OFFICE OF INSPECTOR GENERAL

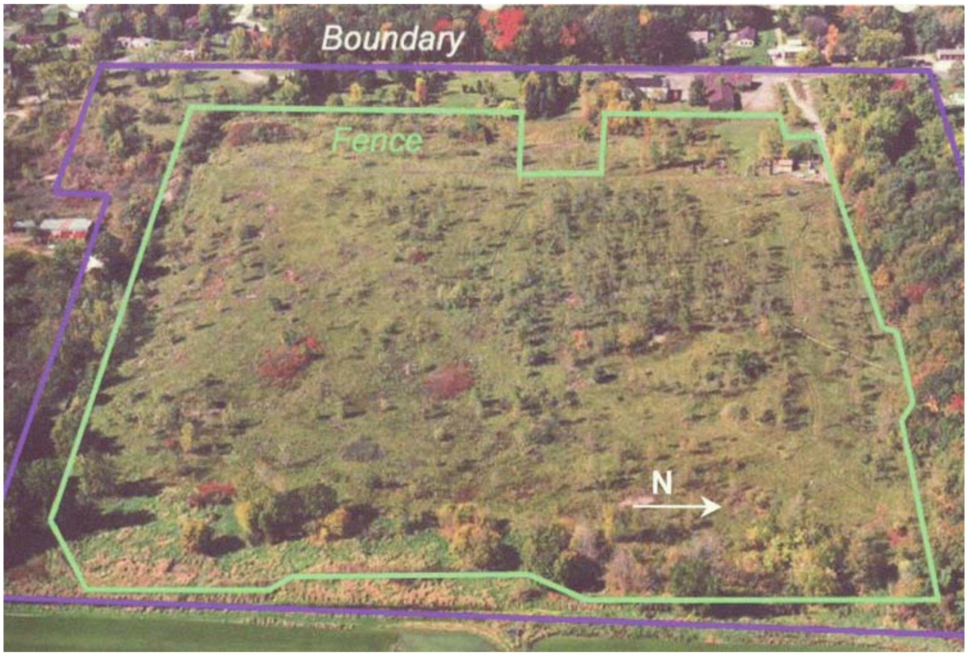
Catalyst for Improving the Environment

Ombudsman Report

Review of Actions at Industrial Excess Landfill Superfund Site, Uniontown, Ohio

Report 2004-P-00031

September 29, 2004



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Abbreviations

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
EPA	U.S. Environmental Protection Agency
IEL	Industrial Excess Landfill
MCL	maximum contaminant level
OIG	Office of Inspector General
pCi/L	picoCuries per liter
TIC	tentatively identified compounds

Glossaries of Terms

Appendix C contains a glossary on radiation-related terms; Appendix D contains a glossary on hydrogeological terms.

Cover photo: A 1997 photograph of the Industrial Excess Landfill, with the site fence and site boundary noted and an arrow indicating the direction north. *Source: September 2003 "Remedial Design Plan for the IEL Site," prepared by Sharp and Associates, Inc., for the Responding Companies.*

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
INSPECTOR GENERAL

September 29, 2004

MEMORANDUM

SUBJECT: Ombudsman Report:
Review of Actions at Industrial Excess Landfill Superfund Site,
Uniontown, Ohio
Report 2004-P-00031

FROM: Paul D. McKechnie Paul D. McKechnie
Acting Ombudsman
Office of Congressional and Public Liaison

TO: Bharat Mathur
Acting Regional Administrator, Region 5

This is a report on the review of complaints regarding the Industrial Excess Landfill Superfund site, Uniontown, Ohio, conducted by the Office of Inspector General (OIG) of the U.S. Environmental Protection Agency (EPA). We undertook this work as a result of issues brought to the former EPA Ombudsman by a citizens' group, Concerned Citizens of Lake Township.

Since we are making no recommendations, you are not required to respond to the report; we plan to close it upon issuance.

If you or your staff have any questions regarding this report, please contact me at (617) 918-1471; Frances E. Tafer, the assignment manager, at (202) 566-2888; or Christine Baughman, the project manager, at (202) 566-2902.

Executive Summary

The Office of Inspector General (OIG) of the U.S. Environmental Protection Agency (EPA) reviewed issues brought to the Ombudsman's attention regarding a landfill in Uniontown, Ohio. Designated as a Superfund site, it is owned by Industrial Excess Landfill, Inc., and is referred to as IEL in this report.

Citizens were concerned (1) that the landfill was contaminated with radioactive waste, and (2) that the method used to clean up contaminants in the groundwater (such as benzene), called monitored natural attenuation, was inappropriate. This method covers a variety of processes that act without human intervention to reduce the contaminants in soil or groundwater.

In the early 1990s, the landfill was tested for radioactivity; the low levels of radiation found were not expected to cause harm to people's health. Then, in 2000, at the request of local citizens concerned about radioactive waste disposal at the site, the local groundwater was again tested for radiation. A radiation expert, retained by the OIG, determined that while the analytical methods could have been better, the groundwater tests performed in 2000 and 2001 met the requirements for drinking water, in regard to radioactivity, and that the water did not pose a danger to public health.

The OIG found that EPA policy was followed in selecting monitored natural attenuation; that the landfill site was appropriately sampled and analyzed, according to EPA policy; and that contaminants from IEL that could pose a danger to public health were being appropriately monitored.

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Chapter 1
Introduction

Purpose

The U.S. Environmental Protection Agency (EPA) Office of Inspector General (OIG) conducted a review of issues that the Concerned Citizens of Lake Township brought to the Ombudsman's attention regarding the Industrial Excess Landfill (IEL) site in Uniontown, Ohio. Ohio is covered by EPA Region 5. The OIG Ombudsman reviews and reports on public concerns regarding EPA activities, including Superfund.

Based on the issues raised, our objectives were to determine:

- From radiation testing since 2000, has Region 5 properly discounted radioactive contamination of the site?

- Did Region 5 select monitored natural attenuation as part of the remedy in accordance with the EPA monitored natural attenuation policy? Does the monitoring planned for the site as part of the monitored natural attenuation include sampling that complies with the policy, and does the sampling cover all appropriate pathways?

Site Information

IEL is a privately-owned, 30-acre, mixed-waste landfill, located at 12646 Cleveland Avenue, Uniontown, Ohio, which is part of Lake Township in Stark County. The landfill closed in 1980. Covered with grasses, small trees, and shrubs, the site is gently sloping, with the highest elevation towards the northwest corner. The area around IEL is a mixture of residential, agricultural, commercial, and light industrial use. Located between Akron and Canton, the area has become increasingly residential, with many new homes being built nearby. Homes are located principally to the north, west, and southwest of the site. A sod farm is located to the east of the landfill, across from a narrow stream called Metzger Ditch. According to the 2000 Census, 2,802 people live in Uniontown, while Lake Township has a population of 25,892.

According to EPA's July 1988 remedial investigation report prepared for IEL, the following conditions existed at the site:

- About 80 to 85 percent of the site was covered with various types of waste.

- About 780,000 tons of waste had been disposed of at the site, including 1,000,000 gallons of liquid waste. The most predominant wastes disposed at the IEL site (with the potential for producing potentially hazardous contaminants and/or conditions) generally can be put into the following categories: flyash; solid and semi-solid latex; liquid wastes (including oils, flammable solvents, and non-flammable solvents); and garbage, trash, septic tank clean-outs, and other organic matter capable of generating methane.

- At the time the remedial investigation report was issued, groundwater contaminated with IEL-related wastes, such as vinyl chloride, was found in some residential wells nearby.

- A groundwater plume of contamination extended approximately a thousand feet west of the landfill boundary along Cleveland Avenue.

EPA has taken several steps to protect public health. The most important of these was providing municipal water to homes near the site where drinking water wells were affected or threatened by IEL contamination. This action was carried out by the Responding Companies – a group of potentially responsible parties, including B.F. Goodrich, Goodyear, Bridgestone/Firestone, and GenCorp. By early 1991, nearly 100 homes in the vicinity of IEL had been connected to a new municipal water line.

Initially, EPA operated and maintained a methane venting system it installed in 1986, to prevent off-site migration of landfill gases that might otherwise threaten nearby homes and businesses. On April 1, 1994, the State of Ohio took over responsibility for operating and maintaining this system. Other measures taken by EPA included temporarily relocating some residents whose homes were adjacent to the landfill, and installing a perimeter fence to restrict site access.

After the remedial investigation, EPA continued to monitor the groundwater, with the addition of 30 new monitoring wells. This monitoring showed that groundwater conditions at IEL improved significantly since 1988. For example, outside of the landfill boundaries, the groundwater data showed organic compounds such as benzene and vinyl chloride were no longer detected above Federal maximum contaminant levels (MCLs) for drinking water. However, there are elevated levels of benzene in the north-central portion of the landfill. The MCLs for drinking water are the criteria for successful cleanup of groundwater at IEL (see Appendix A for further details on MCLs). Also, although certain metals were detected above MCLs outside the landfill, the total number of metals detected were fewer than reported in 1988, concentrations of metals were lower on average, and occasions when metals exceeded the MCLs appeared to be sporadic in nature. A groundwater plume of contamination outside of the landfill can no longer be detected.

The current remedy approved by EPA includes these major components:

- Augmenting the existing vegetative cover with selected planting of trees and other plants at the site.
- Natural attenuation of groundwater contaminants both offsite and onsite. Natural attenuation covers a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil or groundwater.
- Monitoring of groundwater and landfill gas.
- Upgrading the existing groundwater monitoring well network by installing new wells and upgrading and/or abandoning other wells, as needed.
- Maintaining perimeter fencing.
- Deed restrictions.
- Maintenance of alternate water supply.
- Additional design studies.

Two additional design studies were described in the September 2003 remedial design plan. The first is a risk assessment for exposure to site soils and landfill gases. In general, the prior risk assessments showed no unacceptable threats to human health or the environment for the current exposure pathways. However, because the potential exposure pathways may change based on future uses, additional exposure pathways will be evaluated in the planned risk assessment. The other study is of the methane venting system, and will determine whether the system needs to be modified.

Scope and Methodology

Due to complaints from Concerned Citizens of Lake Township, the former National Ombudsman (then located in EPA's Office of Solid Waste and Emergency Response) opened a case on the IEL Superfund site. In October 2000, the former National Ombudsman issued a draft report on IEL. EPA Region 5 responded to this draft report in December 2000, but the former National Ombudsman did not issue a final report on the case. The case was transferred to the OIG when it acquired the Ombudsman function in April 2002. After a preliminary assessment phase in 2003, the OIG concluded that Region 5 had adequately rebutted the recommendations proposed in October 2000 by the former National Ombudsman. Nonetheless, the OIG Acting Ombudsman determined a review of the issues was warranted because substantially more radiation testing was performed after the former National Ombudsman issued his draft report.

We conducted our review from December 2003 through July 2004. We researched the files we obtained from the former Ombudsman and EPA Region 5, and traveled to the site for an overview and discussions with citizens, officials from Region 5 and the State of Ohio who worked on the site, and representatives of the Responding Companies. During the visit, we also toured the IEL site.

We also obtained opinions and reports, which are attached as Appendices C and D, from independent experts in radiation and hydrogeology, respectively. The radiation expert reviewed the methodologies used in, and the related results of, radiation testing of groundwater and soil that was performed after 1999. The hydrogeology experts evaluated the existing geological and hydrogeological information to determine whether the monitoring wells were properly located and developed to adequately characterize and monitor the groundwater.

On August 17, 2004, the OIG issued a draft report to the Regional Administrator of Region 5 for review and comment. In a response dated September 10, 2004, he agreed with the conclusions in the report, but provided comments on some of the issues raised in the report from the OIG radiation expert. This response is included in its entirety as Appendix E.

We performed our review in accordance with *Government Auditing Standards*, issued by the Comptroller General of the United States.

The findings contained in this report are only applicable for OIG Ombudsman purposes. Additionally, the findings in this report are not binding in any enforcement proceedings brought by EPA or the Department of Justice under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) to recover costs incurred not inconsistent with the National Contingency Plan.

Chapter 2

Radiation

We believe EPA properly discounted radionuclides as contaminants of concern at IEL. Although some radiation was found at the site in the early 1990s, the low levels were not expected to cause harm to people's health. At the request of local citizens in 2000, the Responding Companies agreed to again test groundwater for radiation. According to the radiation expert retained by the OIG, the resulting 2000-2001 groundwater analyses were sufficient to declare that site groundwater in 2000 and 2001 met the requirements of the drinking water standards with respect to radioactive elements and isotopes. Thus, the radionuclides do not pose an unacceptable health risk that needs to be addressed by EPA under CERCLA, and do not require cleanup actions. Determining whether *any* radioactive material is present, and whether such material was man-made, would require more sensitive analysis than that performed in 2000-2001, but we do not believe such a level of detail is needed for IEL. Further, according to the EPA Science Advisory Board, it will never be possible to establish unequivocally the absence of radioactive contamination at the site.

Past Testing for Radiation

In the 10 years before 1995, EPA and the State of Ohio tested the air, groundwater, and soil at IEL for radiation. Air testing was done during the remedial investigation of the site. According to the related July 1988 report, these results did not indicate the presence of a radioactive waste source. In response to comments received from the community that radioactive materials were illegally dumped at the landfill, EPA included radiation testing during the remedial design studies. Due to incorrect laboratory procedures in analyzing the samples, data collected in August and December 1990 were determined to be invalid. During 1992 and 1993, four quarterly rounds of both water and sediments collected from residential wells and monitoring wells were tested for radiation. The Agency for Toxic Substances and Disease Registry used the results of the testing in 1992 and 1993 for a health consultation on the possible health effects of radioactivity at the site. They concluded that the low levels of radioactivity detected at IEL were not expected to cause harm to people's health.

An ad hoc panel of EPA's Science Advisory Board was formed to review issues related to the 1990-1993 radiation testing at IEL. According to the September 1994 report from the panel, although the panel noted it was unable to review all of the large amount of data collected, they believed appropriate testing was performed at the site, even though the testing was delayed and did not include a surface survey. From the 1992 and 1993 testing results, the panel concluded "*it to be highly unlikely that radioactive contamination is (or was) present at the site.*"

Groundwater Testing in 2000-2001

Contractors for the Responding Companies collected and analyzed groundwater samples for radiation in August 2000, November 2000, March 2001, and May 2001. The sampling plan called for speciation analysis (i.e., an analysis to identify the major radioactive constituents present in a sample), for the following:

- Radium-226, isotopic uranium, isotopic thorium, and isotopic plutonium, if the gross alpha activity exceeded 5 picoCuries per liter (pCi/L).

- Radium-228, strontium-90, potassium-40, and technetium-99, if the gross beta activity exceeded 50 pCi/L.

During the August 2000 round of sampling, water from 65 wells was screened for gross alpha and beta activity, 10 wells to speciation analysis, and 14 wells to tritium analysis. During the later rounds, the number of wells screened varied from 7 to 10 and, of these screened, 6 or 7 were subjected to speciation analysis and tritium analysis. EPA Region 5 reviewed and approved the sampling plan for these rounds of testing. In addition, EPA's National Air and Radiation Environmental Laboratory evaluated the results for all four rounds. In some cases, other interested organizations also reviewed the results. However, Concerned Citizens of Lake Township believed that the samples were not properly collected or analyzed, so they believed the results understated the radionuclides present.

OIG obtained an independent expert to review the information related to the 2000-2001 radiation testing of groundwater, and another independent expert to review hydrogeologic information about the site as well as information about the monitoring wells. The radiation expert concluded that the tests performed were sufficient to declare that site groundwaters in 2000 and 2001 met the requirements of the drinking water standards with respect to radioactive elements and isotopes. Regarding the specific concerns expressed by Concerned Citizens of Lake Township, the OIG radiation and hydrogeologic experts found:

- The monitoring wells were properly located and developed to characterize the groundwater.

- The groundwater sampling methods used and onsite measurements made followed conventional techniques for groundwater sampling.

- The size of the samples collected was adequate for the analytical methods performed.

- The appropriate container type was used for sampling the various parameters in this study; polyethylene bottles can be used to collect samples for tritium analysis.

- After the groundwater samples were collected, they were stored for short periods of time that were acceptable according to EPA methods.

- Filtration was performed in the laboratory on a portion of the sample so that the rest could be used for analysis of suspended material; this was an acceptable procedure.

- The methods used to analyze the groundwaters were standard for determining radiological properties of groundwaters and for ascertaining the safety of drinking water.

Regarding the substantial reduction in the number of samples taken after the first round of testing, more rigorous analysis of fewer samples in later rounds is consistent with EPA guidance. The *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* states in Chapter 3, on site characterization:

> *...In short, the approach consists of, where appropriate, initially taking a large number of samples using field screening type techniques and then, based on the results of these samples, taking additional samples to be analyzed more rigorously from those locations that showed the highest concentrations in the previous round of sampling....*

With one exception, when samples could be collected from the monitoring wells that exceeded a screening level in August 2000, a sample was collected and screened for radiation during the three later rounds of testing. The exception was monitoring well 16I, which was not tested for radiation during the March 2001 round even though a sample was collected. This omission was not explained.

The opinion from the OIG's radiation expert that the groundwater met the drinking water standards for radionuclides took into account that the MCLs were exceeded on a few occasions. Table 2-1 identifies how many times the results of the 2000-2001 testing exceeded a radionuclide MCL. The instances in which an MCL was exceeded were limited to radium in monitoring wells 14S, 17S, and 23S, and the screening tests for gross alpha activity and gross beta activity in monitoring wells 01I, 14S, and 17S. In all cases in which the result of the gross alpha or gross beta activity exceeded the MCL, speciation analysis was performed. The combined results of this later testing for alpha emitting isotopes did not exceed the MCL for gross alpha. Likewise, the combined results of later testing for beta emitting isotopes did not exceed the MCL for gross beta. Of the four wells that exceeded the MCLs, three of them (monitoring wells 01I, 14S, and 17S) are located on the site. Monitoring well 23S, which exceeded the MCL for radium once in the four times tested in 2000 and 2001, is a short distance south of the site. Thus, except once in monitoring well 23S, the radionuclide MCLs were not exceeded at offsite locations.

Table 2-1:
Maximum Contaminant Levels Exceeded

Radionuclide	No. of Analyses	No. that Exceeded MCL	MCL (in pCi/L)	Range of Results Exceeding MCL	Monitoring Wells with Exceedence
Gross beta -screening	37	7	50.00	57.97 - 70.61	14S, 17S
Gross alpha -screening	37	7	15.00	15.17 - 24.87	01I, 14S, 17S
Radium-226 and Radium-228 combined	32	7	5.00	5.43 - 14.07	14S, 17S, 23S
Uranium	32	0	30.00		
Alpha emitters (except uranium)	33	0	15.00		
Beta emitters (except potassium)	9	0	50.00		
Strontium	9	0	8.00		
Tritium	41	0	20,000		
Totals	**230**	**21**			

The MCLs were established as chemical-specific applicable, or relevant and appropriate, requirements for groundwater at IEL. According to EPA, MCLs are not directly applicable here since, to the extent that groundwater impacted by IEL is used for drinking water, it is used as a private, not a public, water supply. However, because of this private use, and because the aquifer downgradient from IEL is potentially a public drinking water source, EPA considers MCLs to be relevant and appropriate requirements for this site. Consequently, it is appropriate that the MCLs for radionuclides would be used to determine whether radioactive contamination at IEL should be addressed by EPA. In the opinion of OIG's radiation expert, the groundwater met the radionuclide MCLs in 2000-2001.

Future Radiation Testing of Groundwater

As noted, the recent groundwater testing was adequate for drinking water purposes and the groundwater did not require cleanup action for radionuclides under CERCLA. Regarding citizen concerns on the precision of the data, the OIG radiation expert indicated that to determine whether *any* radioactive material is present in the groundwater, and whether such radiation was man-made, more sensitive analysis than that performed in 2000-2001 would be needed. However, because the OIG's radiation expert concluded that the tests performed were sufficient to declare that site groundwaters in 2000 and 2001 met the requirements of the drinking water standards with respect to radioactive elements and isotopes, we believe such sensitive testing is not needed at IEL. Nonetheless, it may be beneficial to use more sensitive analysis in the future at other, unrelated locations where radioactive material is known or suspected to have been dumped. Details on the sensitivity of testing at IEL and potential improvements for future sites are provided in Appendix B. However, as pointed out in the 1994 Science Advisory Board report, it will never be possible to establish unequivocally the absence of radioactive contamination at the site.

Recent Radiation Testing of Soil

Besides testing the groundwater for radiation, radiation testing of soils and material excavated during drilling of wells at the IEL site has been conducted since 2000. In 2000, the radiation level of 255 metal drums and their contents was measured by alpha, beta, and gamma detectors. Gamma spectral analysis was performed to determine whether isotopes such as cobalt-60, cesium-137, and naturally occurring radionuclides in the uranium and thorium decay series were present in any quantity in the waste. All samples were found to contain only background levels of radiation. More recently, soil cuttings from the 2004 drilling of new wells at the site showed no readings greater than background. In late 2003 and early 2004, EPA conducted a surface survey of gamma activity around the site and analyzed soil samples from select locations. The results of the EPA work showed that all radiation levels were comparable to background, except for some elevated readings in the parking lot to the west of the landfill area. However, the elevated readings were not high enough to warrant a cleanup action.

Summary

Since 1999, radiation testing identified measurable amounts of radiation in IEL groundwater and soil. However, the levels in groundwater were generally below the MCL for drinking water, and the levels in the soil were below the levels requiring cleanup action. Under the Superfund program, EPA may take action if the release, or the substantial threat of a release, of a hazardous substance may present a danger to the public health or welfare. Since radiation levels found at IEL do not pose a danger to public health, EPA properly discounted radiation as a concern at IEL.

Chapter 3
Monitored Natural Attenuation

We believe that EPA appropriately selected monitored natural attenuation as part of the remedy at IEL. In March 2000, the approved cleanup remedy for IEL had been changed to eliminate a groundwater pump-and-treat system and to implement monitored natural attenuation to reduce contaminant levels in groundwater. In September 2002, the IEL remedy was changed again, this time eliminating a conventional landfill cap in favor of selectively planting trees and other vegetation throughout the site, and requiring monitored natural attenuation within as well as outside the landfill boundaries. Regarding specific concerns raised by the Concerned Citizens of Lake Township in objecting to the monitored natural attenuation method, we found that:

- EPA policy was followed in selecting monitored natural attenuation as part of the remedy.
- The site contamination was characterized as required by EPA policy.
- The exposure pathways for contaminants from IEL that may pose a danger to public health were being monitored, and the monitoring programs will be adequate if implemented as described.

Monitored Natural Attenuation Selected as Part of Remedy

There are a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil or groundwater. These *in-situ* processes include biodegradation; dispersion; dilution; sorption; volatilization; radioactive decay; and chemical or biological stabilization, transformation, or destruction of contaminants. Collectively, these processes are called natural attenuation.

In April 1999, EPA issued guidance about using monitored natural attenuation at Superfund sites *(Use of Monitored Natural Attenuation at Superfund, RCRA [Resource Conservation and Recovery Act] Corrective Action, and Underground Storage Tank Sites)*. Under this guidance, EPA considers monitored natural attenuation an alternative means of achieving remediation objectives that may be appropriate for specific, well-documented site circumstances where its use meets the applicable statutory and regulatory requirements. However, EPA expects that source control and long-term performance monitoring will be fundamental components of any monitored natural attenuation remedy.

