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ALTERNATIVE ARRAY DOCUMENT
REFUSE HIDEAWAY LANDFILL
MIDDLETON, WISCONSIN

June 13, 1994

Prepared For:

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1.0 EXECUTIVE SUMMARY

The purpose of this document is to develop remedial alternatives to mitigate impacts to human health and welfare and the environment caused by the closed Refuse Hideaway Landfill (RHL) site, located in Middleton, Wisconsin. Specifically, this document presents an Alternative Array Document (AAD) for landfill cover alternatives, ground-water remediation, and alternate water supply and is meant to satisfy Task 9 of the Statement of Work (SOW) between the Wisconsin Department of Natural Resources (WDNR) and Simon Hydro-Search. The AAD includes evaluation of alternative landfill cap designs, ground-water treatment, alternative water supplies, as well as a No Further Action alternative.

The remedial alternatives address the following objectives:

- Prevent direct contact with landfill contents;
- Reduce contaminant leaching to ground water;
- Provide potable water to residents of properties with impacted well water;
- Prevent migration of impacted ground water;
- Restore ground-water quality to the WDNR cleanup standard; and,
- Prevent off-site migration of landfill gas.

Specifically, the scope of work encompassed by this evaluation includes the following:

- Summary of existing RI site data;
- Evaluation of potentially applicable or relevant and appropriate requirements (ARARs);
- Establish Remedial Action Objectives (RAOs) to protect human health and the environment and General Response Actions (GRAs) for each medium of interest;
- Review and screening of available remedial technologies;
- Development and screening of remedial alternatives; and,
- Development and screening of costs to construct, operate, and maintain the remedial alternatives.

Three landfill cap alternatives were developed for the site, including no further action. One ground-water pumping and treatment alternative with three alternatives for discharge and two alternate water supply alternatives have also been developed.

Landfill Cap Alternatives

Alternative A - No Further Action

This alternative includes inspection and maintenance of the existing landfill cap, and continued operation and maintenance of the existing leachate extraction system and the existing landfill gas extraction and destruction system with off-site disposal of leachate. Additionally, ground-water monitoring for volatile organic compounds would be conducted semi-annually at approximately 21 monitoring wells and annually at approximately 12 private wells.

Alternative B - Limited Action

This alternative includes all of the tasks included in Alternative A. Additionally, the RHL would have deed restrictions placed in order to restrict future use of the former disposal area.

Alternative C - Limited Action

This alternative includes all of the tasks included in Alternative B. Additionally, a geomembrane and drainage layer would be constructed over the existing clay cap. Prior to placement, the existing topsoil and cover layer soil would be stripped for reuse.

Ground-Water Extraction and Treatment Alternatives

Alternatives D, E, and F all include the installation of four downgradient extraction wells to intercept the plume in the ground water as it migrates downgradient of the landfill. Ground water would be pumped at a rate of 45 gallons per minute and treated to remove volatile organic compounds (VOCs) by air stripping. The concentration of sediments and hardness in the water would be reduced to reduce maintenance associated with the discharge method selected. Pumping ground water at a rate of 45 gallons per minute is expected to provide hydraulic control of contaminated ground water within five years.

Alternative D - Ground-Water Extraction, Treatment, and Discharge to Surface Waters

Treated ground water would be discharged to a surface-water body near the site under this alternative. Monthly sampling and analysis of the treated ground water would be required.

The proposed ground-water discharge locations are as follows:

1. Black Earth Creek via drainage ditch at SE corner of RHL.
2. Black Earth Creek at the intersection at Twin Valley Road.
3. Black Earth Creek at Cross Plains.
4. East Fork of Pheasant Branch Creek.

Alternative E - Ground-Water Extraction, Treatment, and Discharge to an Infiltration Gallery

Treated ground water would be discharged to an infiltration gallery under this alternative. Monthly sampling and analysis of the treated ground water would be required. The infiltration gallery is likely to clog with precipitated solids over time.

Alternative F - Ground-Water Extraction, Treatment, and Discharge to Injection Wells

Treated ground water would be discharged to a series of ground-water injection wells under this alternative. Monthly sampling and analysis of the treated ground water would be required. A variance from the WDNR would be required for this type of discharge. The injection wells are likely to clog with precipitated solids over time. Injection of treated water upgradient of the plume would help to remediate the impacted ground water by flushing it with clean water.

Water Supply Alternatives

Alternative G - Supply Individual Water Treatment Units

This alternative consists of the construction, operation, and maintenance of point-of-entry treatment systems at approximately 25 residences which have ground-water supply wells which have the potential to be impacted by the RHL.

Alternative H - Construction of a Community Well

This alternative consists of the construction, operation, and maintenance of a community well which would supply unimpacted water to approximately 25 residences which have ground-water supply wells which have the potential to be impacted by the RHL.

2.0 INTRODUCTION

2.1 Overview

Hydro-Search, Inc. (HSI) was contracted by the Wisconsin Department of Natural Resources (WDNR) to prepare a Remedial Investigation/Feasibility Study (RI/FS) for the Refuse Hideaway Landfill (RHL) located in Middleton, Wisconsin. The purpose of the RI/FS is to determine the nature and extent of impacts to the soil, ground water, and air, as well as assess the risks posed by these impacts to human health and the environment. If deemed necessary, the design and implementation of selected remedies will follow in the Remedial Design/Remedial Action (RD/RA) phase.

This document presents the Alternative Array Document (AAD) for the RHL. The purpose of the AAD is to develop and evaluate alternative remedial actions, based in part, on information presented in the RI Report (HSI, 1994). These alternative remedial actions are to mitigate impacts to human health and welfare and the environment caused by the landfill. The AAD presents a review of appropriate technologies, develops alternatives, and evaluates the alternatives based on effectiveness, implementability, and cost. This work was performed in accordance with the National Contingency Plan (NCP) as amended, and RI/FS guidance.

2.2 Background

The RHL accepted municipal, commercial, and industrial waste during its operation and is located in the SW 1/4, NW 1/4, section 8, T7N, R8E, Town of Middleton, Dane County, Wisconsin. John DeBeck, the owner and operator of the RHL, received a landfill license from the WDNR in 1974 to operate a 23 acre landfill. The landfill operated for 14 years between 1974 and 1988. The site was not operated in "phases", therefore, the entire waste volume (approximately 1.5 million cubic yards) was exposed to leaching by rain and snow melt throughout its operating history.

On October 31, 1986, Residuals Management Technology, Inc. (RMT) submitted a closure plan for the landfill to the WDNR. Additional Information was submitted for the plan on November 21, 1986. The closure plan was conditionally approved by the WDNR on April 7, 1987, pending receipt and approval of an In-Field Conditions Report.

In 1986 and 1987, private water supply wells within a 1-mile radius of the landfill were sampled for VOCs by RMT and WDNR. No VOCs were detected in the private wells in 1986. However, in 1987, three private water supply wells, located approximately ½ mile to the southwest of the landfill, had measurable concentrations of VOCs. It appeared to the WDNR that the landfill was having an effect on ground water in these wells located to the southwest of the landfill.

The In-Field Conditions Report (RMT, 1988) documented the installation and sampling of 12 additional ground-water monitor wells, one additional leachate head well, and six gas probes. Ground-water samples were collected from the 12 new and 2 existing monitor wells and analyzed for VOCs to determine the nature and extent of ground-water impacts. The results of the VOC analyses indicated that Chapter NR140 Wisconsin Administrative Code Enforcement Standards (ESs) were exceeded at 12 of the 14 monitor wells sampled, including wells which were apparently upgradient and downgradient. The compounds exceeding ESs included tetrachloroethene (PCE), trichloroethene (TCE), vinyl chloride, benzene, and 1,2-dichloroethane (DCA). The impacts at apparently upgradient wells indicated that the potential for radial flow from the landfill existed.

In May of 1988, the WDNR issued Special Consent Order SOD-88-02A. The Consent Order required Refuse Hideaway, Inc. to close and cap the landfill, conduct an expanded hydrogeologic investigation, and prepare the Remedial Action Report. The hydrogeologic investigation goals were to determine the degree and extent of ground-water contamination around the landfill, evaluate the local and regional ground-water flow directions, and determine the nature, persistence and likely fate of the contaminants. In addition, existing and potential health effects posed by the landfill were to be evaluated. Potential remedial actions for mitigation of the landfill's impacts to the ground water were to be identified and long-term monitoring goals were to be defined.

John DeBeck closed the landfill under court order in May, 1988. At that time, he covered the landfill in accordance with NR504.07, Wisconsin Administrative Code, and placed a 6-inch grading layer of coarse soil over the waste, followed by 2 feet of clay soils. Two and a half feet of general soil was placed over the clay and 6 inches of topsoil, seed and mulch, completed the cap. The final cover was completed in October, 1988. In January, 1989, John DeBeck declared bankruptcy and refused to undertake additional remediation of the landfill or investigation of the degree and extent of ground-water contamination.

In early 1989 the State of Wisconsin undertook the continued remediation and investigation of the site. Costs for this work were paid by the Environmental Fund which are monies directly appropriated by the State legislature for environmental clean-ups

The following actions were accomplished as of the end of 1993:

1. **Landfill gas (LFG) and leachate extraction system.** A LFG and leachate extraction system is in place and operating at the landfill. A partial system was installed in fall, 1989 to conduct LFG extraction tests that led to design of the full extraction system. The complete system consists of 13 LFG/leachate extraction wells, header piping, blower, flow control systems, electrical control systems, telemetry system, a ground flare that meets all applicable air emission standards, and a leachate holding tank. Leachate is extracted from eight of the 13 wells. The other five wells have leachate heads of less than 6 feet at the base of the wells.

2. **Long-term operation and maintenance of the gas/leachate extraction system.** Terra Engineering & Construction Corporation (Terra) is currently under contract to operate and maintain the extraction system and landfill surface for the next 3 to 5 years. Besides actual O & M of the extraction system, Terra monitors gas probes

surrounding the landfill for methane migration, analyzes leachate samples for compliance with a wastewater permit for discharge to the Madison Metropolitan Sewerage District (MMSD), ensure that subcontractors (e.g., leachate hauler) perform all duties, inspects the landfill cover for erosion problems, and ensures that applicable air emission standards are met.

3. **Repair of Final Cover Soils.** Several areas of the landfill cover experienced significant erosion between 1988 and 1992. In Fall, 1992 a cap repair and restoration project was undertaken. Geomembrane and heavy riprap was installed in the areas of worst erosion, settlement cracks were repaired, an access road over the landfill surface was constructed, top soil, seed and mulch were added to areas of sparse vegetation. At this time, the landfill surface is in fairly good repair. The landfill surface will continue to be maintained through the State's O & M contract with Terra, at least until RD/RA.

4. **Methane gas monitoring at private homes.** In 1989 and 1990, private homes were monitored for the presence of methane gas. The homes were all in excess of 1,600 feet from the landfill and no landfill gas was detected in any of the homes.

5. **Private Water Supply Wells.** Three private water supply wells, serving three homes, were discovered to be impacted by VOCs in January, 1988. The landfill owner supplied bottled water until January, 1989 at which time the State took over payment for bottled water deliveries. In Fall, 1989, testing for design of a point-of-entry (POE) water treatment system was undertaken. The system, an activated carbon filtration system manufactured by Hellenbrand Water Systems, was installed in 2 homes in April and May, 1990. The third property (owned by Randall Swanson) is used as a business and the State continues to supply bottled water to the business. The home on the third property is no longer occupied and the water well has been shutdown.

The State maintained and tested the POE systems for two years. In Summer, 1992, ownership of the POE systems was transferred to the homeowners, who are now permanently responsible for maintenance of the system and testing of the water supply. All testing to date indicates that the filtration systems reliably produce safe, drinkable water.

6. **Testing of Private Water Supplies Within One Mile of the Landfill.** In Fall, 1989, 43 private water supply wells (serving 53 homes) were tested for the presence of Volatile Organic Compounds. Two testing rounds were conducted, in October, 1989 and January, 1990. The tests showed that all private wells (except the 3 previously mentioned) were free of VOCs. In one of the testing rounds, toluene was detected at approximately 1 part per billion in several private wells. Laboratory contamination is believed responsible for this. Subsequent testing showed all VOCs to be below detection at all these homes.

7. **Ground-water Monitoring Study.** In Summer, 1990, the State undertook an intensive ground-water investigation to determine the degree and extent of VOC contamination. HSI of Brookfield, Wisconsin performed the investigation. Twenty-seven ground-water monitor wells were installed. There were 30 existing monitor wells at the site, for a total of 57 monitor wells in the study. The study evaluated the geology, the vertical and horizontal ground-water flow, the average ground-water velocity in each geologic unit, the extent of aquifer contamination, the direction of plume movement, preliminarily evaluated four remedial actions, and made recommendations on future work at the site.

   The study showed that the ground-water plume has the potential to contaminate the Deer Run Heights subdivision, located approximately 1 mile southwest of the landfill. In January, 1991, the State began monitoring private wells in the eastern portion of Deer Run Heights.

8. **Numerical Model Simulation and Assessment of Contaminant Plume Migration.** In Summer, 1991, a numerical model was performed by HSI in an effort to estimate movement of the plume front downgradient of the landfill. A number of simulation scenarios were performed, resulting in a range of possible outcomes. The modeling effort provided an evaluation of the State's ground-water monitoring strategy and suggested that at least one additional monitor well be installed in the Black Earth Creek Valley. Model results suggested that the migration of PCE across the valley is unlikely, but cannot be considered conclusive due to the inherent uncertainties in the transport parameters in the analysis.

9. **On-going ground-water monitoring.** The State has established a long-term ground-water monitoring program that monitors the movement of the plume and tests private wells closest to the plume. Testing is conducted semi-annually (in May and October) on 21 monitor wells and 12 private wells. A present, this monitoring will continue through the end of 1994. HSI is under contract to perform this monitoring.

10. **Community Relations.** A community relations program was instituted at the beginning of the State's involvement with investigation and response actions at the RHL. Six public meetings have been held in the last 3 years. Public meetings are always announced by way of fact sheets and news releases. There currently is a mailing list of approximately 150 interested persons. In addition, 3 or 4 "technical availability sessions" have been held. These are less formal, but serve as a mechanism for interested persons to directly ask questions of WDNR staff involved in the RHL clean-up. A copy of each fact sheet and information sheet produced for the public are available at the WDNR.

11. **Remedial Investigation.** In 1994 HSI prepared a RI report for the RHL. This report assessed the characteristics of the waste in the landfill, presented previous investigative results for the RHL, presented an assessment of the nature and extent of contamination at the RHL based on previously collected data, characterized the

geologic and hydrogeologic setting based on previously collected data, identified potential migration pathways, and assessed actual and potential exposure routes. Based on the RI report:

- VOCs and elevated inorganic chemicals have been detected in ground water surrounding the site. The contaminated ground water extends at least 3,800 feet southwest of the landfill boundary. Known contaminants in the ground water consist of VOCs, including, but not limited to, benzene, dichloroethane (DCA), trichloroethane (TCA), dichloroethylene (DCE), trichloroethene (TCE), tetrachloroethene (PCE), vinyl chloride, ethylbenzene, toluene, dichlorodifluoromethane, and trichlorofluoromethane.

- Methane gas and leachate has been documented within the waste mass.

- Site geology/hydrogeology includes shallow bedrock, consisting of Prairie du Chien dolomite overlying late Cambrian age sandstone, which is present north, east, and west of the site. South of the site, up to 300 feet of unconsolidated materials exist, consisting of till, glaciolacustrine, outwash, and recent alluvium deposits. Ground water occurs in the sandstone and in the glacial deposits. Ground-water flow is primarily southwest, toward the Black Earth Creek Valley.

- The principal risk to human health posed by the site is associated with ground-water use through private domestic water supply wells. Three properties located downgradient of the landfill have VOC impacts.

Table 2-1 summarizes the reports produced to date for the WDNR.

2.3 Purpose and Scope of Report

The purpose of this document is to develop and evaluate remedial alternatives, based on the results of the RI, that will mitigate impacts to human health and welfare and the environment, and present the relevant information needed to allow for selection of a site remedy which will be protective of human health and welfare and the environment. Specifically, this document is an AAD for source control and ground-water restoration which encompasses Task 9 of the RI/FS Work Plan in accordance with the WDNR contract. This AAD is a comparative analysis of selected landfill cap and alternatives, landfill gas control alternatives, ground-water extraction and/or treatment alternatives, as well as a no-action alternative. Alternatives are screened for effectiveness, implementability, and cost.

The remedial alternatives address the following objectives:

- Prevent direct contact with landfill contents;
- Reduce contaminant leaching to ground water;
- Provide potable water to residents of properties with impacted well water;
- Prevent migration of impacted ground water;
- Restore ground-water quality to the WDNR cleanup standard; and
- Prevent off-site migration of landfill gas.

Specifically, the scope of work encompassed by this evaluation includes the following:

- Summary of existing RI site data,
- Evaluation of potentially applicable or relevant and appropriate requirements (ARARs),
- Establish Remedial Action Objectives (RAOs) to protect human health and the environment and General Response Actions (GRAs) for each medium of interest,
- Review and screening of available remedial technologies,

- Development and screening of remedial alternatives; and,
- Development and screening of costs to construct, operate, and maintain the remedial alternatives.

3.0 EXISTING CONDITIONS

The RHL is a comprised of a 23 acre parcel located in west central Dane County as shown on Figure 3-1. The landfill was primarily a municipal landfill, although commercial and industrial wastes were also accepted for disposal. The landfill operated as a licensed facility for 14 years between 1974 and 1988. The entire waste volume is approximately 1.5 million cubic yards.

3.1 Type and Integrity of Landfill Cover

The landfill cover was constructed during 1988 in accordance with NR504.07, Wisconsin Administrative Code requirements. A 6-inch grading layer of coarse soil was placed over the waste, followed by 2 feet of clay soils. Two and a half feet of general soil was placed over the clay comprising a root zone layer and 6 inches of topsoil completed the soil cover. The landfill cover was then seeded and mulched. The final cover was completed in October, 1988.

In fall 1992 a cap repair and restoration project was undertaken. Geomembrane and heavy riprap was installed in the areas of worst erosion, settlement cracks were repaired, an access road over the landfill surface was constructed, and top soil, seed and mulch were added to areas of sparse vegetation. At this time, the landfill surface is in fairly good repair. The landfill surface will continue to be maintained through the State's O & M contract with Terra at least until the RD/RA.

3.2 Landfill Gas

3.2.1 Landfill Gas Characterization

Landfill gas samples collected from gas probes completed in the landfill have historically contained relatively high concentrations of VOCs. Detected VOCs include: DCE, TCE, PCE, toluene, ethylbenzene, and xylenes. Historically, low VOC concentrations have also been detected in gas probes located outside the landfill, with VOC concentrations decreasing significantly away from the landfill.

Elevated concentrations of methane have been detected in gas monitor probes outside the perimeter of the landfill. Methane sampling results from 1989 indicated that the landfill gas was migrating rapidly through the subsoils, but migration to the south and southwest, where the largest number of residences in the area are located, appeared to be limited. The basements of nearby homeowners were monitored for combustible gases in March of 1989. Combustible gases were not detected in any of the homes at the time of monitoring.

3.2.2 Landfill Gas Control

In 1991, an active LFG extraction and treatment system comprised of thirteen gas extraction wells and a buried pipeline header which connects the wells to a ground flare was installed and started-up at the RHL site during 1991 (Warzyn, 1991). The intent of the gas extraction system is to control off-site emission and migration of LFG. The location of the leachate and gas extraction system is shown on Figure 3-2.

Each of the vertical gas extraction wells (GW1 through GW13) was constructed of an upper section of non-perforated 6-in. diameter Schedule 80 polyvinyl chloride (PVC) pipe extending into a lower section of perforated 8-in. diameter Schedule 80 PVC pipe. Each well was placed in 36-in. diameter borehole, with the annular space around the perforated section of pipe backfilled with a clean stone pack. Each well extends to the base of the landfill and ranges from 36 to 80 feet in depth. The screened zone extends from the base of the landfill upwards to approximately 20 feet below surface grade.

The gas header piping system transports LFG from the extraction wells to the blower station. The gas header piping system is comprised of three branches; the North, Central, and South which are combined before entering the blower. A 10 horsepower (hp) New

York Blower draws gas from the extraction wells and discharges into a ground flare for irreversible destruction of methane and VOCs. The ground flare maintains a temperature of 1,500 °F with a retention time of 0.5 seconds and a flow rate of 650 cfm.

Annual monitoring of the LFG extraction and treatment system has been conducted since the installation of the full gas extraction system. Observations in 1993 indicated that the system was not effectively controlling gas migration in the areas of GP-11 and GW-5 along the western side of the landfill. In September, 1993 two shallow lateral gas wells were installed. These lateral wells appear to be minimizing the gas migration, but because of historical seasonal variation in gas concentrations continued gas monitoring is necessary to confirm gas control. In general, it appears that off-site migration of landfill gas has been controlled. It is anticipated that additional modifications to the landfill gas control system would be made as necessary, as indicated by the landfill gas monitoring program. As a result, landfill gas remediation alternatives will not be addressed in the AAD.

3.3 Leachate

3.3.1 Leachate Characterization

As part of the remedial investigation completed in November 1988, RMT collected leachate samples from two leachate head wells for analysis of VOCs and inorganics. Leachate samples exceeded NR140 ESs for the following VOC compounds: benzene, 1,4-dichlorobenzene, 1,2-dichloropropane, and vinyl chloride. The following inorganic parameters exceeded NR140 ESs: arsenic, barium, cadmium, chloride, chromium, iron, lead, manganese, mercury, sulfate, and zinc. More recent leachate sampling results indicate the only VOC present at or above NR140 ESs is vinyl chloride and the inorganic parameter concentrations are variable and do not frequently exceed NR140 ESs.

3.3.2 Leachate Control

The leachate extraction system consists of thirteen extraction wells which were constructed as combination gas/leachate extraction wells during 1991 (Warzyn, 1991) and header piping, flow control systems, electrical control systems, and a leachate holding tank. As of 1993, leachate is extracted from eight of the thirteen wells. The other five wells have leachate heads less than 6 feet and are, therefore, not pumped.

Leachate is extracted from the extraction wells via submersible pumps and conveyed by the leachate piping to a leachate holding tank which is located east of the LFG blower and ground flare. The leachate conveyance piping was buried in the same trench as the LFG header system.

The amount of leachate collected in the leachate holding tank on an annual basis was 229,900 gallons and 144,588 gallons for the years 1992 and 1993, respectively. The collected leachate is transported by a tanker truck to the Madison Municipal Sewerage District (MMSD) for treatment and disposal. The extraction system appears to be effectively removing leachate from the landfill, and off-site treatment and disposal is appropriate for addressing this amount of leachate. As a result, leachate collection, treatment, and disposal alternatives will not be addressed in the AAD.

3.4 Hydrogeologic Characterization

3.4.1 Surface Water Hydrogeology

Black Earth Creek is the main surface water feature in the RHL area. The headwaters of Black Earth Creek flow to the west, essentially originating at the RHL, although the drainageway exiting the RHL property is intermittent (Figure 3-3). The flow of upper Black Earth Creek is derived mostly from ground-water discharge, except during and immediately after short periods of precipitation, when most of the flow is received from surface runoff

(Cline, 1963). Approximately 1½ miles downstream of the landfill, several intermittent tributaries join the main Black Earth Creek flow.

3.4.2 Ground-Water Hydrogeology

In the RHL area, the water table can occur in the unconsolidated deposits or in bedrock. Ground-water elevations were measured to determine ground-water flow directions and gradients. In general, the direction of ground-water flow coincides with the flow direction of Black Earth Creek, regionally flowing from the northeast to the southwest. Locally, ground-water flow is to the south in the unconsolidated deposits immediately south and east of the landfill. Further south in the valley, the flow direction changes and merges with the regional flow direction which trends in a western to southwestern direction. This western to southwestern direction of flow is also observed within the topographic ridges to the west and southwest of the landfill. The water table map for October 1993 is presented as Figure 3-4.

Hydraulic conductivities of both the glacial deposits and the bedrock units are high, based on bail-down tests performed in the monitor wells. Table 3-1 summarizes the results of the hydraulic conductivity testing. The highest hydraulic conductivities were detected in the wells screened in sand, with an average hydraulic conductivity of 1.1×10^{-2} cm/sec. Based on HSI's field results, the wells screened in bedrock also had high hydraulic conductivity values, with the sandstone averaging 2.2×10^{-3} cm/sec and the dolomite averaging 5.6×10^{-3} cm/sec. The lowest hydraulic conductivity values were detected in clay, with an average of 5.1×10^{-7} cm/sec.

Horizontal hydraulic gradients are greatest in the immediate vicinity of the landfill and generally decrease further downgradient of the landfill. Vertical gradients were found to be primarily downward with the strongest downward gradients generally noted in the well nests located along the southern edge of the landfill. Small upward gradients have been consistently detected at the P-23 location east of the landfill.

3.5 Contaminant Characterization

Ground-water samples collected from the monitor wells have been analyzed for VOCs (Table 3-2), metals (Table 3-3), semi-volatile organic compounds (SVOCs), and pesticides/PCBs. Based on the sampling results, iron and manganese were the only metal compounds to be detected above WDNR ESs. The concentration of iron and manganese is typically elevated in this area of Wisconsin.

The only positively identified SVOC detected in the ground-water samples was bis-(2-ethylhexyl) phthalate. Well P-20SR was the only well to have more than one detection of bis-(2-ethylhexyl) phthalate. Two rounds of pesticide/PCB samples were collected from three wells (P-17S, P-21S, and P-27S) in 1993. 4,4-DDT was detected in the first sample collected from P-17S (0.075 ppb), but was not detected in the second sample. Low concentrations of heptachlor were detected in both samples collected from P-21S (0.012 ppb and 0.010 ppb, respectively). The first sample collected from P-27S did not contain any detectable pesticides or PCBs, but the second sample contained heptachlor (0.010 ppb). There are no NR140 standards for bis-(2-ethylhexyl) phthalate, 4,4-DDT, and heptachlor. These are not considered contaminants of concern because they are present sporadically and only at low concentrations near the landfill.

Seven VOC compounds (benzene, chloroform, 1,2-DCA, trans-1,2-DCE, PCE, TCE, and vinyl chloride) have been detected at concentrations which exceeded the NR140 ES. The wells on the landfill property, particularly near the west and south landfill boundaries, have the highest VOC concentrations. Figure 3-5 shows a total VOC isoconcentration for the RHL site based on chemical analyses of the ground water from the RHL monitoring wells. The overlay for Figure 3-5 shows the revised total VOC isoconcentrations based on the results of the 1994 HSI Ground-Water Modeling Report. VOC concentrations decrease quickly away from the landfill to the northeast and to the south. VOC concentrations are more pervasive off the northwest and southwest corners of the landfill property. A local ground-water mound at the northwest end of the fill results in contaminant migration to the northwest of the landfill where VOCs have been detected up to 1,200 feet away. Regional ground-water flow transports the VOCs to the southwest up to 3,800 feet from the landfill.

Dispersion and dilution, in combination with degradation, are likely acting to reduce contaminant concentrations below detectable levels. High hydraulic conductivities in the bedrock and unconsolidated deposits likely increase the effectiveness of these processes, but probably less so in bedrock than in sand and gravel.

In bedrock, movement occurs through fractures, potentially at high velocity, and can result in detectable VOC concentrations at extended distances from the contaminant source. Higher velocities in bedrock due to fracture flow was thought to be a reason for contaminant detections up to 3,800 feet from the landfill (P-40). This pathway remains a possibility, but new insight gained from recent HSI (1994) modeling to evaluate the design and performance of a landfill well field indicates another viable scenario. Model results indicate downgradient spreading of the plume may be considerably narrower than past plume maps have shown. Contaminant migration is indicated by the model to follow a course that is mainly down valley within sand and gravel deposits with significantly shorter paths within bedrock adjacent to the landfill. Bedrock migration of contaminants is a strong possibility downgradient of the landfill where fractures intersect sand and gravel deposits within the valley. Migration of contaminants continues within sand and gravel as the southwest course of the valley abruptly takes a more northerly direction past monitor well nests P-30 and P-31 toward P-40.

Ground-water screening during drilling and samples collected from the piezometers around the landfill site indicate that the contaminants originating at the landfill are limited to elevations greater than 800 feet msl. The plume deepens to 700 feet msl further downgradient. The HSI 1991 study identified 700 feet msl to be the base of the plume. In 1992 a new water supply well was drilled on the Schultz property. The well is cased to a depth of approximately 600 feet msl and the base of the well is at approximately 500 feet msl. VOCs were detected in the new Schultz well indicating that contaminants are present below 600 feet msl. The VOC impacts in the new Schultz well may be related to a preferential migration pathway in the fractures of the bedrock.

Historical sampling results seem to indicate that the plume configuration is at equilibrium with dilution/dispersion/degradation processes. This was predicted from ground-water modeling completed in 1991 by HSI and confirmed by sampling results from 1992 and 1993. Based on model results, the plume is predicted to remain at equilibrium even if contaminant release rates from RHL change from current conditions. However, increases in ground-water contaminant concentrations at the RHL are not expected because both landfill gas and leachate are effectively being controlled by the dual leachate/landfill gas extraction system.

4.0 SUMMARY OF APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

The remedial action for the RHL site, under Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Section 121(d), must comply with federal and state environmental laws that are either "applicable" or "relevant and appropriate" requirements (ARARs). "Applicable" requirements are those standards, criteria, or limitations promulgated under federal or state law that address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a specific CERCLA site. "Relevant and appropriate" requirements are those that, while not "applicable," still address problems or situations sufficiently similar to those encountered at the site that their use is well suited to the particular site.

To-be-considered criteria (TBC) are nonpromulgated advisories or guidance that are not legally binding, but that should be used in determining if a remedial action is protective of human health and the environment. TBCs do not have the status of ARARs; however, the U.S. EPA's approach to determining if a remedial action is protective of human health and the environment involves considering both ARARs and TBCs. Potential ARARs and TBCs are discussed in this section. ARARs potentially applicable to Superfund projects in Wisconsin have been compiled by the WDNR and are attached in Appendix A.

4.1 Location-Specific ARARs

Location-specific ARARs are restrictions placed on the presence of hazardous substances or the conduct of activities solely on the basis of location. Examples of location-specific ARARs include state and federal requirements to protect floodplains, critical habitats, wetlands, etc., and solid and hazardous waste facility siting criteria.

The location specific ARARs and TBCs for the RHL facility are presented in Table 4-1. The landfill site does not provide a critical habitat upon which endangered or threatened species depend as stated in the Wisconsin Bureau of Endangered Resources ecological characterization (Appendix B). Wetlands are present to the southeast of the site. State location standards (such as setbacks from wells, property lines, etc.) apply only to new and expanding facilities, not to closed disposal facilities such as the RHL. Some remedial alternatives, however, could be limited by the location requirements for new or existing facilities.

4.2 Action-Specific ARARs

Action-specific ARARs are determined by the selected remedial activities. Table 4-2 lists potential action-specific ARARs for the RHL.

4.3 Chemical-Specific ARARs

Chemical-specific ARARs have been established which relate to soil and ground-water standards for remediation. Wisconsin NR140 Ground-Water Standards is an ARAR for the Ground-Water Operable Unit. A comparison of the WDNR NR140 Ground-Water Standards and the chemical analysis of the ground-water samples is attached in Tables 3-2 and 3-3.

5.0 IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES

5.1 Introduction

This section of the report is intended to identify site-specific Remedial Action Objectives (RAOs), General Response Actions (GRAs), and specific technologies which may be appropriate to the identified RAOs and GRAs for the RHL site. After development of the RAOs and the GRAs, the identified remedial technologies are screened to eliminate those which are inappropriate for inclusion in specific integrated alternatives.

5.2 Remedial Action Objectives

Based upon the existing conditions described in Section 3.0, specific media and locations can be targeted for development and evaluation of remedial alternatives. Remedial Action Objectives to protect human health and the environment for the RHL are presented below:

- Ground-Water RAOs
  - Prevent migration of impacted ground water
  - Restore ground-water quality to the cleanup standard
  - Provide alternative water supply for residents in the RHL area affected by ground-water contamination.
- Solid Waste RAOs
  - Prevent direct contact with landfill contents
  - Minimize contaminant leaching to ground water
  - Control surface water runoff and erosion

5.3 General Response Actions

General response actions have been developed for each medium of interest in order to satisfy the RAOs provided in Section 5.2.

5.3.1 Ground-Water GRAs

In order to prevent the migration of contaminated ground water and treat the ground water to remove the contaminants specified in the RI, the following are the proposed GRAs:

- No Action
- Pump and Treat Ground Water
- In-Situ Treatment of Ground Water

In order to provide an alternate water supply for the RHL the following are the proposed GRAs:

- Provide Bottled Water
- Treat Ground Water
- Install a Community Well Off-Site
- Deepen the Existing Wells

5.3.2 Solid Waste GRAs

In order to meet the RAOs for solid waste, the following are the proposed GRAs:

- No Action
- Limited Action (Fencing and Deed Restrictions)
- Improve the Existing Landfill Cap with a Flexible Membrane Liner (FML)

5.4 Identification and Screening of Process Types and Process Options

The U. S. EPA guidance for CERCLA municipal landfill sites indicates the following points be considered in order to streamline the development of remedial action alternatives:

- Generally, the most practicable remedial alternative for landfills is containment (capping). Depending on site characteristics, containment could range from a soil cover to a multi-component impermeable cap.

- Treatment of soils and wastes may be practicable for hot spots. Consolidation of hot spot materials under a landfill cap is a potential alternative in cases when treatment is not practicable or necessary.

- Extraction and treatment of contaminated ground water and leachate may be required to control off-site migration of wastes.

- Constructing an active LFG collection and treatment system may be required to prevent off-site migration.

The RHL is not known to contain hot spots of hazardous wastes. Therefore, treatment of soils and wastes is not a practical technology for this site. In addition, active leachate removal and off-site treatment has been conducted at the site since August, 1991. The system is effective, thus the assessment of additional leachate removal and treatment alternatives is not required. Active LFG removal and on-site treatment with a flare has been conducted at the site since August, 1991. The landfill gas extraction system appears to be effectively controlling the migration of the landfill gases, and therefore the assessment of additional LFG removal and treatment alternatives is not required. This section will therefore address technologies for access restrictions, containment, ground-water containment, ground-water recovery, in-situ treatment of the ground-water, ex-situ treatment of the ground water, provision of alternate water supplies, and disposal of treated ground water for the RHL.

5.4.1 Access Restrictions

Access restrictions at municipal landfill sites are intended to prevent or reduce exposure to on-site contamination. They include actions such as fencing, signs, and restrictive covenants on the property deed to prevent development of the site or use of ground water below the site. Access restrictions may also be imposed to reduce required maintenance and to protect the integrity of a remedial alternative such as a landfill cap. Some of the conditions at a municipal landfill site that may warrant access restrictions include landfills where no cap has been constructed, where erosion due to traffic is a concern, where liability concerns warrant limiting access, and landfills where active collection and treatment of LFG is being used.

Two types of access restrictions most used at municipal landfill sites include deed restrictions and fencing.

5.4.1.1 Deed Restrictions

Restrictive covenants on the deed to the landfill property are intended to prevent or limit site use and development. Restrictive covenants, written into the landfill property deed, notify any potential purchaser of the landfill property that the land was used for waste disposal and that the land use must be restricted in order to ensure the integrity of the waste containment system. The effectiveness of deed restrictions depends on state and local laws, continued enforcement, and maintenance. Because deed restrictions are generally used in conjunction with other remedial actions, 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 municipal landfill sites, the major purpose of deed restrictions is to protect the integrity of the cap.

5.4.1.2 Fencing

When necessary, fencing is used to physically limit access to the landfill site. Signs may be posted to make clear to potential trespassers that there may be a health threat associated with entering the site. Signs typically are posted at equal intervals along the perimeter of the site and along roads leading to the site. The most common type of fence used to limit access is a chain-link fence 8 feet in height. Barbed wire on top of the fence may also be required to deter trespassing. Gates alone may be sufficient if only vehicular traffic needs to be restricted. The locations and potential risks of the landfill site must be identified to determine whether fencing is necessary.

5.4.2 Containment

Containment refers to technologies that isolate the landfill contents and mitigate off-site migration through the use of engineered controls. Containment technologies include surface controls and capping.

5.4.2.1 Surface Water Controls

Surface water control technologies are designed to control and direct site runoff and to prevent off-site surface water from running onto the site. These technologies reduce water infiltration into the waste and associated leachate generation, and slow down the rate of cap erosion. Surface water controls to divert run-on and minimize infiltration are often implemented in conjunction with other technologies such as the installation of a landfill cap. Surface water controls most commonly used at municipal landfill sites are grading and revegetation.

The existing cover at RHL complies with the NR504 rules and, consequently, surface water controls are currently in place at the RHL. However, consideration will be given as to whether a partial geosynthetic cover at the landfill is warranted using the HELP model.

Surface water controls may need to be reconstructed in the event that a partial geosynthetic cover is deemed appropriate at the RHL.

5.4.2.1.1 Grading

Grading modifies topography in order to promote positive drainage and control the flow of surface water. A properly graded surface will channel uncontaminated surface water around the landfill, thereby minimizing infiltration through the landfill cap. Grading would be required at the RHL in the event that a partial geosynthetic cover is installed at the landfill.

Grading is also the general term for techniques that reshape the surface of landfills in order to control erosion and to manage surface-water infiltration, run-on, and runoff. Designing proper slope lengths and gradients, and creating berms and swales are common grading techniques used to control and route surface water. Earth fill, typically from off-site borrow sources, may be required to change slopes and to construct earthen berms. Regrading existing fill material is recommended in situations where there is a significant quantity of fill and analysis shows the fill is acceptable for re-use.

Generally, slopes on top of the landfill range from 2% to 8% in order to promote runoff and control erosion. Sideslopes can be as steep as 3H:1V (33%) as long as benches (horizontal steps) are provided to interrupt the slopes and thus control soil erosion and maintain slope stability. A well prepared grading plan will take waste settlement into account by recommending top slopes that will remain effective after settlement.

5.4.2.1.2 Revegetation

Revegetation is a method used to stabilize the soil surface of a landfill site and promote evapotranspiration. Revegetation decreases erosion of the soil by wind and water, reduces sedimentation in storm water runoff, and contributes to the development of a naturally stable surface. A systematic revegetation plan includes selection of a suitable plant species, seedbed preparation, seeding/planting, mulching and/or chemical stabilization, fertilization, and maintenance.

Revegetation is used most in concert with other containment technologies such as caps. Trees and shrubs with deep roots that might penetrate the impermeable cover layer should be prevented from growing on the landfill surface.

5.4.2.2 Landfill Cover

Capping technologies are designed to reduce surface-water infiltration, control emissions of gas and odors, reduce erosion, and improve aesthetics. Capping technologies also provide a stable outside surface that prevents direct contact with wastes. The different types of capping technologies typically used at landfills include:

- Native soil cap
- Single barrier cap (e.g. clay)
- Composite cap (e.g. clay plus flexible membrane liners [FMLs])

The native soil (non-clay) covers are appropriate for landfills located in arid climates, and therefore not applicable to the RHL.

Because the existing cover at RHL complies with the NR504 rules and is comprised of a single barrier cap, construction of a new single barrier cap need not be examined. As stated earlier, consideration will be given as to whether a partial geosynthetic cover (composite- barrier cap) at the landfill is warranted.

A composite-barrier cap provides an additional barrier layer, which reduces the rate of infiltration more than a single-barrier cap does. A composite barrier consists of a compacted clay layer overlain by a synthetic liner. A composite barrier, in turn, is overlain by a drainage layer and by a top vegetative/protective layer.

A composite-barrier cap is required when the landfill is used for disposal Resource Conservation and Recovery Act (RCRA) hazardous wastes. RCRA provides technical guidance (U. S. EPA, July 1989) that defines the types of layers U. S. EPA considers to be appropriate for a cap for new RCRA landfills. The minimum thicknesses for the layers in a RCRA cap (from visible top to top of waste) are as follows:

- Vegetative and protective layer - 24 inches of native soil.

