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FINAL

REMEDIAL INVESTIGATION AND FEASIBILITY STUDY

OF ALTERNATIVES

LEES LANE LANDFILL SITE

JEFFERSON COUNTY, KENTUCKY

VOLUME II: FEASIBILITY STUDY

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Appendix

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9.0 SCREENING OF REMEDIAL ACTION TECHNOLOGIES

A two-phased process was used to determine the appropriate remedial response for the Lees Lane Landfill Site. First, an initial screening of technologies was performed to eliminate obviously infeasible, inappropriate, or environmentally unacceptable alternatives. The second phase involved a detailed analysis of a limited number of remedial alternatives, formed from the technologies that passed the initial screening stage.

Numerous technologies are available for use at the Lees Lane Landfill Site. Although many are applicable, it is apparent that a number of technologies can be removed from further consideration based on the information obtained about the site from the Remedial Investigation (RI).

Screening began during the RI as information on the site conditions was obtained and a list of preliminary, applicable technologies was developed. This list comprises actions that address the potential site problems and pathways of contamination identified during the RI:

- No action
- Monitoring
- Alternate water supply
- Surface capping
- Surface regrading and revegetation
- Surface water diversion
- Bank protection controls
- Groundwater barriers
- Leachate collection
- Gas collection and/or venting
- Groundwater collection
- Removal and/or control of surface waste
- Removal of contaminated soil/sediment
- In-Situ treatment
- Excavation
- Incineration
- Disposal technologies

These actions can be grouped as shown on Table 9-1.

Each technology has been reviewed in accordance with the following four criteria:

- Technical Considerations
- Public Health and Environmental Considerations
- Institutional Considerations
- Cost Considerations

During the initial screening, the investigation team and other personnel, with experience in various applicable disciplines, reviewed and evaluated the results and conclusions of the RI. The technologies identified during the RI, as well as technologies encompassing treatment or disposal, which were thought to be of importance, were discussed and evaluated. In the following narratives, each criterion is reviewed and discussed separately under each technology. If the technology is rejected for use at the Lees Lane Landfill Site under a particular criterion, it is eliminated from further consideration.

In some cases, there are several technologies that are similar to each other, such as the various technologies used for leachate collection or alternate water supply. In these cases, an evaluation was performed to determine which technology was most appropriate for the Lees Lane Landfill Site.

9.1 No Action Technologies

The purpose of reviewing the no action technologies is to estimate the effect of not performing additional remedial actions at the site.

9.1.1 Technical Considerations

No Action

These technologies assume that no remedial activities will be undertaken at the Lees Lane Landfill Site. The low level contamination of the groundwater will continue, with the possibility of either increasing or decreasing without anyone

TABLE 9-1
GENERAL RESPONSE ACTIONS AND
ASSOCIATED REMEDIAL TECHNOLOGIES
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

General Response Action	Associated Remedial Technologies
No Action	No Action Monitoring
Alternate Water Supply	Municipal Water Supply Hookup Bottled Water Individual Treatment Units
Containment	Surface Capping Bank Protection Controls Groundwater Barriers
Diversion	Surface Regrading and Revegetation Levees, Terraces, and Benches
Collection	Leachate Collection Gas Collection and/or Venting Groundwater Collection
Reduction	Removal and/or Control of Surface Waste
Onsite Treatment	Leachate Treatment Incineration
Offsite Treatment	Leachate Treatment Incineration
In-Situ Treatment	Inplace Treatment of Soils

TABLE 9-1
GENERAL RESPONSE ACTIONS AND
ASSOCIATED REMEDIAL TECHNOLOGIES
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY
PAGE TWO

General Response Action	Associated Remedial Technologies
Complete Removal	Removal of Contaminated Soil/Sediment Excavation
Offsite Disposal	Landfilling Incineration
Onsite Disposal	Landfilling Incineration

being aware of those changes or being able to take steps to deal with them. The gas collection system may deteriorate and unknown quantities of gases may be released to the air, leading to increased risk of exposure of contaminants.

No Action - Monitoring

Under the no action technologies, additional remedial activities would not be performed. However, a long-term monitoring program would be established so that possible adverse public health or environmental impacts that may arise can be identified and addressed. At the Lees Lane Landfill Site, this would include monitoring the groundwater, air, and landfill-generated gas.

9.1.2 Public Health and Environmental Considerations

No Action

The no action alternative does not address the remediation of the site nor the potential threat to the environment or public via the contamination pathways. Public reaction may be unfavorable, since onsite and offsite contamination will not be mitigated. At the Lees Lane Landfill Site, the no action alternative increases the potential for migration of gas, and its possible health impact on the Riverside Gardens residents. Therefore, no action will not be considered further.

No Action - Monitoring

While this alternative does not address the remediation of contamination, it does provide a mechanism for identifying future problems.

9.1.3 Institutional Considerations

No Action - Monitoring

This technology can be implemented easily once an agency has been selected to perform it.

9.1.4 Cost Considerations

No Action - Monitoring

This technology will involve the design and construction of a gas monitoring system and design and implementation of ambient air, gas, and groundwater sampling programs. The costs of sampling and analyses of all three media should be moderate.

9.2 Alternate Water Supply

During the RI, five private wells in the Riverside Gardens neighborhood were identified for sampling and only three of these were used as a potable water supply. The levels of contaminants found in these private wells were below those triggering any public health concern. Although no contaminant levels of concern are present in the groundwater serving the private wells, there is a potential for groundwater reversal at the site. This technology is being retained for use in the event that future monitoring indicates contamination of the groundwater serving the private wells.

9.2.1 Technical Considerations

Alternative water supply systems are designed to provide residences and other facilities with potable water. Although the private wells at the Lees Lane Landfill Site are normally upgradient of the site, a possibility of flow reversal exists. Currently, groundwater contamination levels in the groundwater found in the private wells are below any public health concern. If contaminated groundwater affects private wells in the future, the following water supply systems have potential application at the site.

- Municipal water supply hookup
- Bottled water
- Individual treatment units

These systems do not alleviate problems that could arise from the landfill leachate and contaminated groundwater plume, but rather provide protection to the receptors.

Municipal Water Supply Hookup

Water lines can be extended from the Louisville municipal water main to the homes in the area. A water line presently serves water to many of the Riverside Gardens' residents and could also provide potable water along with fire protection to those residents still using private wells. This alternative is the most complete and reliable of those considered.

Bottled Water

Providing bottled water is a short-term solution to any problem. Extended usage of bottled water is an inconvenience to the residents and does not provide protection from dermal exposure. Since the time for any improvement of contaminated groundwater is expected to be several years, even with source reduction, this technology will be eliminated from further consideration.

Individual Treatment Units

Installation of individual treatment units on the present wells involves designing an adequate treatment system to remove contaminants found in the groundwater, followed by continuous monitoring of the systems over an extended time. Improper up-keep of these systems could lead to failure and possible future exposure. Therefore, frequent monitoring is required to detect breakthrough of any filter systems. Routine sampling would be required to ensure that each unit is operating properly. This technology is not practical and is therefore eliminated from further consideration.

A summary of the technical screening for alternate water supply systems is presented in Table 9-2.

TABLE 9-2
TECHNICAL SCREENING
ALTERNATE WATER SUPPLY TECHNOLOGY
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Alternate Water Supply Technology	Retained for Further Evaluation	Comments
Municipal Water Supply Hookup	Yes	Most complete and reliable; no monitoring required
Bottled Water	No	Short-term solution
IndividualTreatment Units	No	Requires extensive monitoring and maintenance

9.2.2 Public Health and Environmental Considerations

Provision of an alternate water supply will remove the health hazards presented by the long-term possibility of consumption of contaminated drinking water. It will not affect any current or future environmental impacts caused by the site contaminants.

9.2.3 Institutional Considerations

This technology can be implemented easily, based on standard industry practices and the local water purveyor's requirements.

9.2.4 Cost Considerations

This technology has a low capital cost and nominal operation and maintenance costs.

9.3 Surface Capping

Presently a cover exists at the site, but its permeability and thickness are unknown. Based on the results of the RI, it is believed that local soil was used to cover the landfill. The cover, as it now exists, serves little benefit in the prevention of infiltration of rainwater or the release of landfill gases. Capping is applicable to this site and will be retained for further consideration.

Capping priorities for this site include controlling gas migration and limiting infiltration. A cap constructed to meet these needs would incorporate soil over a semi-impermeable barrier for water drainage and vegetation growth. A gravel layer below the barrier would be necessary to reduce gas migration through the cover. The depth of various layers depends on purpose(s) of the cover and the soils' chemical, physical, geological, and engineering properties.

9.3.1 Technical Considerations

The use of landfill capping is a well documented technology and is currently considered standard procedure in the closing of disposal sites. Caps are constructed primarily to control the release of gases to the atmosphere and to reduce infiltration of surface water.

The capping process, at a minimum, requires a relatively impermeable barrier overlying the landfill contents and a suitable cover soil to protect the barrier and support the growth of vegetation. Capping materials include:

- Clay
- Synthetic membranes
- Concrete
- Asphalt
- Soil mixtures
  - soil/bentonite
  - soil/lime
  - soil/portland or bituminous cement

Clays and Synthetic Membranes

Clays and synthetic membranes have been used extensively in cap construction. For both types of cover, waste compatability must be evaluated. At Lees Lane Landfill, the presence of metals and few organics should allow the use of both clay and synthetic membranes. For synthetic membranes, attention should also be directed toward the prevention of tears, punctures, and the proper lapping of seams (Lutton, 1982). Since the size of the area to be capped is approximately 112 acres, the number of seams and amount of a synthetic membrane would be extensive. Therefore, only clay will be retained for further consideration.

Concrete and Asphalt

Concretes and asphalts can produce low permeability to infiltration and gas migration. However, both are susceptable to shrinkage and/or cracking, increasing

the risk of failure. Certain cover-specific requirements for the installation of these barriers include equipment for their handling and application. Where thick layers of asphalt are needed, multiple applications might be necessary (Ehrenfeld and Bass, 1983). Since the landfill is still subsiding, these methods are considered inappropriate.

Soil Mixtures

Soil mixtures can be advantageous, particularly when onsite soil is suitable. Soil/bentonite layers have been shown to be effective, but in large scale operations homogenous mixtures are difficult to attain. Soil/lime and soil/cement mixtures can also result in desirable barriers; however, experience with such blends has been limited (Lutton, 1982). Therefore, these methods are eliminated from further consideration.

A summary of the technical screening for capping is presented in Table 9-3.

9.3.2 Public Health and Environmental Considerations

The use of a landfill cap meeting RCRA standards has been shown to provide effective cover and erosion control. An appropriate cap will also serve to decrease rainwater infiltration/percolation, reduce the uncontrolled and random vertical migration of gas and prevent direct contact.

While an appropriate cap will provide a barrier to infiltration, groundwater levels on site have been shown to vary widely with Ohio River fluctuations. Rising groundwater levels may at times provide the water necessary to produce leachate. Cap implacement will also increase lateral gas migration, necessitating the continued operation and perhaps modification to the gas collection and venting process presently onsite.

9.3.3 Institutional Considerations

There are similar RCRA and state requirements for the capping of hazardous waste landfills. These regulations specify criteria for both closure and post-closure

TABLE 9-3
TECHNICAL SCREENING
SURFACE CAPPING TECHNOLOGY
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Surface Capping Technology	Retained for Further Evaluation	Comments
Clay	Yes	Need to obtain clay from offsite source
Synthetic Membranes	No	Area too large
Concrete	No	Susceptible to cracking
Asphalt	No	Susceptible to cracking
Soil Mixtures	No	Limited experience

operations. Closure considerations deal primarily with cover material and design, while post-closure concerns involve site maintenance and monitoring.

9.3.4 Cost Considerations

Factors having the greatest impact on capping costs are materials and area to be covered. Use of onsite or nearby soils can reduce expense by decreasing or eliminating transportation charges, but the availability of acceptable clays onsite is unlikely.

Operation and maintenance costs include cover crop maintenance, cap inspections, as well as repairs due to erosion and subsidence. Costs for certain site-specific additions, such as modification of the gas collection system, can also be incurred when site conditions change as a result of capping.

9.4 Surface Regrading and Revegetation

At the Lees Lane Landfill Site the surface elevations vary from approximately 450 to 410 feet above mean sea level (amsl). Because of the heavy vegetative growth and elevation differences, clearing and regrading will be necessary prior to capping and installation of bank protection controls. The regrading is necessary to facilitate drainage to predetermined areas. Revegetation will be performed after the cap is installed. Based on site conditions this technology will only be considered to be necessary if capping or excavation are performed.

9.4.1 Technical Considerations

Regrading is used to reshape the surface of landfills in order to manage surface water infiltration and runoff while controlling erosion. Regrading is often performed in conjunction with surface sealing practices while revegetation is performed because of its inherent aesthetic and soil transport control aspects. Revegetation also involves preparing the soil surface, seeding, fertilizing, and mulching to establish a good growth of vegetation.

The equipment and methods used in regrading and revegetation involve the use of standard construction procedures. Regrading of an existing landfill surface may require substantial quantities of local soil to modify the existing slope since soils must be added rather than relocated because the waste will remain below the cover material. Periodic regrading and future site maintenance may be necessary to repair depressions that form because of differential settlement and/or to repair slopes that slump or become badly eroded.

Regrading and revegetation are widely accepted engineering practices and are applicable for this site. This technology will be retained for further consideration.

9.4.2 Public Health and Environmental Considerations

Regrading and revegetation decrease erosion by wind and water and contribute to the development of a naturally fertile and stable surface environment. Regrading and revegetation also help to minimize infiltration of surface water, thereby reducing leachate generation.

9.4.3 Institutional Considerations

Standards and various guidance documents regarding the performance of vegetation on landfills and appropriate surface slopes are available. These performance standards can be met.

9.4.4 Cost Considerations

Surface area and volume of material moved are the elements that most affect the cost. The unit cost is given in dollars per acre as regrading and revegetation are generally performed on that scale. This technology is expected to be ancillary to the primary alternatives at this site and the cost for surface regrading and revegetation will be incorporated with the associated costs for capping or excavation.

9.5 Surface Water Diversion

The Lees Lane Landfill Site lies along the Ohio River and is impacted by the seasonal rise and fall of this River. The landfill is bordered on the east and south by a flood protection levee which serves to protect Riverside Gardens from flood waters. The designated 100-year flood level would cover approximately 40 percent of the landfill as can be seen in Figure 9-1. A structure could be constructed on the Ohio River side of the site to prevent the landfill from being inundated. Therefore, this technology will be considered further.

9.5.1 Technical Considerations

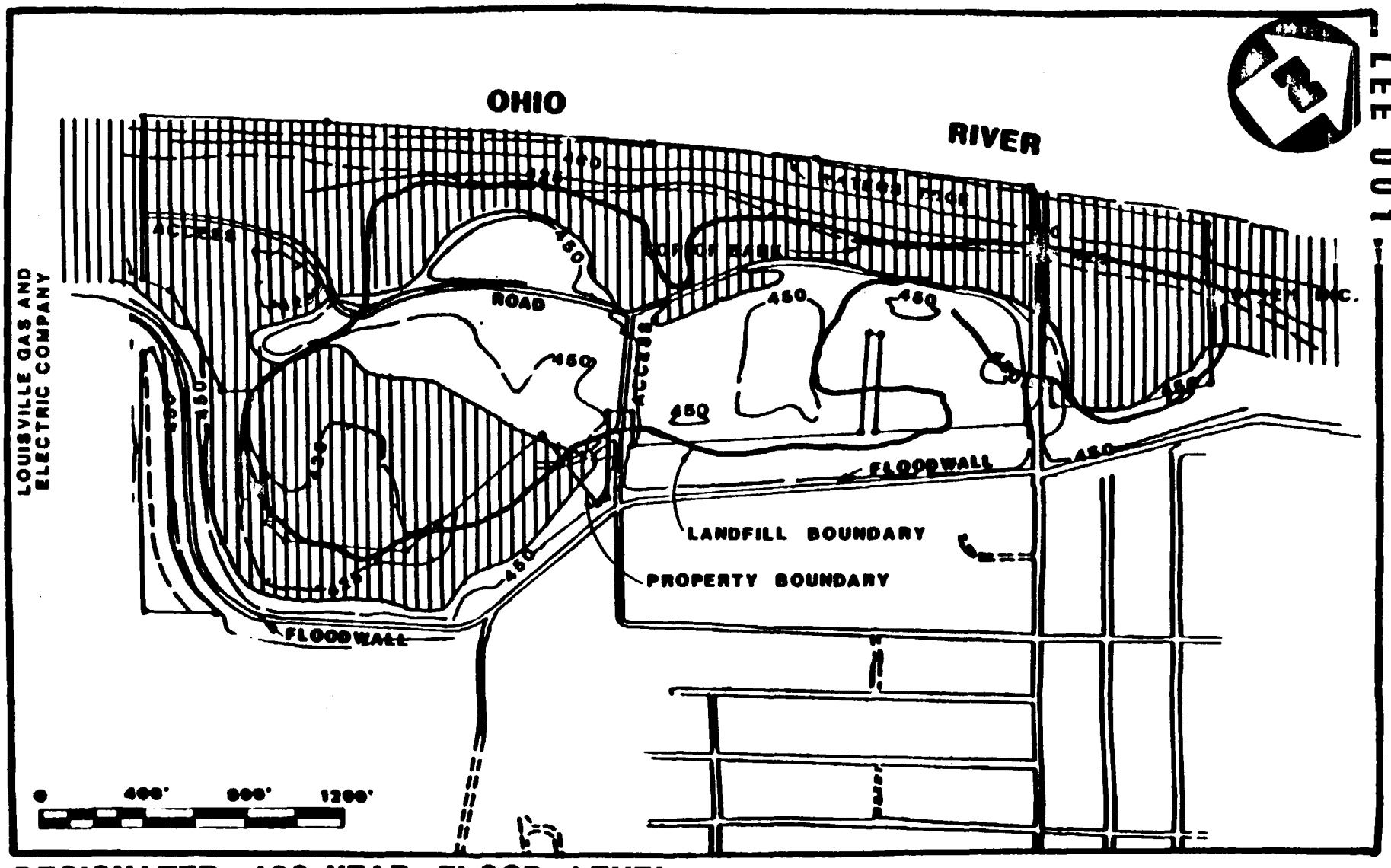
Presently no surface water bodies flow through the site; and therefore, surface water diversion is not required under the current conditions at the site. The construction of surface water diversion and collection structures may provide short-term or permanent measures to hydrologically isolate the Lees Lane Landfill from the Ohio River during high water stages. Surface water runon from the Ohio River can be managed so that flooding and surface water infiltration of the landfill are minimized. In addition, proper implementation of surface water diversion controls may help in reducing leachate generation and erosion of capping materials. Conventional engineering techniques are used to control flooding, surface water infiltration, and offsite transport of possible contaminated soils.

Several well-established construction techniques are available for diverting and handling surface water flow in critical areas. The methods most applicable as remedial measures at Lees Lane Landfill site are:

- Levees
- Terraces and Benches

Levees

Levees are earthen embankments that function as flood protection structures in areas subject to inundation from tidal flow or riverine flooding. Levees create a barrier to confine floodwaters to a floodway and to protect structures behind the



DESIGNATED 100-YEAR FLOOD LEVEL
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

LEGEND

BOUNDARY OF FILL

447.6 FEET MSL

FIGURE 9-1

NUS CORPORATION
A Halliburton Company

LEE 001 001107

barrier. They are most suitable for installation in flood fringe areas or areas subject to storm tide flooding, but not for areas directly within open floodways.

Flood containment levees may be constructed as perimeter embankments surrounding disposal sites located in floodplain fringe areas, or they may be installed at the base of landfills along slope faces that are subject to periodic inundation. Levees serve to protect land disposal sites from floodwaters, which may erode cover materials and transport waste materials offsite, or which may add water to waste materials and thus increase leachate production.

If a levee is to be constructed at Lees Lane Landfill Site to prevent the Ohio River from entering the site during the 100-year flood, it would need to be approximately 67 feet high on the river side of the landfill. Since this would cause additional flooding downstream and floods exceeding the 100-year event would overlap the new levee and create turbulence that would affect the integrity of the existing levee (Curry, 1985), this method is eliminated from further consideration.

Terraces and Benches

Terraces and benches are relatively flat areas constructed along the contour of very long or very steep slopes to slow down runoff and divert it into ditches for offsite transport at nonerosive velocities. These structures are also known as bench terraces or drainage benches.

Although benches and terraces are slope reduction devices, they are generally constructed with reverse fall or natural fall to divert water to stabilized drainageways. Benches and terraces may be used to break up steeply graded slopes of covered disposal sites into less erodible segments. Upslope of disposal sites, they act to slow and divert storm runoff around the site. Downslope of landfill areas, they act to intercept and divert sediment-laden runoff to traps or basins. Hence, they may function to hydrologically isolate active disposal sites, to control erosion of cover materials on completed fills, or to collect contaminated sediments eroded from disposal areas. For disposal sites undergoing final grading (after capping and prior to revegetation), construction of benches or terraces may be included as part of the integrated site closure plan.

This technology already exists at the site, and is effective in slowing down runoff. Further slope reduction cannot be accomplished without excavation into the fill. Therefore, this technology is eliminated from further consideration.

9.6 Bank Protection Controls

Since the Lees Lane Landfill Site is adjacent to the Ohio River, the river bank which comprises the western boundary of the landfill is susceptible to erosion and failure. Visual inspection of the bank reveals exposure of some root systems from trees and other vegetation. A steep non-vegetated area ranging from 5 to 20 feet in height exists below the first terrace throughout the length of the river bank. Refuse, consisting of construction rubble, drums, scrap metal, and other waste material is noticeable in several areas. It appears the trash is on the bank from past dumping methods, which may have included pushing wastes over the bank. Erosion problems arising from drainage are not noticeable due to the very heavy vegetative growth from the first terrace to the top of the river bank. The implementation of a bank protection plan would help prevent future erosion of the bank and reduce the chance of landfill contents entering the Ohio River. This technology, therefore, will be retained for further consideration.

9.6.1 Technical Considerations

Bank protection controls are employed to minimize erosion and failure. Erosion occurs when individual soil particles at the river bank are carried away. Bank failure occurs when large sections of a bank fail and slide into the channel. At this site, both erosion and failure have occurred to a certain extent.

For revetments to be effective they should extend from the top of the embankment to below the toe of the underwater slope. In addition, the structure should begin and end with an erosion resistant feature of the bank. If these design features are not followed, the scouring action of the river can undermine the revetment. The protective barrier should also be able to adapt to changes in the bank surface and be strong enough to resist currents (Lindsey and Franzini, 1979).

Suitable revetments for this site are:

- Articulated concrete mattress
- Asphalt or concrete
- Riprap

Articulated Concrete Mattress

Each section of an articulated concrete mattress is comprised of several mattresses mounted on a wire mesh backing, with individual sections joined by wiring. The entire structure is generally placed on a gravel or other suitable filter blanket. This type of barrier has been shown to be effective but tends to be expensive (Lindsey and Franzini, 1979).

Asphalt or Concrete

The use of compacted asphalt or monolithic concrete will usually require the regrading of slope prior to placement. These revetments are also susceptible to damage from bank heaving or subsidence (Lindsey and Franzini, 1979).

Riprap

Riprap involves the use of stones or similar material for erosion protection. Variations of this technique include randomly dumped, wire-enclosed, and grouted riprap. The greatest advantage of this type of structure is its ability to adjust to bank changes without loss of protection. Considerations for design are stone size, slope, stability of filter blanket, and water velocity (Department of Transportation, 1967).

A summary of the technical screening for bank erosion controls is shown in Table 9-4.

TABLE 9-4
TECHNICAL SCREENING
BANK PROTECTION CONTROL TECHNOLOGY
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Bank Protection Control Technology	Retained for Further Evaluation	Comments
Articulated Concrete Mattress	No	Too expensive
Asphalt or Concrete	No	Very susceptible to subsidence
Riprap	Yes	Resistant to subsidence

9.6.2 Public Health and Environmental Considerations

Ferromagnetic studies conducted at the Lees Lane Landfill Site have shown anomalies along the Central and Northern Tracts of the bank. The presence of these anomalies and their proximity to the river bank suggests the potential for the erosion of landfill materials. Protection of the bank would serve to maintain the integrity of the landfill, decrease the potential for a future pollutant load on the river, and lower the risk to downstream water users.

9.6.3 Institutional Considerations

Many sources are available for the design of bank protection control structures. Any method employed will require routine inspection and repair of erosional effects.

9.6.4 Cost Considerations

The cost for bank protection control is primarily dependent on size of structure and materials used. The incorporation of locally available rock materials can reduce the expenditure for riprap construction. Depending upon the bank slope and condition, regrading can be an additional expense.

9.7 Groundwater Barriers

The hydrogeology of the Louisville area consists of an alluvial aquifer and a series of limestone aquifers. Beneath the alluvial aquifer, at approximately 110 feet below land surface, is a shale aquitard reported to be 100 feet thick. The depth to groundwater, below land surface, ranges from 30 to 50 feet. Regional groundwater flow of the alluvial aquifer is toward the Ohio River, although flow reversal would be possible if the river water level were to remain higher than groundwater level for an extended period of time. This technology will be evaluated in the event future monitoring reveals that contaminants are migrating toward Riverside Gardens.

9.7.1 Technical Considerations

Groundwater barriers are installed vertically to: (1) decrease the possibility of groundwater migration from the site or (2) divert groundwater so that contact with the waste materials is reduced. Groundwater barriers at this site might be constructed upgradient of the landfill to divert groundwater or could be constructed to completely surround the landfill.

Various methods and materials that can be used to construct impermeable groundwater barriers include:

- Slurry walls
  - Soil/bentonite
  - Cement/bentonite
- Sheet piling
- Gel injection
- Grout curtain
- Vibrating beam/asphalt

Construction of groundwater barriers is a relatively specialized technology practiced by only a few firms.

Groundwater barrier control involves a thorough hydrogeologic and geotechnical investigation prior to design. Variables affecting the long-term effectiveness of this technology include:

- Depth to bedrock
- Degree of fracturing of the bedrock
- Permeability of surrounding soils
- Aquifer transmissivity
- Hydraulic conductivity
- Soils classification
- Hydraulic gradient
- Compatibility with contaminants

At the Lees Lane Landfill Site, the depth to bedrock is over 110 feet resulting in serious construction problems. In addition, the RI estimated that the boundary of the filled area was only a few hundred feet from the river, limiting the maneuvering area on the steep bank for heavy construction equipment. Additionally, current levels of groundwater contamination and migration routes do not appear to require the use of groundwater barriers. Therefore, this technology is not being retained for further consideration.

9.8 Leachate Collection

Leachate seeps have been historically observed along the Ohio River side of the landfill. At the Lees Lane Landfill Site evidence indicates that contamination of surface water through leachate is not significant. The leachate reaching groundwater is in response to precipitation and surface water infiltration or runon by the Ohio River during high water stages. Although leachate is presently not a public health concern, leachate collection is being retained for further consideration due to the potential for future needs.

9.8.1 Technical Considerations

Leachate is defined as the contaminated liquid discharged from a waste disposal site to either the surface or subsurface. Leachate control systems are designed to collect and control the leachate prior to entering the groundwater or surface water.

The following leachate collection technologies have been undertaken at various sites:

- French drains
- Tile drains
- Pipe drains

French Drains

French drains are constructed by excavating a trench, lining the trench with filter fabric, and backfilling with gravel. Leachate that is intercepted then flows along the trench to a sump, tank, or appropriate collection point. The French drain is not as efficient as tile and pipe drains for conveying leachate because of lower hydraulic conductivity.

Tile Drains

Tile drains are similar to French drains, but have vitrified clay pipe placed along the bottom of the trench in the gravel to provide a more effective conduit for leachate removal. Leachate seeps into joints between each length of pipe. The joints are, however, subject to clogging and the pipe is susceptible to crushing.

Pipe Drains

Pipe drains are similar to tile drains, except that the clay pipe is replaced with perforated plastic pipe, which is installed with sealed joints. This eliminates the potential for clogging; and plastic pipe has more resistance to crushing than clay pipe. Therefore, pipe drains are the preferable method of shallow leachate collection.

Leachate collection systems are normally followed by treatment. Because the chemical constituency and quantity of leachate varies, the treatment system should be based on a treatability study program. The leachate quality may also change with the age of the landfill.

The infiltration fraction of precipitation is generally the principle contributor to leachate generation. At the Lees Lane Landfill Site the large fluctuations in groundwater levels within the site could also contribute to disparaties in leachate quantities over time. Any system design would need to take this into account.

Some waste may be occassionally below the water table and deep excavation would be needed prior to construction of the leachate collection system. The area in

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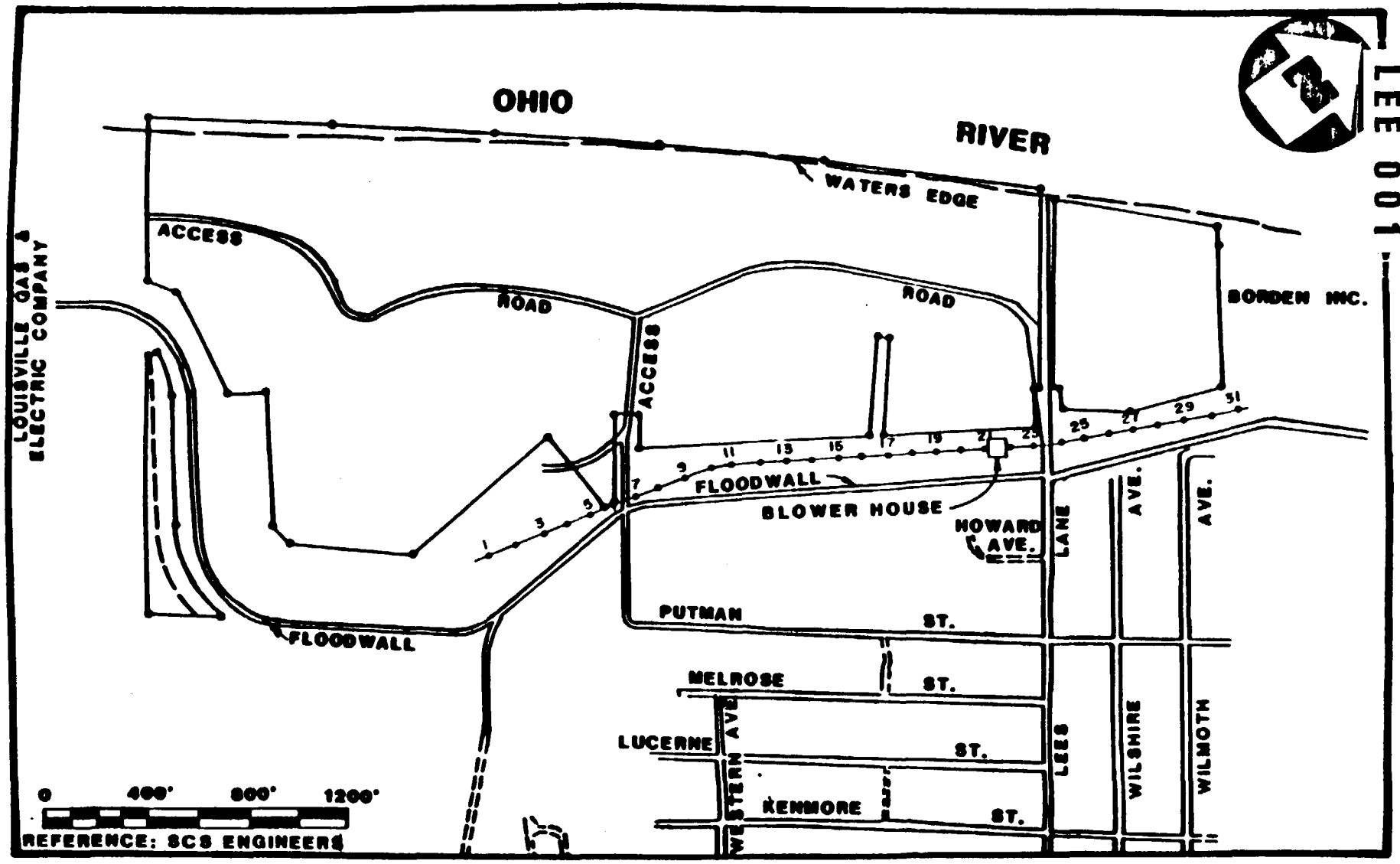
which to construct the collection system would need to be on the Ohio River side of the landfill, but this area is limited due to the proximity of the fill to the Ohio River. Also, any collection system would be very susceptible to clogging. Considering these factors, leachate collection is judged impractical and infeasible and is therefore not being retained for further consideration.

9.9 Gas Collection and/or Venting

A gas migration control system was put into operation at Lees Lane Landfill Site in October 1980 to address the problem of reported flash fires at several homes in Riverside Gardens. The design criteria for the system were discussed in Section 6.3. The system as constructed is shown in Figure 9-2. A total of 31 wells 25 to 30 feet deep were installed and connected to a centralized blower system. The wells are approximately 75 feet inside the landfill boundary, spaced 75 feet apart.

On November 13 through 15, 1984 a field investigation of the gas collection system was performed by IT Corporation. A copy of their report is included in Appendix M. In summary, the system was reportedly in poor and inoperative condition. The landfill had subsided, vegetation had overgrown many of the well systems' components and many of the components were destroyed.

The suspected problems outlined by IT Corporation from their November 1984 investigation were explored on November 3, 1985 by SCS Engineers. Many of the confirmed problem areas were repaired by Jefferson County as directed by SCS Engineers from December 9 to 13, 1985. On February 18, 1986, SCS Engineers re-evaluated the system and is presently working with the county to correct any problems that remain. These problems need to be addressed before determining whether the present system needs additional repair. Since sampling studies have confirmed that gas production is still occurring, this technology will be considered further.



GAS COLLECTION SYSTEM
LEES LANE LANDFILL SITE
JEFFERSON COUNTY , KENTUCKY

FIGURE 9-2

NUS CORPORATION
A Halliburton Company

LEE 001 001117

9.9.1 Technical Considerations

It appears that the present system can be repaired with little additional cost. Active systems, similar to the existing system, draw or force the gas out of the landfill.

The discharge from the gas collection system could include compounds that may pose a public health risk. A gas burner was initially designed for this system and would be the most appropriate method for treating the gases. If future monitoring reveals a potential health risk is being created by discharge from the gas collection system a burner would be installed. Gas collection and treatment is an established, technologically feasible, and acceptable engineering practice. Therefore, it will be retained for further consideration.

9.9.2 Public Health and Environmental Considerations

A gas collection system with treatment minimizes public health and environmental impacts by preventing undesirable and possibly dangerous levels of methane and/or toxic vapors from migrating into the Riverside Gardens neighborhood.

9.9.3 Institutional Considerations

No design requirements are specifically applicable to gas collection systems. Treatment processes for air pollutants are well established. Various guidance documents are available for design and construction of such systems.

9.9.4 Cost Considerations

The costs of repairing the present system and installing a burner should not be significant. The active elements in the gas collection system include fans and blowers, which add considerably to operation and maintenance costs. These elements are maintenance intensive and will eventually require replacement. If treatment is needed, additional capital and operation and maintenance costs will be incurred.

9.10 Groundwater Collection

The Ohio River rises and falls throughout the year and is known to periodically rise above the land surface of the landfill. The groundwater table also rises and falls and may periodically intersect the fill material. However, only low levels of contaminants have been found in the groundwater and this groundwater discharges to the Ohio River at approximately 1.69 cubic feet per second (cfs). Section 4.3.4.4 shows the calculation for the dilution factor of groundwater into the Ohio River (approximately 67,500 to 1). The large flow of the river and the low level of contaminants in the groundwater minimize the effect on the Ohio River.

9.10.1 Technical Considerations

This technology involves removal of a contaminated plume by pumping downgradient wells or through gravity collection. Gravity collection is accomplished through the installation of interceptor trenches or French drains downgradient of the source. Since the depth to the water table is approximately 50 feet, gravity collection will be precluded from further consideration.

A system to extract the groundwater could also involve the installation and pumping of wells downgradient, close to the Ohio River, to remove contaminated groundwater moving through the site. Such a system is expected to extract large volumes of Ohio River water through induced infiltration, and flooding of Ohio River may damage the pumping system. Therefore, the extraction of groundwater from beneath the site through the use of pumping wells is judged not practical and/or effective and it will not be considered further.

9.11 Removal and/or Control of Surface Waste

Past sampling investigations and site reconnaissances have confirmed the presence of approximately 25 drums on the bank of the Southern Tract. Other areas with scattered drums have also been observed. During the RI, the surface soil in the vicinity of the 25 drums and the soil surrounding another area with a few drums were sampled. The results of the analyses showed low or no levels of contaminants in the surrounding soil, but the drums have never been sampled. Eight denuded

areas were also sampled during the RI. Two of these areas, covering approximately 36 square feet, contain contaminant levels above background. A sample of surface waste material was also collected and showed high levels of several contaminants. The southwest outer edge of the Southern Tract has an area of approximately 25 square feet of exposed trash. Removal of the drums on the landfill surface and covering the two soil areas and surface waste material as well as the area in the Southern Tract with exposed trash are considered appropriate at the site and this technology will be retained.

9.11.1 Technical Considerations

Careful handling is necessary whenever drummed waste is removed at a site. Transport of the waste material found in drums at the Lees Lane Landfill Site is the most applicable method available. Pre-transport consolidation of waste from corroded drums to secure drums or blending of wastes in a holding tank would depend on the waste material. It is important that the waste from each drum be analyzed to prevent the mixing of incompatible waste. A mixing tank can be used as a precaution to prevent an accident once the waste is loaded into a tank truck.

The two soil areas and area of exposed waste material can be easily covered with soil and clay. The exposed material on steep slopes of the outer edge of the Southern Tract can also be covered by trucking in soil to reduce the degree of the slope.

9.11.2 Public Health and Environmental Considerations

Clean up of surface waste areas will reduce the site's public health and environmental impacts through direct contact.

9.11.3 Institutional Considerations

Drum removal and covering of soils are well-established techniques and guidance documents are available.

Any waste transport will need to meet Department of Transportation (DOT) and RCRA requirements including the performance of analyses of waste materials. Before shipping hazardous waste, it will be necessary to package the material in accordance with applicable DOT regulations (49 CFR 172) and to prepare a manifest.

9.11.4 Cost Considerations

The costs associated with this technology involve analyses, soil trucked to the site, removal, transportation, and disposal fee.

9.12 Removal of Contaminated Soil/Sediment

At landfill sites, contaminated sediment, ponded water and/or soils may be physically removed. This is considered separately from the surface waste areas discussed in Section 9.11. Removed material may be disposed at an approved offsite facility or in onsite areas that must be constructed and closed in an environmentally safe manner which satisfies the requirements of RCRA. This technology is considered separate from excavation, as soils and sediments are generally surface materials requiring shallow scraping (2 or 3 feet maximum depth) of the material, as opposed to deep excavation. This technology has been frequently applied at similar sites using standard engineering practices.

At the Lees Lane Landfill Site, levels of contamination in surface media are very low and present no health or environmental hazards. Therefore, this technology will not be considered further.

9.13 In-Situ Treatment

The wastes deposited at the landfill could include contained and uncontained solids and liquids. The landfill was believed formed by random dumping of various unknown wastes into open pits created by sand and gravel operations.

In-situ treatment methods are only useful for in-place treatment of soils contaminated to a shallow depth. Since the depth of fill at the Lees Lane Landfill

Site averages 25 feet and the nature of the waste is unknown, this technology will not be considered further.

9.14 Excavation

The approximate volume of waste material in the landfill has been estimated at 2,400,000 cubic yards. Numerous sources, including well logs, aerial photographs, geophysical surveys and topographic maps were used to aid in determining the approximate location and volume of waste material buried in the landfill. Because the types of waste were unknown, no attempts were made during the volume approximation to distinguish between domestic and industrial wastes. This estimated volume does not include the surface debris previously discussed.

9.14.1 Technical Considerations

Excavation involves the physical removal of the wastes using common excavation practices and typical equipment including draglines and backhoes. Excavated material, including both buried drum wastes and contaminated loose wastes, or any combination of these, can be loaded into trucks and hauled to an approved facility. During the excavation process, groundwater may need to be removed and may require treatment prior to discharge to the Ohio River. Pilot studies would be necessary to design the appropriate treatment scheme. After excavation, the site must be backfilled, regraded, and revegetated.

Excavation is a commonly used and well-established technique that involves standard engineering technology.

9.14.2 Public Health and Environmental Considerations

This technology removes the wastes from the site and precludes further contaminant migration. However, during excavation, the public would be subject to greater risks than are presently encountered because of the possible exposure to vapors and particulates released during excavation and the transport of materials through residential areas.

9.14.3 Institutional Considerations

Transporting of wastes resulting from excavation must meet DOT, RCRA, and State/Federal shipping and manifesting regulations.

9.14.4 Cost Considerations

Costs are given in dollars per cubic yard as the standard excavation measure. A cubic yard is assumed to weigh about one ton. Transportation and disposal costs must be included as part of the overall costs. Factors most affecting excavation costs include:

- Depth (volume)
- Health and safety requirements
- Physical state of materials
- Distance to disposal facility
- Disposal fee

Backfilling, regrading and revegetation after removal are necessary to prevent large open areas that would trap rainfall and run-on.

9.15 Incineration

The Lees Lane Landfill Site encompasses approximately 112 acres. The fill material is expected to contain a variety of wastes including a large quantity of contaminated soil. Incineration of the wastes would significantly reduce the volume and toxicity of the landfill materials and will be retained for further evaluation.

9.15.1 Technical Considerations

Incineration is a process where organic and mixtures of organic and inorganic wastes are thermally decomposed. This is a well-established and proven technology which can result in converting toxic components into less harmful material while significantly reducing waste volume.

Identification of numerous chemical, physical, and thermodynamic properties of the waste are essential in determining the suitability for incineration and type of incineration to be employed. Some of the more critical characteristics include organic content, ash content, metals concentration, moisture content, form, and heating value. Prior to any type of incineration, separation of materials in the fill will be required. During incineration wastewater is generated and may need treatment prior to discharge. A pilot study will be necessary to design an appropriate treatment scheme.

Potential incinerator types are:

- Fluidized bed
- Multiple hearth
- Cement kiln
- Lime kiln
- Rotary kiln

Fluidized Bed

Fluidized bed incinerators have a high potential for hazardous waste disposal. This type of incinerator has the capacity to handle all waste forms and can produce temperatures in excess of 810° C (1500° F). An incinerator of this type will not be considered due to the limited experience with hazardous waste.

Multiple Hearth

Multiple hearth incinerators were initially designed for the disposal of sewage sludges. They are not appropriate for wastes which are bulky, contain a large ash content, or require high temperatures for combustion (Bonner, 1980). This type of incinerator will not receive further consideration.

Cement and Lime Kilns

Incineration in industrial processes such as lime and cement kilns would be useful for their destructive capabilities and for the low cost heating value of the wastes.

The frequent need for an altered feed mechanism and the risk of worker exposure, reduce their desirability for hazardous waste use. Therefore, these types of incineration will not be retained for further consideration.

Rotary Kiln

Rotary kiln incinerators have widespread applicability and are the major type used in the destruction of hazardous wastes. Their ability to handle liquid and solid wastes in kiln temperatures in excess of 1400° C (2500° F) make them the most suitable incinerator for this site. Typical components for this process are a waste feed system, rotary kiln, auxillary feed, afterburner, and air pollution control devices (Bonner, 1980). This type of incineration will be retained for further consideration.

A summary of the technical screening for incineration is presented in Table 9-5.

9.15.2 Public Health and Environmental Considerations

Incineration is a disposal technique which can significantly reduce environmental and public exposure to hazardous material. This is achieved by thermal destruction of waste and volume reduction. This benefit can be enhanced with onsite incinerators to prevent accidental exposure from the transporting of the waste to an offsite facility.

The incineration process, while considered an ultimate disposal method, does generate waste byproducts. These include air emissions, waste streams from air pollution devices, and thermally refractive solids. Therefore, appropriate means for handling these byproducts are essential in the development and operation of an incineration facility.

9.15.3 Institutional Considerations

Offsite incineration must be handled by an EPA-approved RCRA facility. Before shipment of any hazardous waste, it will be necessary to package the material in accordance with applicable DOT regulations (49 CFR 172). In addition, RCRA and

TABLE 9-5
TECHNICAL SCREENING
INCINERATION TECHNOLOGY
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Incineration Technology	Retained for Further Consideration	Comments
Fluidized Bed	No	Limited experience
Multiple Hearth	No	Not appropriate for waste requiring high temperatures
Cement Kiln	No	Not appropriate for hazardous waste
Lime Kiln	No	Not appropriate for hazardous waste
Rotary Kiln	Yes	Applicable for variable liquid and solid wastes

the Kentucky Natural Resources and Environmental Protection Cabinet (NREPC) require the preparation of a manifest prior to shipment.

An onsite incinerator must also meet RCRA standards as well as the appropriate state regulations. Prior to obtaining permits, submission of waste analysis and trial burn results may be required. During operation, monitoring of air emissions and wastewater streams would be needed.

9.15.4 Cost Considerations

Capital outlay for an onsite incinerator includes construction costs or lease fees for mobile incineration. Principle operation and maintenance costs for onsite facilities are labor, auxillary fuel, and pollution control. In addition, permitting and testing costs can be incurred. Incineration costs can vary widely depending on process design, capacity, and operational parameters.

The primary costs involved with offsite incineration are commercial facility charges and transportation. Factors having the greatest impact on offsite costs are waste composition and form.

9.16 Disposal Technologies

At the site, any material which is excavated may need to be disposed of at an appropriate installation. As discussed previously, approximately 2.4 million cubic feet of fill would be excavated. Since this technology could follow excavation, it will be considered further.

9.16.1 Technical Considerations

Disposal technologies included are:

- Onsite disposal
- Offsite disposal

Onsite Disposal

Onsite disposal requires the construction of a secure hazardous waste landfill on site. Elements of such a site must meet the applicable RCRA and Kentucky NREPC requirements and regulations. Thus, the landfill would be designed to provide a lined base and sides, a leachate and runoff collection system, and a final cover to reduce rainfall infiltration. This technology is not applicable at the Lees Lane Landfill Site because the entire site falls within the 500-year floodplain and a new landfill could not be constructed in a floodplain due to RCRA regulations.

Offsite Disposal

Offsite disposal involves excavation of the contaminated wastes and soils and transport of the materials to the nearest EPA-approved hazardous waste disposal facility that complies with current RCRA requirements. All aspects of offsite disposal are based on standard engineering practice, provided an approved hazardous waste landfill is used as the disposal site. This technology is applicable for use at the Lees Lane Landfill Site.

9.16.2 Public Health and Environmental Considerations

Offsite disposal techniques may cause airborne contaminants to enter Riverside Gardens and other areas where the transportation of these wastes will occur.

9.16.3 Institutional Considerations

Construction of a new facility for disposal has varied design and construction requirements under RCRA and state regulations. RCRA design and permitting standards are currently contained in Subpart C, 40 CFR Part 264. There are various guidance documents regarding siting, design, construction, and permitting of such facilities. Construction of a landfill could restrict future uses of that land.

Commercial disposal facilities must meet stringent RCRA, and state permitting and compliance standards. Using offsite facilities also requires that DOT and

RCRA requirements for hazardous waste transport are met. In addition, RCRA and the Kentucky NREPC require the preparation of a manifest prior to shipment.

9.16.4 Cost Considerations

Costs for offsite landfill disposal include transportation and disposal expenses at a commercial landfill or the cost of constructing a new landfill.

9.17 Development of Operable Units

The technologies remaining after the initial screening (see Table 9-6) were combined to develop the operable units that would meet the site-specific remedial action objectives and the criteria for the evaluation of alternatives. The combined technologies were screened with respect to the remedial objectives, as outlined below:

- To maintain public health and safety
- To maintain the quality of local environment
- To ensure technical feasibility, public acceptability, and cost-effectiveness of the remedial actions.

In addition, the results of the Remedial Investigation shown below were used to eliminate other technologies as not being applicable to current site problems.

- Based upon the results of the gas migration investigation and public health assessment, gas migration is considered to be a significant problem at the site.
- Based upon the results of the hydrogeologic investigation and public health assessment, potential migration of contaminated groundwater is not considered a significant problem at the site.

TABLE 9-6
POTENTIAL REMEDIAL ACTION TECHNOLOGIES
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Technology	Passed Initial Screening	Applicable To Site Problems
Site Remediation:		
No Action	No	-
No Action-Monitoring	Yes	Yes
Alternate Water Supply (Extension of Municipal Water)	Yes	No
Surface Capping (Clay)	Yes	Yes
Surface Regrading and Revegetation	Yes	Yes
Surface Water Diversion	No	-
Bank Protection Controls (Riprap)	Yes	Yes
Groundwater Barriers	No	-
Leachate Collection	No	-
Gas Collection and/or Venting	Yes	Yes
Groundwater Collection	No	-
Removal and/or Control of Surface Waste	Yes	Yes
Removal of Contaminated Soil/Sediment	No	-
In-Situ Treatment	No	-
Excavation	Yes	Yes
Treatment of Removed Materials:		
Incineration (Rotary Kiln)	Yes	Yes
Disposal of Removed Materials:		
Offsite Disposal	Yes	Yes
Onsite Disposal	No	-

- Based on the hazardous substance and surface water, sediment and soil investigations and the public health assessment, eliminating the exposed surface waste materials and contaminated soils, may be advisable to reduce the possibility of direct contact since access to the site is not restricted.

Table 9-6 also indicates those technologies directly applicable to site problems.

After technologies are considered appropriate they are combined to form operable units that address one or more aspects of the identified site problems. Table 9-7 shows the operable units for the technologies and their objective(s). All the operable units meet the requirements referred to in the NCP (40 CFR 300.68 (e)) as source control types. Source control remedial actions are applied where hazardous substances remain at or near the areas in which they were originally located and are not adequately contained to prevent migration into the environment. Management of migration remedial actions are applied where the hazardous substances have largely migrated from their original locations.

TABLE 9-7
OPERABLE UNITS AND
REMEDIAL ACTION OBJECTIVES
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Operable Units	Objective(s)
Monitoring of Air, Gas and Groundwater	• Establish baseline data • Identify changes in site conditions
Alternate Water Supply	• Prevent future problems • Minimize monitoring requirements
Gas Collection System	• Prevent gas migration to Riverside Gardens
Cleanup of Surface Wastes	• Prevent direct contact
Bank Protection Controls	• Reduce erosion and bank failure • Prevent release of waste materials
Cleanup of Surface Wastes Clay Cap/Regrading and Revegetation	• Control leachate production • Restrict vertical gas migration • Prevent direct contact
Excavation/Onsite Incineration/ Offsite Disposal	• Prevent future problems • Reduce waste volume
Excavation/Offsite Incineration/ Offsite Disposal	• Prevent future problems • Reduce waste volume
Excavation/Offsite Disposal	• Prevent future problems

10.0 DEVELOPMENT OF REMEDIAL ACTION ALTERNATIVES

The operable units developed as a result of the technology screening process were used to form remedial alternatives for the Lees Lane Landfill Site. These remedial alternatives were developed using best engineering judgement to select a technology or groups of technologies that best addressed the problems existing at the site.

In order to study a range of responses, site remediation alternatives that fall into each of five different categories were developed. These categories are described below.

1. No action alternative.

2. Alternatives which do not attain applicable or relevant and appropriate public health or environmental requirements but will reduce the likelihood of present or future threat from the hazardous substances and that provide significant protection to public health, welfare, and the environment. This must include an alternative that closely approaches the level of protection provided by the applicable or relevant and appropriate standards.

3. Alternatives that attain applicable or relevant and appropriate Federal public health or environmental requirements.

4. Alternatives that exceed applicable or relevant and appropriate Federal public health and environmental requirements.

5. Alternatives for treatment or disposal at an off-site facility, as appropriate.

Each category will have at least one alternative, and may have more.

The operable units identified in Section 9.17 and the associated objectives were evaluated to determine the level of protection expected if the operable unit were to be selected as part of a remedial alternative. This evaluation was used to place each operable unit into one of the five categories of response (see Table 10-1). The operable units were then combined to form alternatives within the categories. Where more than one combination of operable units would accomplish the same objectives, two or more alternatives were formed.

After preliminary remedial alternatives were developed within the general response categories, they were subjected to another round of screening. This screening evaluated non-cost criteria, such as public health and environmental factors. Alternatives which did not meet the criteria were dropped, although one alternative was left in each category. The remaining alternatives were then put through an "order of magnitude" cost screening, where alternatives were dropped if they had a cost which was an order of magnitude greater than other alternatives in the same category which had equivalent public and environmental health benefits. The remaining alternatives in each category were then presented for use by the decision-making agency.

10.1 Development of Alternatives

Brief descriptions of the alternatives in each category that were developed for the Lees Lane Landfill Site are summarized in the following sections. All alternatives discussed are classified as source control remedial actions.

10.1.1 No Action Alternative

A base line alternative has been developed that will be used for comparison against other alternatives in which remedial actions will be taken. Under this alternative a monitoring program will be instituted to collect and analyze air, gas, and groundwater samples.

TABLE 10-1
SUMMARY OF TECHNOLOGIES BY ALTERNATIVE CATEGORIES
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Operable Units	No Action	Protect Public Health, Welfare and Environment	Satisfy All Applicable Standards	Exceed All Applicable Standards	Offsite Disposal
Monitoring	X	X	X	X	X
Alternate Water Supply		X	X	X	X
Gas Collection System		X	X		
Cleanup of Surface Waste		X	X		
Bank Protection Controls		X	X		
Cleanup of Surface Waste Clay Cap/Regrading and Revegetation			X		
Excavation/Onsite Incineration Offsite Disposal				X	
Excavation/Offsite Incineration Offsite Disposal					X
Excavation/Offsite Disposal					X

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10.1.2 Alternatives Which Protect Public Health, Welfare, and the Environment

Two alternatives have been developed which provide different levels of remediation. The first alternative includes the installation of a properly operating gas collection and venting system. This alternative will control the potential health threat that may result from gas migration into Riverside Gardens. Air, gas, and groundwater monitoring is included. Also an alternate water supply is contained in this alternative and the next two alternatives on a discretionary basis. The EPA will decide on the applicability of implementing this technology in the event future monitoring reveals contamination or potential contamination of groundwater at any drinking water well.

The second alternative in this category provides for a potential future alternate water supply, gas collection and venting, cleanup of surface waste areas, bank protection controls, and monitoring of air, gas, and groundwater. Implementation of this alternative will provide better protection through the removal of surface waste material and cleanup of exposed drums to reduce the potential for direct contact as well as the installation of bank protection controls to reduce the likelihood of erosion and bank failure.

10.1.3 Alternatives Which Satisfy All Applicable Standards

One alternative has been developed for this category. This alternative provides for air, gas, and groundwater monitoring, cleanup of surface waste areas, installation of a landfill cap, regrading and revegetation, gas collection and venting, bank protection controls, and a potential future alternate water supply.

10.1.4 Alternatives Which Exceed All Applicable Standards

One alternative has been developed for this category. This alternative includes monitoring for air, gas, and groundwater, a potential future alternate water supply, excavation of the waste from the landfill, decontamination of the wastes by

incineration onsite, disposal of decontaminated material in an offsite secure landfill, disposal of fly ash offsite in a secure RCRA landfill, backfilling, regrading, and revegetation of the excavation.

10.1.5 Alternatives that Specify Offsite Disposal

Two alternatives have been developed which provide different levels of waste treatment. The first alternative under this category would be to excavate and transport the waste to an approved RCRA landfill. The site excavation would be backfilled, regraded and revegetated. An air, gas, and groundwater monitoring program would also be implemented.

The second alternative would be to excavate and transport the waste to an incinerator and the non-incinerable material to an appropriate landfill. The site excavation would be backfilled, regraded and revegetated. A monitoring program for air, gas, and groundwater would also be implemented.

10.2 Description of the No Action Alternative

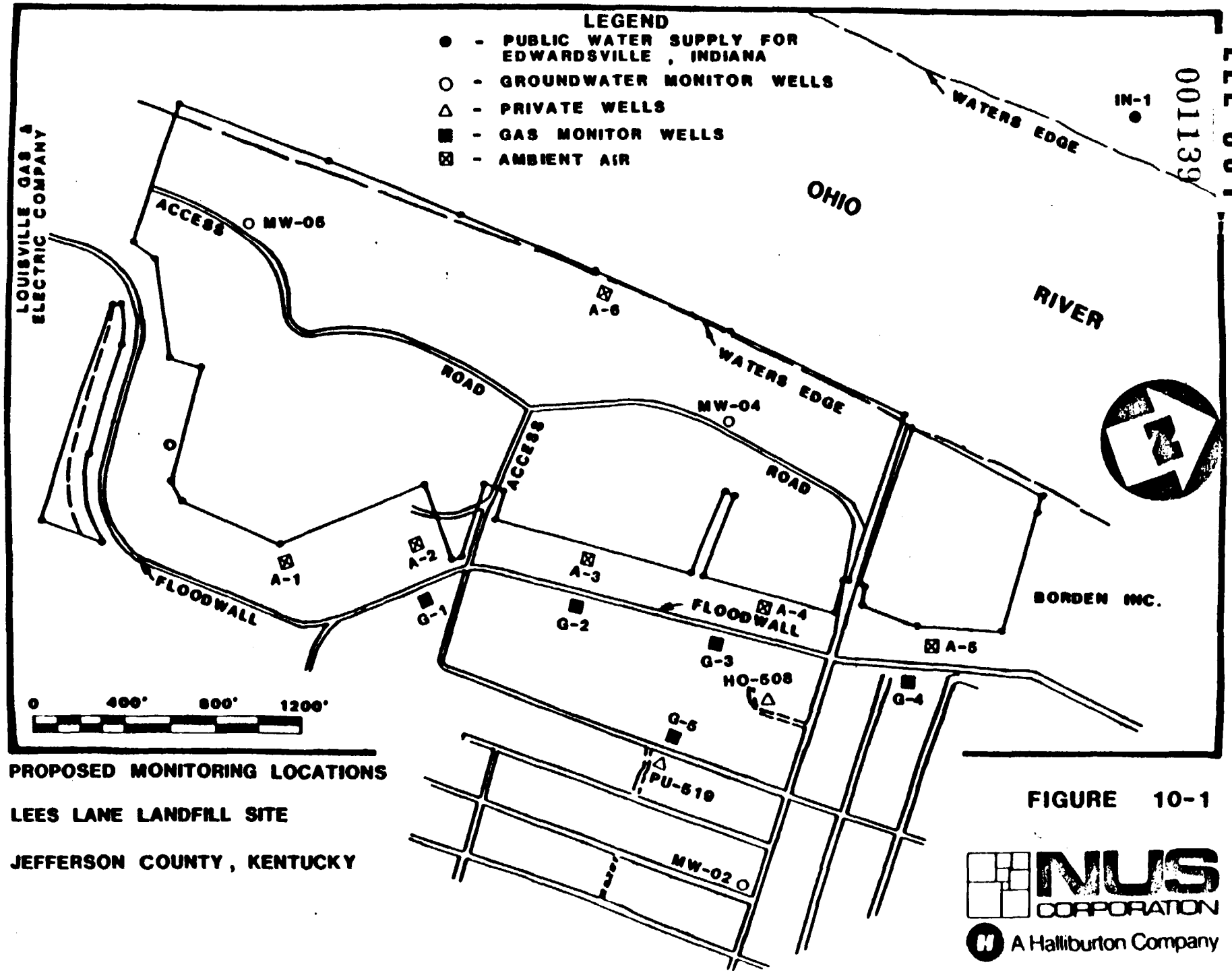
Under a no action alternative, additional remedial activities would not be performed. However, a long-term gas, air, and groundwater monitoring program will be established to provide information on contaminant movement, and on exposure to humans, sensitive and important non-human species, and the environment. Through the use of a comprehensive monitoring program, current baseline conditions can be established and future environmental impacts can be detected and programs implemented to mitigate the effects.

The primary source of contamination found at the Lees Lane Landfill Site is the production and subsequent migration of volatile organic contaminants. The gases have been shown to contain a variety of toxic contaminants, such as vinyl chloride, xylene, toluene, ethyl benzene, 1,2 dichloroethane and benzene. Both an ambient air monitoring program and a subsurface gas migration detection program will be implemented.

The subsurface gas migration detection program will require the installation of new observation wells since the existing wells have been damaged or removed. Four observation wells will be located outside the floodwall between the landfill and Riverside Gardens. One additional well will be located along Putman Street (see Figure 10-1). Each gas monitor well will have the capability of collecting samples from two depths as shown in Figure 10-2. The sampling program for gas will include quarterly monitoring for three years and then the program would be reevaluated for changes in analyses and sampling frequency. Initially, the gas samples will be analyzed for volatile organics.

The monitoring program also includes the collection of ambient air samples and analysis for volatile organic compounds. Initially six sampling locations will be employed three times per year for three years and then the program would be reevaluated for changes in analyses and sampling frequency. Five of these locations are along the southeastern boundary of the landfill and one location (background sample) is along the northwestern boundary of the landfill (see Figure 10-1). The sampling schedule should cover periods when soil temperature is near maximum, during periods of northwesterly winds, and periods in which no antecedent precipitation has occurred over a five-day period. The months of May, July, and September are expected to produce the optimum range for meteorological conditions. Meteorological data should be collected and recorded continuously during periods of ambient air sampling. At least two samples will be collected at each location per period and analyzed for vinyl chloride, xylene, toluene, ethylbenzene, 1,2 dichloroethane, benzene, and other volatile constituents.

Groundwater contaminants may be released to the Ohio River, nearby private wells, residential wells in Riverside Gardens, or public water supply wells in Indiana. Therefore, three of the monitor wells constructed during the RI plus two residential wells in Riverside Gardens and one well in the Indiana public water supply well field (Figure 10-1) will be used to monitor contaminants. Figure 10-3 shows the typical design used for the groundwater monitor wells constructed during the RI. The sampling programs for groundwater will include quarterly monitoring at six locations for three years and then the program would be reevaluated for changes in analyses and sampling frequency. Initially, the groundwater will be analyzed for the complete hazardous substance list (see Appendix F).



PROPOSED MONITORING LOCATIONS

LEES LANE LANDFILL SITE

JEFFERSON COUNTY, KENTUCKY

FIGURE 10-1

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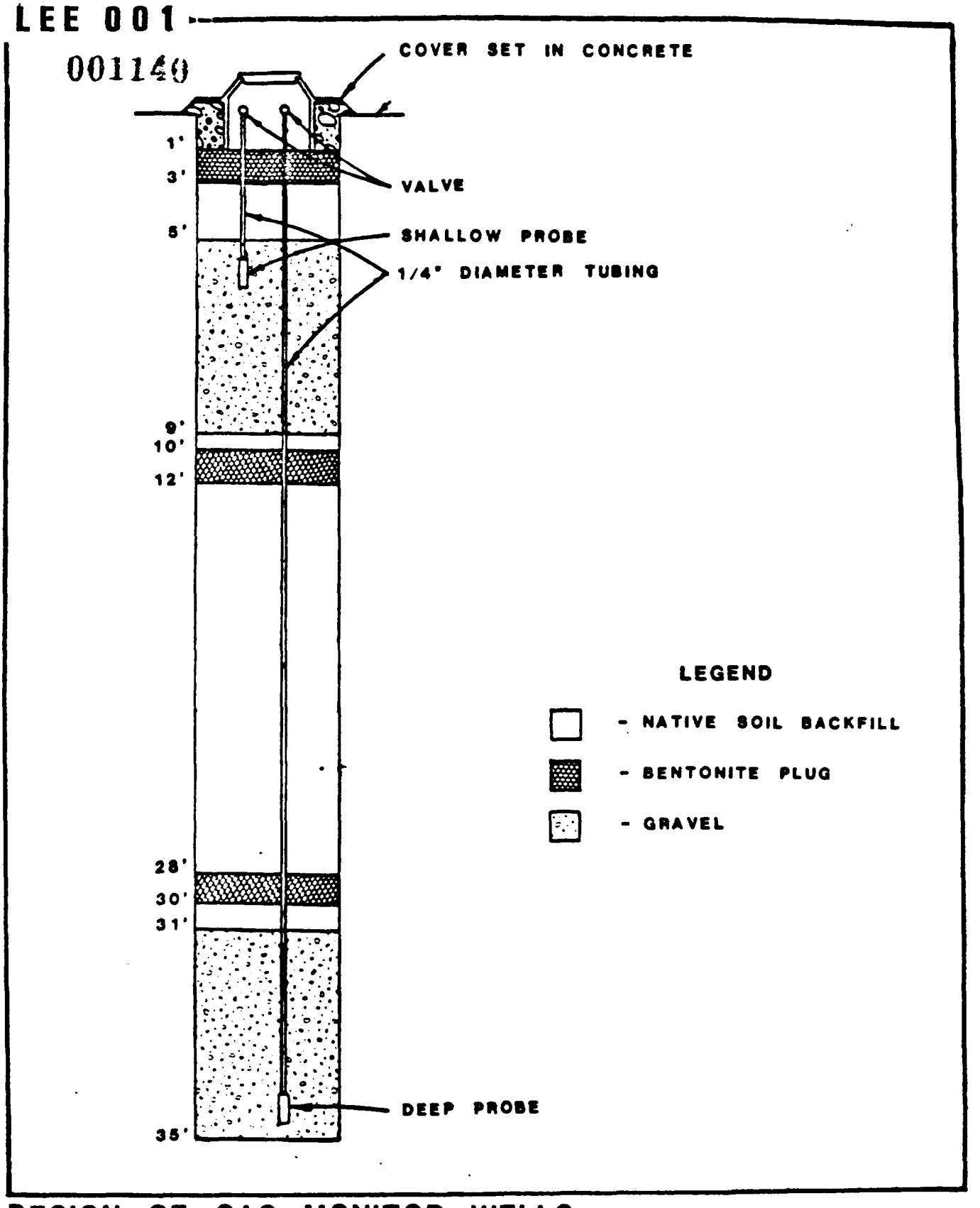

DESIGN OF GAS MONITOR WELLS

LEES LANE LANDFILL SITE

JEFFERSON COUNTY, KENTUCKY

FIGURE 10-2

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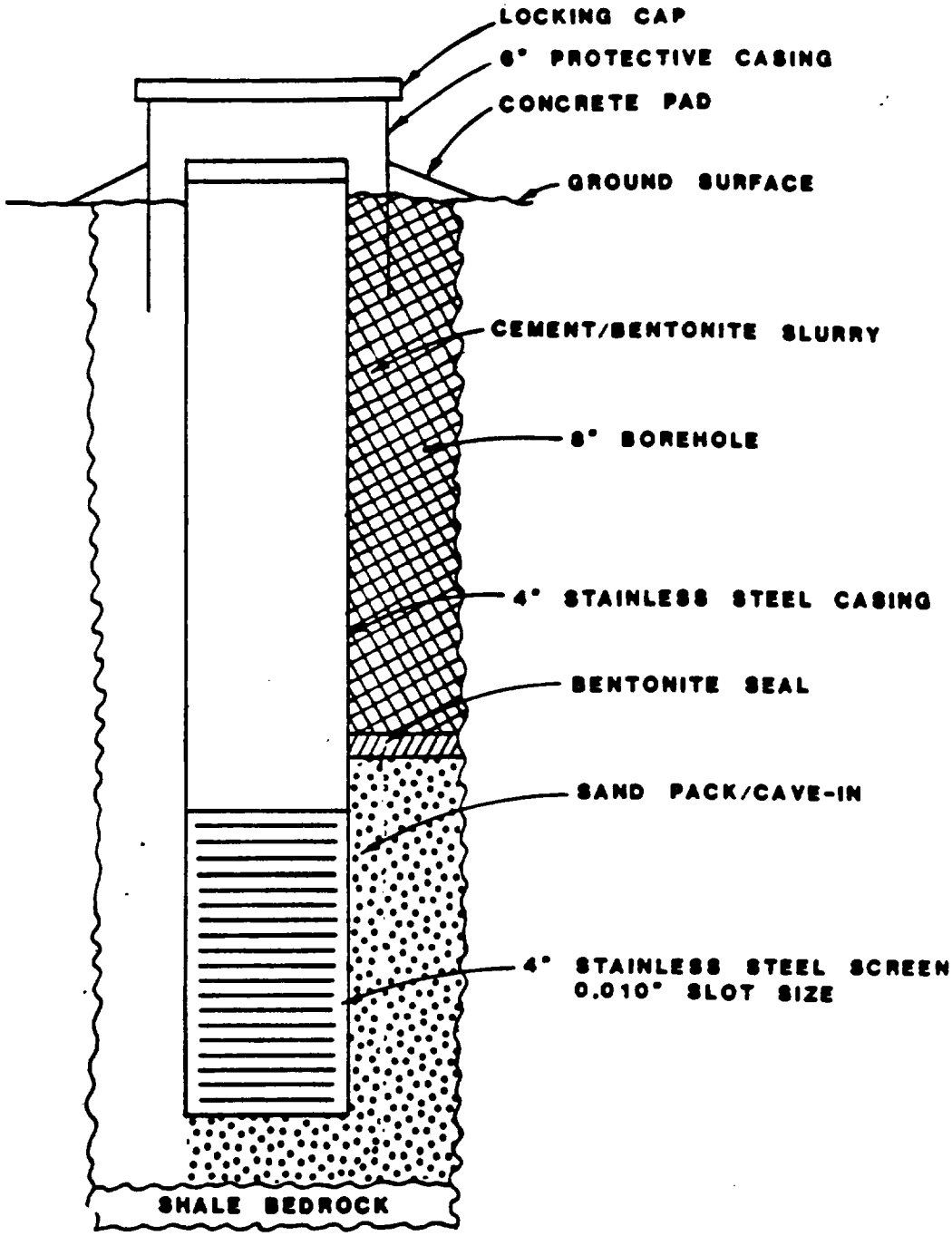

TYPICAL MONITOR WELL CONSTRUCTION
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

FIGURE 10-3

NUS CORPORATION
A Halliburton Company

10.3 Description of the Alternatives Which Protect Public Health, Welfare, and the Environment

The components of the two alternatives under this category include surface waste area cleanup, bank protection controls, gas collection and venting system, potential future alternate water supply, and monitoring. The two alternatives are:

(1) Gas collection and venting system, and monitoring

(2) Surface waste area cleanup, bank protection controls, gas collection and venting system, and monitoring

The monitoring program for the first alternative was discussed in Section 10.2. The monitoring program for the second alternative is discussed in the following section.