Concerned Citizens of Lake Township objected to monitored natural attenuation at IEL for a variety of reasons that centered on whether: (1) the decision complied with EPA policy on monitored natural attenuation; (2) the contamination at the site was sufficiently characterized, i.e., the quality and extent of the sampling and analysis was questionable (even excluding the radiation issue); and (3) monitoring would be adequate. We found the following regarding each issue.

Compliance with EPA Policy

Studies demonstrating the particular processes occurring to naturally attenuate contaminants at a site is one method under the EPA directive to show the effectiveness of natural attenuation. While the citizens groups said this method should have been used, it was not used at IEL. Instead, EPA used historical groundwater data to show a clear and meaningful trend of decreasing contaminant mass and/or concentration over time, and this method is also cited by the EPA directive as an acceptable method. Therefore, EPA complied with the EPA directive in selecting monitored natural attenuation as part of the remedy at IEL.

Characterizing Site Contamination

Chapter 3 of EPA's October 1988 *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* outlines the actions required to characterize a site so that EPA can determine the extent to which the site may pose a threat to human health or the environment. Among the actions are sampling and analysis of five media: groundwater, soil, surface water, sediments, and air. EPA sampled all of these at IEL during the late 1980s and early 1990s. EPA also monitored the tentatively identified compounds found at the site, but did not test for them to the extent that Concerned Citizens of Lake Township believed EPA should have tested and considered them. Additionally, the sampling and analysis at IEL were performed in accordance with EPA requirements concerning quality assurance. Therefore, EPA efforts to characterize the contamination at IEL complied with Agency requirements, even though EPA did not perform a study that included drilling into the landfill waste material, which the Concerned Citizens of Lake Township and the former EPA Ombudsman wanted done.

During the remedial investigation and remedial design, EPA collected and analyzed a variety of samples. This testing covered:

- All five media in the 1980s and early 1990s.
- Non-aqueous phase liquids and dense non-aqueous phase liquids in the 1990s. (The OIG hydrogeology experts confirmed that monitoring wells were located to find dense non-aqueous phase liquids, if they were present; and that EPA tested to find them.)
- Glycol ethers in 1992 and 1993.
- Phosgene in 1986.

The above-mentioned testing disclosed that tentatively identified compounds (TICs) were present. TICs are compounds not included in routine analyses, but which are detected and identified (by mass spectra, if gas chromatograph/mass spectrometer analysis is performed) on a particular sample. The spectra for a TIC may match those in a mass spectral library, so the TICs are listed with other detected chemicals with an indication that the concentrations given are estimates only. Agency guidance suggests using special testing to confirm the identity and concentrations of TICs when (1) there are many TICs compared to the compounds usually identified, (2) TIC concentrations appear high, or (3) site information indicates TICs may be present. Otherwise, TICs need not be included in the risk assessment.

EPA identified TICs during the remedial investigation and, in a few cases (i.e., glycol ethers and phosgene), did the special testing needed to confirm the identity and concentrations of the compounds. Additional testing was considered for others (e.g., pentane and phosphine). However, EPA considered the levels of pentane found at the site to not be a health concern, and the Agency for Toxic Substances and Disease Registry similarly concluded phosphine levels were not a health concern. EPA continued to identify TICs during remedial design studies in the 1990s, as have the Responding Companies in testing since then. Also, the Agency for Toxic Substances and Disease Registry considered TICs in its 1988 health evaluation for IEL.

EPA did not do a waste characterization study at IEL that included extensive drilling in the landfill itself. EPA believed such a study was not needed or appropriate because: other work done to characterize site contaminants was sufficient; the drilling would be costly; and drilling could be dangerous to those doing the drilling. Region 5's decision was consistent with Agency guidance, which warns that drilling in a municipal landfill may not be needed and can be dangerous. Also, during the remedial investigation, landfill waste material was exposed in trenches dug to install the methane venting system, and in a drainage gully. Visual observations of the exposed waste indicated that the majority was miscellaneous residential waste, lumber, and rubber waste, although a number of drums and hospital wastes were also uncovered. Finally, the soil gas levels on the site did not indicate that there were highly contaminated areas of the landfill that might justify drilling in those areas.

Besides the extent of the sampling and analysis at IEL, the Concerned Citizens of Lake Township were concerned about the quality of the testing. EPA guidance requires that EPA design a data collection program to describe the selection of the sampling approaches and analytical options, and document these in the sampling and analysis plan, which consists of a field sampling plan and a quality assurance project plan. A quality assurance project plan was prepared and approved for the remedial investigation, and quality assurance activities were identified in the related report. A quality assurance project plan was also prepared for the remedial design studies. For the sampling done by the responding parties in August 2000 (and similarly in November 2000, March 2001, and May 2001), EPA reviewed and approved the sampling plan. Thus, the sampling and analysis at IEL was performed in accordance with EPA requirements concerning quality assurance.

Monitoring Programs

Since the site has (or will have) a vegetative cover, perimeter fence, and deed restrictions, the groundwater and landfill gas seem to be the likeliest pathways for contaminants to escape from the site. The remedy selected by EPA requires monitoring of both the groundwater and landfill gas. We believe the planned monitoring should be adequate.

The September 2003 remedial design plan provided details on the groundwater monitoring program, including the location of monitoring wells and the type and frequency of testing. After reviewing information about the site, the OIG hydrogeology experts concluded:

- Current conditions in the shallow water-bearing zone were fairly represented by the Responding Companies' contractor.

- The proposed monitoring well network is sufficient and appropriate for future long-term monitoring of the shallow groundwater aquifer at the IEL site.

Regarding landfill gas, the remedial design plan outlined additional studies that will be done of the methane venting system and of soil gas at the site, particularly along the eastern border. This information, along with past data, will be used in a new risk assessment for exposure to site soil and landfill gas. Based on the studies and new risk assessment, changes to the methane venting system may be proposed. Until then, the methane venting system will be operated, maintained, and monitored as it is currently. We believe the monitoring programs will be adequate if implemented as described.

Summary

We believe site contaminants at IEL were adequately characterized in accordance with EPA policies. Further, EPA properly selected monitored natural attenuation as the remedy for groundwater contamination because historical data supported that the condition of the groundwater has been improving since the remedial investigation was completed in 1988. The groundwater will be monitored to ensure that natural attenuation is working, and groundwater contaminants are not migrating off the site. Additionally, landfill gas will also be monitored.

Appendix A

Background Information on Maximum Contaminant Levels

Drinking water standards are regulations that EPA sets under the Safe Drinking Water Act to control the level of contaminants in the nation's drinking water. Drinking water standards apply to public water systems that provide water for human consumption through at least 15 service connections, or regularly serve at least 25 individuals. A National Primary Drinking Water Regulation (or primary standard) is a legally-enforceable standard that applies to public water systems. Primary standards protect drinking water quality by limiting the levels of specific contaminants that can adversely affect public health and are known or anticipated to occur in water. They take the form of maximum contaminant levels (MCLs) or treatment techniques:

- An MCL is the maximum permissible level of a contaminant in water being delivered to any user of a public water system. MCLs are commonly used at Superfund sites as applicable or relevant and appropriate requirements.
- A treatment technique is an enforceable procedure or level of technological performance that public water systems must follow to ensure control of a contaminant.

In December 2000, EPA finalized MCL goals; MCLs; and monitoring, reporting, and public notification requirements for radionuclides in Part 141 of Title 40 Code of Federal Regulations. The MCLs, which are summarized in Table A-1, are generally stated as picoCuries per liter (pCi/L). The technical support document for the above regulation described picoCuries as:

> *Potential effects from radionuclides depends on the number of radioactive particles or rays emitted (alpha, beta, or gamma) and not the mass of the radionuclides (USEPA, 1981). As such, it is essential to have a unit that describes the number of radioactive emissions per time period. The activity unit is used to describe the nuclear transformations or disintegrations of a radioactive substance, which occur over a specific time interval (USEPA, 1991). The activity is related to the half life; longer half lives mean lower activity. A special unit of activity called a* ***Curie*** *is equal to a nuclear transformation rate of 37 billion (3.7×10^{10}) disintegrations or decays per second. One* ***picoCurie*** *is equal to 10^{-12} curies, which is approximately 2 nuclear disintegrations per minute (or more specifically one disintegration every 27 seconds). Historically, by definition, one gram of radium is said to have 1 Curie (1 Ci) of activity.*

Regulations in Part 141 of Title 40 Code of Federal Regulations also addressed how sensitive the radioanalysis must be when monitoring radioactivity concentrations in drinking water. This is called the detection limit. Specifically, the regulations set the detection limit as that concentration that can be counted with a precision of plus or minus 100 percent at the 95-percent confidence level. Detection limits for selected radionuclides are also summarized in Table A-1.

Table A-1:
Standards and Detection Limits for Radionuclides in Drinking Water

Radionuclide	MCL	Detection Limit
Gross alpha particle activity (excluding radon and uranium)	15 pCi/L	3 pCi/L
Gross beta particle and photon radioactivity	4 mrem/yr *	4 pCi/L
Combined radium-226 and radium-228	5 pCi/L	1 pCi/L
Uranium	30 µg/L **	Reserved
Tritium	20,000 pCi/L	1,000 pCi/L
Strontium-90	8 pCi/L	2 pCi/L
Other radionuclides		1/10 of the applicable limit

* The screening level for gross beta particle activity is 50 pCi/L, excluding potassium-40.

** The maximum contaminant level for uranium in drinking water is 30 micrograms per liter (µg/L). EPA assumed a typical conversion factor of 0.9 pCi/µg for the mix of uranium isotopes found at public water systems, which means that an MCL of 30 µg/L will typically correspond to 27 pCi/L. In circumstances with more extreme conversion factors (more than 1.5 pCi/µg), uranium activity levels may exceed 40 pCi/L. In these circumstances, EPA recommended in the 2000 MCL rule that drinking water systems mitigate uranium levels to 30 pCi/L or less, to provide greater assurance that adequate protection from cancer health effects is being afforded.

Note: There is a glossary of radiation-related terms at the end of Appendix C.

Appendix B

Details on Testing Sensitivity

Sensitivity refers to how small an amount of a substance can be reliably measured during the analysis for that substance (the minimum detectable amount), and can vary for each analysis. For example, the MCL for tritium is 20,000 pCi/L and the detection limit is 1,000 pCi/L. The minimum detectable amount for tritium during the 2000-2001 analysis ranged from 550.10 to 665.20 pCi/L, which was under the required detection limit. However, over the last 15 years, tritium in rainwater and snow melt (naturally occurring) has only been 40-60 pCi/L. Consequently, to determine whether tritium is naturally occurring versus man-made, the analysis would need to be sensitive enough to detect 40 pCi/L (or less) of tritium.

As shown in Table B-1, we found that the minimum detectable amount from the 2000-2001 analyses sometimes exceeded the detection limit set in the regulations for that analysis, but was still less than the MCL. Thus, the results were sensitive enough to show if the MCL was exceeded. Since MCLs were not exceeded for IEL, the radionuclides do not pose an unacceptable health risk that needs to be addressed by EPA under CERCLA, and do not require cleanup actions.

Table B-1:
Minimum Detectable Amount Versus Detection Limit

Radionuclide	No. of Analyses Performed	No. Exceeding Limit	Detection Limit Applied (pCi/L)	Range of Those Exceeding Limit
Gross alpha	74 *	25	3.00	3.18 to 9.69
Gross beta	74 *	18	4.00	4.24 to 11.15
Technetium	9	9	5.00	15.48 to 23.39
Radium-228	9	6	1.00	1.05 to 1.49
Radium-226	32	3	1.00	1.08 to 1.36
Strontium	9	3	2.00	2.38 to 4.97
Plutonium	64	0	1.50	
Thorium	96	0	1.50	
Tritium	41	0	1,000.00	
Total	**408**	**64**		

* The samples screened for gross alpha and gross beta were filtered, and both the suspended and dissolved portions were analyzed. In counting the number of analyses, the analyses of the suspended and the dissolved portion were considered separate analysis. However, this count excluded the analysis performed during the first round of testing if the total gross alpha/beta screening level for the monitoring well was not exceeded.

However, while sufficient action was taken for IEL, it may be beneficial to use more sensitive analysis in the future at other, unrelated locations where radioactive material is known or suspected to have been dumped. According to the OIG's radiation expert, the sensitivity of the 2000-2001 analysis could have been increased (i.e., the minimum detectable amount could have been reduced) in several ways:

- Increase the count time for radioactivity to days or weeks instead of minutes or hours.

- For gross alpha and gross beta screening, wait at least 72 hours between preparing the planchet and counting for radioactivity.

- Concentrate plutonium and uranium from a larger volume of groundwater (more than 50 liters for plutonium and 2 liters for uranium).

- Use mass spectrometry instead of alpha spectrometry to count alpha emitters such as plutonium and uranium.

- Use a tritium-enrichment technique such as electrolysis for analyzing tritium.

- When measuring radium-226, either (1) improve the laboratory preparation method to obtain a thin source of BaSO4 containing radium, for alpha counting, as described in published literature on the method; or (2) use the radon emanation method to determine radium-226 by analysis of its decay product or "daughter," radon gas, using standard published methodology.

Appendix C

REVIEW OF RADIOLOGICAL INFORMATION ON GROUNDWATER AT THE INDUSTRIAL EXCESS LANDFILL SITE, AT UNIONTOWN, OHIO.

Prepared for

U.S. Environmental Protection Agency
Office of the Inspector General

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JULY 2, 2004

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ABBREVIATIONS

μg	Microgram
<	Less than
>	More than
Cs	Cesium
EPA	U.S. Environmental Protection Agency
H-3	Tritium
IEL	Industrial Excess Landfill Superfund site
K	Potassium
L	Liter
MCL	Maximum Contaminant Level
MDA	Minimum Detectable Amount
pCi	Pico curies
Pb	Lead
Pu	Plutonium
Ra	Radium
Rn	Radon
Sr	Strontium
Tc	Technetium
Th	Thorium
U	Uranium

EXECUTIVE SUMMARY

In this review of the radioactivity measurements and data generated at the Industrial Excess Landfill (IEL) site, at Uniontown, Ohio, I examined various factors to ascertain whether the methods used and the results obtained were adequate to determine if radioactive waste was disposed of at the site and poses a public health hazard. These factors included data collected at the surface during groundwater sampling, containers used and volumes of sample taken for analysis, storage times, need for filtering and preserving samples, methods used for analysis, results of speciation analysis when screening levels were exceeded, and details of the counting, reporting and subsequent interpretation of the data.

Although it was not possible to conduct a detailed (forensic) examination of all the data in the time available, I reviewed the parts of the data set for sampling during 2000 and 2001 that had a bearing on how accurate and representative are the data. It is my opinion that the tests performed were sufficient to declare that site groundwaters in 2000 and 2001 met the requirements of the drinking water standards with respect to radioactive elements and isotopes. It is not possible, however, to state categorically that no radioactive waste is present at the site because, in many cases, the analytical procedures used to detect specific types of radioactivity were insufficiently sensitive to differentiate measured concentrations from background (natural) levels. Furthermore, the results of the radioactivity measurements in groundwater will only detect materials that are exposed to groundwater leaching; they will not identify the presence of sealed, inert containers of radioactive waste.

1 INTRODUCTION

The Industrial Excess Landfill site is designated as a Superfund site and is located in a rural area near Uniontown in Lake Township, Stark County, Ohio, about 10 miles southeast of the city of Akron. The site contains a 30-acre former landfill and is owned by Industrial Excess Landfill, Inc. Some adjacent property is owned by the U.S. Environmental Protection Agency (EPA).

The site was originally excavated as a sand and gravel pit. Landfill operations took place between 1964 and 1980 and an estimated 780,000 tons of waste, including one million gallons of liquid waste, was received. The most predominant wastes (with the potential for producing potentially hazardous contaminants and/or conditions) disposed at the IEL site were in the following categories: flyash; solid and semi-solid latex; liquid wastes (including oils, flammable solvents, and non-flammable solvents); and garbage, septic tank clean-outs, and other organic matter capable of generating methane. The site was subsequently capped with permeable soils and vegetated.

Although the site was never licensed to receive radioactive waste there was anecdotal evidence from local citizens that radioactive waste was put in the landfill. To address requests by local citizens, an initial survey of radioactivity in groundwaters at the site was performed in the early 1990s. Subsequently, a 1994 report by EPA's Science Advisory Board concluded that it was highly unlikely that any radioactive contamination is, or was, present. A second round of testing was performed by contractors for a consortium of tire and rubber companies in 2000 and 2001 on groundwater samples from many of the monitoring wells during different seasons (August and November 2000, and March and May 2001). The results were variously summarized and discussed in memoranda and letters between EPA, the Ohio Department of Health, Concerned Citizens of Lake Township and several recognized experts. Current plans are to keep the site closed to the public, continue operating a methane venting system installed in 1986, and monitor the groundwater.

To attempt to resolve remaining concerns of possible contamination of groundwater by radioactive waste, this review was commissioned to:

1. Evaluate the radiation testing performed in 2000 and 2001,
2. Provide expert opinion on the methods of groundwater sample collection and analysis used,
3. Determine whether any irregularities in sampling and analysis compromised the results,
4. Indicate whether the data confirm or refute the presence of radioactive contamination of the groundwater at the site and if it is at levels dangerous to public health, and
5. Review the data for radioactive content in excavated material from the site.

2 METHODS OF INVESTIGATION

The field sampling and sample handling procedures were carried out by Sharp and Associates, Inc., Columbus, Ohio, for the 2000/2001 sampling events. Sharp attempted to sample all wells using low-flow (less than one liter (L) per minute) techniques so that sediment was not stirred up and drawn into the samples. These methods included the use of a Grundfos Rediflo II pump or, if the well was damaged, a bailer or Kek pump. Water quality parameters (pH, redox potential, dissolved oxygen, electrical conductivity, turbidity and temperature) were monitored using a clear flow-through cell (to prevent contact of the groundwater with the atmosphere) and a data logger.

For the radiological sampling, 7-8 liters of sample was collected without filtering or preserving and submitted to ThermoRetec (subsequently renamed Eberline Services) at Oak Ridge, TN. Samples were chilled and sent out daily in a cooler. On receipt, ThermoRetec/Eberline withdrew and filtered an aliquot of each groundwater sample, and preserved the remainder for further analysis.

Both the filtered aliquot and filter residue were analyzed for gross alpha and gross beta activity and, if the combined values were above 5 and 50 pico curies per liter (pCi/L), respectively, the sample was analysed for possible components such as isotopes of tritium (H-3), uranium (U), plutonium (Pu), thorium (Th), radium (Ra), strontium (Sr), cesium (Cs) and technetium (Tc), according to standard operating procedures.

Factors examined in this review included:
1. Data collected at the surface during groundwater sampling,
2. Quantity of sample taken for analysis,
3. Types of containers used,
4. Sample storage times,
5. Need for filtering and preserving the samples,
6. Methods used for analysis,
7. Screening and details of the counting, and
8. Subsequent interpretation of the data.

3 RESULTS

The results of this review are summarized below and specific comments are described in the following discussion section.

1. Sampling procedures

The wells were pumped prior to sampling until monitored parameters (mainly pH and conductivity) were stable. The groundwater sampling methods used and on-site measurements made follow conventional techniques for groundwater sampling. Although it is generally regarded as 'best practice' to filter the sample on site and then preserve it, the EPA method followed here was to take a sample of groundwater once the monitored parameters had stabilized, transport the sample quickly (within 24 hours) to the analytical laboratory in a cooler, and then filter a portion for analysis of dissolved species. In this way, it was possible to analyze both the filtered and suspended sediment in the sample. This procedure is acceptable except when there are chemical changes in the groundwater (e.g., oxidation of dissolved ferrous iron, Fe^{2+}, to ferric, Fe^{3+}, resulting in precipitation of insoluble iron oxyhydroxides which may absorb dissolved species such as U or Pu). Analysis of the filtered residue, as performed here, is an acceptable remedy for this problem.

2. Quantity of sample

In the IEL work, typically 7-8 L of groundwater was collected from each well for analysis. While this was adequate for the analytical methods performed here, larger quantities would be necessary if more precise methods of analysis were to be used. For instance, analysis of Pu isotopes by mass spectrometry would require several tens of liters of water in order to get sufficient Pu to allow analysis to concentrations as low as 0.001 pCi/L, as discussed in subsequent sections of this report. Similarly, for the accurate determination of U activity ratio (U-234/U-238) in low-U waters such as these, a sample of at least 2 L is required to give sufficient U for counting by alpha spectrometry with adequate precision. For more precise determination of tritium by electrolysis, at least 1 L is required.

3. Sample containers

The appropriate container type was used for sampling the various parameters in this study. Polyethylene bottles can be use for tritium analysis (see Section 4 of this report).

4. Storage times, filtration and preservatives

After the groundwater samples were collected, they were stored for short periods of time that were acceptable according to EPA methods. As described above, filtration was performed in the laboratory on an aliquot of sample so that the rest could be used for analysis of suspended material. This was an acceptable procedure.

5. Analytical methods

The methods used by ThermoRetec/Eberline in analyzing the groundwaters were modified versions of the EPA (900 series) methods for tritium, Ra-isotopes, potassium (K), gross alpha and gross beta; Environmental Measurements Laboratory (U.S. Department of Energy) methods for Pu, U and Th isotopes; and Eichrom concentration methods for Sr and Tc isotopes. These methods are all standard for determining radiological properties of groundwaters and for ascertaining the safety of drinking water. They are not necessarily suitable for determining whether the groundwater is contaminated by small amounts of radioactive waste (see Section 4).

6. Radioactivity counting

Most analyses of radioactivity level were determined by alpha or beta spectrometry. A significant deficiency in the IEL study was the short periods for which radioactive isotopes were counted. Count times ranged from 30 minutes to about 5 hours but the more important radionuclides (isotopes of Pu, U and Ra) were only counted for 170 minutes each. Because the error in an analysis of these isotopes is determined as the square root of the number of counts recorded, it can be readily seen that obtaining only 100 counts will give larger errors (± 10, i.e. 10%) compared with obtaining 10,000 counts (±100, i.e. 1%). To obtain such an improvement in precision would require counting for 100 times longer than used above and this would take days or weeks rather than minutes or hours. Nevertheless, for the purposes of the IEL study, it would have been beneficial to have counted key samples for a few days to improve the precision of the results.

7. Screening levels and action requirements

EPA guidelines state that screening of radiological measurements should center on the results of gross alpha and gross beta levels. Action is required in the form of further analysis, referred to as "speciation analysis", if preliminary screening levels are exceeded. Currently, the presence of more than (>) 5 pCi/L as alpha activity or > 50 pCi/L as beta activity triggers a requirement for speciation, i.e., analysis for isotopic components of Pu, U, Ra, Th, Sr, Cs, and Tc, and H-3. Other requirements come into effect when various combinations of isotopes are present.

8. Interpretation of the data

The data obtained in the 2000/2001 sampling were generally interpreted on the basis of whether or not the screening levels (mainly for gross alpha and gross beta) were exceeded and, if so whether the Maximum Contaminant Levels (MCL) were exceeded. In many cases, however, the radionuclide concentrations were below detection limits and these were reported as “< MDA”, less than the Minimum Detectable Amount.

4 DISCUSSION

The following comments apply principally to sampling work and radioactivity measurements made over the four sampling periods in 2000/2001.

