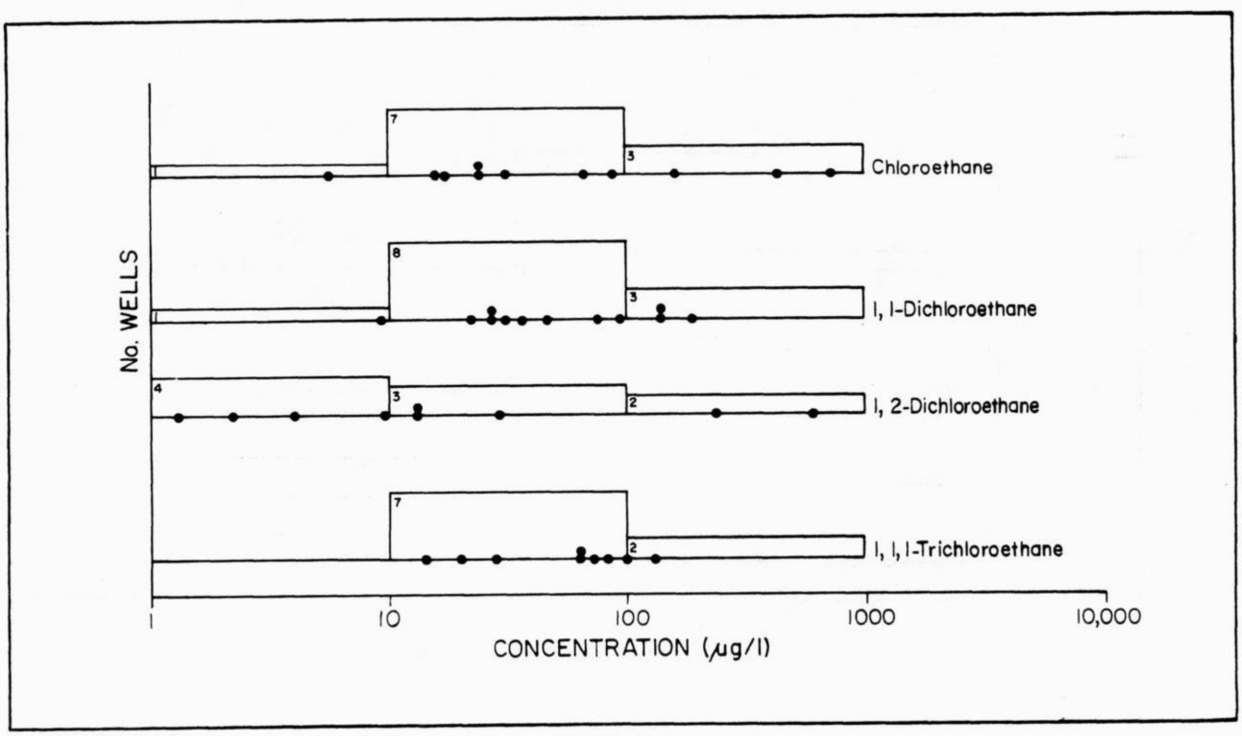

Figure 5. Distribution of chlorinated ethanes in leachate.

* The height of the bar corresponds to the number in the left hand corner. Number in the left hand corner represents the number of wells detecting the compound.

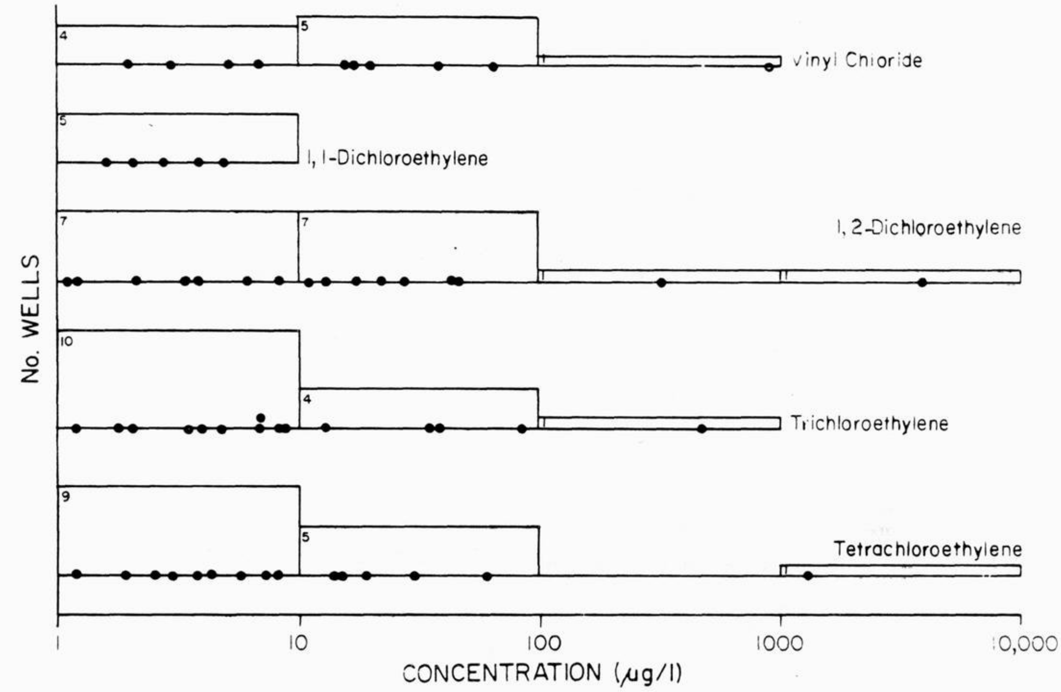

Figure 6. Distribution of chlorinated ethylenes in groundwater.

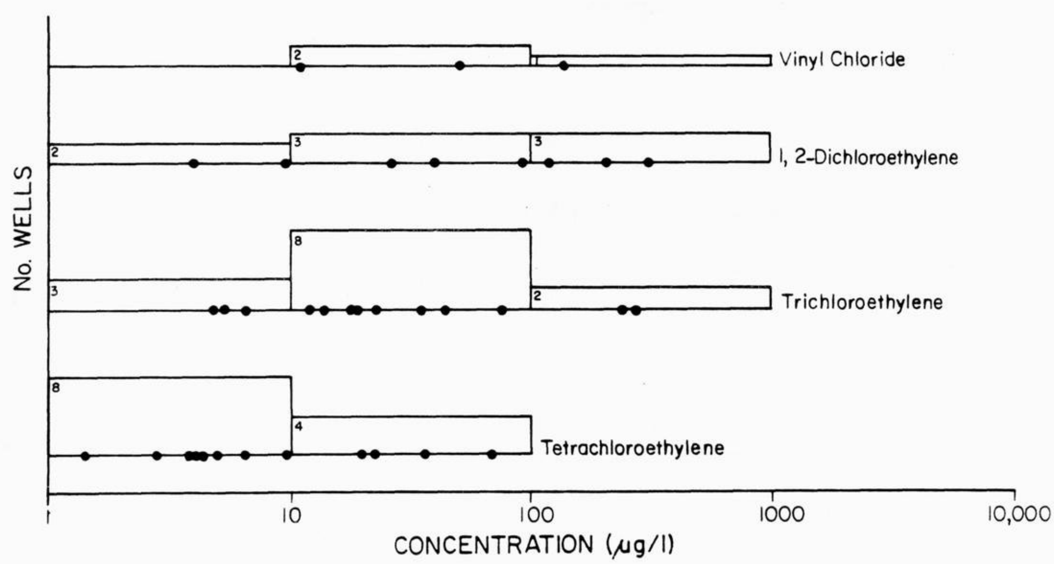

Figure 7. Distribution of chlorinated ethylenes in leachate.

* The height of the bar corresponds to the number in the left hand corner. Number in the left hand corner represents the number of wells detecting the compound.

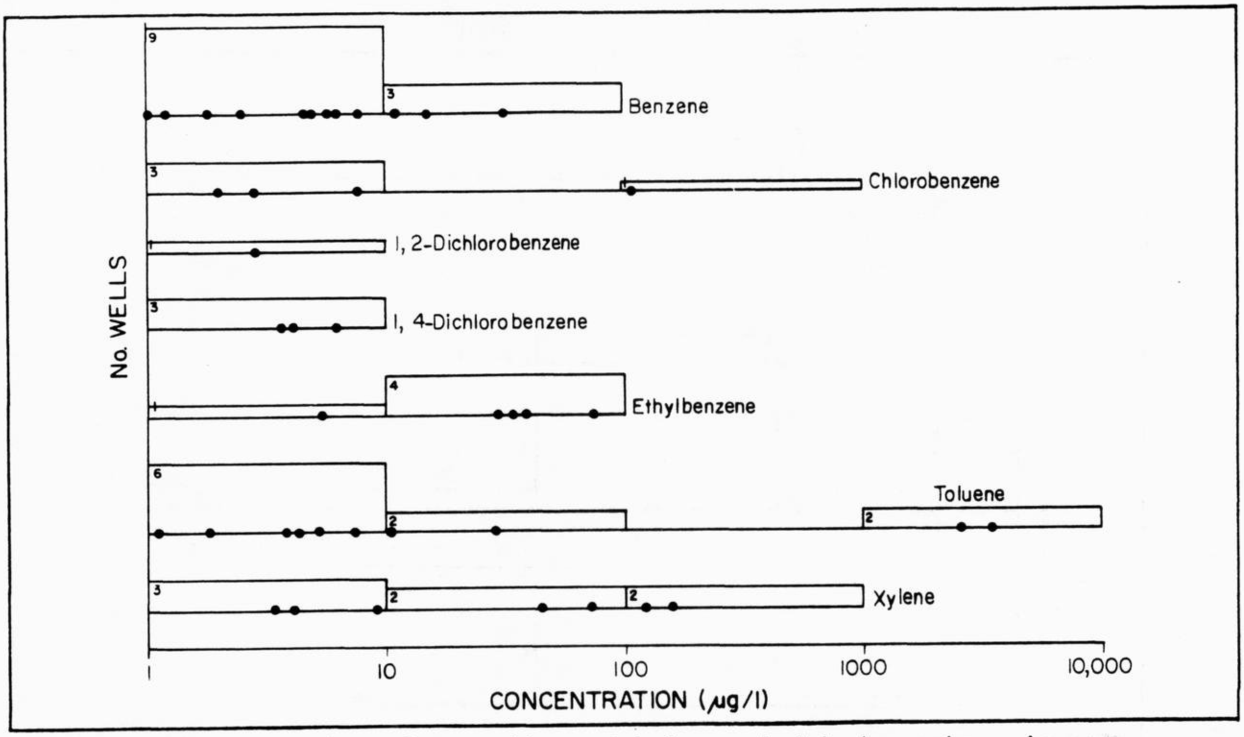

Figure 8. Distribution of aromatic and halogenated hydrocarbons in groundwater.

* The height of the bar corresponds to the number in the left hand corner. Number in the left hand corner represents the number of wells detecting the compound.

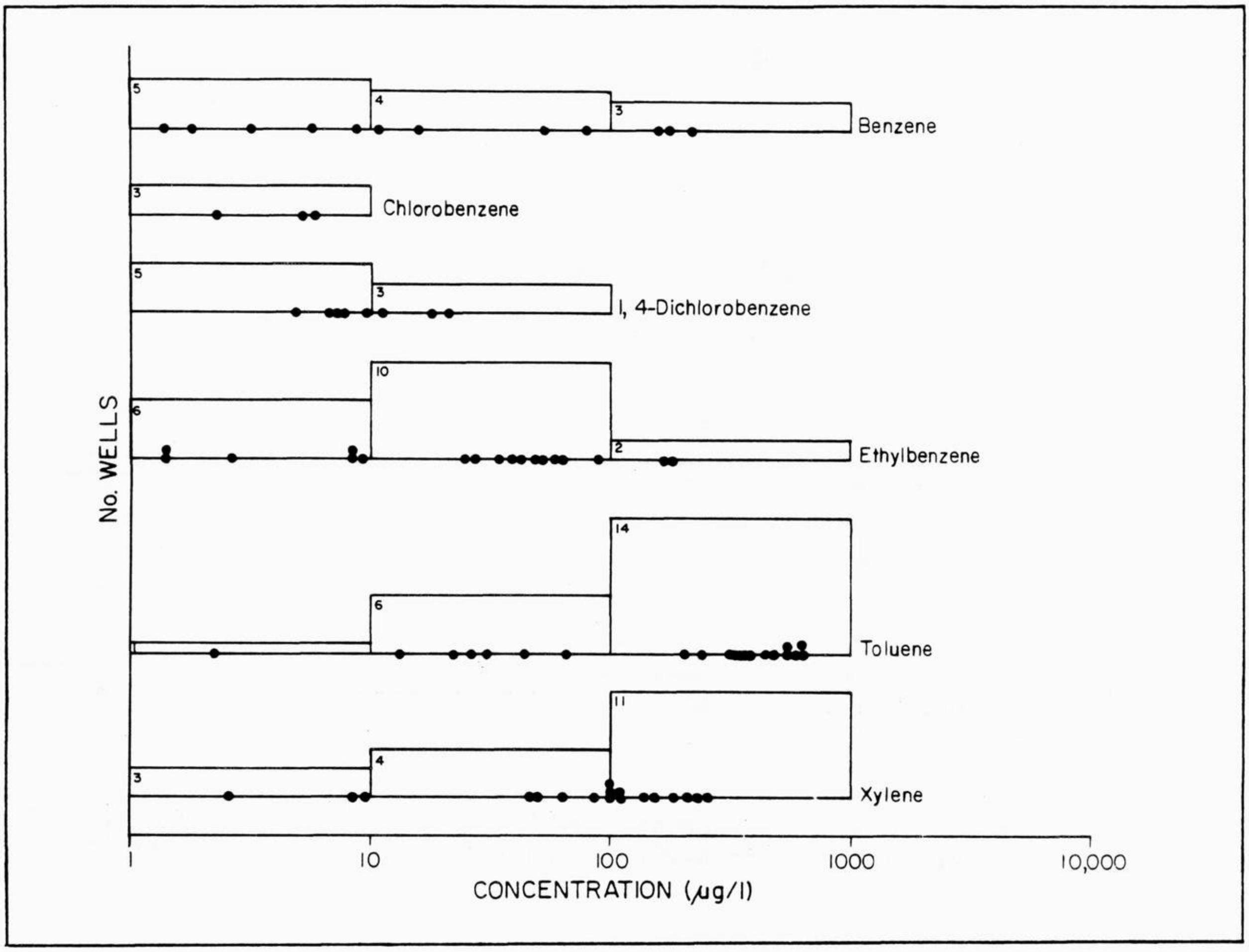

Figure 9. Distribution of aromatic and halogenated hydrocarbons in leachate.

* The height of the bar corresponds to the number in the left hand corner. Number in the left hand corner represents the number of wells detecting the compound.

TABLE 1. Descriptions of municipal and industrial landfills in the study.

		LICENSE #	NAME	OPENING DATE	DESIGN CAPACITY (1X10E6 YD3)	VOLUME IN PLACE (1X10E6 YD3)
MUNICIPAL						
CLAY-LINED		2569	BROWN CO. EAST	1975	7.0	3.30
		2821	EAU CLAIRE CO.	1978	1.5	1.10
		2892	MARATHON CO.	1980	2.1	0.52
		2966	PORTAGE CO.	1982	1.5	0.45
		3019	CTY MENOMINEE	1983	0.2	0.06
		2978	SAUK CO.	1983	1.3	0.26
		2990	GREEN CO.	1983	0.6	0.14
		3023	ROCK CO.	1985	4.5	0.45
ZONE-OF-SATURATION		611	WINNEBAGO CO.	1971	6.4	4.60
		2484	OUTAGAMIE CO.	1976	3.0	3.00
		2568	BROWN CO. WEST	1978	7.5	3.00
		2937	DOOR CO.	1981	0.7	0.19
		2975	KEWAUNEE CO.	1982	0.5	0.10
RETARDER OR COMBINED RETARDER AND NATURAL ATTENUATION		2637	LACROSSE CO.	1976	1.5	1.30
		2565	JUNEAU CO.	1976	0.2	0.17
		2680	DANE CO. #1 ABANDONED	1977	2.0	2.00
NATURAL ATTENUATION		140	GREIDANUS	PRE 1969	2.8	0.64
		057	CTY PHILLIPS	1957	0.1	0.08
		2054	LAKE AREA	1973	0.3	0.25
		2051	SAUK CO. ABANDONED	1974	1.0	1.00
INDUSTRIAL						
CLAY-LINED	PAPER MILL	2875	WAUSAU PAPERS	1981	0.3	0.23
ZONE-OF-SATURATION	PAPER MILL	2873	WEYERHAUSER	1978	0.2	0.20
SLUDGE LINED	PAPER MILL	2695	POPE AND TALBOT	1979	1.0	0.64
RETARDER OR COMBINED RETARDER AND NATURAL ATTENUATION	PAPER MILL	2488	CONSOLIDATED PAPERS WATER QUALITY CENTER	1974	0.5	0.50
	FOUNDRY	2974	GREDE FOUNDRY	1983	0.5	0.07
	MISC	1940	BARRETT	1972	0.7	0.50

TABLE 2. Samples containing VOCs.

MUNICIPAL		LICENSE #	NAME	#WELLS SAMPLED	#WELLS WITH VOCs	LEACHATE SAMPLE (A)	COLLECTION LYSIMETER SAMPLE	COLLECTIO LYSIMETE SAMPLES WITH VOCS
CLAY-LINED		2569	BROWN CO. EAST	5	1	Y		
		2821	EAU CLAIRE CO.	4	0	Y		
		2892	MARATHON CO.	5	0	Y	Y	Y
		2966	PORTAGE CO.	6	0	Y	Y	N
		3019	CTY MENOMINEE	5	0	Y		
		2978	SAUK CO.	4	0	Y	Y	N
		2990	GREEN CO.	4	0	Y	Y	N
		3023	ROCK CO.	4	2	Y	Y	N
ZONE-OF-SATURATION		611	WINNEBAGO CO.	8	3			
		2484	OUTAGAMIE CO.	5	2	Y		
		2568	BROWN CO. WEST	4	1	Y		
		2937	DOOR CO.	5	0	Y		
		2975	KEWAUNEE CO.	5	0	Y		
RETARDER OR COMBINED RETARDER AND NATURAL ATTENUATION		2637	LACROSSE CO.	4	1	Y		
		2565	JUNEAU CO.	4	1			
		2680	DANE CO. #1 ABANDONED	7	6			
NATURAL ATTENUATION		140	GREIDANUS	3	2	Y		
		057	CTY PHILLIPS	5	0			
		2054	LAKE AREA	5	3			
		2051	SAUK CO. ABANDONED	5	3			
INDUSTRIAL								
CLAY-LINED	PAPER MILL	2875	WAUSAU PAPERS	2	0			
ZONE-OF-SATURATION	PAPER MILL	2873	WEYERHAUSER	3	0	Y		
SLUDGE LINED	PAPER MILL	2695	POPE AND TALBOT	8	4	Y		
RETARDER OR COMBINED RETARDER AND NATURAL ATTENUATION	PAPER MILL	2488	CONSOLIDATED PAPERS WATER QUALITY CENTER	5	0	Y		
	FOUNDRY	2974	GREDE FOUNDRY	4	0	Y	Y	Y
	MISC	1940	BARRETT	6	0	Y	Y	Y

(A) All leachate samples detected VOCs except 2974

(B) VOC detects in collection lysimeters do not appear to be caused by the landfill. See text for a further explanation.

TABLE 3. Percent detection for VOC parameters.

PARAMETER	GROUNDWATER # LANDFILLS WITH VOCs	GROUNDWATER % LANDFILLS WITH VOCS (A)	LEACHATE # LANDFILLS WITH VOCs	LEACHATE % LANDFILLS WITH VOCS (B)	COLLECTION LYSIMETER # LANDFILLS WITH VOCs	# FIELD BLANKS WITH VOCs
HALOMETHANES						
CHLOROFORM	1	4	5	26	0	2
BROMODICHLOROMETHANE	0	0	0	0	0	2
TRICHLOROFLUOROMETHANE	6	23	5	26	0	
CHLORINATED ETHANES						
CHLOROETHANE	5	19	11	58	0	
1,1-DICHLOROETHANE	11	42	12	63	0	
1,2-DICHLOROETHANE	4	15	8	42	0	
1,1,1-TRICHLOROETHANE	8	30	9	47	0	2
CHLORINATED ETHYLENES						
VINYL CHLORIDE	4	15	3	16	1	
1,1-DICHLOROETHYLENE	3	11	0	0	0	
1,2-DICHLOROETHYLENE	5	19	8	42	0	
TRICHLOROETHYLENE	8	30	12	63	0	
TETRACHLOROETHYLENE	8	30	11	58	0	
AROMATIC AND HALOGENATED HYDROCARBONS						
BENZENE	7	27	13	63	0	
TOLUENE	6	23	18	95	1	
XYLENE	6	23	16	84	0	
CHLOROBENZENE	3	11	3	16	0	
1,2-DICHLOROBENZENE	1	4	0	0	0	
1,4-DICHLOROBENZENE	3	11	8	42	0	2
ETHYLBENZENE	5	19	16	84	0	
MISCELLANEOUS						
METHYLETHYLKETONE	2	8	7	37	0	
STYRENE	0	0	1	5	0	
TETRAHYDROFURAN	3	11	11	58	3	
# LANDFILLS SAMPLED	26		19		7	
# LANDFILLS WITH VOCS	12		18		3	2

(A) AND (B) LANDFILLS WITH VOCS ARE CALCULATED FROM THE TOTAL NUMBER OF LANDFILLS SAMPLED.
WHERE VOCS WERE DETECTED AT SEVERAL WELLS AT A LANDFILL THE LANDFILL IS ONLY COUNTED ONCE.

