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September 15, 2000

Reference No. 5369

Mr. Vince Epps
Indiana Department of Environmental Management
Federal Programs Section
Office of Land Quality
100 North Senate Avenue
P.O. Box 6015
Indianapolis, Indiana 46206

Dear Mr. Epps:

Re: Responses to Comments -- OU2 Feasibility Study Report
Four County Landfill Site
Fulton County, Indiana

Enclosed, please find four copies of the document entitled OU2 Feasibility Study Report, Four County Landfill Site, Fulton County, Indiana, which has been revised consistent with the responses to comments summarized below and the discussions during our conference call on August 10, 2000. These comments were provided by the Indiana Department of Environmental Management (IDEM) in a letter dated July 17, 2000. Consistent with previous practice, IDEM's comments are reiterated below followed by the response.

GENERAL COMMENTS

IDEM Comment No. 1

The executive summary and Section 8.3 (Conclusions) present no information concerning the results of the detailed analysis of alternatives. The FS report should be revised to include a summary of the detailed analysis of alternatives in the executive summary and in Section 8.3.

Response

These sections were revised to include the information requested by IDEM.

IDEM Comment No. 2

The FS report does not follow the guidelines presented in the U.S. Environmental Protection Agency's "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" for preparing an FS report. Two examples of issues and sections that do not follow the guidance are presented below

- *Section 4 of the FS report does not develop preliminary remediation goals (PRG) based on applicable or relevant and appropriate requirements (ARARs) or the baseline risk assessment. In addition, the FS report does not present a figure showing groundwater plume boundaries for groundwater containing contaminants at concentrations that exceed the PRGs.*

- *The FS report does not compare the alternatives against each other with respect to the detailed evaluation criteria. The information presented in Table 8.1 is a summary, not a comparison, of the alternatives.*

The FS report should be revised to follow the appropriate FS guidance.

Response

The text states that PRGs were set at the MCLs for those organic compounds of concern identified in the OU2 risk assessment. Table 4.1 was added to list PRGs for volatile organic compounds detected in off-Site groundwater at concentrations above the MCLs. Figure 4.1 depicting the lateral extent of the groundwater plume relative to the MCLs was added to the FS.

We believe that the FS does compare the remedial alternatives against each other with respect to the detailed evaluation criteria. For example, Section 7.0 compares similar remedial alternative employing different technologies against each other with respect to the detailed evaluation criteria. Table 8.1 also is intended as a comparison of the remedial alternatives against each other. Nevertheless, Section 7.0 was expanded to include the comparison of the remedial alternatives against each other.

IDEM Comment No. 3

The FS report includes chemical precipitation as a process option for removing metals from groundwater before discharge. Because of the relatively low concentrations of metals in groundwater, the need for chemical precipitation of groundwater is questionable. Based on the groundwater analytical results, it appears that air stripping is the only required treatment process option. As a result of the inclusion of chemical precipitation, the costs for groundwater extraction and treatment are significantly inflated. The FS report should discuss the basis for including chemical precipitation of groundwater; otherwise, this process option should be eliminated.

Response

An important operational concern with any groundwater treatment system involving air stripping is the concentrations of suspended solids, dissolved solids and dissolved metals in

influent groundwater. Buildup of precipitates of common earth elements causes fouling of treatment systems, reducing treatment efficiency resulting in the need to perform frequent maintenance of the primary treatment system. In some circumstances, precipitate buildup results in frequent system maintenance and downtime in significantly increases operational costs. The groundwater at the Site contains characteristically high background concentrations of iron and manganese, which will require frequent maintenance of extraction wells and pumping equipment to maintain its operational efficiency. Groundwater analytical data indicate that the groundwater in the vicinity of the Site (including background conditions) contains high concentrations of dissolved iron (generally above 2 mg/l), total dissolved solids, total suspended solids and has a high hardness (generally above 400 mg/l). These constituents readily form precipitates such as iron oxides and calcium carbonates that quickly foul air-stripping systems. As such, pretreatment to reduce metals toxicity for biological treatment or to prevent precipitation of metals on physical treatment units such as air strippers would be a necessary component of any groundwater treatment system constructed at the Site. Therefore, the system proposed by CRA is equipped to handle both initial solids loading and treat heavy metals to prevent buildup of precipitates.

Following our conference call, IDEM forwarded a memorandum dated August 17, 2000 outlining air stripping pretreatment options. The memorandum suggested that bag filters, sequestering agents and magnetically induced resonance be used to address the solids and dissolved metals issues at the Site. In general, the Freije system outlined by IDEM represents an older form of the magnetic resonance treatment technology. More efficient systems of similar design such as Scalewatcher®, Scalefree® and Zetarod® are now available and were already included in the proposed CRA treatment system. Costs provided by CRA likely represent a savings over the Freije system both in initial capital costs (the Freije system would require two resonance chambers to deal with Site groundwater conditions) and subsequent O&M costs. It is also important to note that these electromagnetic systems do not remove solids from the water, they merely precipitate a fine suspension that will eventually settle somewhere. This may occur, for example, in the discharge pipeline, which would then require maintenance. Costs provided by CRA also reflect this fact and the resulting servicing of the treatment technology to promote continued optimal performance.

A sequestering agent was considered and dismissed. Sequestering agents contain polyphosphate with an associated phosphorous content of approximately 5 to 8 percent. At the calculated discharge rates associated with the Site this would lead to unacceptable phosphorous loading of the discharged groundwater of approximately 200 grams per day. This amount of phosphorous is simply too high to allow long-term discharge of groundwater without negatively impacting the tributary and eventually the surface water body.

CRA provided a cost estimate for a groundwater treatment system that could handle both initial solids loading and removal of dissolved metals to prevent system fouling. We believe this

system is justified based on the current Site data. However, to address IDEM's concern regarding potential inflation of the costs for the groundwater pump and treat options, a cost estimates were prepared assuming minimal pretreatment for inorganics and and assuming that the pretreatment system originally specified would be appropriate. This provides a range in anticipated costs for the groundwater pump and treat options for comparison to other remedial alternatives. It is important to remember that any groundwater treatment system will undergo modification depending upon the results of the treatability studies. This will ensure that the selected treatment technology is optimized for Site-specific conditions.

IDEM Comment No. 4

The discussion of groundwater extraction and treatment does not present an evaluation of site-specific factors that impact the effectiveness of the alternatives. The FS report simply presents select findings from several publications that suggest that groundwater extraction and treatment systems are not effective. The FS report should list factors that impact the effectiveness of groundwater extraction and treatment systems and discuss the effectiveness of a groundwater extraction and treatment system at the Four County Landfill site based on site-specific geologic and hydrogeologic information.

Response

It should be clarified that the text does not conclude that pump and treat systems are not effective. The discussion focuses on the inherent problems with the use of these systems to remediate aquifers to risk-based cleanup objectives such as the MCLs in timeframes that are significantly shorter than other alternatives. The text goes on to state that these systems may be effective for plume containment and reducing the mass of contamination present in aquifers. Site-specific factors that limit the effectiveness of pump and treat systems were added to Section 7.3.3.

IDEM Comment No. 5

The FS report does not present any modeling of contaminant concentrations over time that indicates that monitored natural attenuation (MNA) would reduce contaminant concentrations to below action levels at the nearest groundwater and surface water receptor. The FS report should present modeling results or a similar quantitative evaluation that indicates that MNA would reduce contaminant concentrations to below action levels at the nearest groundwater and surface water receptor and therefore is protective of human health and the environment.

Response

Groundwater modeling has been completed and the results added to the text in Appendix G and in Section 6.3.3.1. The VOC plume does not pose a serious immediate or future threat to a sensitive groundwater receptor. The nearest surface water receptor for groundwater, the Tippecanoe River, is located over 4,000 feet downgradient of the leading edge of the groundwater VOC plume. Based upon residential water sampling completed to date, there are currently no groundwater receptors and no exposed population. Downgradient of the leading edge of the VOC plume and northeast of SR 17, the land is either currently vacant or in use as agricultural pastureland. Beyond the leading edge of the plume, the nearest area where residential supply wells could potentially exist is located over 3,000 feet downgradient of the leading edge of the VOC plume.

IDEM Comment No. 6

The construction expenditures listed in Tables 7.1 through 7.7 are high. Specifically, bonds and insurance, permits, and health and safety costs seem high. In addition, the engineering costs and contingencies seem high for this relatively straightforward project. The FS report should reference the source(s) of these allowances.

Response

The engineering costs in Tables 7.1 through 7.7 reflect the costs to complete the design of the various remedial alternatives including the 30 percent, 60 percent, 90 percent, pre-final and final design submittals to IDEM. Further, engineering costs encompass construction oversight and management, project management, inspections, and construction certification. As such, we believe, based upon our experience, that a 25 percent contingency for engineering is a reasonable figure. Applicable guidance states that professional services capital costs for a project valued between $500,000 and $2,000,000 should be 26 percent.[1] The 25 percent contingency for engineering is consistent with the guidance and was applied uniformly to the remedial alternatives described in Section 7.0. Therefore, the engineering contingency does not inflate the cost of one remedial option relative to the others.

With respect to bonds and insurance, permitting and health and safety costs, the percentage of the total project costs applied to these items varied minimally based on the magnitude of the specific remedial alternative. For example, bonds and insurance was generally set at 5 percent of capital costs. The exception to this was Alternative 3B -- Enhanced Biodegradation, where

[1]U.S. Environmental Protection Agency, A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, EPA 540-R-00-002, July 2000, p. 5-13.

bonds and insurance was set at 3 percent because construction associated with this alternative is minimal (involves well installation only). Similarly, the health and safety costs were generally set at 5 percent which is reasonable for projects involving significant construction activities (i.e., the groundwater pump and treat remedies and the biosparging remedy). Once again, the exception to this was Alternative 3B -- Enhanced Biodegradation, where health and safety was set at 3 percent because construction associated with this alternative is minimal (involves well installation only). These costs do not comprise a significant percentage of the remedial costs and minor variability applied to these items does not affect the cost of the options relative to each other. Therefore, we believe the costs provided in the FS accurately reflect the costs for each remedy given their specific construction requirements.

The cost for permitting varied from 3 percent to 8 percent based upon the anticipated magnitude of the permitting tasks associated with each alternative. For example, permitting charges were set at 5 percent for remedial alternatives likely to require a National Pollutant Discharge Elimination System (NPDES) permit. In addition, other permits likely to be required for the various remedial alternatives include underground injection control (UIC) permits (for groundwater extraction/reinjection), an Army Corps of Engineers nationwide permit for construction activities adjacent to or through wetland areas, air emission equipment construction/operating permits, wastewater treatment construction/operating permits, county and state highway access permits, and access agreements from private property owners. The most permit-intensive remedial alternatives involving subsurface injection were assigned the higher permitting costs.

Lastly, a 30 percent contingency was applied uniformly to the capital costs of each remedial alternative detailed in Section 7.0 of the FS. The contingency accounts for the unforeseen costs at the time of estimate preparation (scope contingency) and additional unforeseen costs that become known as the remedial action or OM&M proceed (bid contingency). The scope contingency typically ranges from 10 to 25 percent and the bid contingency typically ranges from 10 to 20 percent.[2] In total, the contingency may range from 20 to 45 percent for any given alternative. Based upon professional judgement, a contingency of 30 percent was applied to the remedial cost estimates since despite the fact that this may seem to be a relatively straightforward project, additional information is required to determine the costs. For example, in the absence of a groundwater pumping test and bench-scale treatability studies to evaluate treatment options, there is some uncertainty built into the overall costs for groundwater extraction and discharge options. Therefore, based upon this uncertainty, a 30 percent contingency was applied to the costs for these options to account for potentially higher costs associated with extraction of additional groundwater and potentially higher costs for groundwater treatment. So as not to inflate the cost of the various alternatives relative to each

[2] U.S. Environmental Protection Agency, July 2000, pp. 5-10 - 5-12.

other, this 30 percent contingency also was applied to the other remedial alternatives, where there is less uncertainty associated with the costs.

We believe the cost estimates provided in the FS are reasonable. Section 7.1 was revised to include justification of these costs.

SPECIFIC COMMENTS

IDEM Comment No. 1

Section 2.3.7.1, Page 16, Paragraph 3. The text does not discuss the degree of mounding below the wetland. The FS report should be revised to discuss the degree of groundwater mounding below the wetland.

Response

The comment pertains to a summary of a similar discussion presented in the approved OU1 and OU2 Remedial Investigation (RI) reports. On page 16 of the OU2 FS it is stated that the mounding amounts of 0.2 to 0.3 feet in the vicinity of the northeast retention pond. The text in Section 2.3.7.1 has been revised to clarify that the mounding is a local effect noted at monitoring well MW108.

IDEM Comment No. 2

Section 2.3.7.1, Page 17, Paragraphs 0 and 1. The text states that on-site piezometers with similar subunit designations were screened at considerably different elevations; therefore, CRA generated groundwater contours based on elevations and not subunit designations. The text should describe the geology and hydrogeology for each of the elevation intervals selected to allow verification that the wells in the elevation intervals contain groundwater from the same portion of Aquifer C.

Response

A detailed discussion of on-Site well and piezometer construction was provided in the OU1 and OU2 RI reports. The information included in the OU2 FS was provided as a summary of the off-Site hydrogeological data only. Consistent with the discussion during our conference call, additions to the text to address this comment are not necessary.

IDEM Comment No. 3

Section 3.5, Page 42, Paragraph 2. *The text states that contaminant transport will be retarded by dilution and dispersion. It is not clear how dilution and dispersion will retard contaminant transport. The text should present more detail on how dilution and dispersion will retard contaminant transport. Additionally, the last paragraph of this page references a U.S. EPA screening protocol for determining if anaerobic biodegradation processes are present at the site. The site was evaluated using site specific data and given a score of 19. This is within the scoring range that indicates adequate evidence of anaerobic biodegradation. The scoring table is presented as Table 3.3. It does not appear as if the protocol was followed in scoring the site. The protocol calls for sampling 6 wells for scoring purposes. The Four County site does not have a monitoring well in the central area of the plume. This is a required data collection point for the screening. A conceptual model of the groundwater should have been developed, but there is no indication that this was done.*

Response

The text on page 42 was revised to state that average linear groundwater flow velocities should not be considered to be contaminant transport velocities since contaminant transport will be retarded by attenuation mechanisms acting within the saturated zone and dilution/dispersion will reduce contaminant concentrations with distance from the source.

With respect to the protocols used for scoring in Table 3.3, we are unable to find a reference in the natural attenuation guidance to a specific number of wells to be used for screening. What the guidance does say on page 30 is that data from the following areas are necessary to conduct an MNA demonstration: (1) most contaminated portion of the aquifer (the "source area"); (2) downgradient from the source but still in the dissolved plume; (3) downgradient from the dissolved plume; and (4) areas upgradient and lateral to the dissolved plume.

There are numerous monitoring wells located at the Site meeting these criteria as summarized below:

- monitoring wells located or formerly located along the centerline of the plume include the P-2 cluster (now abandoned), MW113/114 and MW123/124;
- monitoring wells located downgradient of the source but still in the dissolved plume include MW110/111, MW113/114 and MW123/124)
- monitoring wells downgradient of the dissolved plume include MW129 and MW130; and
- monitoring wells located upgradient and lateral to the dissolved plume include MW100/101, MW117/118 and MW115/116, MW108/109, MW119/120, MW121/122, MW125/126, and MW127/128.

As evidenced by the preceding, there are more than a sufficient number of monitoring points with which to complete this evaluation. A conceptual model of contaminant degradation was developed through groundwater modeling and has been included as Appendix G in the OU2 FS.

IDEM Comment No. 4

Section 4.4, Page 49, Paragraph 1. *Section 4.4 contains a list of the general response actions (GRA) and potential technologies found applicable for OU2. Section 5 discusses additional GRAs and technologies that are not included in the list in Section 4.4. Section 4.4 should be revised to include the entire list of GRAs and technologies found to be applicable for OU2.*

Response

The list in Section 4.4 was revised to include GRAs discussed in Section 5.0.

IDEM Comment No. 5

Section 5.2.5, Page 55, Paragraph 2. *CRA eliminated point-of-use treatment from consideration because it is not currently applicable. Point-of-use treatment should be retained for consideration because some of the technologies and process options considered do not include active groundwater containment and require significant time frames before they meet cleanup goals. Therefore, alternate viable process options that can be implemented quickly should be included in the FS report to act as a contingency if the selected alternative is not effective.*

Response

We agree that point-of-use treatment, although not currently applicable, is a potentially viable alternative as a contingency. Therefore, the text was revised to include point-of-use technology as a contingency option.

IDEM Comment No. 6

Section 5.2.6, Page 57, Paragraph 1. *The text states that the permeable reactive barrier (PRB) process option is limited to shallow groundwater plumes that are 50 feet below ground surface. A reference should be provided for this information as well as a reason why PRBs cannot be used at greater depths. In addition, PRBs are more appropriately considered in situ chemical treatment because PRBs treat*

contaminated groundwater instead of containing contaminants. Finally, the PRB discussion should be moved to a section that describes in situ chemical treatment (see Specific Comment No. 9).

Response

The text states that PRB technology is limited to shallow groundwater plumes 50 feet or less in depth, and as such, is not applicable to the Site where impacted groundwater is present at depths over 100 feet. This is due to practical engineering constraints including the difficulty associated with emplacement of the reactive medium to these depths and the need to replace the medium periodically. These considerations escalate the costs associated with the remedial technology beyond that which would be considered cost effective and reduce the effectiveness of the technology below that considered acceptable.

The discussion of PRBs was expanded and moved to the section describing in-situ groundwater treatment options.

IDEM Comment No. 7

Section 5.2.8.2, Page 59, Paragraph 1. *The description of chemical treatment of groundwater focuses on metal precipitation. Because the FS report does not list cleanup goals for chemicals, maximum contaminant levels (MCLs), it is unclear whether metals require treatment. Volatile organic compounds (VOCs), primarily chlorinated solvents, are the primary contaminants of concern at the site. Therefore, the discussion should focus on chemical treatment process options such as reductive dechlorination, which may be effective for treating chlorinated VOCs.*

Response

As discussed previously, the primary reason to treat metals is to minimize fouling of the primary treatment unit. Pretreatment to prevent precipitation of metals on physical treatment units such as air strippers would be an integral component of any groundwater treatment system constructed at the Site and, as such must remain in the text. In addition, the text in the FS has been expanded to include an initial screening of chemical treatment options that would potentially address VOCs directly.

IDEM Comment No. 8

Section 5.2.10, Page 65, Paragraphs 1 and 2. *This section of the report compares the advantages and disadvantages of MNA to other technologies. This discussion is inappropriate in this section and should*

be moved to the comparative analysis of alternatives presented in Section 8. Section 5 should only evaluate the effectiveness, implementability, and cost of each technology.

Response

This discussion was moved to Section 6.3.3.1, where the detailed discussion of the alternative occurs.

IDEM Comment No. 9

Section 5.2.13, Page 67, Paragraph 1. *This section discusses only one process option; however, the section should discuss and screen all potentially applicable in-situ chemical treatment technologies. Other potentially applicable in-situ chemical treatment technologies, such as Fenton's reagent and PRBs, should be described in this section.*

Response

The text was expanded to include a discussion of other in-situ process options such as Fenton's reagent and PRBs.

IDEM Comment No. 10

Section 6.3.2.1, Page 71, Paragraph 1. *An equation is used to estimate the pumping rate required for a pump and treat system. This is important in determining the cost of the system. The more water that requires extraction, the higher the expense. One variable in this equation is the width of the plume that the system must capture. The report states that the width of the plume measured at the monitoring well MW-114 cluster is 650 feet. MW-114 and MW-112 are the only C unit wells at this location. They both show contamination. However, these wells are only 300 feet apart. What is the justification for using 650 feet for the plume width based on measurements at these wells?*

Response

It is reasonable to assume that the radius of capture would need to extend beyond the two monitoring wells known to be impacted by volatile organic compounds (VOCs) above the MCLs unless it can be demonstrated otherwise that groundwater impacts do not extend beyond these points. As shown in Figures 4.1 and 6.2, the lateral extent of groundwater at the Site boundary lies between MW109 and MW112 on the east and between MW114 and MW128 on the west. Therefore, the estimated capture width for groundwater impacted above the MCLs is approximately 650 feet. This has been clarified in the text.

IDEM Comment No. 11

Section 6.3.3.1, Page 75, Paragraph 1. *A first order decay equation was used to estimate the time it would take to attenuate the plume to the MCL limit. IDEM staff do not believe that the use of this equation is appropriate in this case. The degradation constant in the equation was obtained by using contaminant concentration data from MW- 114. The data from the first and last sampling events is put into the equation and the constant is obtained. This constant is then used to estimate the time for attenuation to MCLs. This analysis would be appropriate if the plume was stable. A single monitoring point in a stable plume could be used to measure contaminant reduction due to attenuation in a section of the plume. This plume has not been proven to be stable. Section 3.3.4 of the report indicates that the VOC contamination is moving down gradient due to advection. The concentration reduction at MW-114 could be from biodegradation or it could be that the source is becoming exhausted and the VOCs are moving away from MW-114 through advection. This type of analysis will not provide a reliable estimate of degradation rate until the plume stabilizes.*

Response

Two monitoring points were used to demonstrate this effect in the plume, MW112 and MW114. As summarized in the response to General Comment No. 5, there is compelling evidence of biodegradation processes acting to degrade 1,2-DCA at the Site. We agree with IDEM that the source is becoming exhausted and the VOCs are moving away from MW-114 through advection. OU1 remedial actions were designed to cutoff the source of VOCs to groundwater. Source exhaustion and cutoff are positive effects and a precursor to what would occur farther downgradient as groundwater flushes through the plume and biodegradation acts on the contaminants within the plume.

However, the discussion has been removed from the text and replaced with groundwater modeling.

IDEM Comment No. 12

Section 7.4.3, Page 87, Paragraph 1. *The FS report states that each of the in situ groundwater treatment alternatives would provide a permanent remedy for groundwater containing dissolved VOCs at concentrations above maximum contaminant levels (MCLs). No information is presented in the FS report that indicates that dissolved VOC concentrations would be less than MCLs at the nearest groundwater receptor. The FS report also does not describe how the long-term effectiveness of in-situ groundwater treatment would be determined. Procedures that would be used to measure the long-term effectiveness of the in-situ groundwater treatment alternative should be discussed.*

Response

The VOC plume does not pose a serious immediate or future threat to a sensitive groundwater receptor. The nearest surface water receptor for groundwater, the Tippecanoe River, is located over 4,000 feet downgradient of the leading edge of the groundwater VOC plume. To our knowledge, based upon the regular residential well sampling data that were made available, there are currently no groundwater receptors where Site-related compounds are present above MCLs. Downgradient of the leading edge of the VOC plume and northeast of SR 17, the land is either currently vacant or in use as agricultural pastureland. Beyond the leading edge of the plume, the nearest area where residential supply wells could potentially exist is located over 3,000 feet downgradient of the leading edge of the VOC plume.

Groundwater modeling indicates that dissolved VOC concentrations would decline over time under MNA. However, the effectiveness of MNA is dependent on the assumed Site-specific degradation constants and Site-specific conditions that can only be determined with monitoring. We do not believe that the FS is the appropriate document to detail specific procedures to measure the long-term effectiveness of any groundwater remedy, these are more appropriate for the monitoring plan. However, the long-term effectiveness of any groundwater remedy would be judged based upon ongoing groundwater monitoring activities. For MNA or the other in-situ remedies, this groundwater sampling would include analysis of groundwater samples on a periodic basis for MNA indicator compounds, in addition to the compounds of concern. This information is stated in Section 7.4.3.

IDEM Comment No. 13

Section 7.4.7, Page 88. The costs for in-situ groundwater remedial alternatives are evaluated. The cost analyses assume that the current monitoring network is adequate. The current monitoring well network is not adequate for monitoring the effectiveness of any in-situ groundwater remedial alternative. Installation of additional wells will result in higher capital costs for these alternatives.

Response

IDEM does not elaborate as to why the current monitoring well network is inadequate. However, contingency costs associated with the installation of additional monitoring wells were added to the in-situ groundwater remedial alternatives (MNA, enhanced biodegradation and biosparging).

IDEM Comment No. 14

Figures 2.5 and 2.6. Figure 2.5 indicates that gravel is present in the vicinity of MW113/MW114; however, Figure 2.6 does not show gravel at this location. This apparent inconsistency should be rectified.

Response

Figure 2.6 was revised to reflect a gravel layer overlying bedrock consistent with the geologic log and the observations at the GS114 screening boring.

IDEM Comment No. 15

Figure 2.6. This figure does not show the B-B′ cross-section line in the inset to the figure. This cross-section line should be added to the figure.

Response

The location of the cross-section is provided in the inset to Figure 2.6. It is present immediately north of County Highway 1000 North in the inset. The inset was enlarged to better illustrate the cross-section location.

IDEM Comment No. 16

Figures 3.15 and 3.16. These figures do not show the boundaries of the landfill. The boundaries of the landfill should be included with the figures.

Response

As discussed during our conference call, adding the landfill boundaries would unnecessarily clutter these figures. As such, the landfill boundaries were not added to Figures 3.15 and 3.16.

IDEM Comment No. 17

Table 3.3. This table does not list the range of concentrations detected in groundwater for each of the MNA parameters. The range of MNA parameter concentrations detected in off-site wells at the Four County Landfill Site should be added to this table to allow further evaluation of the potential effectiveness of MNA. Additionally, no data to support the site scoring presented in Table 3.3 has been provided.

Some conclusions appear to be contradicted by the data presented in other sections of the FS. These include:

- *Iron II- table 3.3 scores 2 points for the presence of Iron II as an indicator of reduction pathways. However, the C unit groundwater metals analysis shown in figure 3.8 does not identify the presence of Fe^{+2}.*

- *Table 3.3 scores 2 points for TCE detected down gradient as a daughter product. The C unit groundwater VOC analysis shown in figure 3.6 does not indicate the presence of TCE.*

- *TCE and VC are scored as daughter compounds detected down gradient. TCE and VC are daughter compounds formed by reduction of PCE. However TCE reduces to DCE and then DCE will reduce to VC. There is no indication of DCE being present in the C unit groundwater. If reduction of PCE is occurring, DCE should be present.*

Response

Table 3.3 was carried over from the OU2 RI Report where it appeared as Table 8.1. The supporting data for Table 3.3 is provided in the OU2 RI Report.

- When the groundwater becomes depleted of dissolved oxygen and nitrate, conditions become anaerobic. Iron exists in the ferric Fe(III) or ferrous Fe(II) form, depending upon the pH and dissolved oxygen concentration.[3] At neutral pH and in the presence of oxygen, Fe(II) rapidly oxidizes to Fe(III), which readily hydrolyzes to form the insoluble precipitate, ferric hydroxide.[4] In fact, aqueous Fe(III) is not stable in natural waters except under conditions of low pH (below 4 standard units).[5,6] The groundwater near the Site characteristically contains low levels of dissolved oxygen, generally below 1 ppm (see Appendix G, Tables G.4 and G.5 of the OU2 RI Report). Additionally, nitrate has not been detected in groundwater samples collected from monitoring wells installed around the Site (see Figures 3.9 and 3.10 of the OU2 FS Report). Finally, the oxidation-reduction potential (ORP) measured at Site monitoring wells is generally in the range of -50 to -100 millivolts (redox conditions are considered reducing below 0.0 millivolts). This is further evidence that reduced species will be stable in groundwater near the Site.

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[3] Patterson, J.W., Industrial Wastewater Treatment Technology, Second Edition, (Stoneham, MA, Butterworth Publishers, 1985), p. 155.
[4] Patterson, J.W., 1985, p. 155.
[5] Faure, G., Principles and Applications of Inorganic Chemistry, (New York, MacMillan Publishing Company, 1991), pp. 324-338.
[6] Garrels, R.M. and C.L. Christ, Solutions, Minerals and Equilibria, (San Francisco, Freeman, Cooper & Company, 1965), pp. 178-197.

In its oxidized state, Fe(III) is practically insoluble at pH levels between 5 and 7 and dissolved concentrations in groundwater are considered to represent the ferrous iron Fe(II).[7] During the RI, groundwater samples were collected for both total and dissolved iron. (Dissolved iron samples were filtered in the field through a 0.45-micron filter.) The concentrations of dissolved and total iron were, allowing for the margin of analytical error, equivalent at locations where both dissolved and total iron samples were collected for analysis. All of this evidence points to the fact that the aqueous species of iron in groundwater in the vicinity of the Site is ferrous iron Fe(II), not ferric iron Fe(III). Therefore, the points were properly awarded in Table 3.3.

- During the OU1 RI, PCE was detected at concentrations above 2,000 mg/l in groundwater samples collected from on-Site source-area monitoring wells screened in Unit A (P-2A, and P-12A). TCE, cis-1,2-DCE and vinyl chloride were not detected in groundwater samples collected from these locations. However, at monitoring well P-2C2 (a deeper well at the same location as P-2A), in addition to PCE, TCE, cis-1,2-DCE and vinyl chloride are present in groundwater. In fact, the concentration of TCE is greater than PCE in the groundwater sample collected from P-2C2 suggesting that biodegradation is occurring. Further downgradient near the northern boundary of the Site, the only daughter product of PCE/TCE detected in groundwater is vinyl chloride (P-31C2, P-31C3, MW112, and MW114) further suggesting biodegradation of PCE/TCE is occurring.

- Reductive dechlorination of chlorinated solvents is associated with the accumulation of daughter compounds and an increase in the concentration of chloride ions.[8] As stated in the previous paragraph, cis-1,2-DCE is present in the source area and vinyl chloride is the predominant daughter product further downgradient. There is also a significant increase in the concentration of chloride in groundwater samples collected from monitoring wells located along the centerline of the plume (MW114, MW124 and MW129). Groundwater samples from monitoring wells outside the plume contain chloride concentrations of 5 mg/l or less. However, chloride concentrations inside the plume are above 10 mg/l. Figure 6.4 has been added to the FS document depicting the distribution of chloride downgradient of the Site. It appears that the degradation of PCE/TCE and their daughter products is occurring very rapidly beneath the Site, as the only daughter products to appear beyond the Site boundary are vinyl chloride and chloride.

[7] Lyngkilde, J., and T.H. Christensen, Fate of Organic Contaminants in the Redox Zones of a Landfill Leachate Plume, Journal of Contaminant Hydrology, Vol 10, pp. 291-307, 1992.
[8] U.S. Environmental Protection Agency, Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater, September 1998, pp. 24-25.

Given the above information, minor modifications to the scoring summarized in Table 3.3were made. However, the overall conclusion was not affected by the revisions. There is adequate evidence for reductive dechlorination at the Site.

IDEM Comment No. 18

Table 4.1. This table lists general chemical-specific ARARs. Appropriate chemical-specific values should be presented for the chemicals of concern at the site.

Response

Table 4.1, summarizing PRGs for chemicals of concern was added to Section 4.0. The MCLs were identified as chemical-specific ARARs in Table 4.2.

IDEM Comment No. 19

Table 4.2. Footnote 3 states that the National Heritage Program identified a species of mudpuppy as a State rare species in the wetland in the vicinity of the landfill; however, Table 4.2 states that the Endangered Species Act would not be applicable. The applicability of the Endangered Species Act should be clarified.

Response

Footnote No. 3 states that the National Heritage Program identified a species of mudpuppy as a State rare species in "a" (as opposed to "the") wetland in the vicinity of the landfill. The actual location of this wetland and its proximity to the Site were not specified. The Endangered Species Act may be applicable to the extent the selected remedy degrades sensitive habitats where threatened or endangered species may reside, such as wetland areas. Table 4.2 was revised accordingly.

IDEM Comment No. 20

Tables 7.1 and 7.2. The capital and operation and maintenance costs for groundwater treatment in Tables 7.1 through 7.4 are inflated because of the equipment and ancillary structures associated with chemical precipitation. In addition, it is unlikely that a treatability study would be required for groundwater treatment. Tables 7.1 and 7.2 should be revised to include only chemical treatment processes necessary to meet the remedial action objectives.

Response

A bench-scale treatability study is essential in the design of a groundwater treatment system. The treatability study would provide data such as the expected flow volumes and chemical quality of the groundwater that would be required to properly design a treatment system, including an adequate pretreatment system. The groundwater extraction system could not be properly designed without a groundwater pumping test. The costs for a bench-scale treatability study, including a groundwater pumping test are included in the treatability study line item.

We believe that IDEM's request to reflect only the chemical treatment necessary to meet remedial action objectives is inconsistent with the guidance. Inasmuch as the need for chemical precipitation for pretreatment of groundwater is primarily driven by the need to prevent metals precipitates from fouling air-stripping systems, IDEM's comment implies that the necessary groundwater pretreatment should not be included in the cost estimate. However, the pretreatment systems are necessary to ensure the primary system operates effectively and can meet the remedial action objectives. Leaving the costs for these systems out of the cost estimate would run counter to the objectives of the FS guidance, which states that direct and indirect capital costs and O&M-related costs (including operating, maintenance material, labor, energy, residuals disposal sampling and administrative costs) be captured by the cost estimates.

IDEM Comment No. 21

Appendix F. CRA uses initial and final concentrations measured in September 1996 and May 1999, respectively, to calculate degradation rates for 1,2-dichloroethane (1,2-DCA) in groundwater. Since that time, remedial actions have been taken at OU1 that have likely impacted the site's hydrologic equilibrium. The FS report should discuss how the OU1 remedial actions may impact the hydrologic equilibrium and degradation rates for 1,2-DCA.

Response

In addition to containing the waste and preventing direct exposure, the OU1 remedy was designed to reduce the influx of chemicals to the groundwater. This is discussed in Section 3.2.7. The effect that the OU1 remedy is expected to have on dissolved chemicals in groundwater is discussed in Section 3.3.4. As we discussed, what is not expected is a change in groundwater flow direction in Units B and C since groundwater flow in these units is subject to regional effects acting over a large area. However, future groundwater monitoring will provide the data to confirm groundwater flow beneath the Site.

Should you have any questions on the above, please do not hesitate to contact us.

Yours truly,

CONESTOGA-ROVERS & ASSOCIATES

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SJW/ko/399

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FEASIBILITY STUDY
OPERABLE UNIT 2

FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

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EXECUTIVE SUMMARY

The Four County Landfill (Site) commenced operation in August 1972 and continued operating until 1989, when the U.S. District Court ordered operations to cease. On August 13, 1993, an Agreed Order for a Remedial Investigation/Feasibility Study (RI/FS) between a group of Potentially Responsible Parties (PRPs) and the Indiana Department of Environmental Management (IDEM) became effective upon execution by the Commissioner of IDEM. The PRPs identified by IDEM comprised both de minimis and non-de minimis respondents who allegedly contributed waste materials to the Site and/or participated in the operation of the landfill. The majority of non-de minimis respondents identified by IDEM formed the Four County Landfill Group.

An RI/FS Work Plan was prepared and submitted in accordance with Paragraphs 38 and 39 of the Agreed Order, the Statement of Work (SOW) (Exhibit II of the Agreed Order), Section 121 of the Comprehensive Environmental Response Compensation and Liability Act (CERCLA), and applicable U.S. Environmental Protection Agency (U.S. EPA) guidance documents. Much of the Site background and ancillary historical operational information contained in the SOW was incorporated into the Work Plan. On May 3, 1994, IDEM approved the RI/FS Work Plan. Initiation of investigative activities detailed in the approved RI/FS Work Plan commenced on May 23, 1994.

Early in 1995, the Four County Landfill Technical Committee proposed to divide the Site into two operable units. The operable units approach was first proposed to IDEM in February 1995. The first proposed operable unit (OU1) was the landfill cap and the second proposed operable unit (OU2) was groundwater. In response, IDEM approved the "operable units approach" and clarified the components of each of the operable units. On this basis, operable unit OU1 consisted of the landfill cap, leachate collection and treatment from both lined and unlined cells, landfill gas collection and treatment, institutional controls to supplement engineering controls, and source-area groundwater control and treatment. Later, OU1 was expanded to encompass impacted soil and Unit A perched groundwater located adjacent to the western property boundary. The approved OU1 RI Report was submitted to IDEM in June 1997 and the approved OU1 FS Report was submitted to IDEM in February 1998. A predesign investigation was also completed during the OU1 RI/FS and a remedial design was prepared. IDEM approved the OU1 remedial design and issued a Record of Decision for OU1 in July 1998. This culminated in the construction of the OU1 remedy that was substantially completed by the fourth quarter of 1999.

OU2 encompassed off-Site groundwater since on-Site groundwater was encompassed by OU1. Investigative activities associated with the OU2 RI were undertaken through

June 1999. The OU2 groundwater investigation continued until sufficient data were obtained to delineate the nature and extent of off-Site groundwater impacts. An extensive database pertaining to the Site operational history, physical conditions, and nature and extent of contamination were developed during the previous investigations and during the OU2 RI. The OU2 RI Report submitted to IDEM in January 2000 summarized this extensive database. One significant conclusion of the OU2 RI Report was that the data obtained during the OU2 RI are sufficient to proceed with the Feasibility Study for OU2.

This OU2 FS Report has been prepared in accordance with the Work Plan and appropriate U.S. EPA guidance. The Remedial Action Alternatives (RAAs) developed for off-Site groundwater included a number of remedial options under three major technology types as summarized below.

Alternative 1 - No Action

Alternative 2 - Groundwater Extraction, Treatment and Discharge

- Alternative 2A Option 1 - Groundwater Extraction with Air Stripping and Surface Discharge
- Alternative 2A Option 2 - Groundwater Extraction with Air Stripping and Subsurface Injection
- Alternative 2B Option 1 Groundwater Extraction with Granular Activated Carbon (GAC) and Surface Discharge
- Alternative 2B Option 2 - Groundwater Extraction with GAC with Subsurface Injection

Alternative 3 - In-Situ Groundwater Treatment

- Alternative 3C - Biosparging
- Alternative 3B - Enhanced Biodegradation
- Alternative 3A - Monitored Natural Attenuation

The remedial alternatives were evaluated in detail based on seven of the nine criteria setout in the RI/FS guidance. IDEM will evaluate the remaining two criteria, Agency and Community Acceptance. Each of the above-summarized RAAs, with the possible exception of No Action, rated favorably in the following criteria:

1. Overall Protection of Human Health and the Environment,
2. Compliance with Applicable Relevant and Appropriate Requirements (ARARs),

3. Long-Term Effectiveness and Permanence
4. Reduction in the Toxicity, Mobility or Volume of Material,
5. Short-term Effectiveness, and
6. Implementability.

There were significant differences in the RAAs in terms of cost. Costs evaluated in this FS included capital cost and long-term O&M costs. The RAAs involving groundwater extraction and treatment using GAC are the most costly alternatives. This is because both capital and O&M costs are high for these alternatives. The groundwater extraction and air stripping options are the next most costly alternatives. There is concern, based upon published literature, that groundwater pump and treat technology may not health-based cleanup objectives in a timeframe that is appreciably shorter than other, less aggressive remedial technologies. The concerns regarding the effectiveness of this technology need to be weighed in conjunction with the high cost to implement these alternatives.

The in-situ treatment alternatives, biosparging and enhanced biodegradation, are more cost effective than the groundwater extraction and treatment alternatives due to the lower initial capital costs. However, the ongoing O&M costs for these alternatives are relatively high resulting in moderate present worth costs. The monitored natural attenuation alternative is the most cost-effective in-situ treatment alternative. The MNA alternative involves ongoing monitoring to verify the presence and ongoing effectiveness of natural attenuation processes at obtaining Site-specific remedial objectives. The U.S. EPA suggests that MNA typically be used in conjunction with active remediation measures (e.g., source control), or as a follow-up to active remediation measures that have already been implemented. At the Four County Landfill Site, source-control measures such as excavation of VOC impacted soil and construction of a low-permeability RCRA cap over the entire landfill have been completed. These source control measures will have a beneficial impact on off-Site groundwater quality. The estimated timeframe for cleanup of groundwater using MNA compares favorably with expected timeframe for cleanup using other remedial alternatives.

With the exception of Alternative 1 (No Action), bench and/or field-scale treatability studies would be required to obtain the necessary data to determine the effectiveness and/or design the remedial system. For the ex-situ groundwater treatment alternatives, treatability studies would consist of completing a groundwater pumping test and collection of samples to properly design a system for treating impacted groundwater extracted from the subsurface. Similarly, treatability studies for the in-situ groundwater treatment alternatives would include microcosm studies to determine the numbers and

type of degrading bacteria and field studies designed at acquiring data concerning the effectiveness of various amendments to enhance biodegradation.

This OU2 FS is based on a detailed review of the information documented in the OU2 RI and numerous other previous reports. This OU2 FS Report represents a comprehensive summary of remedial technologies applicable to off-Site groundwater at the Four County Landfill Site and provides the basis for selection of a remedy for OU2. IDEM will select the final remedy for OU2 with input from the U.S. EPA, upon submittal of the final OU2 FS Report and following a public review process.

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1.0 INTRODUCTION

1.1 BACKGROUND

The Four County Landfill (Site) commenced operation in August 1972 and continued operating until 1989, when the U.S. District Court ordered operations to cease. On August 13, 1993, an Agreed Order for a Remedial Investigation/Feasibility Study (Agreed Order) between a group of Potentially Responsible Parties (PRPs) and the Indiana Department of Environmental Management (IDEM) became effective upon execution by the Commissioner of IDEM. The PRPs identified by IDEM comprised both de minimis and non-de minimis respondents who allegedly contributed waste materials to the Site and/or participated in the operation of the landfill. The majority of non-de minimis respondents identified by IDEM formed the Four County Landfill Group (Group).

A "Site Background Summary and Detailed Scope of Work" (SOW) was submitted to IDEM by the Group, in support of a Good Faith Offer to IDEM put forth on April 27, 1992. The SOW was incorporated into the Agreed Order by reference and presented a summary of the data previously collected at the Four County Landfill Site, including a compilation and evaluation of available information regarding Site history, Site physical characteristics, waste characteristics, and the nature and extent of contamination. In addition, a scope of work was included for performing Site stabilization activities. Moreover, the SOW, in accordance with the Agreed Order, set out the basis for the work to be undertaken during the Remedial Investigation/Feasibility Study (RI/FS).

An RI/FS Work Plan (hereinafter "Work Plan") was prepared in accordance with Paragraphs 38 and 39 of the Agreed Order, the SOW (Exhibit II of the Agreed Order), Section 121 of the Comprehensive Environmental Response Compensation and Liability Act (CERCLA), and applicable U.S. Environmental Protection Agency (U.S. EPA) guidance documents. Much of the Site background and ancillary historical operational information contained in the SOW was incorporated into the Work Plan. On May 3, 1994, IDEM approved the Work Plan. Initiation of investigative activities detailed in the approved Work Plan commenced on May 23, 1994.

Following the successful implementation of the investigative activities detailed in the Work Plan, a Groundwater Technical Memorandum summarizing Site groundwater data during the RI as well as historical data, was submitted to IDEM. IDEM subsequently approved the Groundwater Technical Memorandum by letter dated May 22, 1995. The Groundwater Technical Memorandum provided a comprehensive

database of available groundwater information. The purpose of the Groundwater Technical Memorandum was to evaluate and discuss the comprehensive database and assess whether supplemental data were necessary to evaluate remedial alternatives for this Site.

A significant finding of the Groundwater Technical Memorandum was that supplemental investigative activities were necessary to adequately define the nature and extent of impacts to groundwater at the Site. Addendum 1 to the approved Work Plan (hereinafter, "Addendum 1") was prepared to outline the additional work that was necessary to complete the RI. Addendum 1 set forth the rationale for these tasks and detailed data collection and analytical protocols that had not been previously established by the Sampling and Analytical Plan (SAP) provided as Appendix H of the approved Work Plan. IDEM approved Addendum 1 by letter dated September 27, 1995.

Early in 1995, the Four County Landfill Technical Committee proposed to divide the Site into two operable units. The "operable units approach" was first proposed in a memorandum to IDEM dated February 10, 1995. The first proposed operable Unit Operable Unit 1 (OU1) was the landfill cap and the second proposed operable Unit Operable Unit 2 (OU2) was groundwater. The rationale for dividing the Site into operable units was to allow the flexibility to close and stabilize the landfill on a separate timetable from a groundwater investigation. In response, IDEM approved the "operable units approach" and clarified the components of each of the operable units. On this basis, operable Unit OU1 consists of the landfill cap, leachate collection and treatment from both lined and unlined cells, landfill gas collection and treatment, institutional controls to supplement engineering controls, and "source-area groundwater" control and treatment.[1] Later, OU1 was expanded to encompass impacted soil and Unit A perched groundwater located adjacent to the western property boundary. The soil and perched Unit A groundwater were investigated during supplemental OU1 investigations including the OU1 predesign investigation and were addressed as part of the OU1 remedial action. As such, OU2 became off-Site groundwater since on-Site groundwater was encompassed by OU1.

The OU1 Remedial Investigation (OU1 RI) Report was submitted to IDEM on June 27, 1997. The OU1 RI Report provided a detailed discussion of the data acquired during the RI and extensive investigative activities performed prior to the RI. The OU1 RI Report was prepared specifically to address OU1. The OU1 RI Report concluded that sufficient

[1] Source-area groundwater refers to all groundwater beneath the Site. Definition of operable units per IDEM letter dated August 16, 1995, Re: Four County Landfill Site, Fulton County, Indiana.

data were available to evaluate and select remedial alternatives necessary to close the landfill. Remedial action objectives for the OU1 were established for surface soil and the landfill contents, air and dust, landfill gas, surface water, sediment leachate and source-area groundwater. The established remedial action objectives consist of media or operable unit-specific goals for protecting human health and the environment.

The Final Feasibility Study Report for OU1 is dated February 24, 1998. Applicable or Relevant and Appropriate Requirements (ARARs) for the Site were identified including chemical, action and location-specific ARARs. The ARARs were used to evaluate each remedial alternative for compliance with regulatory requirements. The Group received IDEM's approval of the OU1 Remedial Investigation Report on December 15, 1997 and IDEM's approval of the OU1 Feasibility Study on March 19, 1998.

Prior to IDEM's issuance of the OU1 Proposed Remedial Action Plan on April 15, 1998, the Group voluntarily initiated OU1 remedial design activities. IDEM approved the OU1 remedial design and issued a Record of Decision for OU1 in July 1998. The remedial design and Record of Decision for OU1 address the following primary remedial activities at the Site:

- consolidation of landfill derived solids (i.e. impacted soil along the western property boundary) into the unused portions of Cell C prior to capping;
- abandonment of on-Site monitoring wells;
- installation of a RCRA cap over the lined and unlined areas;
- installation of a passive landfill gas venting system;
- leachate collection from lined disposal areas with treatment at an authorized off-Site facility;
- closure of the existing leachate tank storage system and construction of a replacement system;
- groundwater monitoring; and
- operation and maintenance.

Construction of the OU1 remedy commenced at the Site in May 1999 and was substantially completed by the fourth quarter of 1999. The remaining OU1 remedial action tasks were addressed at the Site in April - May 2000.

Investigative activities associated with the OU2 RI were undertaken from February 1995, when the operable units approach was approved by IDEM, through June 1999, when the

final round of groundwater samples were collected from the off-Site groundwater monitoring well network. The OU2 groundwater investigation was performed in a "phased" manner wherein findings from a previous phase of the investigation were evaluated and used to scope investigative activities for the subsequent phase. The OU2 groundwater investigation continued in this manner until sufficient data were obtained to delineate the nature and extent of off-Site groundwater impacts. The initial work scope for the OU2 off-Site groundwater investigation was contained in Addendum 1. Addendum 1 set forth the rationale for these tasks and detailed data collection and analytical protocols that had not been previously established by the SAP provided as Appendix H of the approved RI/FS Work Plan.

Additional off-Site groundwater monitoring wells were installed and sampled pursuant to the work scope contained in a memorandum to IDEM dated June 4, 1997 and approved by IDEM by letter dated December 15, 1997. Additional rounds of groundwater sampling were performed in 1998. In a letter dated December 17, 1998, a work plan identifying the work scope for the final phase of the OU2 groundwater investigation was submitted to IDEM. IDEM approved the work plan on December 28, 1998. Field activities associated with the final phase of the OU2 investigation were performed during the period of March through June 1999, following receipt of the necessary access agreements from property owners and permits from the Indiana Department of Transportation. The findings of this investigation were submitted to IDEM in a letter dated July 12, 1999, which concluded that delineation of landfill-related groundwater impacts was completed. In a letter dated July 28, 1999, IDEM concurred with that conclusion stating that the leading edge of the groundwater plume, as well as the nature and extent of off-Site groundwater impacts were defined. Moreover, IDEM's letter stated that no further work was required to provide additional data relative to the nature and extent of off-Site groundwater impacts.

The OU2 RI Report was submitted to IDEM on January 7, 2000. The report summarized the data acquired during the OU2 RI. The purpose of the OU2 RI Report was to evaluate and discuss the comprehensive database as it relates to OU2, evaluate Site risk, and establish remedial action objectives for the Site. The OU2 RI Report concluded that an extensive database pertaining to the Site operational history, physical conditions, and nature and extent of contamination were developed during previous investigations and during the OU2 RI. These data are sufficient to proceed with the Feasibility Study for OU2.

1.2 PURPOSE

This OU2 Feasibility Study (FS) report has been developed in accordance with Section 9.0 of the approved Work Plan. The initial report of the FS process, the Alternatives Array Document (AAD) was prepared and submitted to IDEM in November 1994, prior to the adoption of the operable units approach. The AAD developed and screened a number of remedial technologies applicable to OU1 and OU2. These remedial technologies were assembled into Remedial Action Alternatives (RAAs) for purposes of a detailed evaluation. The remedial technologies screened and retained by the AAD and applicable to OU2 are evaluated further in this document. Additional remedial technologies developed during this FS have also been identified and evaluated herein. Therefore, this FS represents a comprehensive summary of remedial technologies applicable to groundwater containing the OU2 chemical constituents at the Four County Landfill Site.

This document has been prepared in accordance with the Work Plan and appropriate U.S. EPA guidance including "Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites" (EPA/540/P-91/001), "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" (Interim Final, EPA/540/G-89/004), and the "Presumptive Remedy for CERCLA Municipal Landfill Sites", September 1993. Consistent with the approved Work Plan, the identified RAAs are compared to the criteria designated in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This FS is based on a detailed review of the historical information documented by the Work Plan, the Groundwater Technical Memorandum, the Environmental Evaluation Report and the OU1 and OU2 RI Reports.

1.3 REPORT ORGANIZATION

The FS is organized in the following manner:

Section 1.0	Introduction
Section 2.0	Site Overview
Section 3.0	Source Characterization
Section 4.0	Remedial Action Goals and Objectives
Section 5.0	Identification and Screening of Remedial Technologies
Section 6.0	Development of Remedial Action Alternatives
Section 7.0	Evaluation of Remedial Action Alternatives

Section 8.0 Summary and Conclusions

Section 9.0 Major References Relied Upon

2.0 SITE OVERVIEW

2.1 SITE LOCATION AND DESCRIPTION

The Site is located in Aubbeenaubbee Township, Fulton County, Indiana, in the southern half of the southwest quarter of Section 16, Township 31 North, Range 1 East (Figure 2.1). The Site is located approximately 3.5 miles southeast of the common corner of Fulton, Marshall, Starke, and Pulaski counties, near the intersection of State Highway 17 and County Highway 525 North. The nearest towns are Delong, located approximately one mile to the northeast, and Leiters Ford, located approximately two miles to the east-southeast. The Site is approximately six miles south of Culver and 15 miles northwest of Rochester.

The Site occupies approximately 61.5 acres, including the County and State highway rights-of-way. State Highway 17 divides the property into an eastern and western parcel. Land disposal activities were formerly conducted on approximately 30 acres of the western parcel. The western parcel (i.e., the Four County Landfill) is bounded on the east by State Highway 17, on the north by County Highway 525 North, on the west by a county road right-of-way, and on the south by wooded land (Figure 2.2).

2.2 SITE HISTORY

A comprehensive history of the Site, including operational history and references was previously submitted to IDEM in the document entitled "*OU1 Remedial Investigation Report, Four County Landfill, Fulton County, Indiana*" (CRA, June 1997). This section provides an overview of the significant aspects of the Site's history.

In August 1972, a sanitary landfill site located in Fulton County, Indiana began operations as the Four County Landfill. Initially, only sanitary wastes were accepted but the variety of wastes accepted for disposal broadened and ultimately included hazardous wastes as defined by the Resource Conservation and Recovery Act (RCRA). During its tenure as a hazardous waste landfill, the facility operated under interim status pursuant to RCRA.

In February 1987, the U.S. Department of Justice filed a civil action suit (Cause No. S87-55) against the Site owners in the Federal Court of the Northern District of Indiana. The complaint alleged that landfill operations failed to satisfy applicable groundwater monitoring and financial responsibility requirements. Since failure to

satisfy financial and groundwater monitoring requirements would result in the termination of the landfill's interim status, the complaint alleged that the landfill was operating illegally and should be closed. In addition, the complaint alleged that the minimum technology requirements (MTRs) were violated by the disposal of hazardous wastes when the MTRs became effective, through August 19, 1986, in cells and trenches that did not have double liners or leachate collection systems. The complaint also alleged that a release of hazardous waste constituents had occurred at the landfill. The complaint requested the court to order corrective measures to be implemented at the landfill. On December 5, 1988, the civil suit filed by the U. S. Department of Justice (Cause No. S87-55) went to trial in the U.S. District Court, Northern District of Indiana, South Bend Division. West Holding Company, Inc. (WHC), a wholly owned subsidiary of Environmental Waste Control, Inc. (EWC), the Site owners and operators, was formed in 1988 to hold the real estate for the Site.

On March 29, 1989, the U.S. District Court (i) ruled that the landfill lost its interim status on November 8, 1985 and was operating illegally; (ii) ruled that hazardous substances had been released from the landfill into the groundwater under the landfill; (iii) reaffirmed its prior ruling that the landfill illegally disposed of hazardous wastes in cells or trenches without liners and leachate collection systems; (iv) permanently enjoined the defendants from operating a hazardous waste storage and disposal facility at the Site, and (v) ordered the defendants to cease receiving hazardous waste for storage and disposal immediately, to implement an approved closure plan for the facility, to implement corrective action at the landfill, and to pay a civil penalty to the United States of 2.78 million dollars.

Shortly after the court decision, the Site owners filed for Chapter 11 bankruptcy. Thereafter, IDEM initiated Site stabilization activities and pursued PRPs under Indiana State Cleanup Law. IDEM's activities culminated in the execution of an Agreed Order by the Commissioner of the IDEM with a group of responsive PRPs. Upon execution of the Agreed Order, the PRPs commenced a RI/FS and Site operation and maintenance (O&M) activities at the Site. The RI/FS and O&M activities were detailed in a document entitled "Site Background Summary and Detailed Scope of Work" (ERM, 1992).

2.3 SITE BACKGROUND INFORMATION

2.3.1 DEMOGRAPHY AND LAND USE

Fulton County is located in the north-central portion of the State of Indiana and encompasses an area of approximately 237,700 acres.[2] Fulton County had a population of 17,453 in 1900; 15,577 in 1940; 16,984 in 1970; 19,208 in 1980; and 20,351 in 1997.[3,4] The major concentration of the population is in and near Rochester, which is the largest town in the county with a population of approximately 7,500 in 1998. Akron (population 1,200) and Kewanna (population 709) are the next largest communities. Agriculture is the main source of income and employment, with approximately 170,645 acres devoted to farming in Fulton County.[5] The remaining local area businesses and industries are relatively small.

The area to the west of the Site is open and used for agricultural purposes, and properties to the north, south, and east are wooded and sparsely populated, with residents situated on scattered, small farms. The primarily middle class population is involved in agricultural activities, with no notable distributions by age or gender. Land use consists of small farm and dairy operations. Groundwater is the primary source of potable water for the residents.[6]

During a U.S. Geological Survey (USGS) biota study conducted in January 1988, 64 residences and one church were noted on the land within 0.5 mile of the Site. Forty-five of these residences were occupied, and the other 19 appeared to be cottages used only during the summer months. The property immediately north, south, and east of the Site has been separated into many small land plots that have not been developed. Review of this information during the OU2 RI indicates that this information is substantially unchanged.

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[2] U.S. Department of Agriculture, Soil Conservation Service, Soil Survey of Fulton County, Indiana, July 1987.

[3] G.F. Furr, Jr., Soil Survey of Fulton County, Indiana, U.S. Department of Agriculture, Soil Conservation Service, July 1987, pp. 2-3.

[4] Fulton Economic Development Corporation, Community Profile, obtained from World Wide Web site posted by Fulton Economic Development Corporation, www.fultondevelopment.org., March 20, 2000.

[5] U.S. Department of Agriculture, Indiana Agricultural Statistics Service, Census of Agriculture County Profile, obtained from World Wide Web site www.census.gov/population/estimates/county/co-99-1, March 20, 2000.

[6] Agency for Toxic Substances and Disease Registry, 1990

Potential future land use in the vicinity of the Site would most likely consist of one or more of the following: open space, agricultural, residential (either seasonal or permanent), and small commercial developments (particularly near State Highway 17). Zoning ordinances, which may serve to restrict certain land uses, do not exist in Fulton County. However, socioeconomic factors would serve to limit the intensity of any particular use in the vicinity of the Site. For example, the area surrounding the Site is not likely to attract a large permanent residential population due to its relatively remote location and lack of significant industrial development with a large number of jobs. Moreover, the area lacks a sufficient number of major arterial thoroughfares for traffic and a large permanent population that may attract significant industrial development to the area.

2.3.2 TOPOGRAPHY AND DRAINAGE

As a result of glaciation, the area surrounding the Site contains a number of small swamps, streams, and lakes, including 24 natural lakes within Fulton County.[7] The closest large water body is King Lake, which is located approximately 0.25 mile east of the Site. King Lake covers approximately 18 acres and has a north-flowing outlet to the Tippecanoe River (Figure 2.1). Other than King Lake, the nearest large surface water body is the Tippecanoe River located approximately one mile north of the Site. The Tippecanoe River flows in a generally northwesterly direction in the vicinity of the Site.

Based on a review of topographic maps of the area, the three major areas receiving runoff from the Site include: (1) a wetland basin to the north of the Site, (2) forested wetlands and King Lake to the east of the Site, and (3) a series of connected wetlands and an unnamed stream/ditch to the south and west of the Site. The wetland basin to the north also receives surface drainage from small areas northwest of the landfill. Wetland locations in the vicinity of the Site are depicted in Figure 2.3.

OU1 remedial activities completed at the Site have not significantly altered storm water drainage from the Site. Surface water run-on enters the Site from the wooded southern boundary and is directed to natural drainage off the western edge of the Site. Water from this area eventually drains to the unnamed, northwest-trending ditch that flows to the Tippecanoe River. Runoff that does not come into contact with the active portion of the landfill is collected in a series of ditches and drainage control ponds, stored in either the southwest retention pond or the northeast drainage control basin, and ultimately is

[7] M. Harrell, Indiana Department of Public Works, Conservation Department, Division of Geology, Ground Water in Indiana, Publication No. 133, 1935.

discharged from the northeast drainage control basin in accordance with storm water general permit #INR00F104 issued by IDEM on June 3, 1998. Water that collects in the northeast drainage control basin is discharged at the north end of the basin. The discharged water then drains into a culvert (located under County Highway 525 North) that empties into the wetland basin north of the Site.

2.3.3 CLIMATE

The climatological information included in this subsection was obtained primarily from the document entitled "Soil Survey of Fulton County, Indiana" (Furr, 1987). According to Furr, the following climatic data was obtained from the Rochester, Indiana recording station for the period from 1951 to 1974:

- The average winter temperature was 26 degrees Fahrenheit, and the average summer temperature was 68 degrees Fahrenheit.
- The average annual precipitation was approximately 37 inches. Approximately 23 inches of rain, or more than 63 percent of the annual total, usually fell between April and September. The heaviest one-day rainfall event during the period was 4.72 inches on April 29, 1956.
- Thunderstorms occurred on approximately 40 days each year. Occasional tornadoes and severe thunderstorms were local in extent, lasted for only a short duration, and caused damage in scattered areas.
- The average seasonal snowfall was about 25 inches, and the greatest snow depth at any one time was 11 inches. On average, 18 days of the year had at least one inch of snow on the ground; however, the number of such days varied greatly from year to year.
- The average relative humidity in mid-afternoon was about 60 percent. Humidity was higher at night, and the average at dawn was about 80 percent.
- During a typical 24-hour period, it was sunny approximately 70 percent of the day in the summer and 40 percent of the day in the winter.
- The prevailing wind direction was from the southwest, and the average wind speed was generally highest (i.e., 12 miles per hour) in the spring.

2.3.4 ECOLOGY

As part of the landscape environmental evaluation, a survey of flora and fauna indigenous to the study area was completed and a listing of threatened and endangered species obtained from the Indiana Department of Natural Resources was obtained and discussed in the approved document entitled "*Environmental Evaluation Report, Four County Landfill Site, Fulton County, Indiana*" (CRA, May 1995).

2.3.5 GEOLOGY AND HYDROGEOLOGY

2.3.5.1 REGIONAL GEOLOGY

A mantle of unconsolidated glacial deposits covers the bedrock in the area of the Site in Fulton County. Area bedrock consists of middle Devonian Age carbonate rocks, which are part of the Muscatatuck Group. A bedrock core from a well located approximately 2.5 miles east of the Site is described in Doheny, et al. (1975). At that location, there are 67.1 feet of lithographic to bioclastic limestone and fine-grained to saccharoidal dolomite belonging to the Devonian Age Traverse and Detroit River Formations. These Devonian formations overlie 11.9 feet of vuggy Silurian dolomite, assigned to the Salina Formation, which, in turn, overlies 173.7 feet of fine-grained Silurian dolomite assigned to the Wabash Formation. A similar sequence of thick limestone and dolomite bedrock is expected to be present beneath the Site. A structure contour map of the top of the Detroit River Formation (Devonian) prepared by Doheny, et al. (1975) suggests that the bedrock units dip gently to the north or northeast at about 10 feet per mile, away from the Kankakee Arch and toward the Michigan Basin structural feature.

The bedrock in Fulton County is unconformably overlain by glacial deposits that range in thickness from 100 feet to more than 250 feet (Gray, 1982). Regionally, northwestern Fulton County is located between areas known to have been covered by the southwesterly portion of the Michigan Lobe ice and the southeasterly portion of the Huron-Erie Lobe ice. The resultant, complex stratigraphy is typical of interlobate glaciated areas. Wisconsinan Age glacial deposits in Indiana include ground moraine deposits, end moraine deposits, and ice-contact stratified drift of the Trafalgar, Lagro, and Atherton Formations (Schneider and Keller, 1970). The ground moraine is relatively flat lying and consists of till or unsorted gravel, sand, silt, and clay that was deposited by advancing and retreating glaciers. End moraine sediments, comprised primarily of till with smaller areas of stratified sand and gravel, were deposited as ridges. These ridges mark the maximum extent of the ice or a pause in glacial retreat. The

Maxinkuckee end moraine forms a prominent ridge in western Fulton County. Smaller areas of Wisconsinan Age, ice-contact stratified sand and gravel, which were deposited by running water at the margins of the ice, also occur throughout the region (Schneider and Johnson, 1967).

Additional glacial deposits include valley train and outwash sand and gravel, dune sands, and lake sediments of the Atherton Formation. Meltwater streams that flowed from the margins of the glacier and meandered back and forth creating outwash plains deposited sand and gravel. As the ice continued to recede, wind reworked the outwash deposits into dunes. Layers of clay, silt, and fine sands were formed in areas where water was temporarily impounded in lakes or ponds. The general location of the Site relative to these deposits is shown in Figure 2.4. The Site is situated on the Delong end moraine, which overlies glacial outwash sand and gravel.

2.3.5.2 SITE GEOLOGY

Prior to the initiation of the RI, a detailed understanding of stratigraphy beneath the Site was developed as a result of the advancement of numerous on-Site soil borings associated with the investigations completed while the landfill was in operation. In general, unconsolidated sediments on Site were observed to be up to 220 feet thick and were divided into four major stratigraphic units (Units A, B, C, and D) during previous investigations completed by the Site owners.

During the OU2 investigations, over 30 deep soil borings were advanced off-Site to facilitate the installation of groundwater monitoring wells and/or to perform deep groundwater screening activities. Generalized cross-sections trending southwest to northeast and west to east (parallel and perpendicular to groundwater flow across the study area are provided in Figures 2.5 and 2.6, respectively. The stratigraphy encountered during the OU2 investigative activities confirmed observations made during the previous Site investigations. Soil borings were advanced to depth at distances approaching a mile from the Site with no discernible change in the fundamental characteristics of Site stratigraphy. Figure 2.7 depicts the generalized stratigraphy in the Study Area.

Unconsolidated Deposits - Unit A

Stratigraphic Unit A consists of a sequence of four, distinct subunits of loam and silt loam glacial till. Groundwater in the Unit A till sequence occurs in discontinuous

perched zones within thin, stratified, intertill sand and gravel deposits. Off-Site borings advanced during the OU2 RI confirmed the presence of the shallow Unit A deposits and sporadic lenses of perched groundwater in all directions from the Site.

Unconsolidated Deposits - Unit B

Stratigraphic Unit B, a glacio-lacustrine sequence, underlies Unit A and is comprised of well-stratified, fine to medium-grained sand with interbedded silt. Unit B has a relatively uniform thickness on Site of 28 to 42 feet and appears to contain three significant silt beds; one near the top, a second in the middle portion, and a third marking the base. The top of the water table generally lies within Unit B.

The interbedded silt and sand layers associated with Unit B deposits were encountered at off-Site borings and well installations advanced during the OU2 investigation. In addition, a peat layer appears to extend into the top of the Unit B formation immediately north of the Site.

Unconsolidated Deposits - Unit C

Stratigraphic Unit C consists of glaciofluvial sediments comprised of an upper (upward fining) sequence overlying a lower (upward coarsening) sequence that cuts unconformably and irregularly into an underlying glacial till Unit (Unit D). The top of the upper sequence is gradational with the overlying Unit B. In the northwest quadrant of the Site, over 100 feet of sand and gravel overlie Devonian carbonate bedrock. At the southern margin of the southwest quadrant of the Site, the lower sequence of Unit C is approximately five feet thick and overlies glacial till (Unit D).

Unconsolidated Deposits - Unit D

Stratigraphic Unit D consists of unconsolidated loam or finer-textured silty glacial till that is absent in certain areas, presumably as a result of erosion. Where present, the till unconformably overlies the carbonate bedrock of Devonian Age. The maximum thickness of Unit D is 47 feet in the southwest quadrant of the Site. The Unit thins abruptly to the north and is cut out by sand and gravel in the lower part of Unit C. However, investigative activities conducted north of the Site during the OU2 investigation indicate that the erosional feature resulting in the thinning of the Unit D till deposits on Site is likely a localized phenomenon. A boring advanced adjacent to MW114 revealed that the Unit D till is less than 5 feet thick at that location. However, during the installation of MW124, located approximately 600 feet to the northeast of

MW114, Unit D till was once again present. The full thickness of Unit D was not penetrated at MW124.

Bedrock

Bedrock beneath the facility is comprised of carbonate (limestone and dolomite) bedrock of middle Devonian Age, probably of the Detroit River Formation. Approximately 4 feet of light gray to dark brown, fine to coarsely crystalline limestone and dolomite were penetrated at four separate locations during previous investigations. Carbonate bedrock was confirmed at a depth of approximately 204 feet below ground surface adjacent to MW114 during the OU2 investigation. This depth is consistent with the information generated prior to the RI investigation.

2.3.6 REGIONAL HYDROGEOLOGY

Glaciofluvial sand and gravel deposits are the primary sources of groundwater for domestic, livestock, industrial, and public supplies in Fulton County (Rosenshein and Hunn, 1964). CRA obtained information on residential well construction from the existing information collected during the OU1 RI, and an updated database of well information maintained by the Indiana Department of Natural Resources' Division of Water. Wells that tap these sand and gravel units yield from 5 to 1,000 gallons per minute. Water hardness typically is between 200 to 450 parts per million (ppm), and iron content is generally higher than the secondary maximum contaminant level (SMCL) of 0.3 ppm established in the Safe Drinking Water Act of 1974. Examples of ionic species concentrations include iron at 0.1 to 7.5 ppm, bicarbonate at 151 to 532 ppm, sulfate at 5 to 175 ppm, and hardness (as calcium carbonate) at 180 to 540 ppm (Rosenshein and Hunn, 1964). Glacial till in Fulton County is not a viable source of groundwater. These fine-grained, heterogeneous deposits typically are not sufficiently extensive and cannot transmit water at the rate necessary to sustain yields for even modest domestic supplies (Dames & Moore, 1988).

Based on regional topography and hydrogeological data compiled during the RI, the Tippecanoe River, located approximately three-quarters of a mile northeast of the Site, appears to be the discharge point for regional groundwater.

2.3.7 SITE HYDROGEOLOGY

2.3.7.1 OU1 SOURCE-AREA HYDROGEOLOGICAL DATA

During the OU1 RI, two rounds of hydraulic head data were collected from 71 on-Site groundwater monitoring wells and piezometers. A summary of the data obtained during the OU1 RI concerning groundwater flow beneath the Site is summarized in this section. A significant volume of additional data concerning the hydrogeology of the Site was obtained during the OU2 RI and will be discussed later in this document.

Stratigraphic Unit A

Unit A, the uppermost stratigraphic unit, consists of loam and silt loam glacial till. As reported in the RI Work Plan, groundwater in Unit A occurs in discontinuous perched zones within stratified intertill sand and gravel deposits. Each of the Unit A piezometers was screened above the static water table. As a result, piezometers and monitoring wells completed in Unit A did not yield significant quantities of water and did not have consistent water level readings.

Stratigraphic Unit B

The groundwater flow pattern within Unit B was observed to be towards the north to northeast beneath the Site. Groundwater mounding was observed in the vicinity of the northeast retention pond and the wetland located north of the Site during the OU1 RI. The groundwater mounding in this local area was slight and amounted to between 0.2 and 0.3 feet during the study period. This slight mounding is likely attributable to the percolation of water from the wetland near the outlet of the northeast drainage control basin. The mounding locally affected the groundwater flow direction in Unit B in the vicinity of the northeast retention pond. However, the effect on the regional groundwater flow pattern was slight.

The average horizontal hydraulic gradients observed in Unit B across the Site were slight. The observed average horizontal hydraulic gradient in Unit B was in the 10^{-4} range. Across the Site, the local hydraulic gradients varied. For instance, in the vicinity of the northeast retention pond where groundwater mounding was observed, local horizontal hydraulic gradients approached 0.002.

Stratigraphic Unit C

During the OU1 RI, hydraulic head data were collected from on-Site groundwater monitoring wells designated as C1, C2, C3 and C4 wells. During the OU1 RI, it was noted that there was considerable variability in the elevation of the screened intervals between on-Site piezometers installed by the Site owners. On-Site piezometers with a similar subunit designation (e.g. C4) were screened at considerably different elevations. For instance, piezometer P-24C4 was screened at an elevation of approximately 655 feet while piezometer P-8C4 was screened at an elevation of approximately 575 feet, a difference of 80 feet. Moreover, piezometers with similar subunit designations did not appear to correlate to a particular stratigraphic Unit or bed. Conversely, some piezometers with different subunit designations were screened at nearly the same elevation. For example, piezometers P-4C2, P-29C2, P-28C2, P-5C3 and P-24C4 were all observed to be screened within ±3 feet of an elevation of 655 feet.

In order to minimize any uncertainty in the data, which may have resulted from significant variations in the screened interval and the presence of vertical gradients, wells screened at similar elevations were used as a basis to generate groundwater contours that were representative of groundwater flow at different elevations in Unit C. During the OU1 RI, four different elevation intervals within Unit C were selected for evaluation. These elevation intervals included 690 - 710 feet for the upper portion of Unit C, 665 - 685 feet and 635 - 655 feet for the middle portion of Unit C, and 580 - 625 feet for the lower portion of Unit C. During the OU1 RI, groundwater flow in each of these elevation intervals within Unit C was consistently observed to be towards the north to northeast. Average horizontal hydraulic gradients across the Site in Unit C were very slight, in the 10^{-4} range.

2.3.7.2 OU2 HYDROGEOLOGICAL DATA

Groundwater Flow

Water level monitoring performed during the OU2 RI confirms groundwater flow trends established during previous investigations. Seven rounds of water level monitoring were completed during the period from September 1996 to June of 1999. Groundwater levels were measured in September 1996, October 1996, November 1997, September 1998, March 1999, April 1999 and June 1999. Depth to water measurements were tabulated and converted to groundwater elevations referenced to the average mean seal level datum using the reference elevation unique to each well installation.

Surveyors licensed by the State of Indiana supplied reference elevations following the installation of each monitoring well. A summary of the groundwater elevation data from the groundwater measurements collected during the OU2 RI is provided in Table 2.1.

Groundwater contour maps for the B and C stratigraphic units generated from the OU2 water-level data are provided in Appendix A. Groundwater contours generated from these data generally indicate a north to northeasterly groundwater flow direction with a very slight horizontal gradient and negligible vertical gradients. Groundwater flow in Unit B is generally towards the north to north-northeast across the Site while groundwater flow in Unit C is consistently towards the northeast. These flow patterns were persistent throughout the monitoring period and did not vary seasonally. Slight groundwater mounding is generally noted within Unit B in the vicinity of MW108. This slight mounding is likely attributable to the percolation of water from the wetland near the outlet of the northeast drainage control basin. This slight mounding effect is occasionally noted in Unit C but to a lesser extent.

Horizontal groundwater gradients across the Site were also very consistent throughout the monitoring period. With the exception of October 1996, the horizontal groundwater gradient in Unit B across the Site ranged from 3.8×10^{-4} to 4.5×10^{-4}. The horizontal gradient in Unit B during October 1996 was 7.1×10^{-4}. In Unit C, the horizontal hydraulic gradient ranged from 2.5×10^{-4} to 4.2×10^{-4} during the study period. Installation of the shallow and deep monitoring wells in clusters allowed evaluation of the vertical gradients between stratigraphic units. In general, vertical gradients are either nonexistent or negligible in the study area. A summary of the vertical gradients determined from the OU2 monitoring data is provided in Table 2.2.

Hydraulic Conductivity

Single well response tests were also performed at eight monitoring well locations to evaluate the recovery rates and performance of the off-Site monitoring well network. Specifically, monitoring wells MW119 through MW126 were tested in November of 1997 to generate data on both the shallow and deep groundwater units. Four monitoring wells from each Unit were evaluated. Data generated during single-well response testing were evaluated using methods published by Bouwer and Rice with the assistance of the AQTESOLV computer program (Version 2.1). However, data produced from monitoring wells MW122, MW124 and MW126 displayed underdampened or oscillatory water level recovery that is often associated with highly permeable formations. This type of recovery does not lend itself to solution using type curve methods. Instead, data

from these monitoring wells were analyzed using the methodology developed by Van der Kamp. A summary of the hydraulic conductivity data obtained during the OU2 RI is provided in Tables 2.3 and 2.4 for the shallow and deep units, respectively.

The hydraulic conductivity values generated from the November 1997 data ranged from 10^{-3} and 10^{-2} cm/sec for monitoring wells tested in the shallow (Unit B) deposits. Hydraulic conductivity values calculated for the deeper Unit C were in the 10^{-2} cm/sec range. The geometric mean hydraulic conductivity value for Unit B is 5×10^{-3} cm/sec and the geometric mean hydraulic conductivity value for Unit C is 4.8×10^{-2} cm/sec. The calculated groundwater flow velocities using the mean hydraulic conductivity values were 3.2×10^{-7} feet per second (ft/sec) for Unit B and 3.2×10^{-6} ft/sec for Unit C. This translates into groundwater flow velocities of approximately 6.7 feet per year for Unit B and approximately 67 feet per year for Unit C. The groundwater flow velocities calculated will vary dependent on the hydraulic conductivity value used in the calculation. For example, using the low (MW121) and high (MW125) end hydraulic conductivity values from monitoring wells tested in the Unit B monitoring wells results calculated average linear velocities of 1.9 to 15 feet per year. This variation is also apparent in Unit C where low (MW120) and high (MW124) end hydraulic conductivity values result in calculated average linear flow velocities ranging from 23 to 130 feet per year.

Average linear flow velocities should not be considered to be contaminant transport velocities since contaminants transport will be retarded by dilution, dispersion and attenuation mechanisms acting within the saturated zone.

3.0 SOURCE CHARACTERIZATION

3.1 OVERVIEW

Numerous hydrogeological investigations were conducted and a substantial analytical database was compiled before, and during the OU1 and OU2 Remedial Investigations. A comprehensive discussion of the work performed and the analytical data compiled by the Site owners before the OU1 RI was provided in the OU1 RI report. Moreover, the OU1 RI Report summarized the results of extensive characterization activities performed for the various environmental media including groundwater, soil, sediment, surface water, air, landfill gas, biota and residential wells. Much of the information pertaining to on-Site groundwater quality compiled during the OU1 RI and OU1 Predesign Investigation is pertinent to the OU2 remedy selection process and are summarized herein.

The OU2 RI focused on off-Site groundwater and was performed during the period from February 1995 through June 1999. The OU2 groundwater investigation was performed in a "phased" manner in which data from a previous investigative phase was evaluated and used to prepare the work scope for the subsequent investigative phase. The OU2 groundwater investigation continued in this manner until sufficient data were obtained to delineate the nature and extent of contamination in off-Site groundwater. During the OU2 RI, extensive characterization activities were completed and a substantial database was compiled pertaining to the nature and extent of groundwater contamination and the physical hydrogeology in the area near the Site. The OU2 RI report summarized, evaluated, and discussed the comprehensive database as it related to OU2.

This section summarizes the data obtained during the OU1 and OU2 Remedial Investigations that are pertinent to the identification and screening of applicable remedial technologies for off-Site groundwater.

3.2 OU1 SOURCE AREA GROUNDWATER ANALYTICAL DATA SUMMARY

Analytical data pertaining to on-Site groundwater quality compiled during the OU1 RI and the OU1 Predesign Investigation pertinent to the OU2 FS are summarized in this section.

3.2.1 VOLATILE ORGANIC COMPOUNDS

Unit A

Unit A is comprised primarily of silty clay glacial till of low hydraulic conductivity. This is the stratigraphic Unit exposed on the surface at the Site and the Unit upon which the waste deposits were emplaced. The most elevated volatile organic compound (VOC) detections were observed in piezometers completed in the perched groundwater deposits along the western boundary of the Site. Perched groundwater samples collected from on-Site piezometers P-2A, P-10, P-12A, P-13A, P-14A, P-26A, P-32A, and P-33A contained acetone, benzene, chloroform, chloroethane, carbon tetrachloride, 1,2-dichloroethane (1,2-DCA), dichloromethane (DCM), tetrachloroethene (PCE), toluene, 4-methyl-2-pentanone and 1,1,2-trichloroethane (1,1,2-TCA) at concentrations in excess of 1,000 μg/l.

The Unit A VOC analytical data presented in the OU1 RI report is summarized in Figure B.1 in Appendix B.

Unit B

Detectable concentrations of VOCs were noted in groundwater samples collected from only 5 of the 20 monitoring wells/piezometers completed in Unit B. VOC concentrations in groundwater samples collected from Unit B were several orders of magnitude lower than the VOC concentrations detected in Unit A piezometers. Moreover, fewer VOCs were detected in the Unit B monitoring wells than in the Unit A piezometers. Groundwater samples from only one location, P-2B, exhibited VOC concentrations in excess of 100 μg/l for the analytes acetone, benzene, dichloromethane (DCM) and 1,2-dichloroethane (1,2-DCA). There was only one other location where a groundwater sample exhibited an exceedence of a primary maximum contaminant level (MCL) for VOCs. A slight exceedence of the MCL for 1,2-DCA occurred in the duplicate groundwater sample collected from MW-33. No other exceedences of the MCLs were noted in groundwater samples collected from the Unit B monitoring wells.

The Unit B VOC analytical data presented in the OU1 RI report is summarized in Figure B.2 in Appendix B.

Unit C

Exceedences of the MCLs for VOCs were noted in only 3 of the 45 groundwater monitoring wells sampled during the OU1 RI. The highest concentrations of VOCs in Unit C were observed in the groundwater samples collected from piezometer P-2C2 located near the western property boundary. The VOCs present in the highest concentrations at P-2C2 included 1,2-DCA (estimated concentration of 2,000 µg/l) and benzene (estimated concentration of 600 µg/l). VOCs were also detected at concentrations exceeding the MCLs in groundwater samples collected from piezometers P-31C2 and P-31C3, which are hydraulically downgradient of P-2C2.

The Unit C VOC analytical data presented in the OU1 RI report is summarized in Figure B.3 in Appendix B.

3.2.2 SEMIVOLATILE ORGANIC COMPOUNDS

Only six semivolatile organic compounds (SVOCs) were detected in groundwater samples collected from on-Site monitoring wells during the OU1 RI. The magnitude and number of detections of SVOCs were greatest in Unit A and occurred in perched groundwater samples collected from the Unit A monitoring wells and piezometers that exhibited the most elevated concentrations of VOCs. SVOCs were not detected in any of the monitoring wells or piezometers completed in Unit B and only one SVOC, bis(2-ethylhexyl)phthalate (B2EP), was detected at relatively low levels in only two Unit C piezometers (P-5C2 and P-24C2). One low-level B2EP detection occurred at an upgradient Unit C piezometer, P-24C2. The remaining Unit C B2EP detection occurred in the groundwater sample collected from piezometer P-5C2 during the June 1994 groundwater monitoring event but was not detected at the same location during the April 1995 groundwater sampling event.

The SVOC analytical data for Unit A, Unit B and Unit C groundwater samples presented in the OU1 RI report are summarized in Appendix B, Figures B.4 through B.6, respectively.

3.2.3 TARGET ANALYTE LIST METALS

Iron and manganese were regularly detected in all three stratigraphic units above their respective secondary maximum contaminant levels (SMCLs) in both total and dissolved

groundwater samples and the concentrations of these analytes were elevated in samples collected from both upgradient and downgradient of the Site. Therefore, iron and manganese concentrations are attributable to the natural chemistry of groundwater beneath the Site and not the result of former waste disposal practices. These concentrations are consistent with the regional groundwater characteristics discussed previously.[8]

Nickel and aluminum concentrations were also commonly observed to exceed the MCL in unfiltered samples. Each of these metals is relatively common in the subsurface environment and detections of these elements in excess of MCLs or SMCLs in groundwater may not be indicative of a Site-related contaminant source. Additional, metal analytes found to exceed MCLs or SMCLs for either filtered or unfiltered samples collected from the upgradient monitoring wells/piezometers completed in Unit B include arsenic, beryllium, chromium, and lead. The only metal analyte exceeding MCL or SMCL levels detected in a downgradient sample which did not appear in the upgradient groundwater samples was total cadmium which was detected at MW-33B. However, cadmium was not detected above the MCL in the filtered sample collected from MW-33B indicating that its presence may be due to leaching by the acid preservative used for sample collection from suspended solids present in the sample.

A total of seven metals were observed to exceed MCLs or SMCLs in groundwater samples collected from Unit C. Metallic analytes observed infrequently in Unit C included beryllium, chromium, lead and nickel. None of these metals were observed to exceed MCLs in the filtered groundwater samples collected concurrently from each monitoring location.

Detections of metals in groundwater samples at concentrations above the MCLs or SMCLs correlated well with high concentrations of TSS during the OU1 investigation. The number of metals detected in groundwater samples at concentrations above the MCLs/SMCLs in unfiltered samples far exceeded the number in filtered samples at each location. Given the correlation between TSS and the increased number and concentration of metals elements in samples with high TSS, it is likely that many of the exceedences in the unfiltered samples are attributable to the presence of metallic species leached by the acid preservative used for sample collection from solids present in collected groundwater samples. As discussed in the approved OU1 RI Report, the concentrations of metals species may be biased by the presence of suspended solids contained in the groundwater sample. Acid dissolution of elements contained in

[8] Rosenshein and Hunn, 1964.

suspended solids provides an extraneous source of metals, over and above the actual concentration of metallic species in solution, when the acid preservative is added to the sample consistent with U.S. EPA sample preservation requirements. The metals leached from the suspended solids due to dissolution by the acid preservative are then detected when the project laboratory analyzes the sample. Concentrations of metals leached by the acid preservative used for sample collection are not indicative of the metals concentrations, which would be present in groundwater. Metals present in the suspended solids are not mobile in the subsurface environment because groundwater flow velocities are not high enough to transport suspended sediment particles.

The metals analytical data for groundwater samples collected from Unit A, Unit B and Unit C is presented in the OU1 RI report and is summarized in Appendix B, Figure B.7 through B.9, respectively.

3.2.4 GENERAL CHEMISTRY

General chemistry data gathered for on-Site groundwater during the OU1 RI included alkalinity, chloride, total cyanide, nitrogen (as ammonia and as nitrate) total dissolved solids (TDS), total suspended solids (TSS), sulfate and hydrogen ion activity (pH). In Unit A monitoring wells, total cyanide was the only general chemistry analyte found to exceed the primary MCLs in groundwater samples collected from piezometers P-2A and P-14A at concentrations of 0.52 and 0.79 mg/l, respectively. TDS, chloride and sulfate were observed to exceed their respective SMCLs at numerous locations. However, this is not unexpected for a landfill environment.

In Unit B, the SMCL for chloride was exceeded at piezometer P-7B and TDS at ten locations. The pH of Unit B groundwater was slightly above neutral ranging from 7.0 to 8.0. The highest pH was observed in piezometer P-1, an upgradient well. The pH of other upgradient Unit B wells ranged from 7.4 to 7.6, which is more representative of the pH observed at downgradient wells.

General chemistry parameters were within MCL/SMCL limits at all sampling locations in Unit C with one exception. Total cyanide exceeded the MCL of 0.2 mg/l in the groundwater sample collected at piezometer P-34*C2 (0.86 mg/l). The pH of Unit C groundwater ranged from 7.1 to 7.9.

The general chemistry data for groundwater samples collected from Unit A, Unit B and Unit C are summarized in Appendix B, Figure B.10 through B.13, respectively.

3.2.5 RADIONUCLIDES

In October 1995, groundwater samples from 42 on-Site groundwater monitoring wells were analyzed for gross alpha and gross beta activity. In September 1996, groundwater samples were collected from 41 on-Site monitoring wells for gross alpha and gross beta radionuclide analyses. Selected groundwater sampling locations included in the September 1996 round included those monitoring wells completed in the C3 and C4 stratigraphic units that had not been previously sampled as part of the OU1 RI and additional locations selected in consultation with IDEM. Gross alpha activity in all groundwater samples was below the MCL of 15 picoCuries per Liter (pCi/l). Gross beta activity in all samples was below the 50 pCi/l evaluation threshold concentration at each of the sampled monitoring wells and piezometers.

The gross alpha and gross beta radionuclide analytical data for the October 1995 and September 1996 groundwater sampling events are presented in Appendix B as Figure B.13 and B.14, respectively.

3.2.6 OU1 GROUNDWATER ANALYTICAL DATA SUMMARY

Based on the data generated during the OU1 RI, VOCs were determined to be the Site-related groundwater concern. The magnitude of VOC concentrations observed in groundwater samples from Unit A piezometers near the western boundary of the Site, indicate a close proximity to the contaminant source. Due to the intermittent perched nature of groundwater occurrence in Unit A, the predominant direction of groundwater flow within Unit A is downward, under the influence of gravity, toward the underlying saturated zone (water table). However, the thick clay deposits within the Unit A glacial till layer retard the rate of contaminant migration.

Observed VOC concentrations in Unit A are likely indicative of the percolation of leachate from the unlined waste deposits into the thin sand seams and lenses noted within Unit A. Limited lateral transport of contaminants may occur where thin, more permeable sand lenses occur within Unit A. The direction of lateral migration will depend on the slope of the permeable unit. Nevertheless, the OU1 RI data indicate that Unit A was effective at inhibiting the vertical migration of contaminants present near the surface to deeper saturated units, namely Units B and C. This is demonstrated by the fact that although VOC concentrations in excess of 10,000 µg/l occurred in Unit A

monitoring wells located in the western quadrants of the Site, VOC impacts were noted at only a few on-Site monitoring wells screened in the deeper B and C units. The area of VOC impacts in the saturated B and C units beneath the Site is relatively small for a 27-acre landfill site.

Significant VOC detections in the saturated units (Unit B and Unit C) beneath the Site are primarily localized to a relatively narrow zone near the western Site boundary. The P-2 monitoring well cluster was located on the upgradient side but in very close proximity to unlined waste deposits. Since groundwater flow is toward the northeast beneath the Site, monitoring wells P-2B and P-2C2 were receptors for groundwater from off-Site areas located to the southwest of the Site. This groundwater arriving at the Site should be relatively free of Site-related contaminants since the landfill does not extend southwest of the Site. However, the largest number and the most elevated levels of VOCs noted in Units B and C occurred in monitoring wells in the P-2 cluster (specifically P-2B and P-2C2). Moreover, the suite of VOCs that were observed in monitoring wells completed in the upper and lower stratigraphic units at the P-2 cluster were similar.

These data are indicative of a limited contaminant source near the western property boundary that has likely been exacerbated by the installation of deep groundwater monitoring wells through the contaminated layers present at that location at higher elevations within Unit A (see VOC data for P-2A in Appendix B, Figure B.1) and into Units B and C. Well logs indicate that the pre-RI on-Site monitoring wells were not appropriately designed or constructed to prevent the migration of landfill-related contaminants to the lower stratigraphic units through the well annulus. Downward migration of VOCs along the borehole annulus is further supported by the inverse contaminant concentration gradient noted at the P-2 well cluster. The concentrations of VOCs noted in the deepest well in the cluster, P2C2, are higher than the concentrations of VOCs noted in the shallower Unit B well, P-2B, at that same location. Moreover, a greater number of VOCs were detected in the groundwater sample collected from the deeper well, P-2C2. These data are inconsistent with simple downward leaching of contaminants from stratigraphically higher units to the lower units. In the case of downward leaching, VOC detections would be expected to be greater in number and magnitude in the Unit B well than the Unit C well due to the action of advection, dispersion and retardation mechanisms on the contaminants. However, preferential migration of VOCs along a borehole annulus would provide a mechanism that could result in the observed VOC concentrations at the P-2 well cluster. Therefore, a breach of Unit A at these wells may be the reason VOCs are noted at only very few locations in Units B and C.

Downgradient distribution also supports a limited point source for VOCs. There were nine monitoring well clusters located downgradient of the waste deposits on the Site (P-8, P-23, P-25, P-27, P-28, P-29, P-30, P-31, and P-32). These downgradient well clusters were located near the northern and eastern Site boundaries. Since dissolved-phase contaminants will migrate laterally in a direction parallel to groundwater flow, these monitoring well clusters would act as downgradient receptors for VOCs released from the Site. In the event that Unit A was not acting to effectively inhibit the vertical migration of contaminants to lower stratigraphic units, VOC detections in these well clusters would be more prevalent. The OU1 RI data indicate that groundwater samples collected from only one downgradient well cluster, P-31, formerly located in the northwest quadrant of the Site, was impacted by VOCs above the MCLs. These data are consistent with a point source of contamination near the P2 well cluster location.

3.2.7 SELECTED OU1 REMEDY

IDEM issued the OU1 Proposed Remedial Action Plan (Proposed Plan) on April 15, 1998. Prior to issuance of the Proposed Plan, the Group voluntarily initiated OU1 remedial design activities. IDEM approved the OU1 remedial design and issued a Record of Decision for OU1 on July 16, 1998. The remedial design and Record of Decision for OU1 addressed the following primary remedial activities at the Site.

Significant components of the selected remedy for OU1 included:

- construction of RCRA Subtitle C cap with a geocomposite layer;
- collection of leachate from the lined cells with disposal at an off-Site treatment, storage and disposal facility;
- implementation of stormwater controls;
- abandonment of on-Site groundwater monitoring wells;
- consolidation of soil/sediment from Unit A west of the Site and from the cleanout of the sediment basins and disposal within Cell C;
- implementation of deed and groundwater-use restrictions and access control;
- construction of passive landfill gas collection system and monitoring of landfill gases;
- grading and revegetation of the Site; and
- performance of groundwater monitoring.

Construction of the OU1 remedy (landfill cap, grading and drainage improvements, consolidation of soil/sediment in Cell C and installation of passive landfill as vents) commenced at the Site in May 1999 and was substantially completed by the Fall of 1999. The final inspection of the cover improvements will be performed in the Spring of 2000. OU1 groundwater monitoring activities will commence upon approval of the monitoring plan by IDEM. Figure 3.1 provides the final grade drawing for OU1 remedial actions at the Site.

As part of the OU1 remedy, on-Site monitoring wells, including those providing preferential migration pathways to deeper stratigraphic units were abandoned, thereby reducing potential contaminant influx to the subsurface. Performance modeling summarized in the OU1 Feasibility Study and the OU1 Final Design report indicated that installation of a RCRA cap such as the one constructed at the Site together with grading and drainage improvements would virtually eliminate surface water infiltration into the landfill and reduce leachate generation by surface water infiltration by 99.9 percent. Moreover, impacted soil present near the western property boundary was excavated and consolidated into a lined portion of the landfill and capped. Abandonment of on-Site wells, removal of Unit A impacted soil and capping of the landfill were designed to reduce future contaminant influx to the groundwater in Units B and C.

3.3 OU2 DATA SUMMARY

3.3.1 OFF-SITE SURFACE WATER DATA

Two surface water samples were collected from the wetland located north of the Site during the OU2 RI. Surface water samples were collected on November 21, 1997. Surface water samples were analyzed for TAL metals and VOCs. Figure 3.2 depicts the sampling locations and summarizes the analytical data from these surface water samples. Table 3.1 provides a comparison of the detected metals concentrations to ambient water quality criteria.

VOCs were not detected in either of the two surface water samples collected from the wetland north of the Site. As expected, a number of metals were present in both samples. However, only iron and manganese exceeded the applicable U.S. EPA or State of Indiana ambient water quality criteria in the surface water samples collected north of the Site. These results are not unexpected since iron and manganese concentrations have exceeded regulatory criteria in surface water samples collected prior to the OU2

investigation. Iron and manganese concentrations have routinely been elevated in sampling locations representative of upgradient groundwater conditions during previous sampling events. Therefore, it is likely that slightly elevated concentrations of these two metals are typical of surface water in the vicinity of the Site. This is consistent with the published literature on background groundwater quality.[9]

3.3.2 GROUNDWATER SCREENING DATA

Groundwater screening activities were performed during March through May of 1999 to delineate the lateral and vertical extent of impacted groundwater downgradient of the Site and to optimize the placement and screened intervals of permanent monitoring wells installed in 1999. Work tasks included the use of an on-Site mobile gas chromatograph (GC) to generate "real-time" data for use in groundwater plume delineation. All groundwater screening samples were analyzed for 1,2-DCA in substantial compliance with U.S. EPA Method 8020/8021B. The field GC was calibrated to a 1,2-DCA standard as the primary indicator compound. In order to confirm the data generated by the mobile GC, duplicate sample volume was collected concurrently from each groundwater screening interval for potential submittal to the project laboratory for TCL VOC analysis.

3.3.2.1 DOWNGRADIENT GROUNDWATER SCREENING BORINGS

Twenty-three groundwater screening samples were collected from borings GS-1, GS-2, GS-6, GS-7 and GS-10 for analysis using the mobile GC (Figure 3.3). Duplicate samples from 15 of the 23 groundwater screening sample points were also submitted to the project laboratory for confirmatory TCL VOC analysis. Data generated during the downgradient screening activities is summarized in Table 3.2.

The target analyte, 1,2-DCA, was not detected in any of the groundwater screening samples collected from the downgradient screening borings (GS-1, GS-2, GS-6, GS-7, and GS-10). Furthermore, VOCs were not detected at concentrations above their respective MCLs in any of the groundwater screening samples.

The downgradient groundwater screening program successfully met the objectives of delineating the leading edge of the 1,2-DCA plume and optimizing the locations and

[9] Rosenshein and Hunn, 1964.

screened intervals for downgradient monitoring well MW129 and MW130. Based upon the results of the groundwater screening investigation, the downgradient edge of the 1,2-DCA plume was determined to lie between monitoring wells MW124 and MW129. The screened intervals for MW129 and MW130 were placed in coarse sand and gravel at the contact between the base of the Unit C and the top of the Unit D glacial till unit. It is in this layer where the highest concentrations of 1,2-DCA were noted in monitoring well MW124, as depicted in the geologic cross-section in Figure 2.5. Unit D was observed to be of sufficient thickness to prevent the downward migration of VOCs into deeper bedrock units.

3.3.2.2 MW113/114 GROUNDWATER SCREENING BORING

One groundwater screening boring (GS-114) was advanced immediately adjacent to monitoring well cluster MW113/114 (Figure 3.3). Seven groundwater-screening samples were collected from this boring for analysis using the mobile GC. Data generated from samples collected adjacent to the screened interval of MW114 verified that analytical data obtained during groundwater screening activities is comparable to the data obtained using permanent monitoring wells. Both 1,2-DCA and benzene were detected in samples collected from near the base of the screened interval of MW114 at concentrations of 580/820 and 590/680 µg/l, respectively. These data compare favorably to the analytical results for 1,2-DCA and benzene obtained from groundwater samples collected from MW114 during the final groundwater sampling round, which exhibited a concentration of 780 µg/l for 1,2-DCA and 240J µg/l for benzene.

As shown in Figure 3.4, sampling at GS-114 indicates that groundwater VOC impacts extend less than 25 feet below the screened interval of monitoring well MW114. Moreover, concentrations of 1,2-DCA and benzene decrease by an order of magnitude less than 15 feet below the base of MW114. Total xylenes were detected at a concentration of 12 µg/l from the sample collected at the base of the boring (201 feet below ground surface). However, duplicate samples submitted to the project laboratory collected at approximately 135 and 201 feet below ground surface did not contain total xylenes.

During the advancement of the screening boring no visual evidence of a product layer was encountered on any of the recovered formation samples. Therefore, observations and data collected at GS114 demonstrate conclusively that a dense non-aqueous phase liquid (DNAPL) layer is not present at this location.

3.3.2.3 CROSS-GRADIENT GROUNDWATER SCREENING BORING

One groundwater screening boring (GS-128) was advanced to the north of the Kings Lake Baptist Church to determine the most appropriate screened interval for a deep monitoring well at this location (Figure 3.3). Nine groundwater-screening samples were collected from the GS-128 boring. Low-level (generally, less than 10 μg/l) total xylenes concentrations were reported from 8 of the 9 samples collected from GS-128 and analyzed on-Site. The mobile GC detected no other compounds during analyses with the exception of ethylbenzene (1.9 μg/l) from sample 48M. Although sample 40M contained the highest concentration of total xylenes (23 μg/l) during the on-Site analysis, it was not detected in the duplicate sample volume analyzed by the project laboratory. It should also be noted that the 23 μg/l of total xylenes detected at GS-128 is several orders of magnitude below the MCL of 10,000 μg/l.

3.3.3 GROUNDWATER DATA

The OU2 groundwater investigation consisted of three major sampling events conducted in September 1996, November 1997 and April/May of 1999. Several supplemental sampling events were also completed during this timeframe to address specific OU2 RI objectives.

Tabulated summaries of groundwater analytical data compiled during the OU2 RI are provided in Appendix C.

3.3.3.1 VOLATILE ORGANIC COMPOUNDS

VOC Distribution - Shallow Off-Site Groundwater

Fifteen off-Site groundwater monitoring wells were installed in Unit B at the Site. Groundwater samples were collected from the entire network of shallow Unit monitoring wells at least twice during the course of the OU2 RI with the exception of MW127. Monitoring well MW127 was completed during the latter part of the OU2 investigation and, therefore; was sampled only once during the OU2 RI. Figure 3.5 provides the locations of the shallow off-Site monitoring wells and summarizes the VOC data generated during the OU2 investigation.

VOC concentrations above the MCLs were noted in groundwater samples collected from 2 of the 15 off-Site Unit B monitoring wells. In September 1996, 1,2-DCA was detected at an estimated concentration of 12J µg/l in the groundwater sample collected from MW108, which is above the MCL of 5 µg/l for 1,2-DCA. During April 1999, 1,2-DCA was not detected in the groundwater sample collected from MW108. The most elevated VOC detections in groundwater samples collected from monitoring wells completed in Unit B were observed at MW113, which is completed near the northwest corner of the Site. Seven VOCs, consisting of acetone, benzene, carbon disulfide, chloroform, carbon tetrachloride, 1,2-dichloroethane, and dichloromethane were detected in at least one sampling event in groundwater samples collected from MW113. However, chloroform and carbon tetrachloride were the only VOCs detected consistently during each of the four groundwater sampling events. Carbon tetrachloride detections in groundwater samples at MW113, ranged from 45 µg/l to 340 µg/l, and represented the only VOC to be detected consistently at concentrations above the MCLs.

None of the groundwater samples from the other shallow off-Site monitoring wells exhibited a consistent or reproducible pattern of VOC detections during the OU2 investigation. Monitoring wells MW100, MW102, MW108, and MW111 sporadically contained low level (generally less than 5 µg/l) concentrations of benzene, DCM, 1,2-DCA, and toluene during OU2 sampling events. However, VOCs were not detected in groundwater samples collected from these monitoring wells during the sampling event conducted in April/May of 1999. Moreover, VOCs were not detected in groundwater samples collected from monitoring wells MW104, MW106, MW110, MW116, MW118, MW119, MW121, and MW125 during the OU2 investigation. The groundwater sample collected from monitoring well MW127, which was installed in April 1999 and sampled for the first time in May 1999, contained toluene at an estimated concentration of 1.1J µg/l.

VOC Distribution - Deep Off-Site Groundwater

Sixteen off-Site groundwater monitoring wells were completed in the Unit C deposits. Groundwater samples were collected from each of the deep monitoring wells at least twice for VOC analysis during the OU2 RI, with the exception of monitoring wells MW129 and MW130. These monitoring wells were completed during the final phase of the OU2 investigation. Figure 3.6 provides the locations of the deep off-Site monitoring wells and summarizes the VOC analytical data generated during the OU2 investigation.

Consistent VOC detections above the MCLs were observed in groundwater samples collected from three of the 16 deep groundwater monitoring wells (MW112, MW114 and

MW124). Three VOCs (benzene, 1,2-dichloroethane, and vinyl chloride) were detected in deep groundwater samples at concentrations above the MCLs. Benzene and vinyl chloride concentrations in groundwater samples collected from MW114 ranged from 240 to 460 µg/l, and 3.9 to 5.2 µg/l, respectively. The concentration of 1,2-DCA in groundwater samples collected from MW114 has declined during four successive sampling events (September 1996, November 1997, March 1998 and May 1999) from 2,000 µg/l to 780 µg/l. The concentration of 1,2-DCA in the groundwater samples collected from MW112 has declined from 83 µg/l/85 µg/l (in the groundwater sample and duplicate groundwater sample collected in September 1996) to 44 µg/l/38 µg/l (in the groundwater sample and duplicate groundwater sample collected in May 1999). The concentration of 1,2-DCA has increased in groundwater samples collected from monitoring well MW124 from 63 µg/l in November 1997 to 1,400 µg/l in May 1999. Vinyl chloride was detected at MW124 during the final OU2 monitoring event at a concentration of 8.7 µg/l.

The remaining VOCs identified in groundwater samples collected from the deep Unit were detected only sporadically at low concentrations (below the MCLs). Specifically, acetone, chloroethane, methyl ethyl ketone (2-butanone), and toluene have been detected only once during groundwater monitoring. Dichloromethane was detected in groundwater samples collected from MW124 during the March and September 1998 sampling events. However, these concentrations of dichloromethane were only slightly above the method detection limit. Furthermore, dichloromethane was not detected in groundwater samples collected from MW124 in May 1999. Due to the lack of spatial or temporal trends exhibited for these detections of dichloromethane, the presence of this compound must be considered suspect.

3.3.3.2 SEMIVOLATILE ORGANIC COMPOUNDS

Groundwater samples were collected from 19 monitoring wells located around the perimeter of the Site (MW100 through MW118) in September of 1996 and were analyzed for SVOCs. SVOCs were not detected in any of the groundwater samples collected during this event. As discussed previously in this section, SVOCs were detected only rarely in the groundwater samples collected from the on-Site monitoring wells during the OU1 RI. Therefore, the absence of SVOC detections in groundwater samples collected from the perimeter groundwater monitoring wells was not unexpected considering the analytical data previously developed in OU1. These data support the conclusion that SVOCs are not Site-related compounds of concern.

One groundwater sample was collected from monitoring well MW124 and was analyzed for Appendix IX analytes, which includes the SVOC suite of compounds. The resulting data are discussed later in this section.

3.3.3.3 METALS

Metals Distribution - Shallow Off-Site Groundwater

Metal analytes detected at concentrations above the MCLs or SMCLs for either filtered or unfiltered groundwater samples collected from off-Site monitoring wells completed in Unit B included aluminum, antimony, iron, manganese and nickel. Antimony was the only metal detected at a concentration exceeding a primary MCL. Antimony was detected at a concentration of 0.042 mg/l in the groundwater sample collected from monitoring well MW116, which is above the MCL of 0.006 mg/l. However, dissolved antimony was not detected in the filtered groundwater sample collected from MW116. Since MW116 is cross-gradient of the landfill, transport of compounds in groundwater from the Site to MW116 is not expected. Therefore, leaching of antimony from suspended solids in the groundwater sample due to acid dissolution of suspended solids by the acid sample preservative or to the presence of this analyte in the background at the Site are the most likely reasons for this antimony detection.

Aluminum was detected at concentrations above the SMCL of 0.2 mg/l in groundwater samples collected from three shallow downgradient monitoring wells (MW119, MW121 and MW125) during the November 1997 sampling event. However, aluminum was not detected in these same monitoring wells during the April/May 1999 groundwater sampling event. Iron and manganese were found to exceed their respective SMCLs of 0.3 mg/l and 0.05 mg/l ubiquitously in groundwater samples collected from upgradient and downgradient monitoring wells and in both the total and dissolved sample fractions. Iron and manganese have previously been demonstrated to be present in elevated concentrations in upgradient groundwater.[10,11] A summary of the metals data in groundwater samples collected from shallow off-Site monitoring wells is presented in Figure 3.7.

[10] Groundwater Technical Memorandum, p. 7, (CRA, February 1995).
[11] Rosenshein and Hunn, 1964.

Metals Distribution - Deep Off-Site Groundwater

Antimony was the only analyte detected at a concentration exceeding the MCL in the groundwater samples collected from monitoring wells completed in Unit C during the OU2 Remedial Investigation. This detection occurred in the unfiltered groundwater sample collected from monitoring well MW109. Antimony was not detected in the filtered groundwater sample collected from MW109 nor in any other groundwater samples collected from Unit C monitoring wells during the OU2 investigation. This single detection of antimony is not indicative of a landfill-related impact to groundwater with respect to this analyte.

Similar to Unit B, exceedences of SMCLs for iron and manganese in both total and dissolved samples were ubiquitous in groundwater samples collected from both deep upgradient and downgradient locations. As discussed in the previous section, the iron and manganese exceedences are indicative of the natural chemistry of groundwater beneath the Site and not the result of historic waste disposal practices. A summary of the metals data in groundwater samples collected from deep off-Site monitoring wells is presented in Figure 3.8.

3.3.3.4 GENERAL CHEMISTRY

Selected general chemistry data was obtained at the majority of off-Site well locations at least twice during the OU2 RI. Groundwater samples were collected only once from monitoring wells MW127 through MW130 for general chemistry parameters due to their time of installation. Overall, selected general chemistry parameters consisted of alkalinity, chloride, dissolved organic carbon (DOC), ethane, ethene, hardness, methane, nitrate, nitrite, sulfate, sulfide, TDS, TSS, and TOC. The general chemistry data compiled during the OU2 RI are provided in Figures 3.9 and 3.10. Dissolved gases (ethane, ethene and methane) data are summarized in Figures 3.11 and 3.12.

General chemistry parameters were below the MCLs/SMCLs for all groundwater samples collected from shallow and deep off-Site groundwater monitoring wells with the exception of TDS. TDS concentrations exceeded the SMCL of 500 mg/l in groundwater samples collected from five shallow monitoring wells (MW102, MW106, MW111, MW113 and MW119) at least once during the OU2 groundwater investigation. However, groundwater samples collected from only two monitoring wells MW102 and MW113 exceeded the SMCL on more than one occasion.

Total cyanide analysis was performed on groundwater samples collected during the September 1996 sampling event from monitoring wells MW100 through MW118. Total cyanide was not detected in any of these groundwater samples.

3.3.3.5 RADIONUCLIDES

Groundwater samples were collected from a set of 19 monitoring wells (MW100 through MW118) for gross alpha and gross beta radioactivity characterization. These data are summarized in Figure 3.13. Gross alpha activity was detected only in the groundwater sample collected from MW116 and gross beta activity was detected in the groundwater samples collected from monitoring wells MW102, MW110, MW112, MW113, and MW116. Gross alpha activity in monitoring well MW116 was well below the MCL of 15 pCi/l. Gross beta activity in all samples was below the 50 pCi/l evaluation threshold concentration at each of the sampled monitoring wells. Compliance with Section 141.16 of the Safe Drinking Water Act (SDWA) may be assumed without further analysis if the average annual concentration of gross beta particle activity is less than 50 pCi/l. It should also be noted that duplicate sample analyses for groundwater collected from monitoring wells MW110 and MW112 did not confirm the presence of gross beta activity in either sample.

3.3.3.6 APPENDIX IX ANALYTES

Consistent with Section 7.3.2.3 of the Work Plan, one groundwater sample was collected from a groundwater monitoring well located within the plume and was analyzed for Appendix IX parameters. The location selected for these analyses was MW124 from which groundwater samples were observed to have the highest concentration of 1,2-DCA during the OU2 investigation. Analytes comprising the following suites of compounds were not detected in the Appendix IX analyses performed on the groundwater sample collected from MW124:

- SVOCs
- dioxins/furans
- polychlorinated biphenyls
- pesticides/herbicides
- total cyanide
- sulfide

Appendix IX metals detected included arsenic (0.0085J mg/l), barium (0.14 mg/l), total chromium (0.029 mg/l), and vanadium (0.016 mg/l). None of these metals concentrations is above the MCLs. Appendix IX volatile organic compounds detected included 1,2-DCA (1,400 μg/l), and vinyl chloride (8.7J μg/l).

3.3.4 OU2 GROUNDWATER DATA SUMMARY

The only analytes consistently detected above the primary MCLs were several VOCs. No other analytes have been detected consistently above primary MCLs in off-Site groundwater. Therefore, VOCs are considered as the Site-related compounds of concern in groundwater. However, VOC detections in the saturated shallow and deep units (Unit B and Unit C) downgradient of the Site are localized and constrained to four chemicals of concern. Specifically, downgradient detections of VOCs during multiple sampling events at concentrations above the MCLs were noted for benzene, carbon tetrachloride, 1,2-DCA, and vinyl chloride. These detections were confined primarily to the MW113/114 and the MW123/124 monitoring well clusters.

Remedial actions such as abandonment of suspect monitoring wells, capping of the landfill with a low-permeability barrier, excavation of impacted soil and grading improvements completed at the Site in 1999 were designed to reduce the flux of contaminants to the subsurface. The increase in concentrations of 1,2-DCA and vinyl chloride at MW124 are expected, since the VOCs are being transported towards MW124 by advection. A decline in VOC concentrations is also expected to occur at the downgradient monitoring well locations in the future as the remedial actions completed during OU1 reduce the flux of contaminants to the subsurface. These trends would be verified through a groundwater monitoring program

3.4 OU2 RISK ASSESSMENT

3.4.1 OVERVIEW

A Baseline Risk Assessment (RA) is an evaluation of the risks, or potential risks posed to public health, welfare and the environment posed by the Site if the Site is left unremediated. The purpose of the Baseline RA is to provide the required basis to proceed with the Feasibility Study. The Baseline RA consists of two components; an Environmental Evaluation (EE) and a Human Health RA. The EE was previously

submitted and approved by IDEM. The EE was prepared in a manner consistent with the U.S. EPA guidance document "Risk Assessment Guidance for Superfund (RAGS), Volume II: Environmental Evaluation Manual" [Interim Final EPA/540/1-89/001, March 1989] and Region V Regional Guidance for Conducting Ecological Risk Assessment [April 1992]. A summary of the findings of the EE is provided in Section 7.0 of the OU1 RI Report. The Human Health RA for the elements of OU1 was prepared in a manner consistent with the U.S. EPA guidance "Risk Assessment Guidance for Superfund (RAGS), Volume I: Human Health Evaluation Manual (Part A)".

The Risk Assessment was completed for OU2 and was provided as Appendix L of the OU2 RI Report. Since the extent of Site-related impacts to groundwater is present in a limited area located to the north of the Site, the RA was structured to evaluate risk in three separate off-Site areas as shown in Figure 3.14. The upgradient sector includes areas to the west and south of the Site representative of baseline groundwater quality conditions. The east and north downgradient sectors include groundwater conditions downgradient of the Site.

The RA was intended to characterize potential current and future impacts, if any, to human health associated with chemicals of potential concern in groundwater off Site. Information developed during the RA was utilized in the development, evaluation, and selection of appropriate remedial action alternatives including the "no-action" alternative.

3.4.2 POTENTIAL HUMAN EXPOSURE PATHWAYS

The following potential human exposures (i.e., potentially complete pathways) were identified for off-Site groundwater:

- ingestion of drinking water - off-Site residents;
- dermal exposure while showering/bathing - off-Site residents;
- inhalation of volatiles while showering/bathing - off-Site residents;
- inhalation of volatile emissions from a large-scale irrigation system - agricultural workers;
- ingestion of homegrown fruits and vegetables irrigated with groundwater - off-Site residents; and
- ingestion of meat (beef, pork, and poultry) obtained from animals watered with groundwater - off-Site residents.

The locations of known off-Site residential supply wells are shown in Figure 3.15.

3.4.3 OU2 RISK ASSESSMENT SUMMARY

Tables summarizing the OU2 RA are presented in Appendix D. Significant findings of the OU2 RA are summarized below.

UPGRADIENT SECTOR

- There were no landfill-related compounds of potential concern (COPC) identified in the upgradient sector. Therefore, the hazard indices (HI) and lifetime cancer risks were not determined for the upgradient sector.

EAST DOWNGRADIENT SECTOR

- There were no carcinogenic compounds of potential concern (COPCs) identified in the east downgradient sector. Therefore, the lifetime cancer risks for the Mean and Reasonable Maximum Exposure (RME) conditions were not determined.
- The hazard indices for the residential groundwater ingestion and showering/bathing exposure route are below 1.0, the level of potential concern.
- The hazard indices for the exposure to irrigated homegrown fruits and vegetables are below 1.0, the level of potential concern.
- The hazard indices for the agricultural worker exposure by inhalation of volatile emissions from a large-scale irrigation system are below 1.0, the level of potential concern.

NORTH DOWNGRADIENT SECTOR

- The estimated lifetime cancer risks associated with the future potential exposure to groundwater by nearby residents range from 4.4×10^{-4} and 2.9×10^{-3} for the Central Tendency and RME, respectively. 1,2-DCA is the only COPC with estimated cancer risks above U.S. EPA's target risk range.
- The hazard indices associated with the future residential potential exposure to groundwater were above 1.0, the level of potential concern. 1,2-DCA drives the

majority of the total hazard index, contributing up to 90 percent of the total hazard index with metals contributing the remainder of the hazard index.

- The estimated lifetime excess cancer risk associated with the future residential potential exposure through ingestion of homegrown fruits and vegetables irrigated with groundwater are within the target cancer risk range of 10^{-6} to 10^{-4}, as established by U.S. EPA.
- The hazard indices associated with the future residential potential exposure through ingestion of homegrown fruits and vegetables irrigated with groundwater are below 1.0, the level of potential concern.
- The estimated lifetime cancer risk associated with the future potential agricultural worker exposure to volatile emissions from groundwater range from 4.4×10^{-6} and 1.3×10^{-4} for the Central Tendency and RME, respectively. These estimated lifetime cancer risks are within to slightly above the target cancer risk range of 10^{-6} to 10^{-4}, as established by U.S. EPA. 1,2-DCA drives the majority of the cancer risks; contributing 99 percent of the total estimated risks for both the Central Tendency and RME condition. Additional COPCs specifically benzene, carbon tetrachloride and vinyl chloride had estimated lifetime cancer risks below and within the U.S. EPA target risk range of 10^{-6} to 10^{-4}.
- The hazard indices associated with the future potential agricultural worker exposure to volatile emissions from groundwater range from 0.28 and 3.0 for the Central Tendency and RME, respectively. The hazard index for the Central Tendency condition is below 1.0 and the hazard index for the RME condition is slightly above 1.0.

The results of this RA indicate that the estimated lifetime excess cancer risks are above the U.S. EPA target risk levels for the future residents living in the North Downgradient Sector, assuming that the groundwater beneath this area is used for potable purposes. 1,2-DCA drives the majority of the cancer risks contributing 95 percent of the total estimated risks. Additional COPCs such as benzene, carbon tetrachloride, and vinyl chloride had estimated lifetime cancer risks within the U.S. EPA target risk range of 10^{-6} to 10^{-4}. The hazard indices (HI) for the future residents in the North Downgradient Sector are above the U.S. EPA target of 1.0, the level of potential concern. Again, 1,2-DCA is the primary contributor to the total hazard index. The results of this RA indicate that organ-specific HI are above 1.0, the level of potential concern, for the future residents living in the North Downgradient Sector assuming that the groundwater is used for potable purposes.

Currently, there is no excess risk associated with groundwater exposure north of the Site. There are only two locations north of the Site where potential exposure to groundwater containing Site-related VOCs could occur, the Kings Lake Baptist Church and one cottage located north of the wetland area. Regular residential well monitoring has not identified any Site-related compounds or elements above concentrations of concern in any residential wells located near the Site, including the Kings Lake Baptist Church well. There is limited potential for future residential development in the area located immediately north of the northern Site boundary since an extensive wetland is present north of County Highway 525 North. The nearest reasonable location for future residences is north of the wetland area.

Groundwater monitoring during the OU2 RI has demonstrated that the concentrations of COPCs in the off-Site groundwater plume beyond this wetland area are limited to the lower portion of the deep formation (Unit C) at depths greater than 100 feet. Groundwater for residential supply is available at depths of approximately 50 to 80 feet below ground surface (depending upon surface elevation). Well records near the Site indicate that residential wells have been typically completed at these shallower depths. Therefore, although future risk associated with groundwater exposure were calculated in accordance with applicable U.S. EPA guidance, due to the excess cost without additional benefit, it is unlikely that a residential well would be installed at greater depths north of the Site when suitable quantities of groundwater for residential supply are available at shallower depths. Figure 3.16 provides a summary of well depths for residences located proximal to the Site with available well construction logs. There are four known residential wells located downgradient of the Site (north of County Highway 525 North between Highway 17 and County Highway 1000 West. The total depths of these residential wells are between 60 and 80 feet below ground surface. However, one of these residential wells (designated as "E-62 ft" in Figure 3.16) is located on an abandoned, overgrown parcel that is not currently occupied nor is there a structure located on the parcel. Another residence associated with the residential well designated, as well "D-78 ft" on Figure 3.16 appears to be a cottage that is not permanently occupied.

The results of this RA also indicate that the estimated lifetime added cancer risks are within the U.S. EPA target risk levels for the agricultural worker operating a large-scale irrigation system and using the groundwater beneath the North Downgradient Sector for irrigation purposes. The hazard indices for the agricultural worker operating a large-scale irrigation system in the North Downgradient Sector are above 1.0, the level of potential concern. However, as stated previously, much of the land area north of the Site is occupied by a wetland. North of the wetland area, the land is heavily wooded with

trees and thick underbrush. Additionally, the land is divided into hundreds of small plots of land owned by numerous entities. Under these circumstances, it is unlikely that the property north of the Site will be converted to agricultural use in the future.

3.5 FATE AND TRANSPORT

The permanent water table beneath the Site generally occurs at an elevation of between approximately 728 and 730 feet AMSL, within the shallow (Unit B) formation. Groundwater flow in the saturated zones beneath the Site is towards the north and northeast. Data generated during the OU2 investigation confirms that this trend continues in the off-Site saturated formations. Dissolved landfill-related compounds in groundwater are transported primarily by advection, parallel to the direction of bulk groundwater flow, at a rate that is proportional to the groundwater flow velocity. Therefore, dissolved-phase constituents originating from the landfill would be transported in the direction of groundwater flow, north to northeast from beneath the Site.

Groundwater gradients measured at the Site during the OU1 and OU2 study periods were minimal. However, response testing of the off-Site monitoring network generated hydraulic conductivity values that differed from those developed using data from the former on-Site well network. Average groundwater flow velocities calculated using the data generated from the more recent response testing resulted in flow velocities in the range of 1.9 to 130 feet per year. However, average linear groundwater flow velocities should not be considered to be contaminant transport velocities since contaminant transport will typically be slowed by attenuation mechanisms (e.g., adsorption, biodegradation, hydrolysis, etc.) acting within the saturated zone. Additionally, dilution of the dissolved constituents in groundwater will occur along the flowpath as a result of mechanical mixing and molecular diffusion.

The U.S. EPA's preliminary screening for anaerobic biodegradation processes (Table 2.3 of the document entitled, Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater, September 1998) was used to assess the fate of dissolved chlorinated aliphatic hydrocarbons in Site groundwater. Site-specific data were used in this screening method to evaluate conditions at the Four County Landfill Site and the results were reported in Section 8.3.3 of the OU2 RI report. The screening method involves the assignment of points on the basis of Site-specific data (see Table 3.3). Based upon the results of this evaluation, the Site achieves a score of 20 points, which according to the U.S. EPA guidance indicates that there is adequate

evidence supporting the anaerobic biodegradation (reductive dechlorination) of chlorinated organic compounds.

4.0 REMEDIAL ACTION GOALS AND OBJECTIVES

4.1 OVERVIEW

The general objective of the OU2 FS is to develop a remedy which:

- protects public health and the environment;
- satisfies applicable or relevant and appropriate requirements;
- provides practical, cost-effective remediation; and
- utilizes permanent remedies which are completed in a short time frame, where applicable.

Remedial action objectives are established under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Section 121 (Cleanup Standards) as amended by the Superfund Amendment and Reauthorization Act (SARA). Remedial actions are developed in accordance with the requirements of CERCLA Section 121 and, to the greatest extent practicable, with the NCP as codified in 40 CFR Part 300. As stated in the NCP under Section 300.68(i), remedies selected shall be cost effective and shall effectively mitigate and minimize threats to and provide adequate protection of public health and welfare and the environment. SARA expanded the statutory scope of CERCLA and codified requirements, which, before the enactment of SARA, were essentially non-promulgated U.S. EPA policies.

Additional requirements under CERCLA as amended by SARA include the following.

- Preference is to be given to the selection of remedial actions "in which treatment that permanently and significantly reduces the volume, toxicity, or mobility of the hazardous substances, pollutants, and contaminants is a principal element" [SARA, Section 121(b)] (Where permanent remedies involving treatment or recovery technologies are not to be considered, such decisions shall be supported by appropriate explanations).
- Remedial actions "shall attain a degree of cleanup of hazardous substances, pollutants, and contaminants released into the environment and of control of further release at a minimum which assures protection of human health and the environment" [SARA Section 121(d)].
- "With respect to any hazardous substances, pollutant, or contaminant that will remain on Site" that the residual levels will attain "any standard, requirement, criteria, or limitation under any Federal environmental law" and "any promulgated

standard, requirement, criteria, or limitation under a State environmental or facility siting law that is more stringent than the Federal requirements where such goals are relevant and appropriate" [SARA Section 121(d)(2)(A)].

The Federal and State requirements referred to above are collectively referred to as ARARs and are discussed later in this section. Guidelines for the determination of ARARs that may have to be considered during the FS are presented in the U.S. EPA documents entitled:

1. CERCLA Compliance with Other Laws Manual, August 1988;
2. Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, October 1988; and
3. Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites, February 1991.

4.2 PRELIMINARY REMEDIATION GOALS

Preliminary remediation goals (PRGs) are established using readily available information such as reference doses, risk-specific doses, or frequently used standards such as ARARs. Selection of PRGs should permit a range of treatment and containment alternatives to be developed. The final acceptable levels should be based upon the results of the baseline RA and an evaluation of the expected exposures and associated risks for each alternative.

The baseline RA indicated there is no current risk due to an absence of exposed off-Site receptors. However, there was potential excess cancer risk associated with future residential exposure to groundwater by ingestion and inhalation of vapors. There was also potential future excess risk to agricultural workers associated with high-volume irrigation. These potential future excess risks are limited to the area north of the Site where landfill-related compounds are present in groundwater. Currently, the land north of the Site is sparsely populated. In addition to socioeconomic factors, the population density north of the Site is limited by the presence of a wetland along the northern Site boundary (Figures 2.3 and 3.3). This area is inundated with water except during the driest months of the year and, as such, is presently not inhabitable or useful for agricultural development.

Figure 4.1 depicts the areal extent of groundwater impacted by VOCs at concentrations above the MCLs determined through the collection and analysis of groundwater samples from off-Site groundwater monitoring wells. As shown in Figure 4.1, the VOC plume extends from the northwestern corner of the Site towards the northeast, to State Highway 17. The plume is primarily present beneath the wetland located north of the Site. However, the plume emerges from beneath the wetland near MW124 and, at this location is present at over 100 feet in depth. Due to the depth of the groundwater impact and the distance from the nearest downgradient surface water body receptor (the Tippecanoe River is located nearly one mile beyond the leading edge of the plume), there are no known environmental receptors that would be detrimentally affected by the presence of this contamination. Land use beyond Highway 17 for a distance of approximately one-half mile towards the northeast, is primarily agricultural pastureland.

The PRGs for exposure to organic chemicals in groundwater were set at the primary MCLs established by the Federal Safe Drinking Water Act (SWDA). Residences in the vicinity of the Four County Landfill obtain potable water from individual supply wells. The residential supply wells nearest to the groundwater plume are located at Kings Lake Baptist Church (northeast corner of the intersection of County Highways 1000 West and 525 North), at a trailer located across County Highway 1000 West from Kings Lake Baptist Church (northwest corner of the intersection of County Highways 1000 West and 525 North), and a cottage located northeast of the wetland area. However, VOCs have not been detected at concentrations above the MCLs in water samples collected during regular residential well sampling conducted by the Fulton County Hazardous Substance Committee. Although the MCLs are applicable to certain public water delivery systems and not to groundwater supplied by individual residential supply wells, the primary MCLs are standards designed to be protective of human health. Figure 4.1 depicts the areal extent of organic compounds present in groundwater at concentrations above the primary MCLs. Table 4.1 summarizes the PRGs for organic chemicals detected in groundwater samples collected from off-Site monitoring wells.

4.3 REMEDIAL ACTION OBJECTIVES

The U.S. EPA guidance document entitled "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA", October 1988, states that "specific remedial action objectives consist of medium-specific or operable unit-specific goals for protecting human health and the environment". The objectives must not be so specific that the range of remedial alternatives, which can be developed, becomes overly

limited. Remedial action objectives established to protect human health and the environment are to specify:

- the chemicals of concern;
- the exposure routes and receptors; and
- an acceptable chemical concentration or range of concentrations for each exposure route.

Specifying remedial action objectives in this manner is deemed to be appropriate since protectiveness may be achieved by reducing exposure to receptors either separately or in conjunction with reducing chemical levels. The guidance further states that "because remedial action objectives for protecting environmental receptors typically seek to preserve or restore a resource, environmental objectives should be addressed in terms of the medium of interest and target cleanup levels, whenever possible". The remedial objectives themselves are not the motivation for initiating a remedial action, but a set of performance standards against which to compare remedial alternatives. Remedial action objectives for the Four County Landfill will address off-Site groundwater.

The OU2 RA evaluated potential risk to human health and the environment arising from exposure to landfill–related analytes in groundwater. The results of this RA indicate that the estimated lifetime excess cancer risks are above the U.S. EPA target risk levels for the future residents living in the North Downgradient Sector, assuming that the groundwater beneath this area is used for potable purposes. 1,2-DCA was found to drive the majority of the excess cancer risks contributing over 90 percent of the total estimated risks. Additional COPCs such as benzene, carbon tetrachloride, and vinyl chloride had estimated lifetime cancer risks within the U.S. EPA target risk range of 10^{-6} to 10^{-4}. The hazard indices for the future residents in the North Downgradient Sector are above the U.S. EPA target of 1.0, the level of potential concern. Again, 1,2-DCA contributes up to 90 percent of the total hazard index. The results of this RA indicate that organ-specific HI are above 1.0, the level of potential concern, for the future residents living in the North Downgradient Sector assuming that the groundwater is used for potable purposes.

The hazard indices for the agricultural worker operating a large-scale irrigation system in the North Downgradient Sector are above 1.0, the level of potential concern. The excess cancer risk for an agricultural worker operating a large-scale irrigation system in the North Downgradient Sector is within U.S. EPA's target risk range for the Central Tendency condition and slightly above U.S. EPA's target risk range for the RME

condition. However, much of the land area north of the Site is occupied by a wetland. North of the wetland area, the land is heavily wooded with trees and thick underbrush. Additionally, the land is divided into hundreds of small parcels of land owned by numerous entities. Under these circumstances, it is highly unlikely that the property north of the Site will be converted to agricultural use in the future.

The Remedial Action Objectives (RAOs) identified for off-Site groundwater include:

- prevent ingestion of and direct contact to groundwater that may have cancer risk in excess of the U.S. EPA target range;
- prevent inhalation of vapors emanating from groundwater that may have cancer risk in excess of the U.S. EPA target range; and
- minimization of potential migration to surface water bodies.

4.4 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

4.4.1 OVERVIEW

CERCLA/SARA requires that the Applicable ARARs of other laws be identified during the RI/FS in order to aid in the preparation of a list of remedial alternatives, the evaluation of remedial alternatives under an FS, and, ultimately, the selection of a remedy under the ROD. ARARs represent requirements under federal, state or local regulations, which will govern Site remediation. In general, ARARs fall into three categories, as follows:

1. Chemical-Specific ARARs: identify and define acceptable exposure levels for chemicals found at the Site;
2. Action-Specific ARARs: which may set controls or restrictions for particular treatment or disposal activities; and
3. Location-Specific ARARs: which may set restrictions on activities within specific locations such as a flood plain.