1. Comments on Procedures and Measurements

In the reports of analytical results given by the various laboratories used in the study, the analysts claim to have followed designated EPA analytical techniques in all radioactive measurements. However, they frequently indicated that they have used modified versions of the method (indicated by suffix "M") but do not state what the modifications were. This created a problem in the review because it was not possible to determine if any of the methods were significantly altered by this modification. Discussions with Eberline staff suggested that the modifications were minor and inconsequential, although it would have been useful if the reports had described how the methods were modified.

2. Gross Alpha and Beta

EPA Method 900.0 describes the method for gross alpha and beta analysis using the evaporation technique. For several reasons (interference by dissolved salts, residual activity of thoron (Rn-220)-series nuclides and limitations on volume of water used) the method is approximate and is used only as a screening tool to determine if the water needs to be analysed for individual radioactive elements and their isotopes. For the gross alpha measurement, Method 900.0 recommends a delay of at least 72 hours between preparation of the planchet and counting for radioactivity, to allow equilibrium to be established in parent-daughter decay chains and, especially, to allow excess radon and thoron daughters in solution to decay[1]. This delay appears not to have been followed by the contractor's analyst for IEL groundwaters. An example of this is the analysis of groundwater from well MW-10I (May 2001). The sample was received at 16:29 on June 5, prepared at 17:03 on June 6, separated and counted at 14:57 and 19:52, respectively, on June 7 (indicating a 5-hour delay before counting). High initial radon (Rn-222) activities (as are often found in groundwaters) will still contribute measurable daughter activity even after 10 radon-daughter half-lives have elapsed (about 5 hours). Because activities may have been counted earlier than prescribed, the results given will tend to be on the high side and, thus, are conservative; however, these results may cause needless alarm to individuals not familiar with the procedure. Results that are listed as in excess of the 5 pCi/L screening level may actually fall below this level if the procedural requirement for a 72-hour delay is followed.

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[1] Freshly sampled groundwater will contain abundant radon (Rn) gas from decay of natural radium in the soil. The gas decays away with a 3.8-day half-life and so is more than 98% gone after 24 days. However, if the sample is analysed within this time, although the gas will be driven off by evaporation, the daughters will remain in the solid residue phase for about 5 hours after evaporating to dryness. Similarly, in the thoron decay chain, Pb-212 has a 10.6 hour half-life and will be present until about 70 hours after preparation. Both decay daughters will contribute additional radioactivity and interfere with analysis for gross alpha and gross beta.

Quite frequently, gross alpha and beta results exceeded the screening levels (5 pCi/L and 50 pCi/L) and occasionally exceeded the MCL for drinking water. However, the accuracy of these data is questionable because low activities, short count times (1.5 to 5 hours, typically), variation in self-attenuation of alpha particles and the possible presence of short-lived daughters (lack of equilibrium) in the sample if counted soon after preparation, reinforces the fact that gross alpha and gross beta are only approximate methods and serve best as screening methods for determining whether a full isotopic characterisation should be performed.

3. Tritium

The sampling contractor was previously criticized for using plastic bottles (instead of glass) for sampling tritium (H-3) in the 1990s and in 2000 because of the possibility of losing or adding H-3 to samples by diffusion through the bottle walls. However, this criticism is not warranted because atmospheric tritium has been so low (40 - 60 pCi/L) over the last 15 years that it cannot significantly contaminate water samples by diffusion through plastic bottle walls (Solomon and Cook 2000, page 399; see also web site for The Tritium Laboratory, University of Miami, http://www.rsmas.miami.edu). For most sampling and short-term storage of samples, high-density polyethylene is acceptable. The contractor used glass bottles for the 2001 samples.

Of greater importance and not mentioned in EPA methods, is the possibility that samples may become contaminated by tritium if field or laboratory personnel are wearing a luminescent watch (tritium is used to coat the dials and provide luminescence at night). To get an idea of the amounts of tritium that may be involved, information from The Tritium Laboratory (see reference above) indicates that the H-3 level in water vapor in the atmosphere in a room may reach 30,000 pCi when several wearers of these types of watch are present.

Outdoor sampling, as performed at the IEL, is not likely to cause contamination if the operator wore such a watch due to rapid dispersal by wind currents. Any indoor processing of samples could cause contamination, particularly if filtration was performed open to the air of the laboratory. However, unlike the issue of diffusion of tritium out through bottle walls (when tritium is lost from the sample) contamination by laboratory processing or diffusion into the sample through the walls would serve to increase tritium levels, rather than decrease them. Because tritium levels in all samples tested were less than the MDA (which ranges between 550 and 670 pCi/L) and appeared to be evenly distributed across the site, it can be concluded that if there is any leakage of tritium from radioactive materials in the landfill, it is very low, widely dispersed and well below the maximum permissible amount for drinking water (20,000 pCi/L).

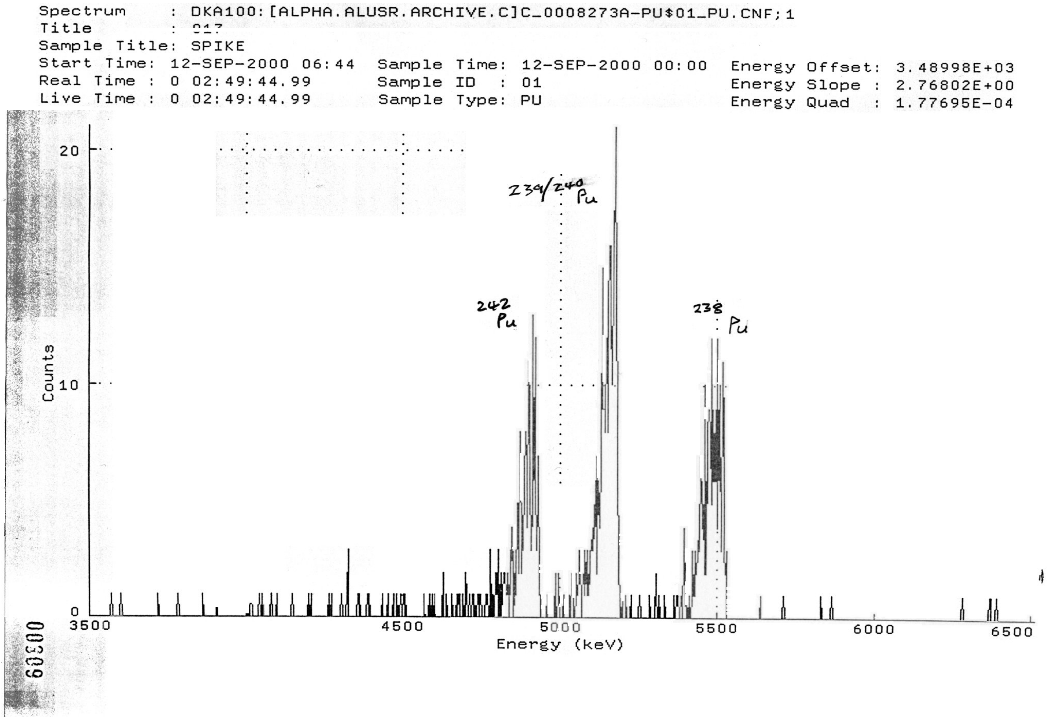
It is possible that the H-3 levels are in fact simply those of rainwater and snow-melt that infiltrate the site (currently about 50 pCi/L). This is an order of magnitude less than the MDA values. Further analysis of IEL groundwaters using a tritium-enrichment technique such as electrolysis would allow measurements as low as 3 pCi/L to be made with good precision and accuracy, and resolve the question of whether there are man-made tritium sources at the IEL. Levels significantly greater than 50 pCi/L could confirm such sources, except it must be shown that they are not due to water that recharged during the 1950s and 1960s when bomb-pulse H-3 levels in the atmosphere were as high as 2000 pCi/L.

4. Plutonium

Data collected in the 2000/2001 samplings sometimes showed detectable amounts of total Pu in the groundwaters (0.2 to 1.9 pCi/L). These values were indicated as being real because they exceeded the MDA for that measurement (MDA values typically ranged from 0.2 to 0.7 pCi/L for any of the Pu isotopes). However, the calculation of total Pu, for which the largest concentrations were found, was not always performed simply by summing the isotopic concentrations. This was in contrast to what was done for other speciated radioelements such as radium, thorium and uranium, and the reason is not clear. For instance, for the May 2001 sampling, well MW-15S had a total Pu of 0.22 pCi/L, but the measurements levels for the isotopes Pu-238 and Pu-239/242 were below-MDA (0.32 and 0.29 pCi/L, respectively). There was no indication of how the total Pu value was determined from these measurements.

Plutonium has a very limited solubility in natural waters and its concentration is typically 2 to 4 orders of magnitude lower than the MDA values for IEL groundwaters. The few finite concentrations of Pu isotopes measured during the 2000/2001 samplings, if real, were well above solubility limits and, therefore, must exist as Pu absorbed onto particulates. It is more likely, however, that these concentrations were false positives caused by the low precision of the plutonium analysis.

A fundamental problem with the Pu data is that they were all determined by alpha spectrometry, a technique that does not possess the level of precision and resolution needed for detecting low, near-background levels of Pu isotopes. Samples were counted for only 170 minutes (several days is the norm in studies of low Pu levels) and gave very few counts in the regions of interest in the alpha spectrum. For instance, Figure 1 shows the locations of the Pu-238 and Pu-239/240 alpha energies relative to that of the yield tracer Pu-242 for the sample labeled 'spike' in the August 2000 suite of analyses. For the groundwaters analyzed in parallel with the spike sample, only Pu-242 was added (to correct for chemical yield), and results in the spectrum shown in Figure 2 (for sample MW-01I, August 2000). It can be seen that there are practically no counts obtained in the Pu-238 and Pu-239/240 regions and this accounts for the '<MDA' value for this sample. Because Pu-242 emits lower energy alphas than Pu-238 and Pu-239/240, there is no possibility for Pu-242 peak 'tailing' (partial self-absorption which reduces the energy of the alpha before detection) into the Pu-238 or Pu-239/240 regions, causing them to be larger than they are.



```
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Title        : 017
Sample Title: SPIKE
Start Time: 12-SEP-2000 06:44  Sample Time: 12-SEP-2000 00:00  Energy Offset: 3.48998E+03
Real Time : 0 02:49:44.99      Sample ID  : 01                 Energy Slope : 2.76802E+00
Live Time : 0 02:49:44.99      Sample Type: PU                 Energy Quad  : 1.77695E-04
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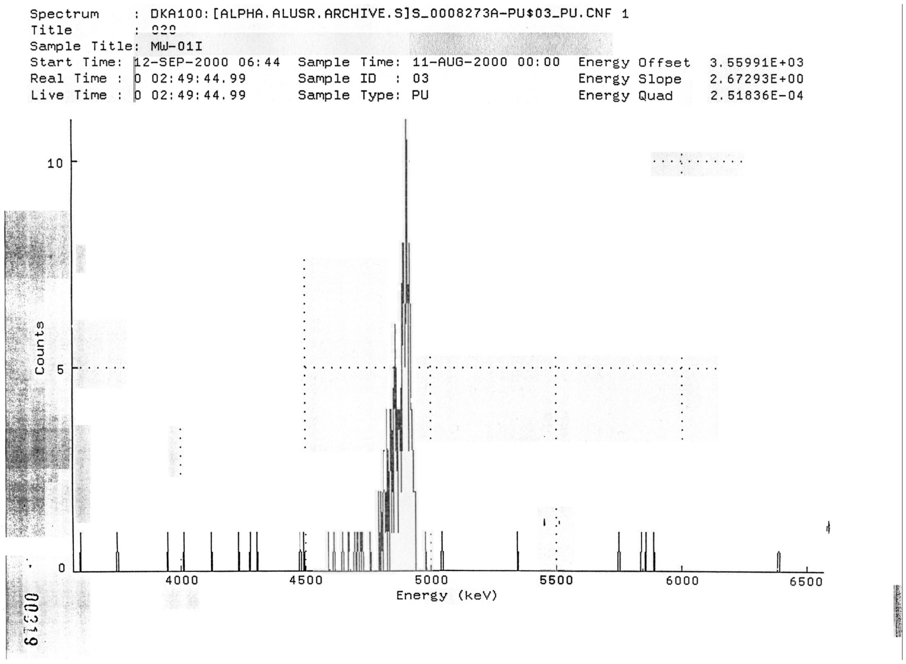
Figure 1. Alpha spectrum of Pu spike showing energies of main Pu isotopes. Note the position of the Pu-242 peak with respect to Pu-238.



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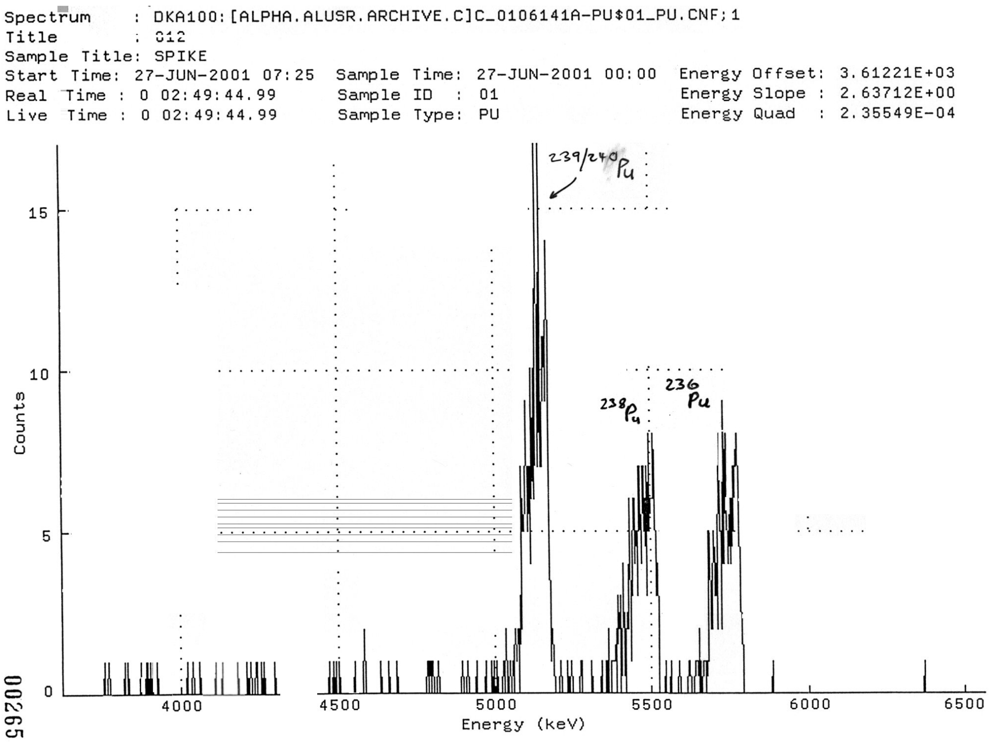
Spectrum     : DKA100:[ALPHA.ALUSR.ARCHIVE.S]S_0008273A-PU$03_PU.CNF 1
Title        : 020
Sample Title: MW-01I
Start Time: 12-SEP-2000 06:44  Sample Time: 11-AUG-2000 00:00  Energy Offset  3.55991E+03
Real Time : 0 02:49:44.99      Sample ID  : 03                 Energy Slope   2.67293E+00
Live Time : 0 02:49:44.99      Sample Type: PU                 Energy Quad    2.51836E-04
```

Figure 2. Alpha spectrum of groundwater sample MW-01I (August 2000) showing yield tracer peak Pu-242.

However, in a later sampling (March 2001), a different tracer, Pu-236, was used as yield tracer and this isotope has an energy greater than those of Pu-238 and Pu-239/240 (Figure 3). Therefore, when used as a tracer in the analysis of groundwaters (e.g. for sample MW-1I), there is potential for tailing of the tracer peak into the region of interest of the next lower-energy peak, Pu-238 (Figure 4), and this gives an apparently finite activity for Pu-238 (0.45 pCi/L). If correction for tailing could be applied to the sample, the activity would probably reduce to a value of < MDA.

Counting for 170 minutes and obtaining only a few counts in the regions of interest of the Pu isotopes (many of which could be part of a higher energy tail), followed by subtraction of background and blank activities, gives count rates that have large error limits and MDA values that are significantly greater than the measured values. An example of the difference between the MDA and actual measured values (where available) for Pu-238 is shown in Figure 5. It can be seen here that measured values, including error limits, are well below the MDA value, in each case, suggesting that Pu concentrations are essentially zero for all samples.

Better precision and accuracy for measuring low levels of Pu in groundwater can be obtained by concentrating Pu from a large (> 50 L) volume of groundwater and analyzing the concentrate by mass spectrometry instead of by alpha counting.



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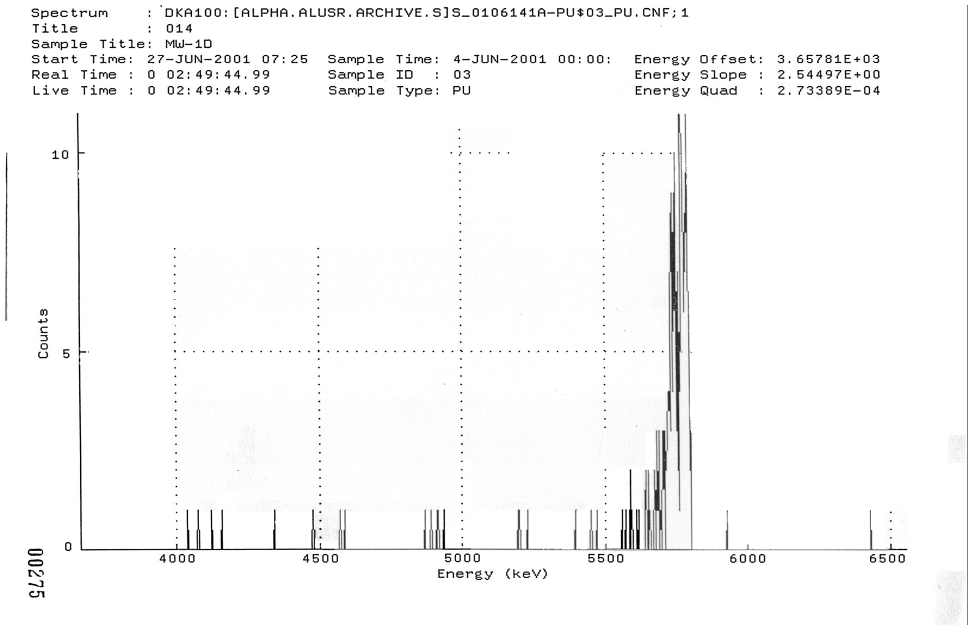
Title        : 012
Sample Title: SPIKE
Start Time: 27-JUN-2001 07:25  Sample Time: 27-JUN-2001 00:00  Energy Offset: 3.61221E+03
Real  Time : 0 02:49:44.99     Sample ID  :  01                Energy Slope : 2.63712E+00
Live  Time : 0 02:49:44.99     Sample Type:  PU                Energy Quad  : 2.35549E-04
```

Figure 3. Alpha spectrum of Pu spike showing energies of Pu isotopes including new Pu-236 used in May 2001 sampling. Note the position of the tracer Pu-236 peak with respect to Pu-238 (compare to location of Pu-242 peak in Figure 1).



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Spectrum    : DKA100:[ALPHA.ALUSR.ARCHIVE.S]S_0106141A-PU$03_PU.CNF;1
Title       : 014
Sample Title: MW-1D
Start Time: 27-JUN-2001 07:25  Sample Time: 4-JUN-2001 00:00:  Energy Offset: 3.65781E+03
Real Time : 0 02:49:44.99      Sample ID  : 03                 Energy Slope : 2.54497E+00
Live Time : 0 02:49:44.99      Sample Type: PU                 Energy Quad  : 2.73389E-04
```

Figure 4. Alpha spectrum of groundwater sample MW-01I (May 2001) showing new yield tracer peak Pu-236 (note the tailing into the Pu-238 region).

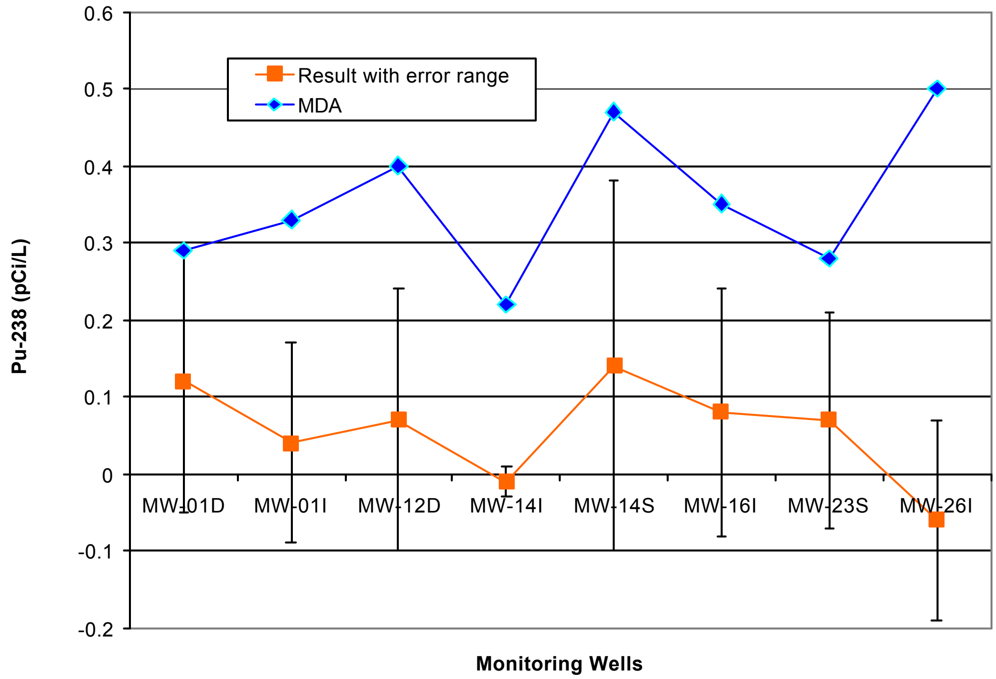


Figure 5. Comparison of MDA values with measured values and error limits of Pu-238 ratios in IEL groundwaters showing that MDA values always exceed the measured values.

5. Uranium

Approximately half of the uranium isotopic concentrations in groundwater at the IEL were greater than the MDA and ranged from 0.3 to 1.5 pCi/L for each of U-234 and U-238. Because U-238 is the most abundant and least radioactive isotope of uranium, its concentration is usually expressed as a mass rather than activity and the IEL data show that U concentrations ranged from <1 to about 5 µg/L. These concentrations are well below the drinking water standard limit of 30 µg/L. Because U-234 is one of the radioactive daughters of U-238, the two isotopes tend to have the same radioactivity level as each other and so their activity ratio is about 1.0. Natural processes such as weathering and rock-water interaction can cause this ratio to vary significantly from 1.0 (values for groundwater up to 20 were found in aquifers in Florida, for instance). The variations seen in the IEL data (Figure 6) are entirely consistent with a natural source for U in groundwater at the site.