TABLE 4. Percent detection for VOC parameters compared with specific gravity and solubility.

PARAMETER	SPECIFIC (A) GRAVITY	SOLUBILITY (B) MG/L	GROUNDWATER % LANDFILLS WITH VOCS (C)	LEACHATE % DETECTED WITH VOCS (D)
METHYLETHYLKETONE	0.8050	353000 [10]	8	37
ETHYLBENZENE	0.8670	140 [15]	19	84
TOLUENE	0.8670	470 [16]	23	95
BENZENE	0.8786	1780 [20]	27	63
XYLENE (o)	0.8800	175 [20]	23	84
TETRAHYDROFURAN	0.8880	M	11	58
STYRENE	0.9045	280 [15]	0	5
VINYL CHLORIDE	0.9121	1.1 [25]	15	16
CHLOROETHANE	0.9200	-	19	58
CHLOROBENZENE	1.1066	448 [30]	11	16
1,1-DICHLOROETHANE	1.1740	5500 [20]	42	63
1,1-DICHLOROETHYLENE	1.2180	-	11	0
1,2-DICHLOROETHANE	1.2500	8690 [20]	15	42
1,2-DICHLOROETHYLENE (trans)	1.2800	600 [20]	19	42
1,2-DICHLOROBENZENE	1.3050	100 [20]	4	0
1,1,1-TRICHLOROETHANE	1.3500	4400 [20]	30	47
1,4-DICHLOROBENZENE	1.4580	49 [22]	11	42
TRICHLOROETHYLENE	1.4600	1100 [25]	30	63
CHLOROFORM	1.4890	8000 [20]	4	26
TRICHLOROFLUOROMETHANE	1.4940	1100 [25]	23	26
TETRACHLOROETHYLENE	1.6260	150 [25]	30	58
BROMODICHLOROMETHANE	1.9710	-	0	0

NOTES: (A) REFERENCE VERSCHUREN (1983)
WISCONSIN STATE LABORATORY OF HYGIENE ANALYZES FOR TOTAL XYLENES AND TOTAL 1,2 DICHLOROETHYLENES SPECIFIC GRAVITY VALUES ARE GIVEN FOR o-XYLENE AND trans-1,2 DICHLOROETHYLENE.
(B) M- MISCIBLE, (DEGREES CELCIUS)
VALUES ARE DERIVED FOR SINGLE COMPOUND SOLUTIONS. MULTI- CONTAMINANT SYSTEMS MAY BEHAVE DIFFERENTLY AND EXHIBIT SYNERGISTIC EFFECTS.
(C) AND (D) % LANDFILLS WITH VOCS CALCULATED FROM THE TOTAL NUMBER OF LANDFILLS SAMPLED. WHERE VOCS WERE DETECTED AT SEVERAL WELLS AT A LANDFILL THE LANDFILL IS ONLY COUNTED ONCE.

TABLE 5. Percent detection for VOC parameters in groundwater in Wisconsin compared with other state studies.

PARAMETER		WISCONSIN GROUNDWATER % LANDFILLS WITH VOCS (A)	MINNESOTA GROUNDWATER % LANDFILLS WITH VOCS (B)	MASSACHUSETTS GROUNDWATER % LANDFILLS WITH VOCS (C)
STYRENE		0		0
BROMODICHLOROMETHANE		0	17	
1,2-DICHLOROBENZENE		4	5	
CHLOROFORM		4	36	0
METHYLETHYLKETONE		8	48	29
CHLOROBENZENE		11	23	29
TETRAHYDROFURAN		11	61	14
1,1-DICHLOROETHYLENE		11	31	14
1,4-DICHLOROBENZENE		11	12	
VINYL CHLORIDE		15	19	7
1,2-DICHLOROETHANE		15	47	7
ETHYLBENZENE		19	53	43
1,2-DICHLOROETHYLENE	(trans)	19	87	21
CHLOROETHANE		19	36	29
TRICHLOROFLUOROMETHANE		23	37	
TOLUENE		23	55	64
XYLENE	(o)	23	74	43
BENZENE		27	58	50
1,1,1-TRICHLOROETHANE		30	58	36
TETRACHLOROETHYLENE		30	48	21
TRICHLOROETHYLENE		30	59	29
1,1-DICHLOROETHANE		42	80	43
# LANDFILLS SAMPLED		26	47 TO 60	14
# LANDFILLS WITH VOCS		12	> 47	9

(A),(B), AND (C) % LANDFILLS WITH VOCS CALCULATED FROM THE TOTAL NUMBER OF LANDFILLS SAMPLED. WHERE VOCS WERE DETECTED AT SEVERAL WELLS AT A LANDFILL THE LANDFILL IS ONLY COUNTED ONCE.

(B) NELSON AND BOOK (1986)

(C) MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL QUALITY ENGINEERING, UNPUBLISHED STUDY (1986)

TABLE 6. Percent detection for VOC parameters in leachate compared with groundwater.

PARAMETER		WISCONSIN LEACHATE % LANDFILLS WITH VOCS (A)	MASSACHUSETTS LEACHATE % LANDFILLS WITH VOCS (B)	WISCONSIN GROUNDWATER % LANDFILLS WITH VOCS (C)
1,1-DICHLOROETHYLENE		0		11
1,2-DICHLOROBENZENE		0		4
BROMODICHLOROMETHANE		0		0
STYRENE		5	14	0
VINYL CHLORIDE		16	0	15
CHLOROBENZENE		16	0	11
TRICHLOROFLUOROMETHANE		26		23
CHLOROFORM		26	14	4
METHYLETHYLKETONE		37	86	8
1,2-DICHLOROETHANE		42	0	15
1,4-DICHLOROBENZENE		42		11
1,2-DICHLOROETHYLENE	(trans)	42	29	19
1,1,1-TRICHLOROETHANE		47	14	30
CHLOROETHANE		58	14	19
TETRAHYDROFURAN		58	14	11
TETRACHLOROETHYLENE		58	14	30
1,1-DICHLOROETHANE		63	29	42
TRICHLOROETHYLENE		63	29	30
BENZENE		63	43	27
XYLENE	(o)	84	71	23
ETHYLBENZENE		84	71	19
TOLUENE		95	86	23

(A), (B) AND (C) % LANDFILLS WITH VOCS CALCULATED FROM THE TOTAL NUMBER OF LANDFILLS SAMPLED. WHERE VOCS WERE DETECTED AT SEVERAL WELLS AT A LANDFILL THE LANDFILL IS ONLY COUNTED ONCE.

(B) MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL QUALITY ENGINEERING (MDEQE), UNPUBLISHED STUDY (198
MDEQE DETECTED OTHER COMPOUNDS IN LEACHATE NOT REPORTED HERE.

TABLE 7. Maximum concentration detected in groundwater samples (ug/l).

SITE #	2054	2054	2054	2051	2051	2051	2695	2695	2695	2695
WELL #	MW-3	MW-4	MW-5	TW-25	TW-26	TW-26A	DH-5	DH-9A	DH-17	DH-17A
PARAMETER										
HALOMETHANES										
CHLOROFORM						2.8				
BROMODICHLOROMETHANE										
TRICHLOROFLUOROMETHANE	24.0	66.0	9.4		4.8					
CHLORINATED ETHANES										
CHLOROETHANE				420.0					4.8	
1,1-DICHLOROETHANE			3.4	130.0	100.0	360.0	2.2	2.9	12.0	
1,2-DICHLOROETHANE				8.5		1.8				
1,1,1-TRICHLOROETHANE	1.8	51.0	1.3		86.0	130.0				
CHLORINATED ETHYLENES										
VINYL CHLORIDE							3.0	5.1	16.0	
1,1-DICHLOROETHYLENE				3.9	2.8	4.9				
1,2-DICHLOROETHYLENE				43.0	3.9	13.0	3.4	11.0	45.0	
TRICHLOROETHYLENE			1.2	4.0	3.5	6.8	2.0		6.9	
TETRACHLOROETHYLENE	2.5			4.3	8.0	15.0			3.0	
AROMATIC AND HALOGENATED HYDROCARBONS										
BENZENE				32.0		6.3		1.2		
TOLUENE				2600.0				1.8	4.4	5.3
XYLENE				160.0		3.3			4.0	
CHLOROBENZENE				7.6		2.8			2.0	
1,2-DICHLOROBENZENE										
1,4-DICHLOROBENZENE				6.2						
ETHYLBENZENE				74.0						
MISCELLANEOUS										
METHYLETHYLKETONE				5100.0					120.0	
STYRENE										
TETRAHYDROFURAN				3400.0						

TABLE 7. Maximum concentration detected in groundwater samples (ug/l).

SITE #	2569	3023	3023	611	611	611	2484	2484	2568
WELL #	MW-7	MW-14	MW-15	P-5-40	P-5-60A	P-9-60A	P-6B	P-9C	P-7C
PARAMETER									
HALOMETHANES									
CHLOROFORM	1.6								
BROMODICHLOROMETHANE									
TRICHLOROFLUOROMETHANE	12.0								
CHLORINATED ETHANES									
CHLOROETHANE					14.0	4.8	26.0	13.0	
1,1-DICHLOROETHANE	16.0		1.0	26.0	3.9		52.0	10.0	
1,2-DICHLOROETHANE			1.0				8.1		
1,1,1-TRICHLOROETHANE	33.0								
CHLORINATED ETHYLENES									
VINYL CHLORIDE				63.0	6.8	20.0	190.0	38.0	
1,1-DICHLOROETHYLENE						2.1			
1,2-DICHLOROETHYLENE				8.1	2.1		3900.0	320.0	
TRICHLOROETHYLENE	8.3						480.0	39.0	
TETRACHLOROETHYLENE	5.8						60.0	1.9	
AROMATIC AND HALOGENATED HYDROCARBONS									
BENZENE				1.8		4.8	15.0	5.8	
TOLUENE				1.1		3.8	3500.0	7.2	
XYLENE						46.0	120.0		
CHLOROBENZENE							110.0		
1,2-DICHLOROBENZENE						2.8			
1,4-DICHLOROBENZENE						4.1		3.7	
ETHYLBENZENE						35.0	39.0		
MISCELLANEOUS									
METHYLETHYLKETONE									
STYRENE									
TETRAHYDROFURAN		520.0							1000.0

(A) 1,1,1 TRICHLOROETHANE WAS ALSO DETECTED IN THE FIELD BLANK FOR SITE #2637

TABLE 7. Maximum concentration detected in groundwater samples (ug/l).

SITE #	2637	2565	2680	2680	2680	2680	2680	2680	140	140
WELL #	MW-12 (A)	MW-4	MW-12R	MW-14	MW-17	MW-17R	MW-18	MW-29	W-22	W-54
PARAMETER										
HALOMETHANES										
CHLOROFORM										
BROMODICHLOROMETHANE										
TRICHLOROFLUOROMETHANE		23.0	3.7					17.0		
CHLORINATED ETHANES										
CHLOROETHANE		99.0								
1,1-DICHLOROETHANE	85.0	1.4	2.7	3.4				70.0	29.0	55.0
1,2-DICHLOROETHANE		1.9								
1,1,1-TRICHLOROETHANE	7.3	1.5	2.1	4.7				25.0		9.9
CHLORINATED ETHYLENES										
VINYL CHLORIDE				2.0				17.0		
1,1-DICHLOROETHYLENE								1.6		
1,2-DICHLOROETHYLENE	28.0		1.2	1.1				22.0	6.1	17.0
TRICHLOROETHYLENE	35.0		1.8	4.8				86.0	8.9	13.0
TETRACHLOROETHYLENE	30.0		1.2	19.0	14.0	3.8		1300.0		7.3
AROMATIC AND HALOGENATED HYDROCARBONS										
BENZENE		2.5					8.0	4.9	1.0	11.0
TOLUENE	10.0							29.0		
XYLENE	71.0							9.0		
CHLOROBENZENE										
1,2-DICHLOROBENZENE										
1,4-DICHLOROBENZENE										
ETHYLBENZENE	29.0							5.4		
MISCELLANEOUS										
METHYLETHYLKETONE										
STYRENE										
TETRAHYDROFURAN										

TABLE 8. Maximum concentration detected in leachate and collection lysimeter samples (ug/l).

SITE #	2569	2821	2892	2892	2966	3019	2978	2990	3023
POINT (A)			42	31					
PARAMETER									
HALOMETHANES									
CHLOROFORM							3.4	4.4	8.3
BROMODICHLOROMETHANE									
TRICHLOROFLUOROMETHANE			180.0					3.2	34.0
CHLORINATED ETHANES									
CHLOROETHANE	24.0	67.0		89.0	160.0	730.0	16.0	5.6	440.0
1,1-DICHLOROETHANE	76.0	140.0	31.0	22.0	46.0	190.0	120.0	36.0	95.0
1,2-DICHLOROETHANE	240.0	13.0			2.2	4.0	13.0		
1,1,1-TRICHLOROETHANE			100.0			28.0	14.0	72.0	130.0
CHLORINATED ETHYLENES									
VINYL CHLORIDE					11.0			150.0	51.0
1,1-DICHLOROETHYLENE									
1,2-DICHLOROETHYLENE		210.0		120.0	40.0	27.0	310.0		9.6
TRICHLOROETHYLENE	19.0	23.0	14.0		6.7	44.0	35.0	5.4	18.0
TETRACHLOROETHYLENE	4.2		4.9		1.4	69.0	36.0	4.0	11.0
AROMATIC AND HALOGENATED HYDROCARBONS									
BENZENE	220.0	80.0		5.7	53.0		180.0	8.9	11.0
TOLUENE	360.0	580.0	200.0	370.0	480.0	240.0	360.0	350.0	580.0
XYLENE	75.0	150.0	110.0	210.0	100.0	64.0	180.0	49.0	240.0
CHLOROBENZENE									
1,2-DICHLOROBENZENE									
1,4-DICHLOROBENZENE	7.6			21.0	4.9	18.0	9.7		
ETHYLBENZENE	180.0	62.0	25.0	58.0	38.0	27.0	77.0	8.2	49.0
MISCELLANEOUS									
METHYLETHYLKETONE		16000.0	1300.0	4700.0	16000.0		20000.0	5900.0	37000.0
STYRENE			28.0						
TETRAHYDROFURAN	780.0	2600.0		270.0	400.0		1300.0	430.0	1400.0

(A) POINT ID ONLY SHOWN FOR LANDFILLS WHERE MORE THAN ONE LEACHATE POINT WAS SAMPLED

(B) DILUTED SAMPLE . NOT REPRESENTATIVE OF LEACHATE CONCENTRATIONS TAKEN BY THE FACILITY IN THE PAST.

TABLE 8. Maximum concentration detected in leachate and collection lysimeter samples (ug/l).

SITE #	2484	2568	2937	2975	2637	140	2488	2873	2695	2695	2695
POINT (A)									16	SE	N
.... (B)											
PARAMETER											
HALOMETHANES											
CHLOROFORM									16.0	32.0	
BROMODICHLOROMETHANE											
TRICHLOROFLUOROMETHANE				8.2		200.0					
CHLORINATED ETHANES											
CHLOROETHANE		31.0		24.0							
1,1-DICHLOROETHANE		140.0		27.0		27.0				9.2	
1,2-DICHLOROETHANE				1.3		600.0			9.9	29.0	
1,1,1-TRICHLOROETHANE		63.0	63.0	20.0		82.0					
CHLORINATED ETHYLENES											
VINYL CHLORIDE											
1,1-DICHLOROETHYLENE											
1,2-DICHLOROETHYLENE		94.0		4.0							
TRICHLOROETHYLENE		77.0		4.8		12.0			280.0	240.0	
TETRACHLOROETHYLENE		22.0		6.4		9.8			2.8	3.9	
AROMATIC AND HALOGENATED HYDROCARBONS											
BENZENE	1.8	160.0		1.4	16.0						
TOLUENE	26.0	540.0	13.0	30.0	66.0	340.0	610.0	22.0	440.0	520.0	42.0
XYLENE	100.0	140.0	2.5	230.0	110.0	100.0			14.0	47.0	8.2
CHLOROBENZENE	2.3								5.1	5.8	
1,2-DICHLOROBENZENE											
1,4-DICHLOROBENZENE	6.7			7.5		11.0					
ETHYLBENZENE	34.0	170.0		19.0	51.0	42.0	1.4		1.4	2.6	
MISCELLANEOUS											
METHYLETHYLKETONE	640.0										
STYRENE											
TETRAHYDROFURAN	730.0	490.0			1200.0						

TABLE 8. Maximum concentration detected in leachate and collection lysimeter samples (ug/l).

	COLLECTION LYSIMETER SAMPLES			
SITE #	1940	2974	1940	2892
POINT (A)		110	254	19
PARAMETER				
HALOMETHANES				
CHLOROFORM				
BROMODICHLOROMETHANE				
TRICHLOROFLUOROMETHANE				
CHLORINATED ETHANES				
CHLOROETHANE	17.0			
1,1-DICHLOROETHANE				
1,2-DICHLOROETHANE				
1,1,1-TRICHLOROETHANE				
CHLORINATED ETHYLENES				
VINYL CHLORIDE			1.5	
1,1-DICHLOROETHYLENE				
1,2-DICHLOROETHYLENE				
TRICHLOROETHYLENE				
TETRACHLOROETHYLENE				
AROMATIC AND HALOGENATED HYDROCARBONS				
BENZENE	3.2			
TOLUENE	2.2	1.2		
XYLENE	9.6			
CHLOROBENZENE				
1,2-DICHLOROBENZENE				
1,4-DICHLOROBENZENE				
ETHYLBENZENE	8.2			
MISCELLANEOUS				
METHYLETHYLKETONE				
STYRENE				
TETRAHYDROFURAN	680.0	11000.0	910.0	800.0

TABLE 9. Attainment or exceedances of groundwater standards for groundwater samples.

PARAMETER	ENFORCEMENT STANDARD (ES) (UG/L) (A)	PREVENTIVE ACTION LIMIT (PAL) (UG/L) (B)	# VOC DETECTIONS	# ATTAINING OR EXCEEDING ES	# ATTAINING OR EXCEEDING PAL
1,2-DICHLOROETHYLENE	0.500	0.050	16	16	16
1,1-DICHLOROETHYLENE	0.240	0.024	5	5	5
TETRACHLOROETHYLENE	1.000	0.100	15	15	15
BENZENE	0.670	0.067	12	12	12
TOLUENE	343.000	68.800	10	2	2
XYLENE	620.000	124.000	7	0	1
1,4-DICHLOROBENZENE	750.000	150.000	3	0	0

(A) = NR 140 WIS. ADM. CODE ENFORCEMENT STANDARD
(B) = NR 140 WIS. ADM. CODE PREVENTIVE ACTION LIMIT

TABLE 10. Comparison of VOC concentrations in groundwater and leachate (ug/l).

SITE #	2569	2569	3023	3023	2568	2568	2637	2637	140	140	140	269
SAMPLE TYPE (A)	GW	LCH	GW	LCH	GW	LCH	GW	LCH	GW	GW	LCH	G
POINT	MW-7		MW-15		P-7C		MW-12		W-22	W-54		DH-
PARAMETER												
HALOMETHANES												
CHLOROFORM	1.6			8.3								
BROMODICHLOROMETHANE												
TRICHLOROFLUOROMETHANE	12.0			34.0							200.0	
CHLORINATED ETHANES												
CHLOROETHANE		24.0		440.0		31.0						
1,1-DICHLOROETHANE	16.0	76.0	1.0	95.0		140.0	85.0		29.0	55.0	27.0	2.
1,2-DICHLOROETHANE		240.0	1.0								600.0	
1,1,1-TRICHLOROETHANE	33.0			130.0		63.0	7.3			9.9	82.0	
CHLORINATED ETHYLENES												
VINYL CHLORIDE				51.0								3.
1,1-DICHLOROETHYLENE												
1,2-DICHLOROETHYLENE				9.6		94.0	28.0		6.1	17.0		3.
TRICHLOROETHYLENE	8.3	19.0		18.0		77.0	35.0		8.9	13.0	12.0	2.
TETRACHLOROETHYLENE	5.8	4.2		11.0		22.0	30.0			7.3	9.8	
AROMATIC AND HALOGENATED HYDROCARBONS												
BENZENE		220.0		11.0		160.0		16.0	1.0	11.0		
TOLUENE		360.0		580.0		540.0	10.0	66.0			340.0	
XYLENE		75.0		240.0		140.0	71.0	110.0			100.0	
CHLOROBENZENE												
1,2-DICHLOROBENZENE												
1,4-DICHLOROBENZENE		7.6									11.0	
ETHYLBENZENE		180.0		49.0		170.0	29.0	51.0			42.0	
MISCELLANEOUS												
METHYLETHYLKETONE				37000.0								
STYRENE												
TETRAHYDROFURAN		780.0		1400.0	1000.0	490.0		1200.0				

(A) GW = GROUNDWATER
LCH = LEACHATE

TABLE 10. Comparison of VOC concentrations in groundwater and leachate (ug/l).