A summary of the ARARs potentially applicable to OU2 are summarized in the following sections.

4.4.2 CHEMICAL-SPECIFIC REQUIREMENTS

Chemical-specific requirements (i.e., technology or risk-based numerical limitations or methodologies) are used to establish acceptable concentrations of chemicals that may be found at the Site or discharged to the environment. The potential chemical-specific requirements for the Four County Landfill Site include: (1) drinking water MCLs; (2) non-zero maximum contaminant level goals (MCLGs); (3) Federal water quality criteria (FWQC); (4) IDEM chronic aquatic criteria; (5) Publicly Owned Treatment Works (POTW) pretreatment standards; and (6) State and Federal NPDES regulations. Potential chemical-specific ARARs are summarized in Table 4.2.

MCLs are the maximum contaminant levels that are allowed in water delivered to any user of a public water system and are the enforceable drinking water standards established by the U.S. EPA under the SDWA. Pursuant to CERCLA Section 121(d)(2)(A)(i), MCLs are potential ARARs because they are the enforceable requirements of the SDWA. According to the NCP, MCLs are generally considered an ARAR for groundwater if Maximum Contaminant Level Goals (MCLGs) are not an ARAR and the MCLs are relevant and appropriate under the circumstances of the release.

MCLGs are non-enforceable goals for drinking water set by the U.S. EPA under the SDWA. The MCLGs represent contaminant levels with no known or anticipated adverse effects on the health of persons, plus an additional margin of safety. Pursuant to the NCP [40 CFR 300.43 (e)(2)(i)(B)], where the MCLGs are determined to be relevant and appropriate under the circumstances of the release, non-zero MCLGs should be attained by remedial actions for groundwater or surface water that is a current or potential source of drinking water. For a contaminant with an MCLG of zero, the MCL for that contaminant should be attained for current or potential sources of drinking water if the MCL is relevant and appropriate.

Pursuant to CERCLA Section 121(d)(2)(B) and the NCP, 40 CFR 300.430(e)(2)(i)(E), FWQC shall be attained if they are relevant and appropriate under the circumstances of the release. FWQC are non-enforceable guidelines for surface water set by the U.S. EPA under the Clean Water Act (CWA) for the purpose of protecting human health and aquatic life. These quantitative levels of pollutants have been established to ensure that the water quality is adequate for a specified use. Whether FWQC are relevant and appropriate depends on the designated or potential water uses, the media affected, and the purposes for which the FWQC was developed. FWQC are used by states to set water quality standards for surface water, and by State and Federal Agencies for

establishing NPDES discharge permit levels. The goals of the FWQC are to protect: (1) humans from hazards associated with drinking contaminated water or consuming aquatic organisms that live in contaminated water; and (2) aquatic life from acute and chronic exposure to pollutants.

The limits on industrial user discharges set by a local POTW are a potential ARAR if treated groundwater discharge to the POTW is part of a potential remedial alternative. The MCLs and MCLGs are potential ARARs for monitoring: (1) the groundwater at the Site boundaries; and (2) the quality of treated groundwater if it is injected into the aquifer. The State of Indiana minimum water quality criteria and the FWQC are potential ARARs for the surface water in adjacent surface water bodies. The POTW pretreatment standards are potential ARARs if groundwater is discharged to the POTW.

4.4.3 LOCATION-SPECIFIC REQUIREMENTS

Location-specific requirements are restrictions placed on the conduct of activities in particular locations. These ARARs relate to the geographical or physical position of the Site rather than the nature of its contamination or the proposed remedial actions. Location-specific requirements may limit and/or impose additional constraints on the type of remedial action that can be implemented at a Site.

Restrictions caused by floodplains and wetlands are among the most common location-specific requirements for municipal landfill Sites. According to 40 CFR 6.302, remediation of a Site located next to wetland areas and/or within a floodplain must be implemented in a manner that: (1) minimizes the loss, destruction, or degradation of the wetland; and (2) preserves the natural and beneficial values of the floodplain. Table 4.3 presents potential location-specific ARARs.

4.4.4 ACTION-SPECIFIC REQUIREMENTS

Action-specific requirements generally set performance, design, or other similar controls or restrictions on particular kinds of activities related to the management of hazardous substances. These requirements are triggered by the particular remedial activities that are selected to accomplish a remedy and are usually technology based. Table 4.4 presents potential action-specific ARARs.

4.5 GENERAL RESPONSE ACTIONS

General response actions are those actions that will satisfy the remedial action objectives. General response actions may include treatment, containment, excavation, disposal, institutional controls or a combination of these actions. As with the remedial action objectives, general response actions are medium specific. Remedial technologies that will be considered for each general response action are based upon those technologies presented within U.S. EPA documents: "Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites", dated February 1991, "Presumptive Remedy for CERCLA Municipal Landfill Sites", dated September 1993, and "Presumptive Response Strategy and Ex-Situ Treatment Technologies for Contaminated Groundwater at CERCLA Sites", dated October 1996.

The general response actions with their respective technologies potentially applicable to off—Site groundwater are summarized below.

a)	No Action	-	no remedial technology
b)	Administrative Controls	-	deed restrictions
		-	groundwater-use restrictions
		-	restrictive ordinances
c)	Monitoring	-	groundwater monitoring
d)	Alternate Water Supply	-	public water supply system
e)	Point-Of-Use	-	individual treatment units
f)	Containment	-	vertical barrier
g)	Groundwater Extraction	-	vertical wells
		-	horizontal trenches
h)	Ex-Situ Groundwater Treatment	-	biological treatment
		-	chemical treatment
		-	physical treatment
i)	Discharge	-	off-Site surface water discharge
		-	off-Site subsurface injection
		-	off-Site disposal at a Publicly Owned Treatment Works (POTW)
		-	off-Site disposal at Treatment/Storage Facility (TSDF)

j) In-Situ Groundwater Treatment

- monitored natural attenuation
- enhanced biodegradation
- biosparging
- ozone injection
- permeable reactive barriers (PRBs)

5.0 IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES

5.1 GENERAL

Remedial technologies applicable to off-Site groundwater that were identified consistent with the remedial action objectives were screened using the criteria summarized below.

a) Short- and Long-Term Effectiveness

A technology's short-term effectiveness is assessed by its ability to protect human health and the environment during the construction and implementation of a remedy before response objectives are met. The time required to meet these response objectives is also factored into this criterion. A technology's long-term effectiveness and permanence are assessed by its ability to maintain the protection of human health and the environment after response objectives have been met. The magnitude of residual risk and adequacy and reliability of controls are also taken into consideration.

b) Implementability

Under this criterion, a technology is assessed in terms of its technical and administrative feasibility and the availability of required goods and services. Also considered is the reliability of the technology, the ability to monitor the effectiveness of the remedy, and the ease of undertaking additional remedial actions, if necessary.

c) Cost

Under this criterion, a technology is assessed in terms of the relative cost to implement the technology as compared to other applicable remedial technologies.

The basis for identifying and screening technologies (using the above-noted criteria) was provided by the following U.S. EPA documents:

1. Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites, February 1991 (EPA/540/P-91/001, OSWER Directive 9355.3-11);

2. Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, October 1988 (EPA 540/G-89/004, OSWER Directive 9355.3-01); and
3. Presumptive Remedy for CERCLA Municipal Landfill Sites, September 1993 (EPA/540/F-93-035, OSWER Directive 9355.0-49-FS).

Remedial technologies applicable to the contaminants and conditions at the Site and consistent with the remedial action objectives are identified and screened in this section. Table 5.1 presents the results of the screening process. All appropriate technology options are categorized and described by technology type and general response action. Those technologies that were found appropriate have been carried forward for detailed analysis in later sections of this FS. The selected technologies are summarized below.

5.2 NO ACTION

Description

The No Action Alternative allows the Site to exist without implementation of any additional remedial technologies. The No Action alternative is also a requirement for evaluation to serve as a baseline for other alternatives.

Evaluation

The effectiveness of No Action is evaluated, in part, on the basis of whether implementation of other technology options cause greater harm to the public welfare and environment than No Action or provide little benefit relative to their cost. Additionally, in the specific case of the Four County Landfill Site, remedial actions completed under OU1 were significant and may beneficially impact off-Site groundwater quality.

Minimal costs would be associated with No Action relative to other potentially applicable remedial technologies and there are no concerns relative to implementability of this remedial technology. However, the long-term effectiveness of this remedial technology relies solely on the effectiveness of the remedial actions completed for OU1 such as capping, excavation of VOC-impacted soil and OU1 groundwater monitoring. This technology will be retained as a baseline for evaluating other remedial technologies.

5.3 ADMINISTRATIVE CONTROLS AND MONITORING

Administrative controls and monitoring options include:

1. Monitoring;
2. Deed Restrictions;
3. Groundwater-Use Restrictions; and
4. Restrictive Ordinances.

5.3.1 MONITORING

Description

Monitoring involves the collection of environmental media samples over time to assess the effectiveness of remedial measures implemented at a site. In the specific case of OU2, monitoring may include monitoring of surface water and groundwater levels and collection of samples for analysis.

Evaluation

Monitoring is frequently used in combination with other remedial technologies. Monitoring is effective in the short and long term in determining Site conditions. There are no concerns with respect to implementability and relative costs are moderate. Short-term risk to site workers is low and can be further reduced through implementation of appropriate health and safety procedures. Monitoring would be an integral part of most remedial alternatives and this technology will be retained.

5.3.2 DEED AND GROUNDWATER-USE RESTRICTIONS

Description

Restrictive covenants on deeds on property are intended to prevent or limit unacceptable Site use and development. Restrictive covenants, written into the property deed, serve to notify any potential purchaser of the property that potential hazards exist with certain property uses. Restrictive covenants on groundwater usage are intended to prevent or limit the use of extracted groundwater. Restrictive covenants, written into

the property deed notifies any potential purchaser of the property that groundwater extracted at the Site may be contaminated and that water use must be restricted and regulated to ensure that there are no health concerns.

Evaluation

The effectiveness of deed restrictions depends on state and local laws, continued enforcement, and maintenance. Most restrictions are subject to changes in political jurisdiction, legal interpretation and level of enforcement. The specific prohibitions outlined in the restrictive covenant are based on the type of remedial action implemented at the Site and how the effectiveness of that remedial action can be improved through deed restrictions. For OU2, the major purpose of deed restrictions would be to advise future owners of the presence of contaminated groundwater and advise against the use of this groundwater without appropriate pretreatment. The permissible uses/limitations for groundwater usage should be identified based on the risk the Site poses and the remedial options likely to be implemented.

The effectiveness of restrictive covenants depends on state and local laws, continued enforcement, and maintenance. Restrictive covenants and regulations to restrict the use of groundwater may not be effective due to the relatively large number of small parcels potentially affected. Further, it would be difficult to secure restrictive covenants from each of the off-Site property owners inasmuch as entering such an agreement would be voluntary on the part of each property owner. However, to the extent such property is controlled by a local government entity (such as the County) or cooperative property owners, this option is potentially very effective at preventing future exposure to impacted groundwater.

Implementability of deed and groundwater-use restrictions may be difficult north of the Site. It would be necessary to acquire title rights to the numerous small parcels in this area and a deed and groundwater-use restriction secured for each of these parcels to be effective. However, deed restrictions and groundwater-use on the property located immediately west of the Site could be easily implemented. The relative cost of obtaining deed restrictions is low and there are no short-term risks to Site workers associated with this option. Deed restrictions will be retained.

5.3.3 RESTRICTIVE ORDINANCES

Description

Local ordinances restricting future land use at the Site could prevent or reduce the potential for human contact with the contaminated groundwater. State or local governments can also implement public education programs. Such programs would be focused on keeping the public aware of both current and future activities at the Site and the concerns raised by potential contaminants at the Site.

Evaluation

The current lack of zoning ordinances in Fulton County would prevent this option from being implemented. Therefore, this option would not be effective in restricting future land use. This option will not be retained for further evaluation.

5.4 ALTERNATE WATER SUPPLY

Description

Residential water supply is obtained from private supply wells located on individual properties. This technology uses a public water supply to replace residential wells. Water is generally supplied to affected residences by buried forcemain. This technology is very effective in eliminating the health risk associated with ingesting, contacting or inhaling vapors emanating from contaminated water.

Evaluation

Currently, the nearest existing public water supply network is located over 10 miles from the Site. Tapping into an existing public water supply network is not practicable. Therefore, implementing this technology would require construction of a complete water supply network including supply wells, treatment plant(s), water pipelines, and residential hookups. Implementation of this technology would also require the performance of operation and maintenance activities (equipment maintenance, testing, repair, etc.), which would normally be required of a public water network. Therefore, this technology would be difficult to implement and would be very costly to design, install, operate, and very difficult to maintain and operate. The short-term risk to Site

workers is low and could be further reduced by implementing proper health and safety procedures.

This technology is potentially applicable if the Site impacts a significant number of private supply wells. However, regular residential well sampling has not established a need to place local residents on an alternate water supply. Consequently, this technology is presently not applicable and will not be retained.

5.5 POINT-OF-USE TREATMENT

Description

This technology uses proven physical and/or chemical treatment options (carbon filtration, softening, etc.) to reduce contaminant levels in potable water below drinking water standards at the affected residential locations.

Evaluation

This technology is very effective both in the short and long term in reducing the health risk associated with exposure to groundwater containing organic chemicals. There are no concerns regarding the implementation of this technology except that the cooperation of affected residents is required. The cost of this technology is low. There are no concerns with respect to short-term risks to Site workers. However, regular residential well sampling has not established a need to place local residents on an alternate water supply because regular residential monitoring has not identified exceedences of the MCLs at the tested residences. Therefore, this technology is not currently applicable, although potentially viable. Therefore, point-of-use treatment will be retained for further evaluation as a contingency should future residential well sampling identify the need for implementation of this option.

5.6 VERTICAL BARRIERS

Description

Vertical barriers are a technology that is applied to isolate the source of contamination and prevent the spread of contaminated groundwater. The most common type of physical vertical barrier used at landfill sites (as well as other hazardous waste sites) to

contain contaminated water is a soil-bentonite slurry wall. Soil-bentonite slurry walls are used as vertical barriers to reduce the horizontal permeability of soil. Steel retaining walls with engineered joints to provide a more effective seal between sections are also common physical vertical barriers at landfill and hazardous waste sites. Steel retaining walls are driven or vibrated into the ground with specialty equipment.

Evaluation

Physical barriers are an established remedial technology. Short and long-term effectiveness of these systems is highly dependent upon site-specific conditions and the degree of care used during construction. Typically, vertical barriers are effective and implementable at depths of up to 30 feet. Expensive limited-availability construction equipment and methods are required to install deeper barriers. Effective sealing of joints become more problematic with increased depth of the installation. Leakage of seals may reduce the effectiveness of this technology. Impacted groundwater at the Site is present at depths of over 100 feet. Therefore, implementation of physical vertical barriers would be difficult and costly. The effectiveness of this technology is questionable at the depths required at the Site. Physical vertical barriers would be effective only if implemented in conjunction with the use of hydraulic control mechanisms such as groundwater extraction wells, which would also require treatment and disposal of extracted groundwater. This further adds to the difficulty and costs associated with the implementation of this technology. The short-term risk to on-Site workers is low to moderate for this technology due to potential contact with contaminated environmental media. However, this risk could be reduced through implementation of appropriate health and safety procedures.

Physical vertical barriers will not be retained for detailed analysis.

5.7 GROUNDWATER EXTRACTION

Description

This technology, frequently referred to as "pump and treat" involves groundwater removal using one or more vertical wells or horizontal collection trenches to extract groundwater from the contaminated area and bring it to the surface for treatment. This technology may also generally be applied at waste sites as a containment measure to prevent the migration of contaminated groundwater.

Evaluation

In certain geologic environments and very specific circumstances, this technology may be effective at reducing the level of contaminants within the groundwater, or controlling further migration of a contaminant plume. Horizontal collection drains would not be implementable at the Site due to the depth of groundwater contamination. However, groundwater extraction using vertical wells is implementable at the Site. The short-term risk to on-Site workers is low since handling of small volumes of contaminated media may be required to implement this technology. This risk could be reduced through implementation of proper health and safety procedures. The cost of this technology is high when used in conjunction with the other remedial technologies required to implement this alternative (groundwater treatment and discharge) compared to other remedial alternatives.

Groundwater extraction using vertical wells will be retained for further evaluation.

5.8 EX-SITU GROUNDWATER TREATMENT

Extracted groundwater is treated at the surface prior to discharge using one or more of the following treatment technologies:

1. biological treatment,
2. chemical treatment, and
3. physical treatment.

5.8.1 BIOLOGICAL TREATMENT

Description

Biological means are used in treating leachate contaminated primarily by biodegradable organic compounds. Biological treatment is especially effective in treating groundwater containing high levels of BOD and COD (e.g., 0-750,000 mg/l). In biological treatment, wastewater is contacted by a culture of microorganisms either suspended in the wastewater or attached to a solid medium. The organic compounds in the wastewater are metabolized by the organisms as a food and energy source. Organics are thus removed from solution and biomass and metabolic waste gases such as carbon dioxide

and methane are produced. Biological treatment systems are configured as fixed growth, suspended growth, or a combination of both. Biological treatment systems have been designed to treat hundreds of millions of gallons per day (MGD) or as little as 1 gallon per minute (0.0015 MGD).

Biological treatment processes are classified as aerobic or anaerobic. Aerobic treatment systems require oxygen, either in air or in pure form, to meet the metabolic needs of the microorganisms. Aerobic treatment systems are the most frequently used form of biological treatment. These systems consist of a reactor, where the waste stream is brought into contact with a culture of organisms, and usually a clarifier or other solids-separation device where organisms suspended in solution are removed by sedimentation.

Anaerobic treatment systems are used most often for treating high-strength wastes such as landfill leachate. These systems are often followed by an aerobic treatment system for additional organics removal. Compared to aerobic systems, anaerobic treatment systems produce less biomass per pound of BOD removed. In addition, anaerobic treatment produces methane of sufficiently high concentration to be used in some cases for energy recovery. Anaerobic digesters are also frequently used in the treatment of sludge produced in aerobic treatment. In this process, the sludge is reduced in volume and methane gas is produced as a by-product.

Evaluation

The relative effectiveness of any biological treatment technology would need to be assessed through treatability studies. The equipment to implement such a technology is readily available. However, the availability of trained personnel near the Site to operate, monitor, and maintain such a treatment system may be limited. The cost to implement biological treatment of off-Site groundwater is relatively high. This technology may not be applicable due to the type and relatively low concentrations of contaminants in off-Site groundwater. The short-term risk to Site workers associated with this remedial technology is minimal.

Based on the foregoing considerations this technology will not be retained for detailed analysis.

5.8.2 CHEMICAL TREATMENT

Description

This technology involves treatment of hazardous constituents by altering these constituents by chemical reactions. During the process, hazardous compounds may be destroyed or altered and the resultant products may still be hazardous but transformed to a form that is more amenable to further processing and/or disposal.

Potential ex-situ chemical treatment process options are as follows:

- Ion Exchange: Contaminated water is passed through a bed of resin material where the exchange of ions occurs between the bed and the contaminants within the water.

- Oxidation: Oxidizing agents such as ozone, hydrogen peroxide, and potassium permanganate, are used to oxidize heavy metals, unsaturated organics, sulfides, phenolics, halogenated aliphatic hydrocarbons, and aromatic hydrocarbons. Oxidation treats these compounds by converting them into less hazardous or non-hazardous forms. Many oxidizing remedial technologies are used in conjunction with secondary or supplemental treatment technologies (such as ultraviolet light or in the case of Fenton's reagent an iron catalyst) to increase their effectiveness.
- Metals Precipitation: The solubility of heavy metals is reduced through the addition of a substance that reacts with the metals or changes the pH. The most common chemical treatment for groundwater is precipitation of heavy metals. Precipitation will remove soluble heavy metals from groundwater by forming insoluble metal compounds (e.g., oxides, hydroxides, sulfides, sulfates and carbonates). Metals are often removed either to meet NPDES permit limits, as pretreatment to reduce metals toxicity for biological treatment or to prevent precipitation of metals on physical treatment units such as air strippers.
- pH Adjustment: Neutralizing agents such as lime are added to adjust the pH to reduce the solubility of inorganic constituents as part of a metals precipitation process.

The precipitates are then removed from solution utilizing separation processes such as sedimentation and filtration.

Evaluation

Ion Exchange: This technology is unsuitable for treatment of volatile organic compounds. Therefore, this technology will not be evaluated further in this document.

Oxidation: Oxidation process options including ozone, hydrogen peroxide, and potassium permanganate were identified as potentially applicable to the Site. However, these process options were found to be either prohibitively expensive to implement, ineffective at the removal of volatile organics compared to other options, or both. Therefore, chemical oxidation technologies were screened from the detailed analyses contained in the remainder of this document. A brief discussion of each oxidation method is provided below.

- Ozone: Ozone is an aggressive oxidizing compound generated by the electrolysis of oxygen. Due to the relatively short decomposition time of ozone significant quantities would be required on-Site. This would require the construction and operation of an ozone generator at the Site. Ongoing operation and maintenance of an ozone generating system at a remote location would be prohibitively expensive. Ozone is an inherently dangerous substance that would be difficult and expensive to handle at a remote location. Therefore, the short-term risk to Site workers is moderate to high. As such, ex-situ groundwater treatment using ozone will not be retained for detailed analysis.
- Fenton's Reagent: Fenton's Reagent is a mixture of hydrogen peroxide with an iron catalyst. This mixture produces highly reactive hydroxyl (OH) radicals that act as the oxidizing agent. The reaction works best in solutions with pH 3-6. Therefore, pH adjustment of the extracted groundwater would be required. This would require the use of a strong acid such as sulfuric acid or hydrochloric acid. A large amount of acid would be required to reduce the pH of the anticipated quantity of extracted groundwater to the acceptable range. Sulfuric and hydrochloric acids are inherently dangerous substances that would be difficult, dangerous and expensive to handle at a remote location. Although hydrogen peroxide is considered relatively safe, proper storage and handling is required. Additionally, caution is necessary when delivering concentrated hydrogen peroxide solutions because the reactions can be vigorous, resulting in the rapid generation of gases. Organic compounds are generally amenable to treatment using Fenton's reagent. However, due to the need to handle large volumes of strong acids, the short-term risk to Site workers is moderate to high. This technology is expected to be expensive to implement due to the need for large volumes of dangerous chemicals and high operational costs. Due

to the foregoing considerations, use of Fenton's reagent as an ex-situ groundwater treatment option will not be retained for detailed analysis.

Metals Precipitation: Metals are not considered to be present at health-based concentrations of concern in groundwater at the Site and as such this technology is not applicable as a primary treatment option. However, this technology is applicable as a potential pretreatment technology to reduce metals toxicity for biological treatment or to prevent precipitation of metals on physical treatment units such as air strippers.

pH Adjustment: Neutralizing agents such as lime are added to adjust the pH to reduce the solubility of inorganic constituents as part of a metals precipitation process. As such, this technology is not applicable as a primary treatment option. However, this technology is applicable as a potential pretreatment technology to reduce metals toxicity for biological treatment or to prevent precipitation of metals on physical treatment units such as air strippers.

5.8.3 PHYSICAL TREATMENT

Description

Two types of physical treatment technologies commonly used to treat groundwater for the removal of organics are air stripping and granular activated carbon (GAC).

- Activated Carbon: Many organic compounds such as phenolics, aromatics, and chlorinated hydrocarbons are readily adsorbed on the surface of activated carbon. In addition, certain heavy metals such as cadmium, chromium, copper, nickel, lead and zinc can be removed from water with carbon, although this technology is not widely used for metals removal.
- Air Stripping: When groundwater containing a volatile compound is brought to equilibrium conditions with air, some portion of the volatile compound transfers from the water to the air. The resulting concentrations of the volatile compound in the air and in the water are a function of the beginning concentration in the water, the temperature, the pressure, and the degree of volatility of the compound. Typically, groundwater contaminated with VOCs is fed into the top of a tower while a large air stream is forced into the bottom. The tower is usually filled with a packing medium that provides a large surface area for contact between the air and

groundwater. The air exits the top of the tower with the VOCs. The leachate is collected at the bottom of the tower and is either pumped to another process area for further treatment or discharged. Groundwater may foul the packing medium and requiring frequent maintenance of the air stripping system particularly if the hardness or concentration of dissolved solids in the groundwater is high. This situation is present at the Site.

Evaluation

The effectiveness of this technology to remove a wide range of volatile organic contaminants from a waste stream is well established. The equipment required to implement this technology is readily available. Using a process option like GAC requires minimal supervision and monitoring. However, maintenance of these units is expensive and labor intensive. Physical treatment processes produce residuals, which must be disposed of using alternative technology. The short-term risk to Site workers associated with this remedial technology is minimal. The cost of this technology is moderate to high compared with other technologies evaluated.

Conventional physical treatment technologies such as sedimentation, flocculation and filtration are often employed to supplement air stripping and GAC technologies. In general, sedimentation removes suspended solids from the influent water by reducing the flow-through velocity. To enhance the solids removal rate, settling basins may also be augmented by upstream processes such as chemical addition/flash mixing/flocculation equipment or aeration tanks. Sand filtration is a physical process whereby suspended solids and colloidal impurities are removed from solution by forcing the groundwater through a filter media typically consisting of a fixed bed of sand or sand with finely ground anthracite. As groundwater laden with suspended solids passes through the media bed the particles become trapped on the sand bed.

Based on the foregoing considerations, this technology will be retained for detailed analysis.

5.9 DISCHARGE OF TREATED GROUNDWATER

5.9.1 SURFACE DISCHARGE

Description

Treated groundwater could be discharged to an off-Site surface water body. Near the Site, the outlet from King Lake would be the nearest suitable location for the discharge of the anticipated treated groundwater flows. This would require an NPDES permit and monitoring to ensure discharged groundwater meets federal and Indiana State water quality criteria. This option would require the construction of a forcemain system from the treatment site to the discharge point.

Evaluation

Off-Site surface discharge of groundwater is only feasible when contaminated water has been treated down to regulatory levels. Off-Site surface discharge of treated water is effective provided such water meets NPDES permit standards and federal and state water quality criteria. There are no major concerns regarding the implementability of discharging treated groundwater to off-Site surface water bodies. For such an action to take place, an on-Site treatment facility would be required. The decision to implement this option is entirely contingent upon the decision to construct a groundwater treatment system. The short-term risk to Site workers is low and could be further reduced through implementation of proper health and safety procedures. The cost of this technology is low to moderate depending on the distance to the discharge point and the topography between the treatment works and the discharge point, which affects the number of lift stations and the depth of forcemain installation.

Based on the foregoing considerations this technology will be retained for detailed analysis.

5.9.2 AQUIFER REINJECTION

Description

Aquifer reinjection of treated groundwater may be accomplished using vertical wells, infiltration galleries and surface impoundments. Aquifer injection may be an effective method for disposing of treated groundwater particularly at sites where the underlying

geologic deposits are relatively permeable. Aquifer reinjection is allowed by law if treated groundwater is injected into the same formation from which it was withdrawn. For groundwater extracted from the Site, aquifer reinjection is a potential course of action.

Evaluation

Aquifer reinjection would also require permits such as an Underground Injection Control (UIC) Permit and perhaps, other permits depending upon jurisdictional requirements. Aquifer reinjection must be performed to minimize the potential for altering hydrogeological conditions and changing the direction of plume migration. A conveyance system would need to be constructed to transport the treated groundwater to the injection point, surface impoundment or infiltration gallery. Costs for reinjection and surface discharge are similar. This option is effective and the short-term risk to Site workers is low.

The process option of aquifer reinjection of extracted groundwater will be retained for detailed analysis.

5.9.3 OFF-SITE DISPOSAL

Description

Two technologies exist to dispose of groundwater off Site, namely:

a) treatment of groundwater at a POTW; and
b) treatment of groundwater at a RCRA-permitted TSDF.

Evaluation

Due to the distance of the nearest POTW or TSDF from the Site, the expected volumes of groundwater that would be extracted should that process option be implemented, the difficulties in implementation of these technologies and the very high costs, this remedial technology will not be evaluated further.

5.10 IN-SITU GROUNDWATER TREATMENT

5.10.1 MONITORED NATURAL ATTENUATION

Description

Monitored natural attenuation (MNA) refers to a remedial technology that relies on the naturally occurring processes in soil and groundwater that act without human intervention to reduce the mass, toxicity, volume, or concentration of contaminants in those media.[12] Biodegradation is the most important in-situ destructive mechanism, while non-destructive mechanisms include adsorption, dispersion, dilution and volatilization. MNA also involves the collection of environmental media samples over time to assess the effectiveness of natural attenuation mechanisms in the aquifer to reduce contaminant mass and concentrations to an acceptable level. MNA may be used in combination with other remedial technologies.

Evaluation

Under certain circumstances, MNA is effective at reducing contaminant mass and volume in an aquifer and is protective of human health and the environment. Groundwater analytical data generated during the OU2 RI demonstrate that groundwater conditions at the Site are anaerobic. As discussed in Section 3.5, the U.S. EPA's preliminary screening for anaerobic biodegradation processes was used to assess the fate of dissolved chlorinated aliphatic hydrocarbons in groundwater. The screening method involves the assignment of points based on Site-specific data (see Table 3.3). Based upon the results of this evaluation, the Site achieves a score of 20 points, which according to the U.S. EPA guidance indicates that there is adequate evidence supporting the natural anaerobic biodegradation (reductive dechlorination) of chlorinated organic compounds.

MNA would be effective in determining if Site conditions are improving by natural means. The relative costs and short-term risk are low. Costs and short-term risk associated with implementation of this technology are low. This option is easily implemented at the Site using the current monitoring well network. This remedial alternative will be retained for detailed evaluation.

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[12] U.S. Environmental Protection Agency, Office of Research and Development, *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater*, EPA/600/R-98/128, September 1998, pg. 1.

5.10.2 ENHANCED BIODEGRADATION

Description

Enhanced biodegradation refers to actions such as the delivery of energy sources and substrates for enhancing the activity of indigenous chemical-degrading microorganisms. Using these technologies, subsurface site conditions can be manipulated to enhance natural attenuation and speed up the degradation of site contaminants.

Evaluation

There are several techniques that can be applied to enhance the biodegradation of the Site-specific compounds in the groundwater, such as:

i) supplementation with suitable sources of nitrogen and phosphorus to enhance the biodegradation of contaminants by indigenous denitrifying microbial population;

ii) injection of co-substrates such as molasses, lactate, or hydrogen release compounds (HRCs) to enhance the reductive dechlorination of chlorinated solvents under anaerobic conditions; or

iii) injection of co-substrates such as methanol or oxygen release compounds (ORCs) to enhance oxidative degradation under aerobic conditions; and

iv) injection of microbial cultures to improve the effectiveness of the microbial population in degrading the compounds of concern.

Short-term risks associated with implementation of this technology are low. This technology is easily implementable and costs are expected to be moderate. Based on the foregoing considerations, this technology will be retained for further evaluation.

5.10.3 BIOSPARGING

Description

Biosparging is similar to enhanced biodegradation in that its objective is to improve the environment for growth of chemical-degrading microorganisms. Biosparging involves the injection of a flow of air into the groundwater at very low flow rates to enhance biodegradation. Airflow is controlled such that vapors are not generated or

accumulated in the vadose zone. This technique can be modified so that the airflow includes a low percentage of methane or propane and subsurface amendments described in the enhanced biodegradation section to stimulate the enrichment and growth of bacteria, which degrade VOCs.

Evaluation

Under the appropriate circumstances, biosparging is an effective remedial technology. Short-term risk associated with implementation of this technology is low. The effectiveness of biosparging relies upon effective dispersal of injected gases in the aquifer. This dispersal may be short-circuited by the development of preferred flow pathways in the subsurface environment. However, low injection rates generally keep this concern to a minimum. There are no serious concerns regarding the implementability of this option and the costs are expected to be moderate. This technology will be retained for further consideration.

5.10.4 IN-SITU CHEMICAL OXIDATION

Description

In-situ chemical oxidation is accomplished through the injection of a chemical compound that reacts with contaminants in the subsurface to form inert or less hazardous substances through oxidizing reactions. During this reaction, the oxidizing agent typically breaks the carbon bonds found in chlorinated compounds converting them into carbon dioxide, chloride and water. Three common compounds used for in-situ chemical oxidation are ozone, Fenton's reagent and potassium permanganate.

Ozone (O_3) is a strong oxidizer that can be used for effective in-situ treatment of chlorinated solvents. It is typically an effective treatment option for remediation of hot spots. It can be used in combination with air sparging to accelerate decomposition of groundwater contaminants. Ozone is an unstable gas with a half-life of 20 to 30 minutes at 68°F and must be produced on-site. Systems generally have higher capital costs because an on-site ozone generator must be used.

Fenton's reagent is a mixture of hydrogen peroxide with an iron catalyst. This mixture produces highly reactive hydroxyl (OH) radicals that act as the oxidizing agent. Residual hydrogen peroxide breaks down into water and oxygen and remaining iron precipitates out. The reaction works best in solutions with pH 3-6. Therefore,

adjustment of the groundwater pH using a strong acid may be required. Since sediments in the area are naturally buffered (i.e., contain a significant quantity of calcium carbonate), a large amount of acid would be required to reduce the pH to the acceptable range. Acid is an inherently dangerous substance that would be difficult, dangerous and expensive to handle at a remote location. Although hydrogen peroxide is considered relatively safe, proper storage and handling is required. Additionally, caution is necessary when delivering concentrated hydrogen peroxide solutions to the subsurface because the reaction can be vigorous, resulting in the rapid generation of gases.

Potassium permanganate is also commonly used as an oxidizing agent. Potassium permanganate is most effective when delivered in an aqueous solution and reacts throughout a wide range of pH conditions (5-12). It is inexpensive and readily available commercially. It is also relatively easy and safe to handle when normal health and safety procedures are followed.

Evaluation

Ozone injection is difficult to implement due to the need to operate on ozone generator and the long-term difficulties in handling an unstable gas at a remote site. The capital costs and O&M costs of the equipment for this treatment system are high compared to other alternatives. The short-term risk to on-Site workers is low to moderate for this technology and is reduced by implementation of appropriate health and safety procedures. However, ozone is an inherently dangerous substance that would require special handling, health and safety protocols, and emergency response contingencies at a remote location. This technology will not be retained for detailed analysis.

Fenton's reagent is difficult and expensive to implement due to the need for pH adjustment of groundwater by a strong acid. Acid is an inherently dangerous substance that would require special handling, health and safety protocols, and emergency response contingencies at a remote location. The short-term risk to on-Site workers is moderate to high for this technology. This technology will not be retained for detailed analysis.

Potassium permanganate would be an effective remedial technology for vinyl chloride and fuel-related compounds such as benzene which readily degrade in the presence of an oxidizing agent. Potassium permanganate is inexpensive and readily available commercially. However, given the recalcitrant nature of 1,2-DCA to oxidizing treatment this technology will not be retained for detailed analysis.

5.10.5 PERMEABLE REACTIVE BARRIERS

Description

Permeable reactive barriers (PRBs) are currently being used in many full-scale field applications for the treatment of chlorinated solvent plumes in groundwater. This technology is comprised of a funnel-and-gate system or continuous trench that is placed in the path of flowing groundwater. The PRB contains zero-valent iron, and when the contaminated groundwater flows through the PRB, the contaminants react in the presence of iron and are converted into nontoxic by-products or immobile compounds.

Evaluation

Use of PRBs is an emerging remedial technology that under certain circumstances has been demonstrated as being effective in treating groundwater impacted with chlorinated aliphatic hydrocarbons. It is a passive treatment technology with no ongoing energy requirement. Although limited maintenance is necessary following installation, the reactive media may require replacement during the life of the PRB to maintain its effectiveness. Most in-situ PRBs installed to date have been constructed using conventional types of excavation methods such as open trench, cofferdam, trench box, and trenching machine. These installations have been limited to less than 50 feet in depth, with some going to as deep as 70 feet, due to the practical limitations of the installation equipment (U.S. EPA 1996, 1998). There are methods currently being developed for installation of deep PRBs, such as jetting, hydrofracturing, biopolymer slurry wall or sheet piling. However, of twenty full-scale PRBs installed in the U.S., sixteen were installed using conventional technologies, and only four used the deeper installation methods. The costs for implementation of PRBs at deeper depths are typically much higher due to need for specialty equipment with limited availability and additional labor required for installation. Additionally, there is less certainty associated with the positive placement of these structures at greater depth and a higher potential for failure.

Impacted groundwater is present at the Site at depths over 100 feet. Therefore, the cost to implement this technology at the Site is very high due to the need to deploy specialty equipment and installation techniques, practical engineering constraints including the difficulty associated with emplacement of the reactive medium to these depths, and the need to periodically replace the medium. This technology would be difficult to

implement due to the depth of groundwater contamination at the Site. These considerations escalate the costs associated with the remedial technology beyond that which would be considered cost effective and reduce the effectiveness of the technology below that considered acceptable. Short and long-term effectiveness of these systems is highly dependent upon site-specific conditions and the degree of care used during construction. The short-term risk to on-Site workers is low to moderate for this technology due to potential contact with contaminated environmental media. However, this risk could be reduced through implementation of appropriate health and safety procedures.

PRBs will not be retained for detailed analysis.

5.11 SUMMARY OF REMEDIAL TECHNOLOGIES

A number remedial technologies were screened for short and long-term effectiveness, implementability and cost and the result of this screening summarized in Table 5.1.

Remedial Technology	*Retained?*
No Action	Yes
Monitoring	Yes
Deed and Groundwater-Use Restrictions	Yes
Restrictive Ordinances	No
Alternate Water Supply	No
Point-of-Use Treatment	Yes (Contingency)
Vertical Barriers	No
Groundwater Extraction	Yes
Ex-Situ Groundwater Treatment	
• Biological Treatment	No
• Chemical Treatment	Yes (Pretreatment only)
• Physical Treatment	Yes
Groundwater Discharge	
• Surface Discharge	Yes
• Subsurface Injection	Yes
• Off-Site Disposal (POTW/TSDF)	No
In-Situ Groundwater Treatment	
• Monitored Natural Attenuation	Yes
• Enhanced Biodegradation	Yes
• Biosparging	Yes

• Ozone Injection	No
• Fenton's Reagent	No
• Potassium Permanganate	No
• PRBs	No

The retained technologies will be evaluated in detail in Sections 6.0 and 7.0 of this report.

6.0 DEVELOPMENT OF REMEDIAL ACTION ALTERNATIVES

6.1 GENERAL

The development of RAAs is based upon combinations of the selected remedial technologies and associated process options required to address the Remedial Action Objectives detailed in the previous section. Specific technology options that survived the initial screening process in Section 5.0 are listed below with their respective technology type. The technology options will be combined to form RAAs in this section.

Technology Type	*Process Options Retained*
No Further Action	- No Process Options
Administrative Controls and Monitoring	- Monitoring - Deed Restrictions
Point of Use Treatment	- Residential Water Treatment (contingency only)
Groundwater Extraction	- Vertical Extraction Wells
Ex-Situ Groundwater Treatment	- Chemical Treatment (pretreatment only) - Granular Activated Carbon - Air Stripping
Groundwater Disposal	- Off-Site Surface Discharge - Aquifer Reinjection
In-Situ Groundwater Treatment	- Monitored Natural Attenuation - Enhanced Biodegradation - Biosparging

A summary of the development of the RAAs for the Site is presented in Figure 6.1.

6.2 DEVELOPMENT OF GROUNDWATER REMEDIAL ACTION ALTERNATIVES

The following RAAs were developed for off-Site groundwater using the retained remedial technologies and process options summarized in the previous section:

Alternative 1 - No Action

Alternative 2 - Vertical Extraction Wells
- Ex-Situ Groundwater Treatment
- Groundwater Discharge
  - A) Air stripping with surface discharge or subsurface injection
  - B) GAC treatment with surface discharge or subsurface injection

Alternative 3 - In-Situ Groundwater Treatment
- A) Monitored Natural Attenuation
- B) Enhanced biodegradation
- C) Biosparging

In addition to the RAAs listed above, the following shared technologies are applicable to Alternatives 2 and 3:

Shared Technologies
- Deed Restrictions and Groundwater-Use Restrictions
- Groundwater Monitoring
- Residential Water Treatment (Contingency only)

Deed and Groundwater Restrictions: This technology group would be carried throughout all the alternatives in order to ensure that there is an administrative procedure for protecting human health on the property west of and adjacent to the Site and that restrictions are placed on land usage in the landfill source area.

Groundwater Monitoring: Off-Site groundwater will be monitored to evaluate groundwater-quality trends and confirm that groundwater remediation efforts are effective. A groundwater-monitoring program is part of the OU1 ROD and will include collection and analysis of groundwater samples from the off-Site groundwater monitoring well network. The scope of the groundwater monitoring effort would vary depending upon the remedy selected.

Residential Water Treatment Contingency: This technology uses proven physical and/or chemical treatment options (carbon filtration, softening, etc.) to reduce contaminant levels in potable water at individual residents below drinking water standards at the affected residential locations. However, residential water sampling conducted to date has not demonstrated the need to install point-of-use filtration systems. Therefore, this technology is retained as a contingency only.

6.3 DESCRIPTION OF GROUNDWATER REMEDIAL ACTION ALTERNATIVES

6.3.1 ALTERNATIVE 1 - NO ACTION

The NCP requires that this alternative be carried through the screening process. This alternative assumes that no additional remedial action would be undertaken at the Site to address off-Site groundwater contamination. It should be noted that, as discussed in the OU2 RI Report, remedial actions undertaken under OU1 will have a positive impact on off-Site groundwater quality separate from any actions taken in OU2.

6.3.2 ALTERNATIVE 2 - GROUNDWATER EXTRACTION, TREATMENT AND DISPOSAL

This alternative seeks to address the potential threats posed by off-Site groundwater through the extraction, treatment and discharge of groundwater. The shared technologies set would also be included as part of this RAA.

6.3.2.1 EXTRACTION RATES

In order to evaluate fully this RAA, an estimate of groundwater pumping rates must be made. A groundwater-pumping test was not a task undertaken during the OU2 RI. However, sufficient data were obtained during the OU2 RI to estimate groundwater-pumping rates required to capture the off-Site groundwater contaminant plume. Once an estimate of the groundwater-pumping rate is obtained, the costs for the other treatment and disposal process options that comprise this RAA can be further refined.

Model Description

The proper pumping rate for a groundwater remediation system is one that effectively captures the full width of the groundwater contaminant plume without capturing an excessive volume of groundwater from clean areas. This minimizes the cost for the operation of the remedial system.

The capture zone of a vertical pumping well in an unconfined aquifer can be estimated using an arithmetic equation developed by Grubb (1993), as follows:

$$w = \pm QL/K(h_1^2 - h_2^2)$$

where:

w	=	capture width (feet);
Q	=	pumping rate (ft^3/day);
K	=	hydraulic conductivity (ft^2/day);
h_1	=	upgradient hydraulic head (feet);
h_2	=	downgradient hydraulic head (feet); and
L	=	distance between the upgradient and downgradient monitoring points (feet).

Model Criteria

Solving for the width in the Grubb (1993) equation requires the hydraulic conductivity value for the aquifer. As summarized in Section 2.0, the geometric mean hydraulic conductivity value for the Deep (Unit C) formation is 4.8×10^{-2} cm/sec (approximately 136 feet per day). However, this hydraulic conductivity value was obtained based upon data from single-well response tests completed during the OU2 RI. Single-well response tests are widely recognized to underestimate the true hydraulic conductivity of the aquifer due to the short duration of these tests, limited areal extent affected by test and borehole skin effects. These effects often result in underestimation of the actual pumping rate required to capture the groundwater contaminant plume. The true hydraulic conductivity value and pumping rate for any groundwater remediation system must be determined through a full-scale groundwater pumping test. The upgradient and downgradient hydraulic head values (h_1 and h_2) are known at monitoring wells MW101 and MW124 and the distance between these two locations (L) is approximately 2,250 feet. As shown in Figure 4.1, the lateral extent of groundwater impacted by organic chemicals at concentrations above the MCLs at the Site boundary lies between MW109 and MW112 on the east and between MW114 and MW128 on the west. Therefore, interpolating chemical concentrations between impacted and

nonimpacted monitoring wells, the estimated capture width for groundwater impacted above the MCLs is approximately 650 feet (see Figure 6.2).

Model Results

Using the values and solving for Q (the pumping rate), the result is approximately 136 gallons per minute (gpm). Therefore, it is assumed that the pumping rate required to obtain plume capture is approximately 150 gpm or 0.2 million gallons per day. The hydrogeological data required to confirm this groundwater pumping rate would need to be determined through the implementation of a groundwater pumping test before a proper groundwater extraction and treatment system could be designed. Groundwater pumping calculations are summarized in Appendix E.

6.3.2.2 GROUNDWATER EXTRACTION

This alternative would include the placement of one or more extraction wells at the downgradient perimeter of the landfill near the location of the MW113/114 monitoring well cluster. The objective of the extraction well(s) would be to cutoff the further downgradient migration of VOCs in groundwater. An extraction well further downgradient (near the MW123/124 cluster) might be needed to remediate that portion of the VOC plume that lies downgradient of the perimeter extraction well. The extraction well(s) would be constructed such that the screened intervals of the extraction wells would capture the vertical extent of groundwater impacted with VOCs above the cleanup objectives (MCLs). The extraction well would also be designed to accommodate downhole pumping equipment necessary to extract groundwater from the shallow and deep formations at the pumping rate necessary to achieve lateral capture of the VOC plume. The extraction well screen and filter pack would need to be designed to minimize the introduction of sand and silt particles that may damage pumping equipment while minimizing resistance to flow through the well screen.

Extraction well screens and pumping equipment often become fouled with bacterial growth that is promoted by local geochemical changes in the groundwater environment caused by groundwater extraction. Generally, physical removal of the bacteria from the well screens and pumping equipment (i.e. removal and cleaning of downhole equipment, jetting or brushing of well screens and redevelopment of the extraction wells) is required at a frequency of every 2 to 5 years. The groundwater at the Site contains characteristically high concentrations of iron and manganese, which will require that frequent maintenance be performed on extraction wells and pumping

equipment to maintain its operational efficiency. This will also add to the cost for ongoing operation of these systems. Under these conditions, bacteria colonies may prevent effective operation of the extraction system, require frequent maintenance to physically remove bacteria from well screens and equipment, or require the regular injection of chemicals designed to inhibit bacterial growth.

Once groundwater is extracted, it must be treated to remove contaminants before its discharge. One of the principal concerns with any groundwater treatment system is the concentration of dissolved metals, particularly common earth elements such as iron, manganese and calcium. These elements occur naturally in groundwater and are derived from the rock and/or sediments through which the groundwater flows. In the subsurface environment, the elements are in geochemical equilibrium. However, the process of extraction and treatment disturbs this geochemical equilibrium resulting in precipitation of elements as oxides, carbonates, sulfates and other compounds. These precipitates cause fouling of treatment systems reducing treatment efficiency and resulting in the need to perform frequent maintenance of the primary treatment systems. Groundwater analytical data indicate that the groundwater near the Site contains high concentrations of dissolved iron (generally above 2 mg/kg), total dissolved and suspended solids and has a high hardness (generally above 400 mg/kg). When exposed to the atmosphere, these constituents readily form precipitates such as iron oxides and calcium carbonates that quickly foul air-stripping systems. As such, pretreatment to reduce metals toxicity for biological treatment or to prevent precipitation of metals on physical treatment units such as air strippers would be a necessary component of any groundwater treatment system constructed at the Site.

6.3.2.3 ALTERNATIVE 2A - GROUNDWATER EXTRACTION WITH AIR STRIPPING AND SURFACE DISCHARGE OR SUBSURFACE INJECTION

This alternative consists of installing a forcemain system from the extraction wells to a groundwater treatment system to a surface discharge point or a subsurface injection point. Following treatment using an air stripper, the treated groundwater would be discharged to the surface water under a NPDES permit or injected into the subsurface west of the Site. Based on the concentrations reported from results of groundwater samples, the conceptual treatment system would include:

i) pH adjustment and chemical precipitation to reduce metals concentrations;

ii) treatment by air stripping;

iii) piping, electrical controls and instrumentation; and

iv) treatment system building.

Capital costs and operation and maintenance costs for constructing this system are based on a 150 gpm capacity and discharge of the treated groundwater to the surface. Surface discharge options for treated groundwater have been considered. As depicted in Figure 6.3, the treated groundwater would be conveyed east approximately 3,500 feet using a subsurface forcemain to a discharge point located near the intersection of a north-flowing creek and County Highway 525 North (Figure 6.3). The creek serves as the outlet to King Lake and conveys surface water to the north toward the Tippecanoe River. This surface water discharges to an oxbow lake located adjacent to the Tippecanoe River approximately 3,300 feet north of the County Highway 525 North.

Treated groundwater injection using wells would need to be conducted in a manner that would minimize the potential for altering groundwater flow and altering the direction of plume transport. It is assumed that injection would occur west of the Site and a subsurface conveyance would be required to transport groundwater from the treatment system to vertical injection wells as depicted in Figure 6.3. The limited permeability of the clay till Unit present at the surface (Unit A) likely precludes the use of infiltration galleries or surface impoundments to discharge groundwater.

6.3.2.4 ALTERNATIVE 2B - GROUNDWATER EXTRACTION WITH GAC TREATMENT AND SURFACE DISCHARGE OR SUBSURFACE INJECTION

Alternative 2B is similar to Alternative 2A with the exception that groundwater would be treated using GAC. Treated groundwater would be discharged to the surface or injected into the subsurface.

6.3.3 ALTERNATIVE 3 - IN-SITU GROUNDWATER TREATMENT

6.3.3.1 ALTERNATIVE 3A - MONITORED NATURAL ATTENUATION

In certain circumstances, MNA is effective at reducing contaminant mass and concentrations in an aquifer and is protective of human health and the environment. The advantages of MNA remedies include:

- lesser volumes of remediation wastes are generated;
- reduced potential for cross-media transfer of contaminants commonly associated with ex-situ treatment;
- reduced risk of human exposure to contaminated media;
- less intrusion as few surface structures are required;
- potential for application to all or part of a given site, depending on site conditions and cleanup objectives;
- may be used in conjunction with, or as a follow up to, other (active) remedial measures; and
- lower overall remediation costs than those associated with active remediation.

The potential disadvantages of MNA include:

- potentially longer time frames may be required to achieve remediation objectives, compared to active remediation;
- site characterization may be more complex and costly; and
- toxicity of transformation products may exceed that of the parent compound.

Analytical data obtained during the OU2 RI suggests that groundwater conditions beneath the Site are primarily anaerobic. These conditions are favorable for the biodegradation of carbon tetrachloride and chloroform in the shallower (Unit B) groundwater. The lack of carbon tetrachloride and chloroform in groundwater monitoring wells further downgradient from the Site in the shallow system suggests that natural attenuation is already occurring.

The contaminant plume in Unit C extends further off-Site. This is likely the result of the slower degradation rate for 1,2-DCA under anaerobic conditions and the higher groundwater flow velocity in Unit C. During the OU2 RI, preliminary screening for destructive natural attenuation mechanisms was completed using Table 2.3 of the

document entitled, Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater, September 1998. Site-specific data were used in this screening method to evaluate conditions at the Four County Landfill Site. Based upon the results of this evaluation, the Site achieves a score of 20 points, which according to the U.S. EPA guidance indicates that there is adequate evidence supporting the ongoing anaerobic biodegradation (reductive dechlorination) of chlorinated organics (see Table 3.3). A detailed breakdown of the rationale for the points awarded to the Site is provided in Appendix F.

MNA relies on natural attenuation processes to achieve site-specific remedial objectives within a time frame that is reasonable compared to that offered by other more active remedial alternatives. At a recent U.S. EPA training seminar on MNA the U.S. EPA lecturer speaking on the Framework for Use of MNA, Fran Kramer (who is also listed as a U.S. EPA MNA contact in the OSWER Directive) indicated that a remediation timeframe for a MNA remedy should be considered reasonable if it is within two to three times greater than the timeframe for an active groundwater remedy.[13]

Evidence of Natural Attenuation

Groundwater conditions at the Site are favorable for the anaerobic biodegradation of 1,2-DCA and vinyl chloride. As discussed in Section 3.0, adequate evidence exists at the Site demonstrating the occurrence of biodegradation processes in groundwater. As a result, the implementation of a MNA remedy may be a viable remedial option for the Site. End products in the anaerobic biodegradation of 1,2-DCA via reductive dechlorination include chloroethane, ethene, ethane, chloride, methane, and carbon dioxide. Under sulfate-reducing and methanogenic oxidation-reduction (redox) reaction conditions in groundwater, 1,2-DCA also may biodegrade via reductive dechlorination to yield vinyl chloride (Bosma et al., 1998[14]), although this degradation pathway is reported less frequently in the relevant literature.

In addition to the information summarized in Table 3.3, there are three other direct lines of evidence that natural attenuation of 1,2-DCA is occurring at the Site. The most compelling evidence lies in an evaluation of chloride concentration trends downgradient of the Site. As shown in Figure 6.4, chloride concentrations in groundwater samples collected from deep groundwater monitoring wells located along the centerline of the

[13] U.S. EPA, 1998, Seminars: Monitored Natural Attenuation for Groundwater, EPA/625/K-98/001.
[14] Bosma, T.N.P., M.A. van Aalst-van Leeuwen, J. Gerritse, and E. va Heiningen, 1998, Intrinsic Dechlorination of 1,2-Dichloroethane at an Industrial Site, in G.B. Wickramanayake and R.E. Hinchee (Eds.), Chlorinated and Recalcitrant Compounds: Volume 3 pp. 7-12, Battelle Press, Columbus, Ohio.

VOC plume (MW114, MW124 and MW129) are above 10 mg/l. However, chloride concentrations in groundwater samples collected from monitoring wells downgradient of the Site and outside the area of the VOC plume are generally below 5 mg/l. As noted above, another degradation product of 1,2-DCA is ethene. During the November 1997 sampling event, ethene was detected at only two locations; both located within the center of the VOC plume (MW114 and MW124). The detection of ethene in the center of the plume is also direct evidence of the occurrence of 1,2-DCA natural attenuation. In addition, low levels of vinyl chloride are present where 1,2-DCA is present. Since vinyl chloride, ethene and chloride are byproducts of 1,2-DCA biodegradation, the presence of vinyl chloride and ethene, and the two to threefold increase in chloride concentrations in the VOC plume area are direct evidence that biodegradation of 1,2-DCA is occurring at the Site. The absence of other vinyl chloride parent compounds in downgradient monitoring wells where 1,2-DCA is detected (e.g., tetrachloroethene, trichloroethene, and dichloroethene) suggests that the anaerobic biodegradation pathway of 1,2-DCA to vinyl chloride to ethene is occurring at the Site.

Degradation Modeling

In order to evaluate groundwater flow and the rate of compound biodegradation, groundwater modeling was conducted to assess the potential future extent of 1,2-DCA and vinyl chloride downgradient from the Site under an MNA remedy. 1,2-DCA and vinyl chloride were selected for this simulation since these are the only VOCs detected in groundwater an appreciable distance beyond the downgradient boundary of the Site. A two-dimensional groundwater flow model was developed to represent average uniform groundwater flow conditions within the deep groundwater system beneath the Site. The groundwater flow model was developed within the framework of the United States Geologic Survey's (USGS's) groundwater flow model MODFLOW-96 (Harbaugh and McDonald, 1996a[15] and 1996b[16]).

1,2-DCA and vinyl chloride concentrations were applied as initial conditions to develop current distributions of these compounds within the deep groundwater system (i.e., Unit C). Attenuation of 1,2-DCA and vinyl chloride within the deep groundwater system was simulated using the Pacific Northwest National Laboratory's (PNNL's)

[15] Harbaugh, A.W. and M. G. McDonald, 1996a, User's Documentation for MODFLOW-96, an update to the U.S. Geological Survey Modular Finite-Difference Ground-Water Flow Model, United States Geological Survey Open-File Report 96-485, Reston, Virginia.

[16] Harbaugh, A.W. and M. G. McDonald, 1996b, Programmer's Documentation for MODFLOW-96, an update to the U.S. Geological Survey Modular Finite-Difference Ground-Water Flow Model, United States Geological Survey Open-File Report 96-486, Reston, Virginia.

reactive solute transport model RT3D (Clement, 1997)[17]. The RT3D simulations included the sequential biodegradation of 1,2-DCA to vinyl chloride under anaerobic conditions, and retardation due solute adsorption onto soil particles. As described above, the sequential biodegradation of 1,2-DCA to vinyl chloride is consistent with observed Site conditions. Due to the OU1 source control measures already implemented at the Site, it was assumed that there are no continuing sources of VOCs to groundwater beneath the Site. OU1 source control measures such as excavation of VOC-impacted soil and placement of a low-permeability cover over the waste deposits already in place are expected to reduce contaminant loading and improve off-Site groundwater quality. As such, these existing OU1 source-control measures would add to the overall effectiveness of MNA. Additional detail concerning model construction and input assumptions is presented in Appendix G. Appendix G also contains figures depicting modeling inputs and results discussed in subsequent text.

Factors that may affect the rate of biodegradation and the length of time required to achieve the groundwater-quality standards under a MNA remedy include the biodegradation rate constant, substrate availability, and presence/absence of a continuing contaminant source. The biodegradation rate constant is a site-specific value that is dependent on numerous factors that provide favorable conditions for indigenous microorganism to degrade the compounds present in the subsurface environment. Insufficient data are available to facilitate a rigorous calculation of Site-specific degradation rates. However, the literature provides references to biodegradation rate constants determined from a variety of studies, although there are relatively few references to biodegradation rate constants derived for the 1,2-DCA to vinyl chloride biodegradation pathway. Suarez and Rifai (1999)[18] present a summary of biodegradation rates for chlorinated VOCs reported in numerous studies through the relevant literature. Suarez and Rifai (1999) present first-order decay rates for several chlorinated VOCs reported from field/in situ studies of reductive dechlorination. Mean values of the reductive dechlorination first-order decay rates for 1,2-DCA and vinyl chloride of 0.0015 $days^{-1}$ (half-life[19] of 462 days) and 0.003 $days^{-1}$ (half-life of 231 days). These decay rate mean values were applied in the RT3D simulation of the sequential biodegradation of 1,2-DCA to vinyl chloride.

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[17] Clement, T.P., 1997, RT3D (Version 1.0), A Modular Computer Code for Simulating reactive Multi-species Transport in 3-Dimensional Groundwater Systems, PNL-SA-11720, PNNL, Richland, Virginia.

[18] Suarez, M.P. and H.S. Rifai, 1999, Biodegradation Rates for Fuel Hydrocarbons and Chlorinated Solvents in Groundwater, Bioremediation Journal, 3(4), pp. 337-362.

[19] Half-life, $t_{½} = ln(2)/\lambda$, where λ is the first order biodegradation, or decay, rate constant.

The simulation of 1,2-DCA and vinyl chloride biodegradation downgradient of the Site using the mean first-order decay rate constants reported by Suarez and Rifai (1999) are depicted in Figures G.4.1 and G.4.2 of Appendix G, respectively. Under this scenario, the 1,2-DCA plume initially expands downgradient past State Highway 17, during the initial 10 years, then contracts rapidly back to the downgradient Site boundary during years 10 through 30. The simulated 1,2-DCA concentrations fall below the MCL of 5 μg/l between 20 and 25 years. The vinyl chloride plume behaves in a similar manner initially expanding to the same relative degree the 1,2-DCA plume expands, then contracting during years 20 through 30. The vinyl chloride concentrations fall below the MCL of 2 μg/l between 25 and 30 years.

To determine the sensitivity of the RT3D simulation results to the biodegradation rate constants of 1,2-DCA and vinyl chloride, sensitivity simulations were completed. The results indicate that the model is sensitive to the degradation rate constant applied to the model. The predicted time for aquifer cleanup under MNA is sensitive to the Site-specific biodegradation rate constants for 1,2-DCA and vinyl chloride. The actual time required for aquifer cleanup, can only be determined with continued data collection associated with monitoring. As such, the groundwater modeling provides a baseline by which to evaluate observed Site conditions and evaluate the ongoing effectiveness of the MNA remedy. The shared technologies described previously would also be employed under this RAA.

6.3.3.2 ALTERNATIVE 3B - ENHANCED BIODEGRADATION

Enhanced biodegradation is a technology that involves the introduction of inert compounds that provide an energy source or substrate, which promotes the growth of the indigenous population of microorganisms by providing a source of energy. The resulting more robust population of indigenous microorganisms then more effectively degrade compounds of concern in groundwater to inert byproducts. The inert compounds are introduced by pumping a liquid mixture into a series of vertical piezometers. The inert compounds generally consist of a mixture of carbon-rich compounds, such as molasses and nitrogen-rich compounds, which stimulate microbial growth. The biodegradation process may be further enhanced by the introduction of compounds that release oxygen (oxygen release compound or "ORC") or hydrogen (hydrogen release compound or "HRC") that act to promote reactions that replace atoms on the molecule of the groundwater contaminant and convert the contaminant into a more inert compound. ORC is a technology that is well established for the treatment of fuel-related contaminants. More recently, studies indicate that HRC may promote the

destructive dechlorination of chlorinated aliphatic hydrocarbons. HRC is a new technology that is currently undergoing pilot and field-scale testing. Although difficult to quantify in the absence of any treatability studies, it is expected that the timeframe required for aquifer cleanup using this technology would be shorter than that required for MNA.

The natural attenuation of carbon tetrachloride and chloroform in the shallower groundwater may be enhanced by the addition of nitrate to establish an active denitrifying treatment zone for the interception and biodegradation of these specific compounds by indigenous denitrifying microbial population. Due to the characteristically low concentration of carbon in the aquifer matrix, the addition of a carbon source such as molasses would likely increase the microbial population and potentially significantly enhance natural attenuation of compounds present in groundwater. The 1,2-DCA at the deeper groundwater level (100 feet BGS) is biodegradable under aerobic conditions. However, 1,2-DCA is more readily degradable in the presence of a suitable co-carbon source such as methanol or molasses. Aerobic conditions can be enhanced by the addition of ORC to establish an active aerobic treatment zone for the interception and treatment of 1,2-DCA. Additionally, suitable sources of nitrogen and phosphorus may be required. However, creation of aerobic conditions in an aquifer where anaerobic and strongly reducing conditions predominate is not considered feasible. Therefore, ORC is not considered a viable alternative for treating compounds present in groundwater.

The shared technologies described previously would also be employed under this RAA.

6.3.3.3 ALTERNATIVE 3C - BIOSPARGING

Biosparging could be applied to enhance the degradation of the lower aquifer contaminants. It would be applied through a series of sparge points/injection wells advanced through the vadose zone into the groundwater along the northern boundary of the Site. As stated in the previous section, 1,2-DCA is more readily degradable in the presence of a suitable co-carbon source such as methane or propane. Therefore, injection of air or oxygen with low percentage of methane or propane (approximately 3 percent) would enhance co-metabolism of 1,2-DCA and benzene under anaerobic conditions. Off-gas collection and treatment would not be required since no off-gases are generated due to the very low flow rates of air or oxygen injected. Although difficult to quantify in the absence of any treatability studies, it is expected that the timeframe required for aquifer cleanup using this technology would be shorter than that required for MNA.

The shared technologies described previously would also be implemented under this RAA.

7.0 EVALUATION OF REMEDIAL ACTION ALTERNATIVES

7.1 EVALUATION CRITERIA

This section presents an evaluation of the remedial alternatives described in the previous section. Each alternative is evaluated based on the criteria identified below, with the exception of IDEM, U.S. EPA, and community acceptance. Evaluation of alternatives for these criteria will be deferred until after IDEM. The nine criteria are:

- Overall Protection of Human Health and the Environment: The assessment of this criterion describes how an alternative, as a whole, achieves and maintains protection of human health and the environment. The focus of this criterion is the effectiveness of the alternative to reduce the overall risk to human health or the environment. Overall protection of human health and the environment is referred to as a threshold criterion. An alternative must meet this criterion to be considered for selection.
- Compliance with ARARs: Each alternative is evaluated based on its compliance with ARARs. ARARs may be action, chemical or location specific and are governed by federal, state and local laws or ordinances.
- Long-Term Effectiveness and Permanence: Long-term effectiveness is defined as the ability of the alternative to maintain protection of human health and the environment after the response objectives have been met.
- Reduction of Toxicity, Mobility or Volume of Materials: This criterion is designed to evaluate a remedial alternative based on its effectiveness in reducing the toxic effects, migration potential and quantity of associated contaminants in order to protect human health and the environment.
- Short-Term Effectiveness: This criterion is designed to assess the protection of human health and the environment during construction and implementation of a remedial alternative prior to meeting the response action objectives.
- Implementability: Each alternative will be assessed with regard to the technical and administrative feasibility of alternatives and the availability of the good or services outlined in the alternatives.
- Cost: The capital cost and annual operation and maintenance costs are provided for comparison of alternatives. Cost estimates are expected to provide an accuracy of -50 to +30 percent. They provide a basis for comparison between alternatives but do not represent exact budget estimates. The cost estimates are based on current price levels and actual costs of similar projects. Engineering costs reflect the costs to complete the design of the various remedial alternatives including the 30 percent, 60 percent, 90 percent, pre-final and final design submittals, and engineering costs

encompass construction oversight and management, project management, inspections, and construction certification. A 25 percent contingency was applied for engineering in accordance with applicable guidance.[20] The 25 percent engineering contingency was applied uniformly to the remedial alternatives described in this Section.

The percentage of the total project costs applied bonds and insurance, permitting and health and safety costs varied somewhat based on the magnitude of the construction effort associated with the a remedial alternative. Bonds and insurance was generally set at 5 percent of capital costs. Bonds and insurance was set at 3 percent for remedial alternatives with minimal construction efforts. Similarly, the health and safety costs were generally set at 5 percent for projects involving significant construction activities. Lower costs were applied to remedial alternatives where construction efforts were minimal (e.g., involved well installation only).

The cost for permitting varied from 3 percent to 8 percent based upon the anticipated magnitude of the permitting tasks associated with each alternative. For example, permitting charges were set at 5 percent for remedial alternatives likely to require a National Pollutant Discharge Elimination System (NPDES) permit. In addition, other permits likely to be required for the various remedial alternatives include underground injection control (UIC) permits (for groundwater extraction/reinjection), an Army Corps of Engineers nationwide permit for construction activities adjacent to or through wetland areas, air emission equipment construction/operating permits, wastewater treatment construction/operating permits, county and state highway access permits, and access agreements from private property owners. The most permit-intensive remedial alternatives involving subsurface injection were assigned the higher permitting costs.

A 30 percent contingency was applied uniformly to the capital costs of each remedial alternative detailed in this Section. The contingency accounts for the unforeseen costs at the time of estimate preparation (scope contingency) and additional unforeseen costs that become known as the remedial action or OM&M proceed (bid contingency). The scope contingency typically ranges from 10 to 25 percent and the bid contingency typically ranges from 10 to 20 percent.[21] In total, the contingency may range from 20 to 45 percent for any given alternative. Based upon professional

[20]U.S. Environmental Protection Agency, A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, EPA 540-R-00-002, July 2000, p. 5-13.
[21] U.S. Environmental Protection Agency, July 2000, pp. 5-10 - 5-12.

judgement, a contingency of 30 percent was applied to the remedial cost estimates. So as not to inflate the cost of the various alternatives relative to each other, this 30 percent contingency also was applied to the other remedial alternatives, where there is less uncertainty associated with the costs.

- Agency Acceptance: This criterion considers what elements of the alternative may or may not be acceptable to IDEM and the U.S. EPA.
- Community Acceptance: This considers what elements of the alternative may or may not be acceptable to the public.

The Agency and Community Acceptance criteria will be evaluated by IDEM as part of the remedy selection process and are not evaluated herein.

7.2 NO ACTION ALTERNATIVE EVALUATION

The No Action employs no remedial technologies for off-Site groundwater. The OU1 technologies including maintenance of the landfill cap and groundwater monitoring at off-Site monitoring wells would be implemented as required in the OU1 ROD. This alternative assumes that these actions will be undertaken for OU1 and no additional monitoring will be performed or remedial technologies employed under OU2.

7.2.1 OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

Independent of future OU2 remedial actions, remedial technologies such as excavation and consolidation of impacted soil and installation of a RCRA cap over waste deposits implemented under OU1 were designed to reduce contaminant influx to groundwater and result in improved off-Site groundwater quality over time. Further, off-Site groundwater monitoring encompassed by the OU1 ROD would provide a measure by which to determine whether off-Site groundwater quality is improving and the rate of groundwater quality improvement. This alternative assumes that no additional remedial action will be undertaken to address groundwater contamination. Therefore, in combination with the activities completed and that remain to be conducted under OU1, the No Further Action alternative may be protective of human health if anticipated improvements in groundwater quality actually occur. However, no monitoring would be employed to that the No Further Action would be effective.

7.2.2 COMPLIANCE WITH ARARS

Off-Site groundwater quality will likely improve over time. However, no attempt would be made to demonstrate whether biodegradation would reduce off-Site groundwater impacts to the MCLs or the time required for this to occur.

7.2.3 LONG-TERM EFFECTIVENESS AND PERMANENCE

Other than the OU1 monitoring data, no additional data would be obtained to judge the effectiveness of the No Action Alternative.

7.2.4 REDUCTION IN TOXICITY, MOBILITY OR VOLUME OF MATERIAL

No additional remedial technology would be implemented to reduce the toxicity, mobility or volume of impacted groundwater. No additional data would be obtained to judge whether natural processes would reduce the toxicity, mobility or volume of impacted groundwater.

7.2.5 SHORT-TERM EFFECTIVENESS

This alternative does not represent a significant risk to the public or workers through exposure to impacted environmental media.

7.2.6 IMPLEMENTABILITY

There are no concerns with respect to implementability of this option.

7.2.7 COST

There are no costs associated with the implementation of this alternative.

7.3 GROUNDWATER EXTRACTION, TREATMENT AND DISPOSAL ALTERNATIVES EVALUATION

This section discusses the groundwater extraction, treatment and disposal alternatives for off-Site groundwater.

7.3.1 OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

Both of the groundwater extraction and treatment alternatives provide protection of human health by collecting impacted groundwater and preventing its further migration. The alternatives differ on how the treated groundwater is managed.

Alternative 2A: Groundwater extraction and treatment using air stripping technology with surface discharge (Option 1) or subsurface injection (Option 2). This alternative is protective of human health and the environment.

Alternative 2B: Groundwater extraction with and treatment using granular activated carbon with surface discharge (Option 1) or subsurface injection (Option 2). This alternative is protective of human health and the environment.

7.3.2 COMPLIANCE WITH ARARS

Both of the groundwater extraction and treatment alternatives comply with ARARs by the removal and treatment of groundwater with VOC concentrations above the MCLs. Following treatment, groundwater would be discharged to the surface or injected into the subsurface.

7.3.3 LONG-TERM EFFECTIVENESS AND PERMANENCE

Both of the alternatives would provide a permanent remedy for groundwater containing dissolved VOCs at concentrations above the MCLs. North of the Site, groundwater contamination is present in both the shallow (Unit B) and deep (Unit C) systems. Since these units consist primarily of granular deposits, groundwater extraction and treatment would likely be effective as a hydraulic containment remedy. However, recent literature suggests that there is significant uncertainty concerning the effectiveness of

groundwater pump-and-treat technology at attaining the MCLs within a timeframe that is shorter than other less aggressive and less costly remedial alternatives.

Pump-and-treat systems for groundwater remediation came into wide use in the early to mid-1980s (U.S. EPA, 1996a, pg. 1). During this period, groundwater pump-and-treat remedies were an accepted and common solution to groundwater contamination problems and pump-and-treat remediation was applied at approximately three-quarters of the Superfund sites. Historically, it was considered that aquifers could be remediated to health-based groundwater quality objectives in a relatively short period by active pumping systems, which flush groundwater in the contaminant plume. Current knowledge based on experience gained from operating pump-and-treat systems, and improved knowledge of contaminant transport processes, supports the conclusion that pump-and-treat remedies are generally not effective for aquifer restoration to residential health-based groundwater quality objectives within a timeframe that is shorter than other less aggressive and less costly remedial alternatives. This considerable experience has led U.S. EPA to conclude:

- "The most important lesson learned during implementation of Superfund and other remediation programs is that complex site conditions are more common than previously anticipated, including those related to the source and type of contaminants as well as site hydrogeology. As a result of these site complexities, restoring all or portions of the contaminant plume to drinking water standards may not be possible at sites using currently available technologies (U.S.EPA 1996b).
- "Widespread experience with P&T [pump and treat] systems during the past 15 years indicates that their ability to reduce and maintain dissolved contaminant concentrations below clean-up standards in reasonable timeframes is hindered at many sites ..." (U.S. EPA, 1997)

By the early 1990s, evaluations by U.S. EPA (Keely, 1989; U.S. EPA, 1989; and Haley et al., 1991) and others (Freeze and Cherry, 1989; and Mackay and Cherry, 1989) called into question the performance of pump and treat systems. The general 'failure' of the pump and treat approach was identified as its inability to achieve 'restoration' (i.e., reduction of contaminants to levels required by health-based standards) in 5 to 10 years, as was anticipated in the design phase of these projects. Pump and treat systems were criticized more openly by Travis and Doty (1990), who asserted that contaminated aquifers cannot be restored through pumping and treating. Groundwater scientists and engineers generally agree that complete aquifer restoration is an unrealistic goal for many, if not all, contaminated sites" (U.S. EPA, 1996a, page 2).

Doty and Travis (1991) conducted an extensive survey of pump-and-treat systems and were unable to find a single aquifer in the United States that had yet been confirmed to be successfully restored through pump-and-treat remediation. Bartow and Davenport (1995) evaluated the effects of groundwater extraction at 37 sites in the Santa Clara Valley, California. One or more chlorinated aliphatic hydrocarbons were present at 32 of the 37 sites. All of these sites had groundwater extraction systems in operation for at least 5 years, with an average duration of 7 years. Only one site had groundwater concentrations reduced to the applicable federal or state MCLs.

Although they may be effective for plume containment and reducing the mass of contamination present in aquifers, it is difficult to predict with a reasonable degree of accuracy the amount of time that would be required for a pump and treat system to achieve health-based remediation objectives or even if such an objective were reasonably attainable using this technology.

7.3.4 REDUCTION IN TOXICITY, MOBILITY OR VOLUME OF MATERIAL

Both of the groundwater extraction alternatives provide a reduction in mobility and volume of contaminated groundwater through collection. A reduction in the toxicity is provided through treatment. The alternatives differ only by the method of discharge of treated groundwater.

7.3.5 SHORT-TERM EFFECTIVENESS

None of the groundwater extraction alternatives represents a significant risk to the public or workers. Construction workers may be subject to short-term exposures to contaminated environmental media during construction. In addition, a slight risk of human contact with contaminated groundwater may occur during treatment. The limited risks could be effectively managed through implementation of health and safety programs.

7.3.6 IMPLEMENTABILITY

Treatment of groundwater can be accomplished using proven and implementable technologies. There are no concerns regarding the implementability of Alternatives 2A

and 2B. An NPDES discharge permit or an injection permit would need to be obtained before constructing these alternatives. Due to the proximity to wetlands, permits for construction of these alternatives may require a permit from the Army Corps of Engineers under Section 404 of the Clean Water Act. Additionally, there are some concerns regarding potential deleterious effects that may occur to adjacent properties through the surface discharge of groundwater. These effects may be exacerbated during periods of high precipitation and flooding. These effects could be mitigated by conveying treated groundwater to larger surface water bodies such as King Lake or the Tippecanoe River. However, as discussed in the following section, this would result in the need to construct a substantially longer and complex conveyance system resulting in much higher cost.

Injection of treated groundwater would be conducted in a manner that would minimize the potential for altering groundwater flow and altering the direction of plume transport. This would require locating the injection points some distance away from the Site. The most likely point for injection of treated groundwater would be on the property west of the Site. A subsurface conveyance would be required to transport groundwater from the treatment system to the injection points.

7.3.7 COST

Based on the modeling presented previously, approximately 150 gpm (0.2 MGD) of groundwater is expected be generated and require treatment over a period of 30 years. Costs include capital and annual operations and maintenance expenses. A range of costs was provided to account for uncertainties associated with the degree of metals pretreatment required to operate the systems. This uncertainty could be eliminated only through treatability studies. The lower number in the range assumes that minimal pretreatment would be necessary for inorganics before primary treatment and higher number in the range assumes a greater effort would be required. Costs for system and long-term groundwater monitoring would also be incurred. Present worth costs assume a 5 percent discount rate over a 30-year period.

Alternative 2A: Groundwater extraction with physical/chemical treatment (air stripping) and surface discharge (Tables 7.1A and 7.1B) and subsurface injection (Tables 7.2A and 7.2B).

	Option 1 *Surface Discharge*	*Option 2* *Subsurface Injection*
Capital Construction Costs	$1,200,000 to 1,800,000	$1,400,000 to 2,000,000
Average Annual O&M	$176,400 to 208,000	$176,400 to 208,000
30-Year Present Worth	$3,900,000 to 5,000,000	$4,100,000 to 5,200,000

The capital cost provided for Option 1 reflect the costs for construction of a subsurface forcemain to discharge treated groundwater to the outlet tributary of King Lake. The capital costs for Option 2 reflect the cost of construction a subsurface forcemain west to the injection wells located west of the Site.

Alternative 2B: Groundwater extraction with physical/chemical treatment (Granular Activated Carbon) and surface discharge (Tables 7.3A and 7.3B) and subsurface injection (Tables 7.4A and 7.4B).

	Option 1 *Surface Discharge*	*Option 2* *Subsurface Injection*
Capital Construction Costs	$1,300,000 to 1,900,000	$1,400,000 to 2,100,000
Average Annual O&M	$366,000 to 445,000	$366,000 to 445,000
30-Year Present Worth	$6,900,000 to 8,700,000	$7,100,000 to 8,900,000

Again, the capital cost provided for Option 1 reflect the costs for construction of a subsurface forcemain to discharge treated groundwater to the outlet tributary of King Lake. The capital costs for Option 2 reflect the cost of construction a subsurface forcemain west to the injection wells located west of the Site.

As demonstrated by the above cost summary, Alternative 2A is more cost-effective than Alternative 2B. This is primarily due to the higher per Unit costs to treat groundwater with GAC versus groundwater treatment using air stripping technology. The capital cost differential between surface and subsurface discharge of treated groundwater are nominal.

7.4 IN-SITU GROUNDWATER REMEDIAL ALTERNATIVES

This section discusses the treatment of off-Site groundwater using in-situ technologies.

7.4.1 OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

All of the in-situ treatment alternatives provide protection of human health through the treatment of impacted groundwater. The alternatives differ on how the groundwater is treated.

Alternative 3A: Monitored Natural Attenuation is protective of human health and the environment. The ongoing monitoring requirements associated with this remedial alternative will provide assurance that this remedy is performing properly and will continue to be protective of human health.

Alternative 3B: Enhanced Biodegradation is a technology that involves the introduction of inert compounds that provides an energy source or substrate, which promotes the growth of the indigenous population of microorganisms by providing the microorganisms with a source of energy. These indigenous microorganisms then degrade groundwater contaminants to inert compounds. This alternative is protective of human health and the environment.

Alternative 3C: Biosparging involves the injection of a flow of air into the groundwater at very low flow rates to enhance biodegradation. This alternative is protective of human health and the environment.

7.4.2 COMPLIANCE WITH ARARS

Each of the in-situ treatment alternatives complies with ARARs by the treatment of groundwater with VOC concentrations above the MCLs.

7.4.3 LONG-TERM EFFECTIVENESS AND PERMANENCE

Each of the in-situ groundwater treatment alternatives would provide a permanent remedy for groundwater containing dissolved VOCs at concentrations above the MCLs. Screening assessments, calculations and modeling completed to date suggest that MNA

(Alternative 3A) would restore the aquifer in a reasonable timeframe. Additional monitoring requirements associated with MNA, biosparging and enhanced biodegradation options would include indicator compounds selected to determine the efficacy of the remedial technologies and microcosm counts to ensure that the population of biodegrading microorganisms remains robust in the subsurface environment.

7.4.4 REDUCTION IN TOXICITY, MOBILITY OR VOLUME OF MATERIAL

Each of the in-situ groundwater treatment alternatives provides a reduction in mobility and volume of contaminated by through degradation of contaminants. A reduction in the toxicity is provided through the degradation of groundwater contaminants to inert byproducts. The alternatives differ in that MNA (Alternative 3A) relies on the natural degradation of contaminants by indigenous microorganisms without relying on anthropogenic influences. Enhanced Biodegradation (Alternative 3B) and biosparging (Alternative 3C) assist the natural degradation of contaminants using chemical, physical and/or biological means.

7.4.5 SHORT-TERM EFFECTIVENESS

None of the in-situ groundwater alternatives represents a significant risk to the public or workers. Workers may be subject to short-term exposures to contaminated environmental media during installation of wells. No such concerns exist for MNA. The risks could be effectively managed through implementation of health and safety programs.

7.4.6 IMPLEMENTABILITY

There are no serious concerns regarding the implementability of any of the in-situ groundwater treatment options. MNA (Alternative 3A) would be the easiest of the three options to implement since there is no additional treatment system to construct to implement this remedial alternative. The Enhanced Biodegradation (Alternative 3B) and the Biosparging (Alternative 3C) are only slightly more difficult to implement due to the necessity to construct vertical wells or injection points.

7.4.7 COST

Tables 7.5 through 7.7 present the detailed cost breakdown for Alternatives 3A, 3B and 3C are summarized below.

Alternative 3A: Monitored Natural Attenuation		
Capital Construction Costs	$	35,000
Average Annual O&M	$	52,000
30-Year Present Worth	$	840,000
Alternative 3B: Enhanced Biodegradation		
Capital Construction Costs	$	357,000
Average Annual O&M (Year 1)	$	150,000
Average Annual O&M (Years 2 through 30)	$	72,000
30-Year Present Worth	$	1,900,000
Alternative 3C: Biosparging		
Capital Construction Costs	$	510,000
Average Annual O&M (Year 1)	$	125,000
Average Annual O&M (Years 2 through 30)	$	62,000
30-Year Present Worth	$	2,100,000

Each of the in-situ groundwater treatment options has a relatively low initial capital cost. However, the need to frequently amend the system with nutrients and conduct ongoing monitoring results in relatively high O&M costs when calculated over a 30 year period.

7.5 COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES

The remedial alternatives were evaluated based on seven of the nine criteria setout in the RI/FS guidance as summarized in Table 7.8. IDEM will evaluate the remaining two criteria, Agency and Community Acceptance. Each of the above-summarized RAAs, except No Action, rated favorably in the following criteria:

1. overall protection of human health and the environment,
2. compliance with ARARs,

3. long-term effectiveness and permanence
4. reduction in the toxicity, mobility or volume of material,
5. short-term effectiveness,
6. implementability.

There were some significant differences in the costs of the remedial alternatives evaluated. This section evaluates the remedial alternatives against each other relative to the criteria summarized above.

7.5.1 OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

Each of the remedial alternatives with the exception of the No Action alternative rated favorably with respect to protection of human health and the environment. There is no current exposure to contaminants in groundwater. However, each of the alternatives evaluated, except the No Action alternative, are protective of human health through ongoing monitoring programs and contingencies, such as point-of-use treatment to address future potential exposure by treatment. There are no environmental receptors to contamination currently threatened by the contaminants present in the deep groundwater. However, monitoring requirements in all but the No Action alternative will allow ongoing evaluation as to whether environmental receptors become threatened in the future.

7.5.2 COMPLIANCE WITH ARARS

Each of the alternatives except the No Action alternative complies with the ARARs through the treatment of groundwater to the MCLs. Alternatives 2A and 2B attain the groundwater objectives through active treatment. Alternatives 3B and 3C attain the groundwater objectives through injection of compounds to enhance natural biodegradation processes. Alternative 3A relies on natural conditions to treat groundwater to achieve the groundwater objectives. Additional ARARs would apply to treated groundwater produced under Alternatives 2A and 2B. These include surface water discharge limitations, subsurface injection requirements and protection of sensitive environments.

Alternatives 2A and 2B require significant construction activity near wetland areas. Precautions would be necessary to minimize impacts to wetlands and potentially sensitive wildlife populations associated with the wetland environment. Alternatives 3A, 3B and 3C require minimal, if any, construction near wetlands.

7.5.3 LONG-TERM EFFECTIVENESS AND PERMANENCE

Each of the remedial alternatives except Alternative 1, would provide a permanent remedy for groundwater containing dissolved VOCs at concentrations above the MCLs. Both of the groundwater extraction and treatment alternatives (Alternatives 2A and 2B) would provide a permanent remedy for groundwater containing dissolved VOCs at concentrations above the MCLs. However, recent literature suggests that there is significant uncertainty concerning the effectiveness of this technology at attaining the MCLs in a significantly shorter timeframe than other less aggressive technologies. Since the impacted geologic units consist primarily of granular deposits, groundwater extraction and treatment would likely be an effective hydraulic containment remedy.

Screening assessments, calculations and modeling completed to date suggest that MNA (Alternative 3A) would restore the aquifer in a reasonable timeframe. However, performance of this remedy would need to be demonstrated through ongoing monitoring. The other in-situ alternatives (Alternatives 3B and 3C) would also require ongoing monitoring to ensure adequate performance.

7.5.4 REDUCTION IN TOXICITY, MOBILITY OR VOLUME OF MATERIAL

Each of the remedial alternatives except Alternative 1, provides a reduction in mobility and volume of contaminated groundwater by either the extraction and treatment or the in-situ degradation of contaminants. A reduction in the toxicity is provided through treatment or the degradation of groundwater contaminants to inert byproducts. However, the extraction and treatment alternatives merely convert the contaminants from one phase to another phase, which is more amenable to disposal. For example, in Alternatives 2A and 2B, VOCs are removed from the extracted groundwater to the gaseous phase. The vapor-phase VOCs are then adsorbed to activated carbon that will be periodically removed and disposed of or further treated and recycled. The in-situ alternatives (Alternatives 3A, 3B and 3C) rely on the permanent degradation of contaminants to inert compounds by indigenous microorganisms. Enhanced

Biodegradation (Alternative 3B) and biosparging (Alternative 3C) assist the natural degradation of contaminants using chemical, physical or biological means.

7.5.5 SHORT-TERM EFFECTIVENESS

None of the alternatives represents a significant risk to the public or workers. Alternative 1 provides the least short-term risk to Site workers and the public. Due to the more onerous construction requirements, the groundwater extraction and treatment alternatives pose the greatest short-term risk to Site workers and the public. This is primarily due to potential exposure to Site-related chemicals. In Alternatives 3A, 3B and 3C, construction workers may be subject to short-term exposures to contaminated environmental media during construction of injection, monitoring or biosparge wells.

The limited risks that exist for all alternatives could be effectively managed through implementation of health and safety programs.

7.5.6 IMPLEMENTABILITY

There are no serious concerns regarding the implementability of Alternative 1 or the in-situ groundwater treatment options (Alternatives 3A, 3B and 3C). The groundwater extraction and treatment alternatives would be significantly more difficult to implement due to initial construction requirements and the considerable ongoing operation, maintenance and monitoring requirements. Alternative 1 would be the easiest of the options to implement followed by MNA. The Enhanced Biodegradation (Alternative 3B) and the Biosparging (Alternative 3C) are only slightly more difficult to implement due to the necessity to construct vertical wells or injection points.

7.5.7 COST

There were significant differences in the RAAs in terms of cost. Costs evaluated in this FS included capital cost and long-term O&M costs. As summary of the RAAs in reverse order of cost (most expensive to least expensive) is provided below:

Remedial Alternative Description	*Present Worth Cost*
Alternative 2B Option 2 - Groundwater Extraction with GAC with Subsurface Injection	$7,100,000 to 8,900,000
Alternative 2B Option 1 Groundwater Extraction with GAC and Surface Discharge	$6,900,000 to 8,700,000
Alternative 2A Option 2 - Groundwater Extraction with Air Stripping and Subsurface Injection	$4,100,000 to 5,200,000
Alternative 2A Option 1 - Groundwater Extraction with Air Stripping and Surface Discharge	$3,900,000 to 5,000,000
Alternative 3C - Biosparging	$2,100,000
Alternative 3B - Enhanced Biodegradation	$1,900,000
Alternative 3A - Monitored Natural Attenuation	$840,000
Alternative 1 - No Action	$0

As summarized above, the RAAs involving groundwater extraction and treatment using GAC are the most costly alternatives. This is because both capital and O&M costs are high for these alternatives. The groundwater extraction and air stripping options are the next most costly alternatives. Although the capital costs for the air stripping and GAC options are nearly equivalent, the air stripping options less costly because of generally lower costs for O&M. Capital costs for the different process options for groundwater disposal (surface discharge and subsurface injection) do not affect the overall costs substantially.

The in-situ treatment alternatives, biosparging and enhanced biodegradation, are more cost effective than the groundwater extraction and treatment alternatives due to the lower initial capital costs. However, the ongoing O&M costs for these alternatives are relatively high resulting in moderate present worth costs.

The MNA alternative is the most cost-effective in-situ treatment alternative. The MNA alternative involves ongoing monitoring to verify the presence and ongoing

effectiveness of natural attenuation processes at obtaining Site-specific remedial objectives.

8.0 SUMMARY AND CONCLUSIONS

8.1 SUMMARY

A number of remedial technologies applicable to off-Site groundwater were screened in this OU2 FS Report. The following RAAs were developed for off-Site groundwater using the retained remedial technologies and associated process options and were evaluated in detail.

Alternative 1 - No Action

Alternative 2 - Vertical Extraction Wells
- Ex-Situ Groundwater Treatment
  - A) Air stripping/chemical treatment
  - B) GAC/chemical treatment with aquifer reinjection
- Groundwater Disposal
  - 1) Surface Discharge
  - 2) Subsurface Injection

Alternative 3 - In-Situ Groundwater Treatment
- A) MNA
- B) Enhanced Biodegradation
- C) Biosparging

In addition to the RAAs listed above, the following shared technologies are applicable to Alternatives 2 and 3.

Shared Technologies
- Deed and Groundwater-Use Restrictions
- Monitoring

The remedial alternatives were evaluated in detail based on seven of the nine criteria setout in the RI/FS guidance. IDEM will evaluate the remaining two criteria, Agency and Community Acceptance. Each of the above-summarized RAAs, with the possible exception of No Action, rated favorably in the following criteria:

1. Overall Protection of Human Health and the Environment,
2. Compliance with ARARs,
3. Long-Term Effectiveness and Permanence
4. Reduction in the Toxicity, Mobility or Volume of Material,
5. Short-term Effectiveness, and

6. Implementability.

There were significant differences in the RAAs in terms of cost. Costs evaluated in this FS included capital cost and long-term O&M costs. As summarized above, the RAAs involving groundwater extraction and treatment using GAC are the most costly alternatives. This is because both capital and O&M costs are high for these alternatives. The groundwater extraction and air stripping options are the next most costly alternatives. Although the capital costs for the air stripping and GAC options are nearly equivalent, the air stripping options are less costly because of generally lower costs for O&M. Capital costs for the different process options for groundwater disposal (surface discharge and subsurface injection) do not affect the overall costs substantially. However, there is considerable debate concerning whether groundwater pump and treat technology is effective at achieving health-based cleanup objectives. The concerns regarding the effectiveness of this technology need to be weighed in conjunction with the high cost to implement these alternatives.

The in-situ treatment alternatives, biosparging and enhanced biodegradation, are more cost effective than the groundwater extraction and treatment alternatives due to the lower initial capital costs. However, the ongoing O&M costs for these alternatives are relatively high resulting in moderate to high present worth costs. The monitored natural attenuation alternative is the most cost-effective in-situ treatment alternative. The MNA alternative involves ongoing monitoring to verify the presence and ongoing effectiveness of natural attenuation processes at obtaining Site-specific remedial objectives. The U.S. EPA suggests that MNA typically be used in conjunction with active remediation measures (e.g., source control), or as a follow-up to active remediation measures that have already been implemented. At the Four County Landfill Site, source-control measures such as excavation of VOC impacted soil and construction of a low-permeability RCRA cap over the entire landfill have been completed. These source control measures will have a beneficial impact on off-Site groundwater quality. The estimated timeframes for cleanup of groundwater using MNA compare favorably with other remedial alternatives.

The No Action Alternative is the most cost-effective alternative since it employs no remedial technologies for off-Site groundwater. This alternative assumes that these actions will be undertaken for OU1 and no additional monitoring will be performed or remedial technologies employed under OU2.

8.2 TREATABILITY STUDIES

With the exception of Alternative 1 (No Action), bench and/or field-scale treatability studies would be required to obtain the necessary data to determine the effectiveness and/or design the remedial system. For the ex-situ groundwater treatment alternatives, treatability studies would consist of completing a groundwater pumping test and collection of samples to properly design a system for treating impacted groundwater extracted from the subsurface. Similarly, treatability studies for the in-situ groundwater treatment alternatives would include microcosm studies to determine the numbers and type of degrading bacteria and field studies designed at acquiring data concerning the effectiveness of various amendments to enhance biodegradation.

The work scope for treatability studies is dependent upon the remedy selected by IDEM.

8.3 CONCLUSIONS

This OU2 FS Report has been prepared in accordance with the Work Plan and appropriate U.S. EPA guidance. Consistent with the approved Work Plan, the identified RAAs are compared to the criteria designated in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This FS is based on a detailed review of the historical information documented by the Work Plan, the Groundwater Technical Memorandum, the Environmental Evaluation Report and the OU1 and OU2 RI Reports.

The Remedial Action Alternatives (RAAs) developed for off-Site groundwater included a number of remedial options under three major technology types as summarized below.

Alternative 1 - No Action

Alternative 2 - Groundwater Extraction, Treatment and Discharge

- Alternative 2A Option 1 - Groundwater Extraction with Air Stripping and Surface Discharge
- Alternative 2A Option 2 - Groundwater Extraction with Air Stripping and Subsurface Injection
- Alternative 2B Option 1 Groundwater Extraction with Granular Activated Carbon (GAC) and Surface Discharge

- Alternative 2B Option 2 - Groundwater Extraction with GAC with Subsurface Injection

<u>Alternative 3 - In-Situ Groundwater Treatment</u>

- Alternative 3C - Biosparging
- Alternative 3B - Enhanced Biodegradation
- Alternative 3A - Monitored Natural Attenuation

The remedial alternatives were evaluated in detail based on seven of the nine criteria setout in the RI/FS guidance. IDEM will evaluate the remaining two criteria, Agency and Community Acceptance. Each of the above-summarized RAAs, with the possible exception of No Action, rated favorably in the following criteria:

1. Overall Protection of Human Health and the Environment,
2. Compliance with Applicable Relevant and Appropriate Requirements (ARARs),
3. Long-Term Effectiveness and Permanence
4. Reduction in the Toxicity, Mobility or Volume of Material,
5. Short-term Effectiveness, and
6. Implementability.

There were significant differences in the RAAs in terms of cost. Costs evaluated in this FS included capital cost and long-term O&M costs. The RAAs involving groundwater extraction and treatment using GAC are the most costly alternatives. This is because both capital and O&M costs are high for these alternatives. The groundwater extraction and air stripping options are the next most costly alternatives. There is concern, based upon published literature, that groundwater pump and treat technology may not health-based cleanup objectives in a timeframe that is appreciably shorter than other, less aggressive remedial technologies. The concerns regarding the effectiveness of this technology need to be weighed in conjunction with the high cost to implement these alternatives.

The in-situ treatment alternatives, biosparging and enhanced biodegradation, are more cost effective than the groundwater extraction and treatment alternatives due to the lower initial capital costs. However, the ongoing O&M cost for these alternatives are relatively high resulting in moderate present worth costs. The monitored natural attenuation alternative is the most cost-effective in-situ treatment alternative. The MNA alternative involves ongoing monitoring to verify the presence and ongoing

effectiveness of natural attenuation processes at obtaining Site-specific remedial objectives.

The U.S. EPA suggests that MNA typically be used in conjunction with active remediation measures (e.g., source control), or as a follow-up to active remediation measures that have already been implemented. At the Four County Landfill Site, source-control measures such as excavation of VOC impacted soil and construction of a low-permeability RCRA cap over the entire landfill have been completed. These source control measures will have a beneficial impact on off-Site groundwater quality. The estimated timeframes for cleanup of groundwater using MNA compare favorably with other remedial alternatives.

With the exception of Alternative 1 (No Action), bench and/or field-scale treatability studies would be required to obtain the necessary data to determine the effectiveness and/or design the remedial system. For the ex-situ groundwater treatment alternatives, treatability studies would consist of completing a groundwater pumping test and collection of samples to properly design a system for treating impacted groundwater extracted from the subsurface. Similarly, treatability studies for the in-situ groundwater treatment alternatives would include microcosm studies to determine the numbers and type of degrading bacteria and field studies designed at acquiring data concerning the effectiveness of various amendments to enhance biodegradation.

This OU2 FS is based on a detailed review of the information documented in the OU2 RI and numerous other previous reports. This OU2 FS Report represents a comprehensive summary of remedial technologies applicable to off-Site groundwater at the Four County Landfill Site and provides the basis for selection of a remedy for OU2. IDEM will select the final remedy for OU2 with input from the U.S. EPA, upon submittal of the final OU2 FS Report and following a public review process.

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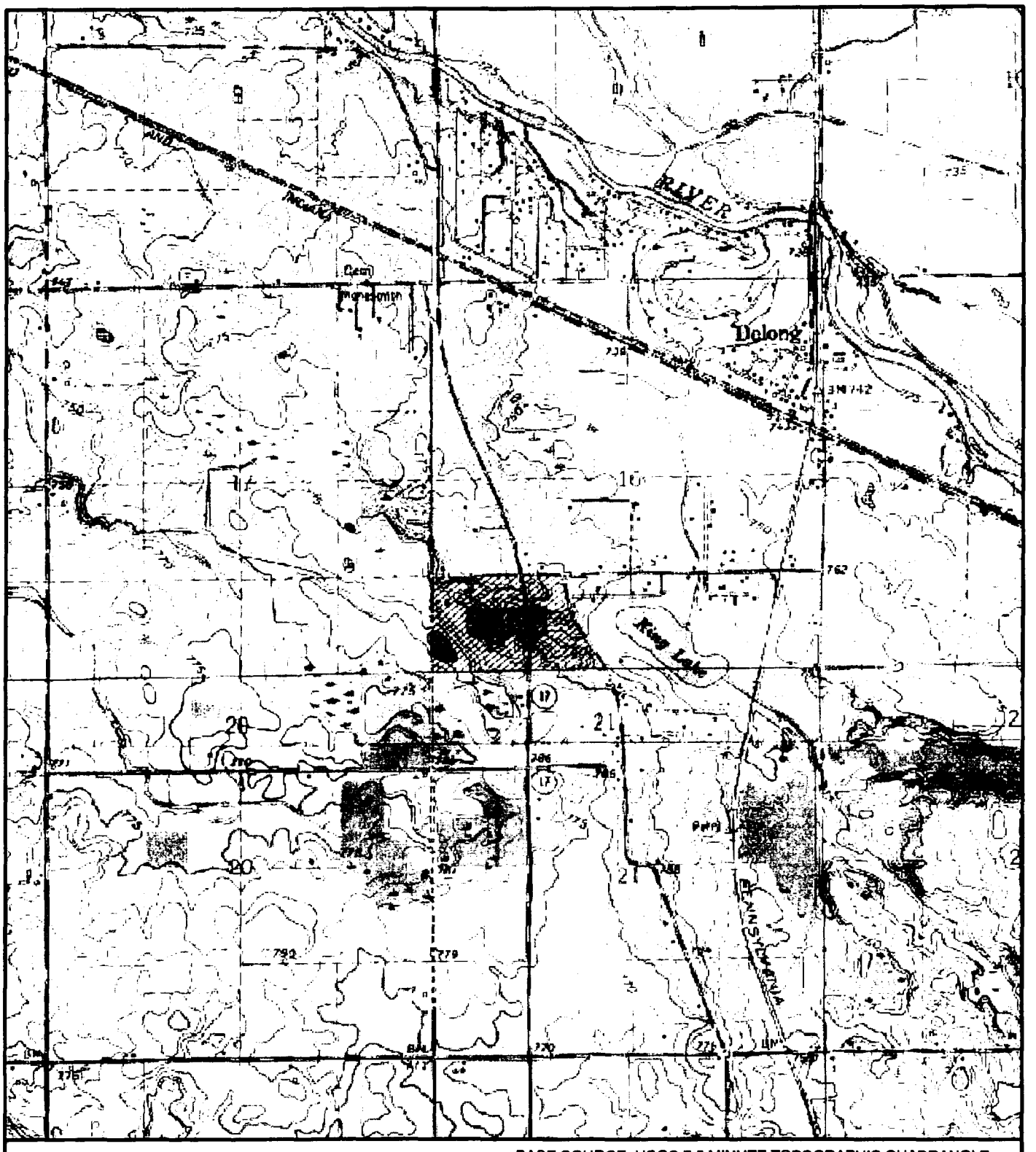

BASE SOURCE: USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE; CULVER 1980 AND KEWANNA 1977

0 1/4 1/2 mile

figure 2.1

SITE LOCATION
FOUR COUNTY LANDFILL
Fulton County, Indiana

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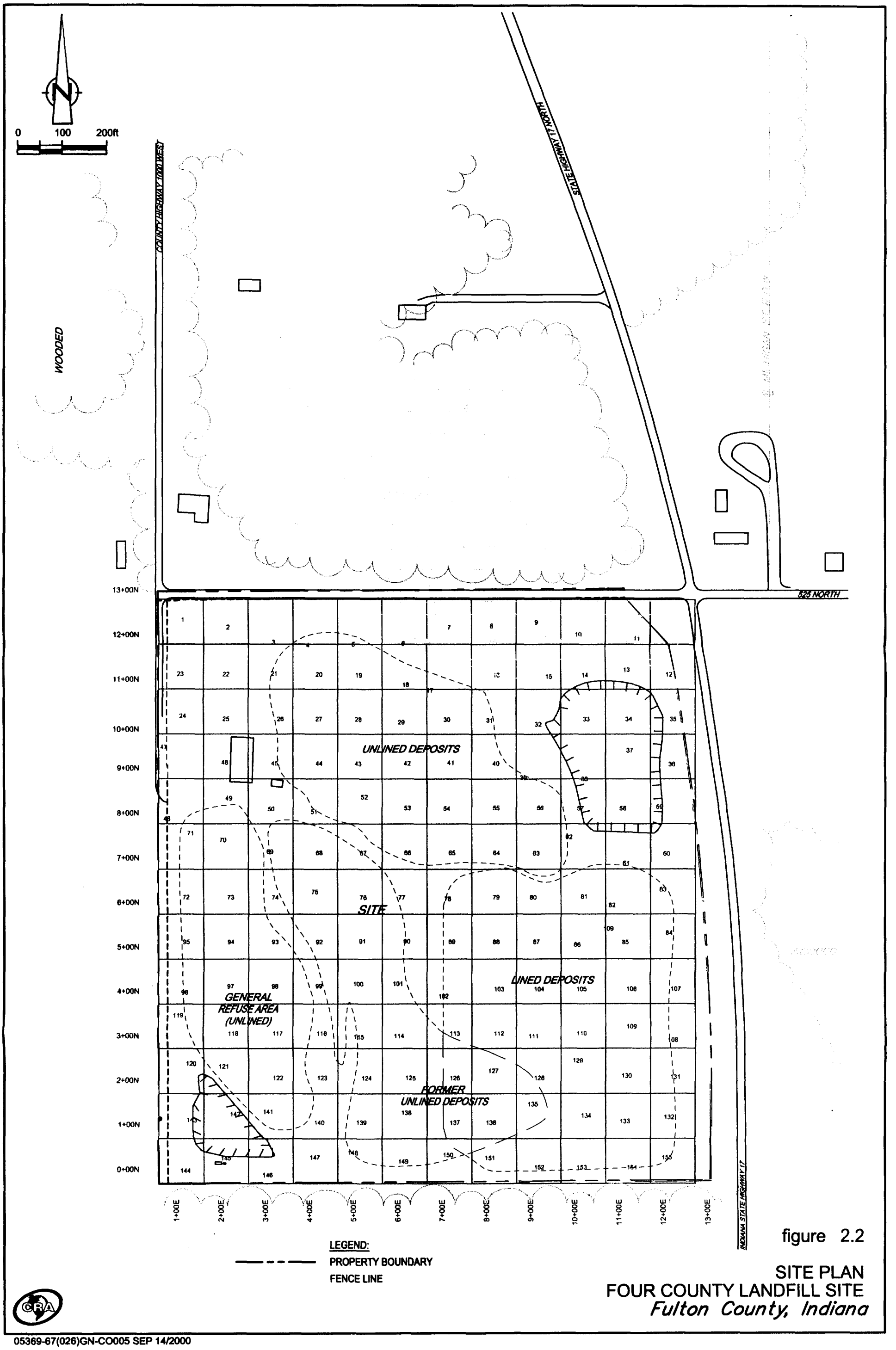

figure 2.2

SITE PLAN
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

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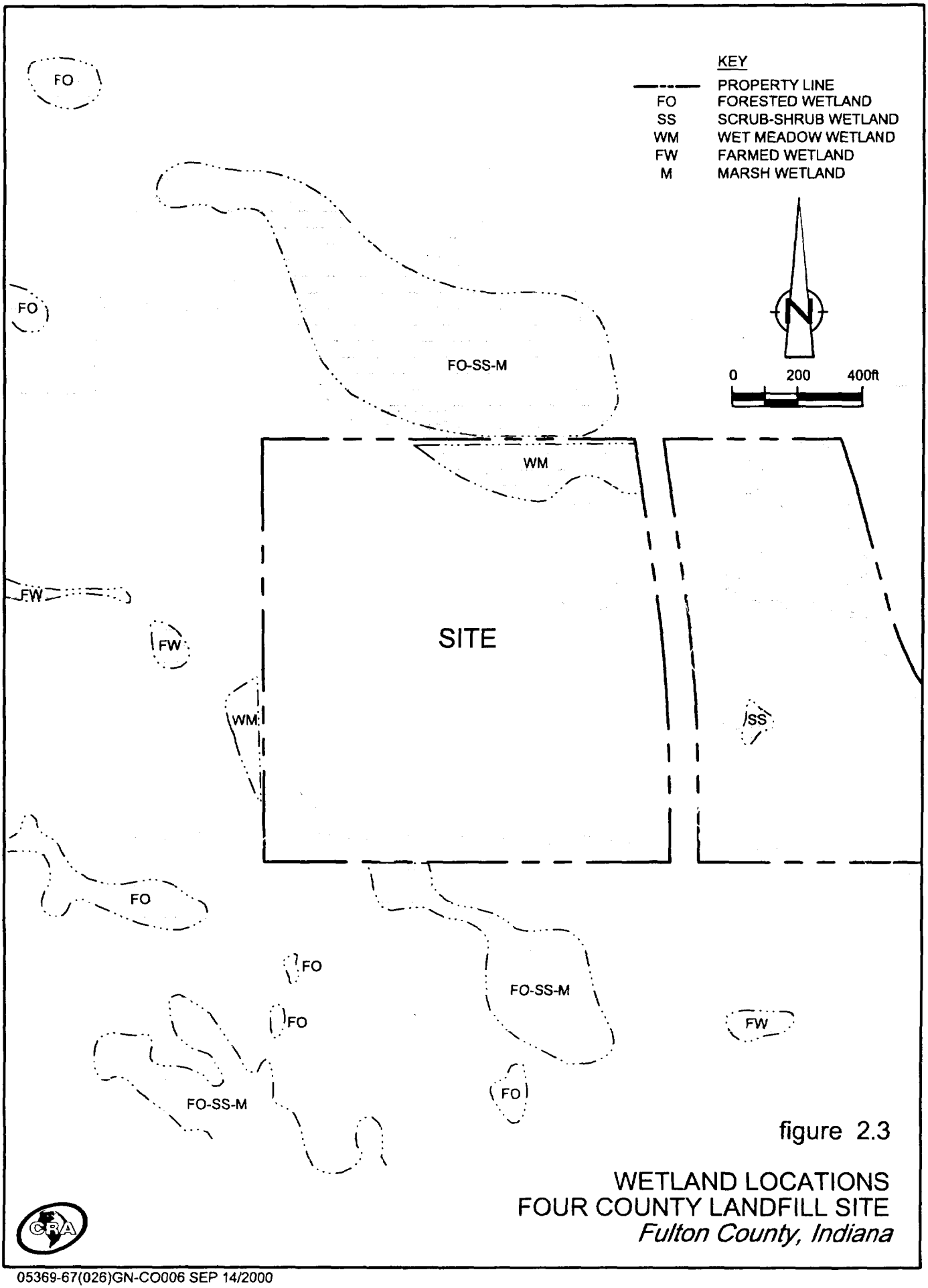
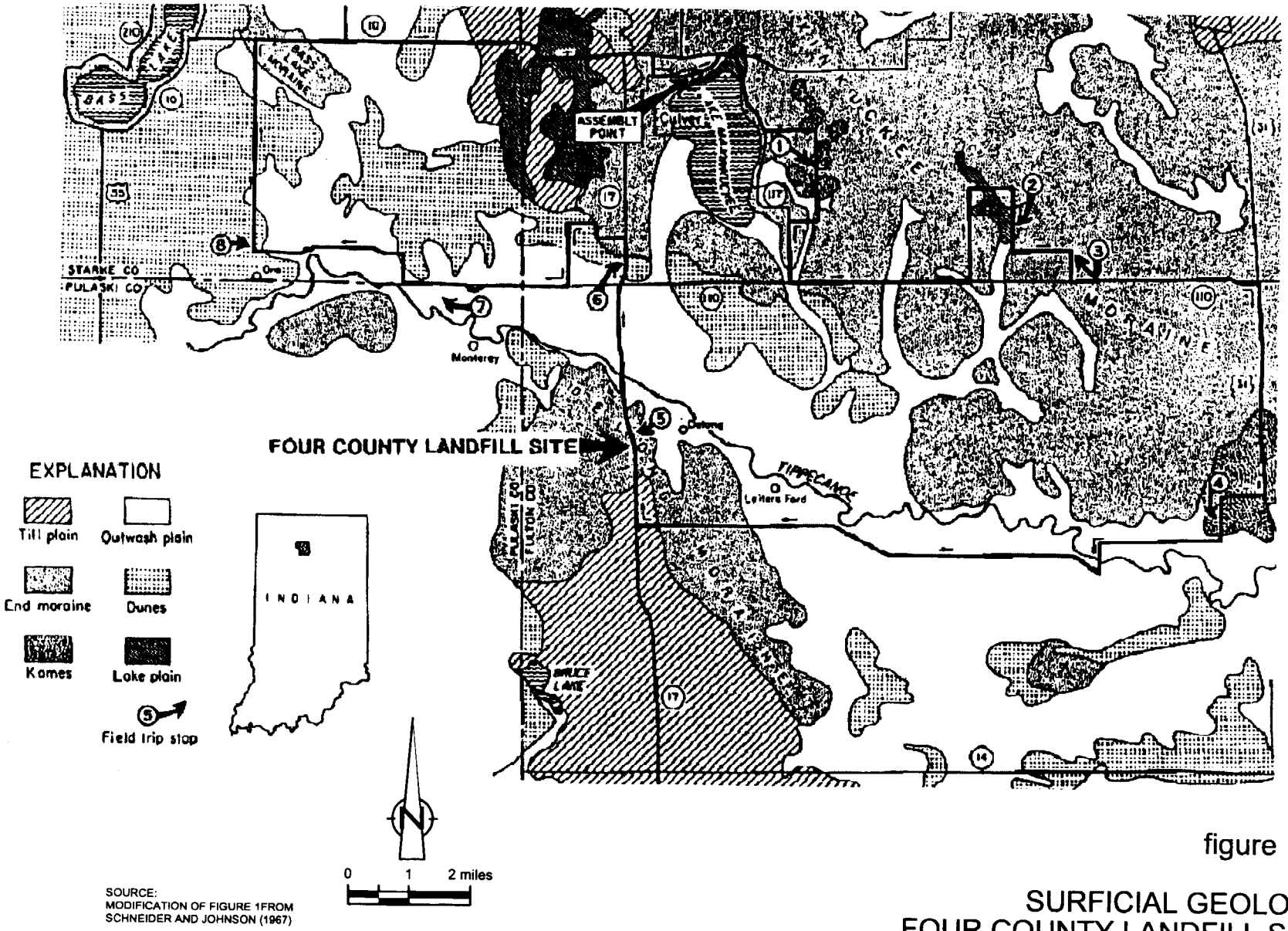


figure 2.3

WETLAND LOCATIONS
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

05369-67(026)GN-CO006 SEP 14/2000

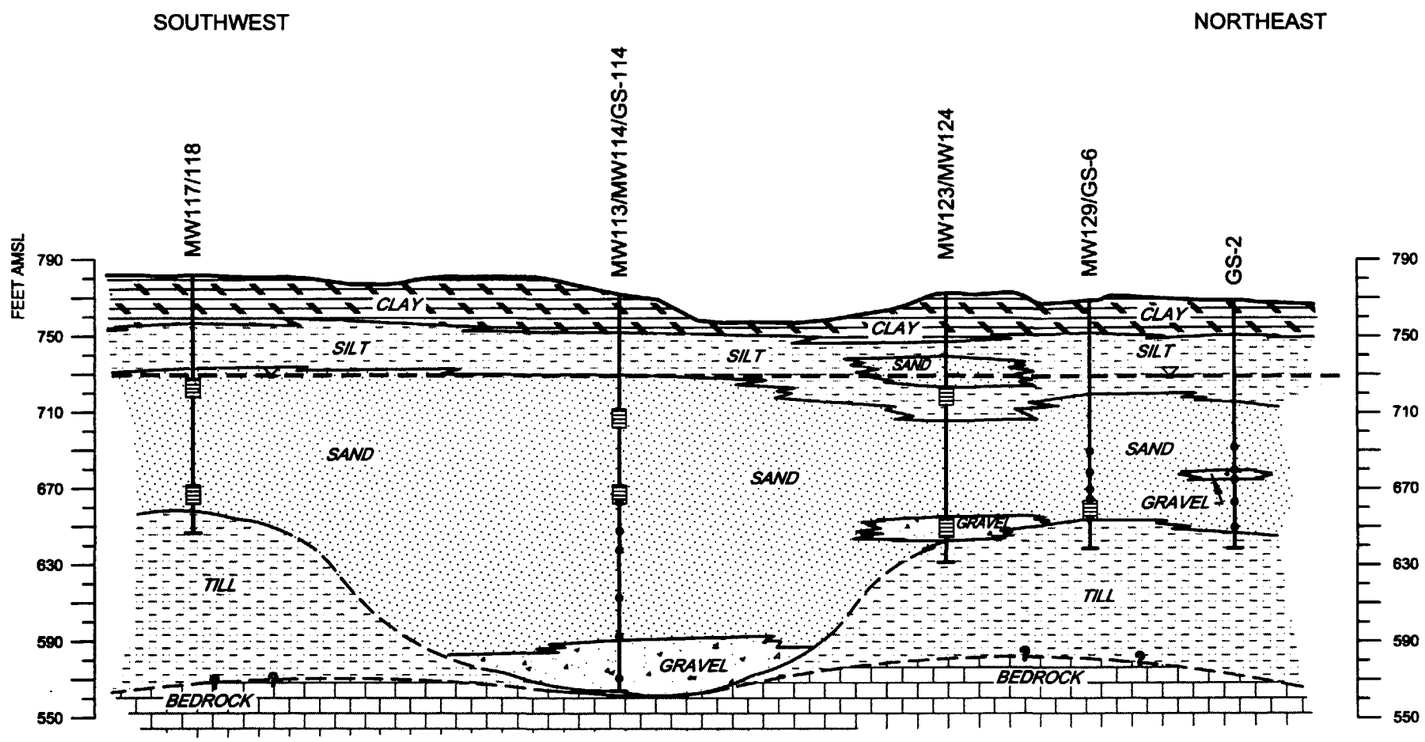


SOURCE:
MODIFICATION OF FIGURE 1FROM
SCHNEIDER AND JOHNSON (1967)

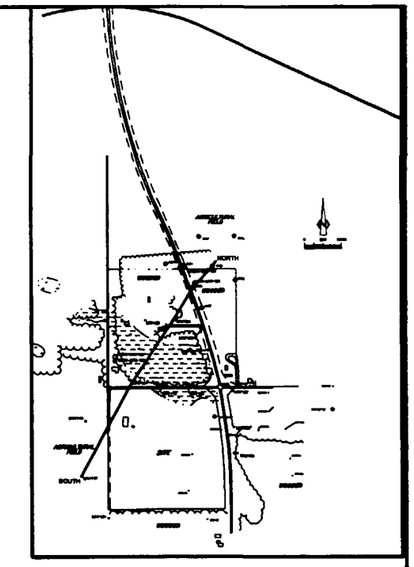
figure 2.4

SURFICIAL GEOLOGY
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

05369-67(026)GN-CO007 SEP 14/2000



SCALE: HORZ. 1"=400'
VERT. 1"=80'



LEGEND

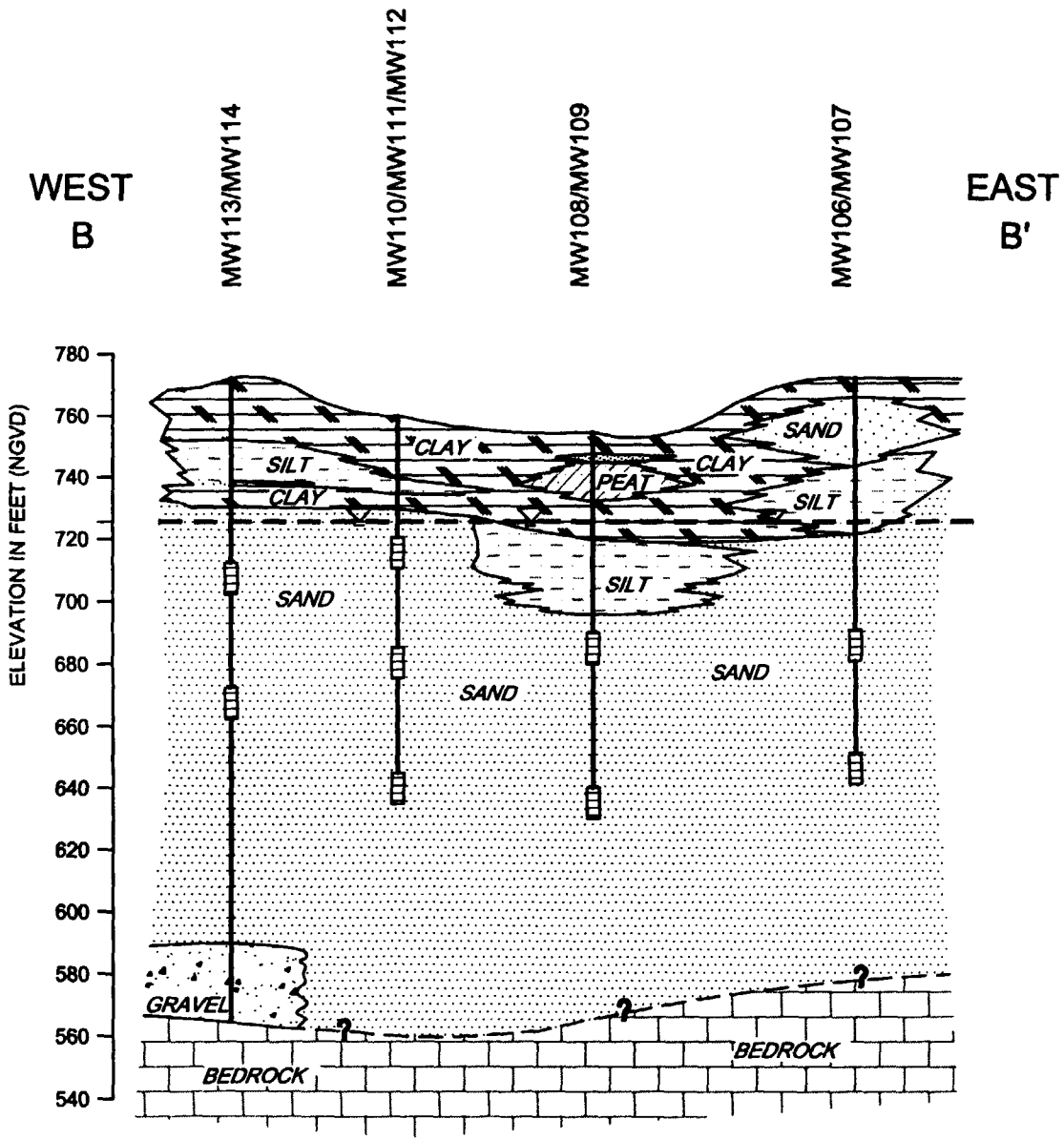
MW117 — MONITORING WELL IDENTIFIER
GROUND SURFACE
WELL CASING
WELL SCREEN
BOTTOM OF BOREHOLE
WATER TABLE

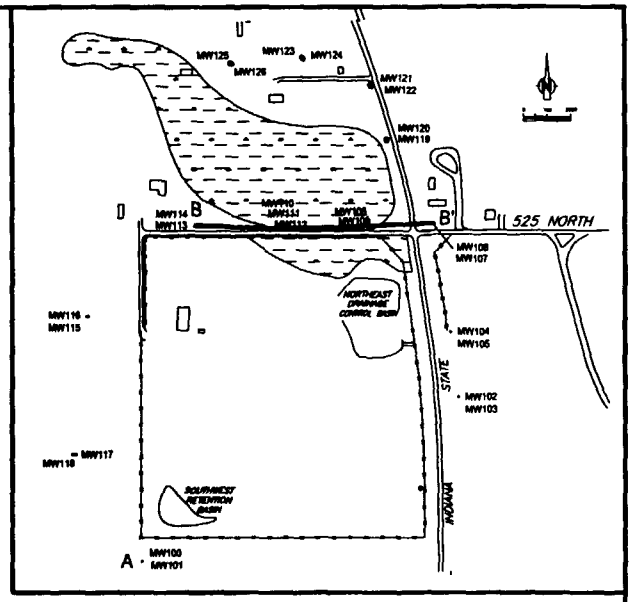
● GROUNDWATER SCREENING SAMPLING LOCATION

figure 2.5

GEOLOGIC CROSS-SECTION
SOUTHWEST TO NORTHEAST
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

05369-67(026)GN-CO008 SEP 14/2000





LEGEND

MW113 — MONITORING WELL IDENTIFIER

GROUND SURFACE

WELL CASING

WELL SCREEN

BOTTOM OF BOREHOLE

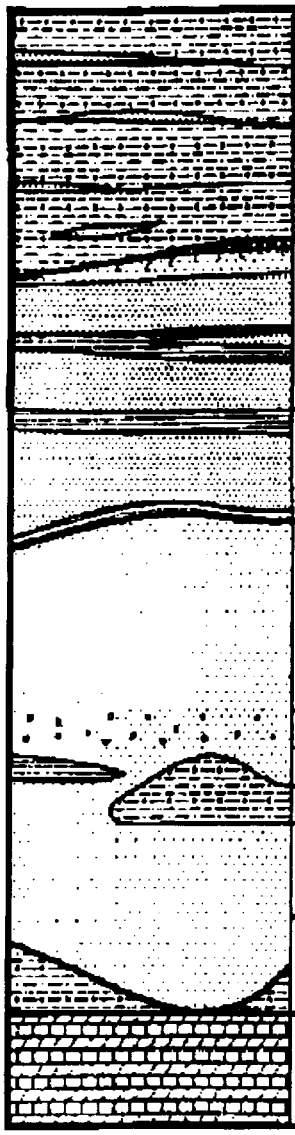
WATER TABLE

SCALE: HORZ. 1"=300'
VERT. 1"=60'

figure 2.6

CROSS SECTION
WEST TO EAST
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

CRA



STRATIGRAPHIC UNIT/MARKER HORIZON		DESCRIPTION
A1	UNIT A	**TILL SEQUENCE** Glacial till of dominant loam and silt loam texture. Subunits are based on variations in texture and pebble composition, occurrence of thin oxidized zones, intertill clastic units and variation in standard penetration resistance.
A2		
A22		
A3		
SILT MARKER	UNIT B	**GLACIO-LACUSTRINE SEQUENCE** Well stratified sequence of fine to medium grained sand and silt commonly capped by a thin pebbly sand and pebbly loam which is strongly oxidized in the upper part. Base of unit is mapped at the base of the lowest silt bed in the sequence.
C2	UNIT C	**GLACIO-FLUVIAL SEQUENCE** Well stratified sequence of sand, gravelly sand, sandy gravel and granular to fine pebble gravel. Unit contains a discontinuous zone of silty material and pebbly loam diamict in the middle part. Upper part of the sequence coarsens downward to a zone of coarse sand, sandy gravel and gravel, designated as Subunit C2. Below this zone are finer grained materials.
SILTY MUD ZONE		
DIAMICT ZONE		
UNIT D		**BASAL TILL** Loam or finer glacial till. Becomes more clayey and has reddish hue in basal part.
BEDROCK		**BEDROCK** Limestone and Dolostone of Devonian age.