- Drainage layer - 12 inches of sand (permeability $\geq 1 \times 10^{-2}$ cm/sec) or geonet (transmissivity $\geq 3 \times 10^{-5}$ m^2/sec)

- First barrier layer component - FML (20-mil minimum)

- Second barrier layer component - 24 inches of compacted clay (permeability $\leq 1 \times 10^{-7}$ cm/sec)

- Bedding layer (optional) - 12 inches of native soil or sand subgrade

The final design profile of a typical composite cap will also include geotextiles as filter between the protective cover and the drainage layer and as a protective layer over the synthetic barrier if a layer of natural drainage stone is used.

5.4.3 Ground-Water Containment

Ground-water containment is used to prevent the migration of impacted ground water via an impermeable barrier. Generally, the impacted ground water contained by the impermeable barrier is treated in-situ or ex-situ in order to reduce the volume and concentration of impacts.

Typically, ground-water containment is achieved by creating slurry walls (fixed underground physical barriers formed by pumping slurry, usually a soil or cement, bentonite, and water mixture, into a trench as excavation proceeds), sheet piling cutoff walls (constructed by driving web sections of sheet piling permanently into the ground), and grout curtains (fixed underground physical barriers formed by injecting grout, either particulate (such as Portland cement) or chemical (such as sodium silicate), into the ground through well points.

Ground-water containment is typically reserved for sites with a relatively shallow water table, relatively shallow ground-water contamination and an underlying confining layer impermeable zone to which the ground-water containment structure can be tied. Because of the depth of the contaminants at the site and the lack of an underlying impermeable zone, ground-water containment will not be addressed further in this document.

5.4.4 Ground-Water Recovery

Ground-water recovery is used to reduce contaminant mass and prevent the migration of impacted ground water by removing it from the aquifer. Treatment is employed in order to reduce the volume and concentration of impacts to the water. The ground-water recovery technologies discussed are ground-water extraction wells and ground-water interception trenches.

5.4.4.1 Ground-Water Extraction Wells

Ground-water pumping uses a series of wells to remove contaminated ground water for treatment and subsequent discharge. A well system utilizes one or more pumps to draw ground water to the surface forming a cone of depression in the ground-water table, the extent and slope of which is dependent on pumping rates and duration as well as local ground-water and geological factors. Ground-water pumping can also be used to lower the water table and to hydraulically control a plume.

5.4.4.2 Interception Trench

An interception trench creates a long area of low hydraulic head which causes subsurface flow to be directed to a recovery location, such as a sump. An interception trench would generally be constructed downgradient of the impacted ground water and perpendicular to ground-water flow.

A 2-foot wide trench would be excavated to the appropriate depth, typically coincident with the maximum depth of contaminants. Then a slotted pipe would be placed at the bottom of the trench. The trench slopes to a collection sump. The trench is backfilled with gravel in order to provide structural stability and a preferential pathway for flow. An impermeable barrier of plastic and compacted clay is placed near the surface in order to minimize infiltration of surface water. Ground water is pumped from the sump for treatment.

Ideally, the ground water of concern is located at a maximum depth of 25 feet below ground surface. Construction of interceptor trenches greater than 25 feet below ground surface can be costly, time consuming, and may be impractical. Because the ground-water of concern is located much deeper than 25 feet below the ground surface, this technology will not be considered for this site.

5.4.5 Ex-Situ Ground-Water Treatment

Ex-situ ground-water treatment is used to remove contaminants from recovered ground water. The treated ground water is then discharged or disposed in accordance with local, state, and federal ARARs.

5.4.5.1 Treatment of Organics

Carbon Adsorption

This technology involves processing ground water through a bed of activated carbon chosen to be suitable for the removal of the organic constituents in question. Carbon adsorption has been shown to provide a high level of removal and is capable of producing water that is of drinking water quality. Carbon adsorption systems are closed, and therefore (unlike other treatment systems) have a low potential for emissions of VOCs to the atmosphere. Because the technology is "non-specific," it is appropriate to ground water containing multiple organics.

Activated carbon has a limited lifetime before regeneration of the carbon is required. The lifetime of the system is dependent upon the composition of the influent and variations in the flow. The most common method of regeneration of spent carbon includes thermal treatment with steam. VOCs are transferred to the vapor phase for solvent recovery and as a result are removed from the surface of the carbon.

Air Stripping

Air stripping is employed when it is desired to transfer VOCs from water into air. The air containing the stripped VOCs is vented to either the atmosphere, or to a vapor phase treatment system if local, state, or federal air pollution regulations require such.

Generally, air is forced by a blower through baffled aeration trays or an irregular solid packing material, while water flows downward by gravity counter-currently with the air. Contact between the air and water streams on the aeration trays or irregular solid packing material generates a froth of bubbles which forms a large mass transfer surface area where the VOCs become volatilized and enter the forced air stream.

The efficiency of the air stripping process is dependent on the air-to-water ratio, the contact time and temperature provided in the tower, and the physical and chemical properties of the constituent of interest. Air stripping may also be used in conjunction with carbon adsorption, where the carbon adsorption process is used to further remove constituents from the ground water or the air stream exiting the stripping unit.

Biological Treatment

Biological treatment removes organic constituents through microbial degradation. This technology requires sufficient organic matter to sustain biological activity and may be inappropriate for dilute ground-water streams. For constituents which are amiable to biological degradation, treatment is typically performed in a continuous process under aerobic conditions. Process options include activated sludge, trickling filters, and rotating biological contractors.

A sludge residue is generated along with the treated effluent which consists of inactive microbes. Disposal options for the sludge include landfilling, incineration, and land application.

5.4.5.2 Discharge Options

Ground water which is removed from the aquifer and is treated to remove contaminants requires discharge. Methods which are typically used to discharge treated ground water include discharge to surface waters, discharge to a Publicly Owned Treatment Works (POTW), discharge to an infiltration gallery, discharge to a series of injection wells, or use of the treated ground water for irrigation purposes.

Discharge to Surface Waters

The nearest surface water body to the RHL is Black Earth Creek, a Class A trout stream. Although the NR105 discharge standards could be met through treatment, approval by the WDNR for discharge to the Black Earth Creek would be required.

The following are the potential surface water discharge locations for treated ground water:

1) Discharge to Black Earth Creek via Intermittent Drainage Ditch
The above-mentioned intermittent drainage ditch is located approximately 20 feet from the southeast corner of the landfill. Treated water would be directed via a pipeline system to the discharge location. Approval for discharge to this intermittent drainage ditch may be difficult since the ditch would discharge to a segment of Black Earth Creek classified an "~~exceptional~~ outstanding" water resource. Any discharges which may cause variation in water quality or quantity are highly regulated.

2) Discharge to Black Earth Creek at Twin Valley Road
This discharge location is located approximately two thirds of a mile southwest of the landfill at the intersection of Black Earth Creek and Twin Valley Road. At this location, the Black Earth Creek has water flow year-round. Treated water would be directed via a pipeline system to the discharge location. Approval for discharge to the creek may be difficult since this segment of Black Earth Creek is classified as an "~~exceptional~~ outstanding" water resource.

3) Discharge to Black Earth Creek at Cross Plains
This Black Earth Creek discharge location is located approximately four miles west of the landfill in the town of Cross Plains. At this location, the Black Earth Creek has water flow year-round. Treated water would be directed via

a pipeline system to the discharge location. WDNR approval for discharge to Black Earth Creek would be easier to obtain than the discharge locations listed above since the discharge would occur at a segment of Black Earth Creek classified as an "~~outstanding~~ exceptional" water resource rather than "~~exceptional~~ outstanding".

4) Discharge to the East Fork of Pheasant Branch Creek
A separate watershed exists to the north of the site which drains to the East Fork of Pheasant Branch Creek. For this intra-basin transfer, water would need to be conveyed a distance of approximately one mile with an elevation rise of approximately 220 feet. The East Fork of the Pheasant Branch Creek ~~is also classified as an "outstanding" water resource~~.

Discharge to a POTW

Discharging to the nearest POTW in Madison, would require that the Madison Metropolitan Sewerage District (MMSD) install a conveyance system in the vicinity of the landfill. The treated water would then be piped to a conveyance system for ultimate disposal at the MMSD located approximately 3 miles east of the site.

However, the MMSD has indicated that is does not anticipate construction of such a conveyance system since the RHL is not located in the MMSD district. Furthermore, the MMSD does not allow discharge of water through conveyance systems constructed by second parties. Consequently, this alternative will not be considered further in this document.

Discharge to an Infiltration Gallery

An infiltration basin would allow treated ground water to percolate through the soil, recharging the aquifer. The size and associated cost of an infiltration basin depends upon the permeability of the underlying soils. It should be noted that a trench would be excavated and backfilled with gravel to maximize the quantity of water which can be discharged. The U. S. EPA recommends that the design percolation rate be 4% of the minimum soil permeability (U. S. EPA, 1981). Consequently, the area of the infiltration gallery would be approximately 76,400 square feet for the sand at the site with a permeability of 1 x 10^{-3} cm/sec and an assumed discharge rate of 45 gallons per minute. This indicates that an infiltration gallery may be a feasible discharge method.

Reinjection via a Series of Injection Wells

Treated ground water could be reinjected to the aquifer via a series of ground-water injection wells. Potential problems associated with this alternative are clogging of the well screens with microorganisms and precipitation of minerals present in the water as hardness. A variance from the WDNR rules prohibiting injection wells would be required and additional field testing would be required before the design of the system would commence. Injection of the treated water upgradient of the ground-water impacts would help to increase the rate of remediation by flushing the area with clean water.

Use of the Treated Water for Irrigation Purposes

Treated ground water could be used to irrigate agricultural areas in the vicinity of the landfill. A potential problem associated with this alternative is the seasonal nature of the demand for irrigation water in Wisconsin since it is anticipated that ground-water treatment and discharge would be required on a continuous basis. Consequently, this alternative will not be considered further in this document.

5.4.6 In-Situ Ground-Water Treatment

In-situ ground-water treatment technologies are considered to be innovative treatment technologies by the EPA. Consequently, air sparging with vapor recovery, in-situ bioremediation, and in-situ chemical oxidation are addressed in this section.

5.4.6.1 Air Sparging with Vapor Collection

Air sparging with vapor collection is used to remove and collect VOCs in ground water. Air discharged from a blower is forced through a network of wells which are screened in the saturated zone. The forced air volatilizes VOCs from the ground water. Air and VOCs are collected with a series of wells screened in the vadose zone. The vadose zone wells are connected to a blower which withdraws air from the vadose zone. The air containing the stripped VOCs is vented to either the atmosphere, or to a vapor phase treatment system, if local, state, or federal air pollution regulations require such. This in-situ remediation technology is not feasible for the RHL site since the air sparging wells would need to be screened at ground water at depths greater than 100 feet below ground surface near the landfill at a prohibitive cost.

5.4.6.2 Bioremediation (Anaerobic/Aerobic)

In-situ anaerobic/aerobic biodegradation is the process of enhancing microbial action to remediate subsurface contaminants which are dissolved in the water phase. This technology is designed to biodegrade both chlorinated and non-chlorinated constituents by employing bacteria which use the carbon in the constituents as their energy source.

Reductive chlorination under anaerobic conditions is relatively rapid for chemicals with a higher number of chlorine constituents such as PCE and TCE. Upon reduction, these compounds lose chlorine, and the resulting products are usually more susceptible to oxidative processes such as aerobic biodegradation. Therefore, the anaerobic /aerobic sequential biodegradation of highly chlorinated compounds by indigenous microbes could occur and should be encouraged (U.S. EPA, 1993).

In order for compounds to undergo natural anaerobic/aerobic sequential environmental conditions, compounds would have to flow from anaerobic zones, which are the normal ecological conditions, to aerobic zones at which air was added. Each of these zones would be comprised of a biofilm which would be installed vertically through the ground water which requires treatment. As the ground water passed through the biofilm, the biological degradation would occur.

Nutrients would be added to provide the proper conditions for the microorganisms. Naturally occurring microorganisms are used to achieve biodegradation. The end result is carbon dioxide, water, and bacterial biomass.

An important factor influencing biological degradation is whether the necessary organisms are present. This would be determined before a full scale remediation system would be designed. It may be necessary to add non-native microorganisms to the subsurface to maximize the effectiveness of this alternative (U.S. EPA, 1993). It should be noted that this bioremediation technology has been applied under controlled laboratory conditions, however, at present there are few applications of this technology under real-world conditions. Consequently, this alternative will not be considered further in this document.

5.4.6.3 Bioremediation (Cometabolism)

In-situ cometabolism biodegradation is the process providing a primary substrate (energy source) for the microorganisms so that the microorganisms can remediate subsurface contaminants which are dissolved in the water phase.

Natural gas would be added to the subsurface for those microorganisms which oxidize methane to carbon dioxide (U.S. EPA, 1993). The microorganisms simultaneously oxidize the chlorinated organic compounds.

Nutrients would be added to provide the proper conditions for the microorganisms. Naturally occurring microorganisms are used to achieve biodegradation. The end result is carbon dioxide, water, and bacterial biomass.

An important factor influencing biological degradation is whether the necessary organisms are present. This would be determined before a full scale remediation system would be designed. It may be necessary to add non-native microorganisms to the subsurface to maximize the effectiveness of this alternative (U.S. EPA, 1993). It should be noted that this technology has been applied under controlled laboratory conditions, however, at present there are few applications of this technology under real-world conditions. Consequently, this alternative will not be considered further in this document.

5.4.6.4 In-Situ Chemical Oxidation

In-situ chemical oxidation is the process providing an oxidizing agent such as hydrogen peroxide to the in-situ ground water via a series of injection wells. The hydrogen peroxide would react with the organics in the ground water to form carbon dioxide, water, and hydrogen chloride. It should be noted that the oxidation potentials of each of the chlorinated hydrocarbons do not allow for chemical oxidation of each of the constituents with the same rate or effectiveness. Some of the constituents such as PCE do not lend themselves to chemical oxidation. Consequently, since PCE is a constituent of concern at this site, this remedial alternative will not be considered further in this document.

5.4.7 Alternative Water Supplies

5.4.7.1 Provision of Bottled Water

This alternative entails providing bottled water to the homes with impacted wells. The bottled water is provided for potable use, with the private water used to meet other water needs. Bottled water is not typically a long term solution, primarily because of the health risks associated with the non-potable uses of impacted well water (e.g. bathing). Therefore, this alternative will not be considered further in this document.

5.4.7.2 Deepening of Ground-Water Wells

This option involves abandoning the private wells that are currently in use. New, deeper wells would be installed at all the residences. The upper portion of the aquifer would be cased off separating it from the lower portion of the aquifer, which would be used for the water supply. This technology assumes that the deeper zone is not contaminated. One of the three impacted residences has already installed a second, deeper well. The new well is cased to a depth of 359 feet and has a total depth of 448 feet. VOC impacts have been detected in this well. Based on these results, installing deeper wells at the private residences is not a viable option and will not be considered further in this document.

5.4.7.3 Individual Point-of-Entry Treatment Units

Point-of-entry (POE) treatment systems treat the contaminated ground water before distribution throughout the home. Typically, a carbon adsorption unit is used for the removal of VOCs from the ground water. This system effectively removes the VOCs. Ground-water quality fluctuation with time may effect the time between carbon unit replacements. Because this technology relies on treating impacted water, routine sampling is required to assure that the residents are receiving potable water and that the carbon units are replaced when necessary. In addition, access control of the treatment systems is limited because the units are contained within private residences.

5.4.7.4 Installation of a Community Off-Site Well

This option involves installing a well upgradient of the contaminant plume. A water distribution system would transport potable water to all effected residences. Installing an up-gradient community well is a reliable long-term solution, but it may be more costly than the other options.

5.5 Technologies Suitable for Further Development

The technologies described above are summarized in Table 5-1. Each technology was screened on the basis of effectiveness and implementability, and a determination was made on whether the technology is appropriate as part of a remedial alternative. These alternatives are detailed in Section 6.

6.0 DEVELOPMENT AND SCREENING OF REMEDIAL ALTERNATIVES

6.1 Purpose

The purpose of this section is to evaluate alternatives that are based upon the technologies screened in Section 5 as appropriate for consideration at the RHL. The following technologies will be included in alternatives to be considered:

- Deed Restrictions
- Fencing
- Grading
- Revegetation
- Composite Cap
- Ground-Water Recovery
- Ex-situ Ground-Water Treatment
- Discharge of Treated Ground Water
- Alternate Water Supply

These technologies will be included as a part of the following alternatives, which will be discussed in further detail below:

Landfill Cap Alternatives

A. No Further Action.
B. Limited Action.
C. Construct a Composite Cover on Landfill.

Ground-Water Extraction, Treatment and Discharge Alternatives

D. Ground-Water Extraction, Treatment and Discharge to Surface Waters.

E. Ground-Water Extraction, Treatment and Discharge to an Infiltration Gallery.

F. Ground-Water Extraction, Treatment and Reinjection by Injection Wells.

Water Supply Alternatives

G. Supply Individual Water Treatment Units.

H. Construction of a Community Well.

Following a discussion of design concepts, each alternative will be screened for effectiveness, implementability and cost. These screening criteria are defined for the site as follows:

Effectiveness - degree to which the alternative protects human health and the environment; attains Federal and State ARARs or other applicable criteria, advisories, or guidance; significantly and permanently reduces the toxicity, mobility, or volume of the hazardous constituents and are technically reliable and effective in other respects. Reliability considerations include the potential for failure and the need to replace the remedy.

Implementability - degree to which the alternatives are technically feasible and employ available technologies; the technical and institutional ability to monitor, maintain, and replace the technologies over time, and the administrative feasibility of implementing the alternatives.

Cost - evaluation of construction and long-term costs to operate and maintain the alternatives based on conceptual costing information. At this stage, cost will be used as a factor when comparing alternatives that provide similar results.

The probable costs to implement the alternatives for the RHL are itemized for direct costs, operation and maintenance (O&M) costs, and present worth. Direct costs are the capital and other initial costs required to implement the alternative. O&M costs are an estimate of the annual cost to operate and maintain the alternative. The present worth estimate is the addition of the direct cost with the present value of the O&M costs discounted at 6% over a 30-year project life. The probable cost is intended to be in the range of +50% to -25% of the actual cost, and provides for relative comparison between alternatives. Probable costs for each alternative are provided in Appendix C and summarized in Table 6-1. The probable costs will be further refined in the remedial design stage.

6.2 Landfill Cap Alternatives

6.2.1 Alternative A - No Further Action

6.2.1.1 Design Concepts

Evaluation of a No Further Action Alternative is required by CERCLA guidance in order to provide a baseline against which other alternatives can be compared. Maintenance of the site includes inspection, occasional mowing to prevent tree growth, and filling low areas resulting from settling.

The existing dual landfill gas/leachate collection and treatment system would be operated as specified in the Operation and Maintenance Plan for that system. It is anticipated that modifications to the LFG collection and treatment portion or the leachate collection portion of the dual system would be implemented as necessary, based upon the results of continued monitoring.

Semi-annual sampling and analysis of the existing up-gradient ground water monitoring wells would be conducted to evaluate background water quality. Select wells within the plume would be monitored to document trends in contaminant concentrations. Wells along the downgradient boundary of the plume would also be monitored to document plume migration. A total of approximately 21 monitor wells, comprised of those wells which are in the existing ground-water monitoring plan, are expected to be included in the ground-water monitoring program. The wells would be sampled for VOCs by U. S. EPA Method 502.2 or SW-846-8021. No samples will be collected for analysis of metals, semi-volatile organic compounds, pesticides or PCBs because previous sampling has indicated that these are not contaminants of primary concern at this site.

In addition to the monitor well sampling, annual samples would also be collected from downgradient private wells that could potentially be impacted by the contaminant plume. A total of approximately 12 private wells, comprised of those wells which are in the existing ground-water monitoring plan, would be included in the monitoring program. The private well samples would be analyzed for VOCs by U. S. EPA Method 502.2.

Continued monitoring of the landfill gas would be conducted with the existing landfill gas probes at the RHL.

6.2.1.2 Effectiveness

Maintenance of the existing cap included with this alternative would be effective in preventing direct contact with solid waste.

The U.S. EPA's Hydrologic Evaluation of Landfill Performance (HELP) model was used to estimate percolation rates for the existing cap. A uniform 31.8-inch compacted clay layer (the average thickness of the existing clay cover) with a permeability of 1×10^{-7} cm/s, which is a reasonable "worst-case" was used in the HELP model. Output from the HELP model is provided in Appendix D. The HELP model predicts a percolation rate through the existing cap of 1.1 inches per year. It is anticipated that this leachate would be collected by the existing leachate collection system at the landfill.

It should be noted that the existing cap at the site does not meet the letter of the specifications provided in NR504 since the existing root zone is less than 18 inches thick. However, the existing compacted clay layer at the site is greater than the 24-inch thickness specified in NR504. HELP modeling of an NR504 cover with a 24-inch thickness of compacted clay and an 18-inch thickness of root zone was modeled so that the performance of the existing cover could be compared to a NR504 specified cover. The HELP model indicates a percolation rate of 1.6 inches per year for the NR504 cover. Therefore, the existing cover is more effective at controlling percolation into the landfill than the NR504 specified cover.

6.2.1.3 Implementability

There are no construction aspects of this alternative; it can be readily implemented.

The operation and maintenance aspects of this alternative are routine procedures which have been implemented at the RHL. Monitoring, collection and off-site disposal of leachate, as well as monitoring, collection and treatment of landfill gas is being conducted at the site. Ground-water sampling and analysis is also being conducted at the site. Thus, all of the monitoring aspects of this alternative have already been implemented.

6.2.1.4 Cost

There are no capital costs associated with the No Further Action Alternative. Operation and maintenance costs include site inspection, cap maintenance, and semi-annual ground-water and gas sampling and analysis. The costs associated with the operation and maintenance of the leachate collection system and the landfill gas collection and disposal systems have also been included in this cost estimate. The estimated costs are summarized as follows:

Total Direct Costs:	$ 0
O&M Costs:	$ 100,000 per year
Present Worth:	$1,376,000

6.2.2 Alternative B - Limited Action

6.2.2.1 Design Concepts

This alternative consists of obtaining deed restrictions for the future use of the former disposal area. A fence and gate have already been constructed along the southern edge of the site to physically limit access. Also, since local topography and vegetation further restrict access to the site, the construction of additional fence around the perimeter of the site is not considered necessary. Signs would be posted along the property boundaries at regular intervals to warn potential trespassers that there may be a potential risk associated with entering the site. All other operation, maintenance and monitoring in the No Further Action Alternative is also included in this alternative.

6.2.2.2 Effectiveness

The fence and associated warning signs of this alternative would help to deter potential trespassers from entering the site. A restriction on the deed for the future use of the disposal area would prevent or limit site use that would have the potential to jeopardize the integrity of the landfill cap.

6.2.2.3 Implementability

Posting signs and placing a restriction on a deed for the site are easily implemented. Operation and maintenance of the existing systems on the site have already been implemented.

6.2.2.4 Cost

The capital cost associated with the Limited Action Alternative includes obtaining deed restrictions for the future use of the disposal area, and placement of warning signs around the site. Operation and maintenance costs include all those in the No Further Action Alternative. The estimated costs are summarized as follows:

Total Direct Costs:	$ 1,000
O&M Costs:	$ 100,000 per year
Present Worth:	$1,377,000

6.2.3 Alternative C - Construct a Composite Cover Over Landfill

6.2.3.1 Design Concepts

This alternative consists of the construction of a composite cover over the entire landfill area. The cover would be constructed in substantial conformance to the requirements described in 40 CFR 241 for hazardous waste landfills. The composite cover would differ from the existing soil cover at the site, with the addition of a 40- or 60-mil geomembrane (low density polyethylene [LDPE] or high density polyethylene [HDPE]) and a drainage layer above it.

Specifically, this alternative includes removal and stockpiling of the existing topsoil and vegetation, removal and stockpiling of the existing cover layer, installation of a geosynthetic liner and a drainage layer over the existing clay cover, replacement and grading of the cover layer, construction and grading of a topsoil layer, and revegetation. The cover system would be constructed to meet the minimum slope requirement specified in s. NR504.05(10)(h), Wisconsin Administrative Code.

The landfill cover system would be constructed to minimize the infiltration of rainwater and snowmelt through wastes and into the ground water. This cover system would include, at a minimum (from top to bottom):

- A soil layer consisting of at least 6 inches of topsoil that will sustain plant growth and reduce erosion and promote drainage. Seed and fertilizer would be applied to this layer to establish a vegetative cover. The vegetation would be a mix of native and cultivated species with the capacity to survive drought and low temperature conditions and be self-sustaining;

- A minimum 18- to 30-inch thick frost protection and rooting zone layer (cover layer). This layer would be of sufficient depth to protect the underlying compacted layer from maximum frost penetration found in the area. The minimum thickness of this layer would be determined during the remedial design phase in accordance with WDNR guidance. For cost estimating purposes, a 30-inch thick layer has been assumed;

- A drainage layer, consisting of either six inches of sand, or a geonet/geofabric drainage layer;

- A minimum of 40 mil HDPE geosynthetic membrane; and,

- The existing 31.8 inch thick low permeability clay layer which was previously constructed in accordance with s. NR504.07(4), Wisconsin Administrative Code.

Documentation of the proposed geomembrane, cover layer, topsoil layer, and vegetation, including drawings, design submittals and construction plans, would be in accordance with s. NR516, Wisconsin Administrative Code. Topsoil and cover material stockpiled from the existing cover would be reused to the extent possible.

Maintenance of the cap would be required, once it is completed. It is assumed that 5% of the total landfill surface area would require regrading and revegetation each year.

6.2.3.2 Effectiveness

The composite cover construction of this alternative would reduce leachate production and subsequent release of contaminants to the ground water. The U.S. EPA's HELP model was used to estimate a percolation rate of 0.01 inches per year for the Alternative C cover. Output from the HELP model is attached in Appendix D. The existing 31.8-inch compacted clay layer with a "worst case" permeability of 1×10^{-7} cm/s and a geosynthetic liner with a 1% leak factor was used in the HELP model.

6.2.3.3 Implementability

The construction of this alternative is readily implementable for the RHL. This alternative would satisfy the substantive requirements of the location-specific ARAR for a RCRA Subtitle C cover. However, this potential ARAR is applicable only for construction of new facilities for the disposal of hazardous wastes and ~~may not be~~ is not applicable for this site.

6.2.3.4 Cost

The capital costs associated with the Construct a Composite Cap Alternative include construction of a topsoil layer and vegetation, a frost protection zone and rooting zone layer, a drainage layer, and a geosynthetic membrane over the existing low permeability clay layer. Topsoil and cover material would be reused to the extent possible. Operation and maintenance costs include all those in the No Further Action Alternative. The estimated costs are summarized as follows:

Total Direct Costs:	$3,207,000
O&M Costs:	$ 100,000 per year
Present Worth:	$4,583,000

6.3 Ground-Water Extraction, Treatment, and Discharge Alternatives

6.3.1 Ground-Water Extraction and Treatment

6.3.1.1 Design Concepts

The ground water extraction treatment alternatives include installation of a series of ground water extraction wells to intercept the plume as it migrates downgradient of the landfill. A ground-water treatment system would be constructed which would treat the extracted ground water. Treated ground water would be disposed in accordance with one of the discharge alternatives specified in Alternatives D, E, or F.

Ground-Water extraction scenarios were modeled using the U.S. Geological Survey's MODFLOW (McDonald and Harbaugh, 1988), a program which models drawdowns using the finite difference method. MODFLOW simulates three-dimensional and transient ground-water flow to calculate hydraulic head distributions, flow rates, and water balances. PATH3D (Zheng, 1991) was used in conjunction with MODFLOW to perform capture zone analysis and particle tracking calculations. This modeling was used to determine the maximum continuous pumping rate and to define the hydraulic control zone. The ground-water modeling results are presented in HSI's technical memorandum titled "Numerical Evaluation and Design of a Wellfield for Contaminant Capture and Ground-Water Control at the Refuse Hideaway Landfill" (HSI, 1994).

Based on the results of the modeling, four recovery wells would be installed southwest of the landfill. The well locations and pumping rates are designed for optimal capture of the highest observed (January, 1991) contaminant concentrations while minimizing the total volume of water which requires treatment and disposal.

The wells would be located as shown on Figure 6-1. One well would be installed to a depth of approximately 29 feet below the water table, two wells at approximately 55 feet below the water table and one well at approximately 87 feet below the water table. A total of approximately 45 gallons of ground water per minute would be extracted from the aquifer for treatment from the four down-gradient ground-water extraction wells.

Ground water would be pumped to a storage tank which would be used to allow steady flow of water to the treatment system. A filter would be used to remove sediments from the ground water prior to treatment.

As shown on Table 3-2, the ground-water constituents which require treatment are benzene, chloroform, 1,2-DCA, trans-1,2-DCE, PCE, TCE, and vinyl chloride in order to meet the WDNR NR140 Ground-Water Quality Enforcement Standards. Although some of the ground-water samples did contain concentrations of iron and manganese above the NR140 enforcement standards, these concentrations of iron and manganese are typically found as natural background conditions in this area and therefore are not expected to require removal in order to meet the discharge limits.

Removal of the organic constituents such as vinyl chloride and cis-1,2-dichloroethene would be performed with a low profile air stripper. Carbon adsorption would not be an effective method of removal of these constituents since vinyl chloride is poorly adsorbed by carbon. Biological degradation of the organic compounds is not feasible given the limited removal capability of biological systems and toxic breakdown products.

At a maximum flow rate of 45 gpm, air stripping ground water with 500 ppb organics and 100% removal efficiency would generate 0.01 pounds per hour of organic compounds from the stack of the air stripper. Vapor control equipment is, therefore, not expected to be required.

Water would be recycled back through the treatment system as necessary prior for reduction in VOC concentrations to levels below WDNR NR140 PALs prior to discharge to the ground-water discharge system.

A water softener would be used to reduce calcium and magnesium hardness from the treated ground water prior to disposal. Disposal of the ground water at its present hardness may cause scaling of the proposed injection wells or infiltration gallery. Water softening may not be required in the event that discharge to surface waters is selected at the treated water disposal method. Iron concentrations in the ground water are not expected to pose a problem. Precipitation of iron may occur in the air stripper, however, periodic maintenance by circulation of hydrochloric acid through the stripper and subsequent disposal of the waste acid would be an effective method of iron removal. Additional chemical analyses of the water and a pilot study would be required before the level of hardness removal can be established.

6.3.1.2 Effectiveness

Based upon the results of the ground-water modeling, hydraulic control of the plume is expected within five years. The well locations and pumping rates are designed for optimal capture of the highest observed contaminant concentration while minimizing the total volume of water which requires treatment and disposal.

6.3.1.3 Implementability

The construction of this alternative is readily implementable for the RHL. The ground water would be treated to meet the chemical specific ARAR of Wisconsin Administrative Code NR140 ground-water quality standards, and any other applicable discharge standards.

6.3.2 Alternative D - Ground-Water Extraction, Treatment, and Discharge to Surface Water

6.3.2.1 Design Concepts

NR140 doesn't apply to surface water

This alternative would be implemented in conjunction with the ground-water extraction and treatment system described above. Treated ground water which meets the ~~WDNR NR140~~

Ground-Water Quality Standards may be able to be discharged to a surface water body near the site pending approval by WDNR. The surface water body may include either wetlands in the vicinity of the site or a drainage ditch which discharges to Black Earth Creek (Location 1). Other potential discharge locations include Black Earth Creek at the intersection of Twin Valley Road (Location 2), Black Earth Creek at the town of Cross Plains (Location 3), and the East Fork of Pheasant Branch Creek (Location 4). Figure 6-2 shows the potential discharge locations. Monthly sampling and analysis of the treated ground-water discharge would be required in order to maintain compliance with the WPDES discharge permit.

Each of the four surface water discharge locations will be evaluated in detail in the subsequent Feasibility Study for this site, when site specific discharge standards are available for each location.

6.3.2.2 Effectiveness

This alternative would provide a highly effective disposal method for treated ground water. The ground water would be discharged to surface water in the vicinity of the site.

6.3.2.3 Implementability

This alternative would require a Wisconsin Pollutant Discharge Elimination System (WPDES) permit before discharge of treated ground water could commence. Monthly sampling and analysis of the discharge water stream would probably be required in order to meet the requirements of the discharge permit. Treated water would be directed to the proposed discharge location via a pipeline system.

This alternative is moderately implementable. Black Earth Creek is a Class A Trout Stream and, thus, WDNR approval for discharge of water which meets the NR105 standards through treatment would be required.

Discharge of treated ground water to Black Earth Creek via the intermittent drainage ditch located approximately 20 feet from the southeast corner of the landfill would require discharge to a segment of Black Earth Creek classified as an "~~exception~~al" outstanding water resource. Additionally, any discharges which may cause variation in water quality or quantity are highly regulated. Consequently, the likelihood of receiving permission to discharge treated ground water to this location is unknown.

Discharge of treated ground water to Black Earth Creek at Twin Valley Road or at Cross Plains would require discharge to segments of Black Earth Creek classified as an "exceptional" water resource and an "outstanding" water resource, respectively. The proposed discharge location at Twin Valley Road is located approximately two thirds of a mile southwest of the landfill and the proposed discharge location at Cross Plains is located approximately four miles west of the landfill. The likelihood of receiving permission to discharge treated ground water to the location at Cross Plains is greater than at the location at Twin Valley Road.

change classific

Discharge of treated ground water to the East Fork of Pheasant Branch Creek would require discharge to a segment of the creek classified as an "exceptional" water resource. For this intra-basin transfer, water would need to be conveyed a distance of approximately one mile with an elevation rise of approximately 220 feet.

6.3.2.4 Cost

The estimated cost of this alternative depends on the discharge location selected. The estimated cost associated with each discharge location is as follows:

Discharge Location		Total Direct Cost ($)	Annual O&M Cost ($)	Present Worth ($)
Location 1:	Black Earth Creek Via Drainage Ditch at SE Corner	217,000	52,000	933,000
Location 2:	Black Earth Creek at the Intersection of Twin Valley Road	270,000	52,000	986,000
Location 3:	Black Earth Creek at Cross Plains	468,000	52,000	1,184,000
Location 4:	East Fork of Pheasant Branch Creek	298,000	52,000	1,014,000

6.3.3 Alternative E - Ground-Water Extraction, Treatment and Discharge to an Infiltration Gallery

6.3.3.1 Design Concepts

This alternative would be implemented in conjunction with the ground water extraction and treatment system discussed in Section 6.3.1. Treated ground water which meets the WDNR NR140 Ground-Water Quality Standards may be able to be discharged to an infiltration gallery pending approval by WDNR. The proposed location of the infiltration gallery is shown on Figure 6-3.

An infiltration gallery would be comprised of a trench excavated upgradient of the site. Ground water would be pumped to the infiltration gallery and discharged to trench filled with a porous material such as gravel. The ground water would infiltrate down through the trench and back in to the shallow aquifer. The infiltration gallery would be surrounded by a berm comprised of compacted clay in order to minimize the potential run-on of surface water into the infiltration gallery.

It is anticipated that the infiltration gallery would be located approximately 600 feet southeast of the proposed ground-water extraction wells, and would be constructed in clean, native soil. Subsurface piping would be constructed in order to allow pumping of the treated ground-water discharge to the infiltration gallery.

Periodic treatment of the infiltration gallery would be required to remove scale and metals. The turbulent flow of the ground water causes air to be mixed with the water, thus oxidizing the metals and forming a precipitate. Removal of the scale and precipitates would require the infiltration of a material such as hydrochloric acid, sulfamic acid, or hydroxyacetic to dissolve the scale and precipitated metals.

6.3.3.2 Effectiveness

This alternative would provide a moderately effective disposal method for treated ground water. It is anticipated that 45 gpm of ground water could be readily discharged through an infiltration gallery which has a surface area of 76,000 square feet. The actual size of the trench required would be determined during detailed design of the infiltration gallery. For cost estimating purposes, it is assumed that the infiltration gallery is 6 feet deep, 275 feet wide, and 275 feet long.

6.3.3.3 Implementability

No permit on-site NR 103

This alternative would require an approval by WDNR with a ground-water discharge permit before discharge of treated ground water could commence. Monthly sampling and analysis of the discharge water stream would probably be required in order to meet the requirements of the discharge permit. WDNR approval of the periodic treatment to remove scale and precipitates must be obtained before this alternative would be implemented. This alternative is moderately implementable.

A number of difficulties associated with discharge via an infiltration gallery include weather effects on year-round maintenance, clogging of bottom sediments in the pond, acquisition and availability of land near the landfill, and lower permeable silt and clay deposits adjacent and northeast of the landfill, which is one of the most likely sites for infiltration at present.

6.3.3.4 Cost

The estimated cost of this alternative is:

Total Direct Costs:	$ 717,000
O&M Costs:	$ 54,000 per year
Present Worth:	$1,461,000

6.3.4 Alternative F - Ground-Water Extraction, Treatment and Discharge to Injection Wells

6.3.4.1 Design Concepts

This alternative would be implemented in conjunction with the ground water extraction and treatment system discussed in Section 6.3.1. Treated ground water which meets the WDNR NR140 Ground-Water Quality Standards may be able to be discharged to injection wells pending approval by WDNR. The proposed locations of the injection wells are shown on Figure 6-4.

Ground-water injection via ground-water wells is essentially the reverse process of ground-water extraction through ground-water extraction wells. Ground water would be pumped to two injection wells at a total flow rate of 45 gallons per minute. Ground water would pass through the screened zone of the wells and would enter the aquifer.

Periodic treatment of the injection wells would be required to remove scale and metals from clogging the screen of the injection well. The turbulent flow of the injected ground water causes air to be mixed with the water, thus oxidizing the metals and forming a precipitate. Removal of the scale and precipitates may require the injection of a material such as hydrochloric acid, sulfamic acid, or hydroxyacetic acid to dissolve the scale and precipitated metals.

It is anticipated that the injection wells would be located approximately 1,600 feet upgradient of the proposed ground-water extraction wells.

6.3.4.2 Effectiveness

This alternative would provide a moderately effective discharge method for treated ground water. It is anticipated that 45 gpm of ground water could be discharged through the injection wells. However, difficulties associated with clogging of the injection wells with silt, microorganisms, and precipitates would require periodic maintenance of the injection wells. This maintenance would sufficiently control this clogging problem.

6.3.4.3 Implementability

This alternative would require a variance from the WDNR for discharge of treated ground water through injection wells. It is believed that no injection wells have been permitted in Wisconsin under current environmental laws. This alternative is moderately implementable.

Some of the difficulties associated with discharge via injection wells include well clogging due to chemical precipitation and/or bacterial growth, air entrainment in injection water which can reduce aquifer hydraulic conductivity, and landfill acquisition if injection occurs off the RHL property.

6.3.4.4 Cost

The estimated cost of this alternative is:

Total Direct Costs:	$ 243,000
O&M Costs:	$ 57,000 per year
Present Worth:	$1,028,000

6.4 Water Supply Alternatives

6.4.1 Alternative G - Supply Individual Water Treatment Units

6.4.1.1 Design Concepts

This alternative involves installation and operation of point-of-entry treatment systems at each residence which have ground water supply wells which have the potential to be impacted by the RHL. Each of these individual water treatment units would treat the entire household water supply prior to distribution of the water throughout the residence. To maximize the protection of human health, the VOCs would be removed to non-detectable concentrations.

It is anticipated that a total of 25 residences in the Deer Run Subdivision, the Highway 14 Valley, and along Rocky Dell Road may require point-of-entry water treatment systems. These residences are located downgradient of the existing ground-water plume.

A Point-of-Entry Water Treatment study was performed by Warzyn Engineering Inc. during November, 1989. This study examined two basic VOC treatment alternatives: (1) VOC destruction and (2) VOC removal. The VOC destruction alternatives were screened out based upon the uncertainties associated with possible incomplete compound destruction and the production of reaction products which have unknown toxicological characteristics.