SITE #	2695	2695	2695	2695	2695	2695
SAMPLE TYPE (A)	GW	GW	GW	LCH	LCH	LCH
POINT	DH-9A	DH-17	DH-17A	16	SE	N
PARAMETER						
HALOMETHANES						
CHLOROFORM				16.0	32.0	
BROMODICHLOROMETHANE						
TRICHLOROFLUOROMETHANE						
CHLORINATED ETHANES						
CHLOROETHANE		4.8				
1,1-DICHLOROETHANE	2.9	12.0			9.2	
1,2-DICHLOROETHANE				9.9	29.0	
1,1,1-TRICHLOROETHANE						
CHLORINATED ETHYLENES						
VINYL CHLORIDE	5.1	16.0				
1,1-DICHLOROETHYLENE						
1,2-DICHLOROETHYLENE	11.0	45.0				
TRICHLOROETHYLENE		6.9		280.0	240.0	
TETRACHLOROETHYLENE		3.0		2.8	3.9	
AROMATIC AND HALOGENATED HYDROCARBONS						
BENZENE	1.2					
TOLUENE	1.8	4.4	5.3	440.0	520.0	42.0
XYLENE		4.0		14.0	47.0	8.2
CHLOROBENZENE		2.0		5.1	5.8	
1,2-DICHLOROBENZENE						
1,4-DICHLOROBENZENE						
ETHYLBENZENE				1.4	2.6	
MISCELLANEOUS						
METHYLETHYLKETONE		120.0				
STYRENE						
TETRAHYDROFURAN						

(A) GW = GROUNDWATER
LCH = LEACHATE

TABLE 11. Low level VOC detections and comparison of VOCs with indicator parameters.

SITE #	WELL	# VOCs DETECTED	#VOCs >10 UG/L	CHLORIDE	ALKALINITY	HARDNESS	SPECIFIC CONDUCTANCE	COD
2569	MW-7	6	3	B	B	B	X	B
3023	MW-14	1	1	B	B	B	B	B
	MW-15	2	0	B	B	B	B	B
611	P-5-40A	5	2	B	X	X	X	R
	P-5-60A	4	1	B	B	B	B	R
	P-9-60A	9	3	B	B	B	B	R
2484	P-6B	12	11	E	X	X	X	X
	P-9C	9	5	B	X	X	X	B
2568	MW-7C	1	1	B	B	B	B	B
2637	MW-12	8	6	B	B	B	B	X
2565	MW-4	6	2	B	-	-	B	B
2680	MW-12R	6	0	X	-	B	X	B
	MW-14	6	1	B	-	X	X	B
	MW-17	1	1	B	-	X	B	B
	MW-17R	1	0	B	-	B	B	B
	MW-18	1	0	B	-	X	X	B
	MW-29	12	8	B	-	X	X	B
140	W-22	4	1	B	B	B	B	B
	W-54	6	4	B	X	X	X	B
2054	MW-3	3	1	B	B	B	B	B
	MW-4	2	2	B	X	X	X	B
	MW-5	4	0	B	X	X	X	X
2051	TW-25	15	9	P	P	P	P	P
	TW-26	7	2	B	P	P	P	B
	TW-26A	11	4	B	P	P	P	B
2695	DH-5	4	0	X	X	X	X	X
	DH-9A	5	0	-	-	-	-	-
	DH-17	10	4	X	X	X	X	X
	DH-17A	1	0	-	X	X	X	X

KEY:

B = BACKGROUND OR BELOW CALCULATED INDICATOR PREVENTIVE ACTION LIMIT (PAL)
X = > BACKGROUND
P = > PAL VALUE
E = > ENFORCEMENT STANDARD VALUE
- = NO DATA
R = ERRATIC DATA

CORRESPONDENCE/MEMORANDUM

STATE OF WISCONSIN

DATE: August 22, 1985

FILE REF: 4400

TO: Carol McCurry - SD
Jim Anklam - WCD
Barry O'Flanagan - NWD
Mike Miller - NCD
Doug Rossberg - LMD

FROM: David Stensby - SW/3

SUBJECT: Suggestions for Sampling Groundwater for Volatile Organic Compounds (VOC's)

In preparation for sampling VOC's at a number of landfills around the state, Lakshmi Sridharan has asked me to develop some suggestions for proper VOC sampling of groundwater for monitoring wells. Good analytical laboratories spend a great deal of time and effort on quality assurance and quality control procedures. Even so, quality results can be obtained only if the sample is taken and preserved as carefully as possible prior to analysis. If everyone follows these suggestions, together with a little care and common sense, this project will result in accurate, consistent and comparable data.

There are really only two ways that a sample can be disrupted - physically or chemically. Physical disruption of a sample can usually be controlled during field sampling. For all sampling involving this project, only a teflon bailer should be used as a sampling device. Lower the bailer gently into contact with the water in the well and allow it to fill. Retrieve the bailer smoothly, and empty the water into the sample bottle as gently as possible. Some of the Department bailers are supplied with drain spigots or bottom emptying devices which push the ball valve open from the bottom and allow the bailer to be emptied without it being inverted. Contact Jack Connelly immediately if you do not have one of these devices for your teflon bailer so that he can order you one in time for the sampling. They should be used for all sampling during this survey to achieve a gentle even flow.

As a final word about possible physical disruption of samples, remember that losses of VOC's can be quite rapid. Fill each bottle completely such that a positive meniscus is formed and there are no visible air bubbles after capping. It is important to cap the samples quickly and tightly, and keep them cool. If possible, precooling the sampling bottles is a good idea.

Chemical disruption of samples can be additive or subtractive. Either the sample can be tainted by the addition of contaminants from leaching or cross-contamination, or losses of volatiles can occur by adsorption of VOC's onto incompatible materials used in sampling.

Leaching of contaminants is prevented by using threaded joints during well construction and inert materials for sampling monitoring wells. The best materials for sampling VOC's are teflon and metal. Teflon bailers and bottom emptying devices should be available for your sampling.

Protect against cross-contamination by thoroughly rinsing (3 times) with deionized distilled water anything in the sampling chain that contacts groundwater. Also, check on the effectiveness of decontamination procedures by doing at least one field blank sample per site. Use the same procedures for the field blank as you use for regular samples. The field blank should be obtained approximately in the middle of your sampling at each site.

The following guidelines should be followed to retrieve samples adhering to the principles discussed previously in this memo.

1. Teflon bailers should be used.

2. Monofilament (single thread) or nylon lines should be used for lowering the bailer. Any portion of the line which enters the water in the well should be cut off after each sample is taken.

3. Bailer and line should be triple rinsed using deionized distilled water in the field between each sample location.

4. The sample should <u>not</u> be field filtered.

5. Glass vials with teflon lined screw caps provided by the State Lab of Hygiene should be used and overfilled so that air bubbles are excluded and a positive meniscus is achieved (see Figure 1). Vials should be capped immediately after being filled.

6. The bailer should be emptied and the sample vials filled such that a minimum of turbulence is created to avoid degassing. A bottom emptying device should be used to empty the bailer.

7. Sampling of wells should start with the least contaminated and proceed to the most contaminated (if known) or from the upgradient wells to those downgradient wells most judged at risk of contamination.

8. All samples should be immediately stored in freezer packs provided by the lab. The blue ice in the freezer pack should be thoroughly frozen before shipment to the laboratory.

9. One field blank should be collected and analyzed during each sampling period at each site. After the triple rinse decontamination procedure and before sampling the next well, a sample consisting of deionized, distilled water should be passed through the bailer and collected.

10. Keep procedures consistent.

11. Document procedures used.

12. Label leachate samples as "leachate" so the lab knows there is a good chance the samples may be highly contaminated.

13. Take VOC samples first, before you sample for any other parameters.

Finally, remember, even the best VOC sample only has a 14 day shelf life. To assure proper bottles are available, you should contact Dave Degenhardt at (608) 262-2797 at the State Laboratory of Hygiene as soon as you know what day you will be sampling. The lab will then send you the proper bottles, but only a week or so before your indicated sampling date. This is to ensure a minimum of exposure to contaminants while the bottles are in storage. If you have any other questions, or need assistance, please contact David Stensby at (608) 267-7559 or Jack Connelly at (608) 267-7574.

DS:cr
6014R

cc: Solid Waste Coordinators
Lakshmi Sridharan - SW/3
Jack Connelly - SW/3
Rick Schuff - SW/3
Paul Didier - SW/3

Department of Natural Resources

VOLATILE ORGANIC – SOLID WASTE PROGRAM
Form 4400-94 10-84

Bill To: ☐ Hazardous Waste ☐ Non-Hazardous Waste ☐ Spill Program

Facility Name ____________ Lic. No. 0 ___ ___ ___ ___ Field No. ____________

County ____________ County Code ___ ___ DNR Point ID No. ___ ___ ___

Collection Date: ___ ___ / ___ ___ / ___ ___ (M M D D Y Y) Time (24-Hour Clock): ___ ___ / ___ ___ (H H M M)

Sample Location ____________

Sample Description ____________

Send Report To:
Name
Address
City, State, Zip Code

Collected by ____________

Telephone ( ) ____________

Account Number ____________ For Lab Use Only

☐ Monitoring Well (W) ☐ Waste (B)
☐ Surface Water (W) ☐ Oil (O)
☐ Private Well (W) ☐ Soil (S)
☐ Wastewater (E) ☐ Leachate (L)
☐ Lysimeter (W) ☐ Other ____________

Enforcement ☐ Yes ☐ No
Split Sample ☐ Yes ☐ No

Received by ____________

Analysis Type (check (✓) one)
☐ GC-MS Screening
☐ Follow-up of GC-MS Screening Sample Number (fill in) ____________
☐ GC-MS Screening and Quantification
☐ Other (explain) ____________

Detection Limits (ug/l) are indicated in brackets [ ]

	Detected	Not Detected	(ug/l)
☐ 007 Acrolein[50]	☐	☐	___ ___ ___ . ___
☐ 009 Acrylonitrile[20]	☐	☐	___ ___ ___ . ___
☐ 025 Benzene[1.0]	☐	☐	___ ___ ___ . ___
☐ 046 Bromobenzene[4.0]	☐	☐	___ ___ ___ . ___
☐ 051 Bromodichloromethane[1.5]	☐	☐	___ ___ ___ . ___
☐ 053 Bromoform[5.0]	☐	☐	___ ___ ___ . ___
☐ 055 Bromomethane[50]	☐	☐	___ ___ ___ . ___
☐ 063 n-Butylacetate[0.5]	☐	☐	___ ___ ___ . ___
☐ 071 Carbon Disulfide[5.0]	☐	☐	___ ___ ___ . ___
☐ 073 Carbon Tetrachloride[1.5]	☐	☐	___ ___ ___ . ___
☐ 083 Chlorobenzene[2.0]	☐	☐	___ ___ ___ . ___
☐ 087 Chloroethane[2.0]	☐	☐	___ ___ ___ . ___
☐ 093 2-Chloroethylvinyl Ether[4.0]	☐	☐	___ ___ ___ . ___
☐ 095 Chloroform[1.0]	☐	☐	___ ___ ___ . ___
☐ 108 o-Chlorotoluene[1.0]	☐	☐	___ ___ ___ . ___
☐ 110 p-Chlorotoluene[1.0]	☐	☐	___ ___ ___ . ___
☐ 147 Dibromochloromethane[2.0]	☐	☐	___ ___ ___ . ___ [not quantified]
☐ 148 1,2-Dibromo-3-Chloropropane	☐	☐	___ ___ ___ . ___
☐ 153 o-Dichlorobenzene[2.0]	☐	☐	___ ___ ___ . ___
☐ 155 m-Dichlorobenzene[2.0]	☐	☐	___ ___ ___ . ___
☐ 157 p-Dichlorobenzene[2.0]	☐	☐	___ ___ ___ . ___
☐ 165 1,1-Dichloroethane[1.0]	☐	☐	___ ___ ___ . ___
☐ 167 1,2-Dichloroethane[1.0]	☐	☐	___ ___ ___ . ___
☐ 169 1,1-Dichloroethylene[1.0]	☐	☐	___ ___ ___ . ___
☐ 171 1,2-Dichloroethylene[1.0]	☐	☐	___ ___ ___ . ___ [not quantified]
☐ 174 Dichloroiodomethane	☐	☐	___ ___ ___ . ___
☐ 181 1,2-Dichloropropane[1.0]	☐	☐	___ ___ ___ . ___

	Detected	Not Detected	ug/l
☐ 183 cis-1,3-Dichloropropene[2.5]	☐	☐	___ ___ ___ . ___
☐ 185 trans-1,3-Dichloropropene[2.5]	☐	☐	___ ___ ___ . ___
☐ 233 Ethylbenzene[1.0]	☐	☐	___ ___ ___ . ___
☐ 427 Fluorotrichloromethane[1.0]	☐	☐	___ ___ ___ . ___
☐ 298 Isopropylbenzene[1.0]	☐	☐	___ ___ ___ . ___
☐ 319 Methylethylketone (MEK)[12]	☐	☐	___ ___ ___ . ___
☐ 393 Styrene[2.0]	☐	☐	___ ___ ___ . ___
☐ 396 1,1,1,2-Tetrachloroethane[3.0]	☐	☐	___ ___ ___ . ___
☐ 397 1,1,2,2-Tetrachloroethane[3.0]	☐	☐	___ ___ ___ . ___
☐ 399 Tetrachloroethylene[1.0]	☐	☐	___ ___ ___ . ___
☐ 401 Tetrahydrofuran (THF)[200]	☐	☐	___ ___ ___ . ___
☐ 411 Toluene[1.0]	☐	☐	___ ___ ___ . ___
☐ 421 1,1,1-Trichloroethane[1.0]	☐	☐	___ ___ ___ . ___
☐ 423 1,1,2-Trichloroethane[1.5]	☐	☐	___ ___ ___ . ___
☐ 425 Trichloroethylene[1.0]	☐	☐	___ ___ ___ . ___
☐ 428 Trichlorotrifluoroethane[3.0]	☐	☐	___ ___ ___ . ___ [not quantified]
☐ 434 Vinyl Chloride	☐	☐	___ ___ ___ . ___
☐ 437 Xylenes[2.0]	☐	☐	___ ___ ___ . ___
☐ ____________	☐	☐	___ ___ ___ . ___
☐ ____________	☐	☐	___ ___ ___ . ___

Comments ____________

Date Received and Sample No. ____________

Date Reported ____________

R.H. Laessig, PhD, Director
Wisconsin State Laboratory
Madison, Wisconsin 53706

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Carroll D. Besadny
Secretary

BOX 7921
MADISON, WISCONSIN 53707

February 11, 1987

IN REPLY REFER TO: 4400

Dear :

The Wisconsin Department of Natural Resources is conducting research on the extent of volatile organic compound (VOC) contamination in groundwater near Wisconsin landfills. We are sampling groundwater as well as compiling existing data on the sites.

We would like to receive any information you might have on efforts to monitor groundwater around landfills in your state for VOC's or priority pollutants. We would appreciate it if you could take a few moments to fill out the attached sheet and return it to us by March 20, 1987.

If you have any questions please call me at (608) 267-3538.

Sincerely,

Marci Friedman, Hydrogeologist
Residuals Management & Land Disposal Section
Bureau of Solid Waste Management

MF:cn

Enclosure

7746R/7747R.PERM

Survey Sent to the Following Agencies:
California Waste Management Board
Colorado Department of Health
Connecticut Department of Environmetal Protection
Florida Department of Environmental Regulation
Illinois Environmental Protection Agency
Massachusetts Department of Environmental Quality Engineering
Michigan Department of Natural Resources
Minnesota Pollution Control Agency
New Jersey Department of Environmental Protection
New York Department of Environmental Conservation
Ohio Environmental Protection Agency
Oklahoma State Department of Health
Pennsylvania Department of Environmental Resources
Washington Department of Ecology

State: ______________________________

Contact Person: ______________________________ Phone: ______________

Address: ____

Please Mail to: Marci A. Friedman, Hydrogeologist
Bureau of Solid Waste Management
Wisconsin Department of Natural Resources
P.O. Box 7921
Madison, WI 53707

1. Has your state conducted a statewide or regional survey of organic contaminants near landfill sites?

   _____ Yes (please explain below) _____ No

2. Do you have information on any of the following:

   a. The extent of organic contamination around landfills in your state.

      _____ Yes (please explain below) _____ No

   b. The influence of design, geologic environment and waste type on the presence of organics.

      _____ Yes (please explain below) _____ No

c. The relationship between VOC's and indicator parameters.

_____ Yes (please explain below) _____ No

3. Do you require periodic groundwater analyses for VOC's? Please explain why or why not and how frequently.

4. Is there other information relating to VOC's at landfills you think we should be aware of?

_____ Yes (please explain below) _____ No

6471R.PERM
2/10/87

APPENDIX D. Groundwater monitoring data sorted by parameter and value.

LICENSE #	WELL #	CLASS	DATE	SERIES	TEST #	TEST NAME	VALUE
611	129	P-9-60A	12/16/86	1	20087	CHLOROETHANE	4.8
2695	15	DH-17	09/16/86	1	20087	CHLOROETHANE	4.8
2484	22	P-9C	12/02/86	1	20087	CHLOROETHANE	13.0
611	118	P-5-60A	12/16/86	1	20087	CHLOROETHANE	14.0
2484	21	P-6B	12/02/86	2	20087	CHLOROETHANE	23.0
2484	21	P-6B	12/02/86	1	20087	CHLOROETHANE	26.0
2565	4	MW-4	03/04/86	1	20087	CHLOROETHANE	99.0
2051	114	TW-25	11/26/85	1	20087	CHLOROETHANE	340.0
2051	114	TW-25	11/26/85	2	20087	CHLOROETHANE	420.0
3023	10	MW-15	12/03/86	1	20165	1,1-DICHLOROETHANE	1.0
2565	4	MW-4	09/09/85	1	20165	1,1-DICHLOROETHANE	1.4
2695	2	DH-5	06/16/86	1	20165	1,1-DICHLOROETHANE	2.2
2680	176	MW-12R	09/06/85	1	20165	1,1-DICHLOROETHANE	2.7
2695	20	DH9A	09/15/86	1	20165	1,1-DICHLOROETHANE	2.9
2680	114	MW-14	09/06/85	1	20165	1,1-DICHLOROETHANE	3.4
2054	805	MW-5	09/23/85	1	20165	1,1-DICHLOROETHANE	3.4
611	118	P-5-60A	12/16/86	1	20165	1,1-DICHLOROETHANE	3.9
2569	7	MW-7	12/10/85	1	20165	1,1-DICHLOROETHANE	5.6
2695	15	DH-17	09/16/86	1	20165	1,1-DICHLOROETHANE	8.2
2484	22	P-9C	12/02/86	1	20165	1,1-DICHLOROETHANE	10.0
2695	15	DH-17	06/16/86	1	20165	1,1-DICHLOROETHANE	12.0
2569	7	MW-7	09/24/85	1	20165	1,1-DICHLOROETHANE	16.0
611	117	P-5-40A	12/16/86	1	20165	1,1-DICHLOROETHANE	26.0
140	211	W-22	09-Jul-86	1	20165	l,l DICHLOROETHANE	29.0
2637	16	MW-12	09/17/85	1	20165	1,1-DICHLOROETHANE	39.0
2484	21	P-6B	12/02/86	2	20165	1,1-DICHLOROETHANE	47.0
2680	179	MW-29	11/26/85	1	20165	1,1-DICHLOROETHANE	48.0
2680	179	MW-29	10-Dec-85	1	20165	1,1-DICHLOROETHANE	50.0
2484	21	P-6B	12/02/86	1	20165	1,1-DICHLOROETHANE	52.0
140	214	W-54	09-Jul-86	1	20165	1,1 DICHLOROETHANE	55.0
2680	179	MW-29	11/26/85	2	20165	1,1-DICHLOROETHANE	56.0
2637	16	MW-12	11/20/85	2	20165	1,1-DICHLOROETHANE	64.0
2680	179	MW-29	09/06/85	1	20165	1,1-DICHLOROETHANE	70.0
2637	16	MW-12	11/20/85	1	20165	1,1-DICHLOROETHANE	85.0
2051	115	TW-26	09/04/85	1	20165	1,1-DICHLOROETHANE	91.0
2051	114	TW-25	11/26/85	1	20165	1,1-DICHLOROETHANE	94.0
2051	115	TW-26	11/26/85	1	20165	1,1-DICHLOROETHANE	100.0
2051	114	TW-25	11/26/85	2	20165	1,1-DICHLOROETHANE	110.0
2051	114	TW-25	09/04/85	1	20165	1,1-DICHLOROETHANE	130.0
2051	116	TW-26A	09/04/85	1	20165	1,1-DICHLOROETHANE	290.0
2051	116	TW-26A	11/26/85	1	20165	1,1-DICHLOROETHANE	360.0
2051	116	TW-26A	11/26/85	1	20167	1,2-DICHLOROETHANE	1.8
2565	4	MW-4	03/04/86	1	20167	1,2-DICHLOROETHANE	1.9
2051	114	TW-25	11/26/85	1	20167	1,2-DICHLOROETHANE	4.4
2051	114	TW-25	11/26/85	2	20167	1,2-DICHLOROETHANE	6.8
2484	21	P-6B	12/02/86	1	20167	1,2-DICHLOROETHANE	7.5
2484	21	P-6B	12/02/86	2	20167	1,2-DICHLOROETHANE	8.1
2051	114	TW-25	09/04/85	1	20167	1,2-DICHLOROETHANE	8.5
2054	805	MW-5	09/23/85	1	20421	1,1,1-TRICHLOROETHANE	1.3
2565	4	MW-4	09/09/85	1	20421	1,1,1-TRICHLOROETHANE	1.5
2637		BLK	11/20/85	1	20421	1,1,1-TRICHLOROETHANE	1.5
2054	803	MW-3	09/23/85	1	20421	1,1,1-TRICHLOROETHANE	1.8
2637		BLK	11/20/85	1	20421	1,1,1-TRICHLOROETHANE	1.8
2821		BLK	11/18/85	1	20421	1,1,1-TRICHLOROETHANE	1.8
2054	803	MW-3	12/10/85	1	20421	1,1,1-TRICHLOROETHANE	1.8