SOURCE: GEOSCIENCES RESEARCH ASSOCIATES, INC. MEMORANDUM REPORT (4/28/89), PLATE 1.

figure 2.7

GENERALIZED SITE STRATIGRAPHY
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

LEGEND:

760 — EXISTING CONTOUR

EXISTING FENCE

INFERRED LIMIT OF EXISTING WASTE

APPROXIMATE LIMIT OF LINED DISPOSAL AREA (LOCATION OF EXISTING ANCHOR TRENCH)

A — A' CROSS-SECTION (SEE SHEETS 9 AND 10)

800 — PROPOSED CONTOUR

x 800 PROPOSED SPOT ELEVATION

PROPOSED ANCHOR TRENCH

PROPOSED ACCESS ROAD

PROPOSED AREAS OF TEXTURED GEOMEMBRANE, DOUBLE SIDED COMPOSITE DRAINAGE LAYER, AND NONWOVEN GCL PLACEMENT

PROPOSED CAP ANCHOR TRENCH DRAIN OUTFALL

PROPOSED CONSTRUCTION ZONE SAFETY FENCE TO BE INSTALLED BY CONTRACTOR

0 100 200ft

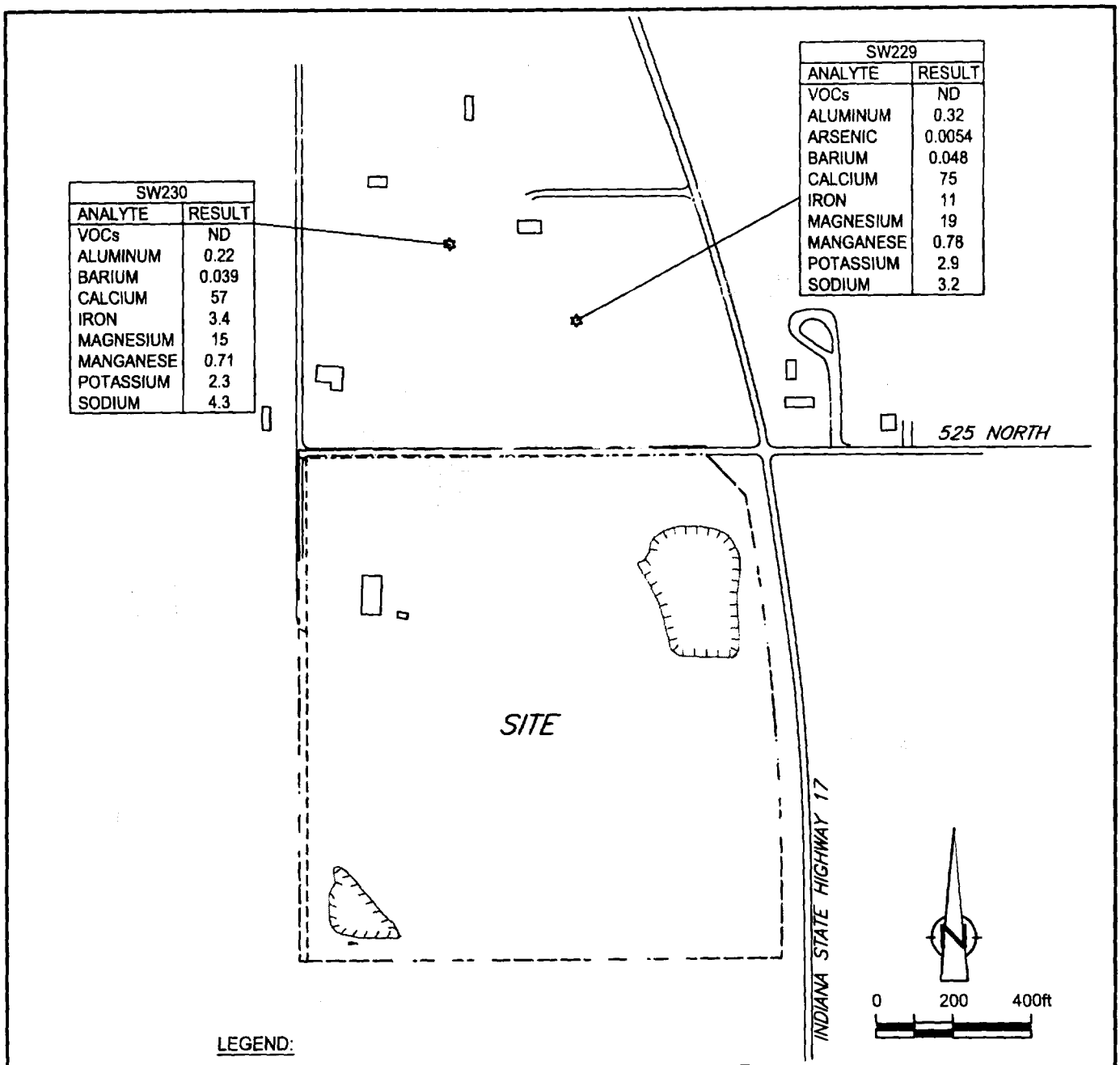
GENERAL NOTES

1. Proposed contours as shown represent final grades.
2. Backfill of temporary benches shall be performed using structural soil fill.
3. Backfill of the 30 -inch diameter reinforced concrete pipe shall be performed using structural soil fill.
4. VOC contaminated soils, waste excavated during construction, and other debris shall be placed in Cell C. Soils placed outside of the existing Cell C liner shall be borrow soils, or soils generated during grading of the existing cover soil.
5. The contractor shall maintain the erosion and sediment control measures shown on Sheet 8 for the entire construction period, and shall only be removed or modified as directed by the Engineer.
6. Placement of textured geomembrane and related geosynthetics on slopes >25% in Cell C may be modified based on actual finished slopes.

figure 3.1

FINAL GRADE DESIGN
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

05369-67(026)GN-CO011 SEP 14/2000



SW230	
ANALYTE	RESULT
VOCs	ND
ALUMINUM	0.22
BARIUM	0.039
CALCIUM	57
IRON	3.4
MAGNESIUM	15
MANGANESE	0.71
POTASSIUM	2.3
SODIUM	4.3

SW229	
ANALYTE	RESULT
VOCs	ND
ALUMINUM	0.32
ARSENIC	0.0054
BARIUM	0.048
CALCIUM	75
IRON	11
MAGNESIUM	19
MANGANESE	0.78
POTASSIUM	2.9
SODIUM	3.2

LEGEND:

PROPERTY BOUNDARY

RIGHT-OF-WAY BOUNDARY

FENCE LINE

MONITORING WELL LOCATION AND IDENTIFIER

SW229 ✡ APPROXIMATE SURFACE WATER SAMPLING LOCATION AND IDENTIFIER

NOTE: ALL RESULTS REPORTED IN MILLIGRAMS PER LITER (mg/L)

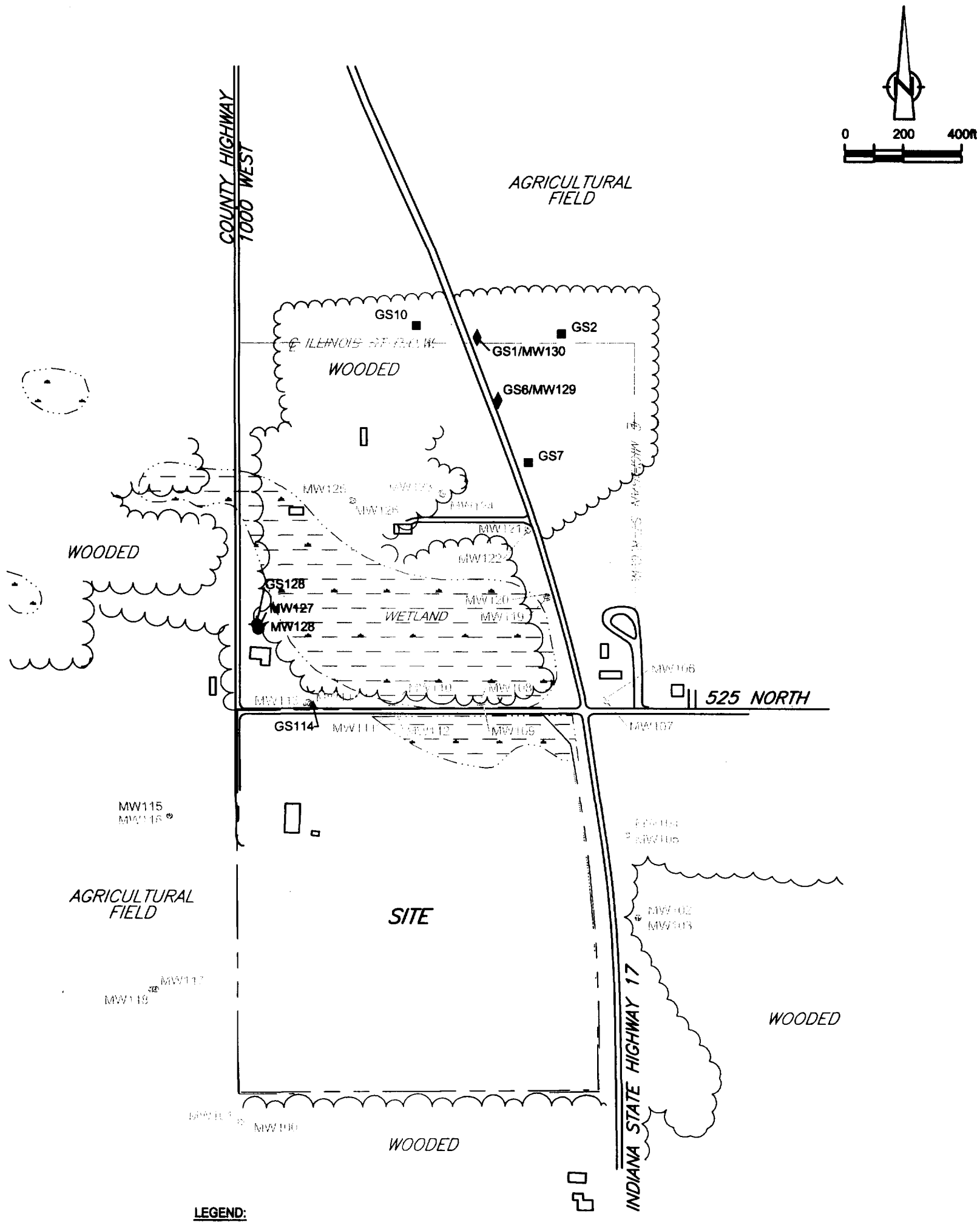
ND NOT DETECTED

VOCs VOLATILE ORGANIC COMPOUNDS

figure 3.2

SUMMARY OF OFF-SITE SURFACE WATER DATA
NOVEMBER 1997
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

05369-67(026)GN-CO012 SEP 14/2000



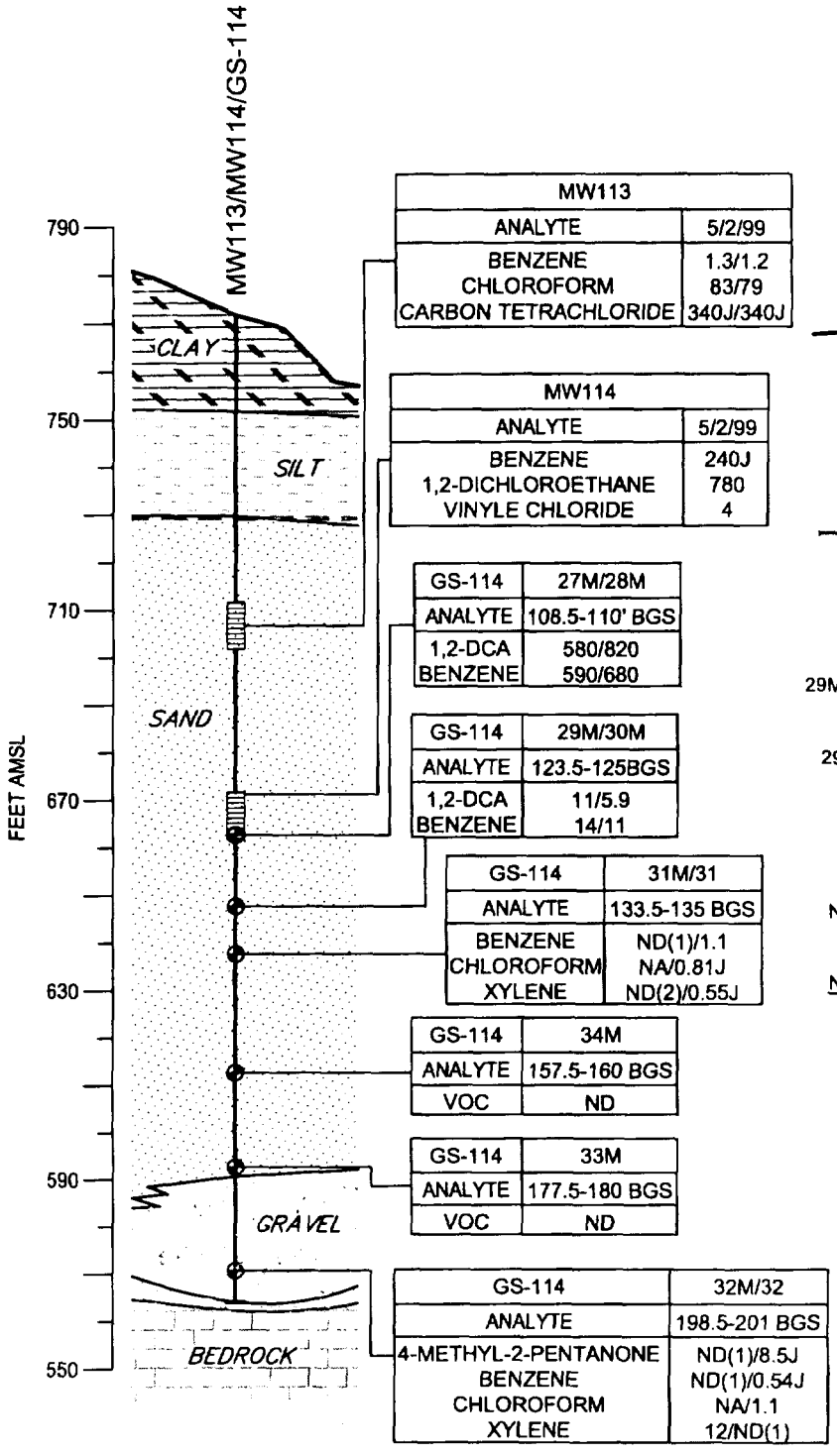
LEGEND:

——— - - ———	PROPERTY BOUNDARY
	FENCE LINE
MW130 ◆	EXISTING MONITORING WELL LOCATION
MW128 ●	NEWLY INSTALLED MONITORING WELL LOCATION AND IDENTIFIER
GS114 ▲	DNAPL GROUNDWATER SCREENING BORING LOCATION AND IDENTIFIER
GS128 ✦	CROSS-GRADIENT GROUNDWATER SCREENING BORING LOCATION AND IDENTIFIER
GS1/MW130 ♦	GROUNDWATER SCREENING/MONITORING WELL LOCATION AND IDENTIFIER
GS2 ■	GROUNDWATER SCREENING BORING LOCATION AND IDENTIFIER

figure 3.3

OFF-SITE GROUNDWATER SCREENING BORING AND MONITORING WELL LOCATIONS
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

05369-67(026)GN-CO013 SEP 14/2000



MW113	
ANALYTE	5/2/99
BENZENE	1.3/1.2
CHLOROFORM	83/79
CARBON TETRACHLORIDE	340J/340J

MW114	
ANALYTE	5/2/99
BENZENE	240J
1,2-DICHLOROETHANE	780
VINYLE CHLORIDE	4

GS-114	27M/28M
ANALYTE	108.5-110' BGS
1,2-DCA	580/820
BENZENE	590/680

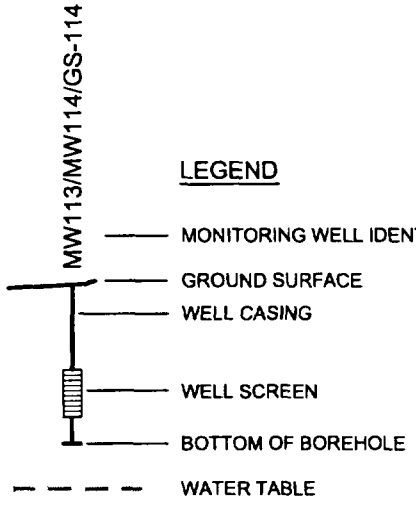
GS-114	29M/30M
ANALYTE	123.5-125BGS
1,2-DCA	11/5.9
BENZENE	14/11

GS-114	31M/31
ANALYTE	133.5-135 BGS
BENZENE	ND(1)/1.1
CHLOROFORM	NA/0.81J
XYLENE	ND(2)/0.55J

GS-114	34M
ANALYTE	157.5-160 BGS
VOC	ND

GS-114	33M
ANALYTE	177.5-180 BGS
VOC	ND

GS-114	32M/32
ANALYTE	198.5-201 BGS
4-METHYL-2-PENTANONE	ND(1)/8.5J
BENZENE	ND(1)/0.54J
CHLOROFORM	NA/1.1
XYLENE	12/ND(1)



GROUNDWATER SCREENING SAMPLING LOCATION

VOC — VOLATILE ORGANIC COMPOUNDS

29M/30M — SAMPLE AND DUPLICATE SAMPLE VOLUME ANALYZED ON-SITE BY MOBILE GC.

29M/30 — ON-SITE SAMPLE ANALYZED BY MOBILE GC. DUPLICATE SAMPLE VOLUME ANALYZED BY PROJECT LABORATORY

J — ESTIMATED CONCENTRATION

NA — NOT ANALYZED

ND( ) — NOT DETECTED AT THE QUANTITATION LIMIT IN PARENTHESES

NOTE: GROUNDWATER SCREENING SAMPLES COLLECTED IN MARCH 1999

GROUNDWATER SAMPLES COLLECTED FROM MW113/MW114 IN MAY 1999

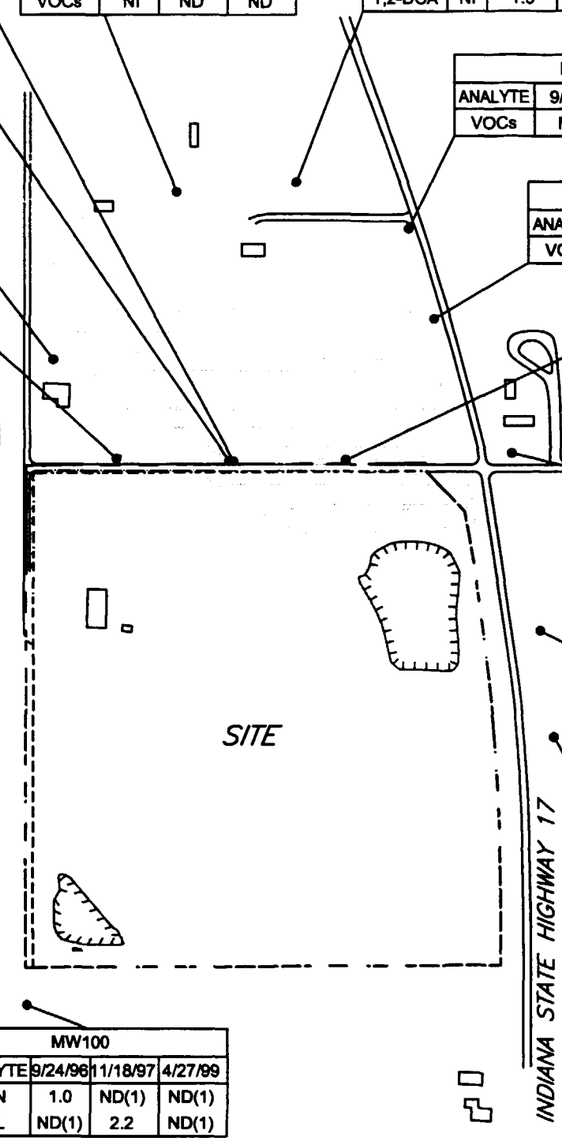
BGS — BELOW GROUND SURFACE

SCALE: HORZ. 1"=400'
VERT. 1"=40'

figure 3.4

VERTICAL DISTRIBUTION OF DETECTED COMPOUNDS IN GROUNDWATER AT MW113/MW114 LOCATIONS
FOUR COUNTY LANDFILL SITE
Fulton County, Landfill

05369-67(026)GN-CO014 SEP 14/2000



MW110			
ANALYTE	9/25/96	11/21/97	5/1/99
VOCs	ND/ND	ND	ND

MW111				
ANALYTE	9/25/96	11/21/97	3/20/98	5/1/99
1,2-DCA	1.3	ND(1)	ND(1.4)U	ND(1)
DCM	ND(1)	ND(1)	1.1J	ND(1)U

MW125			
ANALYTE	9/96	11/19/97	4/29/99
VOCs	NI	ND	ND

MW123				
ANALYTE	9/96	11/19/97	3/20/98	5/2/99
CT	NI	ND(1)	ND(2.5)	2.5
1,2-DCA	NI	1.9	ND(1)	ND(1)

MW121			
ANALYTE	9/96	11/19/97	4/30/99
VOCs	NI	ND	ND

MW127				
ANALYTE	9/96	11/97	3/98	5/1/99
TOL	NI	NI	NI	1.1J

MW119			
ANALYTE	9/96	11/20/97	4/30/99
VOCs	NI	ND	ND

MW113				
ANALYTE	9/25/96	11/21/97	3/20/98	5/2/99
ACE	58J	ND(10)	ND(5)UJ	ND(10)/ND(10)
BEN	3.4J	ND(1)	ND(1)UJ	1.3/1.2
CDS	2.8J	14	19J	ND(1)/ND(1)
CLF	57J	64	66J	83/79
CT	45J	140	96J	340J/340J
1,2-DCA	4.4J	ND(1.1)U	ND(1)UJ	ND(1.3)U/ND(1.1)U
DCM	2.0J	1.1	ND(1)UJ	ND(1)/ND(1)

MW108			
ANALYTE	9/25/96	11/97	4/30/99
BEN	1.3J	NS	ND(1)UJ
1,2-DCA	12J	NS	ND(1)

MW106			
ANALYTE	9/24/96	11/20/97	4/29/99
VOCs	ND	ND	ND

MW116			
ANALYTE	9/24/96	11/97	4/29/99
VOCs	ND	NS	ND

MW104			
ANALYTE	9/24/96	11/97	4/28/99
VOCs	ND	NS	ND

MW118			
ANALYTE	9/23/96	11/18/97	4/27/99
VOCs	ND	ND	ND

MW102			
ANALYTE	9/23/96	11/97	4/28/99
BEN	1.9	NS	ND(1)

MW100			
ANALYTE	9/24/96	11/18/97	4/27/99
BEN	1.0	ND(1)	ND(1)
TOL	ND(1)	2.2	ND(1)

0 200 400ft

LEGEND:

PROPERTY BOUNDARY

RIGHT-OF-WAY BOUNDARY

FENCE LINE

MW100 ● SHALLOW MONITORING WELL LOCATION

MW100		
ANALYTE	9/96	11/97
BEN	1.0	ND(1)

MONITORING WELL IDENTIFIER
SAMPLE DATE
CONCENTRATION (µg/L)
COMPOUND

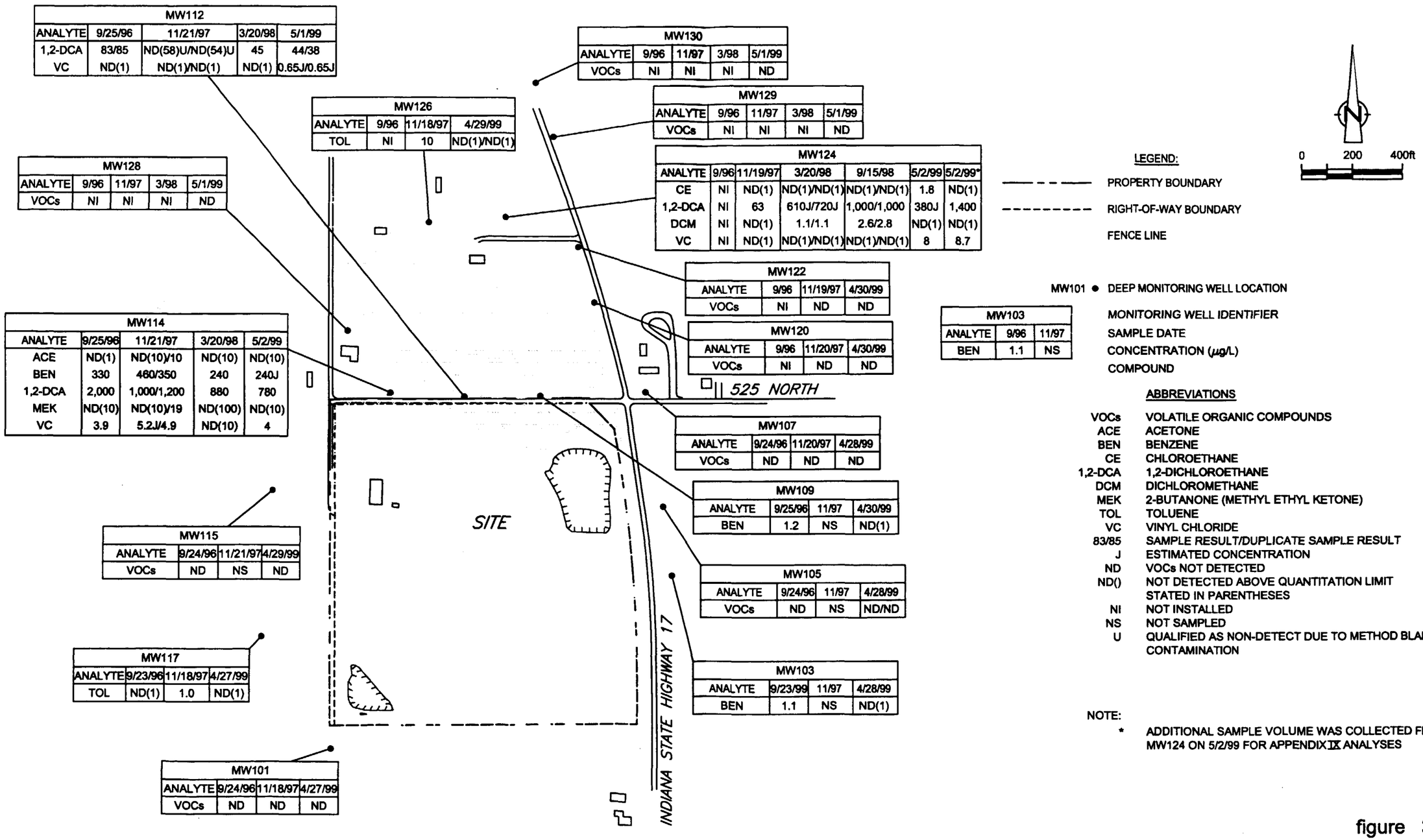
ABBREVIATIONS

VOCs	VOLATILE ORGANIC COMPOUNDS
ACE	ACETONE
BEN	BENZENE
CDS	CARBON DISULFIDE
CLF	CHLOROFORM
CT	CARBON TETRACHLORIDE
1,2-DCA	1,2-DICHLOROETHANE
DCM	DICHLOROMETHANE
TOL	TOLUENE
83/85	SAMPLE RESULT/DUPLICATE SAMPLE RESULT
J	ESTIMATED CONCENTRATION
ND	VOCs NOT DETECTED
ND()	NOT DETECTED ABOVE QUANTITATION LIMIT STATED IN PARENTHESES
NI	NOT INSTALLED
NS	NOT SAMPLED
U	QUALIFIED NON-DETECT DUE TO METHOD BLANK CONTAMINATION

figure 3.5

SUMMARY OF DETECTED VOCs IN GROUNDWATER
SHALLOW OFF-SITE WELL LOCATIONS
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

05369-67(026)GN-CO015 SEP 14/2000



MW112				
ANALYTE	9/25/96	11/21/97	3/20/98	5/1/99
1,2-DCA	83/85	ND(58)U/ND(54)U	45	44/38
VC	ND(1)	ND(1)/ND(1)	ND(1)	0.65J/0.65J

MW130				
ANALYTE	9/96	11/97	3/98	5/1/99
VOCs	NI	NI	NI	ND

MW126			
ANALYTE	9/96	11/18/97	4/29/99
TOL	NI	10	ND(1)/ND(1)

MW129				
ANALYTE	9/96	11/97	3/98	5/1/99
VOCs	NI	NI	NI	ND

MW128				
ANALYTE	9/96	11/97	3/98	5/1/99
VOCs	NI	NI	NI	ND

MW124						
ANALYTE	9/96	11/19/97	3/20/98	9/15/98	5/2/99	5/2/99*
CE	NI	ND(1)	ND(1)/ND(1)	ND(1)/ND(1)	1.8	ND(1)
1,2-DCA	NI	63	610J/720J	1,000/1,000	380J	1,400
DCM	NI	ND(1)	1.1/1.1	2.6/2.8	ND(1)	ND(1)
VC	NI	ND(1)	ND(1)/ND(1)	ND(1)/ND(1)	8	8.7

MW122			
ANALYTE	9/96	11/19/97	4/30/99
VOCs	NI	ND	ND

MW114				
ANALYTE	9/25/96	11/21/97	3/20/98	5/2/99
ACE	ND(1)	ND(10)/10	ND(10)	ND(10)
BEN	330	460/350	240	240J
1,2-DCA	2,000	1,000/1,200	880	780
MEK	ND(10)	ND(10)/19	ND(100)	ND(10)
VC	3.9	5.2J/4.9	ND(10)	4

MW120			
ANALYTE	9/96	11/20/97	4/30/99
VOCs	NI	ND	ND

MW107			
ANALYTE	9/24/96	11/20/97	4/28/99
VOCs	ND	ND	ND

MW109			
ANALYTE	9/25/96	11/97	4/30/99
BEN	1.2	NS	ND(1)

MW115			
ANALYTE	9/24/96	11/21/97	4/29/99
VOCs	ND	NS	ND

MW105			
ANALYTE	9/24/96	11/97	4/28/99
VOCs	ND	NS	ND/ND

MW117			
ANALYTE	9/23/96	11/18/97	4/27/99
TOL	ND(1)	1.0	ND(1)

MW103			
ANALYTE	9/23/99	11/97	4/28/99
BEN	1.1	NS	ND(1)

MW101			
ANALYTE	9/24/96	11/18/97	4/27/99
VOCs	ND	ND	ND

LEGEND:

PROPERTY BOUNDARY

RIGHT-OF-WAY BOUNDARY

FENCE LINE

MW101 ● DEEP MONITORING WELL LOCATION

MW103		
ANALYTE	9/96	11/97
BEN	1.1	NS

MONITORING WELL IDENTIFIER
SAMPLE DATE
CONCENTRATION (µg/L)
COMPOUND

ABBREVIATIONS

VOCs	VOLATILE ORGANIC COMPOUNDS
ACE	ACETONE
BEN	BENZENE
CE	CHLOROETHANE
1,2-DCA	1,2-DICHLOROETHANE
DCM	DICHLOROMETHANE
MEK	2-BUTANONE (METHYL ETHYL KETONE)
TOL	TOLUENE
VC	VINYL CHLORIDE
83/85	SAMPLE RESULT/DUPLICATE SAMPLE RESULT
J	ESTIMATED CONCENTRATION
ND	VOCs NOT DETECTED
ND()	NOT DETECTED ABOVE QUANTITATION LIMIT STATED IN PARENTHESES
NI	NOT INSTALLED
NS	NOT SAMPLED
U	QUALIFIED AS NON-DETECT DUE TO METHOD BLANK CONTAMINATION

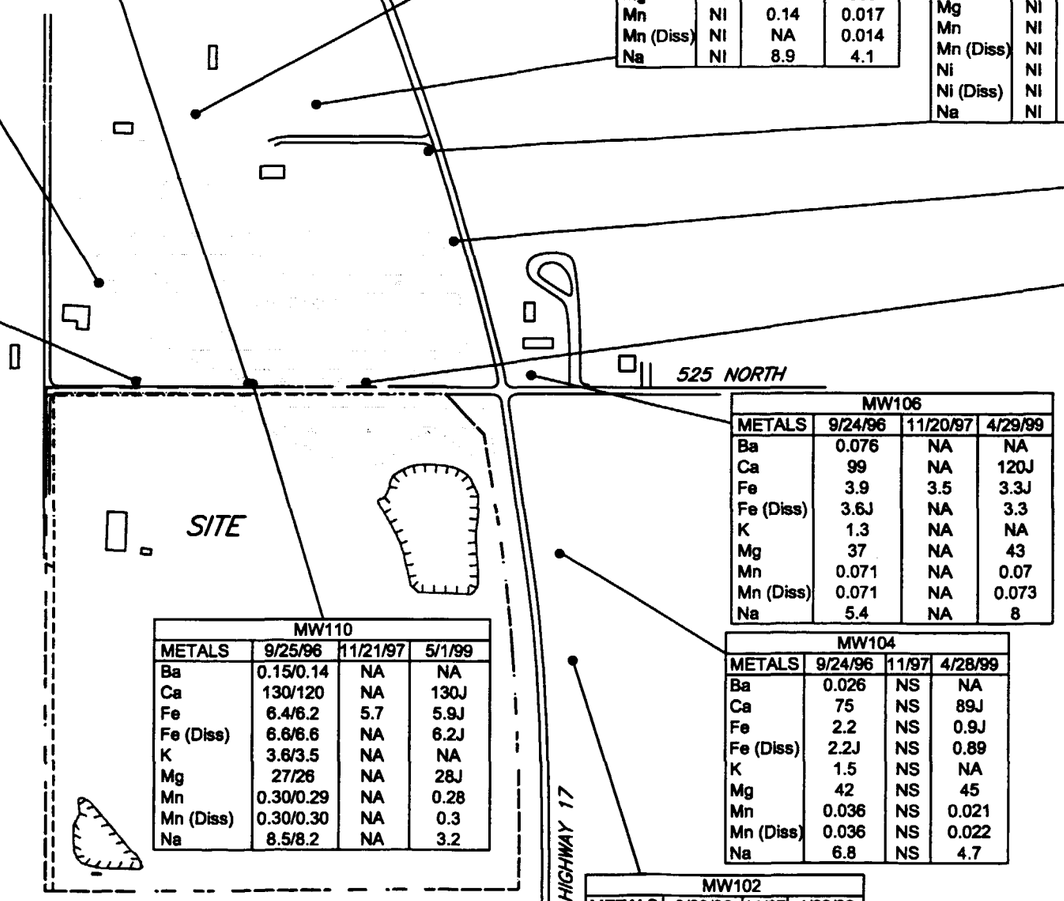
NOTE:

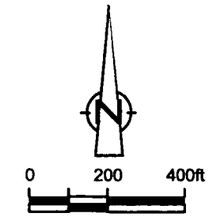
* ADDITIONAL SAMPLE VOLUME WAS COLLECTED FROM MW124 ON 5/2/99 FOR APPENDIX IX ANALYSES

figure 3.6

SUMMARY OF DETECTED VOCs IN GROUNDWATER
DEEP OFF-SITE WELL LOCATIONS
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

05369-67(026)GN-CO016 SEP 14/2000





MW127			
METALS	9/96	11/97	5/1/99
Ca	NI	NI	89J
Fe	NI	NI	1.1J
Fe (Diss)	NI	NI	1J
Mg	NI	NI	34J
Mn	NI	NI	0.24
Mn (Diss)	NI	NI	0.22
Na	NI	NI	17

MW111			
METALS	9/25/96	11/21/97	5/1/99
Ba	0.045	NA	NA
Ca	100	NA	110J
Fe	3.9	1.7	1.3J
Fe (Diss)	3.8	ND(0.10)	1.3J
K	1.9	NA	NA
Mg	37	NA	40J
Mn	0.067	NA	0.046
Mn (Diss)	0.065	NA	0.045
Na	6.0	NA	6.4

MW125			
METALS	9/96	11/19/97	4/29/99
Al	NI	1.7	ND(0.2)
Ba	NI	0.041	NA
Ca	NI	110	120J
Fe	NI	2.4	0.062J
Fe (Diss)	NI	NA	0.035J
K	NI	2.6	NA
Mg	NI	35	33
Mn	NI	0.54	0.94
Mn (Diss)	NI	NA	0.9
Na	NI	6.6	4.6

MW123			
METALS	9/96	11/19/97	5/2/99
Al	NI	0.12	ND(0.2)
Ba	NI	0.030	NA
Ca	NI	91	98J
Fe	NI	ND(0.5)	0.079J
Fe (Diss)	NI	NA	ND(0.05)
K	NI	1.9	NA
Mg	NI	35	38J
Mn	NI	0.14	0.017
Mn (Diss)	NI	NA	0.014
Na	NI	8.9	4.1

MW121			
METALS	9/96	11/19/97	4/30/99
Al	NI	1.3	0.09J
Ba	NI	0.015	NA
Ca	NI	120	78J
Cr	NI	0.026	NA
Fe	NI	2.9	1.4J
Fe (Diss)	NI	NA	0.019J
K	NI	2.7	NA
Mg	NI	46	27
Mn	NI	0.18	0.067
Mn (Diss)	NI	NA	ND(0.01)U
Ni	NI	0.017	NA
Ni (Diss)	NI	NA	NA
Na	NI	15	18

MW119			
METALS	9/96	11/20/97	4/30/99
Al	NI	1.1	ND(0.2)
Ba	NI	0.039	NA
Ca	NI	150	86J
Fe	NI	1.4	0.13J
Fe (Diss)	NI	ND(0.025)	ND(0.05)
K	NI	4.7	NA
Mg	NI	50	27
Mn	NI	0.44	0.0051J
Mn (Diss)	NI	0.12	ND(0.01)
Na	NI	85	21
Pb	NI	0.011	NA

MW108			
METALS	9/25/96	11/97	4/30/99
As	0.0062	NS	NA
Ba	0.069	NS	NA
Ca	93	NS	78J
Fe	25	NS	22J
Fe (Diss)	26	NS	21
K	1.8	NS	NA
Mg	21	NS	18
Mn	0.43	NS	0.38
Mn (Diss)	0.43	NS	0.38
Na	4.7	NS	1.5J

MW113			
METALS	9/25/96	11/21/97	5/2/99
Ba	0.061	NA	NA/NA
Ca	110	NA	130J/140J
Fe	2.8	2.5	1.3J/1.3J
Fe (Diss)	3.0	NA	1.2J/1.3J
K	5.4	NA	NA/NA
Mg	46	NA	45J/46J
Mn	0.38	NA	0.16/0.16
Mn (Diss)	0.40	NA	0.17/0.16
Na	46	NA	37/37

MW116			
METALS	9/24/96	11/97	4/29/99
Al	0.18	NS	ND(0.2)
Ba	0.10	NS	NA
Ca	100	NS	120J
Fe	1.5	NS	0.59J
Fe (Diss)	1.4J	NS	0.63
Mg	42	NS	47
Mn	0.25	NS	0.081
Mn (Diss)	0.24	NS	0.081
K	2.5	NS	NA
Na	22	NS	9.4
Sb	0.042	NS	NA
Sb (Diss)	ND(0.03)	NS	NA

MW118			
METALS	9/23/96	11/18/97	4/27/99
As	ND(0.005)	NA	NA
Ba	0.15	NA	NA
Ca	87	NA	91J
Fe	4.3	2.9	3.1B
Fe (Diss)	4.4	NA	3.2
K	3.5	NA	NA
Mg	40	NA	30
Mn	0.14	NA	0.046
Mn (Diss)	0.14	NA	0.047
Na	4.6	NA	4.7

MW106			
METALS	9/24/96	11/20/97	4/29/99
Ba	0.076	NA	NA
Ca	99	NA	120J
Fe	3.9	3.5	3.3J
Fe (Diss)	3.6J	NA	3.3
K	1.3	NA	NA
Mg	37	NA	43
Mn	0.071	NA	0.07
Mn (Diss)	0.071	NA	0.073
Na	5.4	NA	8

MW110			
METALS	9/25/96	11/21/97	5/1/99
Ba	0.15/0.14	NA	NA
Ca	130/120	NA	130J
Fe	6.4/6.2	5.7	5.9J
Fe (Diss)	6.6/6.6	NA	6.2J
K	3.6/3.5	NA	NA
Mg	27/26	NA	28J
Mn	0.30/0.29	NA	0.28
Mn (Diss)	0.30/0.30	NA	0.3
Na	8.5/8.2	NA	3.2

MW104			
METALS	9/24/96	11/97	4/28/99
Ba	0.026	NS	NA
Ca	75	NS	89J
Fe	2.2	NS	0.9J
Fe (Diss)	2.2J	NS	0.89
K	1.5	NS	NA
Mg	42	NS	45
Mn	0.036	NS	0.021
Mn (Diss)	0.036	NS	0.022
Na	6.8	NS	4.7

MW102			
METALS	9/23/96	11/97	4/28/99
As	0.011	NS	NA
Ba	0.12	NS	NA
Ca	120	NS	140J
Fe	1.9	NS	1.8J
Fe (Diss)	2.0	NS	1.6
K	2.5	NS	NA
Mg	60	NS	65
Mn	0.12	NS	0.11
Mn (Diss)	0.13	NS	0.11
Na	37	NS	67

MW100			
METALS	9/24/96	11/18/97	4/27/99
As	0.0064	NA	NA
Ba	0.10	NA	NA
Ca	90	NA	89J
Fe	2.9	3.2	2.5B
Fe (Diss)	2.6J	NA	2.5
K	2.1	NA	NA
Mg	35	NA	33
Mn	0.081	NA	0.043
Mn (Diss)	0.082	NA	0.042
Na	5.6	NA	5.4

LEGEND:

- PROPERTY BOUNDARY
- RIGHT-OF-WAY BOUNDARY
- FENCE LINE
- MW100 ● SHALLOW MONITORING WELL LOCATION

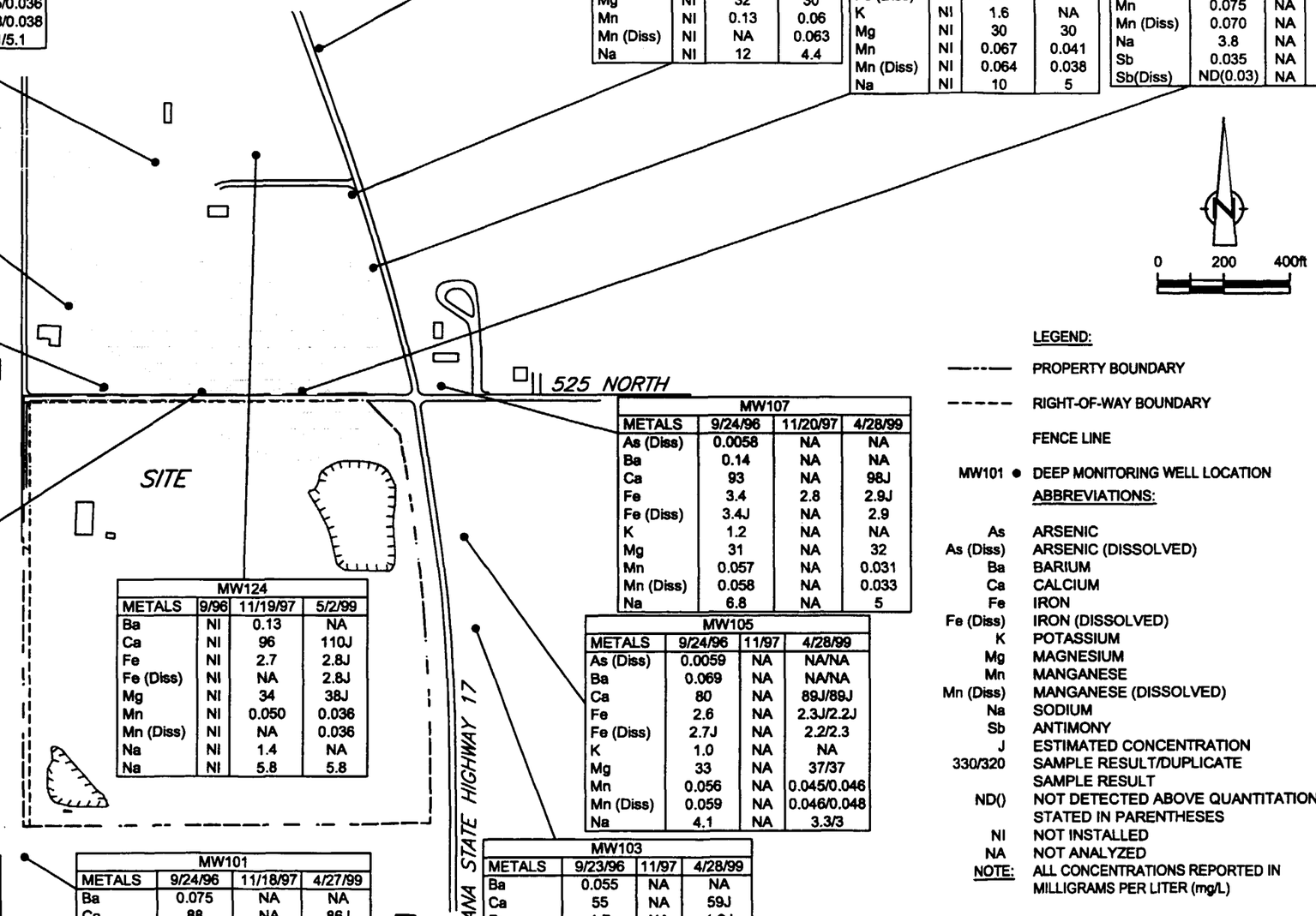
Al	ALUMINUM
As	ARSENIC
Ba	BARIUM
Ca	CALCIUM
Fe	IRON
Fe (Diss)	IRON (DISSOLVED)
K	POTASSIUM
Mg	MAGNESIUM
Mn	MANGANESE
Mn (Diss)	MANGANESE (DISSOLVED)
Na	SODIUM
Ni	NICKEL
Pb	LEAD
Sb	ANTIMONY
J	ESTIMATED CONCENTRATION
U	QUALIFIED AS NON-DETECT DUE TO METHOD BLANK CONTAMINATION
6.6/6.6	SAMPLE RESULT/DUPLICATE SAMPLE RESULT
ND()	NOT DETECTED ABOVE QUANTITATION LIMIT STATED IN PARENTHESES
NI	NOT INSTALLED
NS	NOT SAMPLED
NA	NOT ANALYZED
B	ASSOCIATED VALUE IS ESTIMATED

NOTE: ALL CONCENTRATIONS REPORTED IN MILLIGRAMS PER LITER (mg/L)

figure 3.7

SUMMARY OF METALS IN GROUNDWATER
SHALLOW OFF-SITE WELL LOCATIONS
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

05369-67(026)GN-CO017 SEP 14/2000



MW128			
METALS	9/96	11/97	5/1/99
Ca	NI	NI	90
Fe	NI	NI	2.5J
Fe (Diss)	NI	NI	2.6J
Mg	NI	NI	30J
Mn	NI	NI	0.066J
Mn (Diss)	NI	NI	0.071J
Na	NI	NI	7.9J

MW126			
METALS	9/96	11/18/97	4/29/99
As	NI	0.010	NA/NA
Ba	NI	0.15	NA/NA
Ca	NI	95	100J/100J
Fe	NI	3.3	2.6J/2.6J
Fe (Diss)	NI	NA	2.5/2.7
K	NI	1.5	NA/NA
Mg	NI	34	33/35
Mn	NI	0.084	0.035/0.036
Mn (Diss)	NI	NA	0.038/0.038
Na	NI	7.6	5.1/5.1

MW130			
METALS	9/96	11/97	5/1/99
Ca	NI	NI	97J
Fe	NI	NI	4.4J
Fe (Diss)	NI	NI	4.6J
Mg	NI	NI	35J
Mn	NI	NI	0.061
Mn (Diss)	NI	NI	0.06
Na	NI	NI	5.4

MW129			
METALS	9/96	11/97	5/1/99
Ca	NI	NI	90J
Fe	NI	NI	4.8J
Fe (Diss)	NI	NI	4.8J
Mg	NI	NI	36J
Mn	NI	NI	0.051
Mn (Diss)	NI	NI	0.05
Na	NI	NI	14

MW122			
METALS	9/96	11/19/97	4/30/99
Ba	NI	0.068	NA
Ca	NI	90	93J
Fe	NI	3.6	3.7J
Fe (Diss)	NI	NA	3.7
K	NI	1.6	NA
Mg	NI	32	30
Mn	NI	0.13	0.06
Mn (Diss)	NI	NA	0.063
Na	NI	12	4.4

MW120			
METALS	9/96	11/20/97	4/30/99
Ba	NI	0.13	NA
Ca	NI	86	98J
Fe	NI	2.9	3.2J
Fe (Diss)	NI	2.5	3
K	NI	1.6	NA
Mg	NI	30	30
Mn	NI	0.067	0.041
Mn (Diss)	NI	0.064	0.038
Na	NI	10	5

MW109			
METALS	9/25/96	11/97	4/30/99
As (Diss)	0.0051	NA	NA
Ba	0.046	NA	NA
Ca	92	NA	87J
Fe	4.4	NA	3J
Fe (Diss)	4.2	NA	3.1
K	0.94	NA	NA
Mg	36	NA	34
Mn	0.075	NA	0.054
Mn (Diss)	0.070	NA	0.054
Na	3.8	NA	2.9
Sb	0.035	NA	NA
Sb(Diss)	ND(0.03)	NA	NA

MW114			
METALS	9/25/96	11/21/97	5/2/99
Ba	0.047	NA	NA
Ca	97	NA	100J
Fe	2.7	2.5	2.7J
Fe (Diss)	2.9	NA	2.6J
K	1.0	NA	NA
Mg	34	NA	39J
Mn	0.043	NA	0.042
Mn (Diss)	0.045	NA	0.041
Na	4.2	NA	3.8

MW115			
METALS	9/24/96	11/21/97	5/2/99
Ba	0.12	NS	NA
Ca	95	NS	110J
Fe	4.3	NS	3.4J
Fe (Diss)	4.4J	NS	3.4
K	1.1	NS	NA
Mg	32	NS	34
Mn	0.057	NS	0.04
Mn (Diss)	0.057	NS	0.041
Na	5.3	NS	5.2

MW112			
METALS	9/25/96	11/21/97	5/1/99
As	0.008/0.0074	NA/NA	NA/NA
As (Diss)	0.011/0.0084	NA/NA	NA/NA
Ba	0.12/0.12	NA/NA	NA/NA
Ca	98/96	NA/NA	100J/100J
Fe	3.3/3.2	3.2/3.3	3.5J/3.4J
Fe (Diss)	3.5/3.1	NA/NA	3.6J/3.5J
K	0.99/0.95	NA/NA	NA/NA
Mg	31/31	NA/NA	36J/35J
Mn	0.039/0.038	NA/NA	0.039/0.038
Mn (Diss)	0.040/0.034	NA/NA	0.041/0.041
Na	6.1/5.9	NA/NA	5.8/5.5

MW124			
METALS	9/96	11/19/97	5/2/99
Ba	NI	0.13	NA
Ca	NI	96	110J
Fe	NI	2.7	2.8J
Fe (Diss)	NI	NA	2.8J
Mg	NI	34	38J
Mn	NI	0.050	0.036
Mn (Diss)	NI	NA	0.036
Na	NI	1.4	NA
Na	NI	5.8	5.8

MW107			
METALS	9/24/96	11/20/97	4/28/99
As (Diss)	0.0058	NA	NA
Ba	0.14	NA	NA
Ca	93	NA	98J
Fe	3.4	2.8	2.9J
Fe (Diss)	3.4J	NA	2.9
K	1.2	NA	NA
Mg	31	NA	32
Mn	0.057	NA	0.031
Mn (Diss)	0.058	NA	0.033
Na	6.8	NA	5

MW105			
METALS	9/24/96	11/97	4/28/99
As (Diss)	0.0059	NA	NA/NA
Ba	0.069	NA	NA/NA
Ca	80	NA	89J/89J
Fe	2.6	NA	2.3J/2.2J
Fe (Diss)	2.7J	NA	2.2/2.3
K	1.0	NA	NA
Mg	33	NA	37/37
Mn	0.056	NA	0.045/0.046
Mn (Diss)	0.059	NA	0.046/0.048
Na	4.1	NA	3.3/3

MW117			
METALS	9/23/96	11/18/97	4/27/99
Ba	0.11	NA	NA
Ca	88	NA	99J
Fe	4.0	3.0	2.3B
Fe (Diss)	4.1	NA	2.3
K	1.1	NA	NA
Mg	30	NA	41
Mn	0.064	NA	0.025
Mn (Diss)	0.065	NA	0.027
Na	5.2	NA	7

MW101			
METALS	9/24/96	11/18/97	4/27/99
Ba	0.075	NA	NA
Ca	88	NA	86J
Fe	3.0	5.3	2.6B
Fe (Diss)	3.0J	NA	2.7
K	1.1	NA	NA
Mg	30	NA	28
Mn	0.075	NA	0.066
Mn (Diss)	0.075	NA	0.07
Na	3.6	NA	3

MW103			
METALS	9/23/96	11/97	4/28/99
Ba	0.055	NA	NA
Ca	55	NA	59J
Fe	1.7	NA	1.9J
Fe (Diss)	1.7	NA	1.8
K	3.6	NA	NA
Mg	48	NA	52
Mn	0.033	NA	0.029
Mn (Diss)	0.033	NA	0.029
Na	7.0	NA	6

LEGEND:

PROPERTY BOUNDARY

RIGHT-OF-WAY BOUNDARY

FENCE LINE

MW101 ● DEEP MONITORING WELL LOCATION

ABBREVIATIONS:

As	ARSENIC
As (Diss)	ARSENIC (DISSOLVED)
Ba	BARIUM
Ca	CALCIUM
Fe	IRON
Fe (Diss)	IRON (DISSOLVED)
K	POTASSIUM
Mg	MAGNESIUM
Mn	MANGANESE
Mn (Diss)	MANGANESE (DISSOLVED)
Na	SODIUM
Sb	ANTIMONY
J	ESTIMATED CONCENTRATION
330/320	SAMPLE RESULT/DUPLICATE SAMPLE RESULT
ND()	NOT DETECTED ABOVE QUANTITATION LIMIT STATED IN PARENTHESES
NI	NOT INSTALLED
NA	NOT ANALYZED
NOTE:	ALL CONCENTRATIONS REPORTED IN MILLIGRAMS PER LITER (mg/L)

figure 3.8

SUMMARY OF METALS IN GROUNDWATER
DEEP-OFF SITE WELL LOCATIONS
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

05369-67(026)GN-CO018 SEP 14/2000

MW127			
COMPOUNDS	9/96	11/97	5/1/99
ALKALINITY	NI	NI	340J
CHLORIDE	NI	NI	3.8
HARDNESS	NI	NI	360
NITRATE	NI	NI	ND(0.1)
NITRITE	NI	NI	ND(0.1)
SULFATE	NI	NI	29.4
SULFIDE	NI	NI	ND(1)
TDS	NI	NI	350
TSS	NI	NI	ND(5)
DOC	NI	NI	ND(1)

MW111			
COMPOUNDS	9/25/96	11/21/97	5/1/99
ALKALINITY	340	350	330
CHLORIDE	12	14	20
HARDNESS	NA	NA	430
NITRATE	ND(0.01)	ND(0.01)U	ND(0.1)
NITRITE	NA	NA	ND(0.1)
SULFATE	82	59	59.6
SULFIDE	NA	ND(1)	ND(1)
TDS	460	450	1,200
TSS	10	8	11
TOC	NA	ND(2.1)U	NA
DOC	NA	ND(1.2)U	ND(1.3)U

MW125			
COMPOUNDS	9/96	11/19/97	4/29/99
ALKALINITY	NI	400	350
CHLORIDE	NI	8.7	9.5
HARDNESS	NI	NA	430
NITRATE	NI	0.38	0.0401J
NITRITE	NI	NA	ND(0.1)
SULFATE	NI	29	18.5
SULFIDE	NI	ND(1.0)	ND(1)
TDS	NI	400	410
TSS	NI	7	ND(5)
TOC	NI	4.2	NA
DOC	NI	4.8	ND(5.5)U

MW123			
COMPOUNDS	9/96	11/19/97	5/2/99
ALKALINITY	NI	340	360
CHLORIDE	NI	4.1	4.75
HARDNESS	NI	NA	400
NITRATE	NI	0.24	0.0324J
NITRITE	NI	NA	ND(0.1)
SULFATE	NI	38	33.3
SULFIDE	NI	ND(1.0)	ND(1)
TDS	NI	390	370
TSS	NI	6	ND(5)
TOC	NI	ND(1.0)	NA
DOC	NI	ND(1.0)	ND(1.3)U

MW121			
COMPOUNDS	9/96	11/19/97	4/30/99
ALKALINITY	NI	300	230
CHLORIDE	NI	45	26
HARDNESS	NI	NA	310
NITRATE	NI	1.2	0.395
NITRITE	NI	NA	0.0378J
SULFATE	NI	41	23.6
SULFIDE	NI	ND(1.0)	ND(1.5)U
TDS	NI	420	320
TSS	NI	270	ND(8.8)U
TOC	NI	1.8	NA
DOC	NI	1.7	ND(2.7)U

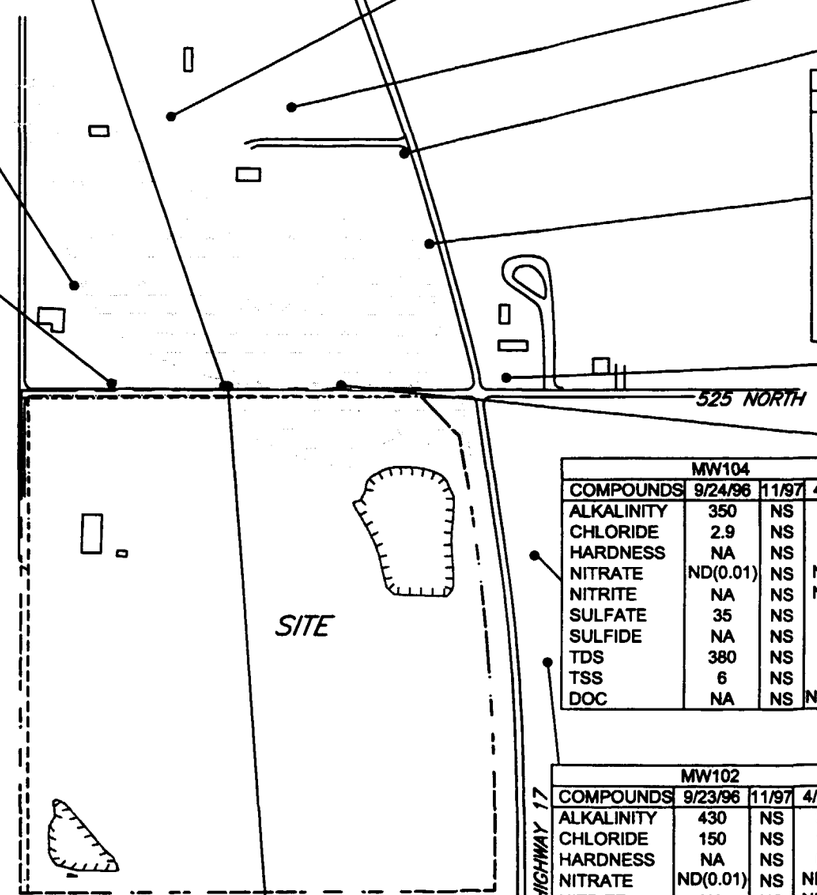
0 200 400ft

MW113			
COMPOUNDS	9/25/96	11/21/97	5/2/99
ALKALINITY	380	420	420/430
CHLORIDE	94	87	68.5/67.5
HARDNESS	NA	NA	520/530
NITRATE	0.02	0.03J	0.0959J/0.0955J
NITRITE	NA	NA	ND(0.1)/ND(0.1)
SULFATE	83	81	88.9/88
SULFIDE	NA	ND(1.0)	ND(1)/ND(1)
TDS	670	650	620/640
TSS	8	10	ND(5)/ND(5)
TOC	NA	ND(1.8)U	NA/NA
DOC	NA	ND(1.6)U	ND(1.6)U/ND(1.6)U

MW119			
COMPOUNDS	9/96	11/20/97	4/30/99
ALKALINITY	NI	380	290
CHLORIDE	NI	200	49
HARDNESS	NI	NA	320
NITRATE	NI	ND(0.01)UJ	ND(0.1)
NITRITE	NI	NA	ND(0.1)
SULFATE	NI	29	20.1
SULFIDE	NI	ND(1.0)	ND(1)
TDS	NI	680	360
TSS	NI	690	ND(5)
TOC	NI	ND(1.0)	NA
DOC	NI	ND(1.0)	ND(1.7)U

MW106			
COMPOUNDS	9/24/96	11/20/97	4/29/99
ALKALINITY	330	340	340
CHLORIDE	16	52	47
HARDNESS	NA	NA	470
NITRATE	ND(0.01)	ND(0.01)UJ	ND(0.1)
NITRITE	NA	NA	ND(0.1)
SULFATE	62	54	51.8
SULFIDE	NA	ND(1.0)	ND(1)
TDS	440	470	510
TSS	10	8	ND(8)U
TOC	NA	ND(1.0)	NA
DOC	NA	1.6	ND(1.8)U

MW116			
COMPOUNDS	9/24/96	11/97	4/29/99
ALKALINITY	410	NS	410
CHLORIDE	5.9	NS	ND(2.5)U
HARDNESS	NA	NS	480
NITRATE	ND(0.01)	NS	ND(0.1)
NITRITE	NA	NS	ND(0.1)
SULFATE	45	NS	43.7
SULFIDE	NA	NS	ND(1)
TDS	470	NS	460
TSS	29	NS	ND(5)
DOC	NA	NS	ND(1.1)U



MW108			
COMPOUNDS	9/25/96	11/97	4/30/99
ALKALINITY	300	NS	230
CHLORIDE	19	NS	29
HARDNESS	NA	NS	270
NITRATE	ND(0.01)	NS	ND(0.1)
NITRITE	NA	NS	0.0579J
SULFATE	ND(5.0)	NS	16.7
SULFIDE	NA	NS	ND(1)
TDS	360	NS	310
TSS	59	NS	ND(52)U
DOC	NA	NS	13

MW104			
COMPOUNDS	9/24/96	11/97	4/28/99
ALKALINITY	350	NS	300
CHLORIDE	2.9	NS	5.2
HARDNESS	NA	NS	410
NITRATE	ND(0.01)	NS	ND(0.1)
NITRITE	NA	NS	ND(0.1)
SULFATE	35	NS	42.5
SULFIDE	NA	NS	ND(1)
TDS	380	NS	410
TSS	6	NS	ND(5)
DOC	NA	NS	ND(1.2)U

MW118			
COMPOUNDS	9/23/96	11/18/97	4/27/99
ALKALINITY	360	400	300
CHLORIDE	6.0	5.1	3.8
HARDNESS	NA	NA	350
NITRATE	ND(0.01)	ND(0.01)	ND(0.1)
NITRITE	NA	NA	ND(0.1)
SULFATE	40	31	59.1
SULFIDE	NA	ND(1.0)	1.3
TDS	440	400	410
TSS	34	16	ND(5)
DOC	NA	1.2	ND(1.9)U

MW102			
COMPOUNDS	9/23/96	11/97	4/28/99
ALKALINITY	430	NS	390
CHLORIDE	150	NS	180
HARDNESS	NA	NS	610
NITRATE	ND(0.01)	NS	ND(0.1)
NITRITE	NA	NS	ND(0.1)
SULFATE	35	NS	25.7
SULFIDE	NA	NS	1.2
TDS	690	NS	730
TSS	20	NS	ND(5)
DOC	NA	NS	ND(3.1)U

MW100			
COMPOUNDS	9/24/96	11/18/97	4/27/99
ALKALINITY	330	340	330
CHLORIDE	3.6	4.6	3.5
HARDNESS	NA	NA	360
NITRATE	ND(0.16)U	ND(0.10)	ND(0.1)
NITRITE	NA	NA	ND(0.1)
SULFATE	56	48	46.6
SULFIDE	NA	ND(0.01)	1.6
TDS	400	370	420
TSS	13	62	ND(5)
TOC	NA	1.7	NA
DOC	NA	1.2	ND(1.6)U

MW110			
COMPOUNDS	9/25/96	11/21/97	5/1/99
ALKALINITY	430/420	420	430J
CHLORIDE	8.5/8.6	9.8	6.5
HARDNESS	NA	NA	430
NITRATE	ND(0.01)/ND(0.01)	ND(0.01)UJ	ND(0.1)
NITRITE	NA	NA	ND(0.1)
SULFATE	21/21	14	18.2
SULFIDE	NA	ND(1.0)	ND(1)
TDS	490/490	500	470
TSS	16/17	20	15
TOC	NA	15	NA
DOC	NA	15	14

LEGEND:

- PROPERTY BOUNDARY
- RIGHT-OF-WAY BOUNDARY
- FENCE LINE
- MW100 ● SHALLOW MONITORING WELL LOCATION AND IDENTIFIER

ABBREVIATIONS:

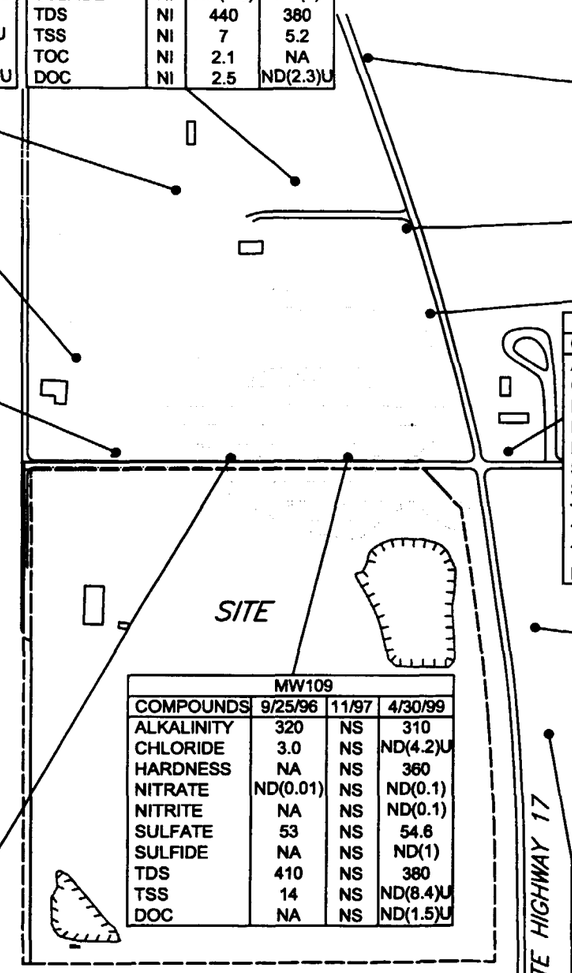
- TDS TOTAL DISSOLVED SOLIDS
- TSS TOTAL SUSPENDED SOLIDS
- TOC TOTAL ORGANIC CARBON
- DOC DISSOLVED ORGANIC CARBON
- NA NOT ANALYZED
- NI NOT INSTALLED
- NS NOT SAMPLED
- ND COMPOUND NOT DETECTED AT THE QUANTITATION LIMIT SHOWN IN PARENTHESES
- 430/420 SAMPLE RESULT/DUPLICATE SAMPLE RESULT
- J ESTIMATED CONCENTRATION
- U QUALIFIED NON-DETECT DUE TO METHOD BLANK CONTAMINATION

NOTE: ALL CONCENTRATIONS REPORTED IN MILLIGRAMS PER LITER (mg/L)

figure 3.9

SUMMARY OF GENERAL CHEMISTRY PARAMETERS IN GROUNDWATER
SHALLOW OFF-SITE WELL LOCATIONS
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

05369-67(026)GN-CO019 SEP 14/2000



MW126			
COMPOUNDS	9/96	11/18/97	4/29/99
ALKALINITY	NI	360	340/340
CHLORIDE	NI	4.0	ND(3.2)U/ND(2.5)U
HARDNESS	NI	NA	390/400
NITRATE	NI	ND(0.01)	ND(0.1)/ND(0.1)
NITRITE	NI	NA	ND(0.1)/ND(0.1)
SULFATE	NI	36	35.6/36
SULFIDE	NI	ND(1.0)	ND(11)/ND(2.5)U
TDS	NI	380	410/390
TSS	NI	11	ND(5)/ND(5.2)U
TOC	NI	1.8	NA/NA
DOC	NI	2.1	ND(1.8)U/ND(2)U

MW124			
COMPOUNDS	9/96	11/19/97	5/2/99
ALKALINITY	NI	350	360
CHLORIDE	NI	14	13.8
HARDNESS	NI	NA	420
NITRATE	NI	ND(0.01)	ND(0.1)
NITRITE	NI	NA	ND(0.1)
SULFATE	NI	39	48.1
SULFIDE	NI	ND(1.0)	ND(1)
TDS	NI	440	380
TSS	NI	7	5.2
TOC	NI	2.1	NA
DOC	NI	2.5	ND(2.3)U

MW130			
COMPOUNDS	9/96	11/97	5/1/99
ALKALINITY	NI	NI	350J
CHLORIDE	NI	NI	3.8
HARDNESS	NI	NI	390
NITRATE	NI	NI	ND(0.1)
NITRITE	NI	NI	ND(0.1)
SULFATE	NI	NI	42.3
SULFIDE	NI	NI	ND(1)
TDS	NI	NI	400
TSS	NI	NI	8
DOC	NI	NI	ND(1.8)U

MW128			
COMPOUNDS	9/96	11/97	5/1/99
ALKALINITY	NI	NI	300J
CHLORIDE	NI	NI	3.5
HARDNESS	NI	NI	350
NITRATE	NI	NI	ND(0.1)
NITRITE	NI	NI	ND(0.1)
SULFATE	NI	NI	48
SULFIDE	NI	NI	ND(1)
TDS	NI	NI	380
TSS	NI	NI	6
DOC	NI	NI	ND(2.2)U

MW129			
COMPOUNDS	9/96	11/97	5/1/99
ALKALINITY	NI	NI	340J
CHLORIDE	NI	NI	12
HARDNESS	NI	NI	370
NITRATE	NI	NI	ND(0.1)
NITRITE	NI	NI	ND(0.1)
SULFATE	NI	NI	42.9
SULFIDE	NI	NI	ND(1)
TDS	NI	NI	400
TSS	NI	NI	7.2
DOC	NI	NI	ND(2.7)U

MW122			
COMPOUNDS	9/96	11/19/97	4/30/99
ALKALINITY	NI	320	280
CHLORIDE	NI	6.6	ND(5.5)U
HARDNESS	NI	NA	350
NITRATE	NI	ND(0.01)	ND(0.1)
NITRITE	NI	NA	ND(0.1)
SULFATE	NI	47	44.2
SULFIDE	NI	ND(1.0)	ND(2.2)U
TDS	NI	400	380
TSS	NI	6	ND(30)U
TOC	NI	2.3	NA
DOC	NI	2.4	ND(2.9)U

MW114			
COMPOUNDS	9/25/96	11/21/97	5/2/99
ALKALINITY	340	350/350	340
CHLORIDE	12	12/12	12
HARDNESS	NA	NA/NA	420
NITRATE	ND(0.01)	ND(0.01)UJ/ND(0.01)UJ	ND(0.1)
NITRITE	NA	NA/NA	ND(0.1)
SULFATE	48	40/41	54.2
SULFIDE	NA	ND(1.0)/ND(1.0)	ND(1)
TDS	430	430/430	420
TSS	5	15/8	ND(5)
DOC	NA	ND(1.0)/ND(1.0)	ND(1.4)U

MW120			
COMPOUNDS	9/96	11/20/97	4/30/99
ALKALINITY	NI	340	330
CHLORIDE	NI	3.9	ND(3.5)U
HARDNESS	NI	NA	370
NITRATE	NI	ND(0.01)UJ	ND(0.1)
NITRITE	NI	NA	ND(0.1)
SULFATE	NI	40	31.9
SULFIDE	NI	ND(1.0)	ND(1)
TDS	NI	360	320
TSS	NI	7	ND(6)U
TOC	NI	2.7	NA
DOC	NI	2.8	ND(2.1)U

MW107			
COMPOUNDS	9/24/96	11/20/97	4/28/99
ALKALINITY	330	330	270
CHLORIDE	3.1	3.1	3.8
HARDNESS	NA	NA	380
NITRATE	ND(0.01)	ND(0.01)	ND(0.1)
NITRITE	NA	NA	ND(0.1)
SULFATE	40	44	43.9
SULFIDE	NA	ND(1)	ND(1)
TDS	390	400	400
TSS	9	7	ND(5)
TOC	NA	1.6	NA
DOC	NA	2.0	ND(2)U

MW115			
COMPOUNDS	9/24/96	11/97	4/29/99
ALKALINITY	320	NS	300
CHLORIDE	2.8	NS	ND(3.8)U
HARDNESS	NA	NS	400
NITRATE	ND(0.01)	NS	ND(0.1)
NITRITE	NA	NS	ND(0.1)
SULFATE	58	NS	49.5
SULFIDE	NA	NS	ND(1)
TDS	420	NS	420
TSS	13	NS	ND(8.4)U
DOC	NA	NS	ND(2)U

MW105			
COMPOUNDS	9/24/96	11/97	4/28/99
ALKALINITY	290	NS	270/260
CHLORIDE	3.8	NS	3.8/4.5
HARDNESS	NA	NS	370/370
NITRATE	ND(0.01)	NS	ND(0.1)/ND(0.1)
NITRITE	NA	NS	ND(0.1)/ND(0.1)
SULFATE	60	NS	55.5/55.6
SULFIDE	NA	NS	ND(1)/1.6
TDS	340	NS	380/370
TSS	7	NS	ND(5)/ND(5)
DOC	NA	NS	ND(1.7)U/ND(2.2)U

MW109			
COMPOUNDS	9/25/96	11/97	4/30/99
ALKALINITY	320	NS	310
CHLORIDE	3.0	NS	ND(4.2)U
HARDNESS	NA	NS	360
NITRATE	ND(0.01)	NS	ND(0.1)
NITRITE	NA	NS	ND(0.1)
SULFATE	53	NS	54.6
SULFIDE	NA	NS	ND(1)
TDS	410	NS	380
TSS	14	NS	ND(8.4)U
DOC	NA	NS	ND(1.5)U

MW117			
COMPOUNDS	9/23/96	11/18/97	4/27/99
ALKALINITY	280	300	410
CHLORIDE	4.7	4.5	1.5
HARDNESS	NA	NA	410
NITRATE	ND(0.01)	ND(0.01)	ND(0.1)
NITRITE	NA	NA	ND(0.1)
SULFATE	54	46	30.1
SULFIDE	NA	ND(1.0)	1.4
TDS	410	360	460
TSS	19	12	ND(5)
DOC	NA	1.4	ND(1.4)U

MW103			
COMPOUNDS	9/23/96	11/97	4/28/99
ALKALINITY	300	NS	290
CHLORIDE	14	NS	13
HARDNESS	NA	NS	360
NITRATE	ND(0.01)	NS	ND(0.1)
NITRITE	NA	NS	ND(0.1)
SULFATE	41	NS	37.1
SULFIDE	NA	NS	2
TDS	380	NS	440
TSS	7	NS	ND(5)
DOC	NA	NS	ND(1.3)U

MW112			
COMPOUNDS	9/25/96	11/21/97	5/1/99
ALKALINITY	330/330	330/320	330J/330J
CHLORIDE	5.6/5.3	5.5/5.4	8.5/8.8
HARDNESS	NA	NA	410/400
NITRATE	ND(0.01)/ND(0.01)	ND(0.01)UJ/ND(0.01)UJ	ND(0.01)/ND(0.01)
NITRITE	NA	NA	ND(0.01)/ND(0.01)
SULFATE	53/56	45/45	52.4/52.7
SULFIDE	NA	ND(1.0)/ND(1.0)	ND(1)/ND(1)
TDS	440/420	390/410	400/390
TSS	11/6	8/6	ND(5)/8.8
TOC	NA	ND(2.3)U/ND(2.4)U	ND(1.9)U/ND(1.9)U
DOC	NA	ND(2.3)U/NA	ND(1.9)U/ND(1.9)U

MW101			
COMPOUNDS	9/24/96	11/18/97	4/27/99
ALKALINITY	270	270	260
CHLORIDE	7.1	7.3	6
HARDNESS	NA	NA	330
NITRATE	ND(0.01)	ND(0.01)	ND(0.1)
NITRITE	NA	NA	ND(0.1)
SULFATE	82	74	71.8
SULFIDE	NA	ND(0.01)	ND(1)
TDS	420	350	400
TSS	7	10	ND(5)
TOC	NA	2.8	NA
DOC	NA	2.0	ND(2.1)U

LEGEND:

PROPERTY BOUNDARY
RIGHT-OF-WAY BOUNDARY
FENCE LINE
MW101 ● DEEP MONITORING WELL LOCATION AND IDENTIFIER

ABBREVIATIONS:

TDS TOTAL DISSOLVED SOLIDS
TSS TOTAL ORGANIC CARBON
TOC TOTAL ORGANIC CARBON
DOC DISSOLVED ORGANIC CARBON
NA NOT ANALYZED
NI NOT INSTALLED
NS NOT SAMPLED
ND COMPOUND NOT DETECTED AT THE QUANTITATION LIMIT SHOWN IN PARENTHESES
8.5/8.8 SAMPLE RESULT/DUPLICATE SAMPLE RESULT
U QUALIFIED AS NON-DETECT DUE TO METHOD BLANK CONTAMINATION
J ESTIMATED CONCENTRATION

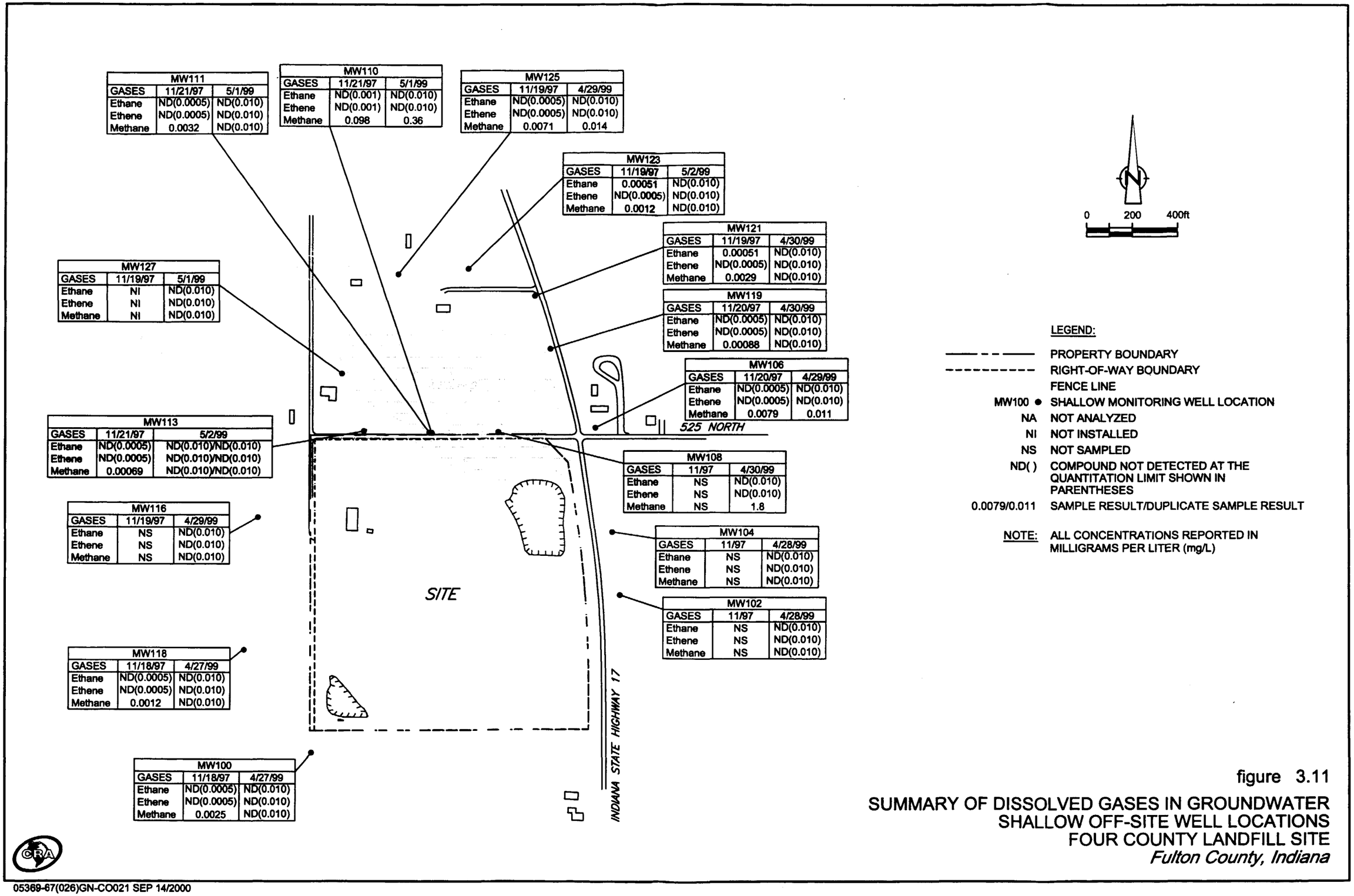
NOTE: ALL CONCENTRATIONS REPORTED IN MILLIGRAMS PER LITER (mg/L)

figure 3.10

SUMMARY OF GENERAL CHEMISTRY PARAMETERS IN GROUNDWATER
DEEP-OFF SITE WELL LOCATIONS
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

CRA

05369-67(026)GN-CO020 SEP 14/2000



MW111		
GASES	11/21/97	5/1/99
Ethane	ND(0.0005)	ND(0.010)
Ethene	ND(0.0005)	ND(0.010)
Methane	0.0032	ND(0.010)

MW110		
GASES	11/21/97	5/1/99
Ethane	ND(0.001)	ND(0.010)
Ethene	ND(0.001)	ND(0.010)
Methane	0.098	0.36

MW125		
GASES	11/19/97	4/29/99
Ethane	ND(0.0005)	ND(0.010)
Ethene	ND(0.0005)	ND(0.010)
Methane	0.0071	0.014

MW123		
GASES	11/19/97	5/2/99
Ethane	0.00051	ND(0.010)
Ethene	ND(0.0005)	ND(0.010)
Methane	0.0012	ND(0.010)

MW121		
GASES	11/19/97	4/30/99
Ethane	0.00051	ND(0.010)
Ethene	ND(0.0005)	ND(0.010)
Methane	0.0029	ND(0.010)

MW127		
GASES	11/19/97	5/1/99
Ethane	NI	ND(0.010)
Ethene	NI	ND(0.010)
Methane	NI	ND(0.010)

MW119		
GASES	11/20/97	4/30/99
Ethane	ND(0.0005)	ND(0.010)
Ethene	ND(0.0005)	ND(0.010)
Methane	0.00088	ND(0.010)

MW106		
GASES	11/20/97	4/29/99
Ethane	ND(0.0005)	ND(0.010)
Ethene	ND(0.0005)	ND(0.010)
Methane	0.0079	0.011

MW113		
GASES	11/21/97	5/2/99
Ethane	ND(0.0005)	ND(0.010)/ND(0.010)
Ethene	ND(0.0005)	ND(0.010)/ND(0.010)
Methane	0.00069	ND(0.010)/ND(0.010)

MW108		
GASES	11/97	4/30/99
Ethane	NS	ND(0.010)
Ethene	NS	ND(0.010)
Methane	NS	1.8

MW116		
GASES	11/19/97	4/29/99
Ethane	NS	ND(0.010)
Ethene	NS	ND(0.010)
Methane	NS	ND(0.010)

MW104		
GASES	11/97	4/28/99
Ethane	NS	ND(0.010)
Ethene	NS	ND(0.010)
Methane	NS	ND(0.010)

MW102		
GASES	11/97	4/28/99
Ethane	NS	ND(0.010)
Ethene	NS	ND(0.010)
Methane	NS	ND(0.010)

MW118		
GASES	11/18/97	4/27/99
Ethane	ND(0.0005)	ND(0.010)
Ethene	ND(0.0005)	ND(0.010)
Methane	0.0012	ND(0.010)

MW100		
GASES	11/18/97	4/27/99
Ethane	ND(0.0005)	ND(0.010)
Ethene	ND(0.0005)	ND(0.010)
Methane	0.0025	ND(0.010)

figure 3.11

SUMMARY OF DISSOLVED GASES IN GROUNDWATER
SHALLOW OFF-SITE WELL LOCATIONS
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

05369-67(026)GN-CO021 SEP 14/2000

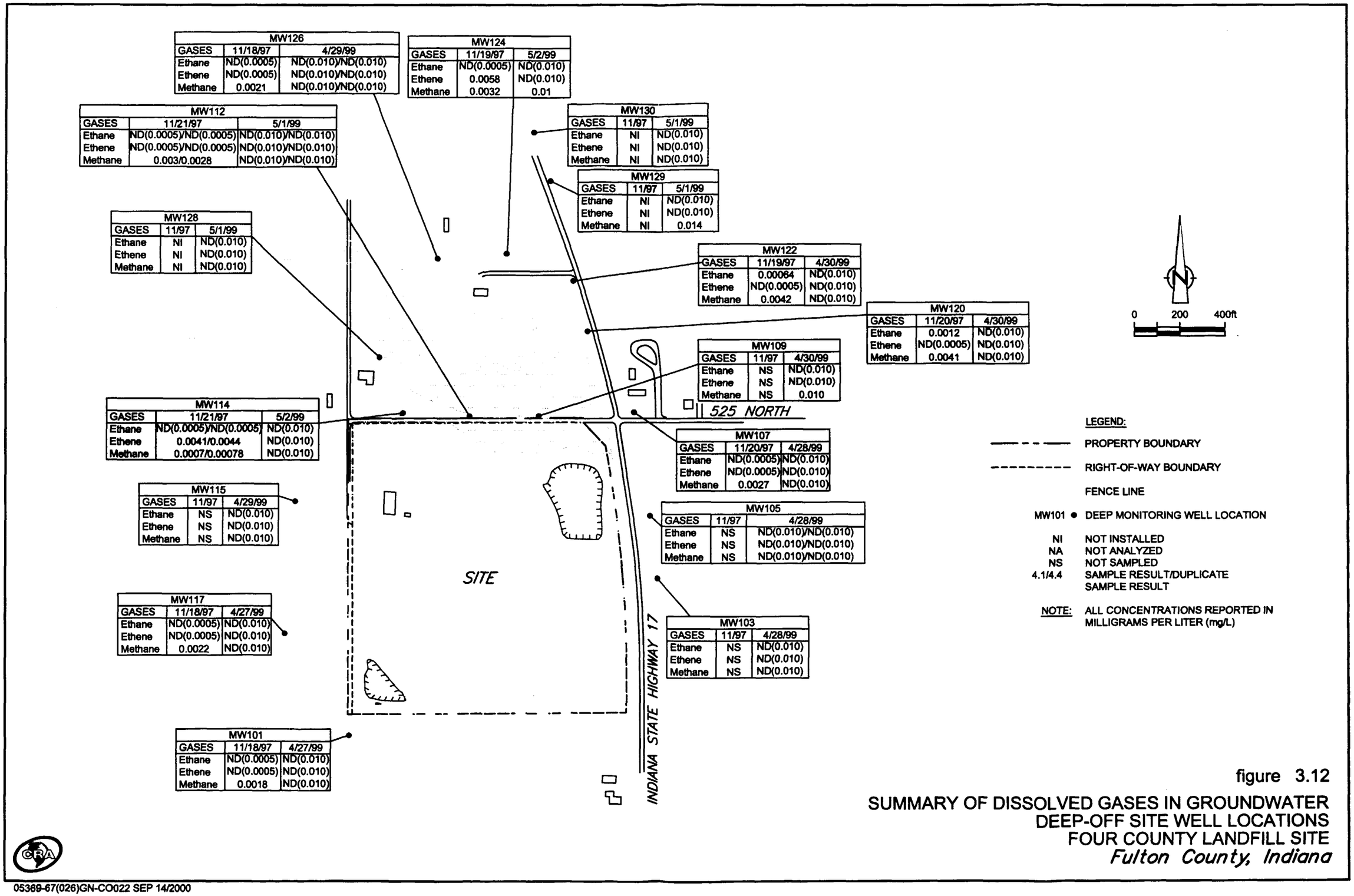


figure 3.12

SUMMARY OF DISSOLVED GASES IN GROUNDWATER
DEEP-OFF SITE WELL LOCATIONS
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

05369-67(026)GN-CO022 SEP 14/2000

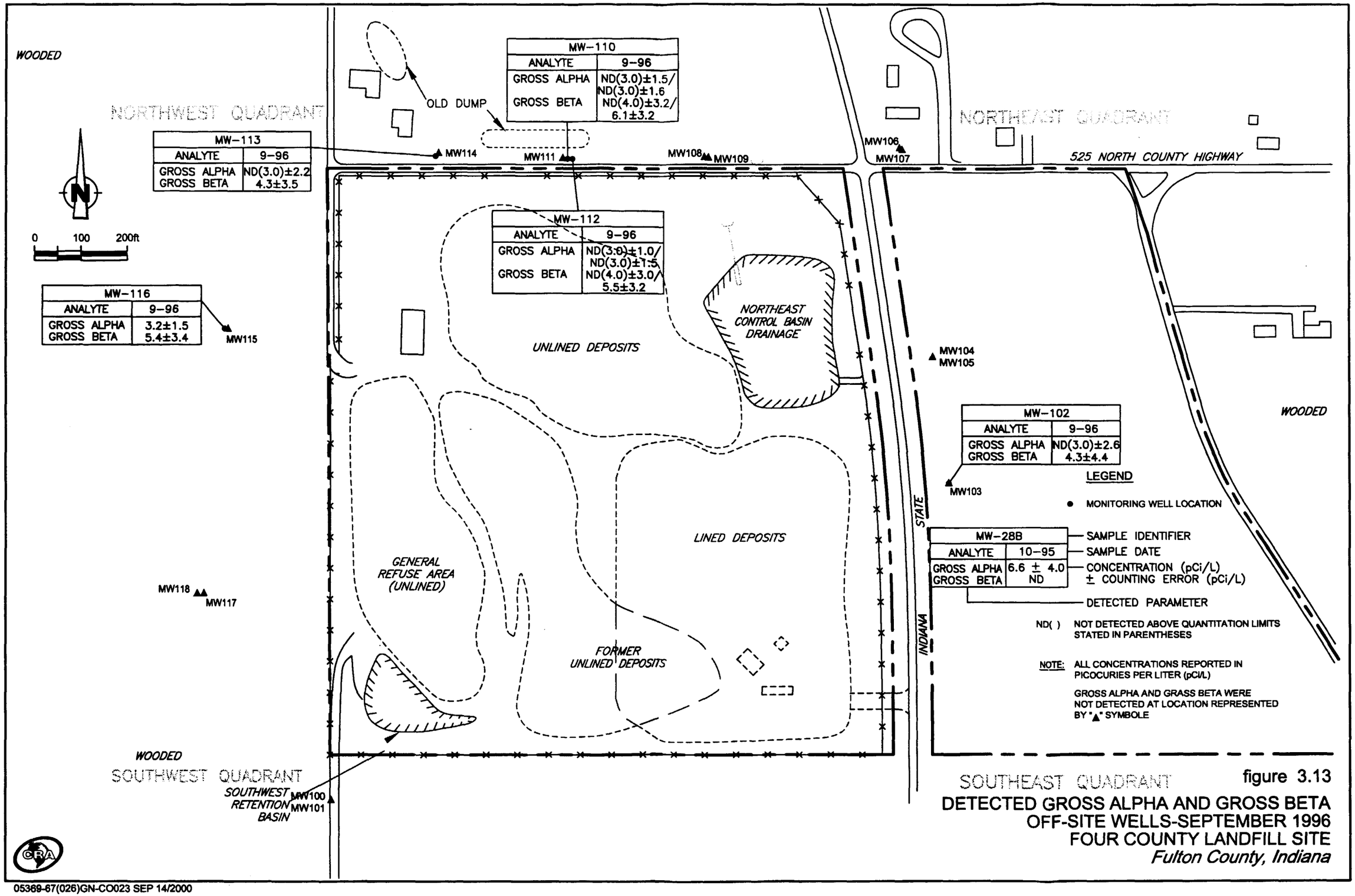
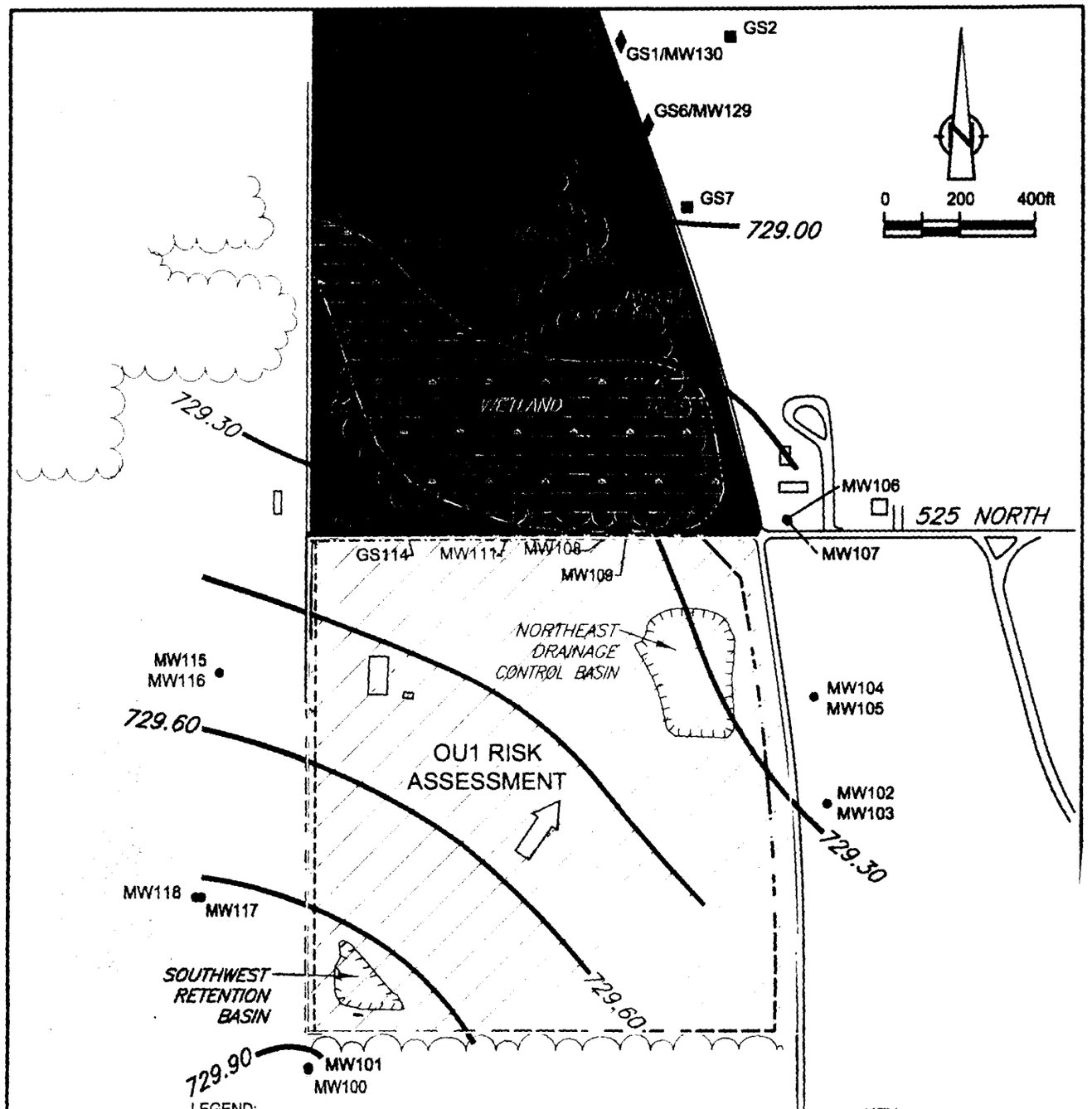


figure 3.13

DETECTED GROSS ALPHA AND GROSS BETA
OFF-SITE WELLS-SEPTEMBER 1996
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

05369-67(026)GN-CO023 SEP 14/2000



LEGEND:

- PROPERTY BOUNDARY
- RIGHT-OF-WAY BOUNDARY
- FENCE LINE
- MW101 ● MONITORING WELL LOCATION AND IDENTIFIER
- GS2 ■ GROUNDWATER SCREENING LOCATION AND IDENTIFIER
- 729.45 GROUNDWATER CONTOUR, INTERVAL = 0.15 FT. (TAKEN FROM JUNE 1999 DATA)
- GROUNDWATER FLOW DIRECTION

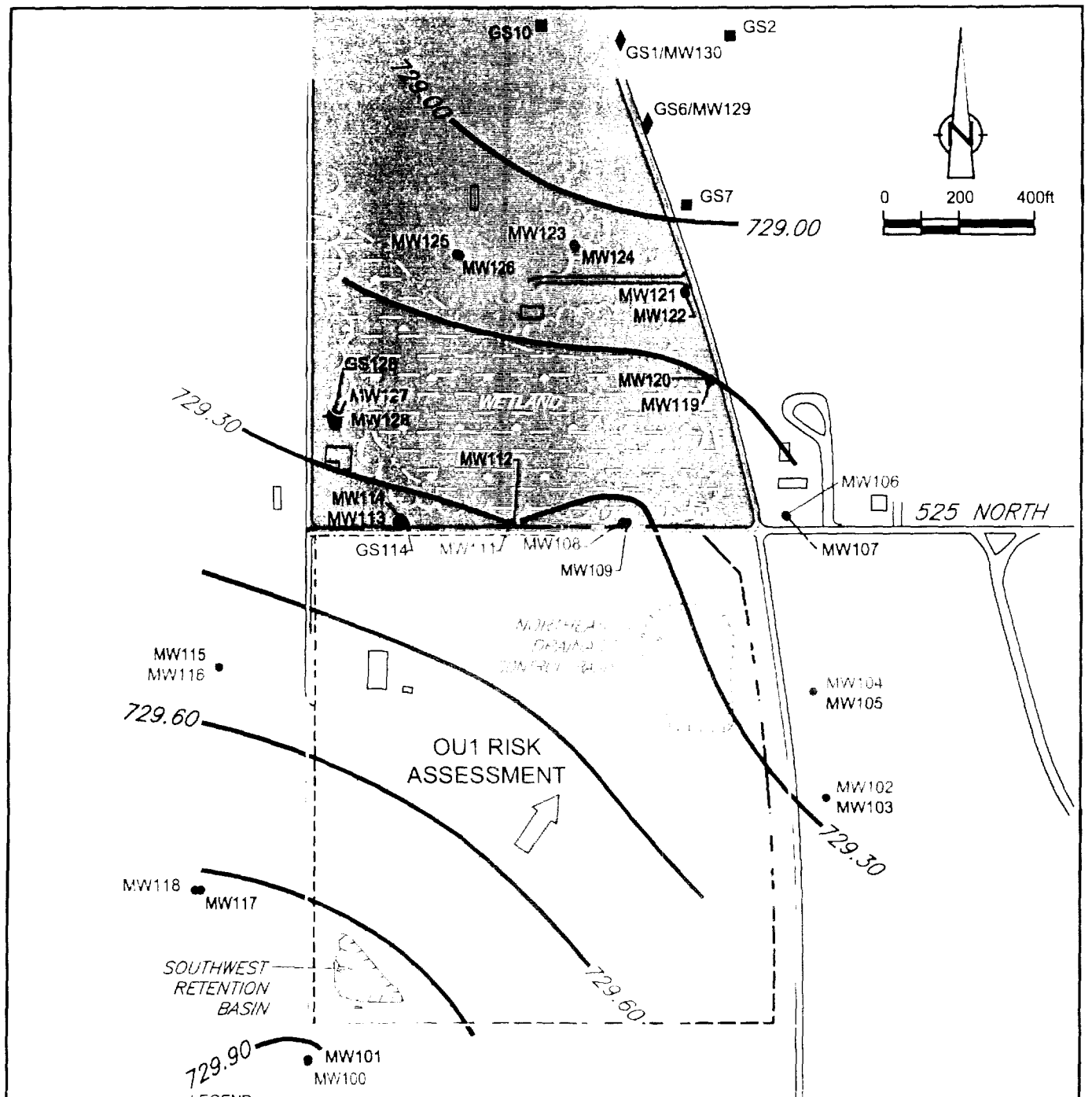
KEY:

- OU1 RISK ASSESSMENT
- UPGRADIENT SECTOR
- EAST DOWNGRADIENT SECTOR
- NORTH DOWNGRADIEN SECTOR

figure 3.14

SECTOR BOUNDARIES-OU2 RISK ASSESSMENT
FOUR COUNTY LANDFILL SITE
Fulton County, Indian

05369-67(026)GN-CO024 SEP 14/2000



LEGEND:

- PROPERTY BOUNDARY
- RIGHT-OF-WAY BOUNDARY
- FENCE LINE
- MW101 ● MONITORING WELL LOCATION AND IDENTIFIER
- GS2 ■ GROUNDWATER SCREENING LOCATION AND IDENTIFIER
- 729.45 GROUNDWATER CONTOUR, INTERVAL = 0.15 FT. (TAKEN FROM JUNE 1999 DATA)
- GROUNDWATER FLOW DIRECTION

KEY:

OU1 RISK ASSESSMENT
UPGRADIENT SECTOR
EAST DOWNGRADIENT SECTOR
NORTH DOWNGRADIENT SECTOR

figure 3.14

SECTOR BOUNDARIES-OU2 RISK ASSESSMENT
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

05369-67(026)GN-CO024 SEP 14/2000

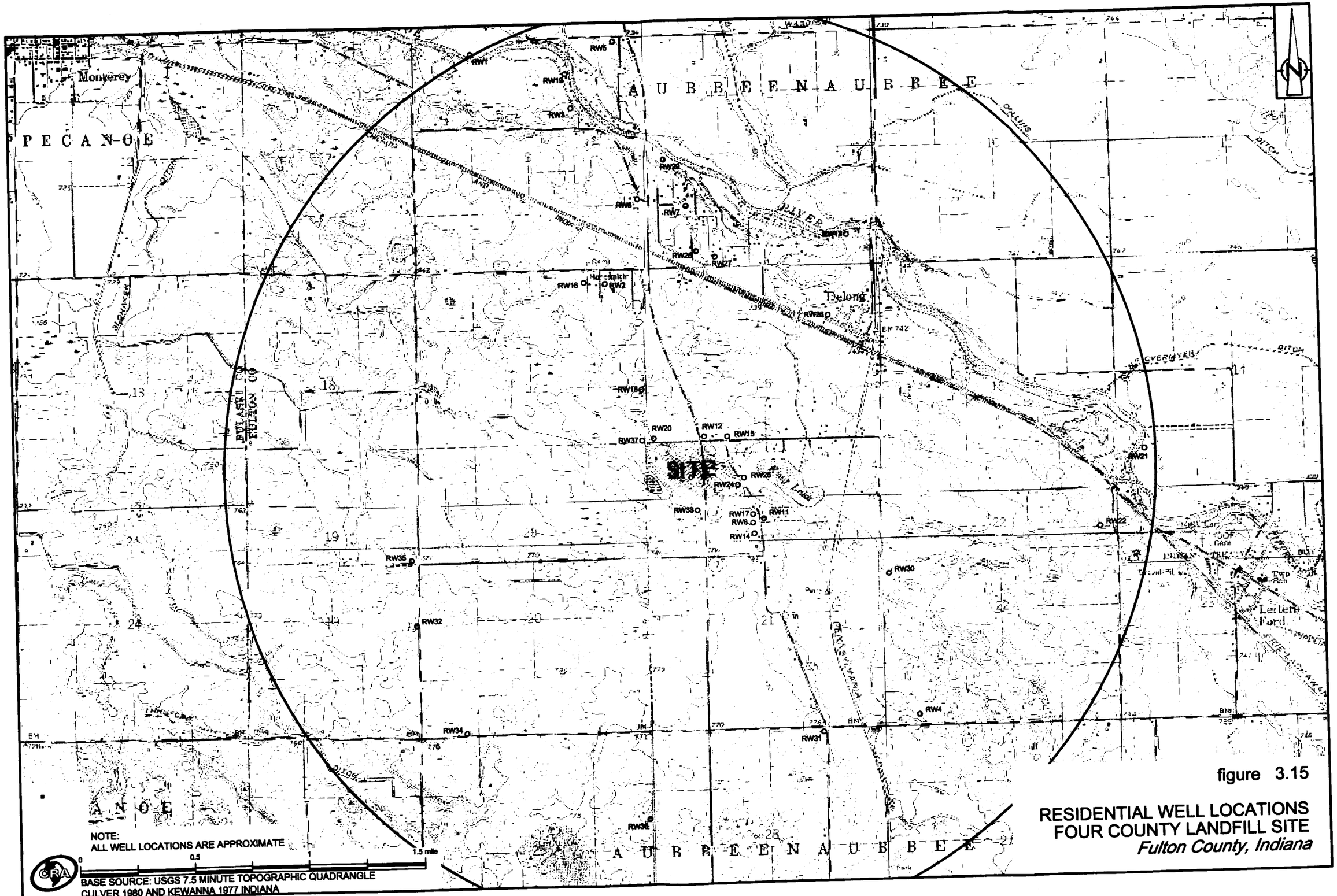
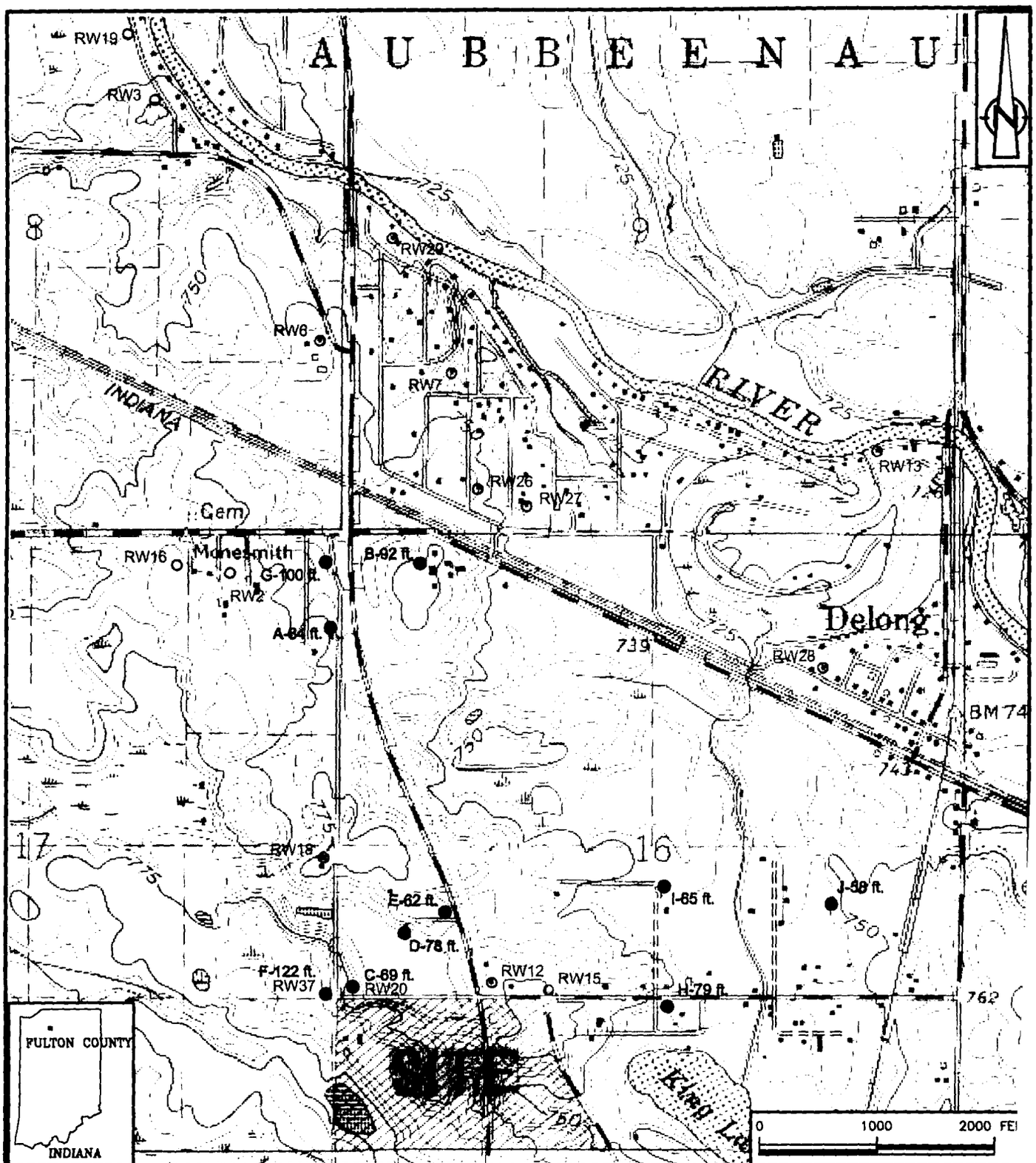


figure 3.15

RESIDENTIAL WELL LOCATIONS
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

05369-67(026)GN-CO025 SEP 14/2000



BASE SOURCE: USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE; CULVER, INDIANA 1962

LEGEND:

A-84 ft.● RESIDENTIAL WELL LOCATION, IDENTIFIER AND TOTAL DEPTH (FEET BELOW GROUND SURFACE)

RW12 O RESIDENTIAL WELL (SAMPLED BY FCHSC)

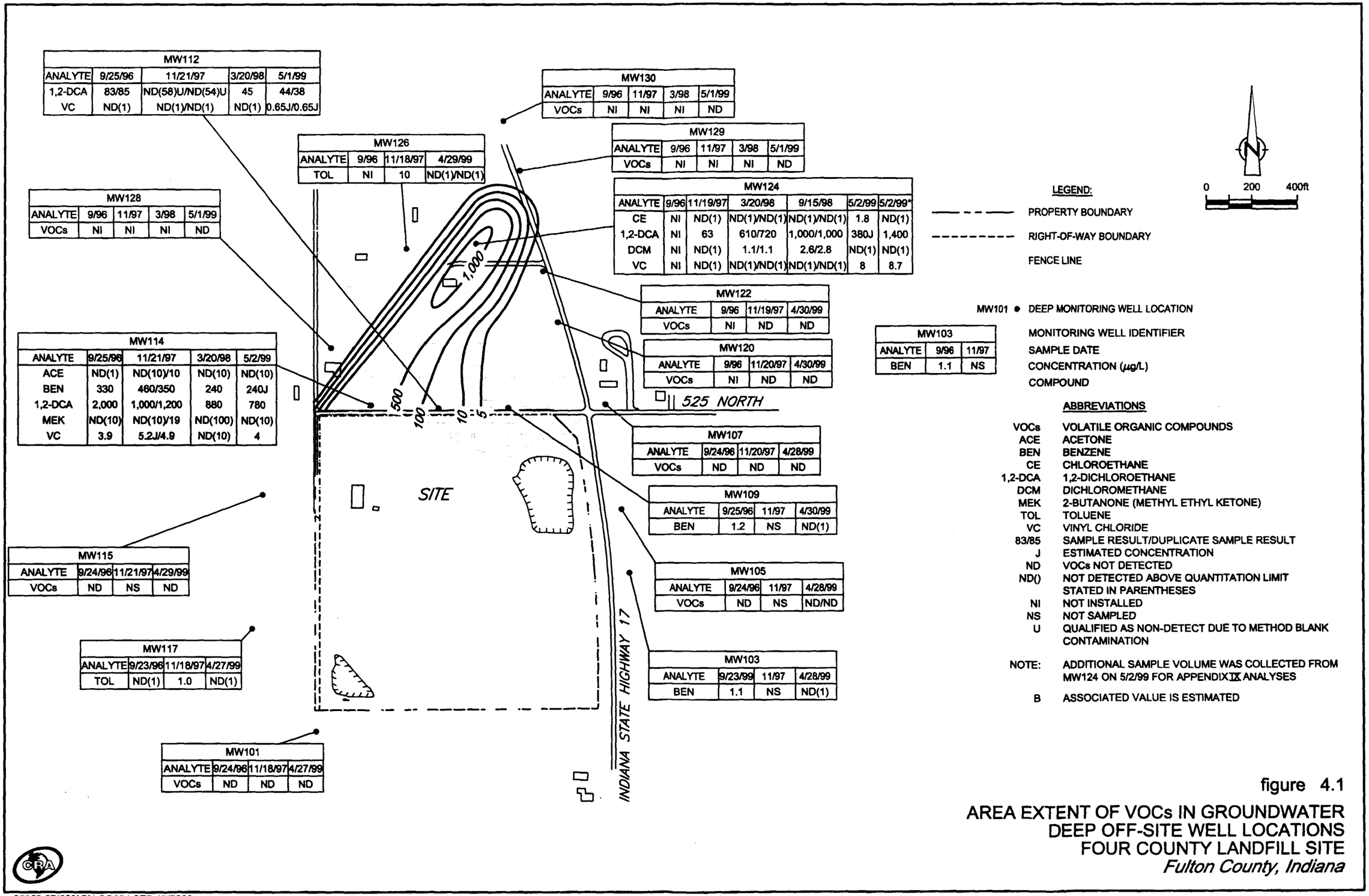
NOTE: ALL WELL LOCATIONS ARE APPROXIMATE

figure 3.16

SELECTED RESIDENTIAL WELL LOCATIONS
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

CRA

05369-67(026)GN-CO026 SEP 14/2000



MW112

ANALYTE	9/25/96	11/21/97	3/20/98	5/1/99
1,2-DCA	83/85	ND(58)U/ND(54)U	45	44/38
VC	ND(1)	ND(1)/ND(1)	ND(1)	0.65J/0.65J

MW130

ANALYTE	9/96	11/97	3/98	5/1/99
VOCs	NI	NI	NI	ND

MW126

ANALYTE	9/96	11/18/97	4/29/99
TOL	NI	10	ND(1)/ND(1)

MW129

ANALYTE	9/96	11/97	3/98	5/1/99
VOCs	NI	NI	NI	ND

MW128

ANALYTE	9/96	11/97	3/98	5/1/99
VOCs	NI	NI	NI	ND

MW124

ANALYTE	9/96	11/19/97	3/20/98	9/15/98	5/2/99	5/2/99*
CE	NI	ND(1)	ND(1)/ND(1)	ND(1)/ND(1)	1.8	ND(1)
1,2-DCA	NI	63	610/720	1,000/1,000	380J	1,400
DCM	NI	ND(1)	1.1/1.1	2.6/2.8	ND(1)	ND(1)
VC	NI	ND(1)	ND(1)/ND(1)	ND(1)/ND(1)	8	8.7

MW122

ANALYTE	9/96	11/19/97	4/30/99
VOCs	NI	ND	ND

MW103

ANALYTE	9/96	11/97
BEN	1.1	NS

MW114

ANALYTE	9/25/96	11/21/97	3/20/98	5/2/99
ACE	ND(1)	ND(10)/10	ND(10)	ND(10)
BEN	330	460/350	240	240J
1,2-DCA	2,000	1,000/1,200	880	780
MEK	ND(10)	ND(10)/19	ND(100)	ND(10)
VC	3.9	5.2J/4.9	ND(10)	4

MW120

ANALYTE	9/96	11/20/97	4/30/99
VOCs	NI	ND	ND

MW107

ANALYTE	9/24/96	11/20/97	4/28/99
VOCs	ND	ND	ND

MW109

ANALYTE	9/25/96	11/97	4/30/99
BEN	1.2	NS	ND(1)

MW115

ANALYTE	9/24/96	11/21/97	4/29/99
VOCs	ND	NS	ND

MW105

ANALYTE	9/24/96	11/97	4/28/99
VOCs	ND	NS	ND/ND

MW117

ANALYTE	9/23/96	11/18/97	4/27/99
TOL	ND(1)	1.0	ND(1)

MW103

ANALYTE	9/23/99	11/97	4/28/99
BEN	1.1	NS	ND(1)

MW101

ANALYTE	9/24/96	11/18/97	4/27/99
VOCs	ND	ND	ND

figure 4.1

AREA EXTENT OF VOCs IN GROUNDWATER
DEEP OFF-SITE WELL LOCATIONS
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

05369-67(026)GN-CO034 SEP 15/2000

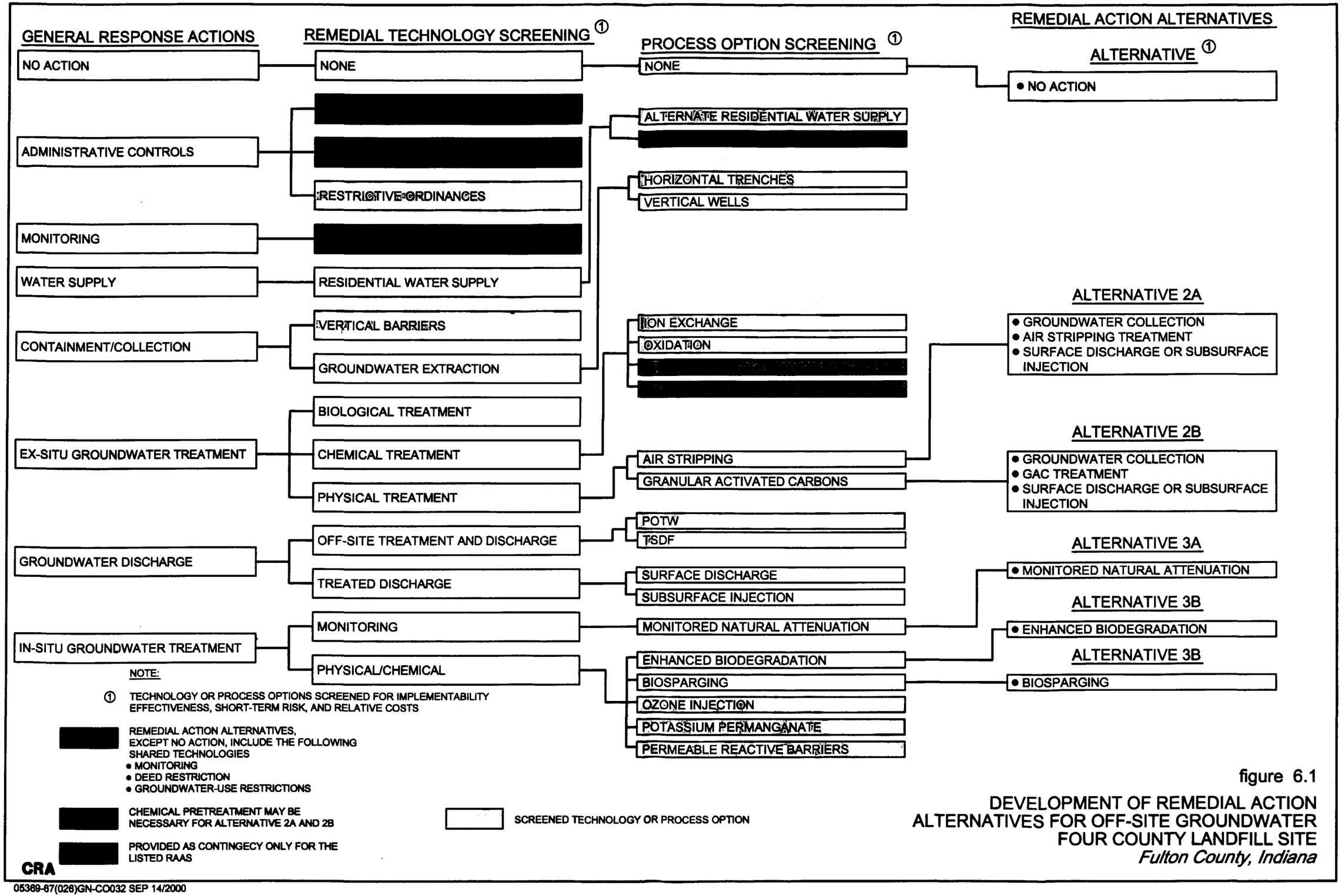
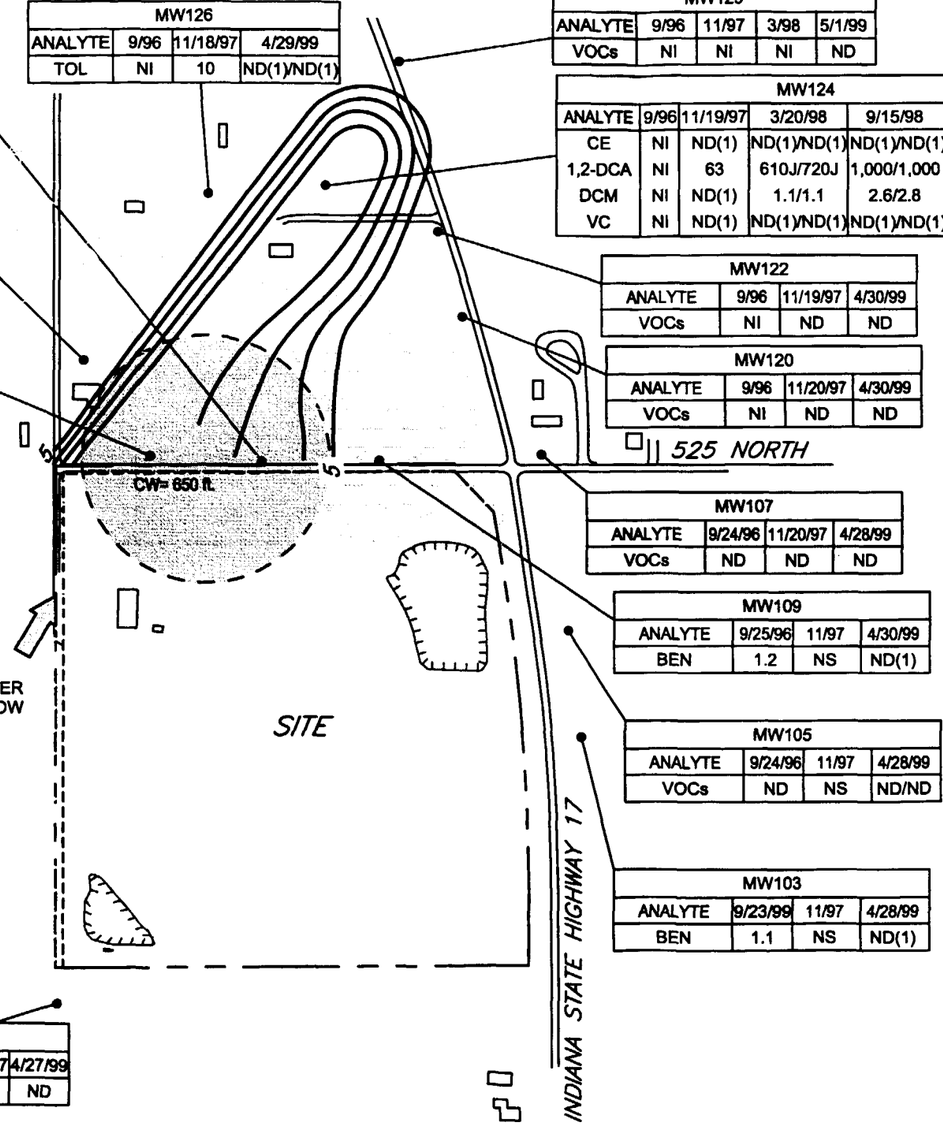


figure 6.1

DEVELOPMENT OF REMEDIAL ACTION ALTERNATIVES FOR OFF-SITE GROUNDWATER FOUR COUNTY LANDFILL SITE

Fulton County, Indiana

05369-87(026)GN-CO032 SEP 14/2000



MW112				
ANALYTE	9/25/96	11/21/97	3/20/98	5/1/99
1,2-DCA	83/85	ND(58)U/ND(54)U	45	44/38
VC	ND(1)	ND(1)/ND(1)	ND(1)	0.65J/0.65J

MW126			
ANALYTE	9/96	11/18/97	4/29/99
TOL	NI	10	ND(1)/ND(1)

MW128				
ANALYTE	9/96	11/97	3/98	5/1/99
VOCs	NI	NI	NI	ND

MW114				
ANALYTE	9/25/96	11/21/97	3/20/98	5/2/99
ACE	ND(1)	ND(10)/10	ND(10)	ND(10)
BEN	330	460/350	240	240J
1,2-DCA	2,000	1,000/1,200	880	780
MEK	ND(10)	ND(10)/19	ND(100)	ND(10)
VC	3.9	5.2J/4.9	ND(10)	4

MW115			
ANALYTE	9/24/96	11/21/97	4/29/99
VOCs	ND	NS	ND

MW117			
ANALYTE	9/23/96	11/18/97	4/27/99
TOL	ND(1)	1.0	ND(1)

MW101			
ANALYTE	9/24/96	11/18/97	4/27/99
VOCs	ND	ND	ND

MW130				
ANALYTE	9/96	11/97	3/98	5/1/99
VOCs	NI	NI	NI	ND

MW129				
ANALYTE	9/96	11/97	3/98	5/1/99
VOCs	NI	NI	NI	ND

MW124						
ANALYTE	9/96	11/19/97	3/20/98	9/15/98	5/2/99	5/2/99*
CE	NI	ND(1)	ND(1)/ND(1)	ND(1)/ND(1)	1.8	ND(1)
1,2-DCA	NI	63	610J/720J	1,000/1,000	380J	1,400
DCM	NI	ND(1)	1.1/1.1	2.6/2.8	ND(1)	ND(1)
VC	NI	ND(1)	ND(1)/ND(1)	ND(1)/ND(1)	8	8.7

MW122			
ANALYTE	9/96	11/19/97	4/30/99
VOCs	NI	ND	ND

MW120			
ANALYTE	9/96	11/20/97	4/30/99
VOCs	NI	ND	ND

MW107			
ANALYTE	9/24/96	11/20/97	4/28/99
VOCs	ND	ND	ND

MW109			
ANALYTE	9/25/96	11/97	4/30/99
BEN	1.2	NS	ND(1)

MW105			
ANALYTE	9/24/96	11/97	4/28/99
VOCs	ND	NS	ND/ND

MW103			
ANALYTE	9/23/99	11/97	4/28/99
BEN	1.1	NS	ND(1)

MW103		
ANALYTE	9/96	11/97
BEN	1.1	NS

0 200 400ft

LEGEND:

PROPERTY BOUNDARY

RIGHT-OF-WAY BOUNDARY

FENCE LINE

MW101 ● DEEP MONITORING WELL LOCATION

MONITORING WELL IDENTIFIER

SAMPLE DATE

CONCENTRATION (µg/L)

COMPOUND

ABBREVIATIONS

VOCs	VOLATILE ORGANIC COMPOUNDS
ACE	ACETONE
BEN	BENZENE
CE	CHLOROETHANE
1,2-DCA	1,2-DICHLOROETHANE
DCM	DICHLOROMETHANE
MEK	2-BUTANONE (METHYL ETHYL KETONE)
TOL	TOLUENE
VC	VINYL CHLORIDE
83/85	SAMPLE RESULT/DUPLICATE SAMPLE RESULT
J	ESTIMATED CONCENTRATION
ND	VOCs NOT DETECTED
ND()	NOT DETECTED ABOVE QUANTITATION LIMIT STATED IN PARENTHESES
NI	NOT INSTALLED
NS	NOT SAMPLED
U	QUALIFIED AS NON-DETECT DUE TO METHOD BLANK CONTAMINATION

NOTE:

* ADDITIONAL SAMPLE VOLUME WAS COLLECTED FROM MW124 ON 5/2/99 FOR APPENDIX IX ANALYSES

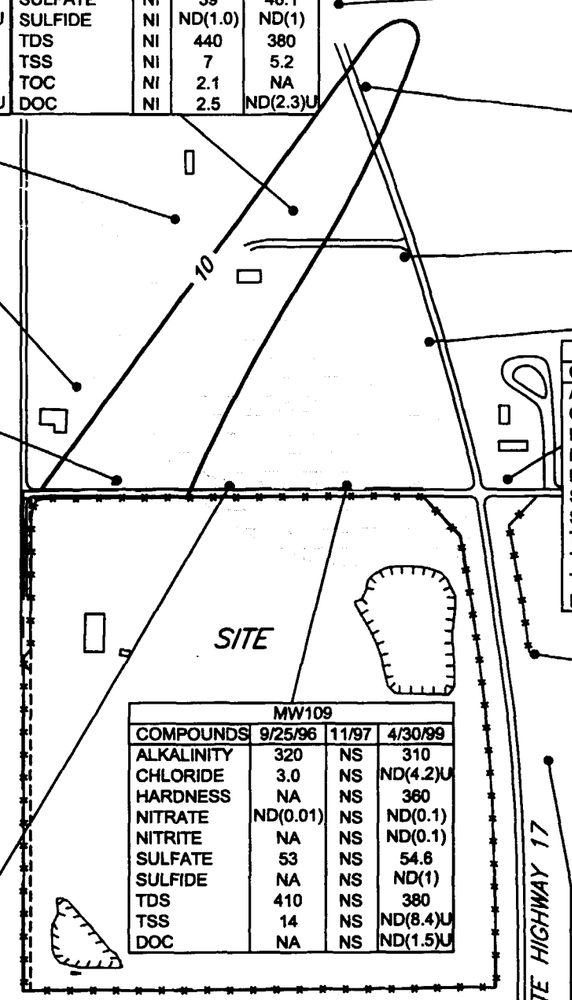
CW= CAPTURE WIDTH

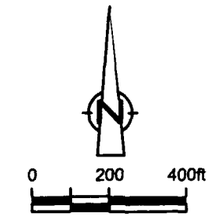
figure 6.2

CAPTURE WIDTH ELEVATION
UNIT C
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

CRA

05369-67(026)GN-CO001 MAY 03/2000





MW126			
COMPOUNDS	9/96	11/18/97	4/29/99
ALKALINITY	NI	360	340/340
CHLORIDE	NI	4.0	ND(3.2)U/ND(2.5)U
HARDNESS	NI	NA	390/400
NITRATE	NI	ND(0.01)	ND(0.1)/ND(0.1)
NITRITE	NI	NA	ND(0.1)/ND(0.1)
SULFATE	NI	36	35.6/36
SULFIDE	NI	ND(1.0)	ND(11)/ND(2.5)U
TDS	NI	380	410/390
TSS	NI	11	ND(5)/ND(5.2)U
TOC	NI	1.8	NA/NA
DOC	NI	2.1	ND(1.8)U/ND(2)U

MW124			
COMPOUNDS	9/96	11/19/97	5/2/99
ALKALINITY	NI	350	360
CHLORIDE	NI	14	13.8
HARDNESS	NI	NA	420
NITRATE	NI	ND(0.01)	ND(0.1)
NITRITE	NI	NA	ND(0.1)
SULFATE	NI	39	48.1
SULFIDE	NI	ND(1.0)	ND(1)
TDS	NI	440	380
TSS	NI	7	5.2
TOC	NI	2.1	NA
DOC	NI	2.5	ND(2.3)U

MW130			
COMPOUNDS	9/96	11/97	5/1/99
ALKALINITY	NI	NI	350J
CHLORIDE	NI	NI	3.8
HARDNESS	NI	NI	390
NITRATE	NI	NI	ND(0.1)
NITRITE	NI	NI	ND(0.1)
SULFATE	NI	NI	42.3
SULFIDE	NI	NI	ND(1)
TDS	NI	NI	400
TSS	NI	NI	8
DOC	NI	NI	ND(1.8)U

MW128			
COMPOUNDS	9/96	11/97	5/1/99
ALKALINITY	NI	NI	300J
CHLORIDE	NI	NI	3.5
HARDNESS	NI	NI	350
NITRATE	NI	NI	ND(0.1)
NITRITE	NI	NI	ND(0.1)
SULFATE	NI	NI	48
SULFIDE	NI	NI	ND(1)
TDS	NI	NI	380
TSS	NI	NI	6
DOC	NI	NI	ND(2.2)U

MW129			
COMPOUNDS	9/96	11/97	5/1/99
ALKALINITY	NI	NI	340J
CHLORIDE	NI	NI	12
HARDNESS	NI	NI	370
NITRATE	NI	NI	ND(0.1)
NITRITE	NI	NI	ND(0.1)
SULFATE	NI	NI	42.9
SULFIDE	NI	NI	ND(1)
TDS	NI	NI	400
TSS	NI	NI	7.2
DOC	NI	NI	ND(2.7)U

MW122			
COMPOUNDS	9/96	11/19/97	4/30/99
ALKALINITY	NI	320	280
CHLORIDE	NI	6.6	ND(5.5)U
HARDNESS	NI	NA	350
NITRATE	NI	ND(0.01)	ND(0.1)
NITRITE	NI	NA	ND(0.1)
SULFATE	NI	47	44.2
SULFIDE	NI	ND(1.0)	ND(2.2)U
TDS	NI	400	380
TSS	NI	6	ND(30)U
TOC	NI	2.3	NA
DOC	NI	2.4	ND(2.9)U

MW114			
COMPOUNDS	9/25/96	11/21/97	5/2/99
ALKALINITY	340	350/350	340
CHLORIDE	12	12/12	12
HARDNESS	NA	NA/NA	420
NITRATE	ND(0.01)	ND(0.01)UJ/ND(0.01)UJ	ND(0.1)
NITRITE	NA	NA/NA	ND(0.1)
SULFATE	48	40/41	54.2
SULFIDE	NA	ND(1.0)/ND(1.0)	ND(1)
TDS	430	430/430	420
TSS	5	15/8	ND(5)
DOC	NA	ND(1.0)/ND(1.0)	ND(1.4)U

MW120			
COMPOUNDS	9/96	11/20/97	4/30/99
ALKALINITY	NI	340	330
CHLORIDE	NI	3.9	ND(3.5)U
HARDNESS	NI	NA	370
NITRATE	NI	ND(0.01)UJ	ND(0.1)
NITRITE	NI	NA	ND(0.1)
SULFATE	NI	40	31.9
SULFIDE	NI	ND(1.0)	ND(1)
TDS	NI	360	320
TSS	NI	7	ND(6)U
TOC	NI	2.7	NA
DOC	NI	2.8	ND(2.1)U

MW107			
COMPOUNDS	9/24/96	11/20/97	4/28/99
ALKALINITY	330	330	270
CHLORIDE	3.1	3.1	3.8
HARDNESS	NA	NA	380
NITRATE	ND(0.01)	ND(0.01)	ND(0.1)
NITRITE	NA	NA	ND(0.1)
SULFATE	40	44	43.9
SULFIDE	NA	ND(1)	ND(1)
TDS	390	400	400
TSS	9	7	ND(5)
TOC	NA	1.6	NA
DOC	NA	2.0	ND(2)U

MW115			
COMPOUNDS	9/24/96	11/97	4/29/99
ALKALINITY	320	NS	300
CHLORIDE	2.8	NS	ND(3.8)U
HARDNESS	NA	NS	400
NITRATE	ND(0.01)	NS	ND(0.1)
NITRITE	NA	NS	ND(0.1)
SULFATE	58	NS	49.5
SULFIDE	NA	NS	ND(1)
TDS	420	NS	420
TSS	13	NS	ND(8.4)U
DOC	NA	NS	ND(2)U