Addition of any processed U can cause this ratio to increase or decrease dramatically depending on whether the source of U is 'enriched' or 'depleted' (from fuel-making or

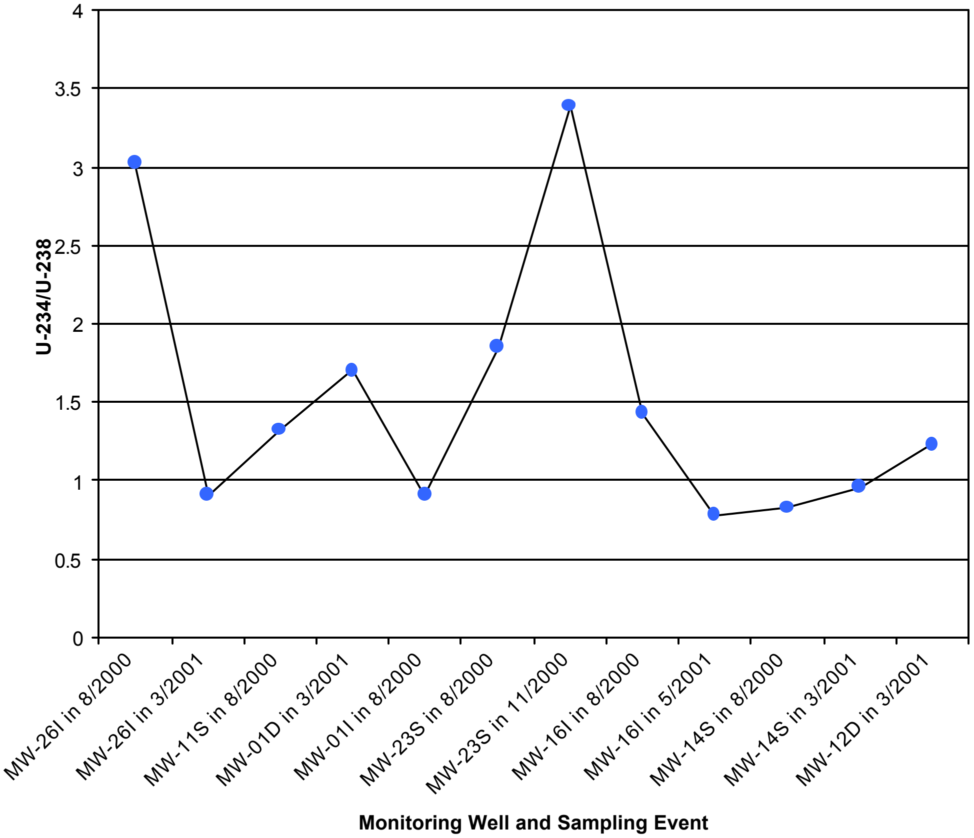
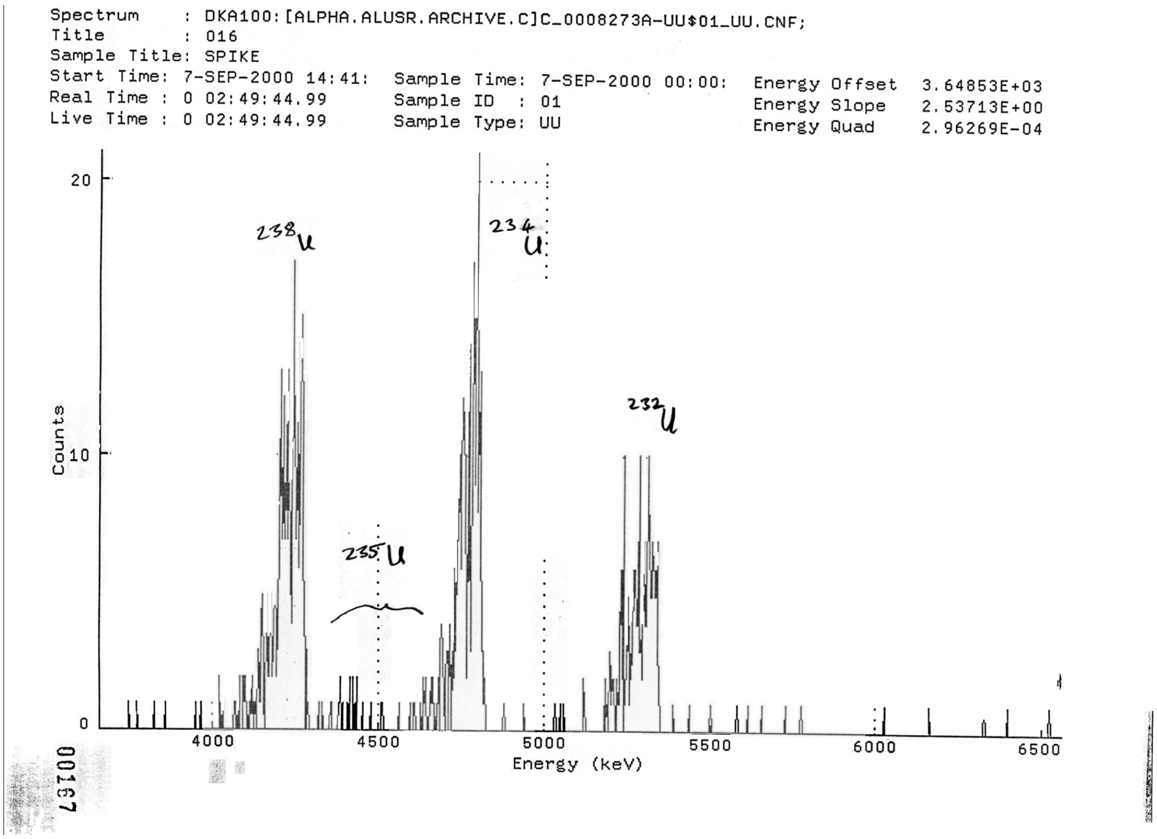


Figure 6. Variation of U-234/U-238 activity ratio from east (right) to west (left) for groundwaters at the IEL.

military purposes). A similar effect would be seen for the U-235 isotope which has a lower abundance than U-238 and has a fixed, world-wide activity ratio of 0.046. This ratio, unlike the ratio between U-238 and U-234, does not vary as a result of weathering processes. An example of the uranium isotope spectrum is given in Figure 7. The isotope U-235 is a low activity, multi-energy peak falling between the U-238 and U-234 peaks.

At first sight, it would appear that the U-235/U-238 ratios in IEL groundwaters do vary from this fixed value and, therefore, indicate the presence of processed uranium in the landfill. However, because the ratio is determined by alpha spectrometry, which records only a few counts in the U-235 region (Figure 7) over a short counting period (170 minutes), the error limits on any measurements are high. There is also the possibility of tailing which does not seem to have been corrected for (in this case, self-attenuated, low-energy U-234 alpha particles will lie in the region of U-235) thereby enhancing the count rate of U-235 and giving a U-235/U-238 ratio greater than 0.046. This and the poor counting precision (due to low U concentrations, insufficient sample taken, short count times) can easily account for all apparent anomalies in the U-235/U-238 ratios in the IEL data.



```
Spectrum    : DKA100:[ALPHA.ALUSR.ARCHIVE.C]C_0008273A-UU$01_UU.CNF;
Title       : 016
Sample Title: SPIKE
Start Time: 7-SEP-2000 14:41:  Sample Time: 7-SEP-2000 00:00:  Energy Offset  3.64853E+03
Real Time : 0 02:49:44.99      Sample ID  : 01                 Energy Slope   2.53713E+00
Live Time : 0 02:49:44.99      Sample Type: UU                 Energy Quad    2.96269E-04
```

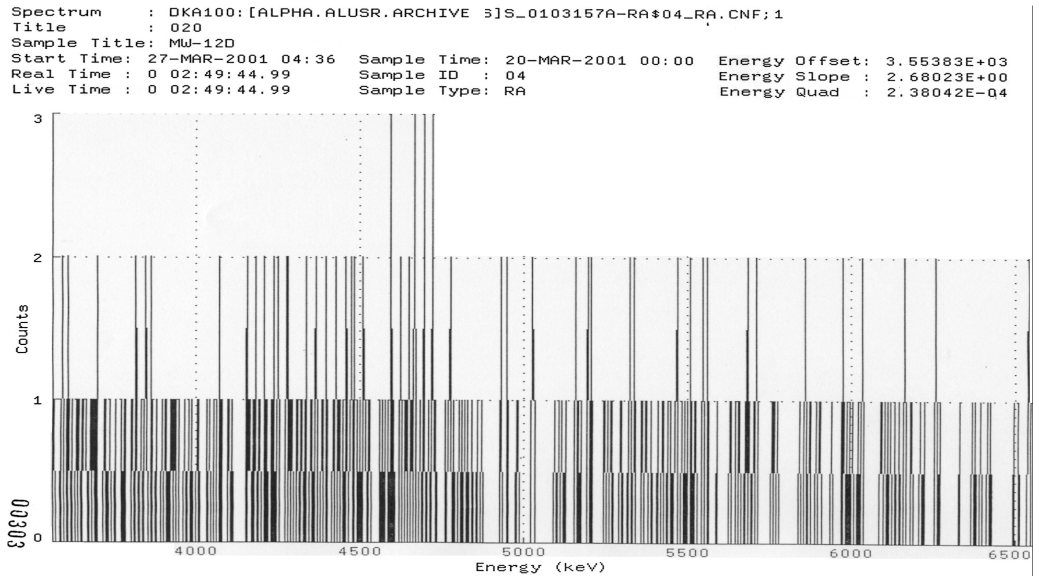
Figure 7. Alpha spectrum of uranium isotopes showing location of low activity U-235 peak relative to the position of the higher activity U-234 peak and potential for 'tailing' to enhance U-235 counts.

6. Radium and Thorium

Isotopes of both Ra and Th were found in measurable concentrations in many of the IEL groundwaters. Radium-226, Ra-224 and all Th isotopes are alpha emitters and are generally counted by alpha spectrometry, whereas Ra-228 is a beta emitter counted by proportional counting.

The Ra-226 data do not show good precision. Examination of the alpha spectra for the Ra analyses shows practically no resolution of the alpha particle energy peak (see example in Figure 8 for sample MW-12D, March 2001). In this example, a single peak with lower energy shoulder should be seen with no significant activity at lower or higher energies if counted immediately after preparation. Instead, no peak is visible and alpha counts tend to be distributed across the energy spectrum, probably as a result of inadequate preparation of a thin, fine-grained barium sulphate source. Discussions with analytical staff at Eberline Services, the analyst contractor, indicated that staff were aware of the problem of resolution; it was attributed to high concentrations of barium (the radium carrier) in the groundwater which gave too much precipitate for counting. To offset this, they determined counts in the region of interest for Ra-226 and then corrected them by a applying a self-absorption factor to include counts in the low energy tail of Ra-226.

Table 1 shows the results of analysis of duplicates and their associated errors and MDA values. It can be seen that individual errors range from 25 to 50% while variability of duplicates can exceed 50% in some cases. The problems of variation in the self-absorption factor, short count times (typically 170 minutes), tailing of higher energy peaks (of Rn-222 and its daughters) and assuring complete recovery of Ra-226, undermine the precision and accuracy of the Ra-226 determination. Consequently, the data are uncertain, at best.



```
Spectrum     : DKA100:[ALPHA.ALUSR.ARCHIVE 5]S_0103157A-RA$04_RA.CNF;1
Title        : 020
Sample Title: MW-12D
Start Time: 27-MAR-2001 04:36  Sample Time: 20-MAR-2001 00:00  Energy Offset: 3.55383E+03
Real Time : 0 02:49:44.99      Sample ID   : 04                 Energy Slope : 2.68023E+00
Live Time : 0 02:49:44.99      Sample Type: RA                  Energy Quad  : 2.38042E-04
```

Figure 8. Alpha spectrum for Ra-226 for groundwater sample MW-12D (March 2001)

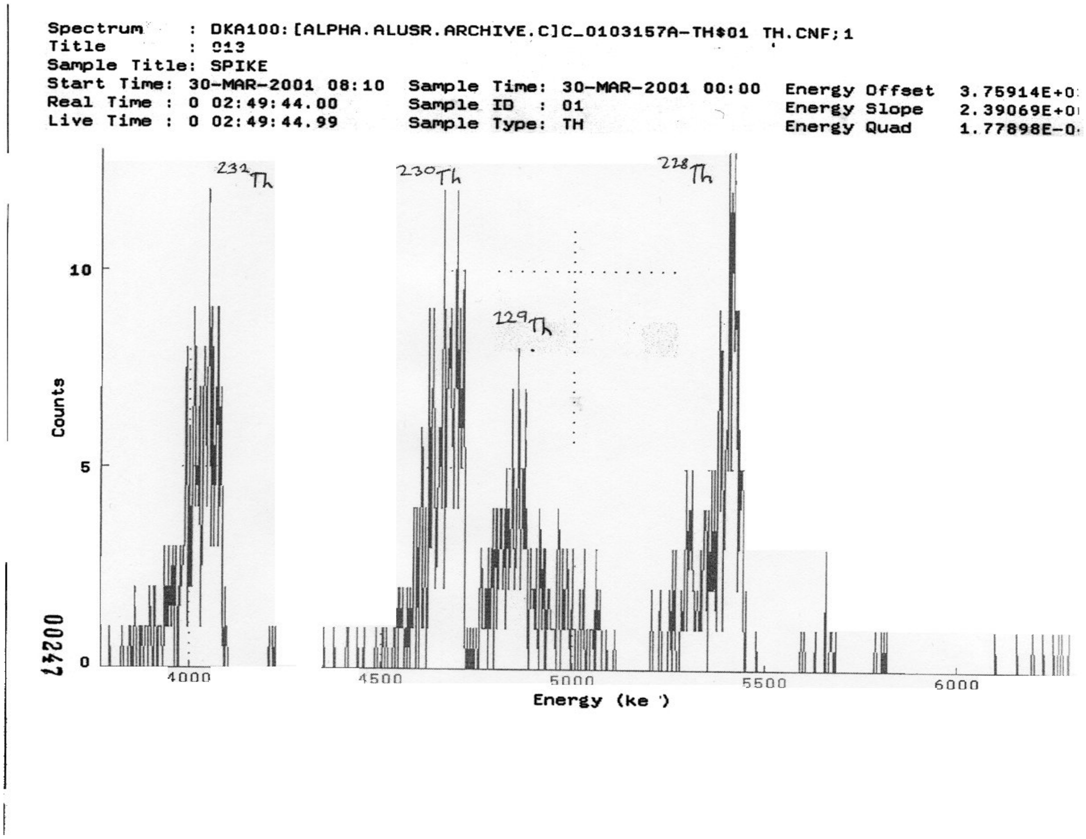
Table 1. Variation of Ra-226 activity of groundwaters in several wells that were reanalyzed (indicated as 'dup') over the four sampling periods.

Sampling Date	**Sample No.**	**Activity (pCi/L)**	**+/- Error (pCi/L)**	**MDA**
May 2001	MW-17S	2.42	0.60	0.21
	MW-17S dup	1.50	0.42	0.21
March 2001	MW-17S	2.21	0.54	0.37
	MW-17S dup	2.36	0.65	0.31
	MW-1D	1.30	0.52	0.33
	MW-1D dup	1.49	0.51	0.32
	MW-23S	1.74	0.59	0.64
	MW-23S dup	1.18	0.50	0.59
November 2000	MW-17S	3.56	0.83	0.54
	MW-17S dup	2.13	0.54	0.34
	MW-1D	1.46	0.77	1.36
	MW-1D dup	2.36	0.95	1.18
August 2000	MW-26I	1.19	0.58	0.60
	MW-26I dup	2.06	0.79	0.66
	MW-12D	0.86	0.32	0.20
	MW-12D dup	1.06	0.37	0.16

A related problem undermines the accuracy of the thorium isotopic data. In the case of Th-232 and Th-228, most analyses showed activities were less than the MDA, whereas in the case of Th-230, analyses showed finite activities, significantly greater than the MDA in many cases. The energies and their distribution are shown for the composite spike in Figure 9 and for a groundwater sample (MW-14S, March 2001) in Figure 10. The proximity of spike Th-227 (added as a yield tracer for the naturally present Th isotopes) to Th-230 can be clearly seen and the low energy tail of Th-227 can readily enter the Th-230 region and so would contribute counts that are summed as Th-230.

7. Technetium, Strontium and Potassium

Analyses of Tc, Sr and K radioactive isotopes were made on a few IEL groundwater samples (MW-12, -14, -17) during the 2000/2001 sampling. The results show that



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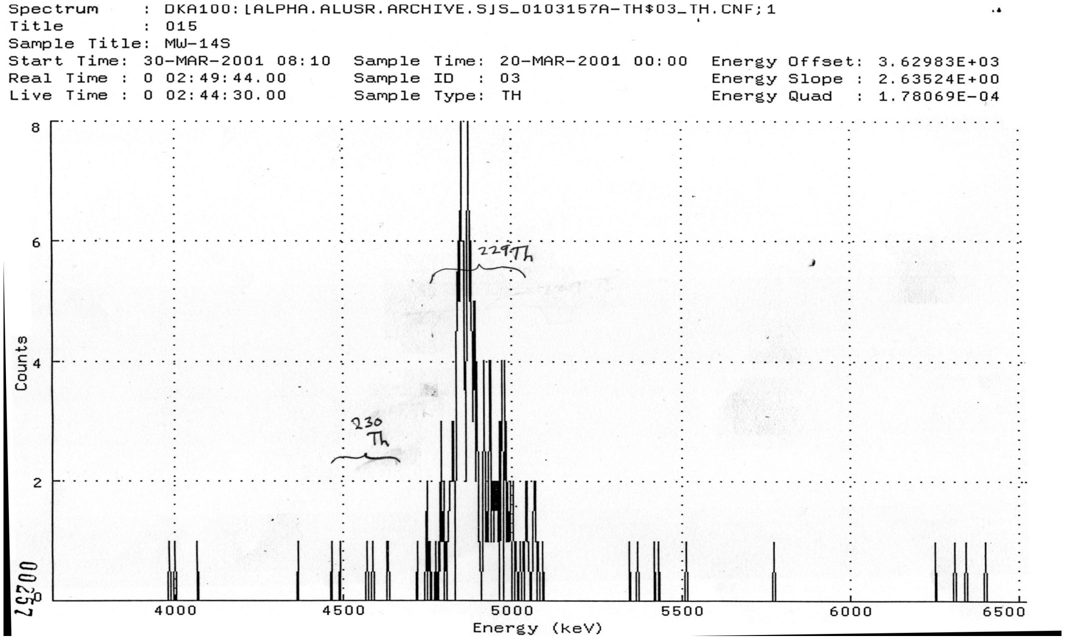
Spectrum    : DKA100:[ALPHA.ALUSR.ARCHIVE.C]C_0103157A-TH$01 TH.CNF;1
Title       : 013
Sample Title: SPIKE
Start Time: 30-MAR-2001 08:10   Sample Time: 30-MAR-2001 00:00   Energy Offset  3.75914E+0
Real Time : 0 02:49:44.00       Sample ID  : 01                  Energy Slope   2.39069E+0
Live Time : 0 02:49:44.99       Sample Type: TH                  Energy Quad    1.77898E-0
```

Figure 9. Alpha spectrum of 'spike' analysis showing locations of Th isotope energies and count distributions.