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2680	176	MW-12R	09/06/85	1	20421	1,1,1-TRICHLOROETHANE	2.1
2637	16	MW-12	09/17/85	1	20421	1,1,1-TRICHLOROETHANE	4.0
2680	114	MW-14	09/06/85	1	20421	1,1,1-TRICHLOROETHANE	4.7
2637	16	MW-12	11/20/85	2	20421	1,1,1-TRICHLOROETHANE	7.1
2637	16	MW-12	11/20/85	1	20421	1,1,1-TRICHLOROETHANE	7.3
140	214	W-54	09-Jul-86	1	20421	1,1,1 TRICHLOROETHANE	9.9
2680	179	MW-29	11/26/85	1	20421	1,1,1-TRICHLOROETHANE	22.0
2054	804	MW-4	12/10/85	1	20421	1,1,1-TRICHLOROETHANE	23.0
2680	179	MW-29	09/06/85	1	20421	1,1,1-TRICHLOROETHANE	24.0
2569	7	MW-7	09/24/85	1	20421	1,1,1-TRICHLOROETHANE	25.0
2680	179	MW-29	10-Dec-85	1	20421	1,1,1-TRICHLOROETHANE	25.0
2680	179	MW-29	11/26/85	2	20421	1,1,1-TRICHLOROETHANE	25.0
2569	7	MW-7	12/10/85	1	20421	1,1,1-TRICHLOROETHANE	33.0
2054	804	MW-4	12/10/85	2	20421	1,1,1-TRICHLOROETHANE	34.0
2054	804	MW-4	09/23/85	1	20421	1,1,1-TRICHLOROETHANE	51.0
2051	115	TW-26	11/26/85	1	20421	1,1,1-TRICHLOROETHANE	61.0
2051	115	TW-26	09/04/85	1	20421	1,1,1-TRICHLOROETHANE	86.0
2051	116	TW-26A	11/26/85	1	20421	1,1,1-TRICHLOROETHANE	110.0
2051	116	TW-26A	09/04/85	1	20421	1,1,1-TRICHLOROETHANE	130.0
2680	114	MW-14	09/06/85	1	20434	VINYL CHLORIDE	2.0
2695	2	DH-5	06/16/86	1	20434	VINYL CHLORIDE	3.0
2695	15	DH-17	09/16/86	1	20434	VINYL CHLORIDE	3.6
2695	20	DH9A	09/15/86	1	20434	VINYL CHLORIDE	5.1
611	118	P-5-60A	12/16/86	1	20434	VINYL CHLORIDE	6.8
2695	15	DH-17	06/16/86	1	20434	VINYL CHLORIDE	16.0
2680	179	MW-29	09/06/85	1	20434	VINYL CHLORIDE	17.0
611	129	P-9-60A	12/16/86	1	20434	VINYL CHLORIDE	20.0
2484	22	P-9C	12/02/86	1	20434	VINYL CHLORIDE	38.0
611	117	P-5-40A	12/16/86	1	20434	VINYL CHLORIDE	63.0
2484	21	P-6B	12/02/86	2	20434	VINYL CHLORIDE	160.0
2484	21	P-6B	12/02/86	1	20434	VINYL CHLORIDE	190.0
2680	179	MW-29	11/26/85	2	20169	1,1-DICHLOROETHYLENE	1.6
611	129	P-9-60A	12/16/86	1	20169	1,1-DICHLOROETHYLENE	2.1
2051	115	TW-26	11/26/85	1	20169	1,1-DICHLOROETHYLENE	2.7
2051	115	TW-26	09/04/85	1	20169	1,1-DICHLOROETHYLENE	2.8
2051	114	TW-25	11/26/85	1	20169	1,1-DICHLOROETHYLENE	2.9
2051	114	TW-25	11/26/85	2	20169	1,1-DICHLOROETHYLENE	3.9
2051	114	TW-25	09/04/85	1	20169	1,1-DICHLOROETHYLENE	3.9
2051	116	TW-26A	11/26/85	1	20169	1,1-DICHLOROETHYLENE	4.6
2051	116	TW-26A	09/04/85	1	20169	1,1-DICHLOROETHYLENE	4.9
3023	10	MW-15	12/03/86	1	20171	1,2-DICHLOROETHYLENE	1.0
2680	114	MW-14	09/06/85	1	20171	1,2-DICHLOROETHYLENE	1.1
2680	176	MW-12R	09/06/85	1	20171	1,2-DICHLOROETHYLENE	1.2
611	118	P-5-60A	12/16/86	1	20171	1,2-DICHLOROETHYLENE	2.1
2695	2	DH-5	06/16/86	1	20171	1,2-DICHLOROETHYLENE	3.4
2051	115	TW-26	09/04/85	1	20171	1,2-DICHLOROETHYLENE	3.6
2051	115	TW-26	11/26/85	1	20171	1,2-DICHLOROETHYLENE	3.9
140	211	W-22	09-Jul-86	1	20171	1,2 DICHLOROETHYLENE	6.1
611	117	P-5-40A	12/16/86	1	20171	1,2-DICHLOROETHYLENE	8.1
2051	116	TW-26A	09/04/85	1	20171	1,2-DICHLOROETHYLENE	9.2
2695	20	DH9A	09/15/86	1	20171	1,2-DICHLOROETHYLENE	11.0
2637	16	MW-12	09/17/85	1	20171	1,2-DICHLOROETHYLENE	13.0
2051	116	TW-26A	11/26/85	1	20171	1,2-DICHLOROETHYLENE	13.0
2680	179	MW-29	11/26/85	1	20171	1,2-DICHLOROETHYLENE	15.0
2680	179	MW-29	11/26/85	2	20171	1,2-DICHLOROETHYLENE	16.0
140	214	W-54	09-Jul-86	1	20171	1,2 DICHLOROETHYLENE	17.0
2680	179	MW-29	09/06/85	1	20171	1,2-DICHLOROETHYLENE	19.0

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2680	179	MW-29	10-Dec-85	1	20171	1,2-DICHLOROETHYLENE	22.0
2637	16	MW-12	11/20/85	2	20171	1,2-DICHLOROETHYLENE	24.0
2637	16	MW-12	11/20/85	1	20171	1,2-DICHLOROETHYLENE	28.0
2695	15	DH-17	06/16/86	1	20171	1,2-DICHLOROETHYLENE	33.0
2051	114	TW-25	09/04/85	1	20171	1,2-DICHLOROETHYLENE	41.0
2051	114	TW-25	11/26/85	1	20171	1,2-DICHLOROETHYLENE	41.0
2051	114	TW-25	11/26/85	2	20171	1,2-DICHLOROETHYLENE	43.0
2695	15	DH-17	09/16/86	1	20171	1,2-DICHLOROETHYLENE	45.0
2484	22	P-9C	12/02/86	1	20171	1,2-DICHLOROETHYLENE	320.0
2484	21	P-6B	12/02/86	1	20171	1,2-DICHLOROETHYLENE	3600.0
2484	21	P-6B	12/02/86	2	20171	1,2-DICHLOROETHYLENE	3900.0
2054	805	MW-5	09/23/85	1	20425	TRICHLOROETHYLENE	1.2
2680	176	MW-12R	09/06/85	1	20425	TRICHLOROETHYLENE	1.8
2695	2	DH-5	06/16/86	1	20425	TRICHLOROETHYLENE	2.0
2051	114	TW-25	11/26/85	1	20425	TRICHLOROETHYLENE	2.5
2051	115	TW-26	09/04/85	1	20425	TRICHLOROETHYLENE	3.3
2051	115	TW-26	11/26/85	1	20425	TRICHLOROETHYLENE	3.5
2051	114	TW-25	11/26/85	2	20425	TRICHLOROETHYLENE	4.0
2680	114	MW-14	09/06/85	1	20425	TRICHLOROETHYLENE	4.8
2569	7	MW-7	09/24/85	1	20425	TRICHLOROETHYLENE	5.9
2695	15	DH-17	06/16/86	1	20425	TRICHLOROETHYLENE	6.3
2051	116	TW-26A	11/26/85	1	20425	TRICHLOROETHYLENE	6.7
2051	116	TW-26A	09/04/85	1	20425	TRICHLOROETHYLENE	6.8
2695	15	DH-17	09/16/86	1	20425	TRICHLOROETHYLENE	6.9
2569	7	MW-7	12/10/85	1	20425	TRICHLOROETHYLENE	8.3
140	211	W-22	09-Jul-86	1	20425	TRICHLOROETHYLENE	8.9
140	214	W-54	09-Jul-86	1	20425	TRICHLOROETHYLENE	13.0
2637	16	MW-12	09/17/85	1	20425	TRICHLOROETHYLENE	17.0
2637	16	MW-12	11/20/85	2	20425	TRICHLOROETHYLENE	28.0
2637	16	MW-12	11/20/85	1	20425	TRICHLOROETHYLENE	35.0
2484	22	P-9C	12/02/86	1	20425	TRICHLOROETHYLENE	39.0
2680	179	MW-29	11/26/85	1	20425	TRICHLOROETHYLENE	72.0
2680	179	MW-29	11/26/85	2	20425	TRICHLOROETHYLENE	74.0
2680	179	MW-29	09/06/85	1	20425	TRICHLOROETHYLENE	85.0
2680	179	MW-29	10-Dec-85	1	20425	TRICHLOROETHYLENE	86.0
2484	21	P-6B	12/02/86	2	20425	TRICHLOROETHYLENE	470.0
2484	21	P-6B	12/02/86	1	20425	TRICHLOROETHYLENE	480.0
2680	176	MW-12R	09/06/85	1	20399	TETRACHLOROETHYLENE	1.2
2051	114	TW-25	11/26/85	1	20399	TETRACHLOROETHYLENE	1.4
2054	803	MW-3	09/23/85	1	20399	TETRACHLOROETHYLENE	1.7
2484	22	P-9C	12/02/86	1	20399	TETRACHLOROETHYLENE	1.9
2054	803	MW-3	12/10/85	1	20399	TETRACHLOROETHYLENE	2.5
2695	15	DH-17	09/16/86	1	20399	TETRACHLOROETHYLENE	2.6
2695	15	DH-17	06/16/86	1	20399	TETRACHLOROETHYLENE	3.0
2680	177	MW-17R	11/26/85	1	20399	TETRACHLOROETHYLENE	3.8
2051	114	TW-25	11/26/85	2	20399	TETRACHLOROETHYLENE	4.3
2569	7	MW-7	09/24/85	1	20399	TETRACHLOROETHYLENE	4.7
2569	7	MW-7	12/10/85	1	20399	TETRACHLOROETHYLENE	5.8
2051	115	TW-26	09/04/85	1	20399	TETRACHLOROETHYLENE	7.2
140	214	W-54	09-Jul-86	1	20399	TETRACHLOROETHYLENE	7.3
2051	115	TW-26	11/26/85	1	20399	TETRACHLOROETHYLENE	8.0
2680	171	MW-17	09/06/85	1	20399	TETRACHLOROETHYLENE	14.0
2051	116	TW-26A	09/04/85	1	20399	TETRACHLOROETHYLENE	14.0
2051	116	TW-26A	11/26/85	1	20399	TETRACHLOROETHYLENE	15.0
2637	16	MW-12	09/17/85	1	20399	TETRACHLOROETHYLENE	16.0
2680	114	MW-14	09/06/85	1	20399	TETRACHLOROETHYLENE	19.0
2637	16	MW-12	11/20/85	2	20399	TETRACHLOROETHYLENE	23.0
2637	16	MW-12	11/20/85	1	20399	TETRACHLOROETHYLENE	30.0

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2484	21	P-6B	12/02/86	1	20399	TETRACHLOROETHYLENE	59.0
2484	21	P-6B	12/02/86	2	20399	TETRACHLOROETHYLENE	60.0
2680	179	MW-29	11/26/85	2	20399	TETRACHLOROETHYLENE	660.0
2680	179	MW-29	11/26/85	1	20399	TETRACHLOROETHYLENE	740.0
2680	179	MW-29	10-Dec-85	1	20399	TETRACHLOROETHYLENE	820.0
2680	179	MW-29	09/06/85	1	20399	TETRACHLOROETHYLENE	1300.0
2565	4	MW-4	03/04/86	1	20025	BENZENE	1.0
140	211	W-22	09-Jul-86	1	20025	BENZENE	1.0
2695	20	DH9A	09/15/86	1	20025	BENZENE	1.2
611	117	P-5-40A	12/16/86	1	20025	BENZENE	1.8
2565	4	MW-4	09/09/85	1	20025	BENZENE	2.5
2680	179	MW-29	11/26/85	2	20025	BENZENE	3.6
611	129	P-9-60A	12/16/86	1	20025	BENZENE	4.8
2680	179	MW-29	11/26/85	1	20025	BENZENE	4.9
2484	22	P-9C	12/02/86	1	20025	BENZENE	5.8
2051	116	TW-26A	11/26/85	1	20025	BENZENE	6.3
2680	175	MW-18	09/06/85	1	20025	BENZENE	8.0
140	214	W-54	09-Jul-86	1	20025	BENZENE	11.0
2484	21	P-6B	12/02/86	2	20025	BENZENE	12.0
2484	21	P-6B	12/02/86	1	20025	BENZENE	15.0
2051	114	TW-25	11/26/85	1	20025	BENZENE	31.0
2051	114	TW-25	09/04/85	1	20025	BENZENE	32.0
2051	114	TW-25	11/26/85	2	20025	BENZENE	32.0
2695	15	DH-17	09/16/86	1	20083	CHLOROBENZENE	2.0
2051	116	TW-26A	11/26/85	1	20083	CHLOROBENZENE	2.8
2051	116	TW-26A	09/04/85	1	20083	CHLOROBENZENE	3.4
2051	114	TW-25	11/26/85	1	20083	CHLOROBENZENE	4.8
2051	114	TW-25	09/04/85	1	20083	CHLOROBENZENE	7.2
2051	114	TW-25	11/26/85	2	20083	CHLOROBENZENE	7.6
2484	21	P-6B	12/02/86	2	20083	CHLOROBENZENE	110.0
2484	21	P-6B	12/02/86	1	20083	CHLOROBENZENE	110.0
2680	179	MW-29	11/26/85	1	20233	ETHYL BENZENE	1.3
2680	179	MW-29	10-Dec-85	1	20233	ETHYL BENZENE	5.4
2637	16	MW-12	09/17/85	1	20233	ETHYL BENZENE	10.0
2637	16	MW-12	11/20/85	2	20233	ETHYL BENZENE	24.0
2637	16	MW-12	11/20/85	1	20233	ETHYL BENZENE	29.0
2484	21	P-6B	12/02/86	1	20233	ETHYL BENZENE	34.0
611	129	P-9-60A	12/16/86	1	20233	ETHYL BENZENE	35.0
2484	21	P-6B	12/02/86	2	20233	ETHYL BENZENE	39.0
2051	114	TW-25	11/26/85	2	20233	ETHYL BENZENE	71.0
2051	114	TW-25	09/04/85	1	20233	ETHYL BENZENE	74.0
2051	114	TW-25	11/26/85	1	20233	ETHYL BENZENE	74.0
611	129	P-9-60A	12/16/86	1	20153	1,2-DICHLOROBENZENE	2.8
2821		BLK	11/18/85	1	20157	1,4-DICHLOROBENZENE	2.7
2821		BLK	11/18/85	1	20157	1,4-DICHLOROBENZENE	3.5
2484	22	P-9C	12/02/86	1	20157	1,4-DICHLOROBENZENE	3.7
2637		BLK	11/20/85	1	20157	1,4-DICHLOROBENZENE	4.1
611	129	P-9-60A	12/16/86	1	20157	1,4-DICHLOROBENZENE	4.1
2637		BLK	11/20/85	1	20157	1,4-DICHLOROBENZENE	4.5
2051	114	TW-25	11/26/85	1	20157	1,4-DICHLOROBENZENE	5.0
2051	114	TW-25	11/26/85	2	20157	1,4-DICHLOROBENZENE	6.2
611	117	P-5-40A	12/16/86	1	20411	TOLUENE	1.1
2637	16	MW-12	09/17/85	1	20411	TOLUENE	1.7
2695	20	DH9A	09/15/86	1	20411	TOLUENE	1.8

2695	15	DH-17	09/16/86	1	20411 TOLUENE	3.5
611	129	P-9-60A	12/16/86	1	20411 TOLUENE	3.8
2637	16	MW-12	11/20/85	2	20411 TOLUENE	4.0
2695	15	DH-17	06/16/86	1	20411 TOLUENE	4.4
2680	179	MW-29	11/26/85	2	20411 TOLUENE	5.1
2680	179	MW-29	11/26/85	1	20411 TOLUENE	5.2
2695	17	DH-17A	06/16/86	2	20411 TOLUENE	5.2
2695	17	DH-17A	06/16/86	1	20411 TOLUENE	5.3
2484	22	P-9C	12/02/86	1	20411 TOLUENE	7.2
2637	16	MW-12	11/20/85	1	20411 TOLUENE	10.0
2680	179	MW-29	10-Dec-85	1	20411 TOLUENE	19.0
2680	179	MW-29	09/06/85	1	20411 TOLUENE	29.0
2051	114	TW-25	11/26/85	1	20411 TOLUENE	2400.0
2051	114	TW-25	11/26/85	2	20411 TOLUENE	2600.0
2484	21	P-6B	12/02/86	1	20411 TOLUENE	3300.0
2484	21	P-6B	12/02/86	2	20411 TOLUENE	3500.0
2051	116	TW-26A	11/26/85	1	20437 XYLENE (TOTAL)	3.3
2695	15	DH-17	06/16/86	1	20437 XYLENE (TOTAL)	4.0
2680	179	MW-29	11/26/85	1	20437 XYLENE (TOTAL)	6.3
2680	179	MW-29	11/26/85	2	20437 XYLENE (TOTAL)	6.4
2680	179	MW-29	10-Dec-85	1	20437 XYLENE (TOTAL)	9.0
2637	16	MW-12	09/17/85	1	20437 XYLENE (TOTAL)	29.0
611	129	P-9-60A	12/16/86	1	20437 XYLENE (TOTAL)	46.0
2637	16	MW-12	11/20/85	2	20437 XYLENE (TOTAL)	55.0
2637	16	MW-12	11/20/85	1	20437 XYLENE (TOTAL)	71.0
2484	21	P-6B	12/02/86	2	20437 XYLENE (TOTAL)	120.0
2484	21	P-6B	12/02/86	1	20437 XYLENE (TOTAL)	120.0
2051	114	TW-25	11/26/85	2	20437 XYLENE (TOTAL)	140.0
2051	114	TW-25	11/26/85	1	20437 XYLENE (TOTAL)	160.0
2051	114	TW-25	09/04/85	1	20437 XYLENE (TOTAL)	160.0
2637		BLK	11/20/85	1	20051 BROMODICHLOROMETHANE	3.1
2637		BLK	11/20/85	1	20051 BROMODICHLOROMETHANE	3.6
2821		BLK	11/18/85	1	20051 BROMODICHLOROMETHANE	4.5
2680	176	MW-12R	09/06/85	1	20427 TRICHLOROFLUOROMETHANE	3.7
2051	115	TW-26	11/26/85	1	20427 TRICHLOROFLUOROMETHANE	4.8
2569	7	MW-7	09/24/85	1	20427 TRICHLOROFLUOROMETHANE	6.8
2054	805	MW-5	09/23/85	1	20427 TRICHLOROFLUOROMETHANE	9.4
2680	179	MW-29	09/06/85	1	20427 TRICHLOROFLUOROMETHANE	9.8
2569	7	MW-7	12/10/85	1	20427 TRICHLOROFLUOROMETHANE	12.0
2680	179	MW-29	11/26/85	2	20427 TRICHLOROFLUOROMETHANE	13.0
2054	803	MW-3	09/23/85	1	20427 TRICHLOROFLUOROMETHANE	15.0
2680	179	MW-29	11/26/85	1	20427 TRICHLOROFLUOROMETHANE	17.0
2565	4	MW-4	03/04/86	1	20427 TRICHLOROFLUOROMETHANE	23.0
2054	803	MW-3	12/10/85	1	20427 TRICHLOROFLUOROMETHANE	24.0
2054	804	MW-4	12/10/85	1	20427 TRICHLOROFLUOROMETHANE	36.0
2054	804	MW-4	12/10/85	2	20427 TRICHLOROFLUOROMETHANE	55.0
2054	804	MW-4	09/23/85	1	20427 TRICHLOROFLUOROMETHANE	66.0
2695	15	DH-17	06/16/86	1	20319 METHYL ETHYL KETONE	120.0
2051	114	TW-25	09/04/85	1	20319 METHYL ETHYL KETONE	5100.0
3023	9	MW-14	11/04/86	1	20401 TETRAHYDROFURAN	520.0
2568	58	MW-7C	12/10/85	1	20401 TETRAHYDROFURAN	980.0
2568	58	MW-7C	09/24/85	1	20401 TETRAHYDROFURAN	1000.0
2568	58	MW-7C	12/10/85	2	20401 TETRAHYDROFURAN	1000.0
2051	114	TW-25	09/04/85	1	20401 TETRAHYDROFURAN	3400.0

APPENDIX D. Groundwater monitoring data sorted by parameter and value.