MW105			
COMPOUNDS	9/24/96	11/97	4/28/99
ALKALINITY	290	NS	270/260
CHLORIDE	3.8	NS	3.8/4.5
HARDNESS	NA	NS	370/370
NITRATE	ND(0.01)	NS	ND(0.1)/ND(0.1)
NITRITE	NA	NS	ND(0.1)/ND(0.1)
SULFATE	60	NS	55.5/55.6
SULFIDE	NA	NS	ND(1)/1.6
TDS	340	NS	380/370
TSS	7	NS	ND(5)/ND(5)
DOC	NA	NS	ND(1.7)U/ND(2.2)U

MW109			
COMPOUNDS	9/25/96	11/97	4/30/99
ALKALINITY	320	NS	310
CHLORIDE	3.0	NS	ND(4.2)U
HARDNESS	NA	NS	360
NITRATE	ND(0.01)	NS	ND(0.1)
NITRITE	NA	NS	ND(0.1)
SULFATE	53	NS	54.6
SULFIDE	NA	NS	ND(1)
TDS	410	NS	380
TSS	14	NS	ND(8.4)U
DOC	NA	NS	ND(1.5)U

MW117			
COMPOUNDS	9/23/96	11/18/97	4/27/99
ALKALINITY	280	300	410
CHLORIDE	4.7	4.5	1.5
HARDNESS	NA	NA	410
NITRATE	ND(0.01)	ND(0.01)	ND(0.1)
NITRITE	NA	NA	ND(0.1)
SULFATE	54	46	30.1
SULFIDE	NA	ND(1.0)	1.4
TDS	410	360	460
TSS	19	12	ND(5)
DOC	NA	1.4	ND(1.4)U

MW103			
COMPOUNDS	9/23/96	11/97	4/28/99
ALKALINITY	300	NS	290
CHLORIDE	14	NS	13
HARDNESS	NA	NS	360
NITRATE	ND(0.01)	NS	ND(0.1)
NITRITE	NA	NS	ND(0.1)
SULFATE	41	NS	37.1
SULFIDE	NA	NS	2
TDS	380	NS	440
TSS	7	NS	ND(5)
DOC	NA	NS	ND(1.3)U

MW112			
COMPOUNDS	9/25/96	11/21/97	5/1/99
ALKALINITY	330/330	330/320	330J/330J
CHLORIDE	5.6/5.3	5.5/5.4	8.5/8.8
HARDNESS	NA	NA	410/400
NITRATE	ND(0.01)/ND(0.01)	ND(0.01)UJ/ND(0.01)UJ	ND(0.01)/ND(0.01)
NITRITE	NA	NA	ND(0.01)/ND(0.01)
SULFATE	53/56	45/45	52.4/52.7
SULFIDE	NA	ND(1.0)/ND(1.0)	ND(1)/ND(1)
TDS	440/420	390/410	400/390
TSS	11/6	8/6	ND(5)/8.8
TOC	NA	ND(2.3)U/ND(2.4)U	ND(1.9)U/ND(1.9)U
DOC	NA	ND(2.3)U/NA	ND(1.9)U/ND(1.9)U

MW101			
COMPOUNDS	9/24/96	11/18/97	4/27/99
ALKALINITY	270	270	260
CHLORIDE	7.1	7.3	6
HARDNESS	NA	NA	330
NITRATE	ND(0.01)	ND(0.01)	ND(0.1)
NITRITE	NA	NA	ND(0.1)
SULFATE	82	74	71.8
SULFIDE	NA	ND(0.01)	ND(1)
TDS	420	350	400
TSS	7	10	ND(5)
TOC	NA	2.8	NA
DOC	NA	2.0	ND(2.1)U

LEGEND:

- PROPERTY BOUNDARY
- RIGHT-OF-WAY BOUNDARY
- FENCE LINE
- MW101 ● DEEP MONITORING WELL LOCATION AND IDENTIFIER

ABBREVIATIONS:

- TDS TOTAL DISSOLVED SOLIDS
- TSS TOTAL ORGANIC CARBON
- TOC TOTAL ORGANIC CARBON
- DOC DISSOLVED ORGANIC CARBON
- NA NOT ANALYZED
- NI NOT INSTALLED
- NS NOT SAMPLED
- ND COMPOUND NOT DETECTED AT THE QUANTITATION LIMIT SHOWN IN PARENTHESES
- 8.5/8.8 SAMPLE RESULT/DUPLICATE SAMPLE RESULT
- U QUALIFIED AS NON-DETECT DUE TO METHOD BLANK CONTAMINATION
- J ESTIMATED CONCENTRATION

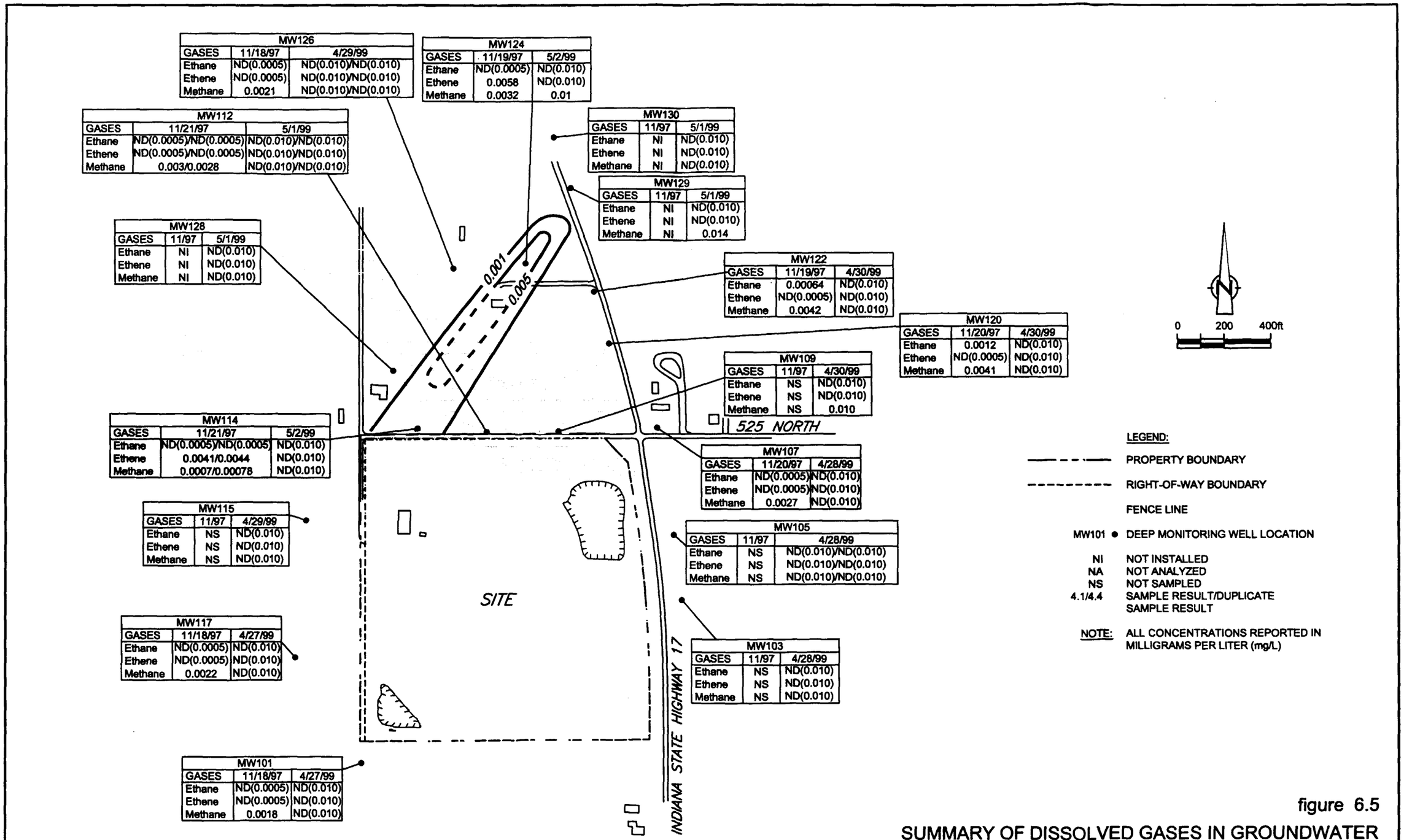
NOTE: ALL CONCENTRATIONS REPORTED IN MILLIGRAMS PER LITER (mg/L)

figure 6.4

SUMMARY OF CHLORIDE CONCENTRATIONS IN GROUNDWATER
DEEP-OFF SITE WELL LOCATIONS
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

CRA

05369-67(026)GN-CO035 SEP 15/2000



MW126		
GASES	11/18/97	4/29/99
Ethane	ND(0.0005)	ND(0.010)/ND(0.010)
Ethene	ND(0.0005)	ND(0.010)/ND(0.010)
Methane	0.0021	ND(0.010)/ND(0.010)

MW124		
GASES	11/19/97	5/2/99
Ethane	ND(0.0005)	ND(0.010)
Ethene	0.0058	ND(0.010)
Methane	0.0032	0.01

MW112		
GASES	11/21/97	5/1/99
Ethane	ND(0.0005)/ND(0.0005)	ND(0.010)/ND(0.010)
Ethene	ND(0.0005)/ND(0.0005)	ND(0.010)/ND(0.010)
Methane	0.003/0.0028	ND(0.010)/ND(0.010)

MW130		
GASES	11/97	5/1/99
Ethane	NI	ND(0.010)
Ethene	NI	ND(0.010)
Methane	NI	ND(0.010)

MW129		
GASES	11/97	5/1/99
Ethane	NI	ND(0.010)
Ethene	NI	ND(0.010)
Methane	NI	0.014

MW128		
GASES	11/97	5/1/99
Ethane	NI	ND(0.010)
Ethene	NI	ND(0.010)
Methane	NI	ND(0.010)

MW122		
GASES	11/19/97	4/30/99
Ethane	0.00064	ND(0.010)
Ethene	ND(0.0005)	ND(0.010)
Methane	0.0042	ND(0.010)

MW120		
GASES	11/20/97	4/30/99
Ethane	0.0012	ND(0.010)
Ethene	ND(0.0005)	ND(0.010)
Methane	0.0041	ND(0.010)

MW109		
GASES	11/97	4/30/99
Ethane	NS	ND(0.010)
Ethene	NS	ND(0.010)
Methane	NS	0.010

MW114		
GASES	11/21/97	5/2/99
Ethane	ND(0.0005)/ND(0.0005)	ND(0.010)
Ethene	0.0041/0.0044	ND(0.010)
Methane	0.0007/0.00078	ND(0.010)

MW107		
GASES	11/20/97	4/28/99
Ethane	ND(0.0005)	ND(0.010)
Ethene	ND(0.0005)	ND(0.010)
Methane	0.0027	ND(0.010)

MW115		
GASES	11/97	4/29/99
Ethane	NS	ND(0.010)
Ethene	NS	ND(0.010)
Methane	NS	ND(0.010)

MW105		
GASES	11/97	4/28/99
Ethane	NS	ND(0.010)/ND(0.010)
Ethene	NS	ND(0.010)/ND(0.010)
Methane	NS	ND(0.010)/ND(0.010)

MW117		
GASES	11/18/97	4/27/99
Ethane	ND(0.0005)	ND(0.010)
Ethene	ND(0.0005)	ND(0.010)
Methane	0.0022	ND(0.010)

MW103		
GASES	11/97	4/28/99
Ethane	NS	ND(0.010)
Ethene	NS	ND(0.010)
Methane	NS	ND(0.010)

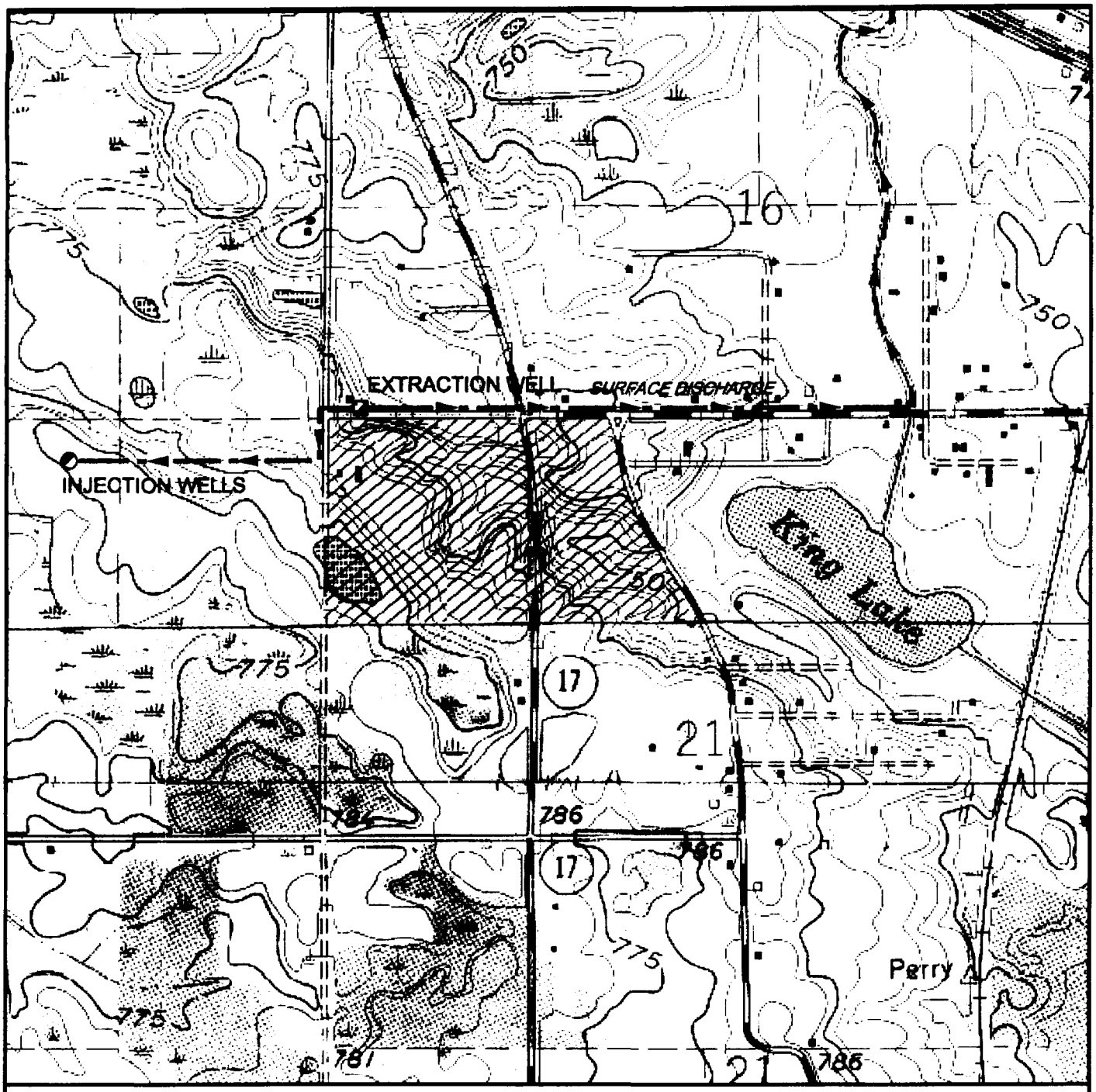
MW101		
GASES	11/18/97	4/27/99
Ethane	ND(0.0005)	ND(0.010)
Ethene	ND(0.0005)	ND(0.010)
Methane	0.0018	ND(0.010)

figure 6.5

SUMMARY OF DISSOLVED GASES IN GROUNDWATER
DEEP-OFF SITE WELL LOCATIONS
FOUR COUNTY LANDFILL SITE
Fulton County, Illinois

CRA

05369-67(026)GN-CO027 SEP 15/2000



BASE SOURCE: USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE; CULVER, INDIANA 1965

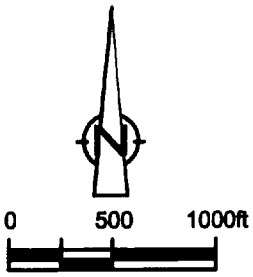


figure 6.3

SURFACE DISCHARGE AND SUBSURFACE INJECTION OPTIONS FOR TREATED GROUNDWATER
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

05369-67(026)GN-CO002 SEP 14/2000

SUMMARY OF GROUNDWATER ELEVATION DATA
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Well Location	*Elevation (ft. NGVD)* [1]	*Depth to Water 09/16/96 (ft. BTOC)* [2]	*Groundwater Elevation 9/16/96 (ft. NGVD)*	*Depth to Water 10/18/96 (ft. BTOC)*	*Groundwater Elevation 10/18/96 (ft. NGVD)*	*Depth to Water 11/17/97 (ft. BTOC)*	*Groundwater Elevation 11/17/97 (ft. NGVD)*	*Depth to Water 9/15/98 (ft. BTOC)*
MW100	785.06	57.12	727.94	57.58	727.48	56.53	728.53	55.69
MW101	785.31	57.37	727.94	57.80	727.51	56.79	728.52	55.98
MW102	758.11	30.61	727.50	31.08	727.03	29.83	728.28	29.06
MW103	758.10	30.83	727.27	31.29	726.81	30.24	727.86	29.45
MW104	773.00	45.90	727.10	46.36	726.64	45.31	727.69	44.52
MW105	773.74	46.55	727.19	47.00	726.74	45.94	727.80	45.17
MW106	768.12	40.97	727.15	41.41	726.71	40.36	727.76	39.60
MW107	768.43	41.26	727.17	41.71	726.72	40.68	727.75	39.91
MW108	756.81	29.44	727.37	29.86	726.95	28.68	728.13	27.88
MW109	756.82	29.62	727.20	30.06	726.76	28.98	727.84	28.18
MW110	762.74	35.31	727.43	35.74	727.00	34.60	728.14	33.82
MW111	762.53	35.22	727.31	35.67	726.86	34.59	727.94	33.83
MW112	761.71	34.41	727.30	34.86	726.85	33.78	727.93	33.02
MW113	774.12	47.22	726.90	47.22	726.90	46.16	727.96	45.40
MW114	774.57	46.78	727.79	47.68	726.89	46.59	727.98	45.82
MW115	784.98	57.50	727.48	57.97	727.01	56.85	728.13	56.09
MW116	784.82	57.35	727.47	57.81	727.01	56.66	728.16	55.92
MW117	784.84	57.07	727.77	57.52	727.32	56.47	728.37	55.55
MW118	784.96	57.19	727.77	57.64	727.32	56.63	728.33	55.81

SUMMARY OF GROUNDWATER ELEVATION DATA
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Well Location	*Elevation (ft. NGVD)* [1]	*Depth to Water 09/16/96 (ft. BTOC)* [2]	*Groundwater Elevation 9/16/96 (ft. NGVD)*	*Depth to Water 10/18/96 (ft. BTOC)*	*Groundwater Elevation 10/18/96 (ft. NGVD)*	*Depth to Water 11/17/97 (ft. BTOC)*	*Groundwater Elevation 11/17/97 (ft. NGVD)*	*Depth to Water 9/15/98 (ft. BTOC)*
MW119	765.71	NI[3]	-	NI	-	37.97	727.74	37.18
MW120	765.30	NI	-	NI	-	37.55	727.75	36.79
MW121	768.92	NI	-	NI	-	41.03	727.89	40.22
MW122	768.48	NI	-	NI	-	40.78	727.70	40.03
MW123	773.88	NI	-	NI	-	46.17	727.71	45.4
MW124	774.03	NI	-	NI	-	46.33	727.70	45.58
MW125	759.34	NI	-	NI	-	31.37	727.97	30.61
MW126	759.07	NI	-	NI	-	31.32	727.75	30.57
MW127	783.03	NI	-	NI	-	NI	-	NI
MW128	782.87	NI	-	NI	-	NI	-	NI
MW129	770.98	NI	-	NI	-	NI	-	NI
MW130	772.14	NI	-	NI	-	NI	-	NI

TABLE 2.1

SUMMARY OF GROUNDWATER ELEVATION DATA
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Well Location	*Elevation (ft. NGVD)* [1]	*Groundwater Elevation 9/15/98 (ft. NGVD)*	*Depth to Water 3/17/99 (ft. BTOC)*	*Groundwater Elevation 3/17/99 (ft. NGVD)*	*Depth to Water 4/26/99 (ft. BTOC)*	*Groundwater Elevation 4/26/99 (ft. NGVD)*	*Depth to Water 6/1/99 (ft. BTOC)*	*Groundwater Elevation 6/1/99 (ft. NGVD)*
MW100	785.06	729.37	56.61	728.45	55.50	729.56	55.11	729.95
MW101	785.31	729.33	56.90	728.41	55.77	729.54	55.39	729.92
MW102	758.11	729.05	30.11	728.00	29.22	728.89	28.56	729.55
MW103	758.10	728.65	30.28	727.82	29.08	729.02	28.83	729.27
MW104	773.00	728.48	45.35	727.65	44.12	728.88	43.87	729.13
MW105	773.74	728.57	45.96	727.78	44.73	729.01	44.52	729.22
MW106	768.12	728.52	40.53	727.59	39.21	728.91	38.96	729.16
MW107	768.43	728.52	40.70	727.73	39.49	728.94	39.26	729.17
MW108	756.81	728.93	28.94	727.87	27.86	728.95	27.30	729.51
MW109	756.82	728.64	29.02	727.80	27.78	729.04	27.49	729.33
MW110	762.74	728.92	34.90	727.84	33.81	728.93	33.21	729.53
MW111	762.53	728.70	34.72	727.81	33.51	729.02	33.24	729.29
MW112	761.71	728.69	33.90	727.81	32.69	729.02	32.41	729.30
MW113	774.12	728.72	46.25	727.87	45.10	729.02	44.78	729.34
MW114	774.57	728.75	46.70	727.87	45.53	729.04	45.24	729.33
MW115	784.98	728.89	57.02	727.96	55.88	729.10	55.44	729.54
MW116	784.82	728.90	56.89	727.93	55.77	729.05	55.36	729.46
MW117	784.84	729.29	56.58	728.26	55.46	729.38	55.07	729.77
MW118	784.96	729.15	56.75	728.21	55.61	729.35	55.24	729.72

TABLE 2.1

SUMMARY OF GROUNDWATER ELEVATION DATA
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Well Location	*Elevation (ft. NGVD)* [1]	*Groundwater Elevation 9/15/98 (ft. NGVD)*	*Depth to Water 3/17/99 (ft. BTOC)*	*Groundwater Elevation 3/17/99 (ft. NGVD)*	*Depth to Water 4/26/99 (ft. BTOC)*	*Groundwater Elevation 4/26/99 (ft. NGVD)*	*Depth to Water 6/1/99 (ft. BTOC)*	*Groundwater Elevation 6/1/99 (ft. NGVD)*
MW119	765.71	728.53	38.00	727.71	36.80	728.91	36.55	729.16
MW120	765.30	728.51	37.60	727.70	36.36	728.94	36.14	729.16
MW121	768.92	728.70	41.25	727.67	40.22	728.70	39.66	729.26
MW122	768.48	728.45	40.86	727.62	39.65	728.83	39.40	729.08
MW123	773.88	728.48	46.28	727.60	45.16	728.72	44.78	729.10
MW124	774.03	728.45	46.41	727.62	45.24	728.79	44.98	729.05
MW125	759.34	728.73	31.65	727.69	30.63	728.71	29.94	729.40
MW126	759.07	728.50	31.43	727.64	30.24	728.83	29.98	729.09
MW127	783.03	-	NI	-	54.12	728.91	53.76	729.27
MW128	782.87	-	NI	-	53.95	728.92	53.62	729.25
MW129	770.98	-	NI	-	42.21	728.77	42.08	728.90
MW130	772.14	-	NI	-	43.40	728.74	43.27	728.87

[1] ft NGVD - feet referenced to National Geodetic Vertical Datum

[2] ft BTOC - feet below top of well casing

[3] NI - Not Installed

VERTICAL HYDRAULIC GRADIENTS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Well Cluster	Screen Midpoint	Groundwater Elevations 9/16/96	Vertical Gradients (September 1996) Shallow - Intermediate	Shallow - Deep	Intermediate - Deep	Groundwater Elevations 10/18/96	Vertical Gradients (October 1996) Shallow - Intermediate	Shallow - Deep	Intermediate - Deep
NORTH OF SITE									
MW-106	686.1	727.15	--	--	5.03E-04	726.71	--	--	2.51E-04
MW-107	646.3	727.17				726.72			
MW-108	685	727.43	--	--	-3.18E-03	727.01	--	--	-3.58E-03
MW-109	634.7	727.27				726.83			
MW-110	715.5	727.41				726.98			
MW-111	680.3	727.27	-3.98E-03	-1.58E-03	4.91E-04	726.82	-4.55E-03	-1.84E-03	4.91E-04
MW-112	639.6	727.29				726.84			
MW-113	707.3	727.35	--	--	-2.47E-04	727.35	--	--	-2.25E-02
MW-114	666.8	727.34				726.44			
MW-119	718.3	NI	--	--	--	NI	--	--	--
MW-120	673.0	NI				NI			
MW-121	718.5	NI	--	--	--	NI	--	--	--
MW-122	664.1	NI				NI			
MW-123	718.1	NI	--	--	--	NI	--	--	--
MW-124	649.3	NI				NI			
MW-125	717.9	NI	--	--	--	NI	--	--	--
MW-126	649.0	NI				NI			
MW-127	717.8	NI	--	--	--	NI	--	--	--
MW-128	657.9	NI				NI			

VERTICAL HYDRAULIC GRADIENTS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Well Cluster	Screen Midpoint	Groundwater Elevations 9/16/96	Vertical Gradients (September 1996) Shallow - Intermediate	Shallow - Deep	Intermediate - Deep	Groundwater Elevations 10/18/96	Vertical Gradients (October 1996) Shallow - Intermediate	Shallow - Deep	Intermediate - Deep
SOUTH OF SITE									
MW-100	718.0	727.94	0.00E+00	--	--	727.48	7.54E-04	--	--
MW-101	678.2	727.94				727.51			
EAST OF SITE									
MW-102	715.9	727.50	-5.76E-03	--	--	727.03	-5.51E-03	--	--
MW-103	676.0	727.27				726.81			
MW-104	716.2	727.10	2.62E-03	--	--	726.64	2.91E-03	--	--
MW-105	681.8	727.19				726.74			
WEST OF SITE									
MW-116	722.7	727.47	1.99E-04	--	--	727.01	0.00E+00	--	--
MW-115	672.5	727.48				727.01			
MW-118	722.7	727.77	0.00E+00	--	--	727.32	0.00E+00	--	--
MW-117	671.8	727.77				727.32			

VERTICAL HYDRAULIC GRADIENTS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Well Cluster	Screen Midpoint	Groundwater Elevations 11/17/97	Vertical Gradients (November 1997) Shallow - Intermediate	Shallow - Deep	Intermediate - Deep	Groundwater Elevations 9/15/98	Vertical Gradients (September 1998) Shallow - Intermediate	Shallow - Deep	Intermediate - Deep
NORTH OF SITE									
MW-106	686.1	727.76	--	--	-2.51E-04	728.52	--	--	0.00E+00
MW-107	646.3	727.75				728.52			
MW-108	685	728.13	--	--	-5.77E-03	728.93	--	--	-5.77E-03
MW-109	634.7	727.84				728.64			
MW-110	715.5	728.14				728.92			
MW-111	680.3	727.94	-5.68E-03	-2.77E-03	-2.46E-04	728.70	-6.25E-03	-3.03E-03	-2.46E-04
MW-112	639.6	727.93				728.69			
MW-113	707.3	727.96	--	--	4.94E-04	728.72	--	--	7.41E-04
MW-114	666.8	727.98				728.75			
MW-119	718.3	727.74	2.21E-04	--	--	728.53	-4.42E-04	--	--
MW-120	673.0	727.75				728.51			
MW-121	718.5	727.89	--	-3.49E-03	--	728.70	--	-5.15E-03	--
MW-122	664.1	727.70				728.42			
MW-123	718.1	727.71	--	-1.45E-04	--	728.48	--	-4.36E-04	--
MW-124	649.3	727.70				728.45			
MW-125	717.9	727.97	--	-3.19E-03	--	728.73	--	-3.34E-03	--
MW-126	649.0	727.75				728.50			
MW-127	717.8	NI	--	--	--	NI	--	--	--
MW-128	657.9	NI				NI			

VERTICAL HYDRAULIC GRADIENTS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Well Cluster	Screen Midpoint	Groundwater Elevations 11/17/97	Vertical Gradients (November 1997) Shallow - Intermediate	Shallow - Deep	Intermediate - Deep	Groundwater Elevations 9/15/98	Vertical Gradients (September 1998) Shallow - Intermediate	Shallow - Deep	Intermediate - Deep
SOUTH OF SITE									
MW-100	718.0	728.53	-2.51E-04	--	--	729.37	-1.01E-03	--	--
MW-101	678.2	728.52				729.33			
EAST OF SITE									
MW-102	715.9	728.28	-1.05E-02	--	--	729.05	-1.00E-02	--	--
MW-103	676.0	727.86				728.65			
MW-104	716.2	727.69	3.20E-03	--	--	728.48	2.62E-03	--	--
MW-105	681.8	727.80				728.57			
WEST OF SITE									
MW-116	722.7	728.16	-5.98E-04	--	--	728.90	-1.99E-04	--	--
MW-115	672.5	728.13				728.89			
MW-118	722.7	728.33	7.86E-04	--	--	728.15	2.24E-02	--	--
MW-117	671.8	728.37				729.29			

VERTICAL HYDRAULIC GRADIENTS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Well Cluster	Screen Midpoint	Groundwater Elevations 3/17/99	Vertical Gradients (March 1999) Shallow - Intermediate	Shallow - Deep	Intermediate - Deep	Groundwater Elevations 4/26/99	Vertical Gradients (April 1999) Shallow - Intermediate	Shallow - Deep	Intermediate - Deep
NORTH OF SITE									
MW-106	686.1	727.59	--	--	3.52E-03	728.91	--	--	7.54E-04
MW-107	646.3	727.73				728.94			
MW-108	685	727.87	--	--	-1.39E-03	728.95	--	--	1.79E-03
MW-109	634.7	727.80				729.04			
MW-110	715.5	727.84				728.93			
MW-111	680.3	727.81	-8.52E-04	-3.95E-04	0.00E+00	729.02	2.56E-03	1.19E-03	0.00E+00
MW-112	639.6	727.81				729.02			
MW-113	707.3	727.87	--	--	0.00E+00	729.02	--	--	4.94E-04
MW-114	666.8	727.87				729.04			
MW-119	718.3	727.71	-2.21E-04	--	--	728.91	2.27E-02	--	--
MW-120	673.0	727.70				729.94			
MW-121	718.5	727.67	--	-9.19E-04	--	728.70	--	2.39E-03	--
MW-122	664.1	727.62				728.83			
MW-123	718.1	727.60	--	2.91E-04	--	728.72	--	1.02E-03	--
MW-124	649.3	727.62				728.79			
MW-125	717.9	727.69	--	-7.26E-04	--	728.71	--	1.74E-03	--
MW-126	649.0	727.64				728.83			
MW-127	717.8	NI	--	--	--	728.91	--	1.67E-04	--
MW-128	657.9	NI				728.92			

VERTICAL HYDRAULIC GRADIENTS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Well Cluster	Screen Midpoint	Groundwater Elevations 3/17/99	Vertical Gradients (March 1999) Shallow - Intermediate	Shallow - Deep	Intermediate - Deep	Groundwater Elevations 4/26/99	Vertical Gradients (April 1999) Shallow - Intermediate	Shallow - Deep	Intermediate - Deep
SOUTH OF SITE									
MW-100	718.0	728.45	-1.01E-03	--	--	729.56	-5.03E-04	--	--
MW-101	678.2	728.41				729.54			
EAST OF SITE									
MW-102	715.9	728.00	-4.51E-03	--	--	728.89	3.26E-03	--	--
MW-103	676.0	727.82				729.02			
MW-104	716.2	727.65	3.78E-03	--	--	728.88	3.78E-03	--	--
MW-105	681.8	727.78				729.01			
WEST OF SITE									
MW-116	722.7	727.93	5.98E-04	--	--	729.05	9.96E-04	--	--
MW-115	672.5	727.96				729.10			
MW-118	722.7	728.21	9.82E-04	--	--	729.35	5.89E-04	--	--
MW-117	671.8	728.26				729.38			

VERTICAL HYDRAULIC GRADIENTS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Well Cluster	Screen Midpoint	Groundwater Elevations 6/1/99	Vertical Gradients (June 1999) Shallow - Intermediate	Shallow - Deep	Intermediate - Deep
NORTH OF SITE					
MW-106	686.1	729.16	--	--	2.51E-04
MW-107	646.3	729.17			
MW-108	685	729.51	--	--	-3.58E-03
MW-109	634.7	729.33			
MW-110	715.5	729.53			
MW-111	680.3	729.29	-6.82E-03	-3.03E-03	2.46E-04
MW-112	639.6	729.30			
MW-113	707.3	729.34	--	--	-2.47E-04
MW-114	666.8	729.33			
MW-119	718.3	729.16	0.00E+00	--	--
MW-120	673.0	729.16			
MW-121	718.5	729.26	--	-3.31E-03	--
MW-122	664.1	729.08			
MW-123	718.1	729.10	--	-7.27E-04	--
MW-124	649.3	729.05			
MW-125	717.9	729.40	--	-4.50E-03	--
MW-126	649.0	729.09			
MW-127	717.8	729.27	--	-3.34E-04	--
MW-128	657.9	729.25			

VERTICAL HYDRAULIC GRADIENTS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Well Cluster	Screen Midpoint	Groundwater Elevations 6/1/99	Vertical Gradients (June 1999) Shallow - Intermediate	Shallow - Deep	Intermediate - Deep
SOUTH OF SITE					
MW-100	718.0	729.95	-7.54E-04	--	--
MW-101	678.2	729.92			
EAST OF SITE					
MW-102	715.9	729.55	-7.02E-03	--	--
MW-103	676.0	729.27			
MW-104	716.2	729.13	2.62E-03	--	--
MW-105	681.8	729.22			
WEST OF SITE					
MW-116	722.7	729.46	1.59E-03	--	--
MW-115	672.5	729.54			
MW-118	722.7	729.72	9.82E-04	--	--
MW-117	671.8	729.77			

TABLE 2.3

SUMMARY OF RESPONSE TEST DATA
SHALLOW UNIT
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

	Hydraulic Conductivity (cm/second) [1]		*Geometric Mean of Initial & Confirmatory Tests*			
Location	*Initial Test*	*Confirmatory Test*	*(cm/s)*	*(ft/sec)* [2]	*(ft/day)* [3]	*(ft/year)* [4]
MW119	0.0059	0.0048	0.0053	0.00017	15.09	5,506
MW121	0.0014	0.0014	0.0014	0.000046	3.97	1,449
MW123	0.0076	0.0072	0.0074	0.00024	20.97	7,654
MW125	0.011	0.011	0.0110	0.00036	31.18	11,381
	Geometric Mean of Shallow Wells		0.0050	0.00016	14.07	5,134

[1] cm/sec - centimeters per second
[2] ft/sec - feet per second
[3] ft/day - feet per day
[4] ft/yr - feet per year

TABLE 2.4

SUMMARY OF RESPONSE TEST DATA
DEEP UNIT
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

	Hydraulic Conductivity (cm/second)[1]		*Geometric Mean of Initial & Confirmatory Tests*			
Location	*Initial Test*	*Confirmatory Test*	*(cm/s)*	*(ft/sec)*[2]	*(ft/day)*[3]	*(ft/year)*[4]
MW120	0.018	0.017	0.0175	0.00057	49.59	18,099
MW122	0.044	0.033	0.0381	0.0013	108.01	39,425
MW124	0.11	0.079	0.0932	0.0031	264.25	96,450
MW126	0.081	0.083	0.0820	0.0027	232.42	84,835
	Geometric Mean of Tested Deep Well		0.0475	0.0016	134.67	49,156

[1] cm/sec - centimeters per second
[2] ft/sec - feet per second
[3] ft/day - feet per day
[4] ft/yr - feet per year

TABLE 3.1

SUMMARY OF AMBIENT WATER QUALITY CRITERIA
FOR DETECTED ANALYTES IN SURFACE WATER
OU2 REMEDIAL INVESTIGATION
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

		AWQC For Freshwater Protection			
		Indiana [1]		*Federal*	
Parameter	*Range of Concentrations (mg/L)*	*Acute (mg/L)*	*Chronic (mg/L)*	*Acute (mg/L)*	*Chronic (mg/L)*
Metals					
Aluminum	0.22 - 0.32	--	--	--	--
Arsenic	ND(0.0050) [2] - 0.0054	0.36*	0.19*	0.36 [3]	0.19 [3]
Barium	0.039 - 0.048	--	--	-- [8]	-- [8]
Calcium	57 - 75	-- [6]	-- [6]	--	--
Iron	3.4 - 11	-- [6]	-- [6]	-- [5]	1 [3]
Magnesium	15 - 19	--	--	--	--
Manganese	0.71 - 0.78	--	--	0.082 [3]	0.0032 [3]
Potassium	2.3 - 2.9	--	--	--	--
Sodium	3.2 - 4.3	--	--	--	--

NOTES :

-- = Not Available

ER-L = Effects Range-Low; a concentration at the low end of reported concentrations in which biological effects have been observed.

ER-M = Effects Range-Moderate; a concentration approximately midway in the range of reported concentrations associated with biological effects.

* = Value taken from Arsenic (III).

[1] Water Pollution Control Board, Title 327 IAC 2-1-6, Minimum Surface Water Quality Standards, November 9, 1993. EPA/540/1-86/060, October 1986.

[2] ND(0.0050) - Analyte not detected at detection limit in parentheses.

[3] IRIS-EPA Integrated Risk Information System Database, July 1994.

SUMMARY OF GROUNDWATER SCREENING DATA
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Sample Location:	GS-1					GS-2				
Sample I.D.:	01M	02M	04M	06M	07M	08M	09M	10M	11M	12M
Sample Depth (ft bgs):	83 - 87	95 - 100	105 - 110	119 - 122	119 - 122	76 - 78.5	87.5 - 90	92.5 - 95	105 - 107.5	117.5 - 120
On-Site Laboratory										
Selected Volatile Organic										
Compounds (µg/L)										
1,2-DCA	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)
Benzene	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)
Ethylbenzene	ND (2)	ND (2)	ND (2)	ND (2)	ND (2)	ND (2)	ND (2)	ND (2)	ND (2)	ND (2)
Xylenes	ND (2)	ND (2)	ND (2)	ND (2)	ND (2)	ND (2)	3.5	ND (2)	ND (2)	ND (2)
Project Laboratory										
Target Compound List										
Volatile Organic Compounds (µg/L)										
1,2-DCA	NA	NA	ND (1)	ND (1)	ND (1) U	NA	ND (1)	ND (1) U	NA	ND (1) U
4-Methyl-2-Pentanone	NA	NA	ND (10)	ND (10)	ND (10)	NA	ND (10)	ND (10)	NA	ND (10) R
Acetone	NA	NA	ND (10) R	ND (10) R	ND (10) R	NA	ND (10) R	ND (10) R	NA	ND (10) R
Benzene	NA	NA	ND (1)	ND (1)	ND (1)	NA	ND (1)	ND (1)	NA	ND (1)
Bromodichloromethane	NA	NA	ND (1)	ND (1)	ND (1)	NA	ND (1)	ND (1)	NA	ND (1)
Bromomethane	NA	NA	0.55 J	ND (1) UJ	ND (1) UJ	NA	ND (1) UJ	ND (1) UJ	NA	0.93 J
Chloroform	NA	NA	0.9 J	ND (1)	ND (1)	NA	ND (1.8) U	ND (1)	NA	U (1)
Ethylbenzene	NA	NA	ND (1)	ND (1)	ND (1)	NA	ND (1)	ND (1)	NA	ND (1)
Toluene	NA	NA	ND (1)	ND (1)	ND (1)	NA	U (1)	ND (1)	NA	ND (1)
Xylenes	NA	NA	ND (1)	ND (1)	ND (1)	NA	ND (1)	ND (1)	NA	ND (1)

SUMMARY OF GROUNDWATER SCREENING DATA
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Sample Location:	GS-6						GS-7				
Sample I.D.:	13M	14M	16M	17M	18M	19M	20M	21M	22M	23M	24M
Sample Depth (ft bgs):	77.5 - 80	87.5 - 90	97.5 - 100	103 - 105.5	113 - 115.5	113 - 115.5	59.5 - 62	75.5 - 78	88.5 - 91	97.5 - 99	103.5 - 105
On-Site Laboratory Selected Volatile Organic Compounds (µg/L)											
1,2-DCA	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)
Benzene	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)
Ethylbenzene	ND (2)	ND (2)	ND (2)	ND (2)	ND (2)	ND (2)	ND (2)	ND (2)	ND (2)	ND (2)	ND (2)
Xylenes	1.3	2.7	ND (2)	ND (2)	ND (2)	ND (2)	ND (2)	ND (2)	ND (2)	ND (2)	ND (2)
Project Laboratory Target Compound List Volatile Organic Compounds (µg/L)											
1,2-DCA	ND (1)	ND (1)	NA	ND (1) U	ND (1)	ND (1) U	NA	ND (1) U	NA	NA	ND (1) U
4-Methyl-2-Pentanone	7.4 J	6.5 J	NA	ND (10)	ND (10)	ND (10)	NA	ND (10)	NA	NA	ND (10)
Acetone	ND (10) R	U (10) R	NA	ND (10) R	ND (10) R	ND (10) R	NA	ND (10) R	NA	NA	ND (10) R
Benzene	ND (1)	ND (1)	NA	ND (1)	ND (1)	ND (1)	NA	ND (1)	NA	NA	ND (1)
Bromodichloromethane	1.2	0.72 J	NA	ND (1)	ND (1)	ND (1)	NA	ND (1)	NA	NA	ND (1)
Bromomethane	ND (1) UJ	ND (1) UJ	NA	ND (1) UJ	ND (1) UJ	ND (1) UJ	NA	ND (1) UJ	NA	NA	ND (1) UJ
Chloroform	4.1 J	U (2.7)	NA	ND(1.1)U	ND(1.1)U	ND(1.1)U	NA	0.85 J	NA	NA	ND (1)
Ethylbenzene	0.64 J	ND (1)	NA	ND (1)	ND (1)	ND (1)	NA	ND (1)	NA	NA	ND (1)
Toluene	ND (1) UJ	ND (1)	NA	ND (1)	ND (1)	ND(1.1)U	NA	0.65 J	NA	NA	0.54 J
Xylenes	0.91 J	ND (1)	NA	ND (1)	ND (1)	ND (1)	NA	ND (1)	NA	NA	ND (1)

SUMMARY OF GROUNDWATER SCREENING DATA
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Sample Location:	GS-10			GS-114							
Sample I.D.:	35M	36M	37M	27M	28M	29M	30M	31M	32M	33M	34M
Sample Depth (ft bgs):	87 - 89.5	95.5 - 98	106.5 - 109	108.5 - 110	108.5 - 110	123.5 - 125	123.5 - 125	133.5 - 135	198.5 - 201	177.5 - 180	157.5 - 160
On-Site Laboratory											
Selected Volatile Organic											
Compounds (µg/L)											
1,2-DCA	ND (1)	ND (1)	ND (1)	580	820	11	5.9	ND (1)	ND (1)	ND (1)	ND (1)
Benzene	ND (1)	ND (1)	ND (1)	590	680	14	11	ND (1)	ND (1)	ND (1)	ND (1)
Ethylbenzene	ND (2)	ND (2)	ND (2)	ND (20)	ND (20)	ND (2)	ND (2)	ND (2)	ND (2)	ND (2)	ND (2)
Xylenes	ND (2)	ND (2)	ND (2)	ND (20)	ND (20)	ND (2)	ND (2)	ND (2)	12	ND (2)	ND (2)
Project Laboratory											
Target Compound List											
Volatile Organic Compounds (µg/L)											
1,2-DCA	NA	ND (1) UJ	ND (1) UJ	NA	NA	NA	NA	ND (1) U	ND (1)	NA	NA
4-Methyl-2-Pentanone	NA	ND (10)	ND (10)	NA	NA	NA	NA	ND (10)	8.5 J	NA	NA
Acetone	NA	ND (10)	ND (10) R	NA	NA	NA	NA	ND (10) R	U (10) R	NA	NA
Benzene	NA	ND (1)	ND (1)	NA	NA	NA	NA	1.1	0.54 J	NA	NA
Bromodichloromethane	NA	ND (1)	ND (1)	NA	NA	NA	NA	ND (1)	ND (1)	NA	NA
Bromomethane	NA	ND (1)	ND (1)	NA	NA	NA	NA	ND (1)	ND (1)	NA	NA
Chloroform	NA	1.9	1.6	NA	NA	NA	NA	0.81 J	1.1	NA	NA
Ethylbenzene	NA	ND (1)	ND (1)	NA	NA	NA	NA	ND (1)	ND (1)	NA	NA
Toluene	NA	ND (1)	ND (1)	NA	NA	NA	NA	ND (1)	ND (1)	NA	NA
Xylenes	NA	ND (1)	ND (1)	NA	NA	NA	NA	0.55 J	ND (1)	NA	NA

SUMMARY OF GROUNDWATER SCREENING DATA
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Sample Location:	GS-128										MW124
Sample I.D.:	38M	40M	41M	42M	43M	44M	45M	46M	47M	48M	25M
Sample Depth (ft bgs):	61.5 - 64	75.5 - 78	83.5 - 86	97.5 - 100	108.5 - 111	117.5 - 120	117.5 - 120	124.5 - 127	137.5 - 140	148.5 - 151	118 - 128
On-Site Laboratory Selected Volatile Organic Compounds (µg/L)											
1,2-DCA	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	670
Benzene	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (1)	ND (5)
Ethylbenzene	ND (2)	ND (2)	ND (2)	ND (2)	ND (2)	ND (2)	ND (2)	ND (2)	ND (2)	1.9	ND (10)
Xylenes	ND (2)	23	14	12	9.9	6.9	6	2.1	10	12	ND (10)
Project Laboratory Target Compound List Volatile Organic Compounds (µg/L)											
1,2-DCA	NA	ND (1)	NA	NA	NA	NA	NA	NA	NA	ND (1)	900
4-Methyl-2-Pentanone	NA	16	NA	NA	NA	NA	NA	NA	NA	13	ND (100)
Acetone	NA	U (10) R	NA	NA	NA	NA	NA	NA	NA	U (10) R	ND (100)
Benzene	NA	ND (1)	NA	NA	NA	NA	NA	NA	NA	ND (1)	ND (10)
Bromodichloromethane	NA	ND (1)	NA	NA	NA	NA	NA	NA	NA	ND (1)	ND (10)
Bromomethane	NA	ND (1)	NA	NA	NA	NA	NA	NA	NA	ND (1)	ND (10)
Chloroform	NA	1.8	NA	NA	NA	NA	NA	NA	NA	1.1	10
Ethylbenzene	NA	ND (1)	NA	NA	NA	NA	NA	NA	NA	0.75 J	ND (10)
Toluene	NA	ND (1)	NA	NA	NA	NA	NA	NA	NA	ND (1)	ND (10)
Xylenes	NA	ND (1)	NA	NA	NA	NA	NA	NA	NA	2.37	ND (10)

Notes:
On-Site laboratory analyzed for selected VOCs using gas chromatograph calibrated to a 1,2-DCA standard.
Project Laboratory analyzed for target compound list volatile organic compounds
M in sample ID denotes mobile (on-Site) laboratory sample and was removed form the sample ID for this samples submitted to the project laboratory
ND( ) - Not detected at the quantitation limit listed in parentheses.
ft bgs - feet below ground surface
µg/L - micrograms per liter
J - Estimated concentration
U - Qualified as non-detect due to method blank contamination
R - data are unusable

ANALYTICAL PARAMETERS AND WEIGHTING FOR PRELIMINARY SCREENING FOR ANAEROBIC BIODEGRADATION PROCESSES[1] FOUR COUNTY LANDFILL SITE FULTON COUNTY, INDIANA

Analysis	*Concentration in Most Contaminated Zone*	*Interpretation*	*Value*	*Points Awarded Site*	*Rationale/Justification*
Oxygen*	<0.5 mg/L	Tolerated, suppresses the reductive pathway at higher concentrations	3	3	Readings collected during well purging
Oxygen*	>5 mg/L	Not tolerated; however, VC may be oxidized aerobically	-3	0	Readings collected during well purging
Nitrate*	<1 mg/L	At higher concentrations may compete with reduction pathway	2	2	Data indicates nitrate not competing with potential reduction
Iron II*	>1 mg/L	Reduction pathway possible; VC may be oxidized under Fe(III)- reducing conditions	3	3	Data indicate reduction pathway possible
Sulfate*	<20 mg/L	At higher concentrations may compete with reduction pathway	2	0	Preliminary data indicate sulfate may be competing with reduction
Sulfide*	>1 mg/L	Reduction pathway possible	3	0	At present, sulfide < 1. Further data required
Methane*	<0.5 mg/L >0.5 mg/L	VC oxidizes Ultimate reductive daughter product, VC accumulates	0 3	0	Methane detected downgradient of Site. Further data required.
Oxidation Reduction Potential* (ORP) against Ag/AgCl electrode	<50 millivolts (mV) <-100 mV	Reduction pathway possible Reductive pathway likely	1 2	2	ORP Site data indicates a highly reducing environment
pH*	5 < pH < 9 5 > pH < 9	Optimal range for reductive pathway Outside optimal range for reductive pathway	0 -2	0	pH for Site in Optimum range
TOC	>20 mg/L	Carbon and energy source; drives dechlorination; can be natural or anthropogenic	2	0	Aquifer system characteristically low in organic carbon content
Temperature*	>20° C	At T >20°C biochemical process is accelerated	1	0	Groundwater temperature below 20°

ANALYTICAL PARAMETERS AND WEIGHTING FOR PRELIMINARY SCREENING FOR ANAEROBIC BIODEGRADATION PROCESSES[1]
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Analysis	*Concentration in Most Contaminated Zone*	*Interpretation*	*Value*	*Points Awarded Site*	*Rationale/Justification*
Carbon Dioxide	>2x background	Ultimate oxidative daughter product	1	0	Not evaluated
Alkalinity	>2x background	Results from interaction between CO2 and aquifer minerals	1	0	Plume concentrations similar to data obtained from background wells
Chloride	>2x background	Daughter product of organic chlorine	2	2	Plume concentrations elevated above background
Hydrogen	>1 nM	Reduction pathway possible; VC may accumulate	3	0	Not evaluated
Hydrogen	<1 nM	VC oxidized	0	0	Not evaluated
Volatile Fatty Acids	>0.1 mg/L	Intermediates resulting from biodegradation of more complex compounds; carbon and Entergy source	2	0	Not evaluated
BTEX*	>0.1 mg/L	Carbon and energy source; drives dechlorination; can be natural or anthropogenic	2	2	Concentrations decrease over distance and time indicating use as substrate
Tetrachloroethene	--	Material released	0	0	Not discernable given nature of the source
Trichloroethene*	--	Material released Daughter product of PCE	0 2[a/]	2	Not present in source but detected downgradient
DCE*	--	Material released Daughter product of PCE If cis is >80% of total DCE it is likely a daughter product 1,1-DCE can be chemical reaction product of TCA	0 2[a/]	0	Not discernable given nature of the source
VC*	--	Material released Daughter product of PCE	0 2[a/]	2	Not present in source but detected downgradient
1,1,1-Trichlorethane*	--	Material released	0	0	Not discernable given nature of the source

ANALYTICAL PARAMETERS AND WEIGHTING FOR PRELIMINARY SCREENING FOR ANAEROBIC BIODEGRADATION PROCESSES[1]
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Analysis	*Concentration in Most Contaminated Zone*	*Interpretation*	*Value*	*Points Awarded Site*	*Rationale/Justification*
DCA	--	Daughter product of TCA under reducing conditions	2	0	Not discernable given nature of the source
Carbon Tetrachloride	--	Material released	0	0	Not discernable given nature of the source
Chloroethane*	--	Daughter product of DCA or VC under reducing conditions	2	1	Not discernable given nature of the source
Ethene/Ethane	>0.01 mg/L >0.1 mg/L	Daughter product of VC/ethene	2 3	1	Further evaluation necessary
Chloroform	--	Material released Daughter product of Carbon Tetrachloride	0 2	0	Not discernable given nature of the source (could be related to heated tap water)
Dichloromethane	--	Material released Daughter product of Chloroform	0 2	0	Not discernable given nature of the source
		Total Points Awarded to Site		20	Any score above 14 points warrants further evaluation into natural attenuation mechanisms

Interpretation of Points Awarded During Screening

Score	*Interpretation*
0 to 5	Inadequate evidence for anaerobic biodegradation* of chlorinated organics
6 to 14	Limited evidence for anaerobic boidegradation* of chlorinated organics
15 to 20	Adequate evidence for anaerobic boidegradation* of chlorinated organics
>20	Strong evidence for anaerobic boidegradation* of chlorinated organics

**reductive declorination*

Notes

1 - Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater, EPA/600/R-98/128, September 1998, Table 2.3.

* - Required Analysis

a/ - Points awarded only if it can be shown that the compound is a daughter product (I.e. not a constituent of the source NAPL).

TABLE 4.1

SUMMARY OF PRELIMINARY REMEDIATION GOALS FOR VOLATILE ORGANIC COMPOUNDS OFF-SITE GROUNDWATER FOUR COUNTY LANDFILL SITE FULTON COUNTY, INDIANA

Analyte [1]	*Preliminary Remediation Goal for Groundwater (micrograms per Liter)* [2]
Benzene	5.0
Carbon tetrachloride	5.0
1,2-Dichloroethane	5.0
Vinyl chloride	2.0

1. Represents volatile organic compounds detected above primary Maximum Contaminant Levels (MCLs) in off-Site groundwater samples.
2. Represents primary MCLs promulgated as of September 2000.

TABLE 4.2

POTENTIAL CHEMICAL-SPECIFIC ARARS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Potential Chemical Specific Requirements	*Citation*
Water Quality Standards (Indiana)	327 IAC 2
Groundwater Protection Standard	40 CFR 264.92
National Primary and Secondary Drinking Water Regulations	40 CFR 141
National Secondary Drinking Water Regulations	40 CFR 143
Public Water Supply; Drinking Water Standards	327 IAC 8-2

TABLE 4.3

POTENTIAL FEDERAL AND STATE LOCATION-SPECIFIC ARARs[1]
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location	*Requirement*	*Citation*	*Applicable, Appropriate or Relevant*
Within 100-year floodplain	Facility must be designed, constructed, operated, and maintained to prevent washout.	40 CFR 264.18(b); 329 IAC 3.1[2]	NA
Within floodplain	Action must avoid adverse effects, minimize potential harm, and if necessary, restore and preserve natural and beneficial values of the floodplain.	Executive Order 11988, Floodplain Management, (40 CFR 6, Appendix A)	NA
Within floodplain in Indiana	Action must avoid adverse effects, minimize potential harm, and restore and preserve natural and beneficial values of the floodplain. Construction of abodes or residences is prohibited and prior approval of the IDNR is required for other types of construction, excavation, or filling in or on a floodway. This includes but is not limited to construction of a fence, water treatment facility, dredging, and/or dewatering in a floodway.	Indiana Flood Control Act (13-2-22)	NA
Wetland	Action must minimize the destruction, loss, or degradation of wetlands and to preserve the value of wetlands.	Executive Order 11990, Protection of Wetlands, (40 CFR 6, Appendix A)	Yes
	Discharge of dredged or fill material into wetlands without permit is prohibited. Water quality certification may also be required from IDEM.	Clean Water Act, Sections 401 and 404; 40 CFR Parts 230, 231	

TABLE 4.3

POTENTIAL FEDERAL AND STATE LOCATION-SPECIFIC ARARs[1]
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location	*Requirement*	*Citation*	*Applicable, Appropriate or Relevant*
Critical habitat upon which endangered species or threatened species depends	Action to conserve endangered species or threatened species, including consultation with the Department of Interior	Endangered Species Act of 1973 (16 USC 1531 et. Seq.); 50 CFR Part 200; 50 CFR Part 402 Fish and Wildlife Coordination Act (16 USC 661 et. seq.); 33 CFR Parts 320-330.	NA[3]
Near a coastal zone	Protect land and waters of coastal zones.	Coastal Zone Management Act, 16 USC 1451	NA
Near a designated coastal barrier	Minimize the damage to fish, wildlife and other natural resources associated with the coastal barriers.	Coastal Barrier Resources Act, 16 USC 3501	NA
Near a Federally-owned area designated as a wilderness area	Protect and preserve Federally designated areas as "wilderness areas".	Wilderness Act, 16 USC 1131	NA
Near a National Wildlife Refuge System	Conservation of fish and wildlife including species that are threatened.	Wildlife Refuge, 16 USC 668 dd; 50 CFR 27	NA

Notes:

[1]Modified from Exhibit 1-2 of USEPA's Draft Guidance CERCLA Compliance With Other Laws (August 1988).

[2]As of February 1992, Indiana adopted new hazardous waste rules titled 329 IAC 3.1, which adopt by reference the Code of Federal Regulations (40 CFR 260 through 270). The State rules generally only cover the administrative procedures while the federal rules cover the standards for RCRA generators and treatment, storage, and disposal facilities.

[3]The National Heritage Program identified a species of mudpuppy listed as a State rare species in a wetland in the vicinity of the landfill.

TABLE 4.4

POTENTIAL FEDERAL AND STATE ACTION-SPECIFIC ARARs[1]
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Actions	*Requirement*	*Citation*
Air stripping	Design system to provide odor-free operation.	CAA Section 101[2]
	Total organic emissions from air strippers be reduced below 1.4 kg/hour or 2.8 Mg/year (3 pounds/hr. or 3.1 tons/year); or that organic emissions be reduced 95 percent by weight	40 CFR 264 AA
	Register with Commissioner of the State of Indiana to include estimation of emission rates for each pollutant expected.	40 CFR 52[2]; 326 IAC 2-1-2
	Verify through emission estimates and dispersion modeling that hydrogen sulfide emissions do not create an ambient concentration greater than or equal to 0.10 ppm: Emissions standards for Hazardous Air Pollutants (HAPs)	40 CFR 61; 326 IAC 14
	Reduce VOC emissions using best available control technology (BACT) for facilities potentially producing emissions of 25 tons or more per year	326 IAC 8-1-6
	Verify facility specific MACT determination for sources of Hazardous Air Pollutants greater than 10 tons per year.	326 IAC 2-1-3-4
	Prevent significant deterioration using best available control technology, air quality analysis, and an analysis on visibility, soils, and generation for emissions greater than 25 tons per year (TPY) of particulate matter, 20 TPY for particulate <10 microns, 40 TPY VOCs, and 0.6 TPY lead.	40 CFR 131
	Follow RCRA generator standards for manifesting, handling, record keeping, and accumulation times for waste water, if determined to be hazardous.	40 CFR 262.10-262.44; 329 IAC 3.1-7[3]
Construction Activity	Stormwater runoff associated with construction activity.	327 IAC 15-5
	Fugitive dust emissions during construction activity	326 IAC 64
Direct discharge of treatment system effluent	Applicable federal water quality criteria for the protection of aquatic life must be complied with when environmental factors are being considered.	50 CFR 30784

TABLE 4.4

POTENTIAL FEDERAL AND STATE ACTION-SPECIFIC ARARs[1]
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Actions	*Requirement*	*Citation*
Direct discharge of treatment system effluent (continued)	Applicable federally approved state water quality standards must be complied with. These standards may be in addition to or more stringent than other federal standards under the CWA.	CWA Sections 301, 302, 303, 307, 318 and 405; 40 CFR 122.44 and state regulations approved under 40 CFR 131; 327 IAC 5-2-10; 327 IAC 2
	The discharge must be consistent with the requirement of a Water Quality Management Plan approved by EPA under Section 208(b) of the Clean Water Act.	CWA Section 208(b); 327 IAC 5-2-10[4]
	Use of best available technology (BAT) economically achievable is required to control toxic and nonconventional pollutants. Use of best conventional pollutant control technology (BCT) is required to control conventional pollutants. Technology-based effluent limitations may be determined on a case-by-case basis. In some cases, the permit limit for a conventional pollutant may be more stringent than BCT.	40 CFR 122.44(a) 327 IAC 5-5-2
	Discharge limitations must be established for all toxic pollutants that are or may be discharged at levels greater than those that can be achieved by technology-based standards.	40 CFR 122.44(e)
	Discharge of pollutants must conform to basic NPDES requirements	327 IAC 5-2-2
	Discharge must be monitored to assure compliance. Discharger will monitor:	40 CFR 122.44(i); 327 IAC 5-2-13
	The mass of each pollutant limited in the permit discharged; The volume of effluent discharged from each outfall; and Frequency of discharge and other measurements as appropriate.	
	The following records must be maintained:	
	Date, place, and time of sampling or measurements; Person(s) who performed sampling or measurement; Date(s) analyses were performed;	

TABLE 4.4

POTENTIAL FEDERAL AND STATE ACTION-SPECIFIC ARARs[1]
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Actions	*Requirement*	*Citation*
Direct discharge of treatment system effluent (continued)	Person(s) who performed analyses; Analytical techniques or methods used; and Results for measurements and analyses.	327 IAC 5-2-14; 40 CFR 122.41(j)
	The discharge monitoring reports (DMRs) must be submitted to IDEM as required by the permit (at least annually).	327 IAC 5-2-15
	Approved test methods for waste constituents to be monitored must be followed. Detailed requirements for analytical procedures and quality controls are provided. Permit application information must be submitted, including a description of activities, listing of environmental permits, etc.	40 CFR 122.44(i); 40 CFR 136; 327 IAC 5-2-13(c) 40 CFR 122.21(f)
	Comply with additional permit conditions such as:	40 CFR 122.41; 327 IAC 5-2-8
	Duty to mitigate any adverse effects of any discharge; Report to IDEM violations of maximum daily discharge for certain pollutants within 24 hours; and Proper operation and maintenance of treatment systems.	
	Develop and implement a Best Management Practices (BMP) program and incorporate in the NPDES permit to prevent the release of toxic constituents to surface waters.	40 CFR 125.100; 327 IAC 5-9
	The BMP program must:	40 CFR 125.104
	Establish specific objectives for the control of toxic and hazardous pollutant spills; Include a prediction of direction, rate of flow, and total quantity of toxic pollutants where experience indicates a reasonable potential for equipment failure; and Prescribe sample preservation procedures, container materials, and maximum allowable holding times.	40 CFR 136.1-136.4; 327 IAC 5-2-13(c)

TABLE 4.4

POTENTIAL FEDERAL AND STATE ACTION-SPECIFIC ARARs[1]
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Actions	*Requirement*	*Citation*
Discharge to POTW	Pollutants that pass through the POTW without treatment, interfere with POTW operation, or contaminate POTW sludge are prohibited.	40 CFR 403.5; 327 IAC 5-11-1
Discharge to POTW	Specific prohibitions preclude the discharge of pollutants to POTWs that: Create a fire or explosion hazard in the POTW; Are corrosive (pH<5.0); Result in the presence of toxic gases, vapors or fumes in a quantity that may cause health and safety problems; Obstruct flow resulting in interference; Are discharged at a flow rate and/or concentration that will result in interference; and/or Increase the temperature of wastewater entering the treatment plant that would result in interference, or raise the POTW influent temperature above 104°F (40°C).	40 CFR 403.5(b); 327 IAC 5-12-2(b)
	Determine acceptable degree of pretreatment for certain industrial wastewater prior to discharge into a POTW	326 IAC 2-1-3-4
	Discharge must comply with local POTW pretreatment program, including POTW-specific pollutants, spill prevention program requirements, and reporting and monitoring requirements.	40 CFR 403.5, 40 CFR 403.8 and local POTW regulations
	RCRA permit-by-rule requirements may be applicable to discharges of RCRA hazardous wastes to POTWs by truck, rail, or dedicated pipe.	40 CFR 264.71; 40 CFR 264.72; 40 CFR 262; 40 CFR 270.60(C); 40 CFR 264.1; 40 CFR 261.3(A)(2)(IV); CWA Section 402 or 307(b); 329 IAC 3.1-7[3]
Operation and maintenance (O&M)	Post-closure care to ensure that site is maintained and monitored.	40 CFR 264.118 (RCRA Subpart G); 329 IAC 3.1[3]
	Develop Contingency Plan and Emergency Procedures to minimize potential hazards from fires, explosions or any unplanned release during closure and post-closure status.	40 CFR 264 (Subpart D)

TABLE 4.4

POTENTIAL FEDERAL AND STATE ACTION-SPECIFIC ARARs[1]
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Actions	*Requirement*	*Citation*
Security	Sites should be secured in accordance with this rule which: 1) Requires prevention of unknowing and unauthorized entry of persons or livestock if physical contact with the waste, etc. could cause injury or, if disturbance of the waste, etc. would cause a violation. 2) The facility must have either: A 24 hour surveillance system which continuously monitors and controls entry or an artificial or natural barrier which completely surrounds the active portion and a means to control entry (i.e., a lock) at all times, through the gates or other entrances to the active portion. 3) "Danger - Unauthorized Personnel Keep Out" signs are required at each entrance and other locations sufficient to be seen from any approach, legible from a distance of at least 25 feet.	40 CFR 264.14 329 IAC 3.1-9
Slurry wall	Excavation of soil for construction of slurry wall may trigger cleanup or land disposal restrictions.	See Excavation in this table.
Surface water control and discharge	Prevent run-on, and control and collect runoff from a 24-hour, 25-year storm during closure and post-closure status.	40 CFR 264.301(f)(g)(h)(i); 329 IAC 3.1[3]
	Management of stormwater run-off associated with Construction Activity, and stormwater run-off associated with industrial activity.	327 IAC 15-5 327 IAC 15-6
Treatment	Prepare fugitive and odor emission control plan for this action.	CAA Section 101[2]; 40 CFR 52[2]
	Establish procedures for review of construction and operation of any source that has the potential to emit criteria air pollutants. Register with Commissioner of the State to include estimation of emission rates for each pollutant expected.	40 CFR 52[2]; 326 IAC 2
	Verify through emission estimates and dispersion modeling that hydrogen sulfide emissions do not create an ambient concentration greater than or equal to 0.10 ppm: Emissions Standards for Hazardous Air Pollutants (HAPs)	40 CFR 61[2]; 326 IAC 14

TABLE 4.4

POTENTIAL FEDERAL AND STATE ACTION-SPECIFIC ARARs[1]
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Actions	*Requirement*	*Citation*
Excavation	Develop fugitive and odor emission control plan for this action if existing site plan is inadequate.	CAA Section 101[2]; 40 CFR 52[2]
	Particulate emissions from earth moving and material handling activities must be controlled, such that no visible emissions cross the property line and the increase in upward/downward total suspended particulate concentration is limited to 50 $\mu g/m^3$.	326 IAC 6-4
	Register with Commissioner of the State to include estimation of emission rates for each pollutant expected.	40 CFR 52[2]; 326 IAC 2-1-2

Notes:

1 Modified from Exhibit 1-3 of USEPA's Draft Guidance CERCLA Compliance With Other Laws (August 1988) and Exhibit 1-3 of CERCLA Compliance With Other Laws, Part II (August 1989).

2 All of the Clean Air Act ARARs that have been established by the Federal government may be covered by matching State regulations. The State may have the authority to manage these programs through the approval of its implementation plans (40 CFR 52).

3 As of February 1992, Indiana adopted new hazardous waste rules titled 329 IAC 3.1, which adopt by reference the federal regulations 40 CFR 260 through 270. Therefore, any reference to these CFR citations implies coverage under the State rules. The State rules generally only cover the administrative procedures while the federal regulations cover the standards for RCRA generators and TSD facilities.

4 Tank storage requirements are for the storage of RCRA hazardous waste. A generator who accumulates or stores hazardous waste on site for 90 days or less in compliance with 40 CFR 262.34(a)(1-4) is not subject to the full RCRA storage requirements.

Key:

CAA = Clean Air Act
CFR = Code of Federal Regulations
CWA = Clean Water Act
IAC = Indiana Administrative Code
TSD = Treatment, Storage, and Disposal

TABLE 5.1

TECHNOLOGY SCREENING SUMMARY
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Technology	*Description*	*Effectiveness*	*Implementability*	*Short Term Risk*	*Relative Cost*	*Retain*
No Action						
No Action	No further remedial technologies are implemented at the Site	May not achieve remedial action objectives.	No Action alternative is required	None	Low	Yes
Administrative Controls and Monitoring						
Monitoring	Collection of environmental media samples	Effective at determining Site conditions	Easily implementable	Low	Low	Yes
Deed and Groundwater-Use Restrictions	Restrictive covenants on deed	Effective at minimizing potential exposure to groundwater	Easily implementable on west property. Difficult to implement north of the Site	None	Low	Yes
Restrictive Ordinances	State or Local zoning restrictions on property use	Ineffective at Site	Not implementable. No zoning ordinances	None	Low	No
Residential Water Supply						
Alternate Water Supply	Connect affected residences to a public water supply system	Potentially very effective at limiting potential exposure to groundwater	Difficult to implement due to engineering and maintenance requirements	Low	High	No
Point-of-Use Treatment	Install treatment units in affected residences	Potentially very effective at limiting potential exposure to groundwater	Easily implemented with cooperation of residents	Low	Low	Yes (contingency only)

TECHNOLOGY SCREENING SUMMARY
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Technology	*Description*	*Effectiveness*	*Implementability*	*Short Term Risk*	*Relative Cost*	*Retain*
Vertical Barriers						
Physical Barriers	Physical containment with slurry or sheetpile walls	Not effective below 50 feet in depth	Difficult to implement for deep (>50 feet) groundwater	Low to Moderate	High	No
Extraction, Treatment and Discharge						
Groundwater Extraction	Groundwater removal via extraction wells for treatment at the surface.	Effective for removal of contaminants	Implementable. Groundwater treatment system would be required. Treated groundwater must be discharged to surface or reinjected	Low to Moderate	High	Yes
Biological Treatment	Treat extracted groundwater using biomass	Effective particularly for highly organic waste	Implementable. Requires trained operator	Low	High	No
Chemical Treatment	Chemical Treatment to remove dissolved inorganics	Effective and proven technology	Implementable. Requires trained operator	Low	Moderate to High	Yes (pretreatment only)
Physical Treatment	Remove VOCs with air stripper or granular activated carbon	Effective and proven technologies	Implementable	Low	Moderate to High	Yes
Surface Water Discharge	Release treated groundwater to surface water body	Effective	Implementable. Requires NPDES permit	Low	Low to Moderate	Yes
Subsurface Injection	Release treated groundwater to subsurface via injection wells	Effective	Implementable. Requires discharge permit	Low	Low to Moderate	Yes

TECHNOLOGY SCREENING SUMMARY
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Technology	*Description*	*Effectiveness*	*Implementability*	*Short Term Risk*	*Relative Cost*	*Retain*
Off-Site Disposal	Transport groundwater to POTW or TSD facility	Effective	Difficult. Would require transport by truck	Moderate	High	No
In Situ Treatment						
Monitored Natural Attenuation	Relies on natural subsurface mechanisms to degrade contaminants	Can effectively degrade contaminants under appropriate circumstances	Easy to implement	Low	Low	Yes
Enhanced Biodegradation	Involves injection of appropriate co-substrates or cultures to improve natural anaerobic/aerobic degradation processes	Effective in degrading contaminants	Easy to implement	Low	Moderate	Yes
Biosparging	Involves the injection of air into groundwater at very low flow rates to enhance biodegradation	Effective in degrading contaminants	Easy to implement. Would require air injection equipment	Low	Moderate	Yes
Ozone Treatment	Involves injection of ozone into groundwater	Effectiveness limited due to depth of contaminant plume	Would require ozone generator	Low to moderate.	High	No
Permeable Reaction Barriers	Respective media placed in groundwater flow path	Effective at shallower depths	Difficult to implement for deep (>50 feet) groundwater	Low to Moderate	High	No

TABLE 7.1A

COST PROJECTION
ALTERNATIVE 2A -OPTION 1
GROUNDWATER TREATMENT SYSTEM (AIR STRIPPER) WITH MINIMAL INORGANICS PRETREATMENT AND SURFACE DISCHARGE
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Description	*Quantity*	*Unit*		*Unit Rate*		*Total Cost*
CAPITAL CONSTRUCTION COSTS						
Treatability Study	1	LS	$	125,000	$	125,000
Extraction Wells	1	EA	$	40,000	$	40,000
Forcemain	3,500	FT	$	35	$	122,500
Pumps & Equipment	1	EA	$	10,000	$	10,000
Equalization Tank	1	LS	$	5,000	$	5,000
Scalewatcher & Bag Filter	1	LS	$	30,000	$	30,000
Air Stripper with Blower	1	LS	$	70,000	$	70,000
Electrical and Controls	1	LS	$	75,000	$	75,000
Yard Piping, Pumping and Valving	1	LS	$	40,000	$	40,000
Building: 1000 ft^2	1	LS	$	60,000	$	60,000
Mobilization and Demobilization	1	LS	$	50,000	$	50,000
				Total Capital Costs:	**$**	**630,000**
OTHER CONSTRUCTION EXPENDITURES						
Contract Administration	%	5	$	31,500	$	31,500
Bonds and Insurance	%	5	$	31,500	$	31,500
Permits	%	5	$	31,500	$	31,500
Health and Safety	%	5	$	31,500	$	31,500
Construction Facilities and Temporary Controls	%	3	$	18,900	$	18,900
				Subtotal	$	144,900
				Engineering (25%)	$	193,725
				Contingencies (30%)	$	232,470
				TOTAL CONSTRUCTION COSTS	**$**	**1,200,000**
ANNUAL OPERATION & MAINTENANCE						
Monitoring	1	LS	$	50,000	$	50,000
Estimated Flow of 150 GPM	79,000,000	GAL		$1.60/1,000 gal	$	126,400
				ANNUAL O & M COSTS		**$176,400**
				30 Year Present Worth O & M Costs (5% Discount)	**$**	**2,720,000**
				TOTAL PRESENT WORTH COST	**$**	**3,920,000**

TABLE 7.1B

COST PROJECTION
ALTERNATIVE 2A - OPTION 1
GROUNDWATER TREATMENT SYSTEM (AIR STRIPPER) WITH FULL INORGANICS PRETREATMENT AND SURFACE DISCHARGE
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Description	*Quantity*	*Unit*		*Unit Rate*		*Total Cost*
CAPITAL CONSTRUCTION COSTS						
Treatability Study	1	LS	$	125,000	$	125,000
Extraction Wells	1	EA	$	40,000	$	40,000
Forcemain	3,500	FT	$	35	$	122,500
Pumps & Equipment	1	EA	$	10,000	$	10,000
Equalization Tank	1	LS	$	5,000	$	5,000
Clarifier with Polymer Addition System	1	LS	$	100,000	$	100,000
Sludge Management System	1	LS	$	150,000	$	150,000
Scalewatcher & Bag Filter	1	LS	$	30,000	$	30,000
Air Stripper with Blower	1	LS	$	70,000	$	70,000
Electrical and Controls	1	LS	$	75,000	$	75,000
Yard Piping, Pumping and Valving	1	LS	$	40,000	$	40,000
Building: 2000 ft^2	1	LS	$	120,000	$	120,000
Mobilization and Demobilization	1	LS	$	50,000	$	50,000
				Total Capital Costs:	**$**	**940,000**
OTHER CONSTRUCTION EXPENDITURES						
Contract Administration	%	5	$	47,000	$	47,000
Bonds and Insurance	%	5	$	47,000	$	47,000
Permits	%	5	$	47,000	$	47,000
Health and Safety	%	5	$	47,000	$	47,000
Construction Facilities and Temporary Controls	%	3	$	28,200	$	28,200
				Subtotal	$	216,200
				Engineering (25%)	$	289,050
				Contingencies (30%)	$	346,860
				TOTAL CONSTRUCTION COSTS	**$**	**1,790,000**
ANNUAL OPERATION & MAINTENANCE						
Monitoring	1	LS	$	50,000	$	50,000
Estimated Flow of 150 GPM	79,000,000	GAL		$2/1,000 gal	$	158,000
				ANNUAL O & M COSTS	**$**	**208,000**
				30 Year Present Worth O & M Costs (5% Discount)	**$**	**3,200,000**
				TOTAL PRESENT WORTH COST	**$**	**4,990,000**

TABLE 7.2A

COST PROJECTION
ALTERNATIVE 2A - OPTION 2
GROUNDWATER TREATMENT SYSTEM (AIR STRIPPER) WITH MINIMAL INORGANICS PRETREATMENT AND SUBSURFACE INJECTION
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Description	*Quantity*	*Unit*		*Unit Rate*		*Total Cost*
CAPITAL CONSTRUCTION COSTS						
Treatability Study	1	LS	$	125,000	$	125,000
Extraction Wells	1	EA	$	40,000	$	40,000
Forcemain	2,500	FT	$	35	$	87,500
Pumps & Equipment	1	EA	$	10,000	$	10,000
Injection Wells	3	EA	$	35,000	$	105,000
Equalization Tank	1	LS	$	5,000	$	5,000
Scalewatcher & Bag Filter	1	LS	$	30,000	$	30,000
Air Stripper with Blower	1	LS	$	70,000	$	70,000
Electrical and Controls	1	LS	$	75,000	$	75,000
Yard Piping, Pumping and Valving	1	LS	$	40,000	$	40,000
Building: 1000 ft^2	1	LS	$	60,000	$	60,000
Mobilization and Demobilization	1	LS	$	50,000	$	50,000
				Total Capital Costs:	**$**	**700,000**
OTHER CONSTRUCTION EXPENDITURES						
Contract Administration	%	5	$	35,000	$	35,000
Bonds and Insurance	%	5	$	35,000	$	35,000
Permits	%	8	$	56,000	$	56,000
Health and Safety	%	5	$	35,000	$	35,000
Construction Facilities and Temporary Controls	%	3	$	21,000	$	21,000
				Subtotal	**$**	**182,000**
				Engineering (25%)	$	220,500
				Contingency (30%)	$	264,600
				TOTAL CONSTRUCTION COSTS	**$**	**1,370,000**
ANNUAL OPERATION & MAINTENANCE						
Monitoring	1	LS	$	50,000	$	50,000
Estimated Flow of 150 GPM	79,000,000	GAL		$1.60/1,000 gal	$	126,400
				ANNUAL O & M COSTS	**$**	**176,400**
				30 Year Present Worth O & M Costs (5% Discount)	**$**	**2,720,000**
				TOTAL PRESENT WORTH COST	**$**	**4,090,000**

TABLE 7.2B

COST PROJECTION
ALTERNATIVE 2A - OPTION 2
GROUNDWATER TREATMENT SYSTEM (AIR STRIPPER) WITH FULL INORGANICS PRETREATMENT AND SUBSURFACE INJECTION
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Description	*Quantity*	*Unit*		*Unit Rate*		*Total Cost*
CAPITAL CONSTRUCTION COSTS						
Treatability Study	1	LS	$	125,000	$	125,000
Extraction Wells	1	EA	$	40,000	$	40,000
Forcemain	2,500	FT	$	35	$	87,500
Pumps & Equipment	1	EA	$	10,000	$	10,000
Injection Wells	3	EA	$	35,000	$	105,000
Equalization Tank	1	LS	$	5,000	$	5,000
Clarifier with Polymer Addition System	1	LS	$	100,000	$	100,000
Sludge Management System	1	LS	$	150,000	$	150,000
Scalewatcher & Bag Filter	1	LS	$	30,000	$	30,000
Air Stripper with Blower	1	LS	$	70,000	$	70,000
Electrical and Controls	1	LS	$	75,000	$	75,000
Yard Piping, Pumping and Valving	1	LS	$	40,000	$	40,000
Building: 2000 ft^2	1	LS	$	120,000	$	120,000
Mobilization and Demobilization	1	LS	$	50,000	$	50,000
				Total Capital Costs:	**$**	**1,010,000**
OTHER CONSTRUCTION EXPENDITURES						
Contract Administration	%	5	$	50,500	$	50,500
Bonds and Insurance	%	5	$	50,500	$	50,500
Permits	%	8	$	80,800	$	80,800
Health and Safety	%	5	$	50,500	$	50,500
Construction Facilities and Temporary Controls	%	3	$	30,300	$	30,300
				Subtotal	**$**	**262,600**
				Engineering (25%)	$	318,150
				Contingency (30%)	$	381,780
				TOTAL CONSTRUCTION COSTS	**$**	**1,970,000**
ANNUAL OPERATION & MAINTENANCE						
Monitoring	1	LS	$	50,000	$	50,000
For Estimated Flow of 150 GPM	79,000,000	GAL		$2/1,000 gal	$	158,000
				ANNUAL O & M COSTS	**$**	**208,000**
				30 Year Present Worth O & M Costs (5% Discount)	**$**	**3,200,000**
				TOTAL PRESENT WORTH COST	**$**	**5,170,000**

TABLE 7.3A

COST PROJECTION
ALTERNATIVE 2B - OPTION 1
GROUNDWATER TREATMENT SYSTEM (GAC) WITH MINIMAL INORGANICS PRETREATMENT AND SURFACE DISCHARGE
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Description	*Quantity*	*Units*		*Unit Rate*		*Total Cost*
CAPITAL CONSTRUCTION COSTS						
Treatability Study	1	LS	$	125,000	$	125,000
Extraction Wells	1	EA	$	40,000	$	40,000
Pumps & Equipment	1	EA	$	10,000	$	10,000
Subsurface Conveyance	3,500	FT	$	35	$	122,500
Equalization Tank	1	LS	$	5,000	$	5,000
Scalewatcher & Bag Filter	1	LS	$	30,000	$	30,000
GAC Adsorbers (10,000 lb)	2	EA	$	30,000	$	60,000
Electrical and Controls	1	LS	$	95,000	$	95,000
Yard piping, pumping and valving	1	LS	$	50,000	$	50,000
Building: 1500 ft^2	1	LS	$	75,000	$	75,000
Mobilization and Demobilization	1	LS	$	50,000	$	50,000
				Total Capital Costs:	**$**	**660,000**
OTHER CONSTRUCTION EXPENDITURES						
Contract Administration	%	5	$	33,000	$	33,000
Bonds and Insurance	%	5	$	33,000	$	33,000
Permits	%	5	$	33,000	$	33,000
Health and Safety	%	5	$	33,000	$	33,000
Construction Facilities and Temporary Controls	%	3	$	19,800	$	19,800
				Subtotal	$	151,800
				Engineering (25%)		202,950
				Contingencies (30%)	$	243,540
				TOTAL CONSTRUCTION COSTS	**$**	**1,260,000**
ANNUAL OPERATION & MAINTENANCE						
Monitoring	1	LS	$	50,000	$	50,000
For Estimated Flow of 150 GPM	79,000,000	GAL	$	4/1,000 gal	$	316,000
				ANNUAL O & M COSTS	$	366,000
				30 Year Present Worth O & M Costs (5% Discount)	**$**	**5,640,000**
				TOTAL PRESENT WORTH COST	**$**	**6,900,000**

TABLE 7.3B

COST PROJECTION
ALTERNATIVE 2B - OPTION 1
GROUNDWATER TREATMENT SYSTEM (GAC) WITH FULL INORGANICS PRETREATMENT AND SURFACE DISCHARGE
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Description	*Quantity*	*Units*		*Unit Rate*		*Total Cost*
CAPITAL CONSTRUCTION COSTS						
Treatability Study	1	LS	$	125,000	$	125,000
Extraction Wells	1	EA	$	40,000	$	40,000
Pumps & Equipment	1	EA	$	10,000	$	10,000
Subsurface Conveyance	3,500	FT	$	35	$	122,500
Equalization Tank	1	LS	$	5,000	$	5,000
Clarifier with Polymer Addition System	1	LS	$	100,000	$	100,000
Sludge Management System	1	LS	$	150,000	$	150,000
Scalewatcher & Bag Filter	1	LS	$	30,000	$	30,000
GAC Adsorbers (10,000 lb)	2	EA	$	30,000	$	60,000
Electrical and Controls	1	LS	$	95,000	$	95,000
Yard piping, pumping and valving	1	LS	$	50,000	$	50,000
Building: 2500 ft^2	1	LS	$	150,000	$	150,000
Mobilization and Demobilization	1	LS	$	50,000	$	50,000
				Total Capital Costs:	**$**	**990,000**
OTHER CONSTRUCTION EXPENDITURES						
Contract Administration	%	5	$	49,500	$	49,500
Bonds and Insurance	%	5	$	49,500	$	49,500
Permits	%	5	$	49,500	$	49,500
Health and Safety	%	5	$	49,500	$	49,500
Construction Facilities and Temporary Controls	%	3	$	29,700	$	29,700
				Subtotal	**$**	227,700
				Engineering (25%)		304,425
				Contingencies (30%)	$	365,310
				TOTAL CONSTRUCTION COSTS	**$**	**1,890,000**
ANNUAL OPERATION & MAINTENANCE						
Monitoring	1	LS	$	50,000	$	50,000
For Estimated Flow of 150 GPM	79,000,000	GAL	$	5/1,000 gal	$	395,000
				ANNUAL O & M COSTS	**$**	445,000
				30 Year Present Worth O & M Costs (5% Discount)	**$**	**6,850,000**
				TOTAL PRESENT WORTH COST	**$**	**8,740,000**

TABLE 7.4A

COST PROJECTION
ALTERNATIVE 2B - OPTION 2
GROUNDWATER TREATMENT SYSTEM (GAC) WITH MINIMAL INORGANICS PRETREATMENT AND SUBSURFACE INJECTION
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Description	*Quantity*	*Units*		*Unit Rate*		*Total Cost*
CAPITAL CONSTRUCTION COSTS						
Treatability Study	1	LS	$	125,000	$	125,000
Extraction Wells	1	EA	$	40,000	$	40,000
Pumps & Equipment	1	EA	$	10,000	$	10,000
Forcemain	2,500	FT	$	35	$	87,500
Injection Wells	3	EA	$	35,000	$	105,000
Equalization Tank	1	LS	$	5,000	$	5,000
Scalewatcher & Bag Filter	1	LS	$	30,000	$	30,000
GAC Adsorbers (10,000 lb)	2	EA	$	30,000	$	60,000
Electrical and Controls	1	LS	$	95,000	$	95,000
Yard piping, pumping and valving	1	LS	$	50,000	$	50,000
Building: 1500 ft^2	1	LS	$	75,000	$	75,000
Mobilization and Demobilization	1	LS	$	50,000	$	50,000
				Total Capital Costs:	**$**	**730,000**
OTHER CONSTRUCTION EXPENDITURES						
Contract Administration	%	5	$	36,500	$	36,500
Bonds and Insurance	%	5	$	36,500	$	36,500
Permits	%	8	$	58,400	$	58,400
Health and Safety	%	5	$	36,500	$	36,500
Construction Facilities and Temporary Control	%	3	$	21,900	$	21,900
				Subtotal	**$**	189,800
				Engineering (25%)		229,950
				Contingencies (30%)		275,940
				TOTAL CONSTRUCTION COSTS	**$**	**1,430,000**
ANNUAL OPERATION & MAINTENANCE						
Monitoring	1	LS	$	50,000	$	50,000
For Estimated Flow of 150 GPM	79,000,000	GAL	$	4/1,000 gal	$	316,000
				ANNUAL O & M COSTS	**$**	366,000
				30 Year Present Worth O & M Costs (5% Discount)	**$**	**5,640,000**
				TOTAL PRESENT WORTH COST	**$**	**7,070,000**

TABLE 7.4B

COST PROJECTION
ALTERNATIVE 2B - OPTION 2
GROUNDWATER TREATMENT SYSTEM (GAC) WITH FULL INORGANICS PRETREATMENT AND SUBSURFACE INJECTION
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Description	*Quantity*	*Units*		*Unit Rate*		*Total Cost*
CAPITAL CONSTRUCTION COSTS						
Treatability Study	1	LS	$	125,000	$	125,000
Extraction Wells	1	EA	$	40,000	$	40,000
Pumps & Equipment	1	EA	$	10,000	$	10,000
Forcemain	2,500	FT	$	35	$	87,500
Injection Wells	3	EA	$	35,000	$	105,000
Equalization Tank	1	LS	$	5,000	$	5,000
Clarifier with Polymer Addition System	1	LS	$	100,000	$	100,000
Sludge Management System	1	LS	$	150,000	$	150,000
Scalewatcher & Bag Filter	1	LS	$	30,000	$	30,000
GAC Adsorbers (10,000 lb)	2	EA	$	30,000	$	60,000
Electrical and Controls	1	LS	$	95,000	$	95,000
Yard piping, pumping and valving	1	LS	$	50,000	$	50,000
Building: 2500 ft^2	1	LS	$	150,000	$	150,000
Mobilization and Demobilization	1	LS	$	50,000	$	50,000
				Total Capital Costs:	**$**	**1,060,000**
OTHER CONSTRUCTION EXPENDITURES						
Contract Administration	%	5	$	53,000	$	53,000
Bonds and Insurance	%	5	$	53,000	$	53,000
Permits	%	8	$	84,800	$	84,800
Health and Safety	%	5	$	53,000	$	53,000
Construction Facilities and Temporary Control	%	3	$	31,800	$	31,800
				Subtotal	**$**	275,600
				Engineering (25%)		333,900
				Contingencies (30%)		400,680
				TOTAL CONSTRUCTION COSTS	**$**	**2,070,000**
ANNUAL OPERATION & MAINTENANCE						
Monitoring	1	LS	$	50,000	$	50,000
For Estimated Flow of 150 GPM	79,000,000	GAL	$	5/1,000 gal	$	395,000
				ANNUAL O & M COSTS	$	445,000
				30 Year Present Worth O & M Costs (5% Discount)	**$**	**6,850,000**
				TOTAL PRESENT WORTH COST	**$**	**8,920,000**

TABLE 7.5

COST PROJECTION
ALTERNATIVE 3A
MONITORED NATURAL ATTENUATION
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Description	*Units*	*Quantity*	*Unit Price*	*Total*
CAPITAL CONSTRUCTION COSTS				
Monitoring Well Installation Contingency	LS	--	$ 20,000	$ 20,000
OTHER CONSTRUCTION EXPENDITURES				
Contract Administration	%	5	$ 1,000	$ 1,000
Bonds and Insurance	%	3	$ 600	$ 600
Permits	%	3	$ 600	$ 600
Health and Safety	%	3	$ 600	$ 600
Construction Facilities and Temporary Controls	%	2	$ 400	$ 400
			Subtotal	**$ 3,200**
			Engineering (25%)	$ 5,800
			Contingencies (30%)	$ 6,000
			TOTAL CONSTRUCTION COST	**$ 35,000**
ANNUAL OPERATION & MAINTENANCE				
Inspections, Sampling, Analysis, and Reporting	LS	-	$ 52,000	$ 52,000
			TOTAL ANNUAL O & M COST	**$ 52,000**
			30 Year Present Worth O & M Cost (5% Discount)	**$ 800,000**
			TOTAL PRESENT WORTH COST	**$ 840,000**

TABLE 7.6

COST PROJECTION
ALTERNATIVE 3B
ENHANCED BIODEGRADATION
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Description		*Quantity*	*Unit Price*	*Total Cost*
CAPITAL CONSTRUCTION COSTS				
Treatability Study	LS	1	$ 100,000	$ 100,000
Shallow Amendment Wells				
Drilling and Installation (70'deep)	EA	12	$ 3,500	$ 42,000
Piping	LS	1	$ 2,400	$ 2,400
Deep Amendment Wells				
Drilling and Installation (110' deep)	EA	35	$ 5,500	$ 192,500
Piping	LS	1	$ 7,200	$ 7,200
Mobilization and Demobilization	LS	1	$ 10,000	$ 10,000
Monitoring Well Installation Contingency	LS	--	$ 20,000	$ 20,000
Access Road	LS	1	$ 3,000	$ 3,000
			Subtotal	**$ 377,100**
OTHER CONSTRUCTION EXPENDITURES				
Contract Administration	%	5	$ 18,855	$ 18,855
Bonds and Insurance	%	3	$ 11,313	$ 11,313
Permits	%	3	$ 11,313	$ 11,313
Health and Safety	%	3	$ 11,313	$ 11,313
Construction Facilities and Temporary Controls	%	2	$ 7,542	$ 7,542
			Subtotal	**$ 60,336**
			Engineering (25%)	$ 109,359
			Contingencies (30%)	$ 113,130
			TOTAL CONSTRUCTION COST	**$ 660,000**
ANNUAL OPERATION & MAINTENANCE				
Year 1				
Amendment Injections	LS			$ 100,000
Monitoring	LS			$ 50,000
			ANNUAL O & M COSTS - YEAR 1	**$ 150,000**
Years 2 through 30				
Amendment Injections	LS			$ 20,000
Monitoring	LS			$ 52,000
			ANNUAL O & M COST YEARS 2 THROUGH 30	**$ 72,000**
			30 Year Present Worth O & M Cost (5% Discount)	**$ 1,260,000**
			TOTAL PRESENT WORTH COST	**$ 1,920,000**

TABLE 7.7

COST PROJECTION
ALTERNATIVE 3C
BIOSPARGING
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Description	*Units*	*Quantity*	*Unit Rate*	*Total Cost*
CAPITAL CONSTRUCTION COSTS				
Treatability Study	LS	1	$ 75,000	$ 75,000
Shallow Biosparge Wells				
Drilling and Installation (70'deep)	EA	12	$ 3,500	$ 42,000
Piping	EA	1	$ 7,500	$ 7,500
Deep Biosparge Wells				
Drilling and Installation (110' deep)	EA	35	$ 5,500	$ 192,500
Piping	EA	1	$ 15,000	$ 15,000
Treatment Building	LS	1	$ 75,000	$ 75,000
Compressor	LS	1	$ 10,000	$ 10,000
Yard Piping	LS	1	$ 40,000	$ 40,000
Electrical Controls	LS	1	$ 25,000	$ 25,000
Access Roadway and Repair of Route 525 North	LS	1	$ 3,000	$ 3,000
Monitoring Well Installation Contingency	LS	--	$ 20,000	$ 20,000
Mobilization and Demobilization	LS	1	$ 20,000	$ 20,000
			Total Capital Costs	**$ 530,000**
OTHER CONSTRUCTION EXPENDITURES				
Contract Administration	%	5	$ 26,500	$ 26,500
Bonds and Insurance	%	5	$ 26,500	$ 26,500
Permits	%	3	$ 15,900	$ 10,600
Health and Safety	%	5	$ 26,500	$ 26,500
Construction Facilities and Temporary Controls	%	3	$ 15,900	$ 15,900
			Subtotal	**$ 106,000**
			Engineering (25%)	$ 159,000
			Contingencies (30%)	$ 190,800
			TOTAL CONSTRUCTION COST	**$ 990,000**
ANNUAL OPERATION & MAINTENANCE				
Year 1				
Amendment Injections	LS			$ 75,000
Monitoring	LS			$ 50,000
			ANNUAL O & M COST YEAR 1	**$ 125,000**
Year 2 through 30				
Amendments	LS			$ 10,000
Monitoring	LS			$ 52,000
			ANNUAL O & M COST YEARS 2 THROUGH 30	**$ 62,000**
			Present Worth O & M Cost (5% Discount)	**$ 1,080,000**
			TOTAL PRESENT WORTH COST	**$ 2,070,000**

REMEDIAL ALTERNATIVES COMPARISON
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

	Alternative 1	*Alternative 2A*	*Alternative 2B*	*Alternative 3A*	*Alternative 3B*	*Alternative 3C*
	No Further Action	*Groundwater Extraction and Air Stripping*	*Groundwater Extraction and GAC Treatment*	*Monitored Natural Attenuation*	*Enhanced Biodegradation*	*Biosparging*
Evaluation Criteria						
Overall Protection of Human Health and Environment	Provides no additional protection.	Protective of human health and the environment.	Protective of human health and the environment.	Protective of human health and the environment.	Protective of human health and the environment.	Protective of human health and the environment.
Compliance with ARARs	May not comply with ARARs.	Complies with ARARs.	Complies with ARARs.	Complies with ARARs.	Complies with ARARs.	Complies with ARARs.
Long-Term Effectiveness and Permanence	Provides no further remediation at the Site.	Reduces concentrations of contaminants in groundwater. May not attain health levels	Reduces concentrations of contaminants in groundwater. May not attain health levels	Can be effective in certain environments. Additional monitoring required.	Enhances natural biodegradation mechanisms. Additional monitoring required.	Enhances natural biodegradation mechanisms. Additional monitoring required.
Reduction of Toxicity, Mobility or Volume of Materials	Would not reduce toxicity, mobility or volume of materials.	Would reduce mobility, toxicity and volume.	Would reduce mobility, toxicity and volume.	Would reduce mobility, toxicity and volume.	Would reduce mobility, toxicity and volume.	Would reduce mobility, toxicity and volume.
Short-Term Effectiveness	No risk posed to workers during implementation.	Utilizes standard construction procedures. Workers potentially exposed to contaminated soil and groundwater during construction.	Utilizes standard construction procedures. Workers potentially exposed to contaminated soil and groundwater during construction.	Utilizes standard construction procedures. Workers potentially exposed to contaminated soil and groundwater during construction.	Utilizes standard construction procedures. Workers potentially exposed to contaminated soil and groundwater during construction.	Utilizes standard construction procedures. Workers potentially exposed to contaminated soil and groundwater during construction.
Implementability	Easily Implemented	Implementable. Not as easily implemented as in-situ alternatives.	Implementable. Not as easily implemented as in-situ alternatives.	Easily implemented.	Easily implemented.	Easily implemented.

REMEDIAL ALTERNATIVES COMPARISON
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

	Alternative 1	*Alternative 2A*	*Alternative 2B*	*Alternative 3A*	*Alternative 3B*	*Alternative 3C*
	No Further Action	*Groundwater Extraction and Air Stripping*	*Groundwater Extraction and GAC Treatment*	*Monitored Natural Attenuation*	*Enhanced Biodegradation*	*Biosparging*
Evaluation Criteria						
Cost (30 Year Present Worth)	No additional cost.	Option 1 - $4.0 to $5.0 million Option 2 - $4.1 to $5.2 million	Option 1 - $6.9 to 8.7 million Option 2 - $7.0 to 8.9 million	$0.84 Million	$1.9 Million	$2.1 Million
Agency Acceptance	Acceptance to be determined.	Acceptance to be determined.	Acceptance to be determined.	Acceptance to be determined.	Acceptance to be determined.	Acceptance to be determined.
Community Acceptance	Acceptance to be determined.	Acceptance to be determined.	Acceptance to be determined.	Acceptance to be determined.	Acceptance to be determined.	Acceptance to be determined.

APPENDIX A

OU2 GROUNDWATER CONTOUR FIGURES

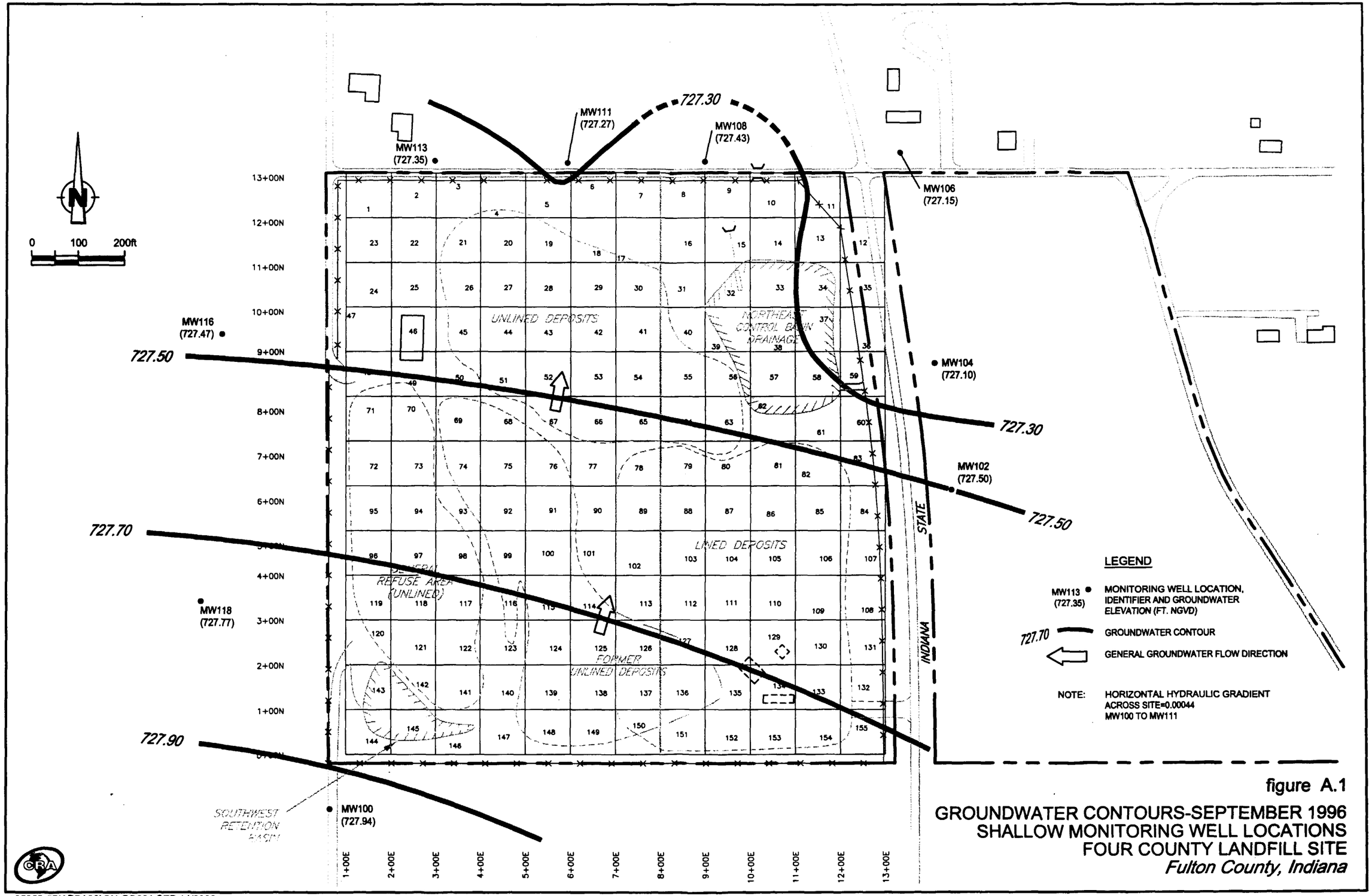


figure A.1

GROUNDWATER CONTOURS-SEPTEMBER 1996
SHALLOW MONITORING WELL LOCATIONS
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

05369-67(APPA26)GN-CO001 SEP 14/2000

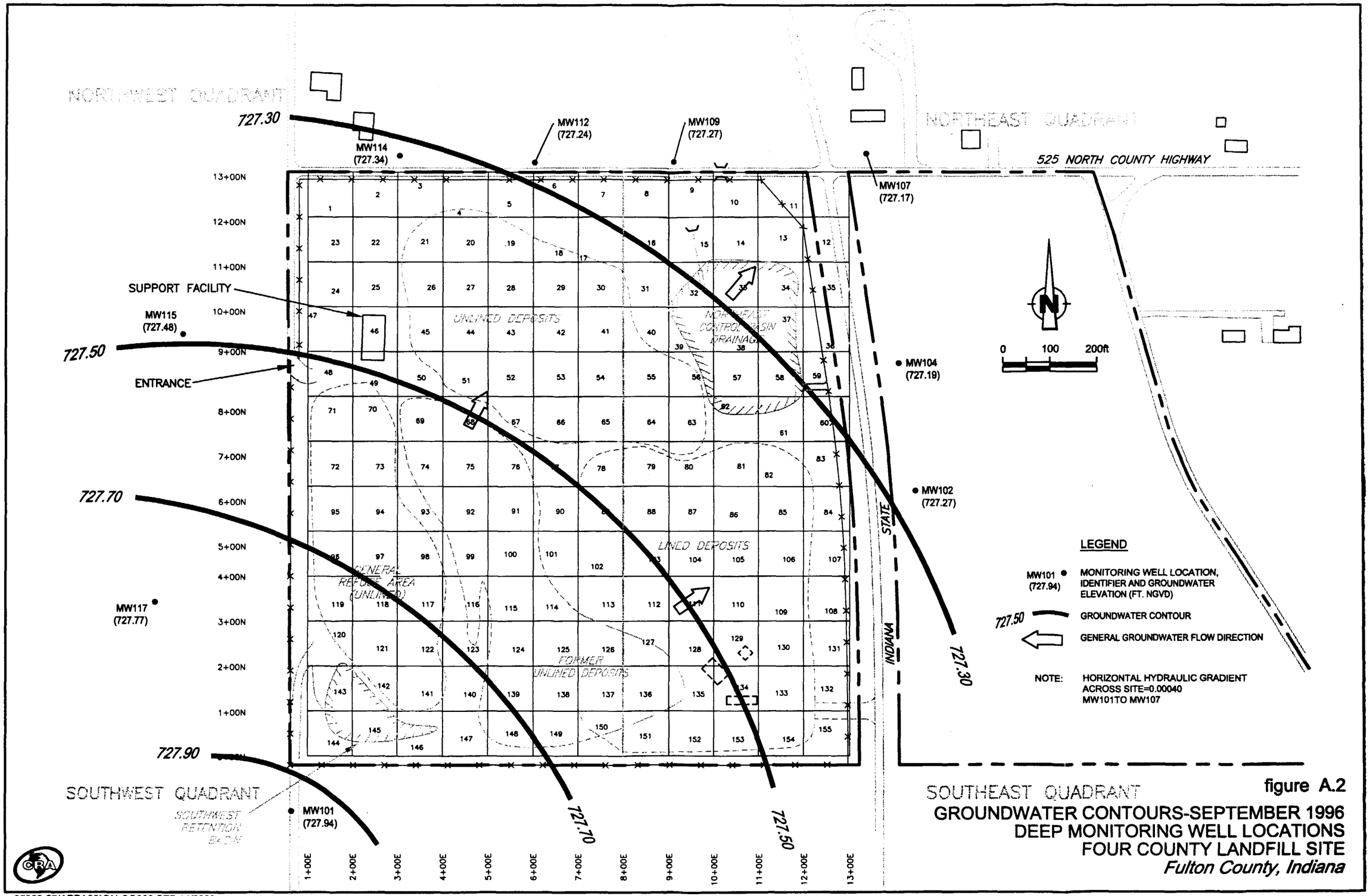


figure A.2

GROUNDWATER CONTOURS-SEPTEMBER 1996
DEEP MONITORING WELL LOCATIONS
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

05369-67(APPA26)GN-CO002 SEP 14/2000

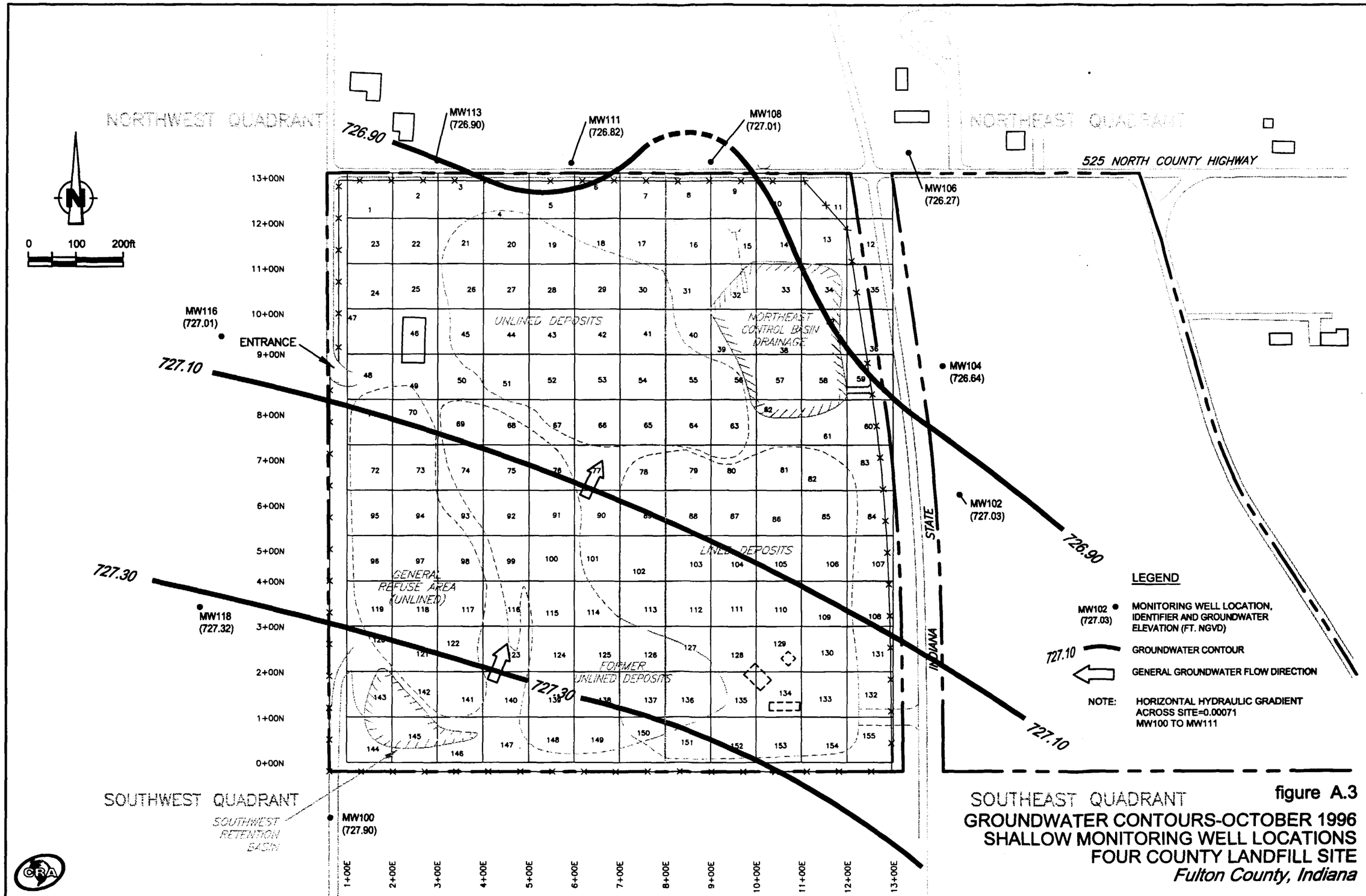


figure A.3

GROUNDWATER CONTOURS-OCTOBER 1996
SHALLOW MONITORING WELL LOCATIONS
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

05369-67(APPA26)GN-CO003 SEP 14/2000

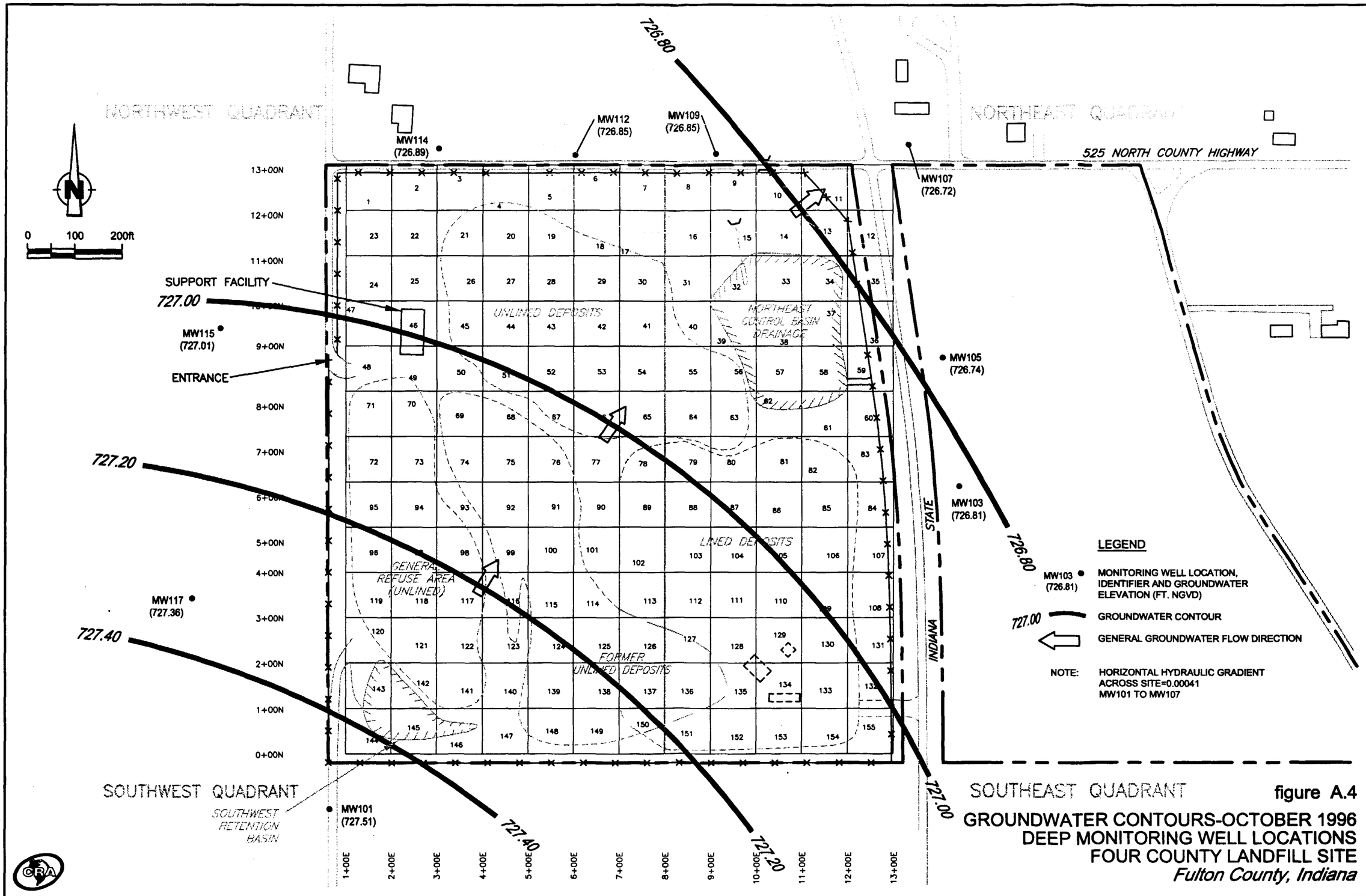
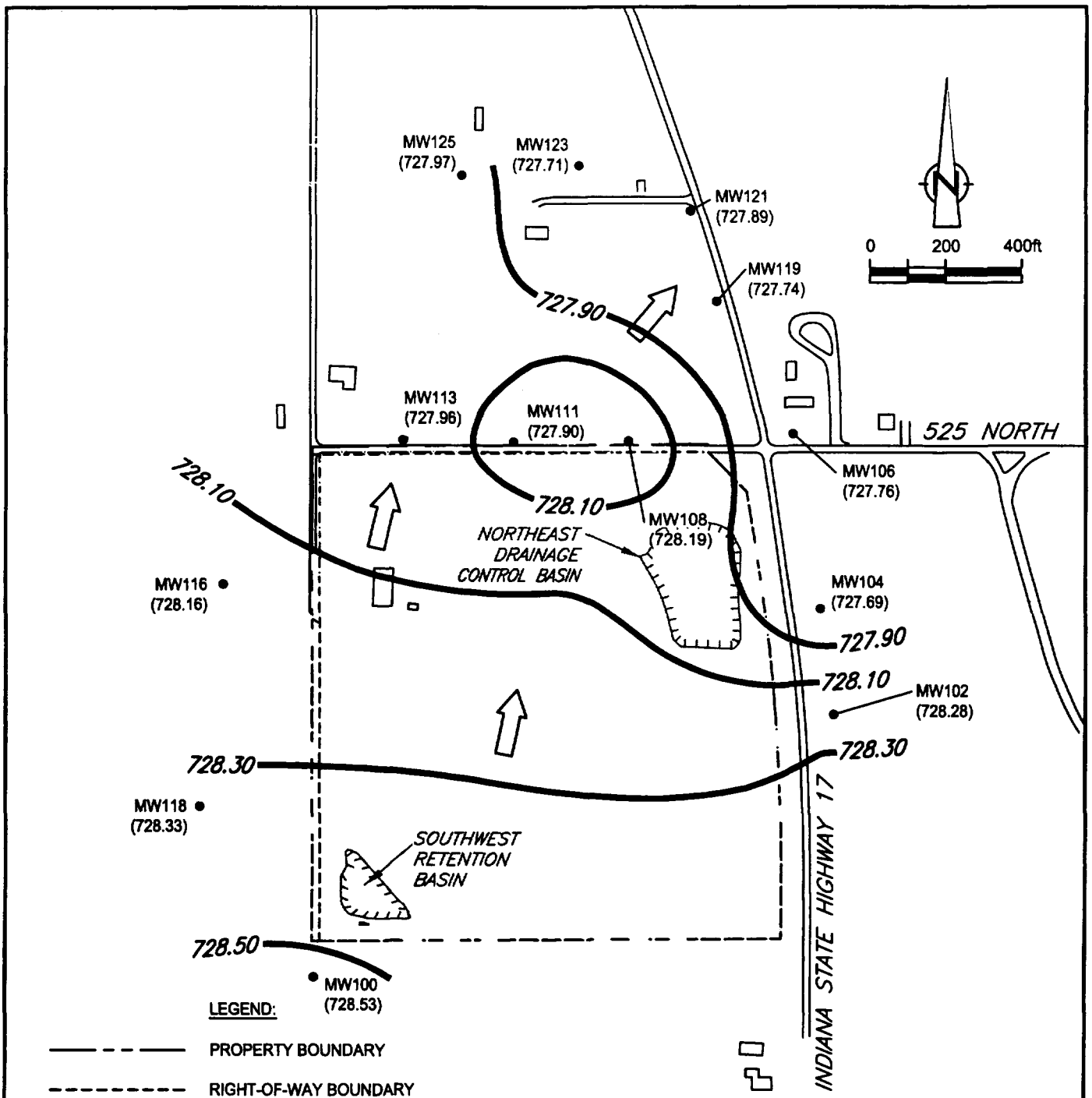


figure A.4

GROUNDWATER CONTOURS-OCTOBER 1996
DEEP MONITORING WELL LOCATIONS
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

05369-67(APPA26)GN-CO004 SEP 14/2000



LEGEND:

——— - - - ———	PROPERTY BOUNDARY
- - - - - - - - -	RIGHT-OF-WAY BOUNDARY
	FENCE LINE
MW100 ●	MONITORING WELL LOCATION AND IDENTIFIER
(728.52)	GROUNDWATER ELEVATION (FT., AMSL)
727.90 ———	GROUNDWATER CONTOUR
⇨	GROUNDWATER FLOW DIRECTION

NOTE: HORIZONTAL HYDRAULIC GRADIENT ACROSS SITE=0.00039 MW100 TO MW113

figure A.5

GROUNDWATER CONTOURS-NOVEMBER 17, 1997
SHALLOW OFF-SITE MONITORING WELL LOCATIONS
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

05369-67(APPA26)GN-CO005 SEP 14/2000

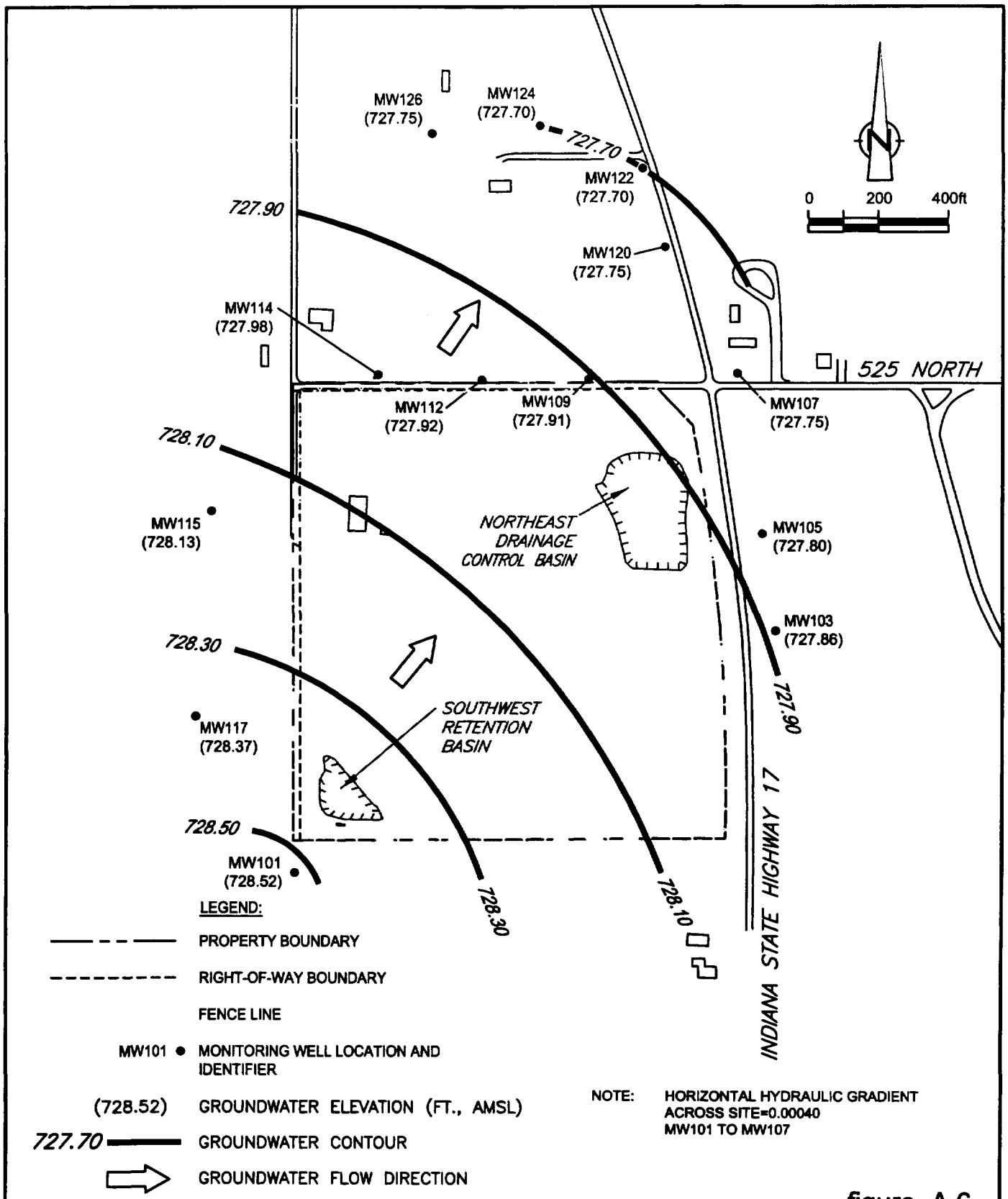
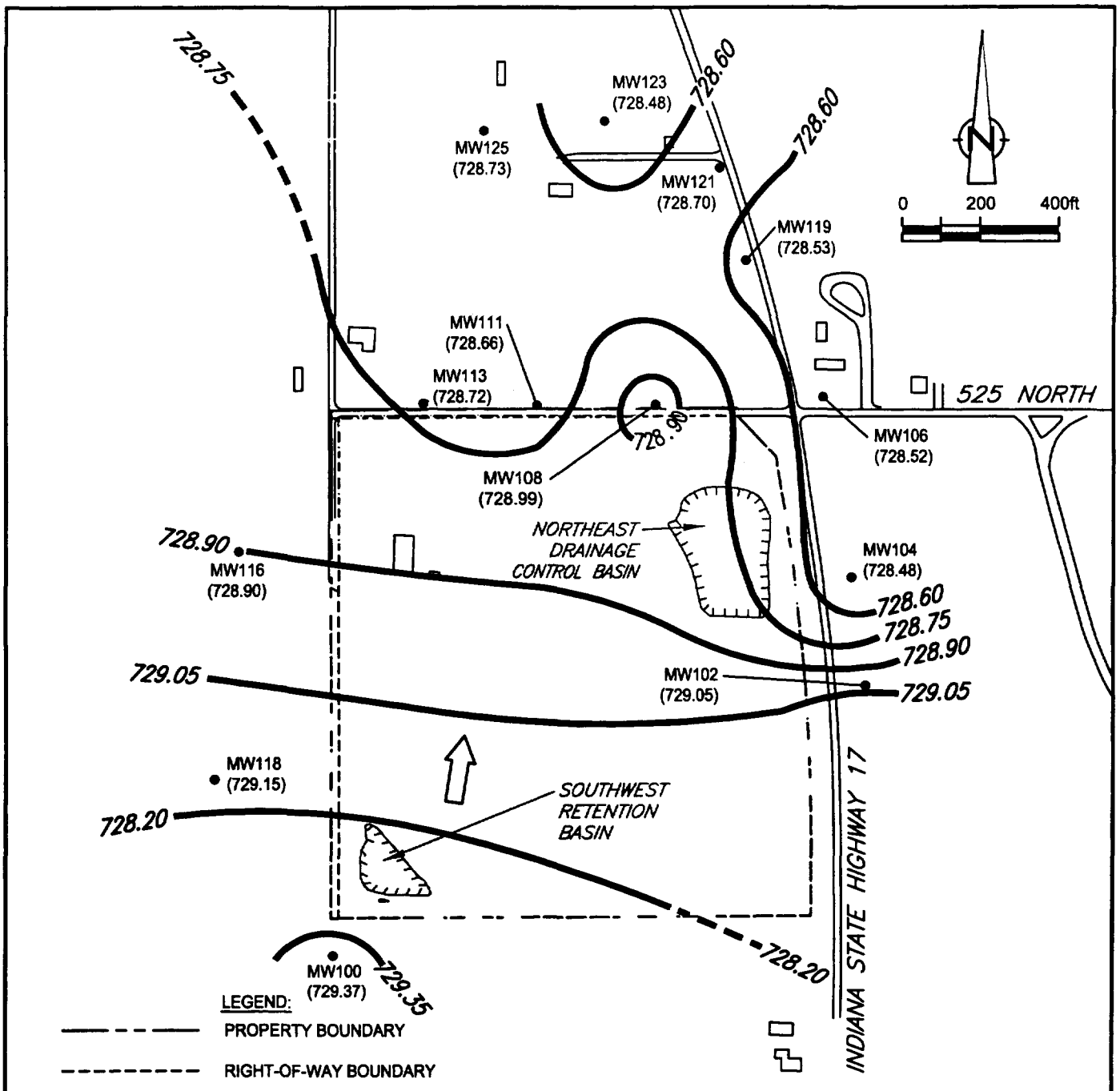


figure A.6

GROUNDWATER CONTOURS-NOVEMBER 17, 1997
DEEP OFF-SITE MONITORING WELL LOCATIONS
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

05369-67(APPA26)GN-CO006 SEP 14/2000



LEGEND:

PROPERTY BOUNDARY

RIGHT-OF-WAY BOUNDARY

FENCE LINE

MW100 ● MONITORING WELL LOCATION AND IDENTIFIER

728.48 GROUNDWATER ELEVATION (FT., AMSL)

728.60 GROUNDWATER CONTOUR

GROUNDWATER FLOW DIRECTION

NOTE: HORIZONTAL HYDRAULIC GRADIENT ACROSS SITE=0.00045 MW100 TO MW113

figure A.7

GROUNDWATER CONTOURS-SEPTEMBER 15, 1998
SHALLOW OFF-SITE MONITORING WELL LOCATIONS
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

05369-67(APPA26)GN-CO007 SEP 14/2000

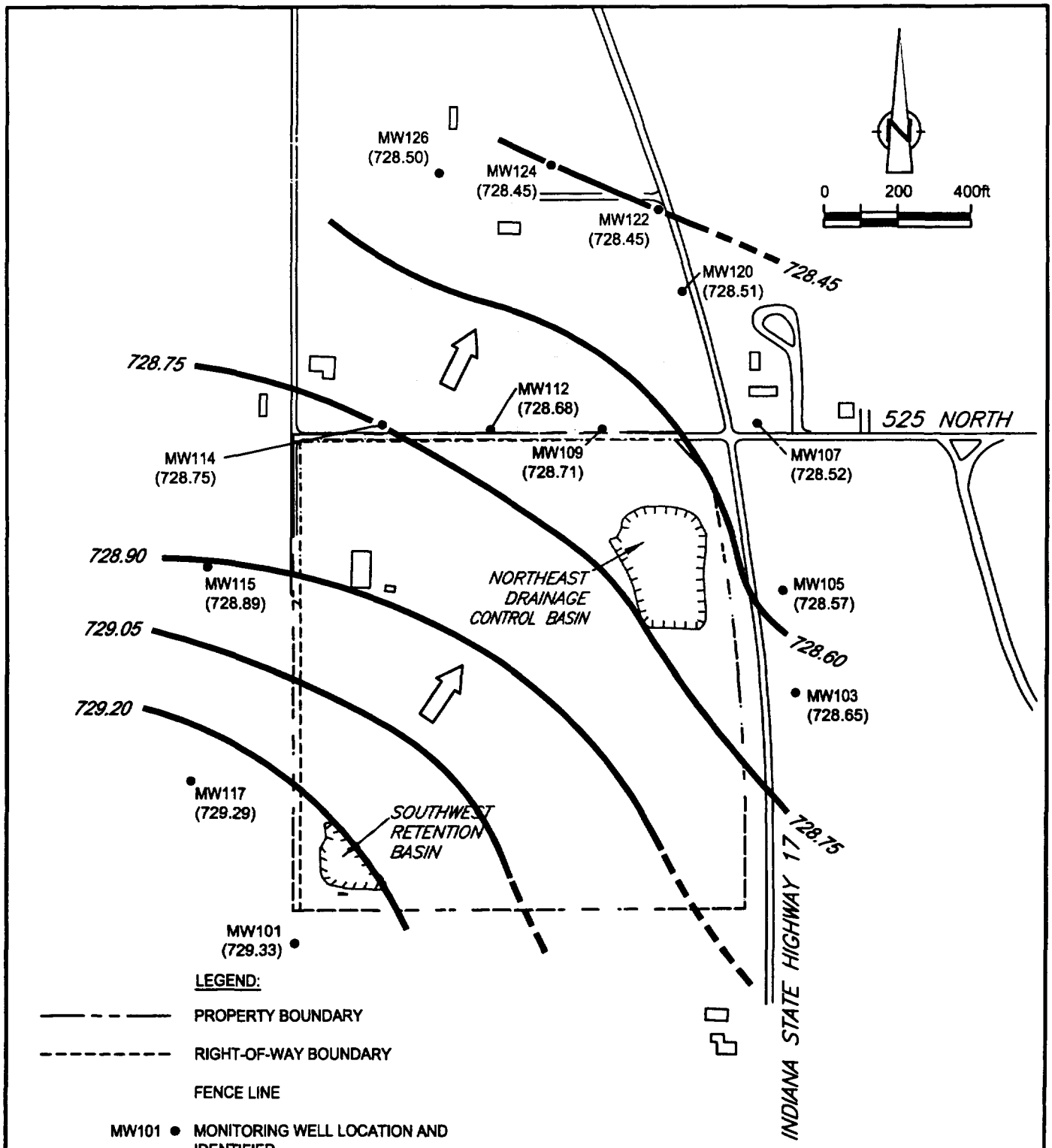


figure A.8

GROUNDWATER CONTOURS-SEPTEMBER 15, 1998
DEEP OFF-SITE MONITORING WELL LOCATIONS
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