10.3.1 Monitoring

Both the gas and air monitoring programs discussed in Section 10.2 will remain the same. The groundwater monitoring program will remain the same with the addition described below.

The RCRA Groundwater Protection Regulations require corrective action if hazardous constituents are found in groundwater in excess of established concentration limits or above background levels. If it can be demonstrated that an alternative concentration limit (ACL) will not pose a substantial present or potential hazard to human health or the environment, then corrective action is not required. In order to identify the appropriate ACL for each hazardous constituent in the groundwater, the potential impact on human health and the environment are assessed and acceptable alternate concentration limits are determined based on potential exposure and toxicity.

The guidance available during the preparation of the FS suggests that before an ACL can be proposed, the hazardous constituents currently in the groundwater must be determined through chemical analysis for the 387 contaminants listed in 40

CFR 261 Appendix VIII and baseline groundwater quality at the site must be established. Based on the hydrogeologic conditions at the site, it is expected that at least two full years of groundwater monitoring data will have to be assembled before the ACL demonstration process can be initiated. During the preparation of the demonstration documentation it may be necessary to sample and characterize the waste materials in the landfill in order to comply with ACL demonstration requirements.

The groundwater monitoring program described here is expected to create the data base necessary for the initiation of the ACL process. As advised by the EPA RCRA permitting staff, groundwater from monitor well LL-9 (Figure 10-4) will be analyzed for the Appendix VIII constituents during the first year of monitoring and the other wells will be analyzed for the hazardous substance list of contaminants. During the remaining years of monitoring, all groundwater samples will be analyzed for the constituents detected in the groundwater sample from monitor well LL-9. At the end of the two-year period, the preparation of the ACL demonstration is expected to be initiated and to require approximately one year for completion and EPA review and approval. Beginning with year four, it is expected that the groundwater monitoring program will include only those constituents for which ACLs have been established.

10.3.2 Gas Collection and Venting System

A properly operating gas collection and venting system will be provided to prevent the migration of gas into the Riverside Gardens neighborhood. This will involve inspecting the existing system, providing any additional repairs identified as necessary, and installing a gas burner if a potential health risk exists.

The current design of the system includes pipe vents consisting of vertical perforated pipe installed in the landfill and connected to a common header. Forced ventilation through the use of a centralized fan pulls the gases out of the landfill and prevents migration. The flow rate of the centralized fan can be increased or decreased as the gas generation or vapor flux rate increases or decreases. Details of the existing system are in Appendix N and Figure 10-5 shows the present design of the gas collection wells.

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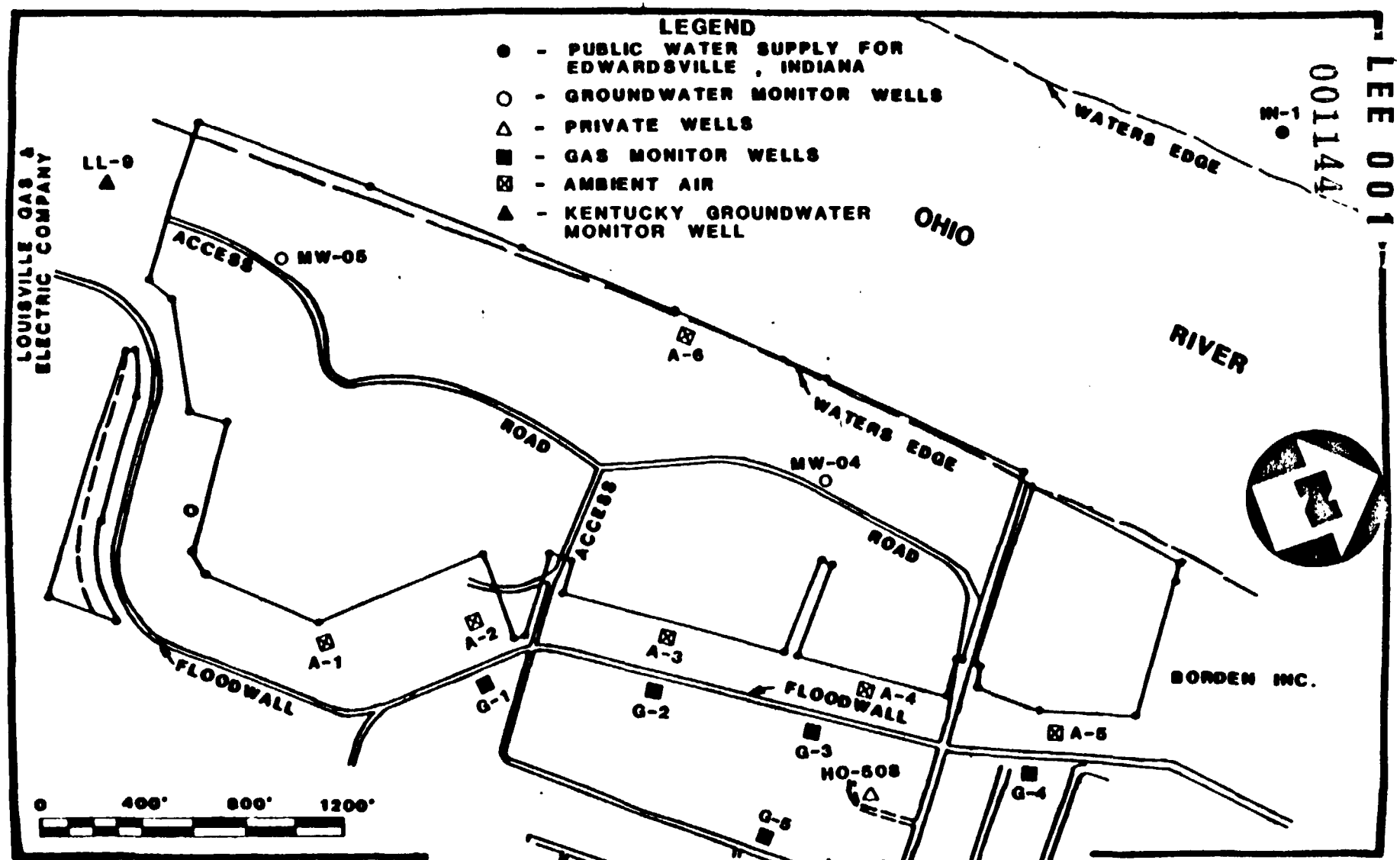

PROPOSED MONITORING LOCATIONS
FOR ACL DEMONSTRATION
LEES LANE LANDFILL SITE
JEFFERSON COUNTY , KENTUCKY

FIGURE 10-4

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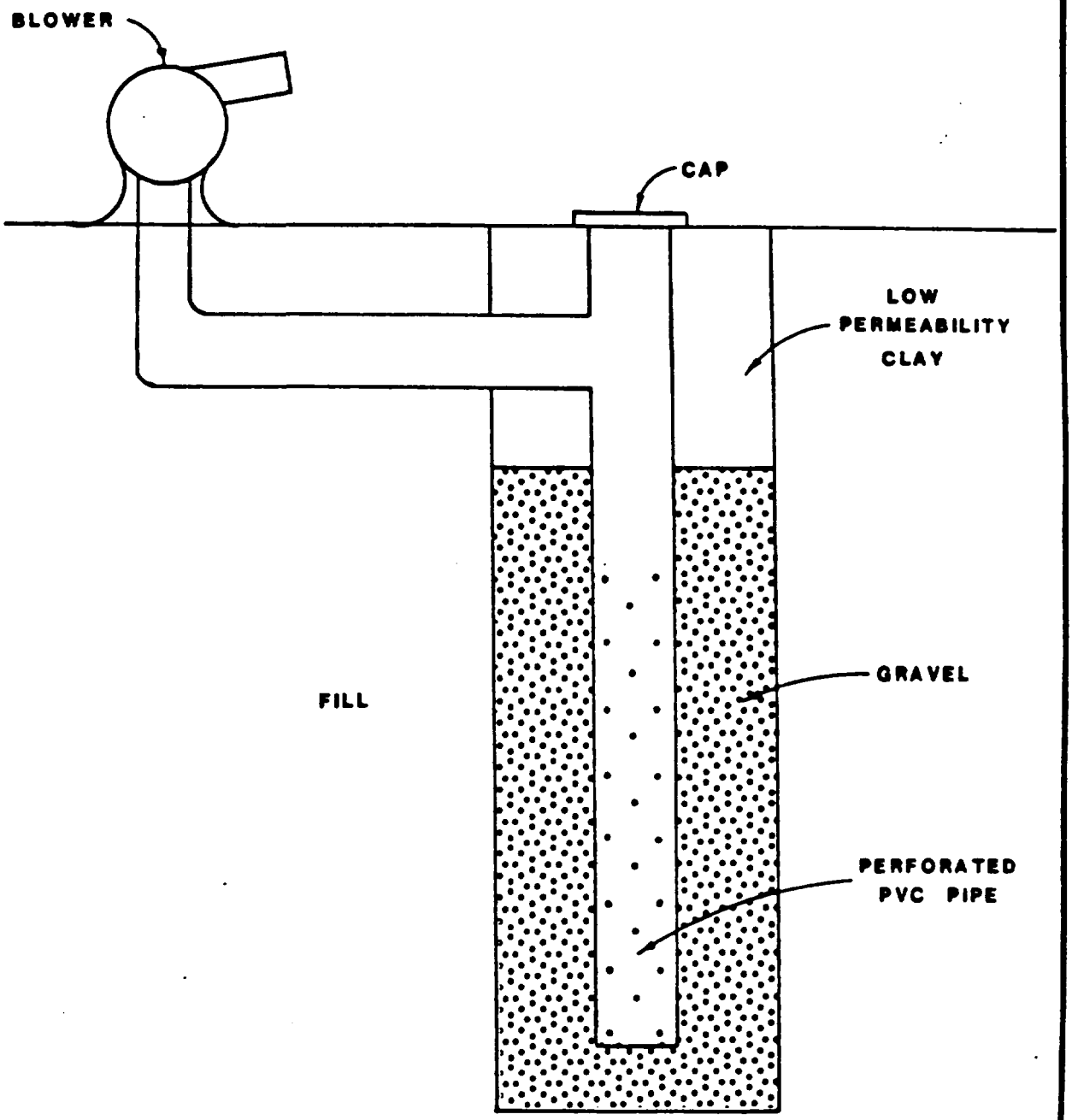

GAS COLLECTION WELL CONNECTED
TO FORCED VENTILATION
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

FIGURE 10-5

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10.3.3 Surface Waste Area Cleanup

During the RI sampling activities, several small surface soil "hot spots" were identified as well as several areas of exposed drums. In addition, on the southwest outer edge of the Southern Tract there is an area of approximately 25 square feet containing exposed trash. Removal of the drums and covering of the "hot spot" soils are planned in this alternative. Details on surface waste area cleanup are discussed below. The condition of many of the exposed drums is undetermined because they are partially buried. The drums need to be analyzed prior to excavation and removal to an approved RCRA landfill. The method of transferring the drums will depend upon their condition. Transport of drummed waste in original, overpacked, or alternate drums is the most applicable when the number of drums at the site is low (EPA, 1983).

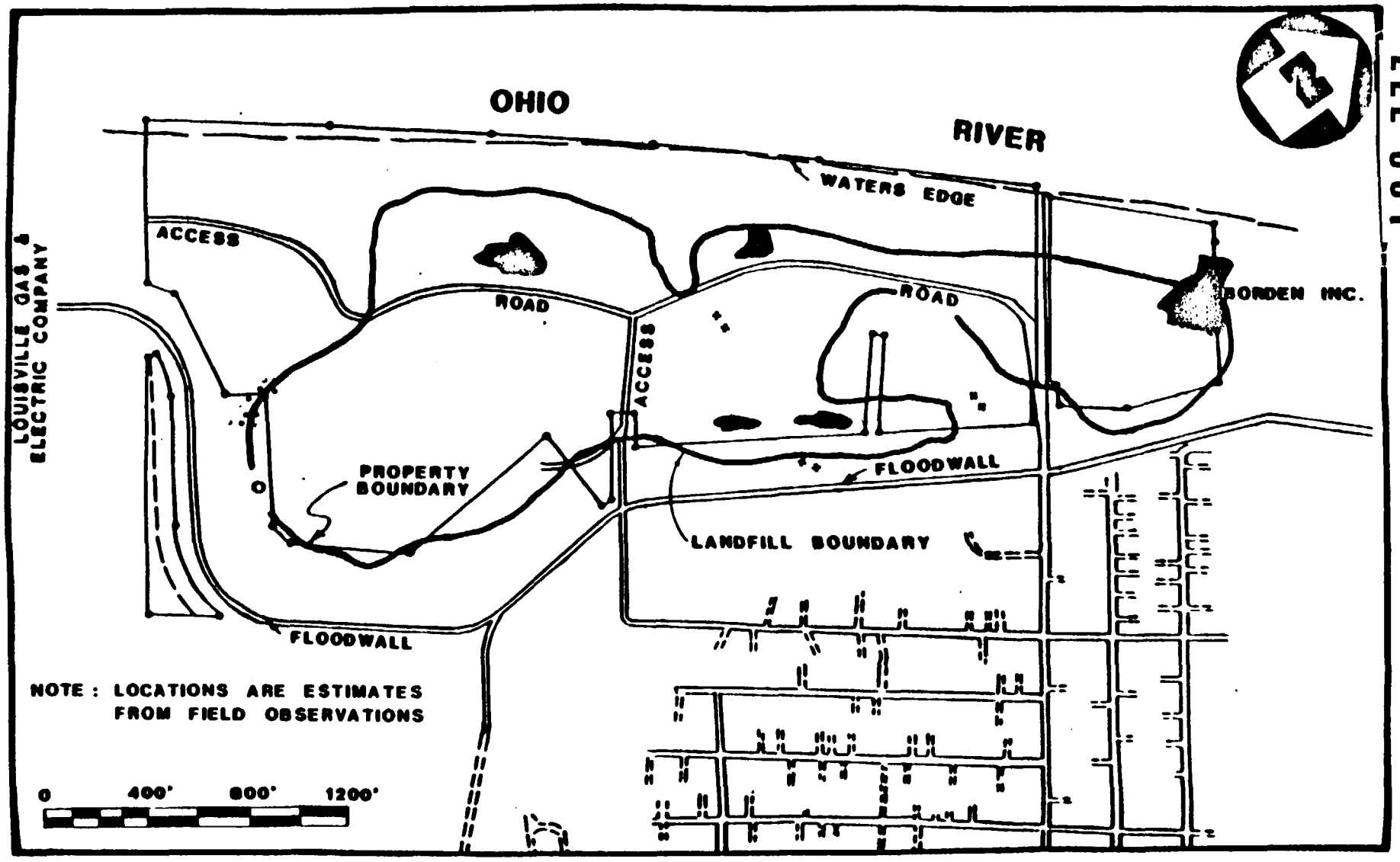
Figure 10-6 shows the location of the surface waste areas identified during the RI. The two surface "hot spot" soils can be covered with approximately 18 cubic yards of clay. This can be transported in one average-sized dump truck.

The exposed trash on the Southern Tract can be covered by trucking in clay and soil. Adequate clay must be available to cover the trash after soil is used to reduce the slope to prevent further erosion problems. Approximately 50 cubic yards of clay and soil will be needed. All three areas will be covered with top soil and seeded.

10.3.4 Bank Protection Controls

Bank protection controls will be employed to minimize the erosion potential and failure of the vulnerable Ohio River embankment. Visual inspection of the bank revealed exposure of vegetation root systems, making erosion due to river flow readily apparent. For the revetment to be effective it must extend from the top of the embankment to below the toe of the underwater slope (Figure 10-7).

Riprap is the most effective means to prevent erosion of the Ohio River bank. Riprap is a layer, facing or protective mound of stones randomly placed to prevent erosion, scour or sloughing of a structure or embankment (DOT, 1967). The



SURFACE WASTE CLEANUP AREAS

LEES LANE LANDFILL SITE

JEFFERSON COUNTY, KENTUCKY

LEGEND

- HOT SPOT AREAS
- EXPOSED TRASH
- DRUM LOCATIONS

FIGURE 10-6

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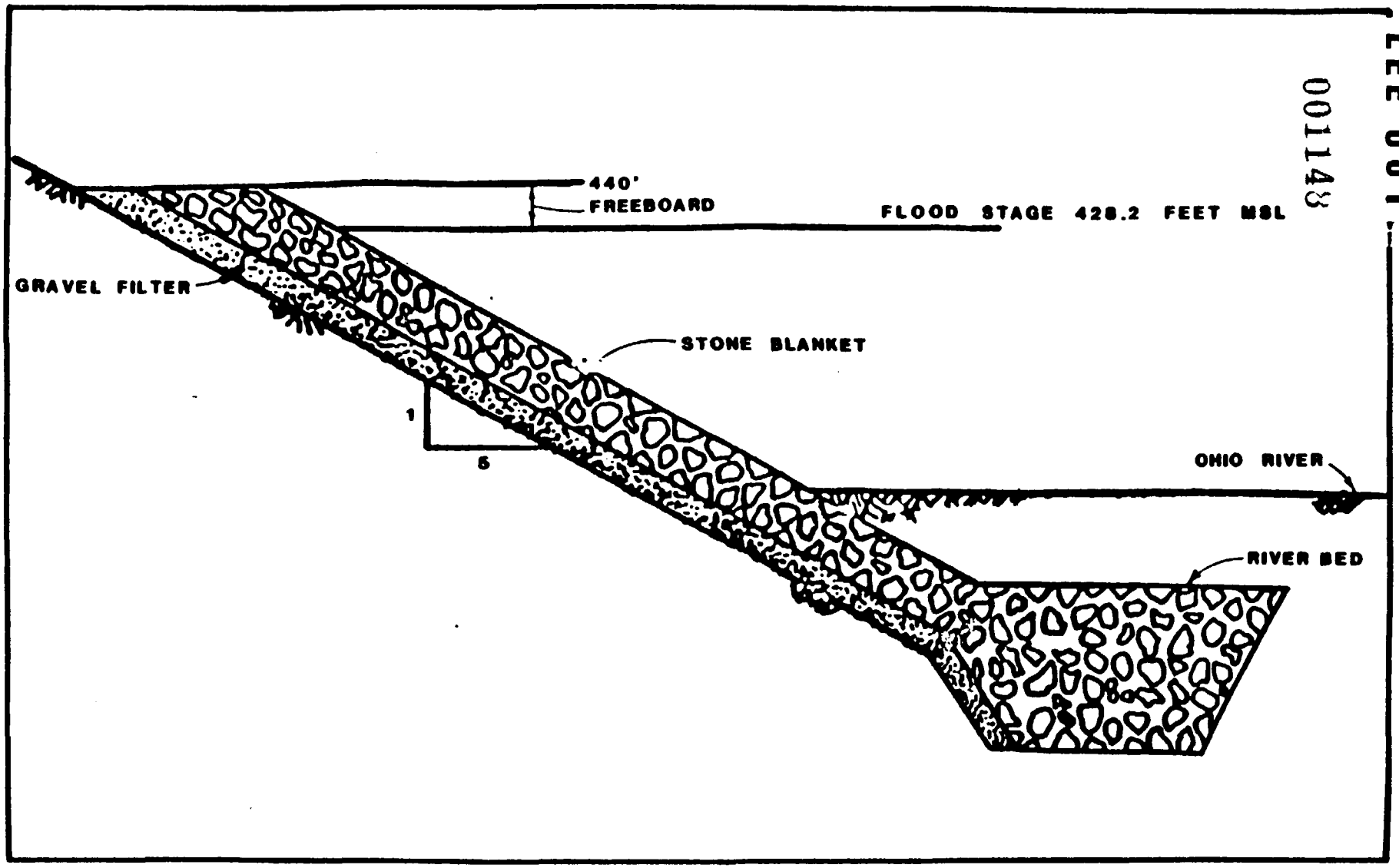


STONE RIPRAP BLANKET

LEES LANE LANDFILL SITE

JEFFERSON COUNTY, KENTUCKY

FIGURE 10-7

NUS CORPORATION
A Halliburton Company

revetment must be designed so that the riprap begins and ends with an erosion resistant feature of the bank. Other features affecting the resistance of the stone to displacement by moving water are:

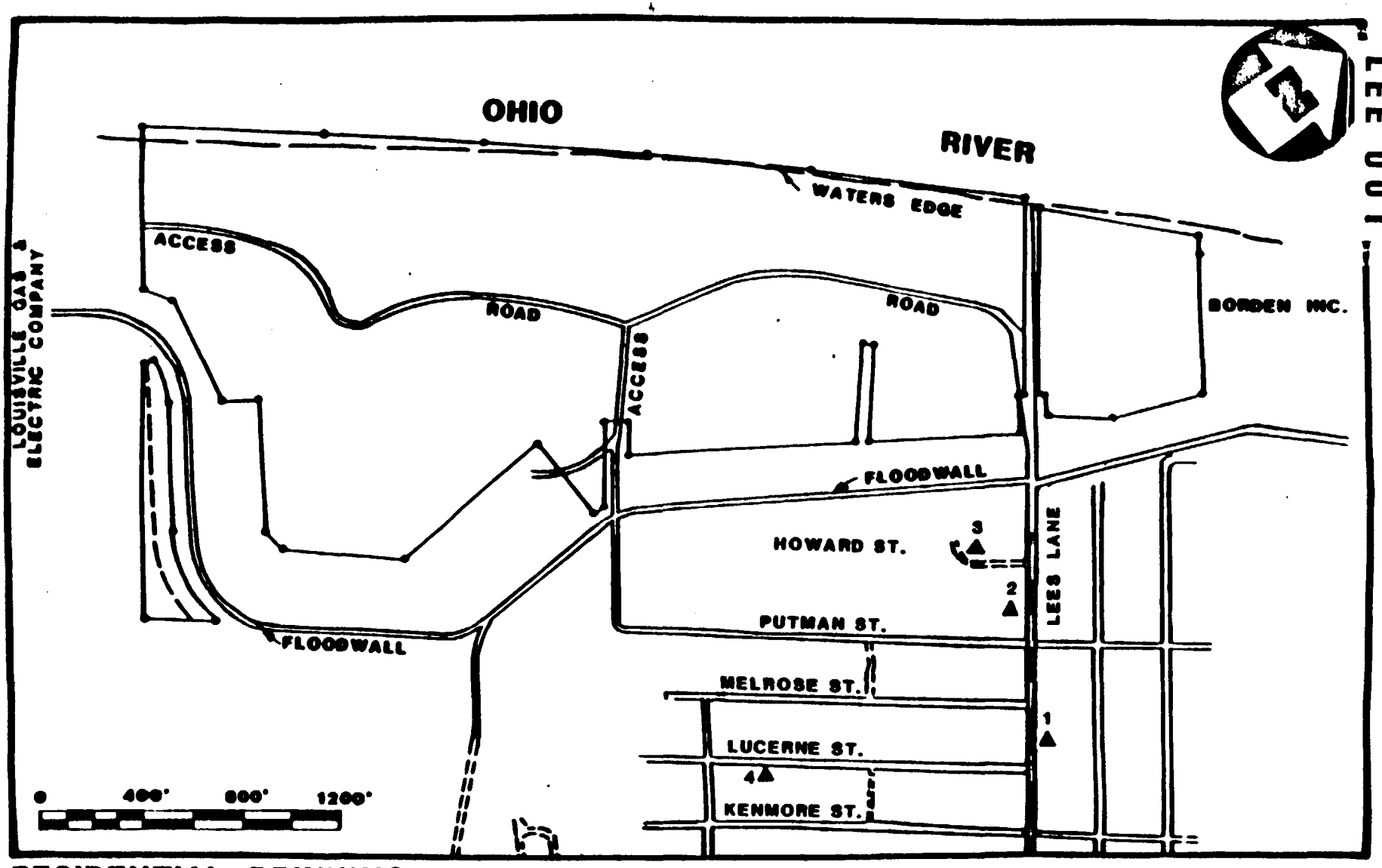
- Weight, size, shape, and composition of the individual stones
- Gradation of the stone
- Depth of water over the stone
- Steepness and stability of the protective stone
- Stability and effectiveness of the filter blanket under the stones
- The velocity of the water against the stones

The area that requires bank protection control is the entire bank (29 acres) along the Ohio River. This area has been defined as a result of a magnetometer investigation performed during the RI and through visual inspections. Prior to the riprap being installed, regrading will be necessary. The slope of the bank after regrading will be approximately 1 to 5. The size of stone needed to protect the bank from erosion by the Ohio River is determined by the figures in Appendix O. In data contained in the Riverport Environmental Impact Statement, the velocity of the Ohio River near the bank is 3 feet per second. Using the figure in Appendix O the size of stone required is 6 inches in diameter with a riprap thickness of 12 inches.

10.3.5 Potential Future Alternate Water Supply

During the RI, the well inventory conducted by Ecology & Environment in 1981 was reviewed and supplemented. The updated inventory indicated only three residential wells, as identified by the owners, were being used for drinking water purposes. In March 1986, five additional wells were identified; one of which had previously been indicated as not in use by the well owner. The other four wells were southeast of Kenmore Street and are presented in Table 2-1. The four wells northwest of Kenmore Street, with the owner's names and addresses, are shown on Figure 10-8.

As shown on Figure 10-8 the Louisville municipal water main extends up Lees Lane and serves most of the Riverside Gardens neighborhood. The Riverside Baptist Church, the Faircloth and Blarr residences as well as the four additional homes



RESIDENTIAL DRINKING WATER SUPPLY WELLS
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

LEGEND

- LOUISVILLE WATER MAIN
- 1▲ - RIVERSIDE BAPTIST CHURCH 4317 LEES LANE
- 2▲ - MR. MARTIN FAIRCLOTH 4416 LEES LANE
- 3▲ - MR. CECIL SIMPSON 6508 HOWARD AVENUE
- 4▲ - MS. TAMMY BLARR 6614

FIGURE 10-8

NUS CORPORATION
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southeast of Kenmore Street, could easily be hooked up to the municipal water main. In order to serve the Simpson's home the water main would need to be extended down Howard Avenue.

This technology is included on a discretionary basis as described in Section 10.1.2. If an alternate water supply is implemented, the monitoring program for the two residential wells described in Section 10.3.1 will not be required.

10.4 Description of the Alternative Which Satisfies All Applicable Standards

The components of the alternative under this category include capping, regrading and revegetation, surface waste area cleanup, bank protection controls, gas collection and venting system, potential future alternate water supply, and monitoring. The gas collection and venting system, surface waste area cleanup, bank protection controls, potential future alternate water supply, and monitoring are described in Sections 10.3.2, 10.3.3, 10.3.4, 10.3.5, and 10.3.1, respectively.

10.4.1 Capping

A low permeability cap which meets the standards listed in the RCRA regulations will be placed over the entire landfill. The cap will minimize the generation of leachate resulting from surface water infiltration and will control vertical movement of gas generated in the landfill. In addition to installation of the cap, regrading and revegetation will be required to facilitate drainage of the area. Details of the cap and the associated regrading and revegetation are discussed below.

Prior to capping, the landfill will be cleared of brush and wooded areas. A brush chipper will be used to perform this function and the material chipped will be stored onsite. This material may be used for mixing with the top loam layer used in the cap. After the landfill is cleared a certain amount of regrading will be required prior to installing the cap. The large ponded area in the Southern Tract of the landfill, consisting of 5.7 acres, was determined to be too costly to fill and level. This depression will be partially backfilled, increasing the elevation of the

bottom to 420 feet above mean sea level, so that it will be above the water table. It will be used as a detention pond for surface runoff from the Northern Tract and Central Tract of the landfill. A pumping station will be placed in this depression for the removal of collected water, which will be discharged to Mill Creek Cutoff as necessary. Other small surface depressions which have resulted in ponding will be eliminated. Compaction will be performed to help prevent cracks and erosion channels after the gravel and clay layers have been installed. The final design for the cap will be as shown in Figure 10-9 and as described below.

A two-foot layer of gravel covered with loose sand (USCS soil type GP, SP) with a permeability of 10^{-2} centimeters per second (cm/sec) (Lutton, 1982) will be placed on the graded surface. The sand will be placed on top of the gravel to aid in preventing the upper clayey layer from mixing into the gravel. This two-foot layer will facilitate gas migration and prevent cracking and/or degrading of the clay barrier. The barrier layer will consist of two feet of compacted clay with a permeability of 10^{-7} cm/sec (USCS soil type CH, CL, SC) (Lutton, 1982). Above the clay a three-foot cover of loam (USCS soil type GM, GC, SM, SC, ML, CL) (Lutton, 1982) will be installed. The loam is conducive to seed germination and easy to keep in good physical condition. Vegetation will be planted on top of the loam.

All of this material will be obtained from an offsite source, since no suitable soil is available at the landfill.

10.4.2 Regrading and Revegetation

As the final three-foot loam layer for the cap is installed grading will be necessary. In order to reduce the amount of soil erosion and still maintain an optimal slope for vegetative growth, the final grade will be 5 percent. To prevent undermining of the riprap, a ditch will be constructed to collect and divert runoff from the Northern and Central Tracts to the Southern Tract. The cover crop selected will be a coarse grass and/or legume for ease of maintenance and hardiness.

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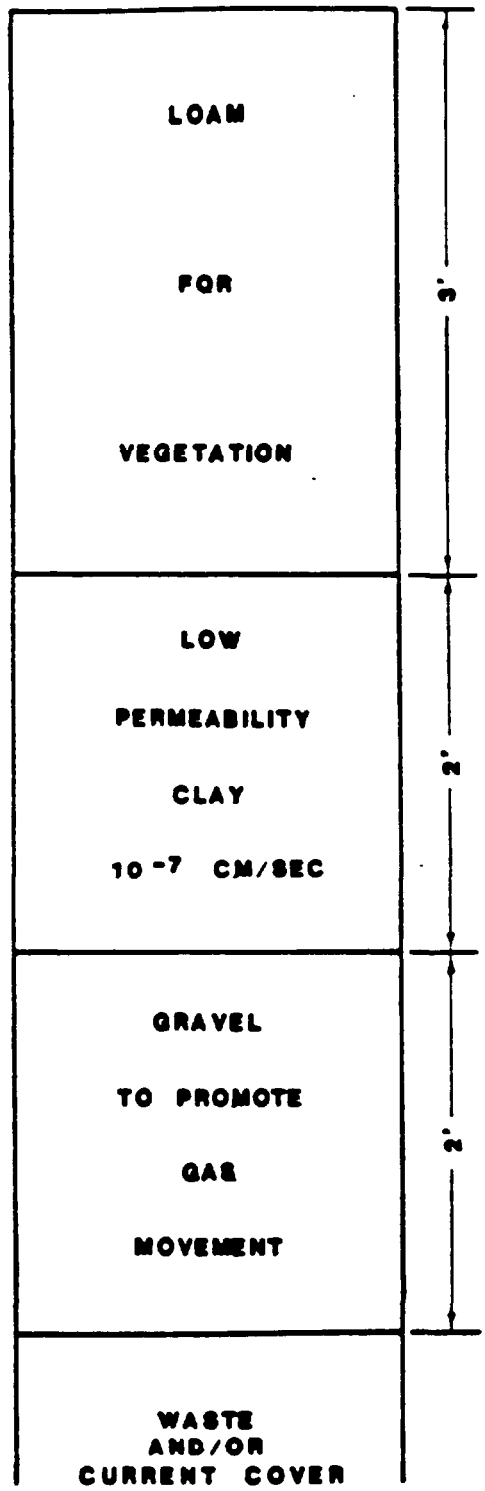


POSSIBLE COVER DESIGN AT
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

FIGURE 10-9

NUS CORPORATION
A Halliburton Company

10.5 Description of the Alternative Which Exceeds All Applicable Standards

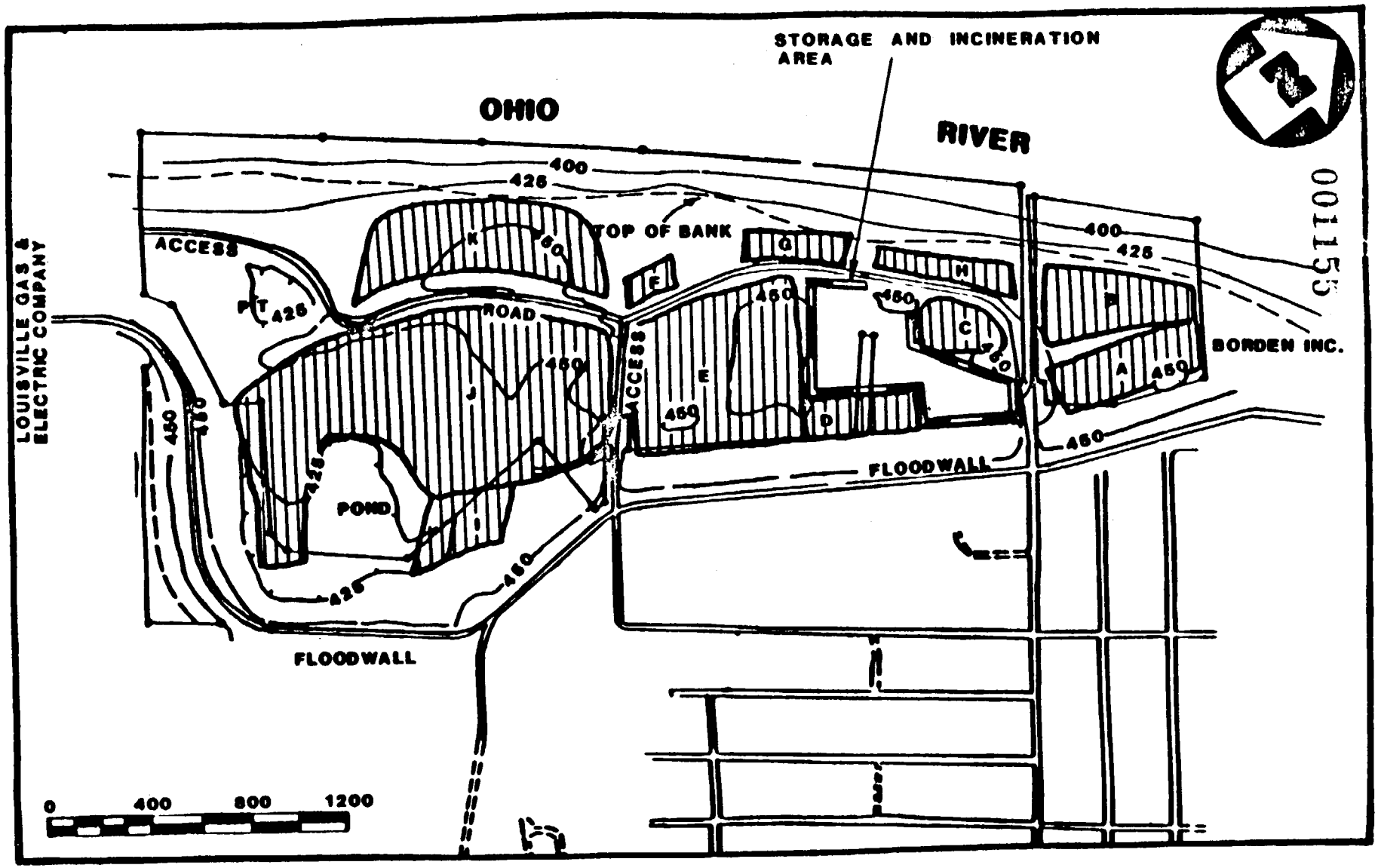
This alternative calls for the excavation and backfilling of the landfill, regrading and revegetation, onsite incineration with fly ash disposal in an offsite RCRA-approved landfill, and monitoring. Monitoring, and regrading and revegetation are discussed in Sections 10.2 and 10.4.2, respectively.

10.5.1 Excavation

The Lees Lane Landfill Site covers an area of 112 acres and is estimated to have a total volume of 4,400,000 cubic yards. Based on site sampling, ferromagnetic surveys, and historical photographs approximately 2,400,000 cubic yards will be excavated. The depth of excavation will vary widely at the site ranging from 5 feet in portions of the Central Tract to 40 feet in parts of the Northern Tract of the landfill. The areas to be excavated are shown in Figure 10-10.

Backhoes and power shovels will be used for the removal of surface material and any additional dry fill, while draglines will be employed for the removal of wet fill. The majority of the material at the excavation depths mentioned above is expected to be dry. Removal of material during the dry season will help to further minimize the amount of wet fill. Excavation will begin along the southern and eastern borders of the landfill and proceed toward the river. This should serve to limit the loss of landfill contents due to the erosional effects of the river and surface runoff.

Excavation will occur at a faster rate than incineration, therefore, a storage area will be required (Figure 10-10). Front end loaders will pick up the exumed material and move it to the storage site, where the waste can be separated and staged prior to incineration. That material not suitable for incineration will be transported to an offsite landfill. Transportation of the waste will be accomplished in 20 cubic yard trucks, with an estimated total of 42,000 loads needed to complete the process. The staging area will also allow the excavated material to further dry prior to incineration. The amount of water loss from the fill is not expected to be significant and its containment and treatment should be managed easily.



AREAS TO BE EXCAVATED
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

FIGURE 10-10

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During the removal process, the release of volatile contaminants can be expected. The extent of this release is unknown, but will likely vary throughout the excavation period. Due to this potential hazard, the use of temporary covers or wetting of the site along with worker protection (breathing apparatus, protective clothing) must be continuously assessed during the project.

Following excavation the site will be backfilled, regraded and revegetated. Backfilling will be conducted concurrently with excavation to maintain the integrity of the landfill and prevent the accumulation of water. Backfill material will be brought from offsite, since no onsite source is available. As the excavation proceeds the monitoring program may require redesign.

10.5.2 Incineration (Onsite)

A rotary kiln incinerator is recommended for this site. This type of incinerator has the ability to handle liquid and solid waste in kiln temperatures in excess of 1400°C, making it ideal for the destruction of variable landfill waste.

Incineration is carried out in a refractory-lined cylinder that is mounted at an angle. The steepness of the angle can be adjusted, enabling the detention time in the incinerator to be controlled. The rotation of the cylinder mixes the waste with the combustion air and auxillary fuel, while providing transportation of the material through the kiln (Bonner, et al., 1980).

Rotary kilns can be fed continuously by a conveyor mechanism or a batch feeding system can be employed. Typical unit feed capacity for a single incinerator burning solids ranges from 0.5 to 2.0 tons per hour (Bonner, et al., 1980).

The principle design criteria for this process are the volume and quality of the waste to be incinerated. After segregation of the 2,400,000 cubic yards of waste excavated, approximately 1,560,000 cubic yards (Tchobanoglous, 1977) are expected to be suitable for incineration and the remainder should be segregated and disposed of at an appropriate landfill. The moisture content of this incinerable portion is estimated at 30 percent. The resulting 70 percent solids concentration

should be compatible with the incineration process. However, auxillary fuel is still expected to be required, since a large part of the material will be of a low heat value.

Byproducts of the incineration process include products of incomplete combustion (PICs), fly ash, and atmospheric emissions. The fly ash, due to potentially high metals concentrations, will be disposed of in an approved RCRA landfill. Atmospheric emissions will be controlled by a venturi scrubber, with scrubber water neutralized with lime prior to discharge. Additional treatment of existing gases and wastewater may be required and will be evaluated prior to construction (Bonner, et al., 1980).

10.6 Description of the Alternatives Which Specify Offsite Disposal

The components of the two alternatives that occur under this category are monitoring, excavation and removal of waste to an offsite approved RCRA landfill, offsite incineration, backfilling, regrading, and revegetation. The first alternative calls for the disposal of the waste material in an offsite approved RCRA landfill. This would be carried out concurrently with excavation and backfilling, which is discussed in Section 10.5.1. In addition, this alternative includes monitoring, as well as regrading and revegetation which are described in Sections 10.2 and 10.4.2, respectively.

The approach of the second alternative is identical to that described above, except that the excavated material will be disposed of at a commercial incineration facility instead of an approved RCRA landfill.

10.6.1 RCRA Landfill Disposal

This alternative will result in the excavation of approximately 2,400,000 cubic yards of fill. The entire quantity of this material will be transported offsite to an approved RCRA landfill. There are presently two offsite commercial landfills in Region IV in compliance with RCRA requirements. These landfills are in Emele, Alabama and Pine Wood, South Carolina. Transportation will be done using 20 cubic yard trucks and will require 120,000 loads for completion.

10.6.2 Incineration (Offsite)

A rotary kiln is the most suitable type of incinerator for the destruction of the highly variable waste found at the Lees Lane Landfill. This process has the ability to handle waste of all forms, and is the predominant incineration technique employed by commercial facilities.

Considerations for this alternative include:

- The large quantity of low BTU material and thermally refractive soil.
- The ability to locate a commercial incinerator that will accept large volumes of contaminated soil and waste.
- The capacity of the commercial facility to incinerate the material in a reasonable amount of time.
- The storage of the excavated material in excess of the incineration capacity.

Offsite incineration would involve the excavation and transportation to an approved RCRA facility. Due to the low heating value and relatively high moisture content of the exumed material, auxillary fuel would be required. This factor will greatly influence the cost of disposal. Rotary kilns incinerating solids have a loading capacity of 0.5 to 2 tons per hour per unit. Having exclusive use of an incineration facility and operating at a maximum incinerator feed rate of 48 tons per day, the time required for disposal of the 1,560,000 tons excavated is approximately 89 years. In addition, excavating at a rate of 1,500 tons per day will easily surpass the 90-day RCRA storage limit, producing the potential need for a RCRA storage permit at the excavation site.

Incineration in an offsite facility would be a technologically feasible and environmentally sound means for the disposal of the waste material at the Lees Lane Landfill. This alternative would also meet or exceed all federal and state

regulations. However, problems involved with the implementation of this option, primarily the storage and handling requirements, eliminate this alternative from further consideration.

11.0 ANALYSIS OF REMEDIAL ACTION ALTERNATIVES

The remedial action alternatives have been evaluated to determine how well they meet the criteria presented below. The majority of the cost analyses with supporting data and costing procedures are presented in Appendix P.

11.1 Criteria Used for Evaluation

In this section, each alternative will be described in detail and then evaluated against both non-cost and cost criteria. Non-cost criteria include technical, public health, environmental, and institutional considerations. Each alternative is assessed for its effect upon the existing floodplains and wetlands. Cost criteria include capital costs, and operation and maintenance costs.

11.1.1 Technical Evaluation

The technical evaluation will assess the appropriateness of the alternative relative to site conditions. Each alternative will be evaluated for the following criteria:

- Performance
  The performance of alternatives will be evaluated in terms of the ability to perform the intended function, as well as the useful life of the alternative.

- Reliability
  The reliability of alternatives will be evaluated in terms of operation and maintenance requirements and demonstrated performance under similar conditions.

- Implementability
  The evaluation of the implementability of alternatives will consider factors such as the ability to actually construct the structures required by each alternative, the time necessary for construction relative to site conditions, and the time needed to implement each alternative.

- Safety

  The safety of the nearby residents and remedial action personnel will also be considered.

11.1.2 Public Health Evaluation

Remedial action alternatives will be evaluated for public health impacts both during and after implementation. Each alternative will be assessed in terms of the extent to which it is expected to effectively mitigate and minimize damage to public health and welfare as well as the adverse affects of alternative implementation.

11.1.3 Environmental Evaluation

Remedial action alternatives will also be evaluated for environmental impacts during and after implementation. Each alternative will be assessed in terms of the extent to which it is expected to effectively mitigate and minimize damage to the environment.

11.1.4 Institutional Evaluation

The impact of Federal, state, and local public health and environmental standards, regulations, guidance, advisories, and ordinances will be evaluated for each alternative as part of the institutional criteria evaluation. Community impacts will be considered as part of this evaluation as well as the effects that each alternative might have on the existing floodplains and wetlands. The floodplain and wetlands assessment is necessitated by EPA policy that all Superfund actions must meet the requirements of Floodplain Management Executive Order (E.O. 11988) and the Protection of Wetlands Executive Order (E.O. 11990). The Superfund policy memo on the implementation of these Executive Orders is included in Appendix Q.

11.1.5 Cost Evaluation

The cost of each alternative will be presented. Capital and operation and maintenance costs, where applicable, will be estimated and converted to present worth values for comparison. A detailed listing of costing components for consideration is included in Appendix P. The costs for each alternative are based on a unit crew output as recommended by the 1985 Means Site Work Cost Data. A description of a unit crew for various technologies is included in Appendix R. A sensitivity analysis of the cost components of an alternative will be performed to evaluate the effects of variations in specific assumptions associated with the design, implementation, operation, and effective life of the estimated present worth cost of the alternative.

Present worth analysis is used to evaluate expenditures that occur over different time periods by discounting all future costs to a common base year, usually the present. This allows the cost of remedial action alternatives to be compared on the basis of a single figure representing the amount of money that, if invested in the base year and disbursed as needed, would be sufficient to cover all costs associated with the remedial action over its planned life.

In conducting the present worth analysis, assumptions will be made regarding the discount rate and the period of performance. For the first, a discount rate of 10 percent before taxes and after inflation will be assumed, as outlined in OMB Circular No. A-94. This rate represents the average rate of return on private investment. Estimates of costs in each of the planning years are made in constant dollars, representing the general purchasing power at the time of construction.

After the present worth of each remedial action alternative is calculated, each cost will be evaluated for effects of variations in assumptions through sensitivity analysis. A sensitivity analysis assesses the effect that variations in specific assumptions associated with the design, implementation, operation, discount rate, and effective life of an alternative can have on the estimated cost of the alternative. These assumptions depend on the accuracy of the data developed during the RI and on predictions of the future behavior of the remedial technology and are subject to varying degrees of uncertainty. The sensitivity of costs to these

uncertainties can be observed by varying these assumptions and noting the effects on estimated costs.

11.2 Analysis of the No Action Alternative

No Action - Monitoring

Under this alternative a long-term gas, air, and groundwater monitoring program would be established to provide information on contaminant movement, and on exposure to humans, sensitive and important non-human species, and the environment. The monitoring will be set up on a quarterly basis for groundwater and gas, and three times per year for air the first three years, and then the program would be reevaluated.

11.2.1 Technical Evaluation

- Performance

  This alternative will not reduce or eliminate any of the impacts resulting from the site contaminants. It will be effective in providing information about the movement of the contaminants, so that future remedial actions can be taken if necessary. This alternative can be implemented almost immediately.

- Implementability

  This alternative can be implemented quickly with little difficulty at the Lees Lane Landfill Site. Five gas monitor wells could be installed in approximately one month at various locations between the fill and Riverside Gardens neighborhood. Groundwater monitor wells were installed during the RI. Ambient air sampling stations will not require construction.

- Reliability

  This alternative will require workers skilled in taking representative environmental samples from several environmental media. Such workers are readily available. Historically, air

monitoring has been proven to be reliable. Gas and groundwater monitor wells are a proven reliable method of determining concentrations of contaminants in these media.

- Safety

  The major risk involved in implementing this alternative will be to the workers constructing the gas monitor wells. Continuous monitoring during construction will prevent exposure to hazardous substances and explosions. There should be no threat to the Riverside Gardens residents.

11.2.2 Public Health Evaluation

- Implementation Phase

  In addition to samplers under the no action option, there would be workers involved in the construction of five gas monitor wells. These remedial personnel could be faced with possible deleterious effects as a result of inhalation of contaminant gases. However, if continuous air monitoring activities are performed, then workers drilling and constructing the monitor wells should not face any risks associated with these activities. Based on previous experience with these activities, the duration of exposures are very short and exposure levels can be adequately controlled to below acceptable levels by existing, readily available technologies. The excess risk of cancer, chronic health effects, and acute health effects should be minimal and therefore not a factor in the implementation of monitoring activities.

- Residual Risk

  Populations of individuals who incur residual risk (i.e., the risk that remains and is incurred by receptors following implementation of this alternative) can be grouped into primary and secondary populations at risk.

At Lees Lane Landfill Site, the primary population at risk is defined as these individuals presently known to be subject to contaminants in excess of 10^{-6} cancer risk and/or an added risk of chronic health effects through ingestion or inhalation. No such groups are known to exist.

The secondary population at risk constitutes all other individuals who may be exposed to site-associated contaminants. At the Lees Lane Landfill Site this involves the people whose homes may be subject to the migration of landfill generated gases. The secondary population at risk also includes individuals who may be exposed to site-associated contaminants on an intermittent basis, such as site remediation workers or children playing on contaminated surface soil. The increased risk is not known, but it may be greater than the risk associated with a control population similar in all regards, who are not exposed to site-associated contaminants.

The remaining residual risk associated with the no-action alternative is the potential for a change in the existing levels of risk due to changes in the concentrations of chemicals that the receptors are presently experiencing. The proposed monitoring program should provide information regarding increases.

11.2.3 Environmental Evaluation

- Implementation Phase

  Implementing the monitoring portion of the no action alternative should create no negative environmental impacts. Sampling of air, gas and groundwater monitor wells and residential water supply wells are the only action proposed. Generally, environmental sampling of this nature is an unobtrusive exercise which, if conducted conscientiously, should not pose a threat to the regional environment.

- Residual Risk

  The no action alternative would provide no protection to the regional ecology from the conditions as they presently exist. Section 8.2.6 indicates that the concentrations of site-associated groundwater contaminants discharged to the nearby Ohio River pose little or no threat to the regional environmental receptors (fauna and flora). A critical element in the analysis of residual environmental risk, which is presently unknown, is the kinetics (mass of material still at the site, stage of depletion, and transport rate) of the contaminant migration process through the groundwater to the potential environmental receptors. The amount of contaminant released and transported through the environment can decrease, increase, or stabilize. It is not known in which of these conditions the system currently exists. However, it does appear that the concentration of contaminants in groundwater is decreasing.

  The condition represents a residual risk which can be incurred by the affected environmental receptors. The risk to these receptors from a change in environmental concentrations of site-associated contaminants should not be appreciable based on the high rate of dilution in the Ohio River.

11.2.4 Institutional Evaluation

This alternative can be implemented without having to obtain any permits or other regulatory approvals; however, it will not satisfy any applicable regulations. It will be necessary to make arrangements for an agency to conduct the sampling, analysis, and interpretation of data.

Implementation of this alternative will provide responsible agencies and the public with information on the location, magnitude, and impact of the contamination from the Lees Lane Landfill Site. It will not correct any problems at the site and consequently will not address any concerns which the agencies or the public may have regarding the site.

Cautionary signs, to inform the public of the site conditions and impending risks, will be posted at all possible entrances to the site. Wording on the signs will be determined by EPA. A gate will also be erected at one location to control access to the site. One gate will be installed at the Putnam Street entrance to the landfill.

- Floodplain
  Since no action is planned, the floodplain will incur no affects.

- Wetlands
  Since no action is planned, the wetlands will incur no affects.

11.2.5 Cost Evaluation

Capital costs for constructing five gas monitor wells, air sampling equipment, and gates and signs are $38,000, $67,000, and $1,000, respectively. Operation and maintenance costs are included with this alternative to inspect the gas monitor wells, provide quarterly gas and groundwater sampling and analyses, and provide sampling and analysis of air three times per year. The number of samples taken in each year is assumed to remain constant at 100 (24 water, 40 gas, and 36 air). For this alternative, the cost was assumed to occur annually for three years since the program will be reevaluated after that time frame. Laboratory analyses of gases and air will include selected volatile organics. Groundwater will be analyzed for the hazardous substance list of contaminants. This estimate results in an annual costs of $94,870 per year. Costs necessary for personnel, equipment, and laboratory analyses can be found in Appendix P.

The present worth value for capital costs and operation and maintenance over 3 years, at a 10 percent discount rate, is $341,000. A variation of 10 percent in the number of samples taken and analyzed results in a variation in the total present worth costs from $318,000 to $365,000.

Costs and sensitivity analyses are summarized in Tables 11-1 and 11-2.

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TABLE 11-1
COST SUMMARY - MONITORING
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

A. Estimation of Costs(1)

Alternative Components	Time to Construct (Yr.)	Capital Costs ($)	O & M Costs ($) Period (Yr.)	Annual ($)	Total ($)	Total Costs ($)
Gas Monitoring	1	38,000	3	20,640	62,000	100,000
Air Monitoring	NA	67,000	3	31,030	93,000	160,000
Groundwater Monitoring	NA	0	3	43,200	130,000	130,000
Gate and Signs	1	1,000	-	-	-	1,000
Total Costs		**106,000**		**94,870**	**285,000**	**391,000**

B. Present Worth Analysis(1)

Alternative Components	Capital Costs ($)	O & M Costs ($)	Total Present Worth ($)
Gas Monitoring	38,000	51,000	89,000
Air Monitoring	67,000	77,000	144,000
Groundwater Monitoring	0	107,000	107,000
Gate and Signs	1,000	-	1,000
Total Present Worth	**106,000**	**235,000**	**341,000**

(1) All costs are rounded to the nearest 1,000 dollars, except annual O & M.

TABLE 11-2
SENSITIVITY ANALYSIS - MONITORING
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

A. Sensitivity Factors

Alternative Components	Sensitivity Factor	Range	Justification for Range
Monitoring	Number of samples	± 10%	Contamination may spread or lessen
Gate and Signs	NA	NA	NA

B. Cost Variation (Present Worth Costs)(1)

Alternative Components	Capital Costs ($)		O & M Costs ($)		Total Variation ($)	
	High	Low	High	Low	High	Low
Gas Monitoring	38,000	38,000	56,000	46,000	94,000	84,000
Air Monitoring	67,000	67,000	85,000	69,000	152,000	136,000
Groundwater Monitoring	0	0	118,000	97,000	118,000	97,000
Gate and Signs	1,000	1,000	-	-	1,000	1,000
Total Variation	**106,000**	**106,000**	**259,000**	**212,000**	**365,000**	**318,000**

(1) All costs are rounded to the nearest 1,000 dollars.

11.3 Analysis of Alternatives Which Protect Public Health, Welfare, and the Environment

Gas Collection and Venting System, and Monitoring

This alternative includes a monitoring program for air, gas, and groundwater in addition to a properly operating gas collection and venting system and a potential future alternate water supply. The existing gas collection system will be inspected and the remaining problems, if any, will be corrected. The monitoring program was described in Section 11.2.

11.3.1 Technical Evaluation

The evaluation of the no action monitoring program also applies here. This section will only evaluate the additional remedial activities.

- Performance

  Gas collection with forced ventilation is a proven technology for preventing gases from migrating from landfills. The system is designed to effectively control the migration of both methane and toxic vapors. It is expected that gas vents from forced ventilation are apt to clog and will need to be replaced (EPA, 1983).

  An alternate water supply from a municipal water system would provide assurance of safe drinking water and reduce monitoring costs.

- Reliability

  The gas collection system will require some operation and maintenance. Pipe vents will need to be inspected at regular intervals to detect clogging and deterioration because of landfill subsidence. Also materials in contact with the gases should be inspected to determine their physical condition. Flow rate analyses and inspections should also be conducted regularly. The

analytical equipment, flow rate equipment and methods of inspection are readily available. Gas collection systems have been studied and used in many landfills. Proper design and periodic inspections are required to insure proper operation.

Once any homes are hooked up to the municipal water supply, no special maintenance will be required.

- Implementability

  The materials and components needed to repair the gas collection system are readily available. Weather conditions permitting, the repairs could be completed in a one-month period. Scheduling of materials and labor must be planned so that they are available on site when needed. Once construction is completed, immediate, beneficial results should be achieved, in that further migration of gases should continue to be prevented.

  The water line can be extended and hooked up to the homes in a one-month period. Water mains are regularly extended and no special training is needed.

- Safety

  The repair of the gas collection system will require constant monitoring to prevent explosion. Explosion can occur when methane is in the 5 to 15 percent volume of air range.

  The extension of the water main would cause no problems other than normal safety precautions performed around construction equipment.

11.3.2 Public Health Evaluation

- Implementation Phase

  The implementation of this alternative will include incurring the same risks to workers involved in the no action-monitoring

alternative. In addition, the risks involved with working in an area where methane and other toxic gases could be present will impose public health hazards in addition to the general and site-specific construction hazards discussed in safety. The hazards include the potential inhalation of volatile chemicals during repair of the gas collection system and the ingestion of contaminanted dust generated from surface activities. Remedial personnel repairing the collection system may be required to wear level B respiratory protection (self-contained breathing apparatus). Surface contamination is expected to be minimal and restricted to relatively small portions of the landfill. Additionally, the period of exposure is restricted to the repair phase, which is expected to be only a month. During this period, workers can be protected from significant exposure through the use of readily available and accepted control technologies. The added risk to offsite public receptors from remedial activities would probably not be significant.

The potential for exposure to offsite public receptors from material taken offsite is minimal since no material will be removed from the landfill. Construction equipment moving offsite will be decontaminated at the site exit, thereby eliminating transport of contaminant material offsite by this mechanism.

- Residual Risk

In terms of its effect on the residual public health risks, implementation of this alternative will eliminate the risks associated with the migration of landfill gases to residential homes. This alternative does not address several surface waste areas with contaminant levels above background, exposed drums, or wastes exposed on the bank and terraces of the landfill. Indirect exposure to the "hot spot" soils through direct contact appears to be minimal.

Implementation of this alternative should eliminate the major public health risk, which is the migration of landfill gases into the Riverside Gardens neighborhood and provide an early warning system should site conditions change (monitoring of air, gas, and groundwater).

If an alternate water supply is included, there will be no risk of consuming contaminated groundwater associated with the site.

11.3.3 Environmental Evaluation

- Implementation Phase

  Impacts on regional environmental receptors during implementation of this alternative will be the same as the no action-monitoring alternative. Although remedial activities may occur in the fill, any impact on the regional environment from this action should be negligible if good work practices are employed.

- Residual Risk

  Some decrease in the risk of harmful environmental impacts may result from the repair of the gas collection system. All other risks described in the no action-monitoring alternative will remain.

11.3.4 Institutional Evaluation

Monitoring was covered in the previous section. Implementation of this alternative should not require permits for discharge of the gas from the gas collection system. The extension of the Louisville water main would be performed by the city and applications would be required from each owner requesting hook up to the supply.

Cautionary signs and a gate as described in Section 11.2.4 will also be implemented under this alternative.

- Floodplain
  This alternative addresses inspection/repair of the gas collection system outside of the floodplain.

- Wetlands
  There will be no effect upon the wetlands.

11.3.5 Cost Evaluation

Capital costs for this alternative are $132,000. The capital cost for installation of an alternate water supply is $23,068, and includes the hookup of ten homes to the municipal water supply. This includes the three wells identified during the RI, the five additional homes identified during March 1986, and two extra homes which could be identified at a later time. These costs are not included on the tables because this technology will be implemented on a discretionary basis. The EPA will decide on the applicability of implementing this technology should site conditions change. The capital costs for the gas collection system ($26,000) consist of a one-time indepth inspection of the existing system plus any repairs identified as necessary.

Operation and maintenance costs would include routine inspections of the gas collection system and the monitoring discussed in Section 11.2.5. The present worth value of the total costs for 30 years at a 10 percent discount rate is $439,000.

A 20 percent sensitivity factor was included for the gas collection operation and maintenance costs because of many variables which could cause equipment failure. This analysis resulted in a variation in total present worth costs from $402,000 to $478,000.

The costs and sensitivity analysis are summarized in Tables 11-3 and 11-4.

TABLE 11-3
COST SUMMARY - GAS COLLECTION SYSTEM
AND MONITORING
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

A. Estimation of Costs(1)

Alternative Components	Time to Construct (Yr.)	Capital Costs ($)	O & M Costs ($) Period (Yr.)	Annual ($)	Total ($)	Total Costs ($)
1. Monitoring	< 1	105,000	3	94,870	285,000	390,000
2. Gas Collection System	< 1	26,000	30	7,680	230,000	256,000
3. Gates and Signs	< 1	1,000	-	-	-	1,000
Total Costs		132,000		102,550	515,000	647,000

B. Present Worth Analysis(1)

Alternative Components	Capital Costs ($)	O & M Costs ($)	Total Present Worth ($)
1. Monitoring	105,000	235,000	340,000
2. Gas Collection System	26,000	72,000	98,000
3. Gates and Signs	1,000	-	1,000
Total Present Worth	132,000	307,000	439,000

(1) All costs are rounded to the nearest 1,000 dollars, except annual O & M.

TABLE 11-4
SENSITIVITY ANALYSIS - GAS COLLECTION SYSTEM AND MONITORING
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

A. Sensitivity Factors

Alternative Components	Sensitivity Factor	Range	Justification for Range
1. Monitoring	Number of samples	± 10%	Contamination may spread or lessen
2. Gas Collection System	Replacement of equipment	± 20%	Repairs necessary for operation and maintenance
3. Gates and Signs	NA	NA	NA

B. Cost Variation (Present Worth Costs)(1)

Alternative Components	Capital Costs ($)		O & M Costs ($)		Total Variation ($)	
	High	Low	High	Low	High	Low
1. Monitoring	105,000	105,000	259,000	212,000	364,000	317,000
2. Gas Collection System	26,000	26,000	87,000	58,000	113,000	84,000
3. Gates and Signs	1,000	1,000	-	-	1,000	1,000
Total Alternative Variation	**132,000**	**132,000**	**346,000**	**270,000**	**478,000**	**402,000**

(1) All costs are rounded to the nearest 1,000 dollars.

Surface Waste Area Cleanup, Bank Protection Controls, Gas Collection and Venting System, and Monitoring

This alternative includes the monitoring program described in Section 11.2 with the additional monitoring of LL-9 to aid in determining alternate concentration limits, the gas collection and venting system, and potential future alternate water supply described in Sections 11.3.1 through 11.3.5. Also several exposed surface waste areas will be covered or removed. These areas involve drums, "hot spot" soil areas, and exposed trash on a steep slope in the Southern Tract. A bank protection program would be instituted to minimize erosion and failure of the landfill buffer zone along the Ohio River.

11.3.6 Technical Evaluation

The evaluation of the previous alternative also applies here. This section will only evaluate the additional remedial activities.

- Performance

  The removal of the drums is a proven technology. The covering of the wastes should be easily accomplished.

  Riprap has been used for bank protection for many years. The selection of the proper stone diameter and thickness depends on the velocity of the Ohio River at the site. With periodic inspection and maintenance of the riprap, the bank should be stabilized for at least 30 years.

- Reliability

  Once the surface waste contaminants are covered, little maintenance will be needed. Removal of the drums will be performed by experienced personnel.

  The materials necessary to perform the bank protection as well as any operation and maintenance are readily available. No special expertise is needed to perform the function. Occasional

inspection of the riprap will be necessary to determine its integrity. Performance should be adequate with proper design and construction.

- Implementability

  There are no known factors which would prevent implementing this alternative. The removal of the drums should be performed quickly and will require a manifest for the hazardous waste and disposal in an approved RCRA landfill.

  It should take no longer than 1 year to install the riprap. The optimal time to construct the toe of the revetment is when the Ohio River is at its lowest level, which is usually September.

- Safety

  The removal of the drums could cause problems if the contents of different drums are inappropriately mixed. Violent reactions and release of hazardous constituents are possible. If analyses are performed prior to removal, this problem should be prevented. In addition, proper safety precautions should be observed while heavy equipment is in use.

11.3.7 Public Health Evaluation

- Implementation Phase

  Implementation of this alternative is essentially the same as discussed for the previous alternative. The additional hazards associated with drum and contaminated soil removal will affect this alternative.

  The major risks added to the alternative are those incurred by drum handling and transportation. Monitoring of areas where the drums are located was performed during the RI with an HNU. No readings above background were recorded. Special precautions should be taken to avoid inhalation and skin contact as the

chemicals may require higher levels of personal protection including special clothing and breathing protection. The period of exposure will be short, which will tend to decrease the risks of chronic health effects. Any risks associated with exposure should be controlled by readily available and proven control technologies.

Nearby offsite public receptors may be exposed during transportation of the wastes to an approved landfill. Since it should take only a few trucks to haul the wastes, no significant risk should be incurred.

- Residual Risk

  This alternative should mitigate any risks to the public. In addition to the residual risks explained for the previous alternative, the potential for indirect exposure to the "hot spot" soils will be eliminated. There is, however, a possibility of other existing contaminated areas on the landfill. Exposed waste on the bank will be removed. Any leachate seeps will be covered with riprap to prevent direct contact.

11.3.8 Environmental Evaluation

- Implementation Phase

  Impacts on regional environmental receptors during implementation will be negligible if good work practices are employed.

- Residual Risk

  Some decrease in the risk of harmful environmental impact may result from removing the "hot spot" soils. It is not certain whether the drums have leaked and caused any impact on the environment. Although the analyses of surrounding soils indicated low levels of contaminants, the surrounding soil appears to exhibit slowed vegetation growth.

11.3.9 Institutional Evaluation

All previously discussed institutional requirements are appropriate under this section. In addition, the regulations set forth in RCRA, 40 CFR Part 263, "Standards Applicable to Transporters of Hazardous Waste" apply to the transportation of the drums removed. Transporters are required to obtain an EPA identification number from the EPA Administrator prior to the movement of the material, and the material must be registered in accordance with the manifest system requirements. Analyses of the drum contents will be required to meet these requirements.

Cautionary signs and gates as described in Section 11.2.4 will also be implemented in this alternative.

- Floodplain
  The excavation and removal of the exposed drums and "hot spot" soils and bank protection controls should have little effect on the floodplain.