2821		BLK	09/10/85	1	20095 CHLOROFORM	1.0
2569	7	MW-7	09/24/85	1	20095 CHLOROFORM	1.6
2051	116	TW-26A	11/26/85	1	20095 CHLOROFORM	2.8
2637		BLK	11/20/85	1	20095 CHLOROFORM	16.0
2821		BLK	11/18/85	1	20095 CHLOROFORM	16.0
2637		BLK	11/20/85	1	20095 CHLOROFORM	17.0
2821		BLK	11/18/85	1	20095 CHLOROFORM	19.0

APPENDIX E. Groundwater monitoring data sorted by landfill and parameter.

LICENSE #	WELL #	CLASS	DATE	SERIES	TEST #	TEST NAME	VALUE
2569	7	MW-7	12/10/85	1	20165	1,1-DICHLOROETHANE	5.6
2569	7	MW-7	09/24/85	1	20165	1,1-DICHLOROETHANE	16.0
2569	7	MW-7	12/10/85	1	20421	1,1,1-TRICHLOROETHANE	33.0
2569	7	MW-7	09/24/85	1	20421	1,1,1-TRICHLOROETHANE	25.0
2569	7	MW-7	12/10/85	1	20425	TRICHLOROETHYLENE	8.3
2569	7	MW-7	09/24/85	1	20425	TRICHLOROETHYLENE	5.9
2569	7	MW-7	12/10/85	1	20399	TETRACHLOROETHYLENE	5.8
2569	7	MW-7	09/24/85	1	20399	TETRACHLOROETHYLENE	4.7
2569	7	MW-7	12/10/85	1	20427	TRICHLOROFLUOROMETHANE	12.0
2569	7	MW-7	09/24/85	1	20427	TRICHLOROFLUOROMETHANE	6.8
2569	7	MW-7	09/24/85	1	20095	CHLOROFORM	1.6
2821		BLK	11/18/85	1	20421	1,1,1-TRICHLOROETHANE	1.8
2821		BLK	11/18/85	1	20157	1,4-DICHLOROBENZENE	2.7
2821		BLK	11/18/85	1	20157	1,4-DICHLOROBENZENE	3.5
2821		BLK	11/18/85	1	20051	BROMODICHLOROMETHANE	4.5
2821		BLK	11/18/85	1	20095	CHLOROFORM	19.0
2821		BLK	11/18/85	1	20095	CHLOROFORM	16.0
2821		BLK	09/10/85	1	20095	CHLOROFORM	1.0
3023	10	MW-15	12/03/86	1	20165	1,1-DICHLOROETHANE	1.0
3023	10	MW-15	12/03/86	1	20171	1,2-DICHLOROETHYLENE	1.0
3023	9	MW-14	11/04/86	1	20401	TETRAHYDROFURAN	520.0
611	129	P-9-60A	12/16/86	1	20087	CHLOROETHANE	4.8
611	118	P-5-60A	12/16/86	1	20087	CHLOROETHANE	14.0
611	118	P-5-60A	12/16/86	1	20165	1,1-DICHLOROETHANE	3.9
611	117	P-5-40A	12/16/86	1	20165	1,1-DICHLOROETHANE	26.0
611	129	P-9-60A	12/16/86	1	20434	VINYL CHLORIDE	20.0
611	118	P-5-60A	12/16/86	1	20434	VINYL CHLORIDE	6.8
611	117	P-5-40A	12/16/86	1	20434	VINYL CHLORIDE	63.0
611	129	P-9-60A	12/16/86	1	20169	1,1-DICHLOROETHYLENE	2.1
611	118	P-5-60A	12/16/86	1	20171	1,2-DICHLOROETHYLENE	2.1
611	117	P-5-40A	12/16/86	1	20171	1,2-DICHLOROETHYLENE	8.1
611	117	P-5-40A	12/16/86	1	20025	BENZENE	1.8
611	129	P-9-60A	12/16/86	1	20025	BENZENE	4.8
611	129	P-9-60A	12/16/86	1	20233	ETHYL BENZENE	35.0
611	129	P-9-60A	12/16/86	1	20153	1,2-DICHLOROBENZENE	2.8
611	129	P-9-60A	12/16/86	1	20157	1,4-DICHLOROBENZENE	4.1
611	129	P-9-60A	12/16/86	1	20411	TOLUENE	3.8
611	117	P-5-40A	12/16/86	1	20411	TOLUENE	1.1
611	129	P-9-60A	12/16/86	1	20437	XYLENE (TOTAL)	46.0
2484	21	P-6B	12/02/86	1	20087	CHLOROETHANE	26.0
2484	21	P-6B	12/02/86	2	20087	CHLOROETHANE	23.0
2484	22	P-9C	12/02/86	1	20087	CHLOROETHANE	13.0
2484	22	P-9C	12/02/86	1	20165	1,1-DICHLOROETHANE	10.0
2484	21	P-6B	12/02/86	2	20165	1,1-DICHLOROETHANE	47.0
2484	21	P-6B	12/02/86	1	20165	1,1-DICHLOROETHANE	52.0
2484	21	P-6B	12/02/86	1	20167	1,2-DICHLOROETHANE	7.5
2484	21	P-6B	12/02/86	2	20167	1,2-DICHLOROETHANE	8.1
2484	21	P-6B	12/02/86	2	20434	VINYL CHLORIDE	160.0
2484	22	P-9C	12/02/86	1	20434	VINYL CHLORIDE	38.0
2484	21	P-6B	12/02/86	1	20434	VINYL CHLORIDE	190.0
2484	21	P-6B	12/02/86	1	20171	1,2-DICHLOROETHYLENE	3600.0
2484	22	P-9C	12/02/86	1	20171	1,2-DICHLOROETHYLENE	320.0
2484	21	P-6B	12/02/86	2	20171	1,2-DICHLOROETHYLENE	3900.0
2484	22	P-9C	12/02/86	1	20425	TRICHLOROETHYLENE	39.0
2484	21	P-6B	12/02/86	1	20425	TRICHLOROETHYLENE	480.0

2484	21 P-6B	12/02/86	2	20425	TRICHLOROETHYLENE	470.0
2484	21 P-6B	12/02/86	1	20399	TETRACHLOROETHYLENE	59.0
2484	21 P-6B	12/02/86	2	20399	TETRACHLOROETHYLENE	60.0
2484	22 P-9C	12/02/86	1	20399	TETRACHLOROETHYLENE	1.9
2484	22 P-9C	12/02/86	1	20025	BENZENE	5.8
2484	21 P-6B	12/02/86	1	20025	BENZENE	15.0
2484	21 P-6B	12/02/86	2	20025	BENZENE	12.0
2484	21 P-6B	12/02/86	2	20083	CHLOROBENZENE	110.0
2484	21 P-6B	12/02/86	1	20083	CHLOROBENZENE	110.0
2484	21 P-6B	12/02/86	1	20233	ETHYL BENZENE	34.0
2484	21 P-6B	12/02/86	2	20233	ETHYL BENZENE	39.0
2484	22 P-9C	12/02/86	1	20157	1,4-DICHLOROBENZENE	3.7
2484	21 P-6B	12/02/86	2	20411	TOLUENE	3500.0
2484	21 P-6B	12/02/86	1	20411	TOLUENE	3300.0
2484	22 P-9C	12/02/86	1	20411	TOLUENE	7.2
2484	21 P-6B	12/02/86	2	20437	XYLENE (TOTAL)	120.0
2484	21 P-6B	12/02/86	1	20437	XYLENE (TOTAL)	120.0
2568	58 MW-7C	12/10/85	1	20401	TETRAHYDROFURAN	980.0
2568	58 MW-7C	12/10/85	2	20401	TETRAHYDROFURAN	1000.0
2568	58 MW-7C	09/24/85	1	20401	TETRAHYDROFURAN	1000.0
2637	16 MW-12	11/20/85	2	20165	1,1-DICHLOROETHANE	64.0
2637	16 MW-12	11/20/85	1	20165	1,1-DICHLOROETHANE	85.0
2637	16 MW-12	09/17/85	1	20165	1,1-DICHLOROETHANE	39.0
2637	16 MW-12	11/20/85	1	20421	1,1,1-TRICHLOROETHANE	7.3
2637	BLK	11/20/85	1	20421	1,1,1-TRICHLOROETHANE	1.8
2637	16 MW-12	11/20/85	2	20421	1,1,1-TRICHLOROETHANE	7.1
2637	16 MW-12	09/17/85	1	20421	1,1,1-TRICHLOROETHANE	4.0
2637	BLK	11/20/85	1	20421	1,1,1-TRICHLOROETHANE	1.5
2637	16 MW-12	11/20/85	1	20171	1,2-DICHLOROETHYLENE	28.0
2637	16 MW-12	09/17/85	1	20171	1,2-DICHLOROETHYLENE	13.0
2637	16 MW-12	11/20/85	2	20171	1,2-DICHLOROETHYLENE	24.0
2637	16 MW-12	11/20/85	1	20425	TRICHLOROETHYLENE	35.0
2637	16 MW-12	09/17/85	1	20425	TRICHLOROETHYLENE	17.0
2637	16 MW-12	11/20/85	2	20425	TRICHLOROETHYLENE	28.0
2637	16 MW-12	11/20/85	1	20399	TETRACHLOROETHYLENE	30.0
2637	16 MW-12	11/20/85	2	20399	TETRACHLOROETHYLENE	23.0
2637	16 MW-12	09/17/85	1	20399	TETRACHLOROETHYLENE	16.0
2637	16 MW-12	09/17/85	1	20233	ETHYL BENZENE	10.0
2637	16 MW-12	11/20/85	2	20233	ETHYL BENZENE	24.0
2637	16 MW-12	11/20/85	1	20233	ETHYL BENZENE	29.0
2637	BLK	11/20/85	1	20157	1,4-DICHLOROBENZENE	4.5
2637	BLK	11/20/85	1	20157	1,4-DICHLOROBENZENE	4.1
2637	16 MW-12	11/20/85	1	20411	TOLUENE	10.0
2637	16 MW-12	11/20/85	2	20411	TOLUENE	4.0
2637	16 MW-12	09/17/85	1	20411	TOLUENE	1.7
2637	16 MW-12	11/20/85	1	20437	XYLENE (TOTAL)	71.0
2637	16 MW-12	09/17/85	1	20437	XYLENE (TOTAL)	29.0
2637	16 MW-12	11/20/85	2	20437	XYLENE (TOTAL)	55.0
2637	BLK	11/20/85	1	20051	BROMODICHLOROMETHANE	3.1
2637	BLK	11/20/85	1	20051	BROMODICHLOROMETHANE	3.6
2637	BLK	11/20/85	1	20095	CHLOROFORM	17.0
2637	BLK	11/20/85	1	20095	CHLOROFORM	16.0
2565	4 MW-4	03/04/86	1	20087	CHLOROETHANE	99.0
2565	4 MW-4	09/09/85	1	20165	1,1-DICHLOROETHANE	1.4
2565	4 MW-4	03/04/86	1	20167	1,2-DICHLOROETHANE	1.9
2565	4 MW-4	09/09/85	1	20421	1,1,1-TRICHLOROETHANE	1.5
2565	4 MW-4	09/09/85	1	20025	BENZENE	2.5

APPENDIX E. Groundwater monitoring data sorted by landfill and parameter.

2565	4 MW-4	03/04/86	1	20025 BENZENE	1.0
2565	4 MW-4	03/04/86	1	20427 TRICHLOROFLUOROMETHANE	23.0
2680	179 MW-29	09/06/85	1	20165 1,1-DICHLOROETHANE	70.0
2680	176 MW-12R	09/06/85	1	20165 1,1-DICHLOROETHANE	2.7
2680	114 MW-14	09/06/85	1	20165 1,1-DICHLOROETHANE	3.4
2680	179 MW-29	10-Dec-85	1	20165 1,1-DICHLOROETHANE	50.0
2680	179 MW-29	11/26/85	2	20165 1,1-DICHLOROETHANE	56.0
2680	179 MW-29	11/26/85	1	20165 1,1-DICHLOROETHANE	48.0
2680	179 MW-29	11/26/85	1	20421 1,1,1-TRICHLOROETHANE	22.0
2680	179 MW-29	11/26/85	2	20421 1,1,1-TRICHLOROETHANE	25.0
2680	114 MW-14	09/06/85	1	20421 1,1,1-TRICHLOROETHANE	4.7
2680	179 MW-29	09/06/85	1	20421 1,1,1-TRICHLOROETHANE	24.0
2680	176 MW-12R	09/06/85	1	20421 1,1,1-TRICHLOROETHANE	2.1
2680	179 MW-29	10-Dec-85	1	20421 1,1,1-TRICHLOROETHANE	25.0
2680	114 MW-14	09/06/85	1	20434 VINYL CHLORIDE	2.0
2680	179 MW-29	09/06/85	1	20434 VINYL CHLORIDE	17.0
2680	179 MW-29	11/26/85	2	20169 1,1-DICHLOROETHYLENE	1.6
2680	179 MW-29	11/26/85	1	20171 1,2-DICHLOROETHYLENE	15.0
2680	176 MW-12R	09/06/85	1	20171 1,2-DICHLOROETHYLENE	1.2
2680	114 MW-14	09/06/85	1	20171 1,2-DICHLOROETHYLENE	1.1
2680	179 MW-29	11/26/85	2	20171 1,2-DICHLOROETHYLENE	16.0
2680	179 MW-29	10-Dec-85	1	20171 1,2-DICHLOROETHYLENE	22.0
2680	179 MW-29	09/06/85	1	20171 1,2-DICHLOROETHYLENE	19.0
2680	179 MW-29	09/06/85	1	20425 TRICHLOROETHYLENE	85.0
2680	179 MW-29	10-Dec-85	1	20425 TRICHLOROETHYLENE	86.0
2680	179 MW-29	11/26/85	2	20425 TRICHLOROETHYLENE	74.0
2680	114 MW-14	09/06/85	1	20425 TRICHLOROETHYLENE	4.8
2680	179 MW-29	11/26/85	1	20425 TRICHLOROETHYLENE	72.0
2680	176 MW-12R	09/06/85	1	20425 TRICHLOROETHYLENE	1.8
2680	171 MW-17	09/06/85	1	20399 TETRACHLOROETHYLENE	14.0
2680	114 MW-14	09/06/85	1	20399 TETRACHLOROETHYLENE	19.0
2680	176 MW-12R	09/06/85	1	20399 TETRACHLOROETHYLENE	1.2
2680	179 MW-29	09/06/85	1	20399 TETRACHLOROETHYLENE	1300.0
2680	179 MW-29	11/26/85	1	20399 TETRACHLOROETHYLENE	740.0
2680	179 MW-29	10-Dec-85	1	20399 TETRACHLOROETHYLENE	820.0
2680	179 MW-29	11/26/85	2	20399 TETRACHLOROETHYLENE	660.0
2680	177 MW-17R	11/26/85	1	20399 TETRACHLOROETHYLENE	3.8
2680	175 MW-18	09/06/85	1	20025 BENZENE	8.0
2680	179 MW-29	11/26/85	1	20025 BENZENE	4.9
2680	179 MW-29	11/26/85	2	20025 BENZENE	3.6
2680	179 MW-29	11/26/85	1	20233 ETHYL BENZENE	1.3
2680	179 MW-29	10-Dec-85	1	20233 ETHYL BENZENE	5.4
2680	179 MW-29	11/26/85	2	20411 TOLUENE	5.1
2680	179 MW-29	11/26/85	1	20411 TOLUENE	5.2
2680	179 MW-29	09/06/85	1	20411 TOLUENE	29.0
2680	179 MW-29	10-Dec-85	1	20411 TOLUENE	19.0
2680	179 MW-29	11/26/85	2	20437 XYLENE (TOTAL)	6.4
2680	179 MW-29	10-Dec-85	1	20437 XYLENE (TOTAL)	9.0
2680	179 MW-29	11/26/85	1	20437 XYLENE (TOTAL)	6.3
2680	179 MW-29	11/26/85	1	20427 TRICHLOROFLUOROMETHANE	17.0
2680	179 MW-29	11/26/85	2	20427 TRICHLOROFLUOROMETHANE	13.0
2680	176 MW-12R	09/06/85	1	20427 TRICHLOROFLUOROMETHANE	3.7
2680	179 MW-29	09/06/85	1	20427 TRICHLOROFLUOROMETHANE	9.8
140	211 W-22	09-Jul-86	1	20165 l,l DICHLOROETHANE	29.0
140	214 W-54	09-Jul-86	1	20165 1,1 DICHLOROETHANE	55.0
140	214 W-54	09-Jul-86	1	20421 1,1,1 TRICHLOROETHANE	9.9
140	214 W-54	09-Jul-86	1	20171 1,2 DICHLOROETHYLENE	17.0
140	211 W-22	09-Jul-86	1	20171 1,2 DICHLOROETHYLENE	6.1

140	214	W-54	09-Jul-86	1	20425	TRICHLOROETHYLENE	13.0
140	211	W-22	09-Jul-86	1	20425	TRICHLOROETHYLENE	8.9
140	214	W-54	09-Jul-86	1	20399	TETRACHLOROETHYLENE	7.3
140	214	W-54	09-Jul-86	1	20025	BENZENE	11.0
140	211	W-22	09-Jul-86	1	20025	BENZENE	1.0
2054	805	MW-5	09/23/85	1	20165	1,1-DICHLOROETHANE	3.4
2054	804	MW-4	12/10/85	2	20421	1,1,1-TRICHLOROETHANE	34.0
2054	803	MW-3	09/23/85	1	20421	1,1,1-TRICHLOROETHANE	1.8
2054	803	MW-3	12/10/85	1	20421	1,1,1-TRICHLOROETHANE	1.8
2054	805	MW-5	09/23/85	1	20421	1,1,1-TRICHLOROETHANE	1.3
2054	804	MW-4	12/10/85	1	20421	1,1,1-TRICHLOROETHANE	23.0
2054	804	MW-4	09/23/85	1	20421	1,1,1-TRICHLOROETHANE	51.0
2054	805	MW-5	09/23/85	1	20425	TRICHLOROETHYLENE	1.2
2054	803	MW-3	09/23/85	1	20399	TETRACHLOROETHYLENE	1.7
2054	803	MW-3	12/10/85	1	20399	TETRACHLOROETHYLENE	2.5
2054	805	MW-5	09/23/85	1	20427	TRICHLOROFLUOROMETHANE	9.4
2054	804	MW-4	09/23/85	1	20427	TRICHLOROFLUOROMETHANE	66.0
2054	803	MW-3	09/23/85	1	20427	TRICHLOROFLUOROMETHANE	15.0
2054	804	MW-4	12/10/85	1	20427	TRICHLOROFLUOROMETHANE	36.0
2054	804	MW-4	12/10/85	2	20427	TRICHLOROFLUOROMETHANE	55.0
2054	803	MW-3	12/10/85	1	20427	TRICHLOROFLUOROMETHANE	24.0
2051	114	TW-25	11/26/85	2	20087	CHLOROETHANE	420.0
2051	114	TW-25	11/26/85	1	20087	CHLOROETHANE	340.0
2051	114	TW-25	11/26/85	1	20165	1,1-DICHLOROETHANE	94.0
2051	114	TW-25	09/04/85	1	20165	1,1-DICHLOROETHANE	130.0
2051	115	TW-26	09/04/85	1	20165	1,1-DICHLOROETHANE	91.0
2051	115	TW-26	11/26/85	1	20165	1,1-DICHLOROETHANE	100.0
2051	116	TW-26A	11/26/85	1	20165	1,1-DICHLOROETHANE	360.0
2051	114	TW-25	11/26/85	2	20165	1,1-DICHLOROETHANE	110.0
2051	116	TW-26A	09/04/85	1	20165	1,1-DICHLOROETHANE	290.0
2051	116	TW-26A	11/26/85	1	20167	1,2-DICHLOROETHANE	1.8
2051	114	TW-25	11/26/85	2	20167	1,2-DICHLOROETHANE	6.8
2051	114	TW-25	09/04/85	1	20167	1,2-DICHLOROETHANE	8.5
2051	114	TW-25	11/26/85	1	20167	1,2-DICHLOROETHANE	4.4
2051	116	TW-26A	11/26/85	1	20421	1,1,1-TRICHLOROETHANE	110.0
2051	116	TW-26A	09/04/85	1	20421	1,1,1-TRICHLOROETHANE	130.0
2051	115	TW-26	11/26/85	1	20421	1,1,1-TRICHLOROETHANE	61.0
2051	115	TW-26	09/04/85	1	20421	1,1,1-TRICHLOROETHANE	86.0
2051	115	TW-26	11/26/85	1	20169	1,1-DICHLOROETHYLENE	2.7
2051	116	TW-26A	11/26/85	1	20169	1,1-DICHLOROETHYLENE	4.6
2051	115	TW-26	09/04/85	1	20169	1,1-DICHLOROETHYLENE	2.8
2051	114	TW-25	09/04/85	1	20169	1,1-DICHLOROETHYLENE	3.9
2051	116	TW-26A	09/04/85	1	20169	1,1-DICHLOROETHYLENE	4.9
2051	114	TW-25	11/26/85	2	20169	1,1-DICHLOROETHYLENE	3.9
2051	114	TW-25	11/26/85	1	20169	1,1-DICHLOROETHYLENE	2.9
2051	114	TW-25	11/26/85	1	20171	1,2-DICHLOROETHYLENE	41.0
2051	116	TW-26A	11/26/85	1	20171	1,2-DICHLOROETHYLENE	13.0
2051	116	TW-26A	09/04/85	1	20171	1,2-DICHLOROETHYLENE	9.2
2051	115	TW-26	09/04/85	1	20171	1,2-DICHLOROETHYLENE	3.6
2051	114	TW-25	09/04/85	1	20171	1,2-DICHLOROETHYLENE	41.0
2051	114	TW-25	11/26/85	2	20171	1,2-DICHLOROETHYLENE	43.0
2051	115	TW-26	11/26/85	1	20171	1,2-DICHLOROETHYLENE	3.9
2051	114	TW-25	11/26/85	2	20425	TRICHLOROETHYLENE	4.0
2051	116	TW-26A	11/26/85	1	20425	TRICHLOROETHYLENE	6.7
2051	114	TW-25	11/26/85	1	20425	TRICHLOROETHYLENE	2.5
2051	116	TW-26A	09/04/85	1	20425	TRICHLOROETHYLENE	6.8
2051	115	TW-26	09/04/85	1	20425	TRICHLOROETHYLENE	3.3
2051	115	TW-26	11/26/85	1	20425	TRICHLOROETHYLENE	3.5