The contaminant removal options evaluated were: (1) stripping, (2) reverse osmosis, and (3) adsorption. Air stripping would be able to respond to variable influent concentrations however, the changes would not necessarily be detected with occasional monitoring. As a consequence, erratic VOC effluent concentrations are possible. Reverse osmosis (RO) was not recommended since RO would not be effective in removal of small molecular size organic constituents and would generate a stream of concentrated organics which would require disposal. Carbon adsorption can remove many VOCs to non-detectable concentrations until the adsorption capacity of the carbon is reached. At this point, the carbon can be removed and disposed and new carbon can be placed in the carbon unit. Pretreatment for iron and manganese removal, particulate removal, or hardness reduction may be required.

6.4.1.2 Effectiveness

Warzyn conducted a pilot study to test the effectiveness of granular activated carbon adsorption. The results of the pilot study indicate that point-of-entry granular activated carbon treatment would be effective in removing the VOCs detected in the raw water. Carbon change frequencies of approximately of 15,000 gallons can be obtained with the equipment specified in the pilot study: Hellenbrand Model POE-VOC-GAC-14 containing virgin Calgon Filtrasorb 400 granular activated carbon.

6.4.1.3 Implementability

This alternative is highly implementable using readily available equipment, technology, and labor. A carbon change frequency would need to be established based upon system monitoring. It is anticipated that the used carbon would be regenerated off-site by the carbon supplier.

Pilot tests may need to be performed at each residence in order to determine if iron, manganese, and/or particulate pretreatment is required.

6.4.1.4 Cost

The estimated cost of alternative is:

Total Direct Costs:	$ 212,000
O&M Costs:	$ 62,500 per year
Present Worth:	$1,072,000

6.4.2 Alternative H - Construction of a Community Well

6.4.2.1 Design Concepts

This alternative involves construction and operation of a community well located several thousand feet downgradient of the impacted ground water. This well would supply unimpacted water via pipeline to each of the residences. It is anticipated that the well would be constructed southwest of the landfill and would be screened at a depth of greater than 150 feet below ground surface. It is assumed that approximately 25 residences require a community water supply; those in the Deer Run Subdivision, the Highway 14 Valley, and along Rocky Dell Road. Assuming 100 persons reside in those residences and each resident uses 80 gallons of water per day, then the average water requirement is 8,000 gallons per day. At peak times, it is expected that the water requirement is 24,000 gallons per day, or 17 gallons per minute. A 50,000 gallon elevated water tank would be used to store the pumped water and water would be distributed to each of the residences via water main with a length of approximately 10,000 feet.

6.4.2.2 Effectiveness

This alternative would be a highly effective method of providing an unimpacted water supply to each of the residences of concern.

6.4.2.3 Implementability

This alternative is moderately implementable using readily available equipment, technology, and labor. Construction of the community well and subterranean water supply pipelines would be required in the event that this alternative was selected.

6.4.2.4 Cost

The estimated cost of this alternative is:

Total Direct Costs:	$ 731,000
O&M Costs:	$ 38,000 per year
Present Worth:	$1,254,000

7.0 REFERENCES

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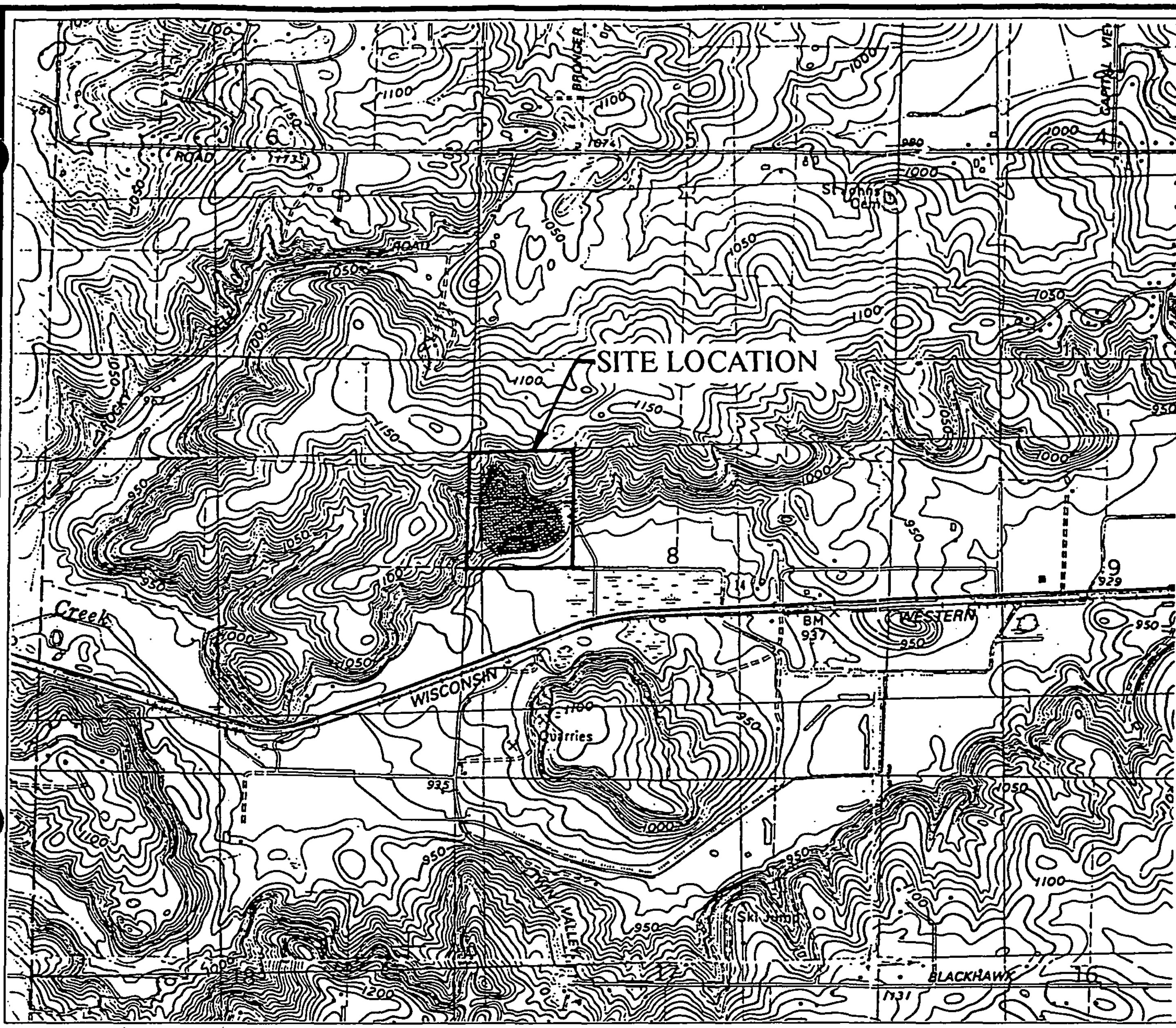


QUADRANGLE LOCATION

SCALE

0 — 5000

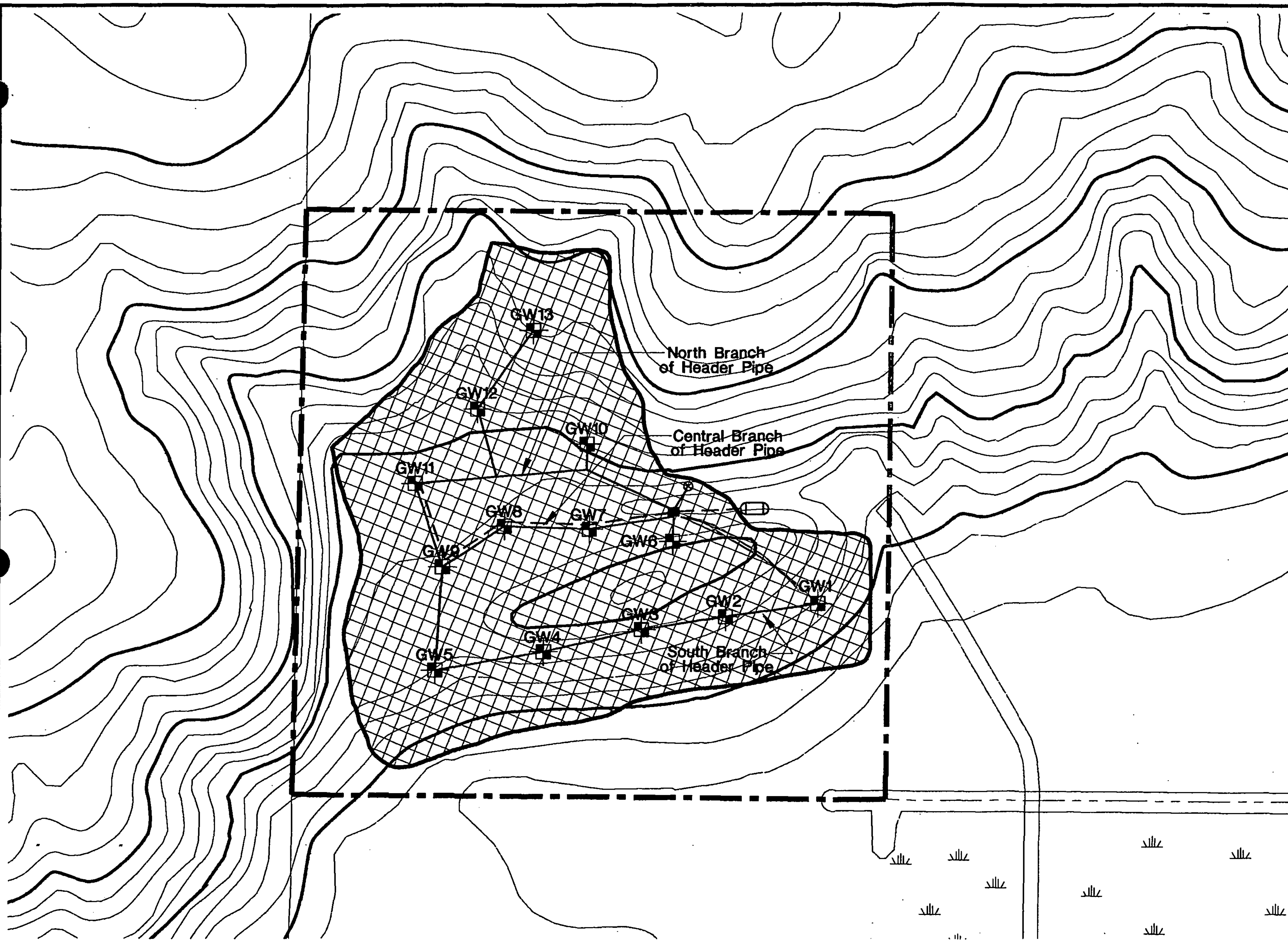
FEET

National Geodetic Vertical Datum of 1929
Contour Interval 10 Feet

N

Base map from U.S.G.S. 7.5' MIDDLETON, WI
topographic quadrangle map, photorevised 1971.

SIMON HYDRO-SEARCH Brookfield Lakes Corporate Center XII 175 N. Corporate Drive, Suite 100 Brookfield, Wisconsin 53045	WI DEPT OF NATURAL RESOURCES REFUSE HIDEAWAY LANDFILL **SITE LOCATION and LOCAL TOPOGRAPHY**
Dsgn. by: RAG / Chk. by: [illegible] / Apprv. by: DCN	
PROJECT: 301483135 / DATE: 12/02/93	DRAWING: 1367-4 / FIGURE: FS 3-1



EXPLANATION

- GW13 — EXISTING LEACHATE/GAS EXTRACTION WELL LOCATION AND DESIGNATION
- GAS HEADER PIPE
- LEACHATE HEADER PIPE
- BLOWER STATION
- GROUND FLARE
- LEACHATE LOADOUT TANK
- REFUSE HIDEAWAY LANDFILL PROPERTY BOUNDARY
- APPROXIMATE FILL LIMITS

Note : Wells with leachate extraction pumps removing leachate are GW-4, GW-5, GW-7, GW-8, GW-9, GW-11, GW-12, and GW-13.

N

SCALE
0 500
Feet

Source : Construction Observation Report, Gas and Leachate Extraction System Refuse Hideaway Landfill, Town of Middleton, Dane County, Wisconsin Warzyn, Inc. (1991) Sheet 3 of 5.

Base map compiled from U.S.G.S. 7.5' Middleton, WI topographic quadrangle map, 1983.
Contour interval 10 feet. National Geodetic Vertical Datum of 1929.

Hydro-Search, Inc.
HYDROLOGISTS GEOLOGISTS ENGINEERS
Reno Denver Milwaukee Huntington Beach Sacramento Houston Phoenix

Dsgn. by: RAG	Chk. by: BK	Apprv. by: GCD
PROJECT: 301483135	DATE: 06/07/94	

WI DEPT OF NATURAL RESOURCES
REFUSE HIDEAWAY LANDFILL

LEACHATE/GAS EXTRACTION WELL LOCATIONS

DRAWING: 3135-b11 | FIGURE: FS 3-2

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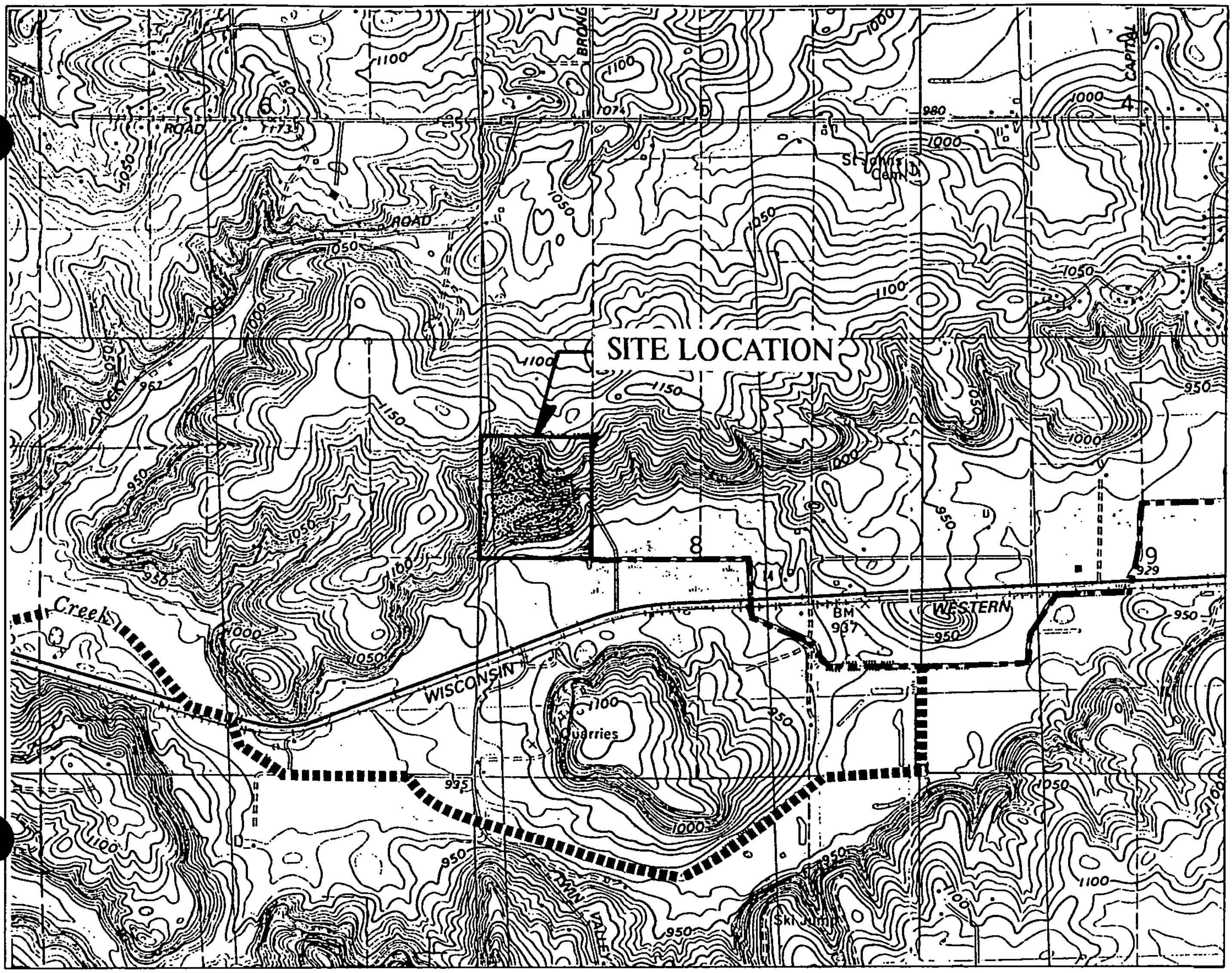

EXPLANATION

- - - INTERMITTENT SECTIONS OF BLACK EARTH CREEK

▪▪▪▪ MAIN BLACK EARTH CREEK FLOW

N

SCALE

0 — 4000

Feet

Hydro-Search, Inc.

HYDROLOGISTS GEOLOGISTS ENGINEERS

Reno Denver Milwaukee Huntington Beach Sacramento Houston Phoenix

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PROJECT: 301483135	DATE: 06/07/94	

WI DEPT OF NATURAL RESOURCES
REFUSE HIDEAWAY LANDFILL

LOCATION OF BLACK EARTH CREEK

DRAWING: 3135-a7	FIGURE: FS-3-3

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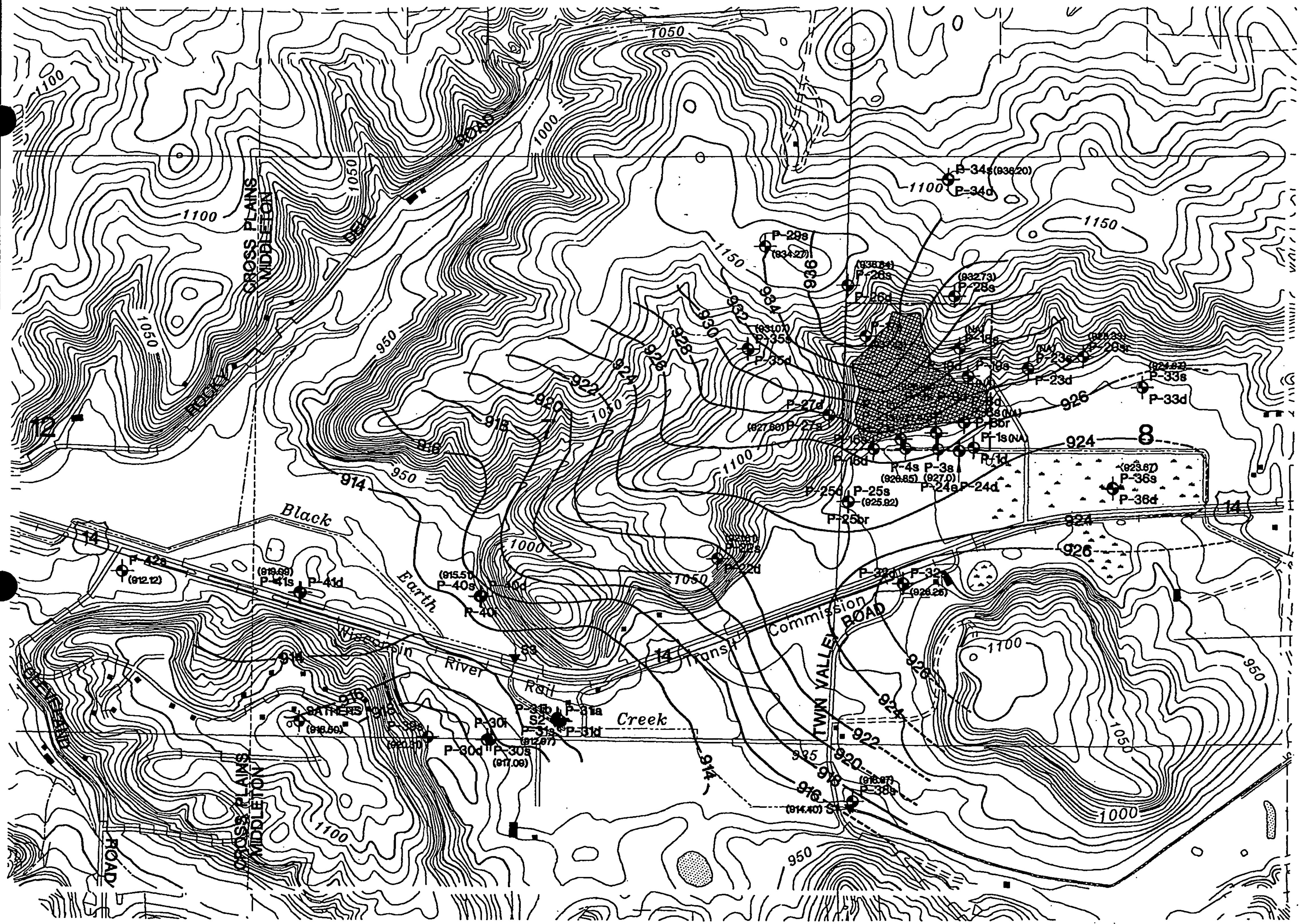


EXPLANATION

FILL LIMITS

REFUSE HIDEAWAY PROPERTY BOUNDARY

PRIVATE RESIDENCE

P-34s — MONITOR WELL LOCATION, DESIGNATION AND GROUND-WATER ELEVATION (ft. msl)

930 — GROUND-WATER CONTOUR (ft. msl, dashed where inferred)

Note: The water level measured at P-41s is not included in the water table because of an anomalously high measurement which is most likely related to geologic materials and subsequent hydraulic conductivity variations and is not representative of the overall water table configuration.

N

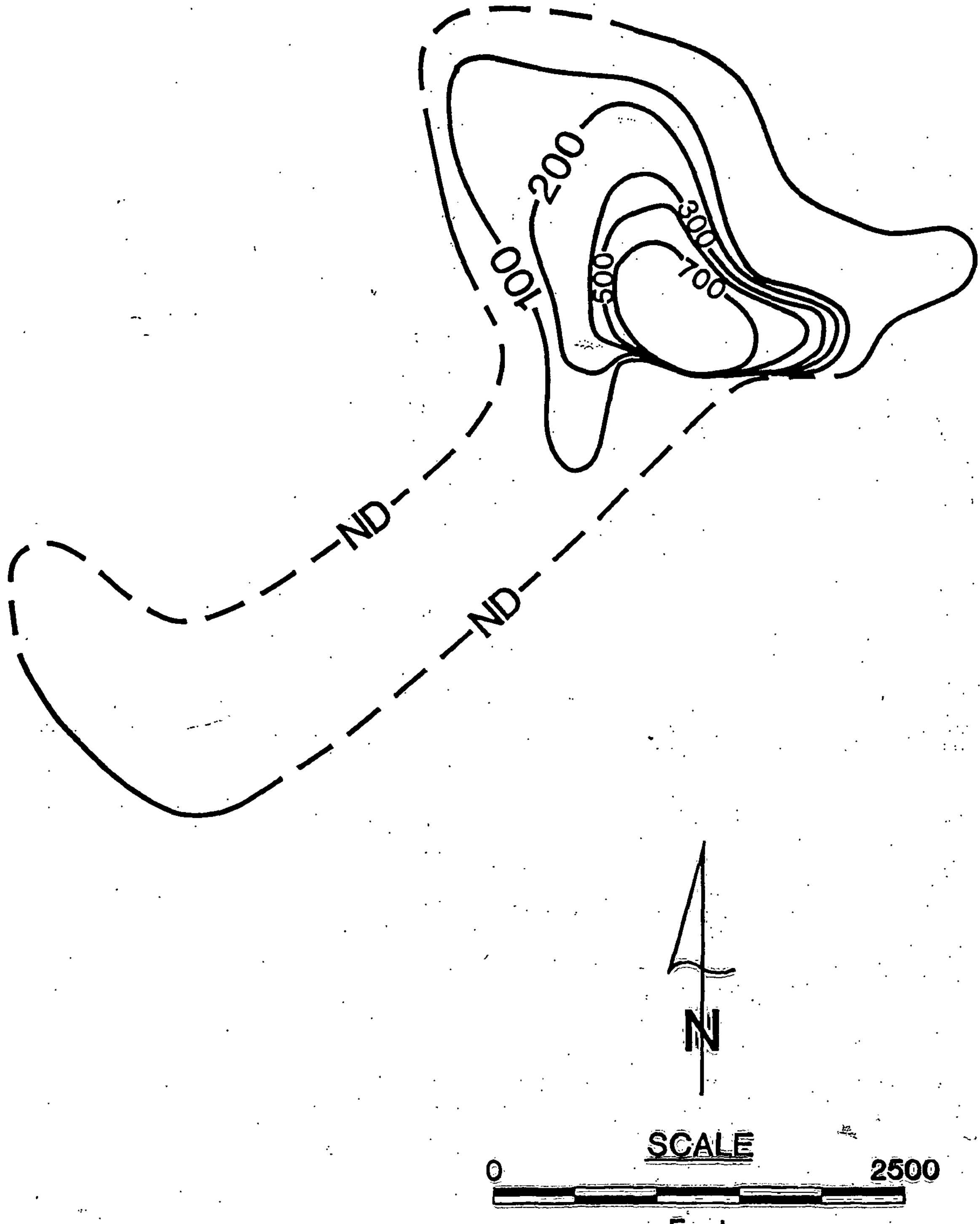
SCALE

0 — 2000

Feet

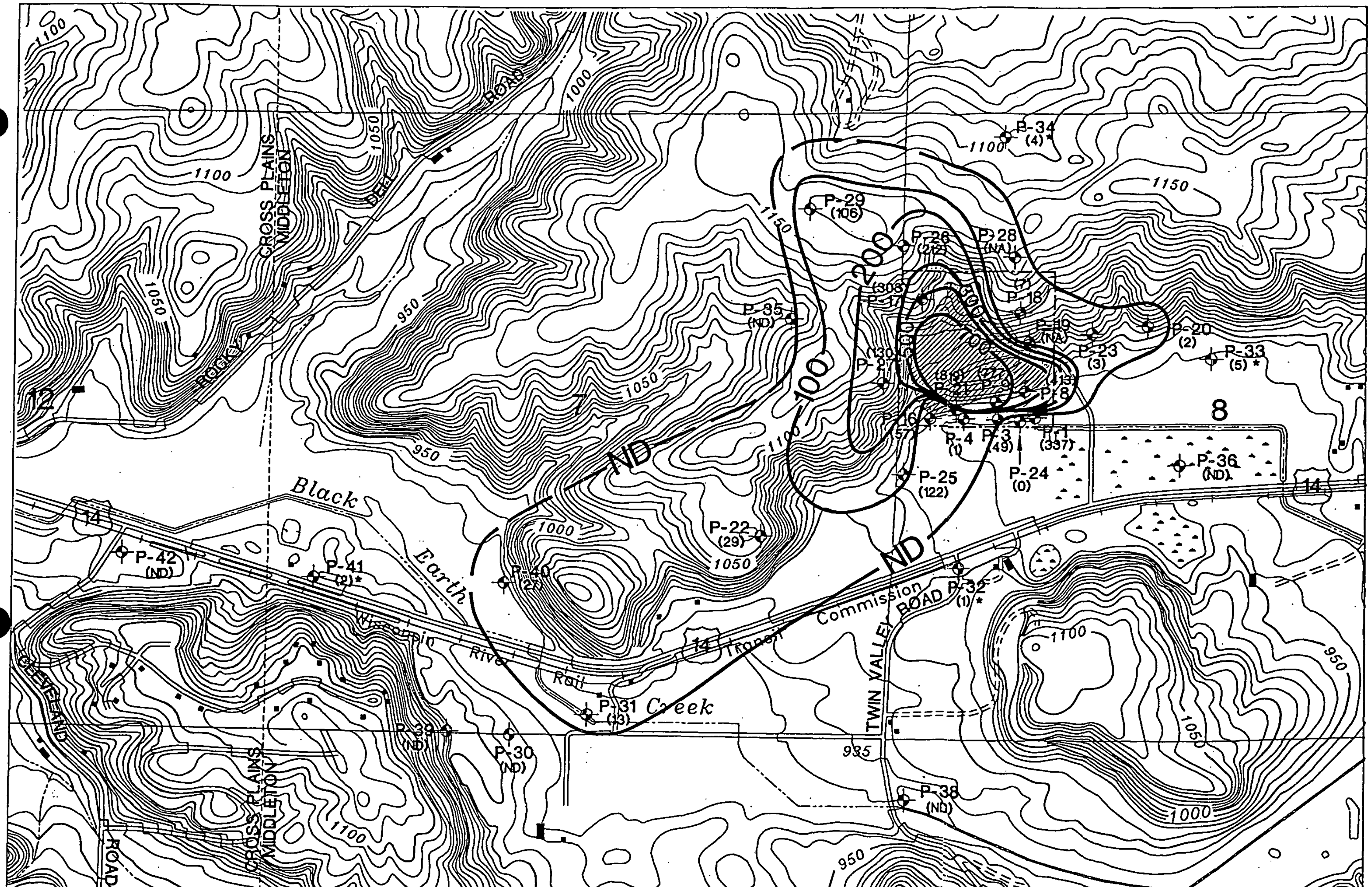
Base map compiled from U.S.G.S. 7.5' Middleton, WI topographic quadrangle map, 1983.
Contour Interval 10 feet. National Geodetic Vertical Datum of 1929.

SIMON HYDRO-SEARCH Brookfield Lakes Corporate Center XII 175 N. Corporate Drive, Suite 100 Brookfield, Wisconsin 53045			WI DEPT OF NATURAL RESOURCES REFUSE HIDEAWAY LANDFILL WATER TABLE MAP (October 18, 1993)	
Dsgn. by: MSL	Chk. by: VJ7	Apprv. by: JEN		
PROJECT: 301483135	DATE: 03/21/94		DRAWING: 3135-B4	FIGURE: FS 3-4



MODIFIED VOC PLUME CONFIGURATION

(Based on 1994 ground water modeling results)



EXPLANATION

REFUSE HIDEAWAY LANDFILL PROPERTY BOUNDARY

FILL LIMITS

P-39 (ND) MONITOR WELL LOCATION, DESIGNATION, AND TOTAL VOLATILE ORGANIC COMPOUNDS (ppb)

100 TOTAL VOLATILE ORGANIC COMPOUNDS CONTOUR (ppb), DASHED WHERE INFERRED

TOTAL VOLATILE ORGANIC COMPOUND VALUES OBTAINED JANUARY, 1991

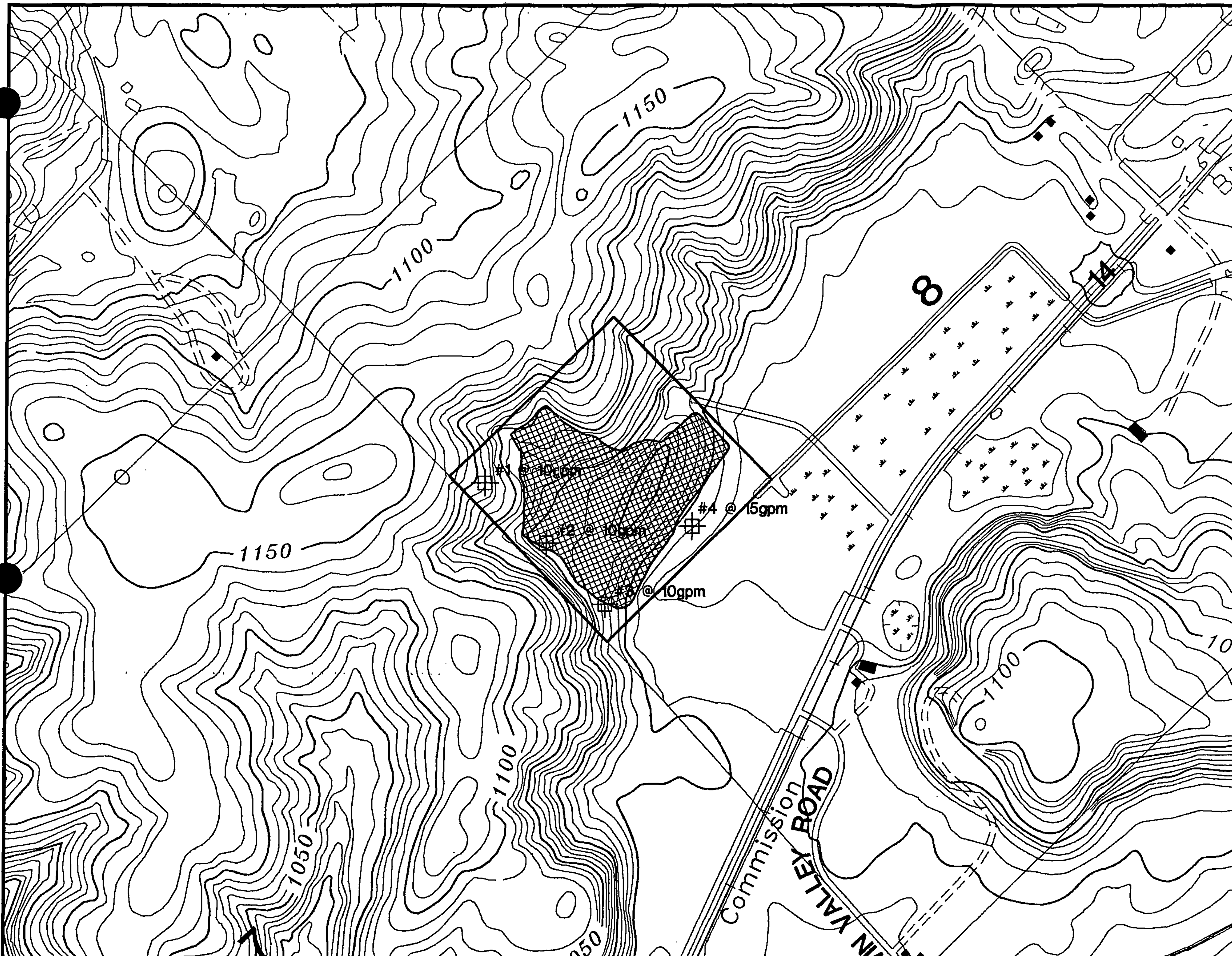
* Detectable levels of volatile organic compounds are believed to be introduced and not actually present in ground water.

ND – not detected
NA – not available

N

SCALE
0 2500
FEET

SIMON HYDRO-SEARCH Brookfield Lakes Corporate Center XII 175 N. Corporate Drive, Suite 100 Brookfield, Wisconsin 53045			WI DEPT. OF NATURAL RESOURCES REFUSE HIDEAWAY LANDFILL TOTAL VOLATILE ORGANIC COMPOUNDS ISOCONCENTRATION MAP	
Dsgn. by: RAG	Chk. by: JEN	Apprv. by: JJ7		
PROJECT: 301483135	DATE: 03/29/94		DRAWING:	FIGURE: FS 3-5



EXTRACTION

#2 @ 10gpm

⌖ PROPOSED EXTRACTION WELL LOCATION

Note : Screen locations for proposed extraction wells.

1) 87 feet below water table
2) 55 feet below water table
3) 55 feet below water table
4) 29 feet below water table

N

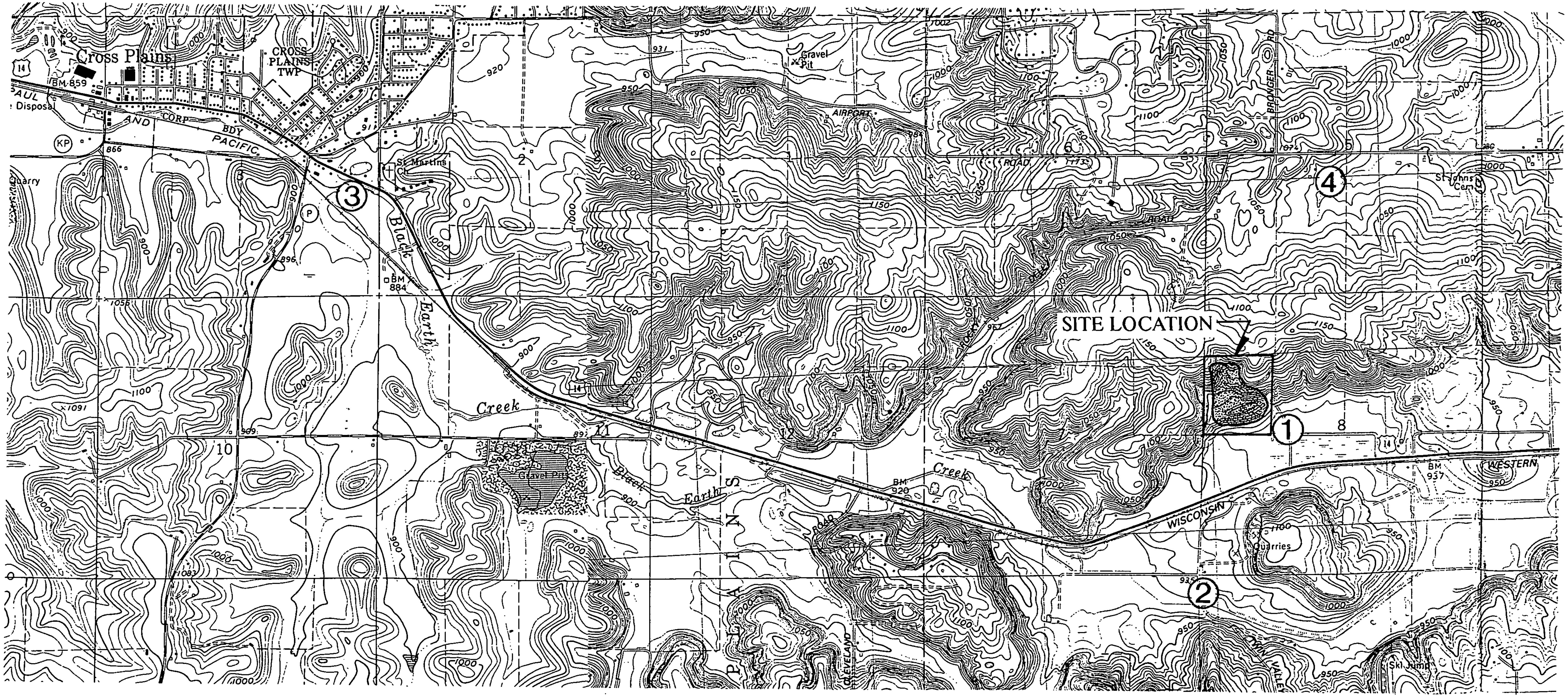
SCALE

0 — 1300

Feet

Hydro-Search, Inc. HYDROLOGISTS GEOLOGISTS ENGINEERS Reno Denver Milwaukee Huntington Beach Sacramento Houston Phoenix			WI DEPT OF NATURAL LANDFILL REFUSE HIDEAWAY LANDFILL
Dsgn. by: RAG	Chk. by: BK	Apprv. by: GSD	PROPOSED GROUND-WATER EXTRACTION WELL LOCATIONS
PROJECT: 301483135		DATE: 06/08/94	DRAWING: 3135-b12 FIGURE: FS 6-1

/hsi/148/3135/3135-b12

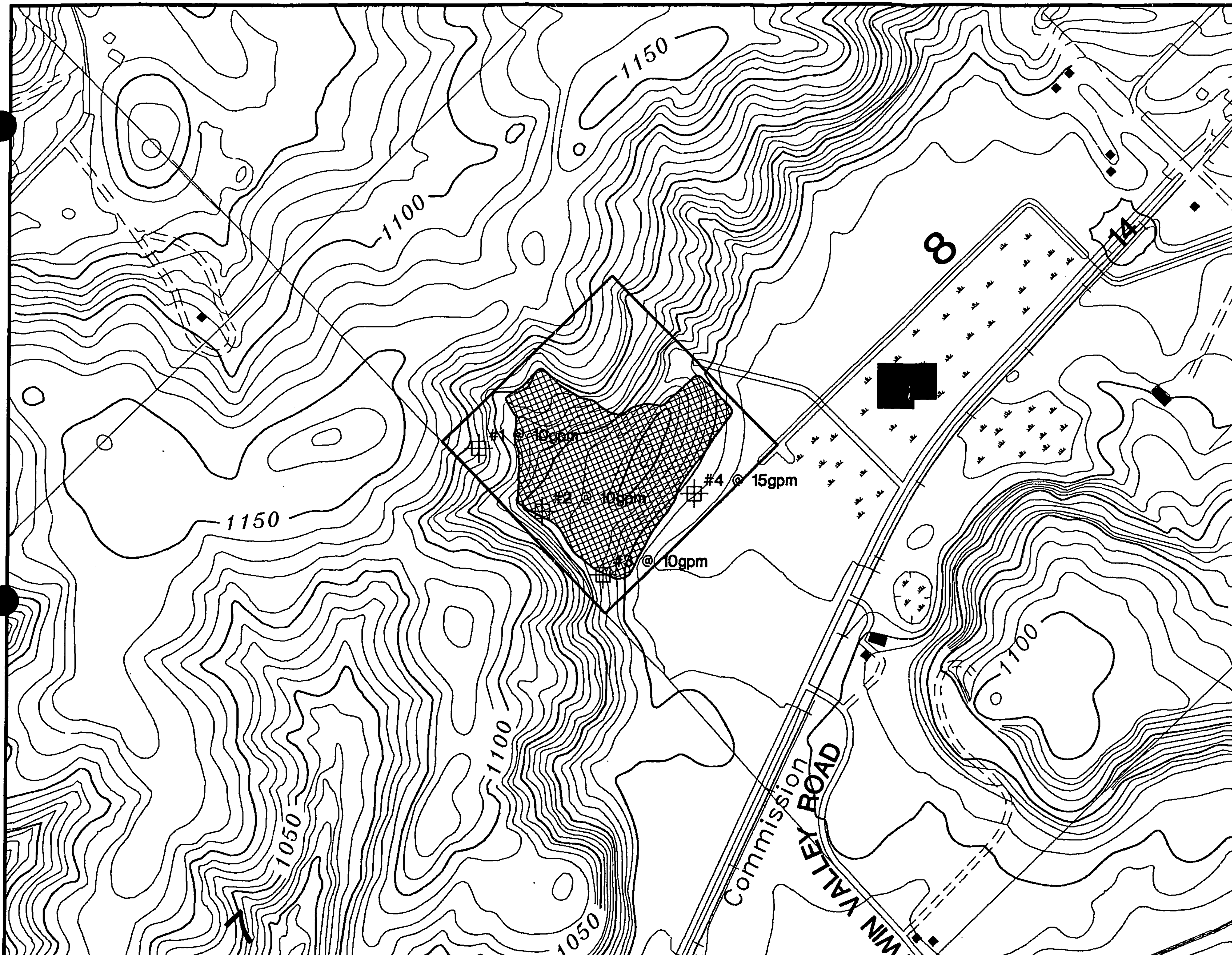


EXPLANATION

1) BLACK EARTH CREEK via INTERMITTENT DISCHARGE DITCH
2) BLACK EARTH CREEK @ TWIN VALLEY ROAD
3) BLACK EARTH CREEK @ CROSS PLAINS
4) INTERMITTENT STREAM TO PHEASANT BRANCH CREEK

Base map complied from U.S.G.S. 7.5' Middleton, WI topographic quadrangle map, 1983.
Contour Interval 10 feet. National Geodetic Vertical Datum of 1929.