- Wetlands
  This alternative involves remedial methods outside the wetlands area.

11.3.10 Cost Evaluation

The capital costs for this alternative are $2,343,000. The capital cost for installation of an alternate water supply is $23,068. These costs are not included on the tables because this technology will be implemented on a discretionary basis. The EPA will decide on the applicability of implementing this technology should site conditions change.

The annual operation and maintenance costs excluding the additional Appendix VIII analyses performed during the first year of monitoring are $103,440. The estimated costs for the analysis for the Appendix VIII constituents are $24,000.

The total present worth costs over 30 years at a 10 percent discount rate are $2,682,000.

The capital cost for surface waste area cleanup is sensitive to the number of drums and size of areas to be covered. Due to the variable nature of drum removal a 15 percent factor was used for the sensitivity analysis. The bank protection controls are sensitive to the total area to be protected and cleared and a variation of 20 percent in capital costs was used in the sensitivity analysis. These variations caused the total costs to vary from $2,243,000 to $3,123,000.

Results of the cost evaluation and the sensitivity analysis are summarized in Tables 11-5 and 11-6.

11.4 Analysis of the Alternative Which Satisfies All Applicable Standards

Capping, Regrading and Revegetation, Surface Waste Area Cleanup, Bank Protection Controls, Gas Collection and Venting System, and Monitoring

This alternative includes the monitoring program, the bank protection controls and surface waste area cleanup described in Sections 11.3.6 through 11.3.10, and the gas collection and venting system and potential future alternate water supply described in Sections 11.3.1 through 11.3.5. In addition, a cap will be installed over the entire landfill to minimize leachate generation and control upward, vertical movement of gas. Regrading and revegetation will be necessary to provide maximum drainage of the area.

11.4.1 Technical Evaluation

The evaluation of the previous alternative also applies here. This section will only evaluate the additional remedial activities.

- Performance

  Clay caps have been demonstrated to be an effective method of minimizing the infiltration of surface water or rainwater and the

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TABLE 11-5
COST SUMMARY - SURFACE WASTE AREA CLEANUP, BANK PROTECTION CONTROLS, GAS COLLECTION SYSTEM, AND MONITORING
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

A. Estimation of Costs(1)

Alternative Components	Time to Construct (Yr.)	Capital Costs ($)	O & M Costs ($) Period (Yr.)	Annual ($)	Total ($)	Total Costs ($)
1. Monitoring	1	105,000	1 3	24,000(2) 94,870	309,000	414,000
2. Gas Collection System	1	26,000	30	7,680	230,000	256,000
3. Surface Waste Areas	1	294,000	30	120	3,600	298,000
4. Bank Protection Controls	1	1,917,000	30	770	23,000	1,940,000
5. Gate and Signs	1	1,000	-	-	-	1,000
Total Costs		**2,343,000**		**127,440**	**566,000**	**2,909,000**

TABLE 11-5
COST SUMMARY - SURFACE WASTE AREA CLEANUP, BANK PROTECTION CONTROLS, GAS COLLECTION SYSTEM, AND MONITORING
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY
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B. Present Worth Analysis(1)

Alternative Components	Capital Costs ($)	O & M Costs ($)	Total Present Worth ($)
1. Monitoring	105,000	259,000	364,000
2. Gas Collection System	26,000	72,000	98,000
3. Surface Waste Areas	294,000	1,000	295,000
4. Bank Protection Controls	1,917,000	7,000	1,924,000
5. Gate and Signs	1,000	-	1,000
Total Present Worth	**2,343,000**	**339,000**	**2,682,000**

(1) All costs are rounded to the nearest 1,000 dollars, except annual O & M.
(2) Costs for complete Appendix VIII analyses on one well quarterly the first year. See Section 10.3.1.

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TABLE 11-6
SENSITIVITY ANALYSIS - SURFACE WASTE AREA CLEANUP, BANK PROTECTION CONTROLS, GAS COLLECTION SYSTEM, AND MONITORING
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

A. Sensitivity Factors

Alternative Components	Sensitivity Factor	Range	Justification for Range
1. Monitoring	Number of samples	± 10%	Contamination may spread or mitigate
2. Gas Collection System	Replacement of equipment	± 20%	Repairs necessary for operation and maintenance
3. Surface Waste Areas	Condition and contents of drums	± 15%	Condition and contents of drums is unknown
4. Bank Protection Controls	Area to be cleared	± 20%	Clearing will depend on waste material present and size of area
5. Gate and Signs	NA	NA	NA

TABLE 11-6
SENSITIVITY ANALYSIS - SURFACE WASTE AREA CLEANUP, BANK PROTECTION CONTROLS, GAS COLLECTION SYSTEM, AND MONITORING
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY
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B. Cost Variation (Present Worth Costs)(1)

Alternative Components	Capital Costs ($)		O & M Costs ($)		Total Variation ($)	
	High	Low	High	Low	High	Low
1. Monitoring	105,000	105,000	285,000	233,000	390,000	338,000
2. Gas Collection System	26,000	26,000	87,000	58,000	113,000	84,000
3. Surface Waste Areas	310,000	278,000	1,000	1,000	311,000	279,000
4. Bank Protection Controls	2,301,000	1,534,000	7,000	7,000	2,308,000	1,541,000
5. Gate and Signs	1,000	1,000	-	-	1,000	1,000
Total Variation	**2,743,000**	**1,944,000**	**380,000**	**299,000**	**3,123,000**	**2,243,000**

(1) All costs are rounded to the nearest 1,000 dollars.

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vertical migration of landfill gases. Regrading and revegetation assist in reducing the volume of water that reaches the clay cap barrier. The expected design life of the cap system proposed is 30 years, although routine maintenance will be required to insure cap integrity. With proper upkeep, the cap could last indefinitely.

- Reliability

  Landfill capping is a well proven technology, and one of the most frequently used remedial actions taken for the control of hazardous wastes sites. The layered cap proposed for this site should effectively limit rainwater infiltration and the vertical migration of gas. Regrading and revegetating the site involve standard techniques and will decrease cap erosion. The cap, however, will not be particularly effective against infiltration due to Ohio River runon. Runon at the site has the potential to be significant since the landfill lies within the 100-year floodplain.

  Operation and maintenance procedures for the cap will be minimal. It will require routine inspection and repair of erosional effects and subsidence. Cover crop maintenance will be modest, consisting primarily of preventing undesirable species from becoming established and weakening the cap. In addition, periodic maintenance of the pumping station will be required.

- Implementability

  There are no factors which should prevent the completion of this alternative. The ability to locate a source for cap components should not present a problem. The scheduling of materials, labor, and equipment is important since the cap should be constructed during the dry months. Time required for cap emplacement is dependent upon the number of crews used, but as the number increases so does the truck interval. Table 11-7 indicates examples of the potential times involved in cap construction. The actual time will be determined in the design phase.

TABLE 11-7
EXAMPLE COMPLETION TIMES FOR CAP CONSTRUCTION
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Crews(1) (#)	Truck Interval (Min.)	Completion Time (Yrs.)
1	50.0	38
2	25.0	19
4	12.5	9.5
8	6.3	4.8

(1) The unit crew is described in Appendix R.

- Safety

  Safety will be an important consideration when the site is being cleared and initially regraded. Explosive gas concentrations will need to be monitored during clearing and capping. In addition, proper safety precautions should be observed while heavy equipment is in use.

11.4.2 Public Health Evaluation

- Implementation Phase

  During construction, the risk of worker exposure to potential volatile emissions and direct waste contact should be low. Assessment of these risks may require that remedial personnel wear special clothing and respiratory protection. The implementation of this alternative should have no other significant impact on public health. Offsite transport of contaminanted particulates and volatile emissions will be small since surface contamination is minimal and the option does not require extensive excavation. Should airborne contaminants become a health factor, the periodic wetting of the site and windscreens could be employed.

- Residual Risk

  The completion of this alternative would mitigate the majority of adverse health effects associated with the landfill. Capping and bank protection controls will maintain the landfill's integrity. The gas collection and treatment system will control gas migration and its related hazards.

  This action does not address currently existing groundwater contamination. While capping will minimize infiltration of rainwater, groundwater levels affected by the Ohio River water levels may intersect the waste material. The offsite migration of water soluble contaminants in groundwater will continue. This is

not considered to be a health hazard based on dilution by the Ohio River. Groundwater monitoring contained in this alternative will enable changes in groundwater quality to be detected.

11.4.3 Environmental Evaluation

- Implementation Phase

  The implementation of the alternative should pose no significant environmental threat. Although the site clearing and regrading processes will generate dust and possible soil loss due to erosion, the use of good construction practices should make any environmental impact small.

- Residual Risk

  The erosion control provided by capping and bank protection controls will eliminate the potential for landfill content loss to the environment. Capping will control the release of landfill gases to the ambient air above the landfill. The gas collection system will decrease exposure to volatile emissions and eliminate environmental stress.

  The environmental effects of currently contaminated groundwater are difficult to assess, but are estimated to be minimal. The installation of the cap and pumping station will reduce rainwater/waste interaction and subsequent leachate formation. The discharge of surface runoff into Mill Creek Cutoff should not present any significant environmental impact, since the transport of contaminants by this mechanism will not be significant.

11.4.4 Institutional Evaluation

In addition to the previous institutional requirements, this alternative addresses capping and the associated regrading and revegetation. The cap will comply with current RCRA requirements which require that the cap be less permeable than the

bottom of the landfill. The cap will be designed following the EPA publication Cover Design for Solid and Hazardous Waste Sites.

Cautionary signs and gates, as described in Section 11.2.4, will also be implemented in this alternative.

- Floodplain
  The only regrading that will occur after capping is in the Central and Northern Tracts. Regrading is planned to an elevation of approximately 450 to 455 feet above mean sea level. While the elevation of these areas will remain essentially unchanged, the readjustment of slope will decrease erosion potential.

- Wetlands
  Capping will eliminate any wetlands which presently exist onsite. This should have little effect upon wildlife, since other accessible wetland areas are close by.

11.4.5 Cost Evaluation

Capital costs for this alternative are $42,067,000. The capital costs for the landfill cap consist of direct and indirect costs for materials, equipment and labor, engineering, contingency, profit and health and safety costs. The capital costs also contain the costs for drum removal and disposal. The capital cost for installation of an alternate water supply is $23,068. These costs are not included on the tables because this technology will be implemented on a discretionary basis. The EPA will decide on the applicability of implementing this technology should site conditions change.

Operation and maintenance costs would include routine inspections of the cap, the bank protection controls, and the gas collection system as well as the groundwater gas and air monitoring program. The annual operation and maintenance costs without the Appendix VIII analyses are $108,580. The present worth for the total costs at a 10 percent discount rate for 30 years is $15,946,000.

A 10 percent sensitivity factor was included for the uncertainty in the size of the area to be capped and the volume of water to be removed from the depression in the Southern Tract. These sensitive factors caused the total costs to vary from $14,182,000 to $17,711,000.

Costs and results of the sensitivity analyses are summarized in Tables 11-8 and 11-9.

11.5 Analysis of the Alternatives Which Exceed All Applicable Standards

Excavation and Backfilling, Regrading and Revegetation, Onsite Incineration, Offsite Fly Ash Disposal, and Monitoring

Implementation of this alternative would require extensive excavation and the construction of an onsite incinerator. As a result of these two procedures, offsite fly ash disposal, backfilling and regrading and revegetation (described in Section 11.4) will also be necessary. The monitoring program, described in Section 11.2.1 through 11.2.5, would be instituted until it is determined whether or not any contaminated media are migrating to possible receptors.

11.5.1 Technical Evaluation

Monitoring, regrading, and revegetation have been described in previous sections and the evaluation also applies to this alternative. This section will only evaluate the additional remedial activities.

- Performance

  Excavation involves standard construction practices and will remove all solid material from the landfill. There is a possibility that isolated pockets of waste exist below the estimated excavation depth. Backfilling is a well established practice and the ability to locate an offsite fill source should not present a problem.

TABLE 11-8
COST SUMMARY - CAPPING, REGRADING AND REVEGETATION, SURFACE WASTE AREA CLEANUP, BANK PROTECTION CONTROLS, GAS COLLECTION SYSTEM, AND MONITORING
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

A. Estimation of Costs[1]

Alternative Components	Time to Construct (Yr.)	Capital Costs ($)	O & M Costs ($) Period (Yr.)	Annual ($)	Total ($)	Total Costs ($)
1. Monitoring	1	105,000	1 3	24,000[2] 94,870	309,000	414,000
2. Gas Collection System	1	26,000	30	7,680	230,000	256,000
3. Capping	38[3]	35,595,000	1 30	3,600 770	27,000	35,622,000
4. Regrading and Revegetation	1	4,129,000	30	770	23,000	4,152,000
5. Bank Protection Controls	1	1,917,000	30	770	23,000	1,940,000
6. Surface Waste Areas	1	294,000	30	120	3,600	298,000
7. Gate and Signs	1	1,000	-	-	-	1,000
Total Costs		**42,067,000**		**132,580**	**616,000**	**42,683,000**

TABLE 11-8
COST SUMMARY - CAPPING, REGRADING AND REVEGETATION, SURFACE WASTE AREA CLEANUP, BANK PROTECTION CONTROLS, GAS COLLECTION SYSTEM, AND MONITORING
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY
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B. Present Worth Analysis(1)

Alternative Components	Capital Costs ($)	O & M Costs ($)	Total Present Worth ($)
1. Monitoring	105,000	259,000	364,000
2. Gas Collection System	26,000	72,000	98,000
3. Capping	9,117,000	11,000	9,128,000
4. Regrading and Revegetation	4,129,000	7,000	4,136,000
5. Bank Protection	1,917,000	7,000	1,924,000
6. Surface Waste Areas	294,000	1,000	295,000
7. Gate and Signs	1,000	-	1,000
Total Present Worth	**15,589,000**	**357,000**	**15,946,000**

(1) All costs are rounded to the nearest 1,000 dollars, except annual O & M.
(2) Costs for complete Appendix VIII analyses on one well quarterly this first year. See Section 10.3.1.
(3) A unit crew for capping is used to make costs comparable to other alternatives.

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TABLE 11-9
SENSITIVITY ANALYSIS - CAPPING, REGRADING AND REVEGETATION, SURFACE WASTE AREA CLEANUP
BANK PROTECTION CONTROLS, GAS COLLECTION SYSTEM, AND MONITORING
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

A. Sensitivity Factors

Alternative Components	Sensitivity Factor	Range	Justification for Range
1. Monitoring	Number of samples	± 10%	Contamination may spread or mitigate
2. Gas Collection System	Replacement of equipment	± 20%	Repairs necessary for operation and maintenance
3. Capping	Dewatering low area and area to be capped	± 10%	Water level rises throughout year and area to be capped estimated
4. Regrading and Revegetation	Area and extent of regrading	± 10%	Area to be regraded estimated
5. Bank Protection Controls	Area to be cleared	± 20%	Clearing will depend on waste material present and size of area
6. Surface Waste Areas	Condition and contents of drums	± 15%	Condition and contents of drums unknown
7. Gate and Signs	NA	NA	NA

TABLE 11-9
SENSITIVITY ANALYSIS - CAPPING, REGRADING AND REVEGETATION, SURFACE WASTE AREA CLEANUP
BANK PROTECTION CONTROLS, GAS COLLECTION SYSTEM, AND MONITORING
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY
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B. Cost Variation (Present Worth Costs)(1)

Alternative Components	Capital Costs ($)		O & M Costs ($)		Total Variation ($)	
	High	Low	High	Low	High	Low
1. Monitoring	105,000	105,000	285,000	233,000	390,000	338,000
2. Gas Collection System	26,000	26,000	87,000	58,000	113,000	84,000
3. Capping	10,028,000	8,205,000	11,000	11,000	10,039,000	8,216,000
4. Regrading and Revegetation	4,542,000	3,716,000	7,000	7,000	4,549,000	3,723,000
5. Bank Protection Controls	2,301,000	1,534,000	7,000	7,000	2,308,000	1,541,000
6. Surface Waste Areas	310,000	278,000	1,000	1,000	311,000	279,000
7. Gate and Signs	1,000	1,000	-	-	1,000	1,000
Total Alternative Variation	**17,313,000**	**13,865,000**	**398,000**	**317,000**	**17,711,000**	**14,182,000**

(1) All costs are rounded to the nearest 1,000 dollars.

The use of a rotary kiln incinerator is a well established technology and should effectively destroy all principle organic hazardous constituents (POHCs) present in the excavated material.

Disposal of material not selected for incineration and fly ash in an offsite landfill will prevent any further site contamination.

- Reliability

  Excavation, backfilling and the removal of fly ash and material not suitable for incineration to an offsite landfill are proven techniques and have been used effectively in similar situations.

  The use of rotary kiln incinerators for the thermal destruction of hazardous waste is well documented; however, evaluation of trial burn results are usually necessary for the selection of optimum operational parameters and treatment requirements.

  Incineration involves extensive operation and maintenance requirements for efficient operation. In addition, the disposal of non-incinerable material has been considered as operation and maintenance costs.

- Implementability

  There are no factors which should prevent the implementation of this alternative. However, it will require careful coordination among the various components for efficiency to be maintained. Table 11-10 indicates example completion times for excavation, but the actual time will be based on the design of the excavation program.

  The volume to be excavated is estimated at 2,400,000 cubic yards. Of this, 840,000 cubic yards will be taken directly to an offsite landfill requiring 42,000 shipments in 20 cubic yard trucks. The

TABLE 11-10
EXAMPLE COMPLETION TIMES FOR EXCAVATION
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Crews(1) (#)	Truck Interval (Min.)	Completion Time (Yrs.)
1	6.4	22
2	3.2	11
4	1.6	5.5
8	0.8	2.8

(1) The unit crew is described in Appendix R.

remaining material will be incinerated. Example incineration times are indicated in Table 11-11 but, again, the actual time will be determined as a result of the design of the incineration program.

- Safety

  One of the principal safety concerns for this alternative involves the extensive use of heavy equipment. The importance of taking proper safety precautions will be amplified due to the large amount of equipment required for the completion of this alternative. Additional critical safety considerations are the chance of explosion from the methane generated on site and worker exposure to uncovered waste material.

11.5.2 Public Health Evaluation

- Implementation Phase

  The implementation of this alternative has the potential to significantly impact public health. During the excavation procedure, the opportunity for offsite migration of contaminants is greatly increased. Pathways for this migration include airborne particulates, gas emission and surface runoff. Receptors in the area of the site would be susceptible to inhalation of gas as well as contaminant laden particulates, the ingestion of particulates and direct contact with wastes.

  Incineration can also produce some public health risk. These risks primarily arise from emitting products of incomplete combustion (PICs). PICs can result not only from the waste material, but from the auxillary fuel as well. The particular PICs emitted are dependent on the waste and incinerator operation parameters. Receptors in the path of the incinerator plume will face the risk of inhaling these emissions.

TABLE 11-11
EXAMPLE COMPLETION TIMES FOR INCINERATION
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Units(1) (#)	Time For Completion (Yrs.)
1 Unit	24
2 Units	12
4 Units	6
8 Units	3

(1) One unit is designated as 3 incinerators operating 24 hours per day and by four operators, eight workers, two supervisors (Vogel, 1984).

Other factors of this option having an impact on public health are the storage of the material prior to incineration and the offsite transportation of fly ash and the material not selected for incineration. Storing the waste onsite increases the chance of contaminant loss due to volatilization and surface runoff. Transporting the waste offsite has the potential to increase receptor exposure to fugitive gas emissions, dust, and direct contact in the event of an accidental spill.

All the potential harmful effects associated with the alternative are further increased considering the extended time required for its completion.

- Residual Risk

  Implementation of this alternative will, in the long-term, eliminate public health risks associated with the landfill. This will be achieved by source removal and destruction. However, there are potential adverse health problems associated with long duration incineration, including chronic and acute health effects. In addition, contaminants presently in the groundwater will continue to migrate offsite until the site has been self-purged. The time required for groundwater to move from the upgradient side of the landfill to the Ohio River has been estimated at 3.6 years. Also, incinerator workers face the risk of exposure to fugitive gas emissions and personal contact with the waste material.

11.5.3 Environmental Evaluation

- Implementation Phase

  As discussed previously the greatest potential risk associated with the implementation of this alternative is during the excavation, storage and transportation phases. In these processes, the waste material will be uncovered and exposed to the environment.

Pathways for contaminant loss include volatilization, airborne particulates and surface runoff. These effects will be partially mitigated by backfilling concurrently with excavation, covering and/or wetting of the excavated material and the possible use of windscreens around the storage area.

Incineration is not expected to add significantly to the environmental impact. However, environmental receptors in direct line with the incinerator plume may be subject to emissions. The use of air pollution devices should keep air emissions within compliance standards and relieve environmental stress.

- Residual Risk

  This alternative through source removal and destruction will alleviate the majority of the contamination at the site. This will mitigate further environmental impact from the slow pollutant release presently occurring.

11.5.4 Institutional Evaluation

The regulations set forth in RCRA, 40 CFR Part 263, establish the responsibilities of transporters engaged in the handling and transportation of hazardous waste. Transporters are required to obtain an EPA identification number from the EPA Administrator prior to the movement of the material, and the material must be manifested in accordance with the manifest system.

The incineration of hazardous waste is regulated under RCRA; therefore, the onsite incinerators would have to operate within these requirements. Additional state and local regulations might include solid waste storage and air quality emissions requirements. The ash generated by incineration would have to be disposed of in an approved RCRA landfill.

If good construction practices are used, public approval of the alternative should be achieved. The site clearing and excavation phases of this action will have the

greatest impact due to noise and the generation of dust. Operation of the incinerator to consistantly meet air quality requirements would enable the process to have a negligible impact.

- Floodplain
  This alternative will effect the floodplain which is covered under Executive Order 11988. The impact on the floodplain will be minimal, consisting primarily of slope adjustment.

- Wetlands
  This alternative will also effect the wetlands which are covered under Executive Order 11990. The onsite wetlands will be eliminated by control and drainage of surface waters. However, other wetland areas are located near the site.

11.5.5 Cost Evaluation

Capital and operation and maintenance costs for the onsite incineration facility are given for one unit crew which includes 3 incinerators. Capital costs for the incinerators are $9,304,000. Similarly, the costs for excavation are also based on a unit crew which includes one front-end loader. The capital costs for excavation are $26,368,000.

The operation and maintenance costs for incineration include the offsite disposal of material not suitable for incineration. The operation and maintenance costs for regrading and revegetation include periodic inspections and cover crop maintenance. The present worth at a 10 percent discount rate for the total costs is $165,766,000.

The volume of material to be excavated and the amount of material that can be incinerated have the greatest impact on costs. A 30 percent variation in quantity was used for both. A 10 percent variation to account for the extent of regrading was also added to the sensitivity analysis. This caused the present worth costs to vary from $117,137,000 to $214,942,000.

A detailed account of costs and the sensitivity analysis are presented in Tables 11-12 and 11-13.

11.6 Analysis of the Alternative Which Specifies Offsite Disposal

Excavation and Backfilling, Regrading and Revegetation, Offsite Disposal, and Monitoring

This alternative calls for the excavation of the fill material and its disposal in an offsite approved RCRA landfill. Due to the excavation process, backfilling, regrading, and revegetating will also be required. The monitoring program described in Section 11.2.1 through 11.2.5 is included in this option as well. Excavation and backfilling were described in Section 11.5 and regrading and revegetation were described in Section 11.4.

11.6.1 Technical Evaluation

The evaluation of excavation and backfilling as well as regrading and revegetation apply here. This section will only evaluate the disposal of waste material in an offsite approved RCRA facility.

- Performance

  Disposal in an offsite landfill is a permanent remedial action and provides a very high level of environmental and public health protection. This option, through source removal, will prevent any further contamination. However, this alternative will have no effect on contaminants which currently exist in the groundwater, but the estimated groundwater travel time from the upgradient boundary of the landfill to the Ohio River is 3.6 years.

- Reliability

  Operation and maintenance for this alternative will be minimal. It will involve routine inspection and repair of erosional effects, as well as the establishment and care for the selected cover crop.

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TABLE 11-12
COST SUMMARY - EXCAVATION AND BACKFILLING, REGRADING AND REVEGETATION, ONSITE INCINERATION, OFFSITE FLY ASH DISPOSAL, AND MONITORING
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

A. Estimation of Costs[1]

Alternative Components	Time to Construct (Yr.)	Capital Costs ($)	O & M Costs ($) Period (Yr.)	Annual ($)	Total ($)	Total Costs ($)
1. Monitoring	1	105,000	3	94,870	285,000	390,000
2. Excavation	22[2]	26,368,000	-	-	-	26,368,000
3. Regrading and Revegetation	1	4,129,000	30	770	23,000	4,152,000
4. Incineration	1	9,304,000	24[2]	15,745,760[3]	377,898,000	387,202,000
Total Costs		**39,906,000**		**15,840,630**	**378,206,000**	**418,112,000**

TABLE 11-12
COST SUMMARY - EXCAVATION AND BACKFILLING, REGRADING AND REVEGETATION, ONSITE INCINERATION, OFFSITE FLY ASH DISPOSAL, AND MONITORING
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY
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B. Present Worth Analysis(1)

Alternative Components	Capital Costs ($)	O & M Costs ($)	Total Present Worth ($)
1. Monitoring	105,000	236,000	341,000
2. Excavation	10,513,000	-	10,513,000
3. Regrading and Revegetation	4,129,000	7,000	4,136,000
4. Incineration	9,304,000	141,472,000	150,776,000
Total Present Worth	**24,051,000**	**141,715,000**	**165,766,000**

(1) All costs are rounded to the nearest 1,000 dollars, except annual O & M.
(2) A unit crew for excavation and a unit incinerator are used to make costs comparable to other alternatives.
(3) O & M costs include operation of the incinerator and offsite disposal of material not suitable for incineration. See Section 11.5.1.

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TABLE 11-13
SENSITIVITY ANALYSIS - EXCAVATION AND BACKFILLING, REGRADING AND REVEGETATION, ONSITE INCINERATION, OFFSITE FLY ASH DISPOSAL, AND MONITORING
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

A. Sensitivity Factors

Alternative Components	Sensitivity Factor	Range	Justification for Range
1. Monitoring	Number of samples	± 10%	Contamination may spread or mitigate
2. Excavation	Volume of fill material	± 30%	Volume of fill estimated
3. Regrading and Revegetation	Area and extent of regrading	± 10%	Area to be regraded estimated
4. Incineration	Volume of material acceptable for incineration	± 30%	Types of fill material unknown

TABLE 11-13
SENSITIVITY ANALYSIS - EXCAVATION AND BACKFILLING, REGRADING AND REVEGETATION, ONSITE INCINERATION, OFFSITE FLY ASH DISPOSAL, AND MONITORING
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY
PAGE TWO

B. Cost Variation (Present Worth Costs)(1)

Alternative Components	Capital Costs ($)		O & M Costs ($)		Total Variation ($)	
	High	Low	High	Low	High	Low
1. Monitoring	105,000	105,000	260,000	212,000	365,000	317,000
2. Excavation	13,667,000	7,359,000	-	-	13,667,000	7,359,000
3. Regrading and Revegetation	4,549,000	3,724,000	7,000	7,000	4,556,000	3,731,000
4. Incineration	12,095,000	6,513,000	184,259,000	99,217,000	196,354,000	105,730,000
Total Alternative Variation	**30,416,000**	**17,701,000**	**184,526,000**	**99,436,000**	**214,942,000**	**117,137,000**

(1) All costs are rounded to the nearest 1,000 dollars.

- Implementability

  The implementation of this option presents some special problems. These primarily concern the coordination and transportation of the large quantity (2,400,000 cubic yards) of material to be excavated. Due to the volume to be disposed of, it may be necessary to utilize more than one landfill facility.

  The estimated time required for completion of excavation is 22.2 years based on a unit crew. Transportation of the excavated waste offsite will be done in trucks with a 20 cubic yard capacity, and will require approximately 120,000 shipments. If more crews are used, the alternative can be completed in less time, assuming the trucks can load and travel to the disposal site as quickly as excavation proceeds.

- Safety

  The safety considerations for this alternative are essentially the same as those discussed in Section 11.5.1.

11.6.2 Public Health Evaluation

- Implementation Phase

  Health effects due to the excavation portion of this alternative have been previously discussed. Additional concerns involve taking the material outside the confines of the site. Transporting personnel and human receptors along the route may be subjected to dust and fugitive gas emissions. These effects will be minimized by covering and wetting the material as needed. Direct contact and inhalation could also occur in the case of accidental spills. The possibility of these incidents are increased due to the large number of shipments (120,000) that will be required to transport the waste.

- Residual Risk

  The long term effects associated with excavation of the landfill contents have been stated earlier. Persistent problems center around currently polluted groundwater and potential contaminant/soil complexes below the level of excavation. The exact effect of these contaminants is difficult to assess since release and transport is dependent on the chemical species, soil type and purging action of the site.

11.6.3 Environmental Evaluation

- Implementation Phase

  The greatest environmental impact will occur during the excavation phase of this alternative. Risks involved are identical to those discussed previously. Additional factors are similar to those listed for public health, namely exposure to dust and fugitive gas emissions with the potential for direct contact in the event of an accidental spill.

  Inhalation of particulates and gases will be reduced with the use of tarps and wetting of the excavated material. The careful planning of truck routes and schedules will also help to decrease exposure and minimize accidents. Decontamination of exiting vehicles should further decrease environmental impact.

- Residual Risk

  The residual risks inherent with this alternative are the same as those described previously.

11.6.4 Institutional Evaluation

The transporter requirements discussed in Section 11.3.9 are also applicable to this alternative. In addition, the offsite landfill facility must be in compliance with all applicable standards of federal environmental and public health statutes. The

temporary storage area needs to be managed under 40 CFR Part 264, Subpart L. All contaminants above background levels will be removed from the site.

- Floodplain
  The alternative effects on the floodplain are identical to those described in Section 11.5.4.

- Wetlands
  The alternative effects on the wetlands are identical to those described in Section 11.5.4.

Considerations for public acceptance with regard to excavation have been previously discussed. Increased traffic generated by the transport of material may create some disruption but attention to routing and scheduling should increase public tolerance.

11.6.5 Cost Evaluation

The capital costs for this alternative are $648,971,000. Capital costs include transportation, excavation, and disposal fees. The disposal fee is based on the costs at the EPA-approved RCRA landfill in Emele, Alabama. These costs are approximately $30 less per ton than the disposal fee at the Pine Wood, South Carolina faciilty. Operation and maintenance costs for the revegetation of the backfilled material was based on four times per year. The present worth at a 10 percent discount rate for 30 years for the total costs is $261,538,000.

A sensitivity analysis was performed on various components of this alternative. The most significant of these concerned the volume of waste to be excavated and transportation to an offsite landfill and a 30 percent difference in the volume was used. The sensitivity analysis resulted in a present worth cost variation of $183,990,000 to $339,099,000.

The costs and sensitivity analysis are summarized in Tables 11-14 and 11-15.

TABLE 11-14
COST SUMMARY - EXCAVATION AND BACKFILLING, REGRADING AND REVEGETATION, OFFSITE DISPOSAL, AND MONITORING
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

A. Estimation of Costs[1]

Alternative Components	Time to Construct (Yr.)	Capital Costs ($)	O & M Costs ($) Period (Yr.)	Annual ($)	Total ($)	Total Costs ($)
1. Monitoring	1	105,000	3	94,870	285,000	390,000
2. Excavation	22[2]	26,368,000	-	-	-	26,368,000
3. Regrading and Revegetation	1	4,129,000	30	770	23,000	4,152,000
4. Offsite Disposal	22[2]	618,369,000	-	-	-	618,369,000
Total Alternative Costs		**648,971,000**		**95,640**	**308,000**	**649,279,000**

TABLE 11-14
COST SUMMARY - EXCAVATION AND BACKFILLING, REGRADING AND REVEGETATION, OFFSITE DISPOSAL, AND MONITORING
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY
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B. Present Worth Analysis(1)

Alternative Components	Capital Costs ($)	O & M Costs ($)	Total Present Worth ($)
1. Monitoring	105,000	236,000	341,000
2. Excavation	10,513,000	-	10,513,000
3. Regrading and Revegetation	4,129,000	7,000	4,136,000
4. Offsite Disposal	246,548,000	-	246,548,000
Total Alternative Present Worth	**261,295,000**	**243,000**	**261,538,000**

(1) All costs are rounded to the nearest 1,000 dollars, except annual O & M.
(2) A unit crew for excavation and a unit incinerator are used to make costs comparable to other alternatives.

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TABLE 11-15
SENSITIVITY ANALYSIS - EXCAVATION AND BACKFILLING, REGRADING AND REVEGETATION, OFFSITE DISPOSAL, AND MONITORING
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

C. Sensitivity Factors

Alternative Components	Sensitivity Factor	Range	Justification for Range
1. Monitoring	Number of samples	± 10%	Contamination may spread or mitigate
2. Excavation	Volume of fill material	± 30%	Volume of fill estimated
3. Regrading and Revegetation	Area and extent of regrading	± 10%	Area to be regraded estimated
4. Offsite disposal	Volume of fill to transport	± 30%	Volume of fill estimated

TABLE 11-15
SENSITIVITY ANALYSIS - EXCAVATION AND BACKFILLING, REGRADING AND REVEGETATION, OFFSITE DISPOSAL, AND MONITORING
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY
PAGE TWO

D. Cost Variation (Present Worth Costs)(1)

Alternative Components	Capital Costs ($)		O & M Costs ($)		Total Variation ($)	
	High	Low	High	Low	High	Low
1. Monitoring	105,000	105,000	260,000	212,000	365,000	317,000
2. Excavation	13,667,000	7,359,000	-	-	13,667,000	7,359,000
3. Regrading and Revegetation	4,549,000	3,724,000	7,000	7,000	4,556,000	3,731,000
4. Offsite disposal	320,511,000	172,583,000	-	-	320,511,000	172,583,000
Total Alternative Variation	**338,832,000**	**183,771,000**	**267,000**	**219,000**	**339,099,000**	**183,990,000**

(1) All costs are rounded to the nearest 1,000 dollars.

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12.0 SUMMARY OF ALTERNATIVES

To assist the decisionmaker in evaluating the remedial alternatives and selecting one for implementation, a summary of the alternatives is presented below. Each alternative is summarized in accordance with cost factors, public health concerns, environmental concerns, technical concerns, and other concerns such as community effects and factors that inhibit implementation.

Each alternative discussed below includes a monitoring program for gas, groundwater, and air. In phasing all work under any alternative, the air monitoring program should be implemented early. Alternatives two through four include an alternate water supply on a discretionary basis. The EPA will decide at a later time on the applicability of implementing this technology should groundwater conditions change at the site.

Table 12-1 summarizes the alternatives identified for implementation at the Lees Lane Landfill Site.

12.1 No Action - Monitoring Alternative

Under the no action alternative, no additional remedial activities would be performed. This alternative does not address the remediation of the site nor the potential threat to the public or the environment via the contamination pathways. However, a multi-media monitoring program will provide information so that possible adverse public health or environmental impacts that may arise can be addressed. At the Lees Lane Landfill Site, early phasing of the air monitoring program should be considered, since limited data is available. Based upon the conclusions of the Remedial Investigation (RI), gas migration is considered a significant problem at the site, and existing gas monitoring wells have been damaged or discharged. Therefore, the air monitoring program should be implemented first, followed by the installation of gas and monitoring wells, and implementation of the gas and groundwater monitoring schemes.

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TABLE 12-1
SUMMARY OF REMEDIAL ACTION ALTERNATIVES
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Alternative	Cost ($) 1,000 Actual	Cost ($) 1,000 Present Worth	Public Health Concern	Environmental Concern	Technical Concern	Other Concerns
1. No Action - Monitoring	391	341	Gas migration and direct contact with surface wastes	Leachate and waste release to Ohio River	-	Community disapproval
2. Gas Collection and Venting System, and Monitoring	647	439	Direct contact with surface wastes	Leachate and waste release to Ohio River	-	-
3. Surface Waste Area Cleanup, Bank Protection Controls, Gas Collection and Venting System, and Monitoring	2,909	2,682	Minimal	Leachate release to Ohio River	-	-
4. Capping, Regrading and Revegetation, Surface Waste Area Cleanup, Bank Protection Controls, Gas Collection and Venting System, and Monitoring	42,683	15,946	Minimal	Leachate release to Ohio River	Time for implementation Cap damage from Ohio River runon during flooding	Transportation of capping material through Riverside Gardens
5. Excavation and Backfilling, Regrading and Revegetation, Onsite Incineration, Offsite Fly Ash Disposal, and Monitoring	418,112	165,766	Gas and particulate migration during excavation	Migration of wastes from flooding during excavation	Coordination of excavation and incineration. Time for implementation	Transportation of wastes through Riverside Gardens
6. Excavation and Backfilling, Regrading and Revegetation, Offsite Disposal, and Monitoring	649,279	261,538	Gas and particulate migration during excavation	Migration of wastes from flooding during excavation	Coordination of excavation and transportation of wastes. Time for implementation	Transportation of wastes through Riverside Gardens

12.2 Gas Collection and Venting System, and Monitoring Alternative

This alternative includes the monitoring program for gas, air, and groundwater discussed in Section 12.1, the provision of a properly operating gas collection system and a potential future alternate water supply. Any problems remaining in the gas collection system will be corrected after a determination of the extent of the damage to the system is made. Implementation of this alternative will ensure that the most potentially significant problem at the site, gas migration, is addressed. Again, the air monitoring program should be implemented first.

12.3 Surface Waste Area Cleanup, Bank Protection Controls, Gas Collection and Venting System, and Monitoring

This alternative includes the monitoring program discussed in Section 12.1, the gas collection system and potential future alternate water supply discussed in Section 12.2, and the cleanup of the surface waste areas and bank protection controls. The monitoring program included in this and the following alternative contains the sampling of an additional groundwater monitor well (LL-9) to aid in determining alternate concentration limits (ACLs). Since site access is not restricted, the cleanup of the surface waste areas will reduce the possibility of direct contact. The installation of bank protection controls will minimize erosion and failure of the Ohio River bank. The cleanup of the surface waste areas and provision of bank protection controls provide an additional level of protection; therefore, these actions should be performed after implementation of the monitoring program and provision of a properly operating gas collection system.

12.4 Capping, Regrading and Revegetation, Surface Waste Area Cleanup, Bank Protection Controls, Gas Collection and Venting System, and Monitoring

In addition to the previously described technologies, monitoring, surface waste area cleanup, bank protection controls, gas collection and venting system, and potential future alternate water supply, a cap will be installed over the entire landfill to minimize leachate generation and to control vertical movement of gas. Regrading

and revegetation will be necessary to provide maximum drainage of the area. The implementation of both the capping and bank protection controls will require some clearing. One drawback of this alternative is that the landfill lies within the 100-year floodplain and a cap may not be effective against infiltration of the Ohio River during flooding.

12.5 Excavation and Backfilling, Regrading and Revegetation, Onsite Incineration, Offsite Fly Ash Disposal, and Monitoring

In addition to monitoring, this alternative would require extensive excavation and construction of an onsite incinerator. As a result of these two procedures, offsite fly ash disposal, backfilling, regrading, and revegetation will be necessary. Excavation will occur at a faster rate than incineration; therefore, a storage area will be required. Coordination among the various components of this alternative will be necessary for efficiency to be maintained. This is critical since there will be times when excavation, incineration, separation of material not suitable for incineration, fly ash disposal and backfilling will occur simultaneously. Implementation of this alternative has the potential to impact public health and the potential for harmful effects is increased considering the time required for its completion. The migration of wastes could become a problem if flood conditions occur during excavation.

12.6 Excavation and Backfilling, Regrading and Revegetation, Offsite Disposal, and Monitoring

In addition to monitoring and excavation, this alternative calls for waste disposal at an offsite EPA-approved RCRA landfill. Disposal in an offsite landfill is a permanent remedial action and provides a high level of environmental and public health protection to nearby residents. The primary concern will be the coordination of the 120,000 trucks required to transport the 2,400,000 cubic yards of fill.

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PROJECT FOR PERFORMANCE OF REMEDIAL RESPONSE ACTIVITIES AT UNCONTROLLED HAZARDOUS SUBSTANCE FACILITIES—ZONE 1

NUS CORPORATION
SUPERFUND DIVISION

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R-586-4-6-1-3

FINAL
REMEDIAL INVESTIGATION AND FEASIBILITY STUDY OF ALTERNATIVES
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

APPENDICES

EPA WA NO. 46-4L43
EPA TDD NO. F4-8403-17
CONTRACT NO. 68-01-6699

NUS PROJECT NUMBERS 0664 and 0764

APRIL 1986
REVISION 2

SUBMITTED FOR NUS BY: 935-7710

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APPENDICES

Appendix

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C	SCS Engineering Well Logs
D	Well Completion Reports, As-Built Well Diagrams and Well Logs
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F	Hazardous Substances List (HSL)
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NOTICE

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APPENDIX A

PROPERTY SURVEY

PROPERTY SURVEY

NUS Corporation contracted AmTech Engineering, Inc. of Indianapolis, Indiana to conduct a property survey of the Lees Lane Landfill Site. The plat of survey was completed on November 1, 1984 and signed by Kentucky Registered Land Surveyor #203, R. R. Waddle and by Kentucky Registered Land Surveyor #2207, Leslie M. Haney.

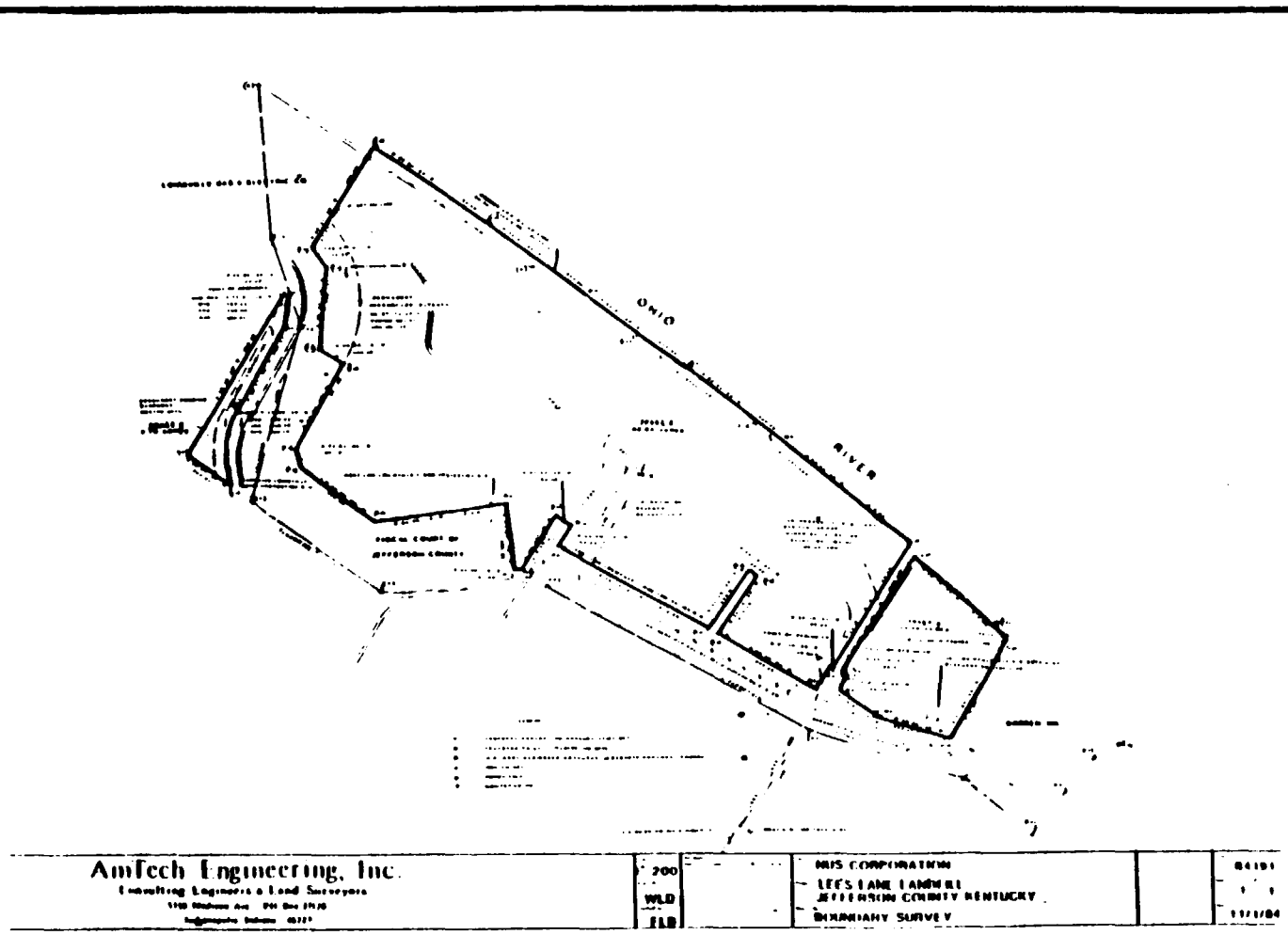
The Lees Lane Landfill Site property consists of three tracts of land (see Figure A-1). Tract 1 has 11.45 acres, tract 2 has 98.03 acres, tract 3 has 2.79 acres. Tracts 1 and 2 are between the Ohio River and the levee. Tract 3 is on the other side of the levee.

Table A-1 lists the property corner numbers and their locations based on the Kentucky State Plane Coordinate System, North Zone.

The legal description of the Lees Lane Landfill is as follows:

Tract 1: Beginning at an iron pin (set) in the northern right-of-way of Lees Lane approximately nine hundred and ninety feet west of the western right-of-way of Putnam Street; then with said Lees Lane right-of-way N 58° 44' 16" W, 723.02 feet to a point on the Ohio River; thence with said River N 40° 12' 20" E, 672.52 feet to a point on the Ohio River, corner to Borden, Inc.; thence leaving the Ohio River with the southern line of Borden, Inc. (passing through an iron pipe (found) 150.56 feet from said point) S 61° 08' 26" E, 619.08 feet to an iron pin (set) in the western right-of-way of the Louisville Flood Protection Levee; thence with said right-of-way for four calls - - S 16° 38' 12" W, 394.47 feet to an iron pin (set); thence S 33° 51' 45" W, 279.16 feet to an iron pin (set); thence N 61° 40' 36" W, 88.42 feet to an iron pin (set); thence S 28° 19' 24" W, 25.24 feet to the Point of Beginning and containing 11.45 Acres.

Tract 2: Beginning at an iron pin (set) in the southern right-of-way of Lees Lane approximately nine hundred and ninety feet west of the western right-of-way of Putnam Street; thence leaving said Lees Lane right-of-way with the western right-



PROPERTY SURVEY

LEES LANE LANDFILL SITE

JEFFERSON COUNTY, KENTUCKY

FIGURE A-1

NUS CORPORATION
A Halliburton Company

TABLE A-1
PROPERTY CORNER LOCATIONS BASED ON THE
KENTUCKY STATE PLANE COORDINATE SYSTEM, NORTH ZONE.
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Property Corner #	Property Corner	
51	257810.838	1532135.952
52	257442.797	1532025.978
53	257210.988	1531870.429
54	257252.938	1531792.594
55	257230.724	1531780.621
56	257191.057	1531759.246
57	257164.981	1531745.192
58	257098.559	1531868.432
59	256544.834	1531569.991
60	256762.771	1531262.453
61	256721.976	1531233.543
62	256500.489	1531546.091
63	255696.789	1531112.921
64	255768.153	1530998.326
65	255683.268	1530945.463
66	255503.536	1531234.074
67	255469.867	1531238.809
68	255419.739	1530882.316
69	254713.873	1530981.571
70	254317.067	1530687.932
71	254291.702	1530594.204
72	254540.698	1530136.321
73	254405.975	1530059.674
74	254441.713	1529614.988
75	254370.560	1529518.953
76	254703.830	1528976.689
77	255308.710	1529378.181
78	255845.527	1529762.143
79	256378.974	1530150.775
80	256909.009	1530544.047
81	257596.114	1531092.054
82	257605.939	1531162.585
83	258120.920	1531597.863
84	254947.417	1530788.496
85	253691.453	1530623.929
86	254211.551	1529777.677
87	254253.925	1529773.896
88	254214.797	1529950.832
89	253964.561	1530390.671

of-way of the Louisville Flood Protection Levee for nineteen calls - - S 28° 19' 24" W, 29.62 feet to an iron pin (set); thence S 61° 40' 36" E, 140.00 feet to an iron pin (set); thence S 28° 19' 24" W, 629.03 feet to an iron pin (set); thence N 54° 40' 36" W, 376.93 feet to an iron pin (set); thence S 35° 19' 24" W, 50.00 feet to an iron pin (set); thence S 54° 40' 36" E, 383.07 feet to an iron pin (set); thence S 28° 19' 24" W, 913.00 feet to an iron pin (set); thence N 58° 05' 15" W, 135.00 feet to an iron pin (set); thence S 31° 54' 45" W, 100.00 feet to an iron pin (set); thence S 58° 05' 15" E, 340.00 feet to an iron pin (set); thence S 08° 00' 15" E, 34.00 feet to an iron pin (set); thence S 81° 59' 45" W, 360.00 feet to an iron pin (set); thence S 08° 00' 15" E, 712.81 feet to an iron pin (set); thence S 36° 30' 06" W, 493.64 feet to an iron pin (set); thence S 74° 51' 26" W, 97.10 feet to an iron pin (set); thence N 61° 27' 46" W, 521.20 feet to an iron pin (set); thence S 29° 38' 12" W, 155.00 feet to an iron pin (set); thence N 85° 24' 19" W, 446.12 feet to an iron pin (set); thence S 53° 27' 54" W, 119.52 feet to an iron pin (set) in the northern line of the Louisville Gas and Electric Company; thence with said northern line (passing through an iron pin (set) 237.41 feet from the iron pin (set) in said northern line) N 58° 25' 32" W, 636.49 feet to a point in the low water mark of the Ohio River as described in Deed Book 3974, Page 253 and Deed Book 4789, Page 248 in the Office of the County Clerk of Jefferson County; thence with said low water mark for five calls - - N 33° 34' 28" E, 726.00 feet; thence N 35° 34' 28" E, 660.00 feet; thence N 36° 04' 28" E, 660.00 feet; thence N 36° 34' 28" E, 660.00 feet; thence N 38° 34' 28" E, 878.88 feet to a point in the southern right-of-way of Lees Lane; thence with said right-of-way S 58° 44' 16" E, 780.52 feet to the Point of Beginning and containing 98.03 Acres.

Tract 3: Beginning at a point in the northern line of the Louisville Gas and Electric Company said point also being in the eastern right-of-way of the Louisville Flood Protection Levee; thence with said right-of-way for four calls - - N 05° 05' 35" W, 42.53 feet; thence along a curve to the right, whose chord bears S 77° 31' 49" E, 181.21 feet, and having a radius of 306.97 feet for a distance of 183.95 feet; thence S 60° 21' 48" E, 506.04 feet; thence along a curve to the left, whose chord bears S 86° 05' 48" E, 398.75 feet, and having a radius of 459.19 feet for a distance of 412.48 feet; thence leaving said right-of-way S 33° 47' 07" W, 295.94 feet to a point in the northern line of the Louisville Gas and Electric Company; thence with

said northern line N 58° 25' 32" W, 993.30 feet to the Point of Beginning and containing 2.79 Acres.

The above described property is subject to all easements and rights-of-way both public and private.

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APPENDIX B

TEST BORING PROGRAM

TEST BORING PROGRAM

The test boring program conducted for this study consisted of five boreholes at four different locations in and around the Lees Lane Landfill Site. The program took place during November and December 1984. All five of the boreholes were converted to monitor wells. Geologic information obtained from the test boring program is discussed below.

Boring locations MW-01 and MW-02 are hydraulically upgradient of the site in Riverside Gardens, approximately 1,600 feet east of the landfill. Boring MW-01 was drilled using 6.5-inch ID hollow stem augers to its final depth. Boring MW-02 was initially drilled using 3.75-inch ID hollow stem augers to the top of the water table. Once the water table was reached the augers were removed from the borehole and the mud rotary method of drilling was used to extend the borehole to the top of bedrock. Split spoon samples were taken at 5 foot intervals starting at ground surface, and a 1.5-inch AX core barrel was used to core the top 5 feet of bedrock in MW-02.

Boring MW-03 is located between the landfill and the Borden Chemical Company. This location is immediately adjacent to the northeastern corner of the landfill. The monitor well installed was used to investigate the prior cone of depression created by industrial groundwater pumping centers east of the landfill and to determine the presence or probable absence of contamination.

Boring MW-03 was initially drilled using 3.75-inch ID hollow stem augers to the top of the water table. The augers were removed once the water table was reached and the borehole was advanced using the mud rotary method of drilling to the top of bedrock. Split spoon samples were taken at 5 foot intervals starting at ground surface. A 1.5-inch AX core barrel was used to core the top 5 feet of bedrock.

Boring location MW-04 is near the Ohio River on the northern edge of the filled area and approximately in the middle of the Central Tract. This location was used

to determine the potential for downward migration of contaminants, if present, and also to investigate the hydraulic connection between the Ohio River and the bottom of the alluvial aquifer.

The boring was initially drilled using 6.5-inch ID hollow stem augers to the suspected bottom of the fill, approximately 40 feet. The augers were removed and a 10-inch steel surface casing was set and cemented in place to seal off potential downward migration of landfill leachate. The borehole was then advanced using the mud rotary method to the top of bedrock.

Boring location MW-05 is in the Southern Tract near the Ohio River. This location is on the landfill property but is downgradient of the area that had been filled. The monitor well was used to determine the presence or probable absence of contamination as a result of groundwater migration toward the Ohio River.

The boring was initially drilled using 3.75-inch ID hollow stem augers to the top of the water table. Once the water table was reached the augers were removed from the borehole and the mud rotary method of drilling was used to extend the borehole to the top of bedrock. Split spoon samples were taken at 5-foot intervals starting at ground surface. A 1.5-inch AX core barrel was used to core the top 5 feet of bedrock.

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APPENDIX C

SCS ENGINEERING WELL LOGS

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TEST BORING REPORT

CLIENT S C S Engineering P. N. 78052

PROJECT Lees Lane Landfill HOLE NO. 3

LOCATION

DRILLER G. Scamahorn LOGGED BY M. Brown DATE STARTED 5- 6-78

ELEVATION REFERENCE Ground Surface DATE COMPLETED 5- 6-78

DEPTH TO WATER: IMMEDIATELY none DAYS AFTER

NOTES Type & Size of Hole, Type of Bit or Spoon, Loss of Drilling Water	DESCRIPTION & Classification of Materials	Samples & Log Boring	Log	PENETRATION RESISTANCE (Blows per foot) ● Actual / Extrapolated 20 40 60 80	No. Blows & Core Recovery
2.0' PLUG 4.0'	Vegetation and Topsoil	X			
		X			
		X			
		X			
	Medium dense, brown silt with a little gray clay and some sand	5 X			
Gravel		X/P			4
		P			5-6
Probe Tip @ 9.0'		X			
		X			
		10 X			
	Wet, very loose, dark brown silty medium sand	X/P			2
12.0' PLUG 14.0'		P			2-2
		X			
		X			
		15 X			
Gravel	Medium dense, light brown clean fine to medium sand	X/P			6
Probe Tip @ 17.0'		P			9-9
19.0'		X			
		X			
		20 X			
PLUG 21.5'		P			
		P			
Gravel		X			
Probe Tip @ 23.0' 23.0'		X			
		25 X			
	Very loose, light brown fine to medium clean sand	X/P			3
Caved below 25.0'		P			2-3
		X			
		X			
30.0'	Terminated @ 30.0'	30 X			

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TEST BORING REPORT

CLIENT S C S Engineering P. N. 78062

PROJECT Lees Lane Landfill HOLE NO. 4

LOCATION

DRILLER G. Scamahorn LOGGED BY M. Brown DATE STARTED 6- 6-78

ELEVATION REFERENCE Ground surface DATE COMPLETED 6- 6-78

DEPTH TO WATER: IMMEDIATELY 55.0' ; DAYS AFTER

NOTES (Type & Size of Hole, Type of Bit or Spoon, Loss of Drilling Water)	DESCRIPTION & Classification of Materials	Samples for Testing	Log	PENETRATION RESISTANCE (Blows per foot) ● Actual / Extrapolated 20 40 60 80	No. Blows & Depth Recovery
	Vegetation and Topsoil	X			
		X			
	Apparent fill, brick, stone and cinders	X			
PLUG 5.0'		X			
		X			
	Moist, medium dense, brown silt with a trace of sand and a little clay	X/P			4
Gravel		P			7-9
Probe Tip @ 9.0'		X			
		X			
		X			
12.0'	Wet, loose, brown fine to medium silty sand	X/P			2
		P			2-5
PLUG		X			
		X			
15.0'		X			
		P			4-5
	Moist, medium dense, brown fine to medium sand	P/X			6
Gravel		X			
Probe Tip @ 23.0'		X			
		X			
		X			
		X			
		X			
		X/P			12
		P			13-26
		X			
	Moist, dense, brown fine sand with a little pebbles	X			
29.0'		X			
		X			
PLUG		X			
		X			
33.0'		X			
Gravel		X			
		X			
Probe Tip @ 35.0'		P			10-15
		P/X			21
		X			
		X			
		X			

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TEST BORING REPORT

CLIENT S C S Engineering P. N. 78062

PROJECT Lees Lane Landfill HOLE NO. 4(continued)

LOCATION

DRILLER G. Scamahorn LOGGED BY M. Brown DATE STARTED 6- 6-78

ELEVATION REFERENCE Ground surface DATE COMPLETED 6- 6-78

DEPTH TO WATER: IMMEDIATELY 55' DAYS AFTER

NOTES Type & Size of Hole Type of Bit or Spoon Loss of Drilling Water	DESCRIPTION & Classification of Materials	Samples for Testing	Log	PENETRATION RESISTANCE (Blows per foot) ● Actual Extrapolated 20 40 60 80	No. Blows & Case Hardness
42.5'	Moist, very dense, brown coarse sand and gravel	X			
		X			
		X			
		X			
Soil		45 X			10-25
		P			32
		P			
Piezometer Tip @ approximately 58'		X			
		X			
		50 X			
		X			
		X			
		X			
		X			
		55 X			
		P			5-7
		P			15
		X			
		X			
60.0'	Terminated @ 60.0'	60 X			

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TEST BORING REPORT

CLIENT S C S Engineering P. N. 78062

PROJECT Lees Lane Landfill HOLE NO. 5

LOCATION

DRILLER G. Scamahorn LOGGED BY M. Brown DATE STARTED 6- 6-78

ELEVATION REFERENCE Ground Surface DATE COMPLETED 6- 6-78

DEPTH TO WATER: IMMEDIATELY none ; DAYS AFTER

NOTES (Type & Size of Hole, Type of Bit or Spoon, Loss of Drilling Water)	DESCRIPTION & Classification of Materials	Sample for testing	Log	PENETRATION RESISTANCE (Blows per foot) ● Actual, Extrapolated 20 40 60 80	No. Blows & Core Recovery
	Vegetation and topsoil	X			
PLUG 4.0'		X			
		X			
		X			
	Moist, loose, brown sand and silt with a trace of gray clay	X			
Gravel		X/P			2
Probe Tip @ 7.0' 9.0'		P			4-4
		X			
		X			
PLUG 12.0'	Moist, dark brown silt and fine sand	X			
Gravel		X			
	Moist, medium dense, light brown fine to medium sand	X			
Probe Tip @ 15.0' 17.0'		X			
		X/P			5
PLUG 19.0'		P			6-7
		X			
		X			
Gravel		X			
		X			
Probe Tip @ 22.5'		X			
		X			
		X			
27.0'	Medium dense, medium to coarse light brown sand and gravel	X/P			5
		P			12-16
Caved below 27.0'		X			
30.0'	Terminated @ 30.0'	X			

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TEST BORING REPORT

CLIENT S C S Engineering P. N. 78062

PROJECT Lees Lane Landfill HOLE NO. 6

LOCATION

DRILLER G. Scamahorn LOGGED BY C. Donahue DATE STARTED 6- 8-78

ELEVATION REFERENCE Ground Surface DATE COMPLETED 6- 8-78

DEPTH TO WATER: IMMEDIATELY 54' DAYS AFTER

NOTES Type & Size of Hole Type of Bit or Spoon Loss of Drilling Water	DESCRIPTION & Classification of Materials	Samples for Testing	Log	PENETRATION RESISTANCE (Blows per foot) ● Actual Extrapolated 20 40 60 80	No. Blows & Core Recovery
2.0'	Vegetation and Topsoil	X			
PLUG		X			
4.0'	Moist, loose, brown clayey silt	X			
		X			
		X			
Gravel		X			
		X			
Probe Tip @ 8.8'		X			
		X			
		X			
		P			3-4
		P/X			4
		X			
13.5'	Wet, brown fine silty sand	X			
PLUG 15.0'		X			
		X			
Gravel		X			
		X			
Probe Tip @ 18.8'	Moist, medium dense, brown fine to medium sand	X			
		P			5-4
		P/X			7
		X			
		X			
		X			
		X			
28.0'		X			
PLUG		X			
30.0'	Moist, dense, brown and gray medium to coarse sand and gravel	X			
		P			11-15
		P/X			18
Gravel		X			
		X			
Probe Tip @ 38.8'		X			
		X			
		X			
		X			
		X			

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TEST BORING REPORT

CLIENT S C S Engineering P. N. 780f2

PROJECT Lees Lane Landfill HOLE NO. 6 (continued)

LOCATION

DRILLER G. Scamahorn LOGGED BY C. Donahue DATE STARTED 6- 8-78

ELEVATION REFERENCE Ground Surface DATE COMPLETED 6- 8-78

DEPTH TO WATER: IMMEDIATELY 54' DAYS AFTER

NOTES Type & Size of Hole Type of Bit or Spoon Loss of Drilling Water	DESCRIPTION & Classification of Materials	Samples for testing	Log	PENETRATION RESISTANCE (Blows per foot) ● Actual · Extrapolated 20 40 60 80	No. Blows & Corr. Hrs. Dry
		P			10-11
		P/X			15
		X			
		X			
	Moist, medium dense, brown and gray medium to coarse sand and gravel	45 X			
		X			
Gravel		X			
		X			
		X			
50.0'		50 X			
		P			9-14
		P/X			16
		X			
		X			
		55 X			
Soil	Dense, gray coarse sand and gravel	P			11-18
		P/X			22
		X			
		X			
		60 X			
		X			
Piezometer Tip		X			
		X			
@ 61.9'		X			
65.0'	Terminated @ 65.0'	65 X			

LEE 001

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001244

TEST BORING REPORT

CLIENT S C S Engineering P. N. 78062

PROJECT Lees Lane Landfill HOLE NO. 7

LOCATION

DRILLER G. Scamahorn LOGGED BY C. Donahue DATE STARTED 6- 8-78

ELEVATION REFERENCE Ground Surface DATE COMPLETED 6- 8-78

DEPTH TO WATER: IMMEDIATELY none ; DAYS AFTER

NOTES Type & Size of Hole Type of Bit or Spoon Loss of Drilling Water	DESCRIPTION & Classification of Materials	PENETRATION RESISTANCE (Blows per foot) ● Actual ◦ Extrapolated 20 40 60 80	No. Blows & Core Recovery
2.0'±	Vegetation and Topsoil		
PLUG 4.0'	Moist, brown clayey silt		
Gravel Probe Tip @ 8.0' 10.0'±			
PLUG 12.0'	Moist, loose, brown fine to medium silty sand		3-3 5
Gravel Probe Tip @ 14.0' 15.5±			
PLUG 17.5'	Moist, loose, brown and gray fine to medium sand		
Gravel Probe Tip @ 25.0' 27.0'			2-3 4
Caved below 27.0' 31.5'	Moist, brown and gray medium to coarse sand and gravel		
	Terminated @ 31.5'		

LEE 001

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001245

TEST BORING REPORT

CLIENT S C S Engineering P. N. 78062

PROJECT Lees Lane Landfill HOLE NO. 8

LOCATION

DRILLER G. Scamahorn LOGGED BY C. Donahue DATE STARTED 6- 8-78

ELEVATION REFERENCE Ground Surface DATE COMPLETED 6- 8-78

DEPTH TO WATER: IMMEDIATELY 50'. DAYS AFTER

NOTES (Type & Size of Hole, Type of Bit or Spoon, Loss of Drilling Water)	DESCRIPTION & Classification of Materials	Samples for testing	Log	PENETRATION RESISTANCE (Blows per foot) ● Actual ○ Extrapolated 20 40 60 80	No. Blows & Char. Recovery
	Vegetation and Topsoil	X			
PLUG 5.0'	Moist, brown clayey silt	5			
Gravel Probe Tip @ 12.0'	Wet, medium dense, brown fine to medium silty sand	10 P, P/X			4-5, 6
17.0'	Moist, loose, brown and gray fine to medium sand with some gravel	15			
PLUG 19.0'		20 P, P/X			2-3, 3
Gravel Probe Tip @ 22.0'		25			
28.0'	Moist, medium dense, brown and gray medium to coarse sand with gravel				
PLUG 30.0'		30 P, P/X			4-6, 11
Gravel		35			
39.5'		40			

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TEST BORING REPORT

CLIENT S C S Engineering P. N. 78062

PROJECT Lees Lane Landfill HOLE NO. 8 (continued)

LOCATION

DRILLER G. Scamahorn LOGGED BY C. Donahue DATE STARTED 6- 8-78

ELEVATION REFERENCE Ground Surface DATE COMPLETED 6- 8-78

DEPTH TO WATER: IMMEDIATELY 50' DAYS AFTER

NOTES Type & Size of Hole Type of Bit or Spoon Loss of Drilling Water	DESCRIPTION & Classification of Materials	Samples for testing	Log	PENETRATION RESISTANCE (Blows per foot) ● Actual / Extrapolated 20 40 60 80	No. Blows & Core Recovery
Soil	Moist, medium dense, brown and gray medium to coarse sand with gravel	P			10-11
		P/X			17
Probe Tip @ 42.0'		X			
		X			
		X			
		X			
		X			
Caved in below 39.5'		X			
		X			
		X			
Piezometer Tip @ 55' ±	Wet, dense, gray coarse sand and gravel	P			10-12
		P/X			21
Caved below 39.5'		X			
		X			
		X			10-10
56.5'		P			11
	Terminated @ 56.5'	P/			

45 50 55 60

LEE 001

1119

MILTON M. GREENBAUM ASSOCIATES, inc. • CONSULTING ENGINEERS

001247

TEST BORING REPORT

CLIENT S C S Engineering P. N. 78062

PROJECT Lees Lane Landfill HOLE NO. 9

LOCATION

DRILLER G. Scamahorn LOGGED BY C. Donahue DATE STARTED 6- 7-78

ELEVATION REFERENCE Ground Surface DATE COMPLETED 6- 7-78

DEPTH TO WATER: IMMEDIATELY none DAYS AFTER

NOTES (Type & Size of Hole, Type of Bit or Spoon, Loss of Drilling Water)	DESCRIPTION & Classification of Materials	Sample	Log	PENETRATION RESISTANCE (Blows per foot) ● Actual ○ Extrapolated 20 40 60 80	No. Blows & Core Lengths
1.0'	Vegetation and Topsoil	X			
PLUG 3.0'	Moist, brown clayey silt	X			
Gravel Probe Tip @ 6.0'		5			
8.0'	Moist, dark brown clayey silt with sand				
PLUG 11.0'	Moist, loose, brown fine to medium silty sand	10 P			3-3 6-6
Gravel Probe Tip @ 15.0'		15			
17.0'					
PLUG 20.0'	Moist, loose, brown and gray fine to medium sand with some gravel	20 P			3-4 5
Gravel Probe Tip @ 28.0'		25			
Hole caved to 28.0'	Moist, medium dense, brown and gray fine to medium sand with some gravel	30 P			6-7 8
31.5'	Terminated @ 31.5'	P/			