2051	114 TW-25	11/26/85	2	20399 TETRACHLOROETHYLENE	4.3
2051	115 TW-26	11/26/85	1	20399 TETRACHLOROETHYLENE	8.0
2051	115 TW-26	09/04/85	1	20399 TETRACHLOROETHYLENE	7.2
2051	116 TW-26A	09/04/85	1	20399 TETRACHLOROETHYLENE	14.0
2051	116 TW-26A	11/26/85	1	20399 TETRACHLOROETHYLENE	15.0
2051	114 TW-25	11/26/85	1	20399 TETRACHLOROETHYLENE	1.4
2051	114 TW-25	11/26/85	2	20025 BENZENE	32.0
2051	114 TW-25	11/26/85	1	20025 BENZENE	31.0
2051	116 TW-26A	11/26/85	1	20025 BENZENE	6.3
2051	114 TW-25	09/04/85	1	20025 BENZENE	32.0
2051	116 TW-26A	09/04/85	1	20083 CHLOROBENZENE	3.4
2051	114 TW-25	11/26/85	2	20083 CHLOROBENZENE	7.6
2051	114 TW-25	11/26/85	1	20083 CHLOROBENZENE	4.8
2051	116 TW-26A	11/26/85	1	20083 CHLOROBENZENE	2.8
2051	114 TW-25	09/04/85	1	20083 CHLOROBENZENE	7.2
2051	114 TW-25	11/26/85	2	20233 ETHYL BENZENE	71.0
2051	114 TW-25	11/26/85	1	20233 ETHYL BENZENE	74.0
2051	114 TW-25	09/04/85	1	20233 ETHYL BENZENE	74.0
2051	114 TW-25	11/26/85	1	20157 1,4-DICHLOROBENZENE	5.0
2051	114 TW-25	11/26/85	2	20157 1,4-DICHLOROBENZENE	6.2
2051	114 TW-25	11/26/85	1	20411 TOLUENE	2400.0
2051	114 TW-25	11/26/85	2	20411 TOLUENE	2600.0
2051	114 TW-25	11/26/85	1	20437 XYLENE (TOTAL)	160.0
2051	116 TW-26A	11/26/85	1	20437 XYLENE (TOTAL)	3.3
2051	114 TW-25	11/26/85	2	20437 XYLENE (TOTAL)	140.0
2051	114 TW-25	09/04/85	1	20437 XYLENE (TOTAL)	160.0
2051	115 TW-26	11/26/85	1	20427 TRICHLOROFLUOROMETHANE	4.8
2051	114 TW-25	09/04/85	1	20319 METHYL ETHYL KETONE	5100.0
2051	114 TW-25	09/04/85	1	20401 TETRAHYDROFURAN	3400.0
2051	116 TW-26A	11/26/85	1	20095 CHLOROFORM	2.8
2695	15 DH-17	09/16/86	1	20087 CHLOROETHANE	4.8
2695	15 DH-17	09/16/86	1	20165 1,1-DICHLOROETHANE	8.2
2695	15 DH-17	06/16/86	1	20165 1,1-DICHLOROETHANE	12.0
2695	20 DH9A	09/15/86	1	20165 1,1-DICHLOROETHANE	2.9
2695	2 DH-5	06/16/86	1	20165 1,1-DICHLOROETHANE	2.2
2695	15 DH-17	06/16/86	1	20434 VINYL CHLORIDE	16.0
2695	15 DH-17	09/16/86	1	20434 VINYL CHLORIDE	3.6
2695	2 DH-5	06/16/86	1	20434 VINYL CHLORIDE	3.0
2695	20 DH9A	09/15/86	1	20434 VINYL CHLORIDE	5.1
2695	15 DH-17	06/16/86	1	20171 1,2-DICHLOROETHYLENE	33.0
2695	20 DH9A	09/15/86	1	20171 1,2-DICHLOROETHYLENE	11.0
2695	15 DH-17	09/16/86	1	20171 1,2-DICHLOROETHYLENE	45.0
2695	2 DH-5	06/16/86	1	20171 1,2-DICHLOROETHYLENE	3.4
2695	15 DH-17	09/16/86	1	20425 TRICHLOROETHYLENE	6.9
2695	2 DH-5	06/16/86	1	20425 TRICHLOROETHYLENE	2.0
2695	15 DH-17	06/16/86	1	20425 TRICHLOROETHYLENE	6.3
2695	15 DH-17	09/16/86	1	20399 TETRACHLOROETHYLENE	2.6
2695	15 DH-17	06/16/86	1	20399 TETRACHLOROETHYLENE	3.0
2695	20 DH9A	09/15/86	1	20025 BENZENE	1.2
2695	15 DH-17	09/16/86	1	20083 CHLOROBENZENE	2.0
2695	15 DH-17	09/16/86	1	20411 TOLUENE	3.5
2695	17 DH-17A	06/16/86	1	20411 TOLUENE	5.3
2695	17 DH-17A	06/16/86	2	20411 TOLUENE	5.2
2695	15 DH-17	06/16/86	1	20411 TOLUENE	4.4
2695	20 DH9A	09/15/86	1	20411 TOLUENE	1.8
2695	15 DH-17	06/16/86	1	20437 XYLENE (TOTAL)	4.0
2695	15 DH-17	06/16/86	1	20319 METHYL ETHYL KETONE	120.0

APPENDIX F. Leachate and collection lysimeter data sorted by parameter and value.

LICENSE	WELL	CLASS	DATE	SERIES	TEST	PARAMETER	VALUE
2990		LCH	30-MAR-87	1	20087	CHLOROETHANE	5.6
2978	113	LCH	23-Sep-86	1	20087	CHLOROETHANE	16.0
1940	258	LCH	06-Oct-86	1	20087	CHLOROETHANE	16.0
1940	258	LCH	06-Oct-86	2	20087	CHLOROETHANE	17.0
2975		LCH	7-APR-87	1	20087	CHLOROETHANE	24.0
2569	67	LCH	24-Sep-85	1	20087	CHLOROETHANE	24.0
2966	35	LCH	11-MAR-87	1	20087	CHLOROETHANE	27.0
2568	62	LCH	24-Sep-85	1	20087	CHLOROETHANE	31.0
2821	23	LCH	18-Nov-85	1	20087	CHLOROETHANE	67.0
2892	31	LCH	01-Jul-86	1	20087	CHLOROETHANE	89.0
2966	35	LCH	25-Jun-86	1	20087	CHLOROETHANE	160.0
3023	20	LCH	03-Dec-86	1	20087	CHLOROETHANE	440.0
3019	12	LCH	09-Sep-86	1	20087	CHLOROETHANE	700.0
3019	12	LCH	24-Jun-86	1	20087	CHLOROETHANE	730.0
2975		LCH	9-DEC-86	1	20165	1,1 DICHLOROETHANE	3.7
2695		LCH	16-Jun-86	1	20165	1,1-DICHLOROETHANE	9.2
2990	13	LCH	03-Nov-86	1	20165	1,1-DICHLOROETHANE	17.0
2892	31	LCH	25-Mar-86	1	20165	1,1-DICHLOROETHANE	22.0
2966	35	LCH	11-MAR-87	1	20165	1,1-DICHLOROETHANE	24.0
140		LCH	9-JUL-86	1	20165	1,1 DICHLOROETHANE	27.0
2975		LCH	7-APR-87	1	20165	1,1 DICHLOROETHANE	27.0
2892	42	LCH	01-Jul-86	1	20165	1,1-DICHLOROETHANE	31.0
2990		LCH	30-MAR-87	1	20165	1,1 DICHLOROETHANE	36.0
2966	35	LCH	25-Jun-86	1	20165	1,1-DICHLOROETHANE	46.0
3023	20	LCH	03-Dec-86	1	20165	1,1-DICHLOROETHANE	63.0
2978	113	LCH	04-Sep-85	1	20165	1,1-DICHLOROETHANE	66.0
2569	67	LCH	10-Dec-85	1	20165	1,1-DICHLOROETHANE	70.0
2569	67	LCH	24-Sep-85	1	20165	1,1-DICHLOROETHANE	76.0
2978	113	LCH	26-Nov-85	1	20165	1,1-DICHLOROETHANE	88.0
3023	20	LCH	04-Nov-86	1	20165	1,1-DICHLOROETHANE	95.0
3019	12	LCH	24-Jun-86	1	20165	1,1-DICHLOROETHANE	100.0
2978	113	LCH	23-Sep-86	1	20165	1,1-DICHLOROETHANE	120.0
2568	62	LCH	10-Dec-85	1	20165	1,1-DICHLOROETHANE	130.0
2568	62	LCH	24-Sep-85	1	20165	1,1-DICHLOROETHANE	140.0
2821	23	LCH	18-Nov-85	1	20165	1,1-DICHLOROETHANE	140.0
3019	12	LCH	09-Sep-86	1	20165	1,1-DICHLOROETHANE	190.0
2975		LCH	7-APR-87	1	20167	1,2 DICHLOROETHANE	1.3
2966	35	LCH	25-Jun-86	1	20167	1,2-DICHLOROETHANE	2.2
3019	12	LCH	09-Sep-86	1	20167	1,2-DICHLOROETHANE	4.0
2821	23	LCH	18-Nov-85	1	20167	1,2-DICHLOROETHANE	13.0
2978	113	LCH	23-Sep-86	1	20167	1,2 DICHLOROETHANE	13.0
140		LCH	9-JUL-86	1	20167	1,2 DICHLOROETHANE	600.0
2990	13	LCH	03-Nov-86	1	20421	1,1,1 TRICHLOROETHANE	3.1
2978	113	LCH	23-Sep-86	1	20421	1,1,1 TRICHLOROETHANE	11.0
2568	62	LCH	10-Dec-85	1	20421	1,1,1 TRICHLOROETHANE	12.0
2978	113	LCH	26-Nov-85	1	20421	1,1,1 TRICHLOROETHANE	14.0
2975		LCH	7-APR-87	1	20421	1,1,1 TRICHLOROETHANE	20.0
3019	12	LCH	09-Sep-86	1	20421	1,1,1 TRICHLOROETHANE	28.0
2937		LCH	7-APR-87	1	20421	1,1,1 TRICHLOROETHANE	63.0
2568	62	LCH	10-Dec-85	1	20421	1,1,1 TRICHLOROETHANE	63.0

3023	20 LCH	03-Dec-86	1	20421	1,1,1 TRICHLOROETHANE	69.0
2990	LCH	30-MAR-87	1	20421	1,1,1 TRICHLOROETHANE	72.0
140	LCH	9-JUL-86	1	20421	1,1,1 TRICHLOROETHANE	82.0
2892	42 LCH	01-Jul-86	1	20421	1,1,1 TRICHLOROETHANE	100.0
3023	20 LCH	04-Nov-86	1	20421	1,1,1 TRICHLOROETHANE	130.0
1940	254 LYS	06-Oct-86	1	20434	VINYL CHLORIDE	1.5
2966	35 LCH	11-MAR-87	1	20434	VINYL CHLORIDE	11.0
3023	20 LCH	03-Dec-86	1	20434	VINYL CHLORIDE	51.0
2990	LCH	30-MAR-87	1	20434	VINYL CHLORODE	150.0
2975	LCH	7-APR-87	1	20171	1,2 DICHLOROETHYLENE	3.6
2975	LCH	9-DEC-86	1	20171	1,2-DICHLOROETHYLENE	4.0
3023	20 LCH	04-Nov-86	1	20171	1,2-DICHLOROETHYLENE	9.6
2695	16 LCH	16-Sep-86	1	20171	1,2-DICHLOROETHYLENE	9.9
2966	35 LCH	25-Jun-86	1	20171	1,2-DICHLOROETHYLENE	21.0
3019	12 LCH	09-Sep-86	1	20171	1,2-DICHLOROETHYLENE	27.0
2695	LCH	16-Jun-86	1	20171	1,2-DICHLOROETHYLENE	29.0
2978	113 LCH	04-Sep-85	1	20171	1,2-DICHLOROETHYLENE	35.0
2966	35 LCH	11-MAR-87	1	20171	1,2-DICHLOROETHYLENE	40.0
2990	13 LCH	03-Nov-86	1	20171	1,2-DICHLOROETHYLENE	42.0
2568	62 LCH	10-Dec-85	1	20171	1,2-DICHLOROETHYLENE	67.0
2892	31 LCH	25-Mar-86	1	20171	1,2-DICHLOROETHYLENE	70.0
2568	62 LCH	24-Sep-85	1	20171	1,2-DICHLOROETHYLENE	94.0
2978	113 LCH	26-Nov-85	1	20171	1,2-DICHLOROETHYLENE	98.0
2892	31 LCH	01-Jul-86	1	20171	1,2-DICHLOROETHYLENE	120.0
2569	67 LCH	24-Sep-85	1	20171	1,2-DICHLOROETHYLENE	120.0
2821	23 LCH	18-Nov-85	1	20171	1,2-DICHLOROETHYLENE	210.0
2569	67 LCH	10-Dec-85	1	20171	1,2-DICHLOROETHYLENE	240.0
2978	113 LCH	23-Sep-86	1	20171	1,2-DICHLOROETHYLENE	310.0
2975	LCH	9-DEC-86	1	20425	TRICHLOROETHYLENE	2.4
2990	13 LCH	03-Nov-86	1	20425	TRICHLOROETHYLENE	2.8
2966	35 LCH	11-MAR-87	1	20425	TRICHLOROETHYLENE	4.4
2975	LCH	7-APR-87	1	20425	TRICHLOROETHYLENE	4.8
2990	LCH	30-MAR-87	1	20425	TRICHLOROETHYLENE	5.4
2966	35 LCH	25-Jun-86	1	20425	TRICHLOROETHYLENE	6.7
2978	113 LCH	26-Nov-85	1	20425	TRICHLOROETHYLENE	8.6
2978	113 LCH	04-Sep-85	1	20425	TRICHLOROETHYLENE	8.6
140	LCH	9-JUL-86	1	20425	TRICHLOROETHYLENE	12.0
2892	42 LCH	01-Jul-86	1	20425	TRICHLOROETHYLENE	14.0
3023	20 LCH	04-Nov-86	1	20425	TRICHLOROETHYLENE	17.0
3023	20 LCH	03-Dec-86	1	20425	TRICHLOROETHYLENE	18.0
2569	67 LCH	24-Sep-85	1	20425	TRICHLOROETHYLENE	19.0
2821	23 LCH	18-Nov-85	1	20425	TRICHLOROETHYLENE	23.0
3019	12 LCH	09-Sep-86	1	20425	TRICHLOROETHYLENE	28.0
2568	62 LCH	10-Dec-85	1	20425	TRICHLOROETHYLENE	29.0
2978	113 LCH	23-Sep-86	1	20425	TRICHLOROETHYLENE	35.0
3019	12 LCH	24-Jun-86	1	20425	TRICHLOROETHYLENE	44.0
2568	62 LCH	24-Sep-85	1	20425	TRICHLOROETHYLENE	59.0
2568	62 LCH	10-Dec-85	1	20425	TRICHLOROETHYLENE	77.0
2695	LCH	16-Jun-86	1	20425	TRICHLOROETHYLENE	240.0
2695	16 LCH	16-Sep-86	1	20425	TRICHLOROETHYLENE	280.0

2966	35 LCH	25-Jun-86	1	20399	TETRACHLOROETHYLENE	1.4
2695	16 LCH	16-Sep-86	1	20399	TETRACHLOROETHYLENE	2.8
2990	13 LCH	03-Nov-86	1	20399	TETRACHLOROETHYLENE	3.1
2695	LCH	16-Jun-86	1	20399	TETRACHLOROETHYLENE	3.9
2990	LCH	30-MAR-87	1	20399	TETRACHLOROETHYLENE	4.0
2569	67 LCH	24-Sep-85	1	20399	TETRACHLOROETHYLENE	4.2
2892	42 LCH	01-Jul-86	1	20399	TETRACHLOROETHYLENE	4.9
2975	LCH	7-APR-87	1	20399	TETRACHLOROETHYLENE	6.4
2978	113 LCH	26-Nov-85	1	20399	TETRACHLOROETHYLENE	8.4
2568	62 LCH	24-Sep-85	1	20399	TETRACHLOROETHYLENE	8.8
140	LCH	9-JUL-86	1	20399	TETRACHLOROETHYLENE	9.8
2978	113 LCH	04-Sep-85	1	20399	TETRACHLOROETHYLENE	9.9
3023	20 LCH	04-Nov-86	1	20399	TETRACHLOROETHYLENE	10.0
3023	20 LCH	03-Dec-86	1	20399	TETRACHLOROETHYLENE	11.0
2568	62 LCH	10-Dec-85	1	20399	TETRACHLOROETHYLENE	13.0
2568	62 LCH	10-Dec-85	1	20399	TETRACHLOROETHYLENE	22.0
2978	113 LCH	23-Sep-86	1	20399	TETRACHLOROETHYLENE	36.0
3019	12 LCH	24-Jun-86	1	20399	TETRACHLOROETHYLENE	39.0
3019	12 LCH	09-Sep-86	1	20399	TETRACHLOROETHYLENE	69.0
2975	LCH	7-APR-87	1	20025	BENZENE	1.4
2484	LCH	02-Dec-86	1	20025	BENZENE	1.8
1940	258 LCH	06-Oct-86	1	20025	BENZENE	2.9
2966	35 LCH	25-Jun-86	1	20025	BENZENE	3.2
1940	258 LCH	06-Oct-86	2	20025	BENZENE	3.2
2990	13 LCH	03-Nov-86	1	20025	BENZENE	3.7
2892	31 LCH	01-Jul-86	1	20025	BENZENE	4.5
2892	31 LCH	25-Mar-86	1	20025	BENZENE	5.7
3023	20 LCH	03-Dec-86	1	20025	BENZENE	7.4
2990	LCH	30-MAR-87	1	20025	BENZENE	8.9
3023	20 LCH	04-Nov-86	1	20025	BENZENE	11.0
2637	17 LCH	20-Nov-85	1	20025	BENZENE	16.0
2978	113 LCH	23-Sep-86	1	20025	BENZENE	22.0
2978	113 LCH	26-Nov-85	1	20025	BENZENE	26.0
2568	62 LCH	24-Sep-85	1	20025	BENZENE	39.0
2966	35 LCH	11-MAR-87	1	20025	BENZENE	53.0
2821	23 LCH	18-Nov-85	1	20025	BENZENE	80.0
2568	62 LCH	10-Dec-85	1	20025	BENZENE	160.0
2978	113 LCH	04-Sep-85	1	20025	BENZENE	180.0
2569	67 LCH	24-Sep-85	1	20025	BENZENE	200.0
2569	67 LCH	10-Dec-85	1	20025	BENZENE	220.0
2484	LCH	02-Dec-86	1	20083	CHLOROBENZENE	2.3
2695	16 LCH	16-Sep-86	1	20083	CHLOROBENZENE	5.1
2695	LCH	16-Jun-86	1	20083	CHLOROBENZENE	5.8
2695	16 LCH	16-Sep-86	1	20233	ETHYL BENZENE	1.4
2488	LCH	04-MAR-87	1	20233	ETHYL BENZENE	1.4
2695	LCH	16-Jun-86	1	20233	ETHYL BENZENE	2.6
2966	35 LCH	25-Jun-86	1	20233	ETHYL BENZENE	5.0
2990	13 LCH	03-Nov-86	1	20233	ETHYL BENZENE	6.9
1940	258 LCH	06-Oct-86	1	20233	ETHYL BENZENE	8.1
2990	LCH	30-MAR-87	1	20233	ETHYL BENZENE	8.2
1940	258 LCH	06-Oct-86	2	20233	ETHYL BENZENE	8.2

APPENDIX F. Leachate and collection lysimeter data sorted by parameter and value.