05369-67(APPA26)GN-CO008 SEP 14/2000

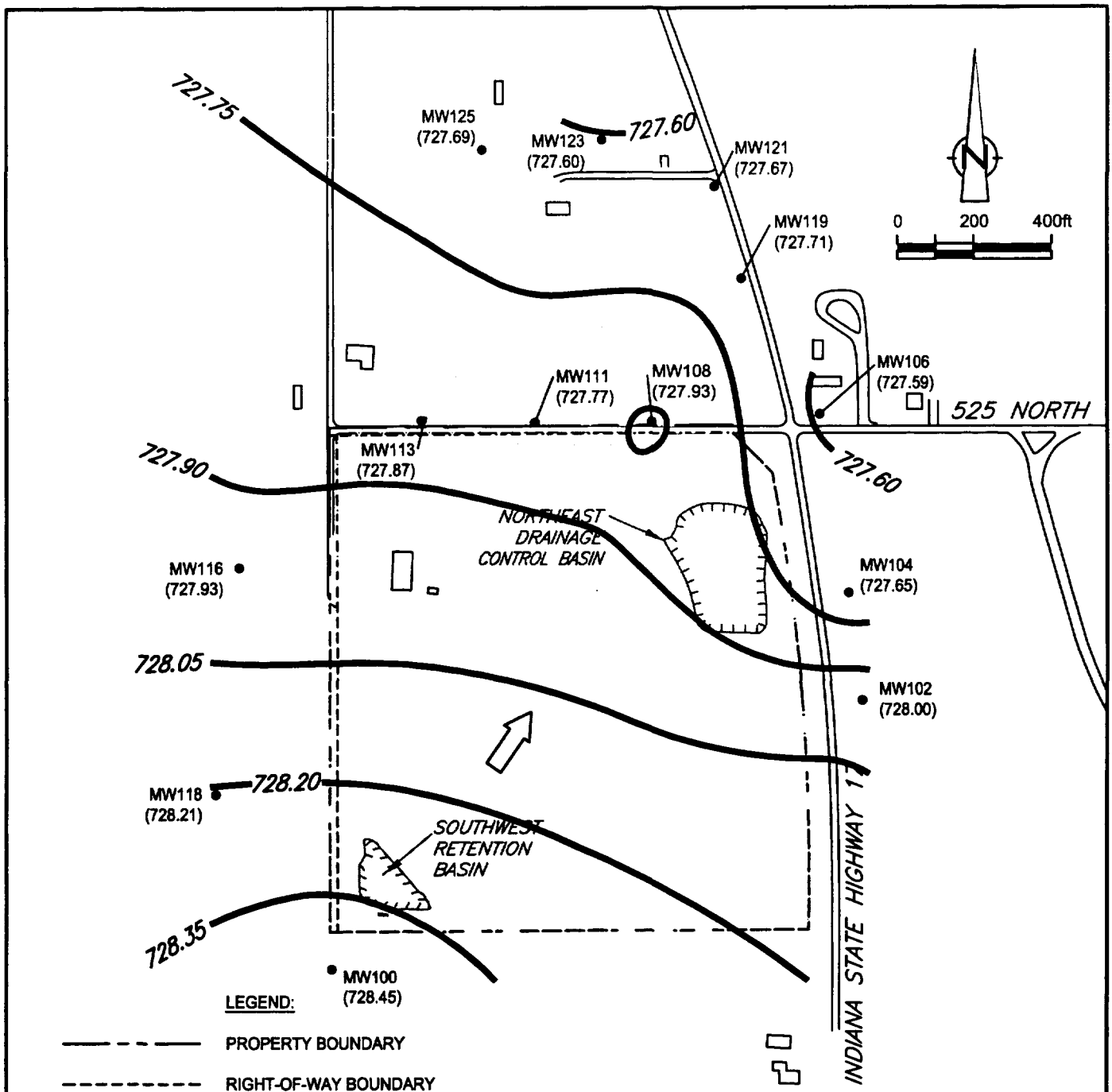
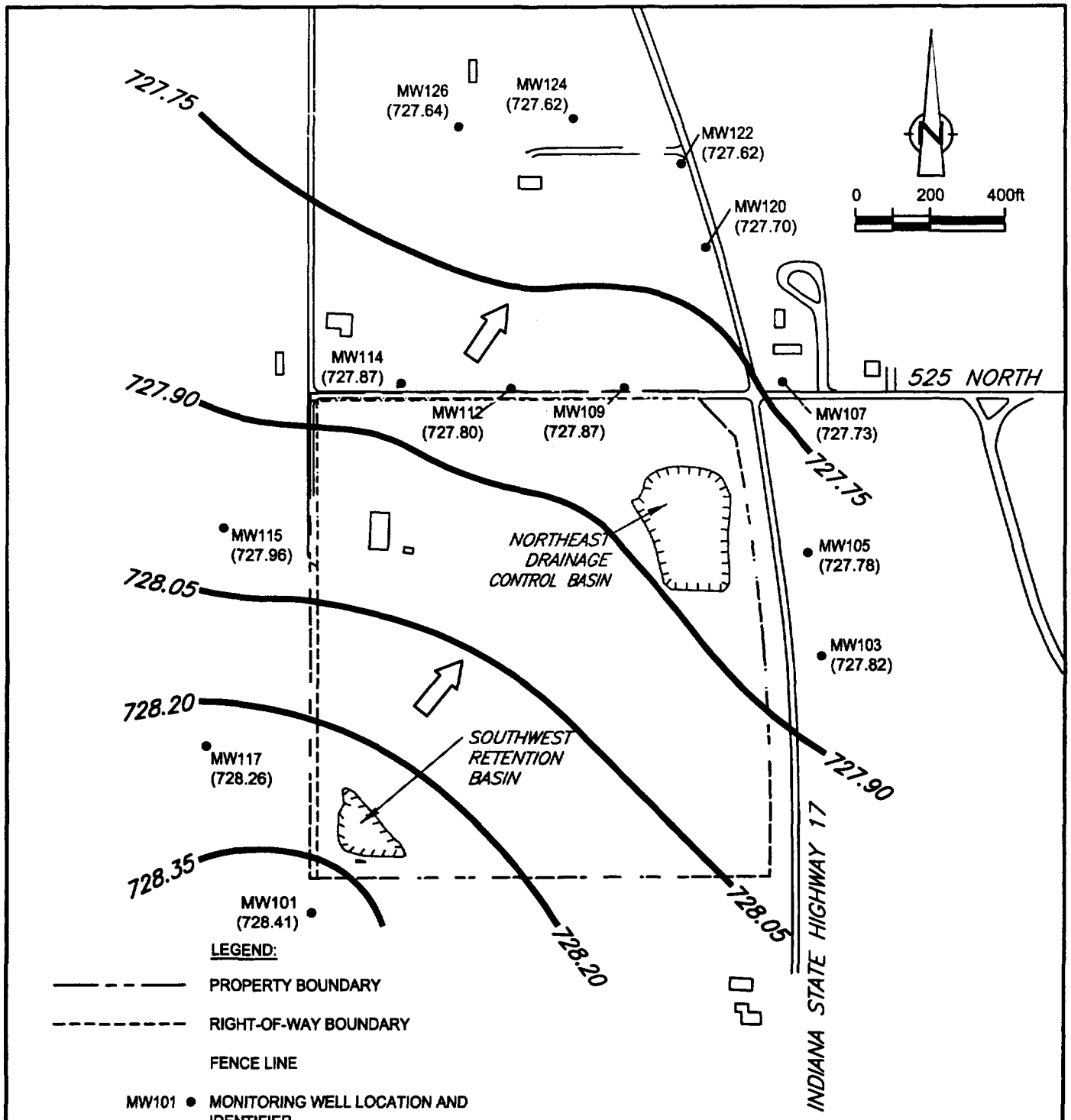


figure A.9

GROUNDWATER CONTOURS-MARCH 17, 1999
SHALLOW OFF-SITE MONITORING WELL LOCATIONS
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

05369-67(APPA26)GN-CO009 SEP 14/2000



LEGEND:

PROPERTY BOUNDARY

RIGHT-OF-WAY BOUNDARY

FENCE LINE

MW101 ● MONITORING WELL LOCATION AND IDENTIFIER

(728.52) GROUNDWATER ELEVATION (FT., AMSL)

727.75 GROUNDWATER CONTOUR (0.15 FOOT CONTOUR INTERVAL)

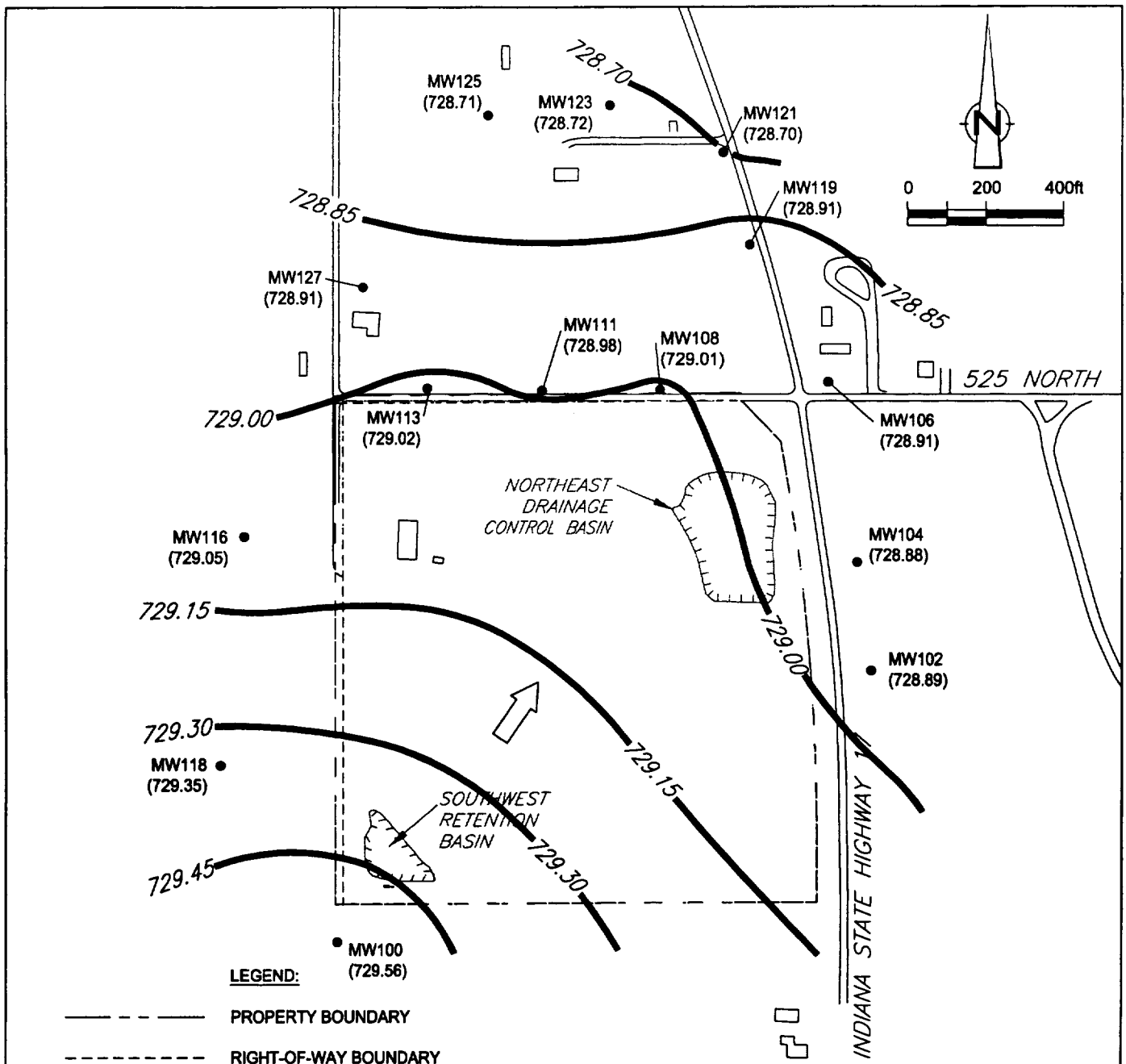
GROUNDWATER FLOW DIRECTION

NOTE: HORIZONTAL HYDRAULIC GRADIENT ACROSS SITE=0.00032 MW101 TO MW109

figure A.10

GROUNDWATER CONTOURS-MARCH 17, 1999
DEEP OFF-SITE MONITORING WELL LOCATIONS
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

05369-67(APPA26)GN-CO010 SEP 14/2000



LEGEND:

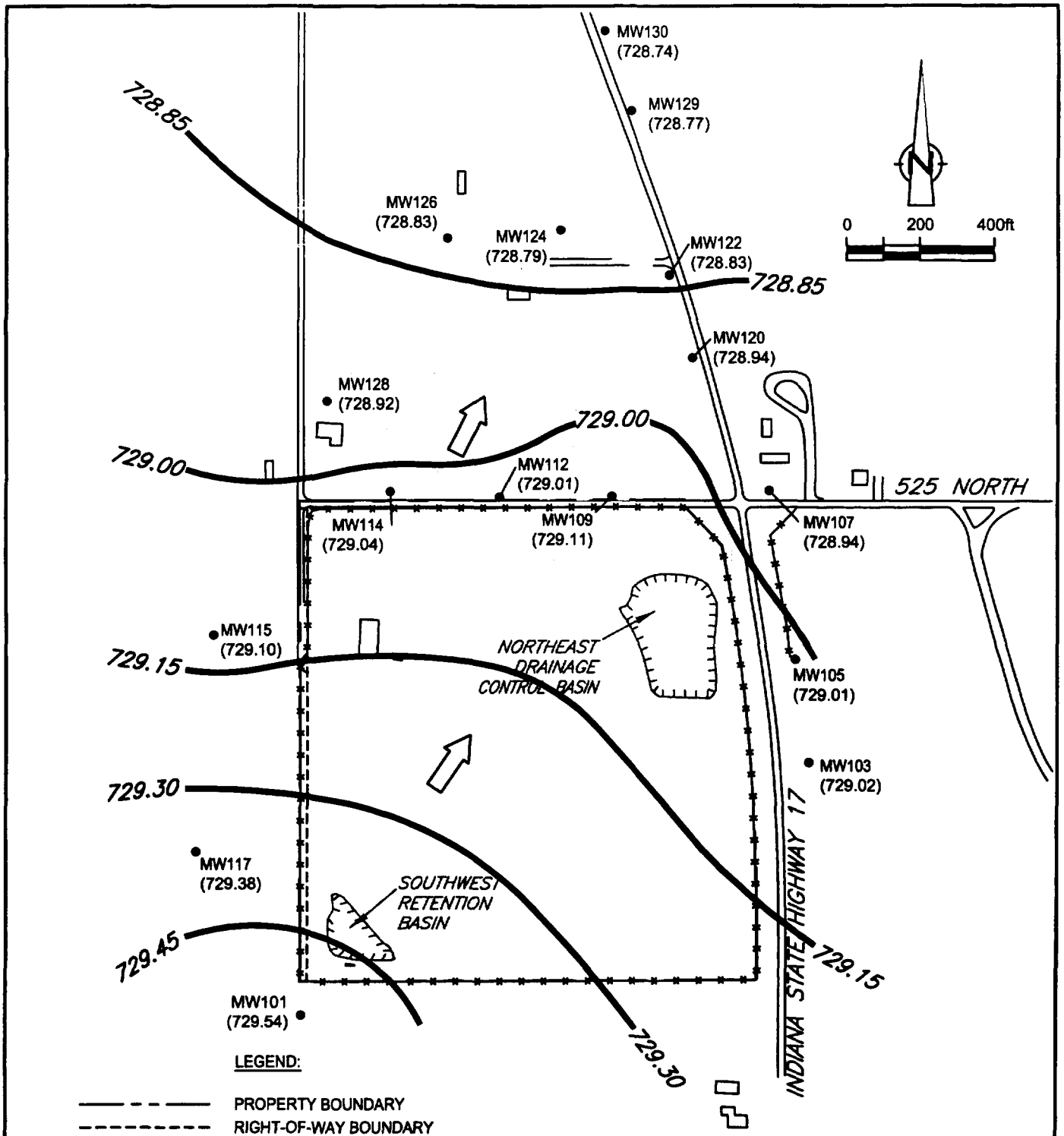
—— - - ——	PROPERTY BOUNDARY
- - - - - - - -	RIGHT-OF-WAY BOUNDARY
	FENCE LINE
MW100 ●	MONITORING WELL LOCATION AND IDENTIFIER
(728.52)	GROUNDWATER ELEVATION (FT., AMSL)
727.90 ▬▬	GROUNDWATER CONTOUR (0.15 FOOT CONTOUR INTERVAL)
⇨	GROUNDWATER FLOW DIRECTION

NOTE: HORIZONTAL HYDRAULIC GRADIENT ACROSS SITE=0.00038 MW100 TO MW111

figure A.11

GROUNDWATER CONTOURS-APRIL 26, 1999
SHALLOW OFF-SITE MONITORING WELL LOCATIONS
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

05369-67(APPA26)GN-CO011 SEP 14/2000



LEGEND:

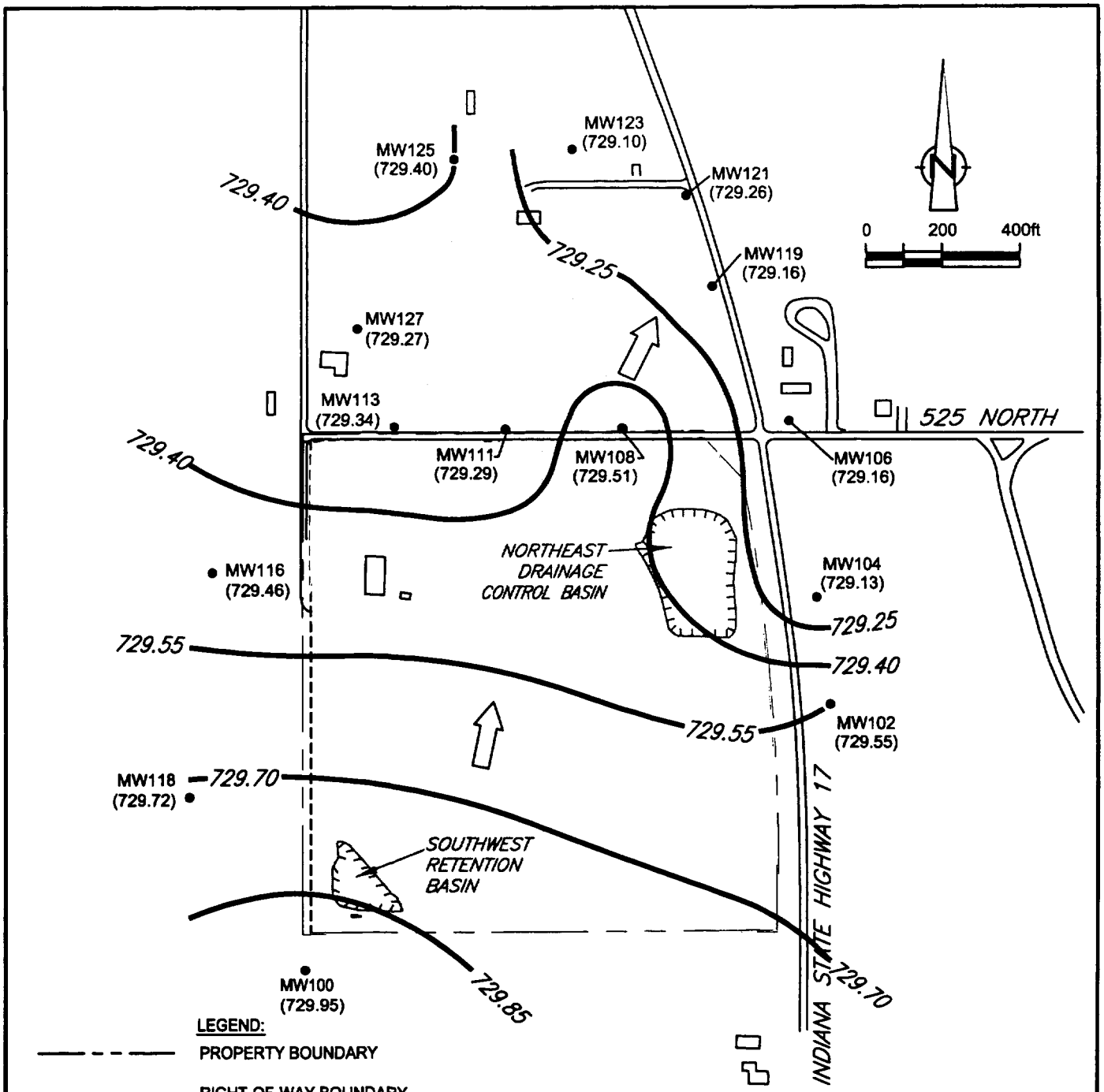
PROPERTY BOUNDARY
RIGHT-OF-WAY BOUNDARY
FENCE LINE
MW101 ● MONITORING WELL LOCATION AND IDENTIFIER
(729.54) GROUNDWATER ELEVATION (FT., AMSL)
728.85 GROUNDWATER CONTOUR (0.15 FOOT CONTOUR INTERVAL)
GROUNDWATER FLOW DIRECTION

NOTE: HORIZONTAL HYDRAULIC GRADIENT ACROSS SITE=0.00025 MW101 TO MW109

figure A.12

GROUNDWATER CONTOURS-APRIL 26, 1999
DEEP OFF-SITE MONITORING WELL LOCATIONS
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

05369-67(APPA26)GN-CO012 SEP 14/2000



LEGEND:

— — — —	PROPERTY BOUNDARY
- - - - - - - -	RIGHT-OF-WAY BOUNDARY
	FENCE LINE
MW100 ●	MONITORING WELL LOCATION AND IDENTIFIER
(729.10)	GROUNDWATER ELEVATION (FT. AMSL)
729.25 ▬▬	GROUNDWATER CONTOUR, INTERVAL=0.15 ft.
⇦	GROUNDWATER FLOW DIRECTION

NOTE: HORIZONTAL HYDRAULIC GRADIENT ACROSS SITE=0.00042 MW100 TO MW113

figure A.13

GROUNDWATER CONTOURS-JUNE 1999
SHALLOW OFF-SITE MONITORING WELL LOCATIONS
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

05369-67(APPA26)GN-CO013 SEP 14/2000

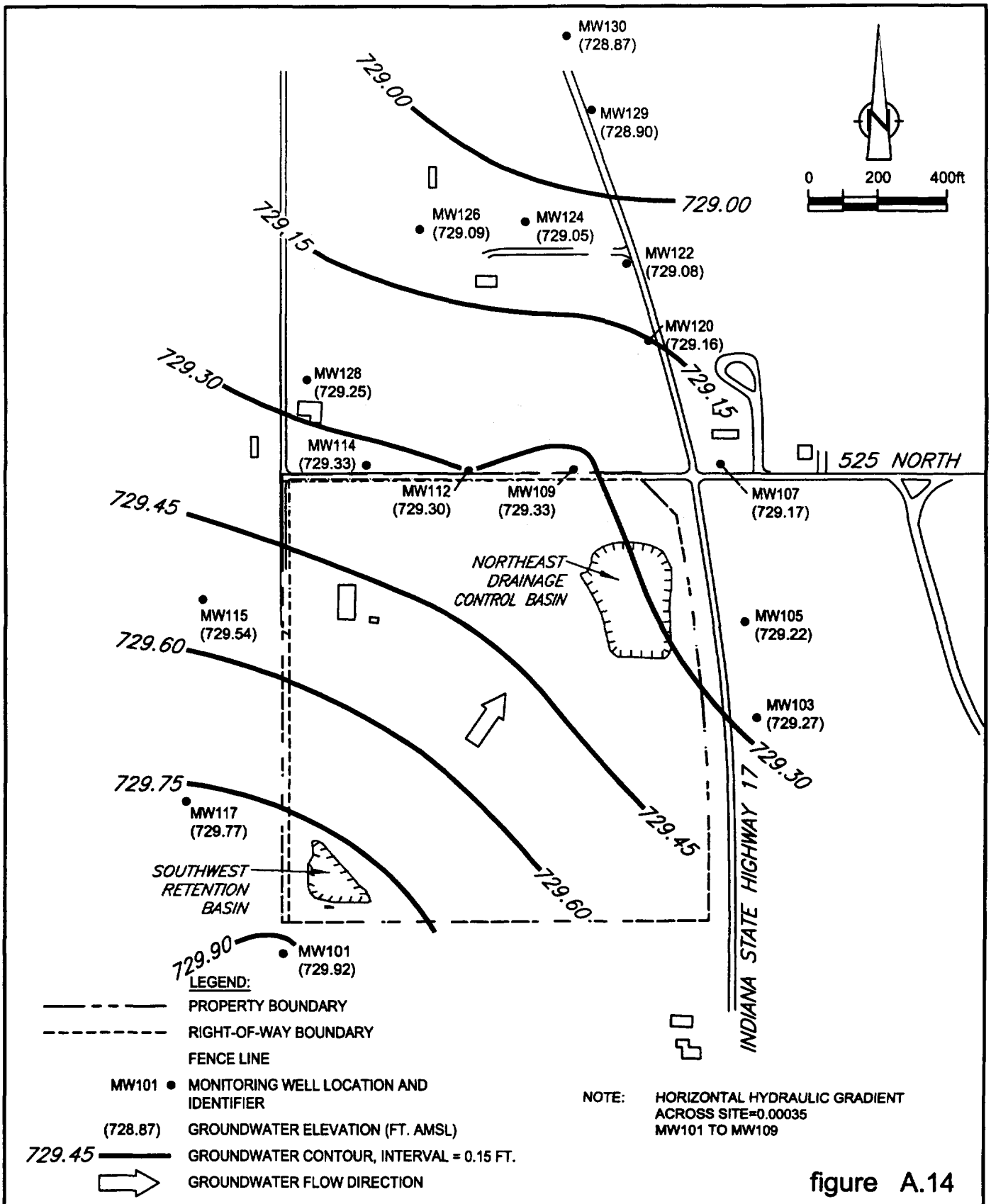


figure A.14

GROUNDWATER CONTOURS-JUNE 1999
DEEP OFF-SITE MONITORING WELL LOCATIONS
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

05369-67(APPA26)GN-CO014 SEP 14/2000

APPENDIX B

OU1 GROUNDWATER ANALYTICAL DATA SUMMARY FIGURES

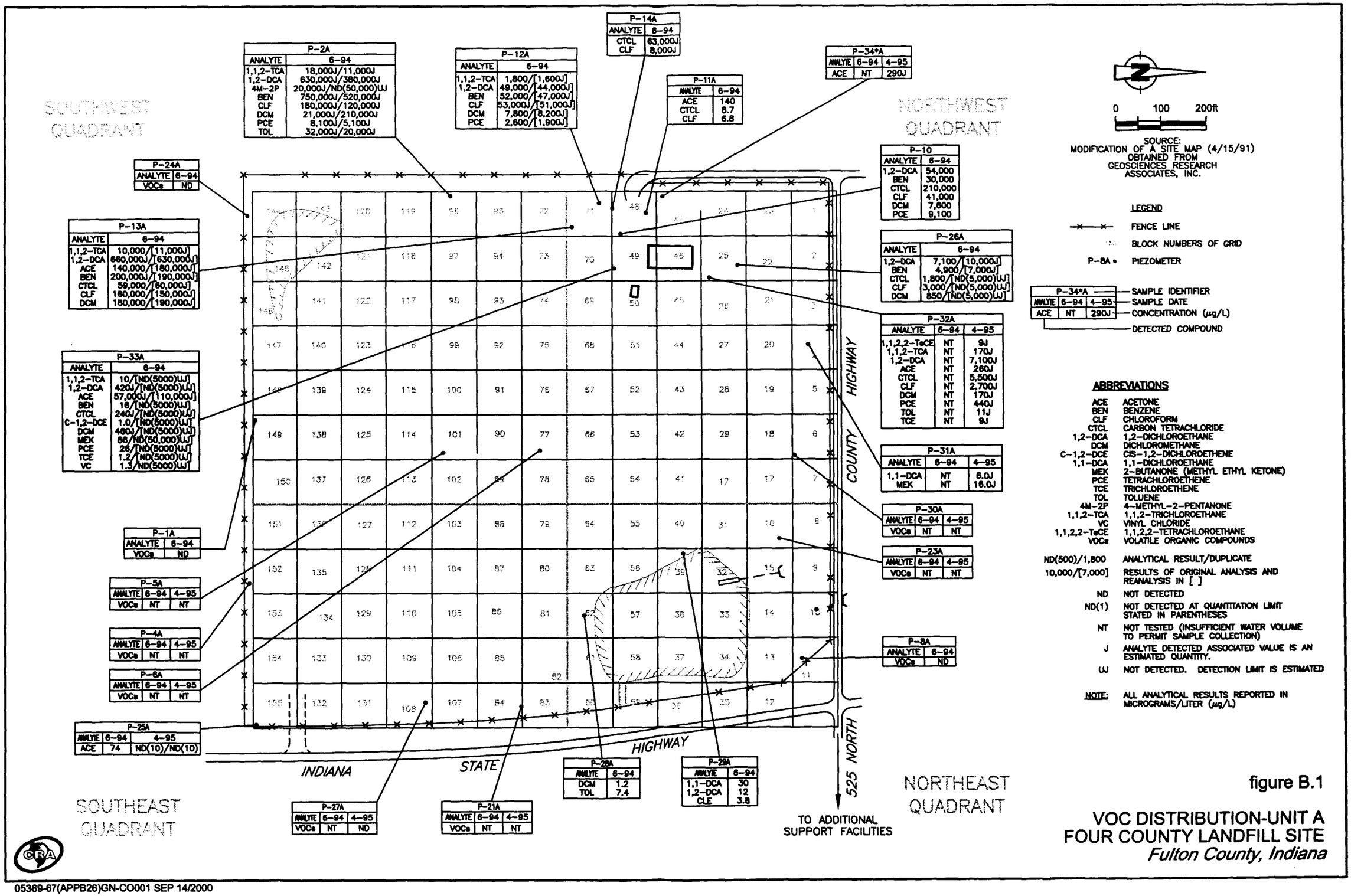


figure B.1

VOC DISTRIBUTION-UNIT A
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

05369-67(APPB26)GN-CO001 SEP 14/2000

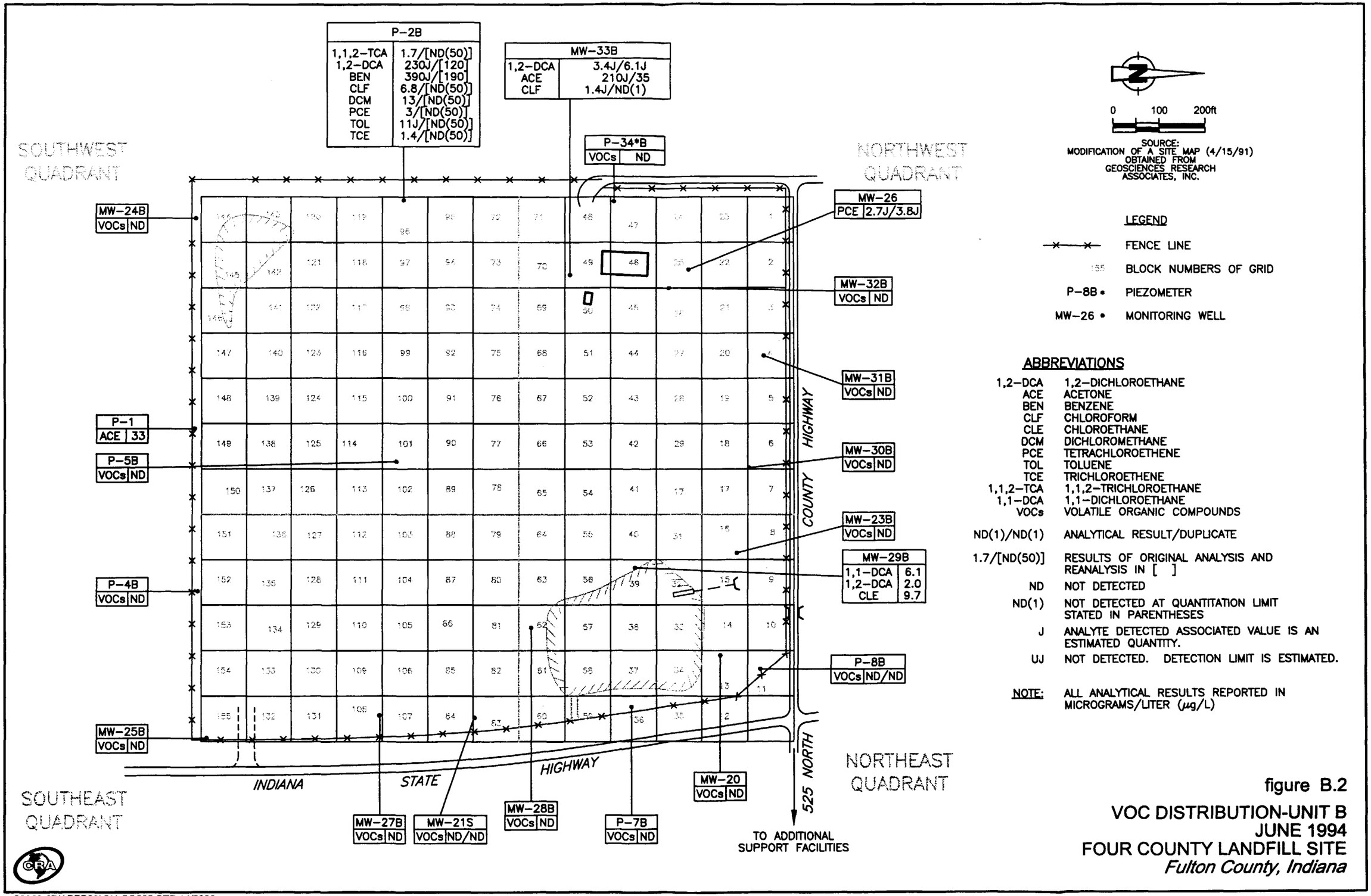


figure B.2

VOC DISTRIBUTION-UNIT B
JUNE 1994
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

05369-67(APPB26)GN-CO002 SEP 14/2000

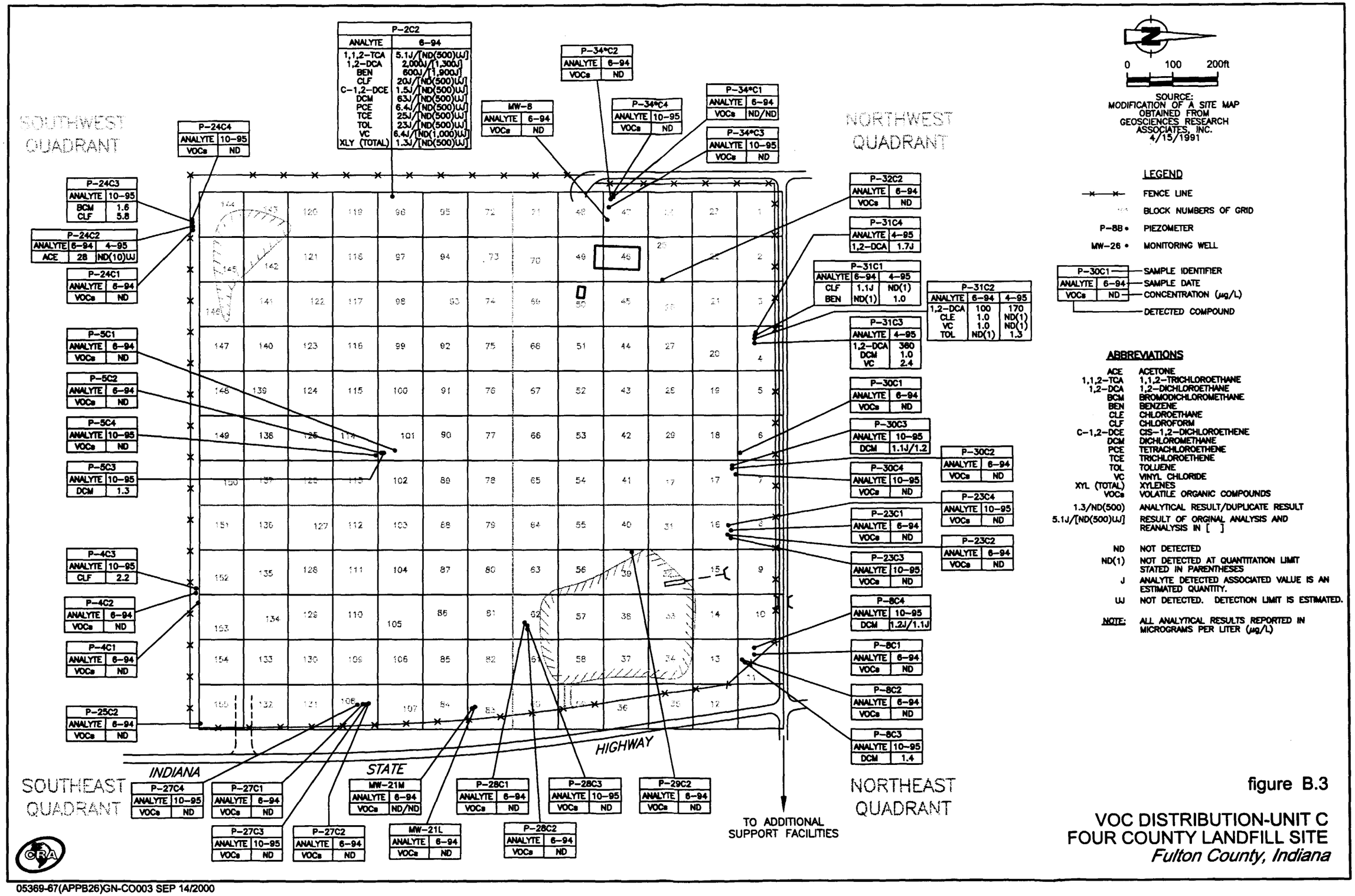


figure B.3

VOC DISTRIBUTION-UNIT C
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

05369-67(APPB26)GN-CO003 SEP 14/2000

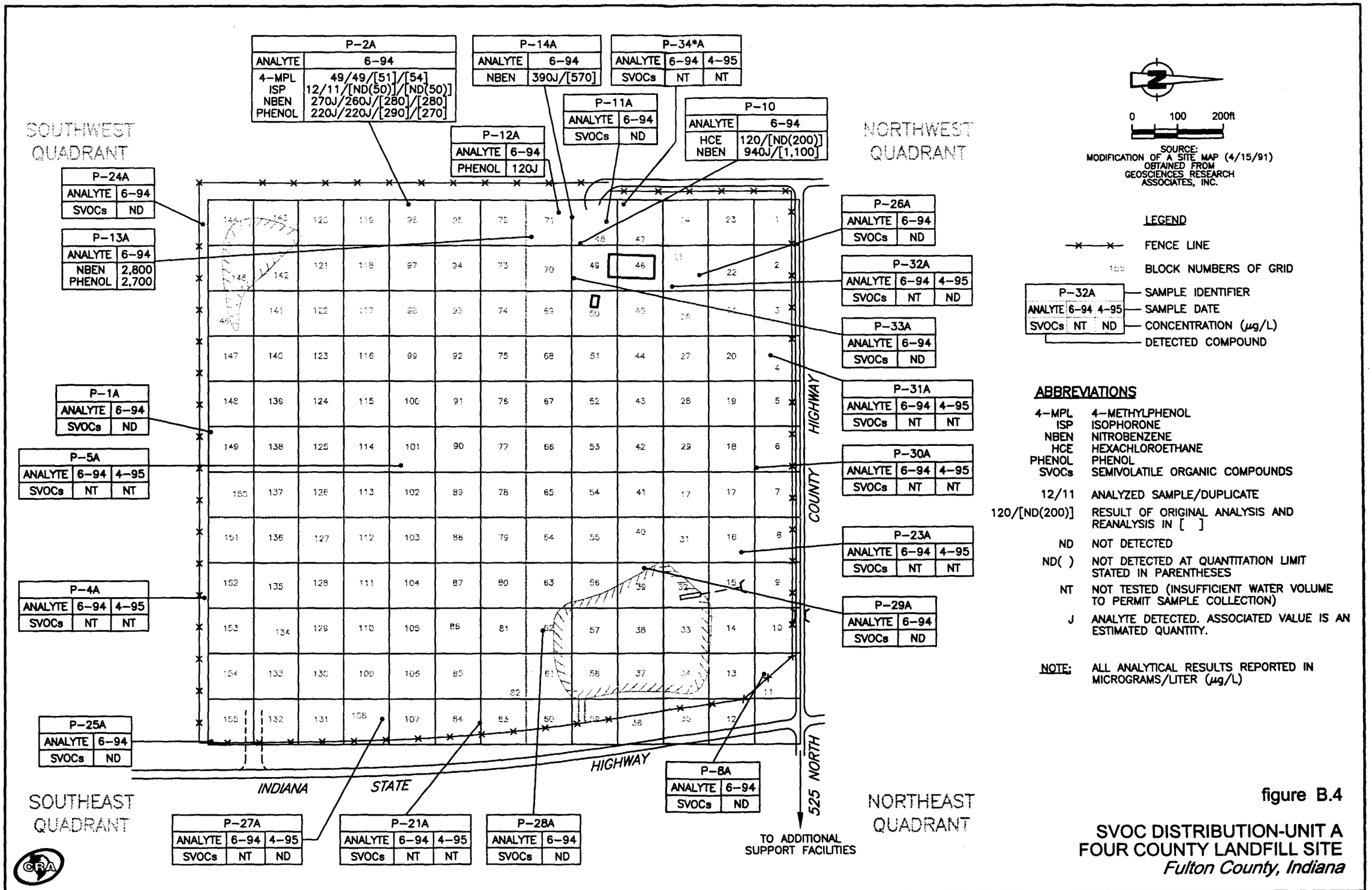


figure B.4

SVOC DISTRIBUTION-UNIT A
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

05369-67(APPB26)GN-CO004 SEP 14/2000

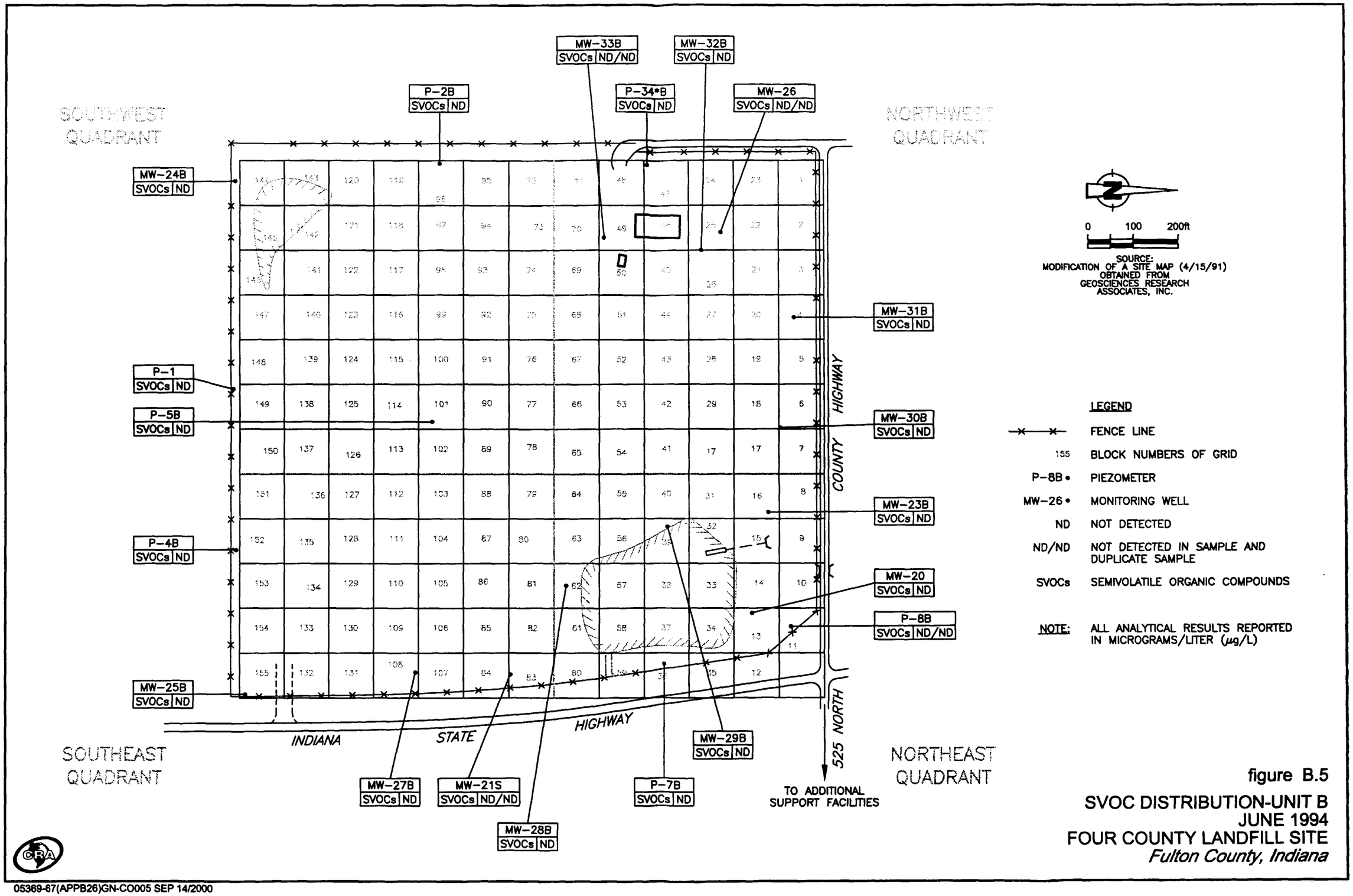


figure B.5

SVOC DISTRIBUTION-UNIT B
JUNE 1994
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

05369-67(APPB26)GN-CO005 SEP 14/2000

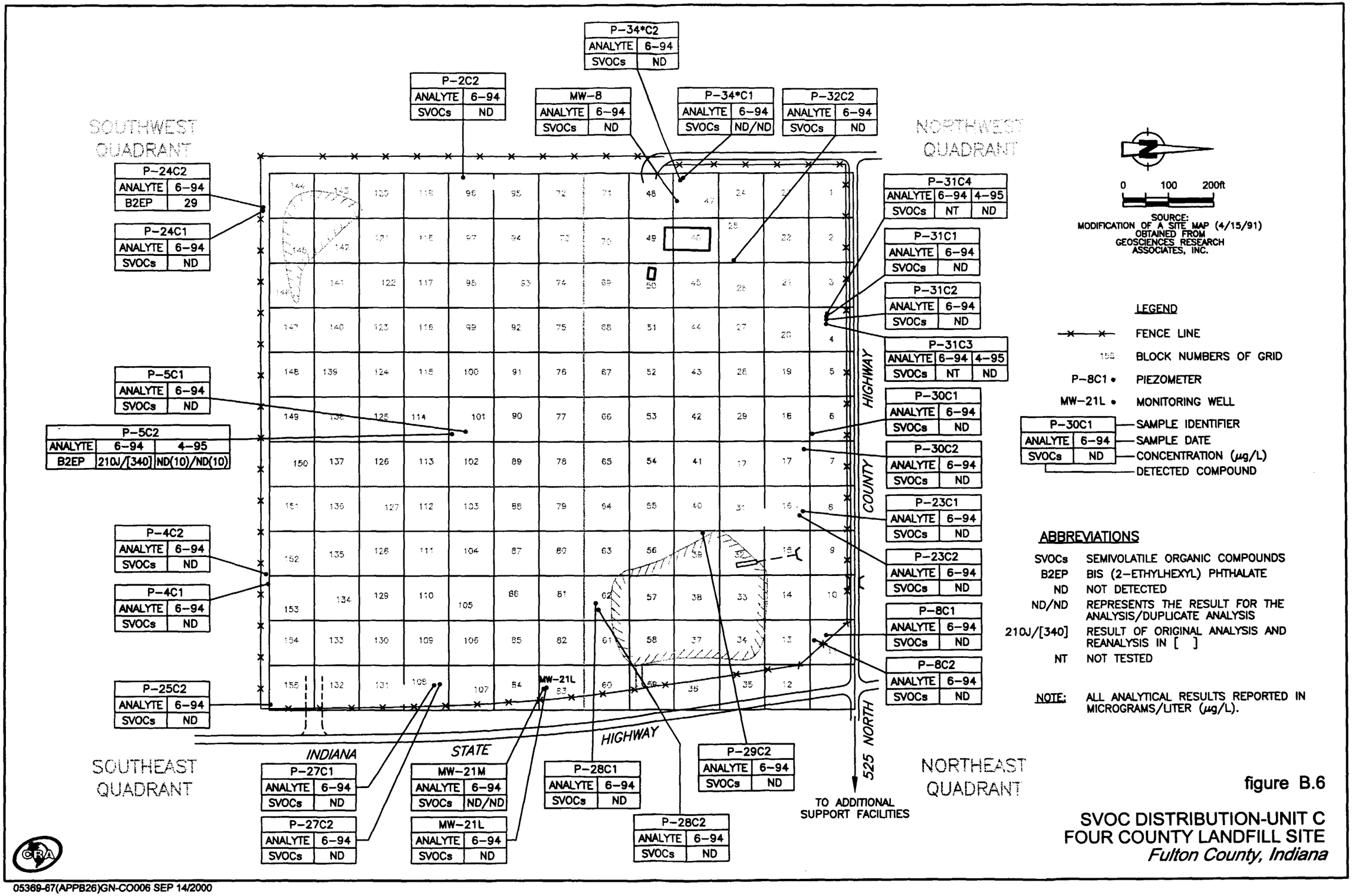
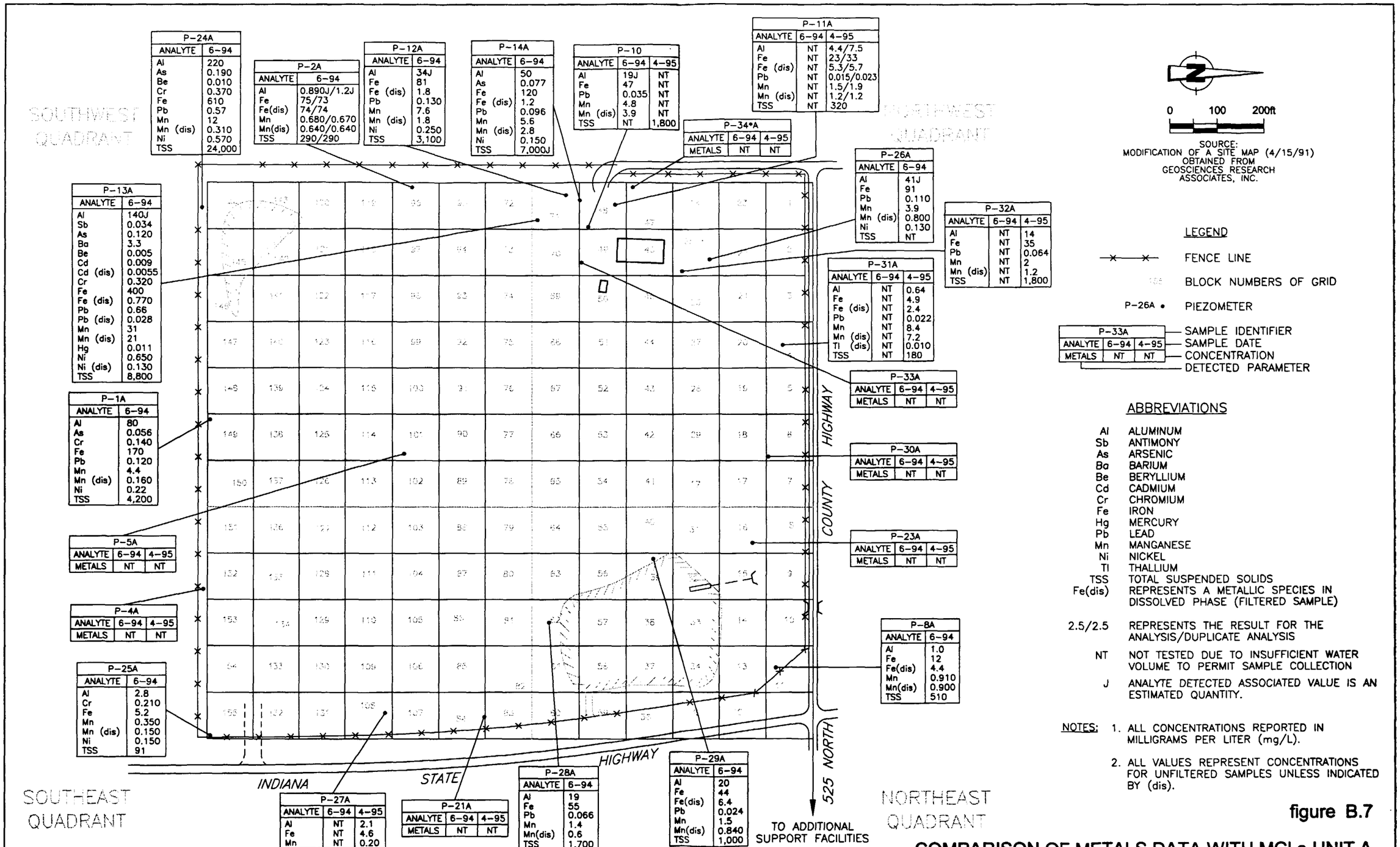


figure B.6

SVOC DISTRIBUTION-UNIT C
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

05369-67(APPB26)GN-CO006 SEP 14/2000



P-24A	
ANALYTE	6-94
Al	220
As	0.190
Be	0.010
Cr	0.370
Fe	610
Pb	0.57
Mn	12
Mn (dis)	0.310
Ni	0.570
TSS	24,000

P-2A	
ANALYTE	6-94
Al	0.890J/1.2J
Fe	75/73
Fe(dis)	74/74
Mn	0.680/0.670
Mn(dis)	0.640/0.640
TSS	290/290

P-12A	
ANALYTE	6-94
Al	34J
Fe	81
Fe (dis)	1.8
Pb	0.130
Mn	7.6
Mn (dis)	1.8
Ni	0.250
TSS	3,100

P-14A	
ANALYTE	6-94
Al	50
As	0.077
Fe	120
Fe (dis)	1.2
Pb	0.096
Mn	5.6
Mn (dis)	2.8
Ni	0.150
TSS	7,000J

P-10		
ANALYTE	6-94	4-95
Al	19J	NT
Fe	47	NT
Pb	0.035	NT
Mn	4.8	NT
Mn (dis)	3.9	NT
TSS	NT	1,800

P-11A		
ANALYTE	6-94	4-95
Al	NT	4.4/7.5
Fe	NT	23/33
Fe (dis)	NT	5.3/5.7
Pb	NT	0.015/0.023
Mn	NT	1.5/1.9
Mn (dis)	NT	1.2/1.2
TSS	NT	320

P-34*A		
ANALYTE	6-94	4-95
METALS	NT	NT

P-26A	
ANALYTE	6-94
Al	41J
Fe	91
Pb	0.110
Mn	3.9
Mn (dis)	0.800
Ni	0.130
TSS	NT

P-32A		
ANALYTE	6-94	4-95
Al	NT	14
Fe	NT	35
Pb	NT	0.064
Mn	NT	2
Mn (dis)	NT	1.2
TSS	NT	1,800

P-13A	
ANALYTE	6-94
Al	140J
Sb	0.034
As	0.120
Ba	3.3
Be	0.005
Cd	0.009
Cd (dis)	0.0055
Cr	0.320
Fe	400
Fe (dis)	0.770
Pb	0.66
Pb (dis)	0.028
Mn	31
Mn (dis)	21
Hg	0.011
Ni	0.650
Ni (dis)	0.130
TSS	8,800

P-31A		
ANALYTE	6-94	4-95
Al	NT	0.64
Fe	NT	4.9
Fe (dis)	NT	2.4
Pb	NT	0.022
Mn	NT	8.4
Mn (dis)	NT	7.2
Tl (dis)	NT	0.010
TSS	NT	180

P-33A		
ANALYTE	6-94	4-95
METALS	NT	NT

P-1A	
ANALYTE	6-94
Al	80
As	0.056
Cr	0.140
Fe	170
Pb	0.120
Mn	4.4
Mn (dis)	0.160
Ni	0.22
TSS	4,200

P-30A		
ANALYTE	6-94	4-95
METALS	NT	NT

P-5A		
ANALYTE	6-94	4-95
METALS	NT	NT

P-23A		
ANALYTE	6-94	4-95
METALS	NT	NT

P-4A		
ANALYTE	6-94	4-95
METALS	NT	NT

P-8A	
ANALYTE	6-94
Al	1.0
Fe	12
Fe(dis)	4.4
Mn	0.910
Mn(dis)	0.900
TSS	510

P-25A	
ANALYTE	6-94
Al	2.8
Cr	0.210
Fe	5.2
Mn	0.350
Mn (dis)	0.150
Ni	0.150
TSS	91

P-27A		
ANALYTE	6-94	4-95
Al	NT	2.1
Fe	NT	4.6
Mn	NT	0.20

P-21A		
ANALYTE	6-94	4-95
METALS	NT	NT

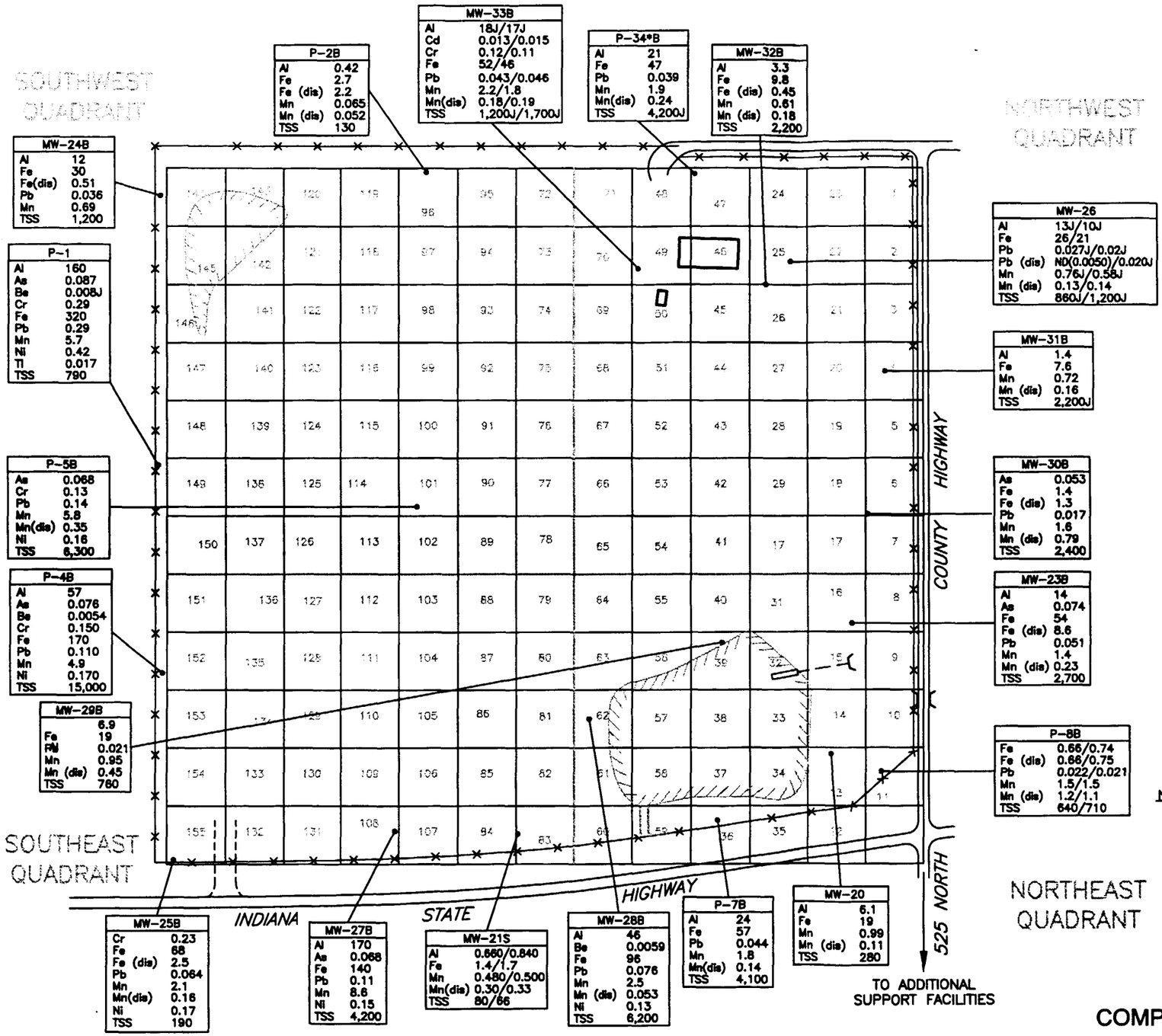
P-28A	
ANALYTE	6-94
Al	19
Fe	55
Pb	0.066
Mn	1.4
Mn(dis)	0.6
TSS	1,700

P-29A	
ANALYTE	6-94
Al	20
Fe	44
Fe(dis)	6.4
Pb	0.024
Mn	1.5
Mn(dis)	0.840
TSS	1,000

figure B.7

COMPARISON OF METALS DATA WITH MCLs-UNIT A
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

05369-67(APPB26)GN-CO007 SEP 14/2000



0 100 200ft

SOURCE:
MODIFICATION OF A SITE MAP (4/15/91) OBTAINED FROM GEOSCIENCES RESEARCH ASSOCIATES, INC.

LEGEND

MW-31B • MONITORING WELL

P-7B • PIEZOMETER

FENCE LINE

BLOCK NUMBERS OF GRID

ABBREVIATIONS

Al	ALUMINUM
As	ARSENIC
Be	BERYLLIUM
Cr	CHROMIUM
Fe	IRON
Pb	LEAD
Mn	MANGANESE
Ni	NICKEL
Tl	THALLIUM
TSS	TOTAL SUSPENDED SOLIDS
Fe(dis)	REPRESENTS A METALLIC SPECIES IN DISSOLVED PHASE (FILTERED SAMPLE)
2.5/2.5	REPRESENTS THE RESULT FOR THE ANALYSIS/DUPLICATE ANALYSIS
J	ANALYTE DETECTED ASSOCIATED VALUE IS AN ESTIMATED QUANTITY.
R	UNABLE TO CONFIRM PRESENCE/ABSENCE OF THIS ANALYTE.

NOTES:
1. ALL CONCENTRATIONS REPORTED IN MILLIGRAMS PER LITER (mg/L).
2. ALL VALUES REPRESENT CONCENTRATIONS FOR UNFILTERED SAMPLES UNLESS INDICATED BY (dis).

figure B.8

COMPARISON OF METALS DATA WITH MCLs-UNIT B
JUNE 1994
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

05369-67(APPB26)GN-CO008 SEP 14/2000

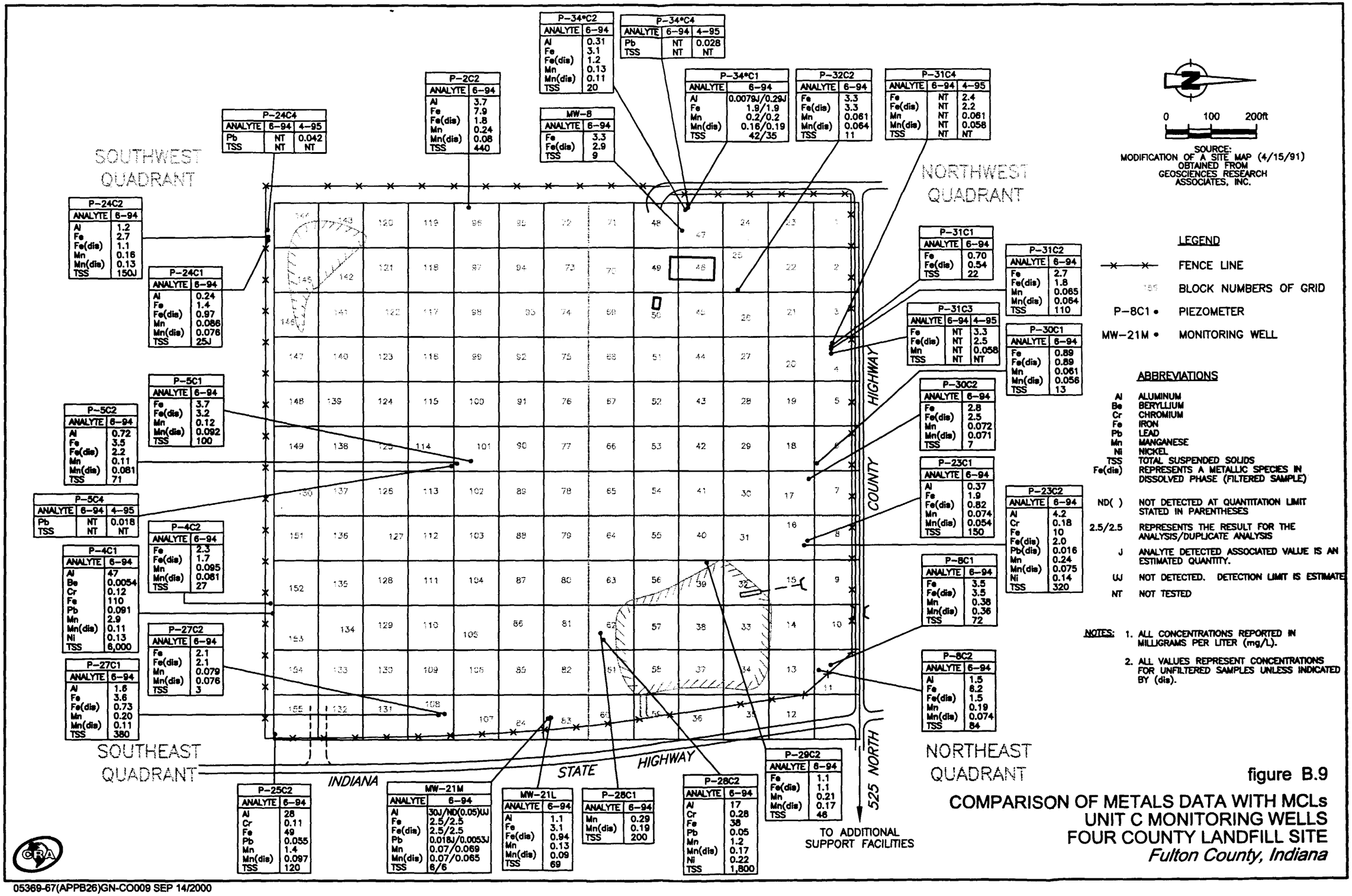


figure B.9

COMPARISON OF METALS DATA WITH MCLs
UNIT C MONITORING WELLS
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

05369-67(APPB26)GN-CO009 SEP 14/2000

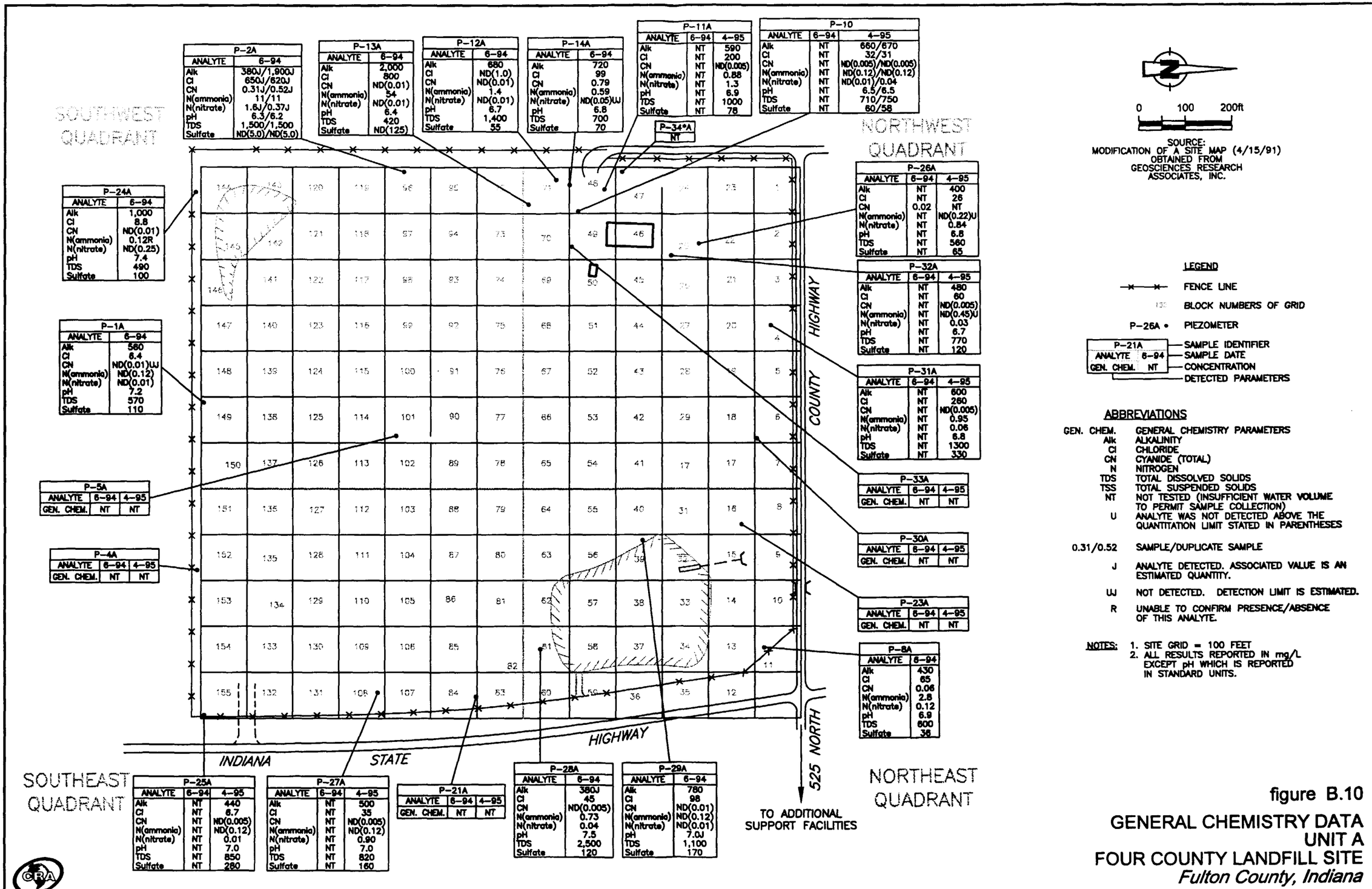
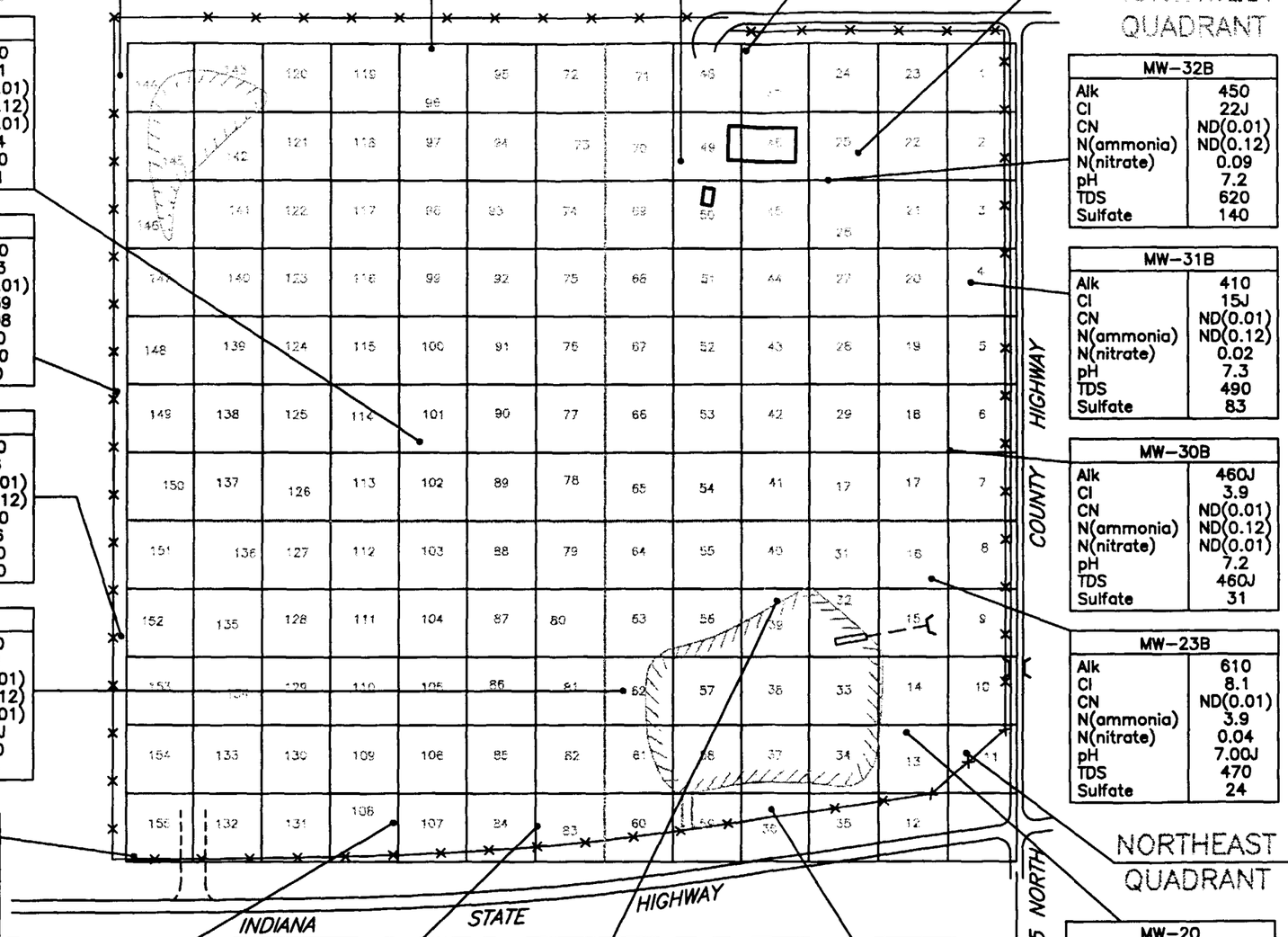


figure B.10

GENERAL CHEMISTRY DATA
UNIT A
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana



MW-24B	
Alk	350
Cl	2.7
CN	ND(0.01)
N(ammonia)	0.13R
N(nitrate)	ND(0.01)
pH	7.4
TDS	360
Sulfate	63

P-2B	
Alk	450
Cl	7.9
CN	0.02
N(ammonia)	1.1
N(nitrate)	ND(0.01)
pH	7.4
TDS	510
Sulfate	52

MW-33B	
Alk	410/420
Cl	7.4/7.0
CN	ND(0.08)U/0.17J
N(ammonia)	0.21R/0.15R
N(nitrate)	ND(0.01)/ND(0.01)
pH	7.3/7.3
TDS	520/490
Sulfate	110/100

P-34*B	
Alk	430
Cl	70
CN	0.59
N(ammonia)	ND(0.12)
N(nitrate)	0.02J
pH	7.2
TDS	760
Sulfate	220

MW-26	
Alk	400/410
Cl	29/29
CN	0.02J/ND(0.01)UJ
N(ammonia)	ND(0.12)/ND(0.12)
N(nitrate)	ND(0.01)/ND(0.01)
pH	7.2/7.3
TDS	510/520
Sulfate	110/110

P-5B	
Alk	620
Cl	6.1
CN	ND(0.01)
N(ammonia)	ND(0.12)
N(nitrate)	ND(0.01)
pH	7.4
TDS	180
Sulfate	91

P-1	
Alk	340
Cl	5.3
CN	ND(0.01)
N(ammonia)	0.39
N(nitrate)	0.08
pH	8.0
TDS	340
Sulfate	60

P-4B	
Alk	970
Cl	36
CN	ND(0.01)
N(ammonia)	ND(0.12)
N(nitrate)	0.10
pH	7.6
TDS	740
Sulfate	210

MW-28B	
Alk	650
Cl	28
CN	ND(0.01)
N(ammonia)	ND(0.12)
N(nitrate)	ND(0.01)
pH	7.5J
TDS	370
Sulfate	54

MW-25B	
Alk	410
Cl	3.4
CN	ND(0.01)
N(ammonia)	ND(0.12)
N(nitrate)	0.03J
pH	7.4
TDS	450
Sulfate	68

MW-27B	
Alk	490
Cl	25
CN	ND(0.01)
N(ammonia)	ND(0.12)
N(nitrate)	0.18J
pH	7.4
TDS	440
Sulfate	110

MW-21S	
Alk	460/460
Cl	2.5/2.4
CN	ND(0.01)/ND(0.01)
N(ammonia)	ND(0.012)/ND(0.12)
N(nitrate)	0.03J/0.04J
pH	7.3/7.3
TDS	650J/340J
Sulfate	180/190

MW-29B	
Alk	370
Cl	42
CN	ND(0.01)
N(ammonia)	ND(0.12)
N(nitrate)	0.71
pH	7.4J
TDS	520
Sulfate	100

P-7B	
Alk	400J
Cl	380
CN	ND(0.01)
N(ammonia)	ND(0.12)
N(nitrate)	0.06
pH	7.3J
TDS	950
Sulfate	100

MW-32B	
Alk	450
Cl	22J
CN	ND(0.01)
N(ammonia)	ND(0.12)
N(nitrate)	0.09
pH	7.2
TDS	620
Sulfate	140

MW-31B	
Alk	410
Cl	15J
CN	ND(0.01)
N(ammonia)	ND(0.12)
N(nitrate)	0.02
pH	7.3
TDS	490
Sulfate	83

MW-30B	
Alk	460J
Cl	3.9
CN	ND(0.01)
N(ammonia)	ND(0.12)
N(nitrate)	ND(0.01)
pH	7.2
TDS	460J
Sulfate	31

MW-23B	
Alk	610
Cl	8.1
CN	ND(0.01)
N(ammonia)	3.9
N(nitrate)	0.04
pH	7.00J
TDS	470
Sulfate	24

MW-20	
Alk	380
Cl	3.1
CN	ND(0.01)
N(ammonia)	ND(0.12)
N(nitrate)	ND(0.01)
pH	7.7
TDS	380
Sulfate	45

P-8B	
Alk	420/430
Cl	17/17
CN	ND(0.01)/ND(0.01)
N(ammonia)	ND(0.12)/ND(0.12)
N(nitrate)	ND(0.01)/ND(0.01)
pH	7.2/7.2
TDS	470/450
Sulfate	25/24

0 100 200ft

SOURCE:
MODIFICATION OF A SITE MAP (4/15/91) OBTAINED FROM GEOSCIENCES RESEARCH ASSOCIATES, INC.

LEGEND

—×—×—	FENCE LINE
155	BLOCK NUMBERS OF GRID
P-8B •	PIEZOMETER
MW-30B•	MONITORING WELL

ABBREVIATIONS

Alk	ALKALINITY
Cl	CHLORIDE
CN	CYANIDE
N	NITROGEN
TDS	TOTAL DISSOLVED SOLIDS
ND	NOT DETECTED
ND( )	NOT DETECTED AT QUANTITATION LIMIT STATED IN PARENTHESES
7.2/7.3	SAMPLE/DUPLICATE SAMPLE
J	ANALYTE DETECTED. ASSOCIATED VALUE IS AN ESTIMATED QUANTITY.
UJ	NOT DETECTED. DETECTION LIMIT IS ESTIMATED.
R	UNABLE TO CONFIRM PRESENCE/ABSENCE OF THIS ANALYTE.

NOTES:
1. SITE GRID = 100 FEET
2. ALL RESULTS REPORTED IN mg/L EXCEPT pH WHICH IS REPORTED IN STANDARD UNITS.

figure B.11

GENERAL CHEMISTRY DATA-UNIT B
JUNE 1994
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

05369-67(APPB26)GN-CO011 SEP 14/2000

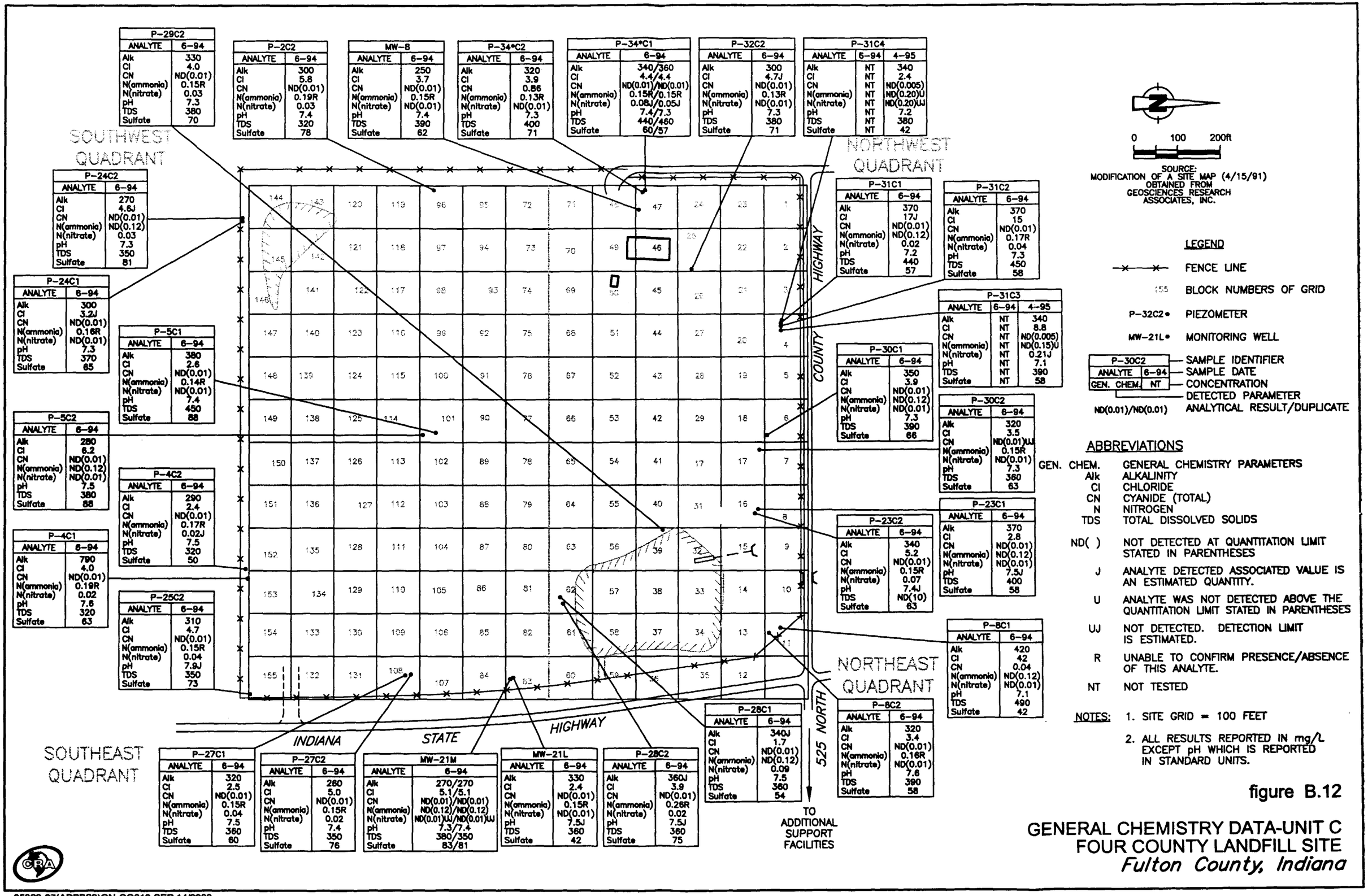


figure B.12

GENERAL CHEMISTRY DATA-UNIT C
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

05369-67(APPB26)GN-CO012 SEP 14/2000

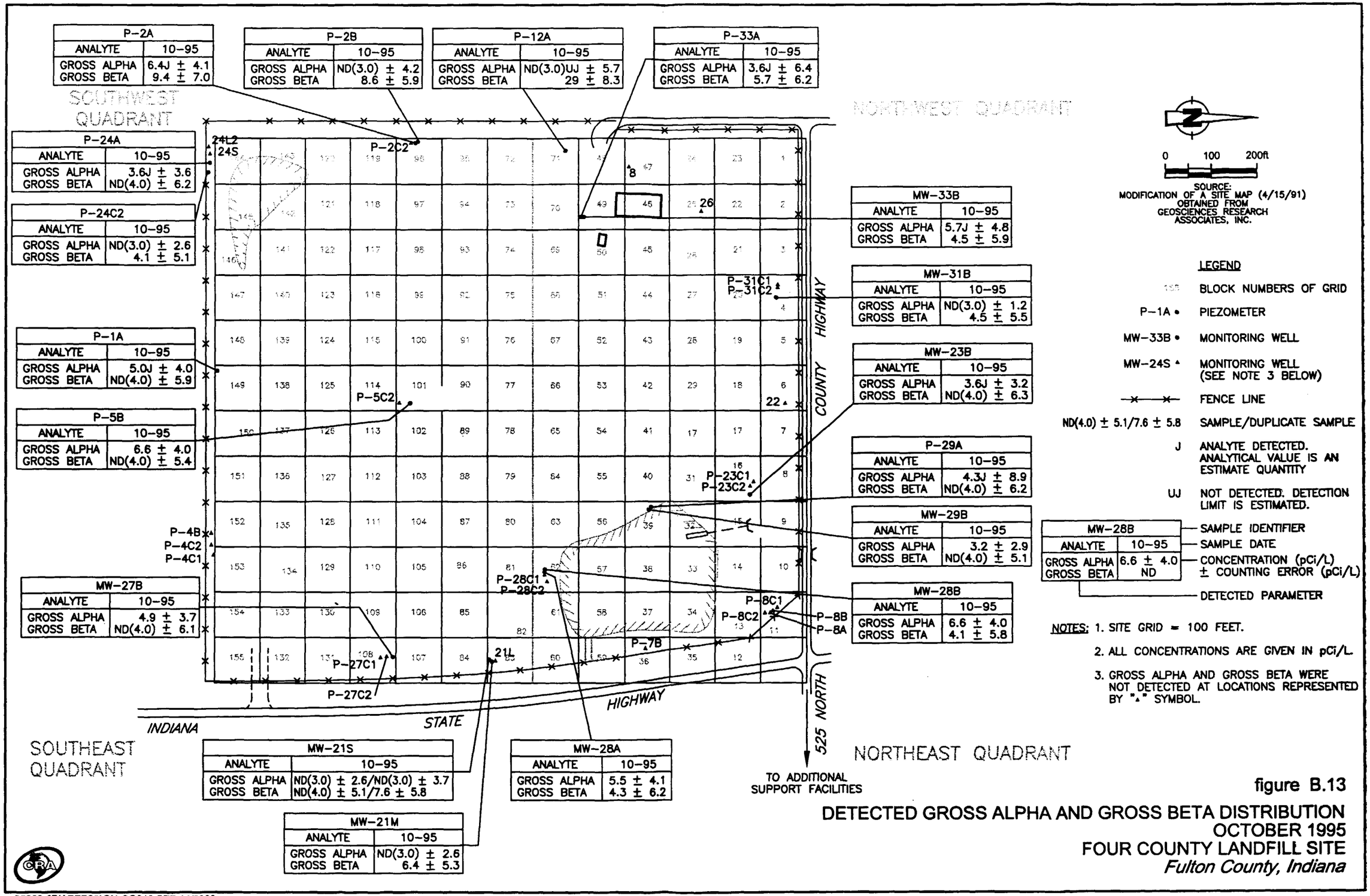


figure B.13

DETECTED GROSS ALPHA AND GROSS BETA DISTRIBUTION
OCTOBER 1995
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

05369-67(APPB26)GN-CO013 SEP 14/2000

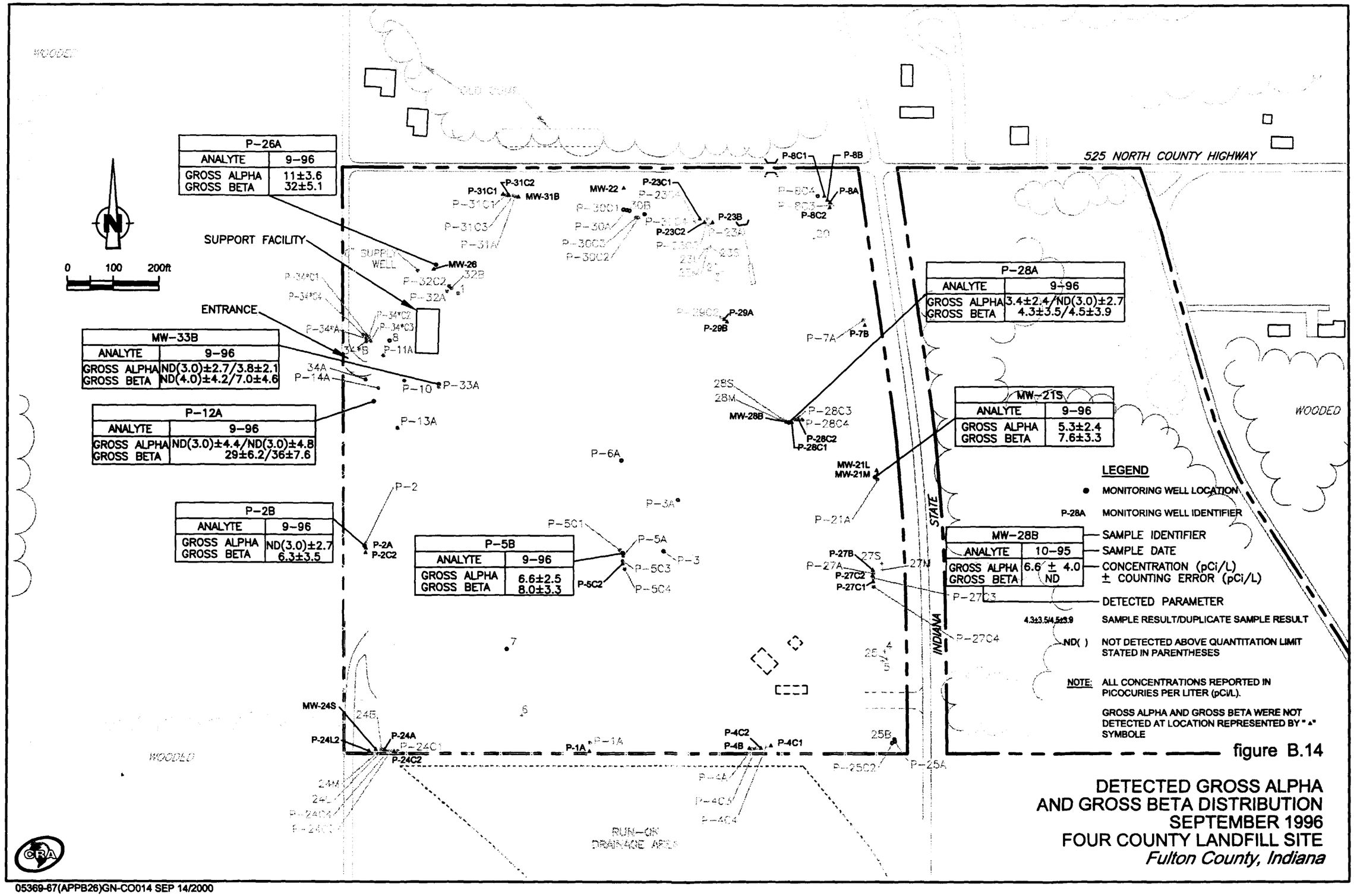


figure B.14

DETECTED GROSS ALPHA
AND GROSS BETA DISTRIBUTION
SEPTEMBER 1996
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

05369-67(APPB26)GN-CO014 SEP 14/2000

APPENDIX C

TABULATED SUMMARIES OF OU2 GROUNDWATER ANALYTICAL DATA

TABLE C.1

ANALYTICAL DATA
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		130 ft.S MW125/126	275 ft.S MW125/126
Sample I.D.:		SW-DS-229	SW-DS-230
Sample Interval:		--	--
Date Sampled:		11/21/1997	11/21/1997
Parameters	Units		
TAL Metals			
ALUMINUM	mg/l	0.32	0.22
ANTIMONY	mg/l	ND(0.030)	ND(0.030)
ARSENIC	mg/l	0.0054	ND(0.0050)
BARIUM	mg/l	0.048	0.039
BERYLLIUM	mg/l	ND(0.0040)	ND(0.0040)
CADMIUM	mg/l	ND(0.0050)	ND(0.0050)
CALCIUM	mg/l	75	57
CHROMIUM	mg/l	ND(0.010)	ND(0.010)
COBALT	mg/l	ND(0.010)	ND(0.010)
COPPER	mg/l	ND(0.020)	ND(0.020)
IRON	mg/l	11	3.4
LEAD	mg/l	ND(0.0030)	ND(0.0030)
MAGNESIUM	mg/l	19	15
MANGANESE	mg/l	0.78	0.71
MERCURY	mg/l	ND(0.00020)	ND(0.00020) UJ
NICKEL	mg/l	ND(0.010)	ND(0.010)
POTASSIUM	mg/l	2.9	2.3
SELENIUM	mg/l	ND(0.0050)	ND(0.0050)
SILVER	mg/l	ND(0.010)	ND(0.010)
SODIUM	mg/l	3.2	4.3
THALLIUM	mg/l	ND(0.010)	ND(0.010)
VANADIUM	mg/l	ND(0.010)	ND(0.010)
ZINC	mg/l	ND(0.027) U	ND(0.020)
Volatile Organic Compounds			
1,1,1-TRICHLOROETHANE	ug/l	ND(1)	ND(1)
1,1,2,2-TETRACHLOROETHANE	ug/l	ND(1)	ND(1)
1,1,2-TRICHLOROETHANE	ug/l	ND(1)	ND(1)
1,1-DICHLOROETHANE	ug/l	ND(1)	ND(1)
1,1-DICHLOROETHENE	ug/l	ND(1)	ND(1)
1,2-DICHLOROETHANE	ug/l	ND(1)	ND(1)
1,2-DICHLOROPROPANE	ug/l	ND(1)	ND(1)
2-BUTANONE	ug/l	ND(10)	ND(10)
2-HEXANONE	ug/l	ND(10)	ND(10)
4-METHYL-2-PENTANONE	ug/l	ND(10)	ND(10)
ACETONE	ug/l	ND(10)	ND(10)
BENZENE	ug/l	ND(1)	ND(1)

TABLE C.1

ANALYTICAL DATA
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		130 ft.S MW125/126	275 ft.S MW125/126
Sample I.D.:		SW-DS-229	SW-DS-230
Sample Interval:		--	--
Date Sampled:		11/21/1997	11/21/1997
Parameters	Units		
Volatile Organic Compounds (Cont'd)			
BROMODICHLOROMETHANE	ug/l	ND(1)	ND(1)
BROMOFORM	ug/l	ND(1)	ND(1)
BROMOMETHANE	ug/l	ND(1)	ND(1)
CARBON DISULFIDE	ug/l	ND(1)	ND(1)
CARBON TETRACHLORIDE	ug/l	ND(1)	ND(1)
CHLOROBENZENE	ug/l	ND(1)	ND(1)
CHLOROETHANE	ug/l	ND(1)	ND(1)
CHLOROFORM	ug/l	ND(1)	ND(1)
CHLOROMETHANE	ug/l	ND(1)	ND(1)
CIS-1,2-DICHLOROETHENE	ug/l	ND(1)	ND(1)
CIS-1,3-DICHLOROPROPENE	ug/l	ND(1)	ND(1)
DIBROMOCHLOROMETHANE	ug/l	ND(1)	ND(1)
DICHLOROMETHANE	ug/l	ND(1)	ND(2.2) U
ETHYL BENZENE	ug/l	ND(1)	ND(1)
STYRENE	ug/l	ND(1)	ND(1)
TETRACHLOROETHENE	ug/l	ND(1)	ND(1)
TOLUENE	ug/l	ND(1)	ND(1)
TRANS-1,2-DICHLOROETHENE	ug/l	ND(1)	ND(1)
TRANS-1,3-DICHLOROPROPENE	ug/l	ND(1)	ND(1)
TRICHLOROETHENE	ug/l	ND(1)	ND(1)
VINYL CHLORIDE	ug/l	ND(1)	ND(1)
XYLENES (TOTAL)	ug/l	ND(1)	ND(1)

Notes

ND	-	The material was analyzed, but not detected above the stated method detection limit.
J	-	The associated numerical value is an estimated quantity.
U	-	The material was analyzed, but was not detected above the level of the associated value due to blank contamination.
--	-	The parameter was not analyzed.
UJ	-	The material was analyzed, but was not detected above the level of the associated value. The associated value may not accurately or precisely represent the sample detection limit.

TABLE C.2

GROUNDWATER SCREENING ANALYTICAL DATA
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		GS-1	GS-1	GS-1	GS-2	GS-2	GS-2	GS-6	GS-6	GS-6	GS-6
Sample I.D.:		GS-SC-04	GS-SC-06	GS-SC-07	GS-SC-09	GS-SC-10	GS-SC-12	GS-SC-13	GS-SC-14	GS-SC-17	GS-SC-18
Sample Interval:		105-110 ft.	119-122 ft.	119-122 ft.	87.5-90 ft.	92.5-95 ft.	117.5-120 ft.	77.5-80 ft.	87.5-90 ft.	103-105.5 ft.	113-115.5 ft.
Date Sampled:		03/24/1999	03/25/1999	03/25/1999	03/26/1999	03/26/1999	03/26/1999	03/28/1999	03/28/1999	03/28/1999	03/28/1999
				Dupl.							
Parameters	Units										
Volatile Organic Compounds											
1,1,1-TRICHLOROETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
1,1,2,2-TETRACHLOROETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
1,1,2-TRICHLOROETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
1,1-DICHLOROETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
1,1-DICHLOROETHENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
1,2-DICHLOROETHANE	ug/l	ND(1)	ND(1)	ND(1) U	ND(1)	ND(1) U	ND(1) U	ND(1)	ND(1)	ND(1) U	ND(1)
1,2-DICHLOROPROPANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
2-BUTANONE	ug/l	ND(10) R	ND(10) R	ND(10) R	ND(10) R	ND(10) R	ND(10) R	ND(10) R	ND(10) R	ND(10) R	ND(10) R
2-HEXANONE	ug/l	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
4-METHYL-2-PENTANONE	ug/l	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	7.4 J	6.5 J	ND(10)	ND(10)
ACETONE	ug/l	ND(10) R	ND(10) R	ND(10) R	ND(10) R	ND(10) R	ND(10) R	ND(10) R	ND(10) R	ND(10) R	ND(10) R
BENZENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
BROMODICHLOROMETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	1.2	0.72 J	ND(1)	ND(1)
BROMOFORM	ug/l	ND(1) UJ	ND(1) UJ	ND(1) UJ	ND(1) UJ	ND(1) UJ	ND(1) UJ	ND(1) UJ	ND(1) UJ	ND(1) UJ	ND(1) UJ
BROMOMETHANE	ug/l	0.55 J	ND(1) UJ	ND(1) UJ	ND(1) UJ	ND(1) UJ	0.93 J	ND(1) UJ	ND(1) UJ	ND(1) UJ	ND(1) UJ
CARBON DISULFIDE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1) UJ	ND(1) UJ	ND(1) UJ	ND(1) UJ	ND(1) UJ	ND(1)
CARBON TETRACHLORIDE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CHLOROBENZENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CHLOROETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CHLOROFORM	ug/l	0.9 J	ND(1)	ND(1)	ND(1.8) U	ND(1)	ND(1) U	4.1 J	ND(2.7) U	ND(1.1) U	ND(1.1) U
CHLOROMETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CIS-1,2-DICHLOROETHENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CIS-1,3-DICHLOROPROPENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
DIBROMOCHLOROMETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
DICHLOROMETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
ETHYL BENZENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	0.64 J	ND(1)	ND(1)	ND(1)
M,P-XYLENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	0.91 J	ND(1)	ND(1)	ND(1)
O-XYLENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
STYRENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
TETRACHLOROETHENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
TOLUENE	ug/l	ND(1)	ND(1)	ND(1)	ND(0.6) U	ND(1)	ND(1)	ND(1) UJ	ND(1)	ND(1)	ND(1)
TRANS-1,2-DICHLOROETHENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
TRANS-1,3-DICHLOROPROPENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
TRICHLOROETHENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
VINYL CHLORIDE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)

TABLE C.2

GROUNDWATER SCREENING ANALYTICAL DATA
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		GS-6	GS-7	GS-7	GS-10	GS-10	GS-114	GS-114	GS-128	GS-128	MW-124(Screening)
Sample I.D.:		GS-SC-19	GS-SC-21	GS-SC-24	GS-SC-36	GS-SC-37	GS-SC-31	GS-SC-32	GS-SC-40	GS-SC-48	GW-SC-25
Sample Interval:		113-115.5 ft.	75.5-78 ft.	103.5-105 ft.	95.5-98 ft.	106.5-109 ft.	133.5-135 ft.	198.5-201 ft.	75.5-78 ft.	148.5-151 ft.	--
Date Sampled:		03/28/1999	03/29/1999	03/29/1999	04/06/1999	04/06/1999	03/30/1999	03/31/1999	04/07/1999	04/08/1999	03/29/1999
		Dupl.									
Parameters	Units										
Volatile Organic Compounds											
1,1,1-TRICHLOROETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
1,1,2,2-TETRACHLOROETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
1,1,2-TRICHLOROETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
1,1-DICHLOROETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
1,1-DICHLOROETHENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
1,2-DICHLOROETHANE	ug/l	ND(1) U	ND(1) U	ND(1) U	ND(1) UJ	ND(1) UJ	ND(1) U	ND(1)	ND(1)	ND(1)	ND(1)
1,2-DICHLOROPROPANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
2-BUTANONE	ug/l	ND(10) R	ND(10) R	ND(10) R	ND(10) R	ND(10) R	ND(10) R	ND(10) R	ND(10) R	ND(10) R	ND(10) R
2-HEXANONE	ug/l	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
4-METHYL-2-PENTANONE	ug/l	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	8.5 J	16	13	ND(10)
ACETONE	ug/l	ND(10) R	ND(10) R	ND(10) R	ND(10) R	ND(10) R	ND(10) R	ND(10) R	ND(10) R	ND(10) R	ND(10) R
BENZENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	1.1	0.54 J	ND(1)	ND(1)	ND(1)
BROMODICHLOROMETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
BROMOFORM	ug/l	ND(1) UJ	ND(1) UJ	ND(1) UJ	ND(1) UJ	ND(1) UJ	ND(1) UJ	ND(1) UJ	ND(1) UJ	ND(1) UJ	ND(1) UJ
BROMOMETHANE	ug/l	ND(1) UJ	ND(1) UJ	ND(1) UJ	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CARBON DISULFIDE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CARBON TETRACHLORIDE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CHLOROBENZENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CHLOROETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CHLOROFORM	ug/l	ND(1.1) U	0.85 J	ND(1)	1.9	1.6	0.81 J	1.1	1.8	1.1	ND(1)
CHLOROMETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CIS-1,2-DICHLOROETHENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CIS-1,3-DICHLOROPROPENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
DIBROMOCHLOROMETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
DICHLOROMETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
ETHYL BENZENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	0.75 J	ND(1)
M,P-XYLENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	0.55 J	ND(1)	ND(1)	1.5	ND(1)
O-XYLENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	0.87 J	ND(1)
STYRENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
TETRACHLOROETHENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
TOLUENE	ug/l	ND(1.1) U	0.65 J	0.54 J	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
TRANS-1,2-DICHLOROETHENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
TRANS-1,3-DICHLOROPROPENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
TRICHLOROETHENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
VINYL CHLORIDE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)

Notes

ND	-	The material was analyzed, but not detected above the stated method detection limit.
J	-	The associated numerical value is an estimated quantity.
U	-	The material was analyzed, but was not detected above the level of the associated value due to blank contamination.
--	-	The parameter was not analyzed.
UJ	-	The material was analyzed, but was not detected above the level of the associated value. The associated value may not accurately or precisely represent the sample detection limit.

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-100	MW-100	MW-100	MW-101	MW-101	MW-101	MW-102	MW-102	MW-103	MW-103
Sample I.D.:		GW-SC-159	GW-DS-189	GW-SC-52	GW-SC-158	GW-DS-188	GW-SC-51	GW-SC-152	GW-SC-56	GW-SC-151	GW-SC-55
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		09/24/1996	11/18/1997	04/27/1999	09/24/1996	11/18/1997	04/27/1999	09/23/1996	04/28/1999	09/23/1996	04/28/1999
Parameters	Units										
Semivolatile Organic Compounds											
1,2,4-TRICHLOROBENZENE	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
1,2-DICHLOROBENZENE	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
1,3-DICHLOROBENZENE	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
1,4-DICHLOROBENZENE	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
2,4,5-TRICHLOROPHENOL	ug/l	ND(50)	--	--	ND(50)	--	--	ND(50)	--	ND(50)	--
2,4,6-TRICHLOROPHENOL	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
2,4-DICHLOROPHENOL	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
2,4-DIMETHYLPHENOL	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
2,4-DINITROPHENOL	ug/l	ND(50)	--	--	ND(50)	--	--	ND(50)	--	ND(50)	--
2,4-DINITROTOLUENE	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
2,6-DINITROTOLUENE	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
2-CHLORONAPHTHALENE	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
2-CHLOROPHENOL	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
2-METHYLNAPHTHALENE	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
2-METHYLPHENOL	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
2-NITROANILINE	ug/l	ND(50)	--	--	ND(50)	--	--	ND(50)	--	ND(50)	--
2-NITROPHENOL	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
3,3'-DICHLOROBENZIDINE	ug/l	ND(20)	--	--	ND(20)	--	--	ND(20)	--	ND(20)	--
3-NITROANILINE	ug/l	ND(50)	--	--	ND(50)	--	--	ND(50)	--	ND(50)	--
4,6-DINITRO-2-METHYLPHENOL	ug/l	ND(50)	--	--	ND(50)	--	--	ND(50)	--	ND(50)	--
4-BROMOPHENYLPHENYL ETHER	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
4-CHLORO-3-METHYLPHENOL	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
4-CHLOROANILINE	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
4-CHLOROPHENYLPHENYL ETHER	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
4-METHYLPHENOL	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
4-NITROANILINE	ug/l	ND(50)	--	--	ND(50)	--	--	ND(50)	--	ND(50)	--
4-NITROPHENOL	ug/l	ND(50)	--	--	ND(50)	--	--	ND(50)	--	ND(50)	--
ACENAPHTHENE	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
ACENAPHTHYLENE	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
ANTHRACENE	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
BENZO(A)ANTHRACENE	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
BENZO(A)PYRENE	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
BENZO(B)FLUORANTHENE	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
BENZO(G,H,I)PERYLENE	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
BENZO(K)FLUORANTHENE	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-100	MW-100	MW-100	MW-101	MW-101	MW-101	MW-102	MW-102	MW-103	MW-103
Sample I.D.:		GW-SC-159	GW-DS-189	GW-SC-52	GW-SC-158	GW-DS-188	GW-SC-51	GW-SC-152	GW-SC-56	GW-SC-151	GW-SC-55
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		09/24/1996	11/18/1997	04/27/1999	09/24/1996	11/18/1997	04/27/1999	09/23/1996	04/28/1999	09/23/1996	04/28/1999
Parameters	Units										
Semivolatile Organic Compounds (Cont'd)											
BIS(2-CHLOROETHOXY)METHANE	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
BIS(2-CHLOROETHYL)ETHER	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
BIS(2-CHLOROISOPROPYL)ETHER	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
BIS(2-ETHYLHEXYL)PHTHALATE	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
BUTYLBENZYLPHTHALATE	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
CARBAZOLE	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
CHRYSENE	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
DI-N-BUTYLPHTHALATE	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
DI-N-OCTYLPHTHALATE	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
DIBENZ(A,H)ANTHRACENE	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
DIBENZOFURAN	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
DIETHYLPHTHALATE	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
DIMETHYLPHTHALATE	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
FLUORANTHENE	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
FLUORENE	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
HEXACHLOROBENZENE	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
HEXACHLOROBUTADIENE	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
HEXACHLOROCYCLOPENTADIENE	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
HEXACHLOROETHANE	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
INDENO(1,2,3-CD)PYRENE	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
ISOPHORONE	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
N-NITROSO-DI-N-PROPYLAMINE	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
N-NITROSODIPHENYLAMINE	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
NAPHTHALENE	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
NITROBENZENE	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
PENTACHLOROPHENOL	ug/l	ND(50)	--	--	ND(50)	--	--	ND(50)	--	ND(50)	--
PHENANTHRENE	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
PHENOL	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
PYRENE	ug/l	ND(10)	--	--	ND(10)	--	--	ND(10)	--	ND(10)	--
General Chemistry											
ALKALINITY	mg/l	330	--	330	270	--	260	430	390	300	290
ALKALINITY, BICARBONATE	mg/l	--	340	330	--	270	260	--	390	--	290
ALKALINITY, CARBONATE	mg/l	--	ND(1)	ND(10)	--	ND(1)	ND(10)	--	ND(10)	--	ND(10)

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-100	MW-100	MW-100	MW-101	MW-101	MW-101	MW-102	MW-102	MW-103	MW-103
Sample I.D.:		GW-SC-159	GW-DS-189	GW-SC-52	GW-SC-158	GW-DS-188	GW-SC-51	GW-SC-152	GW-SC-56	GW-SC-151	GW-SC-55
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		09/24/1996	11/18/1997	04/27/1999	09/24/1996	11/18/1997	04/27/1999	09/23/1996	04/28/1999	09/23/1996	04/28/1999
Parameters	Units										
General Chemistry (Cont'd)											
CHLORIDE	mg/l	3.6	4.6	3.5	7.1	7.3	6	150	180	14	13
COUNT TIME	minutes	280	--	--	280	--	--	280	--	280	--
CYANIDE	mg/l	ND(0.005)	--	--	ND(0.005)	--	--	ND(0.005)	--	ND(0.005)	--
DISSOLVED ORGANIC CARBON (DOC)	mg/l	--	1.2	ND(1.6) U	--	2.0	ND(2.1) U	--	ND(3.1) U	--	ND(1.3) U
FERROUS IRON	mg/l	--	0.42	--	--	0.17	--	--	--	--	--
GROSS ALPHA	pCi/l	ND(3.0) +/-1.4	--	--	ND(3.0) +/-1.2	--	--	ND(3.0) +/-2.6	--	ND(3.0) +/-1.5	--
GROSS BETA	pCi/l	ND(4.0) +/-3.5	--	--	ND(4.0) +/-3.2	--	--	4.3 +/-4.4	--	ND(4.0) +/-3.1	--
HARDNESS, CALCIUM/MAGNESIUM (AS CACO3	mg/l	--	--	360	--	--	330	--	610	--	360
NITRITE	mg/l	--	--	ND(0.1)	--	--	ND(0.1)	--	ND(0.1)	--	ND(0.1)
NITROGEN, AMMONIA	mg/l	ND(0.15) U	--	--	ND(0.15) U	--	--	ND(0.26) U	--	ND(0.25) U	--
NITROGEN, NITRATE	mg/l	ND(0.16) U	ND(0.10)	ND(0.1)	ND(0.01)	ND(0.01)	ND(0.1)	ND(0.01)	ND(0.1)	ND(0.01)	ND(0.1)
PH	std. units	7.3	--	--	7.3	--	--	7.2	--	7.8	--
SULFATE	mg/l	56	48	46.6	82	74	71.8	35	25.7	41	37.1
SULFIDE	mg/l	--	ND(1.0)	1.6	--	ND(1.0)	ND(1)	--	1.2	--	2
TOTAL DISSOLVED SOLIDS	mg/l	400	370	420	420	350	400	690	730	380	440
TOTAL ORGANIC CARBON (TOC)	mg/l	--	1.7	--	--	2.8	--	--	--	--	--
TOTAL SUSPENDED SOLIDS (TSS)	mg/l	13	62	ND(5)	7	10	ND(5)	20	ND(5)	7	ND(5)
TAL Metals											
ALUMINUM	mg/l	ND(0.13) U	--	ND(0.2)	ND(0.050)	--	ND(0.2)	ND(0.078) U	ND(0.2)	ND(0.050)	ND(0.2)
ALUMINUM, DISSOLVED	mg/l	ND(0.050)	--	--	ND(0.050)	--	--	ND(0.050)	--	ND(0.050)	--
ANTIMONY	mg/l	ND(0.030)	--	--	ND(0.030)	--	--	ND(0.030)	--	ND(0.030)	--
ANTIMONY, DISSOLVED	mg/l	ND(0.030)	--	--	ND(0.030)	--	--	ND(0.030)	--	ND(0.030)	--
ARSENIC	mg/l	0.0064	--	--	ND(0.0050)	--	--	0.011	--	ND(0.0050)	--
ARSENIC, DISSOLVED	mg/l	0.0080	--	--	ND(0.0050)	--	--	0.012	--	ND(0.0050)	--
BARIUM	mg/l	0.10	--	--	0.075	--	--	0.12	--	0.055	--
BARIUM, DISSOLVED	mg/l	0.11	--	--	0.075	--	--	0.12	--	0.058	--
BERYLLIUM	mg/l	ND(0.0050)	--	--	ND(0.0050)	--	--	ND(0.0050)	--	ND(0.0050)	--
BERYLLIUM, DISSOLVED	mg/l	ND(0.0050)	--	--	ND(0.0050)	--	--	ND(0.0050)	--	ND(0.0050)	--
CADMIUM	mg/l	ND(0.0050)	--	--	ND(0.0050)	--	--	ND(0.0050)	--	ND(0.0050)	--
CADMIUM, DISSOLVED	mg/l	ND(0.0050)	--	--	ND(0.0050)	--	--	ND(0.0050)	--	ND(0.0050)	--
CALCIUM	mg/l	90	--	89 J	88	--	86 J	120	140 J	55	59 J
CALCIUM, DISSOLVED	mg/l	93	--	--	88	--	--	140	--	60	--
CHROMIUM	mg/l	ND(0.010)	--	--	ND(0.010)	--	--	ND(0.010)	--	ND(0.010)	--

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-100	MW-100	MW-100	MW-101	MW-101	MW-101	MW-102	MW-102	MW-103	MW-103
Sample I.D.:		GW-SC-159	GW-DS-189	GW-SC-52	GW-SC-158	GW-DS-188	GW-SC-51	GW-SC-152	GW-SC-56	GW-SC-151	GW-SC-55
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		09/24/1996	11/18/1997	04/27/1999	09/24/1996	11/18/1997	04/27/1999	09/23/1996	04/28/1999	09/23/1996	04/28/1999
Parameters	Units										
TAL Metals (Cont'd)											
CHROMIUM, DISSOLVED	mg/l	ND(0.010)	--	--	ND(0.010)	--	--	ND(0.010)	--	ND(0.010)	--
COBALT	mg/l	ND(0.010)	--	--	ND(0.010)	--	--	ND(0.010)	--	ND(0.010)	--
COBALT, DISSOLVED	mg/l	ND(0.010)	--	--	ND(0.010)	--	--	ND(0.010)	--	ND(0.010)	--
COPPER	mg/l	ND(0.020)	--	ND(0.02)	ND(0.020)	--	ND(0.02)	ND(0.020)	ND(0.02)	ND(0.020)	ND(0.02)
COPPER, DISSOLVED	mg/l	ND(0.020)	--	--	ND(0.020)	--	--	ND(0.020)	--	ND(0.020)	--
IRON	mg/l	2.9	3.2	2.5 B	3.0	5.3	2.6 B	1.9	1.8 J	1.7	1.9 J
IRON, DISSOLVED	mg/l	2.6 J	--	2.5	3.0 J	--	2.7	2.0	1.6	1.7	1.8
LEAD	mg/l	ND(0.0050)	--	--	ND(0.0050)	--	--	ND(0.0050)	--	ND(0.0050)	--
LEAD, DISSOLVED	mg/l	ND(0.0050)	--	--	ND(0.0050)	--	--	ND(0.0050)	--	ND(0.0050)	--
MAGNESIUM	mg/l	35	--	33	30	--	28	60	65	48	52
MAGNESIUM, DISSOLVED	mg/l	36	--	--	30	--	--	65	--	51	--
MANGANESE	mg/l	0.081	--	0.043	0.075	--	0.066	0.12	0.11	0.033	0.029
MANGANESE, DISSOLVED	mg/l	0.082	--	0.042	0.075	--	0.07	0.13	0.11	0.033	0.029
MERCURY	mg/l	ND(0.0002)	--	--	ND(0.0002)	--	--	ND(0.0002)	--	ND(0.0002)	--
MERCURY, DISSOLVED	mg/l	ND(0.0002)	--	--	ND(0.0002)	--	--	ND(0.0002)	--	ND(0.0002)	--
NICKEL	mg/l	ND(0.010)	--	--	ND(0.010)	--	--	ND(0.010)	--	ND(0.010)	--
NICKEL, DISSOLVED	mg/l	ND(0.010)	--	--	ND(0.010)	--	--	ND(0.010)	--	ND(0.010)	--
POTASSIUM	mg/l	2.1	--	--	1.1	--	--	2.5	--	3.6	--
POTASSIUM, DISSOLVED	mg/l	2.1	--	--	1.1	--	--	2.7	--	4.2	--
SELENIUM	mg/l	ND(0.0050)	--	--	ND(0.0050)	--	--	ND(0.0050)	--	ND(0.0050)	--
SELENIUM, DISSOLVED	mg/l	ND(0.0050)	--	--	ND(0.0050)	--	--	ND(0.0050)	--	0.0058	--
SILVER	mg/l	ND(0.010)	--	--	ND(0.010)	--	--	ND(0.010)	--	ND(0.010)	--
SILVER, DISSOLVED	mg/l	ND(0.010)	--	--	ND(0.010)	--	--	ND(0.010)	--	ND(0.010)	--
SODIUM	mg/l	5.6	--	5.4	3.6	--	3	37	67	7.0	6
SODIUM, DISSOLVED	mg/l	6.0	--	--	3.7	--	--	39	--	7.8	--
THALLIUM	mg/l	ND(0.010)	--	--	ND(0.010)	--	--	ND(0.010)	--	ND(0.010)	--
THALLIUM, DISSOLVED	mg/l	ND(0.010)	--	--	ND(0.010)	--	--	ND(0.010)	--	ND(0.010)	--
VANADIUM	mg/l	ND(0.010)	--	--	ND(0.010)	--	--	ND(0.010)	--	ND(0.010)	--
VANADIUM, DISSOLVED	mg/l	ND(0.010)	--	--	ND(0.010)	--	--	ND(0.010)	--	ND(0.010)	--
ZINC	mg/l	ND(0.020)	--	--	ND(0.020)	--	--	ND(0.020)	--	ND(0.020)	--
ZINC, DISSOLVED	mg/l	ND(0.020)	--	--	ND(0.020)	--	--	ND(0.020)	--	ND(0.020)	--
Volatile Organic Compounds											
1,1,1-TRICHLOROETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-100	MW-100	MW-100	MW-101	MW-101	MW-101	MW-102	MW-102	MW-103	MW-103
Sample I.D.:		GW-SC-159	GW-DS-189	GW-SC-52	GW-SC-158	GW-DS-188	GW-SC-51	GW-SC-152	GW-SC-56	GW-SC-151	GW-SC-55
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		09/24/1996	11/18/1997	04/27/1999	09/24/1996	11/18/1997	04/27/1999	09/23/1996	04/28/1999	09/23/1996	04/28/1999
Parameters	Units										
Volatile Organic Compounds (Cont'd)											
1,1,2,2-TETRACHLOROETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
1,1,2-TRICHLOROETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
1,1-DICHLOROETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
1,1-DICHLOROETHENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
1,2-DICHLOROETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1) UJ	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
1,2-DICHLOROETHENE	ug/l	--	--	--	--	--	--	--	--	--	--
1,2-DICHLOROPROPANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
2-BUTANONE	ug/l	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
2-HEXANONE	ug/l	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
4-METHYL-2-PENTANONE	ug/l	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
ACETONE	ug/l	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
BENZENE	ug/l	1.0	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	1.9	ND(1)	1.1	ND(1)
BROMODICHLOROMETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1) UJ	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
BROMOFORM	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
BROMOMETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CARBON DISULFIDE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CARBON TETRACHLORIDE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1) UJ	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CHLOROBENZENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CHLOROETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CHLOROFORM	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CHLOROMETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CIS-1,2-DICHLOROETHENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CIS-1,3-DICHLOROPROPENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1) UJ	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
DIBROMOCHLOROMETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
DICHLOROMETHANE	ug/l	ND(1)	ND(1)	ND(1) U	ND(1)	ND(1)	ND(1) U	ND(1)	ND(1)	ND(1)	ND(1)
ETHYL BENZENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
M,P-XYLENE	ug/l	--	--	ND(1)	--	--	ND(1)	--	ND(1)	--	ND(1)
O-XYLENE	ug/l	--	--	ND(1)	--	--	ND(1)	--	ND(1)	--	ND(1)
STYRENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1) UJ	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
TETRACHLOROETHENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
TOLUENE	ug/l	ND(1)	2.2	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
TRANS-1,2-DICHLOROETHENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
TRANS-1,3-DICHLOROPROPENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1) UJ	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
TRICHLOROETHENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
VINYL CHLORIDE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-100	MW-100	MW-100	MW-101	MW-101	MW-101	MW-102	MW-102	MW-103	MW-103
Sample I.D.:		GW-SC-159	GW-DS-189	GW-SC-52	GW-SC-158	GW-DS-188	GW-SC-51	GW-SC-152	GW-SC-56	GW-SC-151	GW-SC-55
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		09/24/1996	11/18/1997	04/27/1999	09/24/1996	11/18/1997	04/27/1999	09/23/1996	04/28/1999	09/23/1996	04/28/1999
Parameters	Units										
Volatile Organic Compounds (Cont'd)											
XYLENES (TOTAL)	ug/l	ND(1)	ND(1)	--	ND(1)	ND(1)	--	ND(1)	--	ND(1)	--
Dissolved Gases											
ETHANE	mg/l	--	ND(0.0005)	ND(0.010)	--	ND(0.0005)	ND(0.010)	--	ND(0.010)	--	ND(0.010)
ETHENE	mg/l	--	ND(0.0005)	ND(0.010)	--	ND(0.0005)	ND(0.010)	--	ND(0.010)	--	ND(0.010)
METHANE	mg/l	--	0.0025	ND(0.010)	--	0.0018	ND(0.010)	--	ND(0.010)	--	ND(0.010)

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-104	MW-104	MW-105	MW-105	MW-105	MW-106	MW-106	MW-106	MW-107	MW-107
Sample I.D.:		GW-SC-161	GW-SC-59	GW-SC-160	GW-SC-57	GW-SC-58	GW-SC-163	GW-DS-220	GW-SC-62	GW-SC-162	GW-DS-219
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		09/24/1996	04/28/1999	09/24/1996	04/28/1999	04/28/1999	09/24/1996	11/20/1997	04/29/1999	09/24/1996	11/20/1997
						Dupl.					
Parameters	Units										
Semivolatile Organic Compounds											
1,2,4-TRICHLOROBENZENE	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
1,2-DICHLOROBENZENE	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
1,3-DICHLOROBENZENE	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
1,4-DICHLOROBENZENE	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
2,4,5-TRICHLOROPHENOL	ug/l	ND(50)	--	ND(50)	--	--	ND(50)	--	--	ND(50)	--
2,4,6-TRICHLOROPHENOL	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
2,4-DICHLOROPHENOL	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
2,4-DIMETHYLPHENOL	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
2,4-DINITROPHENOL	ug/l	ND(50)	--	ND(50)	--	--	ND(50)	--	--	ND(50)	--
2,4-DINITROTOLUENE	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
2,6-DINITROTOLUENE	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
2-CHLORONAPHTHALENE	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
2-CHLOROPHENOL	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
2-METHYLNAPHTHALENE	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
2-METHYLPHENOL	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
2-NITROANILINE	ug/l	ND(50)	--	ND(50)	--	--	ND(50)	--	--	ND(50)	--
2-NITROPHENOL	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
3,3'-DICHLOROBENZIDINE	ug/l	ND(20)	--	ND(20)	--	--	ND(20)	--	--	ND(20)	--
3-NITROANILINE	ug/l	ND(50)	--	ND(50)	--	--	ND(50)	--	--	ND(50)	--
4,6-DINITRO-2-METHYLPHENOL	ug/l	ND(50)	--	ND(50)	--	--	ND(50)	--	--	ND(50)	--
4-BROMOPHENYLPHENYL ETHER	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
4-CHLORO-3-METHYLPHENOL	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
4-CHLOROANILINE	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
4-CHLOROPHENYLPHENYL ETHER	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
4-METHYLPHENOL	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
4-NITROANILINE	ug/l	ND(50)	--	ND(50)	--	--	ND(50)	--	--	ND(50)	--
4-NITROPHENOL	ug/l	ND(50)	--	ND(50)	--	--	ND(50)	--	--	ND(50)	--
ACENAPHTHENE	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
ACENAPHTHYLENE	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
ANTHRACENE	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
BENZO(A)ANTHRACENE	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
BENZO(A)PYRENE	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
BENZO(B)FLUORANTHENE	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
BENZO(G,H,I)PERYLENE	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
BENZO(K)FLUORANTHENE	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-104	MW-104	MW-105	MW-105	MW-105	MW-106	MW-106	MW-106	MW-107	MW-107
Sample I.D.:		GW-SC-161	GW-SC-59	GW-SC-160	GW-SC-57	GW-SC-58	GW-SC-163	GW-DS-220	GW-SC-62	GW-SC-162	GW-DS-219
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		09/24/1996	04/28/1999	09/24/1996	04/28/1999	04/28/1999	09/24/1996	11/20/1997	04/29/1999	09/24/1996	11/20/1997
						Dupl.					
Parameters	Units										
Semivolatile Organic Compounds (Cont'd)											
BIS(2-CHLOROETHOXY)METHANE	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
BIS(2-CHLOROETHYL)ETHER	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
BIS(2-CHLOROISOPROPYL)ETHER	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
BIS(2-ETHYLHEXYL)PHTHALATE	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
BUTYLBENZYLPHTHALATE	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
CARBAZOLE	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
CHRYSENE	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
DI-N-BUTYLPHTHALATE	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
DI-N-OCTYLPHTHALATE	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
DIBENZ(A,H)ANTHRACENE	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
DIBENZOFURAN	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
DIETHYLPHTHALATE	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
DIMETHYLPHTHALATE	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
FLUORANTHENE	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
FLUORENE	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
HEXACHLOROBENZENE	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
HEXACHLOROBUTADIENE	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
HEXACHLOROCYCLOPENTADIENE	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
HEXACHLOROETHANE	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
INDENO(1,2,3-CD)PYRENE	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
ISOPHORONE	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
N-NITROSO-DI-N-PROPYLAMINE	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
N-NITROSODIPHENYLAMINE	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
NAPHTHALENE	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
NITROBENZENE	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
PENTACHLOROPHENOL	ug/l	ND(50)	--	ND(50)	--	--	ND(50)	--	--	ND(50)	--
PHENANTHRENE	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
PHENOL	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
PYRENE	ug/l	ND(10)	--	ND(10)	--	--	ND(10)	--	--	ND(10)	--
General Chemistry											
ALKALINITY	mg/l	350	300	290	270	260	330	--	340	330	--
ALKALINITY, BICARBONATE	mg/l	--	300	--	270	260	--	340	340	--	330
ALKALINITY, CARBONATE	mg/l	--	ND(10)	--	ND(10)	ND(10)	--	ND(1)	ND(10)	--	ND(1)