LEE 001

MILTON M. GREENBAUM ASSOCIATES, inc. • CONSULTING ENGINEERS

TEST BORING REPORT

001248

CLIENT S C S Engineering P. N. 78062

PROJECT Lees Lane Landfill HOLE NO. 10

LOCATION

DRILLER G. Scamahorn LOGGED BY C. Donahue DATE STARTED 6- 7-78

ELEVATION REFERENCE Ground Surface DATE COMPLETED 6- 7-78

DEPTH TO WATER: IMMEDIATELY 50' ; DAYS AFTER

NOTES Type & Size of Hole Type of Bit or Spoon Loss of Drilling Water	DESCRIPTION & Classification of Materials	Samples (as taken)	Log	PENETRATION RESISTANCE (Blows per foot) ● Actual ○ Extrapolated 20 40 60 80	No Blows & Core Recovery %
	Vegetation and Topsoil	X			
	Light brown clayey silt	X			
PLUG 4.0'		X			
		X			
		5 X			
		X			
Gravel		X			
		X			
Probe Tip @ 12.0'	Brown clayey silt with sand	10 X			
	Moist, loose, brown fine to medium silty sand	P			2-3 5
		P/X			
		X			
14.8'		15 X			
PLUG 16.8'		X			
		X			
		X			
Gravel Probe Tip @ 22.0'		20 X			
		P			4-4 6
	Moist, loose, brown and gray medium to coarse sand with gravel	P/X			
		X			
		25 X			
		X			
		X			
		X			
30.0'		30 X			
PLUG 32.0'		P			3-4 6
		P/X			
		X			
		X			
Gravel		35 X			
		X			
		X			
		X			
		40 X			

LEE 001

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TEST BORING REPORT

CLIENT S C S Engineering P. N. 78062

PROJECT Lees Lane Landfill HOLE NO. 10 (continued)

LOCATION

DRILLER G. Scamahorn LOGGED BY C. Donahue DATE STARTED 6- 7-78

ELEVATION REFERENCE Ground Surface DATE COMPLETED 6- 7-78

DEPTH TO WATER: IMMEDIATELY 50' ; DAYS AFTER

NOTES Type & Size of Hole Type of Bit or Spoon Loss of Drilling Water	DESCRIPTION & Classification of Materials	Samples for testing	Log	PENETRATION RESISTANCE (Blows per foot) ● Actual ○ Extrapolated 20 40 60 80	No. Blows & Core Recovery %
Gravel	Moist, medium dense, brown medium to coarse sand with gravel	P			5-8
Probe Tip @ 42.0'		P/X			8
45.0'		X			
		X			
		X			
Caved below 45.0'		X			
		X			
		X			
		X			
Soil	Wet, medium dense, gray to brown coarse sand and gravel	P			8-11
		P/X			14
Piezometer Tip @ 54.0'		X			
		X			
		X			
		P			6-14
56.5'	Terminated @ 56.5'	P/			18

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TEST BORING REPORT

001250

CLIENT S C S Engineering P. N. 78062

PROJECT Lees Lane Landfill HOLE NO. 11

LOCATION

DRILLER G. Scamahorn LOGGED BY C. Donahue DATE STARTED 6- 7-78

ELEVATION REFERENCE Ground Surface DATE COMPLETED 6- 7-78

DEPTH TO WATER: IMMEDIATELY none ; DAYS AFTER

NOTES (Type & Size of Hole, Type of Bit or Spoon, Loss of Drilling Water)	DESCRIPTION & Classification of Materials	Samples for testing	Log	PENETRATION RESISTANCE (Blows per foot) ● Actual ○ Extrapolated 20 40 60 80	No. Blows & Core Recovery %
	Vegetation and Topsoil	X			
		X			
		X			
	Moist, very loose, brown and gray clayey silt	X			
Gravel		X			
		P			2-2
Probe Tip @ 7.5'		P			2-3
		X			
		X			
		X			
12.0'		P			2-3
PLUG		P			4-6
14.0'	Moist, loose, brown fine to medium silty sand	X			
		X			
		X			
Gravel		X			
		X			
Probe Tip @ 20' ±		X			
	Moist, loose, brown and gray medium to coarse sand with some gravel	X			
21.75'		X			
PLUG		P			4-4
		P			6-6
23.75'		X			
		X			
Gravel		X			
		X			
Probe Tip @ 27.5'		X			
		X			
Caved to 27.5'		X			
		P			6-7
32.0'	Terminated @ 32.0'	P			9-11

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001251

TEST BORING REPORT

CLIENT: S C S Engineering — P. N. 78062

PROJECT: Lees Lane Landfill — HOLE NO. 12

LOCATION:

DRILLER: G. Scamahorn LOGGED BY: C. Donahue DATE STARTED: 6- 9-78

ELEVATION REFERENCE: Ground Surface DATE COMPLETED: 6- 9-78

DEPTH TO WATER: IMMEDIATELY 51' DAYS AFTER

NOTES Type & Size of Hole Type of Bit or Spoon Loss of Drilling Water	DESCRIPTION & Classification of Materials	Depth	Samples for testing	No. Blows & Core Recovery %
2.0'	Vegetation and Topsoil		X	
PLUG 4.0'	Moist, brown clayey silt		X	
Gravel		5	X	
Probe Tip @ 12.0'	Moist, loose, brown fine to medium silty sand	10	X	
			P	3-4
			P/X	5
		15	X	
16.3' PLUG 18.0'			X	
Gravel	Moist, loose, brown fine to medium sand with some gravel	20	X	
			P	4-4
			P/X	5
Probe Tip @ 22.0'			X	
		25	X	
26.8' PLUG 28.0'	Moist, medium dense, brown and gray medium to coarse sand with gravel		X	
Gravel		30	X	
			P	5-12
			P/X	12
		35	X	
		40	X	

PENETRATION RESISTANCE (Blows per foot) ● Actual ○ Extrapolated 20 40 60 80

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TEST BORING REPORT

CLIENT S C S Engineering P. N. 78062

PROJECT Lees Lane Landfill HOLE NO. 12 (continued)

LOCATION

DRILLER G. Scamahorn LOGGED BY C. Donahue DATE STARTED 6- 9-78

ELEVATION REFERENCE Ground Surface DATE COMPLETED 6- 9-78

DEPTH TO WATER: IMMEDIATELY 51' ; DAYS AFTER

NOTES (Type & Size of Hole, Type of Bit or Spoon, Loss of Drilling Water)	DESCRIPTION & Classification of Materials	Samples for testing	Log	PENETRATION RESISTANCE (Blows per foot) ● Actual ○ Extrapolated 20 40 60 80	No Blows & Core Recovery %
Gravel		P			4-6
Probe Tip @ 42.0' 43.0	Moist, medium dense, brown and gray medium to coarse sand with gravel	P/X			9
		X			
		X			
		45 X			
		X			
		X			
Caved to 43.0'		X			
		X			
		50 X			
Piezometer tip @ 54.0'		P			5-5
	Wet, medium dense, coarse sand with gravel	P/X			8
		X			
		X			
		55 X			
56.5'		P			3-4
	Terminated @ 56.5'	P/			4

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001253

TEST BORING REPORT

CLIENT S C S Engineering P. N. 78062

PROJECT Lees Lane Landfill HOLE NO. 13

LOCATION

DRILLER G. Scamahorn LOGGED BY C. Donahue DATE STARTED 6-12-78

ELEVATION REFERENCE Ground Surface DATE COMPLETED 6-12-78

DEPTH TO WATER: IMMEDIATELY none ; DAYS AFTER

NOTES (Type & Size of Hole, Type of Bit or Spoon, Loss of Drilling Water)	DESCRIPTION & Classification of Materials	Sample for testing	Log	PENETRATION RESISTANCE (Blows per foot) ● Actual ○ Extrapolated 20 40 60 80	No Blows & Core Recovery %
	Vegetation and Topsoil	X			
3.0'		X			
PLUG 5.0'	Moist, medium dense, brown clayey silt	X			
		5 X			4-5
Gravel Probe Tip @ 8.5'		X			7
10.0'	Moist, brown fine to medium sand	10 X			
PLUG		P			
13.0'		P/X			
Gravel		X			
		15 X			
Probe Tip @ 17.0'		X			
19.0'		X			
PLUG	Moist, loose, brown fine to medium sand with organics	20 X			
21.0'		P			3-4
		P/X			4
Gravel Probe Tip @ 25.0'		X			
27.0		25 X			
		X			
Caved to 27.0'		X			
		30 X			
31.5'	Terminated @ 31.5'	P			4-5
		P/			
		35			

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001254

TEST BORING REPORT

CLIENT S C S Engineering P. N. 78062

PROJECT Lees Lane Landfill HOLE NO. 14

LOCATION

DRILLER G. Scamahorn LOGGED BY C. Donahue DATE STARTED 6- 9-78

ELEVATION REFERENCE Ground Surface DATE COMPLETED 6- 9-78

DEPTH TO WATER: IMMEDIATELY 40' DAYS AFTER

NOTES (Type & Size of Hole, Type of Bit or Spoon, Loss of Drilling Water)	DESCRIPTION & Classification of Materials	Samples for Testing	Log	PENETRATION RESISTANCE (Blows per foot) ● Actual ○ Extrapolated 20 40 60 80	No. Blows & Core Recovery %
	Vegetation and Topsoil	X			
4.0'	Moist, brown clayey silt	X			
PLUG 6.0'		5 X			
Gravel Probe Tip @ 15.0'	Moist, medium dense, brown fine to medium silty sand with some clay	10 X P P/X			6-8 11
17.0'		15 X			
PLUG 19.0'	Moist, medium dense, brown and gray fine to medium sand	20 X P P/X			5-7 8
Gravel Probe Tip @ 24.0' 26.0'		25 X			
PLUG 29.0'		30 X P P/X			5-7 7
Gravel Probe Tip @ 35.0'		35 X			
		40 X			

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TEST BORING REPORT

CLIENT S C S Engineering P. N. 78062

PROJECT Lees Lane Landfill HOLE NO. 14(continued)

LOCATION

DRILLER G. Scamahorn LOGGED BY C. Donahue DATE STARTED 6- 9-78

ELEVATION REFERENCE Ground Surface DATE COMPLETED 6- 9-78

DEPTH TO WATER: IMMEDIATELY 40' DAYS AFTER

NOTES Type & Size of Hole Type of Bit or Spoon Loss of Drilling Water	DESCRIPTION & Classification of Materials	Samples for testing	Log	PENETRATION RESISTANCE (Blows per foot) ● Actual ○ Extrapolated 20 40 60 80	No Blows & Core Recovery %
Hole caved to 35.0'	Wet, loose, gray coarse sand and gravel	P			4.5
		P/X			5
		X			
		X			
	45	X			
		P			
46.5'	Terminated @ 46.5'	P/			

LEE 001

001256

APPENDIX D

WELL COMPLETION REPORTS, AS-BUILT WELL DIAGRAMS, AND WELL LOGS

LEE 001

001257

WELL MW-01 CONSTRUCTION INFORMATION
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Driller:	Hardin/Huber Associates
Date of Completion:	November 3, 1984
Drilling Method:	Oversized augers

WATER LEVEL INFORMATION

*Elevation (top of pipe):	452.03'
*Elevation (land surface):	449.30'
*Elevation (water table):	399.93' on 2/8/85

BOREHOLE DATA

Borehole Diameter:	8"
Thickness of Overburden:	53'
Depth Drilled in Rock:	0
Total Depth of Hole:	53'

CASING

Type:	Stainless steel, schedule 5
Diameter:	4"
Length:	45.73'
Type of Joint:	Threaded/flush
Screen Slot:	0.010
Screen Length:	10'
Screen Setting:	43' - 53'

GRAVEL/SAND PACK

Type:	Washed sand/cave-in
Size:	Coarse sand
Depth:	21' - 53'

	SEAL	GROUT
Type:	NA**	Cement - bentonite grout
Method:	NA**	Tremie pipe
Depth:	NA**	0' - 21'

DEVELOPMENT

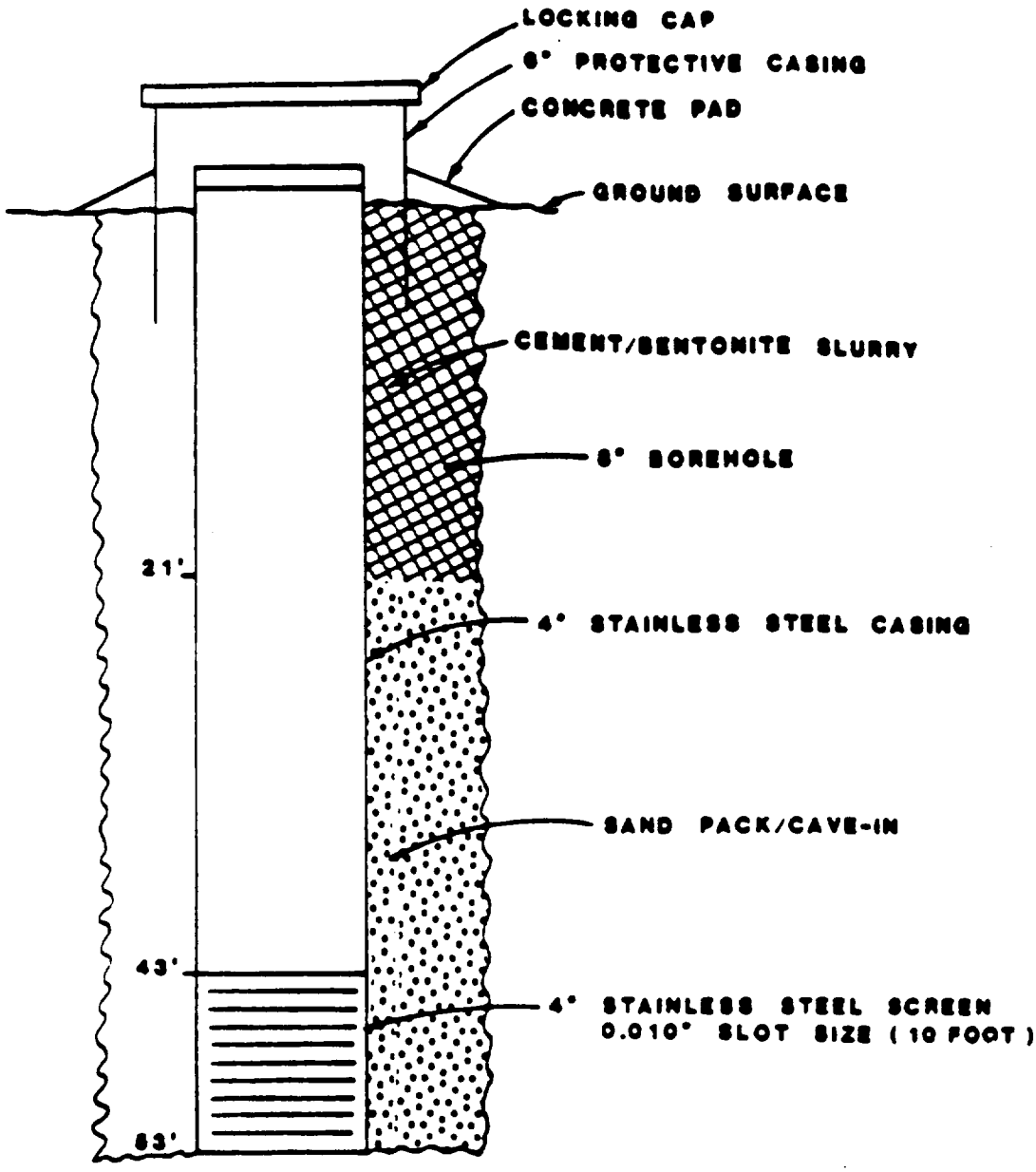
Method:	Bailer
Rate of Flow:	NA**
Length of Time:	1 hour

COMMENTS

*All elevations are recorded adjusted mean sea level (AMSL).
**NA - not applicable

LEE 001

001258



WELL CONSTRUCTION MW-01
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

NUS CORPORATION
A Halliburton Company

LEE 001

001259

WELL MW-02 CONSTRUCTION INFORMATION
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Driller:	Hardin/Huber Associates
Date of Completion:	November 8, 1984
Drilling Method:	Regular augers/mud rotary

WATER LEVEL INFORMATION

*Elevation (top of pipe):	452.37'
*Elevation (land surface):	449.68'
*Elevation (water table):	400.99' on 2/8/85

BOREHOLE DATA

Borehole Diameter:	8"
Thickness of Overburden:	113'
Depth Drilled in Rock:	5'
Total Depth of Hole:	118'

CASING

Type:	Stainless steel, schedule 5
Diameter:	4"
Length:	96'
Type of Joint:	Threaded/flush
Screen Slot:	0.010
Screen Length:	5'
Screen Setting:	93.5' - 98.5'

GRAVEL/SAND PACK

Type:	Washed sand/cave-in
Size:	Coarse sand
Depth:	89' - 98.5'

	SEAL	GROUT
Type:	Bentonite seal	Cement - bentonite
Method:	Dropped	Tremie pipe
Depth:	85' - 89'	0' - 85'

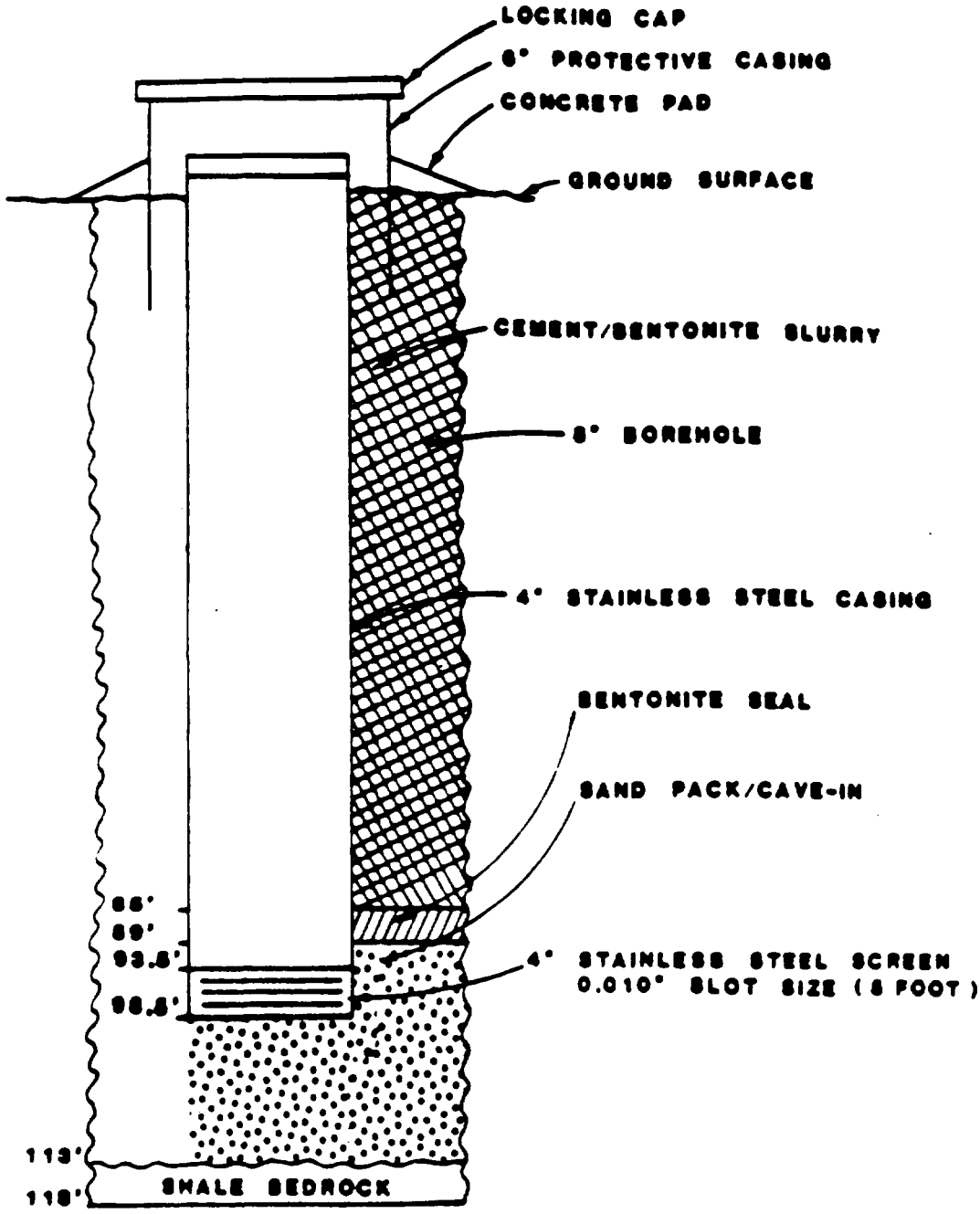
DEVELOPMENT

Method:	Submersible pump
Rate of Flow:	9 gallons per minute
Length of Time:	2 hours

COMMENTS

*All elevations are recorded adjusted mean sea level (AMSL).

001260



WELL CONSTRUCTION MW-02
LEES LANES LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

NUS CORPORATION
A Halliburton Company

Boring No.: MW-02
Lees Lane Landfill
Project No.: TDD F4-8403-17
Date: October 31, 1984
Field Geologist: G. Schank
Subcontractor: Hardin/Huber Associates

Depth (ft)	Blow Count	Grain Size	Sorting	H_2O Content	Lithologic Description
0-1.5	3 2 4	coarse	poor	dry	Gravel, silty, clayey, brown, poorly sorted
5-6.5	4 5 8	clay	good	dry	Clay, trace silt, brown, iron stains, black organic spots, medium dense
10-11.5	3 5 7	silt	fair	damp to moist	Silt, sandy, trace clay, brown
15-16.5	4 5 6	fine	good	moist	Sand, fine, well sorted, brown, moist, silica, micaceous
20-21.5	3 4 5	fine	fair to good	damp	Same as above - drier
25-26.5	4 6 7	fine	fair	damp	Sand, fine, silty, brown, black stringers, damp, micaceous
30-31.5	4 7 9	fine to coarse	poor	moist to wet	Sand, fine to coarse, brown, trace silt, micaceous

Boring No.: MW-02
Lees Lane Landfill
Page Two

Depth (ft)	Blow Count	Grain Size	Sorting	H_2O Content	Lithologic Description
35-36.5	4 8 12	medium to coarse	fair	moist to wet	Sand, medium to coarse, brown with some orange, 2" clay lens, black stringers, trace gravel
40-41.5	6 10 14	coarse	poor	moist	Sand and gravel, poorly sorted, orange and brown, iron stains, clay lens, moist
45-46.5	5 12 17	medium	good	dry	Sand, medium light brown, dry, silica, beach type sand
50-51.5	8 18 26	coarse	poor	wet	Sand, gravel and cobbles, poorly sorted, some black spots, wet, WATER
55-56.5	3 7 8	coarse	poor	wet	Same as above
60-61.5	14 14 22	coarse	poor	wet	Same as above
65-66.5	12 16 24	fine to coarse	poor	wet	Sand, fine to coarse, brown, poorly sorted, wet
70-71.5	12 14 16	fine to coarse	poor	wet	Same as above - trace gravel

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LEE 001

Boring No.: MW-02
Lees Lane Landfill
Page Three

Depth (ft)	Blow Count	Grain Size	Sorting	H_2O Content	Lithologic Description
75-76.5	8 10 12	coarse	poor	wet	Sand and gravel, gray, poorly sorted river gravel
80-81.5	10 11 12	coarse	poor	wet	Same as above
85-86.5	3 6 10	medium to coarse	fair	wet	Sand, medium, trace coarse and fine, gray
90-91.5	22 26 28	coarse	poor	wet	Sand and gravel, poorly sorted, gray and brown, 3" stiff silt lens
95-96.5	35 44 58	coarse	poor	wet	Sand, gravel and cobbles, some large gravel
100-101.5	14 21 22	coarse	poor	wet	Same as above
103-104.5	32 24 26	coarse	poor	wet	Same as above
108-109.5	19 25 26	coarse	poor	wet	Sand and gravel, mostly sand, gray and brown
113-114.5	100/1.5	shale			Shale, black, fractured

Cored bedrock to 118 feet. Black shale, friable
Monitor Well set at 98.5 feet
Ground Elevation: 449.68 feet (msl)
MW-01 installed at same location.

001263
LEE 001

LEE 001

001264

WELL MW-03 CONSTRUCTION INFORMATION
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Driller:	Hardin/Huber Associates
Date of Completion:	November 15, 1984
Drilling Method:	Regular augers/mud rotary

WATER LEVEL INFORMATION

*Elevation (top of pipe):	453.70'
*Elevation (land surface):	451.61'
*Elevation (water table):	399.31' on 2/8/85

BOREHOLE DATA

Borehole Diameter:	8"
Thickness of Overburden:	116'
Depth Drilled in Rock:	3'
Total Depth of Hole:	119'

CASING

Type:	Stainless steel, schedule 5
Diameter:	4"
Length:	73.10'
Type of Joint:	Threaded/flush
Screen Slot:	0.010
Screen Length:	35'
Screen Setting:	71' - 106'

GRAVEL/SAND PACK

Type:	Washed sand/cave-in
Size:	Coarse sand
Depth:	65' - 106'

	SEAL	GROUT
Type:	Bentonite seal	Cement - bentonite
Method:	Dropped	Tremie pipe
Depth:	63' - 65'	0' - 63'

DEVELOPMENT

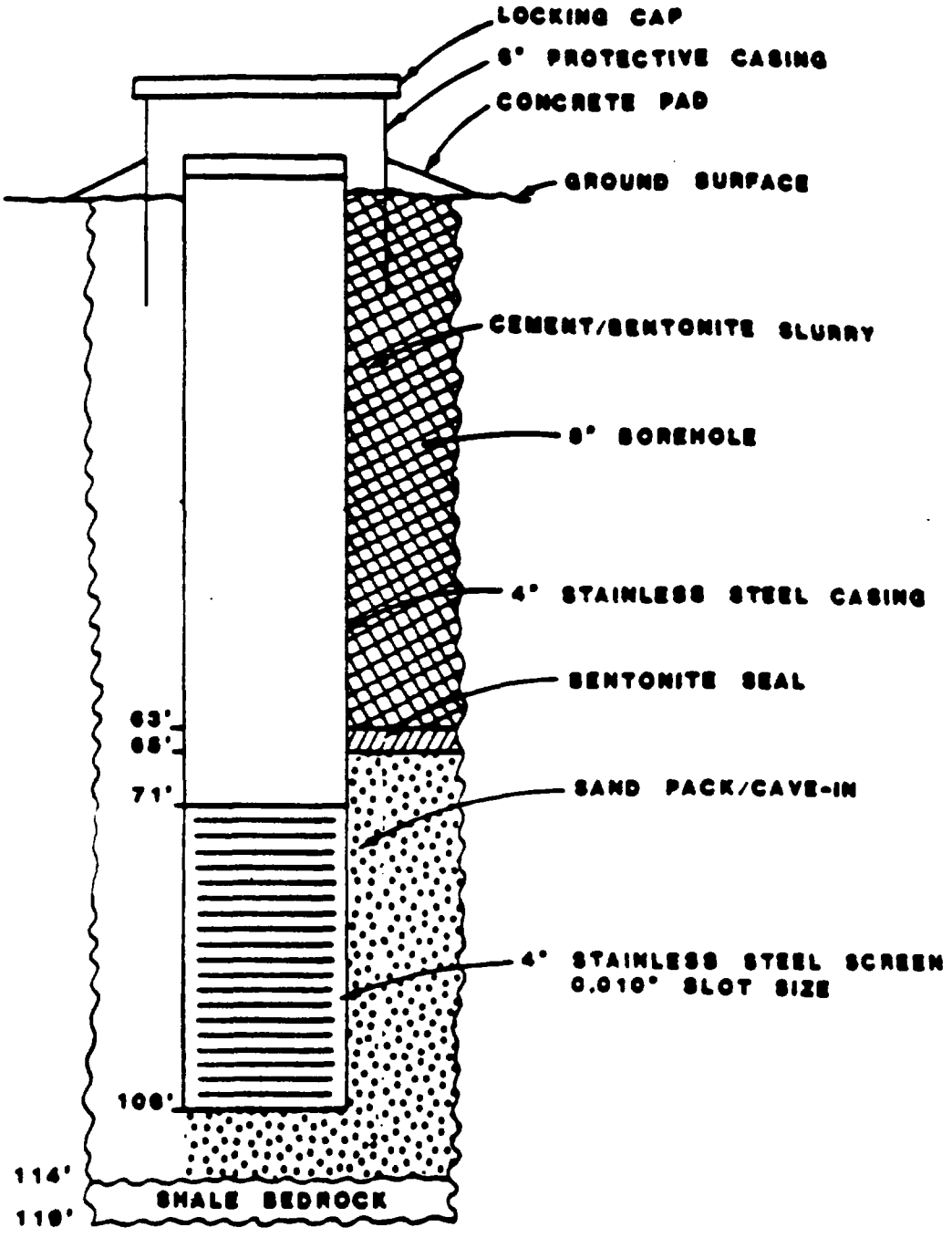
Method:	Submersible pump
Rate of Flow:	9 gallons per minute
Length of Time:	2 hours

COMMENTS

*All elevations are recorded adjusted mean sea level (AMSL).

LEE 001

001265



WELL CONSTRUCTION MW-03
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

NUS CORPORATION
A Halliburton Company

Boring No.: MW-03
Lees Lane Landfill
Project No.: TDD F4-8403-17
Date: November 12, 13, 14, 15, 1984
Driller: Jeff Corron
Field Geologist: K. Perry
Subcontractor: Hardin/Huber Associates

Depth (ft)	Blow Count	Grain Size	Sorting	H_2O Content	Lithologic Description
0.0-1.5	1 3 8	silt	fair	dry	Topsoil, silty, medium, brown and black organic spots
5.0-6.5	6 12 14	silt	fair	dry	Silt, clayey, light and dark brown, black organic spots
10.0-11.5	6 7 6	fine	fair	damp	Sand and clay, silty, sand is fine, brown, some black organic spots
15.0-16.5	3 6 14	fine	fair	damp to moist	Sand, fine, silty, brown
20.0-21.5	6 8 8	fine	fair	damp	Same as above
25.0-26.5	3 6 7	fine to coarse	poor	damp	Sand and gravel, sand is fine, gravel is medium
30.0-31.5	11 15 23	fine to coarse	very poor	moist	Same as above
35.0-36.5	24 23 25	fine to coarse	very poor	damp	Same as above

Boring MW-03
Lees Lane Landfill
Page Two

Depth (ft)	Blow Count	Grain Size	Sorting	H_2O Content	Lithologic Description
40.5-41.5	11 27 32	fine to coarse	very poor	damp	Sand and gravel, sand is fine, gravel is larger
45.0-46.5	22 39 43	fine to coarse	very poor	damp (dryer)	Same as above
50.0-51.5	12 30 41	medium to coarse	poor	dry to damp	Sand, medium, some gravel, light brown to orange brown, dark laminations
55.0-56.5	14 17 16	fine to medium	well	dry to damp	Sand, fine to medium, well sorted, brown
60.0-61.5	6 7 14	medium to coarse	very poor	wet	Sand, medium, silty, clayey, some gravel, shale fragments, wet, WATER
65.0-66.5	30 42 48	medium to coarse	very poor	wet	Same as above
70.0-71.5	24 26 40	medium to coarse	very poor	wet	Same as above, gravel and shale fragments
75.0-76.5	20 28 38	medium to coarse	very poor	wet	Same as above

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LEE 001

Boring No.: MW-03
Lees Lane Landfill
Page Three

Depth (ft)	Blow Count	Grain Size	Sorting	H_2O Content	Lithologic Description
78.0-79.5	20 24 26	medium to coarse	poor	wet	Sand, medium, gravelly, dark brown, poorly sorted, wet
83.0-84.5	24 30 27	coarse	poor	wet	Same as above
88.0-89.5	25 32 40	coarse	poor	wet	Same as above, coarser
93.0-94.5	38 41 37	coarse	very poor	wet	Same as above, coarser
98.0-99.5	30 23 34	coarse	very poor	wet	Same as above
103.0-104.5	36 20 14	coarse	very poor	wet	Same as above, less coarse
108.0-109.5	11 15 16	fine to medium	fair	wet	Sand, fine to medium, silty, some gravel, dark brown

Boring No.: MW-03
Lees Lane Landfill
Page Four

Depth (ft)	Blow Count	Grain Size	Sorting	H_2O Content	Lithologic Description
113	52 69 55		---NO RECOVERY---		Gravel in tip of sampler
116	refusal	bedrock			Black shale

Cored bedrock to 119 feet. Black shale, friable.
Monitor well set at 106 feet
Ground elevation: 451.61 feet (msl)

001269
LEE 001

LEE 001

001270

WELL MW-04 CONSTRUCTION INFORMATION
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Driller:	Hardin/Huber Associates
Date of Completion:	December 4, 1984
Drilling Method:	Regular augers/mud rotary

WATER LEVEL INFORMATION

*Elevation (top of pipe):	448.58'
*Elevation (land surface):	445.48'
*Elevation (water table):	395.63' on 2/8/85

BOREHOLE DATA

	Monitor Well	Surface Casing
Borehole Diameter:	8"	12"
Thickness of Overburden:	91'	40'
Depth Drilled in Rock:	0'	0'
Total Depth of Hole:	91'	40'

CASING

	Monitor Well	Surface Casing
Type:	Stainless steel, schedule 5	Black steel
Diameter:	4"	10"
Length:	87.60'	40'
Type of Joint:	Threaded/flush	Welded
Screen Slot:	0.010	
Screen Length:	5'	
Screen Setting:	84.5' - 89.5'	

GRAVEL/SAND PACK

Type:	Washed sand
Size:	Coarse sand
Depth:	80' - 89.5'

	SEAL	GROUT
Type:	Bentonite seal	Cement - bentonite
Method:	Dropped	Tremie pipe
Depth:	78' - 80'	0' - 78'

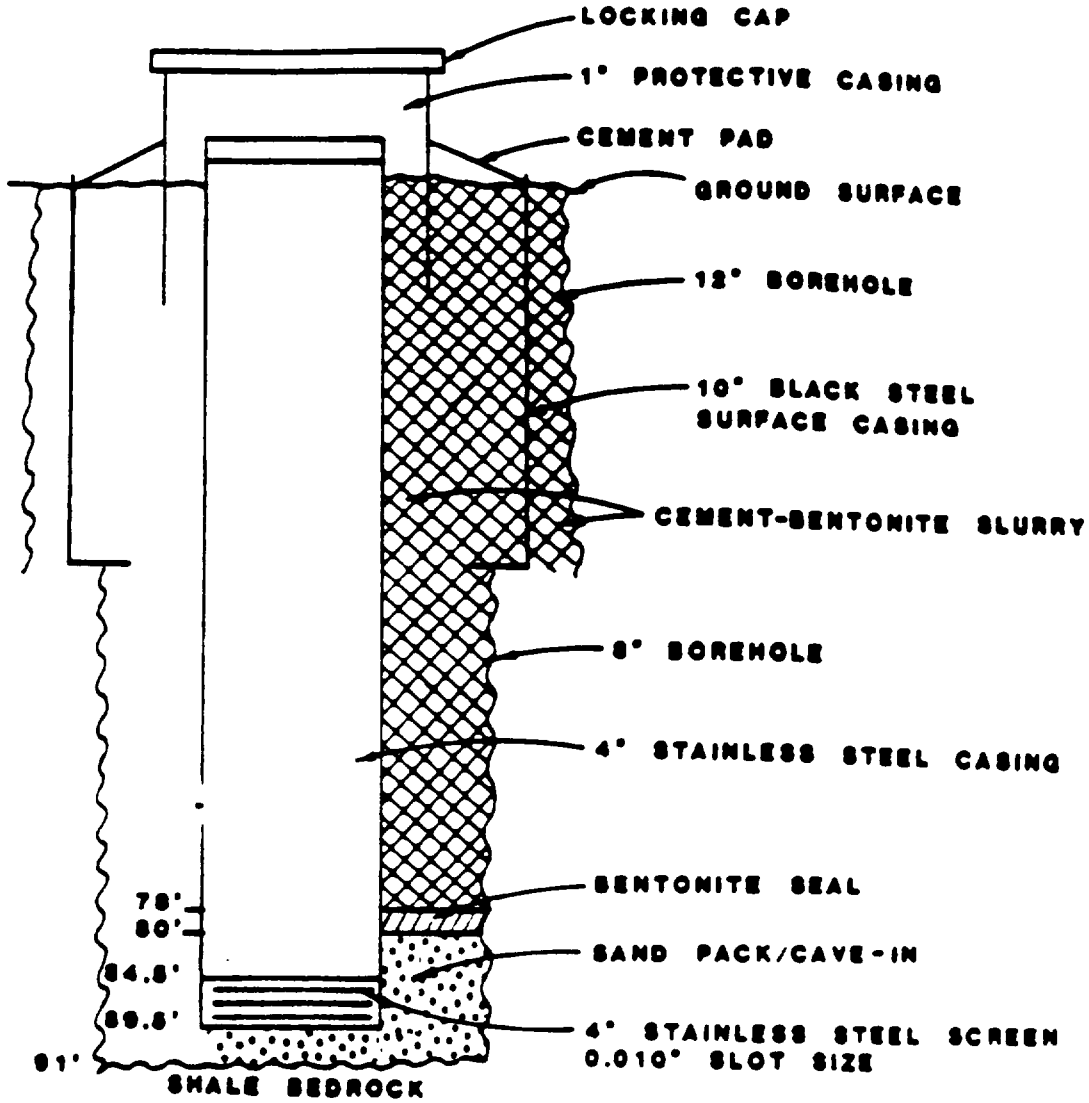
DEVELOPMENT

Method:	Submersible pump
Rate of Flow:	1 gallon per minute
Length of Time:	3 hours

COMMENTS

*All elevations are recorded adjusted mean sea level (AMSL).

001271



WELL CONSTRUCTION MW-04
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

NUS CORPORATION
A Halliburton Company

Boring No.: MW-04
Lees Lane Landfill
Project No.: TDD F4-8403-17
Date: December 1, 2, 3, 4, 1984
Field Geologist: John Anderson
Subcontractor: Hardin/Huber Associates

Depth (ft)	Lithologic Description*
0.0-13.0	Brick fragments, concrete, wood blocks, construction type rubble.
13.0-30.0	Clay, fine grain sand, greenish-gray, very wet, runny.
30.0-53.0	Sand, gravel, silt, drilling easy to this point.
53.0-91.0	Gravel, sand, some very large gravel, drilling difficult. Bedrock at 91 feet.

* Samples taken from drill cuttings
Monitor well set at 89.5 feet
Ground Elevation: 445.48 feet (msl)

LEE 001

001273

WELL MW-05 CONSTRUCTION INFORMATION
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Driller:	Hardin/Huber Associates
Date of Completion:	November 29, 1984
Drilling Method:	Regular augers/mud rotary

WATER LEVEL INFORMATION

*Elevation (top of pipe):	429.78'
*Elevation (land surface):	426.89'
*Elevation (water table):	395.55' on 2/8/85

BOREHOLE DATA

Borehole Diameter:	8"
Thickness of Overburden:	94'
Depth Drilled in Rock:	5'
Total Depth of Hole:	99'

CASING

Type:	Stainless steel, schedule 5
Diameter:	4"
Length:	54.4'
Type of Joint:	Threaded/flush
Screen Slot:	0.010
Screen Length:	35'
Screen Setting:	51.5' - 86.5'

GRAVEL/SAND PACK

Type:	Washed sand
Size:	Coarse sand
Depth:	46' - 86.5'

	SEAL	GROUT
Type:	Bentonite seal	Cement - bentonite
Method:	Dropped	Tremie pipe
Depth:	44' - 46'	0' - 44'

DEVELOPMENT

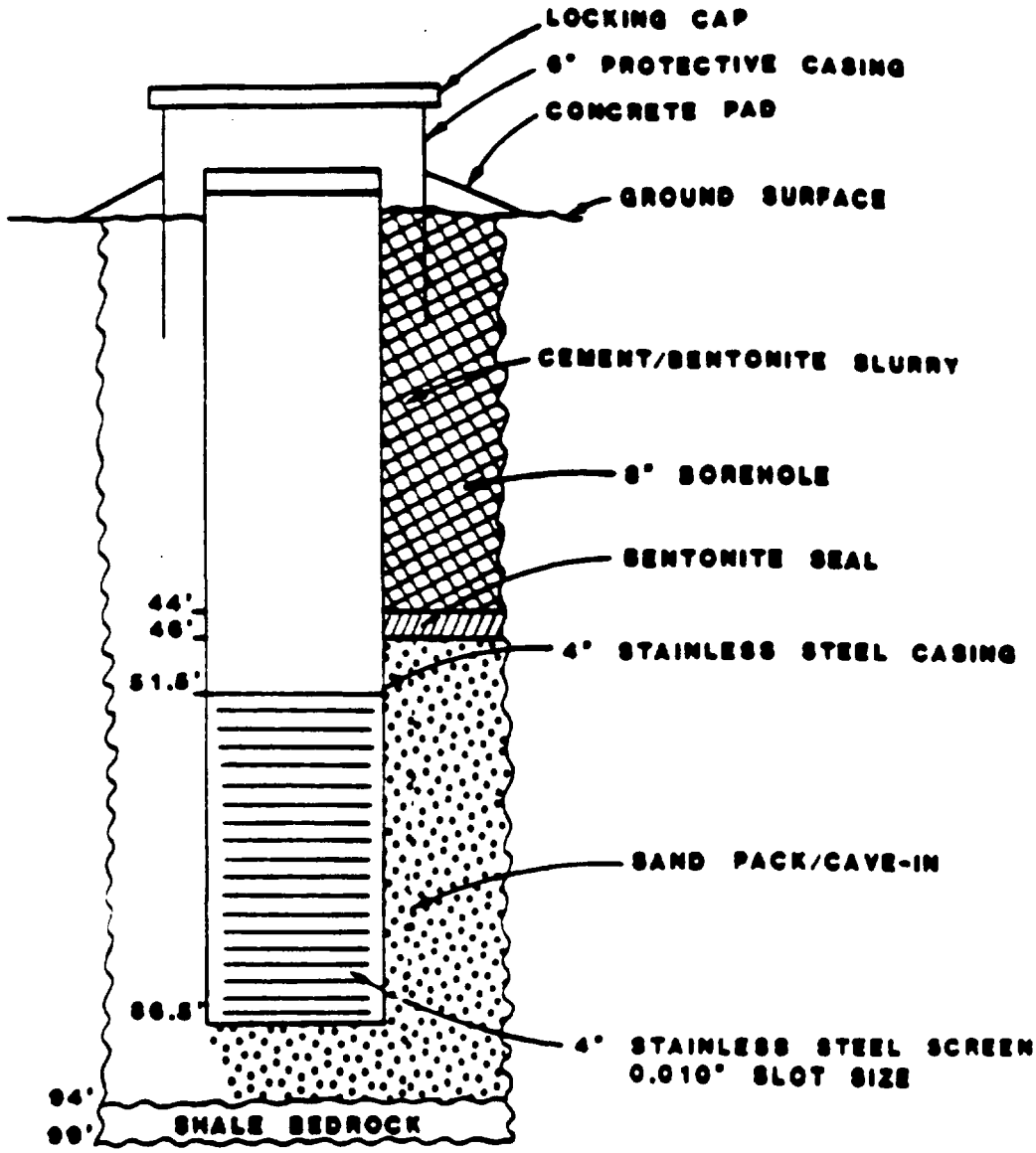
Method:	Submersible pump
Rate of Flow:	9 gallons per minute
Length of Time:	2 hours

COMMENTS

*All elevations are recorded adjusted mean sea level (AMSL).

LEE 001

001274



WELL CONSTRUCTION MW-05
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

NUS CORPORATION
A Halliburton Company

Boring No.: MW-05
Lees Lane Landfill
Project No.: TDD F4-8403-17
Date: October 31, 1984
Field Geologist: J. Anderson
Subcontractor: Hardin/Huber Associates

001275

LEE 001

Depth (ft)	Blow Count	Grain Size	Sorting	H_2O Content	Lithologic Description
0.0'-1.5'	2 4 6	clay	good	damp	Clay, silty, sandy, brown, organic material, damp
5.0-6.5	3 4 5	clay	good	damp	Same as above
10.0-11.5	3 5 5	clay	good	damp	Same as above, no organics
15.0-16.5	2 2 3	clay	good	damp to moist	Same as above
20.0-21.5	2 2 2	clay	good	wet	Same as above, moist to wet
25.0-26.5	1 2 2	clay	good	wet	Same as above
30.0-31.5	1 2 2	clay	good	wet	Clay, silty, sandy, greenish grey, wet
35.0-36.5	3 6 8	clay	good	wet	Same as above

Boring MW-05
Lees Lane Landfill
Page Two

001270

LEE 001

Depth (ft)	Blow Count	Grain Size	Sorting	H_2O Content	Lithologic Description
40.5-41.5	3 3 5	clay	good	wet	Clay, silty, sandy, greenish gray, wet
45.0-46.5	2 4 6	fine to coarse	fair	wet	Sand, fine to coarse, silty, clayey, poorly sorted, brown, wet
50.0-51.5	7 12 15	fine to coarse	poor	wet	Sand, silty, gravel, poorly sorted, greenish gray, wet
55.0-56.5	8 10 15	fine to coarse	fair	wet	Sand and gravel, poorly sorted, brownish gray, wet
60.0-61.5	12 18 19	fine to coarse	poor	wet	Same as above
63.0-64.5	4 3 2	---- NO RECOVERY ----			
68.0-69.5	10 14 26	fine	good	wet	Same as above
73.0-74.5	16 15 13	fine to coarse	poor	wet	Same as above, grayish green and brown

Boring MW-05
Lees Lane Landfill
Page Three

Depth (ft)	Blow Count	Grain Size	Sorting	H_2O Content	Lithologic Description
78.0-79.5	32 33 18	fine to coarse	poor	wet	Sand and gravel, poorly sorted, grayish green and brown, wet
83.0-84.5	24 12 17	fine to coarse	poor	wet	Same as above
88.0-89.5	12 8 6	coarse	fair	wet	Same as above, grayish brown
93.0-94.5	50 100+ Refusal	coarse	poor	wet	Same as above, shale fragments, greenish gray

Cored bedrock to 99 feet. Black shale, friable.
Monitor Well set at 86.5 feet
Ground Elevation: 426.89 feet (msl)

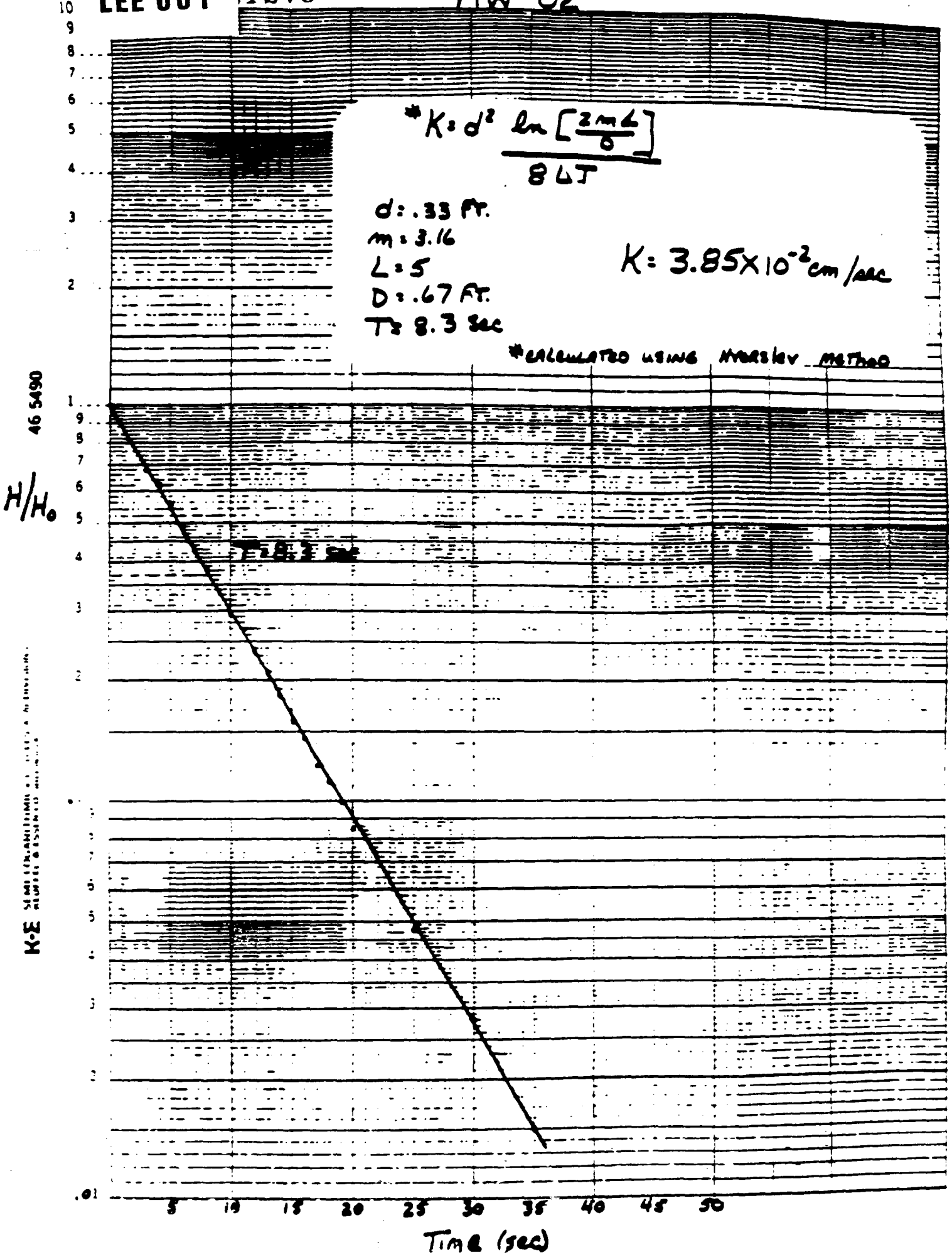
LEE 001

001278

APPENDIX E

IN-SITU HYDRAULIC CONDUCTIVITY TEST RESULTS

LEE 001 11279 MW-02



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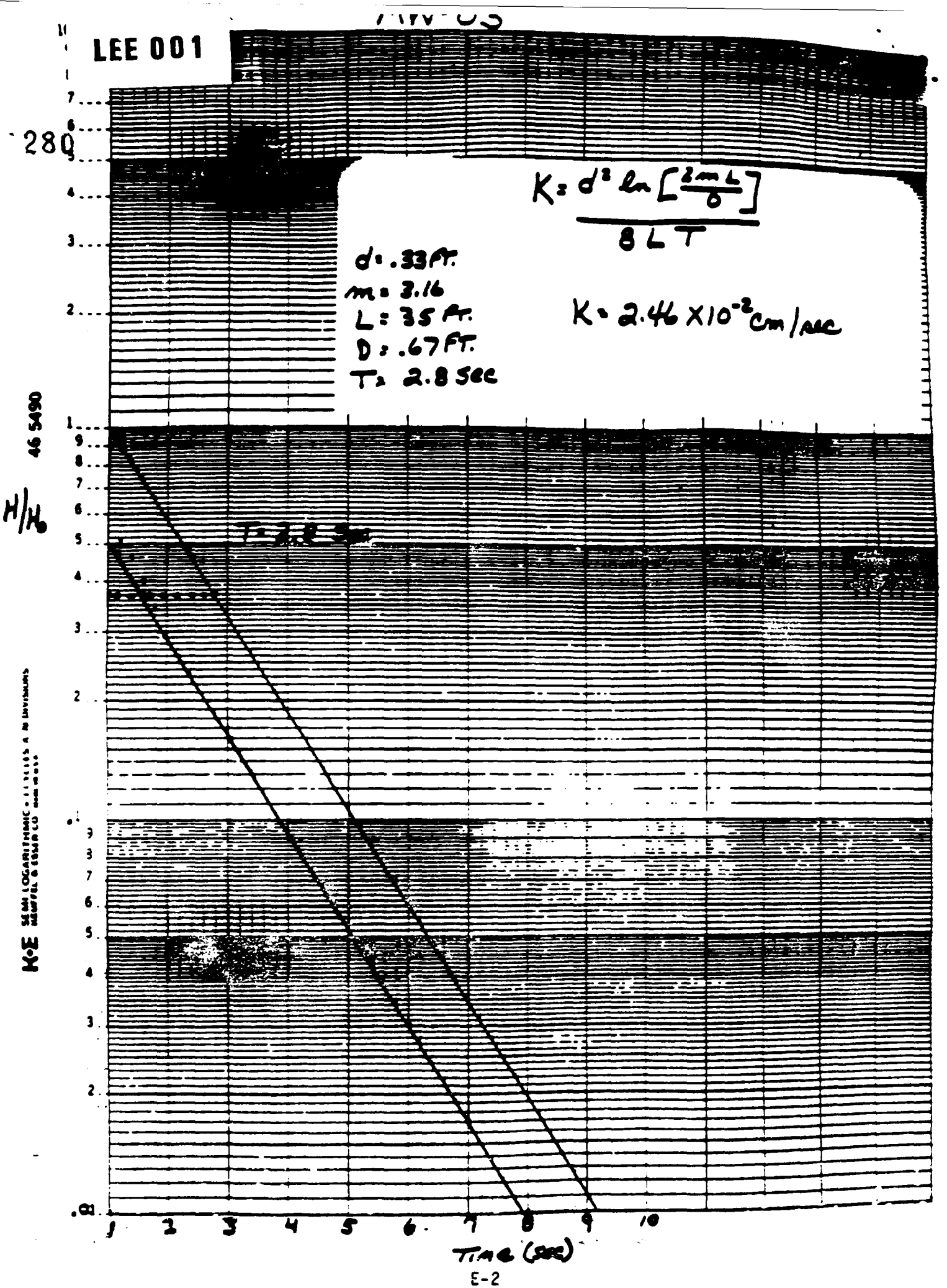

$K = \frac{d^2 \ln\left[\frac{2mL}{D}\right]}{8LT}$
d = .33 FT.
m = 3.16
L = 35 FT.
D = .67 FT.
T = 2.8 SEC
K = 2.46 X10^-2 cm/sec
T = 2.8 Sec
H/H0
TIME (SEC)
K+E SEMI-LOGARITHMIC
46 5490

LEE 001
01281

31

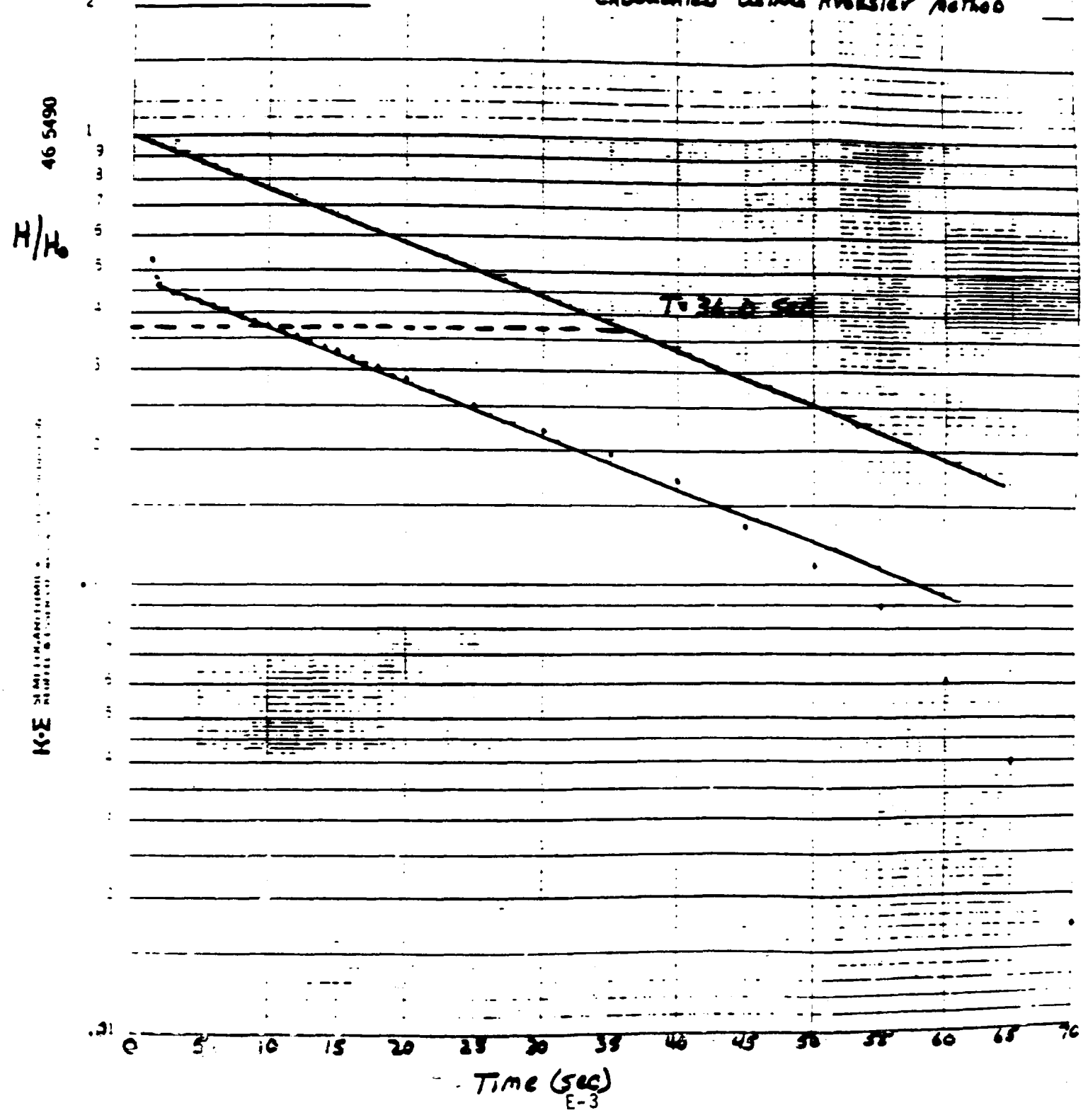
MW-04

$$*K = \frac{d^2 \ln\left[\frac{2mL}{D}\right]}{8LT}$$

d: .33 FT.
m: 3.16
L: 5 FT.
D: .67 FT
T: 36 Sec

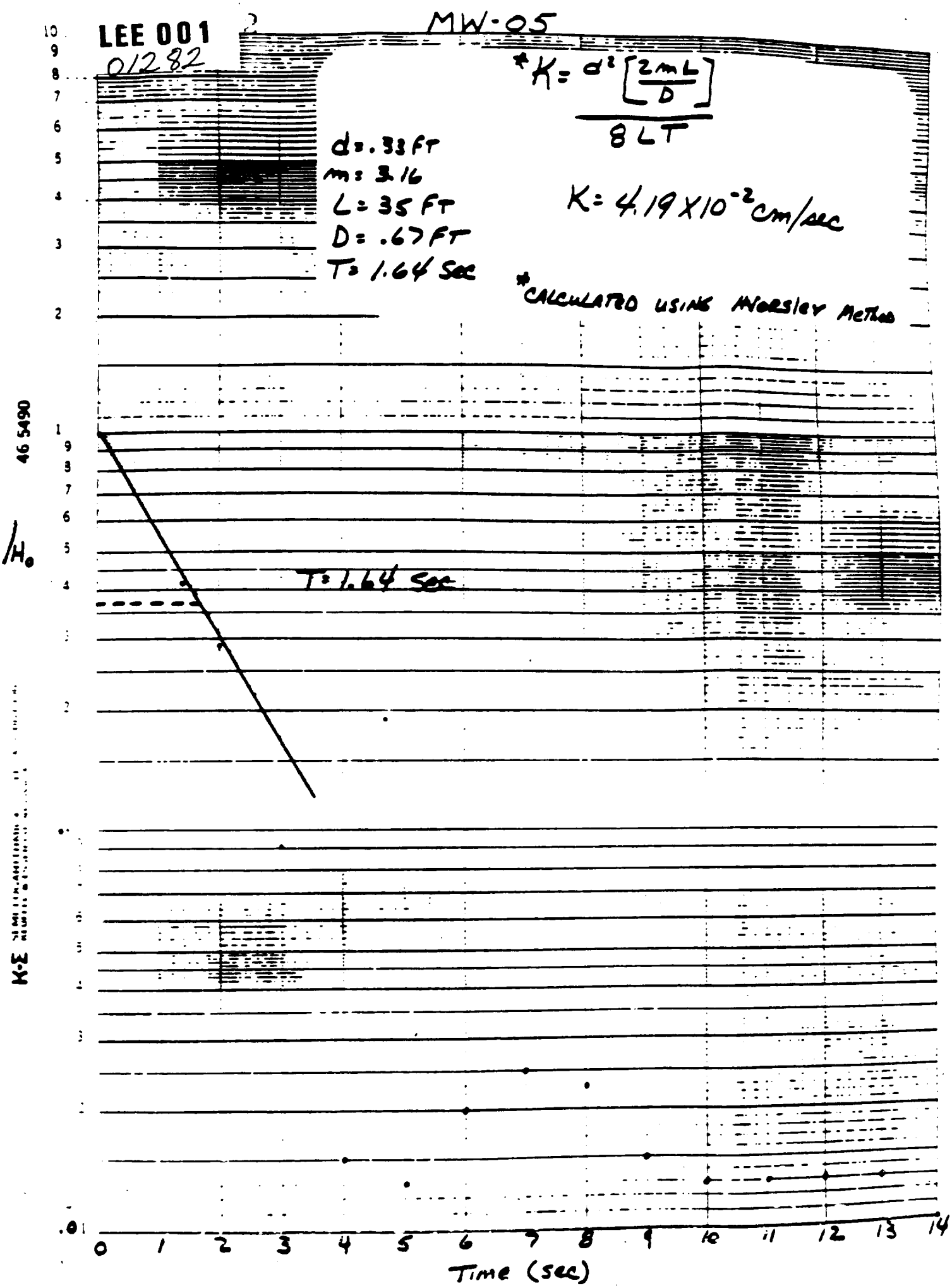
$K = 8.9 \times 10^{-3}$ cm/sec

*CALCULATED USING HVORSLEV METHOD



46 5490

K.E


LEE 001
01282
MW-05
*K = d² [2mL/D] / 8LT
d = .33 FT
m = 3.16
L = 35 FT
D = .67 FT
T = 1.64 sec
K = 4.19 X 10⁻² cm/sec
*CALCULATED USING Hvorslev Method
T = 1.64 sec
H₀/H
Time (sec)
46 5490
K-E

LEE 001

001283

APPENDIX F

SAMPLING AND ANALYTICAL PROTOCOLS

SAMPLING AND ANALYTICAL PROTOCOLS

Sampling Techniques

Detailed sampling procedures used in collecting the water, soil, and sediment samples are outlined in the Site Operations Plans (SOP) for Task 15: Surface Water and Sediment Sampling and Task 16: Surface Soil Sampling and Analysis. These SOP's also cite references which describe the sample handling protocol and chain-of-custody procedures which were followed during the remedial investigation.

Analytical Techniques

Samples collected during this remedial investigation were analyzed by nine laboratories (see Table F-1) which are all part of the Contract Laboratory Program (CLP). As part of the CLP, these laboratories must meet stringent requirements and standards for equipment, personnel, laboratory practices, analytical operations, and quality control operations. These laboratories are closely monitored to assure compliance with the terms and conditions of the contract contained in the Statement of Work (SOW) for Organics Analysis, Revised September 1984, and in the Statement of Work (SOW) for Inorganic Analysis (SOW No. 784), July 1984.

All the samples were analyzed for the Hazardous Substances List (HSL) pollutants shown on Table F-2. The groundwater samples collected in 1984 were also analyzed for four additional parameters: carbonate, bicarbonate, chloride, and sulfate.

Sample Receiving, Chain-of-Custody, and Quality Control Protocols

All samples were shipped from the site to the appropriate laboratories via Federal Express. Chain-of-custody documentation accompanied the samples, and chain-of-custody procedures were maintained in the laboratory.

Quality control measures implemented by the laboratory and reviewed by Region IV validation teams included instrument tuning and calibration; surrogate spiking; matrix spiking, duplicate analysis; and analysis of laboratory prepared blanks, split samples, laboratory control samples, and blind spikes and blanks prepared by

EPA-ESD in athens, Georgia. These quality control requirements are outlined in the SOW for Organic Analysis and the SOW for Inorganic Analysis.

TABLE F-1
CONTRACT LABORATORIES USED FOR ANALYSES OF SAMPLES COLLECTED AT THE LEES LANE LANDFILL SITE

Sample	Medium	Type of Analysis	Date Shipped	Laboratory
Well Points	Water	Organic and Inorganic	11/84	Versar, Inc.
Ohio River	Water	Organic and Inorganic	11/84	Versar, Inc.
Onsite Surface Water	Water	Organic Inorganic	11/84 11/84	Cambridge Analytical Associates Rocky Mountain Analytical Lab, Inc.
Onsite Surface Water	Sediment	Organic Inorganic	11/84 11/84	Pedco Environmental, Inc. Rocky Mountain Analytical Lab, Inc.
Surface Soils	Soil	Organic Inorganic	11/84 11/84	Radian Corporation Rocky Mountain Analytical Lab, Inc.
Groundwater Wells	Water	Organic Inorganic SAS (bicarbonate, carbonate, sulfate, chloride)	12/84 12/84 12/84	Environmental Research Group Chemtech Consulting Group, Ltd. Wilson Laboratories
Quality Control Soil	Soil	Organic Inorganic	12/84	IT Corporation Chemtech Consulting Group, Ltd.
Quick-Turnaround (Deep FIT monitoring wells, Edwardsville well IN-1, Pondwater and Sediment PW/S-9)		Organic and Inorganic	1/85	Rocky Mountain Analytical Lab, Inc.