Hydro-Search, Inc. HYDROLOGISTS GEOLOGISTS ENGINEERS Reno Denver Milwaukee Huntington Beach Sacramento Houston Phoenix	WI DEPT OF NATURAL RESOURCES REFUSE HIDEAWAY LANDFILL
Dsgn. by: RAG Chk. by: BK Apprv. by: GCD	**PROPOSED SURFACE WATER DISCHARGE LOCATIONS**
PROJECT: 301483135 DATE: 06/09/94	DRAWING: FIGURE: FS 6-2



EXTRACTION

#2 @ 10gpm PROPOSED EXTRACTION WELL LOCATION

PROPOSED INFILTRATION GALLERY

SCALE

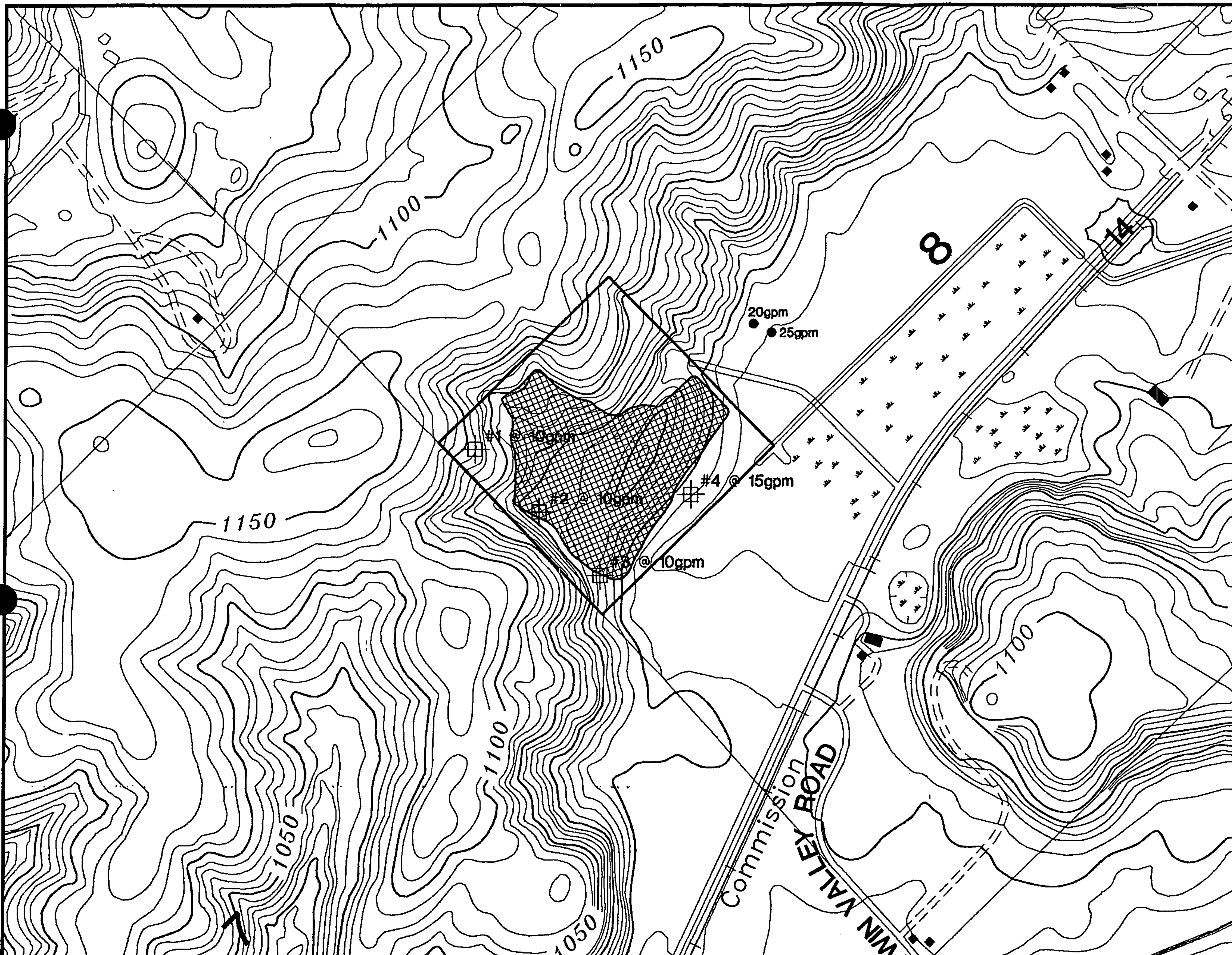
0 1300

Feet

N

Hydro-Search, Inc. HYDROLOGISTS GEOLOGISTS ENGINEERS Reno Denver Milwaukee Huntington Beach Sacramento Houston Phoenix			WI DEPT OF NATURAL LANDFILL REFUSE HIDEAWAY LANDFILL PROPOSED INFILTRATION GALLERY LOCATION	
Dsgn. by: RAG	Chk. by: BK	Apprv. by: GCD		
PROJECT: 301483135		DATE: 06/08/94	DRAWING: 3135-b13	FIGURE: FS 6-3

/hsi/148/3135/3135-b13



EXTRACTION

#2 @ 10gpm

⊕ PROPOSED EXTRACTION WELL LOCATION

● PROPOSED INJECTION WELL

Note : Injection wells are screened at approximately 55 feet below the water table.

N

SCALE

0 — 1300

Feet

Hydro-Search, Inc.
HYDROLOGISTS
GEOLOGISTS
ENGINEERS
Reno Denver Milwaukee Huntington Beach Sacramento Houston Phoenix

Dsgn. by: EAG	Chk. by: BK	Apprv. by: GLD
PROJECT: 301483135	DATE: 06/08/94	

WI DEPT OF NATURAL LANDFILL
REFUSE HIDEAWAY LANDFILL

PROPOSED INJECTION WELL LOCATIONS

DRAWING: 3135-b14	FIGURE: FS 6-4

/hsi/148/3135/3135-b14

Table AAD 2-1. **Summary of Reports Pertaining to Refuse Hideaway Landfill Produced Under Contract for the WDNR**

Report Date	Preparer	Report Title
November 1989	Warzyn	Health and Safety Plan, Interim Remedial Measures, Refuse Hideaway Landfill
November 1989	Warzyn	Report and DILHR/DNR Applications, Point-of-Entry Water Treatment, Interim Remedial Measures, Refuse Hideaway Landfill.
December 1989	Warzyn	Alternative Water Supply, Interim Remedial Measures, Refuse Hideaway Landfill
December 1989	Warzyn	Engineering Design, Partial Gas and Leachate Extraction System, Interim Remedial Measures, Refuse Hideaway Landfill
January 1990	Warzyn	Gas Monitoring Program, Refuse Hideaway Landfill
February 1990	Warzyn	Sampling and Analysis of Residential Wells, Interim Remedial Measures, Refuse Hideaway Landfill
March 1990	Warzyn	Estimate of Costs - Phase II, Groundwater Monitoring, Refuse Hideaway Landfill
April 1990	Warzyn	Community Relations Activities, Refuse Hideaway Landfill
April 1990	HSI	Proposal, Groundwater Monitoring Study, Refuse Hideaway Landfill (includes QAPP, and Health & Safety Plan)
August 1990	Warzyn	Contract Documents, Gas and Leachate Extraction System, Refuse Hideaway Landfill
September 1990	Warzyn	Engineering Design, Gas and Leachate Extraction System, Refuse Hideaway Landfill
November 1990	Warzyn	Construction Observation Report, Partial Gas and Leachate Extraction System, Interim Remedial Measures, Refuse Hideaway Landfill
February 1991	Warzyn	Gas Monitoring Program, Annual Report, Refuse Hideaway Landfill

Table AAD 2-1. Summary of Reports Pertaining to Refuse Hideaway Landfill Produced Under Contract for the WDNR (Cont'd)

Report Date	Preparer	Report Title
March 1991	Warzyn	Phase III, Remedial Option Plan, Refuse Hideaway Landfill
May 1991	Dames & Moore	Proposal for Cap Restoration and Improvements to Refuse Hideaway Landfill, Dane County, WI
June 1991	HSI	Groundwater Monitoring Study, Refuse Hideaway Landfill, 2 Volumes
October 1991	Mostardi Platt,	Refuse Hideaway Landfill Gas System Destruction Efficiency Tests, August 1 & 2, 1991
November 1991	Warzyn	Construction Documentation Report, Landfill Gas and Leachate Extraction System, Refuse Hideaway Landfill
November 1991	Warzyn	Operation and Maintenance Manual, Landfill Gas and Leachate Extraction System, Refuse Hideaway Landfill
March 1992	HSI	Numerical Model Simulation and Assessment of Contaminant Plume Migration, Refuse Hideaway Landfill, Middleton, WI
May 1992	Dames & Moore	Contract Documents, Refuse Hideaway Landfill, Cap Restoration and Improvements, Middleton, Dane County, WI
February 1993	Dames & Moore	Construction Observation Report, Cap Restoration and Improvements, Middleton, Dane County, WI
February 1993	Dames & Moore	Construction Documentation Report, Cap Restoration and Improvements, Middleton, Dane County, WI
Fall, 1993	HSI	Groundwater Quality Data for Semi-Volatiles, Metals, PCBs, Pesticides
March 1994	Terra	1993 Annual Report, Operation and Maintenance Activities, Refuse Hideaway Landfill

Table AAD 3-1. Hydraulic Conductivity Testing Results

Well #	Screen Length (feet)	Calculated Hydraulic Conductivity (ft/min)	(cm/sec)	Screened Geologic Material
P-8S♦	10	5.7×10^{-5}	1.1×10^{-4}	Lake Silt and Clay
P-8D♦	5.5	6.1×10^{-6}	1.2×10^{-5}	Glacial Till
P-8BR♦	5.5	5.1×10^{-4}	1.0×10^{-3}	Sandstone
P-9S♦	10	1.6×10^{-3}	3.1×10^{-3}	Sand and Gravel
P-9D♦	40.5	5.0×10^{-5}	9.8×10^{-5}	Glacial Till
P-16S♦	10.5	3.8×10^{-6}	7.5×10^{-6}	Lake Silt and Clay
P-16D♦	5.5	1.8×10^{-6}	3.5×10^{-6}	Glacial Till
P-17S♦	10	9.5×10^{-5}	1.9×10^{-4}	Sandstone
P-18S♦	10.5	2.3×10^{-4}	4.5×10^{-4}	Sandstone
P-19S♦	10.5	8.7×10^{-4}	1.7×10^{-3}	Sandstone
P-19D♦	5.5	1.8×10^{-3}	3.5×10^{-3}	Sandstone
P-20S♦	10.5	3.0×10^{-4}	5.9×10^{-4}	Sandstone
P-20SR	20	3.4×10^{-3}	1.7×10^{-3}	Sandstone
P-21S♦	10.5	4.2×10^{-4}	8.3×10^{-4}	Lake Silt and Clay
P-21D♦	5.5	5.4×10^{-4}	1.1×10^{-3}	Glacial Till
P-21BR♦	6.0	1.2×10^{-3}	2.4×10^{-3}	Sandstone
P-22S♦	15	$>2 \times 10^{-3}$	$>4 \times 10^{-3}$	Sandstone
P-22D♦	5	5.9×10^{-4}	1.2×10^{-4}	Sandstone
P-23S♦	10	$>2 \times 10^{-3}$	$>4 \times 10^{-3}$	Sandstone
P-23D♦	5	$>2 \times 10^{-3}$	$>4 \times 10^{-3}$	Sandstone
P-24D♦	5	1.0×10^{-4}	2.0×10^{-4}	Sand and Gravel
P-24E♦	5	1.0×10^{-5}	2.0×10^{-5}	Glacial Till
P-25S♦	10	$>2 \times 10^{-3}$	$>4 \times 10^{-3}$	Sand and Gravel
P-25D♦	5	$>2 \times 10^{-3}$	$>4 \times 10^{-3}$	Sand and Gravel
P-25BR♦	5	2.1×10^{-3}	4.1×10^{-3}	Sandstone
P-26S♦	15	1.0×10^{-5}	2.0×10^{-5}	Sandstone
P-26D♦	5	6.6×10^{-4}	1.3×10^{-3}	Sandstone
P-27S♦	15	1.4×10^{-5}	2.8×10^{-4}	Sandstone
P-27D♦	5	8.9×10^{-5}	1.8×10^{-4}	Sandstone
P-28S♦	15	3.0×10^{-5}	5.9×10^{-5}	Sandstone
P-30S	15	6.8×10^{-5}	3.5×10^{-5}	Sand and clay
P-30I*	10	7.9×10^{-2}	4.0×10^{-2}	Sand and gravel
P-30D	10	1.4×10^{-2}	7.1×10^{-3}	Dolomite
P-31S	15	3.5×10^{-4}	1.8×10^{-4}	Silt with sand & gravel
P-31IA	10	1.1×10^{-2}	5.6×10^{-3}	Sand and gravel
P-31IB*	10	4.6×10^{-2}	2.3×10^{-2}	Sand
P-31D	10	6.4×10^{-3}	3.3×10^{-3}	Sandstone
P-32S	15	6.2×10^{-3}	3.1×10^{-3}	Sand and gravel
P-32D	10	1.2×10^{-2}	6.1×10^{-3}	Sandstone
P-33S	15	1.0×10^{-6}	5.1×10^{-7}	Clay
P-33D	10	7.4×10^{-4}	3.8×10^{-4}	Silt with sand & gravel
P-34D	10	1.5×10^{-3}	7.6×10^{-4}	Sandstone
P-35D	10	1.9×10^{-3}	9.7×10^{-4}	Sandstone
P-36S	15	6.0×10^{-6}	3.0×10^{-6}	Silty sand
P-36D	10	3.8×10^{-4}	1.9×10^{-4}	Sandstone
P-38S	15	1.3×10^{-3}	6.6×10^{-4}	Sand
P-39S	15	1.8×10^{-2}	9.1×10^{-3}	Sand
P-40S	15	2.9×10^{-4}	1.5×10^{-4}	Sand and clay
P-40I	10	7.0×10^{-3}	3.6×10^{-3}	Dolomite
P-40D	10	4.3×10^{-3}	2.2×10^{-3}	Sandstone
P-41S	15	8.8×10^{-6}	4.5×10^{-6}	Silty sand and sand
P-41D	10	1.5×10^{-2}	7.6×10^{-3}	Sand and gravel
P-42S	15	3.1×10^{-4}	1.6×10^{-4}	Sand and clay

* Values obtained from questionable data; recovery rates were too rapid for measurement with available technology.

♦ Hydraulic conductivity from RMT, 1988b; remainder from HSI, 1991.

Table AAD 3-2 Summary of Analytical Results for P1S, Refuse Hideaway Landfill (in Parts Per Billion)

Constituents	ES	PAL	12/87	1/16/91
Benzene	5	0.5		
Bromodichloromethane	179	36		
Bromoform	4.4	0.44		
Bromomethane	NL	NL		
Chloroform	6	0.6		
Chloroethane	400	80		
1,4-Dichlorobenzene	75	15		
Dichlorodifluoromethane	1000	200		
1,1-Dichloroethane	850	85		
1,2-Dichloroethane	5	0.5		
trans-1,2-Dichloroethene	100	20		
1,1-Dichloroethylene	7	0.7		
1,2-Dichloropropane	5	0.5		
Ethylbenzene	700	140		31
Methylene chloride	150	15		
Tetrachloroethene	5	0.5		
Toluene	343	68.6		115
1,1,1-Trichloroethane	200	40		
Trichloroethene	5	0.5		
Trichlorofluoromethane	3490	698		
Vinyl chloride	0.2	0.02		
Xylenes	620	124		191
Total VOCs			0	337

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

Table AAD 3-2 Summary of Analytical Results for P1D, Refuse Hideaway Landfill (in Parts Per Billion)

Constituents	ES	PAL	12/87	8/19/88	9/15/88	1/15/91
Benzene	5	0.5			1.1	
Bromodichloromethane	179	36				
Bromoform	4.4	0.44				
Bromomethane	NL	NL				
Chloroform	6	0.6				
Chloroethane	400	80				
1,4-Dichlorobenzene	75	15				
Dichlorodifluoromethane	1000	200				
1,1-Dichloroethane	850	85				
1,2-Dichloroethane	5	0.5				
trans-1,2-Dichloroethene	100	20				
1,1-Dichloroethylene	7	0.7				
1,2-Dichloropropane	5	0.5				
Ethylbenzene	700	140				
Methylene chloride	150	15	3			2J
Tetrachloroethene	5	0.5				
Toluene	343	68.6				
1,1,1-Trichloroethane	200	40			0.57	
Trichloroethene	5	0.5				
Trichlorofluoromethane	3490	698				
Vinyl chloride	0.2	0.02				
Xylenes	620	124				
Total VOCs			3	0	1.67	2

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES
J = Estimated results based on validation findings

Table AAD 3-2 Summary of Analytical Results for P3S, Refuse Hideaway Landfill (in Parts Per Billion)

Constituents	ES	PAL	12/87	8/19/88	9/15/88	1/16/91
Benzene	5	0.5				
Bromodichloromethane	179	36				
Bromoform	4.4	0.44				
Bromomethane	NL	NL				
Chloroform	6	0.6				
Chloroethane	400	80				
1,4-Dichlorobenzene	75	15				
Dichlorodifluoromethane	1000	200				7
1,1-Dichloroethane	850	85				
1,2-Dichloroethane	5	0.5				
trans-1,2-Dichloroethene	100	20				
1,1-Dichloroethylene	7	0.7				
1,2-Dichloropropane	5	0.5				
Ethylbenzene	700	140				
Methylene chloride	150	15				
Tetrachloroethene	5	0.5				
Toluene	343	68.6				2
1,1,1-Trichloroethane	200	40			0.53	
Trichloroethene	5	0.5				
Trichlorofluoromethane	3490	698				
Vinyl chloride	0.2	0.02				40
Xylenes	620	124				
Total VOCs			0	0	0.53	49

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

HYDRO-SEARCH, INC.

Table AAD 3-2 Summary of Analytical Results for P4S, Refuse Hideaway Landfill (in Parts Per Billion)

Constituents	ES	PAL	12/87	8/19/88	9/15/88	1/14/91
Benzene	5	0.5				
Bromodichloromethane	179	36				
Bromoform	4.4	0.44				
Bromomethane	NL	NL				
Chloroform	6	0.6				
Chloroethane	400	80				
1,4-Dichlorobenzene	75	15				
Dichlorodifluoromethane	1000	200				
1,1-Dichloroethane	850	85				
1,2-Dichloroethane	5	0.5				
trans-1,2-Dichloroethene	100	20				
1,1-Dichloroethylene	7	0.7				
1,2-Dichloropropane	5	0.5				
Ethylbenzene	700	140				
Methylene chloride	150	15				
Tetrachloroethene	5	0.5				
Toluene	343	68.6				1
1,1,1-Trichloroethane	200	40				
Trichloroethene	5	0.5				
Trichlorofluoromethane	3490	698				
Vinyl chloride	0.2	0.02				
Xylenes	620	124				
Total VOCs			0	0	0	1

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

Constituents	ES	PAL	6/30/87	8/17/87*	8/18/87	12/87	8/19/88	9/16/88	1/11/91
Benzene	5	0.5	24				2.4	3.5	2
Bromodichloromethane	179	36							
Bromoform	4.4	0.44							
Bromomethane	NL	NL							160
Chloroform	6	0.6							
Chloroethane	400	80					1.2	1.8	
1,4-Dichlorobenzene	75	15							
Dichlorodifluoromethane	1000	200							40
1,1-Dichloroethane	850	85	10	10		5	7.5	7.9	16
1,2-Dichloroethane	5	0.5					1.2	4.9	
trans-1,2-Dichloroethene	100	20	330	390	380	380	540	640	10
1,1-Dichloroethylene	7	0.7	0.84				0.86	1.5	
1,2-Dichloropropane	5	0.5							1
Ethylbenzene	700	140							
Methylene chloride	150	15				2	2.1	3.0	
Tetrachloroethene	5	0.5	530	340	300	340	310	320	7
Toluene	343	68.6							1
1,1,1-Trichloroethane	200	40						1.3	
Trichloroethene	5	0.5	180	140	130	150	110	120	16
Trichlorofluoromethane	3490	698							
Vinyl chloride	0.2	0.02	41	15		8	31	51	160
Xylenes	620	124							
Total VOCs			1115.84	895	810	885	1006.26	1154.9	413

ES = Enforcement Standard NA = Not Analyzed Blank = Not Detected
PAL = Preventive Action Limit NL = Not Listed Shade = Detected compound exceeds ES
* Split Sample - collected and analyzed by WDNR

Table AAD 3-2 Summary of Analytical Results for P8D, Refuse Hideaway Landfill (in Parts Per Billion)

Constituents	ES	PAL	6/30/87	8/17/87*	8/18/87	12/87	8/19/88	9/16/88	1/11/91
Benzene	5	0.5	8		3		3.1	5.7	
Bromodichloromethane	179	36							
Bromoform	4.4	0.44							
Bromomethane	NL	NL							
Chloroform	6	0.6							
Chloroethane	400	80						0.61	
1,4-Dichlorobenzene	75	15							
Dichlorodifluoromethane	1000	200							
1,1-Dichloroethane	850	85				4	4.4	4.4	
1,2-Dichloroethane	5	0.5							
trans-1,2-Dichloroethene	100	20	8.9	9.4	10	270	270	310	
1,1-Dichloroethylene	7	0.7							
1,2-Dichloropropane	5	0.5							
Ethylbenzene	700	140	95	15	19				
Methylene chloride	150	15						1.9	
Tetrachloroethene	5	0.5	11	7.7	7	140	110	120	
Toluene	343	68.6	200	1.4	4				
1,1,1-Trichloroethane	200	40							
Trichloroethene	5	0.5	2.7			75	36	45	
Trichlorofluoromethane	3490	698							
Vinyl chloride	0.2	0.02				7	26	19	
Xylenes	620	124	480	90	110				
Total VOCs			805.6	123.5	153	496	449.5	506.61	0

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

* Split Sample - collected and analyzed by WDNR

Table AAD 3-2 Summary of Analytical Results for P88R, Refuse Hideaway Landfill (in Parts Per Billion)

Constituents	ES	PAL	6/30/87	8/18/87	12/87	8/19/88	9/16/88	1/11/91
Benzene	5	0.5			1			
Bromodichloromethane	179	36						
Bromoform	4.4	0.44						
Bromomethane	NL	NL						
Chloroform	6	0.6						
Chloroethane	400	80						
1,4-Dichlorobenzene	75	15						
Dichlorodifluoromethane	1000	200						
1,1-Dichloroethane	850	85						
1,2-Dichloroethane	5	0.5						
trans-1,2-Dichloroethene	100	20			10			
1,1-Dichloroethylene	7	0.7						
1,2-Dichloropropane	5	0.5						
Ethylbenzene	700	140						
Methylene chloride	150	15						
Tetrachloroethene	5	0.5			7			
Toluene	343	68.6						
1,1,1-Trichloroethane	200	0.5					0.59	
Trichloroethene	5	.18			3			
Trichlorofluoromethane	3490	698						
Vinyl chloride	0.2	0.02						
Xylenes	620	124						
Total VOCs			0	0	21	0	0.59	0

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

Table AAD 3-2 Summary of Analytical Results for P9S, Refuse Hideaway Landfill (in Parts Per Billion)

Constituents	ES	PAL	6/30/87	8/17/87*	8/18/87	12/87	8/18/88	9/15/88	1/15/91
Benzene	5	0.5	4.7	5.3	10	2	14	19	20
Bromodichloromethane	179	36							
Bromoform	4.4	0.44							
Bromomethane	NL	NL							110
Chloroform	6	0.6							
Chloroethane	400	80	1.2					1.2	
1,4-Dichlorobenzene	75	15							
Dichlorodifluoromethane	1000	200							35
1,1-Dichloroethane	850	85	28	32	32	6	29	50	30
1,2-Dichloroethane	5	0.5					4.5	5.4	41
trans-1,2-Dichloroethene	100	20	250	620	600	140	120	110	32
1,1-Dichloroethylene	7	0.7							
1,2-Dichloropropane	5	0.5					5.7	7.7	21
Ethylbenzene	700	140	1.2				6	8.3	
Methylene chloride	150	15					7.8	6.2	4
Tetrachloroethene	5	0.5	50	50	56	62	70	48	16
Toluene	343	68.6	2.9	2.4			5.7	9.8	8
1,1,1-Trichloroethane	200	40							
Trichloroethene	5	0.5	57	40	38	25	29	19	9
Trichlorofluoromethane	3490	698			55		0.66		
Vinyl chloride	0.2	0.02	130	244	200	35	56	53	440
Xylenes	620	124						7.1	11
Total VOCs			525	993.7	991	270	348.36	344.7	777

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

* Split Sample - collected and analyzed by WDNR

Constituents	ES	PAL	6/30/87	8/18/87	12/87	8/18/88	9/15/88	1/16/91
Benzene	5	0.5						4
Bromodichloromethane	179	36						
Bromoform	4.4	0.44						
Bromomethane	NL	NL						250
Chloroform	6	0.6						
Chloroethane	400	80						
1,4-Dichlorobenzene	75	15						
Dichlorodifluoromethane	1000	200						170
1,1-Dichloroethane	850	85				6.2	4.2	16
1,2-Dichloroethane	5	0.5						
trans-1,2-Dichloroethene	100	20			1	230	210	13
1,1-Dichloroethylene	7	0.7				0.77		
1,2-Dichloropropane	5	0.5						
Ethylbenzene	700	140						
Methylene chloride	150	15				4.8	4.3	
Tetrachloroethene	5	0.5						
Toluene	343	68.6						
1,1,1-Trichloroethane	200	40						
Trichloroethene	5	0.5						
Trichlorofluoromethane	3490	698						
Vinyl chloride	0.2	0.02				92	91	32
Xylenes	620	124						
Total VOCs			0	0	1	333.77	309.5	485

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

Table AAD 3-2 Summary of Analytical Results for P16S, Refuse Hideaway Landfill (in Parts Per Billion)

Constituents	ES	PAL	6/30/87	8/17/87*	8/18/87	12/87	8/18/88	9/16/88
Benzene	5	0.5						
Bromodichloromethane	179	36						
Bromoform	4.4	0.44						
Bromomethane	NL	NL						
Chloroform	6	0.6					1.8	3.1
Chloroethane	400	80				2		0.93
1,4-Dichlorobenzene	75	15						
Dichlorodifluoromethane	1000	200						
1,1-Dichloroethane	850	85	1.3	3.8		6	13	17
1,2-Dichloroethane	5	0.5	2.1				0.7	0.83
trans-1,2-Dichloroethene	100	20	11	19	17	89	78	110
1,1-Dichloroethylene	7	0.7		2.1		3	3.3	3.1
1,2-Dichloropropane	5	0.5						
Ethylbenzene	700	140						
Methylene chloride	150	15						
Tetrachloroethene	5	0.5	34	44	46	73	64	86
Toluene	343	68.6						
1,1,1-Trichloroethane	200	40	5.8	4.8		7	4.6	5.8
Trichloroethene	5	0.5	3.8	8.7	6	14	17	23
Trichlorofluoromethane	3490	698	7			4	1.5	1.5
Vinyl chloride	0.2	0.02	15	5		43	4.4	6
Xylenes	620	124						
Total VOCs			80	87.4	69	241	188.3	257.26

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

* Split Sample - collected and analyzed by WDNR

Constituents	ES	PAL	6/30/87	8/18/87	12/87	8/18/88	9/14/88	1/15/91
Benzene	5	0.5						7
Bromodichloromethane	179	36						
Bromoform	4.4	0.44						
Bromomethane	NL	NL						
Chloroform	6	0.6						
Chloroethane	400	80						
1,4-Dichlorobenzene	75	15						
Dichlorodifluoromethane	1000	200						
1,1-Dichloroethane	850	85	0.69			0.73	1	6
1,2-Dichloroethane	5	0.5						
trans-1,2-Dichloroethene	100	20				0.85	1.4	1
1,1-Dichloroethylene	7	0.7						
1,2-Dichloropropane	5	0.5						1
Ethylbenzene	700	140						
Methylene chloride	150	15						
Tetrachloroethene	5	0.5					1.2	3
Toluene	343	68.6						7
1,1,1-Trichloroethane	200	40					0.67	
Trichloroethene	5	0.5			1	2	2	
Trichlorofluoromethane	3490	698						10
Vinyl chloride	0.2	0.02					1.1	19
Xylenes	620	124						3
Total VOCs			0.69	0	1	3.58	7.37	57

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

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Table AAD 3-2 Summary of Analytical Results for P-17S, Refuse Hideaway Landfill (in Parts Per Billion)

Constituents	ES	PAL	7/9/87	8/18/87	8/18/88	9/14/88	1/9/91	6/26/91	10/25/91	5/14/92	10/8/92	5/19/93	10/21/93
Benzene	5	0.5	11		7.7	10	7	4		4	3	3	2J
Bromodichloromethane	179	36	8.2										J
Bromoform	4.4	0.44											J
Bromomethane	NL	NL					36♦						J
Chloroform	6	0.6	3.8		5.4	6.3		3			1.6		J
Chloroethane	400	80	1.1										J
1,4-Dichlorobenzene	75	15			3.6	2.9	6	6		5	7.6	5	4J
Dichlorodifluoromethane	1000	200				♣		15		1	2.7	6	2J
1,1-Dichloroethane	850	85	23	33	38	56	21	26		20	23	22	11J
1,2-Dichloroethane	5	0.5			6.5	4.8	5	9		4	5.7	4	3J
cis-1,2-Dichloroethene	70	7	NA	NA	NA	NA	NA	NA	NA	420	1,900	150	350J
trans-1,2-Dichloroethene	100	20	62	140	320	440	3	2		2	1.4	2	J
1,1-Dichloroethylene	7	0.7			3	1.2							J
1,2-Dichloropropane	5	0.5	4.1	5	12	13	10	14		15	17	13	9J
Ethylbenzene	700	140			2.5	2.5	47	12	12	10	6.3	5	3J
Methylene chloride	150	15		74	14	6.3		1					J
Tetrachloroethene	5	0.5	190	190	99	81	14	18	16	15	18	20	14J
Toluene	343	68.6	1.2		7.4	11	17	5		4	2.9	7	2J
1,1,1-Trichloroethane	200	40	4.6		9.1	4.9	5	5			0.9	2	J
Trichloroethene	5	0.5	79	120	320	320	28	51	65	47	54	160	49J
Trichlorofluoromethane	3490	698	2.5		2.7	1.9		28		12	16		5J
Vinyl chloride	0.2	0.02	6.5	20	31	35♣	68	57	*	27	24	25	10J
Xylenes	620	124				10	36	7		6	4.2	7	1J
Total VOCs			397	582	881.9	1006.8	303	263	93	592	2088.3	431	465

ES = Enforcement Standard
PAL = Preventive Action Limit
J = Estimated results based on validation findings

NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

* Not detected with detection limit of 50 ppb
♦ Bromomethane and chloroethane co-eluted results reported as bromomethane
♣ Vinyl chloride concentration estimated because dichlorodifluoromethane co-elutes and is also present

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Constituents	ES	PAL	7/9/87	8/17/87*	8/18/87	8/18/88	9/14/88	1/16/91
Benzene	5	0.5	9.6					
Bromodichloromethane	179	36	8.9					
Bromoform	4.4	0.44						
Bromomethane	NL	NL						
Chloroform	6	0.6	4					
Chloroethane	400	80	0.96					
1,4-Dichlorobenzene	75	15						
Dichlorodifluoromethane	1000	200						
1,1-Dichloroethane	850	85	23					
1,2-Dichloroethane	5	0.5	1.4					
trans-1,2-Dichloroethene	100	20	69					
1,1-Dichloroethylene	7	0.7						
1,2-Dichloropropane	5	0.5	4.4					
Ethylbenzene	700	140						
Methylene chloride	150	15						
Tetrachloroethene	5	0.5	190	8.2	8	5.5	7.1	5
Toluene	343	68.6	1.3					1
1,1,1-Trichloroethane	200	40	5				0.89	
Trichloroethene	5	0.5	83	1.6			1.2	
Trichlorofluoromethane	3490	698	2.6	3.5		1.4	1.3	1
Vinyl chloride	0.2	0.02	6.2				1.4	
Xylenes	620	124						
Total VOCs			409.36	13.3	8	6.9	11.89	7

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

* Split Sample - collected and analyzed by WDNR

Table AAD 3-2 Summary of Analytical Results for P19S, Refuse Hideaway Landfill (in Parts Per Billion)

Constituents	ES	PAL	6/30/87	8/18/87	8/17/88	9/14/88
Benzene	5	0.5			1.2	
Bromodichloromethane	179	36				
Bromoform	4.4	0.44				
Bromomethane	NL	NL				
Chloroform	6	0.6				
Chloroethane	400	80				
1,4-Dichlorobenzene	75	15				
Dichlorodifluoromethane	1000	200				
1,1-Dichloroethane	850	85	0.69		1	1.1
1,2-Dichloroethane	5	0.5				
trans-1,2-Dichloroethene	100	20	7.5	15	13	13
1,1-Dichloroethylene	7	0.7				
1,2-Dichloropropane	5	0.5				
Ethylbenzene	700	140				
Methylene chloride	150	15				
Tetrachloroethene	5	0.5	39	56	35	38
Toluene	343	68.6				
1,1,1-Trichloroethane	200	40				1.2
Trichloroethene	5	0.5	4.1	8	6.7	6.6
Trichlorofluoromethane	3490	698			1.2	1.2
Vinyl chloride	0.2	0.02	1.4		0.92	2.3
Xylenes	620	124				
Total VOCs			52.69	79	59.02	63.4

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

Table AAD 3-2 Summary of Analytical Results for P19D, Refuse Hideaway Landfill (in Parts Per Billion)

Constituents	ES	PAL	6/30/87	8/18/87	8/17/88	9/14/88
Benzene	5	0.5				
Bromodichloromethane	179	36				
Bromoform	4.4	0.44				
Bromomethane	NL	NL				
Chloroform	6	0.6				
Chloroethane	400	80				
1,4-Dichlorobenzene	75	15				
Dichlorodifluoromethane	1000	200				
1,1-Dichloroethane	850	85			0.53	0.66
1,2-Dichloroethane	5	0.5				
trans-1,2-Dichloroethene	100	20	1.4		2.7	5.3
1,1-Dichloroethylene	7	0.7	1			
1,2-Dichloropropane	5	0.5				
Ethylbenzene	700	140				
Methylene chloride	150	15				
Tetrachloroethene	5	0.5	27	28	24	21
Toluene	343	68.6				
1,1,1-Trichloroethane	200	40				1.2
Trichloroethene	5	0.5	2.5		3.7	3.5
Trichlorofluoromethane	3490	698			0.89	1.4
Vinyl chloride	0.2	0.02	0.78		0.52	3.2
Xylenes	620	124				
Total VOCs			32.68	28	32.34	36.26

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

HYDRO-SEARCH, INC.