```
Spectrum     : DKA100:[ALPHA.ALUSR.ARCHIVE.SJS_0103157A-TH$03_TH.CNF;1
Title        : 015
Sample Title: MW-14S
Start Time: 30-MAR-2001 08:10   Sample Time: 20-MAR-2001 00:00   Energy Offset: 3.62983E+03
Real Time : 0 02:49:44.00       Sample ID  : 03                  Energy Slope : 2.63524E+00
Live Time : 0 02:44:30.00       Sample Type: TH                  Energy Quad  : 1.78069E-04
```

Figure 10. Th isotope content of groundwater sample MW-14S (March 2001) showing potential for tailing of Th-229 spike peak into Th-230 region.

activities of Tc-99 and Sr-90 were consistently at or below MDA levels for all samples. Because these isotopes are produced mainly by nuclear fission, their absence suggests that there is no indication of leaking radioactive waste at the IEL site, although the detection limits are relatively high. Potassium-40 is not produced in any man-made nuclear process but makes a significant, but naturally occurring, contribution to the gross beta activity (at least 44 pCi/L) by its presence in dissolved potassium content (typically several milligrams per liter of water).

8. Radioactivity in Soils and Landfill Wastes

Measurement of radiation fields and analysis of soils and material excavated during drilling of wells at the IEL site was conducted during 2000 and 2003/2004. In 2000, the radiation level of 255 metal drums and their contents was measured by alpha, beta and gamma detectors. Gamma spectral analysis was performed to determine if isotopes such as Co-60, Cs-137 and naturally occurring radionuclides in the U and Th decay series, were present in any quantity in the waste. All samples were found to contain only background levels of radiation. More recently, soil cuttings from the 2004 drilling of new wells at the site showed no readings greater than background. In late 2003 and early 2004, EPA conducted a surface survey of gamma activity around the site and analyzed soil samples from select locations. The results of the EPA work showed that all radiation levels were comparable to background, except for some elevated readings in the parking lot to the west of the landfill area. However, the elevated readings were not high enough to warrant a cleanup action.

5 SUMMARY AND CONCLUSIONS

In this review of the radioactivity measurements and data generated at the Industrial Excess Landfill site, at Uniontown, Ohio, I have examined various factors to determine whether the methods used and the results obtained were adequate to determine if radioactive waste was disposed of at the site and poses a public health hazard. These factors included: surface data collected during groundwater sampling, containers used and volumes of sample taken for analysis, storage times, need for filtering and preserving samples, methods used for analysis, results of speciation analysis when screening levels were exceeded, and details of the counting, reporting and subsequent interpretation of the data.

Although it was not possible to conduct a detailed (forensic) examination of all the data in the time available, I reviewed the parts of the data set for sampling during 2000 and 2001 that had a bearing on how accurate and representative the data are. It is my opinion that the tests performed were sufficient to declare that site groundwaters in 2000 and 2001 met the requirements of the drinking water standards with respect to radioactive elements and isotopes. It is not possible, however, to state categorically that no radioactive waste is present at the site because, in many cases, the analytical procedures used to detect specific types of radioactivity were insufficiently sensitive to differentiate measured concentrations from background (natural) levels. Examples of this include:

1. Tritium. This isotope is very mobile and is a good indicator of the presence of radioactive waste. All analyses show H-3 levels to be below 400-500 pCi/L. However, rainwater and snow-melt are currently about 50-60 pCi/L. Any values in the interval between 50 and 500 pCi/L may indicate the presence of waste if groundwater dating from the 1950s and 1960s can be shown to be absent. Use of the electrolysis enrichment method will determine H-3 down to ~3 pCi/L and will thus be able to show whether groundwaters contained any excess H-3 or contained the same level as rainwater.

2. Plutonium. Some groundwaters appear to contain small amounts of isotopes of Pu but this is based on the use of alpha spectrometry. This method has poor precision when Pu concentrations are low, activities are close to background, count times are short and tails of spikes lead into energy regions of other Pu isotopes. To verify that Pu concentrations are much lower than the minimum detectable amount cited or the finite levels reported, larger volumes of groundwater must be used and the Pu isolated from these should be analysed using mass spectrometric methods (where individual atoms are counted, rather than the decay activity of a concentrate of Pu).

3. Uranium. Anomalies in the U-235/U-238 ratio were cited as evidence of radioactive waste materials at the site. However, alpha spectrometry is not adequate to give a precise value of this ratio, mainly because of tailing (self-absorption) of counts from the adjacent larger U-234 peak into the U-235 region. This ratio must be determined by mass spectrometry. The observation of near-normal ratios of U-234/U-238 in most samples,

however, suggests that there are no deposits of enriched or depleted U that are being leached from the landfill.

4. Radium. Poor source preparation, leading to poor resolution of alpha counts emitted by Ra-226, indicate that the Ra-226 data collected cannot be used with any confidence as an indicator of radioactive contamination.

5. Thorium. The presence of Th-230 but simultaneous absence of Th-232 and Th-228 in IEL groundwaters is probably due to tailing in the alpha spectrum of the Th-229 tracer used in the analytical method and the lack of correction for this. Thorium-230 levels are likely considerably less than those given.

Other data indicate that there are no concentrations that are significantly above background levels of Tc-99, Cs-137 and Sr-90 (radioactive isotopes found in nuclear waste materials) or of any of the U- and Th-decay chain isotopes. I believe that the finite concentrations given in the data set or the levels inferred from high MDA values are a function of imprecise measurement rather than real but low concentrations derived from leaking radioactive waste that is alleged to have been disposed of at the site. The analytical methods used, in most cases, are adequate for showing that the groundwater conforms to drinking water standards, but to remove all doubt as to whether any minor concentrations of radioactive waste are present and are leaking from the landfill into the groundwater, it would be necessary to use methods capable of one to three orders of magnitude more sensitivity than those used here.

It should also be noted that the results of the radioactivity measurements in groundwater will only detect materials that are exposed to groundwater leaching. They will not identify the presence of sealed, inert containers of radioactive waste.

In conclusion, it is my expert opinion that most of the problems and concern that have perpetuated throughout the history of the IEL, regarding the possible presence of radioactive waste at the site, remain unresolved following the 2000 and 2001 sampling, because the analytical methods used were only adequate to show that the groundwaters met drinking water standards. To increase the public's confidence in EPA's claim that no radioactive waste is in the landfill, I recommend that, if further radiological testing of the groundwater is planned, it should include specific sampling for analysis by the more sensitive methods described above, particularly for H-3 and for Pu and U isotopes.

6. REFERENCES

Solomon, D.K. and P.G. Cook. 2000. ^{3}H and ^{3}He. In: Environmental Tracers in Subsurface Hydrology, eds. P. Cook and A.L. Herczeg, Kluwer Academic Publishers, Boston.

GLOSSARY

Absorb: To take up or receive radiation energy .

Aliquot: A measured portion of a sample taken for analysis. One or more aliquots make up a sample.

Alpha particle: A positively charged particle ejected spontaneously from the nuclei of some radioactive elements. It has low penetrating power and a short range (a few centimeters in air). The most energetic alpha particle will generally fail to penetrate the dead layers of cells covering the skin and can be easily stopped by a sheet of paper. Alpha particles are hazardous when an alpha-emitting isotope is inside the body.

Alpha spectrometer: Instrument used to identify the isotopic composition of radioactive elements by their alpha particle energy.

Beta particle: A charged particle emitted from a nucleus during radioactive decay, with a mass equal to 1/1837 that of a proton. A negatively charged beta particle is identical to an electron. A positively charged beta particle is called a positron. Large amounts of beta radiation may cause skin burns, and beta emitters are harmful if they enter the body. Beta particles may be stopped by thin sheets of metal or plastic.

Beta spectrometer: Instrument used to identify the isotopic composition of radioactive elements by their beta particle energy.

Cesium: A rare, highly reactive, soft, metallic element of the alkali metal group, used chiefly in photoelectric cells.

Conductivity: A measure of the ability of a solution to carry an electrical current.

Curie: The basic unit used to describe the intensity of radioactivity in a sample of material. The curie is equal to 37 billion (3.7×10^{10}) disintegrations per second, which is approximately the activity of 1 gram of radium. A curie is also a quantity of any radionuclide that decays at a rate of 37 billion disintegrations per second. It is named for Marie and Pierre Curie, who discovered radium in 1898.

Dissolve: To make a solution of, as by mixing with a liquid; pass into solution.

Electrolysis: A process that uses electrical current to break down water into hydrogen and oxygen. .

EPA 900-series methods: Methods for testing water that were developed by EPA and are numbered between 900 and 999.

Error: the difference between the observed or approximately determined value and the true value of a quantity.

Evaporate: To extract moisture or liquid from a substance using heat, so as to make dry or reduce to a more concentrated state.

Ferric: Of or containing iron in the trivalent state.

Ferrous: Of or containing iron in the bivalent state.

Gamma radiation: High-energy, short wavelength, electromagnetic radiation emitted from the nucleus. Gamma radiation frequently accompanies alpha and beta emissions. Gamma rays are very penetrating and are best stopped or shielded by dense materials, such as lead. Gamma rays are similar to X-rays.

Gross alpha: Total of alpha particles emitted.

Gross beta: Total of beta particles emitted.

Insoluble: Incapable of being dissolved.

Isotope: One of two or more atoms with the same number of protons, but different numbers of neutrons in their nuclei. For example, carbon-12, carbon-13, and carbon- 14 are isotopes of the element carbon, the numbers denote the approximate atomic weights. Isotopes have very nearly the same chemical properties, but often different physical properties (for example, carbon-12 and -13 are stable, carbon-14 is radioactive).

Lead: A heavy, comparatively soft, malleable, bluish-gray metal, sometimes found in its natural state but usually combined as a sulfide.

Liter: In the metric system, a unit of capacity equaling one cubic decimeter. It is slightly more than one liquid quart in the U.S. measuring system.

Mass spectrometer: Instrument used to identify the molecular composition and concentrations of elements in water, rock and soil samples.

Maximum Contaminant Level: The maximum permissible level of a contaminant in water delivered to the user of a public system. MCLs are enforceable standards under the Safe Drinking Water Act.

Microgram: In the metric system, a unit of mass or weight equal to one millionth of a gram, used chiefly in microchemistry.

Minimum Detectable Amount: The lowest concentration of a chemical that can reliably be distinguished from a zero concentration. Also called the detection limit.

Parent-daughter decay chains: The sequence in which, during radioactive decay, a substance (the parent) turns into decay products (the daughter(s)).

pH: An expression of the intensity of the basic or acid condition of a liquid; may range from 0 to 14, where 0 is the most acid, 7 is neutral and 14 is the most basic. Natural waters usually have a pH between 6.5 and 8.5.

Pico curies: A unit of measure for level of radioactivity, it is one trillionth of a curie.

Planchet: A flat piece of metal.

Plutonium: A very heavy element formed when uranium-238 absorbs neutrons and undergoes beta decay.

Potassium: A silvery-white metallic element that oxidizes rapidly in air and whose compounds are used as fertilizer and in special hard glasses.

Radiation: Transmission of energy through space or any medium. Also known as radiant energy.

Radioactive decay: The decrease in the amount of any radioactive material with the passage of time due to the spontaneous emission of charged particles and/or gamma rays; also known as radioactive disintegration and radioactivity.

Radionuclide: A radioactive nuclide. An unstable isotope of an element that decays or disintegrates spontaneously, emitting radiation.

Radium: A highly radioactive metallic element that upon disintegration produces the element radon and alpha particles.

Radon: A radioactive element that is one of the heaviest gases known. Its atomic number is 86. It is found naturally in soil and rocks and is formed by the radioactive decay of radium.

Redox potential: A measure of the oxidizing or reducing potential of groundwater relative to a standard. Oxidizing conditions usually result in precipitation of iron compounds and dissolution of uranium compounds. Reducing conditions have the opposite effect plus the generation of gases such as methane and hydrogen sulfide..

Shoulder: On a spectrum graph, the steplike change in the contour of the radioactivity energy spectrum of a radionuclide .

Speciation analysis: To determine the isotopic components of an element using, for example, a mass spectrometer.

Strontium: A bivalent, metallic element whose compounds resemble those of calcium, found in nature only in the combined state, as in strontianite.

Strontium-90: A harmful radioactive isotope of strontium, produced in certain nuclear reactions and present in their fallout.

Tail: On a spectrum graph, the lower energy portion of a radionuclide energy peak.

Technetium: An element of the manganese family, not found in nature, but obtained in the fission of uranium or by the bombardment of molybdenum.

Thorium: A grayish-white, lustrous, somewhat ductile and malleable, radioactive, metallic element, used as a source for nuclear energy, in sun-lamp and vacuum-tube filament coatings, and in alloys.

Thoron: The name for the radon-220 isotope.

Tritium: A radioactive isotope of hydrogen having an atomic weight of three.

Uranium: A radioactive, metallic element, used chiefly in atomic and hydrogen bombs and as a nuclear fuel in power reactors.

Review of Hydrogeologic & Other Site Documentation
Industrial Excess Landfill (IEL) Superfund Site, Uniontown, Ohio

U.S. EPA Site Designation No.: OHD000377911
PELA Project No.: 667100
July 29, 2004 (Final Version)

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Hard Copy Signed
Dr. Barry F. Beck, P.G.

EXECUTIVE SUMMARY

At the request of the U.S. EPA, P.E. LaMoreaux & Associates, Inc. (PELA) recently completed a review of various technical documents for the Industrial Excess Landfill (IEL) Superfund Site, in Uniontown, Ohio. This review focused primarily on determining whether the monitoring well network listed in the September 2003 Remedial Design Plan was sufficient in characterizing the site. Although it was not possible to conduct a detailed examination of all documents/data provided in the time-frame available, PELA's review focused mainly on evaluating the existing geological and hydrogeological information for this site. The following bullets summarize PELA's critical findings for this project:

- The IEL site is underlain by unconsolidated glacial deposits (up to 200 feet thick) primarily consisting of sand and gravel interspersed with discontinuous finer-grained silt/clay layers. Some of the IEL landfill waste, which was placed directly on top of more permeable sandy sediments, has direct connection to the uppermost aquifer.

- The bedrock surface occurs at depths ranging from approximately 70 to 200 feet below grade within the study area. A bedrock valley, which is present beneath the western portion of the site and extends off-site in a northwesterly direction, has a pronounced influence on the groundwater contours for the uppermost aquifer.

- Earlier interpretations of groundwater flow for the uppermost aquifer included a pronounced area of mounding within or around the waste disposal area, with radial flow outward in all directions. Following a revised interpretation of flow conditions by Sharp & Associates, Inc. (Sharp) after the elimination of several monitoring points, the area of mounding no longer existed and the flow pattern was consistently from east to west across the site, and then turning northwesterly in the area of the bedrock valley. PELA believes that this revised interpretation by Sharp is more representative of true conditions within the shallow water-bearing zone.

- Five post-2000 groundwater level contour maps were prepared by Sharp for the shallow aquifer based on their updated list of appropriate monitoring wells. All five maps showed the same general east to west flow pattern for the uppermost continuous groundwater unit, with a tightening of the contours in the vicinity of the bedrock valley. Twelve additional maps were reportedly redrawn by Sharp using data from the early 1990s, representing every season over several consecutive years. All 12 of these maps reportedly showed the same general flow pattern. Based on this, PELA believes that seasonal variations in groundwater flow patterns have been appropriately evaluated, and that the flow pattern in the uppermost continuous aquifer has remained relatively consistent during the years evaluated by Sharp.