TABLE F-2
HAZARDOUS SUBSTANCES LIST (HSL)
CONTRACT LABORATORY PROGRAM (CLP) STANDARD PARAMETERS

EXTRACTABLE ORGANICS

N-Nitrosodimethylamine
1,2-Diphenylhydrazine/Azobenzene
Benzidine
1,3-Dichlorobenzene
1,4-Dichlorobenzene
1,2-Dichlorobenzene
Bis (2-Chloroethyl) Ether
Hexachloroethane
Bis (2-Chloroisopropyl) Ether
N-Nitrosodi-N-Propylamine
Nitrobenzene
Hexachlorobutadiene
1,2,4-Trichlorobenzene
Naphthalene
Bix (2-Chloroethoxy) Methane
Isophorone
Hexachlorocyclopentadiene
2-Chloronaphthalene
Acenaphthylene
Acenaphthene
Dimethyl Phthalate
Benzo-A-Pyrene
Dibenzo (A,H) Anthracene
2-Chlorophenol
Phenol
2,4-Dichlorophenol
4-Chloro-3-Methylphenol
2-Methyl-4,6-Dinitrophenol
4-Nitrophenol
2-Methylphenol
2,4,5-Trichlorophenol
Benzyl Alcohol
Dibenzofuran
2-Nitroaniline
4-Nitroaniline
2,4-Dinitrotoluene
2,6-Dinitrotoluene
4-Chlorophenyl Phenyl Ether
Fluorene
Diethyl Phthalate
N-Nitrosodiphenlyamine/Diphenylamine
Hexachlorobenzene
4-Bromophenyl Phenyl Ether
Phenanthrene
Anthracene
Di-N-Butylphthalate
Fluoranthene
Pyrene
Benzyl Butyl Phthalate
Bis (2-Ethylhexyl) Phthalate
Benzo (A) Anthracene
Chrysene
3,3'-Dichlorobenzidine
Di-N-Octylphthalate
Benzo (B) Fluoranthene
Benzo (K) Fluoranthene
Indeno (1,2,3-CD) Pyrene
Benzo (GHI) Perylene
2-Nitrophenol
2,4-Dimethylphenol
2,4,6-Trichlorophenol
2,4-Dinitrophenol
Pentachlorophenol
Benzoic Acid
4-Methylphenol
Aniline
4-Chloroaniline
2-Methyl Naphthalene
3-Nitroaniline

TABLE F-2
HAZARDOUS SUBSTANCES LIST (HSL)
CONTRACT LABORATORY PROGRAM (CLP) STANDARD PARAMETERS
PAGE TWO

PURGEABLE ORGANICS

Acrolein
Acrylonitrile
Chloromethane
Bromomethane
Vinyl Chloride
Chloroethane
Methylene Chloride
1,1-Dichloroethene
1,1-Dichloroethane
Trans-1,2-Dichloroethene
Chloroform
1,2-Dichloroethane
1,1,1-Trichloroethane
Carbon Tetrachloride
Bromodichloromethane
1,2-Dichloropropane
Trans-1,3-Dichloropropene
Trichloroethene
Benzene
Dibromochloromethane
1,1,2-Trichloroethane
Cis-1,3-Dichloropropene
2-Chloroethylvinyl Ether
Bromoform
1,1,2,2-Tetrachloroethane
Tetrachloroethene
Toluene
Chlorobenzene
Ethyl Benzene
M-Xylene
O&P-Xylene (Mixed)
Acetone
Methyl Ethyl Ketone
Carbon Disulfide
Methyl Butyl Ketone
Methyl Isobutyl Ketone
Styrene
Vinyl Acetate

HAZARDOUS SUBSTANCES LIST (HSL)
CONTRACT LABORATORY PROGRAM (CLP) STANDARD PARAMETERS
PAGE THREE

PESTICIDES/PCBS

Aldrin
Heptachlor
Heptachlor Epoxide
Alpha-BHC
Beta-BHC
Gamma-BHC
Delta-BHC
Endosulfin I (Alpha)
Dieldrin
4,4'-DDT
4,4'-DDE
4,4'-DDD
Endrin
Endosulfan II (Beta)
Endosulfan Sulfate
Chlordane
PCB-1242
PCB-1254
PCB-1221
PCB-1232
PCB-1248
PCB-1260
PCB-1016
Toxaphene
Endrin Aldehyde
Methoxychlor
Endrin Ketone

TABLE F-2
HAZARDOUS SUBSTANCES LIST (HSL)
CONTRACT LABORATORY PROGRAM (CLP) STANDARD PARAMETERS
PAGE FOUR

INORGANICS

Silver
Arsenic
Barium
Beryllium
Cadmium
Coba't
Chromium
Copper
Nickel
Lead
Antimony
Selenium
Tin
Thallium
Vanadium
Zinc
Mercury
Aluminum
Manganese
Calcium
Magnesium
Iron
Sodium
Cyanide

LEE 001

001291

APPENDIX G

SAMPLE POINT DESCRIPTIONS AND LOCATIONS

001292

SAMPLE POINT DESCRIPTIONS AND LOCATIONS
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Sample Code	Sample Type	Description/Location
Well Point Samples		
WP-1	grab	Water sample collected from well point installed to a depth of approximately 13 feet below ground surface. The well point was located approximately 15 feet from the Ohio River, upstream of the Northern Tract of the landfill and 100 to 200 feet downstream of a methanol loading terminal.
WP-2	grab	Water sample collected from well point installed to a depth of approximately eleven feet below ground surface. The well point was located in the southwest corner of the Northern Tract of the landfill.
WP-3	grab	Water sample collected from well point installed to a depth of approximately eleven feet below ground surface. The well point was located approximately 300 feet downstream of WP-2 in the Central Tract of the landfill, about 5 feet from the Ohio River.
WP-4	grab	Water sample collected from well point installed to a depth of approximately ten feet below ground surface. The well point was located approximately 370 feet downstream of WP-3 in the Central Tract of the landfill. The well point dried up rapidly and the sample had to be collected over a two-day period to allow for recharge.

SAMPLE POINT DESCRIPTIONS AND LOCATIONS
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY
PAGE TWO

Sample Code	Sample Type	Description/Location
WP-5	grab	Water sample collected from well point installed to a depth of approximately ten feet below ground surface. The well point was located approximately 1300 feet downstream of WP-4 and west of an area with about 25 exposed drums, in the Southern Tract of the landfill.
WP-6	grab	Water sample collected from well point installed to a depth of approximately ten feet below ground surface and about 2 feet from the Ohio River. The well point was located about 1800 feet downstream of WP-5, but upstream of the Mill Creek confluence in the Southern Tract of the landfill.
Ohio River Samples		
OR-1	grab	Water sample collected from the Ohio River above the north end of the landfill and 100-200 feet below the methanol loading terminal. This sample point was adjacent to WP-1.
OR-2	grab	Water sample collected from the Ohio River adjacent to WP-4 in the Central Tract of the landfill.
OR-3	grab	Water sample collected from the Ohio River approximately upstream of the Mill Creek confluence, but downstream of WP-6.

SAMPLE POINT DESCRIPTIONS AND LOCATIONS
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY
PAGE THREE

Sample Code	Sample Type	Description/Location
Surface Soil Samples		
SS-11	composite	Soil sample composited from the top 6 inches of a bare area, approximately 35 feet by 20 feet, located in the Northern Tract of the landfill. The area contained gravel, glass, bricks, small amounts of trash, and some grass patches.
SS-12	composite	Soil sample composited from the top 6 inches of a long narrow patch, approximately 50 feet x 15 feet, located in the Northern Tract of the landfill about 200 feet north of SS-11. Buried trash was exposed at the surface and there were some buried drums in the vicinity. There were a few trees and small weeds growing on the sampling area.
SS-13	composite	Soil sample composited from the top 6 inches of a large irregularly shaped area located between SS-11 and SS-12 in the Northern Tract of the landfill. The area contained buried drums and trash with small weeds and some bare spots.
SS-21	composite	Soil sample composited from an area in the Central Tract of the landfill located approximately 300 feet south of the landfill road extension of Lees Lane. The surface was denuded and had a 3" upper layer of soil and gravel. Below this was some dry, black material.

SAMPLE POINT DESCRIPTIONS AND LOCATIONS
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY
PAGE FOUR

Sample Code	Sample Type	Description/Location
SS-23	composite	Soil sample composited from the top 6 inches of a bare area near the southeast corner of the Central Tract, approximately 300 feet west of the floodwall. There were several scattered drums between this area and the floodwall.
SS-24	composite	Soil sample composited from the top 6 inches of two barren gravelly areas near the southwest corner of the Central Tract. Each area was about twenty square feet and they were about 25 feet apart. The surface had exposed trash, scrap metal, and a black, crusty material.
SS-26	composite	Soil sample composited from the top 6 inches of an area about 25 feet by 15 feet, located just north of SS-24 in the southwest corner of the Central Tract of the landfill. This area was barren of vegetation and contained some gravel and exposed scrap metal and trash.
SS-32	composite	Soil sample composited from the top 6 inches of a bare area in the Southern Tract of the landfill, southeast of SS-31. The surface of this 20 foot by 40 foot area consisted of moist tan and grey clay, with some gravel and exposed trash.
SS-41	composite	Background soil sample composited from the top 6 inches of a 10 foot square area between 6720 Putnam Street and the floodwall east of the Central Tract of the landfill.

SAMPLE POINT DESCRIPTIONS AND LOCATIONS
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY
PAGE FIVE

Sample Code	Sample Type	Description/Location
Surface Waste Samples		
DS-1'	composite	Soil sample composited from the top six inches of drill spoils which had been bulldozed and leveled near MW-4. This area may have contained revert, drill water, groundwater, subsurface soil, driller's sand, natural soil, and concrete mix.
SS-22	composite	Waste sample composited from the top 6 inches of two bare areas in the Central Tract, approximately 50 feet southeast of SS-21. One area contained blue sandy material and the other yellow gravelly material.
SS-25	composite	Soil sample composited from the top 6 inches of soil in and around two drums. This area contained a few partially buried drums and other assorted trash, and was lcoated in the Central Tract between the landfill road and the Ohio River, southeast of WP-4.
SS-31	composite	Soil sample composited from the top 6 inches of an area of partially buried drums located in the Southern Tract of the landfill, between the landfill road and the Ohio River, near WP-5.

SAMPLE POINT DESCRIPTIONS AND LOCATIONS
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY
PAGE SIX

Sample Code	Sample Type	Description/Location
Onsite Surface Water and Sediment Samples		
PW-1 PS-1	grab grab	Water and sediment samples collected from an area of ponded water in the Northern Tract of the landfill, just east of SS-12. This area had 2 small ponds covering about 10 feet by 20 feet. Each pond was less than one foot deep.
PW-2 PS-2	grab grab	Water and sediment samples collected from a ponded area approximately 10 feet by 10 feet, in the Central Tract of the landfill. The pond had a slight oil sheen around the edges.
PW-3 PS-3	grab grab	Water and sediment samples collected from a marshy area with a clear open pond in the center of the Southern Tract of the landfill. The pond contained approximately 6 to 12 inches of standing water.
PW-4 PS-4	grab grab	Water and sediment samples collected from a low marshy area west of PW-3 in the Southern Tract of the landfill. The pond had a thick growth of cattails and contained less than 6 inches of water.
PW-5 PS-5	grab grab	Water and sediment samples collected from a marshy area with many cattails in the Southern Tract of the landfill.
PW-6 PS-6	grab grab	Water and sediment samples collected from a small pond in the southeast corner of the Southern Tract of the landfill. Pond had sparse vegetation.

SAMPLE POINT DESCRIPTIONS AND LOCATIONS
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY
PAGE SEVEN

Sample Code	Sample Type	Description/Location
PW-7 PS-7	grab grab	Water and sediment samples collected from a small pond along the east side of the Southern Tract of the landfill.
PW-8 PS-8	grab grab	Water and sediment samples collected from a long narrow pond just north of PW-6 in the Southern Tract of the landfill.
PW-9 PS-9	grab grab	Water and sediment samples collected from a large pond in the Southern Tract of the landfill. The water was clear, about 2 to 3 feet deep, with vegetation around the edges. Gas appeared to be escaping through surface bubbles.
PW-9' PS-9'	grab grab	Water and sediment samples collected from large body of water in southeast corner of landfill's Southern Tract. Ponds from November sampling were all interconnected; water levels had risen significantly. There was approximately one inch of ice on the surface.
Kentucky Well Samples		
LL-7	grab	Water sample collected from Kentucky state monitoring well LL-7, located in the southeast corner of the Southern Tract of the landfill. Sample collected from teflon bailer.
LL-9	grab	Water sample collected from Kentucky state monitoring well LL-9, located in the southwest corner of the Southern Tract of the landfill. Sample collected from teflon bailer.
LL-11	grab	Water sample collected from Kentucky state monitoring well LL-11, located along the Ohio River bank in the Central Tract of the landfill. Sample collected from teflon bailer.

SAMPLE POINT DESCRIPTIONS AND LOCATIONS
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY
PAGE EIGHT

Sample Code	Sample Type	Description/Location
Industrial Well Samples		
BW-1	grab	Water sample collected from Borden's well #4, located closest to the plant's south boundary and landfill's northeast boundary. Sample collected from outside spigot. Pump set at 71.5 feet below ground.
LW-2	grab	Water sample collected from LG&E's well #5 located south of the landfill. Sample collected from outside spigot.
Residential Well Samples		
ME-618	grab	Water sample collected from the Williamson well located at 6618 Melrose, approximately 2 blocks east of the Central Tract of the landfill. Sample was collected from a hand pump.
WL-416	grab	Water sample collected from the Frankie well, now owned by the Geary's, located about one block east of the landfill's Northern Tract at 4416 Wilshire Avenue. Sample was collected from a hand pump.
LE-416	grab	Water sample collected from the Faircloth well at 4416 Lees Lane, approximately 1/2 block northeast of the landfill's Central Tract. Sample was collected from an outside spigot. This well is used for drinking water.
HO-508	grab	Water sample collected from the Simpson well at 6508 Howard Avenue, approximately 50 yards east of the landfill's Central Tract. Sample had to be collected through a garden hose; a pump located underground. This well is used for drinking water.

SAMPLE POINT DESCRIPTIONS AND LOCATIONS
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY
PAGE NINE

Sample Code	Sample Type	Description/Location
RBW-01	grab	Water sample collected from the Riverside Baptist Church well at 4317 Lees Lane, approximately four blocks east of the landfill's Northern Tract. Sample collected from indoor spigot. This well is used for drinking water.
Edwardsville Well Samples		
IN-1	grab	Water sample collected from the Edwardsville Water Corp. well #5, located on the west side of the Ohio River across from the Northern Tract of the landfill. Sample collected from a spigot in an underground well house.
IN-2	grab	Water sample collected from the Edwardsville Water Corp. well #6, located about 300 feet north of IN-2, along the west riverbank of the Ohio. Sample collected from a spigot in an underground well house.
RI Monitor Wells		
MW-1	grab	Water sample collected from new RI shallow monitoring well located approximately 3 blocks upgradient and east of the landfill's Central Tract, on a lot at the intersection of Lucerne Street and Lees Lane. Sample collected from a teflon bailer.
MW-2	grab	Water sample collected from new RI deep monitoring well located about 25 feet east of MW-1. Sample collected from teflon bailer.
MW-3	grab	Water sample collected from new RI deep monitoring well located northeast of the landfill's Northern Tract between the flood wall and Borden, Inc. property. Sample collected from teflon bailer

SAMPLE POINT DESCRIPTIONS AND LOCATIONS
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY
PAGE TEN

Sample Code	Sample Type	Description/Location
MW-4	grab	Water sample collected from new RI deep monitoring well located on the river terrace in the Central Tract of the landfill, between the Ohio River and the landfill road. Sample collected from teflon bailer.
MW-5	grab	Water sample collected from new RI deep monitoring well located on the river terrace in the Southern Tract of the landfill between the Ohio River and the landfill road. Sample collected from teflon bailer.

LEE 001

001302

APPENDIX H

FIELD SAMPLING DATA

LEE 001

001303

SAMPLING DATA FOR WELL POINTS AND OHIO RIVER
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Sample[1] Code	Medium[2]	Sampling Date	Time	pH (s.u.)	Temp.° C	Total[3] Depth	Water[3] Level
LL-WP-1	W	11/5/84	1450	6.9	16.0	13.0	8.5
WP-2	W	11/6/84	1050	6.9	15.5	10.5	10.8
WP-3	W	11/6/84	1450	6.8	15.0	10.7	2.3
WP-3	W	11/7-8/84	1430	6.7	15.0	10.4	5.6
WP-5	W	11/7/84	1540	6.8	14.5	10.2	6.0
WP-6	W	11/8/84	1130	5.9	15.0	10.0	1.0
OR-1	W	11/5/84	1440	7.2	16.5	Samples Collected	
OR-2	W	11/7/84	0915	7.2	14.0	just below water	
OR-3	W	11/8/84	1115	7.1	17.0	surface.	

1 The following abbreviations are used in the sample codes:

LL Lees Lane (This should be assumed for all samples)

WP Well Point Samples

OR Ohio River Samples

2 W Water

3 Measurements are reported in feet below ground surface.

SAMPLING DATA FOR SURFACE SOIL AND WASTE SAMPLES
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Sample[1] Code	Medium	Sampling Date	Time
LL-SS-11	S	11/10/84	1000
SS-12	S	11/10/84	1030
SS-13	S	11/10/84	1115
SS-21	S	11/10/84	1215
SS-22	WM	11/10/84	1230
SS-23	S	11/10/84	1250
SS-24	S	11/10/84	1345
SS-25	S	11/10/84	1415
SS-26	S	11/10/84	1430
SS-31	S	11/11/84	1215
SS-32	S	11/11/84	1300
SS-41	S	11/10/84	0945
DS-1	S	1/9/85	1100

1 The following abbreviations are used in the sample codes:

LL Lees Lane (This should be assumed for all samples)

SS Surface Soil Samples

2 S Soil

WM Waste Material

SAMPLING DATA FOR ONSITE SURFACE WATER AND SEDIMENT SAMPLES
LEES LANE LANDFILL SITE
JEFFERSON COUNTY, KENTUCKY

Sample Code[1]	Medium[2]	Sampling Date	Time	pH (s.u.)	Temp° C
LL-PW/S-1	W/Se	11/12/84	0845	6.1	5.0
PW/S-2	W/Se	11/12/84	1000	6.7	6.5
PW/S-3	W/Se	11/12/84	1100	7.2	8.5
PW/S-4	W/Se	11/12/84	1200	6.5	9.0
PW/S-5	W/Se	11/12/84	1415	7.2	12.0
PW/S-6	W/Se	11/12/84	1530	6.9	9.0
PW/S-7	W/Se	11/12/84	1700	5.8	10.0
PW/S-8	W/Se	11/12/84	1600	6.9	10.0
PW/S-9	W/Se	11/12/84	1630	6.5	12.0
PW/S-9'	W/Se	1/9/85	1615	7.5	3.0

1 The following abbreviations are used in the sample codes:

LL Lees Lane (This should be assumed for all samples.)
PW/S Ponded Water and Sediment Sample

2 W Water
Se Sediment

SAMPLING DATA FOR WELL SAMPLES
LEES LANE LANDFILL SITE
LOUISVILLE, KENTUCKY

Sample[1] Code	Medium[2]	Sampling Date	Time	pH (s.u.)	Temp° C	Conductivity (umhos)	Total[3] Depth	Water[3] Level	Well Construction	Well Use
LL-LL-7	W	12/4/84	0945	6.8	13.0	600	23.3	17.8	PVC	Monitoring
LL-9	W	12/4/84	1630	10.0	6.7	700	34.5	30.1	PVC	Monitoring
LL-11	W	12/9/84	1200	6.8	9.0	1100	35.3	32.8	PVC	Monitoring
BW-1	W	12/5/84	1015	7.2	12.0	650	102	55-60	-	Non-contact cooling
LW-2	W	12/7/84	0900	7.4	16.0	1300	125	65	steel	Fire protection and cooling
IN-1	W	12/10/84	1400	7.3	11.0	550	102	46-50	Steel	Public drinking supply
		1/10/86	1315	7.0	9.0	-				
IN-2	W	12/10/84	1415	7.4	15.0	550	102	46-50	Steel	Public drinking supply
LE-416	W	12/5/84	1345	7.2	12.5	700	-	-	-	Drinking
WL-417	W	12/5/84	1530	7.2	10.0	700	68	-	Galvanized	Recreation
ME-618	W	12/6/84	1200	7.2	10.0	700	-	-	-	Recreation
HO-508	W	12/11/84	1100	7.0	9.0	700	62	-	Stainless	Drinking
RBW-01	W	12/11/84	1015	6.9	12.0	600	-	-	-	Drinking
MW-1	W	12/9/84	1430	7.2	14.0	850	53	51	Stainless	Monitoring
MW-2	W	12/9/84	1100	9.3	12.0	500	91	51	Stainless	Monitoring
		1/9/85	1030	7.5	5.0	-				
MW-3	W	12/10/84	1015	8.1	15.0	450	106	57	Stainless	Monitoring
		1/9/85	1500	7.0	9.0	-				
MW-4	W	12/10/84	0920	7.1	17.0	700	90	51	Stainless	Monitoring
		1/10/85	1115	7.2	6.0	-				
MW-5	W	12/11/84	0900	6.8	13.0	900	87	34	Stainless	Monitoring
		1/10/85	1200	7.4	9.0	-				

SAMPLING DATA FOR WELL SAMPLES
LEES LANE LANDFILL SITE RI/FS
LOUISVILLE, KENTUCKY
PAGE TWO

1 The following abbreviations are used in the sample codes:

LL	Lees Lane (This should be assumed for all samples.)
LL-7,9,11	Kentucky Monitoring Wells
EN-1,2	Edwardsville Water Corp. Wells
LL-416	4416 Lees Lane - residential well
WL-416	4416 Wilshire Avenue - residential well
ME-618	6618 Melrose - residential well
HO-508	6508 Howard Avenue - residential well
RBW-01	Riverside Baptist Church well
MW-1,2,3,4,5	New FIT Monitoring wells

2 W Water

3 Measurements are reported in feet below ground surface

- Information Unknown

001307

LEE 001

LEE 001

001308

APPENDIX I

KENTUCKY WATER QUALITY REGULATIONS

AND

ORSANCO POLLUTION CONTROL STANDARDS

LEE 001

WATER QUALITY REGULATIONS

001309

AS COMPILED TO

TITLE 401
KENTUCKY ADMINISTRATIVE REGULATIONS
CHAPTER 5

LEE 001

CHAPTER 5
DIVISION OF WATER QUALITY

005. Permits to discharge sewage, industrial and other wastes: definitions.
010. Certification of wastewater system operators.
015. Spills and bypasses to be reported to division.
025. [Repealed]
026. Classification of waters.
029. General provisions.
031. Water quality standards for surface waters.
035. Use classifications of waters: treatment requirements: exceptions.
045. Biochemically degradable wastes: treatment.

)1010

401 KAR 5:005. Permits to discharge sewage, industrial and other wastes: definitions.

RELATES TO: KRS Chapter 224
PURSUANT TO: KRS 13.082, 224.033(17)
NECESSITY AND FUNCTION: This regulation embodies requirements needed to effectuate KRS Chapter 224, permit authority for sewage systems. The regulation requires a permit prior to construction and operation of a sewage system and sets forth requirements for receiving a permit to construct and operate such a system.

Section 1. Definitions. (1) "Department," means the Department for Natural Resources and Environmental Protection.

(2) "Division," means the Division of Water Quality.

(3) "Establishment," means any industrial plant, mill, factory, tannery, paper or pulp mill, mine or mineral processing or producing facility, quarry, oil refinery, boat, vessel or other type of commercial, manufacturing or industrial works or facility in the operation of which sewage, industrial wastes or other wastes are produced, or stored.

(4) "Facility," means a sewage system as defined in KRS 224.005(15).

(5) "Industrial wastes," means any liquid, or other waste resulting from any process of industry, manufacture, trade or business, or from the depletion of any natural resource.

(6) "Other wastes," means sawdust, bark or other wood debris, garbage, refuse, ashes, offal, tar, oil, chemicals, acid drainage, wastes from agricultural enterprises, and all other foreign substances not included within the above definitions of industrial wastes and sewage which may cause or contribute to the pollution of any waters of the Commonwealth.

(7) "Permit," means permission in whatever form by the department to construct and operate a facility.

(8) "Professional engineer" or "engineer," means a person registered to practice engineering pursuant to KRS Chapter 322.

(9) "Sewage," means the water-carried human or animal wastes from residences, buildings; industrial establishments or other places together with such industrial wastes, underground, surface, storm or other water, as may be present.

Section 2. Prohibition. No person shall construct, modify or operate a facility without having received a permit from the department.

Section 3. The Permit. (1) A permit to construct a facility shall be effective upon issuance unless otherwise conditioned. If construction is not commenced within the twelve (12) months following a permit's issuance, a new permit shall be obtained prior any construction.

(2) A permit to construct a facility shall automatically become an operational permit when:

(a) The applicant notifies the department that the facility has been properly constructed; and,

(b) A departmental representative inspects the site and determines that the facility is properly operating.

(3) The applicant shall notify the department in writing within thirty (30) days of completed construction and commencement of trial operation.

(4) Permits may contain special conditions not found in this regulation. Such conditions shall be in writing and treated as a part of a permit.

(5) Issuance of a permit represents a judgement of the department that a proposed facility will protect water quality or achieve certain effluent reductions if constructed in accordance with approved plans and specifications. Construction shall be in accord with approved plans and specifications.

Section 4. Permit Application. An application for a permit shall be submitted not less than thirty (30) days prior to the date a permit is desired.

Section 5. The Application: Preliminary Considerations. (1) Where a river basin plan, an areawide waste management plan and/or a regional or facility plan has been developed, the applicant shall provide the department with a statement, from the agency developing any such plan, that the applicant's proposed facility is compatible with any applicable plan.

(2) Any proposed facility with a projected capacity of 50,000 gallons per day, or more, shall submit a preliminary or facilities plan to the department. Said plan shall include:

(a) A seven and one-half (7 1/2) minute, United States Geological Survey topographic map with the projected service area outlined and the discharge point identified thereon.

(b) A schematic of the facility layout and detailed explanation of the proposed facility and its method of operation;

(c) All wastes shall be identified in regard to the processes giving rise to the waste, the character and quantity of the waste, its treatability; and

(d) A statement regarding the expected degree of reduction in pollution load to be accomplished by the facility.

(3) Where the discharge point of a proposed facility fails to coincide with a well defined wet weather stream, the applicant shall demonstrate that he has a legal right to discharge his effluent across any servient estate which comes between the point of discharge and a well defined wet weather stream. The department may require the applicant to provide it with an opinion of counsel to that effect.

Section 6. Plans and Specifications. (1) Not less than three (3) sets of detailed plans and specifications shall be submitted to the department. Said submittal shall be accompanied by a completed permit application form provided by the department.

(2) The department may request such additional information as it needs to evaluate the facility.

(3) Once departmental approval is obtained, no changes shall be made to the plans and specifications which would alter or affect the location, type of process or quality of effluent without prior written approval from the department.

(4) Where a proposed or existing facility is part of or may become a part of a comprehensive sewer system and has a projected capacity of 50,000 gallons per day or more, the plans and specifications shall be prepared by a professional engineer. The plans shall be accompanied by such engineering calculations as are necessary for the understanding of the basis and design of the facility.

Section 7. Design Considerations. (1) Specific design criteria for any facility shall be controlled by current engineering practice. Some references to current engineering practice can be found in the following: "Guidelines for Design, Operation and Maintenance of Waste Water Treatment," by the United States Environmental Protection Agency, and by the latest edition of "Recommended Standards for Sewage Works of the Great Lakes-Upper Mississippi River Board of Sanitary Engineers" and the Water Pollution Control Federation's "Manual of Practice No. 8 and 9."

(2) Consideration should be given to the treatment requirements of the United States Environmental Protection Agency for specific types of facilities and processes.

(3) The applicant shall demonstrate to the department that the effluent from a proposed facility will:

(a) Protect those minimum conditions applicable to all waters of the Commonwealth found in Section 2 of 401 KAR 5:026;

(b) Not cause those waters classified by 401 KAR 5:026 to be of lesser quality than the numeric criteria applicable to those waters in Sections 3 to 9 of 401 KAR 5:026; and

(c) Accord with any general or particular facility requirement mandated by other regulations. An example of a general facility requirement is the "best practicable control technology" found in 401 KAR 5:026.

(4) A recording flow measuring device shall be installed at any facility with a design flow of 50,000 gallons per day, or more. Plants with less capacity may estimate flow from a measuring device at the plant.

(5) Infiltration/Exfiltration:

(a) The access of ground water or loss of waste from a sewer system will be limited to 250 gallons per inch diameter per mile per day with a maximum of 5,000 gallons per mile per day regardless of the pipe diameter. This limitation is inclusive of manholes, sewers, and appurtenances.

(b) The integrity of a new system shall be verified by means of either smoke testing or low pressure air testing or both testing methods. The use of smoke testing shall depend on prevailing ground water conditions at the time of testing. Sewers over eighteen (18) inches in diameter shall be tested by the exfiltration method and/or smoke testing if ground water conditions permit.

(6) Inflow: No new combined, extension or replacement of combined sewers shall be permitted. All points of access of inflow to a separate sanitary system will be identified and eliminated.

Section 8. Application: Other Supporting Documents. (1) The applicant shall demonstrate that provision has been made for continuous inspection of a facility under construction to assure its conformity with approved plans and specifications. Those facilities designed by an engineer shall be inspected by an engineer.

(2) The applicant shall demonstrate that laboratory services shall be provided for self-monitoring to assure facility operation in accord with any permit conditions and to substantiate protection of the receiving waters.

(3) Where a proposed facility will serve multiple users, the applicant shall demonstrate the financial ability to guarantee continuous operation and maintenance to the department's satisfaction. Such guarantee may take the form of a supporting promise by another person to operate the facility if the applicant fails to properly do so, or by posting a bond payable or depositing money in escrow to be available for making necessary repairs only upon the department's determination that the facilities' operation and maintenance is not achieving permit conditions. The above requirement can be demonstrated by a certification from the Public Service Commission.

Section 9. Operation. (1) The department's permit may specify the type of analyses required for a facility and the frequency that such analyses shall be performed and reported to the department.

(2) The department may provide forms for self-monitoring reports.

(3) Facilities having a design capacity of 50,000 gallons per day or more shall submit an annual report which shall include:

(a) A summary of the quantity and quality of waste influent and effluent for each month, for each parameter, with average, minimum and maximum values shown;

(b) A report of the number of times the facility bypassed; and

(c) A report of what percent of the time the minimum treatment conditions were not met. (WP-1; 1 Ky.R. 760; Aug. 1981; eff. 7-2-75.)

401 KAR 5:010. Certification of wastewater system operators.

RELATES TO: KRS 224.135

PURSUANT TO: KRS 13.082, 224.032, 224.033(17)

NECESSITY AND FUNCTION: The Secretary is directed to adopt regulations applicable to certification of wastewater system operators. This regulation establishes standards for classification of wastewater systems; qualifications of applicants; examination procedures;

duties of the board; and, provisions relating to the issuance, renewal or revocation of certificates, fee schedule and other provisions necessary for certification of operators.

Section 1. Definitions. The following terms shall have the meanings set forth below unless the context clearly indicates otherwise:

(1) "Board" means the Kentucky Board of Certification of Wastewater System Operators.

(2) "Department" means the Kentucky Department for Natural Resources and Environmental Protection.

(3) "Secretary" means the secretary of the department.

(4) "Certificate" means a certificate of competency issued by the secretary stating that the operator has met all requirements for the specified operator classifications as set by this regulation.

(5) "Division" means the Division of Water Quality, Department for Natural Resources and Environmental Protection.

(6) "Operator" means the person having primary responsibility of a wastewater system or any portion thereof which may affect the performance of the system.

(7) "Primary responsibility" means having the authority to conduct or supervise the procedures and practices necessary to insure that the wastewater system or any portion thereof is operated in accordance with accepted practices, laws and regulations of the Commonwealth.

(8) "Wastewater system" means the system of pipes, structures, equipment and processes required to collect, carry and treat domestic and/or industrial wastewater, including solids handling. The term "wastewater system" is synonymous and interchangeable with the term "sewage system."

(9) "Association of Boards of Certification for Operating Personnel in Water and Wastewater Utilities (ABC)" means that organization which serves as an information center for certification activities, recommends minimum standards and guidelines for classification of water supply and wastewater systems and state programs, and assists authorities in establishing new certification programs and upgrading existing ones.

Section 2. Membership and Compensation of the Board. Members of the board will be appointed by the Secretary of the Department for Natural Resources and Environmental Protection or his/her designee. The board shall consist of eight (8) members as follows: one (1) employee of a municipality who holds the position of either city manager, city engineer, director of public works, or the equivalent thereof; one (1) member who is a faculty member of a college, university or professional school whose major field is related to wastewater treatment; one (1) non-voting ex-officio member representing the department; and five (5) members currently employed as operators holding valid certificates where one (1) of these five (5) shall be an operator of an industrial wastewater system. Board members shall serve for a four (4) year term, except for the first board to which two (2) of the operators will be appointed for four (4) years and three (3) for two (2) years. The first college faculty member will be appointed for two (2) years and the remaining board members will be appointed for four (4) years. The department's representative shall serve as executive secretary and treasurer and be responsible for maintaining records. The members of the board shall serve without compensation but may be reimbursed for all actual and necessary expenses incurred while discharging their official duties. At least four (4) existing members of the board shall constitute a quorum.

Section 3. General Provisions. (1) Each wastewater system must be operated under the supervision of an individual holding a current Kentucky operator's certificate for at least the class of system he/she supervises. Certified operators are required for the operation of all wastewater treatment facilities.

(2) In the event the operator with primary responsibility is not physically present while a system is operating, he/she must be reasonably available. Such availability shall be determined by the board on a case-by-case basis.

Section 4. Duties of the Board. In carrying out its responsibilities the board shall:

(1) Examine the qualifications of applicants for certification.

(2) Recommend qualified applicants for certification by the department.

(3) Maintain records of operator qualifications, certification and register of certified operators.

(4) Perform such other and further acts as may be necessary to carry out the duties and responsibilities as herein described.

Section 5. Application for Certification. (1) An operator desiring to be certified shall file application with the department preceding examination on an application form provided by the department.

(2) The executive secretary and treasurer of the board shall assemble all the information needed by the board or department to determine eligibility of the applicant for examination and certification.

(3) The board or department shall review applications and supporting documents, determine the eligibility of the applicant for examination and notify him/her of his/her status.

Section 6. Examinations. (1) The board and the department shall be jointly responsible for preparation of the examinations to be used in determining knowledge, ability and judgment of the applicants. The examination questions promulgated by the ABC shall be used as a guideline.

(2) Examinations shall be held at places and times set forth by the department. The examinations shall be conducted at least semiannually.

(3) Except in cases which the board may decide represent proper exceptions, all examinations shall be written. All examinations will be graded by the board, or by the department and the applicant notified of the outcome. Papers will not be returned to the applicant, but means will be provided to review the results with a member of the board or department upon request by the applicant.

(4) Separate examinations will be prepared to cover basic differences in the duties and responsibilities of operators, types of facilities, variations in wastewater quality, conditions of receiving waters and other pertinent matters.

(5) Applicants who fail to pass an examination may reapply for the examination at a regularly scheduled examination or by appointment with the department.

Section 7. Fees. (1) Fees for certification of operators of wastewater systems shall be as follows:

(a) Examination: $10.

(b) Annual renewal of certificate: $4.

(2) Fees accompanying applications will not be returned to those who do not qualify for a certificate.

Section 8. Issuance of Certificates. (1) Upon satisfactory fulfillment of the requirements provided herein and upon recommendation of the board of certification, the department shall issue a suitable certificate to the applicant designating his/her competency. This certificate will indicate the classification of the wastewater system for which the operator is qualified.

(2) Certificates of operators in good standing will be renewed annually, upon written application and submission of applicable renewal fee.

(3) Certified operators who desire to become certified in a higher classification must first satisfactorily complete the requirements for the higher classification before a new certificate is issued.

(4) Certificates shall be valid only so long as the holder uses reasonable care, judgment and application of his/her knowledge in the performance of his/her duties. No certificate will be valid if obtained through fraud, deceit or the submission of inaccurate data on qualifications.

(5) The certificates of operators who terminate their employment at a wastewater system will be valid for five (5) years providing they are renewed as required by subsection 2. After five (5) years, the certificate will be automatically invalidated. Operators whose certificates are invalidated may be issued new certificates of like classification provided appropriate proof of competency is presented to the board. Successful completion of a written or oral examination shall be required by the board.

(6) Certificates may be issued at the discretion of the board in a comparable classification to any person who holds a valid certificate in any state, territory, or possession of the United States or any country provided the requirements for certification of operators under which the person's certificate was issued do not conflict with any provisions of KRS Chapter 224 and are of a comparable standard; and, providing further, that reciprocal privileges are granted to certified operators of this state.

(7) Certificates shall be prominently displayed in the office of the operator.

(8) Certificates heretofore issued by the department shall continue in full force and effect, unless revoked for cause, until such time as the department issues new certificates based upon the classifications provided herein.

(9) Training requirements:

(a) Operators shall have accumulated twelve (12) hours of appropriate board approved training for annual certificate renewal. Such training shall include, but may not be limited to, correspondence courses, short courses, trade association meetings, and on-the-job training. Training hours accumulated in any given year in excess of the minimum requirement necessary for renewal may be carried forward for a period not to exceed two (2) years.

(b) The board may waive any or all of the requirements of paragraph (a) for all or portion(s) of a class of operators as defined in Section 11.

(c) Requirements of this subsection shall be effective for certification renewal at midnight on February 28, 1982.

Section 9. Revocation of Certificates. The department may revoke the certificate of an operator, following a hearing before the board and upon recommendation by the board, when it is found that the operator has practiced fraud or deception; that reasonable care, judgment or the application of his/her knowledge was not used in the performance of his/her duties; or that the operator is incompetent or unable to properly perform his/her duties.

Section 10. Classification of Wastewater Systems. Wastewater systems shall be classified in one (1) of four (4) classes. These classifications shall be made according to population served, type of work, character and volume of wastes to be treated, and the use and nature of the water resources receiving the system effluent. Classification shall be based on the population served or for which the system is designed except that systems may be classified in a group higher than indicated at the discretion of the department by reason of the incorporation in the system of special features of design or characteristics more difficult to operate than usual, or by reason of conditions of flow or use of the receiving water requiring an unusually high degree of system operation control, or for combinations of such conditions or circumstances.

(1) Class I: System serving a population of less than 2,000.

(2) Class II: Systems serving a population between 2,000 and 10,000.

(3) Class III: Systems serving a population between 10,000 and 40,000.

(4) Class IV: Systems serving a population in excess of 40,000.

Section 11. Classification of Wastewater System Operators. Four (4) classes of operators are hereby established and shall range from Class I through Class IV. Each operator classification is intended to relate directly to the corresponding classification of wastewater system.

Section 12. Operator Qualifications: Experience, Education and Equivalencies. (1) Operators shall be examined by the board or department as to education, experience, and knowledge as related to the classification of wastewater systems for which examined. Applicants may be required further to give evidence of good moral character, dependability, initiative, interest in his/her work, and other pertinent characteristics in relation to operation of the class of wastewater system for which certification is being applied.

(2) Experience and educational requirements of operators shall be as follows:

(a) Class I:

1. Completion of high school or equivalent; and

2. One (1) year of acceptable operation of applicable wastewater system.

(b) Class II:

1. Completion of high school or equivalent; and

2. Two (2) years of acceptable operation of applicable wastewater system of Class I or higher.

(c) Class III:

1. Completion of high school or equivalent; and

2. Three (3) years of acceptable operation of applicable wastewater system of Class II or higher.

(d) Class IV:

1. A baccalaureate degree in a standard curriculum in engineering, allied sciences or equivalent; and

2. At least five (5) years of acceptable operation of applicable wastewater system of Class III or higher.

(3) In evaluating qualifications of operators and experience/educational equivalencies the board shall be guided by the following:

(a) Experience requiring some technical knowledge of the work and whether or not responsible charge of work was included. In wastewater systems, where responsibility is divided, supervisors of important divisions may be credited with having responsible charge.

(b) Experience, to be acceptable, must be the result of satisfactory accomplishment of work. Evaluation may be based on reports of the department or other agencies having appropriate responsibilities for supervising wastewater systems.

(c) Partial credit may be given for operating experience in maintenance laboratories or other work of wastewater systems and allied trades such as plumbing.

(d) Where applicable, education may be substituted for a portion of experience requirements as specified below:

1. One (1) year of college work (limited to approved curricula in environmental engineering, environmental technology or related scientific fields) may be considered as equivalent to a maximum of two (2) years of experience or one (1) year of experience with responsible charge.

2. Where education is substituted for experience it shall not exceed an amount which would reduce the requirements of actual operating experience to less than six (6) months for Class I or less than one (1) year for Class II or two (2) years for Class III or three (3) years for Class IV.

3. Education applied to the experience requirement cannot also be applied to the education requirement.

(e) Where applicable, experience may be substituted for education requirements as specified below:

1. One (1) year of experience may be considered as equivalent to a maximum of two (2) years of high school.

2. Each year of responsible charge or two (2) years experience in an important phase of operation, other than responsible charge, will be considered equivalent to one (1) year of college.

3. Experience applied to educational requirements may not also be applied to the experience requirement.

(f) Substitutions for formal education may be as follows:

1. Training credits (T.C.) for board approved operators training schools, seminars and technical courses may be substituted for high school and college requirements. One (1) year of college work equals thirty (30) semester hours or forty-five (45) quarter hours. Six (6) classroom hours of board approved courses shall equal one (1) T.C., and forty-five (45) T.C. equals eighteen (18) semester hours of college or one (1) year of high school.

2. An acceptable high school equivalency certificate may be used to substitute for graduation from high school. (6 Ky.R. 329; Am. 560; eff. 5-7-80.)

401 KAR 5:015. Spills and bypasses to be reported to division.

RELATES TO: KRS Chapter 224
PURSUANT TO: KRS 13.082, 224.033(17)
NECESSITY AND FUNCTION: This regulation requires that spills and bypasses from sewage systems as defined in KRS 224.005(15) be reported to the division. Such reports enable the division to determine what action is need immediate to protect public safety and mitigate or reduce the effect of such spill or bypass.

401 KAR 5:025. Water quality standards. [Repealed]
(WP-4-1; 1 Ky.R. 761; Am. 1382; eff. 7-2-75; repealed by 401 KAR 5:031, 6 Ky.R. 344, eff. 12-5-79.)

401 KAR 5:026. Classification of waters.

RELATES TO: KRS 224.020, 224.060
PURSUANT TO: KRS 13.032, 224.033(17)
NECESSITY AND FUNCTION: This regulation applies the use classifications found in Section 4 of 401 KAR 5:031 to the surface waters of the Commonwealth. This regulation also makes all surface waters subject to the general criteria specified in Section 3 of 401 KAR 5:031.

Section 1. Classification to Designated Uses. Waters classified under this regulation shall be designated for all legitimate uses listed in KRS 224.020(1) except as specified in 401 KAR 5:031, Section 6. Until reclassified in accordance with the procedures of this regulation, the criteria which are indicated for these classifications shall be applicable in all cases unless otherwise ordered by the department pursuant to 401 KAR 5:031, Section 9. Outstanding resource waters may have unique water quality characteristics which shall be maintained even beyond the water's designated classification.

Section 2. Reclassification. The reclassification of waters of the Commonwealth which establishes a different classification than is established under this regulation shall be adopted only upon affirmative findings by the department pursuant to Sections 5 and 6. If a water body is designated for a more stringent use than is currently being attained, the department may reclassify the water body (segment) upon demonstration that the designated use is unattainable due to natural background; irretrievable person-induced conditions; or that existing "point" sources would have to be controlled beyond the most stringent effluent limitation levels required for such sources under 401 KAR 5:035 and imposition of such extra controls would result in "substantial" adverse economic and social impact. Implementation of this section will be consistent with 401 KAR 5:029, Section 2.

Section 3. Priority for Implementation. Except as provided in subsection (4) of this section, the priorities for reclassification of the waters of the Commonwealth are:

(1) Waters receiving (or proposed to receive) discharges from publicly-owned treatment works and/or serving as public water supply sources in the following order of priority:

(a) Any local units of government with a pending public construction permit application for installation or upgrading of a sewage treatment plant and/or public water treatment plant.

(b) Any local units of government in the 201 Construction Grants Program for installation or upgrading of a sewage treatment plant, in an order of priority consistent with their priority project list rank.

(c) Any local units of government which request consideration prior to their entering into either their own construction project, a NPDES permit action, or the 201 Con

struction Grant Program for installation or upgrading of a sewage treatment plant.

(d) Other local units of government.

(2) Waters receiving (or proposed to receive) discharges from any other (private or semi-public) treatment works, in the following order of priority:

(a) New NPDES permit applicants or proposed NPDES permit modifications to waterways which may potentially be classified for a beneficial use of cold-water aquatic habitat.

(b) All other segments with private or semi-public facilities, on a first-come, first-serve basis.

(3) All other surface waters which do not have any existing or proposed point source dischargers.

(4) These priorities may be varied in a particular case pursuant to an administrative hearing.

Section 4. Responsibility for Providing Documentation. The following entities are responsible for providing the documentation for the reclassification of the surface waters under this regulation. The required documentation is outlined in Section 5.

(1) The department shall provide supporting documentation for the reclassification of waters on which are located (or proposed to be located) facilities which are either:

(a) Publicly-owned treatment works;

(b) Outstanding resource waters on publicly owned land; or

(c) New NPDES permit applicants or proposed NPDES permit modifications for waters which may potentially be classified for a beneficial use of outstanding resource waters.

(2) Any applicant filing for reclassification in circumvention of the priority system contained in Section 3 shall provide classification documentation for waters on which discharges from private or semi-public treatment works are located (or proposed to be located). In these cases the applicant sustains the burden of proof that the reclassification is appropriate and necessary.

(3) The department shall provide documentation for all other waters which do not have any existing or proposed point source dischargers.

Section 5. Required Documentation. This section outlines the documentation required to support the reclassifications of surface waters of the Commonwealth as follows:

(1) A USGS 7.5 minute map will be prepared showing those waters or stream segments to be classified. A description consisting of a river mile index with existing and proposed discharge points.

(2) Existing uses and water quality data for the proposed waters or stream segments for which the reclassification is proposed. Where adequate data are unavailable, additional studies may be required by the department.

(3) General land uses (e.g., mining, agricultural, recreation, low, medium, and high density residential commercial-industrial, etc.) as well as specific land uses adjacent to the waters for the length of the segment for which the reclassification is proposed.

(4) The existing and designated uses of the receiving waters into which the segment under consideration discharges and the downstream uses of those receiving waters.

(5) General physical characteristics of the stream segment including, but not limited to width, depth, bottom composition, and slope.

(6) The frequency of occurrence when there is no natural flow in the segment, the low flow in the segment and low flow in adjacent segments.

(7) The first milepoint at which the low flow exceeds one (1) cfs.

(8) An assessment of the existing and potential aquatic life habitat in the stream segment under consideration and the adjacent upstream segment. The existing aquatic life in the area must be documented as well as an assessment of livestock and natural wildlife dependence upon the stream segment.

(9) The existing and proposed designated uses for the stream segment(s) in question.

(10) In addition, for downgrading, information must be supplied pursuant to Section 2, specifically:

(a) An explanation of the irreversible person-induced, or natural conditions which preclude attainment of a higher use designation; or

(b) An assessment of the adverse social and economic impacts of additional controls necessary for existing point sources, beyond the most stringent effluent limitation levels normally required for such sources.

Section 6. Procedures for Reclassification. This section outlines the procedures by which use classifications will be assigned. Procedures for designating the use classifications of a water of the Commonwealth shall be initiated and considered in the order of priority specified in Section 3.

(1) For each of the waters for which a reclassification is proposed, the department or applicant as defined in Section 4(2), shall prepare a fact sheet containing, but not limited to, the following information:

(a) The name and address of the applicant;

(b) The name and sketch or description of the waters proposed for specified use classifications, including the location of existing and proposed dischargers;

(c) The proposed use classifications;

(d) A brief abstract of the supportive documentation which demonstrates that said classification is appropriate;

(e) The appropriate water quality criteria for the segment(s) based on the proposed designated use(s);

(f) The treatment requirements proposed for discharges to the waters in question if designated for the proposed use(s);

(g) A "plain English" summary of the implications of such designation for the community and other users or potential users of the waters in question;

(h) The procedure by which the designation will be made.

(2) Based upon all available information, the staff shall make its recommendation of use classifications of the waters in question to the secretary.

(3) The secretary shall cause to be prepared a list of segments and their classification to be published as an administrative regulation.

(4) Upon completing the review period and the procedures for promulgation under administrative rule making, all designated waters and their use classifications shall be attached as an addendum to this regulation.

Section 7. The provisions of this regulation shall not be severable with 401 KAR 5:029, 401 KAR 5:031, and 401 KAR 5:035. (3 Ky.R. 825; Am. 6 Ky.R. 339; eff. 12-5-79.)

... ...ral provisions.

RELATES TO: KRS Chapter 224
PURSUANT TO: KRS 13.082, 224.020, 224.033, 224.060
NECESSITY AND FUNCTION: This regulation contains a definition and abbreviation section applicable to all water quality regulations. A non-degradation section is included pursuant to KRS Chapter 224. A section pertaining to withdrawal of waters not meeting water quality standards and criteria is included to address withdrawal of contaminated waters. A sample collection and analytical methodology section is included to insure reproducible analytical results.

Section 1. Definitions and Abbreviations. (1) General function of definitions. The following definitions describe terms used in this chapter. Terms not defined below shall have the meaning given to them in relevant statutes or, if not defined in statutes, the meaning attributed by common use.

(a) "Aquifer" means any formation of soil, sand, rock, gravel, limestone, sandstone, or other material or any fracture, crevice, or void in any space formation from which underground water is or may be available.

(b) "Coldwater aquatic habitat" means surface waters and associated substrate that will support indigenous aquatic life as well as stocked trout.

(c) "Conventional domestic water supply treatment" means or includes coagulation, sedimentation, filtration, and chlorination.

(d) "Criteria" means specific concentrations of water constituents which, if not exceeded, are expected to result in an aquatic ecosystem suitable for designated uses of waters. Such criteria are derived to protect legitimate uses such as aquatic life, domestic water supply, and recreational use.

(e) "Division" means the Division of Water Quality.

(f) "Effluent ditch" means that portion of a treatment system which is a discreet, person-made conveyance, either totally owned, leased or under proper easement by the discharger, which transports a discharge to waters of the Commonwealth.

(g) "Epilimnion" means the thermally homogeneous water layer overlying the metalimnion (thermocline) of a lake.

(h) "Eutrophication" means the enrichment of waters of the state by the discharge or addition of nutrients.

(i) "Fecal coliform" means the portion of the coliform group which is present in the gut or the feces of warm-blooded animals. It generally includes organisms which are capable of producing gas from lactose broth in a suitable culture medium within twenty-four (24) hours at 44.5 degrees plus or minus 0.2 degrees C.

(j) "Hypolimnion" means the lower cold region of a stratified body of water that extends from the metalimnion to the bottom of the lake and circulation is restricted while stratified with the upper waters thereby receiving no oxygen from the atmosphere.

(k) "Indigenous aquatic life" means naturally occurring aquatic organisms including but not limited to bacteria, fungi, algae, aquatic insects, other aquatic invertebrates, reptiles and amphibians, and fishes. Under some natural conditions one (1) or more of the above groups may be absent from any given surface water.

(l) "Intermittent stream" means a stream that flows at certain times of the year as when it receives water from springs or precipitation in the immediate watershed.

(m) "LC_m" is used to express the results of bioassays having lethality as the criterion of toxicity. A numerical percentage is used to indicate the percentage of the test animals killed at a given concentration.

(n) "Low flow (seven (7) day, once-in-ten (10) year low flow)" means that minimum average flow which occurs for seven (7) consecutive days with a recurrence interval of ten (10) years.

(o) "Low-flow stream" means that portion of a watercourse where the low flow (not attributable to discharges and other hydraulic alterations) is one (1) cubic foot per second or less.

(p) "Median tolerance limit (TLm)" is a measure of the concentration at which fifty (50) percent of the organisms survive.

(q) "Milligrams per liter (mg/l)" means the milligrams of substance per liter of solution, and is equivalent to parts per million in water assuming unit density.

(r) "Mixing zone" means a domain of a water body contiguous to a treated or untreated wastewater discharge of quality characteristics different from those of the receiving water. The discharge is in transit and progressively diluted from the source to the receiving system. The mixing zone is the domain where wastewater and receiving water mix.

(s) "Natural temperature" means the temperature that would exist in waters of the Commonwealth without the change of enthalpy of artificial origin as opposed to climatic change or naturally occurring seasonally variable temperature associated with riparian vegetation and seasonal changes.

(t) "Natural water quality" means those naturally occurring physical, chemical, and biological properties of waters.

(u) "Non point" means any source of pollutants not defined by point source as used in this regulation.

(v) "Outstanding resource waters" means waters designated by the department pursuant to 401 KAR 5:031, Section 8.

(w) "Point source" means any discernible, confined, and discrete conveyance, including, but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, from which pollutants are or may be discharged. This term does not include return flows from irrigated agriculture.

(x) "Productive aquatic communities" means an assemblage of indigenous aquatic life capable of reproduction and growth.

(y) "Propagation" means the continuance of species by successful spawning, hatching, and development or natural generation in the natural environment, as opposed to the maintenance of species by artificial culture and stocking.

(z) "Public water supply" means only surface water that with conventional treatment will be suitable for human consumption, culinary purposes, or in any food or beverage processing industry and meet state and/or federal regulations for drinking water. This term is synonymous with "domestic water supply."

(aa) "Standard" is a numerical value, range of values, or narrative statement promulgated by the department to maintain and protect the waters of the Commonwealth for designated uses.

(bb) "Surface waters" means those waters having well defined banks and beds, either constantly or intermittently flowing, except effluent ditches; impounded waters; and any subterranean waters flowing in well defined channels and having a clear hydrologic connection with the surface.

(cc) "Thermocline" means the plane in a body of water in which the maximum rate of decrease in temperature occurs.

(dd) "Toxic substances" means substances which are bioaccumulative, synergistic, antagonistic, teratogenic, mutagenic and interfere with the normal propagation of aquatic life, wildlife, or preclude the legitimate uses of any waters of the Commonwealth.

(ee) "Warmwater aquatic habitat" means any surface water and associated substrate capable of supporting indigenous warmwater aquatic life.

(2) Abbreviations used in water quality regulations:

(a) °C means degree(s) Celsius;

(b) EPA—See U. S. EPA;

(c) °F means degree(s) Fahrenheit;

(d) mg/l means milligrams per liter (same as ppm);

(e) NPDES means National Pollutant Discharge Elimination System;

(f) pCi/l means picocuries per liter;

(g) ppm means part(s) per million (assuming unit density, same as mg/l);

(h) ug/l means micrograms per liter;

(i) U.S. EPA means the United States Environmental Protection Agency.

Section 2. Non-degradation. (1) It is the purpose of these regulations to safeguard the waters of the Commonwealth, for their designated uses, to prevent the creation of any new pollution of the waters of the Commonwealth; and to abate any existing pollution.

(2) The state water quality standards and continuing planning process designed to provide for the protection of existing water quality and/or the upgrading or enhancement of water quality in all waters of the Commonwealth shall serve as the method for implementation of this policy.

(3) The implementation of this policy shall conform to 40 CFR 130.17 to the extent allowed by KRS 224.020.

(4) No degradation shall be allowed in outstanding resource waters to the extent that:

(a) The introduction of specific pollutants exceeds the criteria established pursuant to Section 8(2) of 401 KAR 5:031; or

(b) The legitimate beneficial uses of these waters are impaired.

Section 3. Withdrawal of Contaminated Water. It is recognized that waters will, on occasion, not meet the standards and criteria established in these regulations. Withdrawal and subsequent discharge of these waters without alteration of the physical, or chemical characteristics into the same or similar water body will not be considered a violation of these regulations. The department will determine effluent criteria and limitations in these situations based on the quality of the raw and receiving waters. The department retains the right to require modification under the provisions of 401 KAR 5:035, Section 1, if water quality characteristics so dictate.

Section 4. Sample Collection and Analytical Methodology. Sample and analytical procedures will be conducted in a manner consistent with recommendations in "Standard Methods for the Examination of Water and Wastewater" (latest edition), "Methods for Chemical Analysis of Water and Wastes" (EPA), and other methods as determined by the department.

Section 5. The provisions of this regulation shall be inseverable from the provisions of 401 KAR 5:026, 401 KAR 5:031, and 401 KAR 5:035. (5 Ky.R. 827; Am. 6 Ky.R. 341; eff. 12-5-79.)

401 KAR 5:031. Surface water standards.

RELATES TO: KRS Chapter 224
PURSUANT TO: KRS 224.020, 224.060
NECESSITY AND FUNCTION: This regulation sets forth water quality standards which consist of designated legitimate uses of the waters of the Commonwealth and the associated water quality criteria necessary to protect these uses. These standards are minimum criteria which apply to all surface waters in order to maintain and protect them for designated uses. Allowances for mixing zones and criteria for nutrients are recognized and included. These water quality standards are established to protect public health and welfare, protect and enhance the quality of water, and fulfill federal and state requirements for the establishment of water quality standards. These water quality standards are subject to periodic review and revision in accordance with federal and state laws.

Section 1. Mixing Zones. The following guidelines are applicable in determining all mixing zones: (1) The department shall, on a case-by-case basis, specify definable, geometric limits for mixing zones. Applicable limits shall include but may not be limited to the linear distances from the point of discharge, surface area involvement, volume of receiving water, and taking into account other nearby mixing zones.

(2) The mixing zones shall be free from pollutants which are in excess of 0.44 times the 96 hour LC_{50} for a representative indigenous aquatic organism.

(3) The location of a mixing zone shall not interfere with spawning areas, nursery areas, fish migration routes, public water supply intakes, bathing areas, nor preclude the free passage of fish or other aquatic life.

(4) Whenever possible the mixing zone shall not exceed one-third (⅓) of the width or cross-sectional area of the receiving stream, and in no case shall exceed one-half (½) of this volume.

(5) In lakes and other surface impoundments, the volume of a mixing zone shall not affect in excess of ten (10) percent of the volume of that portion of the receiving waters available for mixing.

(6) In all cases, a mixing zone must be limited to an area or volume which will not adversely alter the legitimate uses of the receiving water; nor shall a mixing zone be so large as to adversely affect an established community of aquatic organisms.

Section 2. Nutrient Limits. (1) In surface impoundments and their tributaries where eutrophication problems may exist, nitrogen, phosphorus, carbon, and contributing trace element discharges will be limited as appropriate by the department.

(2) The affected surface waters will be designated as nutrient limited.

Section 3. Minimum Criteria Applicable to all Surface Waters. The following minimum water quality criteria are applicable to all surface waters. Surface waters shall not be aesthetically or otherwise degraded by substances that:

(1) Settle to form objectionable deposits;

(2) Float as debris, scum, oil, or other matter to form a nuisance;

(3) Produce objectionable color, odor, taste, or turbidity;

(4) Injure, be toxic to or produce adverse physiological or behavioral responses in humans, fish, shellfish, and aquatic life;

(5) Produce undesirable aquatic life or result in the dominance of nuisance species;

(6) Cause the following changes in radionuclides:

(a) Cause the gross total alpha particle activity (including radium-226 but excluding radon and uranium) to exceed fifteen (15) pCi/l;

(b) Cause combined radium-226 and radium-228 to exceed five (5) pCi/l (specific determinations of radium-226 and radium-228 are not necessary if dissolved gross particle activity does not exceed five (5) pCi/l);

(c) Cause the concentration of total gross beta particle activity to exceed fifty (50) pCi/l;

(d) Cause the concentration of tritium to exceed 20,000 pCi/l;

(e) Cause the concentration of total Strontium-90 to exceed eight (8) pCi/l.

Section 4. Use Classifications and Associated Criteria. Surface waters may be designated as having one (1) or more of the following legitimate uses and associated use criteria. The classifications in Sections 5, 6, 7 and 8 include the most common usage of surface waters within the Commonwealth. Nothing in this regulation shall be construed to prohibit or impair the legitimate beneficial uses of these waters. The criteria in Section 3 and the indicated use criteria represent minimum conditions necessary to protect designated surface waters for that use.

Section 5. Aquatic Life. (1) Warmwater aquatic habitat. The following parameters and associated criteria are for the protection of productive warmwater aquatic communities, fowl, animal wildlife, arborous growth, agricultural, and industrial uses:

(a) Natural alkalinity as $CaCO_3$ shall not be reduced by more than twenty-five (25) percent. Where natural alkalinity is below twenty (20) mg/l $CaCO_3$, no reduction below the natural level is allowed. Alkalinity shall not be reduced to a degree which may adversely affect the aquatic community.

(b) pH shall not be less than 6.0 nor more than 9.0 and shall not fluctuate more than one (1) unit over a period of twenty-four (24) hours.

(c) Flow shall not be altered to a degree which will adversely affect the aquatic community.

(d) Temperature shall not exceed 31.7 degrees Celsius (eighty-nine (89) degrees Fahrenheit):

1. The normal daily and seasonal temperature fluctuations that existed before the addition of heat due to other than natural causes shall be maintained.

2. The maximum temperature rise other than the effects of a mixing zone shall not exceed the natural temperature by 2.8 degrees Celsius, (five (5) degrees Fahrenheit), with a maximum rate of change not to exceed one (1) degree Celsius, (1.8 degrees Fahrenheit), per hour. The department will maintain guidelines for maximum daily average temperatures based on available data. The department may determine that deviations from these guidelines will be allowed upon the submission of adequate supporting data on naturally occurring temperatures for a specific location. Furthermore, as a guideline, the water temperature for all surface waters should not exceed the maximum limits shown in the following table:

Table I
Stream Maximum Temperature
for Each Month in °F and °C

Month	°F	°C
January	50	10.0
February	50	10.0
March	60	15.6
April	70	21.1
May	80	26.7
June	87	30.6
July	89	31.7
August	89	31.7
September	87	30.6
October	78	25.6
November	70	21.1
December	57	13.9

3. The allowable temperature increase in impounded waters shall be limited to 1.7 degrees Celsius, (three (3) degrees Fahrenheit), above the natural seasonal norm.

(e) Dissolved oxygen:

1. Dissolved oxygen shall be maintained at a minimum concentration of five (5) mg/l daily average and at no time should the instantaneous minimum be less than four (4) mg/l.

2. The dissolved oxygen concentration shall be measured at mid-depth in waters having a total depth of ten (10) feet or less and at representative depths in other waters.

(f) Solids:

1. Total dissolved solids: Total dissolved solids shall not be changed to the extent that the indigenous aquatic community is adversely affected.

2. Total suspended solids: Total suspended solids shall not be changed to the extent that the indigenous aquatic community is adversely affected. The addition of settleable solids that may adversely alter the stream bottom is prohibited.

(g) Ammonia: The concentration of the un-ionized form shall not be greater than 0.05 mg/l at any time in stream after mixing as illustrated in the table entitled "Instream Ammonia-N Concentrations," filed herein by reference. Copies may be obtained from the Division of Water Quality, 1065 Highway 127 South, Century Plaza, Frankfort, Kentucky 40601.

(h) Toxics:

1. The allowable instream concentration of toxic materials which are noncumulative and nonpersistent shall not exceed 0.1 of the ninety-six (96) hour median lethal concentration (LC_{50}) of a representative indigenous aquatic organism.

2. The allowable instream concentration of toxic substances, including pesticides, shall not exceed 0.01 of the ninety-six (96) hour median lethal concentration (LC of a representative indigenous aquatic organism.

3. Maximum allowable concentrations for specific parameters are outlined in Table II.

Table II
Warmwater Aquatic Habitat Criteria[1]

Contaminant	Maximum Concentration Level
Arsenic	50 ug/l
Beryllium	11 ug/l soft water[2] 1100 ug/l hard water[2]
Cadmium	4.0 ug/l soft water[2] 12.0 ug/l hard water[2]
Chlorine, total, residual	10 ug/l
Chromium	100 ug/l
Cyanide, Free	5 ug/l
Hydrogen Sulfide (undissociated)	2 ug/l
Iron	1.0 mg/l[3]
Mercury	0.05 ug/l
Phthalate Esters	3 ug/l
Phenol	5 ug/l

[1]Metal criteria, for purposes of this regulation, are total metals to be measured in an unfiltered sample.
[2]Soft water has an equivalent concentration of calcium carbonate ($CaCO_3$) of 0 to 75 mg/L and hard water has an equivalent concentration of calcium carbonate ($CaCO_3$) of over 75 mg/l.
[3]For low flow streams, the daily average total iron concentration is limited to 3.5 mg/l when it is established that there will be no damage to aquatic life.

(2) Coldwater aquatic habitat. The following parameters and their associated criteria are for the protection of productive coldwater aquatic communities and "put and take" trout streams. All of the criteria adopted for the protection of warmwater aquatic life also apply to the protection of coldwater habitats with the following additions:

(a) Dissolved oxygen:

1. A minimum concentration of six (6) mg/l as a daily average and five (5) mg/l as an instantaneous minimum shall be maintained at all times.

2. In impoundments which support trout, the concentration of dissolved oxygen in waters below the epilimnion shall be kept consistent with natural water quality.

(b) Temperature. Water temperature shall not be increased through man's activities above the natural seasonal temperatures.

(c) Total chlorine residual. The total chlorine residual shall not exceed two (2) ug/l as an instream value.

Section 6. Domestic Water Supply Use. Maximum allowable concentrations to be applicable at the point of withdrawal for use for domestic water withdrawal from surface water sources are specified in Table III:

Table III
Domestic Water Supply Source Criteria[1]

Contaminant	Maximum Concentration Level
Barium	1 mg/l
Chloride, Total	250 mg/l
Chromium, Total	0.05 mg/l
Color	75 Platinum-Cobalt Color Units
Copper	1 mg/l
Fecal Coliform	2000/100 ml (Geometric mean)
Fluoride, Total	1 mg/l
Lead	0.05 mg/l
Manganese	0.05 mg/l
Mercury	0.002 mg/l
Methylene Blue Active Substances	0.5 mg/l
Nitrate (NO_3-N, as Total)	10 mg/l
Selenium	0.01 mg/l
Silver	0.05 mg/l
Sulfate, Total	250 mg/l
Zinc	5 mg/l
Total Dissolved Solids	750 mg/l

[1]See note 1 in Table II

Section 7. Recreational Waters. (1) Primary contact recreation water. Primary contact recreation waters are waters suitable for full body contact recreation during the recreation season of May 1 through October 31.

(a) Fecal coliform content shall not exceed 200 colonies per 100 ml as a monthly geometric mean based on not less than five (5) samples per month; nor exceed 400 colonies per 100 ml in more than ten (10) percent of all samples taken during the month; these limits are applicable during the recreation season.

(b) pH shall be between 6.0 to 9.0 and shall not change more than one (1) pH unit within this range over a period of twenty-four (24) hours.

(2) Secondary contact recreation water. Secondary contact recreation waters are waters suitable for partial body contact recreation, with minimal threat to public health during the recreation season of May 1 through October 1.

(a) Fecal coliform shall not exceed 5,000 colonies per 100 ml in more than ten (10) percent of the samples taken during any thirty (30) day period.

(b) pH shall be between 6.0 to 9.0 and shall not change more than one (1) pH unit within this range over a period of twenty-four (24) hours.

Section 8. Outstanding Resource Waters. This classification category includes certain unique waters of the Commonwealth.

(1) Water for inclusion:

(a) Automatic inclusion. Any surface waters designated under the Kentucky Wild Rivers Act, the Federal Wild and Scenic Rivers Act, or identified under the Kentucky Nature Preserves Act, or that support federally recognized rare or endangered species shall automatically be included in this category.

(b) Permissible consideration. Other surface waters may be included in this category as determined by the department providing:

1. The surface waters flow through or are bounded by state or federal forest land, or of exceptional aesthetic or ecological value or within the boundaries of national, state, or local government parks, or are a part of a unique geological or historical area recognized by state or federal designation.

2. They are a component part of an undisturbed or relatively undisturbed watershed that can provide basic scientific data and possess outstanding water quality characteristics; or two (2) of the following criteria:

a. Supports a diverse or unique aquatic flora and fauna.

b. Possesses physical or chemical characteristics that provide an unusual and uncommon aquatic habitat.

c. Provides an unique aquatic environment within a physiographic region.

(2) Outstanding resource water designation: The classification of certain waters as outstanding resource waters shall fairly and fully reflect those aspects of the waters for which the classification is proposed. The department shall determine water quality criteria for these waters on a case specific basis.

(3) Determination of classification:

(a) Any person may present a proposal to classify certain waters under this section. The department will evaluate the proposal. The following shall be considered:

1. Existing water quality;
2. Current use;
3. Aesthetic, biological, morphological and habitat characteristics of the waters;
4. Occurrence of individuals or populations, indices of diversity and well-being, and abundance of species of any unique biota;
5. Economic and social consequences of the proposed classification;
6. Other justification given for the proposed classification.

(b) After considering all of the pertinent data, a reclassification, if appropriate, shall be made pursuant to 401 KAR 5:026, Section 6.