Table AAD 3-2 Summary of Analytical Results for P20S, Refuse Hideaway Landfill (in Parts Per Billion)

Constituents	ES	PAL	6/30/87	8/17/87*	8/18/87	8/17/88	9/14/88
Benzene	5	0.5					
Bromodichloromethane	179	36					
Bromoform	4.4	0.44					
Bromomethane	NL	NL					
Chloroform	6	0.6					
Chloroethane	400	80					
1,4-Dichlorobenzene	75	15					
Dichlorodifluoromethane	1000	200					
1,1-Dichloroethane	850	85				0.78	0.6
1,2-Dichloroethane	5	0.5					
trans-1,2-Dichloroethene	100	20				1	
1,1-Dichloroethylene	7	0.7					
1,2-Dichloropropane	5	0.5					
Ethylbenzene	700	140					
Methylene chloride	150	15					
Tetrachloroethene	5	0.5	36	39	53	51	48
Toluene	343	68.6					
1,1,1-Trichloroethane	200	40					1.2
Trichloroethene	5	0.5		6.5		5.6	4.7
Trichlorofluoromethane	3490	698		6.2		1.6	1.4
Vinyl chloride	0.2	0.02	1.1			1	2.8
Xylenes	620	124					
Total VOCs			37.1	51.7	53	60.98	58.7

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

* Split Sample - collected and analyzed by WDNR

Constituents	ES	PAL	12/11/90	1/7/91	7/1/91	11/15/91	5/12/92	12/22/92	5/18/93	10/21/93
Benzene	5	0.5								
Bromodichloromethane	179	36								
Bromoform	4.4	0.44								
Bromomethane	NL	NL								
Chloroform	6	0.6							1	
Chloroethane	400	80								
1,4-Dichlorobenzene	75	15								
Dichlorodifluoromethane	1000	200			6			2	1	
1,1-Dichloroethane	850	85								
1,2-Dichloroethane	5	0.5								
cis-1,2-Dichloroethene	70	7	NA	NA	NA	NA	NA			
trans-1,2-Dichloroethene	100	20								
1,1-Dichloroethylene	7	0.7								
1,2-Dichloropropane	5	.05								
Ethylbenzene	700	140				1				
Methylene chloride	150	15								
Tetrachloroethene	5	0.5			3	7	6	6	3	8
Toluene	343	68.6								
1,1,1-Trichloroethane	200	40								
Trichloroethene	5	0.5	3	2						
Trichlorofluoromethane	3490	698								
Vinyl chloride	0.2	0.02								
Xylenes	620	124				4				
Total VOCs			3	2	9	12	6	8	5	8

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

Table AAD 3-2 Summary of Analytical Results for P-21S, Refuse Hideaway Landfill (in Parts Per Billion)

Constituents	ES	PAL	6/30/87	8/17/87*	8/18/87	12/87	8/18/88	9/15/88	1/14/91	6/28/91	11/15/91	5/12/92	11/16/92	5/19/93	10/21/93
Benzene	5	0.5							9	7		4	4	3♦	3
Bromodichloromethane	179	36													
Bromoform	4.4	0.44													
Bromomethane	NL	NL												3	
Chloroform	6	0.6									37				
Chloroethane	400	80						1.1	11	8		2		50J	2
1,4-Dichlorobenzene	75	15													
Dichlorodifluoromethane	1000	200							25J	90		1	10	17J	
1,1-Dichloroethane	850	85	4.8				0.7		40	36	72	18	16	10	8
1,2-Dichloroethane	5	0.5								4					
cis-1,2-Dichloroethene	70	7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA		25	
trans-1,2-Dichloroethene	100	20					2.5	3.5	12	14	25	6		5	4
1,1-Dichloroethylene	7	0.7					0.7			1					
1,2-Dichloropropane	5	0.5							3	2					
Ethylbenzene	700	140													
Methylene chloride	150	15							1J	3					
Tetrachloroethene	5	0.5		1.6		3	4.4	4.2	3	4		2			
Toluene	343	68.6							4	1			1		
1,1,1-Trichloroethane	200	40					0.77	0.61							
Trichloroethene	5	0.5							7	6		5	6	9	4
Trichlorofluoromethane	3490	698							177	190		48			
Vinyl chloride	0.2	0.02	36	57	43	24	42	31	525	470	<250	56	41		5
Xylenes	620	124							2	1					
Total VOCs			40.8	58.6	43	27	51.07	40.41	819	837	134	142	78	119	26

ES = Enforcement Standard
PAL = Preventive Action Limit
J = Estimated value based on validation results
NA = Not Analyzed
NL = Not Listed
♦ = Revised from non-detectable following validation
Blank = Not Detected
Shade = Detected compound exceeds ES

* Split Sample - collected and analyzed by WDNR

HYDRO-SEARCH, INC.

Table AAD 3-2 Summary of Analytical Results for P21D, Refuse Hideaway Landfill (in Parts Per Billion)

Constituents	ES	PAL	6/30/87	8/17/87*	8/18/87	12/87	8/18/88	9/15/88	1/14/91
Benzene	5	0.5					1.7		1
Bromodichloromethane	179	36							
Bromoform	4.4	0.44							
Bromomethane	NL	NL							
Chloroform	6	0.6							
Chloroethane	400	80							
1,4-Dichlorobenzene	75	15							
Dichlorodifluoromethane	1000	200							36J
1,1-Dichloroethane	850	85	0.8				5.5	6.1	1
1,2-Dichloroethane	5	0.5							
trans-1,2-Dichloroethene	100	20	16	26	28	8	84	110	
1,1-Dichloroethylene	7	0.7					0.59	0.7	
1,2-Dichloropropane	5	0.5							
Ethylbenzene	700	140							
Methylene chloride	150	15						3.7	
Tetrachloroethene	5	0.5							
Toluene	343	68.6							1
1,1,1-Trichloroethane	200	40							
Trichloroethene	5	0.5					1.8	2.5	
Trichlorofluoromethane	3490	698					1.1	0.61	20
Vinyl chloride	0.2	0.02	33	28	34	9	67	94	14
Xylenes	620	124							
Total VOCs			49.8	54	62	17	161.69	217.61	73

ES = Enforcement Standard
PAL = Preventive Action Limit
J = Estimated results based on validation findings
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

* Split Sample - collected and analyzed by WDNR

HYDRO-SEARCH, INC.

Table AAD 3-2 Summary of Analytical Results for P21BR, Refuse Hideaway Landfill (in Parts Per Billion)

Constituents	ES	PAL	8/18/88	9/14/88	1/14/91
Benzene	5	0.5			
Bromodichloromethane	179	36			
Bromoform	4.4	0.44			
Bromomethane	NL	NL			
Chloroform	6	0.6			
Chloroethane	400	80			
1,4-Dichlorobenzene	75	15			
Dichlorodifluoromethane	1000	200			
1,1-Dichloroethane	850	85			
1,2-Dichloroethane	5	0.5			
trans-1,2-Dichloroethene	100	20			
1,1-Dichloroethylene	7	0.7			
1,2-Dichloropropane	5	0.5			
Ethylbenzene	700	140			
Methylene chloride	150	15			
Tetrachloroethene	5	0.5			
Toluene	343	68.6			
1,1,1-Trichloroethane	200	40			
Trichloroethene	5	0.5			
Trichlorofluoromethane	3490	698			
Vinyl chloride	0.2	0.02			
Xylenes	620	124			
Total VOCs			0	0	0

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

Table AAD 3-2 Summary of Analytical Results for P22S, Refuse Hideaway Landfill (in Parts Per Billion)

Constituents	ES	PAL	8/16/88	9/15/88	1/17/91	6/27/91	10/25/91	5/18/92	10/7/92	5/18/93	10/21/93
Benzene	5	0.5									
Bromodichloromethane	179	36						1			
Bromoform	4.4	0.44									
Bromomethane	NL	NL									
Chloroform	6	0.6						1			
Chloroethane	400	80									
1,4-Dichlorobenzene	75	15									
Dichlorodifluoromethane	1000	200			4	46		14		3	
1,1-Dichloroethane	850	85	0.7	1	14		1	2			
1,2-Dichloroethane	5	0.5									
cis-1,2-Dichloroethene	70	7	NA	NA	NA	NA	NA	NA	12	9	
trans-1,2-Dichloroethene	100	20	10	12							
1,1-Dichloroethylene	7	0.7	0.51								
1,2-Dichloropropane	5	0.5									
Ethylbenzene	700	140									
Methylene chloride	150	15				1		2			
Tetrachloroethene	5	0.5	8	9.3	9	8	12	12	12	7	6
Toluene	343	68.6									
1,1,1-Trichloroethane	200	40	0.61	1.2					17		
Trichloroethene	5	0.5	2.6	3.2	2	2	3	4	2.4	2	2
Trichlorofluoromethane	3490	698	0.61	0.73		3	4	1			
Vinyl chloride	0.2	0.02		0.68							
Xylenes	620	124									
Total VOCs			23.03	28.11	29	60	20	37	43.4	21	8

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

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Constituents	ES	PAL	8/16/88	9/15/88	1/8/91	6/27/91	10/25/91	5/18/92	10/7/92	5/18/93	10/21/93
Benzene	5	0.5	61								
Bromodichloromethane	179	36									
Bromoform	4.4	0.44									
Bromomethane	NL	NL									
Chloroform	6	0.6									
Chloroethane	400	80									
Chloromethane	NL	NL									2
1,4-Dichlorobenzene	75	15									
Dichlorodifluoromethane	1000	200				39		7	1.6	2	
1,1-Dichloroethane	850	85	1.1	0.96	7			1			
1,2-Dichloroethane	5	0.5									
cis-1,2-Dichloroethene	70	7	NA	NA	NA	NA	NA	NA	8.1	7	
trans-1,2-Dichloroethene	100	20	14	12							
1,1-Dichloroethylene	7	0.7	0.6								
1,2-Dichloropropane	5	0.5									
Ethylbenzene	700	140									
Methylene chloride	150	15						1			
Tetrachloroethene	5	0.5	12	8.8	6	6	8	7	8	5	8
Toluene	343	68.6									
1,1,1-Trichloroethane	200	40	0.77	0.56	1						
Trichloroethene	5	0.5	3.3	2.8		1	2	3	1.4		2
Trichlorofluoromethane	3490	698	0.66	0.64		3					2
Vinyl chloride	0.2	0.02		0.57							
Xylenes	620	124									
Total VOCs			93.43	26.33	14	49	10	19	19.1	14	14

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

HYDRO-SEARCH, INC.

Table AAD 3-2 Summary of Analytical Results for P23S, Refuse Hideaway Landfill (in Parts Per Billion)

Constituents	ES	PAL	8/17/88	9/15/88	1/11/91
Benzene	5	0.5			
Bromodichloromethane	179	36			
Bromoform	4.4	0.44			
Bromomethane	NL	NL			
Chloroform	6	0.6			
Chloroethane	400	80			
1,4-Dichlorobenzene	75	15			
Dichlorodifluoromethane	1000	200			
1,1-Dichloroethane	850	85		1.3	
1,2-Dichloroethane	5	0.5			
trans-1,2-Dichloroethene	100	20	8.5	14	
1,1-Dichloroethylene	7	0.7			
1,2-Dichloropropane	5	0.5			
Ethylbenzene	700	140			
Methylene chloride	150	15			
Tetrachloroethene	5	0.5	15	12	2
Toluene	343	68.6			1
1,1,1-Trichloroethane	200	40		1.3	
Trichloroethene	5	0.5	5.3	3.7	
Trichlorofluoromethane	3490	698		0.7	
Vinyl chloride	0.2	0.02		0.78	
Xylenes	620	124			
Total VOCs			28.8	33.78	3

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

Table AAD 3-2 Summary of Analytical Results for P23D, Refuse Hideaway Landfill (in Parts Per Billion)

Constituents	ES	PAL	8/17/88	9/15/88	1/11/91
Benzene	5	0.067			
Bromodichloromethane	179	36			
Bromoform	4.4	0.44			
Bromomethane	NL	NL			
Chloroform	6	.6			
Chloroethane	400	80			
1,4-Dichlorobenzene	75	15			
Dichlorodifluoromethane	NL	NL			
1,1-Dichloroethane	850	85			
1,2-Dichloroethane	5	.05			
trans-1,2-Dichloroethene	100	20			
1,1-Dichloroethylene	7	.024			
1,2-Dichloropropane	5	0.5			
Ethylbenzene	1360	272			
Methylene chloride	150	15		1.6	
Tetrachloroethene	1	.1	1.9	2.3	
Toluene	343	68.6			2
1,1,1-Trichloroethane	200	40			
Trichloroethene	5	.18			
Trichlorofluoromethane	3490	698			
Vinyl chloride	0.2	.0015			
Xylenes	620	124			
Total VOCs			1.9	3.9	2

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

Table AAD 3-2 Summary of Analytical Results for P24D, Refuse Hideaway Landfill (in Parts Per Billion)

Constituents	ES	PAL	8/19/88	9/16/88	1/15/91
Benzene	5	0.5			
Bromodichloromethane	179	36			
Bromoform	4.4	0.44			
Bromomethane	NL	NL			
Chloroform	6	0.6			
Chloroethane	400	80			
1,4-Dichlorobenzene	75	15			
Dichlorodifluoromethane	1000	200			
1,1-Dichloroethane	850	85			
1,2-Dichloroethane	5	0.5			
trans-1,2-Dichloroethene	100	20			
1,1-Dichloroethylene	7	0.7			
1,2-Dichloropropane	5	0.5			
Ethylbenzene	700	140			
Methylene chloride	150	15			
Tetrachloroethene	5	0.5			
Toluene	343	68.6			
1,1,1-Trichloroethane	200	40			
Trichloroethene	5	0.5			
Trichlorofluoromethane	3490	698			
Vinyl chloride	0.2	0.02			
Xylenes	620	124			
Total VOCs			0	0	0

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

Table AAD 3-2 Summary of Analytical Results for P24E, Refuse Hideaway Landfill (in Parts Per Billion)

Constituents	ES	PAL	8/19/88	9/16/88	1/15/91
Benzene	5	0.5			
Bromodichloromethane	179	36			
Bromoform	4.4	0.44			
Bromomethane	NL	NL			
Chloroform	6	0.6			
Chloroethane	400	80			
1,4-Dichlorobenzene	75	15			
Dichlorodifluoromethane	1000	200			
1,1-Dichloroethane	850	85			
1,2-Dichloroethane	5	0.5			
trans-1,2-Dichloroethene	100	20			
1,1-Dichloroethylene	7	0.7			
1,2-Dichloropropane	5	0.5			
Ethylbenzene	700	140			
Methylene chloride	150	15			
Tetrachloroethene	5	0.5			
Toluene	343	68.6			
1,1,1-Trichloroethane	200	40		1.6	
Trichloroethene	5	0.5			
Trichlorofluoromethane	3490	698			
Vinyl chloride	0.2	0.02			
Xylenes	620	124			
Total VOCs			0	1.6	0

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

Table AAD 3-2 Summary of Analytical Results for P25S, Refuse Hideaway Landfill (in Parts Per Billion)

Constituents	ES	PAL	8/17/88	9/14/88	1/10/91
Benzene	5	0.5			
Bromodichloromethane	179	36			
Bromoform	4.4	0.44			
Bromomethane	NL	NL			
Chloroform	6	0.6			
Chloroethane	400	80			
1,4-Dichlorobenzene	75	15			
Dichlorodifluoromethane	1000	200			
1,1-Dichloroethane	850	85			
1,2-Dichloroethane	5	0.5			
trans-1,2-Dichloroethene	100	20			
1,1-Dichloroethylene	7	0.7			
1,2-Dichloropropane	5	0.5			
Ethylbenzene	700	140			
Methylene chloride	150	15			
Tetrachloroethene	5	0.5			
Toluene	343	68.6			
1,1,1-Trichloroethane	200	40			
Trichloroethene	5	0.5			
Trichlorofluoromethane	3490	698			
Vinyl chloride	0.2	0.02			
Xylenes	620	124			
Total VOCs			0	0	0

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

Table AAD 3-2 Summary of Analytical Results for P25D, Refuse Hideaway Landfill (in Parts Per Billion)

Constituents	ES	PAL	8/17/88	9/14/88	1/10/91
Benzene	5	0.5	1.2		
Bromodichloromethane	179	36			
Bromoform	4.4	0.44			
Bromomethane	NL	NL			
Chloroform	6	0.6			
Chloroethane	400	80			
1,4-Dichlorobenzene	75	15			
Dichlorodifluoromethane	1000	200			
1,1-Dichloroethane	850	85	2.7	2.2	
1,2-Dichloroethane	5	0.5			
trans-1,2-Dichloroethene	100	20	1.9	1.8	
1,1-Dichloroethylene	7	0.7			
1,2-Dichloropropane	5	0.5	1.1		
Ethylbenzene	700	140			14
Methylene chloride	150	15			
Tetrachloroethene	5	0.5	1.2	1.1	
Toluene	343	68.6			58
1,1,1-Trichloroethane	200	40		0.5	
Trichloroethene	5	0.5	4	3.1	
Trichlorofluoromethane	3490	698			
Vinyl chloride	0.2	0.02		0.84	
Xylenes	620	124			50
Total VOCs			12.1	9.54	122

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

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Table AAD 3-2 Summary of Analytical Results for P25BR, Refuse Hideaway Landfill (in Parts Per Billion)

Constituents	ES	PAL	8/17/88	9/14/88	1/10/91
Benzene	5	0.5			
Bromodichloromethane	179	36			
Bromoform	4.4	0.44			
Bromomethane	NL	NL			
Chloroform	6	0.6			
Chloroethane	400	80			
1,4-Dichlorobenzene	75	15			
Dichlorodifluoromethane	1000	200			
1,1-Dichloroethane	850	85		2.6	
1,2-Dichloroethane	5	0.5			
trans-1,2-Dichloroethene	100	20		2.2	
1,1-Dichloroethylene	7	0.7			
1,2-Dichloropropane	5	0.5		1.1	
Ethylbenzene	700	140			
Methylene chloride	150	15			
Tetrachloroethene	5	0.5	3.3	1.4	
Toluene	343	68.6			
1,1,1-Trichloroethane	200	40		0.64	
Trichloroethene	5	0.5		4.2	
Trichlorofluoromethane	3490	698		0.62	
Vinyl chloride	0.2	0.02		1.1	
Xylenes	620	124			
Total VOCs			3.3	13.86	0

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

Table AAD 3-2 Summary of Analytical Results for P26S, Refuse Hideaway Landfill (in Parts Per Billion)

Constituents	ES	PAL	9/26/88	1/11/91
Benzene	5	0.5	1.9	
Bromodichloromethane	179	36		
Bromoform	4.4	0.44		
Bromomethane	NL	NL		
Chloroform	6	0.6		
Chloroethane	400	80		
1,4-Dichlorobenzene	75	15		
Dichlorodifluoromethane	1000	200		
1,1-Dichloroethane	850	85	0.6	
1,2-Dichloroethane	5	0.5		
trans-1,2-Dichloroethene	100	20	1.4	
1,1-Dichloroethylene	7	0.7		
1,2-Dichloropropane	5	0.5		
Ethylbenzene	700	140		14
Methylene chloride	150	15		
Tetrachloroethene	5	0.5	36	38
Toluene	343	68.6		66J
1,1,1-Trichloroethane	200	40	1.7	
Trichloroethene	5	0.5	3.3	7
Trichlorofluoromethane	3490	698	5.2	
Vinyl chloride	0.2	0.02	2.5	10
Xylenes	620	124		77
Total VOCs			52.6	212

ES = Enforcement Standard
PAL = Preventive Action Limit
J = Estimated value based on validation results

NA = Not Analyzed
NL = Not Listed

Blank = Not Detected
Shade = Detected compound exceeds ES

Table AAD 3-2 Summary of Analytical Results for P26D, Refuse Hideaway Landfill (in Parts Per Billion)

Constituents	ES	PAL	8/15/88	9/13/88	1/9/91
Benzene	5	0.5	2.5		
Bromodichloromethane	179	36			
Bromoform	4.4	0.44			
Bromomethane	NL	NL			10
Chloroform	6	0.6			
Chloroethane	400	80			
1,4-Dichlorobenzene	75	15			
Dichlorodifluoromethane	1000	200			53
1,1-Dichloroethane	850	85	1.4	1.5	
1,2-Dichloroethane	5	0.5			
trans-1,2-Dichloroethene	100	20	3.2	3.1	
1,1-Dichloroethylene	7	0.7	1.3		
1,2-Dichloropropane	5	0.5			
Ethylbenzene	700	140			
Methylene chloride	150	15		2.4	
Tetrachloroethene	5	0.5	46	49	28
Toluene	343	68.6			15
1,1,1-Trichloroethane	200	40	1.2	2.5	
Trichloroethene	5	0.5	6.4	5.9	2
Trichlorofluoromethane	3490	698	8.6	7.5	7
Vinyl chloride	0.2	0.02	5.2	8.1	
Xylenes	620	124			
Total VOCs			75.8	80	115

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

Table AAD 3-2 Summary of Analytical Results for P27S, Refuse Hideaway Landfill (in Parts Per Billion)

Constituents	ES	PAL	8/16/88	9/14/88	1/17/91	6/26/91	10/24/91	5/15/92	10/6/92	5/17/93	10/21/93
Benzene	5	0.5	1.8								
Bromodichloromethane	179	36									
Bromoform	4.4	0.44									
Bromomethane	NL	NL									
Chloroform	6	0.6		0.55							
Chloroethane	400	80									
1,4-Dichlorobenzene	75	15									
Dichlorodifluoromethane	1000	200			53	150	14	11	18	7	4
1,1-Dichloroethane	850	85	3.9	4	4	5	4	3	1.5		1
1,2-Dichloroethane	5	0.5									
cis-1,2-Dichloroethene	70	7	NA	NA	NA	NA	NA	9	7.1	3	
trans-1,2-Dichloroethene	100	20	12	12							
1,1-Dichloroethylene	7	0.7	2.7								
1,2-Dichloropropane	5	0.5			1						
Ethylbenzene	700	140									
Methylene chloride	150	15	4.4	2.8	3	7	2	2			
Tetrachloroethene	5	0.5	110	110	114	130	150	120	130	64	50
Toluene	343	68.6			1						
1,1,1-Trichloroethane	200	40	4.7	6.4	5	6	4	4	3.3	1	
Trichloroethene	5	0.5	19	19	12	17	21	16	15	8	6
Trichlorofluoromethane	3490	698	9.3	8.8	37	48	30	19		3	1
Vinyl chloride	0.2	0.02	4.1	4.6							
Xylenes	620	124									
Total VOCs			171.9	168.15	230	363	225	184	174.9	86	62

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

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Constituents	ES	PAL	8/16/88	9/14/88	1/17/91	6/26/91	10/24/91	5/15/92	10/6/92	5/17/93	10/21/93
Benzene	5	0.5									
Bromodichloromethane	179	36									
Bromoform	4.4	0.44									
Bromomethane	NL	NL									
Chloroform	6	0.6									
Chloroethane	400	80		1							
1,4-Dichlorobenzene	75	15									
Dichlorodifluoromethane	1000	200			93	260	16	16	20	24	
1,1-Dichloroethane	850	85	0.51	1.8	11	4	4	4	1.7	1	3J
1,2-Dichloroethane	5	0.5									
cis-1,2-Dichloroethene	70	7	NA	NA	NA	NA	NA	NA	7.1	6	4.9
trans-1,2-Dichloroethene	100	20		4.2	1						
1,1-Dichloroethylene	7	0.7	0.5	0.52							
1,2-Dichloropropane	5	0.5						1			
Ethylbenzene	700	140									
Methylene chloride	150	15	3.7	1.4		2				4	
Tetrachloroethene	5	0.5	20	56	99J	120	150	130	54	72	91D
Toluene	343	68.6									
1,1,1-Trichloroethane	200	40	0.52	3.2	6	5	4	4	3*	3	2J
Trichloroethene	5	0.5	2.1	7.7	11	14	21	17	15	32	12J
Trichlorofluoromethane	3490	698	2.3	8.6		40	33	21		7	3J
Vinyl chloride	0.2	0.02		9.6							
Xylenes	620	124									
Total VOCs			29.63	94.02	221	445	228	193	100.8	149	115.9

ES = Enforcement Standard
PAL = Preventive Action Limit
J = Estimated results based on validation findings
NA = Not Analyzed
NL = Not Listed
D = Sample results based on diluted analysis
Blank = Not Detected
Shade = Detected compound exceeds ES
* = Revised from 9 following validation

HYDRO-SEARCH, INC.

Table AAD 3-2 Summary of Analytical Results for P28S, Refuse Hideaway Landfill (in Parts Per Billion)

Constituents	ES	PAL	8/15/88	9/13/88
Benzene	5	0.5		
Bromodichloromethane	179	36		
Bromoform	4.4	0.44		
Bromomethane	NL	NL		
Chloroform	6	0.6		
Chloroethane	400	80		
1,4-Dichlorobenzene	75	15		
Dichlorodifluoromethane	1000	200		
1,1-Dichloroethane	850	85		1.1
1,2-Dichloroethane	5	0.5		
trans-1,2-Dichloroethene	100	20		
1,1-Dichloroethylene	7	0.7		
1,2-Dichloropropane	5	0.5		
Ethylbenzene	700	140		
Methylene chloride	150	15		2.2
Tetrachloroethene	5	0.5		29
Toluene	343	68.6		
1,1,1-Trichloroethane	200	40		1.9
Trichloroethene	5	0.5		3.2
Trichlorofluoromethane	3490	698		2.6
Vinyl chloride	0.2	0.02		1.4
Xylenes	620	124		
Total VOCs			0	41.4

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

HYDRO-SEARCH, INC.

Table AAD 3-2 Summary of Analytical Results for P29S, Refuse Hideaway Landfill (in Parts Per Billion)

Constituents	ES	PAL	3/21/91	6/26/91	10/24/91	5/15/92	10/6/92	5/19/93	10/21/93
Benzene	5	0.5							
Bromodichloromethane	179	36							
Bromoform	4.4	0.44							
Bromomethane	NL	NL							
Chloroform	6	0.6							
Chloroethane	400	80							
1,4-Dichlorobenzene	75	15							
Dichlorodifluoromethane	1000	200	100	74		5	3	5	
1,1-Dichloroethane	850	85							
1,2-Dichloroethane	5	0.5							
cis-1,2-Dichloroethene	70	7	NA	NA	NA	NA			
trans-1,2-Dichloroethene	100	20							
1,1-Dichloroethylene	7	0.7							
1,2-Dichloropropane	5	0.5							
Ethylbenzene	700	140							
Methylene chloride	150	15		1					
Tetrachloroethene	5	0.5	2	2	1				
Toluene	343	68.6	4						
1,1,1-Trichloroethane	200	40							
Trichloroethene	5	0.5							
Trichlorofluoromethane	3490	698		1					
Vinyl chloride	0.2	0.02							
Xylenes	620	124							
Total VOCs			106	78	1	5	3	5	0

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

Table AAD 3-2 Summary of Analytical Results for P30S, Refuse Hideaway Landfill (in Parts Per Billion)

Constituents	ES	PAL	12/12/90	1/7/91
Benzene	5	0.5		
Bromodichloromethane	179	36		
Bromoform	4.4	0.44		
Bromomethane	NL	NL		
Chloroform	6	0.6		
Chloroethane	400	80		
1,4-Dichlorobenzene	75	15		
Dichlorodifluoromethane	1000	200		
1,1-Dichloroethane	850	85		
1,2-Dichloroethane	5	0.5		
trans-1,2-Dichloroethene	100	20		
1,1-Dichloroethylene	7	0.7		
1,2-Dichloropropane	5	0.5		
Ethylbenzene	700	140		
Methylene chloride	150	15		
Tetrachloroethene	5	0.5		
Toluene	343	68.6		
1,1,1-Trichloroethane	200	40		
Trichloroethene	5	0.5		
Trichlorofluoromethane	3490	698		
Vinyl chloride	0.2	0.02		
Xylenes	620	124		
Total VOCs			0	0

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

Table AAD 3-2 Summary of Analytical Results for P30I, Refuse Hideaway Landfill (in Parts Per Billion)

Constituents	ES	PAL	11/19/90	12/20/90	1/7/91	6/28/91	12/23/91	5/7/92	8/20/92	12/22/92	5/14/93	10/18/93
Benzene	5	0.5										
Bromodichloromethane	179	36										
Bromoform	4.4	0.44										
Bromomethane	NL	NL										
Chloroform	6	0.6						0.6				
Chloroethane	400	80										
1,4-Dichlorobenzene	75	15										
Dichlorodifluoromethane	1000	200										
1,1-Dichloroethane	850	85										
1,2-Dichloroethane	5	0.5										
cis-1,2-Dichloroethene	70	7	NA	NA	NA	NA	NA	NA				
trans-1,2-Dichloroethene	100	20										
1,1-Dichloroethylene	7	0.7										
1,2-Dichloropropane	5	0.5										
Ethylbenzene	700	140										
Methylene chloride	150	15										
Tetrachloroethene	5	0.5										
Toluene	343	68.6										
1,1,1-Trichloroethane	200	40										
Trichloroethene	5	0.5						1.1				
Trichlorofluoromethane	3490	698										
Vinyl chloride	0.2	0.02										
Xylenes	620	124										
Total VOCs			0	0	0	0	0	1.7	0	0	0	0

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

Constituents	ES	PAL	11/16/90	12/12/90	1/7/91	6/28/91	12/23/91	5/7/92	1/11/93	5/13/93	10/21/93
Benzene	5	0.5									
Bromodichloromethane	179	36									
Bromoform	4.4	0.44									
Bromomethane	NL	NL									
Chloroform	6	0.6									
Chloroethane	400	80									
1,4-Dichlorobenzene	75	15									
Dichlorodifluoromethane	1000	200									
1,1-Dichloroethane	850	85									
1,2-Dichloroethane	5	0.5									
cis-1,2-Dichloroethene	70	7	NA	NA	NA	NA	NA	NA			
trans-1,2-Dichloroethene	100	20									
1,1-Dichloroethylene	7	0.7									
1,2-Dichloropropane	5	0.5									
Ethylbenzene	700	140									
Methylene chloride	150	15							2		
Tetrachloroethene	5	0.5									
Toluene	343	68.6									
1,1,1-Trichloroethane	200	40									
Trichloroethene	5	0.5									
Trichlorofluoromethane	3490	698									
Vinyl chloride	0.2	0.02									
Xylenes	620	124									
Total VOCs			0	0	0	0	0	0	2	0	0

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

HYDRO-SEARCH, INC.

Table AAD 3-2 Summary of Analytical Results for P31S, Refuse Hideaway Landfill (in Parts Per Billion)

Constituents	ES	PAL	11/16/90	12/14/90	1/10/91	6/26/91	11/14/91	5/11/92	10/5/92	10/22/93
Benzene	5	0.5								
Bromodichloromethane	179	36								
Bromoform	4.4	0.44								
Bromomethane	NL	NL								
Chloroform	6	0.6								
Chloroethane	400	80								
1,4-Dichlorobenzene	75	15								
Dichlorodifluoromethane	1000	200								
1,1-Dichloroethane	850	85								
1,2-Dichloroethane	5	0.5								
cis-1,2-Dichloroethene	70	7	NA	NA	NA	NA	NA	NA		
trans-1,2-Dichloroethene	100	20								
1,1-Dichloroethylene	7	0.7								
1,2-Dichloropropane	5	0.5								
Ethylbenzene	700/	140								
Methylene chloride	150	15						1		
Tetrachloroethene	5	0.5								
Toluene	343	68.6							0.7	
1,1,1-Trichloroethane	200	40								
Trichloroethene	5	0.5								
Trichlorofluoromethane	3490	698								
Vinyl chloride	0.2	0.02								
Xylenes	620	124								
Total VOCs			0	0	0	0	0	1	0.7	0

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

HYDRO-SEARCH, INC.

Table AAD 3-2 Summary of Analytical Results for P31IA, Refuse Hideaway Landfill (in Parts Per Billion)

Constituents	ES	PAL	11/16/90	12/14/90	1/10/91	6/26/91	11/14/91	5/11/92	10/5/92	5/14/93	10/22/93
Benzene	5	0.5									
Bromodichloromethane	179	36									
Bromoform	4.4	0.44									
Bromomethane	NL	NL									
Chloroform	6	0.6									
Chloroethane	400	80									
1,4-Dichlorobenzene	75	15									
Dichlorodifluoromethane	1000	200		8	8*	28		3	4.9	3	3
1,1-Dichloroethane	850	85		1		1	1	1		1	1
1,2-Dichloroethane	5	0.5									
cis-1,2-Dichloroethene	70	7	NA	NA	NA	NA	NA	NA	10	10	
trans-1,2-Dichloroethene	100	20									
1,1-Dichloroethylene	7	0.7									
1,2-Dichloropropane	5	0.5									
Ethylbenzene	700	140									
Methylene chloride	150	15				1					
Tetrachloroethene	5	0.5	9	12	11	13		13	15	15	13
Toluene	343	68.6						2			
1,1,1-Trichloroethane	200	40									
Trichloroethene	5	0.5	2		2	2	2	3	3.6	3	4
Trichlorofluoromethane	3490	698				6	1	4		3	
Vinyl chloride	0.2	0.02									
Xylenes	620	124									
Total VOCs			11	21	21	51	4	26	33.5	35	21

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES
* = Revised from ND following validation

HYDRO-SEARCH, INC.

Table AAD 3-2 Summary of Analytical Results for P311B, Refuse Hideaway Landfill (in Parts Per Billion)

Constituents	ES	PAL	11/16/90	12/14/90	1/10/91	6/26/91	11/14/91	5/11/92	10/5/92	5/14/93	10/22/93
Benzene	5	0.5									
Bromodichloromethane	179	36									
Bromoform	4.4	0.44									
Bromomethane	NL	NL									
Chloroform	6	0.6									
Chloroethane	400	80									
1,4-Dichlorobenzene	75	15									
Dichlorodifluoromethane	1000	200		11		32		4	5.3	2	3
1,1-Dichloroethane	850	85	1			1	1	1		1	2
1,2-Dichloroethane	5	0.5									
cis-1,2-Dichloroethene	70	7	NA	NA	NA	NA	NA	NA	10	14	
trans-1,2-Dichloroethene	100	20									
1,1-Dichloroethylene	7	0.7									
1,2-Dichloropropane	5	0.5									
Ethylbenzene	700	140									
Methylene chloride	150	15				2					
Tetrachloroethene	5	0.5	17	14	11	13	12	10	16	14	14
Toluene	343	68.6						2	0.8		
1,1,1-Trichloroethane	200	40									
Trichloroethene	5	0.5	3		2	2	3	4	3.1	4	4
Trichlorofluoromethane	3490	698	4			7		5		3	
Vinyl chloride	0.2	0.02									
Xylenes	620	124									
Total VOCs			25	25	13	57	16	26	35.2	38	23

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

HYDRO-SEARCH, INC.

Table AAD 3-2 Summary of Analytical Results for P31D, Refuse Hideaway Landfill (in Parts Per Billion)

Constituents	ES	PAL	11/16/90	12/12/90	1/10/91	6/26/91	11/14/91	5/11/92	10/5/92	5/14/93	10/22/93
Benzene	5	0.5									
Bromodichloromethane	179	36									
Bromoform	4.4	0.44									
Bromomethane	NL	NL									
Chloroform	6	0.6									
Chloroethane	400	80									
1,4-Dichlorobenzene	75	15									
Dichlorodifluoromethane	1000	200									
1,1-Dichloroethane	850	85									
1,2-Dichloroethane	5	0.5									
cis-1,2-Dichloroethene	70	7	NA	NA	NA	NA	NA	NA			
trans-1,2-Dichloroethene	100	20									
1,1-Dichloroethylene	7	0.7									
1,2-Dichloropropane	5	0.5									
Ethylbenzene	700	140									
Methylene chloride	150	15				2					
Tetrachloroethene	5	0.5									
Toluene	343	68.6						2	0.7		
1,1,1-Trichloroethane	200	40									
Trichloroethene	5	0.5									
Trichlorofluoromethane	3490	698									
Vinyl chloride	0.2	0.02									
Xylenes	620	124									
Total VOCs			0	0	0	2	0	2	0.7	0	0

ES = Enforcement Standard NA = Not Analyzed Blank = Not Detected
PAL = Preventive Action Limit NL = Not Listed Shade = Detected compound exceeds ES

HYDRO-SEARCH, INC.

Table AAD 3-2 Summary of Analytical Results for P32S, Refuse Hideaway Landfill (in Parts Per Billion)

Constituents	ES	PAL	12/13/90	1/8/91
Benzene	5	0.5		
Bromodichloromethane	179	36		
Bromoform	4.4	0.44		
Bromomethane	NL	NL		
Chloroform	6	0.6		
Chloroethane	400	80		
1,4-Dichlorobenzene	75	15		
Dichlorodifluoromethane	1000	200		
1,1-Dichloroethane	850	85		
1,2-Dichloroethane	5	0.5		
trans-1,2-Dichloroethene	100	20		
1,1-Dichloroethylene	7	0.7		
1,2-Dichloropropane	5	0.5		
Ethylbenzene	700	140		
Methylene chloride	150	15		1
Tetrachloroethene	5	0.5		
Toluene	343	68.6		
1,1,1-Trichloroethane	200	40		
Trichloroethene	5	0.5		
Trichlorofluoromethane	3490	698		
Vinyl chloride	0.2	0.02		
Xylenes	620	124		
Total VOCs			0	1

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

Table AAD 3-2 Summary of Analytical Results for P32D, Refuse Hideaway Landfill (in Parts Per Billion)

Constituents	ES	PAL	12/13/90	1/10/91	10/21/93
Benzene	5	0.5			
Bromodichloromethane	179	36			
Bromoform	4.4	0.44			
Bromomethane	NL	NL			
Chloroform	6	0.6			
Chloroethane	400	80			
1,4-Dichlorobenzene	75	15			
Dichlorodifluoromethane	1000	200			
1,1-Dichloroethane	850	85			
1,2-Dichloroethane	5	0.5			
cis-1,2-Dichloroethene	70	7	NA	NA	R
trans-1,2-Dichloroethene	100	20			
1,1-Dichloroethylene	7	0.7			
1,2-Dichloropropane	5	0.5			
Ethylbenzene	700	140			
Methylene chloride	150	15			
Tetrachloroethene	5	0.5			
Toluene	343	68.6			
1,1,1-Trichloroethane	200	40			
Trichloroethene	5	0.5			
Trichlorofluoromethane	3490	698			
Vinyl chloride	0.2	0.02			
Xylenes	620	124			
Total VOCs			0	0	0

ES = Enforcement Standard
PAL = Preventive Action Limit
R = Unuseable
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

Table AAD 3-2 Summary of Analytical Results for P33S, Refuse Hideaway Landfill (in Parts Per Billion)

Constituents	ES	PAL	12/10/90	1/7/91	7/1/91
Benzene	5	0.5			
Bromodichloromethane	179	36			
Bromoform	4.4	0.44			
Bromomethane	NL	NL			
Chloroform	6	0.6			
Chloroethane	400	80			
1,4-Dichlorobenzene	75	15			
Dichlorodifluoromethane	1000	200			
1,1-Dichloroethane	850	85			
1,2-Dichloroethane	5	0.5			
trans-1,2-Dichloroethene	100	20			
1,1-Dichloroethylene	7	0.7			
1,2-Dichloropropane	5	0.5			
Ethylbenzene	700	140			
Methylene chloride	150	15		1	
Tetrachloroethene	5	0.5			
Toluene	343	68.6		4	
1,1,1-Trichloroethane	200	40			
Trichloroethene	5	0.5			
Trichlorofluoromethane	3490	698			
Vinyl chloride	0.2	0.02			
Xylenes	620	124			
Total VOCs			0	5	0

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

Table AAD 3-2 Summary of Analytical Results for P33D, Refuse Hideaway Landfill (in Parts Per Billion)

Constituents	ES	PAL	12/12/90	1/7/91
Benzene	5	0.5		
Bromodichloromethane	179	36		
4.4moform	4.4	0.44		
Bromomethane	NL	NL		
Chloroform	6	0.6		
Chloroethane	400	80		
1,4-Dichlorobenzene	75	15		
Dichlorodifluoromethane	1000	200		
1,1-Dichloroethane	850	85		
1,2-Dichloroethane	5	0.5		
trans-1,2-Dichloroethene	100	20		
1,1-Dichloroethylene	7	0.7		
1,2-Dichloropropane	5	0.5		
Ethylbenzene	700	140		
Methylene chloride	150	15		
Tetrachloroethene	5	0.5		
Toluene	343	68.6		
1,1,1-Trichloroethane	200	40		
Trichloroethene	5	0.5		
Trichlorofluoromethane	3490	698		
Vinyl chloride	0.2	0.02		
Xylenes	620	124		
Total VOCs			0	0

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

Constituents	ES	PAL	1/15/91	6/24/91	10/24/91	5/14/92	10/6/92	5/13/93	10/21/93
Benzene	5	0.5							
Bromodichloromethane	179	36							
Bromoform	4.4	0.44							
Bromomethane	NL	NL							
Chloroform	6	0.6							
Chloroethane	400	80							
1,4-Dichlorobenzene	75	15							
Dichlorodifluoromethane	1000	200							
1,1-Dichloroethane	850	85							
1,2-Dichloroethane	5	0.5							
cis-1,2-Dichloroethene	70	7	NA	NA	NA	NA			
trans-1,2-Dichloroethene	100	20							
1,1-Dichloroethylene	7	0.7							
1,2-Dichloropropane	5	0.5							
Ethylbenzene	700	140							
Methylene chloride	150	15							
Tetrachloroethene	5	0.5							
Toluene	343	68.6							
1,1,1-Trichloroethane	200	40							
Trichloroethene	5	0.5							
Trichlorofluoromethane	3490	698							
Vinyl chloride	0.2	0.02							
Xylenes	620	124							
Total VOCs			0	0	0	0	0	0	0

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

HYDRO-SEARCH, INC.