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-104	MW-104	MW-105	MW-105	MW-105	MW-106	MW-106	MW-106	MW-107	MW-107
Sample I.D.:		GW-SC-161	GW-SC-59	GW-SC-160	GW-SC-57	GW-SC-58	GW-SC-163	GW-DS-220	GW-SC-62	GW-SC-162	GW-DS-219
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		09/24/1996	04/28/1999	09/24/1996	04/28/1999	04/28/1999	09/24/1996	11/20/1997	04/29/1999	09/24/1996	11/20/1997
						Dupl.					
Parameters	Units										
General Chemistry (Cont'd)											
CHLORIDE	mg/l	2.9	5.2	3.8	3.8	4.5	16	52	47	3.1	3.1
COUNT TIME	minutes	280	--	280	--	--	280	--	--	280	--
CYANIDE	mg/l	ND(0.005)	--	ND(0.005)	--	--	ND(0.005)	--	--	ND(0.005)	--
DISSOLVED ORGANIC CARBON (DOC)	mg/l	--	ND(1.2) U	--	ND(1.7) U	ND(2.2) U	--	1.6	ND(1.8) U	--	2.0
FERROUS IRON	mg/l	--	--	--	--	--	--	0.15	--	--	0.11
GROSS ALPHA	pCi/l	ND(3.0) +/-1.9	--	ND(3.0) +/-1.3	--	--	ND(3.0) +/-1.3	--	--	ND(3.0) +/-1.1	--
GROSS BETA	pCi/l	ND(4.0) +/-3.6	--	ND(4.0) +/-3.1	--	--	ND(4.0) +/-3.6	--	--	ND(4.0) +/-3.4	--
HARDNESS, CALCIUM/MAGNESIUM (AS CACO3	mg/l	--	410	--	370	370	--	--	470	--	--
NITRITE	mg/l	--	ND(0.1)	--	ND(0.1)	ND(0.1)	--	--	ND(0.1)	--	--
NITROGEN, AMMONIA	mg/l	ND(0.14) U	--	ND(0.14) U	--	--	ND(0.16) U	--	--	ND(0.12)	--
NITROGEN, NITRATE	mg/l	ND(0.01)	ND(0.1)	ND(0.01)	ND(0.1)	ND(0.1)	ND(0.01)	ND(0.01) UJ	ND(0.1)	ND(0.01)	ND(0.01) UJ
PH	std. units	7.4	--	7.2	--	--	7.2	--	--	7.6	--
SULFATE	mg/l	35	42.5	60	55.5	55.6	62	54	51.8	40	44
SULFIDE	mg/l	--	ND(1)	--	ND(1)	1.6	--	ND(1.0)	ND(1)	--	ND(1.0)
TOTAL DISSOLVED SOLIDS	mg/l	380	410	340	380	370	440	470	510	390	400
TOTAL ORGANIC CARBON (TOC)	mg/l	--	--	--	--	--	--	ND(1.0)	--	--	1.6
TOTAL SUSPENDED SOLIDS (TSS)	mg/l	6	ND(5)	7	ND(5)	ND(5)	10	8	ND(8) U	9	7
TAL Metals											
ALUMINUM	mg/l	ND(0.050)	ND(0.2)	ND(0.050)	ND(0.2)	ND(0.2)	ND(0.050)	--	ND(0.2)	ND(0.050)	--
ALUMINUM, DISSOLVED	mg/l	ND(0.050)	--	ND(0.050)	--	--	ND(0.050)	--	--	ND(0.050)	--
ANTIMONY	mg/l	ND(0.030)	--	ND(0.030)	--	--	ND(0.030)	--	--	ND(0.030)	--
ANTIMONY, DISSOLVED	mg/l	ND(0.030)	--	ND(0.030)	--	--	ND(0.030)	--	--	ND(0.030)	--
ARSENIC	mg/l	ND(0.0050)	--	ND(0.0050)	--	--	ND(0.0050)	--	--	ND(0.0050)	--
ARSENIC, DISSOLVED	mg/l	ND(0.0050)	--	0.0059	--	--	ND(0.0050)	--	--	0.0058	--
BARIUM	mg/l	0.026	--	0.069	--	--	0.076	--	--	0.14	--
BARIUM, DISSOLVED	mg/l	0.027	--	0.076	--	--	0.079	--	--	0.14	--
BERYLLIUM	mg/l	ND(0.0050)	--	ND(0.0050)	--	--	ND(0.0050)	--	--	ND(0.0050)	--
BERYLLIUM, DISSOLVED	mg/l	ND(0.0050)	--	ND(0.0050)	--	--	ND(0.0050)	--	--	ND(0.0050)	--
CADMIUM	mg/l	ND(0.0050)	--	ND(0.0050)	--	--	ND(0.0050)	--	--	ND(0.0050)	--
CADMIUM, DISSOLVED	mg/l	ND(0.0050)	--	ND(0.0050)	--	--	ND(0.0050)	--	--	ND(0.0050)	--
CALCIUM	mg/l	75	89 J	80	89 J	89 J	99	--	120 J	93	--
CALCIUM, DISSOLVED	mg/l	79	--	85	--	--	99	--	--	95	--
CHROMIUM	mg/l	ND(0.010)	--	ND(0.010)	--	--	ND(0.010)	--	--	ND(0.010)	--

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-104	MW-104	MW-105	MW-105	MW-105	MW-106	MW-106	MW-106	MW-107	MW-107
Sample I.D.:		GW-SC-161	GW-SC-59	GW-SC-160	GW-SC-57	GW-SC-58	GW-SC-163	GW-DS-220	GW-SC-62	GW-SC-162	GW-DS-219
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		09/24/1996	04/28/1999	09/24/1996	04/28/1999	04/28/1999	09/24/1996	11/20/1997	04/29/1999	09/24/1996	11/20/1997
						Dupl.					
Parameters	Units										
TAL Metals (Cont'd)											
CHROMIUM, DISSOLVED	mg/l	ND(0.010)	--	ND(0.010)	--	--	ND(0.010)	--	--	ND(0.010)	--
COBALT	mg/l	ND(0.010)	--	ND(0.010)	--	--	ND(0.010)	--	--	ND(0.010)	--
COBALT, DISSOLVED	mg/l	ND(0.010)	--	ND(0.010)	--	--	ND(0.010)	--	--	ND(0.010)	--
COPPER	mg/l	ND(0.020)	ND(0.02)	ND(0.020)	ND(0.02)	ND(0.02)	ND(0.020)	--	ND(0.02)	ND(0.020)	--
COPPER, DISSOLVED	mg/l	ND(0.020)	--	ND(0.020)	--	--	ND(0.020)	--	--	ND(0.020)	--
IRON	mg/l	2.2	0.9 J	2.6	2.3 J	2.2 J	3.9	3.5	3.3 J	3.4	2.8
IRON, DISSOLVED	mg/l	2.2 J	0.89	2.7 J	2.2	2.3	3.6 J	--	3.3	3.4 J	--
LEAD	mg/l	ND(0.0050)	--	ND(0.0050)	--	--	ND(0.0050)	--	--	ND(0.0050)	--
LEAD, DISSOLVED	mg/l	ND(0.0050)	--	ND(0.0050)	--	--	ND(0.0050)	--	--	ND(0.0050)	--
MAGNESIUM	mg/l	42	45	33	37	37	37	--	43	31	--
MAGNESIUM, DISSOLVED	mg/l	45	--	35	--	--	37	--	--	32	--
MANGANESE	mg/l	0.036	0.021	0.056	0.045	0.046	0.071	--	0.07	0.057	--
MANGANESE, DISSOLVED	mg/l	0.036	0.022	0.059	0.046	0.048	0.071	--	0.073	0.058	--
MERCURY	mg/l	ND(0.0002)	--	ND(0.0002)	--	--	ND(0.0002)	--	--	ND(0.0002)	--
MERCURY, DISSOLVED	mg/l	ND(0.0002)	--	ND(0.0002)	--	--	ND(0.0002)	--	--	ND(0.0002)	--
NICKEL	mg/l	ND(0.010)	--	ND(0.010)	--	--	ND(0.010)	--	--	ND(0.010)	--
NICKEL, DISSOLVED	mg/l	ND(0.010)	--	ND(0.010)	--	--	ND(0.010)	--	--	ND(0.010)	--
POTASSIUM	mg/l	1.5	--	1.0	--	--	1.3	--	--	1.2	--
POTASSIUM, DISSOLVED	mg/l	1.6	--	1.1	--	--	1.3	--	--	1.2	--
SELENIUM	mg/l	ND(0.0050)	--	ND(0.0050)	--	--	ND(0.0050)	--	--	ND(0.0050)	--
SELENIUM, DISSOLVED	mg/l	ND(0.0050)	--	ND(0.0050)	--	--	ND(0.0050)	--	--	ND(0.0050)	--
SILVER	mg/l	ND(0.010)	--	ND(0.010)	--	--	ND(0.010)	--	--	ND(0.010)	--
SILVER, DISSOLVED	mg/l	ND(0.010)	--	ND(0.010)	--	--	ND(0.010)	--	--	ND(0.010)	--
SODIUM	mg/l	6.8	4.7	4.1	3.3	3	5.4	--	8	6.8	--
SODIUM, DISSOLVED	mg/l	7.4	--	4.4	--	--	5.4	--	--	7.1	--
THALLIUM	mg/l	ND(0.010)	--	ND(0.010)	--	--	ND(0.010)	--	--	ND(0.010)	--
THALLIUM, DISSOLVED	mg/l	ND(0.010)	--	ND(0.010)	--	--	ND(0.010)	--	--	ND(0.010)	--
VANADIUM	mg/l	ND(0.010)	--	ND(0.010)	--	--	ND(0.010)	--	--	ND(0.010)	--
VANADIUM, DISSOLVED	mg/l	ND(0.010)	--	ND(0.010)	--	--	ND(0.010)	--	--	ND(0.010)	--
ZINC	mg/l	ND(0.020)	--	ND(0.020)	--	--	ND(0.020)	--	--	ND(0.020)	--
ZINC, DISSOLVED	mg/l	ND(0.020)	--	ND(0.020)	--	--	ND(0.020)	--	--	ND(0.020)	--
Volatile Organic Compounds											
1,1,1-TRICHLOROETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-104	MW-104	MW-105	MW-105	MW-105	MW-106	MW-106	MW-106	MW-107	MW-107
Sample I.D.:		GW-SC-161	GW-SC-59	GW-SC-160	GW-SC-57	GW-SC-58	GW-SC-163	GW-DS-220	GW-SC-62	GW-SC-162	GW-DS-219
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		09/24/1996	04/28/1999	09/24/1996	04/28/1999	04/28/1999	09/24/1996	11/20/1997	04/29/1999	09/24/1996	11/20/1997
						Dupl.					
Parameters	Units										
Volatile Organic Compounds (Cont'd)											
1,1,2,2-TETRACHLOROETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
1,1,2-TRICHLOROETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
1,1-DICHLOROETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
1,1-DICHLOROETHENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
1,2-DICHLOROETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
1,2-DICHLOROETHENE	ug/l	--	--	--	--	--	--	--	--	--	--
1,2-DICHLOROPROPANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
2-BUTANONE	ug/l	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
2-HEXANONE	ug/l	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
4-METHYL-2-PENTANONE	ug/l	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
ACETONE	ug/l	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
BENZENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
BROMODICHLOROMETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
BROMOFORM	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
BROMOMETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1) U	ND(1)	ND(1)
CARBON DISULFIDE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CARBON TETRACHLORIDE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CHLOROBENZENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CHLOROETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CHLOROFORM	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CHLOROMETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CIS-1,2-DICHLOROETHENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CIS-1,3-DICHLOROPROPENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
DIBROMOCHLOROMETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
DICHLOROMETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1) U	ND(1)	ND(1)	ND(1.4) U	ND(1)	ND(1)
ETHYL BENZENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
M,P-XYLENE	ug/l	--	ND(1)	--	ND(1)	ND(1)	--	--	ND(1)	--	--
O-XYLENE	ug/l	--	ND(1)	--	ND(1)	ND(1)	--	--	ND(1)	--	--
STYRENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
TETRACHLOROETHENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
TOLUENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
TRANS-1,2-DICHLOROETHENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
TRANS-1,3-DICHLOROPROPENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
TRICHLOROETHENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
VINYL CHLORIDE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-104	MW-104	MW-105	MW-105	MW-105	MW-106	MW-106	MW-106	MW-107	MW-107
Sample I.D.:		GW-SC-161	GW-SC-59	GW-SC-160	GW-SC-57	GW-SC-58	GW-SC-163	GW-DS-220	GW-SC-62	GW-SC-162	GW-DS-219
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		09/24/1996	04/28/1999	09/24/1996	04/28/1999	04/28/1999	09/24/1996	11/20/1997	04/29/1999	09/24/1996	11/20/1997
						Dupl.					
Parameters	Units										
Volatile Organic Compounds (Cont'd)											
XYLENES (TOTAL)	ug/l	ND(1)	--	ND(1)	--	--	ND(1)	ND(1)	--	ND(1)	ND(1)
Dissolved Gases											
ETHANE	mg/l	--	ND(0.010)	--	ND(0.010)	ND(0.010)	--	ND(0.0005)	ND(0.010)	--	ND(0.0005)
ETHENE	mg/l	--	ND(0.010)	--	ND(0.010)	ND(0.010)	--	ND(0.0005)	ND(0.010)	--	ND(0.0005)
METHANE	mg/l	--	ND(0.010)	--	ND(0.010)	ND(0.010)	--	0.0079	0.011	--	0.0027

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-107	MW-108	MW-108	MW-109	MW-109	MW-110	MW-110	MW-110	MW-110	MW-111
Sample I.D.:		GW-SC-60	GW-SC-165	GW-SC-75	GW-SC-164	GW-SC-74	GW-SC-172	GW-SC-173	GW-DS-225	GW-SC-78	GW-SC-171
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		04/28/1999	09/25/1996	04/30/1999	09/25/1996	04/30/1999	09/25/1996	09/25/1996	11/21/1997	05/01/1999	09/25/1996
								Dupl.			
Parameters	Units										
Semivolatile Organic Compounds											
1,2,4-TRICHLOROBENZENE	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
1,2-DICHLOROBENZENE	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
1,3-DICHLOROBENZENE	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
1,4-DICHLOROBENZENE	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
2,4,5-TRICHLOROPHENOL	ug/l	--	ND(50)	--	ND(50) UJ	--	ND(50) UJ	ND(50)	--	--	ND(50)
2,4,6-TRICHLOROPHENOL	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
2,4-DICHLOROPHENOL	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
2,4-DIMETHYLPHENOL	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
2,4-DINITROPHENOL	ug/l	--	ND(50)	--	ND(50) UJ	--	ND(50) UJ	ND(50)	--	--	ND(50)
2,4-DINITROTOLUENE	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
2,6-DINITROTOLUENE	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
2-CHLORONAPHTHALENE	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
2-CHLOROPHENOL	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
2-METHYLNAPHTHALENE	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
2-METHYLPHENOL	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
2-NITROANILINE	ug/l	--	ND(50)	--	ND(50) UJ	--	ND(50) UJ	ND(50)	--	--	ND(50)
2-NITROPHENOL	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
3,3'-DICHLOROBENZIDINE	ug/l	--	ND(20)	--	ND(20) UJ	--	ND(20) UJ	ND(20)	--	--	ND(20)
3-NITROANILINE	ug/l	--	ND(50)	--	ND(50) UJ	--	ND(50) UJ	ND(50)	--	--	ND(50)
4,6-DINITRO-2-METHYLPHENOL	ug/l	--	ND(50)	--	ND(50) UJ	--	ND(50) UJ	ND(50)	--	--	ND(50)
4-BROMOPHENYLPHENYL ETHER	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
4-CHLORO-3-METHYLPHENOL	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
4-CHLOROANILINE	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
4-CHLOROPHENYLPHENYL ETHER	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
4-METHYLPHENOL	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
4-NITROANILINE	ug/l	--	ND(50)	--	ND(50) UJ	--	ND(50) UJ	ND(50)	--	--	ND(50)
4-NITROPHENOL	ug/l	--	ND(50)	--	ND(50) UJ	--	ND(50) UJ	ND(50)	--	--	ND(50)
ACENAPHTHENE	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
ACENAPHTHYLENE	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
ANTHRACENE	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
BENZO(A)ANTHRACENE	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
BENZO(A)PYRENE	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
BENZO(B)FLUORANTHENE	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
BENZO(G,H,I)PERYLENE	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
BENZO(K)FLUORANTHENE	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-107	MW-108	MW-108	MW-109	MW-109	MW-110	MW-110	MW-110	MW-110	MW-111
Sample I.D.:		GW-SC-60	GW-SC-165	GW-SC-75	GW-SC-164	GW-SC-74	GW-SC-172	GW-SC-173	GW-DS-225	GW-SC-78	GW-SC-171
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		04/28/1999	09/25/1996	04/30/1999	09/25/1996	04/30/1999	09/25/1996	09/25/1996	11/21/1997	05/01/1999	09/25/1996
								Dupl.			
Parameters	Units										
Semivolatile Organic Compounds (Cont'd)											
BIS(2-CHLOROETHOXY)METHANE	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
BIS(2-CHLOROETHYL)ETHER	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
BIS(2-CHLOROISOPROPYL)ETHER	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
BIS(2-ETHYLHEXYL)PHTHALATE	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
BUTYLBENZYLPHTHALATE	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
CARBAZOLE	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
CHRYSENE	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
DI-N-BUTYLPHTHALATE	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
DI-N-OCTYLPHTHALATE	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
DIBENZ(A,H)ANTHRACENE	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
DIBENZOFURAN	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
DIETHYLPHTHALATE	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
DIMETHYLPHTHALATE	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
FLUORANTHENE	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
FLUORENE	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
HEXACHLOROBENZENE	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
HEXACHLOROBUTADIENE	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
HEXACHLOROCYCLOPENTADIENE	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
HEXACHLOROETHANE	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
INDENO(1,2,3-CD)PYRENE	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
ISOPHORONE	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
N-NITROSO-DI-N-PROPYLAMINE	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
N-NITROSODIPHENYLAMINE	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
NAPHTHALENE	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
NITROBENZENE	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
PENTACHLOROPHENOL	ug/l	--	ND(50)	--	ND(50) UJ	--	ND(50) UJ	ND(50)	--	--	ND(50)
PHENANTHRENE	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
PHENOL	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
PYRENE	ug/l	--	ND(10)	--	ND(10) UJ	--	ND(10) UJ	ND(10)	--	--	ND(10)
General Chemistry											
ALKALINITY	mg/l	270	300	230	320	310	430	420	--	430 J	340
ALKALINITY, BICARBONATE	mg/l	270	--	230	--	310	--	--	420	430 J	--
ALKALINITY, CARBONATE	mg/l	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(1)	ND(10) UJ	--

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-107	MW-108	MW-108	MW-109	MW-109	MW-110	MW-110	MW-110	MW-110	MW-111
Sample I.D.:		GW-SC-60	GW-SC-165	GW-SC-75	GW-SC-164	GW-SC-74	GW-SC-172	GW-SC-173	GW-DS-225	GW-SC-78	GW-SC-171
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		04/28/1999	09/25/1996	04/30/1999	09/25/1996	04/30/1999	09/25/1996	09/25/1996	11/21/1997	05/01/1999	09/25/1996
								Dupl.			
Parameters	Units										
General Chemistry (Cont'd)											
CHLORIDE	mg/l	3.8	19	29	3.0	ND(4.2) U	8.5	8.6	9.8	6.5	12
COUNT TIME	minutes	--	280	--	280	--	280	280	--	--	280
CYANIDE	mg/l	--	ND(0.005)	--	ND(0.005)	--	ND(0.005)	ND(0.005)	--	--	ND(0.005)
DISSOLVED ORGANIC CARBON (DOC)	mg/l	ND(2) U	--	13	--	ND(1.5) U	--	--	15	14	--
FERROUS IRON	mg/l	--	--	--	--	--	--	--	0.72	--	--
GROSS ALPHA	pCi/l	--	ND(3.0) +/-1.0	--	ND(3.0) +/-1.4	--	ND(3.0) +/-1.5	ND(3.0) +/-1.6	--	--	ND(3.0) +/-1.4
GROSS BETA	pCi/l	--	ND(4.0) +/-2.9	--	ND(4.0) +/-3.0	--	ND(4.0) +/-3.2	6.1 +/-3.2	--	--	ND(4.0) +/-3.0
HARDNESS, CALCIUM/MAGNESIUM (AS CACO3	mg/l	380	--	270	--	360	--	--	--	430	--
NITRITE	mg/l	ND(0.1)	--	0.579 J	--	ND(0.1)	--	--	--	ND(0.1)	--
NITROGEN, AMMONIA	mg/l	--	4.0	--	ND(0.22) U	--	1.2	ND(1.0) U	--	--	ND(0.12)
NITROGEN, NITRATE	mg/l	ND(0.1)	ND(0.01)	ND(0.1)	ND(0.01)	ND(0.1)	ND(0.01)	ND(0.01)	ND(0.01) UJ	ND(0.1)	ND(0.01)
PH	std. units	--	6.7	--	7.2	--	7.0	7.0	--	--	7.2
SULFATE	mg/l	43.9	ND(5.0)	16.7	53	54.6	21	21	14	18.2	82
SULFIDE	mg/l	ND(1)	--	ND(1)	--	ND(1)	--	--	ND(1.0)	ND(1)	--
TOTAL DISSOLVED SOLIDS	mg/l	400	360	310	410	380	490	490	500	470	460
TOTAL ORGANIC CARBON (TOC)	mg/l	--	--	--	--	--	--	--	15	--	--
TOTAL SUSPENDED SOLIDS (TSS)	mg/l	ND(5)	59	ND(52) U	14	ND(8.4) U	16	17	20	15	10
TAL Metals											
ALUMINUM	mg/l	ND(0.2)	ND(0.050)	ND(0.2)	ND(0.060) U	ND(0.2)	ND(0.050)	ND(0.050)	--	ND(0.2)	ND(0.050)
ALUMINUM, DISSOLVED	mg/l	--	ND(0.068) U	--	ND(0.050)	--	ND(0.050)	ND(0.050)	--	--	ND(0.050)
ANTIMONY	mg/l	--	ND(0.030)	--	0.035	--	ND(0.030)	ND(0.030)	--	--	ND(0.030)
ANTIMONY, DISSOLVED	mg/l	--	ND(0.030)	--	ND(0.030)	--	ND(0.030)	ND(0.030)	--	--	ND(0.030)
ARSENIC	mg/l	--	0.0062	--	ND(0.0050)	--	ND(0.0050)	ND(0.0050)	--	--	ND(0.0050)
ARSENIC, DISSOLVED	mg/l	--	0.0073	--	0.0051	--	ND(0.0050)	ND(0.0050)	--	--	ND(0.0050)
BARIUM	mg/l	--	0.069	--	0.046	--	0.15	0.14	--	--	0.045
BARIUM, DISSOLVED	mg/l	--	0.075	--	0.042	--	0.16	0.16	--	--	0.046
BERYLLIUM	mg/l	--	ND(0.0050)	--	ND(0.0050)	--	ND(0.0050)	ND(0.0050)	--	--	ND(0.0050)
BERYLLIUM, DISSOLVED	mg/l	--	ND(0.0050)	--	ND(0.0050)	--	ND(0.0050)	ND(0.0050)	--	--	ND(0.0050)
CADMIUM	mg/l	--	ND(0.0050)	--	ND(0.0050)	--	ND(0.0050)	ND(0.0050)	--	--	ND(0.0050)
CADMIUM, DISSOLVED	mg/l	--	ND(0.0050)	--	ND(0.0050)	--	ND(0.0050)	ND(0.0050)	--	--	ND(0.0050)
CALCIUM	mg/l	98 J	93	78 J	92	87 J	130	120	--	130 J	100
CALCIUM, DISSOLVED	mg/l	--	90	--	87	--	120	120	--	--	97
CHROMIUM	mg/l	--	ND(0.010)	--	ND(0.010)	--	ND(0.010)	ND(0.010)	--	--	ND(0.010)

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-107	MW-108	MW-108	MW-109	MW-109	MW-110	MW-110	MW-110	MW-110	MW-111
Sample I.D.:		GW-SC-60	GW-SC-165	GW-SC-75	GW-SC-164	GW-SC-74	GW-SC-172	GW-SC-173	GW-DS-225	GW-SC-78	GW-SC-171
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		04/28/1999	09/25/1996	04/30/1999	09/25/1996	04/30/1999	09/25/1996	09/25/1996	11/21/1997	05/01/1999	09/25/1996
								Dupl.			
Parameters	Units										
TAL Metals (Cont'd)											
CHROMIUM, DISSOLVED	mg/l	--	ND(0.010)	--	ND(0.010)	--	ND(0.010)	ND(0.010)	--	--	ND(0.010)
COBALT	mg/l	--	ND(0.010)	--	ND(0.010)	--	ND(0.010)	ND(0.010)	--	--	ND(0.010)
COBALT, DISSOLVED	mg/l	--	ND(0.010)	--	ND(0.010)	--	ND(0.010)	ND(0.010)	--	--	ND(0.010)
COPPER	mg/l	ND(0.02)	ND(0.020)	ND(0.02) U	ND(0.020)	ND(0.02)	ND(0.020)	ND(0.020)	--	ND(0.02) U	ND(0.020)
COPPER, DISSOLVED	mg/l	--	ND(0.020)	--	ND(0.020)	--	ND(0.020)	ND(0.020)	--	--	ND(0.020)
IRON	mg/l	2.9 J	25	22 J	4.4	3 J	6.4	6.2	5.7	5.9 J	3.9
IRON, DISSOLVED	mg/l	2.9	26	21	4.2	3.1	6.6	6.6	--	6.2 J	3.8
LEAD	mg/l	--	ND(0.0050)	--	ND(0.0050)	--	ND(0.0050)	ND(0.0050)	--	--	ND(0.0050)
LEAD, DISSOLVED	mg/l	--	ND(0.0050)	--	ND(0.0050)	--	ND(0.0050)	ND(0.0050)	--	--	ND(0.0050)
MAGNESIUM	mg/l	32	21	18	36	34	27	26	--	28 J	37
MAGNESIUM, DISSOLVED	mg/l	--	22	--	35	--	28	27	--	--	37
MANGANESE	mg/l	0.031	0.43	0.38	0.075	0.054	0.30	0.29	--	0.28	0.067
MANGANESE, DISSOLVED	mg/l	0.033	0.43	0.38	0.070	0.054	0.30	0.30	--	0.3	0.065
MERCURY	mg/l	--	ND(0.0002)	--	ND(0.0002)	--	ND(0.0002)	ND(0.0002)	--	--	ND(0.0002)
MERCURY, DISSOLVED	mg/l	--	ND(0.0002)	--	ND(0.0002)	--	ND(0.0002)	ND(0.0002)	--	--	ND(0.0002)
NICKEL	mg/l	--	ND(0.010)	--	ND(0.010)	--	ND(0.010)	ND(0.010)	--	--	ND(0.010)
NICKEL, DISSOLVED	mg/l	--	ND(0.010)	--	ND(0.010)	--	ND(0.010)	ND(0.010)	--	--	ND(0.010)
POTASSIUM	mg/l	--	1.8	--	0.94	--	3.6	3.5	--	--	1.9
POTASSIUM, DISSOLVED	mg/l	--	2.2	--	1.0	--	3.8	3.9	--	--	2.0
SELENIUM	mg/l	--	ND(0.0050)	--	ND(0.0050)	--	ND(0.0050)	ND(0.0050)	--	--	ND(0.0050)
SELENIUM, DISSOLVED	mg/l	--	ND(0.0050)	--	ND(0.0050)	--	ND(0.0050)	ND(0.0050)	--	--	ND(0.0086) U
SILVER	mg/l	--	ND(0.010)	--	ND(0.010)	--	ND(0.010)	ND(0.010)	--	--	ND(0.010)
SILVER, DISSOLVED	mg/l	--	ND(0.010)	--	ND(0.010)	--	ND(0.010)	ND(0.010)	--	--	ND(0.010)
SODIUM	mg/l	5	4.7	1.5 J	3.8	2.9	8.5	8.2	--	3.2	6.0
SODIUM, DISSOLVED	mg/l	--	4.8	--	3.8	--	8.5	8.5	--	--	5.9
THALLIUM	mg/l	--	ND(0.010)	--	ND(0.010)	--	ND(0.010)	ND(0.010)	--	--	ND(0.010)
THALLIUM, DISSOLVED	mg/l	--	ND(0.010)	--	ND(0.010)	--	ND(0.010)	ND(0.010)	--	--	ND(0.010)
VANADIUM	mg/l	--	ND(0.010)	--	ND(0.010)	--	ND(0.010)	ND(0.010)	--	--	ND(0.010)
VANADIUM, DISSOLVED	mg/l	--	ND(0.010)	--	ND(0.010)	--	ND(0.010)	ND(0.010)	--	--	ND(0.010)
ZINC	mg/l	--	ND(0.020) U	--	ND(0.020)	--	ND(0.020)	ND(0.17) U	--	--	ND(0.020)
ZINC, DISSOLVED	mg/l	--	ND(0.020)	--	ND(0.020)	--	ND(0.020)	ND(0.020)	--	--	ND(0.020)
Volatile Organic Compounds											
1,1,1-TRICHLOROETHANE	ug/l	ND(1)	ND(1) UJ	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-107	MW-108	MW-108	MW-109	MW-109	MW-110	MW-110	MW-110	MW-110	MW-111
Sample I.D.:		GW-SC-60	GW-SC-165	GW-SC-75	GW-SC-164	GW-SC-74	GW-SC-172	GW-SC-173	GW-DS-225	GW-SC-78	GW-SC-171
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		04/28/1999	09/25/1996	04/30/1999	09/25/1996	04/30/1999	09/25/1996	09/25/1996	11/21/1997	05/01/1999	09/25/1996
								Dupl.			
Parameters	Units										
Volatile Organic Compounds (Cont'd)											
1,1,2,2-TETRACHLOROETHANE	ug/l	ND(1)	ND(1) UJ	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
1,1,2-TRICHLOROETHANE	ug/l	ND(1)	ND(1) UJ	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
1,1-DICHLOROETHANE	ug/l	ND(1)	ND(1) UJ	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
1,1-DICHLOROETHENE	ug/l	ND(1)	ND(1) UJ	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
1,2-DICHLOROETHANE	ug/l	ND(1)	12 J	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1.7) U	ND(1)	1.3
1,2-DICHLOROETHENE	ug/l	--	--	--	--	--	--	--	--	--	--
1,2-DICHLOROPROPANE	ug/l	ND(1)	ND(1) UJ	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
2-BUTANONE	ug/l	ND(10)	ND(10) UJ	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
2-HEXANONE	ug/l	ND(10)	ND(10) UJ	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
4-METHYL-2-PENTANONE	ug/l	ND(10)	ND(10) UJ	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
ACETONE	ug/l	ND(10)	ND(10) UJ	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10) UJ
BENZENE	ug/l	ND(1)	1.3 J	ND(1) UJ	1.2	ND(1)	ND(1)	ND(1)	ND(1.9) U	ND(1) UJ	ND(1)
BROMODICHLOROMETHANE	ug/l	ND(1)	ND(1) UJ	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
BROMOFORM	ug/l	ND(1)	ND(1) UJ	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
BROMOMETHANE	ug/l	ND(1)	ND(1) UJ	ND(1) U	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CARBON DISULFIDE	ug/l	ND(1)	ND(1) UJ	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CARBON TETRACHLORIDE	ug/l	ND(1)	ND(1) UJ	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CHLOROBENZENE	ug/l	ND(1)	ND(1) UJ	ND(1) UJ	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1) UJ	ND(1)
CHLOROETHANE	ug/l	ND(1)	ND(1) UJ	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CHLOROFORM	ug/l	ND(1)	ND(1) UJ	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CHLOROMETHANE	ug/l	ND(1)	ND(1) UJ	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CIS-1,2-DICHLOROETHENE	ug/l	ND(1)	ND(1) UJ	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CIS-1,3-DICHLOROPROPENE	ug/l	ND(1)	ND(1) UJ	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
DIBROMOCHLOROMETHANE	ug/l	ND(1)	ND(1) UJ	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
DICHLOROMETHANE	ug/l	ND(1) U	ND(1) UJ	ND(1.3) U	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
ETHYL BENZENE	ug/l	ND(1)	ND(1) UJ	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
M,P-XYLENE	ug/l	ND(1)	--	ND(1)	--	ND(1)	--	--	--	ND(1)	--
O-XYLENE	ug/l	ND(1)	--	ND(1)	--	ND(1)	--	--	--	ND(1)	--
STYRENE	ug/l	ND(1)	ND(1) UJ	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
TETRACHLOROETHENE	ug/l	ND(1)	ND(1) UJ	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
TOLUENE	ug/l	ND(1)	ND(1) UJ	ND(1) UJ	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1) UJ	ND(1)
TRANS-1,2-DICHLOROETHENE	ug/l	ND(1)	ND(1) UJ	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
TRANS-1,3-DICHLOROPROPENE	ug/l	ND(1)	ND(1) UJ	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
TRICHLOROETHENE	ug/l	ND(1)	ND(1) UJ	ND(1) UJ	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1) UJ	ND(1)
VINYL CHLORIDE	ug/l	ND(1)	ND(1) UJ	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-107	MW-108	MW-108	MW-109	MW-109	MW-110	MW-110	MW-110	MW-110	MW-111
Sample I.D.:		GW-SC-60	GW-SC-165	GW-SC-75	GW-SC-164	GW-SC-74	GW-SC-172	GW-SC-173	GW-DS-225	GW-SC-78	GW-SC-171
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		04/28/1999	09/25/1996	04/30/1999	09/25/1996	04/30/1999	09/25/1996	09/25/1996	11/21/1997	05/01/1999	09/25/1996
								Dupl.			
Parameters	Units										
Volatile Organic Compounds (Cont'd)											
XYLENES (TOTAL)	ug/l	--	ND(1) UJ	--	ND(1)	--	ND(1)	ND(1)	ND(1)	--	ND(1)
Dissolved Gases											
ETHANE	mg/l	ND(0.010)	--	ND(0.010)	--	ND(0.010)	--	--	ND(0.001)	ND(0.010)	--
ETHENE	mg/l	ND(0.010)	--	ND(0.010)	--	ND(0.010)	--	--	ND(0.001)	ND(0.010)	--
METHANE	mg/l	ND(0.010)	--	1.8	--	0.010	--	--	0.098	0.36	--

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-111	MW-111	MW-111	MW-112	MW-112	MW-112	MW-112	MW-112	MW-112	MW-112
Sample I.D.:		GW-DS-226	GW-KD-04	GW-SC-77	GW-SC-169	GW-SC-170	GW-DS-227	GW-DS-228	GW-KD-05	GW-SC-79	GW-SC-80
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		11/21/1997	03/20/1998	05/01/1999	09/25/1996	09/25/1996	11/21/1997	11/21/1997	03/20/1998	05/01/1999	05/01/1999
						Dupl.		Dupl.			Dupl.
Parameters	Units										
Semivolatile Organic Compounds											
1,2,4-TRICHLOROBENZENE	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
1,2-DICHLOROBENZENE	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
1,3-DICHLOROBENZENE	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
1,4-DICHLOROBENZENE	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
2,4,5-TRICHLOROPHENOL	ug/l	--	--	--	ND(50)	ND(50)	--	--	--	--	--
2,4,6-TRICHLOROPHENOL	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
2,4-DICHLOROPHENOL	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
2,4-DIMETHYLPHENOL	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
2,4-DINITROPHENOL	ug/l	--	--	--	ND(50)	ND(50)	--	--	--	--	--
2,4-DINITROTOLUENE	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
2,6-DINITROTOLUENE	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
2-CHLORONAPHTHALENE	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
2-CHLOROPHENOL	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
2-METHYLNAPHTHALENE	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
2-METHYLPHENOL	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
2-NITROANILINE	ug/l	--	--	--	ND(50)	ND(50)	--	--	--	--	--
2-NITROPHENOL	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
3,3'-DICHLOROBENZIDINE	ug/l	--	--	--	ND(20)	ND(20)	--	--	--	--	--
3-NITROANILINE	ug/l	--	--	--	ND(50)	ND(50)	--	--	--	--	--
4,6-DINITRO-2-METHYLPHENOL	ug/l	--	--	--	ND(50)	ND(50)	--	--	--	--	--
4-BROMOPHENYLPHENYL ETHER	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
4-CHLORO-3-METHYLPHENOL	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
4-CHLOROANILINE	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
4-CHLOROPHENYLPHENYL ETHER	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
4-METHYLPHENOL	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
4-NITROANILINE	ug/l	--	--	--	ND(50)	ND(50)	--	--	--	--	--
4-NITROPHENOL	ug/l	--	--	--	ND(50)	ND(50)	--	--	--	--	--
ACENAPHTHENE	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
ACENAPHTHYLENE	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
ANTHRACENE	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
BENZO(A)ANTHRACENE	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
BENZO(A)PYRENE	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
BENZO(B)FLUORANTHENE	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
BENZO(G,H,I)PERYLENE	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
BENZO(K)FLUORANTHENE	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-111	MW-111	MW-111	MW-112	MW-112	MW-112	MW-112	MW-112	MW-112	MW-112
Sample I.D.:		GW-DS-226	GW-KD-04	GW-SC-77	GW-SC-169	GW-SC-170	GW-DS-227	GW-DS-228	GW-KD-05	GW-SC-79	GW-SC-80
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		11/21/1997	03/20/1998	05/01/1999	09/25/1996	09/25/1996	11/21/1997	11/21/1997	03/20/1998	05/01/1999	05/01/1999
						Dupl.		Dupl.			Dupl.
Parameters	Units										
Semivolatile Organic Compounds (Cont'd)											
BIS(2-CHLOROETHOXY)METHANE	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
BIS(2-CHLOROETHYL)ETHER	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
BIS(2-CHLOROISOPROPYL)ETHER	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
BIS(2-ETHYLHEXYL)PHTHALATE	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
BUTYLBENZYLPHTHALATE	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
CARBAZOLE	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
CHRYSENE	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
DI-N-BUTYLPHTHALATE	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
DI-N-OCTYLPHTHALATE	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
DIBENZ(A,H)ANTHRACENE	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
DIBENZOFURAN	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
DIETHYLPHTHALATE	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
DIMETHYLPHTHALATE	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
FLUORANTHENE	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
FLUORENE	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
HEXACHLOROBENZENE	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
HEXACHLOROBUTADIENE	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
HEXACHLOROCYCLOPENTADIENE	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
HEXACHLOROETHANE	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
INDENO(1,2,3-CD)PYRENE	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
ISOPHORONE	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
N-NITROSO-DI-N-PROPYLAMINE	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
N-NITROSODIPHENYLAMINE	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
NAPHTHALENE	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
NITROBENZENE	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
PENTACHLOROPHENOL	ug/l	--	--	--	ND(50)	ND(50)	--	--	--	--	--
PHENANTHRENE	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
PHENOL	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
PYRENE	ug/l	--	--	--	ND(10)	ND(10)	--	--	--	--	--
General Chemistry											
ALKALINITY	mg/l	--	--	330	330	330	--	--	--	330 J	330 J
ALKALINITY, BICARBONATE	mg/l	350	--	330	--	--	330	320	--	330 J	330 J
ALKALINITY, CARBONATE	mg/l	ND(1)	--	ND(10)	--	--	ND(1)	ND(1)	--	ND(10) UJ	ND(10) UJ

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-111	MW-111	MW-111	MW-112	MW-112	MW-112	MW-112	MW-112	MW-112	MW-112
Sample I.D.:		GW-DS-226	GW-KD-04	GW-SC-77	GW-SC-169	GW-SC-170	GW-DS-227	GW-DS-228	GW-KD-05	GW-SC-79	GW-SC-80
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		11/21/1997	03/20/1998	05/01/1999	09/25/1996	09/25/1996	11/21/1997	11/21/1997	03/20/1998	05/01/1999	05/01/1999
						Dupl.		Dupl.			Dupl.
Parameters	Units										
General Chemistry (Cont'd)											
CHLORIDE	mg/l	14	--	20	5.6	5.3	5.5	5.4	--	8.5	8.8
COUNT TIME	minutes	--	--	--	280	280	--	--	--	--	--
CYANIDE	mg/l	--	--	--	ND(0.005)	ND(0.005)	--	--	--	--	--
DISSOLVED ORGANIC CARBON (DOC)	mg/l	ND(1.2) U	--	ND(1.3) U	--	--	ND(2.3) U	--	--	ND(1.9) U	ND(1.9) U
FERROUS IRON	mg/l	ND(0.10)	--	--	--	--	0.12	0.11	--	--	--
GROSS ALPHA	pCi/l	--	--	--	ND(3.0) +/-1.0	ND(3.0) +/-1.5	--	--	--	--	--
GROSS BETA	pCi/l	--	--	--	ND(4.0) +/-3.0	5.5 +/-3.2	--	--	--	--	--
HARDNESS, CALCIUM/MAGNESIUM (AS CACO3	mg/l	--	--	430	--	--	--	--	--	410	400
NITRITE	mg/l	--	--	ND(0.1)	--	--	--	--	--	ND(0.1)	ND(0.1)
NITROGEN, AMMONIA	mg/l	--	--	--	ND(0.16) U	ND(0.14) U	--	--	--	--	--
NITROGEN, NITRATE	mg/l	ND(0.01) UJ	--	ND(0.1)	ND(0.01)	ND(0.01)	ND(0.01) UJ	ND(0.01) UJ	--	ND(0.1)	ND(0.1)
PH	std. units	--	--	--	7.2	7.2	--	--	--	--	--
SULFATE	mg/l	59	--	59.6	53	56	45	45	--	52.4	52.7
SULFIDE	mg/l	ND(1.0)	--	ND(1)	--	--	ND(1.0)	ND(1.0)	--	ND(1)	ND(1)
TOTAL DISSOLVED SOLIDS	mg/l	450	--	1200	440	420	390	410	--	400	390
TOTAL ORGANIC CARBON (TOC)	mg/l	ND(2.1) U	--	--	--	--	ND(2.3) U	ND(2.4) U	--	--	--
TOTAL SUSPENDED SOLIDS (TSS)	mg/l	8	--	11	11	6	8	6	--	ND(5)	8.8
TAL Metals											
ALUMINUM	mg/l	--	--	ND(0.2)	ND(0.050)	ND(0.050)	--	--	--	ND(0.2)	ND(0.2)
ALUMINUM, DISSOLVED	mg/l	--	--	--	ND(0.050)	ND(0.050)	--	--	--	--	--
ANTIMONY	mg/l	--	--	--	ND(0.030)	ND(0.030)	--	--	--	--	--
ANTIMONY, DISSOLVED	mg/l	--	--	--	ND(0.030)	ND(0.030)	--	--	--	--	--
ARSENIC	mg/l	--	--	--	0.0080	0.0074	--	--	--	--	--
ARSENIC, DISSOLVED	mg/l	--	--	--	0.011	0.0084	--	--	--	--	--
BARIUM	mg/l	--	--	--	0.12	0.12	--	--	--	--	--
BARIUM, DISSOLVED	mg/l	--	--	--	0.14	0.12	--	--	--	--	--
BERYLLIUM	mg/l	--	--	--	ND(0.0050)	ND(0.0050)	--	--	--	--	--
BERYLLIUM, DISSOLVED	mg/l	--	--	--	ND(0.0050)	ND(0.0050)	--	--	--	--	--
CADMIUM	mg/l	--	--	--	ND(0.0050)	ND(0.0050)	--	--	--	--	--
CADMIUM, DISSOLVED	mg/l	--	--	--	ND(0.0050)	ND(0.0050)	--	--	--	--	--
CALCIUM	mg/l	--	--	110 J	98	96	--	--	--	100 J	100 J
CALCIUM, DISSOLVED	mg/l	--	--	--	98	88	--	--	--	--	--
CHROMIUM	mg/l	--	--	--	ND(0.010)	ND(0.010)	--	--	--	--	--

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-111	MW-111	MW-111	MW-112	MW-112	MW-112	MW-112	MW-112	MW-112	MW-112
Sample I.D.:		GW-DS-226	GW-KD-04	GW-SC-77	GW-SC-169	GW-SC-170	GW-DS-227	GW-DS-228	GW-KD-05	GW-SC-79	GW-SC-80
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		11/21/1997	03/20/1998	05/01/1999	09/25/1996	09/25/1996	11/21/1997	11/21/1997	03/20/1998	05/01/1999	05/01/1999
						Dupl.		Dupl.			Dupl.
Parameters	Units										
TAL Metals (Cont'd)											
CHROMIUM, DISSOLVED	mg/l	--	--	--	ND(0.010)	ND(0.010)	--	--	--	--	--
COBALT	mg/l	--	--	--	ND(0.010)	ND(0.010)	--	--	--	--	--
COBALT, DISSOLVED	mg/l	--	--	--	ND(0.010)	ND(0.010)	--	--	--	--	--
COPPER	mg/l	--	--	ND(0.02)	ND(0.020)	ND(0.020)	--	--	--	ND(0.02)	ND(0.02)
COPPER, DISSOLVED	mg/l	--	--	--	ND(0.020)	ND(0.020)	--	--	--	--	--
IRON	mg/l	1.7	--	1.3 J	3.3	3.2	3.2	3.3	--	3.5 J	3.4 J
IRON, DISSOLVED	mg/l	--	--	1.3 J	3.5	3.1	--	--	--	3.6 J	3.5 J
LEAD	mg/l	--	--	--	ND(0.0050)	ND(0.0050)	--	--	--	--	--
LEAD, DISSOLVED	mg/l	--	--	--	ND(0.0050)	ND(0.0050)	--	--	--	--	--
MAGNESIUM	mg/l	--	--	40 J	31	31	--	--	--	36 J	35 J
MAGNESIUM, DISSOLVED	mg/l	--	--	--	33	30	--	--	--	--	--
MANGANESE	mg/l	--	--	0.046	0.039	0.038	--	--	--	0.039	0.038
MANGANESE, DISSOLVED	mg/l	--	--	0.045	0.040	0.034	--	--	--	0.041	0.041
MERCURY	mg/l	--	--	--	ND(0.0002)	ND(0.0002)	--	--	--	--	--
MERCURY, DISSOLVED	mg/l	--	--	--	ND(0.0002)	ND(0.0002)	--	--	--	--	--
NICKEL	mg/l	--	--	--	ND(0.010)	ND(0.010)	--	--	--	--	--
NICKEL, DISSOLVED	mg/l	--	--	--	ND(0.010)	ND(0.010)	--	--	--	--	--
POTASSIUM	mg/l	--	--	--	0.99	0.95	--	--	--	--	--
POTASSIUM, DISSOLVED	mg/l	--	--	--	1.3	1.1	--	--	--	--	--
SELENIUM	mg/l	--	--	--	ND(0.0050)	ND(0.0050)	--	--	--	--	--
SELENIUM, DISSOLVED	mg/l	--	--	--	ND(0.0050)	ND(0.0055) U	--	--	--	--	--
SILVER	mg/l	--	--	--	ND(0.010)	ND(0.010)	--	--	--	--	--
SILVER, DISSOLVED	mg/l	--	--	--	ND(0.010)	ND(0.010)	--	--	--	--	--
SODIUM	mg/l	--	--	6.4	6.1	5.9	--	--	--	5.8	5.5
SODIUM, DISSOLVED	mg/l	--	--	--	6.6	5.6	--	--	--	--	--
THALLIUM	mg/l	--	--	--	ND(0.010)	ND(0.010)	--	--	--	--	--
THALLIUM, DISSOLVED	mg/l	--	--	--	ND(0.010)	ND(0.010)	--	--	--	--	--
VANADIUM	mg/l	--	--	--	ND(0.010)	ND(0.010)	--	--	--	--	--
VANADIUM, DISSOLVED	mg/l	--	--	--	ND(0.010)	ND(0.010)	--	--	--	--	--
ZINC	mg/l	--	--	--	ND(0.020)	ND(0.020)	--	--	--	--	--
ZINC, DISSOLVED	mg/l	--	--	--	ND(0.020)	ND(0.020)	--	--	--	--	--
Volatile Organic Compounds											
1,1,1-TRICHLOROETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-111	MW-111	MW-111	MW-112	MW-112	MW-112	MW-112	MW-112	MW-112	MW-112
Sample I.D.:		GW-DS-226	GW-KD-04	GW-SC-77	GW-SC-169	GW-SC-170	GW-DS-227	GW-DS-228	GW-KD-05	GW-SC-79	GW-SC-80
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		11/21/1997	03/20/1998	05/01/1999	09/25/1996	09/25/1996	11/21/1997	11/21/1997	03/20/1998	05/01/1999	05/01/1999
						Dupl.		Dupl.			Dupl.
Parameters	Units										
Volatile Organic Compounds (Cont'd)											
1,1,2,2-TETRACHLOROETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
1,1,2-TRICHLOROETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
1,1-DICHLOROETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
1,1-DICHLOROETHENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
1,2-DICHLOROETHANE	ug/l	ND(1)	ND(1.4) U	ND(1)	83	85	ND(58) U	ND(54) U	45	44	38
1,2-DICHLOROETHENE	ug/l	--	--	--	--	--	--	--	--	--	--
1,2-DICHLOROPROPANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
2-BUTANONE	ug/l	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
2-HEXANONE	ug/l	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
4-METHYL-2-PENTANONE	ug/l	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
ACETONE	ug/l	ND(10)	ND(10)	ND(10)	ND(10) UJ	ND(10) UJ	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
BENZENE	ug/l	ND(1)	ND(1)	ND(1) UJ	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1) UJ	ND(1) UJ
BROMODICHLOROMETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
BROMOFORM	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
BROMOMETHANE	ug/l	ND(1)	ND(1) UJ	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CARBON DISULFIDE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CARBON TETRACHLORIDE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CHLOROBENZENE	ug/l	ND(1)	ND(1)	ND(1) UJ	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1) UJ	ND(1) UJ
CHLOROETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CHLOROFORM	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CHLOROMETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CIS-1,2-DICHLOROETHENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CIS-1,3-DICHLOROPROPENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
DIBROMOCHLOROMETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
DICHLOROMETHANE	ug/l	ND(1)	1.1 J	ND(1) U	ND(1)	ND(1)	ND(1)	ND(1.1) U	ND(1)	ND(1) U	ND(1)
ETHYL BENZENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
M,P-XYLENE	ug/l	--	--	ND(1)	--	--	--	--	--	ND(1)	ND(1)
O-XYLENE	ug/l	--	--	ND(1)	--	--	--	--	--	ND(1)	ND(1)
STYRENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
TETRACHLOROETHENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
TOLUENE	ug/l	ND(1)	ND(1)	ND(1) UJ	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1) UJ	ND(1) UJ
TRANS-1,2-DICHLOROETHENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
TRANS-1,3-DICHLOROPROPENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
TRICHLOROETHENE	ug/l	ND(1)	ND(1)	ND(1) UJ	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1) UJ	ND(1) UJ
VINYL CHLORIDE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	0.65 J	0.65 J

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-111	MW-111	MW-111	MW-112	MW-112	MW-112	MW-112	MW-112	MW-112	MW-112
Sample I.D.:		GW-DS-226	GW-KD-04	GW-SC-77	GW-SC-169	GW-SC-170	GW-DS-227	GW-DS-228	GW-KD-05	GW-SC-79	GW-SC-80
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		11/21/1997	03/20/1998	05/01/1999	09/25/1996	09/25/1996	11/21/1997	11/21/1997	03/20/1998	05/01/1999	05/01/1999
						Dupl.		Dupl.			Dupl.
Parameters	Units										
Volatile Organic Compounds (Cont'd)											
XYLENES (TOTAL)	ug/l	ND(1)	ND(1)	--	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	--	--
Dissolved Gases											
ETHANE	mg/l	ND(0.0005)	--	ND(0.010)	--	--	ND(0.0005)	ND(0.0005)	--	ND(0.010)	ND(0.010)
ETHENE	mg/l	ND(0.0005)	--	ND(0.010)	--	--	ND(0.0005)	ND(0.0005)	--	ND(0.010)	ND(0.010)
METHANE	mg/l	0.0032	--	ND(0.010)	--	--	0.003	0.0028	--	ND(0.010)	ND(0.010)

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-113	MW-113	MW-113	MW-113	MW-113	MW-113	MW-114	MW-114	MW-114	MW-114
Sample I.D.:		GW-SC-168	GW-DS-221	GW-KD-07	GW-KD-07	GW-SC-88	GW-SC-89	GW-SC-167	GW-DS-222	GW-DS-223	GW-KD-08
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		09/25/1996	11/21/1997	03/20/1998	03/20/1998	05/02/1999	05/02/1999	09/25/1996	11/21/1997	11/21/1997	03/20/1998
					Reanal 1		Dupl.			Dupl.	
Parameters	Units										
Semivolatile Organic Compounds											
1,2,4-TRICHLOROBENZENE	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
1,2-DICHLOROBENZENE	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
1,3-DICHLOROBENZENE	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
1,4-DICHLOROBENZENE	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
2,4,5-TRICHLOROPHENOL	ug/l	ND(50)	--	--	--	--	--	ND(50)	--	--	--
2,4,6-TRICHLOROPHENOL	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
2,4-DICHLOROPHENOL	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
2,4-DIMETHYLPHENOL	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
2,4-DINITROPHENOL	ug/l	ND(50)	--	--	--	--	--	ND(50)	--	--	--
2,4-DINITROTOLUENE	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
2,6-DINITROTOLUENE	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
2-CHLORONAPHTHALENE	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
2-CHLOROPHENOL	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
2-METHYLNAPHTHALENE	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
2-METHYLPHENOL	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
2-NITROANILINE	ug/l	ND(50)	--	--	--	--	--	ND(50)	--	--	--
2-NITROPHENOL	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
3,3'-DICHLOROBENZIDINE	ug/l	ND(20)	--	--	--	--	--	ND(20)	--	--	--
3-NITROANILINE	ug/l	ND(50)	--	--	--	--	--	ND(50)	--	--	--
4,6-DINITRO-2-METHYLPHENOL	ug/l	ND(50)	--	--	--	--	--	ND(50)	--	--	--
4-BROMOPHENYLPHENYL ETHER	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
4-CHLORO-3-METHYLPHENOL	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
4-CHLOROANILINE	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
4-CHLOROPHENYLPHENYL ETHER	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
4-METHYLPHENOL	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
4-NITROANILINE	ug/l	ND(50)	--	--	--	--	--	ND(50)	--	--	--
4-NITROPHENOL	ug/l	ND(50)	--	--	--	--	--	ND(50)	--	--	--
ACENAPHTHENE	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
ACENAPHTHYLENE	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
ANTHRACENE	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
BENZO(A)ANTHRACENE	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
BENZO(A)PYRENE	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
BENZO(B)FLUORANTHENE	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
BENZO(G,H,I)PERYLENE	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
BENZO(K)FLUORANTHENE	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-113	MW-113	MW-113	MW-113	MW-113	MW-113	MW-114	MW-114	MW-114	MW-114
Sample I.D.:		GW-SC-168	GW-DS-221	GW-KD-07	GW-KD-07	GW-SC-88	GW-SC-89	GW-SC-167	GW-DS-222	GW-DS-223	GW-KD-08
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		09/25/1996	11/21/1997	03/20/1998	03/20/1998	05/02/1999	05/02/1999	09/25/1996	11/21/1997	11/21/1997	03/20/1998
					Reanal 1		Dupl.			Dupl.	
Parameters	Units										
Semivolatile Organic Compounds (Cont'd)											
BIS(2-CHLOROETHOXY)METHANE	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
BIS(2-CHLOROETHYL)ETHER	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
BIS(2-CHLOROISOPROPYL)ETHER	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
BIS(2-ETHYLHEXYL)PHTHALATE	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
BUTYLBENZYLPHTHALATE	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
CARBAZOLE	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
CHRYSENE	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
DI-N-BUTYLPHTHALATE	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
DI-N-OCTYLPHTHALATE	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
DIBENZ(A,H)ANTHRACENE	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
DIBENZOFURAN	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
DIETHYLPHTHALATE	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
DIMETHYLPHTHALATE	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
FLUORANTHENE	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
FLUORENE	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
HEXACHLOROBENZENE	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
HEXACHLOROBUTADIENE	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
HEXACHLOROCYCLOPENTADIENE	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
HEXACHLOROETHANE	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
INDENO(1,2,3-CD)PYRENE	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
ISOPHORONE	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
N-NITROSO-DI-N-PROPYLAMINE	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
N-NITROSODIPHENYLAMINE	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
NAPHTHALENE	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
NITROBENZENE	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
PENTACHLOROPHENOL	ug/l	ND(50)	--	--	--	--	--	ND(50)	--	--	--
PHENANTHRENE	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
PHENOL	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
PYRENE	ug/l	ND(10)	--	--	--	--	--	ND(10)	--	--	--
General Chemistry											
ALKALINITY	mg/l	380	--	--	--	420	430	340	--	--	--
ALKALINITY, BICARBONATE	mg/l	--	420	--	--	420	430	--	350	350	--
ALKALINITY, CARBONATE	mg/l	--	ND(1)	--	--	ND(10)	ND(10)	--	ND(1)	ND(1)	--

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-113	MW-113	MW-113	MW-113	MW-113	MW-113	MW-114	MW-114	MW-114	MW-114
Sample I.D.:		GW-SC-168	GW-DS-221	GW-KD-07	GW-KD-07	GW-SC-88	GW-SC-89	GW-SC-167	GW-DS-222	GW-DS-223	GW-KD-08
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		09/25/1996	11/21/1997	03/20/1998	03/20/1998	05/02/1999	05/02/1999	09/25/1996	11/21/1997	11/21/1997	03/20/1998
					Reanal 1		Dupl.			Dupl.	
Parameters	Units										
General Chemistry (Cont'd)											
CHLORIDE	mg/l	94	87	--	--	68.5	67.5	12	12	12	--
COUNT TIME	minutes	280	--	--	--	--	--	280	--	--	--
CYANIDE	mg/l	ND(0.005)	--	--	--	--	--	ND(0.005)	--	--	--
DISSOLVED ORGANIC CARBON (DOC)	mg/l	--	ND(1.6) U	--	--	ND(1.6) U	ND(1.6) U	--	ND(1.0)	ND(1.0)	--
FERROUS IRON	mg/l	--	ND(0.10)	--	--	--	--	--	ND(0.10)	ND(0.10)	--
GROSS ALPHA	pCi/l	ND(3.0) +/-2.2	--	--	--	--	--	ND(3.0) +/-1.4	--	--	--
GROSS BETA	pCi/l	4.3 +/-3.5	--	--	--	--	--	ND(4.0) +/-2.9	--	--	--
HARDNESS, CALCIUM/MAGNESIUM (AS CACO3	mg/l	--	--	--	--	520	530	--	--	--	--
NITRITE	mg/l	--	--	--	--	ND(0.1)	ND(0.1)	--	--	--	--
NITROGEN, AMMONIA	mg/l	ND(0.14) U	--	--	--	--	--	ND(0.12)	--	--	--
NITROGEN, NITRATE	mg/l	0.02	0.03 J	--	--	0.0959 J	0.0955 J	ND(0.01)	ND(0.01) UJ	ND(0.01) UJ	--
PH	std. units	7.2	--	--	--	--	--	7.2	--	--	--
SULFATE	mg/l	83	81	--	--	88.9	88	48	40	41	--
SULFIDE	mg/l	--	ND(1.0)	--	--	ND(1)	ND(1)	--	ND(1.0)	ND(1.0)	--
TOTAL DISSOLVED SOLIDS	mg/l	670	650	--	--	620	640	430	430	430	--
TOTAL ORGANIC CARBON (TOC)	mg/l	--	ND(1.8) U	--	--	--	--	--	ND(1.0)	ND(1.0)	--
TOTAL SUSPENDED SOLIDS (TSS)	mg/l	8	10	--	--	ND(5)	ND(5)	5	15	8	--
TAL Metals											
ALUMINUM	mg/l	ND(0.063) U	--	--	--	ND(0.2)	ND(0.2)	ND(0.065) U	--	--	--
ALUMINUM, DISSOLVED	mg/l	ND(0.050)	--	--	--	--	--	ND(0.050)	--	--	--
ANTIMONY	mg/l	ND(0.030)	--	--	--	--	--	ND(0.030)	--	--	--
ANTIMONY, DISSOLVED	mg/l	ND(0.030)	--	--	--	--	--	ND(0.030)	--	--	--
ARSENIC	mg/l	ND(0.0050)	--	--	--	--	--	ND(0.0050)	--	--	--
ARSENIC, DISSOLVED	mg/l	ND(0.0050)	--	--	--	--	--	0.0055	--	--	--
BARIUM	mg/l	0.061	--	--	--	--	--	0.047	--	--	--
BARIUM, DISSOLVED	mg/l	0.068	--	--	--	--	--	0.053	--	--	--
BERYLLIUM	mg/l	ND(0.0050)	--	--	--	--	--	ND(0.0050)	--	--	--
BERYLLIUM, DISSOLVED	mg/l	ND(0.0050)	--	--	--	--	--	ND(0.0050)	--	--	--
CADMIUM	mg/l	ND(0.0050)	--	--	--	--	--	ND(0.0050)	--	--	--
CADMIUM, DISSOLVED	mg/l	ND(0.0050)	--	--	--	--	--	ND(0.0050)	--	--	--
CALCIUM	mg/l	110	--	--	--	130 J	140 J	97	--	--	--
CALCIUM, DISSOLVED	mg/l	110	--	--	--	--	--	100	--	--	--
CHROMIUM	mg/l	ND(0.010)	--	--	--	--	--	ND(0.010)	--	--	--

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-113	MW-113	MW-113	MW-113	MW-113	MW-113	MW-114	MW-114	MW-114	MW-114
Sample I.D.:		GW-SC-168	GW-DS-221	GW-KD-07	GW-KD-07	GW-SC-88	GW-SC-89	GW-SC-167	GW-DS-222	GW-DS-223	GW-KD-08
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		09/25/1996	11/21/1997	03/20/1998	03/20/1998	05/02/1999	05/02/1999	09/25/1996	11/21/1997	11/21/1997	03/20/1998
					Reanal 1		Dupl.			Dupl.	
Parameters	Units										
TAL Metals (Cont'd)											
CHROMIUM, DISSOLVED	mg/l	ND(0.010)	--	--	--	--	--	ND(0.010)	--	--	--
COBALT	mg/l	ND(0.010)	--	--	--	--	--	ND(0.010)	--	--	--
COBALT, DISSOLVED	mg/l	ND(0.010)	--	--	--	--	--	ND(0.010)	--	--	--
COPPER	mg/l	ND(0.020)	--	--	--	ND(0.02)	ND(0.02)	ND(0.020)	--	--	--
COPPER, DISSOLVED	mg/l	ND(0.020)	--	--	--	--	--	ND(0.020)	--	--	--
IRON	mg/l	2.8	2.5	--	--	1.3 J	1.3 J	2.7	2.5	2.6	--
IRON, DISSOLVED	mg/l	3.0	--	--	--	1.2 J	1.3 J	2.9	--	--	--
LEAD	mg/l	ND(0.0050)	--	--	--	--	--	ND(0.0050)	--	--	--
LEAD, DISSOLVED	mg/l	ND(0.0050)	--	--	--	--	--	ND(0.0050)	--	--	--
MAGNESIUM	mg/l	46	--	--	--	45 J	46 J	34	--	--	--
MAGNESIUM, DISSOLVED	mg/l	50	--	--	--	--	--	37	--	--	--
MANGANESE	mg/l	0.38	--	--	--	0.16	0.16	0.043	--	--	--
MANGANESE, DISSOLVED	mg/l	0.40	--	--	--	0.17	0.16	0.045	--	--	--
MERCURY	mg/l	ND(0.0002)	--	--	--	--	--	ND(0.0002)	--	--	--
MERCURY, DISSOLVED	mg/l	ND(0.0002)	--	--	--	--	--	ND(0.0002)	--	--	--
NICKEL	mg/l	ND(0.010)	--	--	--	--	--	ND(0.010)	--	--	--
NICKEL, DISSOLVED	mg/l	ND(0.010)	--	--	--	--	--	ND(0.010)	--	--	--
POTASSIUM	mg/l	5.4	--	--	--	--	--	1.0	--	--	--
POTASSIUM, DISSOLVED	mg/l	6.2	--	--	--	--	--	1.4	--	--	--
SELENIUM	mg/l	ND(0.0050)	--	--	--	--	--	ND(0.0050)	--	--	--
SELENIUM, DISSOLVED	mg/l	ND(0.0050)	--	--	--	--	--	ND(0.0050)	--	--	--
SILVER	mg/l	ND(0.010)	--	--	--	--	--	ND(0.010)	--	--	--
SILVER, DISSOLVED	mg/l	ND(0.010)	--	--	--	--	--	ND(0.010)	--	--	--
SODIUM	mg/l	46	--	--	--	37	37	4.2	--	--	--
SODIUM, DISSOLVED	mg/l	50	--	--	--	--	--	4.5	--	--	--
THALLIUM	mg/l	ND(0.010)	--	--	--	--	--	ND(0.010)	--	--	--
THALLIUM, DISSOLVED	mg/l	ND(0.010)	--	--	--	--	--	ND(0.010)	--	--	--
VANADIUM	mg/l	ND(0.010)	--	--	--	--	--	ND(0.010)	--	--	--
VANADIUM, DISSOLVED	mg/l	ND(0.010)	--	--	--	--	--	ND(0.010)	--	--	--
ZINC	mg/l	ND(0.020)	--	--	--	--	--	ND(0.020)	--	--	--
ZINC, DISSOLVED	mg/l	ND(0.020)	--	--	--	--	--	ND(0.020)	--	--	--
Volatile Organic Compounds											
1,1,1-TRICHLOROETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(5)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(10)

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-113	MW-113	MW-113	MW-113	MW-113	MW-113	MW-114	MW-114	MW-114	MW-114
Sample I.D.:		GW-SC-168	GW-DS-221	GW-KD-07	GW-KD-07	GW-SC-88	GW-SC-89	GW-SC-167	GW-DS-222	GW-DS-223	GW-KD-08
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		09/25/1996	11/21/1997	03/20/1998	03/20/1998	05/02/1999	05/02/1999	09/25/1996	11/21/1997	11/21/1997	03/20/1998
					Reanal 1		Dupl.			Dupl.	
Parameters	Units										
Volatile Organic Compounds (Cont'd)											
1,1,2,2-TETRACHLOROETHANE	ug/l	ND(1)	ND(1)	ND(1) UJ	ND(5)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(10)
1,1,2-TRICHLOROETHANE	ug/l	ND(1)	ND(1)	ND(1) UJ	ND(5)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(10)
1,1-DICHLOROETHANE	ug/l	ND(1)	ND(1)	ND(1) UJ	ND(5)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(10)
1,1-DICHLOROETHENE	ug/l	ND(1)	ND(1)	ND(1) UJ	ND(5)	ND(1)	ND(1)	ND(1) UJ	ND(1)	ND(1)	ND(10)
1,2-DICHLOROETHANE	ug/l	4.4 J	ND(1.1) U	ND(1) UJ	ND(5)	ND(1.3) U	ND(1.1) U	2000	1000	1200	880
1,2-DICHLOROETHENE	ug/l	--	--	--	--	--	--	--	--	--	--
1,2-DICHLOROPROPANE	ug/l	ND(1)	ND(1)	ND(1) UJ	ND(5)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(10)
2-BUTANONE	ug/l	ND(10)	ND(10)	ND(10) UJ	ND(50)	ND(10)	ND(10)	ND(10)	ND(10)	19	ND(100)
2-HEXANONE	ug/l	ND(10)	ND(10)	ND(10) UJ	ND(50)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(100)
4-METHYL-2-PENTANONE	ug/l	ND(10)	ND(10)	ND(10) UJ	ND(50)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(100)
ACETONE	ug/l	58 J	ND(10)	ND(10) UJ	ND(50)	ND(10)	ND(10)	ND(10)	ND(10)	10	ND(100)
BENZENE	ug/l	3.4 J	ND(1)	ND(1) UJ	ND(5)	1.3	1.2	330	460	350	240
BROMODICHLOROMETHANE	ug/l	ND(1)	ND(1)	ND(1) UJ	ND(5)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(10)
BROMOFORM	ug/l	ND(1)	ND(1)	ND(1) UJ	ND(5)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(10)
BROMOMETHANE	ug/l	ND(1)	ND(1)	ND(1) UJ	ND(5)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1) UJ	ND(10)
CARBON DISULFIDE	ug/l	2.8 J	14	19 J	12 J	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(10)
CARBON TETRACHLORIDE	ug/l	45 J	140	ND(1) *UJ	96	340 J	340 J	ND(1)	ND(1.2) U	ND(1.8) U	ND(10)
CHLOROBENZENE	ug/l	ND(1)	ND(1)	ND(1) UJ	ND(5)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(10)
CHLOROETHANE	ug/l	ND(1)	ND(1)	ND(1) UJ	ND(5)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(10)
CHLOROFORM	ug/l	57 J	64	86 J	66	83	79	ND(1)	ND(1)	ND(1)	ND(10)
CHLOROMETHANE	ug/l	ND(1)	ND(1)	ND(1) UJ	ND(5)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(10)
CIS-1,2-DICHLOROETHENE	ug/l	ND(1)	ND(1)	ND(1) UJ	ND(5)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(10)
CIS-1,3-DICHLOROPROPENE	ug/l	ND(1)	ND(1)	ND(1) UJ	ND(5)	ND(1)	ND(1)	ND(1)	ND(1) UJ	ND(1)	ND(10)
DIBROMOCHLOROMETHANE	ug/l	ND(1)	ND(1)	ND(1) UJ	ND(5)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(10)
DICHLOROMETHANE	ug/l	2.0 J	1.1	ND(1) UJ	ND(5)	ND(1.1) U	ND(1)	ND(1)	ND(1)	ND(1)	ND(10)
ETHYL BENZENE	ug/l	ND(1)	ND(1)	ND(1) UJ	ND(5)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(10)
M,P-XYLENE	ug/l	--	--	--	--	ND(1)	ND(1)	--	--	--	--
O-XYLENE	ug/l	--	--	--	--	ND(1)	ND(1)	--	--	--	--
STYRENE	ug/l	ND(1)	ND(1)	ND(1) UJ	ND(5)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(10)
TETRACHLOROETHENE	ug/l	ND(1)	ND(1)	ND(1) UJ	ND(5)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(10)
TOLUENE	ug/l	ND(1)	ND(1)	ND(1) UJ	ND(5)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(10)
TRANS-1,2-DICHLOROETHENE	ug/l	ND(1)	ND(1)	ND(1) UJ	ND(5)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(10)
TRANS-1,3-DICHLOROPROPENE	ug/l	ND(1)	ND(1)	ND(1) UJ	ND(5)	ND(1)	ND(1)	ND(1)	ND(1) UJ	ND(1)	ND(10)
TRICHLOROETHENE	ug/l	ND(1)	ND(1)	ND(1) UJ	ND(5)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(10)
VINYL CHLORIDE	ug/l	ND(1)	ND(1)	ND(1) UJ	ND(5)	ND(1)	ND(1)	3.9	5.2 J	4.9	ND(10)

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-113	MW-113	MW-113	MW-113	MW-113	MW-113	MW-114	MW-114	MW-114	MW-114
Sample I.D.:		GW-SC-168	GW-DS-221	GW-KD-07	GW-KD-07	GW-SC-88	GW-SC-89	GW-SC-167	GW-DS-222	GW-DS-223	GW-KD-08
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		09/25/1996	11/21/1997	03/20/1998	03/20/1998	05/02/1999	05/02/1999	09/25/1996	11/21/1997	11/21/1997	03/20/1998
					Reanal 1		Dupl.			Dupl.	
Parameters	Units										
Volatile Organic Compounds (Cont'd)											
XYLENES (TOTAL)	ug/l	ND(1)	ND(1)	ND(1) UJ	ND(5)	--	--	ND(1)	ND(1)	ND(1)	ND(10)
Dissolved Gases											
ETHANE	mg/l	--	ND(0.0005)	--	--	ND(0.010)	ND(0.010)	--	ND(0.0005)	ND(0.0005)	--
ETHENE	mg/l	--	ND(0.0005)	--	--	ND(0.010)	ND(0.010)	--	0.0041	0.0044	--
METHANE	mg/l	--	0.00069	--	--	ND(0.010)	ND(0.010)	--	0.0007	0.00078	--

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-114	MW-115	MW-115	MW-116	MW-116	MW-117	MW-117	MW-117	MW-118	MW-118
Sample I.D.:		GW-SC-86	GW-SC-155	GW-SC-63	GW-SC-156	GW-SC-64	GW-SC-153	GW-DS-196	GW-SC-49	GW-SC-154	GW-DS-197
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		05/02/1999	09/24/1996	04/29/1999	09/24/1996	04/29/1999	09/23/1996	11/18/1997	04/27/1999	09/23/1996	11/18/1997
Parameters	Units										
Semivolatile Organic Compounds											
1,2,4-TRICHLOROBENZENE	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
1,2-DICHLOROBENZENE	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
1,3-DICHLOROBENZENE	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
1,4-DICHLOROBENZENE	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
2,4,5-TRICHLOROPHENOL	ug/l	--	ND(50)	--	ND(50)	--	ND(50)	--	--	ND(50)	--
2,4,6-TRICHLOROPHENOL	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
2,4-DICHLOROPHENOL	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
2,4-DIMETHYLPHENOL	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
2,4-DINITROPHENOL	ug/l	--	ND(50)	--	ND(50)	--	ND(50)	--	--	ND(50)	--
2,4-DINITROTOLUENE	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
2,6-DINITROTOLUENE	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
2-CHLORONAPHTHALENE	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
2-CHLOROPHENOL	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
2-METHYLNAPHTHALENE	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
2-METHYLPHENOL	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
2-NITROANILINE	ug/l	--	ND(50)	--	ND(50)	--	ND(50)	--	--	ND(50)	--
2-NITROPHENOL	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
3,3'-DICHLOROBENZIDINE	ug/l	--	ND(20)	--	ND(20)	--	ND(20)	--	--	ND(20)	--
3-NITROANILINE	ug/l	--	ND(50)	--	ND(50)	--	ND(50)	--	--	ND(50)	--
4,6-DINITRO-2-METHYLPHENOL	ug/l	--	ND(50)	--	ND(50)	--	ND(50)	--	--	ND(50)	--
4-BROMOPHENYLPHENYL ETHER	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
4-CHLORO-3-METHYLPHENOL	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
4-CHLOROANILINE	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
4-CHLOROPHENYLPHENYL ETHER	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
4-METHYLPHENOL	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
4-NITROANILINE	ug/l	--	ND(50)	--	ND(50)	--	ND(50)	--	--	ND(50)	--
4-NITROPHENOL	ug/l	--	ND(50)	--	ND(50)	--	ND(50)	--	--	ND(50)	--
ACENAPHTHENE	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
ACENAPHTHYLENE	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
ANTHRACENE	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
BENZO(A)ANTHRACENE	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
BENZO(A)PYRENE	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
BENZO(B)FLUORANTHENE	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
BENZO(G,H,I)PERYLENE	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
BENZO(K)FLUORANTHENE	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-114	MW-115	MW-115	MW-116	MW-116	MW-117	MW-117	MW-117	MW-118	MW-118
Sample I.D.:		GW-SC-86	GW-SC-155	GW-SC-63	GW-SC-156	GW-SC-64	GW-SC-153	GW-DS-196	GW-SC-49	GW-SC-154	GW-DS-197
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		05/02/1999	09/24/1996	04/29/1999	09/24/1996	04/29/1999	09/23/1996	11/18/1997	04/27/1999	09/23/1996	11/18/1997
Parameters	Units										
Semivolatile Organic Compounds (Cont'd)											
BIS(2-CHLOROETHOXY)METHANE	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
BIS(2-CHLOROETHYL)ETHER	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
BIS(2-CHLOROISOPROPYL)ETHER	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
BIS(2-ETHYLHEXYL)PHTHALATE	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
BUTYLBENZYLPHTHALATE	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
CARBAZOLE	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
CHRYSENE	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
DI-N-BUTYLPHTHALATE	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
DI-N-OCTYLPHTHALATE	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
DIBENZ(A,H)ANTHRACENE	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
DIBENZOFURAN	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
DIETHYLPHTHALATE	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
DIMETHYLPHTHALATE	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
FLUORANTHENE	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
FLUORENE	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
HEXACHLOROBENZENE	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
HEXACHLOROBUTADIENE	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
HEXACHLOROCYCLOPENTADIENE	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
HEXACHLOROETHANE	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
INDENO(1,2,3-CD)PYRENE	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
ISOPHORONE	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
N-NITROSO-DI-N-PROPYLAMINE	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
N-NITROSODIPHENYLAMINE	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
NAPHTHALENE	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
NITROBENZENE	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
PENTACHLOROPHENOL	ug/l	--	ND(50)	--	ND(50)	--	ND(50)	--	--	ND(50)	--
PHENANTHRENE	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
PHENOL	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
PYRENE	ug/l	--	ND(10)	--	ND(10)	--	ND(10)	--	--	ND(10)	--
General Chemistry											
ALKALINITY	mg/l	340	320	300	410	410	280	--	410	360	--
ALKALINITY, BICARBONATE	mg/l	340	--	300	--	410	--	300	410	--	400
ALKALINITY, CARBONATE	mg/l	ND(10)	--	ND(10)	--	ND(10)	--	ND(1)	ND(10)	--	ND(1)

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-114	MW-115	MW-115	MW-116	MW-116	MW-117	MW-117	MW-117	MW-118	MW-118
Sample I.D.:		GW-SC-86	GW-SC-155	GW-SC-63	GW-SC-156	GW-SC-64	GW-SC-153	GW-DS-196	GW-SC-49	GW-SC-154	GW-DS-197
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		05/02/1999	09/24/1996	04/29/1999	09/24/1996	04/29/1999	09/23/1996	11/18/1997	04/27/1999	09/23/1996	11/18/1997
Parameters	Units										
General Chemistry (Cont'd)											
CHLORIDE	mg/l	12	2.8	ND(3.8) U	5.9	ND(2.5) U	4.7	4.5	1.5	6.0	5.1
COUNT TIME	minutes	--	280	--	280	--	280	--	--	280	--
CYANIDE	mg/l	--	ND(0.005)	--	ND(0.005)	--	ND(0.005)	--	--	ND(0.005)	--
DISSOLVED ORGANIC CARBON (DOC)	mg/l	ND(1.4) U	--	ND(2) U	--	ND(1.1) U	--	1.4	ND(1.4) U	--	1.2
FERROUS IRON	mg/l	--	--	--	--	--	--	0.19	--	--	0.12
GROSS ALPHA	pCi/l	--	ND(3.0) +/-1.7	--	3.2 +/-1.5	--	ND(3.0) +/-1.4	--	--	ND(3.0) +/-2.0	--
GROSS BETA	pCi/l	--	ND(4.0) +/-3.2	--	5.4 +/-3.4	--	ND(4.0) +/-3.5	--	--	ND(4.0) +/-3.5	--
HARDNESS, CALCIUM/MAGNESIUM (AS CACO3	mg/l	420	--	400	--	480	--	--	410	--	--
NITRITE	mg/l	ND(0.1)	--	ND(0.1)	--	ND(0.1)	--	--	ND(0.1)	--	--
NITROGEN, AMMONIA	mg/l	--	ND(0.15) U	--	ND(0.16) U	--	ND(0.20) U	--	--	ND(0.20) U	--
NITROGEN, NITRATE	mg/l	ND(0.1)	ND(0.01)	ND(0.1)	ND(0.01)	ND(0.1)	ND(0.01)	ND(0.01)	ND(0.1)	ND(0.01)	ND(0.01)
PH	std. units	--	7.6	--	7.4	--	7.3	--	--	7.3	--
SULFATE	mg/l	54.2	58	49.5	45	43.7	54	46	30.1	40	31
SULFIDE	mg/l	ND(1)	--	ND(1)	--	ND(1)	--	ND(1.0)	1.4	--	ND(1.0)
TOTAL DISSOLVED SOLIDS	mg/l	420	420	420	470	460	410	360	460	440	420
TOTAL ORGANIC CARBON (TOC)	mg/l	--	--	--	--	--	--	ND(1.0)	--	--	ND(1.0)
TOTAL SUSPENDED SOLIDS (TSS)	mg/l	ND(5)	13	ND(8.4) U	29	ND(5)	19	12	ND(5)	34	16
TAL Metals											
ALUMINUM	mg/l	ND(0.2)	ND(0.050)	ND(0.2)	0.18	ND(0.2)	ND(0.092) U	--	ND(0.2)	ND(0.11) U	--
ALUMINUM, DISSOLVED	mg/l	--	ND(0.050)	--	ND(0.066) U	--	ND(0.050)	--	--	ND(0.050)	--
ANTIMONY	mg/l	--	ND(0.030)	--	0.042	--	ND(0.030)	--	--	ND(0.030)	--
ANTIMONY, DISSOLVED	mg/l	--	ND(0.030)	--	ND(0.030)	--	ND(0.030)	--	--	ND(0.030)	--
ARSENIC	mg/l	--	0.0067	--	ND(0.0050)	--	ND(0.0050)	--	--	ND(0.0050)	--
ARSENIC, DISSOLVED	mg/l	--	ND(0.0050)	--	ND(0.0050)	--	ND(0.0050)	--	--	0.0059	--
BARIUM	mg/l	--	0.12	--	0.10	--	0.11	--	--	0.15	--
BARIUM, DISSOLVED	mg/l	--	0.13	--	0.10	--	0.13	--	--	0.17	--
BERYLLIUM	mg/l	--	ND(0.0050)	--	ND(0.0050)	--	ND(0.0050)	--	--	ND(0.0050)	--
BERYLLIUM, DISSOLVED	mg/l	--	ND(0.0050)	--	ND(0.0050)	--	ND(0.0050)	--	--	ND(0.0050)	--
CADMIUM	mg/l	--	ND(0.0050)	--	ND(0.0050)	--	ND(0.0050)	--	--	ND(0.0050)	--
CADMIUM, DISSOLVED	mg/l	--	ND(0.0050)	--	ND(0.0050)	--	ND(0.0050)	--	--	ND(0.0050)	--
CALCIUM	mg/l	100 J	95	110 J	100	120 J	88	--	99 J	87	--
CALCIUM, DISSOLVED	mg/l	--	98	--	98	--	96	--	--	96	--
CHROMIUM	mg/l	--	ND(0.010)	--	ND(0.010)	--	ND(0.010)	--	--	ND(0.010)	--

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-114	MW-115	MW-115	MW-116	MW-116	MW-117	MW-117	MW-117	MW-118	MW-118
Sample I.D.:		GW-SC-86	GW-SC-155	GW-SC-63	GW-SC-156	GW-SC-64	GW-SC-153	GW-DS-196	GW-SC-49	GW-SC-154	GW-DS-197
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		05/02/1999	09/24/1996	04/29/1999	09/24/1996	04/29/1999	09/23/1996	11/18/1997	04/27/1999	09/23/1996	11/18/1997
Parameters	Units										
TAL Metals (Cont'd)											
CHROMIUM, DISSOLVED	mg/l	--	ND(0.010)	--	ND(0.010)	--	ND(0.010)	--	--	ND(0.010)	--
COBALT	mg/l	--	ND(0.010)	--	ND(0.010)	--	ND(0.010)	--	--	ND(0.010)	--
COBALT, DISSOLVED	mg/l	--	ND(0.010)	--	ND(0.010)	--	ND(0.010)	--	--	ND(0.010)	--
COPPER	mg/l	ND(0.02)	ND(0.020)	ND(0.02) U	ND(0.020)	ND(0.02)	ND(0.020)	--	ND(0.02)	ND(0.020)	--
COPPER, DISSOLVED	mg/l	--	ND(0.020)	--	ND(0.020)	--	ND(0.020)	--	--	ND(0.020)	--
IRON	mg/l	2.7 J	4.3	3.4 J	1.5	0.59 J	4.0	3.0	2.3 B	4.3	2.9
IRON, DISSOLVED	mg/l	2.6 J	4.4 J	3.4	1.4 J	0.63	4.1	--	2.3	4.4	--
LEAD	mg/l	--	ND(0.0050)	--	ND(0.0050)	--	ND(0.0050)	--	--	ND(0.0050)	--
LEAD, DISSOLVED	mg/l	--	ND(0.0050)	--	ND(0.0050)	--	ND(0.0050)	--	--	ND(0.0050)	--
MAGNESIUM	mg/l	39 J	32	34	42	47	30	--	41	40	--
MAGNESIUM, DISSOLVED	mg/l	--	33	--	40	--	32	--	--	42	--
MANGANESE	mg/l	0.042	0.057	0.04	0.25	0.081	0.064	--	0.025	0.14	--
MANGANESE, DISSOLVED	mg/l	0.041	0.057	0.041	0.24	0.081	0.065	--	0.027	0.14	--
MERCURY	mg/l	--	ND(0.0002)	--	ND(0.0002)	--	ND(0.0002)	--	--	ND(0.0002)	--
MERCURY, DISSOLVED	mg/l	--	ND(0.0002)	--	ND(0.0002)	--	ND(0.0002)	--	--	ND(0.0002)	--
NICKEL	mg/l	--	ND(0.010)	--	ND(0.010)	--	ND(0.010)	--	--	ND(0.010)	--
NICKEL, DISSOLVED	mg/l	--	ND(0.010)	--	ND(0.010)	--	ND(0.010)	--	--	ND(0.010)	--
POTASSIUM	mg/l	--	1.1	--	2.5	--	1.1	--	--	3.5	--
POTASSIUM, DISSOLVED	mg/l	--	1.2	--	2.6	--	1.3	--	--	3.7	--
SELENIUM	mg/l	--	ND(0.0050)	--	ND(0.0050)	--	ND(0.0050)	--	--	ND(0.0050)	--
SELENIUM, DISSOLVED	mg/l	--	ND(0.0050)	--	ND(0.0050)	--	ND(0.0050)	--	--	ND(0.0050)	--
SILVER	mg/l	--	ND(0.010)	--	ND(0.010)	--	ND(0.010)	--	--	ND(0.010)	--
SILVER, DISSOLVED	mg/l	--	ND(0.010)	--	ND(0.010)	--	ND(0.010)	--	--	ND(0.010)	--
SODIUM	mg/l	3.8	5.3	5.2	22	9.4	5.2	--	7	15	--
SODIUM, DISSOLVED	mg/l	--	5.6	--	22	--	5.5	--	--	15	--
THALLIUM	mg/l	--	ND(0.010)	--	ND(0.010)	--	ND(0.010)	--	--	ND(0.010)	--
THALLIUM, DISSOLVED	mg/l	--	ND(0.010)	--	ND(0.010)	--	ND(0.010)	--	--	ND(0.010)	--
VANADIUM	mg/l	--	ND(0.010)	--	ND(0.010)	--	ND(0.010)	--	--	ND(0.010)	--
VANADIUM, DISSOLVED	mg/l	--	ND(0.010)	--	ND(0.010)	--	ND(0.010)	--	--	ND(0.010)	--
ZINC	mg/l	--	ND(0.020)	--	ND(0.020)	--	ND(0.020)	--	--	ND(0.020)	--
ZINC, DISSOLVED	mg/l	--	ND(0.020)	--	ND(0.020)	--	ND(0.020)	--	--	ND(0.020)	--
Volatile Organic Compounds											
1,1,1-TRICHLOROETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-114	MW-115	MW-115	MW-116	MW-116	MW-117	MW-117	MW-117	MW-118	MW-118
Sample I.D.:		GW-SC-86	GW-SC-155	GW-SC-63	GW-SC-156	GW-SC-64	GW-SC-153	GW-DS-196	GW-SC-49	GW-SC-154	GW-DS-197
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		05/02/1999	09/24/1996	04/29/1999	09/24/1996	04/29/1999	09/23/1996	11/18/1997	04/27/1999	09/23/1996	11/18/1997
Parameters	Units										
Volatile Organic Compounds (Cont'd)											
1,1,2,2-TETRACHLOROETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
1,1,2-TRICHLOROETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
1,1-DICHLOROETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
1,1-DICHLOROETHENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
1,2-DICHLOROETHANE	ug/l	780	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
1,2-DICHLOROETHENE	ug/l	--	--	--	--	--	--	--	--	--	--
1,2-DICHLOROPROPANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
2-BUTANONE	ug/l	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
2-HEXANONE	ug/l	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
4-METHYL-2-PENTANONE	ug/l	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
ACETONE	ug/l	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
BENZENE	ug/l	240 J	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
BROMODICHLOROMETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
BROMOFORM	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
BROMOMETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CARBON DISULFIDE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CARBON TETRACHLORIDE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CHLOROBENZENE	ug/l	ND(1) UJ	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CHLOROETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CHLOROFORM	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CHLOROMETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CIS-1,2-DICHLOROETHENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CIS-1,3-DICHLOROPROPENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
DIBROMOCHLOROMETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
DICHLOROMETHANE	ug/l	ND(1)	ND(1)	ND(1.1) U	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
ETHYL BENZENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
M,P-XYLENE	ug/l	ND(1)	--	ND(1)	--	ND(1)	--	--	ND(1)	--	--
O-XYLENE	ug/l	ND(1)	--	ND(1)	--	ND(1)	--	--	ND(1)	--	--
STYRENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
TETRACHLOROETHENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
TOLUENE	ug/l	ND(1) UJ	ND(1)	ND(1) UJ	ND(1)	ND(1)	ND(1)	1.0	ND(1)	ND(1)	ND(1)
TRANS-1,2-DICHLOROETHENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
TRANS-1,3-DICHLOROPROPENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
TRICHLOROETHENE	ug/l	ND(1) UJ	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
VINYL CHLORIDE	ug/l	4	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-114	MW-115	MW-115	MW-116	MW-116	MW-117	MW-117	MW-117	MW-118	MW-118
Sample I.D.:		GW-SC-86	GW-SC-155	GW-SC-63	GW-SC-156	GW-SC-64	GW-SC-153	GW-DS-196	GW-SC-49	GW-SC-154	GW-DS-197
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		05/02/1999	09/24/1996	04/29/1999	09/24/1996	04/29/1999	09/23/1996	11/18/1997	04/27/1999	09/23/1996	11/18/1997
Parameters	Units										
Volatile Organic Compounds (Cont'd)											
XYLENES (TOTAL)	ug/l	--	ND(1)	--	ND(1)	--	ND(1)	ND(1)	--	ND(1)	ND(1)
Dissolved Gases											
ETHANE	mg/l	ND(0.010)	--	ND(0.010)	--	ND(0.010)	--	ND(0.0005)	ND(0.010)	--	ND(0.0005)
ETHENE	mg/l	ND(0.010)	--	ND(0.010)	--	ND(0.010)	--	ND(0.0005)	ND(0.010)	--	ND(0.0005)
METHANE	mg/l	ND(0.010)	--	ND(0.010)	--	ND(0.010)	--	0.0022	ND(0.010)	--	0.0012

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-118	MW-119	MW-119	MW-120	MW-120	MW-121	MW-121	MW-122	MW-122	MW-123
Sample I.D.:		GW-SC-50	GW-DS-218	GW-SC-73	GW-DS-217	GW-SC-72	GW-DS-215	GW-SC-70	GW-DS-214	GW-SC-69	GW-DS-213
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		04/27/1999	11/20/1997	04/30/1999	11/20/1997	04/30/1999	11/19/1997	04/30/1999	11/19/1997	04/30/1999	11/19/1997
Parameters	Units										
Semivolatile Organic Compounds											
1,2,4-TRICHLOROBENZENE	ug/l	--	--	--	--	--	--	--	--	--	--
1,2-DICHLOROBENZENE	ug/l	--	--	--	--	--	--	--	--	--	--
1,3-DICHLOROBENZENE	ug/l	--	--	--	--	--	--	--	--	--	--
1,4-DICHLOROBENZENE	ug/l	--	--	--	--	--	--	--	--	--	--
2,4,5-TRICHLOROPHENOL	ug/l	--	--	--	--	--	--	--	--	--	--
2,4,6-TRICHLOROPHENOL	ug/l	--	--	--	--	--	--	--	--	--	--
2,4-DICHLOROPHENOL	ug/l	--	--	--	--	--	--	--	--	--	--
2,4-DIMETHYLPHENOL	ug/l	--	--	--	--	--	--	--	--	--	--
2,4-DINITROPHENOL	ug/l	--	--	--	--	--	--	--	--	--	--
2,4-DINITROTOLUENE	ug/l	--	--	--	--	--	--	--	--	--	--
2,6-DINITROTOLUENE	ug/l	--	--	--	--	--	--	--	--	--	--
2-CHLORONAPHTHALENE	ug/l	--	--	--	--	--	--	--	--	--	--
2-CHLOROPHENOL	ug/l	--	--	--	--	--	--	--	--	--	--
2-METHYLNAPHTHALENE	ug/l	--	--	--	--	--	--	--	--	--	--
2-METHYLPHENOL	ug/l	--	--	--	--	--	--	--	--	--	--
2-NITROANILINE	ug/l	--	--	--	--	--	--	--	--	--	--
2-NITROPHENOL	ug/l	--	--	--	--	--	--	--	--	--	--
3,3'-DICHLOROBENZIDINE	ug/l	--	--	--	--	--	--	--	--	--	--
3-NITROANILINE	ug/l	--	--	--	--	--	--	--	--	--	--
4,6-DINITRO-2-METHYLPHENOL	ug/l	--	--	--	--	--	--	--	--	--	--
4-BROMOPHENYLPHENYL ETHER	ug/l	--	--	--	--	--	--	--	--	--	--
4-CHLORO-3-METHYLPHENOL	ug/l	--	--	--	--	--	--	--	--	--	--
4-CHLOROANILINE	ug/l	--	--	--	--	--	--	--	--	--	--
4-CHLOROPHENYLPHENYL ETHER	ug/l	--	--	--	--	--	--	--	--	--	--
4-METHYLPHENOL	ug/l	--	--	--	--	--	--	--	--	--	--
4-NITROANILINE	ug/l	--	--	--	--	--	--	--	--	--	--
4-NITROPHENOL	ug/l	--	--	--	--	--	--	--	--	--	--
ACENAPHTHENE	ug/l	--	--	--	--	--	--	--	--	--	--
ACENAPHTHYLENE	ug/l	--	--	--	--	--	--	--	--	--	--
ANTHRACENE	ug/l	--	--	--	--	--	--	--	--	--	--
BENZO(A)ANTHRACENE	ug/l	--	--	--	--	--	--	--	--	--	--
BENZO(A)PYRENE	ug/l	--	--	--	--	--	--	--	--	--	--
BENZO(B)FLUORANTHENE	ug/l	--	--	--	--	--	--	--	--	--	--
BENZO(G,H,I)PERYLENE	ug/l	--	--	--	--	--	--	--	--	--	--
BENZO(K)FLUORANTHENE	ug/l	--	--	--	--	--	--	--	--	--	--

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-118	MW-119	MW-119	MW-120	MW-120	MW-121	MW-121	MW-122	MW-122	MW-123
Sample I.D.:		GW-SC-50	GW-DS-218	GW-SC-73	GW-DS-217	GW-SC-72	GW-DS-215	GW-SC-70	GW-DS-214	GW-SC-69	GW-DS-213
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		04/27/1999	11/20/1997	04/30/1999	11/20/1997	04/30/1999	11/19/1997	04/30/1999	11/19/1997	04/30/1999	11/19/1997
Parameters	Units										
Semivolatile Organic Compounds (Cont'd)											
BIS(2-CHLOROETHOXY)METHANE	ug/l	--	--	--	--	--	--	--	--	--	--
BIS(2-CHLOROETHYL)ETHER	ug/l	--	--	--	--	--	--	--	--	--	--
BIS(2-CHLOROISOPROPYL)ETHER	ug/l	--	--	--	--	--	--	--	--	--	--
BIS(2-ETHYLHEXYL)PHTHALATE	ug/l	--	--	--	--	--	--	--	--	--	--
BUTYLBENZYLPHTHALATE	ug/l	--	--	--	--	--	--	--	--	--	--
CARBAZOLE	ug/l	--	--	--	--	--	--	--	--	--	--
CHRYSENE	ug/l	--	--	--	--	--	--	--	--	--	--
DI-N-BUTYLPHTHALATE	ug/l	--	--	--	--	--	--	--	--	--	--
DI-N-OCTYLPHTHALATE	ug/l	--	--	--	--	--	--	--	--	--	--
DIBENZ(A,H)ANTHRACENE	ug/l	--	--	--	--	--	--	--	--	--	--
DIBENZOFURAN	ug/l	--	--	--	--	--	--	--	--	--	--
DIETHYLPHTHALATE	ug/l	--	--	--	--	--	--	--	--	--	--
DIMETHYLPHTHALATE	ug/l	--	--	--	--	--	--	--	--	--	--
FLUORANTHENE	ug/l	--	--	--	--	--	--	--	--	--	--
FLUORENE	ug/l	--	--	--	--	--	--	--	--	--	--
HEXACHLOROBENZENE	ug/l	--	--	--	--	--	--	--	--	--	--
HEXACHLOROBUTADIENE	ug/l	--	--	--	--	--	--	--	--	--	--
HEXACHLOROCYCLOPENTADIENE	ug/l	--	--	--	--	--	--	--	--	--	--
HEXACHLOROETHANE	ug/l	--	--	--	--	--	--	--	--	--	--
INDENO(1,2,3-CD)PYRENE	ug/l	--	--	--	--	--	--	--	--	--	--
ISOPHORONE	ug/l	--	--	--	--	--	--	--	--	--	--
N-NITROSO-DI-N-PROPYLAMINE	ug/l	--	--	--	--	--	--	--	--	--	--
N-NITROSODIPHENYLAMINE	ug/l	--	--	--	--	--	--	--	--	--	--
NAPHTHALENE	ug/l	--	--	--	--	--	--	--	--	--	--
NITROBENZENE	ug/l	--	--	--	--	--	--	--	--	--	--
PENTACHLOROPHENOL	ug/l	--	--	--	--	--	--	--	--	--	--
PHENANTHRENE	ug/l	--	--	--	--	--	--	--	--	--	--
PHENOL	ug/l	--	--	--	--	--	--	--	--	--	--
PYRENE	ug/l	--	--	--	--	--	--	--	--	--	--
General Chemistry											
ALKALINITY	mg/l	300	--	290	--	330	--	230	--	280	--
ALKALINITY, BICARBONATE	mg/l	300	380	290	340	330	300	230	320	280	340
ALKALINITY, CARBONATE	mg/l	ND(10)	ND(1)	ND(10)	ND(1)	ND(10)	ND(1)	ND(10)	ND(1)	ND(10)	ND(1)

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-118	MW-119	MW-119	MW-120	MW-120	MW-121	MW-121	MW-122	MW-122	MW-123
Sample I.D.:		GW-SC-50	GW-DS-218	GW-SC-73	GW-DS-217	GW-SC-72	GW-DS-215	GW-SC-70	GW-DS-214	GW-SC-69	GW-DS-213
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		04/27/1999	11/20/1997	04/30/1999	11/20/1997	04/30/1999	11/19/1997	04/30/1999	11/19/1997	04/30/1999	11/19/1997
Parameters	Units										
General Chemistry (Cont'd)											
CHLORIDE	mg/l	3.8	200	49	3.9	ND(3.5) U	45	26	6.6	ND(5.5) U	4.1
COUNT TIME	minutes	--	--	--	--	--	--	--	--	--	--
CYANIDE	mg/l	--	--	--	--	--	--	--	--	--	--
DISSOLVED ORGANIC CARBON (DOC)	mg/l	ND(1.9) U	ND(1.0)	ND(1.7) U	2.8	ND(2.1) U	1.7	ND(2.7) U	2.4	ND(2.9) U	ND(1.0)
FERROUS IRON	mg/l	--	0.96	--	ND(0.10)	--	0.26	--	ND(0.10)	--	ND(0.10)
GROSS ALPHA	pCi/l	--	--	--	--	--	--	--	--	--	--
GROSS BETA	pCi/l	--	--	--	--	--	--	--	--	--	--
HARDNESS, CALCIUM/MAGNESIUM (AS CACO3	mg/l	350	--	320	--	370	--	310	--	350	--
NITRITE	mg/l	ND(0.1)	--	ND(0.1)	--	ND(0.1)	--	0.0378 J	--	ND(0.1)	--
NITROGEN, AMMONIA	mg/l	--	--	--	--	--	--	--	--	--	--
NITROGEN, NITRATE	mg/l	ND(0.1)	ND(0.01) UJ	ND(0.1)	ND(0.01) UJ	ND(0.1)	1.2	0.395	ND(0.01)	ND(0.1)	0.24
PH	std. units	--	--	--	--	--	--	--	--	--	--
SULFATE	mg/l	59.1	29	20.1	40	31.9	41	23.6	47	44.2	38
SULFIDE	mg/l	1.3	ND(1.0)	ND(1)	ND(1.0)	ND(1)	ND(1.0)	ND(1.5) U	ND(1.0)	ND(2.2) U	ND(1.0)
TOTAL DISSOLVED SOLIDS	mg/l	410	680	360	360	320	420	320	400	380	390
TOTAL ORGANIC CARBON (TOC)	mg/l	--	ND(1.0)	--	2.7	--	1.8	--	2.3	--	ND(1.0)
TOTAL SUSPENDED SOLIDS (TSS)	mg/l	ND(5)	690	ND(5)	7	ND(6) U	270	ND(8.8) U	6	ND(30) U	6
TAL Metals											
ALUMINUM	mg/l	ND(0.2)	1.1	ND(0.2)	ND(0.050)	ND(0.2)	1.3	0.09 J	ND(0.050)	ND(0.2)	0.12
ALUMINUM, DISSOLVED	mg/l	--	ND(0.062) U	--	ND(0.050)	--	--	--	--	--	--
ANTIMONY	mg/l	--	ND(0.030)	--	ND(0.030)	--	ND(0.030)	--	ND(0.030)	--	ND(0.030)
ANTIMONY, DISSOLVED	mg/l	--	ND(0.030)	--	ND(0.030)	--	--	--	--	--	--
ARSENIC	mg/l	--	ND(0.0050)	--	ND(0.0050)	--	ND(0.0050)	--	ND(0.0050)	--	ND(0.0050)
ARSENIC, DISSOLVED	mg/l	--	ND(0.0050)	--	ND(0.0050)	--	--	--	--	--	--
BARIUM	mg/l	--	0.039	--	0.13	--	0.015	--	0.068	--	0.030
BARIUM, DISSOLVED	mg/l	--	0.026	--	0.12	--	--	--	--	--	--
BERYLLIUM	mg/l	--	ND(0.0040)	--	ND(0.0040)	--	ND(0.0040)	--	ND(0.0040)	--	ND(0.0040)
BERYLLIUM, DISSOLVED	mg/l	--	ND(0.0040)	--	ND(0.0040)	--	--	--	--	--	--
CADMIUM	mg/l	--	ND(0.0050)	--	ND(0.0050)	--	ND(0.0050)	--	ND(0.0050)	--	ND(0.0050)
CADMIUM, DISSOLVED	mg/l	--	ND(0.0050)	--	ND(0.0050)	--	--	--	--	--	--
CALCIUM	mg/l	91 J	150	86 J	86	98 J	120	78 J	90	93 J	91
CALCIUM, DISSOLVED	mg/l	--	110	--	81	--	--	--	--	--	--
CHROMIUM	mg/l	--	ND(0.010)	--	ND(0.010)	--	0.026	--	ND(0.010)	--	ND(0.010)

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-118	MW-119	MW-119	MW-120	MW-120	MW-121	MW-121	MW-122	MW-122	MW-123
Sample I.D.:		GW-SC-50	GW-DS-218	GW-SC-73	GW-DS-217	GW-SC-72	GW-DS-215	GW-SC-70	GW-DS-214	GW-SC-69	GW-DS-213
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		04/27/1999	11/20/1997	04/30/1999	11/20/1997	04/30/1999	11/19/1997	04/30/1999	11/19/1997	04/30/1999	11/19/1997
Parameters	Units										
TAL Metals (Cont'd)											
CHROMIUM, DISSOLVED	mg/l	--	ND(0.010)	--	ND(0.010)	--	--	--	--	--	--
COBALT	mg/l	--	ND(0.010)	--	ND(0.010)	--	ND(0.010)	--	ND(0.010)	--	ND(0.010)
COBALT, DISSOLVED	mg/l	--	ND(0.010)	--	ND(0.010)	--	--	--	--	--	--
COPPER	mg/l	ND(0.02)	ND(0.020)	ND(0.02)	ND(0.020)	ND(0.02)	ND(0.020)	ND(0.02) U	ND(0.020)	ND(0.02)	ND(0.020)
COPPER, DISSOLVED	mg/l	--	ND(0.020)	--	ND(0.020)	--	--	--	--	--	--
IRON	mg/l	3.1 B	1.4	0.13 J	2.9	3.2 J	2.9	1.4 J	3.6	3.7 J	ND(0.25) U
IRON, DISSOLVED	mg/l	3.2	ND(0.025)	ND(0.05) U	2.5	3	--	ND(0.05) U	--	3.7	--
LEAD	mg/l	--	0.011	--	ND(0.0050)	--	ND(0.0050)	--	ND(0.0050)	--	ND(0.0050)
LEAD, DISSOLVED	mg/l	--	ND(0.0050)	--	ND(0.0050)	--	--	--	--	--	--
MAGNESIUM	mg/l	30	50	27	30	30	46	27	32	30	35
MAGNESIUM, DISSOLVED	mg/l	--	37	--	28	--	--	--	--	--	--
MANGANESE	mg/l	0.046	0.44	0.0051 J	0.067	0.041	0.18	0.067	0.13	0.06	0.14
MANGANESE, DISSOLVED	mg/l	0.047	0.12	ND(0.01)	0.064	0.038	--	ND(0.01) U	--	0.063	--
MERCURY	mg/l	--	ND(0.00020)	--	ND(0.00020)	--	ND(0.00020)	--	ND(0.00020)	--	ND(0.00020)
MERCURY, DISSOLVED	mg/l	--	ND(0.00020)	--	ND(0.00020)	--	--	--	--	--	--
NICKEL	mg/l	--	ND(0.010)	--	ND(0.010)	--	0.017	--	ND(0.010)	--	ND(0.010)
NICKEL, DISSOLVED	mg/l	--	ND(0.010)	--	ND(0.010)	--	--	--	--	--	--
POTASSIUM	mg/l	--	4.7	--	1.6	--	2.7	--	1.6	--	1.9
POTASSIUM, DISSOLVED	mg/l	--	4.4	--	1.6	--	--	--	--	--	--
SELENIUM	mg/l	--	ND(0.0050)	--	ND(0.0050)	--	ND(0.0050)	--	ND(0.0050)	--	ND(0.0050)
SELENIUM, DISSOLVED	mg/l	--	ND(0.0050)	--	ND(0.0050)	--	--	--	--	--	--
SILVER	mg/l	--	ND(0.010)	--	ND(0.010)	--	ND(0.010)	--	ND(0.010)	--	ND(0.010)
SILVER, DISSOLVED	mg/l	--	ND(0.010)	--	ND(0.010)	--	--	--	--	--	--
SODIUM	mg/l	4.7	85	21	10	5	15	18	12	4.4	8.9
SODIUM, DISSOLVED	mg/l	--	84	--	12	--	--	--	--	--	--
THALLIUM	mg/l	--	ND(0.010)	--	ND(0.010)	--	ND(0.010)	--	ND(0.010)	--	ND(0.010)
THALLIUM, DISSOLVED	mg/l	--	ND(0.010)	--	ND(0.010)	--	--	--	--	--	--
VANADIUM	mg/l	--	ND(0.010)	--	ND(0.010)	--	ND(0.010)	--	ND(0.010)	--	ND(0.010)
VANADIUM, DISSOLVED	mg/l	--	ND(0.010)	--	ND(0.010)	--	--	--	--	--	--
ZINC	mg/l	--	ND(0.038) U	--	ND(0.023) U	--	ND(0.021) U	--	ND(0.020)	--	ND(0.020)
ZINC, DISSOLVED	mg/l	--	ND(0.020)	--	ND(0.020)	--	--	--	--	--	--
Volatile Organic Compounds											
1,1,1-TRICHLOROETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-118	MW-119	MW-119	MW-120	MW-120	MW-121	MW-121	MW-122	MW-122	MW-123
Sample I.D.:		GW-SC-50	GW-DS-218	GW-SC-73	GW-DS-217	GW-SC-72	GW-DS-215	GW-SC-70	GW-DS-214	GW-SC-69	GW-DS-213
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		04/27/1999	11/20/1997	04/30/1999	11/20/1997	04/30/1999	11/19/1997	04/30/1999	11/19/1997	04/30/1999	11/19/1997
Parameters	Units										
Volatile Organic Compounds (Cont'd)											
1,1,2,2-TETRACHLOROETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
1,1,2-TRICHLOROETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
1,1-DICHLOROETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
1,1-DICHLOROETHENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
1,2-DICHLOROETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	1.9
1,2-DICHLOROETHENE	ug/l	--	--	--	--	--	--	--	--	--	--
1,2-DICHLOROPROPANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
2-BUTANONE	ug/l	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
2-HEXANONE	ug/l	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
4-METHYL-2-PENTANONE	ug/l	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
ACETONE	ug/l	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
BENZENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
BROMODICHLOROMETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
BROMOFORM	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
BROMOMETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CARBON DISULFIDE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CARBON TETRACHLORIDE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CHLOROBENZENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CHLOROETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CHLOROFORM	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CHLOROMETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CIS-1,2-DICHLOROETHENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CIS-1,3-DICHLOROPROPENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
DIBROMOCHLOROMETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
DICHLOROMETHANE	ug/l	ND(1)	ND(1)	ND(1) U	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1) U	ND(1)
ETHYL BENZENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
M,P-XYLENE	ug/l	ND(1)	--	ND(1)	--	ND(1)	--	ND(1)	--	ND(1)	--
O-XYLENE	ug/l	ND(1)	--	ND(1)	--	ND(1)	--	ND(1)	--	ND(1)	--
STYRENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
TETRACHLOROETHENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
TOLUENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
TRANS-1,2-DICHLOROETHENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
TRANS-1,3-DICHLOROPROPENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
TRICHLOROETHENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
VINYL CHLORIDE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-118	MW-119	MW-119	MW-120	MW-120	MW-121	MW-121	MW-122	MW-122	MW-123
Sample I.D.:		GW-SC-50	GW-DS-218	GW-SC-73	GW-DS-217	GW-SC-72	GW-DS-215	GW-SC-70	GW-DS-214	GW-SC-69	GW-DS-213
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		04/27/1999	11/20/1997	04/30/1999	11/20/1997	04/30/1999	11/19/1997	04/30/1999	11/19/1997	04/30/1999	11/19/1997
Parameters	Units										
Volatile Organic Compounds (Cont'd)											
XYLENES (TOTAL)	ug/l	--	ND(1)	--	ND(1)	--	ND(1)	--	ND(1)	--	ND(1)
Dissolved Gases											
ETHANE	mg/l	ND(0.010)	ND(0.0005)	ND(0.010)	0.0012	ND(0.010)	0.00051	ND(0.010)	0.00064	ND(0.010)	0.00051
ETHENE	mg/l	ND(0.010)	ND(0.0005)	ND(0.010)	ND(0.0005)	ND(0.010)	ND(0.0005)	ND(0.010)	ND(0.0005)	ND(0.010)	ND(0.0005)
METHANE	mg/l	ND(0.010)	0.00088	ND(0.010)	0.0041	ND(0.010)	0.0029	ND(0.010)	0.0042	ND(0.010)	0.0012

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-123	MW-123	MW-124	MW-124	MW-124	MW-124	MW-124	MW-124	MW-124	MW-124
Sample I.D.:		GW-KD-01	GW-SC-90	GW-DS-203	GW-KD-02	GW-KD-02	GW-KD-03	GW-KD-03	GW-SC-02	GW-SC-04	GW-SC-03
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		03/20/1998	05/02/1999	11/19/1997	03/20/1998	03/20/1998	03/20/1998	03/20/1998	09/15/1998	09/15/1998	09/15/1998
						Reanal 1	Dupl.	Dupl. Reanal		Reanal 1	Dupl.
Parameters	Units										
Semivolatile Organic Compounds											
1,2,4-TRICHLOROBENZENE	ug/l	--	--	--	--	--	--	--	--	--	--
1,2-DICHLOROBENZENE	ug/l	--	--	--	--	--	--	--	--	--	--
1,3-DICHLOROBENZENE	ug/l	--	--	--	--	--	--	--	--	--	--
1,4-DICHLOROBENZENE	ug/l	--	--	--	--	--	--	--	--	--	--
2,4,5-TRICHLOROPHENOL	ug/l	--	--	--	--	--	--	--	--	--	--
2,4,6-TRICHLOROPHENOL	ug/l	--	--	--	--	--	--	--	--	--	--
2,4-DICHLOROPHENOL	ug/l	--	--	--	--	--	--	--	--	--	--
2,4-DIMETHYLPHENOL	ug/l	--	--	--	--	--	--	--	--	--	--
2,4-DINITROPHENOL	ug/l	--	--	--	--	--	--	--	--	--	--
2,4-DINITROTOLUENE	ug/l	--	--	--	--	--	--	--	--	--	--
2,6-DINITROTOLUENE	ug/l	--	--	--	--	--	--	--	--	--	--
2-CHLORONAPHTHALENE	ug/l	--	--	--	--	--	--	--	--	--	--
2-CHLOROPHENOL	ug/l	--	--	--	--	--	--	--	--	--	--
2-METHYLNAPHTHALENE	ug/l	--	--	--	--	--	--	--	--	--	--
2-METHYLPHENOL	ug/l	--	--	--	--	--	--	--	--	--	--
2-NITROANILINE	ug/l	--	--	--	--	--	--	--	--	--	--
2-NITROPHENOL	ug/l	--	--	--	--	--	--	--	--	--	--
3,3'-DICHLOROBENZIDINE	ug/l	--	--	--	--	--	--	--	--	--	--
3-NITROANILINE	ug/l	--	--	--	--	--	--	--	--	--	--
4,6-DINITRO-2-METHYLPHENOL	ug/l	--	--	--	--	--	--	--	--	--	--
4-BROMOPHENYLPHENYL ETHER	ug/l	--	--	--	--	--	--	--	--	--	--
4-CHLORO-3-METHYLPHENOL	ug/l	--	--	--	--	--	--	--	--	--	--
4-CHLOROANILINE	ug/l	--	--	--	--	--	--	--	--	--	--
4-CHLOROPHENYLPHENYL ETHER	ug/l	--	--	--	--	--	--	--	--	--	--
4-METHYLPHENOL	ug/l	--	--	--	--	--	--	--	--	--	--
4-NITROANILINE	ug/l	--	--	--	--	--	--	--	--	--	--
4-NITROPHENOL	ug/l	--	--	--	--	--	--	--	--	--	--
ACENAPHTHENE	ug/l	--	--	--	--	--	--	--	--	--	--
ACENAPHTHYLENE	ug/l	--	--	--	--	--	--	--	--	--	--
ANTHRACENE	ug/l	--	--	--	--	--	--	--	--	--	--
BENZO(A)ANTHRACENE	ug/l	--	--	--	--	--	--	--	--	--	--
BENZO(A)PYRENE	ug/l	--	--	--	--	--	--	--	--	--	--
BENZO(B)FLUORANTHENE	ug/l	--	--	--	--	--	--	--	--	--	--
BENZO(G,H,I)PERYLENE	ug/l	--	--	--	--	--	--	--	--	--	--
BENZO(K)FLUORANTHENE	ug/l	--	--	--	--	--	--	--	--	--	--

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-123	MW-123	MW-124	MW-124	MW-124	MW-124	MW-124	MW-124	MW-124	MW-124
Sample I.D.:		GW-KD-01	GW-SC-90	GW-DS-203	GW-KD-02	GW-KD-02	GW-KD-03	GW-KD-03	GW-SC-02	GW-SC-04	GW-SC-03
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		03/20/1998	05/02/1999	11/19/1997	03/20/1998	03/20/1998	03/20/1998	03/20/1998	09/15/1998	09/15/1998	09/15/1998
						Reanal 1	Dupl.	Dupl. Reanal		Reanal 1	Dupl.
Parameters	Units										
Semivolatile Organic Compounds (Cont'd)											
BIS(2-CHLOROETHOXY)METHANE	ug/l	--	--	--	--	--	--	--	--	--	--
BIS(2-CHLOROETHYL)ETHER	ug/l	--	--	--	--	--	--	--	--	--	--
BIS(2-CHLOROISOPROPYL)ETHER	ug/l	--	--	--	--	--	--	--	--	--	--
BIS(2-ETHYLHEXYL)PHTHALATE	ug/l	--	--	--	--	--	--	--	--	--	--
BUTYLBENZYLPHTHALATE	ug/l	--	--	--	--	--	--	--	--	--	--
CARBAZOLE	ug/l	--	--	--	--	--	--	--	--	--	--
CHRYSENE	ug/l	--	--	--	--	--	--	--	--	--	--
DI-N-BUTYLPHTHALATE	ug/l	--	--	--	--	--	--	--	--	--	--
DI-N-OCTYLPHTHALATE	ug/l	--	--	--	--	--	--	--	--	--	--
DIBENZ(A,H)ANTHRACENE	ug/l	--	--	--	--	--	--	--	--	--	--
DIBENZOFURAN	ug/l	--	--	--	--	--	--	--	--	--	--
DIETHYLPHTHALATE	ug/l	--	--	--	--	--	--	--	--	--	--
DIMETHYLPHTHALATE	ug/l	--	--	--	--	--	--	--	--	--	--
FLUORANTHENE	ug/l	--	--	--	--	--	--	--	--	--	--
FLUORENE	ug/l	--	--	--	--	--	--	--	--	--	--
HEXACHLOROBENZENE	ug/l	--	--	--	--	--	--	--	--	--	--
HEXACHLOROBUTADIENE	ug/l	--	--	--	--	--	--	--	--	--	--
HEXACHLOROCYCLOPENTADIENE	ug/l	--	--	--	--	--	--	--	--	--	--
HEXACHLOROETHANE	ug/l	--	--	--	--	--	--	--	--	--	--
INDENO(1,2,3-CD)PYRENE	ug/l	--	--	--	--	--	--	--	--	--	--
ISOPHORONE	ug/l	--	--	--	--	--	--	--	--	--	--
N-NITROSO-DI-N-PROPYLAMINE	ug/l	--	--	--	--	--	--	--	--	--	--
N-NITROSODIPHENYLAMINE	ug/l	--	--	--	--	--	--	--	--	--	--
NAPHTHALENE	ug/l	--	--	--	--	--	--	--	--	--	--
NITROBENZENE	ug/l	--	--	--	--	--	--	--	--	--	--
PENTACHLOROPHENOL	ug/l	--	--	--	--	--	--	--	--	--	--
PHENANTHRENE	ug/l	--	--	--	--	--	--	--	--	--	--
PHENOL	ug/l	--	--	--	--	--	--	--	--	--	--
PYRENE	ug/l	--	--	--	--	--	--	--	--	--	--
General Chemistry											
ALKALINITY	mg/l	--	360	--	--	--	--	--	--	--	--
ALKALINITY, BICARBONATE	mg/l	--	360	350	--	--	--	--	--	--	--
ALKALINITY, CARBONATE	mg/l	--	ND(10)	ND(1)	--	--	--	--	--	--	--

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-123	MW-123	MW-124	MW-124	MW-124	MW-124	MW-124	MW-124	MW-124	MW-124
Sample I.D.:		GW-KD-01	GW-SC-90	GW-DS-203	GW-KD-02	GW-KD-02	GW-KD-03	GW-KD-03	GW-SC-02	GW-SC-04	GW-SC-03
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		03/20/1998	05/02/1999	11/19/1997	03/20/1998	03/20/1998	03/20/1998	03/20/1998	09/15/1998	09/15/1998	09/15/1998
						Reanal 1	Dupl.	Dupl. Reanal		Reanal 1	Dupl.
Parameters	Units										
General Chemistry (Cont'd)											
CHLORIDE	mg/l	--	4.75	14	--	--	--	--	--	--	--
COUNT TIME	minutes	--	--	--	--	--	--	--	--	--	--
CYANIDE	mg/l	--	--	--	--	--	--	--	--	--	--
DISSOLVED ORGANIC CARBON (DOC)	mg/l	--	ND(1.3) U	2.5	--	--	--	--	--	--	--
FERROUS IRON	mg/l	--	--	ND(0.10)	--	--	--	--	--	--	--
GROSS ALPHA	pCi/l	--	--	--	--	--	--	--	--	--	--
GROSS BETA	pCi/l	--	--	--	--	--	--	--	--	--	--
HARDNESS, CALCIUM/MAGNESIUM (AS CACO3	mg/l	--	400	--	--	--	--	--	--	--	--
NITRITE	mg/l	--	ND(0.1)	--	--	--	--	--	--	--	--
NITROGEN, AMMONIA	mg/l	--	--	--	--	--	--	--	--	--	--
NITROGEN, NITRATE	mg/l	--	0.0324 J	ND(0.01)	--	--	--	--	--	--	--
PH	std. units	--	--	--	--	--	--	--	--	--	--
SULFATE	mg/l	--	33.3	39	--	--	--	--	--	--	--
SULFIDE	mg/l	--	ND(1)	ND(1.0)	--	--	--	--	--	--	--
TOTAL DISSOLVED SOLIDS	mg/l	--	370	440	--	--	--	--	--	--	--
TOTAL ORGANIC CARBON (TOC)	mg/l	--	--	2.1	--	--	--	--	--	--	--
TOTAL SUSPENDED SOLIDS (TSS)	mg/l	--	ND(5)	7	--	--	--	--	--	--	--
TAL Metals											
ALUMINUM	mg/l	--	ND(0.2)	ND(0.050)	--	--	--	--	--	--	--
ALUMINUM, DISSOLVED	mg/l	--	--	--	--	--	--	--	--	--	--
ANTIMONY	mg/l	--	--	ND(0.030)	--	--	--	--	--	--	--
ANTIMONY, DISSOLVED	mg/l	--	--	--	--	--	--	--	--	--	--
ARSENIC	mg/l	--	--	ND(0.0050)	--	--	--	--	--	--	--
ARSENIC, DISSOLVED	mg/l	--	--	--	--	--	--	--	--	--	--
BARIUM	mg/l	--	--	0.13	--	--	--	--	--	--	--
BARIUM, DISSOLVED	mg/l	--	--	--	--	--	--	--	--	--	--
BERYLLIUM	mg/l	--	--	ND(0.0040)	--	--	--	--	--	--	--
BERYLLIUM, DISSOLVED	mg/l	--	--	--	--	--	--	--	--	--	--
CADMIUM	mg/l	--	--	ND(0.0050)	--	--	--	--	--	--	--
CADMIUM, DISSOLVED	mg/l	--	--	--	--	--	--	--	--	--	--
CALCIUM	mg/l	--	98 J	96	--	--	--	--	--	--	--
CALCIUM, DISSOLVED	mg/l	--	--	--	--	--	--	--	--	--	--
CHROMIUM	mg/l	--	--	ND(0.010)	--	--	--	--	--	--	--

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-123	MW-123	MW-124	MW-124	MW-124	MW-124	MW-124	MW-124	MW-124	MW-124
Sample I.D.:		GW-KD-01	GW-SC-90	GW-DS-203	GW-KD-02	GW-KD-02	GW-KD-03	GW-KD-03	GW-SC-02	GW-SC-04	GW-SC-03
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		03/20/1998	05/02/1999	11/19/1997	03/20/1998	03/20/1998	03/20/1998	03/20/1998	09/15/1998	09/15/1998	09/15/1998
						Reanal 1	Dupl.	Dupl. Reanal		Reanal 1	Dupl.
Parameters	Units										
TAL Metals (Cont'd)											
CHROMIUM, DISSOLVED	mg/l	--	--	--	--	--	--	--	--	--	--
COBALT	mg/l	--	--	ND(0.010)	--	--	--	--	--	--	--
COBALT, DISSOLVED	mg/l	--	--	--	--	--	--	--	--	--	--
COPPER	mg/l	--	ND(0.02) U	ND(0.020)	--	--	--	--	--	--	--
COPPER, DISSOLVED	mg/l	--	--	--	--	--	--	--	--	--	--
IRON	mg/l	--	0.079 J	2.7	--	--	--	--	--	--	--
IRON, DISSOLVED	mg/l	--	ND(0.05)	--	--	--	--	--	--	--	--
LEAD	mg/l	--	--	ND(0.0050)	--	--	--	--	--	--	--
LEAD, DISSOLVED	mg/l	--	--	--	--	--	--	--	--	--	--
MAGNESIUM	mg/l	--	38 J	34	--	--	--	--	--	--	--
MAGNESIUM, DISSOLVED	mg/l	--	--	--	--	--	--	--	--	--	--
MANGANESE	mg/l	--	0.017	0.050	--	--	--	--	--	--	--
MANGANESE, DISSOLVED	mg/l	--	ND(0.014) U	--	--	--	--	--	--	--	--
MERCURY	mg/l	--	--	ND(0.00020)	--	--	--	--	--	--	--
MERCURY, DISSOLVED	mg/l	--	--	--	--	--	--	--	--	--	--
NICKEL	mg/l	--	--	ND(0.010)	--	--	--	--	--	--	--
NICKEL, DISSOLVED	mg/l	--	--	--	--	--	--	--	--	--	--
POTASSIUM	mg/l	--	--	1.4	--	--	--	--	--	--	--
POTASSIUM, DISSOLVED	mg/l	--	--	--	--	--	--	--	--	--	--
SELENIUM	mg/l	--	--	ND(0.0050)	--	--	--	--	--	--	--
SELENIUM, DISSOLVED	mg/l	--	--	--	--	--	--	--	--	--	--
SILVER	mg/l	--	--	ND(0.010)	--	--	--	--	--	--	--
SILVER, DISSOLVED	mg/l	--	--	--	--	--	--	--	--	--	--
SODIUM	mg/l	--	4.1	5.8	--	--	--	--	--	--	--
SODIUM, DISSOLVED	mg/l	--	--	--	--	--	--	--	--	--	--
THALLIUM	mg/l	--	--	ND(0.010)	--	--	--	--	--	--	--
THALLIUM, DISSOLVED	mg/l	--	--	--	--	--	--	--	--	--	--
VANADIUM	mg/l	--	--	ND(0.010)	--	--	--	--	--	--	--
VANADIUM, DISSOLVED	mg/l	--	--	--	--	--	--	--	--	--	--
ZINC	mg/l	--	--	ND(0.020)	--	--	--	--	--	--	--
ZINC, DISSOLVED	mg/l	--	--	--	--	--	--	--	--	--	--
Volatile Organic Compounds											
1,1,1-TRICHLOROETHANE	ug/l	ND(1)	ND(1)	ND(10)	ND(1)	ND(20)	ND(1)	ND(20)	ND(1)	ND(33)	ND(1)

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-123	MW-123	MW-124	MW-124	MW-124	MW-124	MW-124	MW-124	MW-124	MW-124
Sample I.D.:		GW-KD-01	GW-SC-90	GW-DS-203	GW-KD-02	GW-KD-02	GW-KD-03	GW-KD-03	GW-SC-02	GW-SC-04	GW-SC-03
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		03/20/1998	05/02/1999	11/19/1997	03/20/1998	03/20/1998	03/20/1998	03/20/1998	09/15/1998	09/15/1998	09/15/1998
						Reanal 1	Dupl.	Dupl. Reanal		Reanal 1	Dupl.
Parameters	Units										
Volatile Organic Compounds (Cont'd)											
1,1,2,2-TETRACHLOROETHANE	ug/l	ND(1)	ND(1)	ND(10)	ND(1)	ND(20)	ND(1)	ND(20)	ND(1)	ND(33)	ND(1)
1,1,2-TRICHLOROETHANE	ug/l	ND(1)	ND(1)	ND(10)	ND(1)	ND(20)	ND(1)	ND(20)	ND(1)	ND(33)	ND(1)
1,1-DICHLOROETHANE	ug/l	ND(1)	ND(1)	ND(10)	ND(1)	ND(20)	ND(1)	ND(20)	ND(1)	ND(33)	ND(1)
1,1-DICHLOROETHENE	ug/l	ND(1)	ND(1)	ND(10)	ND(1)	ND(20)	ND(1)	ND(20)	ND(1)	ND(33)	ND(1)
1,2-DICHLOROETHANE	ug/l	ND(1)	ND(1)	63	ND(1) *	610 J	ND(1) *	720 J	1000	1000	1000
1,2-DICHLOROETHENE	ug/l	--	--	--	--	--	--	--	--	ND(33)	--
1,2-DICHLOROPROPANE	ug/l	ND(1)	ND(1)	ND(10)	ND(1)	ND(20)	ND(1)	ND(20)	ND(1)	ND(33)	ND(1)
2-BUTANONE	ug/l	ND(10)	ND(10)	ND(100)	ND(10)	ND(200)	ND(10)	ND(200)	ND(10)	ND(330)	ND(10)
2-HEXANONE	ug/l	ND(10)	ND(10)	ND(100)	ND(10)	ND(200)	ND(10)	ND(200)	ND(10)	ND(330)	ND(10)
4-METHYL-2-PENTANONE	ug/l	ND(10)	ND(10)	ND(100)	ND(10)	ND(200)	ND(10)	ND(200)	ND(10)	ND(330)	ND(10)
ACETONE	ug/l	ND(10)	ND(10)	ND(100)	ND(10)	ND(200)	ND(10)	ND(200)	ND(10)	ND(330)	ND(10)
BENZENE	ug/l	ND(1)	ND(1)	ND(10)	ND(1)	ND(20)	ND(1)	ND(20)	ND(1)	ND(33)	ND(1)
BROMODICHLOROMETHANE	ug/l	ND(1)	ND(1)	ND(10)	ND(1)	ND(20)	ND(1)	ND(20)	ND(1)	ND(33)	ND(1)
BROMOFORM	ug/l	ND(1)	ND(1)	ND(10)	ND(1)	ND(20)	ND(1)	ND(20)	ND(1)	ND(33)	ND(1)
BROMOMETHANE	ug/l	ND(1)	ND(1) U	ND(10)	ND(1)	ND(20)	ND(1)	ND(20)	ND(1)	ND(67)	ND(1)
CARBON DISULFIDE	ug/l	ND(1)	ND(1)	ND(10)	ND(1)	ND(20)	ND(1)	ND(20)	ND(1)	ND(33)	ND(1)
CARBON TETRACHLORIDE	ug/l	ND(1)	2.5	ND(10)	ND(1)	ND(20)	ND(1)	ND(20)	ND(1)	ND(33)	ND(1)
CHLOROBENZENE	ug/l	ND(1)	ND(1)	ND(10)	ND(1)	ND(20)	ND(1)	ND(20)	ND(1)	ND(33)	ND(1)
CHLOROETHANE	ug/l	ND(1)	ND(1)	ND(10)	ND(1)	ND(20)	ND(1)	ND(20)	2.8	ND(67)	2.6
CHLOROFORM	ug/l	ND(1)	ND(1)	ND(10)	ND(1)	ND(20)	ND(1)	ND(20)	ND(1)	ND(33)	ND(1)
CHLOROMETHANE	ug/l	ND(1)	ND(1)	ND(10)	ND(1)	ND(20)	ND(1)	ND(20)	ND(1)	ND(67)	ND(1)
CIS-1,2-DICHLOROETHENE	ug/l	ND(1)	ND(1)	ND(10)	ND(1)	ND(20)	ND(1)	ND(20)	ND(1)	--	ND(1)
CIS-1,3-DICHLOROPROPENE	ug/l	ND(1)	ND(1)	ND(10)	ND(1)	ND(20)	ND(1)	ND(20)	ND(1)	ND(33)	ND(1)
DIBROMOCHLOROMETHANE	ug/l	ND(1)	ND(1)	ND(10)	ND(1)	ND(20)	ND(1)	ND(20)	ND(1)	ND(33)	ND(1)
DICHLOROMETHANE	ug/l	ND(1)	ND(1) U	ND(10)	1.1	ND(20)	1.1	ND(20)	ND(1)	ND(33)	ND(1)
ETHYL BENZENE	ug/l	ND(1)	ND(1)	ND(10)	ND(1)	ND(20)	ND(1)	ND(20)	ND(1)	ND(33)	ND(1)
M,P-XYLENE	ug/l	--	ND(1)	--	--	--	--	--	--	--	--
O-XYLENE	ug/l	--	ND(1)	--	--	--	--	--	--	--	--
STYRENE	ug/l	ND(1)	ND(1)	ND(10)	ND(1)	ND(20)	ND(1)	ND(20)	ND(1)	ND(33)	ND(1)
TETRACHLOROETHENE	ug/l	ND(1)	ND(1)	ND(10)	ND(1)	ND(20)	ND(1)	ND(20)	--	ND(33)	--
TOLUENE	ug/l	ND(1)	ND(1)	ND(10)	ND(1)	ND(20)	ND(1)	ND(20)	ND(1)	ND(33)	ND(1)
TRANS-1,2-DICHLOROETHENE	ug/l	ND(1)	ND(1)	ND(10)	ND(1)	ND(20)	ND(1)	ND(20)	ND(1)	--	ND(1)
TRANS-1,3-DICHLOROPROPENE	ug/l	ND(1)	ND(1)	ND(10)	ND(1)	ND(20)	ND(1)	ND(20)	ND(1)	ND(33)	ND(1)
TRICHLOROETHENE	ug/l	ND(1)	ND(1)	ND(10)	ND(1)	ND(20)	ND(1)	ND(20)	ND(1)	ND(33)	ND(1)
VINYL CHLORIDE	ug/l	ND(1)	ND(1)	ND(10)	ND(1)	ND(20)	ND(1)	ND(20)	7.8	ND(67)	7.7