Section 9. Variances. (1) Waters for inclusion. The department may grant a variance to classification criteria upon adequate demonstration that maintenance of water quality criteria now applicable are not attainable but the use classification is still appropriate. This determination must be made on a case-by-case basis with respect to a specific stream segment following an analysis of each area. The analysis must show that the necessary water quality cannot be reasonably achieved due to economic and/or technological limitations and/or naturally occurring poor water quality. All exceptions will be temporary and subject to review at least every three (3) years.

(2) Designation under this section shall be final orders of the department and may be appealed pursuant to KRS 224.085.

Section 10. The provisions of this regulation are unseverable with 401 KAR 5:026, 401 KAR 5:029, and 401 KAR 5:035. (5 Ky.R. 829; Am. 6 Ky.R. 344; eff. 12-5-79.)

401 KAR 5:035. Treatment requirements; compliance.

RELATES TO: KRS 224.020, 224.060
PURSUANT TO: KRS 13.082, 224.033(17)
NECESSITY AND FUNCTION: This regulation defines minimum treatment requirements and mandates that all persons discharging pollutants through point sources shall apply these measures, or more stringent as required, to meet water quality standards by certain dates.

Section 1. Applicability. The provisions of this regulation shall apply to all discharges to surface waters of the Commonwealth as defined in 401 KAR 5:029, Section 1(1)(bb).

Section 2. Treatment Requirements. (1) All persons who discharge through a point source shall, as a minimum, apply the secondary treatment, or equivalent, considering such factors as the total cost of the application of such technology in relation to the effluent reduction benefits to be achieved; the age of the equipment and facilities involved; the process employed; the engineering aspects of the application of various types of control techniques; non-water quality environmental impact; and such other factors as the department considers appropriate to treatment facilities not later than July 1, 1977.

(2) All persons who discharge through a point source shall apply the best available waste control technology, or equivalent, not later than July 1, 1984, or three (3) years following the promulgation of applicable categorical or water quality criteria effluent limitations in the Federal Register. In determining what is best available waste-control technology, the factors in subsection (1) of this section shall be considered. In addition, any operating and maintenance procedures, schedules of activities, prohibitions of activities, and other management practices to control site runoff, spillage, leaks, sludge or waste disposal, or drainage from raw material storage may be imposed in addition to or in the absence of other applicable standards and limitations.

Section 3. The department may deny, revoke, or modify a permit to any applicant where the discharge in the judgment of the department does not conform to the policy of the Commonwealth of Kentucky as set forth in KRS 224.020.

Section 4. The provisions of this regulation shall be unseverable with the provisions of 401 KAR 5:026, 401 KAR 5:029, and 401 KAR 5:031. (WP-6-2; 1 Ky.R. 762; eff. 7-2-75; 5 Ky.R. 812; Am. 6 Ky.R. 348; eff. 12-5-79.)

NATURAL RESOURCES AND ENVIRONMENTAL PROTECTION CABINET
Department for Environmental Protection
Division of Water

401 KAR 5:045. Biochemically degradable wastes; treatment.

RELATES TO: KRS 224.020, 224.033(1),(5),(15),(19),(21),(23), 224.060
PURSUANT TO: KRS 13.082, 224.033(17), 224.045(6)
NECESSITY AND FUNCTION: This regulation is necessary to implement KRS 224.020, 224.033(1),(5),(15),(19),(21),(23), and 224.060. It requires a minimum of secondary treatment or best conventional pollutant control technology where applicable for all facilities which receive biochemically degradable wastes, and additional treatment in certain situations. The regulation requires that such treatment facilities receiving such wastes reapply to the cabinet 150 days prior to the expiration of the current permit for a permit to continue operating.

Section 1. Definitions. The following definitions and conditions apply to terms used in Section 3 and Section 4:

(1) "Grab sample" means a single instantaneous portion of the effluent.
(2) "Composite sample" means:
(a) Not less than four (4) effluent portions collected at regular intervals over a period of eight (8) hours and combined in proportion to flow;
(b) Not less than four (4) combined equal volume effluent portions collected over a period of eight (8) hours at intervals proportional to flow;
(c) An effluent portion collected continuously over a period of twenty-four (24) hours at a rate proportional to the flow; or
(d) An effluent portion consisting of a minimum of four (4) combined equal volume grab samples taken approximately two (2) hours apart.
(3) "Arithmetic mean for thirty (30) consecutive days" means the average of a minimum of three (3) samples collected in separate calendar weeks during a period of thirty (30) consecutive days with a minimum of twenty (20) days occurring between the first and last sample days.
(4) "Arithmetic mean for seven (7) consecutive days" means the average of a minimum of two (2) samples taken on separate days in a seven (7) day period.
(5) The samples for determining values of biochemical oxygen demand and suspended solids shall be composite samples. The samples for determining the values of fecal coliform bacteria and pH shall be grab samples and taken at the applicable frequency as noted in subsections (3) and (4) of this section.
(6) "Day" means a twenty-four (24) hour period.
(7) "Cabinet" means the Natural Resources and Environmental Protection Cabinet.

Section 2. Applicability. All facilities discharging into waters of the Commonwealth which receive an influent which is biochemically degradable shall provide a minimum of secondary treatment to that influent prior to its discharge. If other constituents are present, additional treatment may be required. Those facilities subject to best conventional pollutant control technology treatment requirements pursuant to 401 KAR 5:080 Section 1(2) 2.b. shall be exempt from this regulation.

Section 3. "Secondary treatment" is that degree of treatment which results in an effluent quality which meets the following minimum requirements:
(1) Biochemical oxygen demand, five (5) day:
(a) The arithmetic mean of the values for effluent samples collected during a period of thirty (30) consecutive days shall not exceed thirty (30) milligrams per liter.
(b) The arithmetic mean of the values for effluent samples collected during a period of seven (7) consecutive days shall not exceed forty-five (45) milligrams per liter.
(2) Suspended Solids. These requirements shall be achieved except as provided for in Subsection (3) of this section:

(a) The arithmetic mean of the values for suspended solids in effluent samples collected during a period of thirty (30) consecutive days shall not exceed thirty (30) milligrams per liter.

(b) The arithmetic mean of the values for suspended solids in effluent samples collected during a period of seven (7) consecutive days shall not exceed forty-five (45) milligrams per liter.

(3) Suspended solids requirements for waste stabilization ponds which are employed as the sole process for secondary treatment and have a maximum facility design capacity of 2,000,000 gallons per day or less and where operation and maintenance data indicate that the requirements of subsection (2)(a) and (2)(b) of this section cannot be achieved shall be equal to that which is achievable with best waste stabilization pond technology. Best waste stabilization pond technology is defined as the effluent concentration achieved ninety (90) percent of the time within the Commonwealth of Kentucky or appropriate contiguous geographical area by waste stabilization ponds that are achieving the levels of effluent quality established for biochemical oxygen demand in subsection (1) of this section. This suspended solids value will be determined by the cabinet.

Section 4. Additional requirements for all facilities discharging into the waters of the Commonwealth which receive an influent which is biochemically degradable is that degree of treatment which results in an effluent quality which meets the following minimum requirements:

(1) Fecal coliform bacteria:

(a) The geometric mean of the value for fecal coliform bacteria in samples collected during a period of thirty (30) consecutive days shall not exceed 200 colonies per 100 milliliters.

(b) The geometric mean of the values for fecal coliform bacteria in samples collected during a period of seven (7) consecutive days shall not exceed 400 colonies per 100 milliliters.

(c) For operational purposes paragraphs (a) and (b) of this subsection need only be met during the recreational season of May 1 through October 31. In other months the values stipulated in 401 KAR 5:031 Section 7(2)(a) shall be met.

(2) pH: The values for pH shall not be less than 6.0 units nor more than 9.0 units.

Section 5. Treatment in excess of that required under Section 2 of this regulation for influents which are biochemically degradable shall be required for a continuous facility discharge where:

(1) The cabinet determines that the receiving waters will not satisfy applicable water quality standards as a result of a facility discharge or discharges from multiple facilities.

(2) The cabinet determines that a facility lacks the sophistication of process to consistently produce the required effluent quality.

Section 6. (1) Any person responsible for an existing facility as described in Section 2 of this regulation which receives biochemically degradable influent shall 150 days prior to the expiration of the current permit make application to the cabinet for a permit to continue to discharge to the waters of the Commonwealth.

(2) If the cabinet determines, from available information or information requested from the applicant, that an existing facility does not or may not produce an effluent with parameter measurements equal to or less than that specified in Sections 3 and 4 of this regulation, it shall require the applicant to submit plans and specifications or other data showing how the facility will be brought into compliance.

(3) If the facility's effluent parameters are equal to or less than that required in Sections 3 and 4 of this regulation, an operating permit shall be issued to the applicant.

(4) If the facility's effluent does not satisfy the requirements of Sections 3 and 4 of this regulation, the cabinet may issue the applicant a permit to upgrade the facility, provided:

(a) No such permit shall be issued unless the cabinet has received and approved a compliance schedule to bring a facility into compliance at the earliest possible date.

(b) A compliance schedule shall contain a commitment from the applicant to achieve increments of progress to be completed on specified dates.

(c) At a minimum, the increments shall include a date for submitting any additional plans and specifications required for construction, a date for commencement of construction and a date for completion of construction.

(d) Upon request from the cabinet the applicant shall provide the cabinet with periodic reports regarding progress towards compliance schedule increments.

INFORMATIONAL COPY

(5) Failure to meet the dates set forth in a compliance schedule shall constitute a violation of KRS 224.060 unless an alternate date has been negotiated by the person responsible for a facility and has been approved in writing by the cabinet. (1 Ky. R. 763; Am. 1383; eff. 7-2-75; Am. 2 Ky. R. 500; eff. 5-12-76.)

Effective February 1, 1984

[illegible] spills and bypasses to be reported to division.

RELATES TO: KRS Chapter 224
PURSUANT TO: KRS 13.082, 224.033(17)
NECESSITY AND FUNCTION: This regulation requires that spills and bypasses from sewage systems as defined in KRS 224.005(15) be reported to the division. Such reports enable the division to determine what action it need initiate to protect public safety and mitigate or reduce the effect of such spill or bypass.

Section 1. Any person having knowledge in advance of the necessity to bypass a sewage system shall notify the Division of Water before such bypass is commenced. Notification shall be given as far in advance as possible.

Section 2. Whenever by reason of emergency or accident a spill or discharge occurs from a sewage system or from a container or pipeline used to transport or store substances which would result in or contribute to the pollution of the waters, the person in charge of such activity shall immediately notify the Division of Water by the most rapid means available.

Section 3. Any person notifying the division pursuant to Sections 1 and 2 shall report the point of discharge, the nature of the material discharged, the quantity of the material discharged and an assessment of probable environmental impact.

Section 4. Notification required under Section 1 may be made by any mode of communication. Notification required by Section 2 shall be made by the most rapid means of communication available. If notification is not initially made in writing, it shall be confirmed by written notification within ten (10) days if requested by the division director or his appointed representative.

Section 5. Persons failing to report as required in Sections 1, 2, 3 and 4 are subject to the penalties provided by KRS 224.994. (WP-3; 1 Ky.R. 761; Am. 1382; eff. 7-2-75.)

OHIO RIVER VALLEY WATER SANITATION COMMISSION

POLLUTION CONTROL STANDARDS
(September 13, 1984 Revision)

NOTICE OF REQUIREMENTS

ESTABLISHED BY POLLUTION CONTROL STANDARDS
FOR DISCHARGES TO THE OHIO RIVER
September 13, 1984 Revision

You are hereby notified that, having considered all the evidence presented at public hearings, the Ohio River Valley Water Sanitation Commission, at its regularly held meeting on September 13, 1984, acting in accordance with and pursuant to the authority contained in Article VI of the Ohio River Valley Water Sanitation Compact, adopted and promulgated, subject to revision as changing conditions require, Pollution Control Standards (September 13, 1984 Revision) for the modification or treatment of all sewage from municipalities or other political subdivisions, public or private institutions, corporations, or watercraft, and for the modification or treatment of all industrial wastes discharged or permitted to flow into the Ohio River from the point of confluence of the Allegheny and Monongahela Rivers at Pittsburgh, Pennsylvania, designated as Ohio River mile point 0.0, to Cairo Point, Illinois, located at the confluence of the Ohio and Mississippi Rivers, and being 981.0 miles downstream from Pittsburgh, Pennsylvania.

Under terms and provisions of the Ohio River Valley Water Sanitation Compact all sewage from municipalities or other political subdivisions, public or private institutions, corporations or watercraft and all industrial wastes discharged or permitted to flow into the Ohio River will be required to be modified or treated to the extent specified in the standards established as above set forth.

The Commission at its September 13, 1984 meeting also rescinded both Pollution Control Standard No. 1-70 and Pollution Control Standard No. 2-70, which were established by Commission action November 13, 1970, including all definitions and application procedures appended to or incorporated therein, together with such other treatment standards and regulatory actions as have been heretofore adopted.

Leo Weaver
Executive Director and Chief Engineer

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The Ohio River Valley Water Sanitation Commission

An interstate Commission created by compact among Illinois • Indiana • Kentucky • New York • Ohio • Pennsylvania • Virginia • West Virginia •
Headquarters: 414 Walnut Street, Cincinnati, Ohio 45202

I. PREAMBLE[a]

Pollution control standards implement many decisions affecting water quality of the Ohio River and the uses made thereof. The Ohio River Valley Water Sanitation Compact provides the basis for assuring multipurpose uses of the Ohio River, and authorizes the Commission to promulgate standards of treatment for sewage or industrial wastes. It also states that: "The guiding principle of this Compact shall be that pollution by sewage or industrial wastes originating within a signatory state shall not injuriously affect the various uses of the interstate waters as hereinbefore defined."

The purpose of these regulations, therefore, is to recognize those uses to be protected in the Ohio River, establish stream criteria to assure that the uses will be achieved, and set Standards of Treatment needed to attain the established stream criteria and parameter levels. These regulations also implement the formal decisions of the Commission as they are concerned with pollution control activities, the granting of variances upon justification and recognize that individual states may adopt more stringent regulations.

Article IX of the Compact grants the Commission certain enforcement powers. These regulations must be implemented in the issuance of any permit to a discharger to the mainstem of the Ohio River (unless the state or the Federal government has a more stringent regulation).

II. DEFINITIONS

A. "*Cooling Water*" means non-contact cooling water used as a heat transfer medium for once-through cooling or cooling tower blowdown to which no Industrial Wastes, Toxic Wastes, Residues from Potable Water Treatment Plants, untreated Sewage, or Other Wastes, exclusive of approved anti-fouling agents (e.g., chlorine) are added prior to discharge.

*B. "*Compact,*" as used in these regulations, means the Ohio River Valley Water Sanitation Compact and is an agreement entered into by and between the states of Indiana, West Virginia, Ohio, New York, Illinois,

[a] Specific Standards of Treatment are established in these regulations and must be incorporated into discharge permits upon issuance or reissuance when they are more stringent than:

1. applicable US EPA technology-based effluent guidelines required under Section 301 of the Federal Clean Water Act, or
2. any state treatment requirements, effluent standards, or water quality based effluent limitations.

In the absence of promulgated Federal effluent guidelines pursuant to Section 301 of the Clean Water Act, the Compact signatory states have the responsibility to establish effluent limitations to be included in any discharge permit, consistent with the standards contained herein using Best Professional Judgment on a case by case basis.

Kentucky, Pennsylvania, and Virginia, which pledges each to the other of the signatory states faithful cooperation in the control of future pollution and abatement of existing pollution from the waters in the Ohio River basin. This compact created the Ohio River Valley Water Sanitation Commission (ORSANCO).

*C. "*Industrial Wastes*" means any liquid, gaseous, solid materials or waste substances or combination thereof other than Cooling Water as herein defined, resulting from any process or operation including storage and transportation, manufacturing, commercial, agricultural, and government operations.

D. "*Mixing Zone*" means that portion of the water body receiving a discharge where effluent and receiving waters are not totally mixed and uniform with the result that the zone is not representative of the receiving waters and may not meet all ambient water quality standards or other requirements of any signatory state applicable to the particular receiving waters.

E. "*Net Discharge*" is determined by excluding the amount of pollutant in an influent when determining the quality of an effluent if both the intake and discharge are from and to the same body of water.

F. "*96 hour* LC_{50}" as used in these standards means the concentration that kills 50 percent of the test organisms within 96 hours. The test organisms shall be Representative Important Species indigenous to the Ohio River.

G. "*Non-Cumulative Substances*" means compounds which have a biological half-life of less than four days. All other compounds are cumulative substances.

*H. The "*Ohio River,*" as used in these regulations, extends from the point of confluence of the Allegheny and Monongahela Rivers at Pittsburgh, Pennsylvania, designated as Ohio River mile-point 0.0 to Cairo Point, Illinois, located at the confluence of the Ohio and Mississippi Rivers and being 981.0 miles downstream from Pittsburgh.

*I. "*Ohio River Valley Water Sanitation Commission*" (Commission) means a body corporate created by authority of the Compact and is the operating agency established to implement the Compact. It consists of three (3) representatives of each signatory state and three (3) representatives of the Federal government.

*Terms contained in the Ohio River Valley Water Sanitation Compact

J. *"Other Wastes"* means any waste other than Sewage, Cooling Water, Residues from Potable Water Treatment Plants, Industrial Wastes or Toxic Wastes, which if discharged to the Ohio River could cause or contribute to any violations of these regulations, or of any water quality standards of any signatory state or which may be deleterious to the designated uses of those waters.

K. *"Primary Contact Recreation"* means recreational activities where the human body may come in direct contact with water to the point of complete body submergence and where ingestion of the water is probable.

L. *"Representative Important Species"* means those species of aquatic life whose protection and propagation will assure the sustained presence of a balanced indigenous community. Such species are representative in the sense that maintenance of suitable water quality conditions will assure the overall protection and sustained propagation of the balanced indigenous community.

M. *"Residues from Potable Water Treatment Plants"* means those wastes emanating from processes used in water purification. Such processes may include sedimentation, chemical coagulation, filtration, iron and manganese removal, softening and disinfection.

*N. *"Sewage"* means water-carried human or animal wastes from such sources as residences; industrial, commercial or governmental establishments; public or private institutions; or other places. The admixture of Sewage with Industrial Wastes, Toxic Wastes or Other Wastes, in amounts detrimental to the quality of the combined effluent shall also be regarded as Sewage.

*O *"Standards of Treatment"* means the degree of processing of wastes necessary to meet the specific discharge limitations provided by these regulations but does not prescribe the methodology.

*P. *"Substantially Complete Removal"* means removal to the lowest practicable level attainable with current technology.

Q. *"Toxic Wastes"* means wastes containing substances or combinations of substances which might reasonably be expected to cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions, including malfunctions in reproduction, or physical deformations in fish, other aquatic life, wildlife, livestock, or humans.

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*Terms contained in the Ohio River Valley Water Sanitation Compact

III. DESIGNATED USES

The Ohio River, as hereinbefore defined, has been designated by the Compact for safe and satisfactory use as public and industrial water supplies after reasonable treatment, suitable for recreational usage, capable of maintaining fish and other aquatic life and adaptable to such other uses as may be legitimate.

IV. STREAM CRITERIA

A. The stream criteria which these regulations are intended to achieve in the receiving waters outside the Mixing Zone are as follows:

1. Freedom from anything that will settle to form putrescent or otherwise objectionable sludge deposits which interfere with designated water uses;

2. Freedom from floating debris, scum, oil (in whatever state, i.e., free, emulsified, dispersed and dissolved), and other floating material in amount sufficient to be unsightly or deleterious;

3. Freedom from materials producing color or odors in such a degree as to create unaesthetic conditions or a nuisance;

4. Freedom from substances in concentrations which are toxic or harmful to humans, animals, or fish and other aquatic life; which would in any manner adversely affect the flavor, color, odor, or edibility of fish and other aquatic life, wildlife or livestock; or which are otherwise detrimental to the designated uses specified in Section III.

B. These criteria relate to the conditions of waters as affected by the direct and indirect discharges of Sewage, Industrial Wastes, Toxic Wastes, Other Wastes, Cooling Water or Residues from Potable Water Treatment Plants. They also include consideration of permanent alterations of the water body such as channeling, diversions, or impoundment. The natural waters of the Ohio River may have characteristics which do not meet the stream criteria and parameter levels set forth below.

C. To assure that the foregoing criteria will be attained, the following parameter levels shall be met outside the Mixing Zone:

1. DISSOLVED OXYGEN Concentrations shall average at least 5.0 mg/l per calendar day and shall not be less than 4.0 mg/l at any time provided that a minimum of 5.0 mg/l at any time is maintained during the April 15-June 15 spawning season.

2. TEMPERATURE Allowable stream temperatures are:

MONTH DATE	PERIOD AVERAGE °F	INSTANTANEOUS MAXIMUM °F
January 1-31	45	50
February 1-29	45	50
March 1-15	51	56
March 16-31	54	59
April 1-15	58	64
April 16-30	64	69
May 1-15	68	73
May 16-31	75	80
June 1-15	80	85
June 16-30	83	87
July 1-31	84	89
August 1-31	84	89
September 1-15	84	87
September 16-30	82	86
October 1-15	77	82
October 16-31	72	77
November 1-30	67	72
December 1-31	52	57

3. pH: No value below 6.0 nor above 9.0.

4. TOXIC SUBSTANCES

   a. Non-Cumulative Substances — not to exceed one-tenth (0.1) of the 96 hour LC_{50} of Representative Important Species indigenous to the Ohio River.

   b. Cumulative Substances — not to exceed one one-hundredth (0.01) of the 96 hour LC_{50} of Representative Important Species indigenous to the Ohio River.

   c. Other limiting concentrations may be used when justified on the basis of available evidence and approved by the appropriate regulatory agency or agencies.

5. BACTERIA

   Maximum allowable level of fecal coliform for Primary Contact Recreation — Content (either MPN or MF count) shall not exceed 200/100 ml as a monthly geometric mean based on not less than five samples per month; nor exceed 400/100 ml in more than ten percent of all samples taken during the month; these limits are applicable to waters designated for recreational use during the recreation season (May through October).

   Maximum allowable level of fecal coliform for other uses — Fecal coliform content (either MPN or MF count) shall not exceed 2,000/100 ml as a monthly geometric mean based on not less than five samples per month.

6. DISSOLVED SOLIDS Not to exceed 500 mg/l as a monthly average value, nor exceed 750 mg/l at any time. (Equivalent 25 deg. C specific conductance values are 800 and 1,200 micromhos/cm.)

7. AMMONIA The concentration of un-ionized ammonia (as NH_3) shall not exceed 0.05 mg/l; un-ionized ammonia shall be determined from values shown in Appendix B for total ammonia-N, pH and temperature and the following equation:

$$Y = \frac{1.2\,(\text{Total ammonia-N})}{[1 + 10^{(pk_a - pH)}]}$$

$$pk_a = 0.0902 + \frac{2730}{(273.2 + T)}$$

T = Temperature degree C.

Y = Un-ionized ammonia

8. CHEMICAL CONSTITUENTS Not to exceed the concentrations in the following table at any time (dissolved limits, where applicable, are identified):

CONSTITUENTS	CONCENTRATION (mg/l)
Arsenic	0.05
Barium	1.0
Cadmium	0.01
Chloride	250
Chromium (hexavalent)	0.05
Cyanide	0.025
Fluoride	1.0
Lead (dissolved)	0.05
Mercury	0.0002
Nitrite-N + Nitrate-N	10
Nitrite-N	1.0
Phenol (phenolic materials)	0.01
Selenium	0.01
Silver	0.05
Sulfate	250

Copper:

TOTAL HARDNESS AS CALCIUM CARBONATE (mg/l)	CONCENTRATION (mg/l)
50	0.012
80	0.018
100	0.022
160	0.034
200	0.043

Zinc:

Total Hardness As Calcium Carbonate (mg/l)	Concentration (mg/l)
0-80	0.040
81-120	0.055
121-160	0.070
161-180	0.095
181-200	0.115

9. Radionuclides: Gross total alpha activity (including radium-226 but excluding radon and uranium) shall not exceed 15 picocurie per liter (pCi/1) and combined radium-226 and radium-228 shall not exceed 5 pCi/1; provided that specific determinations of radium-226 and radium-228 are not required if gross particle activity does not exceed 5 pCi/1. Concentration of total gross beta particle activity shall not exceed 50 pCi/1; the concentration of tritium shall not exceed 20,000 pCi/1; the concentration of total strontium-90 shall not exceed 8 pCi/1.

V. STANDARDS OF TREATMENT

A. General

1. No discharge of any Sewage, Industrial Wastes, Toxic Wastes, Other Wastes, Cooling Water or Residues from Potable Water Treatment Plants shall cause or contribute to a violation of these regulations, shall preclude the attainment of any designated use of the mainstem waters of the Ohio River or shall interfere with the attainment of the stream criteria and parameter levels set forth in Section IV.

2. All discharge of Sewage, Industrial Wastes, Toxic Wastes, Other Wastes, Cooling Water or Residues from Potable Water Treatment Plants shall be treated or otherwise modified so as to provide:

   a. Substantially Complete Removal of settleable solids, which may form sludge deposits;

   b. Substantially Complete Removal of oil (in whatever state, including free, emulsified, dispersed and dissolved), debris, scum, and other floating material;

   c. Reduction of total suspended solids and other materials to such a degree that the discharge will not produce a substantial negative visible contrast to natural conditions in turbidity, color or odor of the river, or impart taste to the potable water supplies or cause tainting of fish flesh;

d. Reduction of all substances in amounts which, when concentrated or combined in the receiving stream, would result in conditions toxic or harmful to humans, animals, or fish and other aquatic life; which would in any manner adversely affect the flavor, color, odor, or edibility of fish and other aquatic life, wildlife or livestock; or which are otherwise detrimental to the designated water uses specified in Section III.

B. **Sewage**

1. MINIMUM LEVEL OF TREATMENT

The minimum level of treatment required for sewage prior to discharge shall meet the following standards in addition to those contained in Section V.A.

a. Biochemical Oxygen Demand (five day)

i. The arithmetic mean of the values for effluent samples collected in a period of 30 consecutive days shall not exceed 30 milligrams per liter.

ii. The arithmetic mean of the values for effluent samples collected in a period of 7 consecutive days shall not exceed 45 milligrams per liter.

b. Suspended Solids

i. The arithmetic mean of the values for effluent samples collected in a period of 30 consecutive days shall not exceed 30 milligrams per liter.

ii. The arithmetic mean of the values for effluent samples collected in a period of 7 consecutive days shall not exceed 45 milligrams per liter.

c. pH

The effluent values for pH shall be maintained within the limits of 6.0 to 9.0.

d. Bacteria

Reduction of fecal coliform bacteria to such degree that (1) during the months of May through October fecal coliform density in the discharge does not exceed 200/100 ml as a monthly geometric mean (based on not less than ten samples per month), nor exceed 400/100 ml in more than ten percent of the samples examined during a month, and (2) during the months of November through April the den-

sity does not exceed 1,000/100 ml as a monthly geometric mean (based on not less than ten samples per month), nor exceed 2,000/100 ml in more than ten percent of the samples examined during a month.

2. ALTERNATIVE TREATMENT

Notwithstanding the requirements of Section V.B.1(a), (b), and (c), such facilities as oxidation ponds, lagoons and ditches, and trickling filters shall be deemed to provide effective treatment provided that the effluent does not cause a violation of the states' applicable water quality standards, or these regulations.

C. **Industrial Wastes, Toxic Wastes and Other Wastes**

1. The treatment of Industrial Wastes, Toxic Wastes, and Other Wastes prior to discharge shall be in accordance with Section V.A.

2. In addition, a Net Discharge of the following toxic pollutants is hereby prohibited:

   a. Aldrin (1, 2, 3, 4, 10, 10-hexachloro-1, 4, 4a, 5, 8, 8a-hexahydro-1, 4-endo-5, 8-exo-dimethanonaphthalene)

   b. Dieldrin (1, 2, 3, 4, 10, 10-hexachloro-6, 7-epoxy-1, 4, 4a, 5, 6, 7, 8, 8a-octahydro-1, 4-endo-5, 8-exo-dimethano-naphthalene)

   c. DDT, including DDD and DDE

      1. DDT means 1, 1, 1-trichloro-2, 2-bis (p-chlorophenyl) ethane and some o, p'-isomers

      2. DDD (TDE) means 1, 1-dichloro-2, 2-bis (p-chlorophenyl) ethane and some o, p'-isomers

      3. DDE means 1, 1-dichloro-2, 2-bis (p-chlorophenyl) ethylene

   d. Endrin (1, 2, 3, 4, 10, 10-hexachloro-6, 7-epoxy-1, 4, 4a, 5, 6, 7, 8, 8a-octahydro-1, 4-endo-5, 8-endo-dimethano-naphthalene)

   e. Toxaphene - a material consisting of technical grade chlorinated camphene having the approximate formula of $C_{10}H_{10}Cl_8$ and normally containing 67-69 percent chlorine by weight

f. Benzidine - the compound benzidine and its salts as identified by the chemical name 4, 4-diaminobiphenyl

g. Polychlorinated Biphenyls (PCB) - a mixture of compounds composed of the biphenyl molecule which has been chlorinated to varying degrees

D. **Residues from Potable Water Treatment Plants**

The use of controlled discharge for Residues from Potable Water Treatment Plant processes of sedimentation, coagulation and filtration may be authorized provided that as a minimum the discharge meets all the requirements of Section IV. A. and V.A.

VI. MIXING ZONE DESIGNATION

A. A Mixing Zone shall be deemed to exist for each discharge. When required, the specific numerical limits for any Mixing Zone shall be determined on a case by case basis, and shall include considerations for existing uses, linear distance (i.e., length and width) from the point of discharge, surface area involved, and volume of receiving water within the defined zone.

B. Conditions within the Mixing Zone shall not be injurious to human health, in . event of a temporary exposure.

C. Conditions within the Mixing Zone shall not be lethal to aquatic life or wildlife that may enter the zone.

D. The Mixing Zone shall be free from substances attributable to Sewage, Industrial Wastes, Toxic Wastes, Other Wastes, Cooling Water, or Residues from Potable Water Treatment Plants in quantities which:

1. Settle to form sludge deposits;

2. Float as debris, scum, or oil;

3. Contaminate natural sediments so as to cause or contribute to a violation of:

   a. appropriate stream criteria and parameter levels outside the Mixing Zone, or

   b. any condition of the designated uses of the water;

4. Impart a disagreeable flavor or odor to flesh of fish or other aquatic life, wildlife or livestock which are consumed by man and which ac-

quire such a flavor because of passage through or ingestion of the waters from the Mixing Zone.

E. The Mixing Zone shall be located so as not to interfere significantly with migratory movements and passage of fish, other aquatic life and wildlife. No waste discharge related to the Mixing Zone shall, outside the limits of the Mixing Zone, interfere with potable water supply intakes, bathing areas, reproduction of fish, other aquatic life and wildlife; or adversely affect fish or aquatic life normally inhabiting waters prior to addition of waste discharged; or result in any other violations of appropriate stream criteria and parameter levels relating to the designated use at or above critical river flow as shown in Appendix A.

VII. ADDITIONAL TREATMENT

In order to protect the public health or the uses specified in Section III, such higher degrees of treatment or reduction in waste loads may be determined to be necessary by the Commission after investigation, due notice and hearing.

VIII. LIMITATION

Nothing contained in these regulations shall be construed to limit the powers of any state signatory to the Compact to promulgate more stringent criteria, conditions and restrictions to further lessen or prevent the pollution of waters within its jurisdiction.

IX. VARIANCE

A. The Commission may grant a variance from the provisions in Section V of these regulations, in accordance with the following procedures, provided that the uses set forth in Section III are maintained:

1. The burden of proof is upon the applicant to assure that the uses set forth in Section III are maintained;
2. Prior concurrence of the state where the applicant's discharge is located and those state(s) which may be affected must be obtained;
3. The specific reasons for the variance shall be clearly stated in writing;
4. Such additional information shall be provided to the Commission as it may request.

B. A variance may be granted for a period not to exceed the life of the applicable discharge permit; the applicant may apply for a variance renewal prior to the expiration of the permit.

X. ANALYTICAL METHODS

Tests or analytical determinations to determine compliance or non-compliance with the Standards of Treatment, stream criteria and parameter levels established hereby shall be made in accordance with accepted procedures such as those contained in the most recent edition of (a) *Standard Methods for the Examination of Water and Wastewater* prepared and published jointly by the American Public Health Association (APHA), American Water Works Association (AWWA), and Water Pollution Control Federation; (b) *Annual Book of ASTM Standards Part 31 — Water* published by the American Society for Testing and Materials; (c) 40 CFR 136 — *Guidelines Establishing Test Procedures for the Analysis of Pollutants* by the U.S. Environmental Protection Agency; or (d) by such other methods as are approved by the Commission equal to or superior to or not available within methods in documents listed above, provided such other test methods are available to the public.

XI. SEVERABILITY CLAUSE

Should any one or more of the Pollution Control Standards hereby established or should any one or more provision of the regulations herein contained be held or determined to be invalid, illegal or unenforceable, for any reason whatsoever, all other Standards and other provisions shall remain effective and shall be construed, applied and enforced as if the invalid, illegal or unenforceable language had not been included.

APPENDIX A

CRITICAL FLOW VALUES

River Reach		
From	To	Critical Flow in cfs*
Pittsburgh	Montgomery Dam (MP 32.4)	4,800
Montgomery	Willow Island Dam (MP 161.8)	5,800
Willow Island	Gallipolis Dam (MP 279.2)	6,800
Gallipolis	Greenup Dam (MP 341.0)	8,500
Greenup	Meldahl Dam (MP 436.2)	9,800
Meldahl	McAlpine Dam (MP 605.8)	11,000
McAlpine	Uniontown Dam (MP 846.0)	13,000
Uniontown	Smithland Dam (MP 918.5)	18,800
Smithland	Cairo Point (MP 981.0)	46,300

* Minimum 7 day, 10 year low flow based on calculations by the U.S. Corps of Engineers

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APPENDIX B

Concentrations of total Ammonia-N which contain an un-ionized ammonia concentration of 0.05 mg/l NH_3

Temp. (°C) \ pH	6.7	6.8	6.9	7.0	7.1	7.2	7.3	7.4	7.5	7.6	7.7	7.8	7.9	8.0	8.1	8.2	8.3	8.4	8.5	8.6	8.7	8.8	8.9	9.0	9.1	9.2	9.3
5								13.2	10.5	8.4	6.6	5.3	4.2	3.4	2.7	2.1	1.7	1.4	1.1	0.9	0.7	0.6	0.5	0.4	0.3	0.3	0.2
6								12.3	9.8	7.8	6.2	4.9	3.9	3.1	2.5	2.0	1.6	1.3	1.0	0.8	0.7	0.5	0.4	0.4	0.3	0.2	—
7								11.2	8.9	7.1	5.7	4.5	3.6	2.9	2.3	1.8	1.5	1.2	0.9	0.7	0.6	0.5	0.4	0.3	0.3	0.2	
8							13.2	10.5	8.4	6.6	5.3	4.2	3.4	2.7	2.1	1.7	1.4	1.1	0.9	0.7	0.6	0.5	0.4	0.3	0.3	0.2	
9							12.0	9.6	7.6	6.1	4.8	3.8	3.1	2.4	1.9	1.6	1.2	1.0	0.8	0.6	0.5	0.4	0.3	0.3	0.2	—	
10							11.2	8.9	7.1	5.7	4.5	3.6	2.9	2.3	1.8	1.5	1.2	0.9	0.7	0.6	0.5	0.4	0.3	0.3	0.2		
11						13.2	10.5	8.4	6.6	5.3	4.2	3.4	2.7	2.1	1.7	1.4	1.1	0.9	0.7	0.6	0.5	0.4	0.3	0.3	0.2		
12						12.1	9.6	7.6	6.1	4.8	3.8	3.1	2.4	1.9	1.6	1.2	1.0	0.8	0.6	0.5	0.4	0.3	0.3	0.2	—		
13						11.2	8.9	7.1	5.7	4.5	3.6	2.9	2.3	1.8	1.5	1.2	0.9	0.7	0.6	0.5	0.4	0.3	0.3	0.2			
14					13.2	10.5	8.4	6.6	5.3	4.2	3.4	2.7	2.1	1.7	1.4	1.1	0.9	0.7	0.6	0.5	0.4	0.3	0.3	0.2			
15					12.1	9.6	7.6	6.1	4.8	3.8	3.1	2.4	1.9	1.6	1.2	1.0	0.8	0.6	0.5	0.4	0.3	0.3	0.2	—			
16					11.2	8.9	7.1	5.7	4.5	3.6	2.9	2.3	1.8	1.5	1.2	0.9	0.7	0.6	0.5	0.4	0.3	0.3	0.2				
17				13.2	10.5	8.4	6.6	5.3	4.2	3.4	2.7	2.1	1.7	1.4	1.1	0.9	0.7	0.6	0.5	0.4	0.3	0.3	0.2				
18				12.3	9.8	7.8	6.2	4.9	3.9	3.1	2.5	2.0	1.6	1.3	1.0	0.8	0.7	0.5	0.4	0.4	0.3	0.2	—				
19				11.2	8.9	7.1	5.7	4.5	3.6	2.9	2.3	1.8	1.5	1.2	0.9	0.7	0.6	0.5	0.4	0.3	0.3	0.2					
20			13.2	10.5	8.4	6.6	5.3	4.2	3.4	2.7	2.1	1.7	1.4	1.1	0.9	0.7	0.6	0.5	0.4	0.3	0.3	0.2					
21			12.3	9.8	7.8	6.2	4.9	3.9	3.1	2.5	2.0	1.6	1.3	1.0	0.8	0.7	0.5	0.4	0.4	0.3	0.2	—					
22			11.5	9.2	7.3	5.8	4.6	3.7	2.9	2.3	1.9	1.5	1.2	1.0	0.8	0.6	0.5	0.4	0.3	0.3	0.2						
23		13.5	10.8	8.5	6.8	5.4	4.3	3.4	2.7	2.2	1.7	1.4	1.1	0.9	0.7	0.6	0.5	0.4	0.3	0.3	0.2						
24		12.6	10.0	8.0	6.3	5.1	4.0	3.2	2.6	2.0	1.6	1.3	1.0	0.8	0.7	0.5	0.4	0.4	0.3	0.2	—						
25		11.8	9.4	7.5	5.9	4.7	3.8	3.0	2.4	1.9	1.5	1.2	1.0	0.8	0.6	0.5	0.4	0.3	0.3	0.2							
26	13.5	10.8	8.5	6.8	5.4	4.3	3.4	2.7	2.2	1.7	1.4	1.1	0.9	0.7	0.6	0.5	0.4	0.3	0.3	0.2							
27	12.6	10.0	8.0	6.3	5.1	4.0	3.2	2.6	2.0	1.6	1.3	1.0	0.8	0.7	0.5	0.4	0.4	0.3	0.2	0.2							
28	11.8	9.4	7.5	5.9	4.7	3.8	3.0	2.4	1.9	1.5	1.2	1.0	0.8	0.6	0.5	0.4	0.3	0.3	0.2	—							
29	11.0	8.7	7.0	5.5	4.4	3.5	2.8	2.2	1.8	1.4	1.1	0.9	0.7	0.6	0.5	0.4	0.3	0.3	0.2								
30	10.2	8.2	6.5	5.2	4.1	3.3	2.6	2.1	1.7	1.3	1.1	0.9	0.7	0.6	0.4	0.4	0.3	0.2	0.2								

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APPENDIX J

MAMMALS OF JEFFERSON COUNTY

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MAMMALS OF JEFFERSON COUNTY

Species Known From Jefferson County Region	Common Name	Status[a]	Habitat[b] Preference
Didelphidae			
Didelphis virginiana	Virginia opposum	R	WE,F
Soricidae			
Sorex longirostris	Southeastern shrew	PR	WR
Cryptotis parva	Least shrew	PR	WR
Blarina brevicauda	Short-tailed shrew	PR	WR,B
Talpidae			
Scalopus aquaticus	Eastern mole	R	F,B,W
Vespertilionidae			
Myotis Keeni	Keen's myotis	PR	WR,WE,C
M. lucifugus	Little brown myotis	PR	WR,WE,C
M. sodalis	Indiana myotis	PR[1)]	WR,WE,C
M. grisescens	Gray myotis	PR[1)]	C,WE
Lasionycteris noctivagans	Silver-haired bat	PR	WR,U
Pipistrellus subflavus	Eastern pipistrelle	PR	WE,WR,C
Lasiurus cinereus	Hoary bat	PR	W,WR
L. borealis	Red bat	PR	W,WE
Nycticeius humeralis	Evening bat	PR	W,U
Plecotus refinesqueii	Rafinesque's big-eared bat	PR	C,U
Eptesicus fuscus	Big brown bat	PR	WE,U
Procyonidae			
Procyon lotor	Raccoon	R	W,WE,B
Mustelidae			
Mustela frenata	Long-tailed weasel	R	WE,B
M. vison	Mink	PNR	SA
Mephitis mephitis	Striped skunk	R	B,F,WE
Canidae			
Vulpes vulpes	Red fox	PR	WE,F
Urocyon cinereoargenteus	Grey fox	PR	W
Felidae			
Felis rufus	Bobcat	PNR	W,B
Sciuridae			
Marmota monax	Woodchuck	R	WE,F
Tamias striatus	Eastern chipmunk	R	W,WE
Sciurus carolinensis	Eastern gray squirrel	PR	W
S. niger	Eastern fox squirrel	R	W,WE
Glaucomys volans	Southern flying squirrel	PR	W,WR
Castor canadensis	Beaver	PR	SA

MAMMALS OF JEFFERSON COUNTY
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Species Known From Jefferson County Region	Common Name	Status[a]	Habitat[b] Preference
Cricetidae			
Reithrodontomys humilus	Eastern harvest mouse	PR	F
Peromyscus leucopus	White-footed mouse	R	WE,B
P. maniculatus	Deer mouse	PR	B,F
Ochrotomys nuttalli	Golden mouse	PR	W
Neotoma floridama	Eastern woodrat	PNR	R,W
Synaptomys cooperi	Southern bog lemming	PR	F,B
Microtus pennsylvanicus	Meadow vole	PR	F
M. pinetorum	Woodland vole	R	F,WE,W
M. ochrogaster	Prairie vole	R	F,B
Ondatra zibethicus	Muskrat	R	SA
Zapodidae			
Zapus hudsonius	Meadow jumping mouse	PR[2)]	WR,F
Muridae			
Mus musculus	House mouse	R	F,U
Rattus norvegicus	Norway rat	PR	U
R. rattus	Black rat	PR	U
Leporidae			
Sylvilagus floridanus	Eastern cottontail	R	B,WE,U
S. aquaticus	Swamp rabbit	PNR[2)]	WR
Cervidae			
Odocoileus virginianus	White-tailed deer	R	W,F

a) R - Resident, present on site during 1979.
PR - Possible resident - suitable habitat available.
PNR - Probably not present, although known from study region.
1) U.S. Department of Interior, Fish and Wildlife Service, 1979. List of Endangered and Threatened Wildlife and Plants. Federal Register, January 17, 19797.

2) Stephens, et al., 19779. Peripheral species.

b) W - Woodland
WE - Woodland edge
F - Field, open spaces
WR - Wooded rpiarian, moist lowland woods
B - Brushland
C - Caves
U - Urban: buildings - attics
SR - Semi-aquatic, riparian
R - Rocky slopes

Source: U.S. Army Corps of Engineers, 1980

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APPENDIX K

BIRDS COMMON TO THE AREA NEAR LEES LANE LANDFILL SITE

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BIRDS COMMON TO THE AREA NEAR LEES LANE LANDFILL SITE JEFFERSON COUNTY, KENTUCKY

Common Name	Scientific Name	Sightings	Relative Frequency
1. Common Grackle	Quiscalus quiscula	235	16.2
2. American Robin	Turdus migratorious	166	11.5
3. Indigo Bunting	Passerina cyanea	150	10.4
4. Mourning Dove	Zenaidura macroura	119	8.2
5. Cardinal	Cardinalis cardinalis	90	6.2
6. Gray Catbird	Dumetella carolinensis	66	4.6
7. Bluejay	Cyanocitta cristata	54	3.7
8. Eastern Meadowlark	Sturnella magna	48	3.3
9. Red-winged Blackbird	Agelaius phoenicus	42	2.9
10. Field Sparrow	Spizella pusilla	37	2.6
11. Starling	Sturnus vulgaris	36	2.5
12. Common Yellowthroat	Geothlypis trichas	31	2.1
13. Green Heron	Butorides virescens	27	1.9
14. Rufous-sided Towhee	Pipilo erythrophthalmus	27	1.9
15. Yellow-billed Cuckoo	Coccyzus americanus	25	1.7
16. Yellow-breasted Chat	Icteria virens	25	1.7
17. Common Crow	Corvus brachyrhynochos	23	1.6
18. Common Flicker	Colaptes auratus	18	1.2
19. Bobwhite Quail	Colinus virginianus	16	1.1
20. American Kestrel	Falco sparverius	14	1.0
Other		200	13.8
Total		1,746	100.0

Source: U. S. Corps of Engineers, 1980

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APPENDIX L

CHEMICAL AND BIOLOGICAL TOXICITY OF THE CRITICAL CONTAMINANTS

CHEMICAL AND BIOLOGICAL TOXICITY OF THE CRITICAL CONTAMINANTS

Lead

Pharmacokinetics

Kehoe (1961) showed that, in adults, eight percent of dietary lead is absorbed. Alexander et al.. (1973) showed that in children aged three months to 8.5 years, absorption was approximately 50 percent. Similar absorption characteristics were noted in rats by Forbes and Reina (1974).

Six and Goyer (1970 and 1972) observed that low dietary levels of calcium and iron and high fat levels increased the absorption of lead in laboratory animals. Ziegler (1978) observed a similar inverse relation between dietary calcium and lead absorption in human infants.

Once absorbed, lead is carried in blood as the dibasic phosphate or glycerophosphate and deposited in the skeleton as the poorly soluble tribasic phosphate. Barry (1975) showed that following long term exposure, 95 percent of the absorbed lead is deposited in the skeleton in adults and 72 percent in children. The remainder is localized in soft tissues, including the blood, where it is found primarily in the erythrocytes. Only when lead is present in relatively high amounts does a significant portion remain in the plasma.

In most species, including man, biliary excretion of lead predominates over urinary excretion (Cohen, 1970; Rabinowitz, et al., 1973).

Acute Effects

The effects of lead poisoning are detectable on the hematopoietic system at lower levels of exposure than any other organ or system. Piddington and White (1974) showed that lead interferes with heme synthesis by one of two actions. It may act by inhibiting heme synthetase, the enzyme that incorporates iron into protoporphyrin IX (a precursor of heme), or lead may block the entry of iron into the mitochondrion. In either case, heme production is decreased, leading to

decreased hemoglobin production. A decrement in hemoglobin production is detectable at blood lead (referred to as PbB) levels of 50 ug/dl in adults (Tola et al., 1973) and 40 ug/dl in children (Betts et al., 1973).

Chronic Effects

Renal injury is most often observed after high level exposure to lead. Initial signs may include tubular damage, manifested by aminoaciduria, which was found by Clarkson and Kench (1956) to be uncommon at PbBs less than 70 ug/dl. Continued exposure may lead to decreased glomerular filtration, a progressive disease, found by Morgan et al., (1966) to occur at relatively low, 50 ug/dl, blood lead levels.

Lead may induce profound effects on the central nervous system. Landrigan and Baker (1976) showed that nerve conduction velocity slowed at PbBs of 50 ug/dl when no signs of neuromuscular involvement were apparent. Continued exposure may lead to lead palsy, manifested by muscle weakness, fatigue and paralysis. Usually the most active muscle groups are affected first. Degenerative changes occur in the motorneurons and their axons, affecting the upper limbs of adults and the lower limbs of children first. Subtle neurobehavioral effects appear to occur in the 40-80 ug/dl PbB range. More serious effects rarely occur at levels less than 80 ug/dl (Chisolm, 1968) and are usually higher, with a mean of 328 ug/dl reported in children (NAS, 1972). In children, exposure to lead occassionally produces progressive mental deterioration. Motor skills and speech slowly deteriorate and they may exhibit severe behavior disorders. The World Health Organization (WHO, 1977) noted the possibility of noticeable brain dysfunction in children at PbBs of 50 ug/dl.

Reproductive/Teratogenic Effects

McClain and Becker (1975) injected lead intraperitoneally in rats and noted teratogenic and embryotoxic effects. High lead concentrations (250 mg/l) in water, when administered to pregnant rats caused delayed fetal development and fetal resorption but no teratologic effects (Kimmel et al., 1976). There are no references to teratologic effects in man; however, stillbirths and miscarriages were reported among women working in lead trades in the late 19th and early 20th

centuries. Lancranjan et al., (1975) reported an increased incidence of teratospermia (abnormally-shaped sperm) among men working in lead storage battery factories.

Mutagenic Effects

There was no significant excess of chromasome damage in cultured leukocytes obtained from cows accidentally poisoned with a mixture of heavy metals; toxic levels of lead were detected in liver and kidneys (IARC, 1972).

Carcinogenic Effects

An epidemiologic study of the causes of death among people exposed to high levels of lead revealed no increase in malignant neoplasms (Selander and Cramer, 1970). Cooper (1978) studied causes of death among lead-exposed workers and concluded that there was no consistent association between cancer incidence and length of employ or exposure. Kang (1980) looked at the same data and concluded that there was a correlation between lead exposure and excess cancer mortality. Zollinger (1953) showed that lead-induced renal tumors in rats receiving lead acetate subcutaneously for up to 9.5 months. Azar (1973) confirmed these studies and observed that males were more susceptible and that a dose-response relationship existed. Despite evidence that some forms of lead are carcinogenic in some experimental animals, the International Agency for Research on Cancer considers the evidence to be of dubious significance with regard to man (IARC, 1972).

Arsenic

Pharmacokinetics

Absorption of arsenic depends on its chemical form and physical characteristics. Generally, the more soluble compounds are absorbed more readily than the less soluble ones. Greater than 95 percent of inorganic trivalent arsenic taken orally is absorbed and less than 5 percent is found in the feces (Ray-Bettley and O'Shea, 1975). Mappes (1977) reported that insoluble triselinide, when taken orally, passes through the gastrointestinal tract with negligible absorption.

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Absorbed arsenic undergoes in vivo transformation to dimethylarsinic acid which may be considered a dextoxified form. Charbonneau et al., (1978a,b) showed that in dogs, both erythrocytes and the liver are involved in the dimethylation and transport of the dimethylated forms. Braman and Foreback (1973) analyzed the arsenic in urine of four human volunteers. Two-thirds of the total arsenic was dimethylarsinic acid and 17 percent was pentavalent inorganic arsenic. Trivalent inorganic arsenic and methylarsonic acid each were present at 8 percent.

Mappes (1977) showed that 69-72 percent of the daily intake of arsenic in a human volunteer appeared in the urine. Most stored arsenic is found in skin, hair, teeth, bone, and nails. Of soft tissues, Kadowaki (1960) found that in man, heart, kidney, liver, and lung contained the highest levels of arsenic. Brain had levels somewhat below other soft tissues.

Acute Effects

Webb (1966) showed that at least 78 enzymes from a wide variety of species are inhibited or inactivated by trivalent arsenic. The mechanism appears to be through the formation of arsenic-sulfide bonds, especially in oxidative enzymes involved in mitochondrial respiration.

Fowler et al (1977) demonstrated that pentavalent arsenate interferes with phosphate transport and phosphorylation. A competitive replacement of inorganic phosphate by arsenate causes an uncoupling of the mitochondrial oxidative phosphorylation.

Clinically, acute arsenic poisoning due to ingestion causes gastrointestinal disturbances, throat constriction, difficulty swallowing, violent abdominal pain, vomiting, and diarrhea (Buchanan, 1962). Severe hypotension reflecting damage to the muscular system and death from cardiac failure may result. Trivalent arsenic is regarded as more acutely toxic than the pentavalent form with an estimated human lethal dose of 70-180 mg (Vallee et al., 1960).

Chronic Effects

Long term arsenic poisoning may affect the peripheral nervous system, the hematopoietic, cardiovascular, hepatic, and integumentary systems. Clinically, symptoms may include numbness and tingling of extremities, bone marrow injury, commonly aplastic anemia, myocardial toxicity including ventricular fibrillation, renal failure, copperlike pigmentation of the eyes; and the development of white bands across nails of hands and feet.

Teratogenic/Reproductive Effects

Golden hampsters, when injected with sodium arsenate produced offspring with a range of developmental malformations including anencephaly, rib malformations, and cleft lip and palate (Ferm et al., 1971). Similar results were noted by Hood et al., (1977) in mice receiving sodium arsenate via both oral and intraperitoneal routes.

Mutagenic Effects

Petres and Hundeiker (1968) and Petres et al., (1970) reported chromasome breakage in human leukocyte cultures after short term in vitro exposure to sodium arsenate in cultures obtained after long term exposure to arsenical compounds in vivo. The National Academy of Science (1977a) concluded that arsenic compounds have caused chromasome damage in a number of biological systems suggestive of a possible role in chemically induced mutagenesis.

Carcinogenic Effects

Tseng (1968) found a dose-response relationship between exposure to arsenic via drinking water and skin cancer prevalence in Taiwan. Similar health responses were reported in Chile (Borgono and Greiber, 1972), Argentina (Bergoglio, 1964), and Germany (Denk et al., 1969). The Taiwan experience was used by EPA to estimate lifetime cancer risk levels. Assuming a lifetime exposure occurring from the consumption of two liters of water and 6.5 grams of fish and shellfish per day, a level of 2,200 ug/l arsenic corresponds to the 10^{-6} risk level. Meaning, drinking

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water and eating seafood grown in water contaminated with arsenic at 2,200 ug/l for a lifetime increases one's risk of acquiring cancer to one additional case in a population of one million exposed individuals.

Benzene

Pharmacokinetics

Inhalation is the most frequent route of benzene exposure in man. Toxic effects in humans have in the past been attributed to a combined inhalation and dermal exposure, although studies by Conca and Maltagliati (1955) with humans failed to prove that benzene was being absorbed percutaneously. Benzene primarily accumulates in the fatty tissue and bone marrow. The blood, liver, and kidney also contain significant amounts of benzene with the spleen, lungs, and brain containing lesser quantities.

The biotransformation of benzene occurs in the liver. Lutz and Schlatter (1977) showed that the metabolites of benzene appear to be bound covalently to residual protein of liver, brain, kidney, spleen, and fat in mice. The degree of binding is dose dependent and increases in both liver and bone marrow upon repeated exposure. Benzene appears to bind covalently with DNA in liver nuclei. This offers a model for the study of the mechanism of benzene toxicity and/or carcinogenesis in bone marrow.

Exhalation is the major route of excretion of unchanged benzene. Benzene toxicity in humans is usually caused by the inhalation of ambient air containing benzene vapors. Following cessation of exposure, the body burden is decreased either by exhaling benzene or by metabolism.

Acute Toxicity

A single exposure concentration of 66,000 mg/m^3 (20,000 ppm) commercial benzene has been reported to be fatal in man within 5-10 minutes[19]. Acute benzene poisoning is characterized by nausea, vomiting, irregular heart beat, dissiness, headache, and loss of consciousness[1]. Death is usually a result of

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cardiovascular collapse. In cases of acute poisoning, inflammation of the respiratory tract, hemorrhages of the lungs, congestion of the kidneys, and cerebral edema have also been observed. The TLV-TWA for benzene is presently 10 ppm with a STEL of 25 ppm (ACGIH, 1984).

Chronic Toxicity

Benzene is a known hematoxin. In man, it is casually related to pancytopemia and acute mycloblastic leukemia. Pancytopenia is a decrease in the major circulating formed elements in the blood: erythrocytes, leukocytes, and thrombocytes.

Aplastic anemia may be related to the use of benzene-containing adhesives in the shoe making industry. Aksoy, et al., (1967b; 1971) showed that the incidence of aplastic anemia declined following replacement of the adhesive with a benzene-free substance. Benzene levels in air to which the workers were exposed were in the range of 150 to 650 ppm.

A study of printing workers exposed to benzene in concentrations ranging from 71 ppm to 1,060 ppm for three to five years revealed a significant incidence of hematological abnormalities. These included anemia, macrocytosis, and thrombocytopemia. Recovery from these hematological disorders was demonstrated following substitution of benzene with other solvents (IARC, 1981).

Doskin (1971) showed that the effects in occupationally-exposed groups to relatively low concentrations of benzene (10 ppm to 40 ppm) for less than a year produced mild hematological effects. Mild thrombocytopenia was the most common abnormality observed with mild anemia. Also reported were lymphocytosis and bone marrow hypercellularity.

Altered immune function has been reported in both man and animal. Studies of workers exposed to benzene, but not seriously intoxicated by benzene, showed a decrease in complement levels of IgG and IgA. Studies on mice have demonstrated that the administration of benzene inhibits the function of B- and T- lymphocytes, while levels of IgM increased. This may explain why many benzene-intoxicated individuals readily succumb to infection[14].

Synergism and/or Antagonism

The interaction of benzene with other solvents, such as toluene, alters the rate of benzene metabolism. Benzene toxicity is prevented by the co-administration of toluene, which inhibits benzene metabolism. This is because benzene and toluene are oxidized by many of the same hepatic enzyme systems (EPA, 1980).

Mutagenicity

In a study by Simon, et al., (1977), benzene did not show mutagenic activity in the Salmonella typhimusium/microsome in vitro assay. However, it has shown mutagenic activity in man and animals.

Benzene is a mitotic poison, producing a reduction in DNA sythesis in animal bone marrow cells in vitro and in cultured human cells. A significant increase in chromosomal aberrations in blood, bone marrow, and in the lymphocytes has been demonstrated by Doskin (1971) in humans and animals exposed to benzene at levels that caused hemotoxicity. Such abnormalities will persist long after the cessation of benzene exposure. It is not known whether occupational exposure to benzene at levels not producing overt hematological effects is capable of causing chromosomal abnormalities.

Teratogenicity

Some organic solvents (cyclohexane, carbon tetrachloride, chloroethane, and toluene) have been shown to produce congenital malformations in experimental animals (Casarett and Doull, 1980). The reported pancytopemia seen in workers exposed to toxic levels suggest the possibility that benzene could adversely affect the cells of a developing embryo. Pregnant mice that were administered benzene subcutaneously (3 mg/kg body weight) on day 13 of gestation produced fetuses with cleft palate, agnathia, and micrognathia. No other external visible defects were found in this study by Watanabe and Yoshida (1970).

Inhalation studies performed on animal models have proved too inconclusive to either refute or confirm that benzene is a teratogenic hazard. The effect of

benzene on male and female fertility, preimplantation, parturition, and lactation also needs to be evaluated.

Carcinogencity

Doskin (1971) noted that animal data do not presently support conclusively the view that benzene is leukemogenic. This is probably due to the difference in metabolism between the animal model and man. Despite negative results from animal data, the evidence that benzene is a leukemogen for man is overwhelming. Workers exposed to benzene vapors of 150 to 210 ppm for up to 28 years (mean exposure = 11 years) had a high incidence of leukemia and Hodgkins disease (IARC, 1981).

An epidemiological study conducted on workers exposed to benzene in the manufacturing of a rubber product demonstrated convincingly an etiological implication of benzene as a leukemogen. A statistically significant (P 0.002) excess of leukemia was found in this cohort when compared with two control groups: the general American population, and another industry not using benzene. There was a five-fold increased risk of leukemias and a ten-fold increased risk of myelocytic and monocytic leukemias combined. The environment of the workers was not contaminated with any other solvent other than benzene (IARC, 1981).

Also reported in association with benzene exposure have been lymphosarcoma, reticulum cell sarcoma, and multiple myeloma.

Chromium

Pharmacokinetics

The analysis of the movement of chromium through various body pools and the determination of the turnover rates of these pools are complicated by several factors. Firstly, different chromium compounds will exhibit different kinetic characteristics in the body. Additionally, one chemical species of chromium can be transformed into another in the body, for instance, as by the reduction of Cr (VI) to Cr (III). Chromium, like other metals, circulates in the plasma primarily in a bound, nondiffusable form (Mertz, 1969). The high affinity of Cr (III) for the iron-

binding protein sideophilin reflects the fact that this protein provides the normal mechanism of chromium transport to the tissues.

The half-life of plasma chromium is relatively short, and cells tend to accumulate the metal to levels higher than that present in the plasma. This accumulation results from the trapping of chromium compounds which penetrate the cells in the hexavalent form and then react with cell constituents. Inside the cell, the Cr (VI) will be reduced to Cr (III). In man, the highest concentrations of chromium are found in the lungs. The pulmonary levels tend to rise with age as the chromium content of other tissues fall. The lung obtains most of its chromium from the air, not from oral loads. Pulmonary chromium does not come into equilibrium with other body pools.

The majority of chromium is excreted in the urine.

Acute Effect

Changes in pulmonary dynamics have been observed among chromium electroplating workers (Bovett et al., 1977). The major effects of chromium on respiratory passages consist of ulceration of the nasal septum with subsequent perforation, and chronic rhinitis and pharyngitis. Forty-three to 85 % of chromate plant workers exposed to concentrations of hexavalent chromium of 1 mg/m^3 were observed to have nasal septal perforations. Level of 68 ug/m^3 Cr (VI) was found to cause irritation to the eyes and throats of workers in a chromate producing plant. Other symptoms of acute exposures to dust or mist include: coughing and wheezing, headache, eyspnea, fever, and weight loss. Tracheobronchial irritation and edema persist after other symptoms subside (Sittig, 1985). The present TLV-TWA for chromium metal is 0.5 mg/m^3.

The effects of chromium compounds on the skin have been recognized for over a century. The two major effects are the ulcerative changes of the skin developing from contact with various compounds of Cr (VI) and the development of allergic contact dematitis.

Chromium is an essential element for sugar and fat metabolism. The effects of exposure to low levels may be beneficial in deficiency states. The amounts necessary to cause toxic effects are much higher than those to correct deficiencies. The LD_{50} for Cr (III) intravenously is 10 mg/kg body weight exceeds by at least 4 orders of magnitude the dose needed to relieve impairment of glucose tolerance in chromium-deficient rats (EPA, 1978).

Chronic Effect

Dogs exposed to chromium (in the form of K_2CrO_4) for four years at a level of 0.45 mg/l in drinking water increased the chromium concentrations in the liver and spleen. However, no significant pathological changes occurred with such exposure in man. A concentration of 0.45 mg Cr/l did not lead to any overt effects in four cases of prolonged human exposure (Anwar et al., 1961).

Mutagenicity

Soluble chromates of sodium, potassium and calcium stimulated mutagenesis in *E. coli* (Venitt and Levy, 1974).

Recently, it had been demonstrated that compounds of chromium possess the ability to cause clastogenesis and mutations. Both Cr III (as $CrCl_3$) and Cr (VI) (as $K_2Cr_2O_7$) produced morphologic changes in tertiary cultures of mouse fetal cells (Rafetto et al., 1977). Interestingly, hexavalent chromium caused more extensive chromosomal aberrations than did trivalent chromium. The transformation frequency of similar adenovirus in Syrian hamster cells was elevated by calcium chromate.

There is little doubt that chromates can cause mutations and cell transformations. However, in the presence of liver enzymes or gastric juice (but not lung enzymes) chromates lose their mutagenic activity.

Teratogenicity

Sufficient data does not exist to make an evaluation of teratogencity.

Carcinogenicity

Rats injected intramuscularly once weekly for 20 weeks with calcium chromate (total dose 19 mg) developed a significant number of invasive spindle cell and pleomorphic cells at the injection site, none of which metastisized. The mean time of tumor appearance was 323 days. No tumors developed in control groups (Roe and Carter, 1969).

Mice receiving 5 ppm chromic acetate in drinking water for life did not show more tumors than control mice. Rats receiving a 5 ppm level of chromic acetate given in drinking water until death did not significantly increase the incidence of tumors.

The only well documented evidence of cancers associated with chromium exposure in humans involves the lungs. Industrial exposure vastly exceeds that attributed to food, water and air under normal conditions. Chromate workers who were followed over a period of 24 years had an excess lung cancer rate of 8.5. Excess incidence of all other cancers was only 1.3 (Taylor, 1966).

HEALTH EFFECTS OF IRON AND MANGANESE

Manganese

The principal toxic effects associated with manganese have been reported from occupational exposure to dusts and fumes. The effects, neurological in nature resembling Parkinonism, have not been reported from oral ingestion in man or animal (von Oittinggen, 1935). To protect human health, EPA has established threshold limit values for the occupational setting of 5 mg/m^3 for dusts and 1 mg/m^3 for manganese fumes.

The main reason for limiting manganese concentrations in drinking water is to prevent aesthetic and economic damage. Manganese produces a brownish color in laundered goods and imparts an objectionable taste in water. Domestic complaints generally arise when manganese levels exceed 150 ug/l, well above the EPA Secondary Drinking Water Maximum Contaminant Level of 50 ug/l (U.S. EPA, 1979). Manganese is present as a trace element in foods with human intake estimated to be approximately 10 mg/day (Sollman, 1957).

Iron

Like manganese, the principal toxic effects associated with iron stem from occupational exposure to iron dusts and fumes (Sax, 1979). To protect human health, TLV's of 5 mg/m^3 for iron oxide fumes and 1 mg/m^3 for iron salts, have been established.

Iron is similar to manganese in imparting objectionable tastes and causing discoloring of laundry and plumbing fixtures. The taste threshold for iron is above the level which produces staining (50 ug/l) (EPA, 1979) The EPA-established Secondary Drinking Water Maximum Contaminant Level of 300 ug/l was set to minimize objectionable effects and has no toxicological significance. Diets typically contain 7 to 36 mg/day of iron with an average of 16 mg/day (Sollman, 1957).

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APPENDIX M

IT CORPORATION REPORT

EXISTING GAS COLLECTION SYSTEM

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IT CORPORATION

December 14, 1984

Project No. 848028

Mr. John Gilbert
Environmental Engineer
U.S. Environmental Protection Agency
26 West Street, Clair Street
Cincinnati, OH 45268

Draft Letter Report
Lees Lane Landfill - Gas Collection and Control System Evaluation
Louisville, Kentucky

Dear Mr. Gilbert:

IT Corporation (IT) has completed the engineering evaluation of the Lees Lane Landfill Gas Collection and Control System. This letter report contains a description of the work performed and the results of the surficial engineering investigation and laboratory analyses of the air samples obtained at the site.

It should be noted that our investigation, as well as our interpretation of the results, was made based on a surficial examination, only, of the gas collection and control system.

Field Investigation

The field investigation of the gas collection and control system was conducted on November 13, 14, and 15, 1984. The field investigation was directed toward an assessment of the overall physical condition of the system components and an evaluation of the overall system efficiency.

Our findings relative to the gas collection and control system are as follows:

- Gas Extraction Wells - A total of 31 extraction wells, spaced on 100-foot centers (≈3,000 feet) were found (Figure 1).