Table AAD 3-2 Summary of Analytical Results for P34D, Refuse Hideaway Landfill (in Parts Per Billion)

Constituents	ES	PAL	1/10/91	6/24/91	10/24/91	5/15/92	10/6/92	5/18/93	10/21/93
Benzene	5	0.5							
Bromodichloromethane	179	36							
Bromoform	4.4	0.44							
Bromomethane	NL	NL							
Chloroform	6	0.6							
Chloroethane	400	80							
1,4-Dichlorobenzene	75	15							
Dichlorodifluoromethane	1000	200					4.4		
1,1-Dichloroethane	850	85					1.9		
1,2-Dichloroethane	5	0.5							
cis-1,2-Dichloroethene	70	7	NA	NA	NA	NA	12		
trans-1,2-Dichloroethene	100	20							
1,1-Dichloroethylene	7	0.7							
1,2-Dichloropropane	5	0.5							
Ethylbenzene	700	140							
Methylene chloride	150	15							
Tetrachloroethene	5	0.5					18		
Toluene	343	68.6	2						
1,1,1-Trichloroethane	200	40							
Trichloroethene	5	0.5					4.3		
Trichlorofluoromethane	3490	698							
Vinyl chloride	0.2	0.02							
Xylenes	620	124	2						
Total VOCs			4	0	0	0	40.6	0	0

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

Constituents	ES	PAL	1/17/91	6/25/91	10/24/91	5/15/92	10/6/92	5/13/93	10/21/93
Benzene	5	0.5							
Bromodichloromethane	179	36							
Bromoform	4.4	0.44							
Bromomethane	NL	NL							
Chloroform	6	0.6							
Chloroethane	400	80							
1,4-Dichlorobenzene	75	15							
Dichlorodifluoromethane	1000	200							
1,1-Dichloroethane	850	85							
1,2-Dichloroethane	5	0.5							
cis-1,2-Dichloroethene	70	7	NA	NA	NA	NA			
trans-1,2-Dichloroethene	100	20							
1,1-Dichloroethylene	7	0.7							
1,2-Dichloropropane	5	0.5							
Ethylbenzene	700	140							
Methylene chloride	150	15							
Tetrachloroethene	5	0.5							
Toluene	343	68.6							
1,1,1-Trichloroethane	200	40							
Trichloroethene	5	0.5							
Trichlorofluoromethane	3490	698							
Vinyl chloride	0.2	0.02							
Xylenes	620	124							
Total VOCs			0	0	0	0	0	0	0

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

Table AAD 3-2 Summary of Analytical Results for P35D, Refuse Hideaway Landfill (in Parts Per Billion)

Constituents	ES	PAL	1/17/91	6/25/91	10/24/91	5/15/92	10/6/92	5/13/93	10/21/93
Benzene	5	0.5							
Bromodichloromethane	179	36							
Bromoform	4.4	0.44							
Bromomethane	NL	NL							
Chloroform	6	0.6							
Chloroethane	400	80							
1,4-Dichlorobenzene	75	15							
Dichlorodifluoromethane	1000	200							
1,1-Dichloroethane	850	85							
1,2-Dichloroethane	5	0.5							
cis-1,2-Dichloroethene	70	7	NA	NA	NA	NA			
trans-1,2-Dichloroethene	100	20							
1,1-Dichloroethylene	7	0.7							
1,2-Dichloropropane	5	0.5							
Ethylbenzene	700	140							
Methylene chloride	150	15							
Tetrachloroethene	5	0.5							
Toluene	343	68.6							
1,1,1-Trichloroethane	200	40							
Trichloroethene	5	0.5							
Trichlorofluoromethane	3490	698							
Vinyl chloride	0.2	0.02							
Xylenes	620	124							
Total VOCs			0	0	0	0	0	0	0

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

HYDRO-SEARCH, INC.

Table AAD 3-2 Summary of Analytical Results for P36S, Refuse Hideaway Landfill (in Parts Per Billion)

Constituents	ES	PAL	12/11/90	1/8/91
Benzene	5	0.5		
Bromodichloromethane	179	36		
Bromoform	4.4	0.44		
Bromomethane	NL	NL		
Chloroform	6	0.6		
Chloroethane	400	80		
1,4-Dichlorobenzene	75	15		
Dichlorodifluoromethane	1000	200		
1,1-Dichloroethane	850	85		
1,2-Dichloroethane	5	0.5		
trans-1,2-Dichloroethene	100	20		
1,1-Dichloroethylene	7	0.7		
1,2-Dichloropropane	5	0.5		
Ethylbenzene	700	140		
Methylene chloride	150	15		
Tetrachloroethene	5	0.5		
Toluene	343	68.6		
1,1,1-Trichloroethane	200	40		
Trichloroethene	5	0.5		
Trichlorofluoromethane	3490	698		
Vinyl chloride	0.2	0.02		
Xylenes	620	124		
Total VOCs			0	0

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

Constituents	ES	PAL	12/11/90	1/8/91
Benzene	5	0.5		
Bromodichloromethane	179	36		
Bromoform	4.4	0.44		
Bromomethane	NL	NL		
Chloroform	6	0.6		
Chloroethane	400	80		
1,4-Dichlorobenzene	75	15		
Dichlorodifluoromethane	1000	200		
1,1-Dichloroethane	850	85		
1,2-Dichloroethane	5	0.5		
trans-1,2-Dichloroethene	100	20		
1,1-Dichloroethylene	7	0.7		
1,2-Dichloropropane	5	0.5		
Ethylbenzene	700	140		
Methylene chloride	150	15		
Tetrachloroethene	5	0.5		
Toluene	343	68.6		1
1,1,1-Trichloroethane	200	40		
Trichloroethene	5	0.5		
Trichlorofluoromethane	3490	698		
Vinyl chloride	0.2	0.02		
Xylenes	620	124		
Total VOCs			0	1

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

HYDRO-SEARCH, INC.

Table AAD 3-2 Summary of Analytical Results for P38S, Refuse Hideaway Landfill (in Parts Per Billion)

Constituents	ES	PAL	12/13/90	1/10/91
Benzene	5	0.5		
Bromodichloromethane	179	36		
Bromoform	4.4	0.44		
Bromomethane	NL	NL		
Chloroform	6	0.6		
Chloroethane	400	80		
1,4-Dichlorobenzene	75	15		
Dichlorodifluoromethane	1000	200		
1,1-Dichloroethane	850	85		
1,2-Dichloroethane	5	0.5		
trans-1,2-Dichloroethene	100	20		
1,1-Dichloroethylene	7	0.7		
1,2-Dichloropropane	5	0.5		
Ethylbenzene	700	140		
Methylene chloride	150	15		
Tetrachloroethene	5	0.5		
Toluene	343	68.6		
1,1,1-Trichloroethane	200	40		
Trichloroethene	5	0.5		
Trichlorofluoromethane	3490	698		
Vinyl chloride	0.2	0.02		
Xylenes	620	124		
Total VOCs			0	0

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

Constituents	ES	PAL	12/11/90	1/7/91
Benzene	5	0.5		
Bromodichloromethane	179	36		
Bromoform	4.4	0.44		
Bromomethane	NL	NL		
Chloroform	6	0.6		
Chloroethane	400	80		
1,4-Dichlorobenzene	75	15		
Dichlorodifluoromethane	1000	200		
1,1-Dichloroethane	850	85		
1,2-Dichloroethane	5	0.5		
trans-1,2-Dichloroethene	100	20		
1,1-Dichloroethylene	7	0.7		
1,2-Dichloropropane	5	0.5		
Ethylbenzene	700	140		
Methylene chloride	150	15		
Tetrachloroethene	5	0.5		
Toluene	343	68.6		
1,1,1-Trichloroethane	200	40		
Trichloroethene	5	0.5		
Trichlorofluoromethane	3490	698		
Vinyl chloride	0.2	0.02		
Xylenes	620	124		
Total VOCs			0	0

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

Constituents	ES	PAL	12/17/90	1/9/91
Benzene	5	0.5		
Bromodichloromethane	179	36		
Bromoform	4.4	0.44		
Bromomethane	NL	NL		
Chloroform	6	0.6		
Chloroethane	400	80		
1,4-Dichlorobenzene	75	15		
Dichlorodifluoromethane	1000	200		
1,1-Dichloroethane	850	85		
1,2-Dichloroethane	5	0.5		
trans-1,2-Dichloroethene	100	20		
1,1-Dichloroethylene	7	0.7		
1,2-Dichloropropane	5	0.5		
Ethylbenzene	700	140		
Methylene chloride	150	15		
Tetrachloroethene	5	0.5		
Toluene	343	68.6		
1,1,1-Trichloroethane	200	40		
Trichloroethene	5	0.5		
Trichlorofluoromethane	3490	698		
Vinyl chloride	0.2	0.02		
Xylenes	620	124		
Total VOCs			0	0

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

Constituents	ES	PAL	12/17/90	1/10/91	6/26/91	12/23/91	5/7/92	10/7/92	5/14/93	10/21/93
Benzene	5	0.5								
Bromodichloromethane	179	36								
Bromoform	4.4	0.44								
Bromomethane	NL	NL		7						
Chloroform	6	0.6				1				
Chloroethane	400	80								
1,4-Dichlorobenzene	75	15								
Dichlorodifluoromethane	1000	200		5	35		3	4.3	2	
1,1-Dichloroethane	850	85	1	1	1	1	2			
1,2-Dichloroethane	5	0.5								
cis-1,2-Dichloroethene	70	7	NA	NA	NA	NA	12	11	11	4.9
trans-1,2-Dichloroethene	100	20								
1,1-Dichloroethylene	7	0.7								
1,2-Dichloropropane	5	0.5								
Ethylbenzene	700	140								
Methylene chloride	150	15			6	3				
Tetrachloroethene	5	0.5	10	12	13	4	14	15	16	10
Toluene	343	68.6				5				
1,1,1-Trichloroethane	200	40			1	1				
Trichloroethene	5	0.5	2	2	2	2	4	3.1	3	2
Trichlorofluoromethane	3490	698			8	4	4		3	2
Vinyl chloride	0.2	0.02								
Xylenes	620	124				2				
Total VOCs			13	27	66	23	39	33.4	35	18.9

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

Constituents	ES	PAL	12/17/90	1/9/91	6/26/91	12/23/91	5/7/92	10/6/92	5/14/93	10/21/93
Benzene	5	0.5								
Bromodichloromethane	179	36								
Bromoform	4.4	0.44								
Bromomethane	NL	NL								
Chloroform	6	0.6								
Chloroethane	400	80								
1,4-Dichlorobenzene	75	15								
Dichlorodifluoromethane	1000	200								
1,1-Dichloroethane	850	85								
1,2-Dichloroethane	5	0.5								
cis-1,2-Dichloroethene	70	7	NA	NA	NA	NA	NA			
trans-1,2-Dichloroethene	100	20								
1,1-Dichloroethylene	7	0.7								
1,2-Dichloropropane	5	0.5								
Ethylbenzene	700	140								
Methylene chloride	150	15				3				
Tetrachloroethene	5	0.5								
Toluene	343	68.6				3				
1,1,1-Trichloroethane	200	40								
Trichloroethene	5	0.5								
Trichlorofluoromethane	3490	698				3				
Vinyl chloride	0.2	0.02								
Xylenes	620	124								
Total VOCs			0	0	0	9	0	0	0	0

ES = Enforcement Standard NA = Not Analyzed Blank = Not Detected
PAL = Preventive Action Limit NL = Not Listed Shade = Detected compound exceeds ES

HYDRO-SEARCH, INC.

Table AAD 3-2 Summary of Analytical Results for P41S, Refuse Hideaway Landfill (in Parts Per Billion)

Constituents	ES	PAL	12/14/90	1/7/91
Benzene	5	0.5		
Bromodichloromethane	179	36		
Bromoform	4.4	0.44		
Bromomethane	NL	NL		
Chloroform	6	0.6		
Chloroethane	400	80		
1,4-Dichlorobenzene	75	15		
Dichlorodifluoromethane	1000	200		
1,1-Dichloroethane	850	85		
1,2-Dichloroethane	5	0.5		
trans-1,2-Dichloroethene	100	20		
1,1-Dichloroethylene	7	0.7		
1,2-Dichloropropane	5	0.5		
Ethylbenzene	700	140		
Methylene chloride	150	15		
Tetrachloroethene	5	0.5		
Toluene	343	68.6		
1,1,1-Trichloroethane	200	40		
Trichloroethene	5	0.5		
Trichlorofluoromethane	3490	698		
Vinyl chloride	0.2	0.02		
Xylenes	620	124		
Total VOCs			0	0

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

HYDRO-SEARCH, INC.

Constituents	ES	PAL	11/30/90	12/17/90	1/9/91	7/1/91	11/13/91	5/11/92	10/7/92	5/21/93	10/22/93
Benzene	5	0.5									
Bromodichloromethane	179	36									
Bromoform	4.4	0.44									
Bromomethane	NL	NL									
Chloroform	6	0.6									
Chloroethane	400	80									
1,4-Dichlorobenzene	75	15									
Dichlorodifluoromethane	1000	200									
1,1-Dichloroethane	850	85									
1,2-Dichloroethane	5	0.5									
cis-1,2-Dichloroethene	70	7	NA	NA	NA	NA	NA	NA			
trans-1,2-Dichloroethene	100	20									
1,1-Dichloroethylene	7	0.7									
1,2-Dichloropropane	5	0.5									
Ethylbenzene	700	140									
Methylene chloride	150	15									
Tetrachloroethene	5	0.5									
Toluene	343	68.6						0.8			
1,1,1-Trichloroethane	200	40									
Trichloroethene	5	0.5									
Trichlorofluoromethane	3490	698									
Vinyl chloride	0.2	0.02									
Xylenes	620	124			2						
Total VOCs			0	0	2	0	0	0.8	0	0	0

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

HYDRO-SEARCH, INC.

Constituents	ES	PAL	12/17/90	1/9/91
Benzene	5	0.5		
Bromodichloromethane	179	36		
Bromoform	4.4	0.44		
Bromomethane	NL	NL		
Chloroform	6	0.6		
Chloroethane	400	80		
1,4-Dichlorobenzene	75	15		
Dichlorodifluoromethane	1000	200		
1,1-Dichloroethane	850	85		
1,2-Dichloroethane	5	0.5		
trans-1,2-Dichloroethene	100	20		
1,1-Dichloroethylene	7	0.7		
1,2-Dichloropropane	5	0.5		
Ethylbenzene	700	140		
Methylene chloride	150	15		
Tetrachloroethene	5	0.5		
Toluene	343	68.6		
1,1,1-Trichloroethane	200	40		
Trichloroethene	5	0.5		
Trichlorofluoromethane	3490	698		
Vinyl chloride	0.2	0.02		
Xylenes	620	124		
Total VOCs			0	0

ES = Enforcement Standard
PAL = Preventive Action Limit
NA = Not Analyzed
NL = Not Listed
Blank = Not Detected
Shade = Detected compound exceeds ES

Table AAD 3-3. 1993 Inorganic Sampling Results (Page 1 of 7)

Parameter	WDNR NR140		P-17S		P-20SR		P-21S	
	ES	PAL	5/93	10/93	5/93	10/93	5/93	10/93
Aluminum	NL	NL			0.0345B		0.0416B	
Antimony	NL	NL		0.0032BU	0.0031BU	0.0118U	0.0048BU	0.0126U
Arsenic	0.05	0.005						0.0046
Barium	2.0	0.4	0.121	0.125	0.0212	0.0214	0.18	0.187
Beryllium	NL	NL						
Cadmium	0.005	0.0005						
Calcium	NL	*	186	182	66.4	67.6	154	148
Chromium	0.1	0.01						
Cobalt	NL	NL						
Copper	1.3	0.13				0.0021B		
Iron	0.3	0.15	1.21	1.45	0.0132B	0.0287BU	0.666	3.53J
Lead	0.015	0.0015		0.0037				
Magnesium	NL	*	114	112	43.2	43.8	82.6	76
Manganese	0.05	0.025	0.549	0.623	0.004B	0.0042BU	1.52	2.28
Mercury	0.002	0.0002						
Nickel	NL	NL						
Potassium	NL	*	0.964	0.686B	0.679B	0.832		
Selenium	0.05	0.01						
Silver	0.05	0.01					0.002B	
Sodium	NL	*	3.32	3.49J	2.49	2.23JU	6.19	6.23
Thallium	NL	NL						
Vanadium	NL	NL	0.005B					0.0052B
Zinc	5.0	2.5	0.0022B		0.0026B		0.0041B	J
Cyanide	0.2	0.04	J	J	J	J	J	J

Notes: B = Analyte detected below the contract required detection limit (CRDL) but above the instrument detection limit (IDL)
U = Analyte not detected
ES = Enforcement Standard
PAL = Preventative Action Limit
NL = Not Listed
* = Can be calculated with adequate data
Blank = Not detected
Bold = Denotes validation review results
All units in parts per million (ppm)

Table AAD 3-3. 1993 Inorganic Sampling Results (Page 2 of 7)

Parameter	WDNR NR140		P-21D		P-22S		P-22D	
	ES	PAL	5/93	10/93	5/93	10/93	5/93	10/93
Aluminum	NL	NL			0.0419B		0.0374B	
Antimony	NL	NL	0.0038BU	0.0111U	0.0035BU	0.004BU	0.0033BU	0.0071U
Arsenic	0.05	0.005						
Barium	2.0	0.4	0.0917	0.085	0.0333	0.0287	0.0269	0.0285
Beryllium	NL	NL						
Cadmium	0.005	0.0005			J			
Calcium	NL	*	154	151	75.5	74.8	73.1	81.1
Chromium	0.1	0.01	0.003B					
Cobalt	NL	NL						
Copper	1.3	0.13		0.0029B				0.0024B
Iron	0.5	0.15	0.0549B	0.0997BJU	0.0193B	0.0254BJU	0.0165B	0.0293BJ
Lead	0.015	0.0015	0.0014B					
Magnesium	NL	*	70.4	66	42.1	41.7	39.8	43.5
Manganese	0.05	0.025	0.448	0.498	0.0041B	0.0058BU	0.0107	0.013
Mercury	0.002	0.0002						
Nickel	NL	NL	0.0186B	0.0152B				
Potassium	NL	*	1.45	0.969	0.952	0.431B	0.806	0.907
Selenium	0.05	0.01						
Silver	0.05	0.01						
Sodium	NL	*	7.38	6.73	4.24	4.34	3.53	5.03
Thallium	NL	NL						
Vanadium	NL	NL	0.0046B	0.0045B		0.003B		0.0031B
Zinc	5.0	2.5	0.0074B	J	0.0049B	J	0.0025B	0.0053BJ
Cyanide	0.2	0.04	J	J	J	J	J	J

Notes:
- B = Analyte detected below the contract required detection limit (CRDL) but above the instrument detection limit (IDL)
- U = Analyte not detected
- ES = Enforcement Standard
- PAL = Preventative Action Limit
- NL = Not Listed
- * = Can be calculated with adequate data
- Blank = Not detected
- Bold = Denotes validation review results

All units in parts per million (ppm)

Table AAD 3-3. 1993 Inorganic Sampling Results (Page 3 of 7)

Parameter	WDNR NR140		P-26S		P-26D		P-27S	
	ES	PAL	5/93	10/93	5/93	10/93	5/93	10/93
Aluminum	NL	NL	0.0348B		0.0412B		0.0863B	
Antimony	NL	NL	0.0052U	0.0124U	0.0049BU	0.0161U	0.0027BU	0.0045BU
Arsenic	0.05	0.005						
Barium	2.0	0.4	0.0441	0.0436		0.0287	0.041	0.0399
Beryllium	NL	NL						
Cadmium	0.005	0.0005			0.00065B			
Calcium	NL	*	121	120	93.3	87	156	147
Chromium	0.1	0.01						
Cobalt	NL	NL						
Copper	1.3	0.13				0.0031B		
Iron	0.3	0.15	0.0296B	0.0313B	0.0206B	0.0293BJ	0.0356B	0.0376B
Lead	0.015	0.0015				0.0042		0.0028
Magnesium	NL	*	64.8	64	52.6	47.6	79.2	73.7
Manganese	0.05	0.025	0.009B	0.0135	0.0199	0.0165	0.007B	0.0074B
Mercury	0.002	0.0002						
Nickel	NL	NL		0.0154B	0.0315	0.0175B		
Potassium	NL	*	0.901	0.772	1.12	0.437B	1.04	0.691B
Selenium	0.05	0.01						
Silver	0.05	0.01						
Sodium	NL	*	3.86	3.6J	3.33	2.82	3.23	2.93J
Thallium	NL	NL						
Vanadium	NL	NL					0.0044B	
Zinc	5.0	2.5	0.0859	0.0579	0.14	0.0648J	0.0103B	0.0129B
Cyanide	0.2	0.04	J	J	J	J	J	J

Notes:
B = Analyte detected below the contract required detection limit (CRDL) but above the instrument detection limit (IDL)
U = Analyte not detected
ES = Enforcement Standard
PAL = Preventative Action Limit
NL = Not Listed
* = Can be calculated with adequate data
Blank = Not detected
Bold = Denotes validation review results
All units in parts per million (ppm)

Table AAD 3-3. 1993 Inorganic Sampling Results (Page 4 of 7)

Parameter	WDNR NR140		P-27D		P-29S		P-30I	
	ES	PAL	5/93	10/93	5/93	10/93	5/93	10/93
Aluminum	NL	NL	0.144			0.042B	0.0791B	
Antimony	NL	NL	0.0053U	0.0027BU	0.0022BU	0.0053U	0.0083	0.0036BU
Arsenic	0.05	0.005						
Barium	2.0	0.4	0.0388	0.0338	0.0407	0.0379	0.0288	0.0306
Beryllium	NL	NL						
Cadmium	0.005	0.0005						
Calcium	NL	*	152	131	73.6	75	69.8	68.5
Chromium	0.1	0.01						0.0033B
Cobalt	NL	NL						
Copper	1.3	0.13						
Iron	0.3	0.15	0.0368B	0.0346B	0.015B	0.0261BJU	0.0348B	0.0195BU
Lead	0.015	0.0015		0.0026				
Magnesium	NL	*	82.2	70.8	40.8	40.4	37.3	36.7
Manganese	0.05	0.02	0.0256	0.0148	0.0044B	0.0058B	0.0045B	0.0032BU
Mercury	0.002	0.0002						
Nickel	NL	NL						
Potassium	NL	*	1.0	0.807	0.514B	0.538B	1.41	0.898
Selenium	0.05	0.01						
Silver	0.05	0.01						
Sodium	NL	*	3.34	4.38J	5.59	5.68	4.31	3.67J
Thallium	NL	NL						
Vanadium	NL	NL		0.0032B		0.0039B		
Zinc	5.0	2.5	0.0127B	0.0331	0.0069B	**J**		
Cyanide	0.2	0.04	**J**	**J**	**J**	**J**		**J**

Notes: B = Analyte detected below the contract required detection limit (CRDL) but above the instrument detection limit (IDL)
U = Analyte not detected
ES = Enforcement Standard
PAL = Preventative Action Limit
NL = Not Listed
* = Can be calculated with adequate data
Blank = Not detected
Bold = Denotes validation review results
All units in parts per million (ppm)

Table AAD 3-3. 1993 Inorganic Sampling Results (Page 5 of 7)

Parameter	WDNR NR140		P-31IA		P-31IB		P-31D	
	ES	PAL	5/93	10/93	5/93	10/93	5/93	10/93
Aluminum	NL	NL	0.0947B	0.0695BU	0.107	0.0857BU	0.080B	0.0743BU
Antimony	NL	NL	0.004B	0.0028BU		0.0037BU	0.0059	
Arsenic	0.05	0.005						
Barium	2.0	0.4	0.0413	0.0429	0.0444	0.0449	0.0288	0.0318
Beryllium	NL	NL						
Cadmium	0.005	0.0005						
Calcium	NL	*	81.6	81.8	86.1	84.8	62.6	63.5
Chromium	0.1	0.01						
Cobalt	NL	NL						
Copper	1.3	0.13		0.0021B		0.0024B		0.0031B
Iron	0.3	0.15	0.0379B	0.0303B	0.0355B	0.0336B	0.0298B	0.0301B
Lead	0.015	0.0015						
Magnesium	NL	*	45.9	43.8	47.6	45.2	33.9	32.4
Manganese	0.05	0.025	0.0044B	0.005BU	0.0057B	0.0058BU	0.0042B	0.0049B[illegible]
Mercury	0.002	0.0002						
Nickel	NL	NL						
Potassium	NL	*	0.978	1.22	1.03	1.15	0.541B	0.733B
Selenium	0.05	0.01						
Silver	0.05	0.01						
Sodium	NL	*	10.3	11.7J	15.5	11.9J	3.59	4.0J
Thallium	NL	NL						
Vanadium	NL	NL						
Zinc	5.0	2.5						
Cyanide	0.2	0.04		J		J		J

Notes:
B = Analyte detected below the contract required detection limit (CRDL) but above the instrument detection limit (IDL)
U = Analyte not detected
ES = Enforcement Standard
PAL = Preventative Action Limit
NL = Not Listed
* = Can be calculated with adequate data
Blank = Not detected
Bold = Denotes validation review results
All units in parts per million (ppm)

Table AAD 3-3. 1993 Inorganic Sampling Results (Page 6 of 7)

Parameter	WDNR NR140		P-34D		P-40I		P-41D	
	ES	PAL	5/93	10/93	5/93	10/93	5/93	10/93
Aluminum	NL	NL	0.0536B	0.467BU	0.0704B		0.086B	0.062BU
Antimony	NL	NL	0.0029BU	0.0048BU	0.0094	0.0037BU	0.0152	0.0052U
Arsenic	0.05	0.005	0.0022					
Barium	2.0	0.4	0.0228	0.0214	0.0327	0.0327	0.0358	0.0385
Beryllium	NL	NL						
Cadmium	0.005	0.0005						
Calcium	NL	*	68	66.8	82	78.5	72.5	77.1
Chromium	0.1	0.01	0.0071B	0.0045B				0.0048B
Cobalt	NL	NL						
Copper	1.3	0.13					0.0088B	0.0099B
Iron	0.3	0.15	0.022B	0.0198BU	0.0313B	0.0196BU	0.0325B	0.0323B
Lead	0.015	0.0015						
Magnesium	NL	*	38	37.8	47	45.3	39.3	39.6
Manganese	0.05	0.025	0.0045B	0.0032BU	0.0043B	0.0044BU	0.0075B	0.0087BU
Mercury	0.002	0.0002						
Nickel	NL	NL						
Potassium	NL	*	1.64	0.868		0.787	0.674B	1.06
Selenium	0.05	0.01						
Silver	0.05	0.01						
Sodium	NL	*	2.93	2.81J	7.7	6.05J	4.91	6.02J
Thallium	NL	NL	J					
Vanadium	NL	NL	0.0059B					
Zinc	5.0	2.5	0.0511					0.0078B
Cyanide	0.2	0.04	J	J		J		J

Notes: B = Analyte detected below the contract required detection limit (CRDL) but above the instrument detection limit (IDL)
U = Analyte not detected
ES = Enforcement Standard
PAL = Preventative Action Limit
NL = Not Listed
* = Can be calculated with adequate data
Blank = Not detected
Bold = Denotes validation review results
All units in parts per million (ppm)

Table AAD 3-3. 1993 Inorganic Sampling Results (Page 7 of 7)

Parameter	WDNR NR140		PAUZE		STOPPLEWORTH	
	ES	PAL	5/93	10/93	5/93	10/93
Aluminum	NL	NL	0.15			0.0537BU
Antimony	NL	NL	0.0043BU		0.0032BU	
Arsenic	0.05	0.005				
Barium	2.0	0.4	0.0419	0.0379	0.0475	0.0455
Beryllium	NL	NL				
Cadmium	0.005	0.0005				
Calcium	NL	*	89.5	89.2	77.4	75.9
Chromium	0.1	0.01	0.0034B			
Cobalt	NL	NL				
Copper	1.3	0.13	0.013	0.068	0.0073B	0.0212
Iron	0.3	0.15	0.0194B	0.546J	0.0693B	0.361J
Lead	0.015	0.0015		0.0078		0.0025
Magnesium	NL	*	48.2	48.0	41.2	39.7
Manganese	0.05	0.025	0.0061B	0.0122	0.031	0.0364
Mercury	0.002	0.0002				
Nickel	NL	NL				
Potassium	NL	*	1.76	0.807	1.73	0.767
Selenium	0.05	0.01				
Silver	0.05	0.01				
Sodium	NL	*	7.13	5.55	3.39	3.15
Thallium	NL	NL				
Vanadium	NL	NL	0.0054B		0.0049B	
Zinc	5.0	2.5	0.728	0.588J	0.281	0.407J
Cyanide	0.2	0.04	J	J	J	

Notes:
B = Analyte detected below the contract required detection limit (CRDL) but above the instrument detection limit (IDL)
U = Analyte not detected
ES = Enforcement Standard
PAL = Preventative Action Limit
NL = Not Listed
* = Can be calculated with adequate data
Blank = Not detected
Bold = Denotes validation review results
All units in parts per million (ppm)

Table AAD 4-1. Potential Location-Specific ARARs[1] and TBCs[2,3]

LOCATION	CITATION
Wetlands[4]	Clean Water Act Section 404; 40 CFR Part 230, 231; 40 CFR Part 6, Appendix A, Wisconsin NR504 and NR103
Area affecting stream or river	Fish and Wildlife Coordination Act (16 USC 661 et seq.); 40 CFR 6.302; Wisconsin Statutes Ch. 29 and 144.26; Wisconsin NR504, NR117, and NR115.

Notes:

1 Applicable or relevant and appropriate requirements.

2 To-be-considered criteria.

3 CERCLA compliance with Other Laws Manual, Part I (U.S. EPA, 1988).

4 40 CFR Part 6 Subpart A sets forth U.S. EPA policy for carrying out the provisions of Executive Orders 11988 (Floodplain Management) and 11990 (Protection of Wetlands). Executive orders are binding on the level (e.g., federal, state) of government for which they are issued.

Table AAD 4-2. Potential Action-Specific ARARs[1,2]

ACTION[3]	CITATION
Cap in place	40 CFR 264.310; Wisconsin NR500-520
Consolidation	40 CFR 52, 40 CFR 61, Wisconsin NR500-520
Excavation	40 CFR 52, 40 CFR 61, 40 CFR 264, 40 CFR 268; Wisconsin NR500-520
Removal	40 CFR 264; Wisconsin NR500-520
Operation and maintenance (O&M)	40 CFR 264.118 (RCRA, Subpart G); Wisconsin NR500-520
Gas Collection	40 CFR 52 and 40 CFR 61; Wisconsin NR500-520
Surface Water Control	40 CFR 264.301(c)(d); Wisconsin NR500-520

Notes:

1 Applicable or relevant and appropriate requirements.

2 Resource Conservation and Recovery Act (RCRA), Clean Water Act (CWA), and Safe Drinking Water Act (SDWA) requirements are included from CERCLA Compliance With Other Laws Manual, Part I (U.S. EPA, 1988).

3 Action alternatives from ROD keyword index, FY 1986 Record of Decision Annual Report, Hazardous Site Control Division (U.S. EPA, 1987).

AAD Table 6-1. Probable Costs Summary

	Description	Total Direct Cost ($)	Annual O&M ($)	Present Worth ($)
LANDFILL CAP ALTERNATIVES				
A.	No Further Action	0	100,000	1,376,000
B.	Limited Action	1,000	100,000	1,377,000
C.	Construct a Composite Cover on Landfill	3,207,000	100,000	4,583,000
GROUND-WATER EXTRACTION, TREATMENT, AND DISCHARGE ALTERNATIVES				
D.1	Ground-Water Extraction, Treatment, and Discharge to Location 1	217,000	52,000	933,000
D.2	Ground-Water Extraction, Treatment, and Discharge to Location 2	270,000	52,000	986,000
D.3	Ground-Water Extraction, Treatment, and Discharge to Location 3	468,000	52,000	1,184,000
D.4	Ground-Water Extraction, Treatment, and Discharge to Location 4	298,000	52,000	1,014,000
E.	Ground-Water Extraction, Treatment, and Discharge to an Infiltration Gallery	717,000	54,000	1,461,000
F.	Ground-Water Extraction, Treatment, and Discharge by Injection Wells	243,000	57,000	1,028,000
WATER SUPPLY ALTERNATIVES				
G.	Supply Individual Water Treatment Units	212,000	62,500	1,072,000
H.	Construct Community Well	731,000	38,000	1,254,000

Notes: The values shown are the present worth estimates. They were computed based on a 6% discount rate for operation and maintenance costs over the 30-year project life. Present Worth Factor = 13.765. Present Worth = Total Direct Cost + (Annual O&M x Present Worth Factor)

Costs associated with property ownership are not included in Probable Costs Summary

Proposed Ground-Water Discharge Locations are as follows:

Location 1: Black Earth Creek via Drainage Ditch at SE Corner of RHL
Location 2: Black Earth Creek at the intersection of Twin Valley Road
Location 3: Black Earth Creek at Cross Plains
Location 4: East Fork of Pheasant Branch Creek

Table AAD 5-1. Screening of Remedial Technologies (Page 1 of 2)

TECHNOLOGY	EFFECTIVENESS	IMPLEMENTABILITY	COST	APPROPRIATE FOR FURTHER CONSIDERATION
A. Access Restrictions:				
♦ Deed Restrictions	Restricts future land use of site; assists in protection of cap.	Readily implementable.	Low	Yes
♦ Fencing	Will restrict current and future access to site. Will limit occasional recreational use of site by the public.	Readily implementable.	Low	Yes
B. Containment - Surface Controls:				
♦ Grading	Effective in diverting run-on and ponding and reducing erosion.	Readily implementable with revegetation and/or composite cap construction.	Low	Yes
♦ Revegetation	Necessary to prevent erosion of capping material.	Readily implementable in conjunction with composite cap construction.	Low	Yes
Landfill Cover: ♦ Single Barrier Cap ♦ Composite	Would be effective in the following ways: 1) eliminating surface transport; 2) eliminating the potential for direct contact; and 3) minimizing introduction of precipitation	Can be accomplished using conventional equipment and techniques. A single barrier cap has been constructed at the site and need not be examined.	 Low Medium	 No Yes
C. Removal/Disposal: ♦ Waste Excavation ♦ Waste Consolidation ♦ Waste Treatment	Wastes could be transported to off-site engineered landfill. Bottom of excavated landfill would also require cap to prevent further infiltration and leaching of contaminants present in soils.	Appropriate for hot spots and low quantities of wastes only. Refuse Hideaway Landfill has large quantity of wastes, and no known hot spots. Significant health and safety issues involved in excavation of wastes. Any hazardous wastes encountered will require disposal off-site at an approved facility.	 High High High	 No No No
D. Ground-Water Containment:				
♦ Slurry Walls	Effective for containment of shallow ground-water contamination.	Due to the depth of contaminants at the site, ground-water containment will not be considered.		No
♦ Sheet Piling Cutoff Walls	Effective for containment of shallow ground-water contamination.	Due to the depth of contaminants at the site, ground-water containment will not be considered.		No
♦ Grout Curtains	Effective for containment of shallow ground-water contamination.	Due to the depth of contaminants at the site, ground-water containment will not be considered.		No
E. Ground-Water Recovery:				
♦ GW Extraction Wells	Large zone of influence is expected.	Readily implementable.	Medium	Yes
♦ Interception Trench	Large zone of influence is expected.	Ground water at depth of approximately 45 feet. Difficult to implement.	High	No

Table AAD 5-1. Screening of Remedial Technologies (Page 2 of 2)

TECHNOLOGY	EFFECTIVENESS	IMPLEMENTABILITY	COST	APPROPRIATE FOR FURTHER CONSIDERATION
F. Ex-Situ GW Treatment:				
♦ Air Stripping	Effective method of removing VOCs.	Readily implementable.	Medium	Yes
♦ Carbon Adsorption	Not effective for removal of vinyl chloride.	Readily implementable.	High	Yes
♦ Biological Treatment	Effective for removal of organic constituents	Readily implementable.	Medium	Yes
G. Discharge of Treated GW:				
♦ Discharge to Surface Waters	Effective discharge method.	WPDES permit would be required.	Low	Yes
♦ Discharge to a POTW	Effective discharge method.	Construction of a conveyance system outside of the MMSD district is not anticipated.	High	No
♦ Discharge to an Infiltration Gallery	Effective discharge method.	Readily implementable.	Medium	Yes
♦ Reinjection via Injection Wells	Effective discharge method.	Need variance from WDNR.	High	Yes
♦ Use of Treated Water for Irrigation Purposes	Effective discharge method.	Seasonable demand for irrigation water would not allow continuous discharge.	Low	No
H. In-Situ GW Treatment:				
♦ Air Sparging with Vapor Collection	Effective in VOC removal.	Ground-water depth at approximately 45 feet. Difficult to implement.	High	No
♦ Bioremediation Anaerobic/ Aerobic)	Breakdown products of bioremediation may be toxic.	Not an established technology. Difficult to implement.	Medium	No
♦ Bioremediation (Co-metabolism)	Breakdown products of bioremediation may be toxic.	Not an established technology. Difficult to implement.	Medium	No
♦ Chemical Oxidation	Breakdown products of chemical oxidation may be toxic. Incomplete remediation.	Readily implementable.	Medium	No
I. Alternative Water Supplies:				
♦ Provision of Bottled Water	Not effective in eliminating health risks associated with non-potable water uses.	Readily implementable.	High	No
♦ Deepening of Ground-Water Wells	Has not been an effective method of providing unimpacted water.	Readily implementable.	High	No
♦ Individual Point-of-Entry Treatment Units	Has been shown to effectively treat water impacted by the landfill.	Readily implementable.	Medium	Yes
♦ Installation of a Community Off-Site Well	Would be a reliable long-term solution.	Readily implementable.	High	Yes

APPENDIX A

LEGALLY APPLICABLE OR

RELEVANT AND APPROPRIATE STATE STANDARDS,

REQUIREMENTS, CRITERIA AND LIMITATIONS

FOR SUPERFUND PROJECTS IN WISCONSIN

HYDRO-SEARCH, INC.

LEGALLY APPLICABLE OR RELEVANT AND APPROPRIATE STATE STANDARDS, REQUIREMENTS, CRITERIA AND LIMITATIONS FOR SUPERFUND PROJECTS IN WISCONSIN

Introduction

Recent amendments to the Comprehensive Environmental Response and Liability Act (CERCLA, commonly known as Superfund) under the Superfund Amendments and Reauthorization Act of 1986 (SARA) included a section on clean-up standards, Section 121. This section requires that any long-term clean-up (i.e., remedial actions) under the Act attain legally applicable or relevant and appropriate standards, requirements, criteria and limitations (ARAR's) under State and Federal law. State ARAR's must be met if they are promulgated and legally applicable. If they are not legally applicable to a Superfund site, but were developed to regulate or protect an environmental media under a different program, they are still considered relevant and appropriate. State ARAR's must be formally promulgated to be required; they may be waived if they are not consistently applied by the State.

To assist persons (i.e., EPA, their contractors, responsible parties and their contractors) the Bureau of Solid and Hazardous Waste Management, Department of Natural Resources (DNR) has prepared this comprehensive listing of all promulgated State ARAR's which may apply to Superfund long-term clean-ups. By providing this listing to such persons, Wisconsin is satisfying the requirement of Section 121 to provide timely notice of the ARAR's.

The comprehensive listing can be easily matched to specific site responses considered through an alternatives array in a feasibility study. Therefore, it may be used at any Superfund site in Wisconsin by interested persons.