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-123	MW-123	MW-124	MW-124	MW-124	MW-124	MW-124	MW-124	MW-124	MW-124
Sample I.D.:		GW-KD-01	GW-SC-90	GW-DS-203	GW-KD-02	GW-KD-02	GW-KD-03	GW-KD-03	GW-SC-02	GW-SC-04	GW-SC-03
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		03/20/1998	05/02/1999	11/19/1997	03/20/1998	03/20/1998	03/20/1998	03/20/1998	09/15/1998	09/15/1998	09/15/1998
						Reanal 1	Dupl.	Dupl. Reanal		Reanal 1	Dupl.
Parameters	Units										
Volatile Organic Compounds (Cont'd)											
XYLENES (TOTAL)	ug/l	ND(1)	--	ND(10)	ND(1)	ND(20)	ND(1)	ND(20)	ND(1)	ND(33)	ND(1)
Dissolved Gases											
ETHANE	mg/l	--	ND(0.010)	ND(0.0005)	--	--	--	--	--	--	--
ETHENE	mg/l	--	ND(0.010)	0.0058	--	--	--	--	--	--	--
METHANE	mg/l	--	ND(0.010)	0.0032	--	--	--	--	--	--	--

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-124	MW-125	MW-125	MW-126	MW-126	MW-126	MW-127	MW-128	MW-129	MW-130
Sample I.D.:		GW-SC-91	GW-DS-202	GW-SC-67	GW-DS-201	GW-SC-65	GW-SC-66	GW-SC-85	GW-SC-83	GW-SC-82	GW-SC-81
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		05/02/1999	11/19/1997	04/29/1999	11/18/1997	04/29/1999	04/29/1999	05/01/1999	05/01/1999	05/01/1999	05/01/1999
							Dupl.				
Parameters	Units										
Semivolatile Organic Compounds											
1,2,4-TRICHLOROBENZENE	ug/l	--	--	--	--	--	--	--	--	--	--
1,2-DICHLOROBENZENE	ug/l	--	--	--	--	--	--	--	--	--	--
1,3-DICHLOROBENZENE	ug/l	--	--	--	--	--	--	--	--	--	--
1,4-DICHLOROBENZENE	ug/l	--	--	--	--	--	--	--	--	--	--
2,4,5-TRICHLOROPHENOL	ug/l	--	--	--	--	--	--	--	--	--	--
2,4,6-TRICHLOROPHENOL	ug/l	--	--	--	--	--	--	--	--	--	--
2,4-DICHLOROPHENOL	ug/l	--	--	--	--	--	--	--	--	--	--
2,4-DIMETHYLPHENOL	ug/l	--	--	--	--	--	--	--	--	--	--
2,4-DINITROPHENOL	ug/l	--	--	--	--	--	--	--	--	--	--
2,4-DINITROTOLUENE	ug/l	--	--	--	--	--	--	--	--	--	--
2,6-DINITROTOLUENE	ug/l	--	--	--	--	--	--	--	--	--	--
2-CHLORONAPHTHALENE	ug/l	--	--	--	--	--	--	--	--	--	--
2-CHLOROPHENOL	ug/l	--	--	--	--	--	--	--	--	--	--
2-METHYLNAPHTHALENE	ug/l	--	--	--	--	--	--	--	--	--	--
2-METHYLPHENOL	ug/l	--	--	--	--	--	--	--	--	--	--
2-NITROANILINE	ug/l	--	--	--	--	--	--	--	--	--	--
2-NITROPHENOL	ug/l	--	--	--	--	--	--	--	--	--	--
3,3'-DICHLOROBENZIDINE	ug/l	--	--	--	--	--	--	--	--	--	--
3-NITROANILINE	ug/l	--	--	--	--	--	--	--	--	--	--
4,6-DINITRO-2-METHYLPHENOL	ug/l	--	--	--	--	--	--	--	--	--	--
4-BROMOPHENYLPHENYL ETHER	ug/l	--	--	--	--	--	--	--	--	--	--
4-CHLORO-3-METHYLPHENOL	ug/l	--	--	--	--	--	--	--	--	--	--
4-CHLOROANILINE	ug/l	--	--	--	--	--	--	--	--	--	--
4-CHLOROPHENYLPHENYL ETHER	ug/l	--	--	--	--	--	--	--	--	--	--
4-METHYLPHENOL	ug/l	--	--	--	--	--	--	--	--	--	--
4-NITROANILINE	ug/l	--	--	--	--	--	--	--	--	--	--
4-NITROPHENOL	ug/l	--	--	--	--	--	--	--	--	--	--
ACENAPHTHENE	ug/l	--	--	--	--	--	--	--	--	--	--
ACENAPHTHYLENE	ug/l	--	--	--	--	--	--	--	--	--	--
ANTHRACENE	ug/l	--	--	--	--	--	--	--	--	--	--
BENZO(A)ANTHRACENE	ug/l	--	--	--	--	--	--	--	--	--	--
BENZO(A)PYRENE	ug/l	--	--	--	--	--	--	--	--	--	--
BENZO(B)FLUORANTHENE	ug/l	--	--	--	--	--	--	--	--	--	--
BENZO(G,H,I)PERYLENE	ug/l	--	--	--	--	--	--	--	--	--	--
BENZO(K)FLUORANTHENE	ug/l	--	--	--	--	--	--	--	--	--	--

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-124	MW-125	MW-125	MW-126	MW-126	MW-126	MW-127	MW-128	MW-129	MW-130
Sample I.D.:		GW-SC-91	GW-DS-202	GW-SC-67	GW-DS-201	GW-SC-65	GW-SC-66	GW-SC-85	GW-SC-83	GW-SC-82	GW-SC-81
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		05/02/1999	11/19/1997	04/29/1999	11/18/1997	04/29/1999	04/29/1999	05/01/1999	05/01/1999	05/01/1999	05/01/1999
							Dupl.				
Parameters	Units										
Semivolatile Organic Compounds (Cont'd)											
BIS(2-CHLOROETHOXY)METHANE	ug/l	--	--	--	--	--	--	--	--	--	--
BIS(2-CHLOROETHYL)ETHER	ug/l	--	--	--	--	--	--	--	--	--	--
BIS(2-CHLOROISOPROPYL)ETHER	ug/l	--	--	--	--	--	--	--	--	--	--
BIS(2-ETHYLHEXYL)PHTHALATE	ug/l	--	--	--	--	--	--	--	--	--	--
BUTYLBENZYLPHTHALATE	ug/l	--	--	--	--	--	--	--	--	--	--
CARBAZOLE	ug/l	--	--	--	--	--	--	--	--	--	--
CHRYSENE	ug/l	--	--	--	--	--	--	--	--	--	--
DI-N-BUTYLPHTHALATE	ug/l	--	--	--	--	--	--	--	--	--	--
DI-N-OCTYLPHTHALATE	ug/l	--	--	--	--	--	--	--	--	--	--
DIBENZ(A,H)ANTHRACENE	ug/l	--	--	--	--	--	--	--	--	--	--
DIBENZOFURAN	ug/l	--	--	--	--	--	--	--	--	--	--
DIETHYLPHTHALATE	ug/l	--	--	--	--	--	--	--	--	--	--
DIMETHYLPHTHALATE	ug/l	--	--	--	--	--	--	--	--	--	--
FLUORANTHENE	ug/l	--	--	--	--	--	--	--	--	--	--
FLUORENE	ug/l	--	--	--	--	--	--	--	--	--	--
HEXACHLOROBENZENE	ug/l	--	--	--	--	--	--	--	--	--	--
HEXACHLOROBUTADIENE	ug/l	--	--	--	--	--	--	--	--	--	--
HEXACHLOROCYCLOPENTADIENE	ug/l	--	--	--	--	--	--	--	--	--	--
HEXACHLOROETHANE	ug/l	--	--	--	--	--	--	--	--	--	--
INDENO(1,2,3-CD)PYRENE	ug/l	--	--	--	--	--	--	--	--	--	--
ISOPHORONE	ug/l	--	--	--	--	--	--	--	--	--	--
N-NITROSO-DI-N-PROPYLAMINE	ug/l	--	--	--	--	--	--	--	--	--	--
N-NITROSODIPHENYLAMINE	ug/l	--	--	--	--	--	--	--	--	--	--
NAPHTHALENE	ug/l	--	--	--	--	--	--	--	--	--	--
NITROBENZENE	ug/l	--	--	--	--	--	--	--	--	--	--
PENTACHLOROPHENOL	ug/l	--	--	--	--	--	--	--	--	--	--
PHENANTHRENE	ug/l	--	--	--	--	--	--	--	--	--	--
PHENOL	ug/l	--	--	--	--	--	--	--	--	--	--
PYRENE	ug/l	--	--	--	--	--	--	--	--	--	--
General Chemistry											
ALKALINITY	mg/l	360	--	350	--	340	340	340 J	300 J	340 J	350 J
ALKALINITY, BICARBONATE	mg/l	360	400	350	360	340	340	340 J	300 J	340 J	350 J
ALKALINITY, CARBONATE	mg/l	ND(10)	ND(1)	ND(10)	ND(1)	ND(10)	ND(10)	ND(10) UJ	ND(10) UJ	ND(10) UJ	ND(10) UJ

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-124	MW-125	MW-125	MW-126	MW-126	MW-126	MW-127	MW-128	MW-129	MW-130
Sample I.D.:		GW-SC-91	GW-DS-202	GW-SC-67	GW-DS-201	GW-SC-65	GW-SC-66	GW-SC-85	GW-SC-83	GW-SC-82	GW-SC-81
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		05/02/1999	11/19/1997	04/29/1999	11/18/1997	04/29/1999	04/29/1999	05/01/1999	05/01/1999	05/01/1999	05/01/1999
							Dupl.				
Parameters	Units										
General Chemistry (Cont'd)											
CHLORIDE	mg/l	13.8	8.7	9.5	4.0	ND(3.2) U	ND(2.5) U	3.8	3.5	12	3.8
COUNT TIME	minutes	--	--	--	--	--	--	--	--	--	--
CYANIDE	mg/l	--	--	--	--	--	--	--	--	--	--
DISSOLVED ORGANIC CARBON (DOC)	mg/l	ND(2.3) U	4.8	ND(5.5) U	2.1	ND(1.8) U	ND(2) U	ND(1)	ND(2.2) U	ND(2.7) U	ND(1.8) U
FERROUS IRON	mg/l	--	ND(0.10)	--	0.14	--	--	--	--	--	--
GROSS ALPHA	pCi/l	--	--	--	--	--	--	--	--	--	--
GROSS BETA	pCi/l	--	--	--	--	--	--	--	--	--	--
HARDNESS, CALCIUM/MAGNESIUM (AS CACO3	mg/l	420	--	430	--	390	400	360	350	370	390
NITRITE	mg/l	ND(0.1)	--	ND(0.1)	--	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)
NITROGEN, AMMONIA	mg/l	--	--	--	--	--	--	--	--	--	--
NITROGEN, NITRATE	mg/l	ND(0.1)	0.36	0.0401 J	ND(0.01)	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)	ND(0.1)
PH	std. units	--	--	--	--	--	--	--	--	--	--
SULFATE	mg/l	48.1	29	18.5	36	35.6	36	29.4	48	42.9	42.3
SULFIDE	mg/l	ND(1)	ND(1.0)	ND(1)	ND(1.0)	ND(1)	ND(2.5) U	ND(1)	ND(1)	ND(1)	ND(1)
TOTAL DISSOLVED SOLIDS	mg/l	380	440	410	380	410	390	350	380	400	400
TOTAL ORGANIC CARBON (TOC)	mg/l	--	4.2	--	1.8	--	--	--	--	--	--
TOTAL SUSPENDED SOLIDS (TSS)	mg/l	5.2	7	ND(5)	11	ND(5)	ND(5.2) U	ND(5)	6	7.2	8
TAL Metals											
ALUMINUM	mg/l	ND(0.2)	1.7	ND(0.2)	ND(0.050)	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)
ALUMINUM, DISSOLVED	mg/l	--	--	--	--	--	--	--	--	--	--
ANTIMONY	mg/l	--	ND(0.030)	--	ND(0.030)	--	--	--	--	--	--
ANTIMONY, DISSOLVED	mg/l	--	--	--	--	--	--	--	--	--	--
ARSENIC	mg/l	--	ND(0.0050)	--	0.010	--	--	--	--	--	--
ARSENIC, DISSOLVED	mg/l	--	--	--	--	--	--	--	--	--	--
BARIUM	mg/l	--	0.041	--	0.15	--	--	--	--	--	--
BARIUM, DISSOLVED	mg/l	--	--	--	--	--	--	--	--	--	--
BERYLLIUM	mg/l	--	ND(0.0040)	--	ND(0.0040)	--	--	--	--	--	--
BERYLLIUM, DISSOLVED	mg/l	--	--	--	--	--	--	--	--	--	--
CADMIUM	mg/l	--	ND(0.0050)	--	ND(0.0050)	--	--	--	--	--	--
CADMIUM, DISSOLVED	mg/l	--	--	--	--	--	--	--	--	--	--
CALCIUM	mg/l	110 J	110	120 J	95	100 J	100 J	89 J	90 J	90 J	97 J
CALCIUM, DISSOLVED	mg/l	--	--	--	--	--	--	--	--	--	--
CHROMIUM	mg/l	--	ND(0.010)	--	ND(0.010)	--	--	--	--	--	--

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-124	MW-125	MW-125	MW-126	MW-126	MW-126	MW-127	MW-128	MW-129	MW-130
Sample I.D.:		GW-SC-91	GW-DS-202	GW-SC-67	GW-DS-201	GW-SC-65	GW-SC-66	GW-SC-85	GW-SC-83	GW-SC-82	GW-SC-81
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		05/02/1999	11/19/1997	04/29/1999	11/18/1997	04/29/1999	04/29/1999	05/01/1999	05/01/1999	05/01/1999	05/01/1999
							Dupl.				
Parameters	Units										
TAL Metals (Cont'd)											
CHROMIUM, DISSOLVED	mg/l	--	--	--	--	--	--	--	--	--	--
COBALT	mg/l	--	ND(0.010)	--	ND(0.010)	--	--	--	--	--	--
COBALT, DISSOLVED	mg/l	--	--	--	--	--	--	--	--	--	--
COPPER	mg/l	ND(0.02)	ND(0.020)	ND(0.02)	ND(0.020)	ND(0.02)	ND(0.02)	ND(0.02)	ND(0.02) U	ND(0.02)	ND(0.02)
COPPER, DISSOLVED	mg/l	--	--	--	--	--	--	--	--	--	--
IRON	mg/l	2.8 J	2.4	0.062 J	3.3	2.6 J	2.6 J	1.1 J	2.5 J	4.8 J	4.4 J
IRON, DISSOLVED	mg/l	2.8 J	--	0.035 J	--	2.5	2.7	1 J	2.6 J	4.8 J	4.6 J
LEAD	mg/l	--	ND(0.0050)	--	ND(0.0050)	--	--	--	--	--	--
LEAD, DISSOLVED	mg/l	--	--	--	--	--	--	--	--	--	--
MAGNESIUM	mg/l	38 J	35	33	34	33	35	34 J	30 J	36 J	35 J
MAGNESIUM, DISSOLVED	mg/l	--	--	--	--	--	--	--	--	--	--
MANGANESE	mg/l	0.036	0.54	0.94	0.084	0.035	0.036	0.24	0.066	0.051	0.061
MANGANESE, DISSOLVED	mg/l	0.036	--	0.9	--	0.038	0.038	0.22	0.071	0.05	0.06
MERCURY	mg/l	--	ND(0.00020)	--	ND(0.00020)	--	--	--	--	--	--
MERCURY, DISSOLVED	mg/l	--	--	--	--	--	--	--	--	--	--
NICKEL	mg/l	--	ND(0.010)	--	ND(0.010)	--	--	--	--	--	--
NICKEL, DISSOLVED	mg/l	--	--	--	--	--	--	--	--	--	--
POTASSIUM	mg/l	--	2.6	--	1.5	--	--	--	--	--	--
POTASSIUM, DISSOLVED	mg/l	--	--	--	--	--	--	--	--	--	--
SELENIUM	mg/l	--	ND(0.0050)	--	ND(0.0050)	--	--	--	--	--	--
SELENIUM, DISSOLVED	mg/l	--	--	--	--	--	--	--	--	--	--
SILVER	mg/l	--	ND(0.010)	--	ND(0.010)	--	--	--	--	--	--
SILVER, DISSOLVED	mg/l	--	--	--	--	--	--	--	--	--	--
SODIUM	mg/l	5.8	6.6	4.6	7.6	5.1	5.1	17	7.9	14	5.4
SODIUM, DISSOLVED	mg/l	--	--	--	--	--	--	--	--	--	--
THALLIUM	mg/l	--	ND(0.010)	--	ND(0.010)	--	--	--	--	--	--
THALLIUM, DISSOLVED	mg/l	--	--	--	--	--	--	--	--	--	--
VANADIUM	mg/l	--	ND(0.010)	--	ND(0.010)	--	--	--	--	--	--
VANADIUM, DISSOLVED	mg/l	--	--	--	--	--	--	--	--	--	--
ZINC	mg/l	--	ND(0.021) U	--	ND(0.020)	--	--	--	--	--	--
ZINC, DISSOLVED	mg/l	--	--	--	--	--	--	--	--	--	--
Volatile Organic Compounds											
1,1,1-TRICHLOROETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-124	MW-125	MW-125	MW-126	MW-126	MW-126	MW-127	MW-128	MW-129	MW-130
Sample I.D.:		GW-SC-91	GW-DS-202	GW-SC-67	GW-DS-201	GW-SC-65	GW-SC-66	GW-SC-85	GW-SC-83	GW-SC-82	GW-SC-81
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		05/02/1999	11/19/1997	04/29/1999	11/18/1997	04/29/1999	04/29/1999	05/01/1999	05/01/1999	05/01/1999	05/01/1999
							Dupl.				
Parameters	Units										
Volatile Organic Compounds (Cont'd)											
1,1,2,2-TETRACHLOROETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
1,1,2-TRICHLOROETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
1,1-DICHLOROETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
1,1-DICHLOROETHENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
1,2-DICHLOROETHANE	ug/l	380 J	ND(1) UJ	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
1,2-DICHLOROETHENE	ug/l	--	--	--	--	--	--	--	--	--	--
1,2-DICHLOROPROPANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
2-BUTANONE	ug/l	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
2-HEXANONE	ug/l	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
4-METHYL-2-PENTANONE	ug/l	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
ACETONE	ug/l	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)	ND(10)
BENZENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1) UJ	ND(1) UJ	ND(1) UJ	ND(1) UJ
BROMODICHLOROMETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
BROMOFORM	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
BROMOMETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CARBON DISULFIDE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CARBON TETRACHLORIDE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CHLOROBENZENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1) UJ	ND(1) UJ	ND(1) UJ	ND(1) UJ
CHLOROETHANE	ug/l	1.8	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CHLOROFORM	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CHLOROMETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CIS-1,2-DICHLOROETHENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
CIS-1,3-DICHLOROPROPENE	ug/l	ND(1)	ND(1) UJ	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
DIBROMOCHLOROMETHANE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
DICHLOROMETHANE	ug/l	ND(1)	ND(1)	ND(1) U	ND(1)	ND(1)	ND(1) U	ND(1)	ND(1)	ND(1) U	ND(1)
ETHYL BENZENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
M,P-XYLENE	ug/l	ND(1)	--	ND(1)	--	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
O-XYLENE	ug/l	ND(1)	--	ND(1)	--	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
STYRENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
TETRACHLOROETHENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
TOLUENE	ug/l	ND(1)	ND(1)	ND(1)	10	ND(1)	ND(1)	1.1 J	ND(1) UJ	ND(1) UJ	ND(1) UJ
TRANS-1,2-DICHLOROETHENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
TRANS-1,3-DICHLOROPROPENE	ug/l	ND(1)	ND(1) UJ	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)
TRICHLOROETHENE	ug/l	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1) UJ	ND(1) UJ	ND(1) UJ	ND(1) UJ
VINYL CHLORIDE	ug/l	8	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)	ND(1)

TABLE C.3

GROUNDWATER ANALYTICAL DATA
OFF-SITE MONITORING WELLS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Location:		MW-124	MW-125	MW-125	MW-126	MW-126	MW-126	MW-127	MW-128	MW-129	MW-130
Sample I.D.:		GW-SC-91	GW-DS-202	GW-SC-67	GW-DS-201	GW-SC-65	GW-SC-66	GW-SC-85	GW-SC-83	GW-SC-82	GW-SC-81
Sample Interval:		--	--	--	--	--	--	--	--	--	--
Date Sampled:		05/02/1999	11/19/1997	04/29/1999	11/18/1997	04/29/1999	04/29/1999	05/01/1999	05/01/1999	05/01/1999	05/01/1999
							Dupl.				
Parameters	Units										
Volatile Organic Compounds (Cont'd)											
XYLENES (TOTAL)	ug/l	--	ND(1)	--	ND(1)	--	--	--	--	--	--
Dissolved Gases											
ETHANE	mg/l	ND(0.010)	ND(0.0005)	ND(0.010)	ND(0.0005)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)
ETHENE	mg/l	ND(0.010)	ND(0.0005)	ND(0.010)	ND(0.0005)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)
METHANE	mg/l	0.010	0.0071	0.014	0.0021	ND(0.010)	ND(0.010)	ND(0.010)	ND(0.010)	0.014	ND(0.010)

Notes

ND	-	The material was analyzed, but not detected above the stated method detection limit.
J	-	The associated numerical value is an estimated quantity.
U	-	The material was analyzed, but was not detected above the level of the associated value due to blank contamination.
--	-	The parameter was not analyzed.
UJ	-	The material was analyzed, but was not detected above the level of the associated value. The associated value may not accurately or precisely represent the sample detection limit.

TABLE C.4

Summary of Appendix IX Groundwater Analytical Groundwater
Four County Landfill Site
Fulton County, Indiana

Location:		MW-124
Sample I.D.:		GW-SC-92
Sample Interval:		--
Date Sampled:		05/02/1999
Parameters	Units	
Appendix IX - Semi-Volatile Organics		
0,0,0-TRIETHYL PHOSPHOROTHIOATE	ug/l	ND(11)
1,2,4,5-TETRACHLOROBENZENE	ug/l	ND(11)
1,2-DICHLOROBENZENE	ug/l	ND(11)
1,3,5-TRINITROBENZENE	ug/l	ND(57)
1,3-DICHLOROBENZENE	ug/l	ND(11)
1,3-DINITROBENZENE	ug/l	ND(11)
1,4-DICHLOROBENZENE	ug/l	ND(11)
1,4-NAPHTHOQUINOLINE,1-OXIDE	ug/l	ND(11)
1-NAPHTHYLAMINE	ug/l	ND(11)
2,3,4,6-TETRACHLOROPHENOL	ug/l	ND(11)
2,4,5-TRICHLOROPHENOL	ug/l	ND(57)
2,4,6-TRICHLOROPHENOL	ug/l	ND(11)
2,4-DICHLOROPHENOL	ug/l	ND(11)
2,4-DIMETHYLPHENOL	ug/l	ND(11)
2,4-DINITROPHENOL	ug/l	ND(57)
2,4-DINITROTOLUENE	ug/l	ND(11)
2,6-DICHLOROPHENOL	ug/l	ND(11)
2,6-DINITROTOLUENE	ug/l	ND(11)
2-ACETYLAMINOFLUORENE	ug/l	ND(11)
2-CHLORONAPHTHALENE	ug/l	ND(11)
2-CHLOROPHENOL	ug/l	ND(11)
2-METHYLNAPHTHALENE	ug/l	ND(11)
2-METHYLPHENOL	ug/l	ND(11)
2-NAPHTHYLAMINE	ug/l	ND(11)
2-NITROANILINE	ug/l	ND(57)
2-NITROPHENOL	ug/l	ND(11)
2-PICOLINE	ug/l	ND(11)
2-TOLUIDINE	ug/l	ND(11)
3,3'-DICHLOROBENZIDINE	ug/l	ND(57)
3,3'-DIMETHYLBENZIDINE	ug/l	ND(57)
3-METHYLCHOLANTHRENE	ug/l	ND(11)
3-NITROANILINE	ug/l	ND(57)
4,6-DINITRO-2-METHYLPHENOL	ug/l	ND(57)
4-AMINOBIPHENYL	ug/l	ND(11)
4-BROMOPHENYLPHENYL ETHER	ug/l	ND(11)
4-CHLORO-3-METHYLPHENOL	ug/l	ND(23)
4-CHLOROANILINE	ug/l	ND(23)
4-CHLOROPHENYLPHENYL ETHER	ug/l	ND(11)

TABLE C.4

Summary of Appendix IX Groundwater Analytical Groundwater
Four County Landfill Site
Fulton County, Indiana

Location:	MW-124
Sample I.D.:	GW-SC-92
Sample Interval:	--
Date Sampled:	05/02/1999

Parameters	Units	
Appendix IX - Semi-Volatile Organics (Cont'd)		
4-METHYLPHENOL	ug/l	ND(11)
4-NITROANILINE	ug/l	ND(57)
4-NITROPHENOL	ug/l	ND(57)
4-NITROQUINOLINE-1-OXIDE	ug/l	ND(110)
4-PHENYLENEDIAMINE	ug/l	ND(57)
5-NITRO-O-TOLUIDINE	ug/l	ND(11)
7,12-DIMETHYLBENZ(A)ANTHRACENE	ug/l	ND(11)
A,A-DIMETHYLPHENETHYLAMINE	ug/l	ND(11)
ACENAPHTHENE	ug/l	ND(11)
ACENAPHTHYLENE	ug/l	ND(11)
ACETOPHENONE	ug/l	ND(11)
ANILINE	ug/l	ND(11)
ANTHRACENE	ug/l	ND(11)
ARAMITE	ug/l	ND(11)
BENZO(A)ANTHRACENE	ug/l	ND(11)
BENZO(A)PYRENE	ug/l	ND(11)
BENZO(B)FLUORANTHENE	ug/l	ND(11)
BENZO(G,H,I)PERYLENE	ug/l	ND(11)
BENZO(K)FLUORANTHENE	ug/l	ND(11)
BENZYL ALCOHOL	ug/l	ND(23)
BIS(2-CHLOROETHOXY)METHANE	ug/l	ND(11)
BIS(2-CHLOROETHYL)ETHER	ug/l	ND(11)
BIS(2-CHLOROISOPROPYL)ETHER	ug/l	ND(11)
BIS(2-ETHYLHEXYL)PHTHALATE	ug/l	ND(11)
BUTYL BENZYL PHTHALATE	ug/l	ND(11)
CAFFEINE	ug/l	ND(11)
CHRYSENE	ug/l	ND(11)
DI-N-BUTYLPHTHALATE	ug/l	ND(11)
DI-N-OCTYLPHTHALATE	ug/l	ND(11)
DIALLATE	ug/l	ND(11)
DIBENZ(A,H)ANTHRACENE	ug/l	ND(11)
DIBENZOFURAN	ug/l	ND(11)
DIETHYLPHTHALATE	ug/l	ND(11)
DIMETHOATE	ug/l	ND(11)
DIMETHYLPHTHALATE	ug/l	ND(11)
DINOSEB	ug/l	ND(11)
DIPHENYLAMINE	ug/l	ND(11)
ETHYL METHANESULFONATE	ug/l	ND(11)

TABLE C.4

Summary of Appendix IX Groundwater Analytical Groundwater
Four County Landfill Site
Fulton County, Indiana

Location:		MW-124
Sample I.D.:		GW-SC-92
Sample Interval:		--
Date Sampled:		05/02/1999
Parameters	Units	
Appendix IX - Semi-Volatile Organics (Cont'd)		
ETHYL PARATHION	ug/l	ND(11)
FLUORANTHENE	ug/l	ND(11)
FLUORENE	ug/l	ND(11)
HEXACHLOROBENZENE	ug/l	ND(11)
HEXACHLOROBUTADIENE	ug/l	ND(11)
HEXACHLOROCYCLOPENTADIENE	ug/l	ND(11)
HEXACHLOROETHANE	ug/l	ND(11)
HEXACHLOROPHENE	ug/l	ND(11)
HEXACHLOROPROPENE	ug/l	ND(11)
INDENO(1,2,3-CD)PYRENE	ug/l	ND(11)
ISODRIN	ug/l	ND(11)
ISOPHORONE	ug/l	ND(11)
ISOSAFROLE	ug/l	ND(11)
KEPONE	ug/l	ND(11)
METHAPYRILENE	ug/l	ND(11)
METHYL METHANESULFONATE	ug/l	ND(11)
N-NITROSO-DI-N-BUTYLAMINE	ug/l	ND(11)
N-NITROSO-DI-N-PROPYLAMINE	ug/l	ND(11)
N-NITROSODIETHYLAMINE	ug/l	ND(11)
N-NITROSODIMETHYLAMINE	ug/l	ND(11)
N-NITROSODIPHENYLAMINE	ug/l	ND(11)
N-NITROSOMETHYLETHYLAMINE	ug/l	ND(11)
N-NITROSOMORPHOLINE	ug/l	ND(11)
N-NITROSOPIPERIDINE	ug/l	ND(11)
N-NITROSOPYRROLIDINE	ug/l	ND(11)
NAPHTHALENE	ug/l	ND(11)
NITROBENZENE	ug/l	ND(11)
P-DIMETHYLAMINOAZOBENZENE	ug/l	ND(11)
PENTACHLOROBENZENE	ug/l	ND(11)
PENTACHLOROETHANE	ug/l	ND(57)
PENTACHLORONITROBENZENE	ug/l	ND(11)
PENTACHLOROPHENOL	ug/l	ND(57)
PHENACETIN	ug/l	ND(11)
PHENANTHRENE	ug/l	ND(11)
PHENOL	ug/l	ND(11)
PYRENE	ug/l	ND(11)
PYRIDINE	ug/l	ND(11)
SAFROLE	ug/l	ND(11)

TABLE C.4

Summary of Appendix IX Groundwater Analytical Groundwater
Four County Landfill Site
Fulton County, Indiana

Location:		MW-124
Sample I.D.:		GW-SC-92
Sample Interval:		--
Date Sampled:		05/02/1999
Parameters	Units	
Appendix IX - Semi-Volatile Organics (Cont'd)		
SULFOTEPP	ug/l	ND(11)
Appendix IX - Dioxin Furans		
2,3,7,8-TETRACHLORODIBENZO-P-DI	ug/l	ND(100)
Appendix IX - General Chemistry		
CYANIDE	mg/l	ND(0.005)
SULFIDE	mg/l	ND(1)
Appendix IX - Metals		
ANTIMONY	mg/l	ND(0.3)
ARSENIC	mg/l	0.0085 J
BARIUM	mg/l	0.14
BERYLLIUM	mg/l	ND(0.005)
CADMIUM	mg/l	ND(0.01)
CHROMIUM	mg/l	0.029
COBALT	mg/l	ND(0.05)
COPPER	mg/l	ND(0.01)
LEAD	mg/l	ND(0.005)
MERCURY	mg/l	ND(0.0002)
NICKEL	mg/l	ND(0.04)
SELENIUM	mg/l	ND(0.005)
SILVER	mg/l	ND(0.01) U
THALLIUM	mg/l	ND(0.005)
TIN	mg/l	ND(1)
VANADIUM	mg/l	0.016 J
ZINC	mg/l	ND(0.05) U
Appendix IX - PCBs		
AROCHLOR 1016	mg/l	ND(0.63)
AROCHLOR 1221	mg/l	ND(0.63)
AROCHLOR 1232	mg/l	ND(0.63)
AROCHLOR 1242	mg/l	ND(0.63)
AROCHLOR 1248	mg/l	ND(0.63)

TABLE C.4

Summary of Appendix IX Groundwater Analytical Groundwater
Four County Landfill Site
Fulton County, Indiana

Location:		MW-124
Sample I.D.:		GW-SC-92
Sample Interval:		--
Date Sampled:		05/02/1999
Parameters	Units	
Appendix IX - PCBs (Cont'd)		
AROCHLOR 1254	mg/l	ND(0.63)
AROCHLOR 1260	mg/l	ND(1.3)
Appendix IX - Pesticides/Herbicides		
2,4,5-T	mg/l	ND(2)
2,4,5-TP (SILVEX)	mg/l	ND(2)
2,4-D	mg/l	ND(20)
4,4'-DDD	mg/l	ND(0.13)
4,4'-DDE	mg/l	ND(0.13)
4,4'-DDT	mg/l	ND(0.13)
ALDRIN	mg/l	ND(0.063)
ALPHA-BHC	mg/l	ND(0.063)
BETA-BHC	mg/l	ND(0.063)
CHLORBENZILATE	mg/l	ND(11)
CHLORDANE	mg/l	ND(0.63)
DELTA-BHC	mg/l	ND(0.063)
DIELDRIN	mg/l	ND(0.13)
DISULFOTON	mg/l	ND(11)
ENDOSULFAN I	mg/l	ND(0.063)
ENDOSULFAN II	mg/l	ND(0.13)
ENDOSULFAN SULFATE	mg/l	ND(0.13)
ENDRIN	mg/l	ND(0.13)
ENDRIN ALDEHYDE	mg/l	ND(0.13)
FAMPHUR	mg/l	ND(11)
HEPTACHLOR	mg/l	ND(0.063)
HEPTACHLOR EPOXIDE	mg/l	ND(0.063)
METHOXYCHLOR	mg/l	ND(0.63)
METHYL PARATHION	mg/l	ND(11)
PHORATE	mg/l	ND(11)
PRONAMIDE	mg/l	ND(11)
THIONAZIN	mg/l	ND(11)
TOXAPHENE	mg/l	ND(1.3)
Appendix IX - Volatile Organic Compounds		
1,1,1,2-TETRACHLOROETHANE	ug/l	ND(5)
1,1,1-TRICHLOROETHANE	ug/l	ND(5)

TABLE C.4

Summary of Appendix IX Groundwater Analytical Groundwater
Four County Landfill Site
Fulton County, Indiana

Location:	MW-124
Sample I.D.:	GW-SC-92
Sample Interval:	--
Date Sampled:	05/02/1999

Parameters	Units	
Appendix IX - Volatile Organic Compounds (Cont'd)		
1,1,2,2-TETRACHLOROETHANE	ug/l	ND(5)
1,1,2-TRICHLOROETHANE	ug/l	ND(5)
1,1-DICHLOROETHANE	ug/l	ND(5)
1,1-DICHLOROETHENE	ug/l	ND(5)
1,2,3-TRICHLOROPROPANE	ug/l	ND(5)
1,2,4-TRICHLOROBENZENE	ug/l	ND(11)
1,2-DIBROMO-3-CHLOROPROPANE(DBCP)	ug/l	ND(20)
1,2-DIBROMOETHANE (EDB)	ug/l	ND(20)
1,2-DICHLOROETHANE	ug/l	1400
1,2-DICHLOROPROPANE	ug/l	ND(5)
1,4-DIOXANE	ug/l	ND(1000)
2-BUTANONE	ug/l	ND(50)
2-HEXANONE	ug/l	ND(50)
4-METHYL-2-PENTANONE	ug/l	ND(50)
ACETONE	ug/l	ND(50)
ACETONITRILE	ug/l	ND(50)
ACROLEIN	ug/l	ND(100)
ACRYLONITRILE	ug/l	ND(70)
ALLYL CHLORIDE	ug/l	ND(20)
BENZENE	ug/l	ND(5)
BROMODICHLOROMETHANE	ug/l	ND(5)
BROMOFORM	ug/l	ND(10)
BROMOMETHANE	ug/l	ND(10)
CARBON DISULFIDE	ug/l	ND(5)
CARBON TETRACHLORIDE	ug/l	ND(10)
CHLOROBENZENE	ug/l	ND(5)
CHLOROETHANE	ug/l	ND(10)
CHLOROFORM	ug/l	ND(5)
CHLOROMETHANE	ug/l	ND(10)
CHLOROPRENE	ug/l	ND(20)
CIS-1,2-DICHLOROETHENE	ug/l	ND(5)
DIBROMOCHLOROMETHANE	ug/l	ND(5)
DIBROMOMETHANE	ug/l	ND(5)
DICHLORODIFLUOROMETHANE	ug/l	ND(20)
DICHLOROMETHANE	ug/l	ND(5)
ETHYL BENZENE	ug/l	ND(5)
IODOMETHANE	ug/l	ND(20)
ISOBUTANOL	ug/l	ND(1000)

TABLE C.4

Summary of Appendix IX Groundwater Analytical Groundwater
Four County Landfill Site
Fulton County, Indiana

Location:		MW-124
Sample I.D.:		GW-SC-92
Sample Interval:		--
Date Sampled:		05/02/1999
Parameters	Units	
Appendix IX - Volatile Organic Compounds (Cont'd)		
M,P-XYLENE	ug/l	ND(5)
METHACRYLONITRILE	ug/l	ND(20)
METHYL METHACRYLATE	ug/l	ND(20)
O-XYLENE	ug/l	ND(5)
PROPIONITRILE (ETHYL CYANIDE)	ug/l	ND(100)
STYRENE	ug/l	ND(5)
TOLUENE	ug/l	ND(5)
TRANS-1,2-DICHLOROETHENE	ug/l	ND(5)
TRANS-1,3-DICHLOROPROPENE	ug/l	ND(5)
TRANS-1,4-DICHLORO-2-BUTENE	ug/l	ND(20)
TRICHLOROETHENE	ug/l	ND(5)
TRICHLOROFLUOROMETHANE	ug/l	ND(5)
VINYL ACETATE	ug/l	ND(50)
VINYL CHLORIDE	ug/l	8.7 J

Notes

ND	-	The material was analyzed, but not detected above the stated method detection limit.
J	-	The associated numerical value is an estimated quantity.
U	-	The material was analyzed, but was not detected above the level of the associated value due to blank contamination.
--	-	The parameter was not analyzed.

APPENDIX D

OU2 RISK ASSESSMENT SUMMARY TABLES

TABLE 1.0

SELECTION OF EXPOSURE PATHWAYS

FOUR COUNTY LANDFILL

FULTON COUNTY, INDIANA

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current/Future	Groundwater	Groundwater	Potable Use	Residents	Children & Adults	Dermal Ingestion	Off-Site Off-Site	Quant Quant	Potential potable use of groundwater by nearby residents.
		Air	Vapors	Residents	Children & Adults	Inhalation	Off-Site	Quant	Potential exposure during showering/bathing activities.
				Agricultural Workers	Adults	Inhalation	Off-Site	Quant	Potential exposure to volatile emissions from irrigation system.
		Homegrown Fruits/Vegetables	Irrigation Use and Uptake	Residents	Children & Adults	Ingestion	Off-Site	Quant	Potential exposure to homegrown fruits and vegetables irrigated with groundwater.
		Meat (beef, pork, poultry)	Irrigation Use and Uptake	Residents	Children & Adults	Ingestion	Off-Site	Qual	Potential exposure to contaminated meat due to uptake of groundwater.

TABLE 2.1
SUMMARY OF OCCURRENCE AND DISTRIBUTION OF CHEMICALS IN GROUNDWATER
UPGRADIENT SECTOR (BACKGROUND)
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Scenario Timeframe: Current/ Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Ingestion, Dermal and Inhalation

CAS Number	Chemical	Minimum (1,2 Detected Concentration	Minimum Qualifier	Maximum (1,2 Detected Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (2)	Range of Detection (2)	Mean Background Concentration
	VOCs									
71-43-2	Benzene	1				ug/L	MW-100 (GW-SC-59)	1/16	1	0.531
108-88-3	Toluene	1		2.2		ug/L	MW-100 (GW-DS-189)	2/16	1 - 2.2	0.638
	Total Metals									
7429-90-5	Aluminum	0.18				mg/L	MW-116 (GW-SC-156)	1/12	0.18	0.083
7440-36-8	Antimony	0.042				mg/L	MW-116 (GW-SC-156)	1/6	0.042	0.0195
7440-38-2	Arsenic	0.0064		0.0067		mg/L	MW-115 (GW-SC-155)	2/6	0.0064 - 0.0067	0.00385
7440-39-3	Barium	0.075		0.15		mg/L	MW-118 (GW-SC-154)	6/6	0.075 - 0.15	0.109
7440-70-2	Calcium	86	J	120	J	mg/L	MW-116 (GW-SC-64)	12/12	86 J - 120 J	95.3
7439-89-6	Iron	0.59	J	5.3		mg/L	MW-101 (GW-DS-188)	16/16	0.59 J - 5.3	3.06
7439-95-4	Magnesium	28		47		mg/L	MW-116 (GW-SC-64)	12/12	28 - 47	35.2
7439-96-5	Manganese	0.025		0.25		mg/L	MW-116 (GW-SC-156)	12/12	0.025 - 0.25	0.0807
7440-09-7	Potassium	1.1		3.5		mg/L	MW-118 (GW-SC-154)	6/6	1.1 - 3.5	1.9
7440-23-5	Sodium	3		22		mg/L	MW-116 (GW-SC-156)	12/12	3 - 22	7.62
	Dissolved Metals									
7440-38-2	Arsenic	0.0059		0.008		mg/L	MW-100 (GW-SC-159)	2/6	0.0059 - 0.008	0.00398
7440-39-3	Barium	0.075		0.17		mg/L	MW-118 (GW-SC-154)	6/6	0.075 - 0.17	0.119
7440-70-2	Calcium	88		98		mg/L	MW-115 (GW-SC-155)	6/6	88 - 98	94.8
7439-89-6	Iron	0.63		4.4		mg/L	MW-115 (GW-SC-155)	12/12	0.63 - 4.4	2.89
7439-95-4	Magnesium	30		42		mg/L	MW-118 (GW-SC-154)	6/6	30 - 42	35.5
7439-96-5	Manganese	0.027		0.24		mg/L	MW-116 (GW-SC-156)	12/12	0.027 - 0.24	0.0806
7440-09-7	Potassium	1.1		3.7		mg/L	MW-118 (GW-SC-154)	6/6	1.1 - 3.7	2
7440-23-5	Sodium	3.7		22		mg/L	MW-116 (GW-SC-156)	6/6	3.7 - 22	9.63

J = Associated value is estimated.
(1) Minimum/maximum detected concentration.
(2) Based on data collected from Off-Site sampling locations : MW-100, MW-101, MW-115, MW-116, MW-117, MW-118.

TABLE 2.2
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR GROUNDWATER
EAST DOWNGRADIENT SECTOR
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Scenario Timeframe: Current/ Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Ingestion, Dermal and Inhalation

CAS Number	Chemical	Minimum (1,2) Detected Concentration	Minimum Qualifier	Maximum (1,2) Detected Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (2)	Range of Detection (2)	Mean Concentration Used for Screening (2)	Mean (3) Background Concentration	Screening (4) Criteria		COPC Flag	Rationale for (5) Contaminant Deletion or Selection
	VOCs														
108-10-1	4-Methyl-2-Pentanone	6.5	J	7.4	J	ug/L	GS-6 (GS-SC-13)	2/27	6.5 J - 7.4 J	5.14	–	NA	D	x	FD
71-43-2	Benzene	1.1		1.9		ug/L	MW-102 (GW-SC-152)	2/27	1.1 - 1.9	0.574	–	5	A		BSC
75-27-4	Bromodichloromethane	0.72	J	1.2		ug/L	GS-6 (GS-SC-13)	2/27	0.72 J - 1.2	0.534	–	100	B2		BSC
74-83-9	Bromomethane	0.55	J	0.93	J	ug/L	GS-2 (GS-SC-12)	2/27	0.55 J - 0.93 J	0.518	–	NA	D	x	FD
67-66-3	Chloroform	0.85	J	4.1	J	ug/L	GS-6 (GS-SC-13)	3/27	0.85 J - 4.1 J	0.711	–	100	B2		BSC
100-41-4	Ethylbenzene	0.64	J			ug/L	GS-6 (GS-SC-13)	1/27	0.64 J	0.505	–	700	D		BSC, IFD
1330-20-7	m,p-Xylenes	0.91	J			ug/L	GS-6 (GS-SC-13)	1/27	0.91 J	0.516	–	10000	D		BSC, IFD
108-88-3	Toluene	0.54	J	0.65	J	ug/L	GS-7 (GS-SC-21)	3/27	0.54 J - 0.65 J	0.511	–	1000	D		BSC
	Total Metals														
7440-38-2	Arsenic	0.011				mg/L	MW-102 (GW-SC-152)	1/6	0.011	0.00392	0.00365	0.05	A		BSC, BBC
7440-39-3	Barium	0.026		0.14		mg/L	MW-107 (GW-SC-162)	6/6	0.026 - 0.14	0.081	0.109	2	D		BSC, BBC
7440-70-2	Calcium	55		140	J	mg/L	MW-102 (GW-SC-56)	14/14	55 - 140 J	93.1	95.3	NA	D		BBC, NTX, NUT
7439-89-6	Iron	0.9	J	4.8	J	mg/L	MW-129 (GW-SC-82)	16/16	0.9 J - 4.8 J	2.77	3.06	NA	D		BBC
7439-95-4	Magnesium	31		65		mg/L	MW-102 (GW-SC-56)	14/14	31 - 65	42.6	35.2	NA	D		BBC, NTX, NUT
7439-96-5	Manganese	0.021		0.12		mg/L	MW-102 (GW-SC-152)	14/14	0.021 - 0.12	0.0565	0.0807	NA	D		BBC
440-09-7	Potassium	1		3.6		mg/L	MW-103 (GW-SC-151)	6/6	1 - 3.6	1.65	1.9	NA	D		BBC, NTX, NUT
7440-23-5	Sodium	3		67		mg/L	MW-102 (GW-SC-56)	14/14	3 - 67	12.9	7.62	NA	D		BBC, NTX, NUT
	Dissolved Metals														
7440-38-2	Arsenic	0.006		0.012		mg/L	MW-102 (GW-SC-152)	2/6	0.006 - 0.012	0.0052	0.00398	0.05	A		BSC, BBC
7440-39-3	Barium	0.027		0.14		mg/L	MW-107 (GW-SC-162)	6/6	0.027 - 0.14	0.0833	0.119	2	D		BSC, BBC
7440-70-2	Calcium	60		140		mg/L	MW-102 (GW-SC-152)	6/6	60 - 140	93	94.8	NA	D		BBC, NTX, NUT
7439-89-6	Iron	0.89		4.8	J	mg/L	MW-129 (GW-SC-82)	14/14	0.89 - 4.8 J	2.7	2.89	NA	D		BBC
7439-95-4	Magnesium	32		65		mg/L	MW-102 (GW-SC-152)	6/6	32 - 65	44.2	35.5	NA	D		BBC, NTX, NUT
7439-96-5	Manganese	0.022		0.13		mg/L	MW-102 (GW-SC-152)	14/14	0.022 - 0.13	0.0579	0.0806	NA	D		BBC
440-09-7	Potassium	1.1		4.2		mg/L	MW-103 (GW-SC-151)	6/6	1.1 - 4.2	2.02	2	NA	D		BBC, NTX, NUT
7782-49-2	Selenium	0.006				mg/L	MW-103 (GW-SC-151)	1/6	0.006	0.00305	ND	0.05	D		BSC
7440-23-5	Sodium	4.4		39		mg/L	MW-102 (GW-SC-152)	6/6	4.4 - 39	11.9	9.63	NA	D		BBC, NTX, NUT

(1) Minimum/maximum detected concentration.
(2) Based on data collected from Off-Site sampling location : MW-102, MW-103, MW-104, MW-105, MW-106, MW-107, MW-129, MW-130, GS-1, GS-2, GS-6, GS-7.
(3) Mean background concentration based on data collected from locations in the upgradient sector (see Table 2.1)
(4) USEPA National Primary and Secondary Drinking Water Regulations, 40 CFR 141-143, July 1999.
(5) Rationale Codes Selection Reason: Above Screening Criterion (ASC)
Above 2 times the Mean Background Concentration (ABC)
Frequent Detection (FD)
Deletion Reason: Below Screening Criterion (BSC)
Below 2 times the Mean Background Concentration (BBC)
Infrequent Detection (IFD)
No Toxicity Data (NTX)
Essential Nutrient (NUT)

A = Known Human Carcinogen
B1 = Probable Human Carcinogen with limited evidence in humans
B2 = Probable Human Carcinogen with sufficient evidence in animals
C = Possible Human Carcinogen with limited evidence in animals
D = Not Classified as to Human Carcinogenicity
J = Associated value is estimated.
NA = Not Available
ND = Not Detected
– = Not Applicable

TABLE 2.3
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR GROUNDWATER
NORTH DOWNGRADIENT SECTOR
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Scenario Timeframe: Current/ Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Ingestion, Dermal and Inhalation

CAS Number	Chemical	Minimum (1,2) Detected Concentration	Minimum Qualifier	Maximum (1,2) Detected Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (2)	Range of Detection (2)	Mean Concentration Used for Screening (2)	Mean (3) Background Concentration	Screening Criteria (4)		COPC Flag	Rationale for (5) Contaminant Deletion or Selection
	VOCs														
107-06-2	1,2-Dichloroethane	1.3		2000		ug/L	MW-114 (GW-SC-167)	15/49	1.3 - 2000	118	--	5	B2	x	ASC, FD
108-10-1	4-Methyl-2-Pentanone	8.5	J	16	J	ug/L	GS-128 (GS-SC-40)	3/49	8.5 J - 16	8.47	--	NA	D	x	FD
67-64-1	Acetone	10		58	J	ug/L	MW-113 (GW-SC-168)	2/43	10 - 58 J	9.72	--	NA	D		IFD
71-43-2	Benzene	1.2		460		ug/L	MW-114 (GW-DS-222)	10/49	1.2 - 460	25.6	--	5	A	x	ASC, FD
75-15-0	Carbon Disulfide	2.8	J	19		ug/L	MW-113 (GW-KD-07)	3/49	2.8 J - 19	1.41	--	NA	NA	x	FD
56-23-5	Carbon Tetrachloride	2.5		340	J	ug/L	MW-113 (GW-SC-88)	5/49	2.5 - 340 J	12.5	--	5	B2	x	ASC, FD
75-00-3	Chloroethane	1.8				ug/L	MW-124 (GW-SC-91)	1/49	1.8	0.828	--	NA	NA		IFD
67-66-3	Chloroform	0.81	J	86		ug/L	MW-113 (GW-KD-07)	10/49	0.81 J - 86	6.52	--	100	B2		BSC
75-09-2	Dichloromethane	1.1		2	J	ug/L	MW-113 (GW-SC-168)	4/49	1.1 - 2 J	0.866	--	5	B2		BSC
100-41-4	Ethylbenzene	0.75	J			ug/L	GS-128 (GS-SC-48)	1/49	0.75 J	0.806	--	700	D		BSC, IFD
1330-20-7	m,p-Xylenes	0.55	J	1.5		ug/L	GS-128 (GS-SC-48)	2/23	0.55 J - 1.5	0.546	--	10000	D		BSC
95-47-6	o-Xylene	0.87	J			ug/L	GS-128 (GS-SC-48)	1/23	0.87 J	0.516	--	10000	D		BSC, IFD
108-88-3	Toluene	1.1	J	10		ug/L	MW-126 (GW-DS-201)	2/49	1.1 J - 10	1.01	--	1000	D		BSC, IFD
75-01-4	Vinyl Chloride	0.65	J	8		ug/L	MW-124 (GW-SC-91)	5/49	0.65 J - 8	1.19	--	2	A	x	BSC (6)
	General Chemistry														
14797-55-8	Nitrate	0.02		1.2		mg/L	MW-121 (GW-DS-215)	9/37	0.02 - 1.2	0.0848	ND	10	NA		BSC
1594-56-5	Nitrite	0.0378	J	0.579	J	mg/L	MW-108 (GW-SC-75)	2/17	0.0378 - 0.579	0.0804	ND	1	NA		BSC
	Total Metals														
7429-90-5	Aluminum	0.09	J	1.7		mg/L	MW-125 (GW-DS-202)	5/32	0.09 J - 1.7	0.194	0.083	NA	D	x	ABC, FD
7440-36-8	Antimony	0.035				mg/L	MW-109 (GW-SC-164)	1/15	0.035	0.0163	0.0195	0.006	D		BBC
7440-38-2	Arsenic	0.006		0.01		mg/L	MW-126 (GW-DS-201)	3/15	0.006 - 0.01	0.00359	0.00385	0.05	A		BSC, BBC
7440-39-3	Barium	0.015		0.15		mg/L	MW-110 (GW-SC-172)	15/15	0.015 - 0.15	0.0757	0.109	2	D		BSC, BBC
7440-70-2	Calcium	78	J	150		mg/L	MW-119 (GW-DS-218)	32/32	78 J - 150	102	95.3	NA	D		BBC, NTX, NUT
7440-47-3	Chromium	0.026				mg/L	MW-121 (GW-DS-215)	1/15	0.026	0.0064	ND	0.1	D		BSC
7439-89-6	Iron	0.062	J	25		mg/L	MW-108 (GW-SC-165)	36/37	0.062 J - 25	3.8	3.06	NA	D		BBC
7439-92-1	Lead	0.011				mg/L	MW-119 (GW-DS-218)	1/15	0.011	0.00307	ND	0.015	B2		BSC
7439-95-4	Magnesium	18		50		mg/L	MW-119 (GW-DS-218)	32/32	18 - 50	34	35.2	NA	D		BBC, NTX, NUT
7439-96-5	Manganese	0.0051	J	0.94		mg/L	MW-125 (GW-SC-67)	32/32	0.0051 J - 0.94	0.171	0.0807	NA	D	x	ABC, FD
7440-02-0	Nickel	0.017				mg/L	MW-121 (GW-DS-215)	1/15	0.017	0.0058	ND	NA	D	x	ABC, FD
7440-09-7	Potassium	0.94		5.4		mg/L	MW-113 (GW-SC-168)	15/15	0.94 - 5.4	2.24	1.9	NA	D		NTX, NUT
7440-23-5	Sodium	1.5	J	85		mg/L	MW-119 (GW-DS-218)	32/32	1.5 J - 85	12	7.62	NA	D		NTX, NUT

TABLE 2.3
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR GROUNDWATER
NORTH DOWNGRADIENT SECTOR
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Scenario Timeframe: Current/ Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Ingestion, Dermal and Inhalation

CAS Number	Chemical	Minimum (1,2) Detected Concentration	Minimum Qualifier	Maximum (1,2) Detected Concentration	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (2)	Range of Detection (2)	Mean Concentration Used for Screening (2)	Mean (3) Background Concentration	Screening (4) Criteria		COPC Flag	Rationale for (5) Contaminant Deletion or Selection
	Dissolved Metals														
7440-38-2	Arsenic	0.005		0.011		mg/L	MW-112 (GW-SC-169)	4/9	0.005 - 0.011	0.00446	0.00398	0.05	A		BSC, BBC
7440-39-3	Barium	0.026		0.16		mg/L	MW-110 (GW-SC-172 & GW-SC-173)	9/9	0.026 - 0.16	0.08	0.119	2	D		BSC, BBC
7440-70-2	Calcium	81		120		mg/L	MW-110 (GW-SC-172 & GW-SC-173)	9/9	81 - 120	98.7	94.8	NA	D		BBC, NTX, NUT
7439-89-6	Iron	0.035	J	26		mg/L	MW-108 (GW-SC-165)	22/26	0.035 J - 26	4.12	2.89	NA	D		BBC
7439-95-4	Magnesium	22		50		mg/L	MW-113 (GW-SC-168)	9/9	22 - 50	33.9	35.5	NA	D		BBC, NTX, NUT
7439-96-5	Manganese	0.033		0.9		mg/L	MW-125 (GW-SC-67)	22/26	0.033 - 0.9	0.152	0.0806	NA	D		BBC
7440-09-7	Potassium	1		6.2		mg/L	MW-113 (GW-SC-168)	9/9	1 - 6.2	2.65	2	NA	D		BBC, NTX, NUT
7440-23-5	Sodium	3.8		84		mg/L	MW-119 (GW-DS-218)	9/9	3.8 - 84	20	9.63	NA	D		NTX, NUT

(1) Minimum/maximum detected concentration.
(2) Based on data collected from Off-Site sampling locations : MW-108, MW-109, MW-110, MW-111, MW-112, MW-113, MW-114, MW-119, MW-120, MW-121, MW-122, MW-123, MW-124, MW-125, MW-126, MW-127, MW-128, GS-10, GS-114, GS-128.
(3) Mean background concentration based on data collected from locations in the upgradient sector (see Table 2.1)
(4) USEPA National Primary and Secondary Drinking Water Regulations, 40 CFR 141-143, July 1999.
(5) Rationale Codes Selection Reason:
Above Screening Criterion (ASC)
Above 2 times the Mean Background Concentration (ABC)
Frequent Detection (FD)
Deletion Reason:
Below Screening Criterion (BSC)
Below 2 times the Mean Background Concentration (BBC)
Infrequent Detection (IFD)
No Toxicity Data (NTX)
Essential Nutrient (NUT)

(5) Identified as a COPC even though below the MCL screening criterion because it is a known human carcinogen.

A = Known Human Carcinogen
B1 = Probable Human Carcinogen with limited evidence in humans
B2 = Probable Human Carcinogen with sufficient evidence in animals
C = Possible Human Carcinogen with limited evidence in animals
D = Not Classified as to Human Carcinogenicity
J = Associated value is estimated.
NA = Not Available
ND = Not Detected
-- = Not Applicable

TABLE 3.1
SUMMARY OF MEAN AND 95% UCL CONCENTRATIONS FOR CHEMICALS IN GROUNDWATER
UPGRADIENT SECTOR (BACKGROUND)
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Scenario Timeframe: Current/ Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Ingestion, Dermal and Inhalation

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL of Normal Data	Maximum Detected Concentration	EPC Units	Reasonable Maximum Exposure			Central Tendency		
						Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value Value	Medium EPC Statistic Statistic	Medium EPC Rationale Rationale
VOCs											
Benzene	ug/L	5.31E-01	--	1.00E+00	ug/L	5.74E-01	95% UCL-T	W-Test (1)	5.31E-01	--	Mean-N
Toluene	ug/L	6.38E-01	--	2.20E+00	ug/L	7.58E-01	95% UCL-T	W-Test (1)	6.38E-01	--	Mean-N
Total Metals											
Aluminum	mg/L	8.30E-02	1.05E-01	1.80E-01	mg/L	1.05E-01	95% UCL-N	W-Test (1)	8.30E-02	--	Mean-N
Antimony	mg/L	1.95E-02	--	4.20E-02	mg/L	3.12E-02	95% UCL-T	W-Test (1)	1.95E-02	--	Mean-N
Arsenic	mg/L	3.85E-03	--	6.70E-03	mg/L	7.12E-03	95% UCL-T	W-Test (1)	3.85E-03	--	Mean-N
Barium	mg/L	1.09E-01	1.30E-01	1.50E-01	mg/L	1.30E-01	95% UCL-N	W-Test (1)	1.09E-01	--	Mean-N
Calcium	mg/L	9.53E+01	--	1.20E+02	mg/L	1.01E+02	95% UCL-T	W-Test (1)	9.53E+01	--	Mean-N
Iron	mg/L	3.06E+00	3.55E+00	5.33E+00	mg/L	3.55E+00	95% UCL-N	W-Test (1)	3.06E+00	--	Mean-N
Magnesium	mg/L	3.52E+01	3.83E+01	4.70E+01	mg/L	3.83E+01	95% UCL-N	W-Test (1)	3.52E+01	--	Mean-N
Manganese	mg/L	8.07E-02	--	2.50E-01	mg/L	1.21E-01	95% UCL-T	W-Test (1)	8.07E-02	--	Mean-N
Potassium	mg/L	1.90E+00	2.71E+00	3.50E+00	mg/L	2.71E+00	95% UCL-N	W-Test (1)	1.90E+00	--	Mean-N
Sodium	mg/L	7.62E+00	--	2.20E+01	mg/L	1.11E+01	95% UCL-T	W-Test (1)	7.62E+00	--	Mean-N
Dissolved Metals											
Arsenic	mg/L	3.98E-03	--	8.00E-03	mg/L	7.81E-03	95% UCL-T	W-Test (1)	3.98E-03	--	Mean-N
Barium	mg/L	1.19E-01	1.46E-01	1.70E-01	mg/L	1.46E-01	95% UCL-N	W-Test (1)	1.19E-01	--	Mean-N
Calcium	mg/L	9.48E+01	9.80E+01	9.80E+01	mg/L	9.80E+01	95% UCL-N	W-Test (1)	9.48E+01	--	Mean-N
Iron	mg/L	2.89E+00	3.48E+00	4.40E+00	mg/L	3.48E+00	95% UCL-N	W-Test (1)	2.89E+00	--	Mean-N
Magnesium	mg/L	3.55E+01	3.94E+01	4.20E+01	mg/L	3.94E+01	95% UCL-N	W-Test (1)	3.55E+01	--	Mean-N
Manganese	mg/L	8.06E-02	--	2.40E-01	mg/L	1.34E-01	95% UCL-T	W-Test (1)	8.06E-02	--	Mean-N
Potassium	mg/L	2.00E+00	2.84E+00	3.70E+00	mg/L	2.84E+00	95% UCL-N	W-Test (1)	2.00E+00	--	Mean-N
Sodium	mg/L	9.63E+00	1.56E+01	2.20E+01	mg/L	1.56E+01	95% UCL-N	W-Test (1)	9.63E+00	--	Mean-N

For non-detects, 1/2 laboratory detection limit was used as a proxy concentration.
W-Test : Developed by Shapiro and Wilks for data sets with under 50 samples.
Refer to USEPA Supplemental Guidance to RAGS: Calculating the Concentration Term (RAGS, 1992), OSWER Directive 9285.7-081, May 1992.
Statistics: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T);
Mean of Log-transformed Data (Mean-T); Mean of Normal Data (Mean-N).

(1) Shapiro-Wilks W Test was used since n<=50.

TABLE 3.2
EXPOSURE POINT CONCENTRATION (EPC) SUMMARY FOR CHEMICALS OF POTENTIAL CONCERN IN GROUNDWATER
EAST DOWNGRADIENT SECTOR
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Scenario Timeframe: Current/ Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Ingestion, Dermal and Inhalation

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL of Normal Data	Maximum Detected Concentration	EPC Units	Reasonable Maximum Exposure			Central Tendency		
						Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value Value	Medium EPC Statistic Statistic	Medium EPC Rationale Rationale
VOCs											
4-Methyl-2-Pentanone	ug/L	5.14E+00	--	7.40E+00	ug/L	5.30E+00	95%UCL-T	W-Test (1, 2)	5.14E+00	--	Mean-N
Bromomethane	ug/L	5.18E-01	--	9.30E-01	ug/L	5.39E-01	95% UCL-T	W-Test (1, 2)	5.18E-01	--	Mean-N

For non-detects, 1/2 laboratory detection limit was used as a proxy concentration.
W-Test : Developed by Shapiro and Wilks for data sets with under 50 samples.
Refer to USEPA Supplemental Guidance to RAGS: Calculating the Concentration Term (RAGS, 1992), OSWER Directive 9285.7-081, May 1992.
Statistics: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T);
Mean of Log-transformed Data (Mean-T); Mean of Normal Data (Mean-N).

(1) Shapiro-Wilks W Test was used since n<=50.
(2) Data set is neither normally or lognormally distributed. However, it was assumed that the data set is lognormally distributed. Refer to RAGS (1992).

TABLE 3.3
EXPOSURE POINT CONCENTRATION (EPC) SUMMARY FOR CHEMICALS OF POTENTIAL CONCERN IN GROUNDWATER
NORTH DOWNGRADIENT SECTOR
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Scenario Timeframe: Current/ Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Ingestion, Dermal and Inhalation

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL of Normal Data	Maximum Detected Concentration	EPC Units	Reasonable Maximum Exposure			Central Tendency		
						Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value Value	Medium EPC Statistic Statistic	Medium EPC Rationale Rationale
VOCs											
1,2-Dichloroethane	ug/L	1.18E+02	--	2.00E+03	ug/L	3.90E+02	95% UCL-T	W-Test (1,2)	1.18E+02	--	Mean-N
4-Methyl-2-Pentanone	ug/L	8.47E+00	--	1.60E+01	ug/L	8.86E+00	95% UCL-T	W-Test (1,2)	8.47E+00	--	Mean-N
Benzene	ug/L	2.56E+01	--	4.60E+02	ug/L	1.24E+01	95% UCL-T	W-Test (1,2)	2.56E+01	--	Mean-N
Carbon Disulfide	ug/L	1.41E+00	--	1.90E+01	ug/L	1.33E+00	95% UCL-T	W-Test (1,2)	1.41E+00	--	Mean-N
Carbon Tetrachloride	ug/L	1.25E+01	--	3.40E+02	ug/L	6.01E+00	95% UCL-T	W-Test (1,2)	1.25E+01	--	Mean-N
Vinyl Chloride	ug/L	1.19E+00	--	8.00E+00	ug/L	1.30E+00	95% UCL-T	W-Test (1,2)	1.19E+00	--	Mean-N
Total Metals											
Aluminum	mg/L	1.94E-01	--	1.70E+00	mg/L	2.52E-01	95% UCL-T	W-Test (1,2)	1.94E-01	--	Mean-N
Manganese	mg/L	1.71E-01	--	9.40E-01	mg/L	3.06E-01	95% UCL-T	W-Test (1)	1.71E-01	--	Mean-N
Nickel	mg/L	5.80E-03	--	1.70E-02	mg/L	6.69E-03	95% UCL-T	W-Test (1,2)	5.80E-03	--	Mean-N

For non-detects, 1/2 laboratory detection limit was used as a proxy concentration.
W-Test : Developed by Shapiro and Wilks for data sets with under 50 samples.
Refer to USEPA Supplemental Guidance to RAGS: Calculating the Concentration Term (RAGS, 1992), OSWER Directive 9285.7-081, May 1992.
Statistics: Maximum Detected Value (Max); 95% UCL of Normal Data (95% UCL-N); 95% UCL of Log-transformed Data (95% UCL-T);
Mean of Log-transformed Data (Mean-T); Mean of Normal Data (Mean-N).

(1) Shapiro-Wilks W Test was used since n<=50.
(2) Data set is neither normally or lognormally distributed. However, it was assumed that the data set is lognormally distributed. Refer to RAGS (1992).

TABLE 4.1
VALUES USED FOR DAILY INTAKE CALCULATIONS - RESIDENTIAL EXPOSURE
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Scenario Timeframe: Current/ Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Ingestion, Dermal and Inhalation
Receptor Population: Residential
Receptor Age: Children and Adults

Exposure Rout	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CW	Chemical Concentration in Groundwater	mg/L	See Section 3 Tables	See Section 3 Tables	See Section 3 Tables	See Section 3 Tables	CDI (mg/kd-day) =
	IR - child	Ingestion Rate	L/day	1.5	EPA, 1997	0.87	EPA, 1997	CW x IR x EF x ED x 1/BW x 1/AT
	IR - adult	Ingestion Rate	L/day	2.4	EPA, 1997	1.4	EPA, 1997	
	EF	Exposure Frequency	days/year	350	EPA, 1991	350	EPA, 1991	EPA, 1989
	ED (child)	Exposure Duration	years	6	EPA, 1991	6	EPA, 1991	
	ED (adult)	Exposure Duration	years	24	EPA, 1991	3	EPA, 1991	
	BW - child	Body Weight	kg	15	EPA, 1991	15	EPA, 1991	
	BW - adult	Body Weight	kg	70	EPA, 1991	70	EPA, 1991	
	AT-C	Averaging Time (cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	
	AT-N (child)	Averaging Time (non-cancer)	days	2,190	EPA, 1989	2,190	EPA, 1989	
	AT-N (adult)	Averaging Time (non-cancer)	days	8,760	EPA, 1989	1,095	EPA, 1989	
Dermal	CW	Chemical Concentration in Groundwater	mg/L	See Section 3 Tables	See Section 3 Tables	See Section 3 Tables	See Section 3 Tables	CDI (mg/kd-day) =
	SA - child	Skin Surface Area Available for Contact	cm2	7500	EPA, 1997	6600	EPA, 1997	CW x SA x CF x PC x ET x EF x ED x 1/BW x 1/AT
	SA - adult	Skin Surface Area Available for Contact	cm2	22000	EPA, 1997	18000	EPA, 1997	
	CF	Conversion Factor	L/cm3	0.001	EPA, 1989; EPA, 1991	0.001	EPA, 1989; EPA, 1991	EPA, 1989
	ET - child	Exposure Time	hours/day	1	EPA, 1997	0.33	EPA, 1997	
	ET - adult	Exposure Time	hours/day	0.58	EPA, 1997	0.25	EPA, 1997	
	EF	Exposure Frequency	days/year	350	EPA, 1991	350	EPA, 1991	
	ED (child)	Exposure Duration	years	6	EPA, 1991	6	EPA, 1991	
	ED (adult)	Exposure Duration	years	24	EPA, 1991	3	EPA, 1991	
	BW - child	Body Weight	kg	15	EPA, 1991	15	EPA, 1991	
	BW - adult	Body Weight	kg	70	EPA, 1991	70	EPA, 1991	
	AT-C	Averaging Time (cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	
	AT-N (child)	Averaging Time (non-cancer)	days	2,190	EPA, 1989	2,190	EPA, 1989	
	AT-N (adult)	Averaging Time (non-cancer)	days	8,760	EPA, 1989	1,095	EPA, 1989	
	PC	Permeability Constant	cm/hour	chemical specific	EPA, 1992	chemical specific	EPA, 1992	
Inhalation	CW	Chemical Concentration in Groundwater	mg/L	See Section 3 Tables	See Section 3 Tables	See Section 3 Tables	See Section 3 Tables	CDI (mg/kd-day) =
	INR - child	Inhalation Rate	m3/day	8.7	EPA, 1997 (1)	8.7	EPA, 1997 (1)	CW x INR x K x EF x ED x 1/BW x 1/AT
	INR - adult	Inhalation Rate	m3/day	15	EPA, 1997 (1)	15	EPA, 1997 (1)	
	K	Volatilization Factor	L/m3	0.5	EPA, 1991A	0.5	EPA, 1991A	EPA, 1991A
	EF	Exposure Frequency	days/year	350	EPA, 1991	350	EPA, 1991	
	ED (child)	Exposure Duration	years	6	EPA, 1991	6	EPA, 1991	
	ED (adult)	Exposure Duration	years	24	EPA, 1991	3	EPA, 1991	
	ED - NC	Exposure Duration	years	6	EPA, 1991	6	EPA, 1991	
	BW - child	Body Weight	kg	15	EPA, 1991	15	EPA, 1991	
	BW - adult	Body Weight	kg	70	EPA, 1991	70	EPA, 1991	
	AT-C	Averaging Time (cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	
	AT-N (child)	Averaging Time (non-cancer)	days	2,190	EPA, 1989	2,190	EPA, 1989	
	AT-N (adult)	Averaging Time (non-cancer)	days	8,760	EPA, 1989	1,095	EPA, 1989	

(1) The recommended inhalation rates for children and adults are based on mean concentrations. EPA states in the 1997 document that an upper percentile is not recommended.

Sources :

EPA, 1989: Risk Assessment Guidance for Superfund. Vol. 1: Human Health Evaluation Manual, Part A OERR. EPA/540-1-89-002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol. 1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 1991A : Risk Assessment Guidance for Superfund: Part B, Development of Risk-Based Preliminary Remediation Goals, Publication No. 9285.7-01B, December 1991.

EPA, 1992: Dermal Exposure Assessment: Principles and Applications, EPA/600/8-91/011B, January 1992.

EPA, 1997: Exposure Factors Handbook, EPA/600/P-95/002F, August 1997.

TABLE 4.2
VALUES USED FOR DAILY INTAKE CALCULATIONS - GROUNDWATER RESIDENTIAL IRRIGATION USE SCENARIO
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Scenario Timeframe: Current/ Future
Medium: Groundwater for Irrigation Use
Exposure Medium: Fruits/Vegetables
Exposure Point: Ingestion
Receptor Population: Residential
Receptor Age: Children and Adults

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	CW	Chemical Concentration in Groundwater	mg/L	See Section 3 Tables	See Section 3 Tables	See Section 3 Tables	See Section 3 Tables	CDI (mg/kd-day) =
	IR_{fruit} - child	Ingestion Rate for Fruit	kg/meal	0.294	EPA, 1997	0.108	EPA, 1997	(CW x % IRR x MC) x CF x (IR_{fruit}+ IR_{veg}) x FI x EF x ED x 1/BW x 1/AT
	IR_{fruit} - adult	Ingestion Rate for Fruit	kg/meal	0.305	EPA, 1997	0.092	EPA, 1997	
	IR_{veg} - child	Ingestion Rate for Vegetable	kg/meal	0.240	EPA, 1997	0.111	EPA, 1997	EPA, 1989
	IR_{veg} - adult	Ingestion Rate for Vegetable	kg/meal	0.549	EPA, 1997	0.254	EPA, 1997	
	FI	Fraction Intake	unitless	0.4	EPA, 1991	0.4	EPA, 1991	
	CF	Conversion Factor	L/kg	1	EPA, 1991	1	EPA, 1991	
	EF	Exposure Frequency	meals/year	350	EPA, 1991	350	EPA, 1991	
	ED (child)	Exposure Duration	years	6	EPA, 1991	6	EPA, 1991	
	ED (adult)	Exposure Duration	years	24	EPA, 1991	3	EPA, 1991	
	BW - child	Body Weight	kg	15	EPA, 1991	15	EPA, 1991	
	BW - adult	Body Weight	kg	70	EPA, 1991	70	EPA, 1991	
	AT-C	Averaging Time (cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	
	AT-N (child)	Averaging Time (non-cancer)	days	2,190	EPA, 1989	2,190	EPA, 1989	
	AT-N (adult)	Averaging Time (non-cancer)	days	8,760	EPA, 1989	1,095	EPA, 1989	
	% IRR	Percent Irrigation	%/100	0.50	Professional Judgement	0.15	Professional Judgement	
	MC	Moisture Content of Fruits/Vegetables	%/100	0.9	EPA, 1997	0.9	EPA, 1997	

Sources :
EPA, 1989: Risk Assessment Guidance for Superfund. Vol. 1: Human Health Evaluation Manual, Part A OERR. EPA/540-1-89-002.
EPA, 1991: Risk Assessment Guidance for Superfund. Vol. 1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.
EPA, 1997: Exposure Factors Handbook, EPA/600/P-95/002F, August 1997.

TABLE 4.3

VALUES USED FOR DAILY INTAKE CALCULATIONS - WORKER EXPOSURE TO VOLATILE EMISSIONS FROM IRRIGATION SYSTEM

FOUR COUNTY LANDFILL

FULTON COUNTY, INDIANA

Scenario Timeframe: Current/ Future
Medium: Groundwater
Exposure Medium: Ambient Air
Exposure Point: Inhalation
Receptor Population: Worker
Receptor Age: Adult

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Inhalation	CA	Modelled Concentration in Air	mg/m3	Appendix A	Appendix A	Appendix A	Appendix A	CDI (mg/kd-day) =
	INR	Inhalation Rate	m3/hour	3.5	EPA, 1997	1.3	EPA, 1997	CW x INR x ET x EF x ED x 1/BW x 1/AT
	ET	Exposure Time	hours/day	4	Professional Judgement	2	Professional Judgement	
	EF	Exposure Frequency	days/year	90	Professional Judgement (1)	45	Professional Judgement (1)	EPA, 1989
	ED	Exposure Duration	years	25	EPA, 1991	9	EPA, 1991	
	BW	Body Weight	kg	70	EPA, 1991	70	EPA, 1991	
	AT-C	Averaging Time (cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	
	AT-N	Averaging Time (non-cancer)	days	9,125	EPA, 1989	3,285	EPA, 1989	

(1) Professional judgment. Based on local agricultural information, growing season could extend to a maximum length of 180 days in any given year. However, this scenario assumes a worker irrigating crops only during the dry summer season which is assumed to be 90 days. Therefore, it is assumed that irrigation occurs daily during the dry summer months or 90 days (RME), and every other day during the dry summer months or 45 days (CT).

Sources :

EPA, 1989: Risk Assessment Guidance for Superfund. Vol. 1: Human Health Evaluation Manual, Part A OERR. EPA/540-1-89-002.

EPA, 1991: Risk Assessment Guidance for Superfund. Vol. 1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

EPA, 1997: Exposure Factors Handbook, EPA/600/P-95/002F, August 1997.

TABLE 4.4
VALUES USED FOR DAILY INTAKE CALCULATIONS - EXPOSURE TO CONTAMINATED MEAT
USING GROUNDWATER AS ANIMAL WATER SOURCE
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Scenario Timeframe: Current/ Future
Medium: Groundwater as Animal Water Source
Exposure Medium: Beef/Pork/Poultry
Exposure Point: Ingestion
Receptor Population: Farmers
Receptor Age: Children and Adults

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	CT Value	CT Rationale/ Reference	Intake Equation/ Model Name
Ingestion	C_{meat}	Chemical Concentration in Meat	mg/kg	(1)	(1)	(1)	(1)	CDI (mg/kd-day) =
	IR_{meat} - child	Ingestion Rate for Meat	kg/day	0.120	EPA, 1997	0.057	EPA, 1997	C_{meat} x IR_{meat} x FI x EF x ED x 1/BW x 1/AT
	IR_{meat} - adult	Ingestion Rate for Meat	kg/day	0.292	EPA, 1997	0.137	EPA, 1997	
	FI	Fraction Intake	unitless	0.44	EPA, 1994	0.44	EPA, 1994	EPA, 1989
	EF	Exposure Frequency	meals/year	350	EPA, 1991	350	EPA, 1991	
	ED - C (child)	Exposure Duration	years	6	EPA, 1991	6	EPA, 1991	
	ED - C (adult)	Exposure Duration	years	24	EPA, 1991	3	EPA, 1991	
	ED - NC	Exposure Duration	years	6	EPA, 1991	6	EPA, 1991	
	BW - child	Body Weight	kg	15	EPA, 1991	15	EPA, 1991	
	BW - adult	Body Weight	kg	70	EPA, 1991	70	EPA, 1991	
	AT-C	Averaging Time (cancer)	days	25,550	EPA, 1989	25,550	EPA, 1989	
	AT-N	Averaging Time (non-cancer)	days	2,190	EPA, 1989	2,190	EPA, 1989	

(1) Volatile COCs are not considered bioaccumulative and therefore, will not be evaluated. Qualitative discussions are provided in the main text of the risk assessment.

Sources :

EPA, 1989: Risk Assessment Guidance for Superfund. Vol. 1: Human Health Evaluation Manual, Part A OERR. EPA/540-1-89-002.
EPA, 1991: *Risk Assessment Guidance for Superfund. Vol. 1: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.*
EPA, 1994: Exposure Assessment Guidance for RCRA Hazardous Waste Combustion Facilities, EPA 530-R-94-021, Solid Waste and Emergency Response.
EPA, 1997: Exposure Factors Handbook, EPA/600/P-95/002F, August 1997.

TABLE 5.1
NON-CANCER TOXICITY DATA -- ORAL/DERMAL ROUTE
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Chemical of Potential Concern (COPC)	Chronic/ Subchronic	Oral RfD Value	Oral RfD Units	Oral to Dermal Adjustment Factor (1)	Adjusted Dermal RfD (2)	Units	Primary Target Organ	Combined Uncertainty/Modifying Factors	Sources of RfD: Target Organ	Dates of RfD: Target Organ (3) (MM/DD/YY)
VOCs										
1,2-Dichloroethane	chronic	3.00E-02	mg/kg-d	100%	3.00E-02	mg/kg-d	--	--	R3-RBC	10/7/99
4-Methyl-2-Pentanone	chronic	8.00E-02	mg/kg-d	100%	8.00E-02	mg/kg-d	liver	3000	HEAST	7/1/97
Benzene	chronic	3.00E-03	mg/kg-d	100%	3.00E-03	mg/kg-d	--	--	R3-RBC	10/7/99
Bromomethane	chronic	1.40E-03	mg/kg-d	100%	1.40E-03	mg/kg-d	gastrointestinal tract	1000	IRIS	1/19/00
Carbon Disulfide	chronic	1.00E-01	mg/kg-d	100%	1.00E-01	mg/kg-d	reproduction toxicity	100	IRIS	1/19/00
Carbon Tetrachloride	chronic	7.00E-04	mg/kg-d	100%	7.00E-04	mg/kg-d	liver	1000	IRIS	1/19/00
Vinyl Chloride	chronic	--	mg/kg-d	100%	--	mg/kg-d	--	--	--	--
Metals										
Aluminum	chronic	1.00E+00	mg/kg-d	100%	1.00E+00	mg/kg-d	--	--	R3-RBC	10/7/99
Manganese (4)	chronic	4.67E-02	mg/kg-d	100%	4.67E-02	mg/kg-d	CNS	3	IRIS	1/19/00
Manganese (5)	chronic	1.40E-01	mg/kg-d	NA	NA	mg/kg-d	CNS	1	IRIS	1/19/00
Nickel	chronic	2.00E-02	mg/kg-d	100%	2.00E-02	mg/kg-d	organ weights	300	IRIS	1/19/00

-- = Not Available
NA = Not Applicable
(1) Assume 100% for dermal RfD.
(2) Adjusted Dermal RfD = Oral RfD x Oral to Dermal Adjustment Factor
(3) *IRIS, Integrated Risk Information System Database, January 19, 2000.*
HEAST, Health Effects Assessment Table, 9200.6-303 (95-2), EPA/540-R-95-142, July 1997.
R3-RBC, NCEA Regional Support provisional value, Region III Risk-Based Concentration Table, October 7, 1999.
(4) RfD criterion in water and soil.
(5) RfD criterion in food.

TABLE 5.2
NON-CANCER TOXICITY DATA – INHALATION
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Chemical of Potential Concern (COPC)	Chronic/ Subchronic	Value Inhalation RfC	Units	Adjusted Inhalation RfD (1)	Units	Primary Target Organ	Combined Uncertainty/Modifying Factors	Sources of RfC:RfD: Target Organ	Dates (2) (MM/DD/YY)
VOCs									
1,2-Dichloroethane	chronic	--	mg/m^3	1.40E-03	mg/kg-d	--	--	R3-RBC	10/7/99
4-Methyl-2-Pentanone	chronic	8.00E-02	mg/m^3	2.00E-02	mg/kg-d	liver	1000	HEAST	7/1/97
Benzene	chronic	--	mg/m^3	1.70E-03	mg/kg-d	--	--	R3-RBC	10/7/99
Bromomethane	chronic	5.00E-03	mg/m^3	1.40E-03	mg/kg-d	gastrointestinal tract	100	IRIS	1/19/00
Carbon Disulfide	chronic	7.00E-01	mg/m^3	2.00E-01	mg/kg-d	reproduction toxicity	30	IRIS	1/19/00
Carbon Tetrachloride	chronic	--	mg/m^3	5.71E-04	mg/kg-d	--	--	R3-RBC	10/7/99
Vinyl Chloride	chronic	--	mg/m^3	--	mg/kg-d	--	--	--	--
Metals									
Aluminum	chronic	--	mg/m^3	1.00E-03	mg/kg-d	--	--	R3-RBC	10/7/99
Manganese	chronic	5.00E-05	mg/m^3	1.43E-05	mg/kg-d	CNS	1000	IRIS	1/19/00
Nickel	chronic	--	mg/m^3	--	mg/kg-d	--	--	--	--

-- = Not Available
(1) (RfC x Inhalation Rate) / Body Weight
(2) IRIS, Integrated Risk Information System Database, January 19, 2000.
HEAST, Health Effects Assessment Table, 9200.6-303 (95-2), EPA/540-R-95-142, July 1997.
R3-RBC, NCEA Regional Support provisional value, Region III Risk-Based Concentration Table, October 7, 1999.

TABLE 6.1
CANCER TOXICITY DATA – ORAL/DERMAL ROUTE
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Chemical of Potential Concern (COPC)	Oral Cancer Slope Factor	Oral to Dermal Adjustment Factor (1)	Adjusted Dermal Cancer Slope Factor (2)	Units	Weight of Evidence/ Cancer Guideline Description	Source	Date (3) (MM/DD/YY)
VOCs							
1,2-Dichloroethane	9.10E-02	100%	9.10E-02	(mg/kg-day) $^{-1}$	B2	IRIS	1/19/00
4-Methyl-2-Pentanone	--	100%	--	(mg/kg-day) $^{-1}$	D	--	--
Benzene	2.90E-02	100%	2.90E-02	(mg/kg-day) $^{-1}$	A	IRIS	1/19/00
Bromomethane	--	100%	--	(mg/kg-day) $^{-1}$	D	--	--
Carbon Disulfide	--	100%	--	(mg/kg-day) $^{-1}$	--	--	--
Carbon Tetrachloride	1.30E-01	100%	1.30E-01	(mg/kg-day) $^{-1}$	B2	IRIS	1/19/00
Vinyl Chloride	1.90E+00	100%	1.90E+00	(mg/kg-day) $^{-1}$	A	HEAST	7/1/97
Metals							
Aluminum	--	100%	--	(mg/kg-day) $^{-1}$	D	--	--
Manganese	--	100%	--	(mg/kg-day) $^{-1}$	D	--	--
Nickel	--	100%	--	(mg/kg-day) $^{-1}$	--	--	--

-- = Not Available
(1) Assume 100% for dermal CSF.
(2) Adjusted Dermal CSF = Oral CSF / Oral to Dermal Adjustment Factor
(3) IRIS, Integrated Risk Information System Database, January 19, 2000
HEAST, Health Effects Assessment Table, 9200.6-303 (95-2), EPA/540-R-95-142, July 1997.
R3-RBC, NCEA Regional Support provisional value, Region III Risk-Based Concentration Table, October 7, 1999.

EPA Weight of Evidence Classification :
A - Known Human carcinogen
B1 - Probable human carcinogen - indicates that limited human data are available
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
C - Possible human carcinogen
D - Not classifiable as a human carcinogen
E - Evidence of noncarcinogenicity

TABLE 6.2
CANCER TOXICITY DATA – INHALATION
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Chemical of Potential Concern (COPC)	Unit Risk	Units	Adjustment (1)	Inhalation Cancer Slope Factor (2)	Units	Weight of Evidence/ Cancer Guideline Description	Source	Date (3) (MM/DD/YY)
VOCs								
1,2-Dichloroethane	2.60E-05	ug/m^3	3500	9.10E-02	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	1/19/00
4-Methyl-2-Pentanone	--	ug/m^3	3500	--	$(mg/kg\text{-}day)^{-1}$	D	--	--
Benzene	8.29E-06	ug/m^3	3500	2.90E-02	$(mg/kg\text{-}day)^{-1}$	A	IRIS	1/19/00
Bromomethane	--	ug/m^3	3500	--	$(mg/kg\text{-}day)^{-1}$	D	--	--
Carbon Disulfide	--	ug/m^3	3500	--	$(mg/kg\text{-}day)^{-1}$	--	--	--
Carbon Tetrachloride	1.50E-05	ug/m^3	3500	5.30E-02	$(mg/kg\text{-}day)^{-1}$	B2	IRIS	1/19/00
Vinyl Chloride	8.60E-05	ug/m^3	3500	3.00E-01	$(mg/kg\text{-}day)^{-1}$	A	HEAST	7/1/97
Metals								
Aluminum	--	ug/m^3	3500	--	$(mg/kg\text{-}day)^{-1}$	D	--	--
Manganese	--	ug/m^3	3500	--	$(mg/kg\text{-}day)^{-1}$	D	--	--
Nickel	--	ug/m^3	3500	--	$(mg/kg\text{-}day)^{-1}$	--	--	--

-- = Not Available
(1) Adjustment Factor = 70 kg x 1/20 m3/day x 1000 ug/mg
(2) Inhalation CSF = Unit Risk x Adjustment Factor
(3) IRIS, Integrated Risk Information System Database, January 19, 2000.
HEAST, Health Effects Assessment Table, 9200.6-303 (95-2), EPA/540-R-95-142, July 1997.
R3-RBC, NCEA Regional Support provisional value, Region III Risk-Based Concentration Table, October 7, 1999.

EPA Weight of Evidence Classification :
A - Known Human carcinogen
B1 - Probable human carcinogen - indicates that limited human data are available
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
C - Possible human carcinogen
D - Not classifiable as a human carcinogen
E - Evidence of noncarcinogenicity

TABLE 6.3
SUMMARY OF PHYSICOCHEMICAL PROPERTIES FOR COPCs
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

PARAMETER	Physical Properties Reference	Molecular Weight (g/mol)	Melting Point (°C)	Boiling Point [°C @ 1atm (760mm)]	Specific Density (@ 20°C)	Water Solubility (mg/L)	Vapour Pressure (mm Hg @ 20°C)	Henry's Law Constant (atm-m^3/mol)	Koc	Log Kow	BCF (L/kg)
VOCs											
1,2-Dichloroethane	ATSDR, 1992.	98.96	-35.3	83.5	1.25	8.69E+03	6.10E+01	4.50E-02	13.8	1.48	1.2 AWQC
4-Methyl-2-Pentanone	GCDR	100.16	-84.7	116.8	0.7978	1.70E+04	1.50E+01	1.49E-05	6.16	1.09	4.73 ORNL
Benzene	ATSDR, 1991.	78.11	5.5	80.1	0.8765	1.78E+03	9.52E+01	5.50E-03	63-79	2.13	5.2 AWQC
Bromomethane	ATSDR, 1990.	94.95	-93.7	3.6	3.97	--	1.42E+03	1.30E-02	5.89	1.1	3.75 AWQC
Carbon Disulfide	ATSDR, 1994.	76.14	-110.8	46.5	1.263	2.94E+03	2.60E+02	1.22E-02	240	1.84 - 2.16	--
Carbon Tetrachloride	ATSDR, 1994.	153.82	-23	76.5	1.594	8.00E+02	9.00E+01	2.94E-02	110	2.64	18.75 AWQC
Vinyl Chloride	ATSDR, 1992.	62.5	-153.8	-13.4	0.9106	2.76E+03	2.53E+03	1.20E+00	98	1.36	1.17 AWQC
Metals											
Aluminum	ATSDR, 1990.	26.98	660	2327	--	insoluble	1mm @ 1284°C	--	--	--	36 SCDM
Manganese	ATSDR, 1998.	54.94	1244	1962	7.2	decomposes	1 mm @ 1292°C	--	--	--	100-600 ATSDR
Nickel	ATSDR, 1992.	58.69	1455	2730	8.9	insoluble	1 mm @ 1810°C	--	--	--	110 SCDM

Notes :
-- = Not Available

References :
ATSDR - Chemical specific toxicological profiles from USEPA.
GCDR - *Groundwater Chemicals Desk Reference, Volume 1, John H. Montgomerey, Lewis Publishers Inc., 1990.*
SCDM - Superfund Chemical Data Matrix, Office of Emergency and Remedial Response, USEPA, September 1997.
AWQC - Chemical specific ambient water quality criteria profiles from USEPA.
ORNL - *Toxicological Benchmarks for Wildlife: 1996 Revision, Oak Ridge National Laboratory, June 1996.*

TABLE 7.1.CT
CALCULATION OF NON-CANCER HAZARDS FOR RESIDENTIAL EXPOSURE TO GROUNDWATER
EAST DOWNGRADIENT SECTOR
CENTRAL TENDENCY
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Scenario Timeframe: Current/ Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Ingestion, Dermal and Inhalation
Receptor Population: Resident
Receptor Age: Children & Adults

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Permeability Constant (PC)	PC Units	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion (child)	4-Methyl-2-Pentanone	5.14E+00	ug/L	5.14E-03	mg/L	M	N/A	cm/hr	2.86E-04	mg/kg-day	8.00E-02	mg/kg-day	N/A	N/A	3.57E-03
	Bromomethane	5.18E-01	ug/L	5.18E-04	mg/L	M	N/A	cm/hr	2.88E-05	mg/kg-day	1.40E-03	mg/kg-day	N/A	N/A	2.06E-02
	(Total)														2.42E-02
Dermal (child)	4-Methyl-2-Pentanone	5.14E+00	ug/L	5.14E-03	mg/L	M	3.0E-03	cm/hr	2.15E-06	mg/kg-day	8.00E-02	mg/kg-day	N/A	N/A	2.68E-05
	Bromomethane	5.18E-01	ug/L	5.18E-04	mg/L	M	3.5E-03	cm/hr	2.52E-07	mg/kg-day	1.40E-03	mg/kg-day	N/A	N/A	1.80E-04
	(Total)														2.07E-04
Inhalation (child)	4-Methyl-2-Pentanone	5.14E+00	ug/L	5.14E-03	mg/L	M	N/A	cm/hr	1.43E-03	mg/kg-day	2.00E-02	mg/kg-day	N/A	N/A	7.15E-02
	Bromomethane	5.18E-01	ug/L	5.18E-04	mg/L	M	N/A	cm/hr	1.44E-04	mg/kg-day	1.40E-03	mg/kg-day	N/A	N/A	1.03E-01
	(Total)														1.74E-01
														Total Hazard Index Across All Exposure Routes/Pathways	2.0E-01

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Permeability Constant (PC)	PC Units	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion (adult)	4-Methyl-2-Pentanone	5.14E+00	ug/L	5.14E-03	mg/L	M	N/A	cm/hr	9.86E-05	mg/kg-day	8.00E-02	mg/kg-day	N/A	N/A	1.23E-03
	Bromomethane	5.18E-01	ug/L	5.18E-04	mg/L	M	N/A	cm/hr	9.93E-06	mg/kg-day	1.40E-03	mg/kg-day	N/A	N/A	7.10E-03
	(Total)														8.33E-03
Dermal (adult)	4-Methyl-2-Pentanone	5.14E+00	ug/L	5.14E-03	mg/L	M	3.0E-03	cm/hr	9.51E-07	mg/kg-day	8.00E-02	mg/kg-day	N/A	N/A	1.19E-05
	Bromomethane	5.18E-01	ug/L	5.18E-04	mg/L	M	3.5E-03	cm/hr	1.12E-07	mg/kg-day	1.40E-03	mg/kg-day	N/A	N/A	7.98E-05
	(Total)														9.17E-05
Inhalation (adult)	4-Methyl-2-Pentanone	5.14E+00	ug/L	5.14E-03	mg/L	M	N/A	cm/hr	5.28E-04	mg/kg-day	2.00E-02	mg/kg-day	N/A	N/A	2.64E-02
	Bromomethane	5.18E-01	ug/L	5.18E-04	mg/L	M	N/A	cm/hr	5.32E-05	mg/kg-day	1.40E-03	mg/kg-day	N/A	N/A	3.80E-02
	(Total)														6.44E-02
														Total Hazard Index Across All Exposure Routes/Pathways	7.3E-02

N/A = Not Applicable
(1) Medium-Specific (M) EPC selected for hazard calculation.

TABLE 7.1.RME
CALCULATION OF NON-CANCER HAZARDS FOR RESIDENTIAL EXPOSURE TO GROUNDWATER
EAST DOWNGRADIENT SECTOR
REASONABLE MAXIMUM EXPOSURE
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Scenario Timeframe: Current/ Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Ingestion, Dermal and Inhalation
Receptor Population: Resident
Receptor Age: Children & Adults

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Permeability Constant (PC)	PC Units	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion (child)	4-Methyl-2-Pentanone	5.30E+00	ug/L	5.30E-03	mg/L	M	N/A	cm/hr	5.08E-04	mg/kg-day	8.00E-02	mg/kg-day	N/A	N/A	6.35E-03
	Bromomethane	5.39E-01	ug/L	5.39E-04	mg/L	M	N/A	cm/hr	5.17E-05	mg/kg-day	1.40E-03	mg/kg-day	N/A	N/A	3.69E-02
	(Total)														4.33E-02
Dermal (child)	4-Methyl-2-Pentanone	5.30E+00	ug/L	5.30E-03	mg/L	M	3.0E-03	cm/hr	7.62E-06	mg/kg-day	8.00E-02	mg/kg-day	N/A	N/A	9.53E-05
	Bromomethane	5.39E-01	ug/L	5.39E-04	mg/L	M	3.5E-03	cm/hr	9.04E-07	mg/kg-day	1.40E-03	mg/kg-day	N/A	N/A	6.46E-04
	(Total)														7.41E-04
Inhalation (child)	4-Methyl-2-Pentanone	5.30E+00	ug/L	5.30E-03	mg/L	M	N/A	cm/hr	1.47E-03	mg/kg-day	2.00E-02	mg/kg-day	N/A	N/A	7.37E-02
	Bromomethane	5.39E-01	ug/L	5.39E-04	mg/L	M	N/A	cm/hr	1.50E-04	mg/kg-day	1.40E-03	mg/kg-day	N/A	N/A	1.07E-01
	(Total)														1.81E-01
														Total Hazard Index Across All Exposure Routes/Pathways	2.2E-01

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Permeability Constant (PC)	PC Units	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion (adult)	4-Methyl-2-Pentanone	5.30E+00	ug/L	5.30E-03	mg/L	M	N/A	cm/hr	1.74E-04	mg/kg-day	8.00E-02	mg/kg-day	N/A	N/A	2.18E-03
	Bromomethane	5.39E-01	ug/L	5.39E-04	mg/L	M	N/A	cm/hr	1.77E-05	mg/kg-day	1.40E-03	mg/kg-day	N/A	N/A	1.27E-02
	(Total)														1.48E-02
Dermal (adult)	4-Methyl-2-Pentanone	5.30E+00	ug/L	5.30E-03	mg/L	M	3.0E-03	cm/hr	2.78E-06	mg/kg-day	8.00E-02	mg/kg-day	N/A	N/A	3.47E-05
	Bromomethane	5.39E-01	ug/L	5.39E-04	mg/L	M	3.5E-03	cm/hr	3.30E-07	mg/kg-day	1.40E-03	mg/kg-day	N/A	N/A	2.36E-04
	(Total)														2.70E-04
Inhalation (adult)	4-Methyl-2-Pentanone	5.30E+00	ug/L	5.30E-03	mg/L	M	N/A	cm/hr	5.45E-04	mg/kg-day	2.00E-02	mg/kg-day	N/A	N/A	2.72E-02
	Bromomethane	5.39E-01	ug/L	5.39E-04	mg/L	M	N/A	cm/hr	5.54E-05	mg/kg-day	1.40E-03	mg/kg-day	N/A	N/A	3.96E-02
	(Total)														6.68E-02
														Total Hazard Index Across All Exposure Routes/Pathways (includes total metals)	8.2E-02

N/A = Not Applicable
(1) Medium-Specific (M) EPC selected for hazard calculation.

TABLE 7.2.CT
CALCULATION OF NON-CANCER HAZARDS FOR RESIDENTIAL EXPOSURE TO GROUNDWATER
NORTH DOWNGRADIENT SECTOR
CENTRAL TENDENCY
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Scenario Timeframe: Current/ Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Ingestion, Dermal and Inhalation
Receptor Population: Resident
Receptor Age: Children & Adults

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Permeability Constant (PC)	PC Units	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion (child)	1,2-Dichloroethane	1.18E+02	ug/L	1.18E-01	mg/L	M	N/A	cm/hr	6.56E-03	mg/kg-day	3.00E-02	mg/kg-day	N/A	N/A	2.19E-01
	4-Methyl-2-Pentanone	8.47E+00	ug/L	8.47E-03	mg/L	M	N/A	cm/hr	4.71E-04	mg/kg-day	8.00E-02	mg/kg-day	N/A	N/A	5.89E-03
	Benzene	2.56E+01	ug/L	2.56E-02	mg/L	M	N/A	cm/hr	1.42E-03	mg/kg-day	3.00E-03	mg/kg-day	N/A	N/A	4.75E-01
	Carbon Tetrachloride	1.25E+01	ug/L	1.25E-02	mg/L	M	N/A	cm/hr	6.95E-04	mg/kg-day	7.00E-04	mg/kg-day	N/A	N/A	9.93E-01
	Carbon Disulfide	1.41E+00	ug/L	1.41E-03	mg/L	M	N/A	cm/hr	7.84E-05	mg/kg-day	1.00E-01	mg/kg-day	N/A	N/A	7.84E-04
	Vinyl Chloride	1.19E+00	ug/L	1.19E-03	mg/L	M	N/A	cm/hr	6.62E-05	mg/kg-day	--	mg/kg-day	N/A	N/A	0.00E+00
	Aluminum	1.94E-01	mg/L	1.94E-01	mg/L	M	N/A	cm/hr	1.08E-02	mg/kg-day	1.00E+00	mg/kg-day	N/A	N/A	1.08E-02
	Manganese	1.71E-01	mg/L	1.71E-01	mg/L	M	N/A	cm/hr	9.51E-03	mg/kg-day	4.67E-02	mg/kg-day	N/A	N/A	2.04E-01
	Nickel	5.80E-03	mg/L	5.80E-03	mg/L	M	N/A	cm/hr	3.23E-04	mg/kg-day	2.00E-02	mg/kg-day	N/A	N/A	1.61E-02
	(Total)														1.92E+00
Dermal (child)	1,2-Dichloroethane	1.18E+02	ug/L	1.18E-01	mg/L	M	5.3E-03	cm/hr	8.71E-05	mg/kg-day	3.00E-02	mg/kg-day	N/A	N/A	2.90E-03
	4-Methyl-2-Pentanone	8.47E+00	ug/L	8.47E-03	mg/L	M	3.0E-03	cm/hr	3.54E-06	mg/kg-day	8.00E-02	mg/kg-day	N/A	N/A	4.42E-05
	Benzene	2.56E+01	ug/L	2.56E-02	mg/L	M	2.1E-02	cm/hr	7.49E-05	mg/kg-day	3.00E-03	mg/kg-day	N/A	N/A	2.50E-02
	Carbon Tetrachloride	1.25E+01	ug/L	1.25E-02	mg/L	M	2.2E-02	cm/hr	3.83E-05	mg/kg-day	7.00E-04	mg/kg-day	N/A	N/A	5.47E-02
	Carbon Disulfide	1.41E+00	ug/L	1.41E-03	mg/L	M	2.4E-02	cm/hr	4.71E-06	mg/kg-day	1.00E-01	mg/kg-day	N/A	N/A	4.71E-05
	Vinyl Chloride	1.19E+00	ug/L	1.19E-03	mg/L	M	7.3E-03	cm/hr	1.21E-06	mg/kg-day	--	mg/kg-day	N/A	N/A	0.00E+00
	Aluminum	1.94E-01	mg/L	1.94E-01	mg/L	M	1.0E-03	cm/hr	2.70E-05	mg/kg-day	1.00E+00	mg/kg-day	N/A	N/A	2.70E-05
	Manganese	1.71E-01	mg/L	1.71E-01	mg/L	M	1.0E-03	cm/hr	2.38E-05	mg/kg-day	1.87E-03	mg/kg-day	N/A	N/A	1.27E-02
	Nickel	5.80E-03	mg/L	5.80E-03	mg/L	M	1.0E-03	cm/hr	8.08E-07	mg/kg-day	8.00E-04	mg/kg-day	N/A	N/A	1.01E-03
	(Total)														9.64E-02
Inhalation (child)	1,2-Dichloroethane	1.18E+02	ug/L	1.18E-01	mg/L	M	N/A	cm/hr	3.28E-02	mg/kg-day	1.40E-03	mg/kg-day	N/A	N/A	2.34E+01
	4-Methyl-2-Pentanone	8.47E+00	ug/L	8.47E-03	mg/L	M	N/A	cm/hr	2.36E-03	mg/kg-day	2.00E-02	mg/kg-day	N/A	N/A	1.18E-01
	Benzene	2.56E+01	ug/L	2.56E-02	mg/L	M	N/A	cm/hr	7.12E-03	mg/kg-day	1.70E-03	mg/kg-day	N/A	N/A	4.19E+00
	Carbon Tetrachloride	1.25E+01	ug/L	1.25E-02	mg/L	M	N/A	cm/hr	3.48E-03	mg/kg-day	5.71E-04	mg/kg-day	N/A	N/A	6.09E+00
	Carbon Disulfide	1.41E+00	ug/L	1.41E-03	mg/L	M	N/A	cm/hr	3.92E-04	mg/kg-day	2.00E-01	mg/kg-day	N/A	N/A	1.96E-03
	Vinyl Chloride	1.19E+00	ug/L	1.19E-03	mg/L	M	N/A	cm/hr	3.31E-04	mg/kg-day	--	mg/kg-day	N/A	N/A	0.00E+00
	(Total)														3.38E+01
														Total Hazard Index Across All Exposure Routes/Pathways	3.6E+01

TABLE 7.2.CT
CALCULATION OF NON-CANCER HAZARDS FOR RESIDENTIAL EXPOSURE TO GROUNDWATER
NORTH DOWNGRADIENT SECTOR
CENTRAL TENDENCY
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Scenario Timeframe: Current/ Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Ingestion, Dermal and Inhalation
Receptor Population: Resident
Receptor Age: Children & Adults

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Permeability Constant (PC)	PC Units	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion (adult)	1,2-Dichloroethane	1.18E+02	ug/L	1.18E-01	mg/L	M	N/A	cm/hr	2.26E-03	mg/kg-day	3.00E-02	mg/kg-day	N/A	N/A	7.54E-02
	4-Methyl-2-Pentanone	8.47E+00	ug/L	8.47E-03	mg/L	M	N/A	cm/hr	1.62E-04	mg/kg-day	8.00E-02	mg/kg-day	N/A	N/A	2.03E-03
	Benzene	2.56E+01	ug/L	2.56E-02	mg/L	M	N/A	cm/hr	4.91E-04	mg/kg-day	3.00E-03	mg/kg-day	N/A	N/A	1.64E-01
	Carbon Tetrachloride	1.25E+01	ug/L	1.25E-02	mg/L	M	N/A	cm/hr	2.40E-04	mg/kg-day	7.00E-04	mg/kg-day	N/A	N/A	3.42E-01
	Carbon Disulfide	1.41E+00	ug/L	1.41E-03	mg/L	M	N/A	cm/hr	2.70E-05	mg/kg-day	1.00E-01	mg/kg-day	N/A	N/A	2.70E-04
	Vinyl Chloride	1.19E+00	ug/L	1.19E-03	mg/L	M	N/A	cm/hr	2.28E-05	mg/kg-day	--	mg/kg-day	N/A	N/A	0.00E+00
	Aluminum	1.94E-01	mg/L	1.94E-01	mg/L	M	N/A	cm/hr	3.72E-03	mg/kg-day	1.00E+00	mg/kg-day	N/A	N/A	3.72E-03
	Manganese	1.71E-01	mg/L	1.71E-01	mg/L	M	N/A	cm/hr	3.28E-03	mg/kg-day	4.67E-02	mg/kg-day	N/A	N/A	7.02E-02
	Nickel	5.80E-03	mg/L	5.80E-03	mg/L	M	N/A	cm/hr	1.11E-04	mg/kg-day	2.00E-02	mg/kg-day	N/A	N/A	5.56E-03
	(Total)														6.63E-01
Dermal (adult)	1,2-Dichloroethane	1.18E+02	ug/L	1.18E-01	mg/L	M	5.3E-03	cm/hr	3.86E-05	mg/kg-day	3.00E-02	mg/kg-day	N/A	N/A	1.29E-03
	4-Methyl-2-Pentanone	8.47E+00	ug/L	8.47E-03	mg/L	M	3.0E-03	cm/hr	1.57E-06	mg/kg-day	8.00E-02	mg/kg-day	N/A	N/A	1.96E-05
	Benzene	2.56E+01	ug/L	2.56E-02	mg/L	M	2.1E-02	cm/hr	3.31E-05	mg/kg-day	3.00E-03	mg/kg-day	N/A	N/A	1.10E-02
	Carbon Tetrachloride	1.25E+01	ug/L	1.25E-02	mg/L	M	2.2E-02	cm/hr	1.70E-05	mg/kg-day	7.00E-04	mg/kg-day	N/A	N/A	2.42E-02
	Carbon Disulfide	1.41E+00	ug/L	1.41E-03	mg/L	M	2.4E-02	cm/hr	2.09E-06	mg/kg-day	1.00E-01	mg/kg-day	N/A	N/A	2.09E-05
	Vinyl Chloride	1.19E+00	ug/L	1.19E-03	mg/L	M	7.3E-03	cm/hr	5.36E-07	mg/kg-day	--	mg/kg-day	N/A	N/A	0.00E+00
	Aluminum	1.94E-01	mg/L	1.94E-01	mg/L	M	1.0E-03	cm/hr	1.20E-05	mg/kg-day	1.00E+00	mg/kg-day	N/A	N/A	1.20E-05
	Manganese	1.71E-01	mg/L	1.71E-01	mg/L	M	1.0E-03	cm/hr	1.05E-05	mg/kg-day	1.87E-03	mg/kg-day	N/A	N/A	5.64E-03
	Nickel	5.80E-03	mg/L	5.80E-03	mg/L	M	1.0E-03	cm/hr	3.58E-07	mg/kg-day	8.00E-04	mg/kg-day	N/A	N/A	4.47E-04
	(Total)														4.27E-02
Inhalation (adult)	1,2-Dichloroethane	1.18E+02	ug/L	1.18E-01	mg/L	M	N/A	cm/hr	1.21E-02	mg/kg-day	1.40E-03	mg/kg-day	N/A	N/A	8.66E+00
	4-Methyl-2-Pentanone	8.47E+00	ug/L	8.47E-03	mg/L	M	N/A	cm/hr	8.70E-04	mg/kg-day	2.00E-02	mg/kg-day	N/A	N/A	4.35E-02
	Benzene	2.56E+01	ug/L	2.56E-02	mg/L	M	N/A	cm/hr	2.63E-03	mg/kg-day	1.70E-03	mg/kg-day	N/A	N/A	1.55E+00
	Carbon Tetrachloride	1.25E+01	ug/L	1.25E-02	mg/L	M	N/A	cm/hr	1.28E-03	mg/kg-day	5.71E-04	mg/kg-day	N/A	N/A	2.25E+00
	Carbon Disulfide	1.41E+00	ug/L	1.41E-03	mg/L	M	N/A	cm/hr	1.45E-04	mg/kg-day	2.00E-01	mg/kg-day	N/A	N/A	7.24E-04
	Vinyl Chloride	1.19E+00	ug/L	1.19E-03	mg/L	M	N/A	cm/hr	1.22E-04	mg/kg-day	--	mg/kg-day	N/A	N/A	0.00E+00
	(Total)														1.25E+01
														Total Hazard Index Across All Exposure Routes/Pathways	1.3E+01

-- = Not Available
N/A = Not Applicable
(1) Medium-Specific (M) EPC selected for hazard calculation.

TABLE 7.2.RME
CALCULATION OF NON-CANCER HAZARDS FOR RESIDENTIAL EXPOSURE TO GROUNDWATER
NORTH DOWNGRADIENT SECTOR
REASONABLE MAXIMUM EXPOSURE
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Scenario Timeframe: Current/ Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Ingestion, Dermal and Inhalation
Receptor Population: Resident
Receptor Age: Children & Adults

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Permeability Constant (PC)	PC Units	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion (child)	1,2-Dichloroethane	3.90E+02	ug/L	3.90E-01	mg/L	M	N/A	cm/hr	3.74E-02	mg/kg-day	3.00E-02	mg/kg-day	N/A	N/A	1.25E+00
	4-Methyl-2-Pentanone	8.86E+00	ug/L	8.86E-03	mg/L	M	N/A	cm/hr	8.50E-04	mg/kg-day	8.00E-02	mg/kg-day	N/A	N/A	1.06E-02
	Benzene	1.24E+01	ug/L	1.24E-02	mg/L	M	N/A	cm/hr	1.19E-03	mg/kg-day	3.00E-03	mg/kg-day	N/A	N/A	3.96E-01
	Carbon Tetrachloride	6.01E+00	ug/L	6.01E-03	mg/L	M	N/A	cm/hr	5.76E-04	mg/kg-day	7.00E-04	mg/kg-day	N/A	N/A	8.23E-01
	Carbon Disulfide	1.33E+00	ug/L	1.33E-03	mg/L	M	N/A	cm/hr	1.28E-04	mg/kg-day	1.00E-01	mg/kg-day	N/A	N/A	1.28E-03
	Vinyl Chloride	1.30E+00	ug/L	1.30E-03	mg/L	M	N/A	cm/hr	1.25E-04	mg/kg-day	--	mg/kg-day	N/A	N/A	0.00E+00
	Aluminum	2.52E-01	mg/L	2.52E-01	mg/L	M	N/A	cm/hr	2.42E-02	mg/kg-day	1.00E+00	mg/kg-day	N/A	N/A	2.42E-02
	Manganese	3.06E-01	mg/L	3.06E-01	mg/L	M	N/A	cm/hr	2.93E-02	mg/kg-day	4.67E-02	mg/kg-day	N/A	N/A	6.28E-01
	Nickel	6.69E-03	mg/L	6.69E-03	mg/L	M	N/A	cm/hr	6.42E-04	mg/kg-day	2.00E-02	mg/kg-day	N/A	N/A	3.21E-02
	(Total)														3.16E+00
Dermal (child)	1,2-Dichloroethane	3.90E+02	ug/L	3.90E-01	mg/L	M	5.3E-03	cm/hr	9.91E-04	mg/kg-day	3.00E-02	mg/kg-day	N/A	N/A	3.30E-02
	4-Methyl-2-Pentanone	8.86E+00	ug/L	8.86E-03	mg/L	M	3.0E-03	cm/hr	1.27E-05	mg/kg-day	8.00E-02	mg/kg-day	N/A	N/A	1.59E-04
	Benzene	1.24E+01	ug/L	1.24E-02	mg/L	M	2.1E-02	cm/hr	1.25E-04	mg/kg-day	3.00E-03	mg/kg-day	N/A	N/A	4.16E-02
	Carbon Tetrachloride	6.01E+00	ug/L	6.01E-03	mg/L	M	2.2E-02	cm/hr	6.34E-05	mg/kg-day	7.00E-04	mg/kg-day	N/A	N/A	9.06E-02
	Carbon Disulfide	1.33E+00	ug/L	1.33E-03	mg/L	M	2.4E-02	cm/hr	1.53E-05	mg/kg-day	1.00E-01	mg/kg-day	N/A	N/A	1.53E-04
	Vinyl Chloride	1.30E+00	ug/L	1.30E-03	mg/L	M	7.3E-03	cm/hr	4.55E-06	mg/kg-day	--	mg/kg-day	N/A	N/A	0.00E+00
	Aluminum	2.52E-01	mg/L	2.52E-01	mg/L	M	1.0E-03	cm/hr	1.21E-04	mg/kg-day	1.00E+00	mg/kg-day	N/A	N/A	1.21E-04
	Manganese	3.06E-01	mg/L	3.06E-01	mg/L	M	1.0E-03	cm/hr	1.47E-04	mg/kg-day	1.87E-03	mg/kg-day	N/A	N/A	7.85E-02
	Nickel	6.69E-03	mg/L	6.69E-03	mg/L	M	1.0E-03	cm/hr	3.21E-06	mg/kg-day	8.00E-04	mg/kg-day	N/A	N/A	4.01E-03
	(Total)														2.48E-01
Inhalation (child)	1,2-Dichloroethane	3.90E+02	ug/L	3.90E-01	mg/L	M	N/A	cm/hr	1.08E-01	mg/kg-day	1.40E-03	mg/kg-day	N/A	N/A	7.75E+01
	4-Methyl-2-Pentanone	8.86E+00	ug/L	8.86E-03	mg/L	M	N/A	cm/hr	2.46E-03	mg/kg-day	2.00E-02	mg/kg-day	N/A	N/A	1.23E-01
	Benzene	1.24E+01	ug/L	1.24E-02	mg/L	M	N/A	cm/hr	3.45E-03	mg/kg-day	1.70E-03	mg/kg-day	N/A	N/A	2.03E+00
	Carbon Tetrachloride	6.01E+00	ug/L	6.01E-03	mg/L	M	N/A	cm/hr	1.67E-03	mg/kg-day	5.71E-04	mg/kg-day	N/A	N/A	2.93E+00
	Carbon Disulfide	1.33E+00	ug/L	1.33E-03	mg/L	M	N/A	cm/hr	3.70E-04	mg/kg-day	2.00E-01	mg/kg-day	N/A	N/A	1.85E-03
	Vinyl Chloride	1.30E+00	ug/L	1.30E-03	mg/L	M	N/A	cm/hr	3.62E-04	mg/kg-day	--	mg/kg-day	N/A	N/A	0.00E+00
	(Total)														8.25E+01
														Total Hazard Index Across All Exposure Routes/Pathways	8.6E+01

TABLE 7.2.RME
CALCULATION OF NON-CANCER HAZARDS FOR RESIDENTIAL EXPOSURE TO GROUNDWATER
NORTH DOWNGRADIENT SECTOR
REASONABLE MAXIMUM EXPOSURE
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Scenario Timeframe: Current/ Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Ingestion, Dermal and Inhalation
Receptor Population: Resident
Receptor Age: Children & Adults

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Permeability Constant (PC)	PC Units	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion (adult)	1,2-Dichloroethane	3.90E+02	ug/L	3.90E-01	mg/L	M	N/A	cm/hr	1.28E-02	mg/kg-day	3.00E-02	mg/kg-day	N/A	N/A	4.27E-01
	4-Methyl-2-Pentanone	8.86E+00	ug/L	8.86E-03	mg/L	M	N/A	cm/hr	2.91E-04	mg/kg-day	8.00E-02	mg/kg-day	N/A	N/A	3.64E-03
	Benzene	1.24E+01	ug/L	1.24E-02	mg/L	M	N/A	cm/hr	4.08E-04	mg/kg-day	3.00E-03	mg/kg-day	N/A	N/A	1.36E-01
	Carbon Tetrachloride	6.01E+00	ug/L	6.01E-03	mg/L	M	N/A	cm/hr	1.98E-04	mg/kg-day	7.00E-04	mg/kg-day	N/A	N/A	2.82E-01
	Carbon Disulfide	1.33E+00	ug/L	1.33E-03	mg/L	M	N/A	cm/hr	4.37E-05	mg/kg-day	1.00E-01	mg/kg-day	N/A	N/A	4.37E-04
	Vinyl Chloride	1.30E+00	ug/L	1.30E-03	mg/L	M	N/A	cm/hr	4.27E-05	mg/kg-day	--	mg/kg-day	N/A	N/A	0.00E+00
	Aluminum	2.52E-01	mg/L	2.52E-01	mg/L	M	N/A	cm/hr	8.28E-03	mg/kg-day	1.00E+00	mg/kg-day	N/A	N/A	8.28E-03
	Manganese	3.06E-01	mg/L	3.06E-01	mg/L	M	N/A	cm/hr	1.01E-02	mg/kg-day	4.67E-02	mg/kg-day	N/A	N/A	2.15E-01
	Nickel	6.69E-03	mg/L	6.69E-03	mg/L	M	N/A	cm/hr	2.20E-04	mg/kg-day	2.00E-02	mg/kg-day	N/A	N/A	1.10E-02
	(Total)														1.08E+00
Dermal (adult)	1,2-Dichloroethane	3.90E+02	ug/L	3.90E-01	mg/L	M	5.3E-03	cm/hr	3.61E-04	mg/kg-day	3.00E-02	mg/kg-day	N/A	N/A	1.20E-02
	4-Methyl-2-Pentanone	8.86E+00	ug/L	8.86E-03	mg/L	M	3.0E-03	cm/hr	4.65E-06	mg/kg-day	8.00E-02	mg/kg-day	N/A	N/A	5.81E-05
	Benzene	1.24E+01	ug/L	1.24E-02	mg/L	M	2.1E-02	cm/hr	4.55E-05	mg/kg-day	3.00E-03	mg/kg-day	N/A	N/A	1.52E-02
	Carbon Tetrachloride	6.01E+00	ug/L	6.01E-03	mg/L	M	2.2E-02	cm/hr	2.31E-05	mg/kg-day	7.00E-04	mg/kg-day	N/A	N/A	3.30E-02
	Carbon Disulfide	1.33E+00	ug/L	1.33E-03	mg/L	M	2.4E-02	cm/hr	5.58E-06	mg/kg-day	1.00E-01	mg/kg-day	N/A	N/A	5.58E-05
	Vinyl Chloride	1.30E+00	ug/L	1.30E-03	mg/L	M	7.3E-03	cm/hr	1.66E-06	mg/kg-day	--	mg/kg-day	N/A	N/A	0.00E+00
	Aluminum	2.52E-01	mg/L	2.52E-01	mg/L	M	1.0E-03	cm/hr	4.40E-05	mg/kg-day	1.00E+00	mg/kg-day	N/A	N/A	4.40E-05
	Manganese	3.06E-01	mg/L	3.06E-01	mg/L	M	1.0E-03	cm/hr	5.35E-05	mg/kg-day	1.87E-03	mg/kg-day	N/A	N/A	2.86E-02
	Nickel	6.69E-03	mg/L	6.69E-03	mg/L	M	1.0E-03	cm/hr	1.17E-06	mg/kg-day	8.00E-04	mg/kg-day	N/A	N/A	1.46E-03
	(Total)														9.05E-02
Inhalation (adult)	1,2-Dichloroethane	3.90E+02	ug/L	3.90E-01	mg/L	M	N/A	cm/hr	4.01E-02	mg/kg-day	1.40E-03	mg/kg-day	N/A	N/A	2.86E+01
	4-Methyl-2-Pentanone	8.86E+00	ug/L	8.86E-03	mg/L	M	N/A	cm/hr	9.10E-04	mg/kg-day	2.00E-02	mg/kg-day	N/A	N/A	4.55E-02
	Benzene	1.24E+01	ug/L	1.24E-02	mg/L	M	N/A	cm/hr	1.27E-03	mg/kg-day	1.70E-03	mg/kg-day	N/A	N/A	7.49E-01
	Carbon Tetrachloride	6.01E+00	ug/L	6.01E-03	mg/L	M	N/A	cm/hr	6.17E-04	mg/kg-day	5.71E-04	mg/kg-day	N/A	N/A	1.08E+00
	Carbon Disulfide	1.33E+00	ug/L	1.33E-03	mg/L	M	N/A	cm/hr	1.37E-04	mg/kg-day	2.00E-01	mg/kg-day	N/A	N/A	6.83E-04
	Vinyl Chloride	1.30E+00	ug/L	1.30E-03	mg/L	M	N/A	cm/hr	1.34E-04	mg/kg-day	--	mg/kg-day	N/A	N/A	0.00E+00
	(Total)														3.05E+01
														Total Hazard Index Across All Exposure Routes/Pathways	3.2E+01

-- = Not Available
N/A = Not Applicable
(1) Medium-Specific (M) EPC selected for hazard calculation.

TABLE 7.3.CT
CALCULATION OF NON-CANCER HAZARDS FOR RESIDENTIAL IRRIGATION USE SCENARIO
EAST DOWNGRADIENT SECTOR
CENTRAL TENDENCY
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Scenario Timeframe: Current/ Future
Medium: Groundwater for Irrigation Use
Exposure Medium: Fruits/Vegetables
Exposure Point: Ingestion
Receptor Population: Resident
Receptor Age: Children & Adults

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion (child)	4-Methyl-2-Pentanone	5.14E+00	ug/L	5.14E-03	mg/L	M	3.89E-06	mg/kg-day	8.00E-02	mg/kg-day	N/A	N/A	4.86E-05
	Bromomethane	5.18E-01	ug/L	5.18E-04	mg/L	M	3.92E-07	mg/kg-day	1.40E-03	mg/kg-day	N/A	N/A	2.80E-04
	(Total)												3.28E-04
												Total Hazard Index Across All Exposure Routes/Pathways	3.3E-04

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion (adult)	4-Methyl-2-Pentanone	5.14E+00	ug/L	5.14E-03	mg/L	M	1.32E-06	mg/kg-day	8.00E-02	mg/kg-day	N/A	N/A	1.64E-05
	Bromomethane	5.18E-01	ug/L	5.18E-04	mg/L	M	1.33E-07	mg/kg-day	1.40E-03	mg/kg-day	N/A	N/A	9.47E-05
	(Total)												1.11E-04
												Total Hazard Index Across All Exposure Routes/Pathways	1.1E-04

-- = Not Available
N/A = Not Applicable
(1) Medium-Specific (M) EPC selected for hazard calculation.

TABLE 7.3.RME
CALCULATION OF NON-CANCER HAZARDS FOR RESIDENTIAL IRRIGATION USE SCENARIO
EAST DOWNGRADIENT SECTOR
REASONABLE MAXIMUM EXPOSURE
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Scenario Timeframe: Current/ Future
Medium: Groundwater for Irrigation Use
Exposure Medium: Fruits/Vegetables
Exposure Point: Ingestion
Receptor Population: Resident
Receptor Age: Children & Adults

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion (child)	4-Methyl-2-Pentanone	5.30E+00	ug/L	5.30E-03	mg/L	M	3.26E-05	mg/kg-day	8.00E-02	mg/kg-day	N/A	N/A	4.07E-04
	Bromomethane	5.39E-01	ug/L	5.39E-04	mg/L	M	3.31E-06	mg/kg-day	1.40E-03	mg/kg-day	N/A	N/A	2.37E-03
	(Total)												2.77E-03
												Total Hazard Index Across All Exposure Routes/Pathways	2.8E-03

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion (adult)	4-Methyl-2-Pentanone	5.30E+00	ug/L	5.30E-03	mg/L	M	1.12E-05	mg/kg-day	8.00E-02	mg/kg-day	N/A	N/A	1.40E-04
	Bromomethane	5.39E-01	ug/L	5.39E-04	mg/L	M	1.14E-06	mg/kg-day	1.40E-03	mg/kg-day	N/A	N/A	8.11E-04
	(Total)												9.50E-04
												Total Hazard Index Across All Exposure Routes/Pathways	9.5E-04

-- = Not Available
N/A = Not Applicable
(1) Medium-Specific (M) EPC selected for hazard calculation.

TABL. . .4.CT

CALCULATION OF NON-CANCER HAZARDS FOR RESIDENTIAL IRRIGATION USE SCENARIO
NORTH DOWNGRADIENT SECTOR
CENTRAL TENDENCY
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Scenario Timeframe: Current/ Future
Medium: Groundwater for Irrigation Use
Exposure Medium: Fruits/Vegetables
Exposure Point: Ingestion
Receptor Population: Resident
Receptor Age: Children & Adults

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion (child)	1,2-Dichloroethane	1.18E+02	ug/L	1.18E-01	mg/L	M	8.92E-05	mg/kg-day	3.00E-02	mg/kg-day	N/A	N/A	2.97E-03
	4-Methyl-2-Pentanone	8.47E+00	ug/L	8.47E-03	mg/L	M	6.40E-06	mg/kg-day	8.00E-02	mg/kg-day	N/A	N/A	8.00E-05
	Benzene	2.56E+01	ug/L	2.56E-02	mg/L	M	1.94E-05	mg/kg-day	3.00E-03	mg/kg-day	N/A	N/A	6.45E-03
	Carbon Tetrachloride	1.25E+01	ug/L	1.25E-02	mg/L	M	9.45E-06	mg/kg-day	7.00E-04	mg/kg-day	N/A	N/A	1.35E-02
	Carbon Disulfide	1.41E+00	ug/L	1.41E-03	mg/L	M	1.07E-06	mg/kg-day	1.00E-01	mg/kg-day	N/A	N/A	1.07E-05
	Vinyl Chloride	1.19E+00	ug/L	1.19E-03	mg/L	M	9.00E-07	mg/kg-day	--	mg/kg-day	N/A	N/A	0.00E+00
	Aluminum	1.94E-01	mg/L	1.94E-01	mg/L	M	1.47E-04	mg/kg-day	1.00E+00	mg/kg-day	N/A	N/A	1.47E-04
	Manganese	1.71E-01	mg/L	1.71E-01	mg/L	M	1.29E-04	mg/kg-day	4.67E-02	mg/kg-day	N/A	N/A	2.77E-03
	Nickel	5.80E-03	mg/L	5.80E-03	mg/L	M	4.38E-06	mg/kg-day	2.00E-02	mg/kg-day	N/A	N/A	2.19E-04
	(Total)												2.61E-02
												Total Hazard Index Across All Exposure Routes/Pathways	2.6E-02

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion (adult)	1,2-Dichloroethane	1.18E+02	ug/L	1.18E-01	mg/L	M	3.02E-05	mg/kg-day	3.00E-02	mg/kg-day	N/A	N/A	1.01E-03
	4-Methyl-2-Pentanone	8.47E+00	ug/L	8.47E-03	mg/L	M	2.17E-06	mg/kg-day	8.00E-02	mg/kg-day	N/A	N/A	2.71E-05
	Benzene	2.56E+01	ug/L	2.56E-02	mg/L	M	6.55E-06	mg/kg-day	3.00E-03	mg/kg-day	N/A	N/A	2.18E-03
	Carbon Tetrachloride	1.25E+01	ug/L	1.25E-02	mg/L	M	3.20E-06	mg/kg-day	7.00E-04	mg/kg-day	N/A	N/A	4.57E-03
	Carbon Disulfide	1.41E+00	ug/L	1.41E-03	mg/L	M	3.61E-07	mg/kg-day	1.00E-01	mg/kg-day	N/A	N/A	3.61E-06
	Vinyl Chloride	1.19E+00	ug/L	1.19E-03	mg/L	M	3.05E-07	mg/kg-day	--	mg/kg-day	N/A	N/A	0.00E+00
	Aluminum	1.94E-01	mg/L	1.94E-01	mg/L	M	4.97E-05	mg/kg-day	1.00E+00	mg/kg-day	N/A	N/A	4.97E-05
	Manganese	1.71E-01	mg/L	1.71E-01	mg/L	M	4.38E-05	mg/kg-day	4.67E-02	mg/kg-day	N/A	N/A	9.37E-04
	Nickel	5.80E-03	mg/L	5.80E-03	mg/L	M	1.48E-06	mg/kg-day	2.00E-02	mg/kg-day	N/A	N/A	7.42E-05
	(Total)												8.85E-03
												Total Hazard Index Across All Exposure Routes/Pathways	8.9E-03

N/A = Not Applicable
(1) Medium-Specific (M) EPC selected for hazard calculation.