2975		LCH	9-DEC-86	1	20233 ETHYL BENZENE	11.0
3019	12	LCH	09-Sep-86	1	20233 ETHYL BENZENE	15.0
2975		LCH	7-APR-87	1	20233 ETHYL BENZENE	19.0
2892	31	LCH	25-Mar-86	1	20233 ETHYL BENZENE	20.0
2892	42	LCH	01-Jul-86	1	20233 ETHYL BENZENE	25.0
3019	12	LCH	24-Jun-86	1	20233 ETHYL BENZENE	27.0
3023	20	LCH	03-Dec-86	1	20233 ETHYL BENZENE	30.0
2484		LCH	02-Dec-86	1	20233 ETHYL BENZENE	34.0
2966	35	LCH	11-MAR-87	1	20233 ETHYL BENZENE	38.0
2978	113	LCH	26-Nov-85	1	20233 ETHYL BENZENE	42.0
140		LCH	9-JUL-86	1	20233 ETHYL BENZENE	42.0
3023	20	LCH	04-Nov-86	1	20233 ETHYL BENZENE	49.0
2637	17	LCH	20-Nov-85	1	20233 ETHYL BENZENE	51.0
2892	31	LCH	01-Jul-86	1	20233 ETHYL BENZENE	58.0
2978	113	LCH	23-Sep-86	1	20233 ETHYL BENZENE	61.0
2821	23	LCH	18-Nov-85	1	20233 ETHYL BENZENE	62.0
2978	113	LCH	04-Sep-85	1	20233 ETHYL BENZENE	77.0
2568	62	LCH	24-Sep-85	1	20233 ETHYL BENZENE	98.0
2569	67	LCH	24-Sep-85	1	20233 ETHYL BENZENE	120.0
2568	62	LCH	10-Dec-85	1	20233 ETHYL BENZENE	170.0
2569	67	LCH	10-Dec-85	1	20233 ETHYL BENZENE	180.0

2975		LCH	9-DEC-86	1	20157 1,4 DICHLOROBENZENE	3.0
2978	113	LCH	26-Nov-85	1	20157 1,4-DICHLOROBENZENE	3.7
2966	35	LCH	11-MAR-87	1	20157 1,4-DICHLOROBENZENE	4.9
3023	20	LCH	04-Nov-86	1	20157 1,4-DICHLOROBENZENE	5.6
3023	20	LCH	03-Dec-86	1	20157 1,4-DICHLOROBENZENE	5.9
2484		LCH	02-Dec-86	1	20157 1,4-DICHLOROBENZENE	6.7
2975		LCH	7-APR-87	1	20157 1,4 DICHLOROBENZENE	7.5
2569	67	LCH	10-Dec-85	1	20157 1,4-DICHLOROBENZENE	7.6
3019	12	LCH	24-Jun-86	1	20157 1,4-DICHLOROBENZENE	8.8
2978	113	LCH	23-Sep-86	1	20157 1,4-DICHLOROBENZENE	9.7
140		LCH	9-JUL-86	1	20157 1,4 DICHLOROBENZENE	11.0
3019	12	LCH	09-Sep-86	1	20157 1,4-DICHLOROBENZENE	18.0
2892	31	LCH	25-Mar-86	1	20157 1,4-DICHLOROBENZENE	19.0
2892	31	LCH	01-Jul-86	1	20157 1,4-DICHLOROBENZENE	21.0

2974	110	LYS	29-Sep-86	1	20411 TOLUENE	1.2
1940	258	LCH	06-Oct-86	1	20411 TOLUENE	2.2
1940	258	LCH	06-Oct-86	2	20411 TOLUENE	2.2
2892	42	LCH	10-Sep-85	1	20411 TOLUENE	2.3
2937		LCH	7-APR-87	1	20411 TOLUENE	13.0
2975		LCH	9-DEC-86	1	20411 TOLUENE	19.0
2873	15	LCH	17-MAR-87	1	20411 TOLUENE	22.0
2484		LCH	02-Dec-86	1	20411 TOLUENE	26.0
2975		LCH	7-APR-87	1	20411 TOLUENE	30.0
2695		LCH	16-Sep-86	1	20411 TOLUENE	42.0
2637	17	LCH	20-Nov-85	1	20411 TOLUENE	66.0
2990		LCH	30-MAR-87	1	20411 TOLUENE	71.0
2966	35	LCH	25-Jun-86	1	20411 TOLUENE	180.0
3019	12	LCH	09-Sep-86	1	20411 TOLUENE	200.0
2892	42	LCH	01-Jul-86	1	20411 TOLUENE	200.0
2978	113	LCH	26-Nov-85	1	20411 TOLUENE	210.0
2568	62	LCH	10-Dec-85	1	20411 TOLUENE	220.0

APPENDIX F. Leachate and collection lysimeter data sorted by parameter and value.

3019	12 LCH	24-Jun-86	1	20411	TOLUENE	240.0
2568	62 LCH	24-Sep-85	1	20411	TOLUENE	250.0
3023	20 LCH	03-Dec-86	1	20411	TOLUENE	320.0
2978	113 LCH	04-Sep-85	1	20411	TOLUENE	340.0
140	LCH	9-JUL-86	1	20411	TOLUENE	340.0
2990	13 LCH	03-Nov-86	1	20411	TOLUENE	350.0
2978	113 LCH	23-Sep-86	1	20411	TOLUENE	360.0
2569	67 LCH	24-Sep-85	1	20411	TOLUENE	360.0
2892	31 LCH	01-Jul-86	1	20411	TOLUENE	370.0
2695	16 LCH	16-Sep-86	1	20411	TOLUENE	440.0
2966	35 LCH	11-MAR-87	1	20411	TOLUENE	480.0
2695	LCH	16-Jun-86	1	20411	TOLUENE	520.0
2568	62 LCH	10-Dec-85	1	20411	TOLUENE	540.0
3023	20 LCH	04-Nov-86	1	20411	TOLUENE	580.0
2821	23 LCH	18-Nov-85	1	20411	TOLUENE	580.0
2488	LCH	04-MAR-87	1	20411	TOLUENE	610.0
2937	LCH	7-APR-87	1	20437	XYLENE (TOTAL)	2.5
2695	LCH	16-Sep-86	1	20437	XYLENE (TOTAL)	8.2
1940	258 LCH	06-Oct-86	1	20437	XYLENE (TOTAL)	9.4
1940	258 LCH	06-Oct-86	2	20437	XYLENE (TOTAL)	9.6
2695	16 LCH	16-Sep-86	1	20437	XYLENE (TOTAL)	14.0
3019	12 LCH	24-Jun-86	1	20437	XYLENE (TOTAL)	19.0
2990	LCH	30-MAR-87	1	20437	XYLENE (TOTAL)	31.0
2695	LCH	16-Jun-86	1	20437	XYLENE (TOTAL)	47.0
2990	13 LCH	03-Nov-86	1	20437	XYLENE (TOTAL)	49.0
2978	113 LCH	04-Sep-85	1	20437	XYLENE (TOTAL)	51.0
2966	35 LCH	11-MAR-87	1	20437	XYLENE (TOTAL)	62.0
3019	12 LCH	09-Sep-86	1	20437	XYLENE (TOTAL)	64.0
2569	67 LCH	24-Sep-85	1	20437	XYLENE (TOTAL)	75.0
2978	113 LCH	26-Nov-85	1	20437	XYLENE (TOTAL)	82.0
2484	LCH	02-Dec-86	1	20437	XYLENE (TOTAL)	100.0
140	LCH	9-JUL-86	1	20437	XYLENE (TOTAL)	100.0
2966	35 LCH	25-Jun-86	1	20437	XYLENE (TOTAL)	100.0
2637	17 LCH	20-Nov-85	1	20437	XYLENE (TOTAL)	110.0
2892	42 LCH	01-Jul-86	1	20437	XYLENE (TOTAL)	110.0
2975	LCH	9-DEC-86	1	20437	XYLENE (TOTAL)	120.0
3023	20 LCH	03-Dec-86	1	20437	XYLENE (TOTAL)	130.0
2568	62 LCH	10-Dec-85	1	20437	XYLENE (TOTAL)	140.0
2821	23 LCH	18-Nov-85	1	20437	XYLENE (TOTAL)	150.0
2978	113 LCH	23-Sep-86	1	20437	XYLENE (TOTAL)	180.0
2892	31 LCH	01-Jul-86	1	20437	XYLENE (TOTAL)	210.0
2975	LCH	7-APR-87	1	20437	XYLENE (TOTAL)	230.0
3023	20 LCH	04-Nov-86	1	20437	XYLENE (TOTAL)	240.0
2990	13 LCH	03-Nov-86	1	20051	BROMODICHLOROMETHANE	1.9
2990	LCH	30-MAR-87	1	20427	TRICHLOROFLUOROMETHANE	3.2
2975	LCH	7-APR-87	1	20427	TRICHLOROFLUOROMETHANE	8.2
3023	20 LCH	03-Dec-86	1	20427	TRICHLOROFLUOROMETHANE	34.0
2892	42 LCH	01-Jul-86	1	20427	TRICHLOROFLUOROMETHANE	180.0
140	LCH	9-JUL-86	1	20427	TRICHLOROFLUOROMETHANE	200.0
2484	LCH	02-Dec-86	1	20319	METHYL ETHYL KETONE	640.0

2892	42	LCH	01-Jul-86	1	20319	METHYL ETHYL KETONE	1300.0
2990		LCH	30-MAR-87	1	20319	METHYL ETHYL KETONE	2100.0
2892	31	LCH	01-Jul-86	1	20319	METHYL ETHYL KETONE	4700.0
2990	13	LCH	03-Nov-86	1	20319	METHYL ETHYL KETONE	5900.0
2975		LCH	9-DEC-86	1	20319	METHYL ETHYL KETONE	13000.0
2966	35	LCH	11-MAR-87	1	20319	METHYL ETHYL KETONE	13000.0
2821	23	LCH	18-Nov-85	1	20319	METHYL ETHYL KETONE	16000.0
2966	35	LCH	25-Jun-86	1	20319	METHYL ETHYL KETONE	16000.0
2978	113	LCH	04-Sep-85	1	20319	METHYL ETHYL KETONE	20000.0
3023	20	LCH	04-Nov-86	1	20319	METHYL ETHYL KETONE	37000.0
2892	42	LCH	01-Jul-86	1	20393	STYRENE	28.0
2892	31	LCH	01-Jul-86	1	20401	TETRAHYDROFURAN	270.0
2966	35	LCH	11-MAR-87	1	20401	TETRAHYDROFURAN	340.0
2966	35	LCH	25-Jun-86	1	20401	TETRAHYDROFURAN	400.0
2990		LCH	30-MAR-87	1	20401	TETRAHYDROFURAN	410.0
2990	13	LCH	03-Nov-86	1	20401	TETRAHYDROFURAN	430.0
2568	62	LCH	10-Dec-85	1	20401	TETRAHYDROFURAN	490.0
2978	113	LCH	26-Nov-85	1	20401	TETRAHYDROFURAN	520.0
1940	258	LCH	06-Oct-86	1	20401	TETRAHYDROFURAN	650.0
1940	258	LCH	06-Oct-86	2	20401	TETRAHYDROFURAN	680.0
2484		LCH	02-Dec-86	1	20401	TETRAHYDROFURAN	730.0
2569	67	LCH	24-Sep-85	1	20401	TETRAHYDROFURAN	780.0
2892	19	LYS	01-Jul-86	1	20401	TETRAHYDROFURAN	800.0
1940	254	LYS	06-Oct-86	1	20401	TETRAHYDROFURAN	910.0
3023	20	LCH	03-Dec-86	1	20401	TETRAHYDROFURAN	1000.0
2637	17	LCH	20-Nov-85	1	20401	TETRAHYDROFURAN	1200.0
2978	113	LCH	04-Sep-85	1	20401	TETRAHYDROFURAN	1300.0
3023	20	LCH	04-Nov-86	1	20401	TETRAHYDROFURAN	1400.0
2821	23	LCH	18-Nov-85	1	20401	TETRAHYDROFURAN	2600.0
2974	110	LYS	29-Sep-86	1	20401	TETRAHYDROFURAN	11000.0
2978	113	LCH	23-Sep-86	1	20095	CHLOROFORM	3.4
2990		LCH	30-MAR-87	1	20095	CHLOROFORM	4.4
3023	20	LCH	03-Dec-86	1	20095	CHLOROFORM	6.0
3023	20	LCH	04-Nov-86	1	20095	CHLOROFORM	8.3
2695	16	LCH	16-Sep-86	1	20095	CHLOROFORM	16.0
2695		LCH	16-Jun-86	1	20095	CHLOROFORM	32.0

APPENDIX G. Leachate and collection lysimeter data sorted by landfill and parameter.

LICENSE	WELL	CLASS	DATE	SERIES	TEST	PARAMETER	VALUE
2569	67	LCH	24-Sep-85	1	20087	CHLOROETHANE	24.0
2569	67	LCH	10-Dec-85	1	20165	1,1-DICHLOROETHANE	70.0
2569	67	LCH	24-Sep-85	1	20165	1,1-DICHLOROETHANE	76.0
2569	67	LCH	24-Sep-85	1	20171	1,2-DICHLOROETHYLENE	120.0
2569	67	LCH	10-Dec-85	1	20171	1,2-DICHLOROETHYLENE	240.0
2569	67	LCH	24-Sep-85	1	20425	TRICHLOROETHYLENE	19.0
2569	67	LCH	24-Sep-85	1	20399	TETRACHLOROETHYLENE	4.2
2569	67	LCH	10-Dec-85	1	20025	BENZENE	220.0
2569	67	LCH	24-Sep-85	1	20025	BENZENE	200.0
2569	67	LCH	24-Sep-85	1	20233	ETHYL BENZENE	120.0
2569	67	LCH	10-Dec-85	1	20233	ETHYL BENZENE	180.0
2569	67	LCH	10-Dec-85	1	20157	1,4-DICHLOROBENZENE	7.6
2569	67	LCH	24-Sep-85	1	20411	TOLUENE	360.0
2569	67	LCH	24-Sep-85	1	20437	XYLENE (TOTAL)	75.0
2569	67	LCH	24-Sep-85	1	20401	TETRAHYDROFURAN	780.0
2821	23	LCH	18-Nov-85	1	20087	CHLOROETHANE	67.0
2821	23	LCH	18-Nov-85	1	20165	1,1-DICHLOROETHANE	140.0
2821	23	LCH	18-Nov-85	1	20167	1,2-DICHLOROETHANE	13.0
2821	23	LCH	18-Nov-85	1	20171	1,2-DICHLOROETHYLENE	210.0
2821	23	LCH	18-Nov-85	1	20425	TRICHLOROETHYLENE	23.0
2821	23	LCH	18-Nov-85	1	20025	BENZENE	80.0
2821	23	LCH	18-Nov-85	1	20233	ETHYL BENZENE	62.0
2821	23	LCH	18-Nov-85	1	20411	TOLUENE	580.0
2821	23	LCH	18-Nov-85	1	20437	XYLENE (TOTAL)	150.0
2821	23	LCH	18-Nov-85	1	20319	METHYL ETHYL KETONE	16000.0
2821	23	LCH	18-Nov-85	1	20401	TETRAHYDROFURAN	2600.0
2892	31	LCH	01-Jul-86	1	20087	CHLOROETHANE	89.0
2892	31	LCH	25-Mar-86	1	20165	1,1-DICHLOROETHANE	22.0
2892	42	LCH	01-Jul-86	1	20165	1,1-DICHLOROETHANE	31.0
2892	42	LCH	01-Jul-86	1	20421	1,1,1 TRICHLOROETHANE	100.0
2892	31	LCH	01-Jul-86	1	20171	1,2-DICHLOROETHYLENE	120.0
2892	31	LCH	25-Mar-86	1	20171	1,2-DICHLOROETHYLENE	70.0
2892	42	LCH	01-Jul-86	1	20425	TRICHLOROETHYLENE	14.0
2892	42	LCH	01-Jul-86	1	20399	TETRACHLOROETHYLENE	4.9
2892	31	LCH	25-Mar-86	1	20025	BENZENE	5.7
2892	31	LCH	01-Jul-86	1	20025	BENZENE	4.5
2892	31	LCH	25-Mar-86	1	20233	ETHYL BENZENE	20.0
2892	31	LCH	01-Jul-86	1	20233	ETHYL BENZENE	58.0
2892	42	LCH	01-Jul-86	1	20233	ETHYL BENZENE	25.0
2892	31	LCH	25-Mar-86	1	20157	1,4-DICHLOROBENZENE	19.0
2892	31	LCH	01-Jul-86	1	20157	1,4-DICHLOROBENZENE	21.0
2892	31	LCH	01-Jul-86	1	20411	TOLUENE	370.0
2892	42	LCH	10-Sep-85	1	20411	TOLUENE	2.3
2892	42	LCH	01-Jul-86	1	20411	TOLUENE	200.0
2892	31	LCH	01-Jul-86	1	20437	XYLENE (TOTAL)	210.0
2892	42	LCH	01-Jul-86	1	20437	XYLENE (TOTAL)	110.0
2892	42	LCH	01-Jul-86	1	20427	TRICHLOROFLUOROMETHANE	180.0
2892	31	LCH	01-Jul-86	1	20319	METHYL ETHYL KETONE	4700.0
2892	42	LCH	01-Jul-86	1	20319	METHYL ETHYL KETONE	1300.0
2892	42	LCH	01-Jul-86	1	20393	STYRENE	28.0
2892	31	LCH	01-Jul-86	1	20401	TETRAHYDROFURAN	270.0
2892	19	LYS	01-Jul-86	1	20401	TETRAHYDROFURAN	800.0
2966	35	LCH	11-MAR-87	1	20087	CHLOROETHANE	27.0
2966	35	LCH	25-Jun-86	1	20087	CHLOROETHANE	160.0
2966	35	LCH	11-MAR-87	1	20165	1,1-DICHLOROETHANE	24.0
2966	35	LCH	25-Jun-86	1	20165	1,1-DICHLOROETHANE	46.0

APPENDIX G. Leachate and collection lysimeter data sorted by landfill and parameter.

2966	35 LCH	25-Jun-86	1	20167 1,2-DICHLOROETHANE	2.2
2966	35 LCH	11-MAR-87	1	20434 VINYL CHLORIDE	11.0
2966	35 LCH	25-Jun-86	1	20171 1,2-DICHLOROETHYLENE	21.0
2966	35 LCH	11-MAR-87	1	20171 1,2-DICHLOROETHYLENE	40.0
2966	35 LCH	25-Jun-86	1	20425 TRICHLOROETHYLENE	6.7
2966	35 LCH	11-MAR-87	1	20425 TRICHLOROETHYLENE	4.4
2966	35 LCH	25-Jun-86	1	20399 TETRACHLOROETHYLENE	1.4
2966	35 LCH	11-MAR-87	1	20025 BENZENE	53.0
2966	35 LCH	25-Jun-86	1	20025 BENZENE	3.2
2966	35 LCH	11-MAR-87	1	20233 ETHYL BENZENE	38.0
2966	35 LCH	25-Jun-86	1	20233 ETHYL BENZENE	5.0
2966	35 LCH	11-MAR-87	1	20157 1,4-DICHLOROBENZENE	4.9
2966	35 LCH	25-Jun-86	1	20411 TOLUENE	180.0
2966	35 LCH	11-MAR-87	1	20411 TOLUENE	480.0
2966	35 LCH	25-Jun-86	1	20437 XYLENE (TOTAL)	100.0
2966	35 LCH	11-MAR-87	1	20437 XYLENE (TOTAL)	62.0
2966	35 LCH	11-MAR-87	1	20319 METHYL ETHYL KETONE	13000.0
2966	35 LCH	25-Jun-86	1	20319 METHYL ETHYL KETONE	16000.0
2966	35 LCH	25-Jun-86	1	20401 TETRAHYDROFURAN	400.0
2966	35 LCH	11-MAR-87	1	20401 TETRAHYDROFURAN	340.0
3019	12 LCH	24-Jun-86	1	20087 CHLOROETHANE	730.0
3019	12 LCH	09-Sep-86	1	20087 CHLOROETHANE	700.0
3019	12 LCH	09-Sep-86	1	20165 1,1-DICHLOROETHANE	190.0
3019	12 LCH	24-Jun-86	1	20165 1,1-DICHLOROETHANE	100.0
3019	12 LCH	09-Sep-86	1	20167 1,2-DICHLOROETHANE	4.0
3019	12 LCH	09-Sep-86	1	20421 1,1,1 TRICHLOROETHANE	28.0
3019	12 LCH	09-Sep-86	1	20171 1,2-DICHLOROETHYLENE	27.0
3019	12 LCH	09-Sep-86	1	20425 TRICHLOROETHYLENE	28.0
3019	12 LCH	24-Jun-86	1	20425 TRICHLOROETHYLENE	44.0
3019	12 LCH	09-Sep-86	1	20399 TETRACHLOROETHYLENE	69.0
3019	12 LCH	24-Jun-86	1	20399 TETRACHLOROETHYLENE	39.0
3019	12 LCH	24-Jun-86	1	20233 ETHYL BENZENE	27.0
3019	12 LCH	09-Sep-86	1	20233 ETHYL BENZENE	15.0
3019	12 LCH	09-Sep-86	1	20157 1,4-DICHLOROBENZENE	18.0
3019	12 LCH	24-Jun-86	1	20157 1,4-DICHLOROBENZENE	8.8
3019	12 LCH	09-Sep-86	1	20411 TOLUENE	200.0
3019	12 LCH	24-Jun-86	1	20411 TOLUENE	240.0
3019	12 LCH	09-Sep-86	1	20437 XYLENE (TOTAL)	64.0
3019	12 LCH	24-Jun-86	1	20437 XYLENE (TOTAL)	19.0
2978	113 LCH	23-Sep-86	1	20087 CHLOROETHANE	16.0
2978	113 LCH	23-Sep-86	1	20165 1,1-DICHLOROETHANE	120.0
2978	113 LCH	04-Sep-85	1	20165 1,1-DICHLOROETHANE	66.0
2978	113 LCH	26-Nov-85	1	20165 1,1-DICHLOROETHANE	88.0
2978	113 LCH	23-Sep-86	1	20167 1,2 DICHLOROETHANE	13.0
2978	113 LCH	23-Sep-86	1	20421 1,1,1 TRICHLOROETHANE	11.0
2978	113 LCH	26-Nov-85	1	20421 1,1,1 TRICHLOROETHANE	14.0
2978	113 LCH	23-Sep-86	1	20171 1,2-DICHLOROETHYLENE	310.0
2978	113 LCH	26-Nov-85	1	20171 1,2-DICHLOROETHYLENE	98.0
2978	113 LCH	04-Sep-85	1	20171 1,2-DICHLOROETHYLENE	35.0
2978	113 LCH	04-Sep-85	1	20425 TRICHLOROETHYLENE	8.6
2978	113 LCH	23-Sep-86	1	20425 TRICHLOROETHYLENE	35.0
2978	113 LCH	26-Nov-85	1	20425 TRICHLOROETHYLENE	8.6
2978	113 LCH	26-Nov-85	1	20399 TETRACHLOROETHYLENE	8.4
2978	113 LCH	23-Sep-86	1	20399 TETRACHLOROETHYLENE	36.0
2978	113 LCH	04-Sep-85	1	20399 TETRACHLOROETHYLENE	9.9
2978	113 LCH	26-Nov-85	1	20025 BENZENE	26.0
2978	113 LCH	04-Sep-85	1	20025 BENZENE	180.0
2978	113 LCH	23-Sep-86	1	20025 BENZENE	22.0

APPENDIX G. Leachate and collection lysimeter data sorted by landfill and parameter.