Rules, statutes and program requirements are subject to revisions. As the Bureau of Solid and Hazardous Waste Management becomes aware of them, this listing will be revised.

Explanation and Use of the Listings

Table 1 is a list of general options for possible remedial actions at Superfund sites. With exception of item D. in the table, it is arranged in a "ascending order" of more comprehensive response activities. For example, the options listed under category A are generally "easier" or less involved than, say, the options in category C. It is also important to note that more comprehensive options, when used at a site, will generally include less comprehensive options as part of a total site remedial action. For example, the treatment of hazardous substances in-place (B.1.) will usually include the management of extracted substances (A.4.) and monitoring (A.1.) as part of an action.

Table 2 matches all promulgated State ARAR's with the general options described in Table 1. Where no ARAR is given for an option from Table 1, there is no promulgated standard we are aware of. The Table describes the requirement in a general way, lists any important exceptions and specifies regulated activity and media regulated or protected.

Table 3 is a list of construction-related activities associated with the remedial actions listed in Table 1. These activities are not traditionally described in remedial option alternative descriptions, but are often encountered at Superfund construction projects, and are subject to State ARAR's. Often, these activities are not identified until detailed design for an action is prepared.

Table 4 matches the promulgated State ARAR's with the construction-related activities described in Table 3. The Table describes the requirements in a general way and any important exceptions.

Construction contractors who operate in Wisconsin will usually have a good knowledge of these ARAR's.

Appendices 1-10 are the specific requirements, regulations and laws promulgated by the State and administered by the DNR. The Appendices are arranged by each Department program. The names of each specific program contact is provided so interested persons may contact them for further details as a project progresses. Policies and guidelines utilized by DNR in interpreting the requirements, regulations and laws are also provided. Regulations administered by the Department of Industry, Labor and Human Relations may be obtained from the Office of Document Sales, P.O. Box 7840, Madison, Wisconsin 53707 (608-266-3358).

State Permits, Licenses, Plan Approvals and Other Approvals

In order for the listing to be comprehensive, State permit, approval, license and plan approval ARAR's are provided. In many instances, technical standards and design or construction requirements are imposed through a license, permit or plan review and approval process. Section 121 of SARA states that "on-site" actions are not subject to State "permits". Generally, the Department will require that the necessary permits, approvals, licenses and plan approvals be obtained. However, some programs can waive these requirements if the "substantive" technical standards applied through such approvals are met.

Wisconsin Environmental Policy Act

Many DNR decisions, such as permits, license and plan approvals are subject to review under the Wisconsin Environmental Policy Act (WEPA), Section 1.11, Stats. and Chapter NR 150, which is provided in Appendix 10. Department decisions involving Superfund sites could be subject to review under these provisions. For some projects, it is possible that an environmental impact statement would have to be written before the project may proceed. Although it is not entirely clear if WEPA will apply at all Superfund sites, it is necessary to mention it so interested persons have been provided with timely notice.

Table 1 - General Options for Remediation

A. Leave hazardous substances in place; and

1. Monitor

   a. Groundwater
   b. Air
   c. Surface water/sediments
   d. Soil gas/subsurface gas migration

2. Contain

   a. Cap, cut-off walls; covers

3. Extract Migrating Substances

   a. Collection trenches/drains
   b. Withdrawal wells
   c. Gas collection

4. Manage Extracted Substances (from 3.)

   a. Discharge to groundwater; with treatment; without treatment

      1) Seepage/infiltration/spray irrigation
      2) Injection wells

   b. Discharge to surface water; with treatment; without treatment

   c. Discharge to publicly owned treatment works; with treatment; without treatment

   d. Release to air; with treatment; without treatment

      1) Vents/flares/stripper tower discharges

   e. Residuals; sludges; etc., generated from above - See C.

B. Manage hazardous substances in place; and

1. Treat/stabilize

   a. Physical treatment/stabilization

      1) Vitrification/heat/electrical/microwave, etc.

   b. Chemical treatment

      1) Chemical addition/flushing, etc.

   c. Biological treatment

1) In-situ biodegradation

C. Remove hazardous substances; and

1. Manage on-site

a. Re-disposal; landfill

b. Treat/stabilize

1) Physical treatment/incineration
2) Chemical treatment
3) Biological treatment
4) Recycle
5) Land spread/land treat

c. Storage

2. Manage off-site.

a. In Wisconsin

1) Landfill
2) Treatment - all methods
3) Recycle
4) Landspread/land treat
5) Storage

b. Out-of-State

D. Water Supply (Does not "Remediate" the Facility Itself)

1. New Public Water Supply

2. New Private Water Supply Well(s)

3. Treat Public Water Supply

a. Air Stripping Tower
b. Activated Carbon
c. Other

4. Treat Private Water Supply(s)

a. In-house unit(s)

Table 2 - Promulgated Standards/Requirements
Activity and Media Regulated or Protected
General Options for Remediation
(Revised 3/91)

A. Chs. NR 600 - 685: Activity - Any disposal or management in surface impoundments or landfills of hazardous waste (generally, defined the same as RCRA) after August 1, 1981, even if the unit ceased accepting waste before being addressed by the Environmental Repair Program or Superfund, must meet the closure and long-term care requirements (see ss. NR 685.05, 685.06, 660.15, 660.16 and 660.17) as well as groundwater monitoring requirements (See s. NR 635) that are generally consistent with RCRA 40 CFR 264/265 Subpart F. Clean closure or closure as a landfill is required for surface impoundments. These requirements are applicable to units that accepted hazardous waste after August 1, 1981, and may be relevant and appropriate to units that accepted hazardous waste before that date. Also see A.2.a., below. Media - Soil and groundwater.

A. Chs. NR 500 - 520: Activity - Any solid waste landfill, regardless of when it accepted waste or when it closed, must meet the minimum closure and monitoring requirements the rule. Such landfills, should they have exceedances of Ch. NR 140 standards, must have a cover that meets the requirements of s. NR 504.07 (see A.1.e., A.2.a and A.3.c., below). Media - Soil and groundwater.

A.1.a. Ch. NR 140: Activity - Legally applicable to all Department regulated activities that may have an impact on groundwater. The rule include groundwater monitoring and sampling frequency standards and specifies the actions required should groundwater standards be exceeded at the point of standards application. Media - Groundwater.

A.1.a. Ch. NR 141: Activity - Groundwater monitoring well standards. Applies to all Department regulated activities that involve groundwater monitoring. Media - Groundwater.

A.1.a. Ch. 149: Activity - Use of laboratories for testing of samples from groundwater monitoring.

A.1.a. Chs. NR 500-520: Activity - Groundwater monitoring at solid waste landfills. See s. NR 508. This also relates to chs. NR 140 and NR 141.

A.1.a. Ch. NR 109: Drinking water standards for water supplies. The standards include federal MCLs. The standards for maximum contaminant amounts in drinking water supplies are generally considered relevant and appropriate for groundwater at facilities addressed under Superfund. Media: Groundwater.

A.1.b. Chs. NR 400-499: Media - Air pollution control standards
Chs. NR 445 governs hazardous air pollutant emissions

A.1.c. Chs. NR 500-520: Activity - Surface water monitoring at solid waste landfills. See s. NR 508.04(3).

A.1.c. Chs. NR 102, NR 104, NR 105, NR 106 and NR 219: Activity - Stream classification/standards and sampling/testing methods. Water quality criteria must be met for surface waters where contaminants from Superfund sites cause exceedances.

Discharges from in-place pollutants, such as sediments or contaminated groundwater are included. Media - Surface water and sediments.

A.1.e. Chs. NR 500-520: Activity - Solid waste disposal landfill gas monitoring standards. See ss. NR 506.07(3), NR 504.04(4)(e) and NR 508.04(2). Media - Landfill gas in soils.

A.2.a. Chs. NR 500-520: Activity - Solid waste disposal landfill cap standards. See ss. NR 506.08(3), NR 504.07, Ch. 516 and s. NR 514.07.

A.2.a. Chs. NR 600 - 685: Activity - Hazardous waste disposal landfill cap standards. See ss. NR 660.15 and 660.16.

A.3.b. Ch. NR 112: Activity - Any withdrawal well or combination of wells withdrawing 70 gpm or greater; standards and approvals. Media - Groundwater (drawdown impacts).

A.3.c. Chs. NR 500-520: Activity - Solid waste disposal landfill gas control standards. Media - Landfill gas in soils and the air. See ss. NR 506.08(6), NR 506.07(3) and NR 504.04(4)(e). This also relates to Ch. NR 445, hazardous air pollution control standards. See guidance memos relating to solid waste and air pollution control rules for further details.

A.4.a.1) Ch. NR 108: Activity - Wastewater treatment facility plan review and standards.

A.4.a.1) Chs. NR 140, NR 200, NR 214, NR 219, NR 220 and Ch. 147, Stats.: Activity - Discharge of wastewater to the land (i.e., groundwater); effluent limits; discharge permits; sampling/testing methods. Media - Groundwater.

A.4.a.2) Ch. NR 112: Activity - Prohibits injection wells of any sort. Media - Groundwater.

A.4.b. Ch. NR 108: Activity - Wastewater treatment facility plan review and standards.

A.4.b. Chs. NR 102, NR 104, NR 105, NR 106, NR 200, NR 207, NR 219 and NR 220 and Ch. 147, Stats.: Activity - Discharge of wastewater to surface waters; effluent limits; discharge permits; sampling/testing methods. Media - Surface water.

A.4.c. Ch. NR 108: Activity - Wastewater pretreatment facility plan review and standards.

A.4.c. Ch. NR 211 and Ch. 147, Stats.: Activity - Discharge of wastewater to publicly owned treatment works; effluent limits. Media - Discharges from publicly owned treatment works - surface water/groundwater.

A.4.d.1) Chs. 400-499: Media - Air pollution control standards.
Ch. NR 445 governs hazardous air pollutant emissions.

A.4.e. See C.

B.1.b. Chs. NR 112, NR 140, NR 200, NR 214, NR 219, NR 220 and Ch. 147, Stats.: Activity - Discharge of wastewater to the land (i.e., groundwater; provided that a discharge to carry chemicals is used). Use of injection wells of any sort to inject chemicals is prohibited. Media - Groundwater.

B.1.c. Same as B.1.b., but applies to nutrients as well as any chemicals.

C.1.&2. Chs. NR 157, NR 500-520, NR 600 - 685 and s. 144.79, Stats.: Activity - Management of PCB contaminated wastes. The treatment, storage, disposal and transportation of PCB wastes are subject to special State requirements and standards. Generally, the standards applied to wastes of concentrations greater than 50 ppm of PCBs follow the federal requirements. For wastes containing less than 50 ppm of PCBs, see the special guidance document in Appendix 3, which is a restatement and clarification of promulgated State standards. Media - Groundwater, soil and air.

C.1.a. Chs. NR 500-520 and s. 144.44, Stats.: Activity - Solid waste disposal licensing process, plan review and standards. Standards are applied through plan review and a siting process which involves local governments and a State siting board. Media - Groundwater, soil.

C.1.a. Chs. NR 600 - 685 and s. 144.44, Stats.: Activity - Hazardous waste disposal licensing process, plan review and standards. Standards are applied through plan review and a siting process which involves local governments and a State siting board. Media - Groundwater, soil.

C.1.b.1), 2),3) Chs. NR 600 - 685: Activity - Hazardous waste treatment (includes incineration) facilities are subject to a licensing process, plan review and standards. For new facilities, standards are applied through plan review and a siting process which involves local governments and a State siting board. Systems for treating wastewater which discharge to surface water, groundwater, or a publicly owned treatment works pursuant to Ch. 147, Stats., fall under A. or B., above. Media - Air, groundwater and soil.

C.1.b.1) Chs. 400-499: Activity - Emissions from treatment systems/incinerators. Media - Air pollution control. Ch. NR 445 governs hazardous air pollutant emissions.

C.1.b.4) Chs. NR 600 - 685: Activity - Recycling of hazardous waste requires a special written exemption. Standards are applied through plan review of the exemption request. Media - Groundwater and soil.

C.1.b.5) Chs. NR 600 - 685: Activity - Land treatment of hazardous waste is prohibited. Media - Groundwater and soil.

C.1.b.5) Chs. NR 140, NR 214, NR 200 and NR 219: Activity - Landspreading of wastewater treatment facility sludges (nonhazardous waste sludges) is regulated under the wastewater program rules. Media - Groundwater and soil.

C.1.c. Chs. NR 600 - 685: Activity - Hazardous waste storage facilities are subject to a licensing process, plan review and standards. For new facilities, standards are applied through plan review and a siting process involving local governments and a State siting board. Media - Groundwater and soil.

C.2. Chs. NR 600 - 685: Activity - Generation and transportation standards for hazardous waste are specified. They are based on RCRA standards. Manifests must be used for hazardous waste shipments. Transporters must be licensed to haul hazardous waste.

C.2.a.1) Chs. NR 500-520 and s. 144.44, Stats.: Activity - Solid waste disposal licensing process, plan review and standards. For new sites, standards are applied through plan review and siting process which involves local governments and a State siting board. Existing sites must be given special one-time waste disposal approval for solid (nonhazardous) waste disposal (See ss. NR 506.09 through NR 506.14). Media - Groundwater and soil.

C.2.a.1) Chs. NR 600 - 685 and s. 144.44, Stats.: Activity - Hazardous waste disposal licensing process, plan review and standards. For new sites, standards are applied through plan review and siting process which involves local governments and a State siting board. There are currently no existing commercially available sites for hazardous waste land disposal in the State of Wisconsin. Media - Groundwater and soil.

C.2.a.2) Chs. NR 600 - 685: Activity - Hazardous waste treatment (includes incineration) facilities are subject to a licensing process, plan review and standards. For new facilities, standards are applied through a siting process involving local governments and a State siting board. Existing commercially available treatment facilities must be approved (through modification of their existing licenses) for acceptance of new waste streams they are not already approved to accept. Systems for treating wastewater which discharges to surface water, groundwater or a publicly owned treatment works, pursuant to Ch. 147, Stats., fall under A. or B., above. Media - Air, groundwater and soil.

C.2.a.2) Chs. 400-499: Activity - Emissions from treatment systems. Media - Air pollution control. Ch. NR 445 governs hazardous air pollutant emissions.

C.2.a.3) Chs. NR 600 - 685: Activity - Recycling of hazardous waste requires a special written exemption. Standards are applied through plan review of the exemption request. Existing, commercially available recycling facilities must be approved (through modification of their existing written exemption) for acceptance of new waste streams they are not already approved to accept. Off-site storage licensing may also apply. Media - Groundwater and soil.

C.2.a.4) Chs. NR 600 - 685: Activity - Land treatment of hazardous waste is prohibited. Media - Groundwater and soil.

C.2.a.4) Chs. NR 140, NR 214, NR 200 and NR 219: Activity - Landspreading of wastewater treatment facility sludges (nonhazardous waste sludges) is regulated under the wastewater program rules. Media - Groundwater and soil.

C.2.a.5) Chs. NR 600 - 685: Activity - Hazardous waste storage facilities are subject to a licensing process, plan review and standards. For new facilities, standards are applied through a siting process involving local governments and a State siting board. Existing, commercially available storage facilities must be approved (through modification of their existing licenses) for acceptance of new waste types they are not already licensed to accept. Media - Groundwater and soil.

C.2.b. Note: The Department has recently issued interim guidelines, dated March 14, 1991, for clean-up actions involving hazardous wastes. These guidelines specify that on-site and/or in-state management of hazardous wastes is preferred. These guidelines are not promulgated, so they are not ARAR's, but are to be considered (TBC's) during remedy selection.

D.1. See Tables 3 and 4, item B.1.

D.2. See Tables 3 and 4, item B.1.a.

D.3. See Tables 3 and 4, item B.1.a.

D.3.a. Activity - Stripper discharges: See A.4.d.

D.3.b. Activity - Spent Carbon: See C

D.3.c. Activity - Other treatment residuals: See C

D.4. Ch. NR 112: Activity - In-house treatment units must be approved by the Department. See ss. NR 112.15(5) and (6). The property owner is responsible for obtaining the approval. As a matter of policy, the Department will only approve such systems as a method of last resort.

D.4. Chs. ILHR 81-84 (Uniform Plumbing Code): Activity - Plumbing system plans for in-house treatment units must be approved by DILHR. Only DILHR-approved products may be used in such systems. Products must have prior, separate approval. The plumbing code contains technical standards the system must conform to.

D.4. Activity - Spend carbon or other residuals from home treatment units: See C. Household waste may not be subject to ch. NR 181 requirements.

Table 3 - Construction Related Activities Associated With Options for Remediation

A. Construction Dewatering

1. Withdrawal wells

   a. Discharge to groundwater or surface water of withdrawn water; treated; untreated

2. Other methods of dewatering

   a. Discharge to groundwater or surface water of withdrawn water; treated; untreated

B. Water Supply

1. Potable supply

   a. Well(s)
   b. Surface water withdrawal

2. Nonpotable supply

   a. Well(s)
   b. Surface water withdrawal

C. Sewage/Sanitary Disposal

1. Discharge to surface water - with treatment
2. Discharge to groundwater - with treatment
3. Septic systems/holding tanks
4. Hook-up to local sewers
5. Landspreading/septage

D. Solid Waste Disposal/Dredge Spoil Disposal

1. On-site
2. Off-site

E. Buildings/Structures/Equipment

1. Tanks - flammable materials

   a. Below ground
   b. Above ground

2. Plumbing

3. Structures

4. Boilers/pressure vessels

5. Refrigeration

F. Floodplain/Shoreland Activities

1. Any construction in the floodplain

   a. Incorporated areas, including wetlands
   b. Unincorporated areas
   c. St. Croix River

G. Surface Water/Sediment Management and Structures

1. Dredging
2. Surface water rerouting
3. Pond construction
4. Filling
5. Dams
6. Bridges
7. Any other structure

H. Wetland/Shoreland Activities

1. Dredging/removal
2. Filling

I. Spills of Hazardous Materials

J. Safety in the Work Place

1. Trenches, excavations and tunnels
2. Noise
3. Compressed air
4. Illumination
5. Fire prevention
6. Dust, fumes, vapors and gases
7. Spray coatings

Table 4 - Promulgated Standards/Requirements Construction Regulated Activities Associated with Options for Remediation (Revised 3/91)

A.1. Ch. NR 112: Any withdrawal well or combination of wells withdrawing 70 GPM or greater; standards and approvals.

A.1.a. Chs. NR 102, NR 104, NR 105, NR 106, NR 200, NR 207, NR 219, NR 220 and Ch. 147, Stats.: Discharge of wastewater to surface waters; effluent limits; discharge permits; sampling/testing methods. If no pollutants are to be discharged, several of these requirements can be waived.

A.1.a. Chs. NR 112, NR 140, NR 200, NR 214, NR 219, NR 220 and Ch. 147, Stats.: Discharge of wastewater to land (i.e., groundwater). Use of injection wells of any sort is prohibited. Effluent limits; discharge permits; sampling/testing methods. If no pollutants are to be discharged several of these requirements may be waived.

A.1.a. Ch. NR 108: Treatment facility (if needed to meet effluent limits) plan review and standards.

A.2.a. Same as A.1.a.

B.1.a. Chs. NR 111, NR 112, NR 108 and NR 109: Potable well construction for all applications must meet the ch. NR 112 construction and design standards. For any application withdrawing 70 GPM or more, standards and approvals are required under ch. NR 112. Wells, treatment and distribution systems for community and municipal water supplies must meet the construction and design standards in ch. NR 111, and are subject to the plan approval requirements of ch. NR 108. Potable water quality must meet ch. NR 109 standards.

B.1.b. Chs. NR 111, NR 112, NR 108 and NR 109: Surface waters may not be used for private water supplies in accordance with ch. NR 112, nor for community supplies per ch. NR 111. They may be used for municipal water supplies; such systems utilizing surface water for a source are subject to the design and construction standards in ch. NR 111, plan approval under ch. NR 108 and the water quality standards in ch. NR 109.

B.2.a. Ch. NR 112: Wells for all applications must meet ch. NR 112 construction and design standards. Any applications withdrawing 70 GPM or more are subject to standards and approvals.

C.1.&2. Chs. NR 110, NR 104, NR 105, NR 106, NR 210, NR 214 and NR 219: Generally, separate sewage treatment facilities are prohibited unless determined to be necessary under s. NR 110.08(5)(c). If allowed, plans and reports are required under ch. NR 110. Effluent limits, permits and sampling/analysis requirements apply under the other rules. Land application is regulated under ch. NR 214.

C.3.&4. Chs. ILHR81-84: Plumbing code requirements apply to the design and construction of septic systems, holding tanks and lateral connections to public sewer systems.

C.5. Ch. NR 113: Septage and holding tank hauling and landspreading requirements, licenses and approvals.

D.1.&2.	Ch. 147, Stats.: Confined dredge disposal areas adjacent to surface waters are regulated through a wastewater permit. Plan review, construction and design requirements apply.
D.1.	Chs. NR 500-520 and ss. 144.436 and 144.44, Stats., Solid waste disposal landfills licensing process, plan review and standards. Standards are applied through plan review and a siting process than involves local governments and a State siting board. Generally, involves local governments and a State siting board. Generally, under s. 144.436, Stats., open burning of solid waste is prohibited.
D.2.	Chs. NR 500-520 and s. 144.44, Stats.: Same as D.1. Off-site commercial or municipal landfills may need a special approval (plan modification) to accept special (nongarbage) wastes. See ss. NR 506.09 through 506.14.
E.1.	Ch. IND 8: Tanks, including underground tanks, standards and design.
E.2.	Chs. ILHR81-84: Plumbing code (see C.3. and 4.).
E.3.	Chs. ILHR50-53 and 64: Building code - design, standards, construction, etc.
E.4.	Chs. ILHR41 and 42: Boiler and pressure vessel design, standards, construction, etc.
E.5.	ILHR45: Refrigeration design and standards.
F.1.	Ch. NR 116: Regulates all construction activities in the floodplain (generally, the 100-year floodplain). Any construction activity must be evaluated for impact on upstream flooding. Generally, no activities are allowed in the "floodway", including solid or hazardous waste disposal.
F.1.a.	Ch. NR 117: Requirements (implemented by local zoning) for floodplain activities in incorporated areas.
F.1.b.	Ch. NR 115: Requirements for floodplain activities in unincorporated areas.
F.1.c.	Ch. NR 118: Requirements for floodplain activities in the St. Croix basin.
G.1.	Chs. NR 345-347 and Chapter 30, Stats.: Permits, approvals and technical standards for dredging activities. See the dredge spoil disposal requirements (D., above).
G.2.	Ch. 30, Stats.: Permits, approvals, technical standards.
G.3.	Ch. 30, Stats.: Permits, approvals, technical standards (if connected to, or within 500 feet of a stream).
G.4.	Ch. 30, Stats.: Generally, this activity is prohibited, except for structures.
G.5.	Ch. NR 333 and Ch. 31, Stats.: Permits, approvals and standards for construction.
G.6.	Ch. NR 320 and Chs. 30 and 31, Stats.: Permits, approvals and standards.

G.7. Chs 30 and 31, Stats.: Permits, approvals and technical standards.

H.2. Chs. NR 115-117: Regulates filling in wetlands that are in the shoreland zone. Generally, implemented by local zoning.

I. Ch. 144.76, Stats. and Ch. NR 158: Spill law. Requires reporting and clean-up of spills of any hazardous substance.

J. Ch. IND1: General safety requirements.

J.1. Ch. IND6: Safety requirements for trenches, excavations and tunnels.

J.2. Ch. IND11: Safety requirements for noise protection.

J.3. Ch. IND12: Safety requirements for compressed air.

J.4. Ch. IND19: Safety requirements related to illumination.

J.5. Ch. IND65: Safety requirements for fire prevention.

J.6. Ch. IND220: Safety requirements for dust, fumes, vapors and gases.

J.7. Ch. IND221: Safety requirements for spray coating operations.

Appendix 1 - General/Permit Primer

Appendix 2 - Water Resources Program Rules

Chapter NR 140 - Groundwater Quality

Chapter NR 141 - Groundwater Monitoring Well Requirements
Note: This code replaces the groundwater well installation and sampling guidelines in appendix 3.
Contact: David Lindorff, 266-9265/Kevin Kessler, 267-9350

Chapter NR 102 - Water Quality Standards for Surface Waters

Chapter NR 104 - Classification Standards

Chapter NR 105 - Surface Water Quality Criteria for Toxic Substances

Chapter NR 106 - Procedures for Calculating Toxic Effluent Limits
Contact: Duane Schuettpelz, 266-0156

Appendix 3 - Solid Waste/Hazardous Waste Program Rules/Statutes/Guidance

Chapter NR 157 - PCBs
Contacts: District Hazardous Waste Specialists, Ed Lynch, 266-3084, or any Engineer in the Hazardous Waste Section

Chapter NR 158 - Spills
Contact: Kim McCutcheon, 266-2857 (This program however, is decentralized to the DNR Districts)

Chapter NR 500-520 - Solid Waste
General Contact: Lakshmi Sridharan, 266-0520
Gas and Cover Systems: Dennis Mack, 267-9386
Groundwater Monitoring: Jack Connelly, 267-7574
Solid Waste Program Guidance:
Memorandum dated 9/27/89 and letter dated 11/12/90 to Landfill Owners w/attachments - Guidance on how Solid Waste Rules apply to landfill gas emission control

Chapters NR 600 - 685 - Hazardous Waste
Contact: Barbara Zellmer, 266-7055, or Ed Lynch, 266-3084

Chapter NR 550 - Environmental Response and Repair
Contact: Mark Giesfeldt, 267-7562
Emergency and Remedial Response Program Guidance:
Landfill ARAR's Training Document dated 4/12/90
Interim Policy for Promoting the In-State and On-Site Management of Hazardous Wastes in Wisconsin, dated 3/14/91

Chapter NR 144, Stats., - Solid Waste, Hazardous Waste, PCBs, and Spills

PCB Guidance (Based on promulgated rules and Statutes)
Contacts: District Hazardous Waste Specialists, Ed Lynch, 266-3084, or any Engineer in the Hazardous Waste Section

Appendix 4 - Wastewater Program Rules/Statutes

General Explanation
Contact: Ken Wiesner, 266-0014

Chapter NR 108 - Plan Approvals

Chapter NR 200 - Wastewater Permit Applications

Chapter NR 211 - Pretreatment

Chapter NR 214 - Land Application

Chapter NR 219 - Test Methods

Chapter NR 220 - Categories and Classes of Point Sources and Effluent Limitations

Section 144.04, Stats. - Plan Approvals

Chapter 147, Stats. - Wastewater Program Statute

Appendix 5 - Air Program Rules

Chapters NR 400-499, Air Pollution Control
General Contact: Pat Kirsop, 266-2060
Landfill Gas and Toxic Emissions: Steve Dunn, 267-0566
Air Monitoring Plans: Julian Chazin, 266-1902
Air Management Program Guidance:
Memorandum dated 11/17/89 - Guidance on Compliance with NR 445 for Landfill Gas Emissions

Appendix 6 - Water Supply Program Rules

Chapter NR 108 - Plan Approvals

Chapter NR 109 - Safe Drinking Water

Chapter NR 111 - Community Water Systems
Contact: Robert Baumeister, 266-2299

Chapter NR 112 - Well Construction
Contact: Bill Rock, 267-7649

Appendix 7 - Municipal Wastewater Program Rules

Chapter NR 110 - Sewage Systems
Contact: Chuck Burney, 266-2304

Chapter NR 113 - Servicing Septic/Holding Tanks
Contact: Bob Steindorf, 266-0449

Chapter NR 210 - Effluent Limits for Sewage Treatment Works

Appendix 8 - Technical Services Program Rules

Chapter NR 149 - Lab Certification
Contact: Ron Arneson, 267-7633

Appendix 9 - Water Regulation and Zoning Rules and Statutes

Chapter NR 115 - Shoreland Management

Chapter NR 116 - Floodplain Management

Chapter NR 117 - City/Village Program

Chapter NR 118 - St. Croix River

Chapter NR 320 - Bridges

Chapter NR 333 - Dams

Chapter NR 340 - Waterway Construction

Chapter 345 - Waterway Beds Construction

Chapter NR 346 - Fees

Chapter NR 347 - Dredging Project

Chapter 30, Stats.

Chapter 31, Stats.
Contact: Scott Hausmann, 266-7360
(This program, however, is mostly decentralized to the DNR district offices).
Water Regulation and Zoning Guidance:
Water Regulation and Zoning ARAR's Training Document dated 4/12/90

Appendix 10 - Environmental Impact Rules

Chapter NR 150 - Environmental Analysis and Review
Contact: Roger Fritz, 266-1201

Department of Industry, Labor & Human Relations Rules

Copies of these codes are available through: Document Sales - Department of Administration, P.O. Box 7840, Madison, WI 53707, 266-3358
Contacts: Ron Buchholtz, 266-9420
Loretta Trapp, 266-2990 (Home treatment units)

(Revised 3/91)

Enclosures for Revision #3 (3/91):

1. Revised NR 140 - Groundwater Quality - This replaces the earlier version of the same rule in Appendix 2, which may be discarded or kept for historical reference.

2. NR 141 - Groundwater Monitoring Well Requirements - Add to Appendix 2. Also, this replaces the monitoring well construction and groundwater sampling procedure guidance documents in appendix 3. The guidance documents may be discarded or kept for historical reference.

3. Water Resource Management ARAR's Training Document dated 4/12/90 - Add to Appendix 2.

4. NR 600 - 685 - Hazardous Waste Rules - These rules replace NR 181 in Appendix 3, which may be discarded or kept for historical reference.

5. Landfill ARAR's Training Document dated 4/12/90 - Add to Appendix 3.

6. Letter dated 11/12/90 to Landfill Owners with attachments - Guidance on how Solid Waste Rules apply to landfill gas emission control - Add to Appendix 3.

7. Interim Policy for Promoting the In-State and On-Site Management of Hazardous Wastes in Wisconsin, dated 3/14/91 - Add to Appendix 3.

8. NR 207 - Water Quality Antidegradation - Add to Appendix 4.

9. NR 220 - Categories and Classes of Point Sources and Effluent Limitations - Add to appendix 4.

10. Revised NR 109 - Safe Drinking Water and Revised NR 112 - Well Construction and Pump Installation - These replace the earlier versions of the rules in Appendix 6, which may be discarded or kept for historical reference.

11. Water Regulation and Zoning ARAR's Training Document dated 4/12/90 - Add to Appendix 9.

Note: The DNR is currently in the process of developing guidelines for soil cleanup levels and how ch. NR 140 groundwater standards apply at clean-up sites. They will be added to Appendix 3 when complete.

APPENDIX B

ECOLOGICAL CHARACTERIZATION

CORRESPONDENCE/MEMORANDUM

State of Wisconsin

DATE: December 22, 1993

TO: Terry Evanson - SW/3

FROM: Chuck Pils, ER/4 *Chuck*

SUBJECT: Endangered Resource Information Review (Log Number 93-443)

CONFIDENTIAL INFORMATION
NOT TO BE RELEASED TO PUBLIC
MAINTAIN IN SEPARATE FILE

FILE REF: 1650

The Bureau of Endangered Resources has reviewed the Draft Work Plan for the Refuse Hideaway Landfill remediation investigation and feasibility study (RI/FS).

Our Natural Heritage Inventory (NHI) data files contain the following rare species information for the project site located in the SW1/4 NW1/4 of Section 8 in T7N R8E, Dane County. In addition to the actual project site, I am providing endangered resource information for an area within five miles of the landfill for aquatic species. I provide this information both so impacts to nearby endangered resources can be assessed and to assist in determining which rare species may occur in the project's impact area if appropriate habitat exists. If the described habitat types occur in the project's impact area, then species that occur nearby may be present there. The species information provided includes the location, date of the most recent observation, and other information useful in planning protection measures. A rare, aquatic species occurring near the project site is:

> *Potamogeton vaginatus* (sheathed pondweed), a plant listed as Threatened in Wisconsin, occurs in T8N R6E [redacted] (Black Earth Creek). The observation date for this occurrence record is 1985. This species prefers fast cold streams and large lakes. Blooming occurs from August through October.

In addition to the above information, our data files also contain historical records (generally, records that are 25 years old or older) of rare species known to occur within the vicinity of the project site. Unfortunately, the Bureau does not have more current survey information documenting the continued existence of these species in this area. I am including these older records as an indication of species that may still occur in the project area if appropriate habitat exists:

> *Moxostoma duquesnei* (black redhorse), a State Special Concern fish, has been known to occur in Black Earth Creek (T8N R6E). This species prefers swiftly flowing sections of small- to medium-sized streams. It is found in clear water over gravel, bedrock, and sand where siltation is at a minimum. Spawning occurs in from early March through late April.
>
> *Nasiaeschna pentacantha* (Cyrano darner), a State Special Concern dragonfly, has been known to occur in Black Earth Creek (T8N R6E). This southern species typically breeds in larger swampy streams and lake coves, north to Lincoln and Marinette counties and west to Buffalo county. The flight period is from June through July.
>
> Special Concern (Watch) species are species about which some problem of abundance or distribution is suspected but not yet proved. The main purpose of this category is to focus attention on certain species <u>before</u> they become endangered or threatened.

Unfortunately, comprehensive endangered resource surveys have not been completed for the Black Earth Creek watershed, particularly upstream from Cross Plains. As a result, our data files may be incomplete. The lack of additional known occurrences does not preclude the possibility that other endangered resources may be present. It does not appear that any surveys for rare fish and invertebrate species have been conducted recently in Black Earth Creek.

RECEIVED
DEC 28 1993
EMERG & REMEDIAL RESPONSE SECTION
BUR OF SOLID & HAZ'D WASTE

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As for the RI/FS, I don't believe that additional surveys for endangered resources need to be conducted. I do believe it is critical to assess how remediation alternatives will impact water quality, quantity, velocity, and temperature in this creek. It is my understanding that these issues will be addressed in the Feasibility Study.

The specific location of endangered resources is sensitive information that has been provided to you for the analysis and review of this project. Exact locations should not be released or reproduced in any publicly disseminated documents.