- Before the final soil cover was added in 1980, the open pit landfill would have served as a local recharge area for the shallow groundwater system. At that time, it is possible that localized mounding of groundwater (or other alteration from normal flow patterns) beneath the landfill was occurring due to increased infiltration of surface water into the aquifer. This recharge could have acted as a flushing mechanism to move contaminants through the landfill debris and down into the groundwater system during the years that the landfill was an open pit and accepting wastes (~1964-1980).

- PELA agrees with the findings of a 1997 Geraghty & Miller report that the horizontal component of the flow within the uppermost continuous water-bearing zone is likely more significant than the vertical flow component.

- A Geraghty & Miller (1997) report states that the groundwater in the sand and gravel aquifer occurs under “unconfined” conditions. PELA believes rather that semi-confined conditions do occur in certain areas, such as in the vicinity of MW-3S/I/D, where a 15-foot-thick layer of sand is underlain and overlain by layers of fine-grained clastics (i.e., silts and/or clays) that are at least 20 feet thick. The water level for the intermediate well at this location (MW-3I), which is screened across the sand unit, occurs approximately 22 feet above the top of the sand unit.

- PELA’s review of various site documents indicates that DNAPLs were tested for during various investigation phases at IEL. In addition, there are several monitoring well locations where DNAPLs/chlorinated solvents are likely to have been identified, if in fact they were placed into the landfill, including MW-17D, MW-11D, MW-9S, MW-21I, MW-27I/D, and MW-18I. No evidence of DNAPLs has been identified.

- PELA concludes that there are enough monitoring wells located to the west (downgradient) of the waste disposal area to allow continued monitoring of possible off-site migration of contaminants, and that the overall number of wells is sufficient to characterize the site in terms of geology, hydrogeology, and water quality. Also, well development and installation methods seemed appropriate for the conditions encountered.

I. INTRODUCTION

This is a summary of PELA's findings for the above-referenced site, based on reviewing documents listed in the March 1, 2004 statement of work (SOW) entitled "Groundwater Radiation Testing Expertise", in addition to reviewing various other Environmental Protection Agency (EPA) supplied documents. As stated in the SOW, this review was undertaken to address the following matters:

1) Reliability of the radiological testing at IEL in 2000 and 2001.
2) Whether additional radiation testing of groundwater is warranted and, if so, the type of analysis that should be performed.
3) Whether the monitoring well locations and frequency in the September 2003 Remedial Design Plan are sufficient.
4) Whether other locations and timing should be used for the testing.

PELA's portion of the above work was primarily to evaluate, based on the geology and hydrogeology at IEL, the placement of the monitoring wells for characterizing and monitoring groundwater at the site. Dr. Melvyn Gascoyne, a radiological expert, addressed issues involving radiological analyses and contamination. A summary of site background information is presented in Dr. Gascoyne's report dated July 2, 2004, and is not repeated here. Before discussing the specific findings from PELA's review, some basic information regarding the geology/hydrogeology of the site (as obtained from review of multiple IEL documents) is presented below to orient the reader.

II. GEOLOGY/HYDROGEOLOGY BACKGROUND INFORMATION

The IEL site is underlain by unconsolidated glacial sediments, largely consisting of sand and gravel interspersed with relatively discontinuous layers of finer-grained clastic sediments (i.e., silts and clays) that range in thickness from very thin layers to more than 20 feet. The total thickness of these glacial deposits ranges from approximately 70 to 200 feet. The majority of the waste materials within the IEL landfill are underlain by a layer of fine-grained clastics (silt/clays). However, some of the waste in the eastern portion of the site was placed directly on top of more permeable sandy sediments, which are in direct contact with the uppermost groundwater body.

Bedrock underlying the site and immediate surrounding area consists of Pennsylvanian-aged Pottsville Formation sandstones, siltstones, limestones, and coal; this formation is up to 400 feet thick locally. The bedrock surface beneath the site is highly variable due to previous glacial activity and erosion, and occurs at depths ranging from approximately 70 to 200 feet below grade within the study area. A well-defined bedrock valley is present beneath the western portion of the site and extends off-site in a northwesterly direction. This bedrock valley has a pronounced influence on the groundwater contours for the uppermost continuous groundwater unit at the site (i.e., the groundwater contours mimic the bedrock contours). This is illustrated on **Figure 18** (attached) from Sharp & Associates, Inc. (Sharp) (2003). It has not been confirmed whether the bedrock valley transects the site due to lack of deep drilling in the central and eastern portions of the IEL site. A Geraghty & Miller report (1997) states that the bedrock valley transects the entire site, although data to support this hypothesis has not been confirmed.

Monitoring wells were installed on-site at various depths, primarily within the unconsolidated sediments, and were designated as shallow, intermediate, or deep. Well locations are illustrated on **Figure 17** (attached) from Sharp (2003). Based on the lithologic logs of these wells, the cross-sections from Sharp's "Revised Summary Report on an Assessment of Individual Monitoring Wells at the IEL Site" (2003), and the water levels reported throughout the monitoring history, it is PELA's conclusion that most of the shallow and intermediate wells (except as explained below) are monitoring one continuous shallow aquifer. However, because of the irregular lenses of silts and clays dispersed throughout the coarser sediments, the vertical permeability is distinctly less than the horizontal permeability. These low permeability lenses may cause local variations in water levels within this shallow aquifer; but in the nested wells, the shallow and intermediate water levels are usually within a few inches of each other.

The deepest of the "deep" monitoring wells (MW-11D, MW-23D, and MW-27D) are screened solely within the bedrock. Based on distinctly lower water levels found therein (approximately 6 to 30 feet lower), these wells are screened in a lower aquifer that appears to be separated from the shallow aquifer. However, the shallower wells that were designated "deep" (for example, MW-3D, MW-7D, and MW-17D) appear to be completed in the continuous surficial aquifer inasmuch as their water levels are identical to the intermediate and shallow wells, within measurement error, even when the "deep" wells bottomed in bedrock.

Earlier interpretations of the groundwater flow conditions for the uppermost continuous groundwater unit at the IEL site included a pronounced area of mounding within or around the waste disposal area, with radial flow outward in all directions from this area of mounding. However, the concentrations of volatile organic compounds (VOCs) in the groundwater, based on over 10 years of sampling, did not support a radial flow pattern since the highest levels of contamination outside the waste area were located in the western portion of the site, with some occasional low concentrations in off-site wells to the west. The distribution of VOCs in the groundwater did not correspond to the radial groundwater flow pattern. Therefore, in early 2000 a systematic evaluation of all IEL monitoring wells was completed by Sharp to verify the appropriateness of the Shallow (S), Intermediate (I), and Deep (D) well designations, and to verify that water levels used to construct contour maps were appropriate (i.e., data was representative of the uppermost continuous groundwater unit). This evaluation resulted in the identification of several monitoring wells in which water levels were found not to be representative of the uppermost continuous groundwater unit at the site, according to Sharp. Sharp subsequently removed these non-representative data points from the July 2003, May 2001, March 2001, August 2000, and November 2000 data and revised the contour maps. After this correction, the area of mounding no longer existed and the general flow pattern was from east to west across the site, then turning northwesterly in the area of the bedrock valley. Average horizontal flow velocities calculated by Sharp for the uppermost continuous groundwater unit ranged from 223-266 feet/year and 230-274 feet/year based on the November 2000 and May 2001 data, respectively.

III. PELA REVIEW FINDINGS/DISCUSSION

The points listed in the subsections below address PELA's concerns and issues as related to answering the above questions posed by the EPA OIG. All of these points should be considered collectively in answering the questions. For ease of review, the concerns and issues have been categorized into two subsections including Geology and Hydrogeology, and Monitoring Well Network.

A. GEOLOGY AND HYDROGEOLOGY

The following nine points address PELA's concerns and issues as related to the geology and hydrogeology of the site.

Point #1: Removal of Water Levels for Contour Maps

In Sharp's revised 2003 report regarding "Assessment of Individual Groundwater Monitoring Wells at IEL", a systematic evaluation of all project wells and the appropriateness of the S, I, and D well designations was completed. Following this evaluation, Sharp recommended the removal of groundwater elevation data for three wells completed in the Carlisle Muck (MW-9S, MW-5S, and MW-4S), three wells containing "perched water" (MW-14S, MW-1S, and MW-18S), three dry wells (MW-2S, MW-3S, and MW-13S), and one well completed in waste (MW-7S), because these wells did not monitor the uppermost continuous groundwater unit (i.e., the shallow aquifer). According to Sharp, removal of these wells makes the groundwater mounding, that was previously identified on various contour maps for the uppermost water-bearing zone in the vicinity of the landfill, disappear.

PELA has reviewed the available geologic well log information for these above-removed wells and generally agrees with Sharp's findings and has the following additional comments:

- The wells completed in the Carlisle Muck will not provide useful data regarding the uppermost continuous water-bearing zone beneath the site and are really only useful measures of the surface water levels within the muck and low-lying/wetland areas to the east of the site. While there may be some interaction between the waters of the Carlisle Muck and the uppermost continuous water-bearing zone beneath the site, the wells completed solely in the Carlisle Muck should not be considered representative of the uppermost continuous water-bearing zone beneath this site.

- A review of the geologic log and the **Figure 4** Cross-Section (attached) from Sharp (2003-revised) for MW-7S indicates that this well is not screened in waste as Sharp mentions, but instead appears to be screened entirely across Carlisle Muck.

Sharp states that the boring log for this location does not indicate the presence of waste at this location even though waste is in fact present. Regardless of whether MW-7S is screened across waste or the Carlisle Muck, based on the bullet above, water levels for MW-7S should not be used to construct water level contour maps for the shallow aquifer.

- The three dry wells (MW-2S, MW-3S, and MW-13S) noted by Sharp could only be used to establish maximum groundwater levels for these locations. Since no accurate water level data are available, these wells should not be used to construct water level contour maps for the shallow aquifer.

- The removal of water level data for MW-14S, MW-1S, and MW-18S because they are “perched” is discussed in detail for each location below. Bear in mind that Sharp defines “perched” simply as having an abnormally high water level and does not attach any causative restrictions to this designation.

  - Sharp reports that MW-14S is not representative of the uppermost continuous groundwater unit. PELA generally agrees with this comment based on the fact that: (a) the water level at this location is substantially higher than all other wells on-site, (b) the well reportedly bails dry after the removal of less than a gallon of water, and (c) alternating layers of silty sand and clayey sand are present beneath the screened interval. These facts indicate that the water level tapped by this well may be locally held above the general water table by low permeability sediments, the more common meaning of the term “perched”. PELA has also noted that MW-13S (located to the west of MW-14S), which is screened in the same interval as MW-14S, is a dry well. PELA concurs that there are several justifiable reasons why this well should not be used to construct groundwater contour maps for the shallow aquifer.

  - For MW-1S, Sharp does not appear to offer any significant reason for the removal of this well other than the fact the water level is abnormally high (“perched” in their terminology) and therefore is not representative of the upper water-bearing zone. Because the lithology of this well is not very detailed and/or legible, it is hard to say whether there are geologic controls in the vicinity of the MW-1S well screen that may be causing the water level to be more elevated.

  - For MW-18S, Sharp reports a 6-foot-thick section immediately below the screened interval containing clayey sand and lenses of fine to coarse sand. Sharp suggests that this could be causing perched water levels at this location. PELA’s review of the attached **Figure 4** Cross-Section (Sharp, 2003-revised) reveals that the screened interval is placed predominately across fine-grained clastics (silts/clays), but also across an approximately 2-foot-thick sand/gravel layer. PELA notes that because this sand/gravel layer is relatively thin and appears to be discontinuous, and it also generally appears to be contained within the fine-grained clastics, it is very plausible that the groundwater elevation at this location is in fact elevated due to local variations in permeability.

In summary, PELA has evaluated the revised water level elevation contour maps prepared by Sharp based on the July 2003, May 2001, March 2001, November 2000, and August 2000 water levels and we agree with the revised interpretation of groundwater flow in the uppermost water-bearing zone for the area of investigation.

Point #2: Selective Use of Intermediate vs. Shallow Well Data to Construct Maps

In Sharp's August 22, 2003 response letter to EPA comments, it is stated under "response to comment 5" that one well in each cluster was identified as being most representative of the uppermost continuous groundwater unit. Data for the shallowest wells were selected unless information suggested its use was inappropriate. According to Sharp, any observation of "perched" conditions was sufficient information to select the next deepest screened well in a cluster. Regarding these points, MW-11S reportedly showed a "perched" elevation and therefore the data for MW-11I was selected at this location. According to Sharp's "response to comment 6", a thinly interbedded sequence of silts and fine sands are present below the screened interval for MW-11S, which could potentially be causing perched conditions at this location. Because of this, Sharp's selection of MW-11I as the most representative well seems justified.

Furthermore, it should also be noted that the glacial deposits at this site are relatively non-uniform. In glacial deposits, local variations in water levels can readily occur. It is not uncommon to have two wells screened at the same intervals in generally similar (or dissimilar) glacial materials that yield different water levels, or to have one well dry while the other is not. For this site, given the variations in lithology, permeability, and water levels within the uppermost continuous aquifer, it appears that the selective removal of water levels can be justified. Note that in PELA's evaluation of the lithologic and water level data, we have concluded that the shallow, intermediate, and some of the deep wells all tap one generally continuous (although irregular) aquifer.

Point #3: Water Level Contour Maps

The Remedial Design Plan (Sharp, 2003) states that a general east-to-west groundwater flow pattern is present at the site in keeping with the dominant influence of the bedrock valley; **Figure 18** (Uppermost Continuous Groundwater Unit Potentiometric Map 7/18/03) of the same document is referenced and is attached. The document further states that this flow pattern has remained consistent through many years of measurement. PELA reviewed four additional contour maps, or portions of these maps, prepared by Sharp based on March 2001, May 2001, August 2000, and November 2000 data. All four additional contour maps illustrate this same general east to west flow pattern for the uppermost continuous groundwater unit, with a tightening of the contours in the vicinity of the bedrock valley.

To further evaluate flow conditions, Sharp personnel were contacted by PELA on June 23, 2004, to inquire whether earlier groundwater contour maps were redrawn following

Sharp's removal of "perched" and other non-representative water level elevations. According to Mr. Kim Stemen at Sharp, a total of 12 additional maps were redrawn using data in the early 1990s (from every season over several consecutive years). All 12 of these maps reportedly showed the same general east to west flow pattern.

Based on this information, PELA believes that seasonal variations in groundwater flow patterns have been appropriately evaluated, and that the flow pattern in the uppermost continuous aquifer has remained relatively consistent during the years evaluated by Sharp.