TABLE 7.4.RME
CALCULATION OF NON-CANCER HAZARDS FOR RESIDENTIAL IRRIGATION USE SCENARIO
NORTH DOWNGRADIENT SECTOR
REASONABLE MAXIMUM EXPOSURE
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Scenario Timeframe: Current/ Future
Medium: Groundwater for Irrigation Use
Exposure Medium: Fruits/Vegetables
Exposure Point: Ingestion
Receptor Population: Resident
Receptor Age: Children & Adults

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion (child)	1,2-Dichloroethane	3.90E+02	ug/L	3.90E-01	mg/L	M	2.40E-03	mg/kg-day	3.00E-02	mg/kg-day	N/A	N/A	7.99E-02
	4-Methyl-2-Pentanone	8.86E+00	ug/L	8.86E-03	mg/L	M	5.44E-05	mg/kg-day	8.00E-02	mg/kg-day	N/A	N/A	6.81E-04
	Benzene	1.24E+01	ug/L	1.24E-02	mg/L	M	7.62E-05	mg/kg-day	3.00E-03	mg/kg-day	N/A	N/A	2.54E-02
	Carbon Tetrachloride	6.01E+00	ug/L	6.01E-03	mg/L	M	3.69E-05	mg/kg-day	7.00E-04	mg/kg-day	N/A	N/A	5.28E-02
	Carbon Disulfide	1.33E+00	ug/L	1.33E-03	mg/L	M	8.17E-06	mg/kg-day	1.00E-01	mg/kg-day	N/A	N/A	8.17E-05
	Vinyl Chloride	1.30E+00	ug/L	1.30E-03	mg/L	M	7.99E-06	mg/kg-day	--	mg/kg-day	N/A	N/A	0.00E+00
	Aluminum	2.52E-01	mg/L	2.52E-01	mg/L	M	1.55E-03	mg/kg-day	1.00E+00	mg/kg-day	N/A	N/A	1.55E-03
	Manganese	3.06E-01	mg/L	3.06E-01	mg/L	M	1.88E-03	mg/kg-day	4.67E-02	mg/kg-day	N/A	N/A	4.03E-02
	Nickel	6.69E-03	mg/L	6.69E-03	mg/L	M	4.11E-05	mg/kg-day	2.00E-02	mg/kg-day	N/A	N/A	2.06E-03
	(Total)												2.03E-01
												Total Hazard Index Across All Exposure Routes/Pathways	2.0E-01

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Ingestion (adult)	1,2-Dichloroethane	3.90E+02	ug/L	3.90E-01	mg/L	M	8.21E-04	mg/kg-day	3.00E-02	mg/kg-day	N/A	N/A	2.74E-02
	4-Methyl-2-Pentanone	8.86E+00	ug/L	8.86E-03	mg/L	M	1.87E-05	mg/kg-day	8.00E-02	mg/kg-day	N/A	N/A	2.33E-04
	Benzene	1.24E+01	ug/L	1.24E-02	mg/L	M	2.61E-05	mg/kg-day	3.00E-03	mg/kg-day	N/A	N/A	8.70E-03
	Carbon Tetrachloride	6.01E+00	ug/L	6.01E-03	mg/L	M	1.27E-05	mg/kg-day	7.00E-04	mg/kg-day	N/A	N/A	1.81E-02
	Carbon Disulfide	1.33E+00	ug/L	1.33E-03	mg/L	M	2.80E-06	mg/kg-day	1.00E-01	mg/kg-day	N/A	N/A	2.80E-05
	Vinyl Chloride	1.30E+00	ug/L	1.30E-03	mg/L	M	2.74E-06	mg/kg-day	--	mg/kg-day	N/A	N/A	0.00E+00
	Aluminum	2.52E-01	mg/L	2.52E-01	mg/L	M	5.31E-04	mg/kg-day	1.00E+00	mg/kg-day	N/A	N/A	5.31E-04
	Manganese	3.06E-01	mg/L	3.06E-01	mg/L	M	6.44E-04	mg/kg-day	4.67E-02	mg/kg-day	N/A	N/A	1.38E-02
	Nickel	6.69E-03	mg/L	6.69E-03	mg/L	M	1.41E-05	mg/kg-day	2.00E-02	mg/kg-day	N/A	N/A	7.04E-04
	(Total)												6.95E-02
												Total Hazard Index Across All Exposure Routes/Pathways	6.9E-02

N/A = Not Applicable
(1) Medium-Specific (M) EPC selected for hazard calculation.

TABLE 7.5.CT
CALCULATION OF NON-CANCER HAZARDS FOR WORKER EXPOSURE TO VOLATILE EMISSIONS FROM IRRIGATION SYSTEM
EAST DOWNGRADIENT SECTOR
CENTRAL TENDENCY
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Scenario Timeframe: Current/ Future
Medium: Groundwater
Exposure Medium: Ambient Air
Exposure Point: Inhalation
Receptor Population: Worker
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentratio	Reference Concentratio Units	Hazard Quotient
Inhalation	4-Methyl-2-Pentanone	5.14E+00	ug/L	1.10E-03	mg/m3	R	5.04E-06	mg/kg-day	2.00E-02	mg/kg-day	N/A	N/A	2.52E-04
	Bromomethane	5.39E-01	ug/L	1.11E-04	mg/m3	R	5.08E-07	mg/kg-day	1.40E-03	mg/kg-day	N/A	N/A	3.63E-04
	(Total)												6.15E-04
												Total Hazard Index Across All Exposure Routes/Pathways	6.1E-04

-- = Not Available
N/A = Not Applicable
(1) Route-Specific (R) EPC selected for hazard calculation.

TABLE 7.5.RME
CALCULATION OF NON-CANCER HAZARDS FOR WORKER EXPOSURE TO VOLATILE EMISSIONS FROM IRRIGATION SYSTEM
EAST DOWNGRADIENT SECTOR
REASONABLE MAXIMUM EXPOSURE
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Scenario Timeframe: Current/ Future
Medium: Groundwater
Exposure Medium: Ambient Air
Exposure Point: Inhalation
Receptor Population: Worker
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentratio	Reference Concentratio Units	Hazard Quotient
Inhalation	4-Methyl-2-Pentanone	5.30E+00	ug/L	1.10E-03	mg/m3	R	1.50E-04	mg/kg-day	2.00E-02	mg/kg-day	N/A	N/A	7.51E-03
	Bromomethane	5.39E-01	ug/L	1.11E-04	mg/m3	R	1.52E-05	mg/kg-day	1.40E-03	mg/kg-day	N/A	N/A	1.09E-02
	(Total)												1.84E-02
												Total Hazard Index Across All Exposure Routes/Pathways	1.8E-02

-- = Not Available
N/A = Not Applicable
(1) Route-Specific (R) EPC selected for hazard calculation.

TABLE 7.6.CT
CALCULATION OF NON-CANCER HAZARDS FOR WORKER EXPOSURE TO VOLATILE EMISSIONS FROM IRRIGATION SYSTEM
NORTH DOWNGRADIENT SECTOR
CENTRAL TENDENCY
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Scenario Timeframe: Current/ Future
Medium: Groundwater
Exposure Medium: Ambient Air
Exposure Point: Inhalation
Receptor Population: Worker
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentration	Reference Concentration Units	Hazard Quotient
Inhalation	1,2-Dichloroethane	3.90E+02	ug/L	8.06E-02	mg/m3	R	3.69E-04	mg/kg-day	1.40E-03	mg/kg-day	N/A	N/A	2.64E-01
	4-Methyl-2-Pentanone	8.86E+00	ug/L	1.83E-03	mg/m3	R	8.38E-06	mg/kg-day	2.00E-02	mg/kg-day	N/A	N/A	4.19E-04
	Benzene	1.24E+01	ug/L	2.56E-03	mg/m3	R	1.17E-05	mg/kg-day	1.70E-03	mg/kg-day	N/A	N/A	6.90E-03
	Carbon Tetrachloride	6.01E+00	ug/L	1.24E-03	mg/m3	R	5.69E-06	mg/kg-day	5.71E-04	mg/kg-day	N/A	N/A	9.96E-03
	Carbon Disulfide	1.33E+00	ug/L	2.75E-04	mg/m3	R	1.26E-06	mg/kg-day	2.00E-01	mg/kg-day	N/A	N/A	6.30E-06
	Vinyl Chloride	1.30E+00	ug/L	2.69E-04	mg/m3	R	1.23E-06	mg/kg-day	--	mg/kg-day	N/A	N/A	0.00E+00
	(Total)												2.81E-01
												Total Hazard Index Across All Exposure Routes/Pathways	2.8E-01

-- = Not Available
N/A = Not Applicable
(1) Route-Specific (R) EPC selected for hazard calculation.

TABLE 7.6.RME
CALCULATION OF NON-CANCER HAZARDS FOR WORKER EXPOSURE TO VOLATILE EMISSIONS FROM IRRIGATION SYSTEM
NORTH DOWNGRADIENT SECTOR
REASONABLE MAXIMUM EXPOSURE
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Scenario Timeframe: Current/ Future
Medium: Groundwater
Exposure Medium: Ambient Air
Exposure Point: Inhalation
Receptor Population: Worker
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Hazard Calculation (1)	Intake (Non-Cancer)	Intake (Non-Cancer) Units	Reference Dose	Reference Dose Units	Reference Concentratio	Reference Concentratio Units	Hazard Quotient
Inhalation	1,2-Dichloroethane	3.90E+02	ug/L	8.06E-02	mg/m3	R	3.98E-03	mg/kg-day	1.40E-03	mg/kg-day	N/A	N/A	2.84E+00
	4-Methyl-2-Pentanone	8.86E+00	ug/L	1.83E-03	mg/m3	R	9.03E-05	mg/kg-day	2.00E-02	mg/kg-day	N/A	N/A	4.51E-03
	Benzene	1.24E+01	ug/L	2.56E-03	mg/m3	R	1.26E-04	mg/kg-day	1.70E-03	mg/kg-day	N/A	N/A	7.43E-02
	Carbon Tetrachloride	6.01E+00	ug/L	1.24E-03	mg/m3	R	6.12E-05	mg/kg-day	5.71E-04	mg/kg-day	N/A	N/A	1.07E-01
	Carbon Disulfide	1.33E+00	ug/L	2.75E-04	mg/m3	R	1.36E-05	mg/kg-day	2.00E-01	mg/kg-day	N/A	N/A	6.78E-05
	Vinyl Chloride	1.30E+00	ug/L	2.69E-04	mg/m3	R	1.33E-05	mg/kg-day	--	mg/kg-day	N/A	N/A	0.00E+00
	(Total)												3.03E+00
												Total Hazard Index Across All Exposure Routes/Pathways	3.0E+00

-- = Not Available
N/A = Not Applicable
(1) Route-Specific (R) EPC selected for hazard calculation.

TABLE 8.1.CT
CALCULATION OF CANCER RISKS FOR RESIDENTIAL EXPOSURE TO GROUNDWATER
EAST DOWNGRADIENT SECTOR
CENTRAL TENDENCY
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Scenario Timeframe: Current/ Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Ingestion, Dermal and Inhalation
Receptor Population: Resident
Receptor Age: Children & Adults

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Permeability Constant (PC)	PC Units	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Ingestion	4-Methyl-2-Pentanone	5.14E+00	ug/L	5.14E-03	mg/L	M	N/A	cm/hr	2.87E-05	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	Bromomethane	5.18E-01	ug/L	5.18E-04	mg/L	M	N/A	cm/hr	2.90E-06	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	(Total)												0.00E+00
Dermal	4-Methyl-2-Pentanone	5.14E+00	ug/L	5.14E-03	mg/L	M	3.0E-03	cm/hr	2.25E-07	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	Bromomethane	5.18E-01	ug/L	5.18E-04	mg/L	M	3.5E-03	cm/hr	2.64E-08	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	(Total)												0.00E+00
Inhalation	4-Methyl-2-Pentanone	5.14E+00	ug/L	5.14E-03	mg/L	M	N/A	cm/hr	1.45E-04	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	Bromomethane	5.18E-01	ug/L	5.18E-04	mg/L	M	N/A	cm/hr	1.46E-05	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	(Total)												0.00E+00
												Total Risk Across All Exposure Routes/Pathways	0.0E+00

-- = Not Available
N/A = Not Applicable
(1) Medium-Specific (M) EPC selected for risk calculation.

TABLE 8.1.RME
CALCULATION OF CANCER RISKS FOR RESIDENTIAL EXPOSURE TO GROUNDWATER
EAST DOWNGRADIENT SECTOR
REASONABLE MAXIMUM EXPOSURE
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Scenario Timeframe: Current/ Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Ingestion, Dermal and Inhalation
Receptor Population: Resident
Receptor Age: Children & Adults

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Permeability Constant (PC)	PC Units	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Ingestion	4-Methyl-2-Pentanone	5.30E+00	ug/L	5.30E-03	mg/L	M	N/A	cm/hr	1.03E-04	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	Bromomethane	5.39E-01	ug/L	5.39E-04	mg/L	M	N/A	cm/hr	1.05E-05	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	(Total)												0.00E+00
Dermal	4-Methyl-2-Pentanone	5.30E+00	ug/L	5.30E-03	mg/L	M	3.0E-03	cm/hr	1.61E-06	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	Bromomethane	5.39E-01	ug/L	5.39E-04	mg/L	M	3.5E-03	cm/hr	1.91E-07	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	(Total)												0.00E+00
Inhalation	4-Methyl-2-Pentanone	5.30E+00	ug/L	5.30E-03	mg/L	M	N/A	cm/hr	3.13E-04	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	Bromomethane	5.39E-01	ug/L	5.39E-04	mg/L	M	N/A	cm/hr	3.18E-05	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	(Total)												0.00E+00
												Total Risk Across All Exposure Routes/Pathways	0.0E+00

-- = Not Available
N/A = Not Applicable
(1) Medium-Specific (M) EPC selected for risk calculation.

TABLE 8.2.CT
CALCULATION OF CANCER RISKS FOR RESIDENTIAL EXPOSURE TO GROUNDWATER
NORTH DOWNGRADIENT SECTOR
CENTRAL TENDENCY
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Scenario Timeframe: Current/ Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Ingestion, Dermal and Inhalation
Receptor Population: Resident
Receptor Age: Children & Adults

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Permeability Constant (PC)	PC Units	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Ingestion	1,2-Dichloroethane	1.18E+02	ug/L	1.18E-01	mg/L	M	N/A	cm/hr	6.60E-04	mg/kg-day	9.10E-02	(mg/kg-day) -1	6.00E-05
	4-Methyl-2-Pentanone	8.47E+00	ug/L	8.47E-03	mg/L	M	N/A	cm/hr	4.73E-05	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	Benzene	2.56E+01	ug/L	2.56E-02	mg/L	M	N/A	cm/hr	1.43E-04	mg/kg-day	2.90E-02	(mg/kg-day) -1	4.15E-06
	Carbon Tetrachloride	1.25E+01	ug/L	1.25E-02	mg/L	M	N/A	cm/hr	6.99E-05	mg/kg-day	1.30E-01	(mg/kg-day) -1	9.08E-06
	Carbon Disulfide	1.41E+00	ug/L	1.41E-03	mg/L	M	N/A	cm/hr	7.88E-06	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	Vinyl Chloride	1.19E+00	ug/L	1.19E-03	mg/L	M	N/A	cm/hr	6.65E-06	mg/kg-day	1.90E+00	(mg/kg-day) -1	1.26E-05
	Aluminum	1.94E-01	mg/L	1.94E-01	mg/L	M	N/A	cm/hr	1.08E-03	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	Manganese	1.71E-01	mg/L	1.71E-01	mg/L	M	N/A	cm/hr	9.56E-04	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	Nickel	5.80E-03	mg/L	5.80E-03	mg/L	M	N/A	cm/hr	3.24E-05	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	(Total)												8.59E-05
Dermal	1,2-Dichloroethane	1.18E+02	ug/L	1.18E-01	mg/L	M	5.3E-03	cm/hr	9.12E-06	mg/kg-day	9.10E-02	(mg/kg-day) -1	8.30E-07
	4-Methyl-2-Pentanone	8.47E+00	ug/L	8.47E-03	mg/L	M	3.0E-03	cm/hr	3.70E-07	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	Benzene	2.56E+01	ug/L	2.56E-02	mg/L	M	2.1E-02	cm/hr	7.84E-06	mg/kg-day	2.90E-02	(mg/kg-day) -1	2.27E-07
	Carbon Tetrachloride	1.25E+01	ug/L	1.25E-02	mg/L	M	2.2E-02	cm/hr	4.01E-06	mg/kg-day	1.30E-01	(mg/kg-day) -1	5.21E-07
	Carbon Disulfide	1.41E+00	ug/L	1.41E-03	mg/L	M	2.4E-02	cm/hr	4.93E-07	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	Vinyl Chloride	1.19E+00	ug/L	1.19E-03	mg/L	M	7.3E-03	cm/hr	1.27E-07	mg/kg-day	1.90E+00	(mg/kg-day) -1	2.41E-07
	Aluminum	1.94E-01	mg/L	1.94E-01	mg/L	M	1.0E-03	cm/hr	2.83E-06	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	Manganese	1.71E-01	mg/L	1.71E-01	mg/L	M	1.0E-03	cm/hr	2.49E-06	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	Nickel	5.80E-03	mg/L	5.80E-03	mg/L	M	1.0E-03	cm/hr	8.45E-08	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	(Total)												1.82E-06
Inhalation	1,2-Dichloroethane	1.18E+02	ug/L	1.18E-01	mg/L	M	N/A	cm/hr	3.33E-03	mg/kg-day	9.10E-02	(mg/kg-day) -1	3.03E-04
	4-Methyl-2-Pentanone	8.47E+00	ug/L	8.47E-03	mg/L	M	N/A	cm/hr	2.39E-04	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	Benzene	2.56E+01	ug/L	2.56E-02	mg/L	M	N/A	cm/hr	7.23E-04	mg/kg-day	2.90E-02	(mg/kg-day) -1	2.10E-05
	Carbon Tetrachloride	1.25E+01	ug/L	1.25E-02	mg/L	M	N/A	cm/hr	3.53E-04	mg/kg-day	5.30E-02	(mg/kg-day) -1	1.87E-05
	Carbon Disulfide	1.41E+00	ug/L	1.41E-03	mg/L	M	N/A	cm/hr	3.98E-05	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	Vinyl Chloride	1.19E+00	ug/L	1.19E-03	mg/L	M	N/A	cm/hr	3.36E-05	mg/kg-day	3.00E-01	(mg/kg-day) -1	1.01E-05
	(Total)												3.53E-04

Total Hazard Index Across All Exposure Routes/Pathways 4.4E-04

-- = Not Available
N/A = Not Applicable
(1) Medium-Specific (M) EPC selected for risk calculation.

TABLE 8.2.RME
CALCULATION OF CANCER RISKS FOR RESIDENTIAL EXPOSURE TO GROUNDWATER
NORTH DOWNGRADIENT SECTOR
REASONABLE MAXIMUM EXPOSURE
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Scenario Timeframe: Current/ Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Ingestion, Dermal and Inhalation
Receptor Population: Resident
Receptor Age: Children & Adults

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Permeability Constant (PC)	PC Units	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Ingestion	1,2-Dichloroethane	3.90E+02	ug/L	3.90E-01	mg/L	M	N/A	cm/hr	7.60E-03	mg/kg-day	9.10E-02	(mg/kg-day) -1	8.92E-04
	4-Methyl-2-Pentanone	8.86E+00	ug/L	8.86E-03	mg/L	M	N/A	cm/hr	1.73E-04	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	Benzene	1.24E+01	ug/L	1.24E-02	mg/L	M	N/A	cm/hr	2.42E-04	mg/kg-day	2.90E-02	(mg/kg-day) -1	7.01E-06
	Carbon Tetrachloride	6.01E+00	ug/L	6.01E-03	mg/L	M	N/A	cm/hr	1.17E-04	mg/kg-day	1.30E-01	(mg/kg-day) -1	1.52E-05
	Carbon Disulfide	1.33E+00	ug/L	1.33E-03	mg/L	M	N/A	cm/hr	2.59E-05	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	Vinyl Chloride	1.30E+00	ug/L	1.30E-03	mg/L	M	N/A	cm/hr	2.53E-05	mg/kg-day	1.90E+00	(mg/kg-day) -1	4.81E-05
	Aluminum	2.52E-01	mg/L	2.52E-01	mg/L	M	N/A	cm/hr	4.91E-03	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	Manganese	3.06E-01	mg/L	3.06E-01	mg/L	M	N/A	cm/hr	5.96E-03	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	Nickel	6.69E-03	mg/L	6.69E-03	mg/L	M	N/A	cm/hr	1.30E-04	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	(Total)												7.62E-04
Dermal	1,2-Dichloroethane	3.90E+02	ug/L	3.90E-01	mg/L	M	5.3E-03	cm/hr	2.09E-04	mg/kg-day	9.10E-02	(mg/kg-day) -1	1.90E-05
	4-Methyl-2-Pentanone	8.86E+00	ug/L	8.86E-03	mg/L	M	3.0E-03	cm/hr	2.69E-06	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	Benzene	1.24E+01	ug/L	1.24E-02	mg/L	M	2.1E-02	cm/hr	2.63E-05	mg/kg-day	2.90E-02	(mg/kg-day) -1	7.63E-07
	Carbon Tetrachloride	6.01E+00	ug/L	6.01E-03	mg/L	M	2.2E-02	cm/hr	1.34E-06	mg/kg-day	1.30E-01	(mg/kg-day) -1	1.74E-06
	Carbon Disulfide	1.33E+00	ug/L	1.33E-03	mg/L	M	2.4E-02	cm/hr	3.22E-06	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	Vinyl Chloride	1.30E+00	ug/L	1.30E-03	mg/L	M	7.3E-03	cm/hr	9.59E-07	mg/kg-day	1.90E+00	(mg/kg-day) -1	1.82E-06
	Aluminum	2.52E-01	mg/L	2.52E-01	mg/L	M	1.0E-03	cm/hr	2.55E-05	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	Manganese	3.06E-01	mg/L	3.06E-01	mg/L	M	1.0E-03	cm/hr	3.09E-05	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	Nickel	6.69E-03	mg/L	6.69E-03	mg/L	M	1.0E-03	cm/hr	6.76E-07	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	(Total)												2.33E-05
Inhalation	1,2-Dichloroethane	3.90E+02	ug/L	3.90E-01	mg/L	M	N/A	cm/hr	2.30E-02	mg/kg-day	9.10E-02	(mg/kg-day) -1	2.10E-03
	4-Methyl-2-Pentanone	8.86E+00	ug/L	8.86E-03	mg/L	M	N/A	cm/hr	5.23E-04	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	Benzene	1.24E+01	ug/L	1.24E-02	mg/L	M	N/A	cm/hr	7.32E-04	mg/kg-day	2.90E-02	(mg/kg-day) -1	2.12E-05
	Carbon Tetrachloride	6.01E+00	ug/L	6.01E-03	mg/L	M	N/A	cm/hr	3.55E-04	mg/kg-day	5.30E-02	(mg/kg-day) -1	1.88E-05
	Carbon Disulfide	1.33E+00	ug/L	1.33E-03	mg/L	M	N/A	cm/hr	7.86E-05	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	Vinyl Chloride	1.30E+00	ug/L	1.30E-03	mg/L	M	N/A	cm/hr	7.68E-05	mg/kg-day	3.00E-01	(mg/kg-day) -1	2.30E-05
	(Total)												2.16E-03
												Total Hazard Index Across All Exposure Routes/Pathways	2.9E-03

-- = Not Available
N/A = Not Applicable
(1) Medium-Specific (M) EPC selected for risk calculation.

TABLE 8.3.CT
CALCULATION OF CANCER RISKS FOR RESIDENTIAL IRRIGATION USE SCENARIO
EAST DOWNGRADIENT SECTOR
CENTRAL TENDENCY
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Scenario Timeframe: Current/ Future
Medium: Groundwater for Irrigation Use
Exposure Medium: Fruits/Vegetables
Exposure Point: Ingestion
Receptor Population: Resident
Receptor Age: Children & Adults

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Ingestion	4-Methyl-2-Pentanone	5.14E+00	ug/L	5.14E-03	mg/L	M	3.89E-07	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	Bromomethane	5.18E-01	ug/L	5.18E-04	mg/L	M	3.92E-08	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	(Total)										0.00E+00

Total Hazard Index Across All Exposure Routes/Pathways 0.0E+00

-- = Not Available
(1) Medium-Specific (M) EPC selected for hazard calculation.

TABLE 8.3.RME
CALCULATION OF CANCER RISKS FOR RESIDENTIAL IRRIGATION USE SCENARIO
EAST DOWNGRADIENT SECTOR
REASONABLE MAXIMUM EXPOSURE
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Scenario Timeframe: Current/ Future
Medium: Groundwater for Irrigation Use
Exposure Medium: Fruits/Vegetables
Exposure Point: Ingestion
Receptor Population: Resident
Receptor Age: Children & Adults

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Ingestion	4-Methyl-2-Pentanone	5.30E+00	ug/L	5.30E-03	mg/L	M	6.62E-06	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	Bromomethane	5.39E-01	ug/L	5.39E-04	mg/L	M	6.73E-07	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	(Total)										0.00E+00
										Total Hazard Index Across All Exposure Routes/Pathways	0.0E+00

-- = Not Available
(1) Medium-Specific (M) EPC selected for hazard calculation.

TABLE 8.4.CT
CALCULATION OF CANCER RISKS FOR RESIDENTIAL IRRIGATION USE SCENARIO
NORTH DOWNGRADIENT SECTOR
CENTRAL TENDENCY
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Scenario Timeframe: Current/ Future
Medium: Groundwater for Irrigation Use
Exposure Medium: Fruits/Vegetables
Exposure Point: Ingestion
Receptor Population: Resident
Receptor Age: Children & Adults

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Ingestion	1,2-Dichloroethane	1.18E+02	ug/L	1.18E-01	mg/L	M	8.94E-06	mg/kg-day	9.10E-02	(mg/kg-day) -1	8.14E-07
	4-Methyl-2-Pentanone	8.47E+00	ug/L	8.47E-03	mg/L	M	6.42E-07	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	Benzene	2.56E+01	ug/L	2.56E-02	mg/L	M	1.94E-06	mg/kg-day	2.90E-02	(mg/kg-day) -1	5.63E-08
	Carbon Tetrachloride	1.25E+01	ug/L	1.25E-02	mg/L	M	9.47E-07	mg/kg-day	1.30E-01	(mg/kg-day) -1	1.23E-07
	Carbon Disulfide	1.41E+00	ug/L	1.41E-03	mg/L	M	1.07E-07	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	Vinyl Chloride	1.19E+00	ug/L	1.19E-03	mg/L	M	9.02E-08	mg/kg-day	1.90E+00	(mg/kg-day) -1	1.71E-07
	Aluminum	1.94E-01	mg/L	1.94E-01	mg/L	M	1.47E-05	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	Manganese	1.71E-01	mg/L	1.71E-01	mg/L	M	1.30E-05	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	Nickel	5.80E-03	mg/L	5.80E-03	mg/L	M	4.39E-07	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	(Total)										1.16E-06
										Total Hazard Index Across All Exposure Routes/Pathways (includes total metals)	1.2E-06

-- = Not Available
(1) Medium-Specific (M) EPC selected for hazard calculation.

TABLE 8.4.RME
CALCULATION OF CANCER RISKS FOR RESIDENTIAL IRRIGATION USE SCENARIO
NORTH DOWNGRADIENT SECTOR
REASONABLE MAXIMUM EXPOSURE
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Scenario Timeframe: Current/ Future
Medium: Groundwater for Irrigation Use
Exposure Medium: Fruits/Vegetables
Exposure Point: Ingestion
Receptor Population: Resident
Receptor Age: Children & Adults

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Ingestion	1,2-Dichloroethane	1.18E+02	ug/L	1.18E-01	mg/L	M	1.47E-04	mg/kg-day	9.10E-02	(mg/kg-day) -1	1.34E-05
	4-Methyl-2-Pentanone	8.47E+00	ug/L	8.47E-03	mg/L	M	1.06E-05	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	Benzene	2.56E+01	ug/L	2.56E-02	mg/L	M	3.20E-05	mg/kg-day	2.90E-02	(mg/kg-day) -1	9.27E-07
	Carbon Tetrachloride	1.25E+01	ug/L	1.25E-02	mg/L	M	1.56E-05	mg/kg-day	1.30E-01	(mg/kg-day) -1	2.03E-06
	Carbon Disulfide	1.33E+00	ug/L	1.33E-03	mg/L	M	1.66E-06	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	Vinyl Chloride	1.30E+00	ug/L	1.30E-03	mg/L	M	1.62E-06	mg/kg-day	1.90E+00	(mg/kg-day) -1	3.08E-06
	Aluminum	2.52E-01	mg/L	2.52E-01	mg/L	M	3.15E-04	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	Manganese	3.06E-01	mg/L	3.06E-01	mg/L	M	3.82E-04	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	Nickel	6.69E-03	mg/L	6.69E-03	mg/L	M	8.35E-06	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	(Total)										1.94E-05
										Total Hazard Index Across All Exposure Routes/Pathways	1.9E-05

-- = Not Available
(1) Medium-Specific (M) EPC selected for hazard calculation.

TABLE 8.5.CT
CALCULATION OF CANCER RISKS FOR WORKER EXPOSURE TO VOLATILE EMISSIONS FROM IRRIGATION SYSTEM
EAST DOWNGRADIENT SECTOR
CENTRAL TENDENCY
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Scenario Timeframe: Current/ Future
Medium: Groundwater
Exposure Medium: Ambient Air
Exposure Point: Inhalation
Receptor Population: Worker
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Inhalation	4-Methyl-2-Pentanone	5.30E+00	ug/L	1.10E-03	mg/m3	R	6.45E-07	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	Bromomethane	5.39E-01	ug/L	1.11E-04	mg/m3	R	6.54E-08	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	(Total)										0.00E+00
										Total Risk Across All Exposure Routes/Pathways	0.0E+00

-- = Not Available
N/A = Not Applicable
(1) Route-Specific (R) EPC selected for risk calculation.

TABLE 8.5.RME
CALCULATION OF CANCER RISKS FOR WORKER EXPOSURE TO VOLATILE EMISSIONS FROM IRRIGATION SYSTEM
EAST DOWNGRADIENT SECTOR
REASONABLE MAXIMUM EXPOSURE
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Scenario Timeframe: Current/ Future
Medium: Groundwater
Exposure Medium: Ambient Air
Exposure Point: Inhalation
Receptor Population: Worker
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Inhalation	4-Methyl-2-Pentanone	5.30E+00	ug/L	1.10E-03	mg/m3	R	1.94E-05	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	Bromomethane	5.39E-01	ug/L	1.11E-04	mg/m3	R	1.95E-06	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	(Total)										0.00E+00
										Total Risk Across All Exposure Routes/Pathways	0.0E+00

-- = Not Available
N/A = Not Applicable
(1) Route-Specific (R) EPC selected for risk calculation.

TABLE 8.6.CT
CALCULATION OF CANCER RISKS FOR WORKER EXPOSURE TO VOLATILE EMISSIONS FROM IRRIGATION SYSTEM
NORTH DOWNGRADIENT SECTOR
CENTRAL TENDENCY
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Scenario Timeframe: Current/ Future
Medium: Groundwater
Exposure Medium: Ambient Air
Exposure Point: Inhalation
Receptor Population: Worker
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Inhalation	1,2-Dichloroethane	3.90E+02	ug/L	8.06E-02	mg/m3	R	4.75E-05	mg/kg-day	9.10E-02	(mg/kg-day) -1	4.32E-06
	4-Methyl-2-Pentanone	8.86E+00	ug/L	1.83E-03	mg/m3	R	1.08E-06	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	Benzene	1.24E+01	ug/L	2.56E-03	mg/m3	R	1.51E-06	mg/kg-day	2.90E-02	(mg/kg-day) -1	4.38E-08
	Carbon Tetrachloride	6.01E+00	ug/L	1.24E-03	mg/m3	R	7.31E-07	mg/kg-day	5.30E-02	(mg/kg-day) -1	3.88E-08
	Carbon Disulfide	1.33E+00	ug/L	2.75E-04	mg/m3	R	1.62E-07	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	Vinyl Chloride	1.30E+00	ug/L	2.69E-04	mg/m3	R	1.58E-07	mg/kg-day	3.00E-01	(mg/kg-day) -1	4.75E-08
	(Total)										4.45E-06
										Total Risk Across All Exposure Routes/Pathways	4.4E-06

-- = Not Available
N/A = Not Applicable
(1) Route-Specific (R) EPC selected for risk calculation.

TABLE 8.6.RME
CALCULATION OF CANCER RISKS FOR WORKER EXPOSURE TO VOLATILE EMISSIONS FROM IRRIGATION SYSTEM
NORTH DOWNGRADIENT SECTOR
REASONABLE MAXIMUM EXPOSURE
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Scenario Timeframe: Current/ Future
Medium: Groundwater
Exposure Medium: Ambient Air
Exposure Point: Inhalation
Receptor Population: Worker
Receptor Age: Adult

Exposure Route	Chemical of Potential Concern	Medium EPC Value	Medium EPC Units	Route EPC Value	Route EPC Units	EPC Selected for Risk Calculation (1)	Intake (Cancer)	Intake (Cancer) Units	Cancer Slope Factor	Cancer Slope Factor Units	Cancer Risk
Inhalation	1,2-Dichloroethane	3.90E+02	ug/L	8.06E-02	mg/m3	R	1.42E-03	mg/kg-day	9.10E-02	(mg/kg-day) -1	1.29E-04
	4-Methyl-2-Pentanone	8.86E+00	ug/L	1.83E-03	mg/m3	R	3.22E-05	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	Benzene	1.24E+01	ug/L	2.56E-03	mg/m3	R	4.51E-05	mg/kg-day	2.90E-02	(mg/kg-day) -1	1.31E-06
	Carbon Tetrachloride	6.01E+00	ug/L	1.24E-03	mg/m3	R	2.18E-05	mg/kg-day	5.30E-02	(mg/kg-day) -1	1.16E-06
	Carbon Disulfide	1.33E+00	ug/L	2.75E-04	mg/m3	R	4.84E-06	mg/kg-day	--	(mg/kg-day) -1	0.00E+00
	Vinyl Chloride	1.30E+00	ug/L	2.69E-04	mg/m3	R	4.74E-06	mg/kg-day	3.00E-01	(mg/kg-day) -1	1.42E-06
	(Total)										1.33E-04
										Total Risk Across All Exposure Routes/Pathways	1.3E-04

-- = Not Available
N/A = Not Applicable
(1) Route-Specific (R) EPC selected for risk calculation.

TABLE 9.1.CT

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs IN GROUNDWATER

EAST DOWNGRADIENT SECTOR

CENTRAL TENDENCY

FOUR COUNTY LANDFILL

FULTON COUNTY, INDIANA

Scenario Timeframe: Current/ Future
Receptor Population: Residents
Receptor Age: Children & Adults

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient								
										Child				Adult			
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	--	4-Methyl-2-Pentanone	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4-Methyl-2-Pentanone	liver	3.57E-03	7.15E-02	2.68E-05	7.51E-02	1.23E-03	2.64E-02	1.19E-05	2.76E-02
			Bromomethane	0.00E+00	0.00E+00	0.00E+00	0.00E+00	Bromomethane	gastrointestinal tract	2.06E-02	1.03E-01	1.80E-04	1.24E-01	7.10E-03	3.80E-02	7.98E-05	4.52E-02
Groundwater for Irrigation Use	Fruit/ Vegetables	--	4-Methyl-2-Pentanone	0.00E+00	--	--	0.00E+00	4-Methyl-2-Pentanone	liver	4.86E-05	--	--	4.86E-05	1.64E-05	--	--	1.64E-05
			Bromomethane	0.00E+00	--	--	0.00E+00	Bromomethane	gastrointestinal tract	2.80E-04	--	--	2.80E-04	9.47E-05	--	--	9.47E-05

Total Risk for Groundwater Potable Use: 0.0E+00

Total Risk for Irrigation Use: 0.0E+00

Total Risk Across All Media and All Exposure Routes: 0.0E+00

CHILD

Total Hazard Index Across All Media and All Exposure Routes: 2.0E-01

Total Liver HI = 7.5E-02

Total Gastrointestinal Tract HI = 1.2E-01

ADULT

Total Hazard Index Across All Media and All Exposure Routes: 7.3E-02

Total Liver HI = 2.8E-02

Total Gastrointestinal Tract HI = 4.5E-02

TABLE 9.1.RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs IN GROUNDWATER

EAST DOWNGRADIENT SECTOR

REASONABLE MAXIMUM EXPOSURE

FOUR COUNTY LANDFILL

FULTON COUNTY, INDIANA

Scenario Timeframe: Current/ Future
Receptor Population: Residents
Receptor Age: Children & Adults

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient								
										Child				Adult			
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	--	4-Methyl-2-Pentanone	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4-Methyl-2-Pentanone	liver	6.35E-03	7.37E-02	9.53E-05	8.01E-02	2.18E-03	2.72E-02	3.47E-05	2.94E-02
			Bromomethane	0.00E+00	0.00E+00	0.00E+00	0.00E+00	Bromomethane	gastrointestinal tract	3.69E-02	1.07E-01	6.46E-04	1.45E-01	1.27E-02	3.96E-02	2.36E-04	5.25E-02
Groundwater for Irrigation Use	Fruit/ Vegetables	--	4-Methyl-2-Pentanone	0.00E+00	--	--	0.00E+00	4-Methyl-2-Pentanone	liver	4.07E-04	--	--	4.07E-04	1.40E-04	--	--	1.40E-04
			Bromomethane	0.00E+00	--	--	0.00E+00	Bromomethane	gastrointestinal tract	2.37E-03	--	--	2.37E-03	8.11E-04	--	--	8.11E-04

Total Risk for Groundwater Potable Use: 0.0E+00

Total Risk for Irrigation Use: 0.0E+00

Total Risk Across All Media and All Exposure Routes: 0.0E+00

CHILD

Total Hazard Index Across All Media and All Exposure Routes: 2.3E-01

Total Liver HI = 8.1E-02

Total Gastrointestinal Tract HI = 1.5E-01

ADULT

Total Hazard Index Across All Media and All Exposure Routes: 8.3E-02

Total Liver HI = 3.0E-02

Total Gastrointestinal Tract HI = 5.3E-02

TABLE 5.2.CT

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs IN GROUNDWATER

NORTH DOWNGRADIENT SECTOR

CENTRAL TENDENCY

FOUR COUNTY LANDFILL

FULTON COUNTY, INDIANA

Scenario Timeframe: Current/ Future
Receptor Population: Resident
Receptor Age: Children & Adults

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient								
										Child				Adult			
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	–	1,2-Dichloroethane	6.00E-05	3.03E-04	8.30E-07	3.64E-04	1,2-Dichloroethane	–	2.19E-01	2.34E+01	2.90E-03	2.37E+01	7.54E-02	8.66E+00	1.29E-03	8.74E+00
			4-Methyl-2-Pentanone	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4-Methyl-2-Pentanone	liver	5.89E-03	1.18E-01	4.42E-05	1.24E-01	2.03E-03	4.35E-02	1.96E-05	4.56E-02
			Benzene	4.15E-06	2.10E-05	2.27E-07	2.53E-05	Benzene	–	4.75E-01	4.19E+00	2.50E-02	4.69E+00	1.64E-01	1.55E+00	1.10E-02	1.72E+00
			Carbon Tetrachloride	9.08E-06	1.87E-05	5.21E-07	2.83E-05	Carbon Tetrachloride	liver	9.93E-01	6.09E+00	5.47E-02	7.14E+00	3.42E-01	2.25E+00	2.42E-02	2.62E+00
			Carbon Disulfide	0.00E+00	0.00E+00	0.00E+00	0.00E+00	Carbon Disulfide	reproduction toxicity	7.84E-04	1.96E-03	4.71E-05	2.79E-03	2.70E-04	7.24E-04	2.09E-05	1.02E-03
			Vinyl Chloride	1.26E-05	1.01E-05	2.41E-07	2.30E-05	Vinyl Chloride	–	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
			Aluminum	0.00E+00	–	0.00E+00	0.00E+00	Aluminum	–	1.08E-02	–	2.70E-05	1.08E-02	3.72E-03	–	1.20E-05	3.73E-03
			Manganese	0.00E+00	–	0.00E+00	0.00E+00	Manganese	CNS	2.04E-01	–	1.27E-02	2.16E-01	7.02E-02	–	5.64E-03	7.59E-02
			Nickel	0.00E+00	–	0.00E+00	0.00E+00	Nickel	organ weights	1.61E-02	–	1.01E-03	1.71E-02	5.56E-03	–	4.47E-04	6.01E-03
Groundwater for Irrigation Use	Fruit/ Vegetables	–	1,2-Dichloroethane	8.14E-07	–	–	8.14E-07	1,2-Dichloroethane	–	2.97E-03	–	–	2.97E-03	1.01E-03	–	–	1.01E-03
			4-Methyl-2-Pentanone	0.00E+00	–	–	0.00E+00	4-Methyl-2-Pentanone	liver	8.00E-05	–	–	8.00E-05	2.71E-05	–	–	2.71E-05
			Benzene	5.63E-08	–	–	5.63E-08	Benzene	–	6.45E-03	–	–	6.45E-03	2.18E-03	–	–	2.18E-03
			Carbon Tetrachloride	1.23E-07	–	–	1.23E-07	Carbon Tetrachloride	liver	1.35E-02	–	–	1.35E-02	4.57E-03	–	–	4.57E-03
			Carbon Disulfide	0.00E+00	–	–	0.00E+00	Carbon Disulfide	reproduction toxicity	1.07E-05	–	–	1.07E-05	3.61E-06	–	–	3.61E-06
			Vinyl Chloride	1.71E-07	–	–	1.71E-07	Vinyl Chloride	–	0.00E+00	–	–	0.00E+00	0.00E+00	–	–	0.00E+00
			Aluminum	0.00E+00	–	–	0.00E+00	Aluminum	–	1.47E-04	–	–	1.47E-04	4.97E-05	–	–	4.97E-05
			Manganese	0.00E+00	–	–	0.00E+00	Manganese	CNS	2.77E-03	–	–	2.77E-03	9.37E-04	–	–	9.37E-04
			Nickel	0.00E+00	–	–	0.00E+00	Nickel	organ weights	2.19E-04	–	–	2.19E-04	7.42E-05	–	–	7.42E-05

Total Risk for Groundwater Potable Use: 4.4E-04

Total Risk for Irrigation Use: 1.2E-06

Total Risk Across All Media and All Exposure Routes: 4.4E-04

CHILD

Total Hazard Index Across All Media and All Exposure Routes: 3.6E+01

Total Liver HI = 7.3E+00

Total Reproduction Toxicity HI = 2.8E-03

Total CNS HI = 2.2E-01

Total Organ Weights HI = 1.7E-02

ADULT

Total Hazard Index Across All Media and All Exposure Routes: 1.3E+01

Total Liver HI = 2.7E+00

Total Reproduction Toxicity HI = 1.0E-03

Total CNS HI = 7.7E-02

Total Organ Weights HI = 6.0E-03

TABLE 9.2.RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs IN GROUNDWATER

NORTH DOWNGRADIENT SECTOR

REASONABLE MAXIMUM EXPOSURE

FOUR COUNTY LANDFILL

FULTON COUNTY, INDIANA

Scenario Timeframe: Current/ Future
Receptor Population: Resident
Receptor Age: Children & Adults

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient								
										Child				Adult			
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	--	1,2-Dichloroethane	6.92E-04	2.10E-03	1.90E-05	2.81E-03	1,2-Dichloroethane	--	1.25E+00	7.75E+01	3.30E-02	7.87E+01	4.27E-01	2.86E+01	1.20E-02	2.91E+01
			4-Methyl-2-Pentanone	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4-Methyl-2-Pentanone	liver	1.06E-02	1.23E-01	1.59E-04	1.34E-01	3.64E-03	4.55E-02	5.81E-05	4.92E-02
			Benzene	7.01E-06	2.12E-06	7.63E-07	2.90E-05	Benzene	--	3.96E-01	2.03E+00	4.16E-02	2.47E+00	1.36E-01	7.49E-01	1.52E-02	9.00E-01
			Carbon Tetrachloride	1.52E-05	1.88E-06	1.74E-06	3.58E-05	Carbon Tetrachloride	liver	8.23E-01	2.93E+00	9.06E-02	3.84E+00	2.82E-01	1.08E+00	3.30E-02	1.40E+00
			Carbon Disulfide	0.00E+00	0.00E+00	0.00E+00	0.00E+00	Carbon Disulfide	reproduction toxicity	1.28E-03	1.85E-03	1.53E-04	3.28E-03	4.37E-04	6.83E-04	5.58E-05	1.18E-03
			Vinyl Chloride	4.81E-05	2.30E-05	1.82E-06	7.30E-05	Vinyl Chloride	--	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
			Aluminum	0.00E+00	--	0.00E+00	0.00E+00	Aluminum	--	2.42E-02	--	1.21E-04	2.43E-02	8.28E-03	--	4.40E-05	8.33E-03
			Manganese	0.00E+00	--	0.00E+00	0.00E+00	Manganese	CNS	6.28E-01	--	7.85E-02	7.07E-01	2.15E-01	--	2.86E-02	2.44E-01
			Nickel	0.00E+00	--	0.00E+00	0.00E+00	Nickel	organ weights	3.21E-02	--	4.01E-03	3.61E-02	1.10E-02	--	1.46E-03	1.25E-02
Groundwater for Irrigation Use	Fruit/ Vegetables	--	1,2-Dichloroethane	1.34E-05	--	--	1.34E-05	1,2-Dichloroethane	--	7.99E-02	--	--	7.99E-02	2.74E-02	--	--	2.74E-02
			4-Methyl-2-Pentanone	0.00E+00	--	--	0.00E+00	4-Methyl-2-Pentanone	liver	6.81E-04	--	--	6.81E-04	2.33E-04	--	--	2.33E-04
			Benzene	9.27E-07	--	--	9.27E-07	Benzene	--	2.54E-02	--	--	2.54E-02	8.70E-03	--	--	8.70E-03
			Carbon Tetrachloride	2.03E-06	--	--	2.03E-06	Carbon Tetrachloride	liver	5.28E-02	--	--	5.28E-02	1.81E-02	--	--	1.81E-02
			Carbon Disulfide	0.00E+00	--	--	0.00E+00	Carbon Disulfide	reproduction toxicity	8.17E-05	--	--	8.17E-05	2.80E-05	--	--	2.80E-05
			Vinyl Chloride	3.08E-06	--	--	3.08E-06	Vinyl Chloride	--	0.00E+00	--	--	0.00E+00	0.00E+00	--	--	0.00E+00
			Aluminum	0.00E+00	--	--	0.00E+00	Aluminum	--	1.55E-03	--	--	1.55E-03	5.31E-04	--	--	5.31E-04
			Manganese	0.00E+00	--	--	0.00E+00	Manganese	CNS	4.03E-02	--	--	4.03E-02	1.38E-02	--	--	1.38E-02
			Nickel	0.00E+00	--	--	0.00E+00	Nickel	organ weights	2.06E-03	--	--	2.06E-03	7.04E-04	--	--	7.04E-04

Total Risk for Groundwater Potable Use: 2.9E-03

Total Risk for Irrigation Use: 1.9E-05

Total Risk Across All Media and All Exposure Routes: 3.0E-03

CHILD

Total Hazard Index Across All Media and All Exposure Routes: 8.6E+01

Total Liver HI = 4.0E+00
Total Reproduction Toxicity HI = 3.4E-03
Total CNS HI = 7.5E-01
Total Organ Weights HI = 3.8E-02

ADULT

Total Hazard Index Across All Media and All Exposure Routes: 3.2E+01

Total Liver HI = 1.5E+00
Total Reproduction Toxicity HI = 1.2E-03
Total CNS HI = 2.6E-01
Total Organ Weights HI = 1.3E-02

TABLE 9.3.CT

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs IN GROUNDWATER

EAST DOWNGRADIENT SECTOR

CENTRAL TENDENCY

FOUR COUNTY LANDFILL

FULTON COUNTY, INDIANA

Scenario Timeframe: Current/ Future
Receptor Population: Construction Worker
Receptor Age: Adults

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	--	4-Methyl-2-Pentanone	--	0.00E+00	--	0.00E+00	4-Methyl-2-Pentanone	liver	--	2.52E-04	--	2.52E-04
			Bromomethane	--	0.00E+00	--	0.00E+00	Bromomethane	gastrointestinal tract	--	3.63E-04	--	3.63E-04
							Total Risk for Groundwater Potable Use: 0.0E+00						Total Hazard Index Across All Media and All Exposure Routes: 6.2E-04

Total Risk Across All Media and All Exposure Routes: 0.0E+00

Total Liver HI (includes total metals) = 2.5E-04

Total Gastrointestinal Tract HI (includes total metals) = 3.6E-04

TABLE 9.3.RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs IN GROUNDWATER

EAST DOWNGRADIENT SECTOR

REASONABLE MAXIMUM EXPOSURE

FOUR COUNTY LANDFILL

FULTON COUNTY, INDIANA

Scenario Timeframe: Current/ Future
Receptor Population: Construction Worker
Receptor Age: Adults

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	--	4-Methyl-2-Pentanone	--	0.00E+00	--	0.00E+00	4-Methyl-2-Pentanone	liver	--	7.51E-03	--	7.51E-03
			Bromomethane	--	0.00E+00	--	0.00E+00	Bromomethane	gastrointestinal tract	--	1.09E-02	--	1.09E-02
						Total Risk for Groundwater Potable Use	0.0E+00					Total Hazard Index Across All Media and All Exposure Routes	1.8E-02

Total Risk Across All Media and All Exposure Routes: 0.0E+00

Total Liver HI (includes total metals) = 7.5E-03

Total Gastrointestinal Tract HI (includes total metals) = 1.1E-02

TABLE 9.4.CT

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs IN GROUNDWATER

NORTH DOWNGRADIENT SECTOR

CENTRAL TENDENCY

FOUR COUNTY LANDFILL

FULTON COUNTY, INDIANA

Scenario Timeframe: Current/ Future
Receptor Population: Construction Worker
Receptor Age: Adults

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	--	1,2-Dichloroethane	--	4.32E-06	--	4.32E-06	1,2-Dichloroethane	--	--	2.64E-01	--	2.64E-01
			4-Methyl-2-Pentanone	--	0.00E+00	--	0.00E+00	4-Methyl-2-Pentanone	liver	--	4.19E-04	--	4.19E-04
			Benzene	--	4.38E-08	--	4.38E-08	Benzene	--	--	6.90E-03	--	6.90E-03
			Carbon Tetrachloride	--	3.88E-08	--	3.88E-08	Carbon Tetrachloride	--	--	9.96E-03	--	9.96E-03
			Carbon Disulfide	--	0.00E+00	--	0.00E+00	Carbon Disulfide	reproduction toxicity	--	6.30E-06	--	6.30E-06
			Vinyl Chloride	--	4.75E-08	--	4.75E-08	Vinyl Chloride	--	--	0.00E+00	--	0.00E+00
						Total Risk for Groundwater Potable Use	4.5E-06					Total Hazard Index Across All Media and All Exposure Routes	2.8E-01

Total Risk Across All Media and All Exposure Routes: 4.5E-06

Total Liver HI (includes total metals) = 4.2E-04

Total Reproduction Toxicity HI (includes total metals) = 6.3E-06

TABLE 9.4.RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs IN GROUNDWATER

NORTH DOWNGRADIENT SECTOR

REASONABLE MAXIMUM EXPOSURE

FOUR COUNTY LANDFILL

FULTON COUNTY, INDIANA

Scenario Timeframe: Current/ Future
Receptor Population: Construction Worker
Receptor Age: Adults

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	--	1,2-Dichloroethane	--	1.29E-04	--	1.29E-04	1,2-Dichloroethane	--	--	2.84E+00	--	2.84E+00
			4-Methyl-2-Pentanone	--	0.00E+00	--	0.00E+00	4-Methyl-2-Pentanone	liver	--	4.51E-03	--	4.51E-03
			Benzene	--	1.31E-06	--	1.31E-06	Benzene	--	--	7.43E-02	--	7.43E-02
			Carbon Tetrachloride	--	1.16E-06	--	1.16E-06	Carbon Tetrachloride	--	--	1.07E-01	--	1.07E-01
			Carbon Disulfide	--	0.00E+00	--	0.00E+00	Carbon Disulfide	reproduction toxicity	--	6.78E-05	--	6.78E-05
			Vinyl Chloride	--	1.42E-06	--	1.42E-06	Vinyl Chloride	--	--	0.00E+00	--	0.00E+00
						Total Risk for Groundwater Potable Use	1.3E-04					Total Hazard Index Across All Media and All Exposure Routes	3.0E+00

Total Risk Across All Media and All Exposure Routes: 1.3E-04

Total Liver HI (includes total metals) = 4.5E-03

Total Reproduction Toxicity HI (includes total metals) = 6.8E-05

TABLE 10.1.CT

RISK ASSESSMENT SUMMARY FOR OFF-SITE GROUNDWATER

NORTH DOWNGRADIENT SECTOR

CENTRAL TENDENCY

FOUR COUNTY LANDFILL

FULTON COUNTY, INDIANA

Scenario Timeframe: Current/ Future
Receptor Population: Resident
Receptor Age: Children & Adults

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient								
										Child				Adult			
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	--	1,2-Dichloroethane	6.00E-05	3.03E-04	8.30E-07	3.64E-04	1,2-Dichloroethane	--	2.19E-01	2.34E+01	2.90E-03	2.37E+01	7.54E-02	8.66E+00	1.29E-03	8.74E+00
			Benzene	4.15E-06	2.10E-05	2.27E-07	2.53E-05	Benzene	--	4.75E-01	4.19E+00	2.50E-02	4.69E+00	1.64E-01	1.55E+00	1.10E-02	1.72E+00
			Carbon Tetrachloride	9.08E-06	1.87E-05	5.21E-07	2.83E-05	Carbon Tetrachloride	liver	9.93E-01	6.09E+00	5.47E-02	7.14E+00	3.42E-01	2.25E+00	2.42E-02	2.62E+00
			Vinyl Chloride	1.26E-05	1.01E-05	2.41E-07	2.30E-05	Vinyl Chloride	--	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Total Risk for Groundwater Potable Use: 4.4E-04

Total Risk Across All Media and All Exposure Routes: 4.4E-04

CHILD

Total Hazard Index Across All Media and All Exposure Routes: 3.5E+01

Total Liver HI = 7.1E+00

ADULT

Total Hazard Index Across All Media and All Exposure Routes: 1.3E+01

Total Liver HI = 2.6E+00

TABLE 10.1.RME

RISK ASSESSMENT SUMMARY FOR OFF-SITE GROUNDWATER

NORTH DOWNGRADIENT SECTOR

REASONABLE MAXIMUM EXPOSURE

FOUR COUNTY LANDFILL

FULTON COUNTY, INDIANA

Scenario Timeframe: Current/ Future
Receptor Population: Resident
Receptor Age: Children & Adults

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient								
										Child				Adult			
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	--	1,2-Dichloroethane	6.92E-04	2.10E-03	1.90E-05	2.81E-03	1,2-Dichloroethane	--	1.25E+00	7.75E+01	3.30E-02	7.87E+01	4.27E-01	2.86E+01	1.20E-02	2.91E+01
			Benzene	7.01E-06	2.12E-05	7.63E-07	2.90E-05	Benzene	--	3.96E-01	2.03E+00	4.16E-02	2.47E+00	1.36E-01	7.49E-01	1.52E-02	9.00E-01
			Carbon Tetrachloride	1.52E-05	1.88E-05	1.74E-06	3.58E-05	Carbon Tetrachloride	liver	8.23E-01	2.93E+00	9.06E-02	3.84E+00	2.82E-01	1.08E+00	3.30E-02	1.40E+00
			Vinyl Chloride	4.81E-05	2.30E-05	1.82E-06	7.30E-05	Vinyl Chloride	--	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Groundwater for Irrigation Use	Fruit/ Vegetables	--	1,2-Dichloroethane	1.34E-05	--	--	1.34E-05	1,2-Dichloroethane	--	7.99E-02	--	--	7.99E-02	2.74E-02	--	--	2.74E-02
			Carbon Tetrachloride	2.03E-06	--	--	2.03E-06	Carbon Tetrachloride	liver	5.28E-02	--	--	5.28E-02	1.81E-02	--	--	1.81E-02
			Vinyl Chloride	3.08E-06	--	--	3.08E-06	Vinyl Chloride	--	0.00E+00	--	--	0.00E+00	0.00E+00	--	--	0.00E+00

Total Risk for Groundwater Potable Use: 2.9E-03

Total Risk for Irrigation Use: 1.9E-05

Total Risk Across All Media and All Exposure Routes: 3.0E-03

CHILD

Total Hazard Index Across All Media and All Exposure Routes: 8.5E+01

Total Liver HI = 3.9E+00

ADULT

Total Hazard Index Across All Media and All Exposure Routes: 3.1E+01

Total Liver HI = 1.4E+00

TABLE 10.2.CT
RISK ASSESSMENT SUMMARY FOR OFF-SITE GROUNDWATER
NORTH DOWNGRADIENT SECTOR
CENTRAL TENDENCY
FOUR COUNTY LANDFILL
FULTON COUNTY, INDIANA

Scenario Timeframe: Current/ Future
Receptor Population: Construction Worker
Receptor Age: Adults

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	--	1,2-Dichloroethane	--	4.32E-06	--	4.32E-06	1,2-Dichloroethane	--	--	2.64E-01	--	2.64E-01
						Total Risk for Groundwater Potable Use	4.3E-06					Total Hazard Index Across All Media and All Exposure Routes	2.6E-01

Total Risk Across All Media and All Exposure Routes 4.3E-06

TABLE 10.2.RME

RISK ASSESSMENT SUMMARY FOR OFF-SITE GROUNDWATER

NORTH DOWNGRADIENT SECTOR

REASONABLE MAXIMUM EXPOSURE

FOUR COUNTY LANDFILL

FULTON COUNTY, INDIANA

Scenario Timeframe: Current/ Future
Receptor Population: Construction Worker
Receptor Age: Adults

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	--	1,2-Dichloroethane	--	1.29E-04	--	1.29E-04	1,2-Dichloroethane	--	--	2.84E+00	--	2.84E+00
			Benzene	--	1.31E-06	--	1.31E-06	Benzene	--	--	7.43E-02	--	7.43E-02
			Carbon Tetrachloride	--	1.16E-06	--	1.16E-06	Carbon Tetrachloride	--	--	1.07E-01	--	1.07E-01
			Vinyl Chloride	--	1.42E-06	--	1.42E-06	Vinyl Chloride	--	--	0.00E+00	--	0.00E+00
						Total Risk for Groundwater Potable Use	1.3E-04					Total Hazard Index Across All Media and All Exposure Routes	3.0E+00

Total Risk Across All Media and All Exposure Routes: 1.3E-04

APPENDIX E

GROUNDWATER PUMPAGE CALCULATIONS

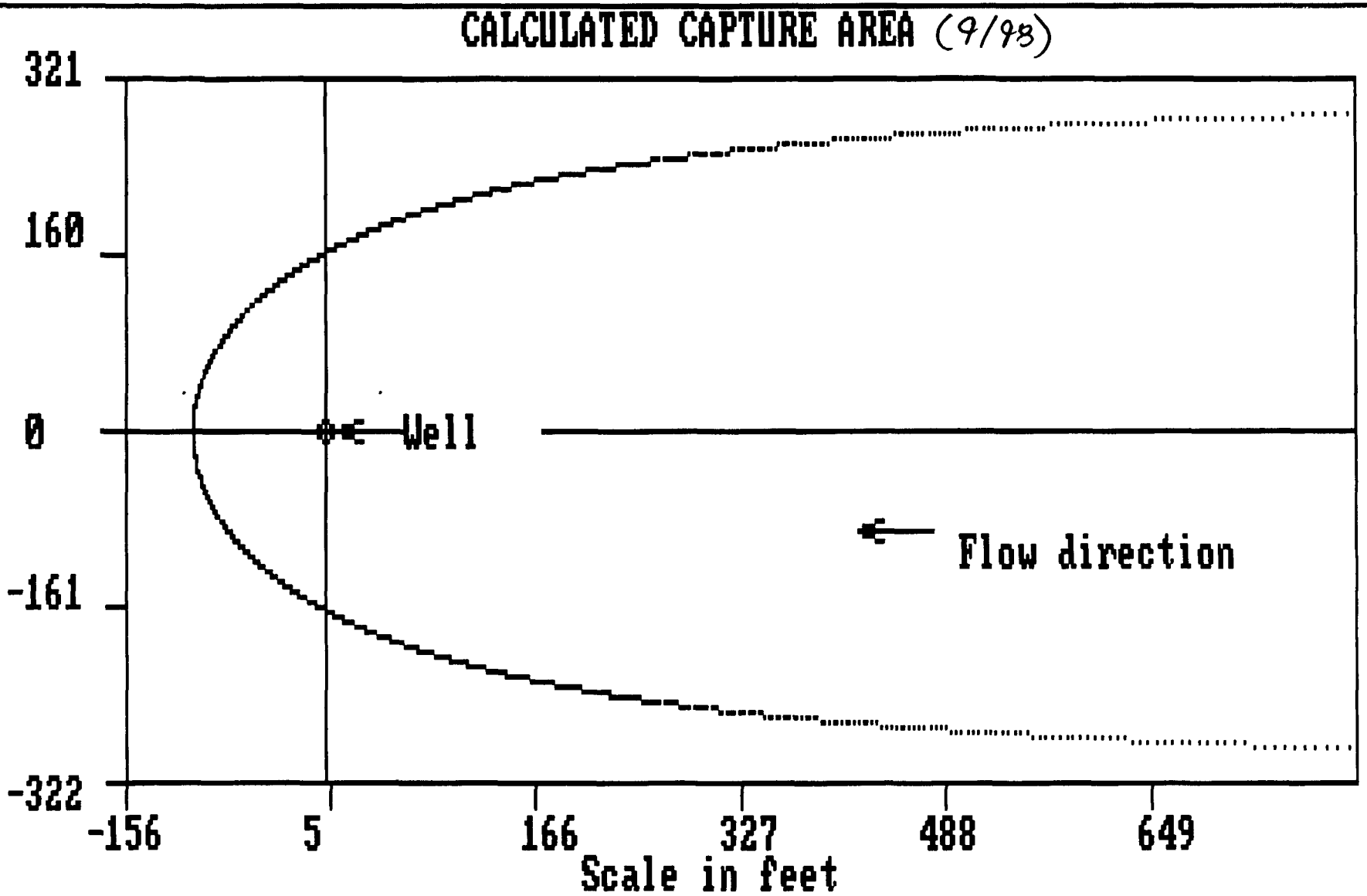
DATA: (9/98)

Confined or unconfined aquifer (C or U)?	u	u
Units of length (L):	feet	f
Units of time (T):	day	d
Hydraulic conductivity (K) (feet/day)	136	1
Pumping rate (Q) (cubic feet/day)	26343	2
Aquifer thickness at P1 (phi[1]) (feet)	729.37	7
Aquifer thickness at P2 (phi[2]) (feet)	728.45	7
Distance between P1 and P2 (L) (feet)	2250	2

RESULTS: Calculated stagnation point (Xstag) 103 feet
Calculated upgradient divide (Ydiv) 324 feet
Points along the dividing streamline:

X	Y	X	Y
-103	16	28	179
-96	49	108	211
-81	81	244	244
-58	114	542	276
-23	146	1949	309

Options: (V) View graph (D) Enter Data
(I) Instructions (X) Exit program



Hydraulic conductivity (K): 136 feet/day
Pumping rate (Q): 26343 cubic feet/day

APPENDIX F

MONITORED NATURAL ATTENUATION SCREENING RATIONALE

This appendix summarizes the results of the bioattenuation screening process summarized in Table 3.3 of this document. The screening process was conducted in accordance with the document entitled Technical protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater (EPA/600/R-98/128). The approach allows an initial determination as to whether bioattenuation is likely to be a viable remedial alternative before additional monitoring and modeling are undertaken.

Figures and tables summarizing the analytical data compiled from OU2 groundwater sampling events are provided in the main body of this document and Appendix C, respectively.

		Points Awarded	*Points Possible*
1.	**Dissolved Oxygen Content in Groundwater**	3	3

In general, the dissolved oxygen (DO) content of deep off-Site groundwater was below 0.5 milligrams per liter (mg/L). Therefore, in accordance with the screening criteria, three points were awarded to the Site for this category. Concentrations below 0.5 mg/L indicate a general depletion of dissolved oxygen in groundwater forcing anaerobic microbes to utilize alternative electron receptors to drive reductive dechlorination.

Slightly higher (DO) readings were recorded for several monitoring wells during the November 1997 groundwater sampling event. However, the two subsequent events recorded DO concentrations at these same locations below the 0.5 mg/L criteria.

The dissolved oxygen content of off-Site groundwater was monitored during groundwater sampling activities performed in November 1997, March 1998, and April/May of 1999. DO readings were collected using a downhole probe located in the screened interval of each monitoring well to ensure readings were representative of groundwater conditions. A summary of the purging parameters for each monitoring well was provided in Appendix G of the OU2 RI report.

		Points Awarded	*Points Possible*
2.	**Nitrate Concentration in Groundwater**	2	2

Nitrate was not detected in the groundwater samples collected from downgradient monitoring wells completed in the deep (Unit C) system. Nitrate was detected only sporadically, at concentrations below 1 mg/l, in groundwater samples collected from the shallow downgradient monitoring wells. This eliminates nitrate as a potential competitor (electron donor) in the reductive dehalogenation process.

Groundwater samples were collected for nitrate analysis from off-site monitoring wells in November 1997 and April/May 1999.

		Points Awarded	Points Possible
3.	Iron (II) Concentrations in Groundwater	3	3

Concentrations of total and dissolved iron in off-Site groundwater exceed the 1 mg/L screening criteria. As explained below, Site conditions indicate that iron is present in groundwater in the +2 valence state. Therefore, in accordance with the screening criteria, three points were awarded in this category.

Concentrations of iron above 1 mg/L indicate a highly reducing environment in which reductive dechlorination is possible. When the groundwater becomes depleted of dissolved oxygen and nitrate, conditions become anaerobic. Iron exists in the ferric Fe(III) or ferrous Fe(II) form, depending upon the pH and dissolved oxygen concentration.[1] At neutral pH and in the presence of oxygen, Fe(II) rapidly oxidizes to Fe(III), which readily hydrolyzes to form the insoluble precipitate, ferric hydroxide.[2] In fact, aqueous Fe(III) is not stable in natural waters except under conditions of low pH (below 4 standard units).[3,4] The groundwater near the Site characteristically contains low levels of dissolved oxygen, generally below 1 mg/l (see Appendix G, Tables G.4 and G.5 of the OU2 RI Report). Additionally, nitrate has not been detected in groundwater samples collected from monitoring wells installed around the Site (see Figures 3.9 and 3.10 of the OU2 FS Report). Finally, the oxidation-reduction potential (ORP) measured at Site monitoring wells is generally in the range of -50 to -100 millivolts (redox conditions are considered reducing below 0.0 millivolts). This is further evidence that reduced species will be stable in groundwater near the Site.

In its oxidized state, Fe(III) is practically insoluble at pH levels between 5 and 7 and dissolved concentrations in groundwater are considered to represent the ferrous iron Fe(II).[5] All of this evidence points to the fact that the aqueous species of iron in groundwater in the vicinity of the Site is ferrous iron Fe(II), not ferric iron Fe(III).

During the OU2 RI, groundwater samples were collected for both total and dissolved iron analyses on several occasions. This includes two complete sampling rounds of the existing off-Site well network in September of 1996 and April/May of 1999. Dissolved iron samples were filtered in the field through a 0.45-micron filter prior to submittal to the project laboratory. The concentrations of dissolved and total iron were, allowing for the margin of analytical error, equivalent at locations where both dissolved and total iron samples were collected for analysis.

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[1] Patterson, J.W., Industrial Wastewater Treatment Technology, Second Edition, (Stoneham, MA, Butterworth Publishers, 1985), p. 155.
[2] IBID, p. 155.
[3] Faure, G., Principles and Applications of Inorganic Chemistry, (New York, MacMillan Publishing Company, 1991), pp. 324-338.
[4] Garrels, R.M. and C.L. Christ, Solutions, Minerals and Equilibria, (San Francisco, Freeman, Cooper & Company, 1965), pp. 178-197.
[5] Lyngkilde, J., and T.H. Christensen, Fate of Organic Contaminants in the Redox Zones of a Landfill Leachate Plume, Journal of Contaminant Hydrology, Vol 10, pp. 291-307, 1992.

		Points Awarded	Points Possible
4.	**Sulfate Concentrations in Groundwater**	0	2

Concentrations of sulfate in groundwater exceed the 20 mg/L screening criteria. Therefore, zero points were awarded in this category. Concentrations of sulfate above 20 mg/L may indicate competition among electron acceptors. However, reductive dechlorination can still occur in groundwater plumes containing high sulfate concentrations.[6]

Groundwater samples were collected for sulfate analysis from off-Site monitoring wells in September 1996, November 1997 and April/May 1999.

		Points Awarded	Points Possible
5.	**Sulfide Concentrations in Groundwater**	0	3

In general, sulfide was not detected in groundwater samples collected from deep (Unit C) monitoring wells. Therefore, zero points were awarded for this screening category. The presence of sulfide is an indicator that sulfate-reducing conditions are present, and thus, reductive dechlorination is a possibility. However, the absence of sulfide does not preclude that reductive dechlorination processes are occurring.

Groundwater samples were collected for sulfide analysis from off-Site monitoring wells in September 1996, November 1997 and April/May 1999.

		Points Awarded	Points Possible
6.	**Methane Concentrations in Groundwater**	0	3

Groundwater samples were collected for methane analysis from off-Site monitoring wells in November 1997 and April/May 1999. Methane was present only in groundwater samples collected downgradient from the Site and within the plume of impacted groundwater. Although present, concentrations were below the screening criteria (0.5 mg/l) and no points were awarded for this screening category. Further evaluation, using a lower detection limit more suited to Site conditions, is warranted.

		Points Awarded	Points Possible
7.	**ORP Groundwater Data**	2	2

The oxidation-reduction potential (ORP or redox) measured at Site monitoring wells was below -100 millivolts during the latest round of groundwater sampling (April/May

[6] Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater, EPA/600/R-98/128, page 39.

of 1999). Redox conditions are considered reducing below 0.0 millivolts. Therefore, two points were awarded to the Site for this screening category. ORP values below –100 millivolts indicate that reduction pathways are likely.

The ORP content of off-Site groundwater was measured during groundwater sampling activities performed in November 1997 and April/May of 1999. ORP readings were collected using a flow-through cell to ensure readings were representative of groundwater conditions. A summary of the purging parameters for each monitoring well containing the ORP data was provided in Appendix G of the OU2 RI report.

		Points Awarded	*Points Possible*
8.	**pH Groundwater Data**	0	-2

The pH of groundwater measured during each sampling event fell into the optimal range (pH 5 to 9) for reductive dechlorination. Therefore, points were not subtracted from the Site total for this screening category.

The pH of off-Site groundwater was monitored during each groundwater sampling event performed during the OU2 RI. Readings were collected using a flow-through cell to ensure readings were representative of groundwater conditions. A summary of the purging parameters for each monitoring well was provided in Appendix G of the OU2 RI report.

		Points Awarded	*Points Possible*
9.	**TOC Data**	0	2

Groundwater sampling and analysis indicates TOC concentrations are below 20 mg/l in groundwater. No points were awarded for this category.

		Points Awarded	*Points Possible*
10.	**Temperature Groundwater Data**	0	1

The temperature of groundwater measured during each sampling event fell below the criteria (>20 degrees Celsius) advocated by the screening guidance for optimal reductive dechlorination conditions. Therefore, points were not awarded to the Site for this screening category.

Temperature was monitored during each groundwater sampling event performed during the OU2 RI. Readings were collected using a flow-through cell to ensure readings were representative of groundwater conditions. A summary of the purging parameters for each monitoring well was provided in Appendix G of the OU2 RI report.

		Points Awarded	Points Possible
11.	Carbon Dioxide Groundwater Data	0	1

This parameter was not evaluated during the OU2 RI. Therefore, points were not awarded for this category.

		Points Awarded	Points Possible
12.	Alkalinity Groundwater Data	0	1

The alkalinity of groundwater measured at the Site ranged from approximately 300 to 400 mg/L. Concentration trends were not readily apparent either between sampling location or between sampling events. Therefore, zero points were awarded to the Site for this screening category.

Groundwater samples were collected for alkalinity analysis from off-Site monitoring wells in September 1996, November 1997 and April/May 1999.

		Points Awarded	Points Possible
13.	Chloride Groundwater Data	2	2

Chloride concentrations in groundwater samples collected from deep groundwater monitoring wells located along the centerline of the plume (MW114, MW124 and MW129) are above 10 mg/l. However, chloride concentrations in groundwater samples collected from monitoring wells downgradient of the Site and outside the area of the VOC plume downgradient of the Site are generally below 5 mg/l. Two points were awarded to the Site for this screening category.

Chloride is an end product in the anaerobic degradation of 1,2-DCA. The increasing trend in chloride concentrations downgradient and within the plume indicates natural attenuation of 1,2-DCA is occurring.

Groundwater samples were collected for chloride analysis from off-Site monitoring wells in September 1996, November 1997 and April/May 1999.

		Points Awarded	Points Possible
14.	Hydrogen Groundwater Data	0	3

This parameter was not evaluated during the OU2 RI. Therefore, points were not awarded in this screening category.

		Points Awarded	Points Possible
15.	**Volatile Fatty Acids Groundwater Data**	0	2

This parameter was not evaluated during the OU2 RI. Therefore, points were not awarded in this screening category.

		Points Awarded	Points Possible
16.	**BTEX Groundwater Data**	2	2

Decreasing trends in the concentration of benzene from the source area to downgradient monitoring locations indicate potential reductive pathways. Two points were awarded to the Site for this screening category.

Benzene is present at concentrations above 0.1 mg/l in groundwater samples collected at MW114. BTEX compounds often provide an anthropogenic source of carbon and energy capable of driving or sustaining destructive dechlorination. Benzene was detected in the source area of the landfill at concentrations up to several hundred parts per million. However, monitoring of groundwater downgradient of the landfill demonstrates a decrease in the concentration of benzene by several orders of magnitude. This indicates that benzene is likely being utilized as a primary substrate in the reductive dechlorination process.

Figure F.1 provides a comparison of groundwater data from a former on-Site monitoring location near the source area to current downgradient groundwater concentrations.

		Points Awarded	Points Possible
17.	**Tetrachloroethene Groundwater Data**	0	0

Points are not awarded or subtracted from the cumulative Site score for this screening category. However, the presence of tetrachloroethene (PCE) is important in determining subsequent parent/daughter compound relationships, which indicate degradation. Although, as outlined below, the Site source area does not lend itself to identification of an original suite of contaminants released, soil and groundwater analytical data do indicate that PCE was likely disposed of in the source area.

Records indicate that F-coded hazardous wastes were disposed of in the unlined areas of the landfill (see Table 4.2 in the OU1 Remedial Investigation Report). PCE was detected in soil west of the Site at concentrations up to 30,000 micrograms per kilogram (µg/kg). Additionally, groundwater samples collected from source-area groundwater monitoring wells indicate that PCE is present.

		Points Awarded	Points Possible
18.	Trichloroethene Groundwater Data	2	2

Groundwater analytical data developed during the OU1 RI indicates that trichloroethene (TCE) is likely a degradation product (daughter compound) of PCE. Therefore, two points were awarded to the Site for this screening category.

During the OU1 RI, PCE was detected at concentrations above 2,000 mg/l in groundwater samples collected from on-Site source-area monitoring wells screened in Unit A (P-2A, and P-12A). TCE, cis-1,2-DCE and vinyl chloride were not detected in groundwater samples collected from these locations. However, at monitoring well P-2C2 (a deeper well at the same location as P-2A), in addition to PCE, TCE, cis-1,2-DCE and vinyl chloride are present in groundwater. In fact, the concentration of TCE is greater than PCE in the groundwater sample collected from P-2C2 suggesting that biodegradation is occurring. Further downgradient near the northern boundary of the Site, the only daughter product of PCE/TCE detected in groundwater is vinyl chloride (P-31C2, P-31C3, MW112, and MW114) further suggesting biodegradation of PCE/TCE is occurring.

		Points Awarded	Points Possible
19.	1,2-Dichloroethene Groundwater Data	0	2

1,2-dichloroethane (1,2-DCA) and cis-1,2-dichloroethene (cis-1,2-DCE) are present in groundwater near the source and both generate vinyl chloride as a degradation product. Therefore, in order to avoid biasing the screening process in favor of potential reductive dechlorination processes, points have not been awarded to the Site for this category. This was done despite detections of cis-1,2-DCE in the source area which indicate a likely reduction pathway of TCE into cis-1,2-DCE.

Reductive dechlorination of TCE is associated with the accumulation of cis-1,2-dichloroethene. EPA screening guidance indicates that concentrations of total 1,2-DCE consisting of greater than 80% of the cis isomer are usually indicative of the degradation of TCE.

cis-1,2-DCE was not detected in Unit A perched groundwater proximal to the source area. However, cis-1,2-DCE is present in Unit C groundwater (P-2C2) completed at this same location. Similarly, cis-1,2-DCE is not present further downgradient of the landfill but vinyl chloride (a degradation product of cis-1,2-DCE) concentrations are shown increasing. It appears that the degradation of PCE/TCE and their daughter products is occurring very rapidly beneath the Site, as only the daughter products of these compounds appear beyond the Site boundary.

		Points Awarded	Points Possible
20.	Vinyl Chloride Groundwater Data	2	2

Low levels of vinyl chloride are present where 1,2-DCA is present. Since vinyl chloride is a byproduct of 1,2-DCA biodegradation, the presence of vinyl chloride in the VOC plume area indicates that biodegradation of 1,2-DCA is occurring at the Site. Therefore, two points were awarded to the Site for this screening category.

		Points Awarded	Points Possible
21.	1,1,1-Trichloroethane Groundwater Data	0	0

1,1,1-Trichloroethane was not detected in groundwater samples collected from source-area or off-Site groundwater monitoring wells.

		Points Awarded	Points Possible
22.	1,2-Dichloroethane Groundwater Data	0	2

1,2-dichloroethane (1,2-DCA) and cis-1,2-dichloroethene (cis-1,2-DCE) are present in groundwater near the source and both generate vinyl chloride as a degradation product. Therefore, in order to avoid biasing the screening process in favor of potential reductive dechlorination processes, points have not been awarded to the Site for this category. This was done despite detections of 1,2-DCA downgradient of the Site, which indicate its likely reduction into vinyl chloride.

		Points Awarded	Points Possible
23.	Carbon Tetrachloride Groundwater Data	0	0

Carbon tetrachloride was detected at several hundred parts per million in Unit A of the source area making it likely that this was one of the compounds released from the landfill. No points were awarded to the Site in this screening category.

		Points Awarded	Points Possible
24.	Chloroethane Groundwater Data	1	2

Chloroethane was detected in the groundwater sample collected from monitoring well MW124 at a concentration of 0.0018 mg/during the April/May 1999 groundwater sampling event. Pending further evaluation of this concentration trend, only one point was awarded to the Site for this screening category.

It should be noted that chloroethane is a degradation product of both 1,2-DCA and vinyl chloride, both of which are present in groundwater downgradient of the landfill. The detection of chloroethane during the May 1999 round of groundwater sampling could be indicative of the destructive dechlorination of contaminants in the plume.

		Points Awarded	*Points Possible*
25.	**Ethene/Ethane Groundwater Data**	1	3

Ethene is a daughter product of the degradation of 1,2-DCA. During the November 1997 sampling event, ethene was detected at two locations (MW114 and MW124) both located within the center of the VOC plume. The detection of ethene in the center of the plume is indicative of the natural degradation of 1,2-DCA. Detection limits in subsequent groundwater sampling events were too high to detect low-level ethene concentrations in groundwater. Further evaluation is warranted thus only one point was awarded.

		Points Awarded	*Points Possible*
26.	**Chloroform Groundwater Data**	0	2

Chloroform was detected at several hundred parts per million in Unit A of the source area. Therefore, no points were awarded to the Site in this screening category.

		Points Awarded	*Points Possible*
27.	**Dichloromethane Groundwater Data**	0	2

Dichloromethane was detected at several hundred parts per million in Unit A of the source area. Therefore, no points were awarded to the Site in this screening category.

APPENDIX G

GROUNDWATER MODELING SUMMARY

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1.0 INTRODUCTION

1.1 BACKGROUND

On July 16, 1998, the Indiana Department of Environmental Management (IDEM) approved the remedial design for Operable Unit 1 (OU1) and issued a Record of Decision for OU1 at the Four County Landfill Site located in Fulton County, Indiana (Site). The significant components of the selected remedy for OU1 included:

- construction of RCRA Subtitle C landfill cap with a geocomposite layer;
- collection of leachate from the lined cells with disposal at an off-Site treatment, storage, and disposal facility;
- implementation of storm water controls;
- abandonment of on-Site groundwater monitoring wells;
- consolidation of soil/sediment from Unit A west of the Site and from the clean-out of the sediment basins and disposal within Cell C;
- implementation of deed and groundwater-use restrictions and access control;
- construction of passive landfill gas collection system and monitoring of landfill gases;
- grading and revegetation of the Site; and
- performance of groundwater monitoring.

Construction of the OU1 remedy (landfill cap, grading and drainage improvements, consolidation of soil/sediment in Cell C, and installation of passive landfill as vents) commenced at the Site in May 1999 and was substantially completed by the Fall of 1999. OU1 groundwater monitoring activities will commence upon approval of the monitoring plan by IDEM.

As part of the OU1 remedy, on-Site monitoring wells, including those providing preferential migration pathways to deeper stratigraphic units were abandoned, thereby reducing potential contaminant influx to the subsurface. Performance modeling summarized in the OU1 Feasibility Study and the OU1 Final Design report indicated that installation of a RCRA cap such as the one constructed at the Site together with grading and drainage improvements would virtually eliminate surface water infiltration into the landfill and reduce leachate generation by surface water infiltration by 99.9 percent. Moreover, impacted soil present near the western property boundary was excavated and consolidated into a lined portion of the landfill and capped.

Abandonment of on-Site wells, removal of impacted soil Unit A and capping of the landfill were designed to reduce future contaminant influx to the groundwater.

Volatile organic compounds (VOCs) consisting predominantly of 1,2-dichloroethane (1,2-DCA) and vinyl chloride impact groundwater downgradient from the Site. Groundwater geochemical and oxidation-reduction (redox) reaction data collected downgradient from the Site demonstrate that anaerobic groundwater conditions are prevalent. Under anaerobic conditions, studies have reported the biodegradation of 1,2-DCA to vinyl chloride to ethene (Bosma et al., 1998). Evidence exists at the Site demonstrating the occurrence of this biodegradation pathway.

1.2 OBJECTIVE AND METHODOLOGY

This appendix presents the groundwater flow and contaminant transport modeling work conducted to assess the potential future extent of 1,2-DCA and vinyl chloride downgradient from the Site under an MNA remedy. 1,2-DCA and vinyl chloride were selected for this simulation since these are the only VOCs detected in groundwater samples collected from monitoring wells located beyond the downgradient Site boundary.

A two-dimensional groundwater flow model was developed to represent average groundwater flow conditions within the deep groundwater system beneath the Site (Unit C). The groundwater flow model was developed within the framework of the United States Geologic Survey's (USGS's) groundwater flow model MODFLOW-96 (Harbaugh and McDonald, 1996a and 1996b). Detected 1,2-DCA and vinyl chloride concentrations were applied to estimate current distributions of these compounds within the deep groundwater system. The concentration distributions were applied as initial conditions, and the natural attenuation of 1,2-DCA and vinyl chloride within the deep groundwater system was simulated using the Pacific Northwest National Laboratory's (PNNL's) reactive solute transport model RT3D (Clement, 1997). RT3D simulations were conducted which included the sequential biodegradation of 1,2-DCA to vinyl chloride under anaerobic conditions, and retardation due solute adsorption onto soil particles.

1.3 ORGANIZATION

This appendix is organized as follows:

- Section 1.0: Introduction

  Presents the background, objectives, and methodology for the groundwater flow and contaminant transport modeling presented herein;

- Section 2.0: Site Hydrogeologic Conditions

  Presents a summary of the hydrogeologic conditions and chemical presence in groundwater observed at the Site;

- Section 3.0: Model Construction and Simulated Groundwater Flow

  Presents the construction the groundwater flow model consistent with the hydrogeologic conditions observed at Site;

- Section 4.0: MNA Remedy Simulation

  Presents the RT3D simulations conducted to assess the potential future extent of 1,2-DCA and vinyl chloride migration downgradient from the Site under an MNA remedy; and

A list of all references cited in this appendix is presented in Section 5.0.

2.0 SITE CONDITIONS

2.1 HYDROGEOLOGIC CONDITIONS

The stratigraphic conditions beneath the Site consist of the following (from ground surface):

- Unit A: an unsaturated glacial clay till interbedded with thin, discontinuous sand lenses (approximately 15 to 30 feet in thickness);
- Unit B: a glacio-lacustrine sequence of stratified fine to medium-grained sand with interbedded silt (approximately 25 to 45 feet in thickness);
- Unit C: a glacio-fluvial sequence of stratified fine to coarse grained sand and gravel (approximately 70 to over 150 feet in thickness);
- Unit D: a glacial till (discontinuous across the Site); and
- Carbonate bedrock.

The water table beneath the Site generally occurs within Unit B. Although the water table does reside within the lower portion of the silt and sand unit to the northeast of the Site, Unit C is the primary water-bearing zone beneath the Site. The upper 20 to 30 feet of the sand and gravel unit is referred to as the shallow groundwater flow system, and includes the lower silt and sand unit where saturated. The lower portion of the sand and gravel unit is referred to as the deep groundwater flow system. The deep groundwater flow system (Unit C) is the focus of the groundwater flow modeling presented herein since the migration of VOCs from the Site is occurring in the lower portion of Unit C.

Five groundwater elevation measurement events were conducted at the Site from November 17, 1997 to June 1999. Groundwater elevation contours developed for these events demonstrate that groundwater flow within the shallow and deep systems consistently is directed toward the northeast (see Figures A.5 to A.14 of Appendix A). Based on these groundwater elevation contours, groundwater flow across the Site approximately is directed on average north 30° east. Horizontal hydraulic gradients over the Site within the deep system were determined for each event using the monitoring well pairs MW101/MW122 and MW115/MW126, as presented in Table G.2.1. An average horizontal hydraulic gradient of 0.00032 feet per foot (ft/ft) was calculated across the Site.

Both upward and downward vertical hydraulic gradients of relatively small magnitude are observed throughout the Site between the shallow and deep groundwater flow systems (see Table 2.2 of the main report). Both the small magnitude and the upward/downward variations in the observed vertical hydraulic gradients suggest that

groundwater flow within the sand and gravel unit occurs predominantly in the horizontal direction.

The interpretation of single-well response tests conducted within deep monitoring wells provided hydraulic conductivity values ranging from 1.4×10^{-3} centimeters per second (cm/s) to 1.1×10^{-2} cm/s with a geometric mean of 5.0×10^{-3} cm/s [or 134.7 feet per day (ft/d)] (see Table 2.4 of the OU2 FS Report).

2.2 CHEMICAL PRESENCE IN GROUNDWATER

Recent groundwater quality monitoring demonstrates the presence of predominantly 1,2-DCA and vinyl chloride within the deep groundwater flow system, particularly beyond the downgradient Site boundary. Current distributions for 1,2-DCA and vinyl chloride within the deep system were developed based on the May 2, 1999 groundwater quality monitoring event. Recent groundwater quality data directly beneath the Site are unavailable, and historical groundwater quality data for monitoring points P-2C2 and P-31C3 from June 1994 and April 1995, respectively, were combined with the May 2, 1999 data to estimate 1,2-DCA and vinyl chloride distributions beneath the Site. The estimated concentration distributions of 1,2-DCA and vinyl chloride in the deep groundwater flow system are presented on Figures G.2.1 and G.2.2, respectively.

Strongly reducing anaerobic oxidation-reduction (redox) reaction conditions are observed in groundwater beneath and downgradient from the Site. Under anaerobic conditions, the biodegradation of 1,2-DCA may occur via reductive dechlorination producing chloroethane, ethene, ethane, chloride, methane, and carbon dioxide. Under sulfate-reducing and methanogenic redox conditions in groundwater, 1,2-DCA also may biodegrade via reductive dechlorination to yield vinyl chloride (Bosma et al., 1998), although this degradation pathway is reported less frequently in the relevant literature.

Existing Site data, which provide strong evidence of the occurrence of biodegradation processes in groundwater downgradient from the Site, includes the following:

- chloride concentrations in groundwater samples collected from deep groundwater monitoring wells located along the centerline of the VOC plume (MW114, MW124 and MW129) are above 10 milligrams per liter (mg/l). However, chloride concentrations in groundwater samples collected from monitoring wells downgradient of the Site and outside the area of the VOC plume downgradient of the Site are generally below 5 mg/l;

- during the November 1997 sampling event, ethene was detected at only two locations; both located within the center of the VOC plume (MW114 and MW124). The detection of ethene in the center of the VOC plume is also direct evidence of the occurrence of 1,2-DCA biodegradation;
- low levels of vinyl chloride are present where 1,2-DCA is present. Since vinyl chloride, ethene, and chloride are byproducts of 1,2-DCA biodegradation, the presence of vinyl chloride and ethene, and the two to threefold increase in chloride concentrations in the VOC plume area are direct evidence that biodegradation of 1,2-DCA is occurring; and
- the absence of other vinyl chloride parent compounds in downgradient monitoring wells where 1,2-DCA is detected (e.g., tetrachloroethene, trichloroethene, and dichloroethene) suggests that the anaerobic biodegradation pathway of 1,2-DCA to vinyl chloride to ethene is occurring at the Site.

The above evidence supports the occurrence of the sequential anaerobic biodegradation to 1,2-DCA to vinyl chloride to ethene via reductive dechlorination.

Insufficient data are available to facilitate a rigorous calculation of Site-specific degradation rates. However, relevant literature provides references to biodegradation rate constants determined from a variety of studies, although there are relatively few references to biodegradation rate constants derived for the 1,2-DCA to vinyl chloride biodegradation pathway. Suarez and Rifai (1999) present a summary of biodegradation rates for chlorinated VOCs reported in numerous studies throughout the relevant literature. Suarez and Rifai (1999) present first-order decay rates for several chlorinated VOCs reported from field/in situ studies of reductive dechlorination. Mean values of the reductive dechlorination first-order decay rates for 1,2-DCA and vinyl chloride of 0.0015 $days^{-1}$ (half-life[1] of 462 days) and 0.003 $days^{-1}$ (half-life of 231 days).

[1] Half-life, $t_{1/2} = ln(2)/\lambda$, where λ is the first-order biodegradation, or decay, rate constant.

3.0 MODEL CONSTRUCTION AND SIMULATED GROUNDWATER FLOW

A two-dimensional plan view groundwater flow model was constructed to represent average groundwater flow conditions within the deep sand and gravel unit at the Site. It was neither the purpose nor the intent of this modeling work to develop a groundwater flow model that rigorously reflected the stratigraphic and groundwater flow conditions observed at the Site. Considering that monitoring will continue at the Site, a groundwater flow model representing average groundwater flow conditions beneath the Site was considered appropriate for assessing the potential future migration of 1,2-DCA and vinyl chloride under an MNA remedy. Moreover, hydraulic monitoring indicates that groundwater flow primarily occurs in the horizontal direction (there is an absence of significant vertical gradients). Therefore, a two-dimensional model is adequate to represent groundwater flow conditions for the purposes of the analysis presented herein.

The groundwater flow model was developed to represent uniform horizontal groundwater flow conditions under the average observed horizontal hydraulic gradient of 0.00032 ft/ft (see Table G.2.1). The model domain was oriented in the average observed direction of groundwater flow (north 30° east), as described in Section 2.1. Figure 3.1 presents the plan view of the model domain. The model domain was oriented such that site is located in the approximate center upgradient section of the model domain. The model domain was extended over 2,000 feet northeast (downgradient) of the groundwater plume. Although, groundwater within the sand and gravel unit beneath the Site is considered to ultimately discharge to the Tippecanoe River, there is insufficient data to support the presence of uniform hydraulic gradient nearer to Tippecanoe River. As a result, the model domain was extended to approximately 1,800 feet upgradient of Tippecanoe River. The model domain boundaries were extended laterally a distance sufficient to avoid unduly influencing the simulated groundwater flow conditions in the immediate Site vicinity. The model domain extends 5,600 feet in the direction of groundwater flow and 4,000 feet in the direction transverse to groundwater flow.

A general finite-difference grid spacing of 100 feet was applied over the model domain. This grid spacing was refined to 25 feet in the Site vicinity and immediately downgradient. The model domain consists of 110 rows and 184 columns. The finite-difference grid is presented on Figure G.3.1. As a two-dimensional plan view model, only one model layer is applied.

Constant hydraulic head boundary conditions were specified at the upgradient and downgradient model domain boundaries to establish the average regional horizontal

hydraulic gradient of 0.00032 ft/ft over the model domain. No-flow boundary conditions were specified along the model domain boundaries transverse to groundwater flow. The specified boundary conditions are presented on Figure 3.1. Since the purpose of the model was to represent uniform groundwater flow conditions over the Site area, recharge was not specified over the top of the model domain. A horizontal hydraulic conductivity value of 134.7 ft/d was assigned corresponding to the geometric mean of the hydraulic conductivity values determined from single-well response tests conducted in the deep monitoring wells at the Site, as described in Section 2.1. The simulated groundwater flow field is presented on Figure G.3.1.

4.0 MNA REMEDY SIMULATION

The implementation of a MNA remedy at the Site was conducted using RT3D assuming the sequential reductive dechlorination of 1,2-DCA to vinyl chloride. The process of retardation due to solute adsorption onto soil particles also was represented. RT3D simulation was conducted using the simulated groundwater flow field described in Section 3.0. The estimated 1,2-DCA and vinyl chloride concentration distributions presented on Figures 2.1 and 2.2 were applied as the initial condition for the MNA remedy simulation. No continuing source of 1,2-DCA or vinyl chloride to groundwater was represented due to the OU1 source control measures already implemented at the Site, as described in Section 1.1. First-order decay rates of 0.0015 days^{-1} ($t_{1/2}$ = 462 days) and 0.003 days^{-1} ($t_{1/2}$ = 231 days) were applied for 1,2-DCA and vinyl chloride, respectively. These decay rates correspond to the mean decay rate values reported for 1,2-DCA and vinyl chloride by Suarez and Rifai (1999) for field/in situ studies of reductive declorination. The sequential degradation of 1,2-DCA to vinyl chloride was simulated over 30 years. A summary of all applied solute transport input parameters is presented in Table G.4.1.

The simulated 1,2-DCA and vinyl chloride concentration distributions at 10, 20, and 30 years for the MNA remedy simulation are presented on Figures G.4.1 and G.4.2, respectively. Under the conditions simulated, the 1,2-DCA plume initially expands downgradient past SR 17 during the initial 10 years, then contracts rapidly back to the downgradient Site boundary during years 10 through 30 (see Figure G.4.1). The simulated 1,2-DCA concentrations fall below the MCL of 5 micrograms per liter (µg/l) between 20 and 25 years. The vinyl chloride plume behaves in a similar manner, initially expanding to the same relative degree the 1,2-DCA plume expands, then contracting during years 20 through 30 (see Figure G.4.2). The vinyl chloride concentrations fall below the MCL for vinyl chloride of 2 µg/l between 25 and 30 years.

The results of the MNA remedy simulation are subject to the applied first-order decay rates. The sensitivity of the MNA remedy simulation results to the applied first-order decay rates is addressed in Section 5.0.

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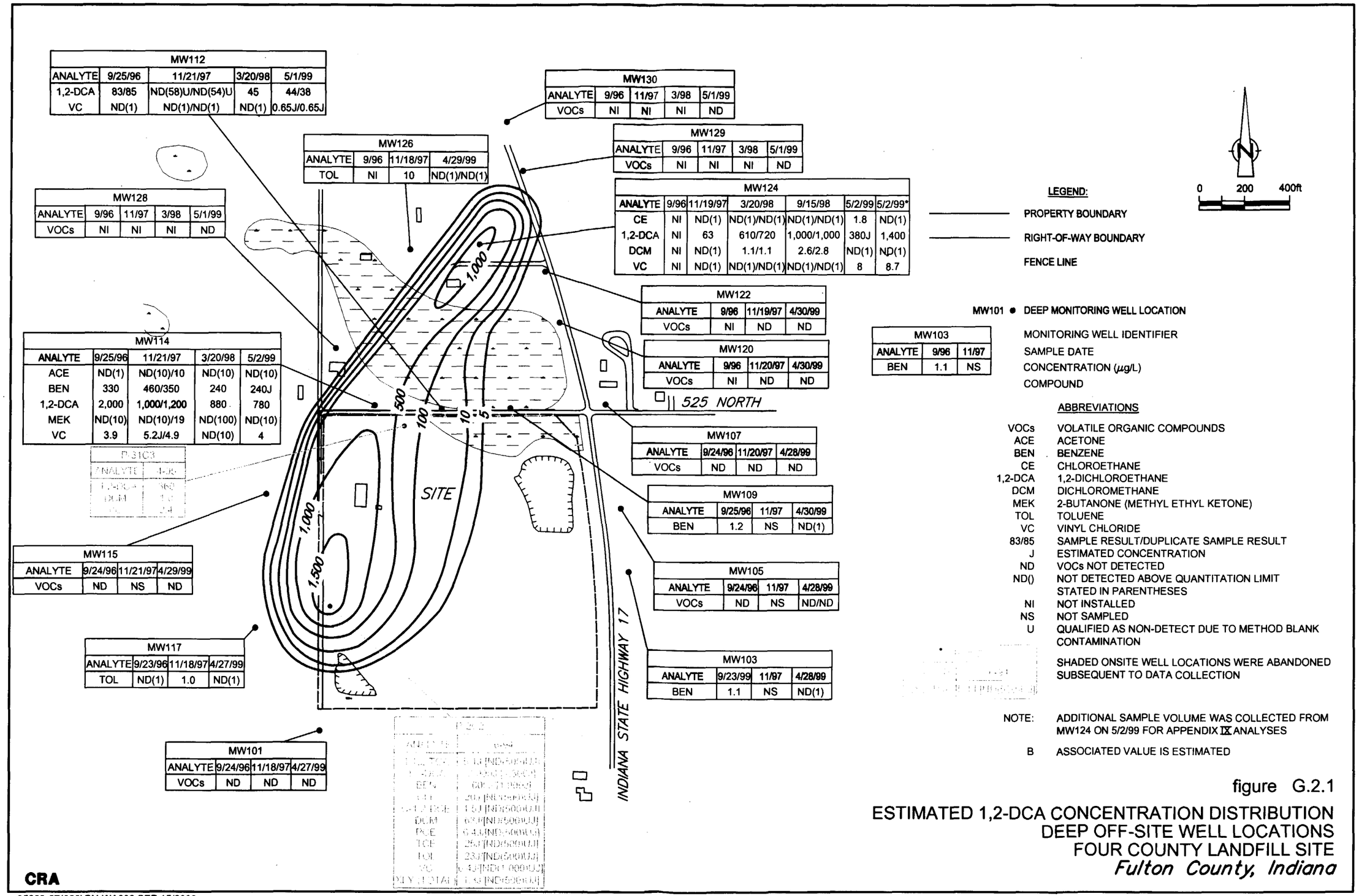


MW112				
ANALYTE	9/25/96	11/21/97	3/20/98	5/1/99
1,2-DCA	83/85	ND(58)U/ND(54)U	45	44/38
VC	ND(1)	ND(1)/ND(1)	ND(1)	0.65J/0.65J

MW126			
ANALYTE	9/96	11/18/97	4/29/99
TOL	NI	10	ND(1)/ND(1)

MW130				
ANALYTE	9/96	11/97	3/98	5/1/99
VOCs	NI	NI	NI	ND

MW129				
ANALYTE	9/96	11/97	3/98	5/1/99
VOCs	NI	NI	NI	ND

MW128				
ANALYTE	9/96	11/97	3/98	5/1/99
VOCs	NI	NI	NI	ND

MW124						
ANALYTE	9/96	11/19/97	3/20/98	9/15/98	5/2/99	5/2/99*
CE	NI	ND(1)	ND(1)/ND(1)	ND(1)/ND(1)	1.8	ND(1)
1,2-DCA	NI	63	610/720	1,000/1,000	380J	1,400
DCM	NI	ND(1)	1.1/1.1	2.6/2.8	ND(1)	ND(1)
VC	NI	ND(1)	ND(1)/ND(1)	ND(1)/ND(1)	8	8.7

MW122			
ANALYTE	9/96	11/19/97	4/30/99
VOCs	NI	ND	ND

MW120			
ANALYTE	9/96	11/20/97	4/30/99
VOCs	NI	ND	ND

MW103		
ANALYTE	9/96	11/97
BEN	1.1	NS

MW114				
ANALYTE	9/25/96	11/21/97	3/20/98	5/2/99
ACE	ND(1)	ND(10)/10	ND(10)	ND(10)
BEN	330	460/350	240	240J
1,2-DCA	2,000	1,000/1,200	880	780
MEK	ND(10)	ND(10)/19	ND(100)	ND(10)
VC	3.9	5.2J/4.9	ND(10)	4

MW107			
ANALYTE	9/24/96	11/20/97	4/28/99
VOCs	ND	ND	ND

MW109			
ANALYTE	9/25/96	11/97	4/30/99
BEN	1.2	NS	ND(1)

MW115			
ANALYTE	9/24/96	11/21/97	4/29/99
VOCs	ND	NS	ND

MW105			
ANALYTE	9/24/96	11/97	4/28/99
VOCs	ND	NS	ND/ND

MW117			
ANALYTE	9/23/96	11/18/97	4/27/99
TOL	ND(1)	1.0	ND(1)

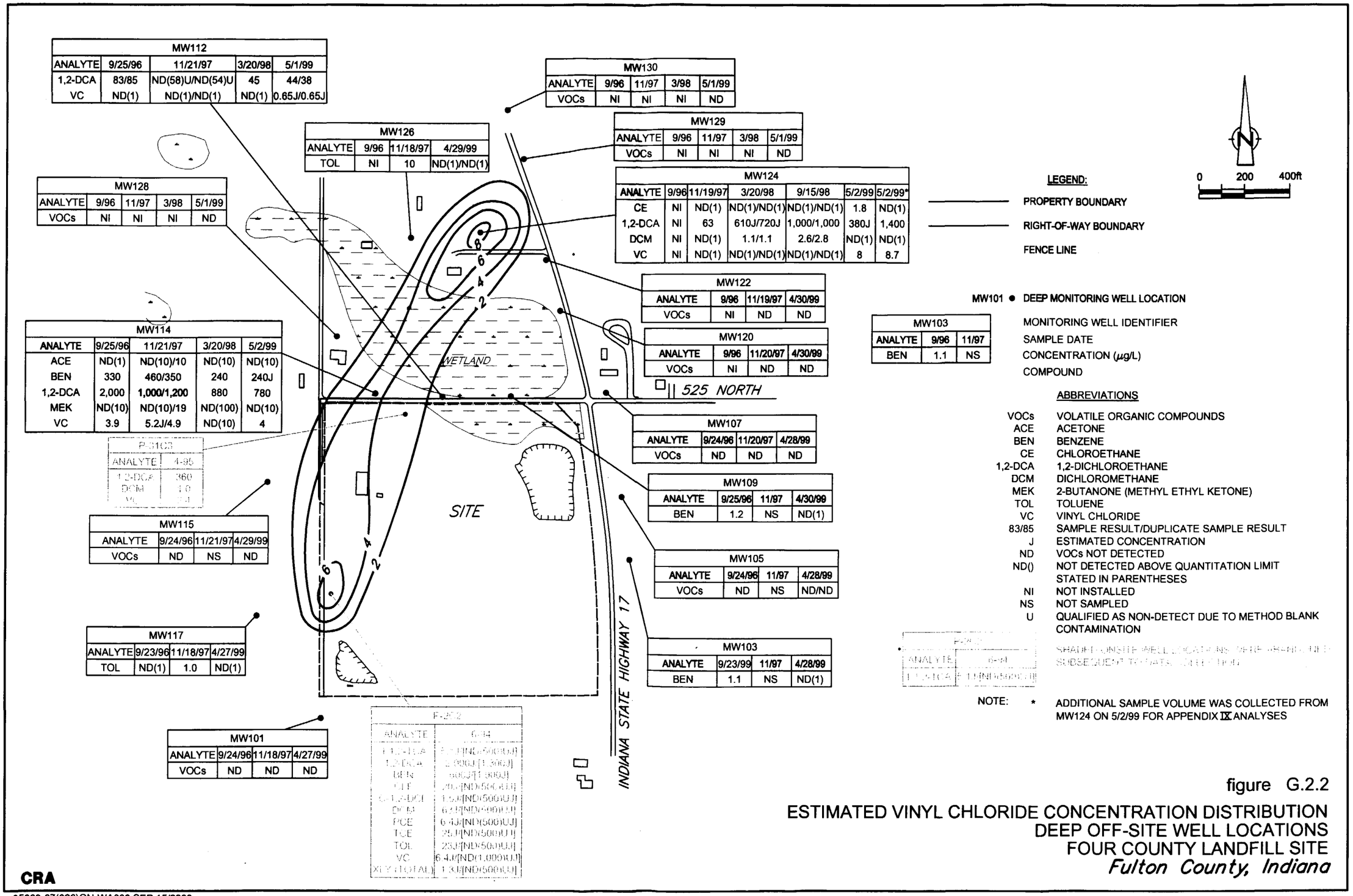
MW103			
ANALYTE	9/23/99	11/97	4/28/99
BEN	1.1	NS	ND(1)

MW101			
ANALYTE	9/24/96	11/18/97	4/27/99
VOCs	ND	ND	ND

figure G.2.1

ESTIMATED 1,2-DCA CONCENTRATION DISTRIBUTION
DEEP OFF-SITE WELL LOCATIONS
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

05369-67(026)GN-WA002 SEP 15/2000



MW112				
ANALYTE	9/25/96	11/21/97	3/20/98	5/1/99
1,2-DCA	83/85	ND(58)U/ND(54)U	45	44/38
VC	ND(1)	ND(1)/ND(1)	ND(1)	0.65J/0.65J

MW130				
ANALYTE	9/96	11/97	3/98	5/1/99
VOCs	NI	NI	NI	ND

MW126			
ANALYTE	9/96	11/18/97	4/29/99
TOL	NI	10	ND(1)/ND(1)

MW129				
ANALYTE	9/96	11/97	3/98	5/1/99
VOCs	NI	NI	NI	ND

MW128				
ANALYTE	9/96	11/97	3/98	5/1/99
VOCs	NI	NI	NI	ND

MW124						
ANALYTE	9/96	11/19/97	3/20/98	9/15/98	5/2/99	5/2/99*
CE	NI	ND(1)	ND(1)/ND(1)	ND(1)/ND(1)	1.8	ND(1)
1,2-DCA	NI	63	610J/720J	1,000/1,000	380J	1,400
DCM	NI	ND(1)	1.1/1.1	2.6/2.8	ND(1)	ND(1)
VC	NI	ND(1)	ND(1)/ND(1)	ND(1)/ND(1)	8	8.7

MW122			
ANALYTE	9/96	11/19/97	4/30/99
VOCs	NI	ND	ND

MW114				
ANALYTE	9/25/96	11/21/97	3/20/98	5/2/99
ACE	ND(1)	ND(10)/10	ND(10)	ND(10)
BEN	330	460/350	240	240J
1,2-DCA	2,000	1,000/1,200	880	780
MEK	ND(10)	ND(10)/19	ND(100)	ND(10)
VC	3.9	5.2J/4.9	ND(10)	4

MW120			
ANALYTE	9/96	11/20/97	4/30/99
VOCs	NI	ND	ND

MW103		
ANALYTE	9/96	11/97
BEN	1.1	NS

MW107			
ANALYTE	9/24/96	11/20/97	4/28/99
VOCs	ND	ND	ND

P-3103	
ANALYTE	4-95
1,2-DCA	360
DCM	1.0
VC	2.1

MW109			
ANALYTE	9/25/96	11/97	4/30/99
BEN	1.2	NS	ND(1)

MW115			
ANALYTE	9/24/96	11/21/97	4/29/99
VOCs	ND	NS	ND

MW105			
ANALYTE	9/24/96	11/97	4/28/99
VOCs	ND	NS	ND/ND

MW117			
ANALYTE	9/23/96	11/18/97	4/27/99
TOL	ND(1)	1.0	ND(1)

MW103			
ANALYTE	9/23/99	11/97	4/28/99
BEN	1.1	NS	ND(1)

F-2012	
ANALYTE	6-94
1,1,2-TCA	1.0J[ND(500)UJ]
1,2-DCA	2.00J[1.30J]
BEN	.60J[1.30J]
CE	20.4[ND(500)UJ]
c-1,2-DCE	1.5J[ND(500)UJ]
DCM	6.2J[ND(500)UJ]
PCE	6.4J[ND(500)UJ]
TCE	25J[ND(500)UJ]
TOL	23J[ND(500)UJ]
VC	6.4J[ND(1,000)UJ]
XLY (TOTAL)	1.3J[ND(500)UJ]

MW101			
ANALYTE	9/24/96	11/18/97	4/27/99
VOCs	ND	ND	ND

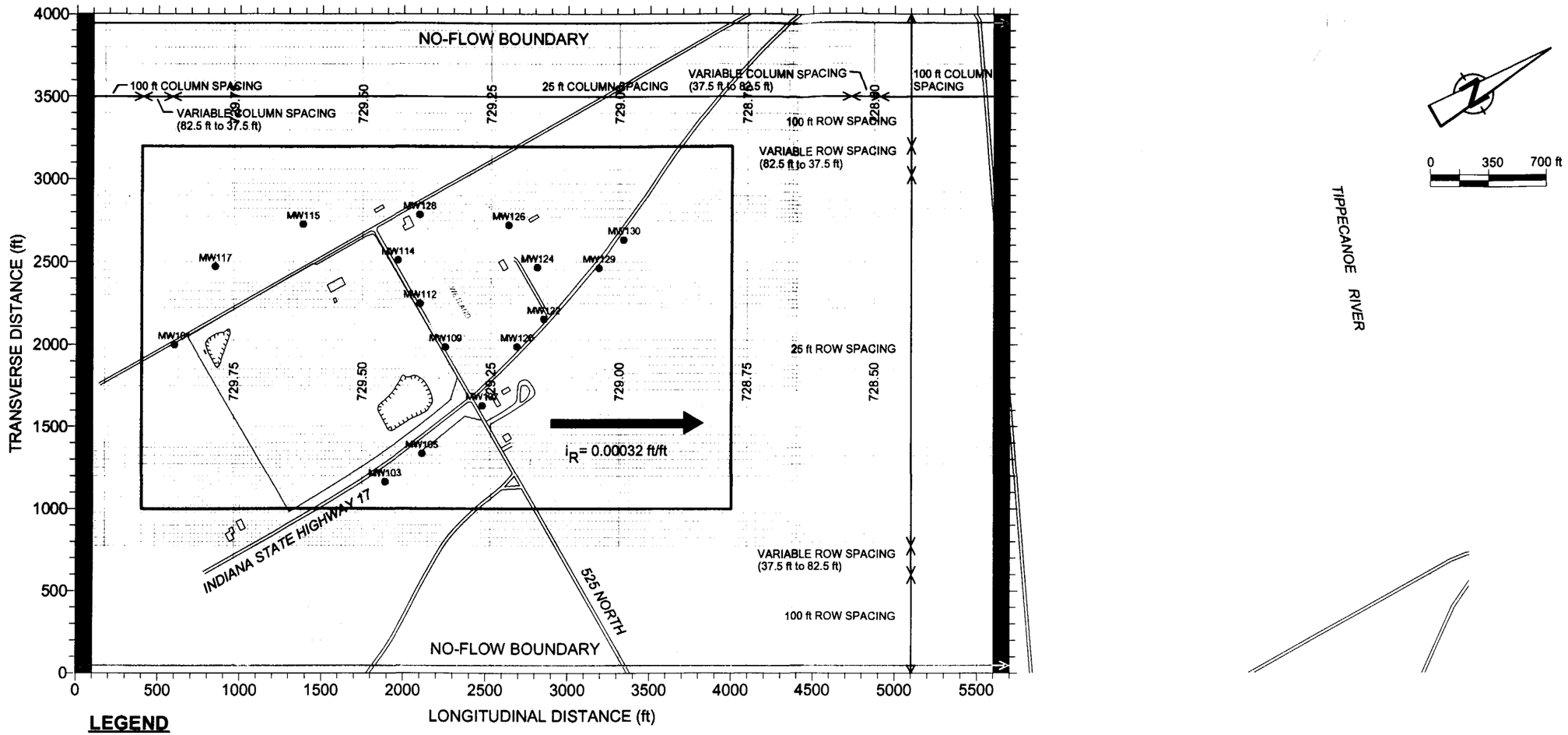
F-2012	
ANALYTE	6-94
1,1,2-TCA	1.0J[ND(500)UJ]

SHADED ONSITE WELL LOCATIONS REPRESENT THE SUBSEQUENT TO THAT SELECTION

figure G.2.2

ESTIMATED VINYL CHLORIDE CONCENTRATION DISTRIBUTION
DEEP OFF-SITE WELL LOCATIONS
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

05369-67(026)GN-WA003 SEP 15/2000



LEGEND

HYDROGEOLOGIC PARAMETERS

- UNIFORM SAND UNIT (K_h= 134.7 ft/d)
- FINITE-DIFFERENCE GRID
- 25.0 ft — FINITE-DIFFERENCE GRID SPACING
- MW 101 — MONITORING WELL LOCATION

GROUNDWATER FLOW SIMULATION RESULTS

- —2.55— SIMULATED GROUNDWATER LEVEL (ft AMSL)
- LIMITS OF CONTAMINANT TRANSPORT SIMULATION RESULTS

GROUNDWATER FLOW SIMULATION BOUNDARY CONDITIONS

- UPGRADIENT CONSTANT HYDRAULIC HEAD BOUNDARY CONDITION (730.0 ft AMSL)
- DOWNGRADIENT CONSTANT HYDRAULIC HEAD BOUNDARY CONDITION (727.5 ft AMSL)
- REGIONAL GROUDWATER FLOW DIRECTION
- i_R REGIONAL HYDRAULIC GRADIENT

CRA

figure G.3.1

MODEL CONSTRUCTION, BOUNDARY CONDITIONS, AND SIMULATED GROUNDWATER FLOW FIELD
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

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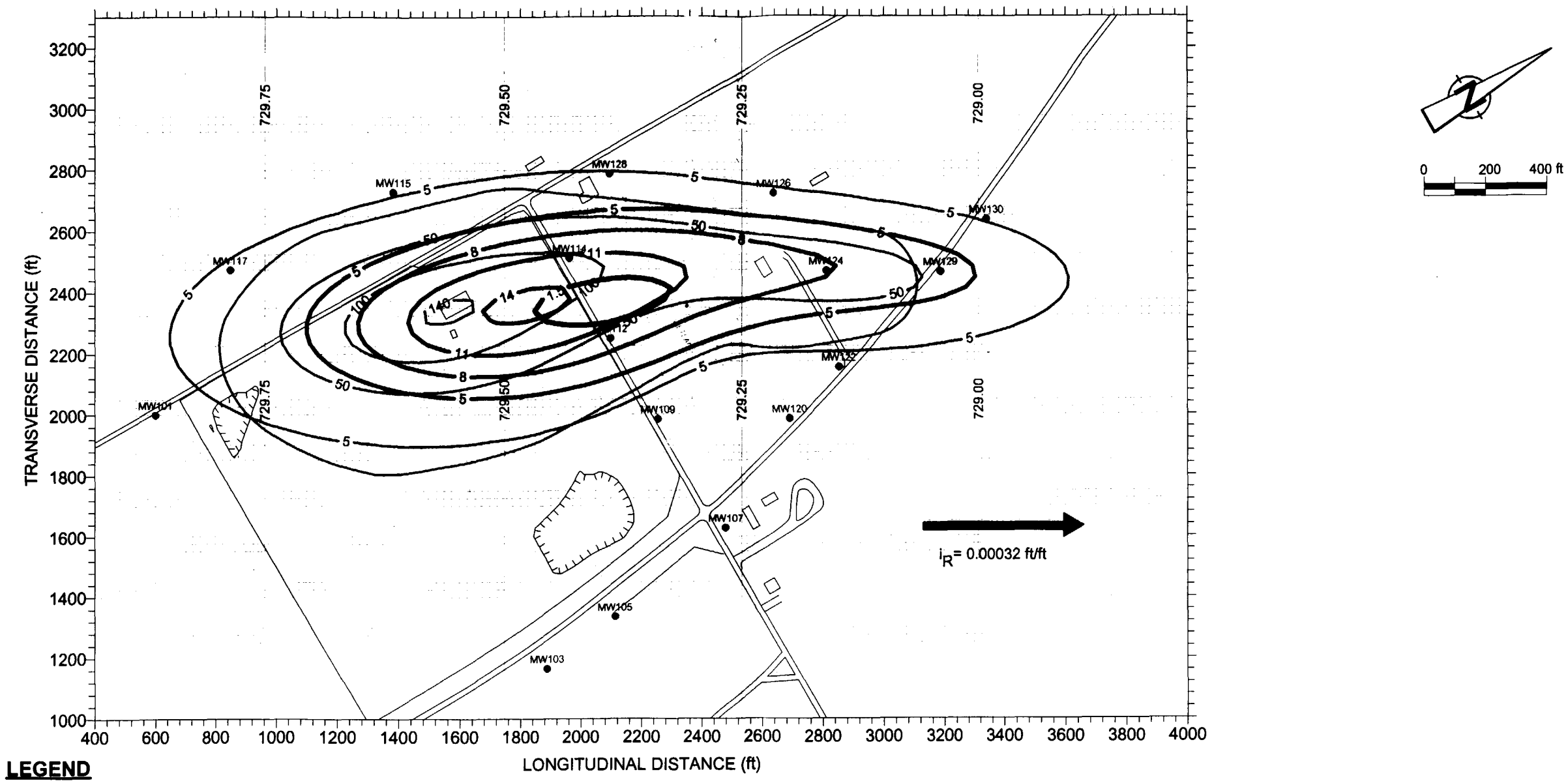


LEGEND

HYDROGEOLOGIC PARAMETERS

- UNIFORM SAND UNIT (K_h= 134.7 ft/d)
- FINITE-DIFFERENCE GRID
- MW 101 MONITORING WELL LOCATION
- REGIONAL GROUDWATER FLOW DIRECTION
- i_R REGIONAL HYDRAULIC GRADIENT

GROUNDWATER FLOW SIMULATION RESULTS

- —728.75— SIMULATED GROUNDWATER LEVEL (ft MSL)

CONTAMINANT TRANSPORT SIMULATION RESULTS

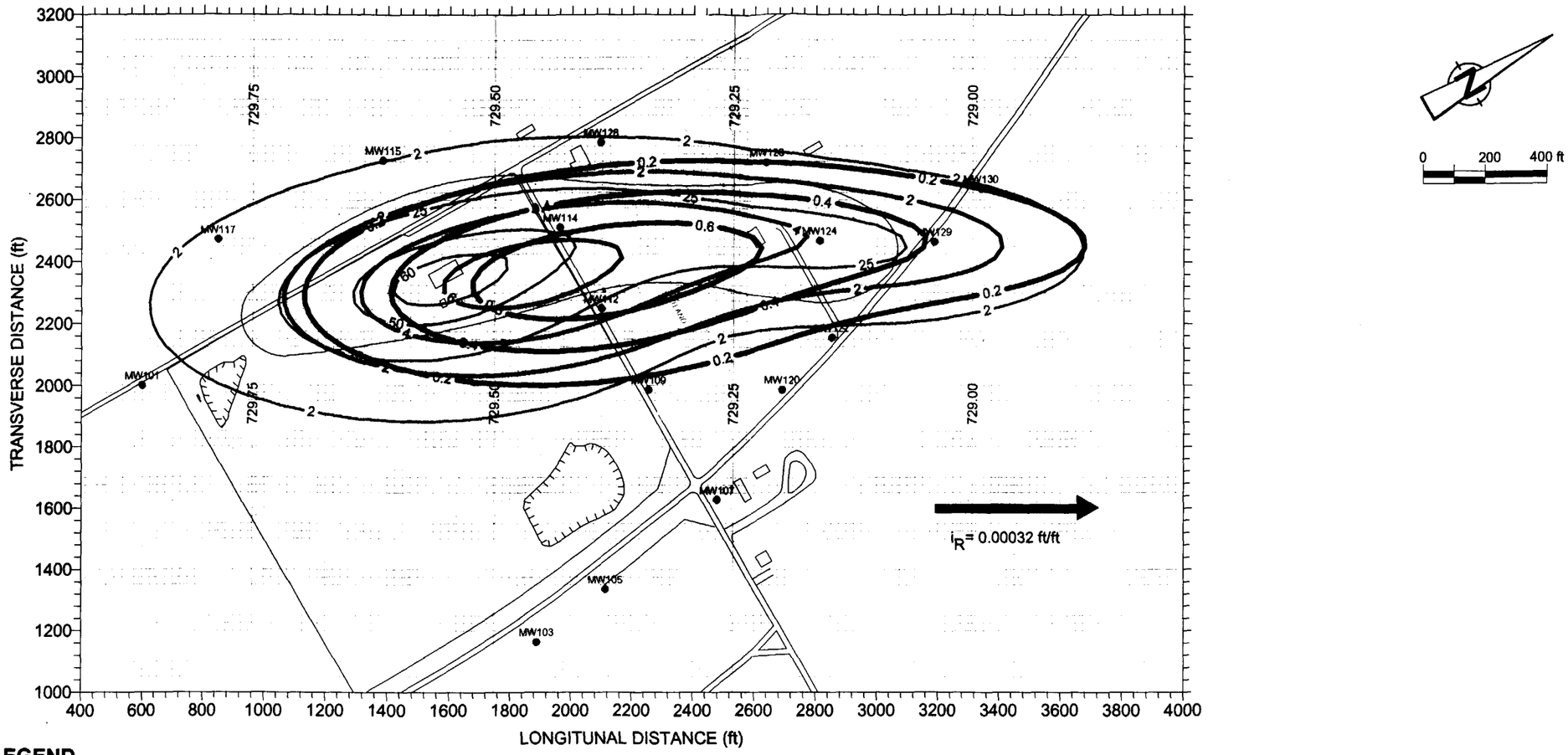
- INITIAL CONCENTRATION ENVELOPE AT 5 ug/L
- —5— SIMULATED CONCENTRATION AFTER 10 YEARS (ug/L)
- —5— SIMULATED CONCENTRATION AFTER 20 YEARS (ug/L)
- —5— SIMULATED CONCENTRATION AFTER 30 YEARS (ug/L)

figure G.4.1

MNA REMEDY
SIMULATED 1,2-DCA CONCENTRATION
DISTRIBUTIONS OVER 30 YEARS
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

CRA

05369-67(026)GN-WA-HYD (N:\HEG\05369\MOD\5369_ATA_DCA.SRF) SEP 15/2000



LEGEND

HYDROGEOLOGIC PARAMETERS

- UNIFORM SAND UNIT (K_h= 134.7 ft/d)
- FINITE-DIFFERENCE GRID
- MW 101 MONITORING WELL LOCATION
- REGIONAL GROUDWATER FLOW DIRECTION
- i_R REGIONAL HYDRAULIC GRADIENT

GROUNDWATER FLOW SIMULATION RESULTS

- —728.75— SIMULATED GROUNDWATER LEVEL (ft MSL)

CONTAMINANT TRANSPORT SIMULATION RESULTS

- INITIAL CONCENTRATION ENVELOPE AT 2 ug/L
- —5— SIMULATED CONCENTRATION AFTER 10 YEARS (ug/L)
- —5— SIMULATED CONCENTRATION AFTER 20 YEARS (ug/L)
- —5— SIMULATED CONCENTRATION AFTER 30 YEARS (ug/L)

figure G.4.2

MNA REMEDY
SIMULATED VINYL CHLORIDE CONCENTRATION
DISTRIBUTIONS OVER 30 YEARS
FOUR COUNTY LANDFILL SITE
Fulton County, Indiana

CRA

05369-67(026)GN-WA-HYD (N:\HEG\05369\MOD\5369_ATA_VC.SRF) SEP 15/2000

INPUT PARAMETERS FOR RT3D MULTI-SPECIES SOLUTE TRANSPORT SIMULATIONS
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Retardation Parameters

Compound of Concern	*Organic Carbon Partitioning Coefficient, K_{oc}* [1] *(L/kg)*	*Sorption Retardation Factor, R* [2] *(Dimensionless)*
1,2-Dichloroethane (1,2-DCA)	38.0	2.71
Vinyl Chloride (VC)	18.6	1.84

Biodegradation Parameters

	First -Order Decay Rates, λ, For Reductive Dechlorination From Field/In Situ Studies [3]					
	Mean Reported Value Applied in MNA Remedy Simulation		*Value Applied in Sensitivity Simulation 1*		*Value Applied in Sensitivity Simulation 2*	
Compound of Concern	*λ (days^{-1})*	*$t_{1/2}$* [4] *(days)*	*λ (days^{-1})*	*$t_{1/2}$ (days)*	*λ (days^{-1})*	*$t_{1/2}$ (days)*
1,2-Dichloroethane (1,2-DCA)	0.0015	462.1	0.003	231.0	0.00075	924.2
Vinyl Chloride (VC)	0.0030	231.0	0.006	115.5	0.00150	462.1

Biodegradation Parameters (Cont'd)

	Stochiometric Yield Coefficient [5]	
Compound of Concern	*Value (Dimensionless)*	*Daughter/Parent Compound*
1,2-Dichloroethane (1,2-DCA)	-	-
Vinyl Chloride (VC)	0.634	VC/1,2-DCA

Notes:

(1) Values reported in USEPA (1996; Table 39). Measure values were applied where available.

(2) Retardation factor values determined from $R=1+K_{oc}*f_{oc}*\rho_{db}/n$ with the following input parameters:

Input Parameter	*Deep Groundwater Flow System (Unit C)* *Value*	*Basis*
Fraction of organic carbon, f_{oc}	0.007	- Average of measured values obtained from non-impacted soil samples obtained from Unit C (CRA, 2000; Table 3.5)
Soil dry bulk density, ρ_{bd} (g/mL)	1.93	- Average of measured values obtained from soil samples obtained from Unit C (CRA, 2000; Table 3.5)
Porosity, n	0.3	- Conservative value for the sand and gravel that comprises Unit C

(3) Values reported in Suarez and Rifai (1999).

(4) Half-life, $t_{1/2}=\ln(2)/\lambda$

(5) Stochiometric yield coefficient equal to the gram-molar mass ratio of the daughter product to the parent compound.
The molar mass of 1,2-DCA and vinyl chloride is 99 grams and 62.5 grams, respectively.

TABLE G.2.1

HORIZONTAL HYDRAULIC GRADIENTS
DEEP GROUNDWATER FLOW SYSTEM
FOUR COUNTY LANDFILL SITE
FULTON COUNTY, INDIANA

Date	*Monitoring Well Pair MW 101/MW 122*				*Monitoring Well Pair MW 115/MW 126*				*Average*
	Measured Groundwater Elevation				*Measured Groundwater Elevation*				
	MW 101 (ft AMSL)	*MW 122 (ft AMSL)*	*Δh* (1) *(ft)*	i_H (2)	*MW 115 (ft AMSL)*	*MW 126 (ft AMSL)*	*Δh* (1) *(ft)*	i_H (3)	i_H
17-Nov-97	728.52	727.70	0.82	0.00036	728.13	727.75	0.38	0.00030	0.00033
15-Sep-98	729.33	728.42	0.91	0.00040	728.89	728.50	0.39	0.00031	0.00036
17-Mar-99	728.41	727.62	0.79	0.00035	727.96	727.64	0.32	0.00026	0.00030
26-Apr-99	729.54	728.83	0.71	0.00031	729.10	728.83	0.27	0.00022	0.00026
1-Jun-99	729.92	729.08	0.84	0.00037	729.54	729.09	0.45	0.00036	0.00037

Average i_H (all events) = 0.00032

Notes:

ft AMSL Feet above mean sea level.

(1) Change in groundwater elevation from upgradient to downgradient monitoring well.

(2) Horizontal hydraulic gradient determined from $i_H = \Delta h / \Delta l$, where the horizontal distance between the monitoring wells Δl=2258.17 ft.

(3) Horizontal hydraulic gradient determined from $i_H = \Delta h / \Delta l$, where the horizontal distance between the monitoring wells, Δl=1254.44 ft.