Please contact John Pohlman at (608) 264-6263 if you have any questions about this information.

cc: Bruce Braun - EA/6
Harold Meier - SD
Carl Batha - SD

APPENDIX C

PROBABLE COSTS OF EACH ALTERNATIVE

REFUSE HIDEAWAY LANDFILL
ALTERNATIVE A - NO FURTHER ACTION
COST ESTIMATE

CAPITAL COSTS

	Quantity	Units	Unit Cost	Total Cost
None				
TOTAL CAPITAL COST =				$0

OTHER DIRECT COSTS

None

TOTAL DIRECT COSTS = $0

OPERATION & MAINTENANCE COSTS

Annual Discount Rate = 6.0%
Life of Project = 30 years

	Quantity	Annual Cost	Present Worth
Annual Inspection and Maintenance of Landfill Cap,	1		
Operation and Maintenance of Leachate Collection / LFG Collection & Disposal System, &	1		
Off-site Leachate Disposal	1	$75,000	$1,032,000
Semi-annual Ground Water and LFG Sampling and Analysis, &	21 wells		
Annual Private Water Well Sampling and Analysis	12 wells	$25,000	$344,000

ANNUAL O&M COSTS = $100,000

PRESENT WORTH O&M COSTS = $1,376,000

TOTAL DIRECT COSTS =	$0
PRESENT WORTH O&M COSTS =	$1,376,000
TOTAL PRESENT WORTH COSTS =	$1,376,000

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REFUSE HIDEAWAY LANDFILL
ALTERNATIVE B - LIMITED ACTION
COST ESTIMATE

CAPITAL COSTS

	Quantity	Units	Unit Cost	Total Cost
Place Restriction on Deed	1	each	$1,000	$1,000
TOTAL CAPITAL COST =				$1,000

OTHER DIRECT COSTS

None	$0
TOTAL DIRECT COSTS =	$1,000

OPERATION & MAINTENANCE COSTS

Annual Discount Rate = 6.0%
Life of Project = 30 years

	Quantity	Annual Cost	Present Worth
Annual Inspection and Maintenance of Landfill Cap,	1		
Operation and Maintenance of Leachate Collection / LFG Collection & Disposal System, &	1		
Off-site Leachate Disposal	1	$75,000	$1,032,000
Semi-annual Ground Water and LFG Sampling and Analysis, &	21 wells		
Annual Private Water Well Sampling and Analysis	12 wells	$25,000	$344,000

ANNUAL O&M COSTS = $100,000

PRESENT WORTH O&M COSTS = $1,376,000

TOTAL DIRECT COSTS =	$1,000
PRESENT WORTH O&M COSTS =	$1,376,000
TOTAL PRESENT WORTH COSTS =	$1,377,000

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REFUSE HIDEAWAY LANDFILL
ALTERNATIVE C - CONSTRUCT COMPOSITE CAP
COST ESTIMATE

CAPITAL COSTS

	Quantity	Units	Unit Cost	Total Cost
Place Restriction on Deed	1	each	$1,000	$1,000
Strip, Disc & Stockpile Existing Vegetation and Topsoil	33,700	cubic yards	$3	$101,000
Import Cover Layer Soil	74,200	cubic yards	$8	$594,000
Place & Grade Cover Layer Soil	74,200	cubic yards	$3	$223,000
Place and Grade Stockpiled Soil	33,700	cubic yards	$3	$101,000
Revegetate Landfill	111,300	Sq. Yd.	$0.30	$33,000
Import & Place Geoliner and Geonet	111,300	Sq. Yd.	$11	$1,224,000
Mobilization/Demobilization	10% of Capital Costs			$228,000

TOTAL CAPITAL COST = $2,505,000

OTHER DIRECT COSTS

Permitting and Design	(10% of Total Capital Costs)	$251,000
Construction Oversight	(8% of Total Capital Costs)	$200,000
Contingency	(10% of Total Capital Costs)	$251,000

TOTAL DIRECT COSTS = $3,207,000

OPERATION & MAINTENANCE COSTS

Annual Discount Rate = 6.0%
Life of Project = 30 years

	Quantity	Annual Cost	Present Worth
Annual Inspection and Maintenance of Landfill Cap,	1		
Operation and Maintenance of Leachate Collection / LFG Collection & Disposal System, &	1		
Off-site Leachate Disposal	1	$75,000	$1,032,000
Semi-annual Ground Water and LFG Sampling and Analysis, &	21 wells		
Annual Private Water Well Sampling and Analysis	12 wells	$25,000	$344,000

ANNUAL O&M COSTS = $100,000

PRESENT WORTH O&M COSTS = $1,376,000

TOTAL DIRECT COSTS =	$3,207,000
PRESENT WORTH O&M COSTS =	$1,376,000
TOTAL PRESENT WORTH COSTS =	$4,583,000

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REFUSE HIDEAWAY LANDFILL
Alternative D- GROUND-WATER EXTRACTION AND TREATMENT SYSTEM
COST ESTIMATE

CAPITAL COSTS

	Quantity	Units	Unit Cost	Total Cost
Install GW Extraction Wells	4	each	$10,000	$40,000
Install GW Header System	1,000	Linear Ft	$20	$20,000
Purchase/Install Submersible Pump	4	each	$3,000	$12,000
Automated Controller System	1	each	$3,000	$3,000
Electrical Hook-Up	1	each	$3,000	$3,000
Storage Tank	1	each	$3,000	$3,000
Filter System	1	each	$6,000	$6,000
Air Stripper + Blower	1	each	$15,000	$15,000
Water Softener	1	each	$10,000	$10,000
Water Softener Waste Tank	1	each	$1,000	$1,000
Pumps	2	each	$800	$2,000
Piping	1,000	Linear Ft	$10	$10,000
Concrete Pad	1	each	$1,000	$1,000
Building for GW Treatment System	1	each	$10,000	$10,000
Mobilization/Demobilization	10% of Capital Costs			$14,000
	TOTAL CAPITAL COST =			$150,000

OTHER DIRECT COSTS

Permitting and Design	(10% of Total Capital Costs)	$15,000
Construction Oversight	(8% of Total Capital Costs)	$12,000
Contingency	(10% of Total Capital Costs)	$15,000
	TOTAL DIRECT COSTS =	$192,000

OPERATION & MAINTENANCE COSTS   Annual Discount Rate = 6.0%
Life of Project = 30 years

	Quantity	Unit Cost	Annual Cost	Present Worth
System Operation	1	$12,000	$12,000	$165,000
Equipment Inspection/Maintenance	52	$500	$26,000	$358,000
Annual Water Softener Maintenance	1	$2,000	$2,000	$28,000

ANNUAL O&M COSTS = $40,000
PRESENT WORTH O&M COSTS = $551,000

TOTAL DIRECT COSTS = $192,000
PRESENT WORTH O&M COSTS = $551,000
TOTAL PRESENT WORTH COSTS = $743,000

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SIMON HYDRO-SEARCH

REFUSE HIDEAWAY LANDFILL

ALTERNATIVE D1 – GROUND-WATER EXTRACTION, TREATMENT, AND DISCHARGE TO BLACK EARTH CREEK VIA INTERMITTENT DRAINAGE DITCH

COST ESTIMATE

CAPITAL COSTS

	Quantity	Units	Unit Cost	Total Cost
GW Extraction/Treatment System	1	each	$150,000	$150,000
Outfall	200	ft	$10	$2,000
WPDES Permit Application	1	each	$2,000	$2,000
Mobilization/Demobilization	10% of Capital Costs			$15,000
	TOTAL CAPITAL COST =			$169,000

OTHER DIRECT COSTS

Permitting and Design	(10% of Total Capital Costs)	$17,000
Construction Oversight	(8% of Total Capital Costs)	$14,000
Contingency	(10% of Total Capital Costs)	$17,000
	TOTAL DIRECT COSTS =	$217,000

OPERATION & MAINTENANCE COSTS

Annual Discount Rate = 6.0%

Life of Project = 30 years

	Quantity	Unit Cost	Annual Cost	Present Worth
Ground-Water Extraction and Treatment System	1	$40,000	$40,000	$551,000
Monthly Water Discharge Sampling and Analysis	12	$1,000	$12,000	$165,000
	ANNUAL O&M COSTS =		$52,000	
	PRESENT WORTH O&M COSTS =			$716,000

TOTAL DIRECT COSTS =	$217,000
PRESENT WORTH O&M COSTS =	$716,000
TOTAL PRESENT WORTH COSTS =	$933,000

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REFUSE HIDEAWAY LANDFILL

ALTERNATIVE D2 - GROUND-WATER EXTRACTION, TREATMENT, AND DISCHARGE TO LOCATION 2

BLACK EARTH CREEK AT TWIN VALLEY ROAD

COST ESTIMATE

CAPITAL COSTS

	Quantity	Units	Unit Cost	Total Cost
GW Extraction/Treatment System	1	each	$150,000	$150,000
Outfall	4,000	ft	$10	$40,000
WPDES Permit Application	1	each	$2,000	$2,000
Mobilization/Demobilization	10% of Capital Costs			$19,000
	TOTAL CAPITAL COST =			$211,000

OTHER DIRECT COSTS

Permitting and Design	(10% of Total Capital Costs)	$21,000
Construction Oversight	(8% of Total Capital Costs)	$17,000
Contingency	(10% of Total Capital Costs)	$21,000
	TOTAL DIRECT COSTS =	$270,000

OPERATION & MAINTENANCE COSTS   Annual Discount Rate = 6.0%

Life of Project = 30 years

	Quantity	Unit Cost	Annual Cost	Present Worth
Ground-Water Extraction and Treatment System	1	$40,000	$40,000	$551,000
Monthly Water Discharge Sampling and Analysis	12	$1,000	$12,000	$165,000
	ANNUAL O&M COSTS =		$52,000	
	PRESENT WORTH O&M COSTS =			$716,000

TOTAL DIRECT COSTS =	$270,000
PRESENT WORTH O&M COSTS =	$716,000
TOTAL PRESENT WORTH COSTS =	$986,000

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REFUSE HIDEAWAY LANDFILL

ALTERNATIVE D3 - GROUND-WATER EXTRACTION, TREATMENT, AND DISCHARGE TO LOCATION 3

BLACK EARTH CREEK AT CROSS PLAINS

COST ESTIMATE

CAPITAL COSTS

	Quantity	Units	Unit Cost	Total Cost
GW Extraction/Treatment System	1	each	$150,000	$150,000
Outfall	18,000	ft	$10	$180,000
WPDES Permit Application	1	each	$2,000	$2,000
Mobilization/Demobilization	10% of Capital Costs			$33,000
	TOTAL CAPITAL COST =			$365,000

OTHER DIRECT COSTS

Permitting and Design	(10% of Total Capital Costs)	$37,000
Construction Oversight	(8% of Total Capital Costs)	$29,000
Contingency	(10% of Total Capital Costs)	$37,000
	TOTAL DIRECT COSTS =	$468,000

OPERATION & MAINTENANCE COSTS

Annual Discount Rate = 6.0%

Life of Project = 30 years

	Quantity	Unit Cost	Annual Cost	Present Worth
Ground-Water Extraction and Treatment System	1	$40,000	$40,000	$551,000
Monthly Water Discharge Sampling and Analysis	12	$1,000	$12,000	$165,000
	ANNUAL O&M COSTS =		$52,000	
	PRESENT WORTH O&M COSTS =			$716,000

TOTAL DIRECT COSTS =	$468,000
PRESENT WORTH O&M COSTS =	$716,000
TOTAL PRESENT WORTH COSTS =	$1,184,000

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REFUSE HIDEAWAY LANDFILL

ALTERNATIVE D4 - GROUND-WATER EXTRACTION, TREATMENT, AND DISCHARGE TO LOCATION 4
INTERMITTENT STREAM TO PHEASANT BRANCH CREEK

COST ESTIMATE

CAPITAL COSTS

	Quantity	Units	Unit Cost	Total Cost
GW Extraction/Treatment System	1	each	$150,000	$150,000
Outfall	6,000	ft	$10	$60,000
WPDES Permit Application	1	each	$2,000	$2,000
Mobilization/Demobilization	10% of Capital Costs			$21,000
	TOTAL CAPITAL COST =			$233,000

OTHER DIRECT COSTS

Permitting and Design	(10% of Total Capital Costs)	$23,000
Construction Oversight	(8% of Total Capital Costs)	$19,000
Contingency	(10% of Total Capital Costs)	$23,000
	TOTAL DIRECT COSTS =	$298,000

OPERATION & MAINTENANCE COSTS

Annual Discount Rate = 6.0%
Life of Project = 30 years

	Quantity	Unit Cost	Annual Cost	Present Worth
Ground-Water Extraction and Treatment System	1	$40,000	$40,000	$551,000
Monthly Water Discharge Sampling and Analysis	12	$1,000	$12,000	$165,000
	ANNUAL O&M COSTS =		$52,000	
	PRESENT WORTH O&M COSTS =			$716,000

TOTAL DIRECT COSTS =	$298,000
PRESENT WORTH O&M COSTS =	$716,000
TOTAL PRESENT WORTH COSTS =	$1,014,000

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REFUSE HIDEAWAY LANDFILL
ALTERNATIVE E - GROUND WATER EXTRACTION, TREATMENT AND DISCHARGE GROUND WATER TO INFILTRATION GALLERY
COST ESTIMATE

CAPITAL COSTS

	Quantity	Units	Unit Cost	Total Cost
GW Extraction/Treatment System	1	each	$150,000	$150,000
Excavate Soil for Infiltration Gallery	17,000	cu yd	$10	$170,000
Backfill Infiltration Gallery with Gravel	17,000	cu yd	$10	$170,000
Contsruct Clay Berm Around Gallery	400	cu yd	$10	$4,000
Subsurface Pipeline to Infiltration Gallery	1,000	Linear Ft	$15	$15,000
Mobilization/Demobilization	10% of Capital Costs			$51,000
	TOTAL CAPITAL COST =			$560,000

OTHER DIRECT COSTS

Permitting and Design	(10% of Total Capital Costs)	$56,000
Construction Oversight	(8% of Total Capital Costs)	$45,000
Contingency	(10% of Total Capital Costs)	$56,000
	TOTAL DIRECT COSTS =	$717,000

OPERATION & MAINTENANCE COSTS

Annual Discount Rate = 6.0%
Life of Project = 30 years

	Quantity	Unit Cost	Annual Cost	Present Worth
Ground Water Extraction and Treatment System	1	$40,000	$40,000	$551,000
Maintenance of Infiltration Gallery	1	$2,000	$2,000	$28,000
Monthly Water Discharge Sampling and Analysis	12	$1,000	$12,000	$165,000
	ANNUAL O&M COSTS =		$54,000	
	PRESENT WORTH O&M COSTS =			$744,000

TOTAL DIRECT COSTS =	$717,000
PRESENT WORTH O&M COSTS =	$744,000
TOTAL PRESENT WORTH COSTS =	$1,461,000

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REFUSE HIDEAWAY LANDFILL

ALTERNATIVE F - GROUND-WATER EXTRACTION, TREATMENT, AND DISCHARGE TO INJECTION WELLS

COST ESTIMATE

CAPITAL COSTS

	Quantity	Units	Unit Cost	Total Cost
Ground-Water Extraction And Treatment System	1	each	$150,000	$150,000
Install Injection Wells	2	each	$4,000	$8,000
Subsurface Pipeline to Injection Wells	1,000	Linear Ft	$15	$15,000
Mobilization/Demobilization	10% of Capital Costs			$17,000
	TOTAL CAPITAL COST =			$190,000

OTHER DIRECT COSTS

Permitting and Design	(10% of Total Capital Costs)	$19,000
Construction Oversight	(8% of Total Capital Costs)	$15,000
Contingency	(10% of Total Capital Costs)	$19,000
	TOTAL DIRECT COSTS =	$243,000

OPERATION & MAINTENANCE COSTS

Annual Discount Rate = 6.0%

Life of Project = 30 years

	Quantity	Unit Cost	Annual Cost	Present Worth
Ground-Water Extraction and Treatment System	1	$40,000	$40,000	$551,000
Maintenance of Injection Wells	1	$5,000	$5,000	$69,000
Monthly Water Discharge Sampling and Analysis	12	$1,000	$12,000	$165,000
	ANNUAL O&M COSTS =		$57,000	
	PRESENT WORTH O&M COSTS =			$785,000

TOTAL DIRECT COSTS =	$243,000
PRESENT WORTH O&M COSTS =	$785,000
TOTAL PRESENT WORTH COSTS =	$1,028,000

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ALTERNATIVE G - SUPPLY INDIVIDUAL WATER TREATMENT UNITS
COST ESTIMATE

CAPITAL COSTS

	Quantity	Units	Unit Cost	Total Cost
Purchase/Install Individual Water Treatment Units	25	each	$6,000	$150,000
Mobilization/Demobilization	10% of Capital Costs			$15,000
	TOTAL CAPITAL COST =			$165,000

OTHER DIRECT COSTS

Permitting and Design	(10% of Total Capital Costs)	$17,000
Construction Oversight	(8% of Total Capital Costs)	$13,000
Contingency	(10% of Total Capital Costs)	$17,000
	TOTAL DIRECT COSTS =	$212,000

OPERATION & MAINTENANCE COSTS

Annual Discount Rate = 6.0%
Life of Project = 30 years

	Quantity	Unit Cost	Annual Cost	Present Worth
Equipment Operation/Maintenance	25	$2,500	$62,500	$860,000
	ANNUAL O&M COSTS =		$62,500	
	PRESENT WORTH O&M COSTS =			$860,000

TOTAL DIRECT COSTS =	$212,000
PRESENT WORTH O&M COSTS =	$860,000
TOTAL PRESENT WORTH COSTS =	$1,072,000

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REFUSE HIDEAWAY LANDFILL
ALTERNATIVE H - CONSTRUCT COMMUNITY WELL
COST ESTIMATE

CAPITAL COSTS

	Quantity	Units	Unit Cost	Total Cost
Install Community Well	1	each	$10,000	$10,000
Install Water Main	10,000	Linear Ft	$30	$300,000
Connect Each Residence	25	each	$1,200	$30,000
Purchase/Install Pump	1	each	$5,000	$5,000
Building for Community Well	1	each	$10,000	$10,000
Purchase/Install Water Tower	1	each	$180,000	$180,000
Mobilization/Demobilization	10% of Capital Costs			$36,000
	TOTAL CAPITAL COST =			$571,000

OTHER DIRECT COSTS

Permitting and Design	(10% of Total Capital Costs)	$57,000
Construction Oversight	(8% of Total Capital Costs)	$46,000
Contingency	(10% of Total Capital Costs)	$57,000
	TOTAL DIRECT COSTS =	$731,000

OPERATION & MAINTENANCE COSTS   Annual Discount Rate = 6.0%
Life of Project = 30 years

	Quantity	Unit Cost	Annual Cost	Present Worth
System Operation	1	$12,000	$12,000	$165,000
Equipment Inspection/Maintenance	52	$500	$26,000	$358,000

ANNUAL O&M COSTS = $38,000
PRESENT WORTH O&M COSTS = $523,000

TOTAL DIRECT COSTS =	$731,000
PRESENT WORTH O&M COSTS =	$523,000
TOTAL PRESENT WORTH COSTS =	$1,254,000

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APPENDIX D
HELP MODELLING RESULTS

HELP MODELING

The effectiveness of each of the landfill cover alternatives was evaluated using the "Hydrologic Evaluation of Landfill Performance" (HELP) Model, Version 2.0 (EPA, 1986). The HELP model uses the water balance method to determine the percolation of precipitation through the specified landfill cover. The volume of water which percolates through the specified cap is equivalent to the amount of leachate generated.

The three alternatives which were evaluated with the HELP model are as follows:

Case 1: Existing Conditions

Case 2: NR500 Conditions

Case 3: Proposed Flexible Membrane Liner (FML) Installation

(Same as Case 1 with the addition of an FML above the existing clay)

Data from 41 soil borings constructed in the existing landfill cover was used as a basis for the thicknesses of the topsoil layer, the root zone, and the compacted clay layers. For simplicity, the average thickness of each layer was used as input to the HELP model for Case 1 and Case 3. The thickness of the topsoil layer averaged 0.91 feet, the thickness of the root zone averaged 0.71 feet, and the thickness of the compacted clay averaged 2.65 feet.

It should be noted that the existing conditions do not meet the letter of the NR500 requirements since the existing root zone layer is less than 18 inches thick. However, the existing compacted clay layer at the site is greater than the 24 inch thickness specified in NR500. Consequently, the NR500 specified thicknesses were used during the modelling of Case 2 so that the performance of the existing landfill cover could be compared to a NR500 landfill cover.

Soil moisture and conductivity data from laboratory analyses of soil samples were used in the model. The permeability of the compacted clay sample was determined to be 1.4 x 10^{-8} cm/sec. A permeability of 1 x 10^{-7} was used as a "worst case" permeability during the modeling of each of the three cases. The FML liner in Case 3 was assumed to allow 1% of the water which percolated through the topsoil and root zone to pass through the liner.

Data for the porosity, field capacity, wilting point, and initial soil water content for each soil layer was based upon the results of soil testing performed upon the existing soil at the site.

Climatological data used for the HELP modeling was based upon the default data generated by the HELP model for Madison, Wisconsin. The average precipitation and average temperature data was adjusted by using data for the years 1951-1980 from the National Oceanic and Atmospheric Administration (NOAA) weather station at Prairie du Sac, Wisconsin.

The sensitivity of the Soil Conservation Service (SCS) Curve Number was upon the output of the HELP model was also investigated. The number used in the HELP model was 75, a number used in most situations. The values of 40, 60, and 80 were also used during the model and, however, the differences for each case of the SCS curve number was less than 1%. As a result, the SCS Curve Number of 75 was used in all HELP model calculations.

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REFUSE HIDEAWAY LANDFILL

EXISTING CONDITIONS

HYDRO-SEARCH, INC.

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REFUSE HIDEAWAY LANDFILL
EXISTING CONDITIONS
5-23-94

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LAYER 1

VERTICAL PERCOLATION LAYER

THICKNESS	=	10.90 INCHES
POROSITY	=	0.5010 VOL/VOL
FIELD CAPACITY	=	0.2837 VOL/VOL
WILTING POINT	=	0.1353 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2837 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000799999980 CM/SEC

LAYER 2

VERTICAL PERCOLATION LAYER

THICKNESS	=	8.50 INCHES
POROSITY	=	0.4360 VOL/VOL
FIELD CAPACITY	=	0.2320 VOL/VOL
WILTING POINT	=	0.1157 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2330 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000370000023 CM/SEC

LAYER 3

BARRIER SOIL LINER

THICKNESS	=	31.80 INCHES
POROSITY	=	0.4000 VOL/VOL
FIELD CAPACITY	=	0.3560 VOL/VOL
WILTING POINT	=	0.2899 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4000 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000000100000 CM/SEC

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	75.00
TOTAL AREA OF COVER	=	1001880. SQ FT
EVAPORATIVE ZONE DEPTH	=	19.00 INCHES
UPPER LIMIT VEG. STORAGE	=	8.9925 INCHES
INITIAL VEG. STORAGE	=	5.7892 INCHES
INITIAL SNOW WATER CONTENT	=	0.7383 INCHES
INITIAL TOTAL WATER STORAGE IN SOIL AND WASTE LAYERS	=	17.7928 INCHES

SOIL WATER CONTENT INITIALIZED BY PROGRAM.

CLIMATOLOGICAL DATA

SYNTHETIC RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND SOLAR RADIATION FOR MADISON WISCONSIN

MAXIMUM LEAF AREA INDEX	=	3.30
START OF GROWING SEASON (JULIAN DATE)	=	135
END OF GROWING SEASON (JULIAN DATE)	=	273

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
15.60	20.50	31.00	46.30	58.40	67.90
72.30	70.20	61.70	50.70	35.70	22.50

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 20

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.80	1.04	2.02	3.10	2.66	3.84
	3.27	3.77	3.45	2.08	1.99	1.43
STD. DEVIATIONS	0.34	0.54	0.99	1.32	0.98	1.66
	1.74	1.79	2.08	1.11	1.18	0.67

RUNOFF

TOTALS	0.016	0.000	0.085	0.065	0.004	0.002
	0.009	0.006	0.021	0.015	0.004	0.054
STD. DEVIATIONS	0.074	0.000	0.375	0.210	0.012	0.006
	0.026	0.011	0.064	0.048	0.013	0.240

EVAPOTRANSPIRATION

TOTALS	0.482	0.886	1.948	2.971	3.028	5.234
	4.244	3.455	2.613	1.748	0.982	0.504
STD. DEVIATIONS	0.103	0.271	0.514	0.746	0.809	1.157
	1.429	1.566	0.915	0.811	0.324	0.132

PERCOLATION FROM LAYER 3

TOTALS	0.1123	0.1088	0.1281	0.1309	0.1339	0.1237
	0.0870	0.0120	0.0255	0.0505	0.0662	0.0947
STD. DEVIATIONS	0.0449	0.0399	0.0348	0.0188	0.0138	0.0127
	0.0342	0.0290	0.0430	0.0595	0.0575	0.0563

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 20

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	29.44	(3.952)	2457570.	100.00
RUNOFF	0.280	(0.562)	23380.	0.95
EVAPOTRANSPIRATION	28.096	(3.633)	2345763.	95.45
PERCOLATION FROM LAYER 3	1.0734	(0.3054)	89617.	3.65
CHANGE IN WATER STORAGE	-0.014	(2.232)	-1190.	-0.05

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 20

	(INCHES)	(CU. FT.)
PRECIPITATION	3.41	284700.9
RUNOFF	0.592	49404.9
PERCOLATION FROM LAYER 3	0.0055	458.6
HEAD ON LAYER 3	19.6	

SNOW WATER	2.45	204946.7

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4733
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1265

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FINAL WATER STORAGE AT END OF YEAR 20

LAYER	(INCHES)	(VOL/VOL)
1	2.98	0.2730
2	3.44	0.4047
3	12.72	0.4000
SNOW WATER	0.00	

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REFUSE HIDEAWAY LANDFILL
NR500 CONDITIONS

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 REFUSE HIDEAWAY LANDFILL
 NR500 CONDITIONS
 5-23-94

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                              LAYER  1
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                     VERTICAL PERCOLATION LAYER
   THICKNESS                                =      6.00 INCHES
   POROSITY                                 =      0.5010 VOL/VOL
   FIELD CAPACITY                           =      0.2837 VOL/VOL
   WILTING POINT                            =      0.1353 VOL/VOL
   INITIAL SOIL WATER CONTENT               =      0.2837 VOL/VOL
   SATURATED HYDRAULIC CONDUCTIVITY         =      0.000799999980 CM/SEC


                              LAYER  2
                              --------

                     VERTICAL PERCOLATION LAYER
   THICKNESS                                =     18.00 INCHES
   POROSITY                                 =      0.4360 VOL/VOL
   FIELD CAPACITY                           =      0.2320 VOL/VOL
   WILTING POINT                            =      0.1157 VOL/VOL
   INITIAL SOIL WATER CONTENT               =      0.2330 VOL/VOL
   SATURATED HYDRAULIC CONDUCTIVITY         =      0.000370000023 CM/SEC


                              LAYER  3
                              --------

                         BARRIER SOIL LINER
   THICKNESS                                =     24.00 INCHES
   POROSITY                                 =      0.4000 VOL/VOL
   FIELD CAPACITY                           =      0.3560 VOL/VOL
   WILTING POINT                            =      0.2899 VOL/VOL
   INITIAL SOIL WATER CONTENT               =      0.4000 VOL/VOL
   SATURATED HYDRAULIC CONDUCTIVITY         =      0.000000100000 CM/SEC
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GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	75.00
TOTAL AREA OF COVER	=	1001880. SQ FT
EVAPORATIVE ZONE DEPTH	=	19.00 INCHES
UPPER LIMIT VEG. STORAGE	=	8.6740 INCHES
INITIAL VEG. STORAGE	=	4.7639 INCHES
INITIAL SNOW WATER CONTENT	=	0.7383 INCHES
INITIAL TOTAL WATER STORAGE IN SOIL AND WASTE LAYERS	=	15.4962 INCHES

SOIL WATER CONTENT INITIALIZED BY PROGRAM.

CLIMATOLOGICAL DATA

SYNTHETIC RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND
SOLAR RADIATION FOR MADISON WISCONSIN

MAXIMUM LEAF AREA INDEX	=	3.30
START OF GROWING SEASON (JULIAN DATE)	=	135
END OF GROWING SEASON (JULIAN DATE)	=	273

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
15.60	20.50	31.00	46.30	58.40	67.90
72.30	70.20	61.70	50.70	35.70	22.50

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 20

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.80	1.04	2.02	3.10	2.66	3.84
	3.27	3.77	3.45	2.08	1.99	1.43
STD. DEVIATIONS	0.34	0.54	0.99	1.32	0.98	1.66
	1.74	1.79	2.08	1.11	1.18	0.67
RUNOFF						

TOTALS	0.015	0.000	0.079	0.043	0.003	0.000
	0.008	0.006	0.022	0.016	0.004	0.048
STD. DEVIATIONS	0.067	0.000	0.352	0.142	0.010	0.000
	0.020	0.011	0.065	0.048	0.014	0.213

EVAPOTRANSPIRATION

TOTALS	0.483	0.887	1.947	2.967	3.036	5.059
	3.882	3.452	2.629	1.745	0.977	0.502
STD. DEVIATIONS	0.103	0.272	0.517	0.745	0.809	1.311
	1.433	1.565	0.921	0.825	0.308	0.134

PERCOLATION FROM LAYER 3

TOTALS	0.1372	0.1289	0.1481	0.1517	0.1549	0.1422
	0.1282	0.1232	0.1184	0.1282	0.1220	0.1333
STD. DEVIATIONS	0.0427	0.0408	0.0429	0.0281	0.0227	0.0189
	0.0117	0.0066	0.0067	0.0244	0.0313	0.0344

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 20

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	29.44	(3.952)	2457570.	100.00
RUNOFF	0.242	(0.509)	20175.	0.82
EVAPOTRANSPIRATION	27.565	(3.698)	2301441.	93.65
PERCOLATION FROM LAYER 3	1.6163	(0.2534)	134948.	5.49
CHANGE IN WATER STORAGE	0.012	(2.306)	1005.	0.04

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 20

	(INCHES)	(CU. FT.)
PRECIPITATION	3.41	284700.9
RUNOFF	0.585	48873.2
PERCOLATION FROM LAYER 3	0.0068	569.2
HEAD ON LAYER 3	24.2	

SNOW WATER 2.45 204852.1

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.4565

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1215

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FINAL WATER STORAGE AT END OF YEAR 20

LAYER	(INCHES)	(VOL/VOL)
1	1.59	0.2646
2	6.33	0.3519
3	9.60	0.4000
SNOW WATER	0.00	

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REFUSE HIDEAWAY LANDFILL
PROPOSED FML COVER

HYDRO-SEARCH, INC.

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REFUSE HIDEAWAY LANDFILL
PROPOSED FML
5-23-94

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LAYER 1

VERTICAL PERCOLATION LAYER

THICKNESS	=	10.90 INCHES
POROSITY	=	0.5010 VOL/VOL
FIELD CAPACITY	=	0.2837 VOL/VOL
WILTING POINT	=	0.1353 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2837 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000799999980 CM/SEC

LAYER 2

VERTICAL PERCOLATION LAYER

THICKNESS	=	8.50 INCHES
POROSITY	=	0.4360 VOL/VOL
FIELD CAPACITY	=	0.2320 VOL/VOL
WILTING POINT	=	0.1157 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2330 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000370000023 CM/SEC

LAYER 3

BARRIER SOIL LINER WITH FLEXIBLE MEMBRANE LINER

THICKNESS	=	31.80 INCHES
POROSITY	=	0.4000 VOL/VOL
FIELD CAPACITY	=	0.3560 VOL/VOL
WILTING POINT	=	0.2899 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4000 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000000100000 CM/SEC

LINER LEAKAGE FRACTION = 0.01000000

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	75.00
TOTAL AREA OF COVER	=	1001880. SQ FT
EVAPORATIVE ZONE DEPTH	=	19.00 INCHES
UPPER LIMIT VEG. STORAGE	=	8.9925 INCHES
INITIAL VEG. STORAGE	=	5.8808 INCHES
INITIAL SNOW WATER CONTENT	=	0.7383 INCHES
INITIAL TOTAL WATER STORAGE IN SOIL AND WASTE LAYERS	=	17.7928 INCHES

SOIL WATER CONTENT INITIALIZED BY PROGRAM.

CLIMATOLOGICAL DATA

SYNTHETIC RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND SOLAR RADIATION FOR MADISON WISCONSIN

MAXIMUM LEAF AREA INDEX	=	3.30
START OF GROWING SEASON (JULIAN DATE)	=	135
END OF GROWING SEASON (JULIAN DATE)	=	273

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
15.60	20.50	31.00	46.30	58.40	67.90
72.30	70.20	61.70	50.70	35.70	22.50

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 20

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.80	1.04	2.02	3.10	2.66	3.84
	3.27	3.77	3.45	2.08	1.99	1.43
STD. DEVIATIONS	0.34	0.54	0.99	1.32	0.98	1.66
	1.74	1.79	2.08	1.11	1.18	0.67

RUNOFF

TOTALS	0.023	0.006	0.147	0.177	0.007	0.030
	0.010	0.006	0.028	0.023	0.012	0.066
STD. DEVIATIONS	0.101	0.018	0.467	0.508	0.020	0.128
	0.028	0.011	0.077	0.072	0.043	0.297

EVAPOTRANSPIRATION

TOTALS	0.482	0.884	1.947	2.968	3.025	5.391
	4.891	3.476	2.610	1.739	0.977	0.503
STD. DEVIATIONS	0.103	0.270	0.508	0.743	0.799	1.003
	1.435	1.568	0.912	0.797	0.327	0.131

PERCOLATION FROM LAYER 3

TOTALS	0.0013	0.0012	0.0014	0.0014	0.0014	0.0013
	0.0011	0.0011	0.0011	0.0011	0.0011	0.0013
STD. DEVIATIONS	0.0002	0.0002	0.0002	0.0001	0.0001	0.0001
	0.0001	0.0001	0.0000	0.0002	0.0002	0.0002

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 20

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	29.44	(3.952)	2457570.	100.00
RUNOFF	0.535	(0.849)	44671.	1.82
EVAPOTRANSPIRATION	28.890	(3.656)	2412033.	98.15
PERCOLATION FROM LAYER 3	0.0149	(0.0012)	1242.	0.05
CHANGE IN WATER STORAGE	-0.005	(2.206)	-377.	-0.02

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 20

	(INCHES)	(CU. FT.)
PRECIPITATION	3.41	284700.9
RUNOFF	1.125	93895.4
PERCOLATION FROM LAYER 3	0.0001	4.6

HEAD ON LAYER 3	19.6	
SNOW WATER	2.46	205083.5

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.4733
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1265

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FINAL WATER STORAGE AT END OF YEAR 20

LAYER	(INCHES)	(VOL/VOL)
1	3.10	0.2847
2	3.60	0.4236
3	12.72	0.4000
SNOW WATER	0.00	

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REFUSE HIDEAWAY LANDFILL

HELP MODEL INPUT DATA

HYDRO-SEARCH, INC.

HELP SIMULATIONS

19" evaporative zone depth

	1		2		3	
10.9"	TOPSOIL	.91'	TOPSOIL	.91'	TOPSOIL	
8.5"	RZ	.71'	RZ	.71'	RZ	
					LINER	
31.8"	1.4×10^{-8} cm/sec CLAY	2.65'	1×10^{-7} CLAY	2.65'	CLAY	2.65'

TOP SLOPE

SE	S	SW
$\frac{1040-990}{9.5'' \times 60} =$	$\frac{1140-1010}{9.5'' \times 60} =$	$\frac{1040-1015}{9.5 \times 60} = \frac{25}{570} = 4.3$
$\frac{50}{570} = 8.7\%$	$\frac{30}{570} = 5.2\%$	Avg = 6 %

SIDE SLOPE

$\frac{1003-947}{3'' \times 60} =$	$\frac{999-945}{180} =$	$\frac{990-937}{180} =$
31%	30%	29%

Avg = 30%

SIMULATION		TOP		SIDE	
1	(12,856 FT3)	.1963" (avg annual over 20yrs.)		.1961"	(3530)
2	(68,155)	1.0407"		1.0370"	(18665)
3	(131)	0.002"		0.002"	(36)

1 acre = 43,560 ft^2

20" x 3" = 1200' x 180' = 216,000 ft^2

Landfill = 23 acres = 1,001,880 ft^2

1,001,880
− 216,000 side
top 785,880 ft^2
(18 acres)

USCS	HELP #	Porosity	Field capacity	Wilting point	sat K cm/sec	
ML	(8)	.463	.232	.116	3.7×10^{-4}	Layer 2 (sand)
ML	(9)	.501	.284	.135	1.9×10^{-4}	Layer 1 (clayey silt)
CL	11	.464	.310	.187	6.4×10^{-5}	
CL	12	.471	.342	.210	4.2×10^{-5}	
Liner Soil	16	.430	.366	.280	1×10^{-7}	
Liner Soil	(17)	.400	.356	.290	1×10^{-8}	Layer 3

CLIMATOGRAPHY OF THE UNITED STATES NO. 20

PRAIRIE DU SAC, WI

PERIOD: 1951-80
ELEVATION: 780 FT

CLIMATOLOGICAL SUMMARY

TEMPERATURE (F)

	MEANS			EXTREMES						MEAN NUMBER OF DAYS				DEGREE DAYS	
										MAX		MIN			
	* DAILY MAXIMUM	* DAILY MINIMUM	* MONTHLY	RECORD HIGHEST	YEAR	DAY	RECORD LOWEST	YEAR	DAY	90 AND ABOVE	32 AND BELOW	32 AND BELOW	0 AND BELOW	* HEATING BASE 65	* COOLING BASE 65
JAN	24.6	6.6	15.6	55+	67	24	-42	51	30	0	22	31	11	1531	0
FEB	30.0	10.9	20.5	56+	76	15	-30	51	2	0	16	28	7	1246	0
MAR	40.0	22.1	31.0	79+	78	31	-28	62	1	0	7	27	1	1054	0
APR	56.1	36.4	46.3	94+	80	22	10+	54	3	0	0	11	0	561	0
MAY	69.0	47.8	58.4	91+	68	24	26+	76	3	0	0	1	0	239	34
JUN	78.4	57.3	67.9	97+	53	19	39+	69	9	2	0	0	0	39	126
JUL	82.7	61.9	72.3	101+	76	10	45+	72	5	5	0	0	0	7	233
AUG	80.5	59.9	70.2	99+	55	21	40+	65	29	3	0	0	0	18	179
SEP	71.9	51.5	61.7	98+	78	8	26+	74	22	1	0	0	0	126	27
OCT	60.5	40.9	50.7	91	63	6	15+	72	19	0	0	6	0	452	9
NOV	43.7	27.7	35.7	76	64	3	-9+	77	26	0	4	21	0	879	0
DEC	30.3	14.7	22.5	65	61	4	-22+	62	26	0	17	30	5	1318	0
YEAR	55.6	36.5	46.1	101	JUL 76	10	-42	JAN 51	30	11	66	155	24	7470	608

PRECIPITATION TOTALS (INCHES)

	* MEAN	* GREATEST MONTHLY	YEAR	GREATEST DAILY	YEAR	DAY	SNOW MEAN	SNOW MAXIMUM MONTHLY	SNOW YEAR	MEAN NUMBER OF DAYS .10 OR MORE	.50 OR MORE	1.00 OR MORE
JAN	1.03	2.61	69	1.12	67	24	9.1	24.4	51	3	0	0
FEB	1.00	3.04	71	1.23	77	23	6.7	20.2	75	3	1	0
MAR	1.93	4.62	76	1.64	76	04	7.2	22.7	59	5	1	0
APR	2.95	6.49	73	1.66	75	28	1.2	16.2	73	6	2	0
MAY	3.25	5.73	78	2.88	78	13	.0	.0	0	7	2	1
JUN	3.58	7.83	69	2.40	67	09	.0	.0	0	7	3	1
JUL	3.83	7.57	52	5.05	51	21	.0	.0	0	6	3	1
AUG	3.63	11.41	80	2.77	80	07	.0	.0	0	6	3	1
SEP	3.34	12.59	65	4.27	65	09	.0	.0	0	6	2	1
OCT	2.10	5.17	59	2.08	59	23	.1	1.5	55	5	1	0
NOV	1.84	4.58	75	2.44	75	29	2.7	10.3	59	4	1	0
DEC	1.42	3.91	68	1.73	68	19	8.6	20.5	70	4	1	0
YEAR	29.90	12.59	SEP 65	5.05	JUL 51	21	35.6	24.4	JAN 51	62	20	5

*FROM 1951-80 NORMALS

ESTIMATED VALUE BASED ON DATA FROM SURROUNDING STATIONS

\+ ALSO ON EARLIER DATES.

DEGREE DAYS TO SELECTED BASE TEMPERATURES (F)

BASE	HEATING DEGREE DAYS												
BELOW	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
65	1531	1246	1054	561	239	39	7	18	126	452	879	1318	7470
60	1376	1106	899	415	140	8	0	0	44	313	729	1163	6193
57	1283	1022	806	330	94	0	0	0	16	240	639	1070	5500
55	1221	966	744	277	66	0	0	0	8	198	579	1008	5067
50	1066	826	595	162	23	0	0	0	0	114	435	853	4074

BASE	COOLING DEGREE DAYS												
ABOVE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
55	0	0	0	16	171	387	536	471	209	65	0	0	1855
57	0	0	0	9	137	327	474	409	157	45	0	0	1558
60	0	0	0	0	91	245	381	319	95	25	0	0	1156
65	0	0	0	0	34	126	233	179	27	9	0	0	608
70	0	0	0	0	11	48	111	79	0	0	0	0	249

DERIVED FROM THE 1951-80 MONTHLY NORMALS

PROBABILITY THAT THE MONTHLY PRECIPITATION WILL BE EQUAL TO OR LESS THAN THE INDICATED PRECIPITATION AMOUNT

MONTHLY PRECIPITATION (INCHES)

PROBABILITY LEVELS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
.05	.20	.10	.39	1.21	1.26	1.15	1.80	.75	.32	.20	.27	.25
.10	.29	.18	.57	1.48	1.57	1.49	2.13	1.09	.56	.35	.42	.38
.20	.44	.31	.85	1.86	2.00	1.99	2.59	1.62	1.02	.64	.69	.59
.30	.58	.45	1.11	2.17	2.35	2.42	2.96	2.11	1.48	.93	.94	.78
.40	.72	.60	1.37	2.47	2.69	2.83	3.30	2.60	1.99	1.25	1.21	.98
.50	.87	.77	1.65	2.77	3.03	3.26	3.65	3.12	2.56	1.61	1.50	1.19
.60	1.05	.97	1.97	3.09	3.41	3.73	4.02	3.71	3.23	2.03	1.84	1.43
.70	1.25	1.22	2.35	3.46	3.84	4.28	4.44	4.42	4.08	2.56	2.25	1.73
.80	1.53	1.57	2.86	3.93	4.38	4.98	4.96	5.36	5.23	3.29	2.80	2.12
.90	1.97	2.13	3.67	4.65	5.22	6.08	5.76	6.86	7.16	4.50	3.70	2.76
.95	2.39	2.68	4.44	5.30	5.99	7.10	6.48	8.28	9.04	5.69	4.57	3.36

THESE VALUES WERE DETERMINED FROM THE INCOMPLETE GAMMA DISTRIBUTION.

Avg Moisture Content
41 borings - 16.03%

Average Cap		
Topsoil	0.91 feet	
RZ	0.71 feet	
Clay	2.65 feet	

Existing Cap [REFUSE HIDEAWAY]

41 borings

Clay moisture 17.9 to 22.9 % (optimum for compaction 13.7%)

Clay permeability 1.4×10^{-8} cm/sec (not true field K) — done in lab

#	2nd col.	TOP SOIL (37.6)		RZ (29.4)		CLAY (108.7)		Comments	
1		1'	2	3'	1	2'	2	clay 1-2'	sand 5-5.7
	B-25	.6	.6	3	—	1.9	2.6	clay .6-1.2 sand 1.2-2.6	sand 1.6-2 sand 3.6-4
		—	.6	—	1.4	2	2		RZ is sand
		1	1.4	—	.6	3	.8		RZ is sand sand 2.8-4
5		.6	.6	1.4	—	3.4	2.9	silt 3.4-6.5	
		1.4	.6	1.2	—	2.4	2.4	clay 1.4-1.6	sand 1.6-2.2 sand 3-6
	B-30	2	.6	—	—	3	3.1	clay topsoil	sand [illegible]2
		.6	.6	1.4	1.4	1.8	3.8	sand 3.8-5	RZ is sand
		.6	1	1	2	2.65	3	RZ is sand	
10		.6	.6	—	—	3	5.4	Sand 3.6-4	
		1	1	—	—	2.4	3	sand 3.4-3.8	
	B-35	1	1	—	2	5	1		clay 1-1.6 sand 4-6
		1	—	1.2	3	1.4	—	sand 3.6-4 silt 4-5.5	
		1	.6	.8	—	1.2	3.4	clay topsoil RZ is sand silt 3-4	sand 1.6-2
15		1	2	.8	—	2.2	1.8	clay topsoil RZ is sand	
		1	.6	—	1.4	5	1.8		clay topsoil
	B-40	.6	1.6	1.2	—	1.7	2.4	RZ is sand	clay topsoil
	B-41	.6	.6	—	—	4.75	1.2	sand 1.6-2	sand 1.8-2
		1.4		.6		4		RZ is sand	
20		2		—		3.5			
		.6	|			2.8		sand 3.4-5 clay 5-5.6 sand 5.6-6	
		1		—		5			
		1		1		2		RZ is sand	