Point #4: Groundwater Mounding

Many of the earlier groundwater contour maps that were drawn by various parties showed an area of significant mounding in the vicinity of the waste disposal area at the IEL site. However, it is PELA's opinion that these earlier maps were not representative of the shallow groundwater conditions because: (1) no previous review of the appropriateness of the S, I, and D designations had been completed, and (2) additional new data, which was not previously available, has been obtained through the installation of additional monitoring well clusters which provided the information needed to support newly found conclusions regarding groundwater flow conditions at the IEL site. Therefore, it is PELA's opinion that the current and revised water level contour maps, using the revised list of appropriate monitoring wells as developed by Sharp (2003-revised), are most representative of true conditions within the shallow water-bearing zone for the years evaluated.

However, it is also important to recognize that groundwater flow and recharge conditions during the time of waste placement were likely much different than what occurs today, where a large portion of today's precipitation is dissipated through evapotranspiration and/or as surface run-off. Before it was completely filled and the final soil cover was added in 1980, the open pit landfill would have served as a local recharge area for the shallow groundwater system. At that time, it is possible that localized mounding of groundwater (or other alteration from normal flow patterns) within the uppermost continuous groundwater unit beneath the landfill was occurring due to increased infiltration of surface water into the aquifer. This recharge could have also acted as a flushing mechanism to move contaminants through the landfill debris and down and into the groundwater system during the years that the landfill was an open pit and accepting wastes (~1964-1980). This could have transported a significant amount of contamination into and through the groundwater system. These conditions would not be expected to have occurred after the final soil cover was placed. Furthermore, because: infiltration conditions were different during the years of landfill operation; landfill waste is in direct contact with the sand and gravel aquifer in places (see attached **Figures 1, 2, and 5** from Sharp, 2003-revised); the sand and gravel deposits beneath the landfill are highly permeable; and, the groundwater flow velocities for the site and immediate area are relatively high at 223-767 feet/year based on the November 2000 and May 2001 data (as calculated by Sharp, 2003-revised), it seems possible that much of the site contamination could have migrated significantly off-site prior to the initial subsurface investigation which began in 1986 (approximately 22 years after the landfill first accepted wastes).

Point #5: Bedrock Groundwater Level Contour Map

Geraghty & Miller (1997) present a discussion regarding groundwater flow on page 3-5 of their report (Subsection 3.3). In this subsection, they reference **Figure 3-3** (attached) as illustrating the groundwater flow within the bedrock aquifer. The text of the Geraghty & Miller report states that the flow (for both shallow and bedrock aquifers) shows localized radial flow of groundwater from the site based on March 1997 data. This radial flow to the east and southeast is towards Metzger Ditch, while flow to the west is generally consistent with regional flow patterns.

PELA did not see any other information within the provided documentation regarding groundwater flow patterns within the bedrock wells. However, using the bedrock water level elevations from **Figure 18** (attached) from Sharp's Remedial Design Plan (2003), the contours seem to follow a pattern similar to that observed for the uppermost continuous unit water level contour map prepared by Sharp (i.e., with general east to west flow direction and tightening of contours near the bedrock valley). However, no detailed maps were drawn by PELA. Inasmuch as only a few wells on-site penetrated the bedrock aquifer, and because the bedrock varies in lithology across the site, conclusions regarding radial flow appear to be only weakly supported, if at all. Because the deeper bedrock aquifer appears to be isolated from the shallow aquifer and has only shown non-detect and/or low and sporadic VOC concentrations to date (based on historical data in Sharp's 2003 Remedial Design Plan), this issue would appear to be moot.

Point #6: Evaluation of Vertical Gradients Between Water-bearing Zones

Under a discussion of hydraulic gradients (subsection 3.3.1), Geraghty & Miller (1997) state that based on water levels in the shallow, intermediate, and bedrock well clusters, a downward gradient (or potential) exists throughout most of the site and that the highest downward gradients occur in the vicinity of MW-11 and MW-23 with a maximum gradient of 0.172 feet/foot. Geraghty & Miller (1997) further state that an upward flow gradient (indicating a groundwater discharge area) exists in the eastern and southeastern portions of the site. Additionally, they state that the primary direction of groundwater flow is most likely horizontal through more permeable sand and gravel deposits.

For comparison purposes, using data from the August 2000 Groundwater Map (Figure 7, Sharp, 2003-revised) PELA calculated vertical gradients for wells screened at different intervals within the uppermost continuous aquifer, and between the bedrock and uppermost continuous aquifer. Downward vertical gradients exist between the uppermost continuous aquifer and the bedrock aquifer at all bedrock well locations except MW-12D, with the highest downward gradients at the MW-11 and MW-23 clusters. This conclusion is similar to Geraghty & Miller's findings. Vertical gradients between wells screened in different intervals of the uppermost continuous aquifer, however, were both upwards and downwards but at generally low values, with the highest gradient (approximately 0.081feet/foot upward) located at the MW-24S/I cluster. The overall conclusion from this evaluation is that within the uppermost continuous water-bearing zone, the horizontal component of flow is generally more significant than the vertical component.

Evaluation of vertical flow gradients is important to properly understand subsurface flow conditions and hydrogeologic patterns. It may be useful to evaluate all quarterly vertical (and horizontal) gradients for at least one annual cycle to ensure that there are no significant changes in flow conditions during different times of the year/season. None of the provided documentation indicated that this had been done.

Point #7: Confined versus Unconfined Aquifer Conditions

Geraghty & Miller (1997) report that the groundwater in the sand and gravel aquifer occurs under "unconfined" conditions. While this may be true in parts of the site and surrounding area where less permeable barriers (aquitards) are not present within the sand and gravel aquifer, PELA does not believe unconfined water table conditions occur in all areas in and around the site. Rather, it appears that semi-confined groundwater conditions do occur in certain areas. As an example of this, PELA refers the reader to the area near MW-3S/I/D on **Figure 1** (Water Level Cross-Section #1) attached from Sharp (2003-revised). According to that cross-section, a 15-foot-thick layer of sand is present at that location which is underlain and overlain by layers of fine-grained clastics (i.e., silts and/or clays) that are at least 20 feet thick. Although these fine-grained clastic layers do not appear laterally continuous, the water level for the intermediate well at this location (MW-3I), which is screened across the sand unit, occurs approximately 22 feet above the top of the sand unit at this location. This water level in MW-3I corresponds to the screened interval for MW-3S (which is dry) and is screened within the upper most fine-grained clastic unit. The elevated water level at this location indicates some type of semi-confining or confined conditions are occurring.

Point #8: Bedrock Surface Contour Map

Other than an Ohio Department of Natural Resources Bedrock Topography Map of the North Canton, Ohio Quadrangle, (Open File Map BT-C2H4, 5,1996), which contained limited bedrock elevations at the IEL site, no other bedrock contour maps were observed in the site literature provided. Therefore, PELA plotted the bedrock elevations for all on- and immediately off-site wells to better understand the characteristics of the bedrock surface underlying the site. After reviewing the data, it is apparent that the bedrock surface is highly variable (which corresponds with published literature on the regional glacial geology of the area) and ranges from a high of approximately 1,103 feet above mean sea level (AMSL) (MW-2D – northwest corner of the site) to a low of 970 feet AMSL in the vicinity of MW-11D (along the western property boundary). In plotting this elevation information, it is apparent that a bedrock valley is present on the western portion of the site and extends off-site in a northwesterly direction. The uppermost groundwater contour pattern (as prepared by Sharp and referenced above) very closely mimics the contours of this bedrock valley confirming that bedrock topography strongly influences the shallow groundwater flow pattern in that area (as discussed by Sharp). One point that is not clear, due to the lack of wells that encountered bedrock within the landfill footprint, is whether or not the bedrock valley transects the entire site to the east. However, it should be noted that Geraghty & Miller (1997) state that based on "data acquired from site drilling activities", the bedrock valley does in fact trend from east to west across the site; however, the data used to reach this conclusion was not provided.

Point #9: Surface Water to Groundwater Relationship
Limited information was available in the supplied review documents pertaining to the relationship between surface water and groundwater, as related to the Carlisle Muck/wetland areas east of the site, and Metzger ditch (old and new locations).

B. MONITORING WELL NETWORK

The following six points address PELA's concerns and issues as related to the monitoring well network for the IEL site.

Point #1: Distribution/Placement of Wells/Sufficiency for Characterization
Over the years, a significant number of monitoring wells (approximately 58) have been installed to investigate the IEL site and surrounding area. Of this total, approximately 12 wells were installed within or screened across the bedrock/overburden interface, while the remaining 46 wells were installed in unconsolidated overburden (glacial or fill/waste) materials. While several wells have been installed within the waste footprint, the majority of the wells were placed outside the waste boundaries, but surround the waste area along (or near to) the eastern, southern, and western property boundaries. Eight overburden wells have also been installed off-site to the west, and two background (upgradient) wells (MW-12I/D) were installed approximately 500 feet to the north-northeast of the IEL site.

In light of the most current thinking regarding the revised groundwater flow conditions within the uppermost continuous groundwater unit, it is apparent that wells located to the west of the landfill area (both on- and off-site) will be critical for future groundwater monitoring efforts and in monitoring for potential off-site migration. The most critical on-site wells in this area include MW-11I/D, MW-2S/I, and MW-1S/I/D, consisting of two bedrock wells (one at the lowest identified bedrock location on-site), two "shallow" wells screened at or near the water-table surface, and four wells screened primarily in sand/gravel units at intervals below the "shallow" wells. Several wells or well clusters have also been installed cross-gradient to the western portion of the landfill area. This is illustrated on the attached **Figure 3** Cross-Section (Sharp, 2003-revised). Off-site wells MW-24S/I and MW-26S/I (and to a lesser extent MW-27S/I/D) will also be critical for downgradient monitoring purposes. PELA concludes that these wells are sufficient for monitoring any continuing off-site migration of contaminants.

Point #2: Well Installation/Development
During the initial phase of drilling at the IEL site, difficult drilling conditions (i.e., heaving sands and gravels) were encountered on many of the intermediate and deeper drilling locations. As a result, the contractor switched from using water as the drilling fluid to air rotary drilling methods. When this did not work for the deeper well locations, pure

bentonite mud was used as the primary drilling fluid. Following installation, the deeper wells were developed using air surging, while bailing or pumping was used to develop the shallow wells. No details were reviewed or available regarding specific amounts of time spent developing the wells or the volumes removed.

During Phase II drilling efforts, when 17 additional wells were placed at 6 locations, all of the deeper wells were drilled using mud rotary to depths approximately 10-15 feet above the planned screen intervals, after which the boreholes were flushed with water until cleared of all bentonite mud; drilling then continued using water rotary to the desired depth. The majority of shallow wells were drilled using hollow-stem augers. No specifics regarding well development techniques used during the Phase II drilling effort were mentioned; however, it is expected that similar methods would have been used.

Given the limited time for this work, PELA did not review every well completion report in detail to ensure that wells were properly installed and/or developed. However, it appears that, in general, these well development and installation methods were appropriate given the conditions encountered.

Point #3: Dense Non-Aqueous Phase Liquids (DNAPLs)

DNAPLs and various chlorinated solvents have specific gravities greater than that of water. Therefore these compounds readily sink through the groundwater until stopped by more impermeable barriers such as bedrock or very fine-grained sediments (i.e., silts, clays, etc.). PELA's review indicates that DNAPLs have in fact been tested for during various investigation phases at IEL as supported by the following:

- According to the U.S. EPA's 1989 Record of Decision (page 17 of PDF version), the design study was to include an investigation for NAPLs.

- A December 14, 1990 U.S. EPA memorandum to the IEL Technical Information Committee regarding the status of the Quality Assurance Project Plan, states that as part of the groundwater monitoring program, the U.S. EPA will sample for both light and dense NAPLs.

- According to a 1992 U.S. EPA document entitled "Questions & Answers About the Industrial Excess Landfill Superfund Site", MW-17D was installed specifically to "determine the potential existence of dense non-aqueous phase liquids (DNAPLs) where the sand/gravel and bedrock layers meet".

- Appendix 3 of Sharp's Remedial Design Plan (2003) contains a summary of VOC water-quality data from approximately 1988 through 2003. A review of this analytical data indicates that the analyses included various chlorinated (heavier than water) compounds for all monitoring well locations.

Furthermore, there are some monitoring well locations where DNAPLs/chlorinated solvents are likely to have been identified, if in fact they were placed into the landfill, including:

- Bedrock interface well MW-17D located in the northeastern corner of the landfill area, where the landfill waste is in direct contact with the uppermost groundwater-bearing unit (see attached Sharp **Figure 2** Cross-Section; 2003-revised).

- MW-11D, a bedrock well installed down hydraulic gradient at the lowest topographic elevation within the study area within the bedrock valley (see attached Sharp **Figure 3** Cross-Section; 2003-revised).

- MW-9S which is screened across IEL fill materials and Carlisle Muck directly above an approximately 5-foot-thick clayey silt layer (see attached Sharp **Figure 2** Cross-Section; 2003-revised).

- MW-21I located in the east-central portion of the IEL site and screened directly on top of till material.

- MW-27I/D which are located off-site to the west of the northwestern corner of the IEL site and are screened across the sand/till interface and bedrock, respectively.

- MW-18I which is located near the southeastern corner of the site and screened across the bedrock/gravel interface.

In terms of finding DNAPLs at this site, it should also be noted that the EPA answer to comment 11 in the 2000 ROD Amendment states that NAPLs were not found during the design study investigation. Also, based on the ROD Amendment (EPA, 2002), DNAPLs were not placed into the landfill per an EPA study conducted in the 1990s. Additionally, where detected, chlorinated solvents have only been identified at relatively low concentrations and are believed to be daughter products of other VOC-type solvents. This would support the fact that DNAPLs are not likely present at the site. Noting all of the above information, it appears that the investigations conducted at IEL were specifically designed to identify the presence of DNAPLs/chlorinated solvents and did not detect them at any significant levels.

Point #4: Future Monitoring Well Network

In reviewing the groundwater contour maps for the uppermost continuous aquifer showing Sharp's revised flow configuration based on the July 2003, May 2001, March 2001, August 2000, and November 2000 data, with respect to the VOC distribution in groundwater, a large area with no coverage existed down hydraulic gradient to the west of the landfill area between the MW-21 and MW-2 well clusters. However, this previously unchecked area will (in fact) be appropriately monitored with recently installed wells MW-29 and MW-31, as illustrated on the attached **Figure 19** – Post 2003 IEL Monitoring in the Remedial Design Plan (Sharp, 2003).

Point #5: Post–2003 IEL Monitoring