  Each extraction well has been placed at about a 45-degree angle, as a lateral, off the main header pipe. As shown in Figure 1, each extraction well consists of the following components:

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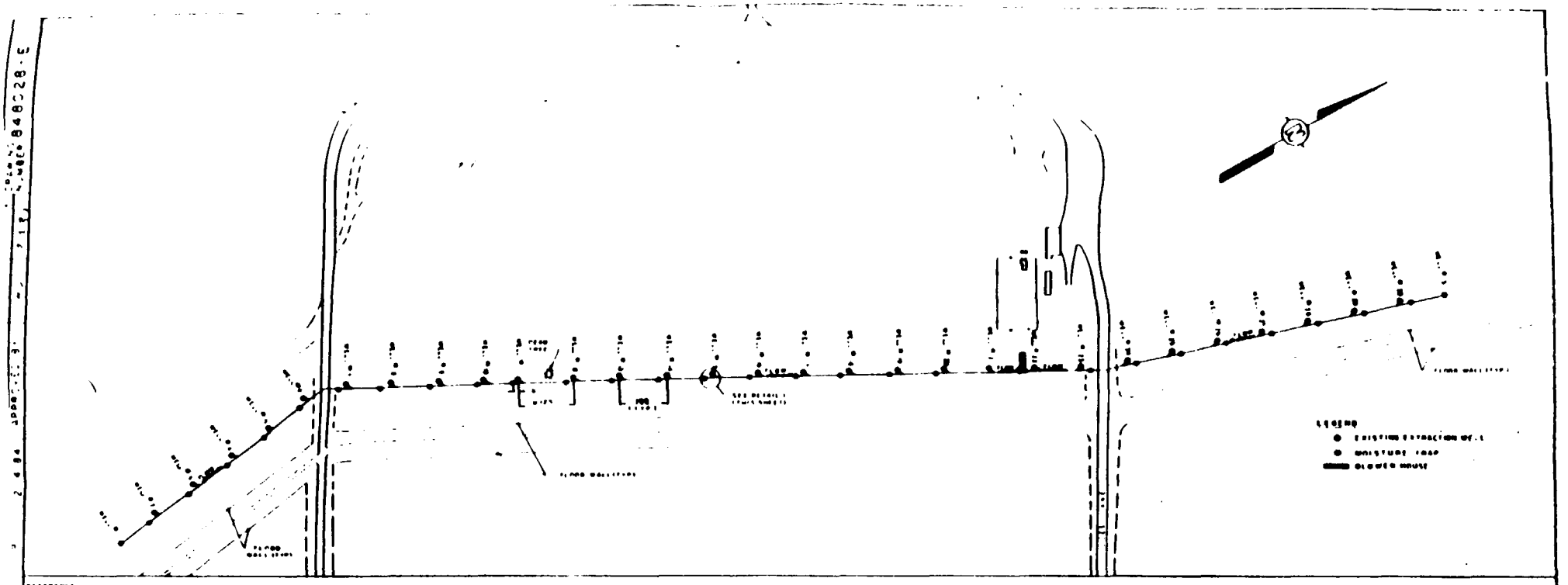
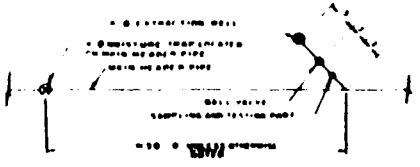


PLAN



DETAIL 1

FIGURE 1

LEES LANE LANDFILL
GAS COLLECTION AND
CONTROL SYSTEM

PREPARED FOR

U S ENVIRONMENTAL PROTECTION AGENCY
EMERGENCY RESPONSE BRANCH
CINCINNATI, OHIO

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- A four-inch gas extraction well with a stopcock valve (sampling port) located on the well pipe cap.

- A ball valve with operating nut used for adjusting the airflow in the well. Each ball valve assembly consists of a valve box and a polyvinyl chloride (PVC) pipe sleeve. The valve can be adjusted by turning the operating nut with a valve wrench.

- A one-inch PVC sampling and testing pipe about six inches long. This one-inch pipe is part of a two-inch PVC pipe which extends to the lateral pipe.

- A four-inch-diameter PVC moisture trap pipe. In the majority of cases, one moisture trap is located between every two extraction wells. This is true for Wells Nos. 1 through 20 and 23 through 31. No moisture trap was found between Wells Nos. 20 and 21 and there are two moisture traps between Wells Nos. 21 and 22 located just outside the blower house. Figure 1 shows the location of these traps. The moisture traps appear to be constructed on the main header pipe rather than as a lateral.

- Well System Conditions - The field inspection of the gas collection and control network indicates that, in general, the system is in poor and inoperative condition. The following additional general conditions were noted during the inspection:

  - Vegetation has overgrown many of the well system components making them difficult to locate.

  - Many of the system components were covered with dirt and had to be dug out to obtain access to the service box lids and well system components.

  - Many of the service box lids are missing and/or broken.

  - The ground has subsided around many of the wells, especially the extraction wells and moisture traps.

- Many of the concrete collars around the service boxes have sunk below ground, are listing severely, or have subsided two to three feet. This listing of the concrete collars made it very difficult and, in some cases, impossible to remove the extraction well and/or moisture trap caps for inspection and testing.

- Many of the PVC sleeves inside the valve boxes are filled with dirt and dead vegetation. This, in some cases, has made the valve operating nut inaccessible. Water is standing in some of the valve boxes.

- Some of the wells and moisture traps have been broken off below ground. Some of this damage appears to have been caused by subsidence and some by vandals. Vandals have also broken other parts of the extraction well system, including some of the sampling ports and stopcocks located in the extraction wells. Vandals have also indiscriminately shot holes in the blower house doors.

In addition to these general observations, a detailed examination of each well system was made. The findings of this inspection are discussed in Table 1.

- Main Header - The inspection indicated the main header appears to be blocked, plugged, or broken between Wells Nos. 13 and 14 and between Wells Nos. 26 and 27. This is evidenced by the suction (reduced air pressure over the pipe surface) that exists at the moisture traps located along the main header. For example, high suction exists at the moisture trap between Wells Nos. 13 and 14 even though the pipe is broken off below ground. There is no suction at Well 13 or the moisture trap between Wells Nos. 12 and 13.

  A similar situation exists at Well No. 26. The moisture trap between Wells Nos. 26 and 27 is pulling suction, however, there is no suction existing at Well 27 or the moisture trap between Wells Nos. 27 and 28.

- Blower System - As was previously mentioned, the blower building has been vandalized. The enclosed area houses the blower system components, including blower, blower motor, valves, piping, and ancillary equipment. The blower system components, overall, appear to be in good condition. The flexible sleeves on the intake lines have been taped to prevent or reduce leaks at these connections. The vent room, an uncovered area adjacent to the enclosed portion, houses the electrical and alarm system components and the exhaust stack.

- Well Testing - In addition to the inspection of the system, tests were conducted on a number of the functioning wells to determine pressure and air flow velocities at the extraction wells and at the moisture traps. This was done to confirm the well system design criteria. Knowing the internal diameter of the pipe, the airflow velocities were used to calculate the flow rates. Wells Nos. 13 through 28 were tested. See Table 2.

  It should be noted, the caps from many of the wells could not be removed for testing.

  To determine air flow velocities at the extraction wells and moisture traps, a Kurz air velocity meter was used. It should be noted that to obtain the most accurate readings, the air flow velocity probe should be placed in the pipe and perpendicular to the flow of air. Since the pipes were below ground surface, this was not possible and the probe had to be held at slight angles to the pipe to obtain a reading. It is felt, however, that this procedure of having to hold the probe at an angle did not significantly affect the accuracy of the readings.

  To determine the pressure at the extraction wells stopcock valve, a Dwyer manometer was used.

Data Analysis and Evaluation

The results and findings of our investigation and testing indicates the following:

- The July 30, 1979 (Revised August 6, 1979) Design Report prepared by SCS Engineers (SCS) and submitted to the Jefferson County Department of Public Works (County) described the gas collection and control system as consisting of a total of 21 extraction wells spaced on 150-foot centers. The SCS design drawings, on the other hand, show the system as it was found, which is 31 total extraction wells spaced on 100-foot centers.

- Because of lack of maintenance, subsided extraction wells, subsided moisture traps and vandalism, the gas collection and control system is in a rather poor and inoperative state. For example, Extraction Wells Nos. 1 through 13 and 27 through 31 are not operating. Extraction Wells Nos. 14 through 26 appear to be operating. Simply, based on this ratio of working to nonworking wells, it is estimated the system efficiency is less than 50 percent and possibly more like 42 percent efficient.

  In the interpretation of our findings, it appears the main header has undergone structural damage between Extraction Wells Nos. 13 and 14 before the moisture trap and also between Wells Nos. 26 and 27 but just after the moisture trap, since the moisture trap sounds like it is pulling suction.

  Based on the results of the testing as shown in Table 2, it appears the system design criteria including an air flow rate of 25 cubic feet per minute (cfm) and a well head design pressure of 2.5 inches of water have been met or exceeded. As shown in Table 2, the only air velocity reading, which when calculated, was below the 25 cfm design value was at the one-inch diameter sampling and testing pipe at Well No. 15. The value would be questionable since the test pipe was difficult to access with the air velocity probe.

All pressure readings are either equal to or exceed the extraction well design pressure.

A strong suction exists at the blower house. Readings taken from the two vacuum gauges located on the intake lines in the blower house were -34 inches water and -30 inches water for the two main north and main south header sections, respectively. The exhaust pressure was almost +3 inches water.

Gas Monitoring in Extraction Wells and Pumphouse

The extraction wells identified as inoperational through visual inspection and engineering design criteria were used for the gas monitoring program. The wells selected for the monitoring program covered the entire site and are identified in Table 3:

Extraction Well No. 3 - Southern Tract
Extraction Well No. 7 - Central Tract
Extraction Well No. 9 - Central Tract
Extraction Well No. 31 - Northern Tract
Pumphouse Building - Door

To evaluate the effect of the recovery system, the concentration of methane and organic vapors in extraction wells were determined under the following conditions:

- Gas recovery system operational (blower on)
- Gas recovery system off (blower off), overnight prior to the collection of any data.

Methane Monitoring

Methane concentrations in all selected extraction wells were determined using MSA Gasscope Model 62S, combination explosimeter, and methanemeter. The instrument was calibrated against methane and the concentrations read directly as a percent by volume. The methane readings in these wells was determined by inserting the probe two feet into each of the one-inch pipes (identified as the sampling port). The results are presented in Table 4.

High initial methane concentration of 46 to 48 percent was recorded in Extraction Well No. 3 located in the Southern Tract. Overnight shutoff of the blower system did not show any significant change in methane concentration of 38 percent. A strong sewer-like odor at the well head was persistent and unaffected by blower operation. Slight changes in

methane concentrations, 30 to 34 percent and 4 to 11 percent was observed in Extraction Wells Nos. 7 and 9 located in the Central Tract with the on and off blower conditions. Septic-like odors were also noticed in these wells and were also unaffected by the blower.

A progressive drop in methane concentration from Extraction Wells Nos. 3 to 9 possibly reflects the proximity of these wells to the pumphouse, although a broken valve box and main header between Extraction Wells Nos. 13 and 14 located in the Central Tract may be partially responsible for the comparatively lower methane concentrations observed in Extraction Wells Nos. 7 and 9.

No detectable concentrations of methane or sewer odor could be found at Extraction Well No. 31 located in the northern tract even with the blower running. Presence of water was noticed in the control valve pipe of this well and there may be a direct connection to the main header which may be creating a barrier to methane migration causing an undetectable methane concentration.

Organic Vapor Monitoring

As shown in Table 3, the extraction wells used for methane monitoring were also used for organic vapor monitoring. The exhaust system evaluation consisted of air quality monitoring downwind of the pumphouse. The monitoring program was similar to that outlined by the National Institute of Occupational Safety and Health (NIOSH) Pand CAM Method 127 and involved the collection of known volumes of air samples using a sampling pump and charcoal sorption tubes followed by gas liquid chromatographic analysis. In the present program, MSA C-210 and Gillian HFS-11 3 UT portable battery operated air sampling pumps were used. The sampled charcoal tubes were analyzed for six indicated compounds (Table 5) selected from SCS Engineering report (1979).[1]

Concentrations of volatile organics in the extraction wells and adjacent to the pumphouse and the effect of the blower system are shown in Tables 6 and 7. A limited number of indicator compounds in trace quantities could be identified in these samples (please see attached chromatograms in Appendix A). Many unidentified large peaks were present in these

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(1) Selected from "Data Summary Monitoring of Lees Lane Landfill," June to December 1978. Performed by SCS Engineers; Report Submitted to Jefferson County Department of Public Works, Louisville, Kentucky, 1979.

chromatograms; therefore, all the peaks exceeding a concentration of 1 ppm were computed against benzene and their concentrations reported.

Trace concentrations of dichloroethane, along with 11 unidentified large peaks for various organics totaling 47 ppm, were present in Extraction Well No. 3. A slight change in total organic vapor concentration of 25 ppm was noticed, following the shutdown of the blower. Similar observations were made for Extraction Well No. 7 located in the Central Tract. Extraction Wells Nos. 9 and 31 located in Central and Northern Tracts, respectively, showed only trace concentrations of organic volatile compounds and the data could not be used to evaluate these wells though it seemed these wells were unaffected by the blower operation. Insignificant amounts of organic vapor present adjacent to the pumphouse were not affected by the blower operation.

Dangerously high concentrations of methane and organic vapors are present in the wells located on the Southern Tract and southern portion of the Central Tract. The monitoring data from wells located in this area shows the organic vapor concentrations are not affected by the blower operation indicating a total failure of the extraction system in these regions. Due to the lack of monitoring data at Well No. 31 in the Northern Tract, operational efficiency could not be established; however, the engineering evaluation suggests the well to be inoperational.

Recommendations

The emphasis in these preliminary recommendations is on corrective actions and possible design alternatives and actions that may improve the condition, increase the efficiency of the existing system or possibly act as a solution in itself to the methane migration problem. These action items have been included where, in our opinion, their implementation would have substantial benefit. Based on the investigation and the evaluation of the data, the following preliminary recommendations are included for your consideration:

- There should be a definitive determination made as to the condition of the buried (main header) pipe. This is especially important in the area around Well No. 13 and Well No. 26. These two areas are the suspected locations along the main header that appear to have some structural damage to the header.

- Repair and/or replace broken piping components, subsided areas around pipes, tilting concrete collars, and service boxes.

- Replace missing and/or broken service box lids. Any replacement of service boxes and lids should include the type with locking lids.

- Clean the dirt out of service boxes and out of valve boxes so that valve operating nuts are accessible for adjustment of the air flow in the well.

- Repair and/or replace broken or missing stopcock valves.

- Post the property against trespassers, hunters, and/or shooters.

- After repair and/or replacement of the system, provide a security fence around the system.

- Occasionally monitor selected wells to determine the presence and/or concentrations of methane and organic vapors.

Once the condition of the buried header pipe and other system components are known, the costs associated with repair can be developed along with other alternatives.

- The alternatives can then be thoroughly evaluated to determine if there are feasible and practical alternatives that could be used alone or in conjunction with the existing gas collection and control system on the site. The possible other alternatives include the following additional methods of collecting and controlling gas movement such as:

  - Slurry Wall - This is a trench excavation filled with a bentonite/soil mixture. A slurry wall would provide an impermeable barrier to gas migration. This alternative discussion assumes the slurry wall would be constructed only in the areas along Wells Nos. 1 through 13 and 27 through 31, although it could be extended slightly further or even constructed along the entire route of the existing well network depending on the need and costs.

- Synthetic Membrane - This is similar to a slurry wall in that a synthetic liner provides a barrier to the migration of methane. Synthetic membranes can also be used at building structures to prevent the upward migrating gas into the buildings.

- Venting Wells - Venting wells are approximately two-feet diameter wells spaced on predetermined centers. The wells are filled with sand or gravel. This alternate assumes the wells would be placed along the same lines as the existing wells. This alternate could also be used in conjunction with a slurry wall.

- Ventilation Trench - A ventilation trench is a trench excavated into the fill material and filled with sand or gravel. This alternate can be used by itself or in conjunction with a slurry wall or synthetic liner barrier. A possible modification to the use of ventilation trench is to include a collection pipe(s) in the gravel trench and connect the pipe to the existing blower network or to a separate unit to actively remove methane.

- Ventilation Blanket - This is the construction of a sand or gravel blanket over a portion of the top of the fill to allow gas to escape at an area of higher permeability than the soils confining the waste material at the sides of the fill. This higher permeability blanket allows the gas to migrate upward and escape the fill at the surface rather than migrate horizontally through the soil.

We trust this report provides a sufficient data and information base which can be utilized in making decisions relative to the course of future work. If a question arises, please contact us at your convenience.

Very truly yours,

F. H. Beattie

Frederick H. Beattie
Senior Project Engineer

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FHB:VKS:scs

TABLES

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TABLE 1

EXISTING CONDITIONS
GAS COLLECTION AND CONTROL SYSTEM

- Well No. 1

  - Service box lids exist for 1, 2, and 4.

    1 Sampling and testing pipe is in good condition. No suction.

    2 Ball valve operating nut is accessible.

    3 Extraction well pipe and cap are in fair condition. The stopcock is broken off the pipe cap. Water is standing in service box.

    4 Moisture trap is in good condition. No suction.

- Well No. 2

  - Service box lids exist for 1, 2, 3, and 4.

    1 Sampling and testing pipe is in good condition. No suction.

    2 Water in service box. Ball valve operating nut is not accessible.

    3 Extraction well pipe, cap, and stopcock are in good condition. No suction at stopcock.

    4 Moisture trap is in good condition. Concrete collar tilted and sinking slightly and service box lid will not go on. There is a septic odor coming from pipe.

- Well No. 3

  - Service box lids exist for 1, 2, 3, and 4.

    1 Sampling and testing pipe is broken off in service box. No suction.

    2 Valve box is in good condition, but valve operating nut is not accessible.

    3 Extraction well has dirt in service box. Stopcock is in good condition. No suction at the stopcock.

TABLE 1
(Continued)

4 Moisture trap concrete collar is sinking and tilting slightly. No suction.

- Well No. 4

  - Service box lids exist for 1, 2, 3, and 4.

    1 Sampling and testing pipe is in good condition. No suction.

    2 Valve box tilted and cannot see valve operating nut.

    3 Extraction well has dirt and dead vegetation in service box. Stopcock is in good condition. No suction at the stopcock.

    4 Moisture trap concrete collar is sinking and tilting slightly and service box lid will not fit. No suction.

- Well No. 5

  - Service box lids exist for 1, 2, 3, and 4.

    1 Sampling and testing pipe is in good condition. No suction.

    2 Valve box is in good condition and valve operating nut is accessible.

    3 Extraction well pipe, cap, and stopcock are in good condition. No suction at the stopcock.

    4 Moisture trap concrete collar has sunk below ground and service box lid does not fit. No suction. There is a septic odor coming from the pipe.

- Well No. 6

  - Service box lids exist for 1, 2, 3, 4.

    1 Sampling and testing pipe is in good condition. No suction.

    2 Valve box has dirt in it and valve operating nut is not accessible.

    3 Extraction well pipe, cap, and stopcock are in good condition. No suction at the stopcock.

    4 Moisture trap is in good condition. No suction.

TABLE 1
(Continued)

- Well No. 7
  - Service box lids exist for 1, 2, and 3.
    1. Sampling and testing pipe is in good condition. No suction.
    2. Valve box has water standing in hole and operating nut is not accessible.
    3. Extraction well pipe, cap, and stopcock are in good condition. Water is standing in service box. No suction at the stopcock.
    4. Moisture trap pipe and cap are broken off. The concrete collar is tilted slightly, and the service box lid is broken. The hole is open and there is a septic odor coming from the hole. No suction.
- Well No. 8
  - Service box lids exist for 1, 2, 3, and 4.
    1. Sampling and testing pipe is in good condition. No suction.
    2. Valve box is in good condition and valve operating nut is accessible.
    3. Extraction well pipe is in good condition. The stopcock is broken off of the pipe cap. No suction at the stopcock.
    4. Moisture trap pipe is in good condition. Concrete collar around service box is sinking and tilting, and because of this, the service box lid does not fit properly.
- Well No. 9
  - Service box lids exist for 1, 2, 3, and 4.
    1. Sampling and testing pipe is in good condition. No suction.
    2. Valve box is in good condition and valve operating nut is accessible.

TABLE 1
(Continued)

3 Extraction well pipe, cap, and stopcock are in good condition. No suction at the stopcock.

4 Moisture trap pipe is in good condition. Concrete collar around service box is tilting slightly. No suction.

- Well No. 10

  - Service box lids exist for 1, 3, and 4.

    1 Sampling and testing pipe is in good condition. No suction.

    2 Valve box tilted and water is standing in the four-inch-diameter PVC sleeve pipe. Valve operating nut is not accessible.

    3 Extraction well pipe, cap, and stopcock are in good condition. Concrete collar around service box is sinking and tilting slightly. No suction at the stopcock.

    4 Moisture trap pipe is in good condition. Concrete collar is sinking and tilting and service box lid does not fit properly. No suction.

- Well No. 11

  - Service box lids exist for 1, 2, 3, and 4.

    1 Sampling and testing pipe is in good condition, but it is buried in the service box.

    2 Valve service box is tilted and there is dirt and dead vegetation in the pipe. The valve operating nut is not accessible.

    3 Extraction well has subsided about one foot. Stopcock and well cap is in good condition. No suction at the stopcock.

    4 Moisture trap pipe is in good condition. Concrete collar has sunk slightly. No suction.

TABLE 1
(Continued)

- Well No. 12

  - Service box lids exist for 1, 2, and 3.

    1 Sampling and testing pipe is broken off at the increaser collar.

    2 Valve box has dirt in hole and operating nut is not accessible.

    3 Extraction well pipe, cap, and stopcock are in good condition. No suction at the stopcock.

    4 Moisture trap pipe is broken off about 2'-6" below ground. The area around the pipe has subsided approximately 1'-6". No suction at pipe.

- Well No. 13

  - Service box lids exist for 1, 2, and 3.

    1 Sampling and testing pipe is in good condition. There is dirt in service box and the service box is sinking slightly. No suction.

    2 Valve box is in good condition and valve operating nut is accessible.

    3 Extraction well pipe, cap, and stopcock are in good condition. The well has subsided and there is no suction at the stopcock valve.

    4 Moisture trap pipe is broken off about three feet below ground. The hole is open and high suction exists at the pipe.

- Well No. 14

  - Service box lids exist for 2.

    1 Sampling and testing pipe is in good condition.

    2 Valve box appears to be in good condition, but operating nut is not accessible.

TABLE 1
(Continued)

3 Extraction well has sunk about two feet. The area around the well has subsided; however, the pipe and cap appear to be in good condition. The stopcock on the extraction well cap is broken off. There is suction at the stopcock.

4 Moisture trap pipe is in good condition. The concrete collar is tilted slightly.

- Well No. 15

  - There are no service box lids for this well system.

    1 Sampling and testing pipe is in good condition. High suction exists at this pipe.

    2 Valve box appears to be in good condition. There is dirt in valve box sleeve and the operating nut is not accessible.

    3 Extraction well pipe, cap, and stopcock are in good condition. There is suction at the stopcock.

    4 Moisture trap pipe and cap are in good condition. High suction exists at the pipe.

- Well No. 16

  - There are no service box lids for this well system.

    1 Sampling and testing pipe is in good condition. High suction.

    2 Valve box is in good condition; there is dirt in valve box sleeve and operating nut is not accessible.

    3 Extraction well pipe, cap, and stopcock are in good condition. There is suction at the stopcock.

    4 Moisture trap pipe has subsided about six inches.

- Well No. 17

  - There are no service box lids for this well system.

    1 Sampling and testing pipe is in good condition. High suction.

    2 Valve box in good condition and operating nut is accessible.

TABLE 1
(Continued)

3 Extraction well pipe, cap, and stopcock are in good condition. There is suction at the stopcock.

4 Moisture trap pipe in good condition. High suction exists at the pipe.

- Well No. 18

  - Service box lids exist for 1, 2, and 3.

    1 Sampling and testing pipe is in good condition. High suction.

    2 Valve box is in good condition, but operating nut is not accessible.

    3 Extraction well has subsided about one foot and the stopcock is broken off. High suction exists at the pipe.

    4 Moisture trap pipe and cap are in good condition. High suction exists at the pipe.

- Well No. 19

  - There are no service box lids for this well system.

    1 Sampling and testing pipe is in good condition.

    2 Valve box is in good condition. There is dirt in the valve box and valve operating nut is not accessible.

    3 Extraction well has subsided about two feet and the stopcock has been broken off. A determination could not be made as to whether there was any suction present at the well head.

    4 Moisture trap has sunk slightly. There is high suction at the pipe.

- Well No. 20

  - There are no service box lids for this well system. All are missing.

    1 Sampling and testing pipe has sunk into the larger diameter PVC collar. The cap could not be taken off for testing.

TABLE 1
(Continued)

2 Valve box has dirt and dead vegetation in it and valve operating nut is not accessible.

3 The extraction well pipe, cap, and stopcock are in good condition. The well has subsided about one foot.

4 No moisture trap was found between Wells No. 20 and 21.

- Well No. 21

  - A service box lid exists for 3.

    1 Sampling and testing pipe is in good condition.

    2 Valve box is in good condition and valve operating nut is accessible.

    3 Extraction well pipe, cap, and stopcock are in good condition. There is a suction at stopcock.

    4 Moisture trap is located just outside blower building. Could not get cap off to test the suction, but could hear it drawing air.

- Well No. 22

  - Service box lids exist for 1, 2, and 3.

    1 Due to a tilt in the service box the sampling and testing pipe is up against the side of the service box and the cap could not be taken off.

    2 Valve box is in good condition, but there is dirt and dead vegetation in the hole and the operating nut is not accessible.

    3 Extraction well pipe, cap, and stopcock are in good condition. There is a suction at the stopcock.

    4 Moisture trap pipe and cap are in good condition. There is high suction at the pipe.

TABLE 1
(Continued)

Well No. 23

- Service box lids exist for 1, 2, and 3.

  1 Sampling and testing pipe is in good condition. High suction.

  2 Valve box is in good condition and operating nut is accessible.

  3 Extraction well pipe, cap, and stopcock are in good condition. There is suction at the stopcock.

  4 Moisture trap pipe and cap are in good condition. High suction exists at the pipe.

- Well No. 24

  - Service box lids exist for 1, 2, and 3. They are laying in the subsided area of No. 2 and 3.

    1 Sampling and testing pipe is in good condition. The service box is filled with dirt. High suction exists at the pipe.

    2 Valve box and area around valve box has subsided.

    3 An area of about three feet diameter and three feet deep around extaction well has subsided. Extraction well pipe has sunk about two feet and there is a suction existing at the stopcock valve. When the stopcock valve is in the closed position, it leaks slightly.

    4 Moisture trap pipe is in good condition and high suction exists at the pipe.

- Well No. 25

  - Service box lids exist for 3 and 4.

    1 Sampling and testing pipe is in good condition. High suction exists at the pipe.

    2 Valve box is in good condition, but operating nut is not accessible. There is dirt and dead vegetation in the valve box sleeve pipe.

TABLE 1
(Continued)

Extraction well pipe and cap are in good condition. Stopcock is broken off, but there is a slight suction at the hole in the cap.

4 Moisture trap pipe is in good condition; however, the service box has tilted and the inside edge of the service box is up against the pipe cap and the cap cannot be taken off. In putting an ear to the top of the pipe, it sounds like it is pulling suction.

- Well No. 26

  - Service box lids exist for 1 and 3.

    1 Sampling and testing pipe is in good condition, but service box is full of dirt and the pipe was buried.

    2 Valve box is in good condition, but operating nut is not accessible.

    3 Extraction well pipe, cap, and stopcock are in good condition. The service box is sinking slightly. There is a suction at the stopcock.

    4 Moisture trap pipe and cap are in good condition; however, the concrete collar and service box have tilted enough so that the pipe cap cannot be removed. It sounds like it is pulling suction.

- Well No. 27

  - Service box lids exist for 1 and 2.

    1 Sampling and testing pipe is in good condition. There is no suction at the pipe.

    2 Valve box is in good condition and valve operating nut is accessible.

    3 Extraction well pipe and cap are in poor condition. The area around pipe and the pipe have subsided and stopcock is broken off. There is no suction at stopcock valve.

    4 Moisture trap pipe is broken off three feet below ground surface. There is no suction at the pipe.

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TABLE 1
(Continued)

- Well No. 28

  - Service box lids exist for 1, 2, and 4.

    1 Sampling and testing pipe is in good condition, but no suction exists at the pipe.

    2 Valve box is in good condition and operating nut is accessible.

    3 Extraction well pipe is in poor condition. The area around the pipe and the pipe have subsided slightly, the stopcock is broken and there is no suction at the hole in the cap.

    4 Moisture trap pipe is in good condition; however, area around pipe has subsided. There is no suction at the pipe.

- Well No. 29

  - Service box lids exist for 1 and 2.

    1 Sampling and testing pipe is in good condition. No suction.

    2 Valve box is in good condition. There is dirt and dead vegetation in the pipe sleeve and the operating nut is not accessible. Valve box pipe has sunk slightly.

    3 Extraction well pipe is in poor condition. The service box has sunk and is filled with dirt and the pipe will have to be dug out. There is no suction at the pipe.

    4 Moisture trap pipe is in good condition. The concrete collar has tilted and sunk slightly. No suction exists at the pipe.

- Well No. 30

  - Service box lids exist for 2 and 3.

    1 Sampling and testing pipe is in good condition. There is no suction at the pipe.

    2 Valve box is in good condition and operating nut is accessible.

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TABLE 1
(Continued)

3 Extraction well pipe, cap, and stopcock are in good condition. There is a slight positive pressure (possibly methane gas) existing at the stopcock.

4 Moisture trap is in poor condition. The pipe and service box have sunk and there is no cap on the pipe. There is no suction at the open pipe.

- Well No. 31

  - There are no service box lids for this well system. All are missing.

    1 Sampling and testing pipe has the cap missing. There is no suction at the pipe.

    2 Valve box is in good condition, but operating nut is not accessible.

    3 Extraction well concrete collar is tilting and sinking slightly and the stopcock valve is broken off the cap. There is no suction at the pipe.

Legend:

1 One-inch-diameter sampling and testing pipe.

2 Valve box and valve assembly.

3 Extraction well.

4 Moisture trap.

TABLE 2

RESULTS OF WELL SYSTEM TESTING

	AIR FLOW VELOCITY (fpm)	AIR FLOW RATE (cfm)	PRESSURE (inches water)
Well No. 13			
1	-	-	-
3	-	-	0
4	1,300	102.7	-
Well No. 14			
1	-	-	-20.5
3	-	-	-
4	-	-	-
Well No. 15			
1	2,100	12.6	-
3	-	-	-4.5
4	5,000	395	
Well No. 16			
1	-	-	-
3	-	-	-4.2
4	-	-	-
Well No. 17			
1	-	-	-
3	-	-	-3.4
4	6,500	513	-
Well No. 18			
1	-	-	-
3	-	-	-3.5
4	7,200	569	-
Well No. 19			
1	-	-	-
3	-	-	-
4	-	-	-
Well No. 20			
1	-	-	-
3	-	-	0
4	-	-	-

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TABLE 2
(Continued)

	AIR FLOW VELOCITY (fpm)	AIR FLOW RATE (cfm)	PRESSURE (inches water)
Well No. 21			
1	-	-	-
3	-	-	-3.5
4*	-	-	-
Well No. 22			
1	-	-	-
3	-	-	-3.5
4**	5,000	395	-
Well No. 23			
1	-	-	-
3	1,100	87	-3.2
4	5,500	435	-
Well No. 24			
1	-	-	-
3	1,200	95	>-23.0
4	5,000	395	-
Well No. 25			
1	-	-	-
3	-	-	-2.5
4	4,500	356	-
Well No. 26			
1	-	-	-
3	-	-	-12.2
4	-	-	-
Well No. 27			
1	-	-	-
3	-	-	0
4	-	-	-

TABLE 2
(Continued)

	AIR FLOW VELOCITY (fpm)	AIR FLOW RATE (cfm)	PRESSURE (inches water)
Well No. 28			
1	-	-	-
3	-	-	0
4	-	-	-

*Moisture trap located south of well, just outside of blower house.

**Moisture trap located north of well, just outside of blower house.

Legend:

1 One-inch-diameter sampling and testing pipe.

3 Extraction well - four-inch-diameter Schedule 80 pipe internal diameter 3.826 inches; A = 0.079 square feet.

4 Moisture trap - four-inch-diameter Schedule 80 pipe internal diameter 3.826 inches; A = 0.079 square feet.

TABLE 3

METHANE/ORGANIC VAPOR MONITORING LOCATIONS
LEES LANE LANDFILL

METHANE[1] AND ORGANIC VAPORS[2]		ORGANIC VAPORS	
SAMPLING POINT	LOCATION	SAMPLING POINT	LOCATION
Head, Extraction Well 3	Southern Tract	East door of the pumphouse building	South end of pumphouse (downwind)
Head, Extraction Well 7	Central Tract		
Head, Extraction Well 9	Central Tract		
Head, Extraction Well 31	Northern Tract		

(1) Methane reading determined using portable MSA Gasscope Model 62S.

(2) Air samples were collected using portable battery-operated sampling pumps and charcoal sorption tubes.

TABLE 4
METHANE CONCENTRATION IN EXTRACTION WELLS

EXTRACTION WELL NUMBER/LOCATION	METHANE CONCENTRATION[1] % BY VOLUME	
	BLOWER ON	BLOWER OFF
3, Southern Tract	46-48[2]	38[3]
7, Central Tract	30	34
9, Central Tract	4	10-12[2]
31, Northern Tract	ND	ND

(1) Determined at two feet depth in 1-inch pipe (sample port) using MSA Gasscope Model 62S, calibrated for methane.

(2) Duplicate readings.

(3) Determined during sampling operations.

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TABLE 5

INDICATOR VOLATILE ORGANIC COMPOUNDS SELECTED FOR EXTRACTION WELL MONITORING(1)

Benzene

Dichloroethane (both 1,1 and 1,2 isomers)

Ethyl benzene

Heptane

Toluene

Xylenes

Source: SCS Engineers, Inc. (1979).

TABLE 6

CONCENTRATION[1] OF INDICATOR VOLATILE ORGANICS IN EXTRACTION WELLS[2]

ANALYTICAL PARAMETER	BLOWER ON				BLOWER OFF			
	WELL NO. 3	WELL NO. 7	WELL NO. 9	WELL NO. 31	WELL NO. 3	WELL NO. 7	WELL NO. 9	WELL NO. 31
benzene	_[3]	0.75	0.038	0.019	-	0.18	0.044	0.053
Dichloroethane[4]	016	0.62	0.014	-	0.015	0.054	-	-
Ethylbenzene	-	-	-	0.44	-	-	-	-
Heptane	-	1.3	-	-	-	-	-	-
Toluene	-	-	-	-	-	-	-	-
Xylenes	-	-	-	-	-	-	-	-
Unknown Peaks	11	3	0	-	11	1	-	-
Concentration[5]	47	7.2	<1.0	<1.0	25	2.1	<1.0	<1.0

(1) Units ppm.

(2) Samples were collected on the wellhead after the caps were removed.

(3) "_" indicates none detected. Detection Limits: All compounds <0.001 ppm
Xylenes <0.01 ppm.

(4) 1,1 and 1,2 dichloroethanes computed together.

(5) Indicates number of unidentified peaks with concentrations >1 ppm computed against benzene.

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TABLE 7

CONCENTRATION(1) OF INDICTOR VOLATILE ORGANICS
IN THE VICINITY OF BLOWER HOUSE

ANALYTICAL PARAMETERS	BLOWER ON	BLOWER OFF
Benzene	_(2)	0.006
Dichloroethane(3)	-	-
Ethylbenzene	-	-
Heptane	-	-
Toluene	0.058	0.003
Xylenes	-	-
Unknown Peaks	<1.0	<1.0

(1)Units ppm

(2)"_" indicates none detected.

(3)1,1 and 1,2 dichloroethanes computed together.

Detection Limits: all compounds <0.001 ppm
xylenes <0.01 ppm.

LEE 001

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APPENDIX N

SCS ENGINEERS

DESIGN OF EXISTING GAS COLLECTION SYSTEM

LEE 001

001399

LEES LANE LANDFILL
METHANE GAS CONTROL SYSTEM

DESIGN REPORT

Submitted to:

Jefferson County Department of Public Works
401 Fiscal Court Building
Louisville, Kentucky 40202
Attention: Mr. Edward Robinson, P.E.

Submitted by:

SCS Engineers
211 Grandview Drive
Covington, Kentucky 41017
(606) 341-5353

July 30, 1979

DESIGN CRITERIA

Based on the above data and evaluations, and in conjunction with previous projects performed by SCS Engineers, the following design criteria were established:

1. Well depth = 5 ft below the bottom of the refuse.

2. Well boring diameter = 24 in.

3. Well pipe diameter = 4 in.

4. Well spacing = 150 ft.

5. Flow rate = 25 cfm per well.

6. Pressure = -2.5 in. of water at each well head.

Well depths should be 5 ft below the bottom of the refuse. Drilling through the landfill floor and into dry sand will allow water in the refuse around the bore hole to drain. Otherwise, water might collect in the well, reducing the well's efficiency by that fraction of perforated pipe immersed in water. Well boring diameters are usually 24, 30, or 36 in. The larger the surface area of the boring well, the greater the efficiency of the extraction well. Twenty-four in. should be sufficient and will probably be more readily available and less costly than larger diameters. A similar relationship exists between well pipe diameters and extraction well efficiency. In addition, 4 in. diameter pipe is less likely to have its perforations clogged with refuse or soil since the perforated area is greater than for a 2 in. diameter pipe.

The well spacing of 150 ft was dictated by a radius of influence set at 75 ft. This figure and the flow rate per well (set at 25 cfm) were determined as a result of the pumping test data in Table 7. As shown in that table, a flow of 25 cfm was sufficient to generate a negative pressure of -0.10 at Probe IV-1A. Generally, any type of detectable negative pressure is sufficient to indicate a radius of influence. Thus, the 25 cfm rate generated a radius of influence of 100 ft. Increasing this flow rate to increase the

well spacing would have diminishing returns. Thus, the design flow was held at 25 cfm per well; the radius of influence was set at 75 ft to allow some factor of safety. Pressure at the well head was set at -2.5 in. of water. This represents a safety factor of 2.0 over the -1.25 in. of water demonstrated by the 25 cfm flow in Table 7.

SYSTEM DESCRIPTION

The Lees Lane Landfill Gas Control System is outlined in Figure 5. Complete facility design is outlined in the plans and specifications submitted under separate cover. Notable components of this system are described as follows:

1. Extraction Wells. A total of 21 wells spaced 150 ft on center will be installed along a 3300 ft line parallel to, and 75 ft inside the landfill property boundary. Each well is to be a 24 in. diameter hole drilled to a depth 5 ft below the bottom of the refuse. (Thus, total hole depth will average 25 to 35 ft.) The bottom 5 ft of each hole will be backfilled with gravel and a 4 in. diameter PVC pipe (slotted on the bottom 15 ft) inserted atop the gravel. The annular space around these perforations will be backfilled with gravel: the balance of this space backfilled with alternate plugs of bentonite, soil, sand, concrete, or refuse. Each well will be of slip-joint construction to allow settlement. The top of the well will contain a sample port and clean-out and be covered by a valve box placed flush with the ground. Laterals to connective headers will include a ball valve and port for sample collection and pressure and velocity measurement.

2. Connective Headers. The header line will be approximately 3300 ft long and of 4 in. diameter PVC pipe. Headers will be completely under ground and covered by at least 3 ft of cover. Header pipes will be sloped at least 4 percent in the direction of gas movement to promote condensate flow toward moisture traps. Header pipes will be snaked or zig-zagged in header trenches to allow for settlement and thermal expansion/contraction. Snaking shall not exceed manufacturer's allowances.

3. Moisture Traps. Moisture traps will be placed on the header line between every two extraction well laterals. These will be placed in a 24 in. diameter bored hole to a depth of approximately 9 ft below the header pipe. They will be fashioned predominantly of 2 and 6 in. PVC pipe. The annular space around each moisture trap apparatus will

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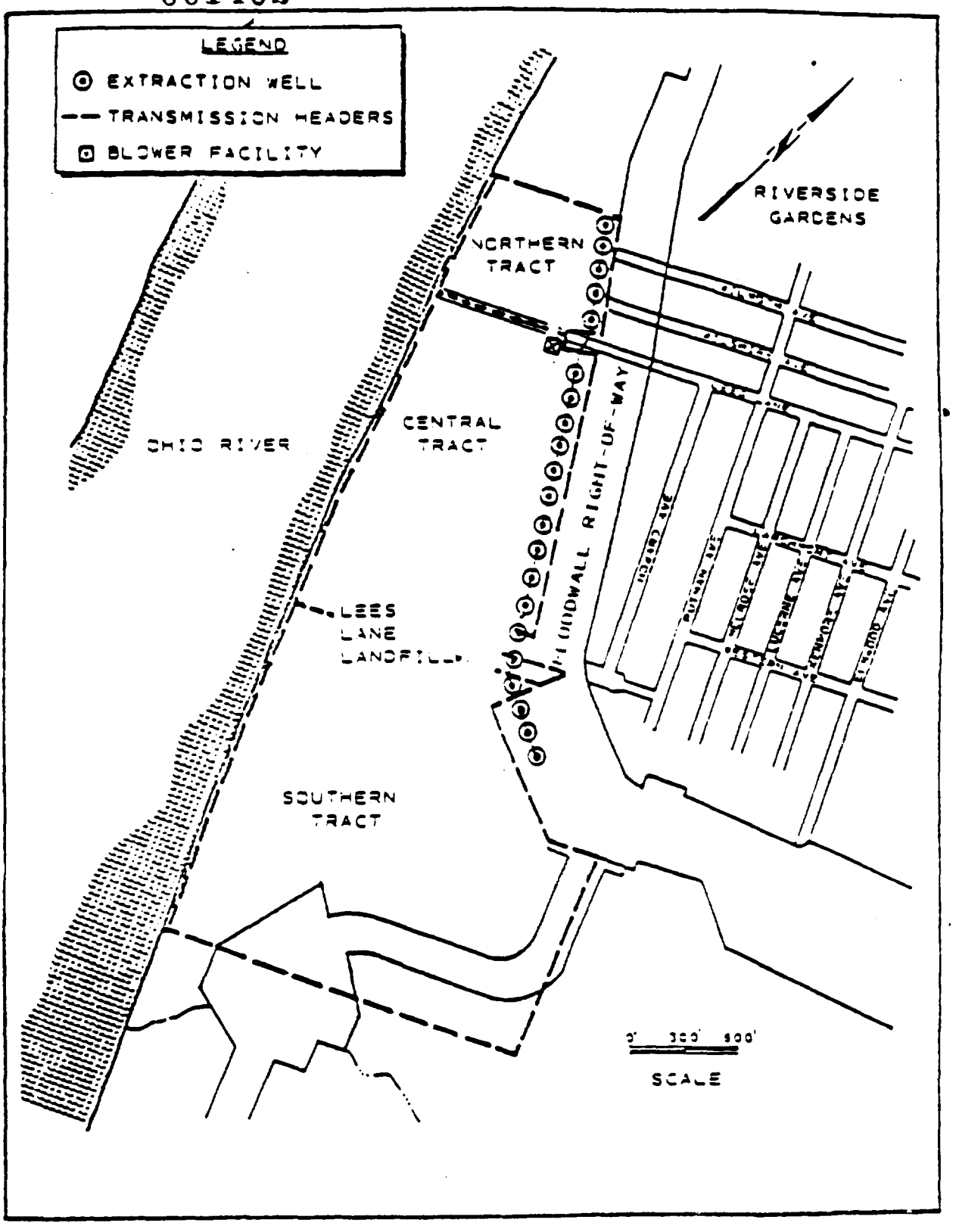

Figure 5.

Landfill Gas Control System Location

be backfilled with gravel and topped with a clay plug. Access to each moisture trap will be provided via a cleanout placed under a valve cover flush with the ground surface.

4. Blower House. The blower housing will be a 14 by 30 ft masonry block structure built on a slab. Approximately 2/3 of this facility will be covered with a wood truss roof. This enclosed area will be completely secure and will house the blower, flare arrestors, and many other appurtenances. The uncovered area will also be secured, but separate from the enclosed area. It will house the gas burner.

5. Blower and Motor. Blower will be a Paxton Model CB-95 manufactured by Paxton Products, Inc., Santa Monica, California. This model is rated at 4.5 psig or 6.75 in. of Hg for the design flow of 550 cfm. The blower shaft does not require outside fluids or air sealing systems. A filter will be installed at the intake to the blower to prevent intrusion of solids and blower damage. The blower motor will be rated at 10 HP, 3-phase, 60 Hz, and 3500 RPM. Only one blower and motor will be installed and it will be sufficient for normal operations as well as increased flow up to 150 percent of design. A back-up blower and motor will be on hand at all times and should be ordered and delivered at the same time as the operating blower/motor. The back-up blower/motor should not be stored on-site as it would be vulnerable to vandalism, theft, or other damage. It should be stored in the Louisville area at a facility of the County Department of Public Works. Delivery times on these Paxton models are reported by the manufacturer to be currently 6 to 8 weeks.

6. Other Blower House Appurtenances. Other notable blower house appurtenances include flame arrestors, a drip trap, and an explosion relief valve. Two flame arrestors will be installed, one on the intake and one at the exhaust end of the blower. Flame arrestors will be 6 in. nominal size Varec Figure No. 53-81. Automatic drip traps will be Varec Figure No. 245. Explosion relief valves will be Varec Figure 700g-81, 6 in. nominal size at 12 in. water column. All Varec products are manufactured by the Varec Division of Emerson Electric Co. The manufacturer reports that delivery times on these three products are 8 to 12 weeks for flame arrestors, 3 to 4 weeks for automatic drip traps, and 6 to 8 weeks for explosion relief valves.

7. Gas Burners. A single 8 in. waste gas burner will be used for combustion of the exhausted gas. This burner will have an automatic pilot ignition and weather proof cover. The burner is a Varec Figure No. 239a. The automatic pilot is a Varec Figure No. 241. In order for the gas to burn, the methane content in the exhaust must equal or exceed the lower explosive limit (5%). Pumping tests conducted in May 1979 were able to maintain methane at over 30 percent even at flows up to 150 cfm per well (versus the 25 cfm rate planned for this project). Thus, flame in the burner should be maintained. If it is extinguished, the automatic pilot device (sustained by an external propane source) will reignite the exhuast if it contains at least 5% methane. According to the manufacturer, delivery times on waste gas burners are currently 8 to 10 weeks.

   Conversations have been held with personnel from the Air Pollution Control Division. It was decided that this burner would probably be sufficient to mitigate any hazards posed by exotic gases such as vinyl chloride. Additional testing to verify this fact may be needed after system start-up.

8. Alarm System. An audible alarm bell will be installed at the blower house and set to sound whenever the differential pressure across the blower drops to or below 10 in. of water. This detector system, then, will sound for a number of system failures including: (1) electrical outage, (2) blower/motor failure, or (3) pipe rupture. A sign should be mounted on the blower house wall indicating who to contact when it sounds. From previous experience in the design of such systems, these controls should be sufficient. It is over 300 ft from the landfill to the nearest residences and will take several days for gas to move back into Riverside Gardens at explosive concentrations.

LEE 001

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APPENDIX O

FIGURES FOR SIZING RIPRAP

LEE 001

001406

Use of Riprap for Bank Protection

Hydraulic Engineering Circular No. 11 June 1967

Prepared by the Hydraulics Branch, Bridge Division, Office of Engineering and Operations, Bureau of Public Roads, Washington, D.C. 20591

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001407

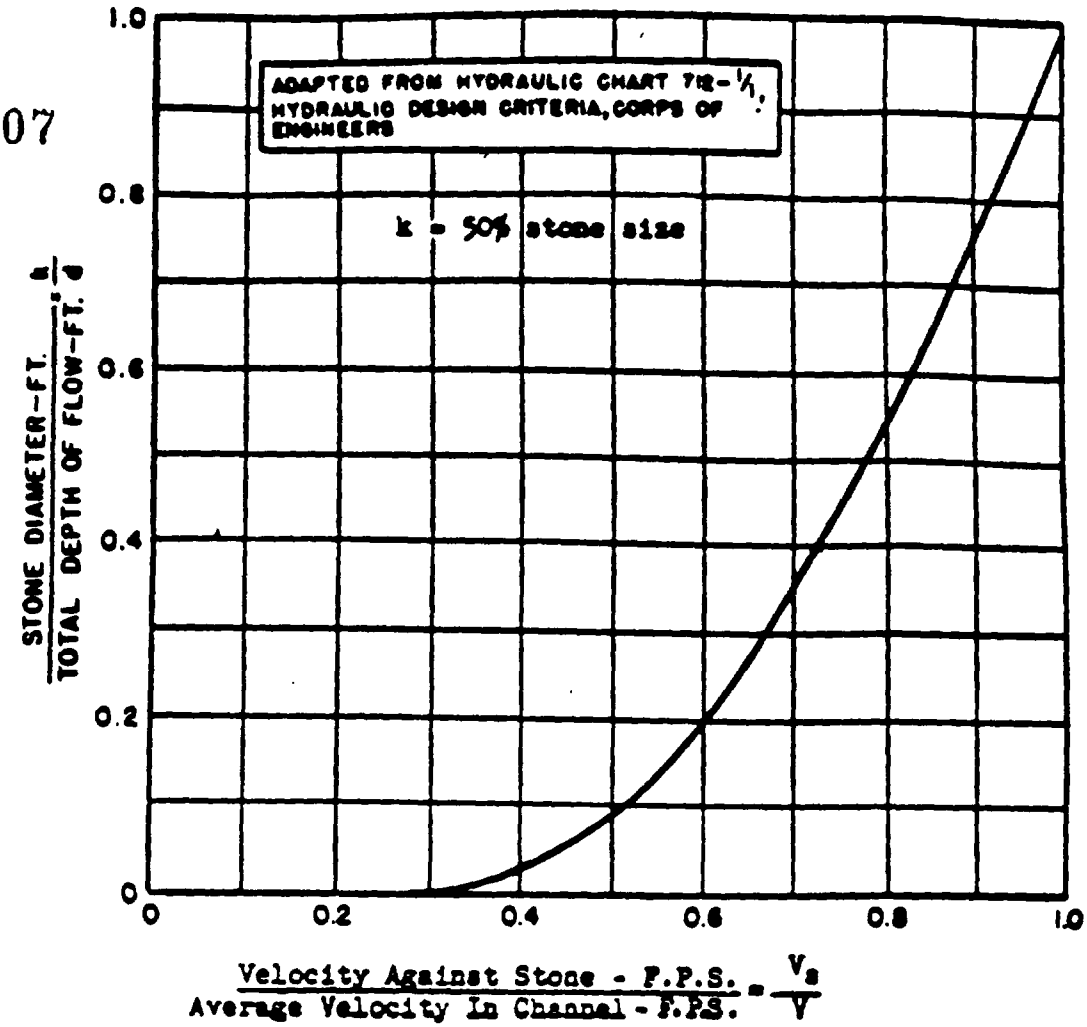

FIG. 1 - VELOCITY AGAINST STONE ON CHANNEL BOTTOM

The size of stone required to resist displacement from direct impingement of the current as might occur with a sharp change in stream alinement is greater than the value obtained from figure 2, although research data is lacking on just how much larger the stone should be. The California Division of Highways (6) recommends doubling the velocity against the stone as determined for straight alinement before entering figure 2 for stone size. Lane (9) recommends reducing the allowable velocity by 22 percent for very sinuous channels; for determining stone size by figure 2, the velocity (V_s) would be increased by 22 percent. Until data are available for determining the stone size at the point of impingement, a factor which would vary from 1 to 2 depending upon the severity of the attack by the current, should be applied to the velocity V_s before entering figure 2.

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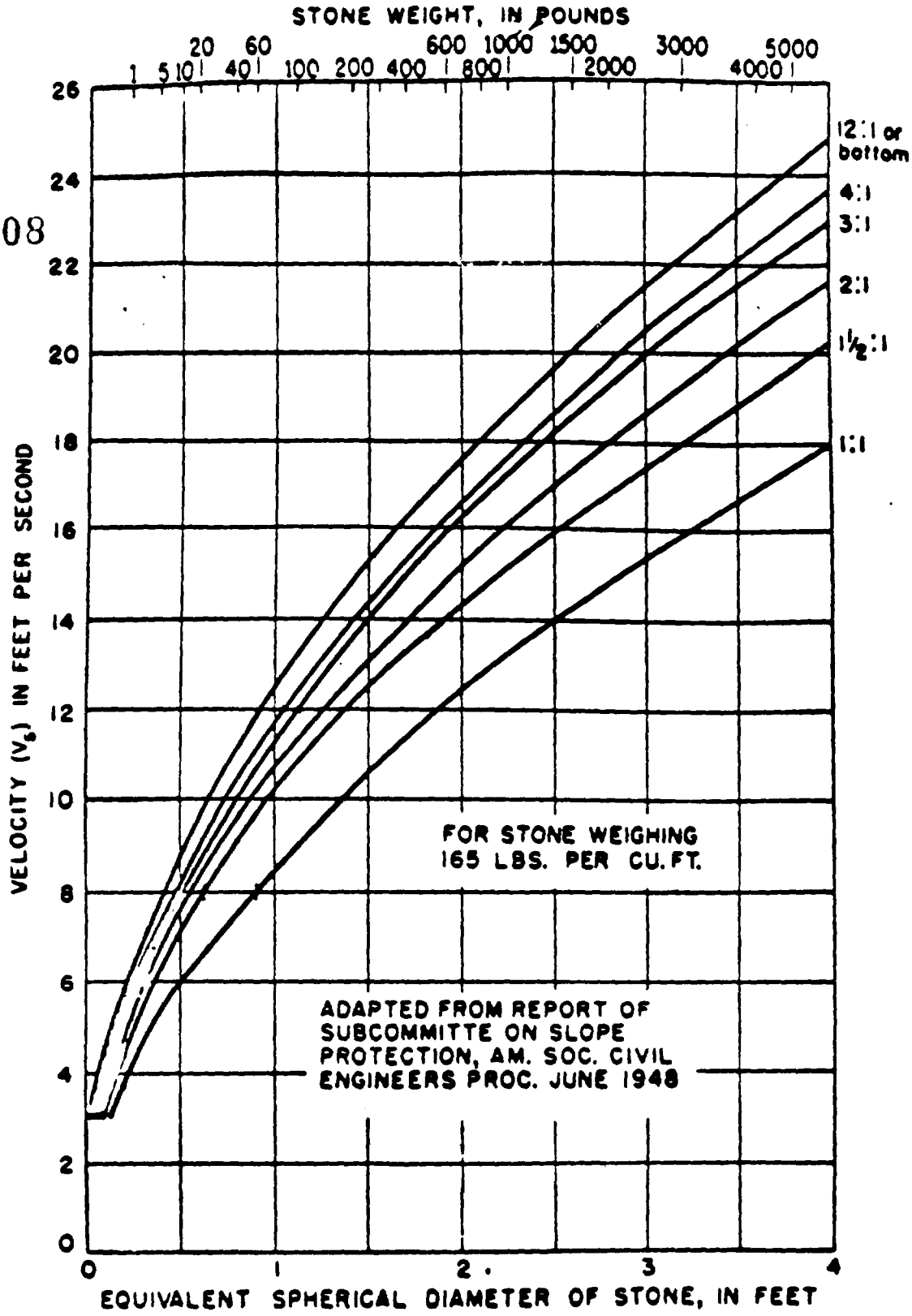

FIG. 2-SIZE OF STONE THAT WILL RESIST DISPLACEMENT FOR VARIOUS VELOCITIES AND SIDE SLOPES

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APPENDIX P

COST BACKGROUND AND ANALYSIS

COST BACKGROUND AND ANALYSIS

In the following costing analysis, labor, material and equipment subtotals were computed from prices and work crews recommended in the 1985 Means Site Work Cost Data and 1985 Building Construction Cost Data manuals.

Total direct costs are determined by adding the subtotals, burden, labor and materials. Burden (13% of labor subtotal) includes FICA, workmen's compensation, unemployment insurance and builder's risk insurance. Labor (15% of labor subtotal) includes administrative and overhead, and handling. Materials (10% of material subtotal) includes mark-up on goods used.

The total direct costs are then used to compute indirect costs, profit and the construction condition. The sum of these components equals the total field costs. The indirect costs (75% of total direct labor costs) include supervision, travel, utilities, communication, medical, supplies, data processing, bond premium insurance, guard service, temporary office and storage, clerk, timekeeper, testing and analysis, maintenance and clean-up. Profit is computed as 10% of the total direct costs. Construction condition is based on the level of respiratory protection used at the site. Since Level D is anticipated, the cost is figured as 15% of the sum of total direct labor and total direct equipment costs.

The total field costs are used to compute health and safety, engineering and contingency costs. Health and safety costs are determined by the total field costs and range from 10% of total field costs, if the costs are $500,000 or less, to 4% of total field costs if the costs are greater than $10,000,000. The engineering costs, ranging from 3 to 20% of total field costs, are based on best engineering judgment. The contingency costs are 20% of the total field costs. The total project costs are determined by adding the health and safety costs, engineering costs and contingency costs to the total field costs.

NO ACTION MONITORING
CAPITAL COSTS

DESCRIPTION:	QUANTITY CU. YDS.	P	MATERIAL $	LABOR $	EQUIPMENT $	TOTAL $
GAS MONITORING						
CONSTRUCTION (5 WELLS)						
MOBILIZATION				5,000		5,000
SUPERVISION				2,000		2,000
CONSTRUCT			433	2,975		3,408
AIR MONITORING						
WEATHER STATION					7,000	7,000
AIR SAMPLERS					7,200	7,200
CALIBRATION EQUIP.					2,500	2,500
PROGRAM DESIGN				2,000		2,000
DATA REDUCTION				1,600		1,600
SHORT TERM MODEL				800		800
LONG TERM MODEL				4,000		4,000
COMPUTER COSTS					1,000	1,000
TRAVEL AND LIVING				1,000		1,000
SUBTOTAL			433	19,375	17,700	37,508
INS. BURDEN AT 14%				2,519		2,519
ADM. BURDEN AT 15%				2,906		2,906
MATERIALS BURDEN 10%			43			43
TOTAL DIRECT COSTS			476	24,800	17,700	42,976
INDIRECT COST AT 75%						18,600
PROFIT AT 10%						4,298
CONSTRUCTION AT 15%						6,375
TOTAL FIELD COSTS						72,249
HEALTH AND SAFETY 10%						7,225
ENGINEERING AT 15%						10,837
CONTINGENCY AT 20%						14,450
TOTAL ACTIVITY COSTS						104,761

NO ACTION MONITORING
OPERATION AND MAINTENANCE COSTS

DESCRIPTION	QUANTITY	W ($)	AMOUNT	TIMES	TOTAL ($)
GROUNDWATER:					
LABOR:	30	20	2	4	4,800
TRAVEL AND LIVING	4	25	2	4	2,400
GAS					
LABOR:	30	20	2	4	4,800
TRAVEL AND LIVING	4	25	2	4	2,400
AIR					
WEATHER FORCASTING	3	20		3	480
PREPARATION	8	20		3	480
TESTING	96	20		3	5,760
DOCUMENTATION	8	20		3	480
RO CALIBRATION DATA	24	20		3	1,440
CALCULATIONS	60	20		3	3,600
SAMPLING TUBES	12	45		3	1,620
COMPUTER					3,000
ANALYSES					
GROUNDWATER	6	1,200		4	28,800
GAS	10	250		4	10,000
AIR	12	250		3	9,000
SUBTOTAL					79,060
CONTINGENCY AT 20%					15,812
TOTAL					94,872
PRESENT WORTH AT 10% AND 3 YEARS					235,000

NO ACTION MONITORING
OPERATIONS AND MAINTENANCE

DESCRIPTION:	TOTAL ($)	SENSITIVITY 110% TOTAL ($)	10% TOTAL ($)
GROUNDWATER			
LABOR	4,800	5,280	4,320
TRAVEL AND LIVING	2,400	2,640	2,160
GAS			
LABOR	4,800	5,280	4,320
TRAVEL AND LIVING	2,400	2,640	2,160
AIR			
WEATHER FORCASTING	480	528	432
PREPARATION	480	528	432
TESTING	5,760	6,336	5,184
DOCUMENTATION	480	528	432
QA CALIBRATION DATA	1,440	1,584	1,296
CALCULATIONS	5,600	6,160	5,040
SAMPLING TOOLS	1,620	1,782	1,458
COMPUTER	3,000	3,300	2,700
ANALYSES			
GROUNDWATER	28,800	31,680	25,920
GAS	10,000	11,000	9,000
AIR	9,000	9,900	8,100
SUBTOTAL	79,060	86,966	71,154
CONTINGENCY AT 20%	15,812	17,393	14,231
TOTAL	94,872	104,359	85,385

001413

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NO ACTION MONITORING
CAPITAL COSTS SENSITIVITY 110%

DESCRIPTION	QUANTITY CU. YDS.	@	MATERIAL $	LABOR $	EQUIPMENT $	TOTAL $
GAS MONITORING						
CONSTRUCTION (5 WELLS)						
MOBILIZATION				5,500		5,500
SUPERVISION				2,200		2,200
CONSTRUCT	476			3,273		3,749
AIR MONITORING						
WEATHER STATION					7,700	7,700
AIR SAMPLERS					7,920	7,920
CALIBRATION EQUIP.					2,750	2,750
PROGRAM DESIGN				2,200		2,200
DATA REDUCTION				1,760		1,760
SHORT TERM MODEL				880		880
LONG TERM MODEL				4,400		4,400
COMPUTER COSTS					1,100	1,100
TRAVEL AND LIVING				1,100		1,100
SUBTOTAL	476			21,313	19,470	41,259
INS. BURDEN AT 13%				2,771		2,771
ADM. BURDEN AT 15%				3,197		3,197
MATERIALS BURDEN 10%	48					48
TOTAL DIRECT COSTS	524			27,281	19,470	47,274
INDIRECT COST AT 75%						20,460
PROFIT AT 10%						4,727
CONSTRUCTION AT 15%						7,013
TOTAL FIELD COSTS						79,475
HEALTH AND SAFETY 10%						7,947
ENGINEERING AT 15%						11,921
CONTINGENCY AT 20%						15,895
TOTAL ACTIVITY COSTS						115,238

NO ACTION MONITORING
CAPITAL COSTS SENSITIVITY 10%

DESCRIPTION	QUANTITY CU. YDS.	#	MATERIAL $	LABOR $	EQUIPMENT $	TOTAL $
GAS MONITORING						
CONSTRUCTION (5 WELLS)						
MOBILIZATION				4,500		4,500
SUPERVISION				1,800		1,800
CONSTRUCT			390	2,678		3,068
AIR MONITORING						
WEATHER STATION					6,300	6,300
AIR SAMPLERS					6,400	6,400
CALIBRATION EQUIP.					2,250	2,250
PROGRAM DESIGN				1,800		1,800
DATA REDUCTION				1,440		1,440
SHORT TERM MODEL				720		720
LONG TERM MODEL				3,600		3,600
COMPUTER COSTS					900	900
TRAVEL AND LIVING				900		900
SUBTOTAL			390	17,438	15,930	33,758
INS. BURDEN AT 13%				2,267		2,267
ADM. BURDEN AT 15%				2,616		2,616
MATERIALS BURDEN 10%			39			39
TOTAL DIRECT COSTS			429	22,321	15,930	38,680
INDIRECT COST AT 25%						16,740
PROFIT AT 10%						3,868
CONSTRUCTION AT 15%						5,738
TOTAL FIELD COSTS						65,026
HEALTH AND SAFETY 10%						6,503
ENGINEERING AT 15%						9,754
CONTINGENCY AT 20%						13,005
TOTAL ACTIVITY COSTS						94,287

ALTERNATE WATER SUPPLY

DESCRIPTION:	QUANTITY	#	MATERIAL $	LABOR $	EQUIPMENT $	TOTAL $
APPLICATION	10	15				150
METER CONNECTION	10		450			4,500
HOOK UP FROM HOUSE	10			200		2,000
INSTALL WATER MAIN	300'		25			7,500
SUBTOTAL			475	200	0	14,150
INS. BURDEN AT 13%				26		26
ADM. BURDEN AT 15%				30		30
MATERIALS BURDEN 10%			48			48
TOTAL DIRECT COSTS			523	256	0	14,254
INDIRECT COST AT 25%						192
PROFIT AT 10%						1,4[illegible]
CONSTRUCTION AT 1%						33
TOTAL FIELD COSTS						15,909
HEALTH AND SAFETY 10%						1,591
ENGINEERING AT 15%						2,386
CONTINGENCY AT 20%						3,182
TOTAL ACTIVITY COSTS						23,068

GAS COLLECTION SYSTEM
CAPITAL COSTS

ASSUME BLOWER HOUSE IN
WORKING CONDITION
(SEE APPENDIX B)

DESCRIPTION:	QUANTITY	@	MATERIAL $	LABOR $	EQUIPMENT $	TOTAL $
TOTAL INSPECTION	1			3,000		3,000
GAS BURNER	1				8,000	8,000
SUBTOTAL			0	3,000	8,000	11,000
INS. BURDEN AT 13%				390		390
ADM. BURDEN AT 15%				450		450
MATERIALS BURDEN 10%			0			0
TOTAL DIRECT COSTS			0	3,840	8,000	11,840
INDIRECT COST AT 25%						2,880
PROFIT AT 10%						1,184
CONSTRUCTION AT 15%						1,776
TOTAL FIELD COSTS						17,680
HEALTH AND SAFETY 10%						1,768
ENGINEERING AT 15%						2,652
CONTINGENCY AT 20%						3,536
TOTAL ACTIVITY COSTS						25,636

O & M COSTS

OPERATIONS AND MAINTENANCE	VISITS	TIME	RATE	TOTAL
INSPECTIONS	8	40	20	6,400
CONTINGENCY				1,280
TOTAL				7,680
FEES AT WORTH AT 10% AND 30 YEARS				77,499

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GAS COLLECTION SENSITIVITY

ASSUME BLOWER HOUSE IN
WORKING CONDITION
SEE APPENDIX N

DESCRIPTION:	QUANTITY	#	TOTAL $	SENSITIVITY +20% TOTAL $	-20% TOTAL $
TOTAL INSPECTION	1		3,000	3,600	2,400
GAS BURNER	1		8,000	9,600	6,400
SUBTOTAL			11,000	13,200	8,800
INS. BURDEN AT 13%			390	468	312
ADM. BURDEN AT 15%			450	540	360
MATERIALS BURDEN 10%			0	0	0
TOTAL DIRECT COSTS			11,840	14,208	9,472
INDIRECT COST AT 25%			2,880	3,456	2,304
FEE AT 10%			1,184	1,421	947
CONSTRUCTION AT 15%			1,776	2,131	1,421
TOTAL FIELD COSTS			17,680	21,216	14,144
HEALTH AND SAFETY 10%			1,768	2,122	1,414
ENGINEERING AT 15%			2,652	3,182	2,122
CONTINGENCY AT 20%			3,536	4,243	2,829
TOTAL ACTIVITY COSTS			25,636	30,763	20,509

SURFACE WASTE REMOVAL
CAPITAL COSTS

DESCRIPTION:	QUANTITY	@	MATERIAL $	LABOR $	EQUIPMENT $	TOTAL $
FILL MATERIAL	48.3 CY	$1.50/CU.YD.				
SOUTH TRACT			68			68
HOT SPOTS			4			4
SEED/FERTILIZER			20			20
						0
ROLL DOZER				224	614	838
TRACTOR					300	300
DUMP TRUCK				129	95	224
SEED SPREADER				62	35	97
DRUM REMOVAL	40 DRUMS	$620/DRUM		24,800		24,800
DRUM TRANSPORTATION	40 DRUMS	$38/DRUM		1,520		1,520
DRUM ANALYSIS	40 DRUMS	$1200/DRUM		48,000		48,000
DRUM DISPOSAL	40 DRUMS	$200/DRUM			8,000	8,000
SUBTOTAL			92	74,734	9,044	83,870
INS. BURDEN AT 13%				9,715		9,715
ADM. BURDEN AT 15%				11,210		11,210
MATERIALS BURDEN 10%			9			9
TOTAL DIRECT COSTS			102	95,660	9,044	104,805
INDIRECT COST AT 75%						71,745
PROFIT AT 10%						10,481
CONSTRUCTION AT 15%						15,706
TOTAL FIELD COSTS						202,736
HEALTH AND SAFETY 10%						20,274
ENGINEERING AT 15%						30,410
CONTINGENCY AT 20%						40,547
TOTAL ACTIVITY COSTS						293,967