2978	113 LCH	26-Nov-85	1	20233	ETHYL BENZENE	42.0
2978	113 LCH	04-Sep-85	1	20233	ETHYL BENZENE	77.0
2978	113 LCH	23-Sep-86	1	20233	ETHYL BENZENE	61.0
2978	113 LCH	26-Nov-85	1	20157	1,4-DICHLOROBENZENE	3.7
2978	113 LCH	23-Sep-86	1	20157	1,4-DICHLOROBENZENE	9.7
2978	113 LCH	04-Sep-85	1	20411	TOLUENE	340.0
2978	113 LCH	23-Sep-86	1	20411	TOLUENE	360.0
2978	113 LCH	26-Nov-85	1	20411	TOLUENE	210.0
2978	113 LCH	23-Sep-86	1	20437	XYLENE (TOTAL)	180.0
2978	113 LCH	26-Nov-85	1	20437	XYLENE (TOTAL)	82.0
2978	113 LCH	04-Sep-85	1	20437	XYLENE (TOTAL)	51.0
2978	113 LCH	04-Sep-85	1	20319	METHYL ETHYL KETONE	20000.0
2978	113 LCH	26-Nov-85	1	20401	TETRAHYDROFURAN	520.0
2978	113 LCH	04-Sep-85	1	20401	TETRAHYDROFURAN	1300.0
2978	113 LCH	23-Sep-86	1	20095	CHLOROFORM	3.4
2990	LCH	30-MAR-87	1	20087	CHLOROETHANE	5.6
2990	13 LCH	03-Nov-86	1	20165	1,1-DICHLOROETHANE	17.0
2990	LCH	30-MAR-87	1	20165	1,1 DICHLOROETHANE	36.0
2990	LCH	30-MAR-87	1	20421	1,1,1 TRICHLOROETHANE	72.0
2990	13 LCH	03-Nov-86	1	20421	1,1,1 TRICHLOROETHANE	3.1
2990	LCH	30-MAR-87	1	20434	VINYL CHLORODE	150.0
2990	13 LCH	03-Nov-86	1	20171	1,2-DICHLOROETHYLENE	42.0
2990	13 LCH	03-Nov-86	1	20425	TRICHLOROETHYLENE	2.8
2990	LCH	30-MAR-87	1	20425	TRICHLOROETHYLENE	5.4
2990	LCH	30-MAR-87	1	20399	TETRACHLOROETHYLENE	4.0
2990	13 LCH	03-Nov-86	1	20399	TETRACHLOROETHYLENE	3.1
2990	LCH	30-MAR-87	1	20025	BENZENE	8.9
2990	13 LCH	03-Nov-86	1	20025	BENZENE	3.7
2990	13 LCH	03-Nov-86	1	20233	ETHYL BENZENE	6.9
2990	LCH	30-MAR-87	1	20233	ETHYL BENZENE	8.2
2990	13 LCH	03-Nov-86	1	20411	TOLUENE	350.0
2990	LCH	30-MAR-87	1	20411	TOLUENE	71.0
2990	LCH	30-MAR-87	1	20437	XYLENE (TOTAL)	31.0
2990	13 LCH	03-Nov-86	1	20437	XYLENE (TOTAL)	49.0
2990	13 LCH	03-Nov-86	1	20051	BROMODICHLOROMETHANE	1.9
2990	LCH	30-MAR-87	1	20427	TRICHLOROFLUOROMETHANE	3.2
2990	LCH	30-MAR-87	1	20319	METHYL ETHYL KETONE	2100.0
2990	13 LCH	03-Nov-86	1	20319	METHYL ETHYL KETONE	5900.0
2990	13 LCH	03-Nov-86	1	20401	TETRAHYDROFURAN	430.0
2990	LCH	30-MAR-87	1	20401	TETRAHYDROFURAN	410.0
2990	LCH	30-MAR-87	1	20095	CHLOROFORM	4.4
3023	20 LCH	03-Dec-86	1	20087	CHLOROETHANE	440.0
3023	20 LCH	03-Dec-86	1	20165	1,1-DICHLOROETHANE	63.0
3023	20 LCH	04-Nov-86	1	20165	1,1-DICHLOROETHANE	95.0
3023	20 LCH	03-Dec-86	1	20421	1,1,1 TRICHLOROETHANE	69.0
3023	20 LCH	04-Nov-86	1	20421	1,1,1 TRICHLOROETHANE	130.0
3023	20 LCH	03-Dec-86	1	20434	VINYL CHLORIDE	51.0
3023	20 LCH	04-Nov-86	1	20171	1,2-DICHLOROETHYLENE	9.6
3023	20 LCH	04-Nov-86	1	20425	TRICHLOROETHYLENE	17.0
3023	20 LCH	03-Dec-86	1	20425	TRICHLOROETHYLENE	18.0
3023	20 LCH	03-Dec-86	1	20399	TETRACHLOROETHYLENE	11.0
3023	20 LCH	04-Nov-86	1	20399	TETRACHLOROETHYLENE	10.0
3023	20 LCH	04-Nov-86	1	20025	BENZENE	11.0
3023	20 LCH	03-Dec-86	1	20025	BENZENE	7.4
3023	20 LCH	03-Dec-86	1	20233	ETHYL BENZENE	30.0
3023	20 LCH	04-Nov-86	1	20233	ETHYL BENZENE	49.0
3023	20 LCH	04-Nov-86	1	20157	1,4-DICHLOROBENZENE	5.6
3023	20 LCH	03-Dec-86	1	20157	1,4-DICHLOROBENZENE	5.9

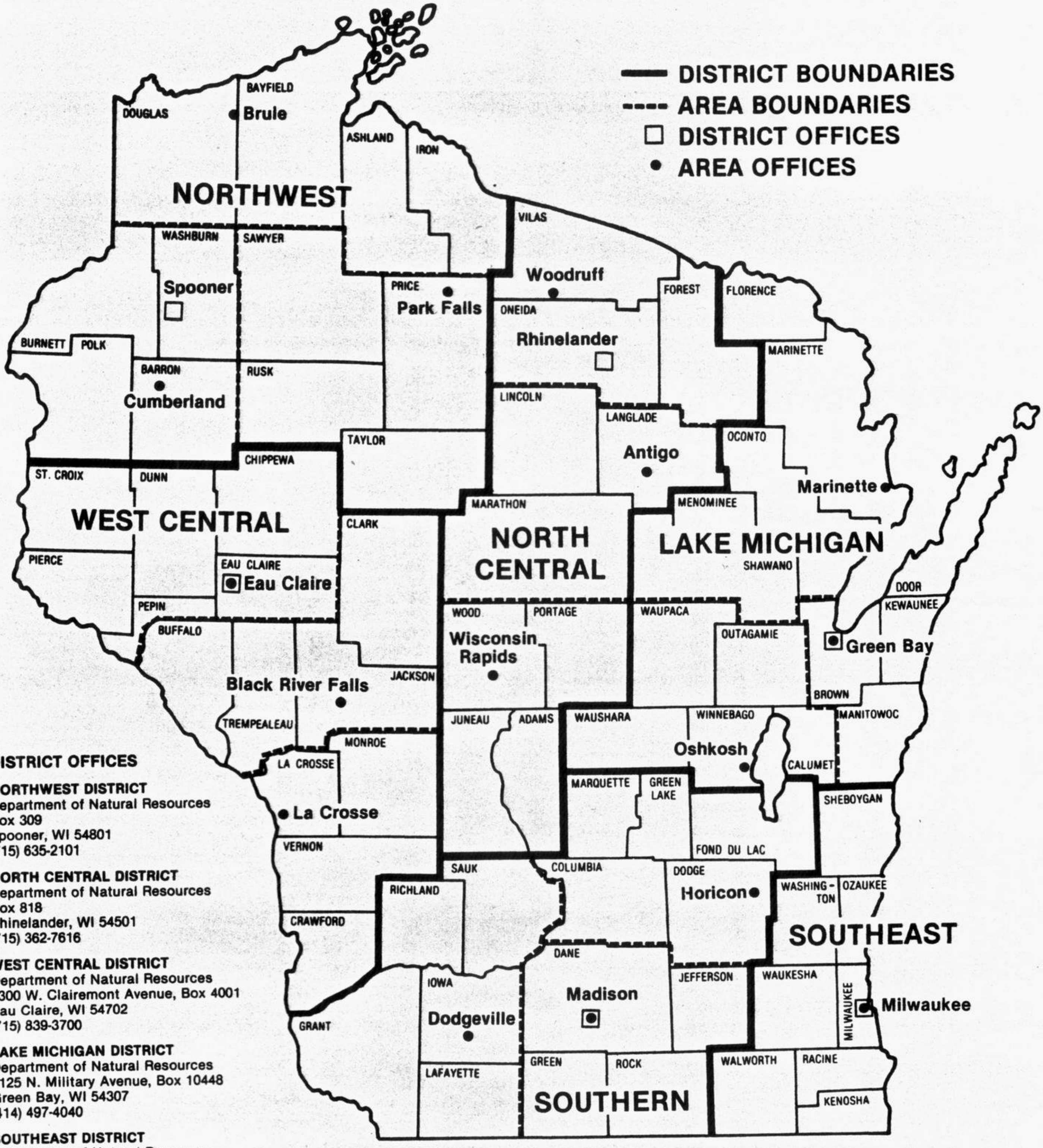
APPENDIX G. Leachate and collection lysimeter data sorted by landfill and parameter.

3023	20	LCH	04-Nov-86	1	20411	TOLUENE	580.0
3023	20	LCH	03-Dec-86	1	20411	TOLUENE	320.0
3023	20	LCH	04-Nov-86	1	20437	XYLENE (TOTAL)	240.0
3023	20	LCH	03-Dec-86	1	20437	XYLENE (TOTAL)	130.0
3023	20	LCH	03-Dec-86	1	20427	TRICHLOROFLUOROMETHANE	34.0
3023	20	LCH	04-Nov-86	1	20319	METHYL ETHYL KETONE	37000.0
3023	20	LCH	03-Dec-86	1	20401	TETRAHYDROFURAN	1000.0
3023	20	LCH	04-Nov-86	1	20401	TETRAHYDROFURAN	1400.0
3023	20	LCH	04-Nov-86	1	20095	CHLOROFORM	8.3
3023	20	LCH	03-Dec-86	1	20095	CHLOROFORM	6.0
2484		LCH	02-Dec-86	1	20025	BENZENE	1.8
2484		LCH	02-Dec-86	1	20083	CHLOROBENZENE	2.3
2484		LCH	02-Dec-86	1	20233	ETHYL BENZENE	34.0
2484		LCH	02-Dec-86	1	20157	1,4-DICHLOROBENZENE	6.7
2484		LCH	02-Dec-86	1	20411	TOLUENE	26.0
2484		LCH	02-Dec-86	1	20437	XYLENE (TOTAL)	100.0
2484		LCH	02-Dec-86	1	20319	METHYL ETHYL KETONE	640.0
2484		LCH	02-Dec-86	1	20401	TETRAHYDROFURAN	730.0
2488		LCH	04-MAR-87	1	20233	ETHYL BENZENE	1.4
2488		LCH	04-MAR-87	1	20411	TOLUENE	610.0
2568	62	LCH	24-Sep-85	1	20087	CHLOROETHANE	31.0
2568	62	LCH	10-Dec-85	1	20165	1,1-DICHLOROETHANE	130.0
2568	62	LCH	24-Sep-85	1	20165	1,1-DICHLOROETHANE	140.0
2568	62	LCH	10-Dec-85	1	20421	1,1,1 TRICHLOROETHANE	12.0
2568	62	LCH	10-Dec-85	1	20421	1,1,1 TRICHLOROETHANE	63.0
2568	62	LCH	24-Sep-85	1	20171	1,2-DICHLOROETHYLENE	94.0
2568	62	LCH	10-Dec-85	1	20171	1,2-DICHLOROETHYLENE	67.0
2568	62	LCH	10-Dec-85	1	20425	TRICHLOROETHYLENE	29.0
2568	62	LCH	24-Sep-85	1	20425	TRICHLOROETHYLENE	59.0
2568	62	LCH	10-Dec-85	1	20425	TRICHLOROETHYLENE	77.0
2568	62	LCH	10-Dec-85	1	20399	TETRACHLOROETHYLENE	13.0
2568	62	LCH	24-Sep-85	1	20399	TETRACHLOROETHYLENE	8.8
2568	62	LCH	10-Dec-85	1	20399	TETRACHLOROETHYLENE	22.0
2568	62	LCH	24-Sep-85	1	20025	BENZENE	39.0
2568	62	LCH	10-Dec-85	1	20025	BENZENE	160.0
2568	62	LCH	10-Dec-85	1	20233	ETHYL BENZENE	170.0
2568	62	LCH	24-Sep-85	1	20233	ETHYL BENZENE	98.0
2568	62	LCH	24-Sep-85	1	20411	TOLUENE	250.0
2568	62	LCH	10-Dec-85	1	20411	TOLUENE	540.0
2568	62	LCH	10-Dec-85	1	20411	TOLUENE	220.0
2568	62	LCH	10-Dec-85	1	20437	XYLENE (TOTAL)	140.0
2568	62	LCH	10-Dec-85	1	20401	TETRAHYDROFURAN	490.0
2937		LCH	7-APR-87	1	20421	1,1,1 TRICHLOROETHANE	63.0
2937		LCH	7-APR-87	1	20411	TOLUENE	13.0
2937		LCH	7-APR-87	1	20437	XYLENE (TOTAL)	2.5
2975		LCH	7-APR-87	1	20087	CHLOROETHANE	24.0
2975		LCH	7-APR-87	1	20165	1,1 DICHLOROETHANE	27.0
2975		LCH	9-DEC-86	1	20165	1,1 DICHLOROETHANE	3.7
2975		LCH	7-APR-87	1	20167	1,2 DICHLOROETHANE	1.3
2975		LCH	7-APR-87	1	20421	1,1,1 TRICHLOROETHANE	20.0
2975		LCH	7-APR-87	1	20171	1,2 DICHLOROETHYLENE	3.6
2975		LCH	9-DEC-86	1	20171	1,2-DICHLOROETHYLENE	4.0
2975		LCH	7-APR-87	1	20425	TRICHLOROETHYLENE	4.8
2975		LCH	9-DEC-86	1	20425	TRICHLOROETHYLENE	2.4
2975		LCH	7-APR-87	1	20399	TETRACHLOROETHYLENE	6.4

2975	LCH	7-APR-87	1	20025 BENZENE	1.4
2975	LCH	9-DEC-86	1	20233 ETHYL BENZENE	11.0
2975	LCH	7-APR-87	1	20233 ETHYL BENZENE	19.0
2975	LCH	9-DEC-86	1	20157 1,4 DICHLOROBENZENE	3.0
2975	LCH	7-APR-87	1	20157 1,4 DICHLOROBENZENE	7.5
2975	LCH	7-APR-87	1	20411 TOLUENE	30.0
2975	LCH	9-DEC-86	1	20411 TOLUENE	19.0
2975	LCH	7-APR-87	1	20437 XYLENE (TOTAL)	230.0
2975	LCH	9-DEC-86	1	20437 XYLENE (TOTAL)	120.0
2975	LCH	7-APR-87	1	20427 TRICHLOROFLUOROMETHANE	8.2
2975	LCH	9-DEC-86	1	20319 METHYL ETHYL KETONE	13000.0
2637	17 LCH	20-Nov-85	1	20025 BENZENE	16.0
2637	17 LCH	20-Nov-85	1	20233 ETHYL BENZENE	51.0
2637	17 LCH	20-Nov-85	1	20411 TOLUENE	66.0
2637	17 LCH	20-Nov-85	1	20437 XYLENE (TOTAL)	110.0
2637	17 LCH	20-Nov-85	1	20401 TETRAHYDROFURAN	1200.0
140	LCH	9-JUL-86	1	20165 1,1 DICHLOROETHANE	27.0
140	LCH	9-JUL-86	1	20167 1,2 DICHLOROETHANE	600.0
140	LCH	9-JUL-86	1	20421 1,1,1 TRICHLOROETHANE	82.0
140	LCH	9-JUL-86	1	20425 TRICHLOROETHYLENE	12.0
140	LCH	9-JUL-86	1	20399 TETRACHLOROETHYLENE	9.8
140	LCH	9-JUL-86	1	20233 ETHYL BENZENE	42.0
140	LCH	9-JUL-86	1	20157 1,4 DICHLOROBENZENE	11.0
140	LCH	9-JUL-86	1	20411 TOLUENE	340.0
140	LCH	9-JUL-86	1	20437 XYLENE (TOTAL)	100.0
140	LCH	9-JUL-86	1	20427 TRICHLOROFLUOROMETHANE	200.0
2873	15 LCH	17-MAR-87	1	20411 TOLUENE	22
2695	LCH	16-Jun-86	1	20165 1,1-DICHLOROETHANE	9.2
2695	16 LCH	16-Sep-86	1	20171 1,2-DICHLOROETHYLENE	9.9
2695	LCH	16-Jun-86	1	20171 1,2-DICHLOROETHYLENE	29.0
2695	16 LCH	16-Sep-86	1	20425 TRICHLOROETHYLENE	280.0
2695	LCH	16-Jun-86	1	20425 TRICHLOROETHYLENE	240.0
2695	16 LCH	16-Sep-86	1	20399 TETRACHLOROETHYLENE	2.8
2695	LCH	16-Jun-86	1	20399 TETRACHLOROETHYLENE	3.9
2695	LCH	16-Jun-86	1	20083 CHLOROBENZENE	5.8
2695	16 LCH	16-Sep-86	1	20083 CHLOROBENZENE	5.1
2695	16 LCH	16-Sep-86	1	20233 ETHYL BENZENE	1.4
2695	LCH	16-Jun-86	1	20233 ETHYL BENZENE	2.6
2695	LCH	16-Jun-86	1	20411 TOLUENE	520.0
2695	LCH	16-Sep-86	1	20411 TOLUENE	42.0
2695	16 LCH	16-Sep-86	1	20411 TOLUENE	440.0
2695	LCH	16-Jun-86	1	20437 XYLENE (TOTAL)	47.0
2695	16 LCH	16-Sep-86	1	20437 XYLENE (TOTAL)	14.0
2695	LCH	16-Sep-86	1	20437 XYLENE (TOTAL)	8.2
2695	LCH	16-Jun-86	1	20095 CHLOROFORM	32.0
2695	16 LCH	16-Sep-86	1	20095 CHLOROFORM	16.0
2974	110 LYS	29-Sep-86	1	20411 TOLUENE	1.2
2974	110 LYS	29-Sep-86	1	20401 TETRAHYDROFURAN	11000.0
1940	258 LCH	06-Oct-86	1	20087 CHLOROETHANE	16.0
1940	258 LCH	06-Oct-86	2	20087 CHLOROETHANE	17.0
1940	254 LYS	06-Oct-86	1	20434 VINYL CHLORIDE	1.5
1940	258 LCH	06-Oct-86	2	20025 BENZENE	3.2
1940	258 LCH	06-Oct-86	1	20025 BENZENE	2.9
1940	258 LCH	06-Oct-86	2	20233 ETHYL BENZENE	8.2

1940	258 LCH	06-Oct-86	1	20233	ETHYL BENZENE	8.1
1940	258 LCH	06-Oct-86	1	20411	TOLUENE	2.2
1940	258 LCH	06-Oct-86	2	20411	TOLUENE	2.2
1940	258 LCH	06-Oct-86	1	20437	XYLENE (TOTAL)	9.4
1940	258 LCH	06-Oct-86	2	20437	XYLENE (TOTAL)	9.6
1940	258 LCH	06-Oct-86	2	20401	TETRAHYDROFURAN	680.0
1940	254 LYS	06-Oct-86	1	20401	TETRAHYDROFURAN	910.0
1940	258 LCH	06-Oct-86	1	20401	TETRAHYDROFURAN	650.0

DNR FIELD DISTRICTS AND AREAS



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To provide a clean environment
and a full range of outdoor opportunities.

To insure the right of all Wisconsin citizens
to use and enjoy these resources in
their work and leisure.

And in cooperation with all our citizens
to consider the future
and those who will follow us.

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