On **Figure 19** (Post–2003 IEL Monitoring) attached from Sharp's 2003 Remedial Design Plan, three monitoring wells (MW-10I, MW-25S and MW-27I) are illustrated as “downgradient" monitoring wells. However, review of these well locations with respect to the most current groundwater level contour maps for July 2003, May 2001, March 2001, August 2000, and November 2000 clearly show that these wells are in fact not located down gradient of the landfill, based on the most current interpretations of groundwater flow.

Point #6: MW-11S as Sentinel Well

Table 8 of Sharp’s Remedial Design Plan lists MW-11S as a “Sentinel” well located along the western boundary of the landfill. However, the table also states that the water level in this well is perched and is not representative of the uppermost continuous unit. Identifying it as “not representative” casts doubt on why MW-11S would be included in the proposed monitoring network. Some clarification regarding the use of this well would be useful (note it has historically been clean for VOCs).

IV. CONCLUSIONS

Based on PELA’s review for this project, there were and are a sufficient number of wells to characterize the geology/hydrogeology and groundwater quality at this site. Although there were several areas where additional or more detailed information would have been useful (such as more accurate/detailed/consistent logs of geology, more frequent soil sampling intervals, etc.), we believe an adequate understanding of site conditions was achieved, including the revised interpretation of groundwater flow conditions within the upper aquifer beneath the site. Furthermore, regardless of MW-25 and MW-10 not being located downgradient of the waste disposal area, it appears that the proposed monitoring network is sufficient and appropriate for future long-term monitoring of the shallow groundwater aquifer at the IEL site. With respect to the potential migration of contamination off-site, still of concern is the fact that the initial investigation took place approximately 22 years after the initial placement of waste in the landfill.

V. LIST OF REFERENCES

Geraghty & Miller, Inc., 1997. Evaluation of Groundwater Chemistry and Natural Attenuation Processes at the Industrial Excess Landfill, Stark County Ohio. Prepared for Fuller & Henry P.L.L., September 19, 1997.

Sharp and Associates, Inc., 2003. Remedial Design Plan for the Industrial Excess Landfill (IEL) Site, Uniontown, Ohio. September 22, 2003. Prepared on behalf of the Responding Companies.

Sharp and Associates, Inc., 2003. Summary Report on an Assessment of Individual Groundwater Monitoring Wells at the Industrial Excess Landfill (IEL) Site and the Regional Hydrogeologic Setting. December 12, 2000; Revised August 22, 2003.

Ohio Department of Natural Resources, 1996. Bedrock Topography Map of the North Canton, Ohio Quadrangle. Open File Map BT-C2H4, May 1996.

U.S. EPA, 1989. Record of Decision, Industrial Excess Landfill. July 17, 1989.

U.S. EPA, 1990. Memorandum to the Industrial Excess Landfill Technical Information Committee regarding the status of the Quality Assurance Project Plan. December 14, 1990.

U.S. EPA, 1992. Questions & Answers About the Industrial Excess Landfill Superfund Site. December 1992.

U.S. EPA, 2000. Record of Decision Amendment, Industrial Excess Landfill Superfund Site, Uniontown, Stark County, Ohio. March 2000.

U.S. EPA, 2002. Record of Decision Amendment, Industrial Excess Landfill Superfund Site, Uniontown, Stark County, Ohio. September 2002.

VI. GLOSSARY OF TERMS

Aquifer - a geologic formation with sufficient interconnected porosity and permeability to store and transmit significant quantities of water to wells and/or springs under natural hydraulic conditions. Aquifers are general areally extensive and can be underlain or overlain by confining beds.

Aquitard - low permeability formations which store water but cannot readily supply production wells, and which may function as the upper or lower boundary of an aquifer. An aquitard may transfer appreciable amounts of water to or from aquifers and where sufficiently thick, may make up important groundwater storage zones; sandy clay is an example.

Carlisle Muck - A laterally discontinuous layer of organic-rich peat identified during drilling in the eastern portion of the IEL site and areas to the east. This unit is present at the land surface east of the site and ranges from approximately 5 to 35 feet thick.

Confining Bed - A relatively impermeable material stratigraphically adjacent to one or more aquifers. Aquitards are one type of confining bed.

DNAPLs - Dense non-aqueous phase liquids. Organic substances with specific gravities greater than that of water (i.e., will readily sink through the water column).

Downgradient - downstream along the direction of groundwater flow.

Screen - the portion of a well that is slotted or perforated to permit the flow of water into and through a well.

Unconfined Aquifer - An aquifer of which the first saturated water encountered in a drilling program is usually not confined or impeded from moving up or down by less permeable materials or confining layers.

VOCs - Volatile Organic Compounds

VII. LIST OF ATTACHED FIGURES

From Geraghty & Miller, Inc., 1997, Evaluation of Groundwater Chemistry and Natural Attenuation Processes at the Industrial Excess Landfill, Stark County Ohio:

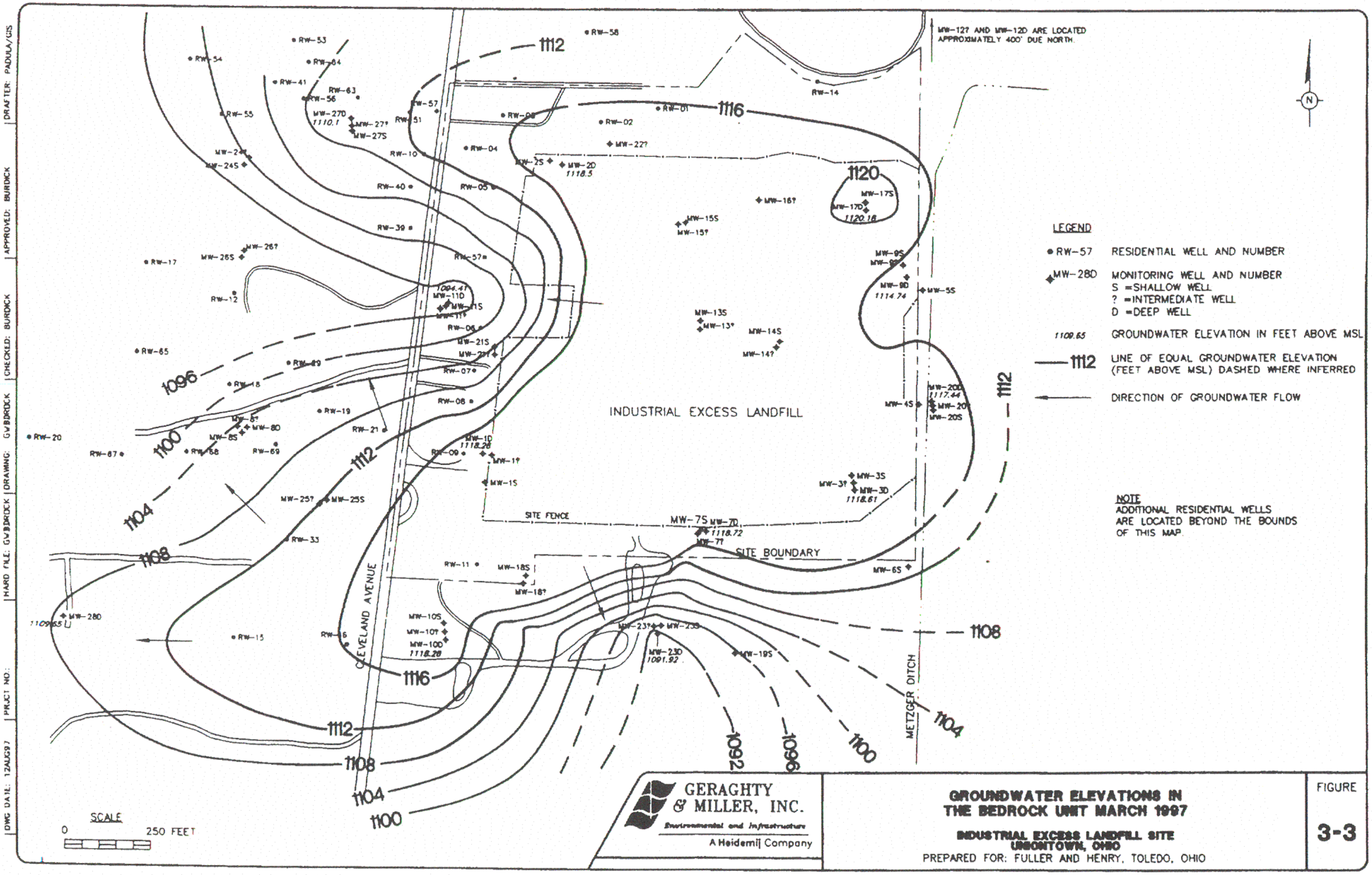
- Figure 3-3, "*Groundwater Elevations in the Bedrock Unit March 1997*".

From Sharp and Associates, Inc., Remedial Design Plan for the Industrial Excess Landfill (IEL) Site, Uniontown, Ohio, September 22, 2003:

- Figure 17, "*IEL Site Map w/Current Monitoring Well Network*"
- Figure 18, "*Uppermost Continuous Groundwater Unit Potentiometric Map, 7/18/03*"
- Figure 19, "*Post-2003 IEL Monitoring Well Network*"

From Sharp and Associates, Inc., 2003. Summary Report on an Assessment of Individual Groundwater Monitoring Wells at the Industrial Excess Landfill (IEL) Site and the Regional Hydrogeologic Setting, December 12, 2000; Revised August 22, 2003:

- Figure B, "*IEL Site w/Monitoring Well Network, Cross-Section Index Map*"
- Figure 1, "*Water Level Cross-Section #1*"
- Figure 2, "*Water Level Cross-Section #2*"
- Figure 3, "*Water Level Cross-Section #3*"
- Figure 4, "*Water Level Cross-Section #4*"
- Figure 5, "*Water Level Cross-Section #5*"



LEGEND

● RW-57	RESIDENTIAL WELL AND NUMBER
◆ MW-28D	MONITORING WELL AND NUMBER S =SHALLOW WELL ? =INTERMEDIATE WELL D =DEEP WELL
1109.65	GROUNDWATER ELEVATION IN FEET ABOVE MSL
—— 1112	LINE OF EQUAL GROUNDWATER ELEVATION (FEET ABOVE MSL) DASHED WHERE INFERRED
←	DIRECTION OF GROUNDWATER FLOW

NOTE
ADDITIONAL RESIDENTIAL WELLS ARE LOCATED BEYOND THE BOUNDS OF THIS MAP.

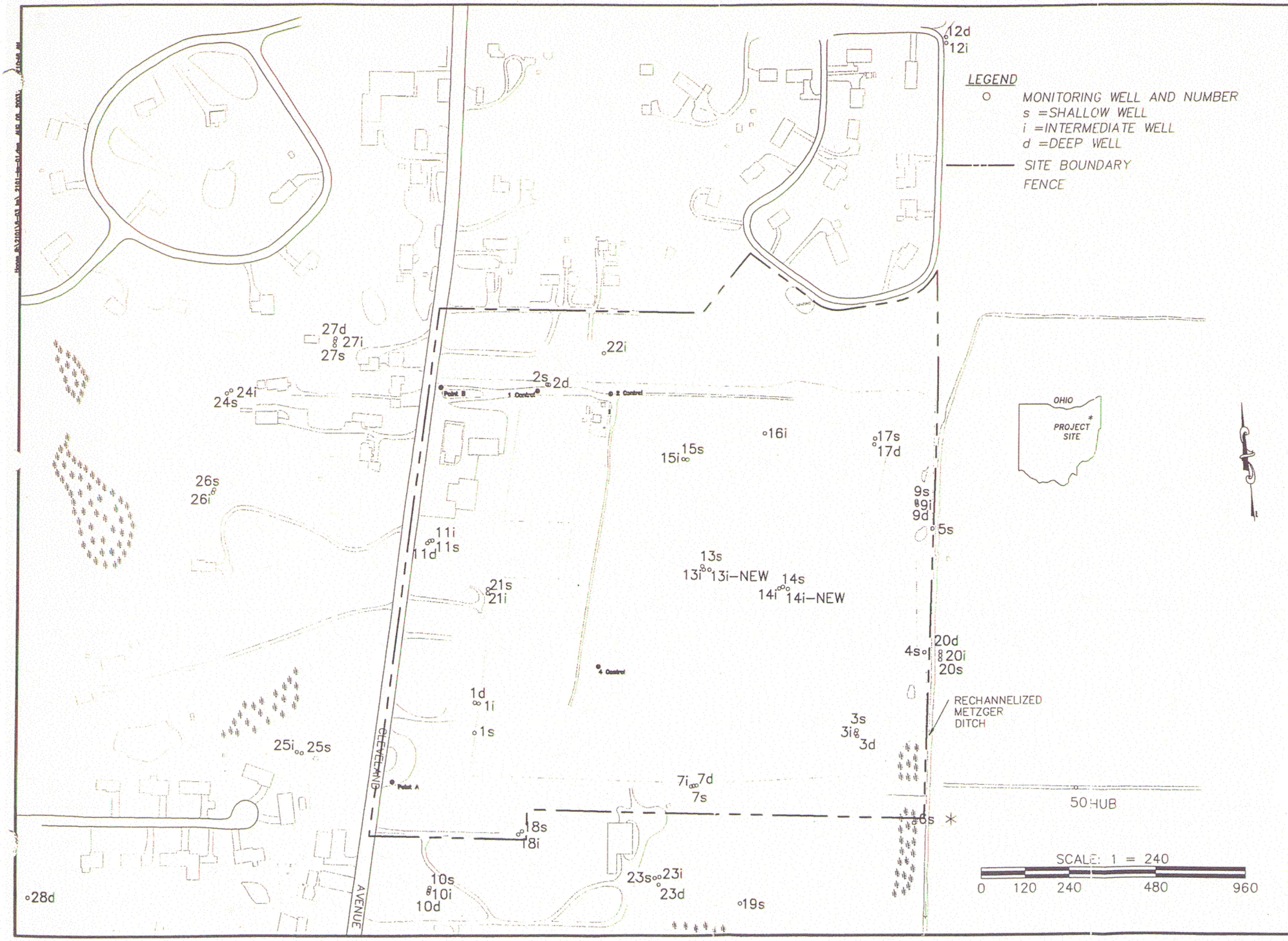
GERAGHTY & MILLER, INC.
Environmental and Infrastructure
A Heidemij Company

GROUNDWATER ELEVATIONS IN THE BEDROCK UNIT MARCH 1997

INDUSTRIAL EXCESS LANDFILL SITE
UNIONTOWN, OHIO
PREPARED FOR: FULLER AND HENRY, TOLEDO, OHIO

FIGURE
3-3

DRAFTER: PADULA/GIS | APPROVED: BURDICK | CHECKED: BURDICK | DRAWING: GWBDRDCK | HARD FILE: GWBDRDCK | PRJCT NO: | DWG DATE: 12AUG97



SHARP
AND ASSOCIATES, INC.
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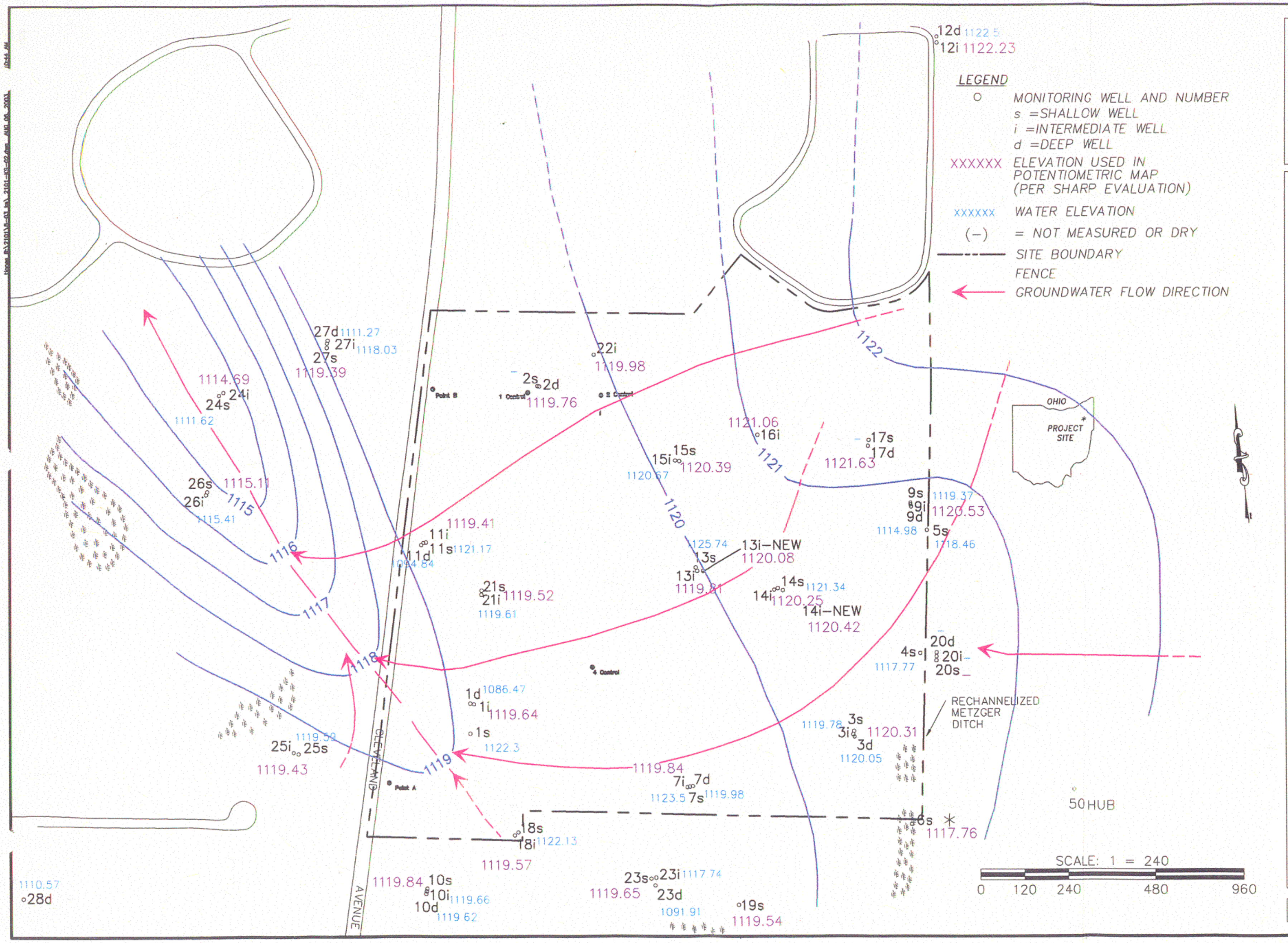
COLUMBUS, OHIO 43229
(614) 841-4659 / FAX (614) 841-4660

Project Reference: 2101

Client: IEL PRP GROUP

IEL SITE MAP W/CURRENT
MONITORING WELL NETWORK

FIGURE 17



Project Reference: 2101

JULY 18, 2003

Client: IEL PRP GROUP

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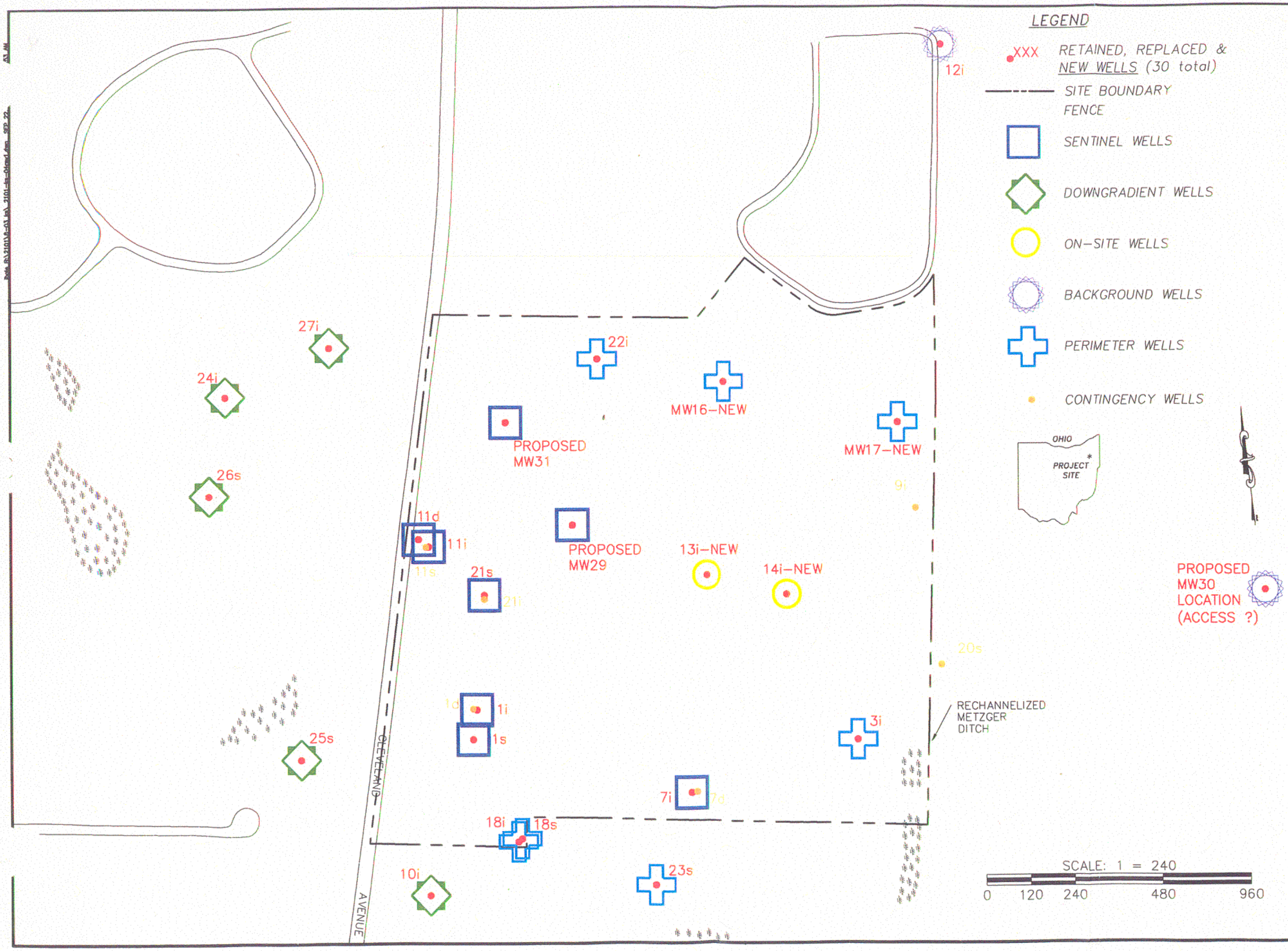
UPPERMOST CONTINUOUS GROUNDWATER UNIT POTENTIOMETRIC MAP

FIGURE 18



POST-2003 IEL MONITORING WELL NETWORK

FIGURE 19

Project Reference: 2101

Client: IEL PRP GROUP

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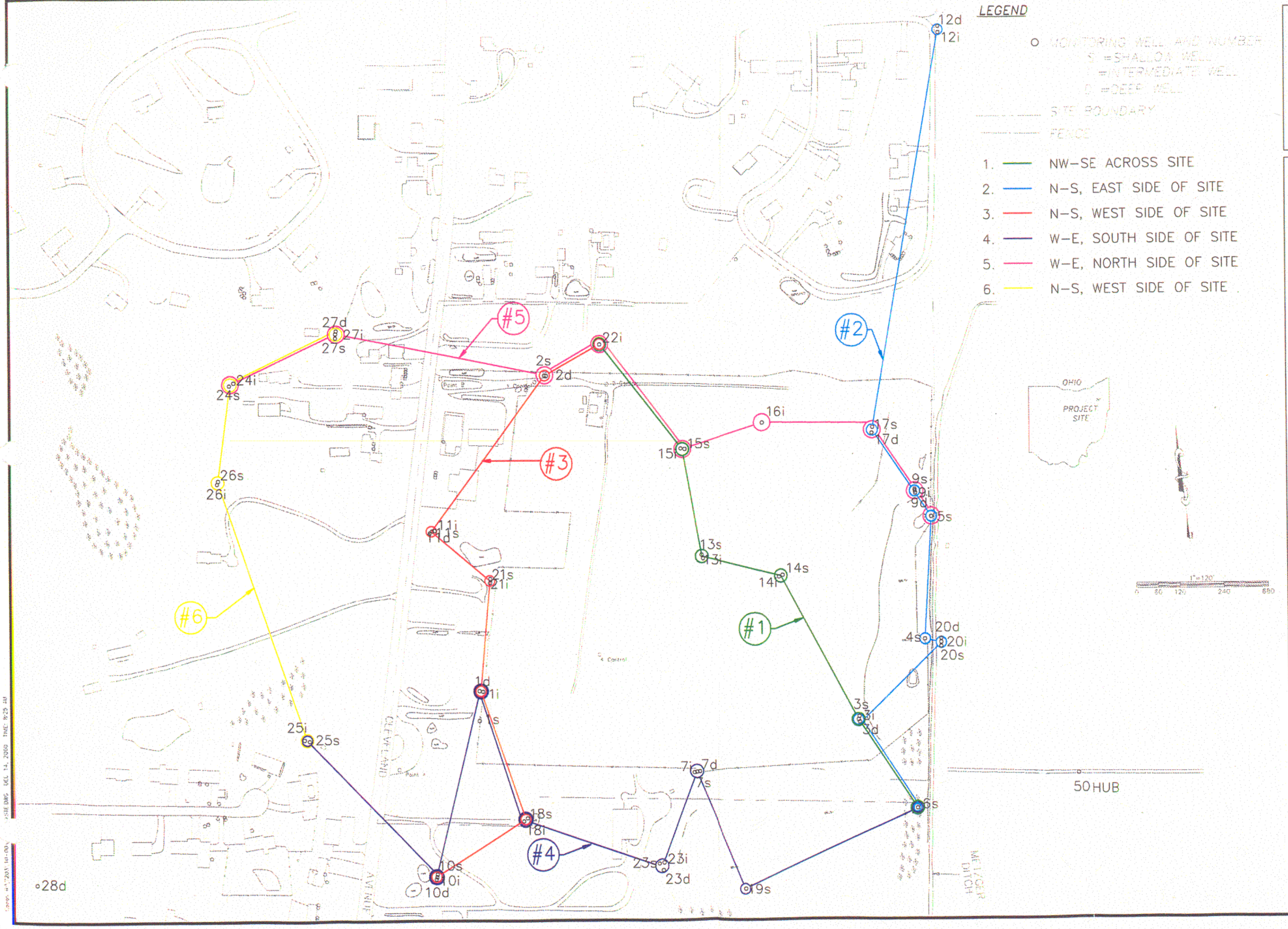

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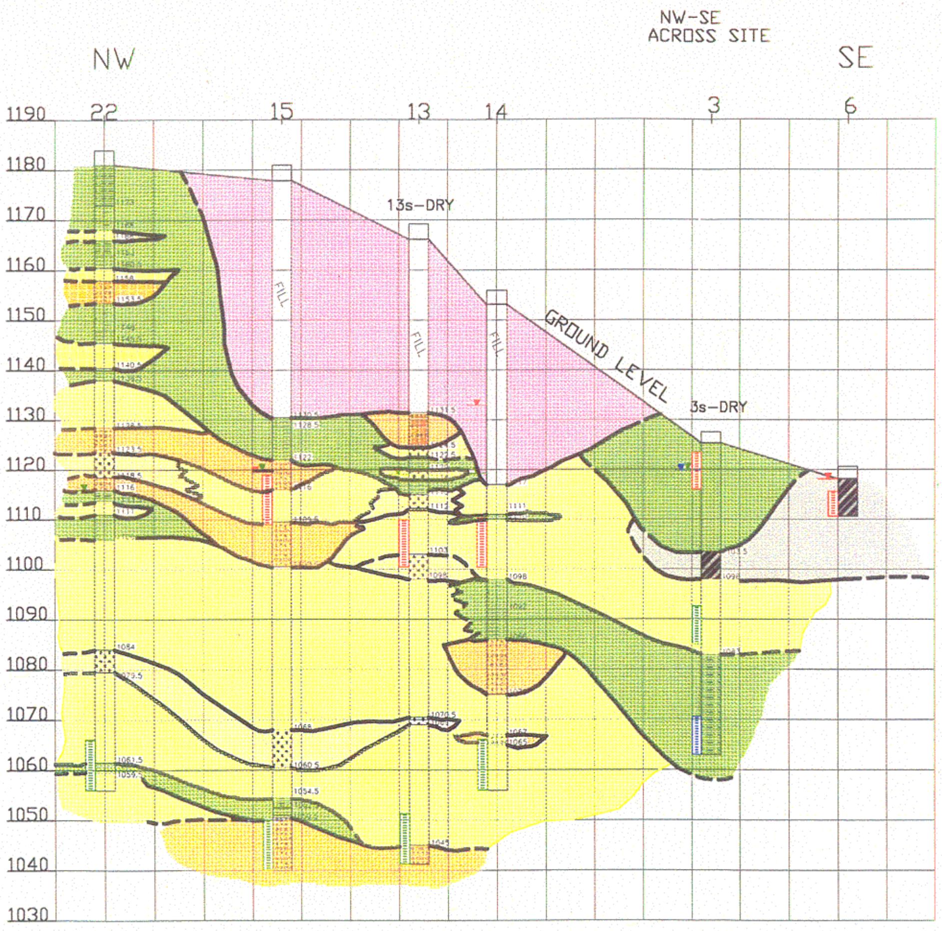
Project Reference: 7203

IEL SITE
W/MONITORING
WELL
NETWORK
CROSS–SECTION INDEX MAP

Client: IEL PRP GROUP

FIGURE B

CROSS-SECTION #1



LEGEND

- ▼ "SHALLOW" WATER LEVEL
- ▼ "INTERMEDIATE" WATER LEVEL
- ▼ "DEEP" WATER LEVEL

NOTE: MW-13S (DRY)
MW-3S (DRY)

- ▨ IEL FILL MATERIALS
- ▨ FILL MATERIALS WEST OF CLEVELAND AVENUE
- ▨ CARLISLE MUCK
- ▨ FINE GRAINED CLASTICS (SILTS AND/OR CLAYS)
- ▨ SILTY SAND
- ▨ SAND
- ▨ GRAVEL
- ▨ TILL
- ■ TOP OF ERODED BEDROCK

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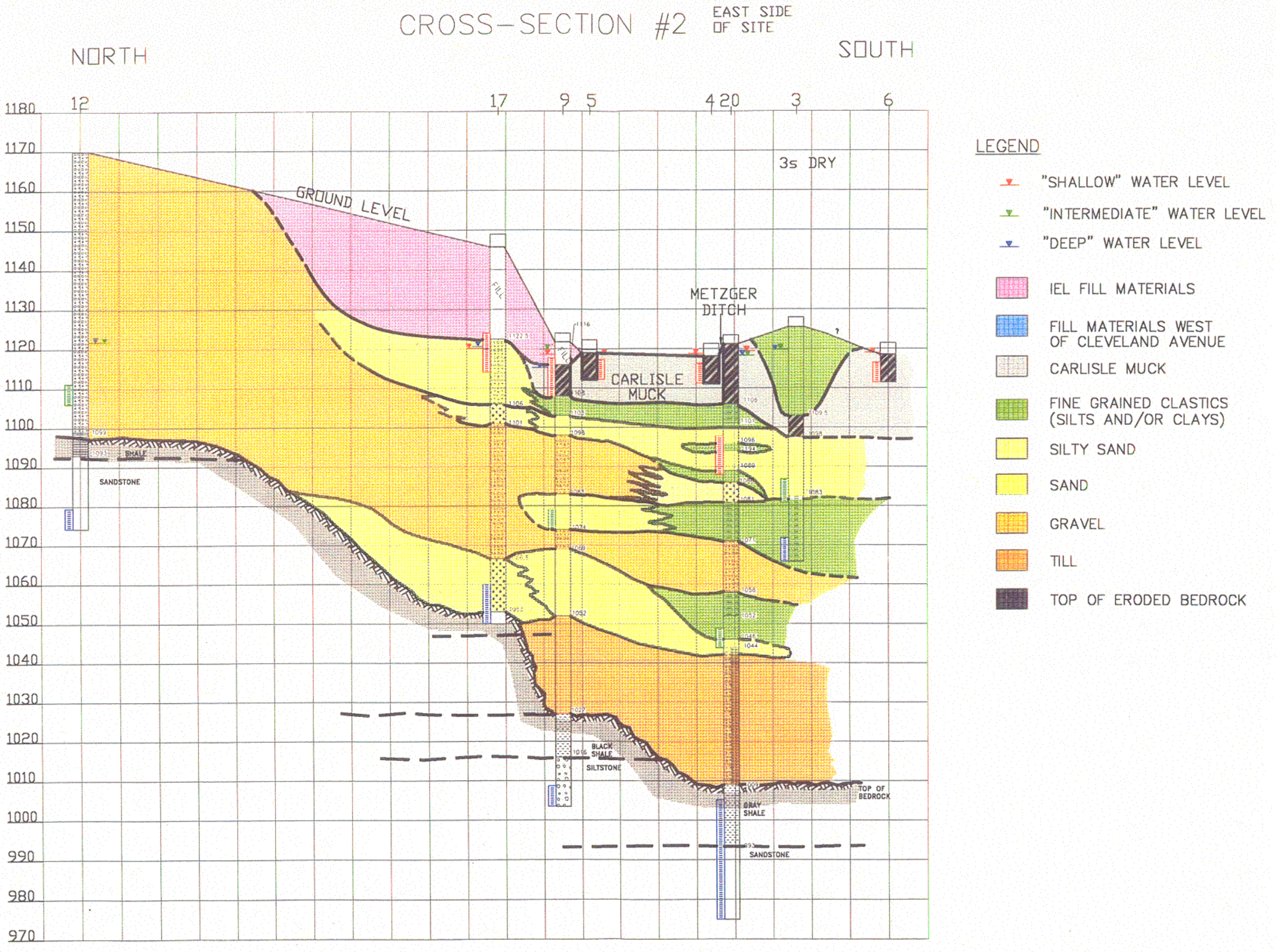
Client: IEL PRP GROUP

WATER LEVEL
CROSS-SECTION #1

Project Reference: 7203

FIGURE 1

CROSS-SECTION #2



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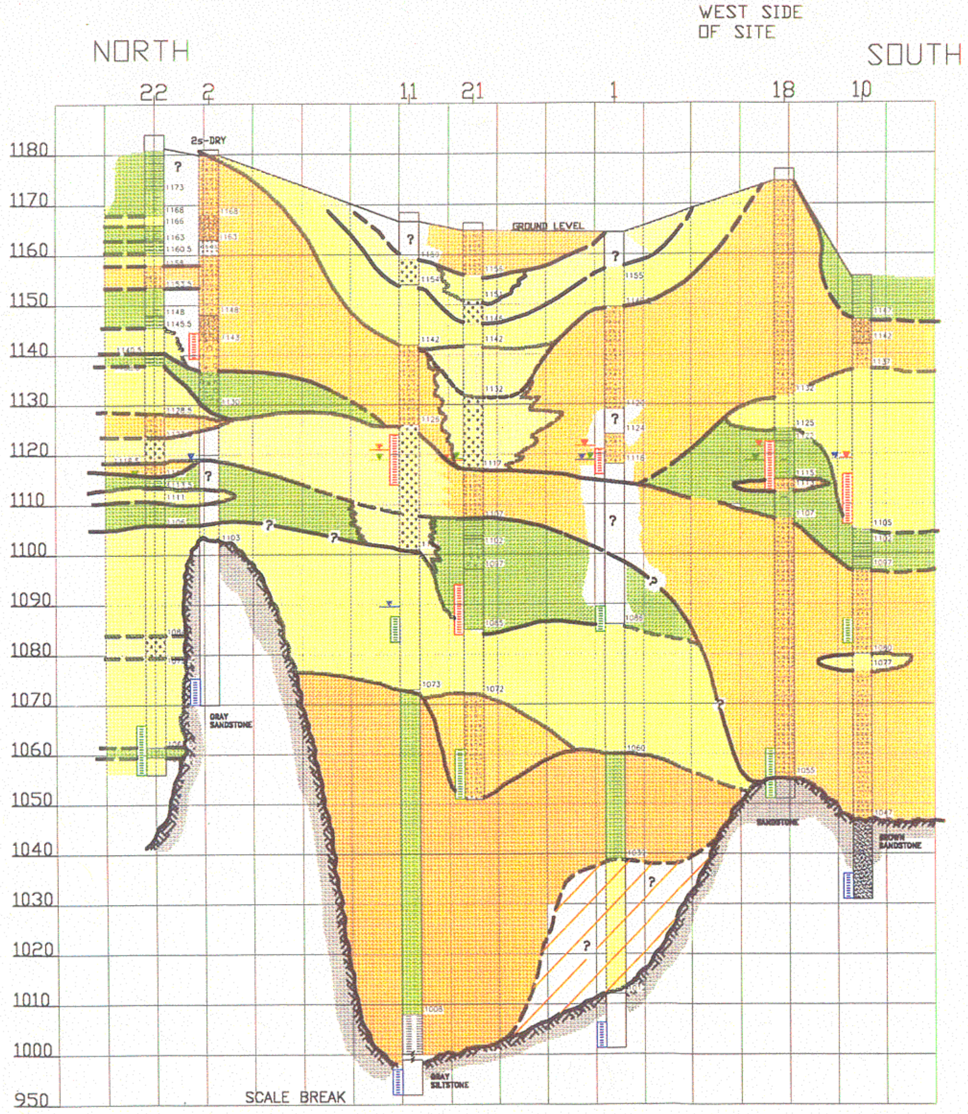
Project Reference: 7203

WATER LEVEL
CROSS-SECTION #2

FIGURE 2

CROSS-SECTION #3



LEGEND

- "SHALLOW" WATER LEVEL
- "INTERMEDIATE" WATER LEVEL
- "DEEP" WATER LEVEL

NOTE: MW-2S (DRY)

- 🟪 IEL FILL MATERIALS
- 🟦 FILL MATERIALS WEST OF CLEVELAND AVENUE
- ⬜ CARLISLE MUCK
- 🟩 FINE GRAINED CLASTICS (SILTS AND/OR CLAYS)
- 🟨 SILTY SAND
- 🟨 SAND
- 🟧 GRAVEL
- 🟧 TILL
- ⬛ TOP OF ERODED BEDROCK

NOTE:
THE LITHOLOGY RECORDS
FOR THE OLDER WELLS ARE
POORLY PRESERVED.

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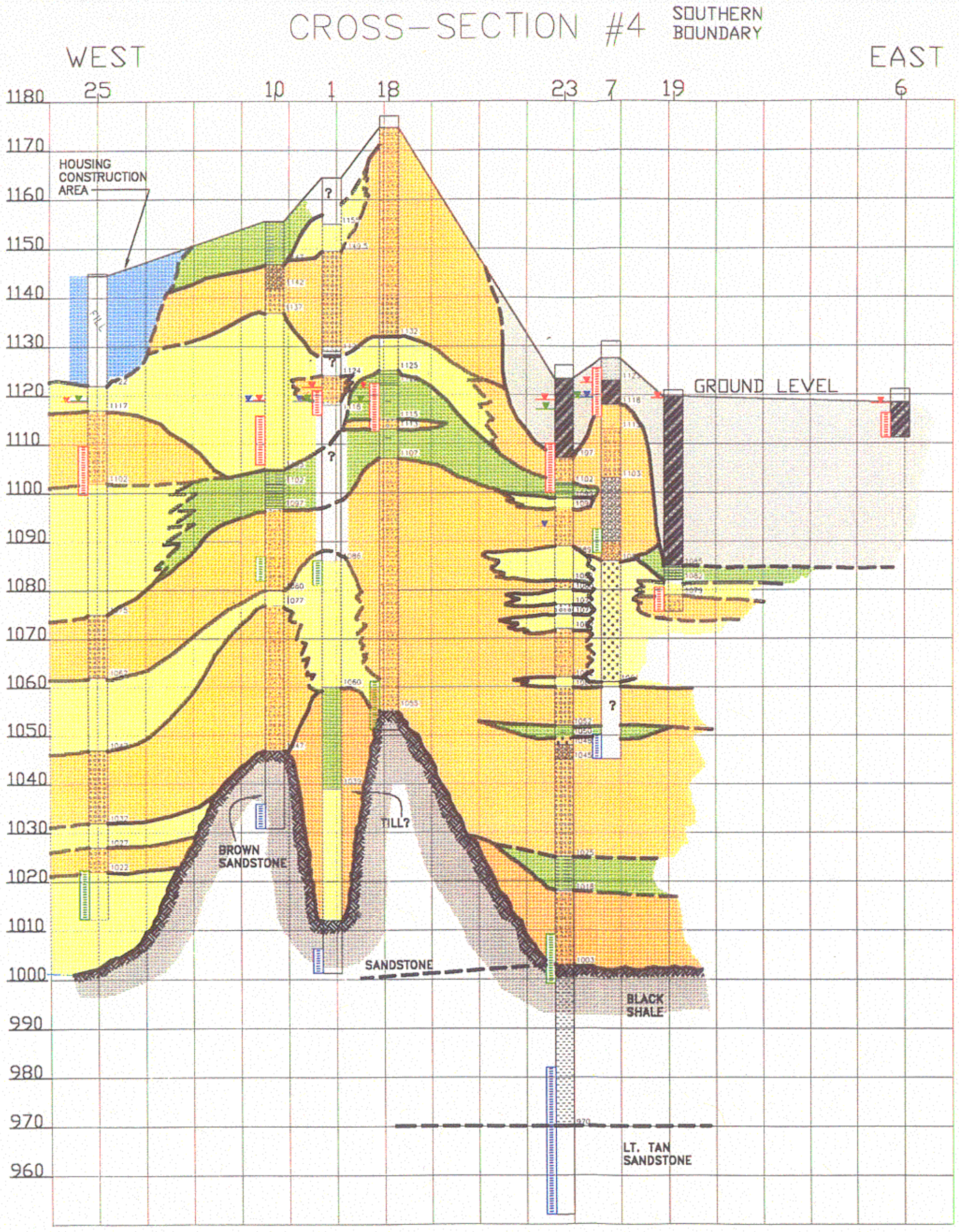
Project Reference: 7203

WATER LEVEL
CROSS-SECTION #3

FIGURE 3



LEGEND

- "SHALLOW" WATER LEVEL
- "INTERMEDIATE" WATER LEVEL
- "DEEP" WATER LEVEL
- ▨ IEL FILL MATERIALS
- ▨ FILL MATERIALS WEST OF CLEVELAND AVENUE
- ▨ CARLISLE MUCK
- ▨ FINE GRAINED CLASTICS (SILTS AND/OR CLAYS)
- ▨ SILTY SAND
- ▨ SAND
- ▨ GRAVEL
- ▨ TILL
- ▨ TOP OF ERODED BEDROCK

NOTE: MW-10I, NO WATER LEVEL COLLECTED. MW COVER HAD BEEN BURIED.

MW-10I WAS UNCOVERED IN LATE 2000.

WATER LEVEL MEASUREMENTS FOR MARCH 2001 WERE:
MW-10I=1118.98'
MW-1I=1118.94'

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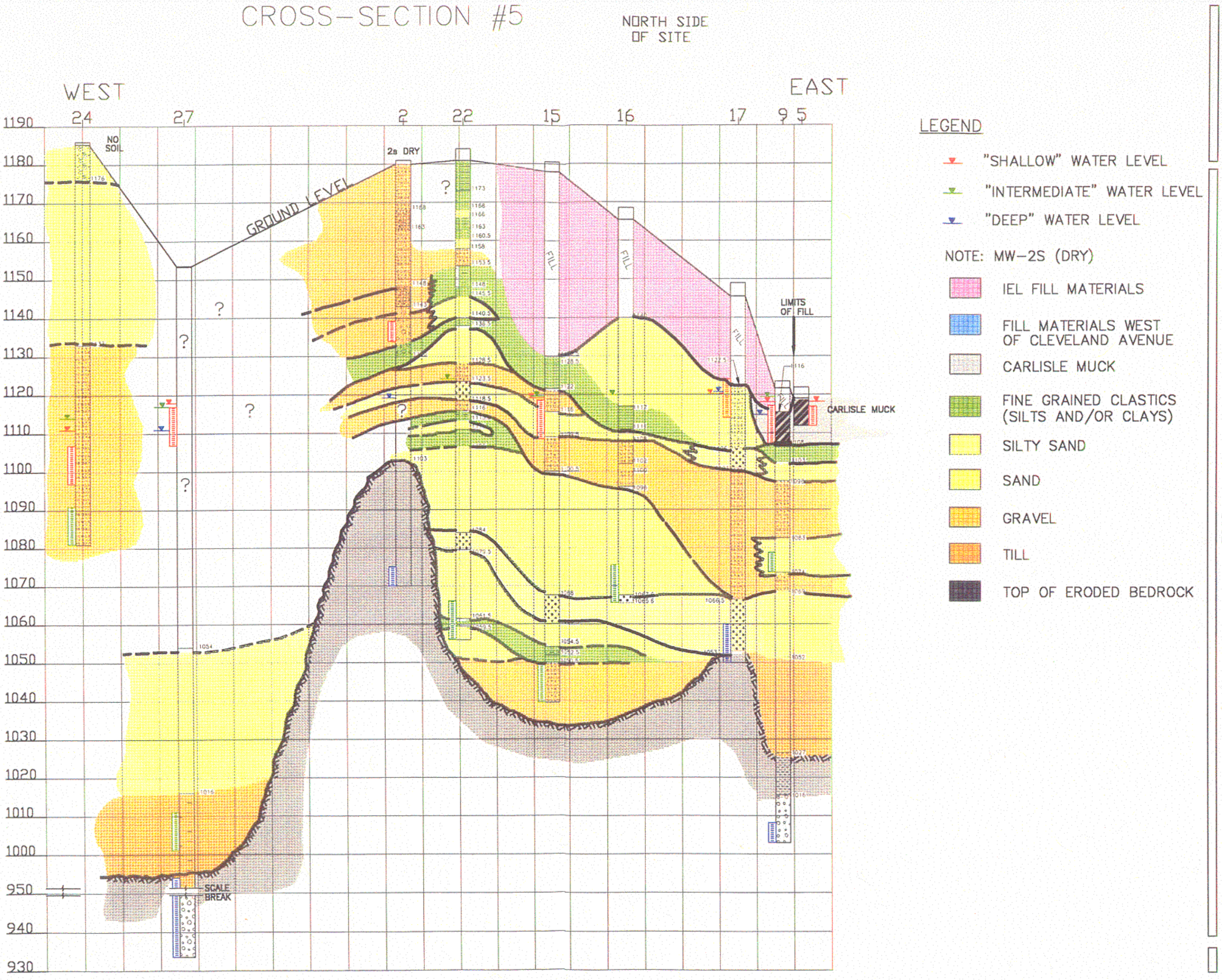
WATER LEVEL
CROSS-SECTION #4

FIGURE 4



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WATER LEVEL
CROSS-SECTION #5

FIGURE 5

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

MEMORANDUM

SUBJECT: Industrial Excess Landfill - Draft Ombudsman Report

FROM: Bharat Mathur
Acting Regional Administrator, Region 5

Original signed by
Norman R. Niedergang
Dated SEP 10 2004

TO: Paul D. McKechnie
Acting Ombudsman
Office of Congressional and Public Liaison

I would like to thank you for providing Region 5 with the opportunity to review and comment on the draft report entitled "Review of Actions at Industrial Excess Landfill Superfund Site, Uniontown, Ohio." The report focuses on two issues that citizens brought to the Ombudsman's attention: concerns about possible radioactive contamination at the site, and the selection of monitored natural attenuation as a remedy for groundwater contamination. Region 5 is pleased that the report concludes the Region properly discounted radionuclides as contaminants of concern, and appropriately selected monitored natural attenuation as part of the remedy at IEL. We intend to place copies of the final report in the public information repositories for IEL, and to post a copy on the website for IEL. We hope that the release of the final report to the public will help allay any remaining concern about these matters. Although Region 5 concurs with the overall findings of the report, we would also like to take this opportunity to present our response to certain radiation issues raised in Dr. Mel Gascoyne's report regarding the 2000-2001 radiation sampling at IEL.

Dr. Gascoyne states in his July 2, 2004, report to the Ombudsman that, "[i]t is not possible. . . to state categorically that no radioactive waste is present at the site because, in many cases, the analytical procedures used to detect specific types of radioactivity were insufficiently sensitive to differentiate measured concentrations from background (natural) levels." Dr. Gascoyne's statement implies that more sensitive testing could establish *categorically* the absence of radioactive contamination at IEL. Region 5 questions whether that is indeed the case. In 1994, a special panel of radiation experts and statisticians convened by the Science Advisory Board (SAB) declared that it would *never* be possible to establish unequivocally the absence of radioactive contamination at IEL (or anywhere else, for that matter). But while the SAB discounted the possibility of categorical proof, it nevertheless concluded that radioactive contamination in the landfill was very unlikely. Rather than requiring more sensitive testing, the SAB reached a conclusion based on the consistent pattern in IEL radiation data over time. We should note here that, because of time constraints, Dr. Gascoyne's analysis was limited to the data collected by the Responding Companies (Goodyear, Goodrich, Bridgestone/Firestone, and GenCorp) in 2000-2001. Region 5, however, has based its conclusions concerning radiation on all the IEL data, extending back to the early 1990s. The 2000-2001 findings are consistent with what EPA found earlier, giving us no reason to revisit the SAB's conclusions.

Region 5 also would like to provide a clarification regarding the recent radiation testing of soil near the IEL site. There are a few instances in Dr. Gascoyne's report where he refers to the testing of excavated material from "the site". Dr. Gascoyne appears to be referring to the soil cuttings generated during the installation of groundwater wells at the IEL site, and Region 5 agrees that these soils are properly designated as site soils. But Region 5 also conducted radiation testing in soil at a parking lot west of the landfill along Cleveland Avenue. We would not classify this as IEL soil, since the parking lot property was not owned by the landfill, was not used by the landfill, and is unlikely to have been affected by the landfill as far as the surface soil is concerned. Until a few years ago, the parking lot area was the site of Uniontown Tire, a local retail business. While the landfill was operating, there was a 60-foot drop-off between the elevation of land along Cleveland Avenue where Uniontown Tire was located and the bottom of the sand and gravel pit where IEL was depositing wastes. This differential in elevation would have made the spread of surface waste materials from IEL to property along Cleveland Avenue unlikely. In any event, sampling results obtained from the parking lot area show only naturally-occurring radioactive isotopes and concentrations within the expected background ranges.

Another issue raised in Dr. Gascoyne's report is the fact that groundwater testing will not identify the presence of sealed, inert containers of radioactive waste. That may be true, but EPA maintains that there is no good reason to believe there are any such containers of radioactive waste at IEL. The suspicion that there might be such containers buried at IEL derives solely from 2 anecdotal accounts, neither of which bears scrutiny: (1) the account of Charles Kittinger that the Army disposed of 3 large, egg-shaped stainless steel objects containing plutonium-238; and (2) the account of Liz and Harlan McGregor that Army flatbed trucks disposed of 50 to 100 stainless steel canisters bearing "hazardous markings." Mr. Kittinger's account was thoroughly investigated by the Justice Department, which reported its findings to Judge John Manos. Judge Manos concluded that it was almost certainly untrue that the military disposed of plutonium-238 at IEL as Mr. Kittinger described. As for the McGregors' account, none of IEL's owner/operators or employees confirmed the McGregors' story. It seems very unlikely that the military could dump dozens of marked canisters at the landfill without the owner/operators or employees being aware of it. In any case, "hazardous markings" do not necessarily mean radioactive contents.

Finally, Dr. Gascoyne concludes that "most of the problems and concern that have perpetuated throughout the history of the IEL, regarding the possible presence of radioactive waste at the site, remain unresolved following the 2000 and 2001 sampling, because the analytical methods used were only adequate to show that the groundwaters [sic] met drinking water standards." Region 5 disagrees with this conclusion. Once again, Region 5 notes that Dr. Gascoyne did not include in his analysis the entire radiation data set for IEL, only the data from the 2000-2001 sampling. That sampling was done voluntarily by the Responding Companies in response to concerns voiced by the Lake Township Trustees. The purpose of this testing was not primarily to confirm or refute the absence of radioactive contamination, but to reassure the Trustees that there was no health threat posed by the landfill. As Dr. Gascoyne acknowledges, the results show that there is no health threat from radiation at the landfill. In addition, however, the results are consistent with earlier rounds of radiation sampling in the 1990s, tending to support the conclusion that there is no radioactive contamination in the landfill. Region 5, like the SAB, believes that there can be no one, definitive test for radiation at IEL. Rather, one must look at the overall picture derived from many hundreds of samples. The SAB did this and concluded that it was very unlikely there was radioactive contamination at IEL. We believe that the "problems and concern that have perpetuated" have less to do with the quality of the testing, and more to do with some individuals' unwillingness to accept the SAB's conclusions.

Again, Region 5 very much appreciates the opportunity to review and provide clarification of our position on these issues. If there are any questions I can answer or if there is any other information Region 5 can provide to assist you, please do not hesitate to contact me at (312) 886-3000.

Appendix F

Distribution

Regional Administrator, Region 5
Region 5 Audit Followup Coordinator
Assistant Administrator for Solid Waste and Emergency Response (5101T)
Assistant Administrator for Enforcement and Compliance Assurance (2201A)
Agency Followup Official (the CFO) (2710A)
Deputy Chief Financial Officer (2710A)
Agency Followup Coordinator (2724A)
Audit Liaison, Office of Solid Waste and Emergency Response (5103T)
Associate Administrator for Congressional and Intergovernmental Relations (1301A)
Associate Administrator, Office of Public Affairs (1101A)
Inspector General (2410)