O & M COSTS

OPERATION AND MAINTENANCE COSTS $30.00/INSPECTION X 4 TIMES/YEAR = $120

PRESENT WORTH AT 10% FOR 30 YEARS 1,131

SURFACE WASTE REMOVAL SENSITIVITY 115%

DESCRIPTION:	QUANTITY	@	MATERIAL $	LABOR $	EQUIPMENT $	TOTAL $	
FILL MATERIAL	40.3 CY	$1.50/CY					
SOUTH TRACT			68			68	
HOT SPOTS			4			4	
SEED/FERTILIZER			20			20	
						0	
BULLDOZER				223	614	837	
TRACTOR					300	300	
DUMP TRUCK				129	95	224	
SEED SPREADER				62	35	97	
DRUM REMOVAL	40 DRUMS	$620/DRUM		28,520		28,520	*
DRUM TRANSPORTATION	40 DRUMS	$38/DRUM		1,520		1,520	
DRUM ANALYSIS	40 DRUMS	$1,200/DRUM		48,000		48,000	
DRUM DISPOSAL	40 drums	$200/DRUM			9,200	9,200	*
SUBTOTAL			92	78,454	10,244	88,790	
INS. BURDEN AT 13%				10,199		10,199	
ADM. BURDEN AT 15%				11,768		11,768	
MATERIALS BURDEN 10%			9			9	
TOTAL DIRECT COSTS			101	100,421	10,244	110,766	
INDIRECT COST AT 75%						75,316	
PROFIT AT 10%						11,077	
CONSTRUCTION AT 15%						16,600	
TOTAL FIELD COSTS						213,759	
HEALTH AND SAFETY 10%						21,376	
ENGINEERING AT 15%						32,064	
CONTINGENCY AT 20%						42,752	
TOTAL ACTIVITY COSTS						309,950	

* VALUES THAT ARE SENSITIVE

SURFACE WASTE REMOVAL SENSITIVITY 15%

DESCRIPTION:	QUANTITY	@	MATERIAL $	LABOR $	EQUIPMENT $	TOTAL $
FILL MATERIAL	40.3 CY	$1.50/CY				
SOUTH TRACT			60			60
HOT SPOTS			4			4
SEED/FERTILIZER			20			20
						0
BULLDOZER				223	614	837
TRACTOR					300	300
DUMP TRUCK				129	95	224
SEED SPREADER				62	35	97
DRUM REMOVAL	40 DRUMS	$620/DRUM		28,520		28,520 *
DRUM TRANSPORTATION	40 DRUMS	$38/DRUM		1,520		1,520
DRUM ANALYSIS	40 DRUMS	$1200/DRUM		48,000		48,000
DRUM DISPOSAL	40 drums	$200/DRUM			9,200	9,200 *
SUBTOTAL			92	71,014	7,844	78,950
INS. BURDEN AT 13%				9,232		9,232
GEN. BURDEN AT 15%				10,652		10,652
MATERIALS BURDEN 10%			9			9
TOTAL DIRECT COSTS			101	90,898	7,844	98,845
INDIRECT COST AT 75%						68,173
PROFIT AT 10%						9,884
CONSTRUCTION AT 15%						14,811
TOTAL FIELD COSTS						191,712
HEALTH AND SAFETY 10%						19,171
ENGINEERING AT 15%						28,757
CONTINGENCY AT 20%						38,342
TOTAL ACTIVITY COSTS						277,983

* VALUES THAT ARE SENSITIVE

COFFING
CAPITAL COSTS

DESCRIPTION	QUANTITY CU. YDS.	#	MATERIAL $	LABOR $	EQUIPMENT $	TOTAL $
CLEARING	4,051,000					
CLEAR BRUSH COVER				41,700	89,700	131,400
BRUSH CHIPPER					3,690	3,690
SUBTOTAL			0	41,700	93,390	135,090
INS. BURDEN AT 13%				5,421		5,421
ADM. BURDEN AT 15%				6,255		6,255
MATERIALS BURDEN 10%			0			0
TOTAL DIRECT COSTS			0	53,376	93,390	146,766
INDIRECT COST AT 25%						40,032
FEE AT 10%						14,677
CONSTRUCTION AT 15%						22,015
TOTAL COFFING COSTS						223,490
HEALTH AND SAFETY 4%						8,949
ENGINEERING AT 5%						11,174
CONTINGENCY AT 20%						44,698
SUBTOTAL ALLOWED COSTS						288,301

CAPPING CAPITAL COSTS

DESCRIPTION	QUANTITY CU. YDS.	P	MATERIAL $	LABOR $	EQUIPMENT $	TOTAL $
FILL AND CAP						
CRUSHED STONE FILL						
FILL 1.5 IN. STONE	150,040	7	1,050,280	120,650	293,000	1,463,930
COMPACTION				67,096	83,100	150,196
FILL 3/8 IN. STONE	150,040	9	1,350,360	120,650	293,000	1,764,010
HAULING	300,000	5.46		405,108	1,233,328	1,638,436
CLAY CAP	300,000		2,700,720	756,202	1,671,445	5,128,367
HAULING				405,108	1,233,328	1,638,436
COMPACTION ONE/FOOT				67,096	83,100	150,196
TOPSOIL 3 FOOT THICK	450,120	5.5	2,475,660	361,950	879,000	3,716,610
HAULING				607,662	1,849,992	2,457,654
COMPACTION ONE/FOOT				100,644	124,650	225,294
SUBTOTAL			7,577,020	3,012,166	7,743,943	18,333,129
INS. BURDEN AT 13%				391,582		391,582
ADM. BURDEN AT 15%				451,825		451,825
MATERIALS BURDEN 10%			757,702			757,702
TOTAL DIRECT COSTS			8,334,722	3,855,573	7,743,943	19,934,237
INDIRECT COST AT 25%						2,891,679
PROFIT AT 10%						1,993,424
CONSTRUCTION AT 15%						1,739,937
TOTAL FIELD COSTS						26,559,268
HEALTH AND SAFETY 4%						1,062,371
ENGINEERING 6.5%						1,727,963
CONTINGENCY AT 20%						5,311,854
SUBTOTAL COSTS						34,261,456

COPPING
CAPITAL COSTS

DESCRIPTION	QUANTITY CU. YDS.	#	MATERIAL $	LABOR $	EQUIPMENT $	TOTAL $
DEWATERING CONDED AREA	2,430.[illegible]				500	500
FILL IN CONDED AREA	51,279		76,920	41,262	99,620	217,802
HAULING 20 MILE TRIP	150,040			69,[illegible]	210,449	279,675
COMPACTION				11,[illegible]	14,127	25,530
SUBTOTAL			76,920	121,891	324,696	523,507
INS. BURDEN AT 13%				15,846		15,846
ADM. BURDEN AT 15%				18,284		18,284
MATERIALS BURDEN 10%			7,692			7,692
TOTAL DIRECT COSTS			84,612	156,020	324,696	565,328
INDIRECT COST AT 25%						117,015
PROFIT AT 10%						56,533
CONSTRUCTION AT 15%						72,107
TOTAL FIELD COSTS						810,984
HEALTH AND SAFETY 4%						32,439
ENGINEERING AT 5%						40,549
CONTINGENCY AT 20%						162,197
SUBTOTAL COSTS						1,046,170

PNS SERI WORTH AT 10% AND 30 YEARS	9,116,708	10,028,478	8,205,047
TOTAL	54,195,470	52,195,470	52,095,608
IN WAITING FOUND A AREA	1,045,465	1,149,899	940,827
CLEARING	388,501	427,151	359,471
SITE AND CAP	34,261,476	42,487,602	30,835,310
IN CONDITIONS	TOTAL ACTIVITY COST	TOTAL $	TOTAL $
		10%	10%
	SENSITIVITY		

CAPITAL TOTAL SENSITIVITY

CAPPING - TOTALS

DESCRIPTION	TOTAL ACTIVITY COST
FILL AND CAP	34,261,456
CLEARING	288,301
DEWATERING FORDED AREA	1,045,363
TOTAL	35,595,120
PRESENT WORTH AT 10% AND 30 YEARS	9,116,708
OPERATIONS AND MAINTENANCE	
PUMP AND PUMPHOUSE	3,000
INSPECTIONS 4/YR. FOR 8 HRS.	640
SUBTOTAL	3,640
CONTINGENCY AT 20%	728
TOTAL O&M	4,368
PRESENT WORTH AT 10% AND 30 YEARS	
IS EQUAL TO PUMP PLUS O&M	3,500
	770
TOTAL PRESENT WORTH	11,000

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LEE 001

BANK PROTECTION CORRIDOR CAPITAL COSTS

DESCRIPTION	QUANTITY CU. YDS.	@	MATERIAL $	LABOR $	EQUIPMENT $	TOTAL $	
ROAD INSTALLATION							
GRADING	5110	3.19		264	1,340	1,604	
CRUSHED STONE	3,125	9.62	22,085	2,414	5,864	30,363	
COMPACTION	3,125	0.95		1,342	1,662	3,004	
CLEARING							
TRASH	10 DAYS	2634 CU YD. DA		11,072	15,274	26,346	67K
BRUSH	140650 SQ.YD.	0.2925SQ.YD.		12,852	27,630	40,482	
GRADING BANK	24,174	1.00		3,960	20,096	24,056	24K
RIPRAP COVER							
1/2 IN. DIA. ROCK	23,442	10.25	187,540	18,829	45,739	252,108	
6 IN. DIA. ROCK	46,979	10.25	375,830	37,802	91,478	505,110	
HAULING				19,274	110,291	129,565	
2 KEY TRENCHES	444	9.94	4,552	302	560	4,414	
SUBTOTAL			589,007	108,111	319,934	1,017,052	
INS. BURDEN AT 13%				14,054		14,054	
ADM. BURDEN AT 15%				16,217		16,217	
MATERIALS BURDEN 10%			58,901			58,901	
TOTAL DIRECT COSTS			647,908	138,382	319,934	1,106,224	
INDIRECT COST AT 25%						103,787	
PROFIT AT 10%						110,622	
CONSTRUCTION AT 15%						68,747	
TOTAL FIELD COSTS						1,389,380	
HEALTH AND SAFETY 8%						111,150	
ENGINEERING AT 10%						138,938	
CONTINGENCY AT 20%						277,876	
TOTAL ACTIVITY COSTS						1,917,345	

BANK PROTECTION CONTROLS
O & M COSTS

OPERATIONS AND MAINTENANCE	VISITS	TIME	RATE	TOTAL
INSPECTIONS	4	8	20	640
CONTINGENCY				128
TOTAL				768
PRESENT WORTH AT 10% AND 30 YEARS				7,240

LEE 001

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BANK PROTECTION CONTROLS SENSITIVITY

DESCRIPTION:	BUDGETED CU. YDS.	@	TOTAL $	+20% TOTAL $	-20% TOTAL $
ROAD INSTALLATION					
GRADING	510	3.10	1,604	1,925	1,283
CRUSHED STONE	3,155	9.62	30,363	36,436	24,290
COMPACTION	3,155	0.95	3,004	3,605	2,403
CLEARING					
TRASH	10 DAYS	2634 CU.YD./DAY	26,346	31,615	21,077
BRUSH	140655 SQ.YD.	0.27/SQ.YD.	40,402	48,578	32,386
GRADING BANK	24,174	1.00	24,056	28,867	19,245
RIPRAP COVER					
1 1/2 IN. DIA. ROCK	26,442	10.75	252,108	302,530	201,686
6 IN. DIA. ROCK	46,979	10.75	505,110	606,132	404,088
HAULING			129,565	155,478	103,652
2 KEY TRENCHES	444	9.94	4,414	5,297	3,531
SUBTOTAL			1,017,052	1,220,462	813,642
INS. BURDEN AT 13%			14,054	16,865	11,244
ADM. BURDEN AT 15%			16,217	19,460	12,973
MATERIALS BURDEN 10%			58,901	70,681	47,121
TOTAL DIRECT COSTS			1,106,224	1,327,469	884,979
INDIRECT COST AT 25%			103,707	124,544	83,029
PROFIT AT 10%			110,622	132,747	88,498
CONSTRUCTION AT 15%			68,747	82,497	54,998
TOTAL FIELD COSTS			1,389,380	1,667,256	1,111,504
HEALTH AND SAFETY 8%			111,150	133,380	88,920
ENGINEERING AT 10%			138,938	166,726	111,150
CONTINGENCY AT 20%			277,876	333,451	222,301
TOTAL ACTIVITY COSTS			1,917,345	2,300,813	1,533,876

REVEGETATE
CAPITAL COSTS

DESCRIPTION:	QUANTITY	#	MATERIAL $	LABOR $	EQUIPMENT $	TOTAL $
REVEGETATE	93 ACRES		1,255,810	163,944	23,782	1,443,536
SUBTOTAL			1,255,810	163,944	23,782	1,443,536
INS. BURDEN AT 13%				21,313		21,313
ADM. BURDEN AT 15%				24,592		24,592
MATERIALS BURDEN 10%			125,581			125,581
TOTAL DIRECT COSTS			1,381,391	209,848	23,782	1,615,021
INDIRECT COST AT 25%						157,386
FEE AT 10%						161,502
CONSTRUCTION AT 15%						35,045
TOTAL FIELD COSTS						1,968,954
HEALTH AND SAFETY 4%						78,758
ENGINEERING AT 15%						98,448
CONTINGENCY AT 20%						393,791
TOTAL ALLOWED COSTS						2,539,951

O & M COSTS

OPERATIONS AND MAINTENANCE	VISITS	TIME	RATE	TOTAL
INSPECTIONS	4	8	20	640
CONTINGENCY				128
TOTAL				768
PRESENT WORTH AT 10% AND 30 YEARS				7,240

REVEGETATE SENSITIVITY 1 10%
CAPITAL COSTS

DESCRIPTION	QUANTITY	#	MATERIAL $	LABOR $	EQUIPMENT $	TOTAL $
REVEGETATE	93 ACRES		1,381,391	180,338	26,160	1,587,889
SUBTOTAL			1,381,391	180,338	26,160	1,587,889
INS. BURDEN AT 15%				23,444		23,444
ADM. BURDEN AT 15%				27,051		27,051
MATERIALS BURDEN 10%			138,139			138,139
TOTAL DIRECT COSTS			1,519,530	230,833	26,160	1,776,523
INDIRECT COST AT 25%						173,124
PROFIT AT 10%						177,652
CONSTRUCTION AT 15%						38,549
TOTAL FIELD COSTS						2,165,848
HEALTH AND SAFETY 4%						86,634
ENGINEERING AT 15%						108,292
CONTINGENCY AT 20%						433,170
TOTAL ACTIVITY COSTS						2,793,944

O & M COSTS

OPERATIONS AND MAINTENANCE	VISITS	TIME	RATE	TOTAL
INSPECTIONS	4	8	20	640
CONTINGENCY				128
TOTAL				768
PRESENT WORTH AT 10% AND 30 YEARS				7,240

VEGETATE SENSITIVITY 10%
CAPITAL COSTS

DESCRIPTIONS	QUANTITY	#	MATERIAL $	LABOR $	EQUIPMENT $	TOTAL $
REVEGETATE	93 ACRES		1,130,229	147,550	21,404	1,299,183
SUBTOTAL			1,130,229	147,550	21,404	1,299,183
ENG. BURDEN AT 13%				19,182		19,182
ADM. BURDEN AT 15%				22,133		22,133
MATERIALS BURDEN 10%			113,023			113,023
TOTAL DIRECT COSTS			1,243,252	188,864	21,404	1,453,520
INDIRECT COST AT 75%						141,648
PROFIT AT 10%						145,352
CONSTRUCTION AT 15%						31,540
TOTAL FIELD COSTS						1,772,060
HEALTH AND SAFETY 4%						70,882
ENGINEERING AT 15%						88,603
CONTINGENCY AT 20%						354,412
TOTAL ACTIVITY COSTS						2,285,958

O & M COSTS

OPERATIONS AND MAINTENANCE	VISITS	TIME	RATE	TOTAL
INSPECTIONS	4	8	20	640
CONTINGENCY				128
TOTAL				768
PRESENT WORTH AT 10% AND 30 YEARS				7,240

GRADING CAPITAL COSTS

DESCRIPTION:	QUANTITY CU. YDS.	%	MATERIAL $	LABOR $	EQUIPMENT $	TOTAL $
GRADING	815,046			134,482	681,932	816,414
TRENCH				8,854	4,712	13,566
[illegible]			4,275	[illegible]	152	4,962
SUBTOTAL			4,275	143,871	686,796	834,942
INS. BURDEN AT 13%				18,703		18,703
AUG. BURDEN AT 15%				21,581		21,581
MATERIALS BURDEN 10%			428			428
TOTAL DIRECT COSTS			4,703	184,155	686,796	875,653
INDIRECT COST AT 25%						138,116
PROFIT AT 10%						87,565
CONSTRUCTION AT 15%						130,643
TOTAL FIELD COSTS						1,231,978
HEALTH AND SAFETY 4%						49,279
ENGINEERING AT 5%						61,599
CONTINGENCY AT 20%						246,396
TOTAL ACTIVITY COSTS						1,589,251

GRADING SUBACTIVITY 110%

DESCRIPTION	QUANTITY CU. YDS.	P	MATERIAL $	LABOR $	EQUIPMENT $	TOTAL $
GRADING	815,046			147,930	750,125	898,055
TRENCH				9,735	5,183	14,918
COLVERT			4,702	588	167	5,457
SUBTOTAL			4,702	158,253	755,475	918,430
INS. BURDEN AT 13%				20,573		20,573
ADM. BURDEN AT 15%				23,738		23,738
MATERIALS BURDEN 10%			470			470
TOTAL DIRECT COSTS			5,172	202,564	755,475	963,211
INDIRECT COST AT 75%						151,923
PROFIT AT 10%						96,321
CONSTRUCTION AT 15%						143,706
TOTAL FIELD COSTS						1,355,161
HEALTH AND SAFETY 4%						54,206
ENGINEERING AT 5%						67,758
CONTINGENCY AT 20%						271,032
TOTAL ACTIVITY COSTS						1,748,157

GRADING SENSITIVITY 10%

DESCRIPTION:	QUANTITY CU. YDS.	@	MATERIAL $	LABOR $	EQUIPMENT $	TOTAL $
GRADING	815,046			121,034	613,739	734,77
TRENCH				7,965	4,240	12,20
CULVERT			3,848	482	136	4,46
SUBTOTAL			3,848	129,481	618,115	751,444
ENG. BURDEN AT 13%				16,833		16,833
ADM. BURDEN AT 15%				19,422		19,422
MATERIALS BURDEN 10%			385			385
TOTAL DIRECT COSTS			4,233	165,736	618,115	788,083
INDIRECT COST AT 75%						124,302
PROFIT AT 10%						78,808
CONSTRUCTION AT 15%						117,578
TOTAL FIELD COSTS						1,108,771
HEALTH AND SAFETY 4%						44,351
ENGINEERING AT 5%						55,439
CONTINGENCY AT 20%						221,754
TOTAL ACTIVITY COSTS						1,430,315

EXCAVATION SECTION A
CAPITAL COSTS

DESCRIPTION:	QUANTITY CU. YDS.	@	MATERIAL $	LABOR $	EQUIPMENT $	TOTAL $
SECTION A	706,000					
EXCAVATION		.21/CY		31,080	116,065	147,145
FILL		4.26/CY	309,000	165,261	402,770	877,031
COMPACTION		.07/CY		46,061	57,062	103,123
SUBTOTAL			309,000	242,902	575,397	1,127,299
INS. BURDEN AT 13%				31,577		31,577
ADM. BURDEN AT 15%				36,435		36,435
MATERIALS BURDEN 10%			30,900			30,900
TOTAL DIRECT COSTS			339,900	310,915	575,397	1,226,212
INDIRECT COST AT 25%						233,186
PROFIT AT 10%						122,621
CONSTRUCTION AT 15%						132,947
TOTAL FIELD COSTS						1,714,965
HEALTH AND SAFETY 4%						68,599
ENGINEERING AT 7%						120,048
CONTINGENCY AT 20%						342,993
SUBTOTAL ACTIVITY COSTS						2,246,605

EXCAVATION SECTION B
CAPITAL COSTS

DESCRIPTION:	QUANTITY CU. YDS.	P	MATERIAL $	LABOR $	EQUIPMENT $	TOTAL $
SECTION B	250,000					
EXCAVATION		.47/CY		37,[illegible]	141,115	178,903
FILL		3.26/CY	375,000	201,166	489,057	1,065,223
COMPACTION		.5/CY		55,900	69,250	125,150
SUBTOTAL			375,000	294,854	699,422	1,369,276
INS. BURDEN AT 13%				38,331		38,331
ADM. BURDEN AT 15%				44,228		44,228
MATERIALS BURDEN AT 10			37,500			37,500
TOTAL DIRECT COSTS			412,500	377,413	699,422	1,489,335
INDIRECT COST AT 25%						283,060
PROFIT AT 10%						148,934
CONSTRUCTION AT 15%						161,525
TOTAL FIELD COSTS						2,082,854
HEALTH AND SAFETY 4%						83,314
ENGINEERING AT 7%						145,800
CONTINGENCY AT 20%						416,571
SUBTOTAL ACTIVITY COSTS						2,728,538

EXCAVATION SECTION C
COSTING COSTS

DESCRIPTION	QUANTITY CU. YDS.	@	MATERIAL $	LABOR $	EQUIPMENT $	TOTAL $
SECTION C	22,000					
EXCAVATION		[illegible]		[illegible]	[illegible]	15,879
FILL		[illegible]	55,000	17,164	43,494	94,258
COMPACTION		[illegible]		4,917	6,094	11,013
SUBTOTAL			55,000	26,137	62,013	121,150
INS. BURDEN AT 13%				3,398		3,398
ADM. BURDEN AT 15%				3,921		3,921
MATERIALS BURDEN 10%			5,500			5,500
TOTAL DIRECT COSTS			56,500	33,456	62,013	131,768
INDIRECT COST AT 75%						25,092
FEE AT 10%						13,177
CONSTRUCTION AT 15%						14,320
TOTAL FIELD COSTS						184,357
HEALTH AND SAFETY 4%						7,374
ENGINEERING AT 7%						12,905
CONTINGENCY AT 20%						36,871
SUBTOTAL ACTIVITY COSTS						241,508

EXCAVATION SECTION D
CAPITAL COSTS

DESCRIPTION:	QUANTITY CU. YDS.	@	MATERIAL $	LABOR $	EQUIPMENT $	TOTAL $
SECTION D	9,700					
EXCAVATION		.71/CY		1,455	5,427	6,880
FILL		4.26/CY	14,550	7,724	18,764	41,038
COMPACTION		.53/CY		2,236	2,770	5,006
SUBTOTAL			14,550	11,415	26,961	52,924
INS. BURDEN AT 13%				1,484		1,484
ADM. BURDEN AT 15%				1,712		1,712
MATERIALS BURDEN 10%			1,455			1,455
TOTAL DIRECT COSTS			16,005	14,609	26,961	57,575
INDIRECT COST AT 25%						10,956
PROFIT AT 10%						5,757
CONSTRUCTION AT 15%						6,235
TOTAL FIELD COSTS						80,524
HEALTH AND SAFETY 4%						3,221
ENGINEERING AT 7%						5,637
CONTINGENCY AT 20%						16,105
SUBTOTAL ACTIVITY COSTS						105,486

EXCAVATION SECTION I
CAPITAL COSTS

DESCRIPTION	QUANTITY CU. YDS.	P	MATERIAL $	LABOR $	EQUIPMENT $	TOTAL $
SECTION I	524,000					
EXCAVATION		.71/CY		79,166	295,590	374,756
FILL		4.26/CY	786,000	404,104	1,024,854	2,214,958
COMPACTION		.50/CY		117,116	145,148	262,264
SUBTOTAL			786,000	600,386	1,464,592	2,850,978
INS. BURDEN AT 13%				78,050		78,050
GEN. BURDEN AT 15%				90,058		90,058
MATERIALS BURDEN 10%			78,600			78,600
TOTAL DIRECT COSTS			864,600	768,494	1,464,592	3,097,686
INDIRECT COST AT 25%						576,371
FEE AT 10%						309,769
CONSTRUCTION AT 15%						334,953
TOTAL FIELD COSTS						4,318,788
HEALTH AND SAFETY 4%						172,752
ENGINEERING AT 7%						302,315
CONTINGENCY AT 20%						863,758
SUBTOTAL ACTIVITY COSTS						5,657,612

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EXCAVATION SECTION 1
CAPITAL COSTS

DESCRIPTION:	QUANTITY CU. YDS.	@	MATERIAL $	LABOR $	EQUIPMENT $	TOTAL $
SECTION 1	20,000					
EXCAVATION		.21/CY		3,022	11,272	14,294
FILL		4.24/CY	30,000	16,955	38,202	84,795
COMPACTION		.5/CY		4,422	5,540	10,012
SUBTOTAL			30,000	24,587	55,514	109,101
INS. BURDEN AT 13%				3,066		3,066
ADM. BURDEN AT 15%				3,538		3,538
MATERIALS BURDEN 10%			3,000			3,000
TOTAL DIRECT COSTS			33,000	30,191	55,514	118,705
INDIRECT COST AT 25%						29,644
PROFIT AT 10%						11,871
CONSTRUCTION AT 15%						17,806
TOTAL FIELD COSTS						166,026
HEALTH AND SAFETY 4%						6,643
ENGINEERING AT 7%						11,625
CONTINGENCY AT 20%						33,215
SUBTOTAL ACTIVITY COSTS						217,559

EXCAVATION SECTION G
CAPITAL COSTS

DESCRIPTION:	QUANTITY CU. YDS.	@	MATERIAL $	LABOR $	EQUIPMENT $	TOTAL $
SECTION G	58,000					
EXCAVATION		.27/CY		8,[illegible]	42,565	41,285
CUT		4.26/CY	87,000	46,[illegible]	113,762	247,594
COMPACTION		.52/CY		12,769	16,066	29,035
SUBTOTAL			87,000	68,521	162,393	317,914
ADM. BURDEN AT 13%				8,908		8,908
ADM. BURDEN AT 15%				10,278		10,278
MATERIALS BURDEN 10%			8,700			8,700
TOTAL DIRECT COSTS			95,700	87,707	162,393	345,800
INDIRECT COST AT 25%						65,780
PROFIT AT 10%						34,580
CONSTRUCTION AT 15%						37,515
TOTAL FIELD COSTS						483,675
HEALTH AND SAFETY 4%						19,347
ENGINEERING AT 7%						33,857
CONTINGENCY AT 20%						96,735
SUBTOTAL ACTIVITY COSTS						633,614

EXCAVATION SECTION II
CAPITAL COSTS

DESCRIPTION:	QUANTITY CU. YDS.	#	MATERIAL $	LABOR $	EQUIPMENT $	TOTAL $
SECTION II	61,000					
EXCAVATION		21 CY		9,216	34,235	43,451
HAUL		3.26 CY	91,500	49,246	119,626	260,372
COMPACTION		.5CY		13,640	16,897	30,537
SUBTOTAL			91,500	72,102	170,758	334,360
INS. BURDEN AT 13%				9,373		9,373
ADM. BURDEN AT 15%				10,815		10,815
MATERIALS BURDEN 10%			9,150			9,150
TOTAL DIRECT COSTS			100,650	92,291	170,758	363,699
INDIRECT COST AT 25%						69,218
PROFIT AT 10%						36,370
CONSTRUCTION AT 15%						39,457
TOTAL FIELD COSTS						508,744
HEALTH AND SAFETY 4%						20,350
ENGINEERING AT 7%						47,612
CONTINGENCY AT 20%						101,749
SUBTOTAL ACTIVITY COSTS						666,454

EXCAVATION SECTION 1
CAPITAL COSTS

DESCRIPTION:	QUANTITY CU. YDS.	@	MATERIAL $	LABOR $	EQUIPMENT $	TOTAL $
SECTION 1	109,000					
EXCAVATION		.71/CY		16,468	61,790	78,258
FILL		4.26/CY	163,500	87,870	213,450	464,820
COMPACTION		.5/CY		24,372	30,193	54,565
SUBTOTAL			163,500	128,710	305,433	597,643
TRS. BURDEN AT 13%				16,732		16,732
ADM. BURDEN 2%				19,307		19,307
MATERIALS BURDEN 10%			16,350			16,350
TOTAL DIRECT COSTS			179,850	164,749	305,433	650,032
INDIRECT COST AT 25%						123,562
PROFIT AT 10%						65,003
CONSTRUCTION AT 15%						70,527
TOTAL FIELD COSTS						909,124
HEALTH AND SAFETY 4%						36,365
ENGINEERING AT 7%						63,639
CONTINGENCY AT 20%						181,825
SUBTOTAL ACTIVITY COSTS						1,190,952

EXCAVATION SECTION J
CAPITAL COSTS

DESCRIPTION:	QUANTITY CU. YDS.	@	MATERIAL $	LABOR $	EQUIPMENT $	TOTAL $
SECTION J	843,000					
EXCAVATION		.71/CY		127,952	475,950	603,402
FILL		4.26/CY	1,264,500	678,533	1,647,784	3,590,618
COMPACTION		.50/CY		188,495	233,511	422,006
SUBTOTAL			1,264,500	994,980	2,357,245	4,616,026
INS. BURDEN AT 13%				129,257		129,257
ADM. BURDEN AT 15%				149,142		149,142
MATERIALS BURDEN 10%			126,450			126,450
TOTAL DIRECT COSTS			1,390,950	1,272,680	2,357,245	5,020,875
INDIRECT COST AT 25%						954,510
PROFIT AT 10%						502,087
CONSTRUCTION AT 15%						544,489
TOTAL FIELD COSTS						7,021,961
HEALTH AND SAFETY 4%						280,878
ENGINEERING AT 7%						491,537
CONTINGENCY AT 20%						1,404,392
SUBTOTAL ACTIVITY COSTS						9,198,768

EXCAVATION SECTION K
CAPITAL COSTS

DESCRIPTION:	QUANTITY CU. YDS.	@	MATERIAL $	LABOR $	EQUIPMENT $	TOTAL $
SECTION K	419,000					
EXCAVATION		.21/CY		48,[illegible]	179,5[illegible]	227,220
FILL		3.26/CY	428,500	256,350	775,930	1,459,280
COMPACTION		.57/CY		71,5[illegible]	88,363	159,691
SUBTOTAL			428,500	376,373	891,818	1,746,691
INS. BURDEN AT 13%				48,928		48,928
ADM. BURDEN AT 15%				56,456		56,456
MATERIALS BURDEN 10%			47,850			47,850
TOTAL DIRECT COSTS			526,350	481,757	891,818	1,899,925
INDIRECT COST AT 25%						361,318
PROFIT AT 10%						189,993
CONSTRUCTION AT 15%						206,036
TOTAL FIELD COSTS						2,657,272
HEALTH AND SAFETY 4%						106,291
ENGINEERING AT 7%						186,009
CONTINGENCY AT 20%						531,454
SUBTOTAL ACTIVITY COSTS						3,481,027

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TOTAL EXCAVATION CAPITAL COSTS

DESCRIPTION	TOTAL ACTIVITY COSTS
SECTION A	2,246,607
SECTION B	2,[illegible],548
SECTION C	241,508
SECTION D	105,886
SECTION E	5,657,612
SECTION F	217,559
SECTION G	633,614
SECTION H	666,434
SECTION I	1,190,992
SECTION J	2,198,768
SECTION K	3,401,077
TOTAL	26,368,123
PRESENT WORTH AT 10% INTEREST FOR 22 YEARS	10,513,139

TOTAL EXCAVATION CAPITAL COSTS SENSITIVITY

DESCRIPTION	TOTAL ACTIVITY COSTS	SENSITIVITY 130% TOTAL $	SENSITIVITY 30% TOTAL $
SECTION A	1,246,605	2,920,587	1,572,624
SECTION B	2,228,138	5,547,099	1,909,977
SECTION C	241,508	313,960	169,056
SECTION D	105,486	137,132	73,840
SECTION E	5,457,613	7,094,896	3,960,328
SECTION F	217,559	282,827	152,291
SECTION G	633,614	823,698	443,530
SECTION H	666,454	866,390	466,518
SECTION I	1,190,952	1,548,238	833,666
SECTION J	9,198,768	11,958,398	6,439,138
SECTION K	3,401,077	4,421,535	2,436,719
TOTAL	26,620,123	34,270,560	18,957,686
PRESENT WORTH AT 10% INTEREST FOR 20 YEARS	10,513,132	13,667,080	7,359,197

OFFSITE DISPOSAL SECTION A
CAPITAL COSTS

DESCRIPTION:	QUANTITY CU. YDS.	#	MATERIAL $	LABOR $	EQUIPMENT $	TOTAL $
SECTION A	206,000					
HAULING		3.30/LOADED MI		9,064,440		9,064,440
DISPOSAL FEE		68.00/TON	14,008,000			14,008,000
SUBTOTAL			14,008,000	9,064,440	0	23,072,440
INS. BURDEN AT 13%				1,178,377		1,178,377
ADM. BURDEN AT 15%				1,359,666		1,359,666
MATERIAL BURDEN 10%			1,400,800			1,400,800
TOTAL DIRECT COSTS			15,408,800	11,602,483	0	27,011,283
INDIRECT COST AT 25%						8,701,862
FEE AT 10%						3,701,128
CONSTRUCTION AT 15%						1,740,373
TOTAL FIELD COSTS						40,154,646
HEALTH AND SAFETY 4%						1,606,186
ENGINEERING AT 7%						2,810,825
CONTINGENCY AT 20%						8,030,929
SUBTOTAL ACTIVITY COSTS						52,602,587

WESTE DISPOSAL SECTION 8 — PAGE 2 OF 12

CAPITAL COSTS

DESCRIPTION	QUANTITY CU. YDS.	%	MATERIAL $	LABOR $	EQUIPMENT $	TOTAL $
SECTION 8	250,000					
HAULING		4.50/LOADED MI		11,000,000		11,000,000
DISPOSAL FEE		68.00/TON	17,000,000			17,000,000
SUBTOTAL			17,000,000	11,000,000	0	28,000,000
INS. BURDEN AT 15%				1,650,000		1,650,000
ADM. BURDEN AT 15%				1,650,000		1,650,000
MATERIAL BURDEN 10%			1,700,000			1,700,000
TOTAL DIRECT COSTS			18,700,000	14,000,000	0	32,780,000
INDIRECT COSTS AT 25%						10,560,000
PROFIT AT 10%						3,278,000
CONSTRUCTION AT 15%						2,112,000
TOTAL FIELD COSTS						48,730,000
HEALTH AND SAFETY 4%						1,949,200
ENGINEERING AT 7%						3,411,100
CONTINGENCY AT 20%						9,746,000
SUBTOTAL ACTIVITY COSTS						63,836,300

DEESTE DISPOSAL SECTION C
CAPITAL COSTS

PAG 2

DESCRIPTION:	QUANTITY CU. YDS.	@	MATERIAL $	LABOR $	EQUIPMENT $	$
SECTION C	22,000					[illegible]
BORING		3.30/LOOSE D.M.		968,000		[illegible]
DISPOSAL FEE		68.00/TON	1,496,000			[illegible]
SUBTOTAL			1,496,000	968,000	0	[illegible]
INS. BURDEN AT 13%				125,840		125,840
ADM. BURDEN AT 15%				145,200		145,200
MATERIAL BURDEN 10%			149,600			149,600
TOTAL DIRECT COSTS			1,645,600	1,239,040	0	2,884,640
INDIRECT COST AT 25%						929,280
PROFIT AT 10%						288,464
CONSTRUCTION AT 15%						185,856
TOTAL FIELD COSTS						4,288,240
HEALTH AND SAFETY 4%						171,530
ENGINEERING AT 7%						300.177
CONTINGENCY AT 20%						857,648
SUBTOTAL ACTIVITY COSTS						5,617,594

DEBRIS DISPOSAL SECTION D
CAPITAL COSTS

DESCRIPTION	QUANTITY CU. YDS.	@	MATERIAL $	LABOR $	EQUIPMENT $	TOTAL $
SECTION D	9,700					
HAULING		3.30 LOADED MI		426,360		426,360
DISPOSAL FEE		68.00/TON	659,600			659,600
SUBTOTAL			659,600	426,360	0	1,085,960
INS. BURDEN AT 13%				55,427		55,427
ADM. BURDENAT 15%				63,954		63,954
MATERIAL BURDEN 10%			65,960			65,960
TOTAL DIRECT COSTS			725,560	545,741	0	1,271,301
INDIRECT COST AT 25%						409,306
PROFIT AT 10%						127,130
CONSTRUCTION AT 15%						81,861
TOTAL FIELD COSTS						1,889,598
HEALTH AND SAFETY 4%						75,584
ENGINEERING AT 7%						132,272
CONTINGENCY AT 20%						377,920
SUBTOTAL ACTIVITY COSTS						2,475,373

OLESCH DISPOSAL SECTION F
CAPITAL COSTS

DESCRIPTION:	QUANTITY CU. YDS.	W	MATERIAL $	LABOR $	EQUIPMENT $	TOTAL $
SECTION F	524,000					
HAULING		3.30/LOADED MI		23,056,000		23,056,000
DISPOSAL FEE		60.00/TON	35,632,000			35,632,000
SUBTOTAL			35,632,000	23,056,000	0	58,688,000
INS. BURDEN AT 13%				2,997,280		2,997,280
ADM. BURDEN AT 15%				3,458,400		3,458,400
MATERIAL BURDEN 10%			3,563,200			3,563,200
TOTAL DIRECT COSTS			39,195,200	29,511,680	0	68,706,880
INDIRECT COST AT 25%						22,133,760
FEE AT 10%						6,870,688
CONSTRUCTION AT 15%						4,436,752
TOTAL FIELD COSTS						102,138,080
HEALTH AND SAFETY 4%						4,085,523
ENGINEERING AT 7%						7,149,666
CONTINGENCY AT 20%						20,427,616
SUBTOTAL ACTIVITY COSTS						133,800,885

DEBRIS DISPOSAL SECTION I
FACTUAL COSTS

DESCRIPTION	QUANTITY CU. YDS.	#	MATERIAL $	LABOR $	EQUIPMENT $	TOTAL $
SECTION F	20,000					
HAULING		2,500 LOADED MI		880,000		880,000
DISPOSAL FEE		24.00 TON	1,360,000			1,360,000
SUBTOTAL			1,360,000	880,000	0	2,240,000
EQ. BURDEN AT 13%				114,400		114,400
ABR. BURDEN AT 15%				132,000		132,000
MATERIAL BURDEN 10%			136,000			136,000
TOTAL DIRECT COSTS			1,496,000	1,126,400	0	2,622,400
INDIRECT COST AT 25%						844,800
PROFIT AT 10%						262,240
CONSTRUCTION AT 15%						168,960
TOTAL FIELD COSTS						3,898,400
HEALTH AND SAFETY 4%						155,936
ENGINEERING AT 2						77,968
CONTINGENCY AT 20%						779,600
SUBTOTAL ACTIVITY COSTS						5,106,904

DEESTE DISPOSAL SECTION 6
CAPITAL COSTS

DESCRIPTION	QUANTITY CU. YDS.	U	MATERIAL $	LABOR $	EQUIPMENT $	TOTAL $
SECTION 6	58,000					
BUILDING		2,20 LOGBUILD MI		2,552,000		2,552,000
DISPOSAL FEE		68.00/TON	3,944,000			3,944,000
SUBTOTAL			3,944,000	2,552,000	0	6,496,000
INS. BURDEN AT 13%				331,760		331,760
ADM. BURDENAT 15%				382,800		382,800
MATERIAL BURDEN 10%			394,400			394,400
TOTAL DIRECT COSTS			4,338,400	3,266,560	0	7,604,960
INDIRECT COST AT 25%						2,449,920
PROFIT AT 10%						760,496
CONSTRUCTION AT 15%						489,984
TOTAL FIELD COSTS						11,305,360
HEALTH AND SAFETY 4%						452,214
ENGINEERING AT 7%						791,375
CONTINGENCY AT 20%						2,261,072
SUBTOTAL ACTIVITY COSTS						14,810,022

DEEPCUT DISPOSAL SECTION H
CAPITAL COSTS

DESCRIPTION	QUANTITY CU. YDS.	%	MATERIAL $	LABOR $	EQUIPMENT $	TOTAL $
SECTION H	61,000					
HAULING		3.30 LOADED MI		2,604,000		2,604,000
DISPOSAL FEE		60.00/TON	4,140,000			4,140,000
SUBTOTAL			4,140,000	2,604,000	0	6,332,000
INS. BURDEN AT 15%				348,920		348,920
AUTO. BURDEN AT 15%				402,600		402,600
MATERIAL BURDEN 10%			414,800			414,800
TOTAL DIRECT COSTS			4,562,800	3,435,520	0	7,998,320
INDIRECT COST AT 27%						2,576,640
PROFIT AT 10%						799,832
CONSTRUCTION AT 15%						515,328
TOTAL FIELD COSTS						11,890,120
HEALTH AND SAFETY 4%						475,605
ENGINEERING AT 7%						832,308
CONTINGENCY AT 20%						2,378,016
SUBTOTAL ACTIVITY COSTS						15,576,057

OFFSITE DISPOSAL SECTION 1
CAPITAL COSTS

DESCRIPTION:	QUANTITY CU. YDS.	#	MATERIAL $	LABOR $	EQUIPMENT $	TOTAL $
SECTION 1	109,000					
HAULING		3.50 TO 6.00 PER CU		4,296,000		4,296,000
DISPOSAL FEE		30.00/TON	2,412,000			2,412,000
SUBTOTAL			2,412,000	4,296,000	0	12,208,000
INS. BURDEN AT 15%				523,480		623,480
ADM. BURDEN AT 15%				719,400		719,400
MATERIAL BURDEN 10%			741,200			741,200
TOTAL DIRECT COSTS			8,153,200	6,138,880	0	14,292,080
INDIRECT COST AT 25%						4,604,160
FIXED AT 10%						1,429,208
CONSTRUCTION AT 15%						920,832
TOTAL FIELD COSTS						21,246,280
HEALTH AND SAFETY 4%						849,851
ENGINEERING AT 7%						1,487,240
CONTINGENCY AT 20%						4,249,256
SUBTOTAL ACTIVITY COSTS						27,832,627

DEESCE DISPOSAL SECTION 3
CAPITAL COSTS

DESCRIPTION:	QUANTITY CU. YDS.	@	MATERIAL $	LABOR $	EQUIPMENT $	TOTAL $
SECTION 3	843,000					
HAULING		1.50 LOADED MI		37,092,000		37,092,000
DISPOSAL FEE		38.00/TON	57,324,000			57,324,000
SUBTOTAL			57,324,000	37,092,000	0	94,416,000
INS. BURDEN AT 13%				4,821,960		4,821,960
ADM. BURDEN AT 15%				5,563,800		5,563,800
MATERIAL BURDEN 10%			5,732,400			5,732,400
TOTAL DIRECT COSTS			63,056,400	47,477,760	0	110,534,160
INDIRECT COST AT 25%						35,608,320
FEE AT 10%						11,053,416
CONSTRUCTION AT 15%						7,121,664
TOTAL LIFE COSTS						164,317,560
HEALTH AND SAFETY 4%						6,572,702
ENGINEERING 6.5%						11,506,229
CONTINGENCY AT 20%						33,865,513
SUBTOTAL ACTIVITY COSTS						215,256,004

OLESTER DISPOSAL SECTION K
CAPITAL COSTS

DESCRIPTION	QUANTITY CU. YDS.	%	MATERIAL $	LABOR $	EQUIPMENT $	TOTAL $
SECTION K	319,000					
CAPPING		3.50/LOOSE CU. YD		14,036,000		14,036,000
DISPOSAL FEE		68.00/TON	21,692,000			21,692,000
SUBTOTAL			21,692,000	14,036,000	0	35,728,000
EQUIP. BURDEN AT 13%				1,824,680		1,824,680
LABOR BURDEN AT 15%				2,105,400		2,105,400
MATERIAL BURDEN 10%			2,169,200			2,169,200
TOTAL DIRECT COSTS			23,861,200	17,966,080	0	41,827,280
INDIRECT COST AT 25%						13,474,560
PROFIT AT 10%						4,182,728
CONSTRUCTION AT 15%						2,694,912
TOTAL FIELD COSTS						62,179,480
HEALTH AND SAFETY 4%						2,487,179
ENGINEERING AT 7%						4,352,564
CONTINGENCY AT 20%						12,435,896
SUBTOTAL ACTIVITY COSTS						81,455,119

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TOTAL OFFSITE DISPOSAL CAPITAL COSTS

DESCRIPTION	TOTAL ACTIVITY COSTS
SECTION A	52,602,587
SECTION B	63,836,400
SECTION C	5,617,574
SECTION D	7,475,373
SECTION E	133,800,980
SECTION F	5,106,204
SECTION G	14,810,022
SECTION H	15,576,057
SECTION I	27,833,627
SECTION J	215,256,004
SECTION K	81,455,119
TOTAL	618,369,472
PRESENT WORTH AT 10% INTEREST FOR 30 YEARS	264,968,912

TOTAL DEFSER DISPOSAL CAPITAL COSTS SENSITIVITY

DESCRIPTIONS	TOTAL ACTIVITY COSTS	SENSITIVITY 130% TOTAL $	SENSITIVITY 30% TOTAL $
SECTION A	52,602,587	68,383,253	36,821,911
SECTION B	33,336,300	43,337,190	44,681,410
SECTION C	5,617,594	7,302,872	3,932,316
SECTION D	7,425,573	9,217,985	1,632,761
SECTION E	133,300,885	173,341,151	93,660,620
SECTION F	5,106,904	6,638,975	3,574,833
SECTION G	13,100,022	17,030,029	10,367,015
SECTION H	15,576,057	20,248,874	10,903,240
SECTION I	72,832,627	96,482,413	49,482,839
SECTION J	215,256,004	279,832,805	150,679,203
SECTION K	81,455,112	105,891,656	57,018,568
TOTAL	618,365,472	803,880,514	432,850,630
PRESENT WORTH AT 10 % INTEREST FOR 22 YEARS	246,547,854	320,512,206	172,583,496

INCINERATOR
CAPITAL COSTS

DESCRIPTION:	QUANTITY	%	MATERIAL $	LABOR $	EQUIPMENT $	TOTAL $
INCINERATOR 50,000,00 BTU/HR 2.5 TON/HR						
LOADING SYSTEM					10,000	10,000
FIRST COMB. CHAMBER						
SHELL AND REFRA MECH.					664,000	664,000
INTERVALS (FIRE BRICK)					89,500	89,500
SECOND COMB. CHAMBER						
SHELL AND REFRA MECH					77,100	77,100
INTERVALS					13,400	13,400
BURNER SYSTEM						
50,000,000 BTU/HR					48,000	48,000
MATERIAL REMOVAL SYS.					220,000	220,000
ENERGY RECOVERY SYS.					270,000	270,000
AIR POLL. CONT. EQUIP.					360,000	360,000
STACK WITH FAN					263,400	263,400
INSTALLATION		50% EQUIP.		1,189,000		1,189,000
SITE PREP. & UTILITIES		7% EQUIP.			166,000	166,000
START UP		10% EQUIP.		238,000		238,000
SPARE PARTS		8% EQUIP.			190,000	190,000
INSTRUMENTS/CONTROL		2% EQUIP.			476,000	476,000
0						
SUBTOTAL			0	1,427,000	2,847,400	4,274,400
INS. BURDEN AT 15%				185,510		185,510
ADM. BURDEN AT 15%				214,050		214,050
MATERIALS BURDEN 10%			0			0
TOTAL DIRECT COSTS			0	1,826,560	2,847,400	4,673,960
INDIRECT COST AT 25%						1,369,920
FEE AT 10%						467,396
CONSTRUCTION AT 15%						701,094
TOTAL FIELD COSTS						7,212,370
HEALTH AND SAFETY 4%						288,495
ENGINEERING AT 5%						360,619
CONTINGENCY AT 20%						1,442,474
TOTAL ACTIVITY COSTS						9,303,957

INCINERATION
OPERATION AND MAINTENANCE

DESCRIPTION:	UNIT $	TOTAL $
LABORS:		
4 OPERATORS	[illegible]/YR	88,000
3 WORKERS FOR 2 SHIFTS	[illegible],000/YR	120,000
1 SUPERVISORS FOR 2 SHIFTS	[illegible]/YR	52,000
1 [illegible] FOR 1 SHIFT	[illegible]/YR	[illegible]
UTILITIES:		
POWER		[illegible]
WATER		[illegible]
FUEL OIL		2,940,000
CHEMICAL COSTS		107,000
MAINTENANCE COSTS		463,700
SUBTOTAL		3,97[illegible],700
FLY ASH DISPOSAL:		
2[illegible]% OF VOLUME IS ASH		
5% OF ASH IS FLY ASH (1[illegible],500 LY) (60 LINER/LD) (1/30)		30,600
7.[illegible] TONS/HR/UNIT @ [illegible] HRS.		
340 DAYS/YR X 25% 15,300 TONS/YR/UNIT		
DISPOSAL	65/TON	995,000
TRANSPORTATION (ENGLEE AL.)	5.3/LOADED MI.	673,000
SUBTOTAL FOR DISPOSAL		1,6[illegible],600
TOTAL		5,673,900
CONTINGENCY AT 20%		1,134,700
TOTAL O & M		6,808,600
PRESENT WORTH @ 10% FOR 30 YEARS		64,184,844

** DATA FROM CHEMICAL ENGINEERING FEB. 6, 1984

OFFSITE DISPOSAL OF NON INCINERABLE MATERIAL

DESCRIPTION:	QUANTITY CU. YDS.	@	MATERIAL $	LABOR $	EQUIPMENT $	TOTAL $
	840,000					
HAULING		3.30/LOADED MI		36,960,000		36,960,000
DISPOSAL FEE		68.00/TON	57,120,000			57,120,000
SUBTOTAL			57,120,000	36,960,000	0	94,080,000
INS. BURDEN AT 13%				4,804,800		4,804,800
ADM. BURDENAT 15%				5,544,000		5,544,000
MATERIAL BURDEN 10%			5,712,000			5,712,000
TOTAL DIRECT COSTS			62,832,000	47,308,800	0	110,140,800
INDIRECT COST AT 75%						35,481,600
PROFIT AT 10%						11,014,080
CONSTRUCTION AT 15%						7,096,320
TOTAL FIELD COSTS						163,732,800
HEALTH AND SAFETY 4%						6,549,312
ENGINEERING AT 7%						11,461,296
CONTINGENCY AT 20%						32,746,560
TOTAL ACTIVITY COSTS						214,489,968
PRESENT WORTH FOR 24 YEARS						78,391,975

INCINERATOR SENSITIVITY

DESCRIPTION	TOTAL $	+30% TOTAL$	-30% TOTAL $
OPERATIONS AND MAINTENANCE	15,745,762	20,469,491	11,022,033
CAPITAL COSTS	9,303,957	12,095,144	6,512,770
O&M PRESENT WORTH	141,471,641	148,433,952	103,904,766
CAPITAL COSTS	9,303,757	12,095,144	6,512,770
TOTAL PRESENT WORTH	150,775,398	160,529,096	110,416,536

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GATE AND SIGNS

DESCRIPTION:	QUANTITY TIME	R ($)	MATERIAL $	LABOR $	EQUIPMENT $	TOTAL $
GATE	6.00	22.00	532.00	39.76		571.76
SIGNS	5.00	20.00	100.00			100.00
SUBTOTAL			632.00	39.76		671.76
INS. BURDEN AT 15%				5.17		5.17
SOC. BURDEN AT 17%				5.96		5.96
MATERIALS BURDEN AT 10%						
TOTAL DIRECT COSTS				50.89		682.39
INDIRECT COSTS AT 25%				29.82		29.82
FEE AT 10%						68.22
CONSTRUCTION AT 15% OF LABOR AND EQUIPMENT						7.63
TOTAL FIELD COSTS						788.64
HEALTH AND SAFETY AT 4%						31.55
ENGINEERING AT 5%						39.43
CONTINGENCY AT 20%						157.73
TOTAL ACTIVITY COSTS						1,017.34

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APPENDIX Q

POLICY ON FLOODPLAINS AND WETLAND ASSESSMENTS

LEE 001

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

DRAFT

001468

OFFICE OF
SOLID WASTE AND EMERGENCY RESPONSE

MEMORANDUM

SUBJECT: Policy on Floodplains and Wetland Assessments for CERCLA Actions

FROM: William N. Hedeman, Jr., Director
Office of Emergency and Remedial Response

TO: Superfund Coordinators
Regions I-X

Response to releases of hazardous substances is often affected by floodplain and wetland issues. The policy we are adopting in regard to floodplains and wetlands is that Superfund actions must meet the substantive requirements of the Floodplain Management Executive Order (E.O. 11988), and the Protection of Wetlands Executive Order (E.O. 11990), (see attached), and Appendix A of 40 CFR Part 6, entitled Statement of Procedures on Floodplain Management and Wetland Protection. The purpose of Appendix A of 40 CFR Part 6 is to set forth policy and guidance for carrying out the provisions of Executive Orders 11988 and 11990.

For removal actions, the on-scene coordinator (OSC) should consider, whenever possible considering the exigencies of the situation, the effect the reponse action will have on floodplains and wetlands. For remedial actions, a floodplain/wetlands assessment must be incorporated into the analysis conducted during the planning of the remedial action.

This memo discussess when a floodplains or wetlands assessment should be prepared and the factors which should be considered when preparing this assessment.

I. Background

A. Floodplains

Floodplains are relatively flat areas or lowlands adjoining the channel of a river, stream or water course which have been or may be covered by floodwater. A flood is a general and temporary condition of partial or compete inundation of normally dry land areas from the overflow of inland and/or tidal waters and/or the unusal and rapid accumulation or runoff of surface waters from any source. A reference to a floodplain should be accompanied by a modifier indicating the level of flooding, e.g. 100 year floodplain (one percent chance of flooding in any year).

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Executive Order 11988 - Floodplain Management

Executive Order 11988 requires Federal agencies carrying out their responsibilities to take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health and welfare, and to restore and preserve the natural and beneficial values served by floodplains. To do this, Federal agencies must evaluate the potential effects of any actions they may take in a floodplain to ensure that their planning programs and budget requests reflect consideration of flood hazards and floodplain management, including the restoration and preservation of such land areas as natural undeveloped floodplains. This order emphasizes the importance of evaluating alternatives to avoid effects and incompatible development in the floodplains, of minimizing the potential harm to floodplains if the only practicable alternative requires siting an action in a floodplain and providing early and adequate opportunities for public review of plans and proposals involving actions in floodplains.

B. Wetlands

Wetlands are land areas which, because of their frequent inundation by surface or groundwater can support vegetative or aquatic life that requires saturated soil conditions. Wetlands generally include but are not limited to swamps, marshes, bogs and similar areas such as sloughs, pot holes, wet meadows, river overflows, mud flats and natural ponds.

Executive Order 11990 - Protection of Wetlands

Executive Order 11990 requires Federal agencies in carrying out their responsibilities to take action to minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands. The order emphasizes the importance of avoiding undertaking new construction located in wetlands unless there is no practicable alternative to that construction, minimizing the harm to wetlands if the only practicable alternative requires construction in the wetland and providing early and adequate opportunities for public review of plans and proposals involving new construction in wetlands.

C. Statement of Procedures on Floodplain Management and Wetlands Protection - Appendix A to 40 CRF Part 6

EPA has promulgated regulations implementing procedures on the National Environmental Policy Act (NEPA) at 40 CFR Part 6. Appendix A of Part 6 (Appendix A) deals with procedures on Floodplain Management and Wetland Protection. The purpose of Appendix A is to set forth Agency policy and guidance for carrying out the provisions of Executive Orders 11988 and 11990.

Appendix A provides that it is the intent of these Executive Orders that, wherever possible, Federal agencies implement the floodplains/wetlands requirement through existing procedures, such as those internal procedures established to implement NEPA. In those instances where the environmental impacts of a proposed action are not significant enough to require an environmental impact statement (EIS) pursuant to section 102(2)(C) of NEPA, or where programs are not subject to the requirements of NEPA, alternative but equivalent floodplain/wetlands evaluation and public comment and notice procedures must be established. Furthermore, Appendix A prescribes the requirements for floodplain/wetlands review of proposed EPA actions.

II. REMOVAL ACTIONS

Removal actions are exempt from compliance with Section 102(2)(C) of NEPA due to the fundamental conflict in statutory purpose between EIS requirements and EPA's removal authority. This conflict arises from the fact that it would be virtually impossible for EPA to follow the lengthy EIS process and at the same time expeditiously undertake removal actions. For the same reasons, removal actions are not required to have alternative but equivalent floodplain/wetlands assessments and public notice and comment procedures. In view of the focus of removals on emergency and near emergency situations, it is evident that the Agency's removal authority would be seriously undermined if the Agency, as a pre-condition to initiating removal actions, was required to complete the equivalent of an EIS for floodplain and wetlands evaluation.

However, as part of the preliminary assessment for removal actions, the OSC or lead Agency should consider, whenever possible considering the exigencies of the situation, the following: whether or not the action will be located in or affect a floodplain or wetland; the impact of the action on the floodplain or wetland; the alternatives available; and measures to minimize potential harm to the floodplain or wetland if there is no practicable alternative to locating in or affecting floodplains or wetlands. In the OSC's discretion, considering the exigencies of the circumstances, the OSC may consult with the Regional 404 staff (under Clean Water Act) when wetlands/floodplains are involved or suspected to be involved.

For removal actions, a spokesperson will be designated by the lead agency to inform the communities of actions being taken, to respond to inquiries and to provide information concerning the release. If the exigencies of the situation permit, the floodplain/wetland measures mentioned above should be included in the spokesperson's presentation.

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III. REMEDIAL ACTIONS

An EIS required by Section 102(2)(C) of NEPA is unnecessary for remedial actions provided the Agency complies with the standards for a functional equivalent exception to the EIS requirement. To comply with the functional equivalent exception the agency must have expertise in environmental matters and meet the following criteria. First, the agency's authorizing statute must provide substantive and procedural standards that ensure full and adequate consideration of environmental issues. Second, the agency must afford an opportunity for public participation in the evaluation of environmental factors prior to arriving at a final decision.

A. Consideration of Environmental Issues

Remedial actions satisfy the first criterion for a functional equivalent exception because of the mandate for environmental assessment contained in Section 104 of CERCLA and the procedural safeguards developed by EPA for the remedial planning process. The language in Section 104, that directs that remedial actions be necessary to protect public health, welfare, and the environment, establishes a standard mandating consideration of environmental effects. Moreover, the procedures set forth in the National Contingency Plan (NCP) establishes a process for conducting an analysis during the planning of remedial actions that is basically similar to the evaluation underlying an EIS. This analysis is contained in the Remedial Investigation/Feasibility Study (RI/FS). Therefore, for a remedial action to comply with the alternative but equivalent floodplain/wetland evaluation contained in Appendix A of 40 CFR Part 6, a floodplain/wetlands assessment must be incorporated into the analysis conducted during the planning of remedial actions which is established by the NCP.

During the scoping of remedial response actions, the Remedial Project Manager (RPM) or the lead Agency should identify any floodplain or wetlands located within the site area or that could be affected by the response action. If the area is predominately privately owned, the RPM or the lead agency shall consult with the Federal Insurance Administration of the Federal Emergency Management Agency (FEMA) which has two maps that will be useful in identifying floodplains. The Flood Insurance Rate Map (FIRM) shows the boundaries and elevations of the 100 and 500 years floodplains. The other map, Flood Hazard Boundary Map (FHBM), shows the appropriate area of the 100 years zone. A copy of these maps can be obtained by calling 1-800-638-6620. For areas predominately State or Federally owned, consult with the controlling Federal or State agency. Maps are available for some wetland areas from the Fish and Wildlife Service (National Wetlands Inventory Maps) or from local and State planning agencies.

If there are no floodplains/wetlands located within the site area or that could be affected by a response action, the feasibility study should so state, and the response action may proceed without

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further consideration of the procedures set forth below. However, if the site is located within a flooplain/wetland or if the proposed remedial action would affect a floodplain/wetland, the RPM or the lead agency must conduct a floodplain/wetland assessment which will be integrated into the feasibility study. In the RPM's discretion, the RPM may consult with the Regional 404 staff (under Clean Water Act) when conducting a floodplains/wetlands assessment. Floodplain/Wetland assessments shall consist of a description of the proposed action, a discussion of its effect on the floodplain/wetlands, a description of the alternatives considered and their effects on the floodplains and wetlands, and measures to minimize potential harm to the floodplain/wetland if there is no practicable alternative to locating in or affecting floodplain/wetlands.

FLOODPLAIN ASSESSMENT OF ALTERNATIVES

In assessing the alternatives and their effects on the floodplain and floodplain protection, the RPM or lead Agency should consider such factors as environmental effects, community welfare, cost and technology. All possible alternatives must be considered including the no action alternative. If one or more of the alternatives will be located in a floodplain, those alternatives may not be selected unless a determination is made that no practicable alternatives exists outside the floodplain.

If no practicable alternatives exists outside the floodplain, and the RPM or lead agency has determined or proposes to allow a remedial action to be located in a floodplain, then the RPM or lead agency shall act to minimize potential harm or avoid adverse effects to the floodplain. This includes acting to restore and preserve the natural and beneficial values of floodplains. The benefits of preserving floodplains in their natural or relatively undisturbed state include not only reduction of flood hazards, but maintenance of water quality standards, replenishment of groundwater, soil conservation, the fostering of fish, wildlife and plant resources and the provision of recreational areas.

The following are possible methods for minimizing potential harm to floodplains. This list, however, does not preclude the RPM or lead agency from using other measures that minimize potential harm or avoid adverse effects to floodplains.

1. Use minimum grading requirements;
2. Return site to natural contours;
3. Maintain floodplain vegetation to reduce sedimentation;
4. Regulate methods used for grading, filling, soil removal, and replacement to reduce sedimentation;
5. Require topsoil protection program;
6. Raise site above the floodplain;
7. Construct new structures or facilities in floodplains in accordance with accepted floodproofing and other flood protection measures and elevate structures above the base flood level rather than filling in land, wherever practicable.

WETLAND ASSESSMENT OF ALTERNATIVES

In assessing the alternatives and their effects on wetlands, the RPM or lead agency should consider such factors as environmental effects, community welfare, cost and technology. All possible alternatives must be considered including the no action alternative. If one or more of the alternatives will be located in a wetland, those alternatives may not be selected unless a determination is made that no practicable alternative exists outside the wetlands.

If no practicable alternative exists outside the wetlands, and the RPM or lead agency has determined or proposes to allow a remedial action to be located in a wetlands, then the RPM or lead agency shall act to minimize potential harm or to avoid adverse effects to the wetlands. This includes action to restore and preserve the natural and beneficial values of the wetlands. The benefits of preserving wetlands in their natural or relatively undisturbed state include the control of flood and storm hazards, maintenance of water quality standards and water supply, maintenance of natural systems, natural pollution abatement, conservation and long term productivity of existing flora and fauna, species. and habitat diversity and stability, hydrologic utility, fish, wildlife, timber and food resources, and other uses of wetlands. in the public interest including recreational, scientific and cultural uses. All impacts caused by an action occurring in a wetland must be evaluated and mitigated according to any EPA mitigation policy (or EPA Regional interim mitigation policy) in effect at the time of the proposed action, including the effects on the wetlands natural or beneficial value.

DOCUMENTATION OF DECISION

For all lead agency response actions proposed to be in or affecting a floodplain/wetland the RPM or lead agency shall document their decision in the Record of Decision (ROD). The decision shall be accompanied by a Statement of Findings, not to exceed three pages that includes (i) The reasons why the proposed action must be located in or affect the floodplain or wetlands; (ii) a description of significant facts considered in making the decision to locate in or affect the floodplain or wetlands including alternative sites and actions; (iii) a statement indicating whether the proposed action conforms to applicable State or local floodplain protection standards; (iv) a description of the steps taken to design or modify the proposed action to minimize potential harm to or within the floodplain or wetlands; and (v) a statement indicating how the proposed action affects the natural or beneficial values of the floodplain or wetlands.

B. Opportunity for Public Participation

Remedial actions satisfy the second criterion for a functional equivalent exception because current Agency procedures for public comment on remedial actions afford the public an ample opportunity for participation in the evaluation of environmental

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factors prior to arriving at a final decision.

Appendix A, however, appears to require two further public notice requirements. One is any early public notice when it is apparent that a proposed or potential agency action is likely to impact a floodplain or wetlands and the other is public notice of the selected decision.

Current Agency procedure requires that a fact sheet summarizing the feasibility study response alternatives and other issues, be provided to the public two weeks prior to the 3 week public comment period for the feasibility study. The fact sheet will include a statement explaining whether a proposed or potential remedial action is likely to impact a floodplain or wetlands. The feasibility study may be included with the fact sheet, if possible, resulting in a five week public comment period. The fact sheet will satisfy the early public notice required by Appendix A.

Furthermore, current Agency procedure requires that a public notice and updated fact sheet summarizing the ROD be provided to the public. The ROD is also available for public review. The fact sheet will contain the alternative selected, any effects the response action will have on floodplain/wetlands, and the Statement of Findings described in the Documentation of Decision Section above. In addition, upon completion of the final engineering design another public notice and updated fact sheet should be prepared. Prior to selecting the final engineering design, the Agency may hold a public meeting to inform the public of the design alternatives and solicit comments. The public notice and fact sheet and the availability of the ROD to the public will satisfy the requirement for public notice of the selected decision.

COMPLIANCE WITH OTHER FLOODPLAIN/WETLAND LAWS

The Agency has concluded that CERCLA cleanups need not comply with other Federal environmental standards, as a matter of law, but that as a matter of policy, they should, except in very limited circumstances. (See attached memo, "CERCLA Compliance with other Environmental Statutes"). In addition, Federal public health and environmental criteria and advisories and State standards shall be used, with appropriate adjustment, in determining the appropriate response action. Therefore, the Agency should attempt to conform to applicable state and local floodplain/wetland protection standards.

If the Agency does not comply with applicable State and local standards, the reason why should be documented in the record of decision. Furthermore, the Agency must be aware of the existing Federal laws that regulate wetlands. Section 10 of the Rivers and Harbors Act of 1899 and Section 404 of the Clean Water Act apply to dredge and fill activities and must be complied with

except in very limited circumstances. (See "CERCLA Compliance with other Environmental Statutes"). In particular the Section 404(b)(1) Guidelines promulgated by EPA should be considered in evaluation impacts and alternatives. In addition, the Administrator of EPA can prohibit the filling of wetlands if he determines such activities will have an unacceptable adverse impact on municipal water supply, shellfish beds, fisheries, wildlife or recreational areas.

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APPENDIX R

UNIT CREW FOR VARIOUS TECHNOLOGIES

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Clearing

1 foreman
4 laborers
1 equipment operator
1 chipping machine
1 frontend loader

Fill

1 equipment operator
.5 building laborer
2 truck drivers
2 dump trucks
1 dozer

Excavation

1 equipment operator
.5 building laborer
Frontend loader, 5.5 cy

Grading

1 equipment operator
.5 building laborer
.25 equipment operator
1 scraper - 24 cy
.25 dozer - 300 Hp

Trench Construction

1 equipment operator
1 building laborer
1 backhoe loader

Hauling

1 truck driver
1 truck tractor 40 ton
1 dump trailer 20 cy

Hauling to Disposal Site[2]

1 truck driver
1 truck

Placement

1 equipment operator
.5 building laborer
2 truck drivers
2 dump trucks
1 dozer

Compaction

1 equipment operator
.5 building laborer
1 vibratory drum roller

(1) Robert Snow Means Co., Inc., Means Site Work Cost Data. Robert Sturgis Godfrey, Pub., Kingston, MA. 1984.

(2) Personal Communication, Chem Waste Management, Emele, Alabama. June 1985.