PERFORMANCE OF REMEDIAL RESPONSE ACTIVITIES AT UNCONTROLLED HAZARDOUS WASTE SITES (REM II)

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DRAFT FINAL OFFSITE FEASIBILITY STUDY REPORT FOR LIPARI LANDFILL

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OFFSITE FEASIBILITY STUDY REPORT FOR LIPARI LANDFILL

EXECUTIVE SUMMARY

This offsite feasibility study addresses those geographical areas outside the existing slurry wall/synthetic membrane encapsulation system (the "onsite" portion) of the LiPari Landfill. The study identifies response objectives and criteria and screens technologies for remediating the offsite areas in accordance with Federal, State, and local statutes, including the National Contingency Plan (NCP) and the Superfund Amendment and Reauthorization Act (SARA). In the study, remedial alternatives have been developed through technical, environmental, public health, and institutional screenings. Detailed analyses are performed of each of the candidate remedial technologies to determine its implementability, ability to meet remediation objectives, and cost-effectiveness.

1. BACKGROUND AND GENERAL INFORMATION

LiPari Landfill is located in Gloucester County, New Jersey, about 15 miles south of the Greater Philadelphia metropolitan area. The offsite study area, which lies in the drainage basin east-northeast of the landfill, includes Alcyon Lake, the Chestnut Branch marsh area, three tributary streams of Chestnut Branch (Rabbit Run, Girl Scout Branch, Lost Lake Run), and three public parks (Alcyon Park, Hollywood Dell Park, Betty Park) that surround Alcyon Lake. The area's land use ranges from undeveloped wooded and recreational lands to agricultural, residential, commercial, and industrial uses. A residential area lies northeast of the site and east of Chestnut Branch. Most of the immediate area is surrounded by the Zee Orchard.

Alcyon Lake, a manmade lake with a surface area of approximately 18.5 acres, first showed signs of deterioration in the 1950s. The lake is now eutrophic. The lake's deterioration has been the result of a number of factors, including point and nonpoint pollution sources; in 1980, Gloucester County identified LiPari Landfill as an important source of the adverse water quality in the Lake.

LiPari Landfill operated from 1958 until 1971. Although the precise nature of the wastes dumped there is unknown, liquid wastes disposed at the site are reported to have included solvents, paints and paint thinners, phenol and amine wastes and residues, as well as resins and ester press cakes. In 1971, the landfill was closed after inspectors from the New Jersey Department of Health observed leachate seeping from the landfill and discharging into adjacent portions of Chestnut Branch. Odors associated with the seepage were reported by neighboring residents.

Since the landfill's closing, a number of investigations and studies have been carried out at the landfill, including the REM II remedial investigation/feasibility study performed by Camp Dresser & McKee (CDM), which began in 1985. The alternative eventually selected by the U.S. Environmental Protection Agency (EPA) for onsite remediation was the "batch-flushing" alternative, which involves the installation of extraction and injection wells within the encapsulation system to dewater and flush water-borne contaminants for treatment at an onsite facility. It is important to note that the long-term success of any remedial action taken in the offsite areas will be directly affected by the effectiveness of the onsite remedial action. Potentially, contaminants may seep through the slurry wall during flushing, but EPA's record of decision (ROD) of September 30, 1985, specifies that this will be mitigated by an offsite collection system and that the start-up of batch-flushing onsite will not begin until an offsite collection system is in place.

Geological and Hydrogeological Characteristics of the Offsite Area

Geology and hydraulic characteristics of unconsolidated sediments are important when evaluating the potential migration of hazardous wastes through water bearing zones. The Cohansey Sand outcrops over the southeastern portion of Gloucester County and is predominant in the surface geology of the LiPari Landfill offsite area. In addition to the Cohansey, the Kirkwood and other formations outcrop within three miles of the LiPari Landfill. The Kirkwood is a minor aquifer in Gloucester County, tapped mainly in its outcrop area.

In Glassboro, Pitman, and Mantua townships, ground water withdrawal constitutes the primary source of water for domestic, agricultural, and industrial purposes. Municipal water is drawn from the Raritan-Magothy formation at depths that are considered isolated from any potential contaminant migration.

Biotic Characteristics of the Offsite Area

The biotic community in the offsite area is comparable to that of other rural/suburban land use areas of Gloucester County. Although the habitats (streams, a lake, parks) in the offsite area are limited in size, they are designated as environmentally sensitive by the Gloucester County Development Management Plan. These habitats' importance derives both from their support of fish and wildlife and from their proximity to land used for agriculture.

Flora. The floral habitat in the Chestnut Branch marsh area is riparian in character. The public parks in the area contain typical suburban park vegetation. Vascular aquatic plants in Alcyon Lake and the adjacent Zee Pond are limited to spatterdock and milfoils, and algal surveys in these bodies have had quite inconsistent results, claiming both low and high species diversity and quantity.

Fauna. Faunal populations in the offsite area are qualitatively similar to other stream and lake environments in rural suburban settings in the Delaware River watershed. Although carp predominate, other fish are supported by Alcyon lake.

2. OFFSITE REMEDIAL INVESTIGATION RESULTS

In the offsite RI, several types of media were sampled, and a list of indicator chemicals was developed. A baseline or "no action" risk assessment was performed to determine the potential risks and hazards to human health from the LiPari Landfill offsite areas in the absence of remediation.

Specific offsite areas have been identified as requiring consideration for remedial action due to the presence of certain contaminants detected in these areas. These contaminants are present at levels in one or more of the following categories; exceed background levels by an order of magnitude, present at concentrations that pose an unacceptable public health risks, present at concentration that violate environmental standards. These contaminated media are the <u>Chestnut Branch marsh soils</u>, the <u>sediments underlying Rabbit Run, Alcyon Lake</u> and <u>Chestnut Branch below the Alcyon Lake spillway</u>, and the <u>Kirkwood Aquifer</u>. The most significant risks associated with the marsh soils are those associated with potential inhalation of volatile organic compounds (especially BCEE, benzene, and 1,2-dichloroethane) and potential ingestion of arsenic. Contaminants in the sediments of Rabbit Run have been identified as metals and BCEE. In Alcyon Lake's sediments, arsenic and mercury were detected at levels greater than background. Other metals are present as well as a number of organic contaminants. The soils in the public parks in the offsite area also have a potential ingestion risk associated with arsenic and lead. However, the levels detected in the parks are comparable to background soil levels in the area.

It is notable that the potency factor used in the public health assessment for arsenic has undergone considerable review in the past few years. It is expected that the present value will be reduced in the near future. Appendix A to this document contains recent information regarding pending changes in the values used in arsenic risk assessments. The impacts on the offsite areas containing arsenic would be to downgrade the previous risks to the extent that they would no longer pose an elevated (greater than 10^{-6}) risk. For the purposes of evaluating alternatives in this document, the previous risk numbers for arsenic have been utilized.

SARA requires that Superfund-financed remedial actions comply with requirements or standards under Federal and State environmental laws. These requirements are those that are legally applicable or relevant and appropriate (ARARs) to particular substances or the circumstances of their release. Interim guidance has been developed to define the nature, scope, and use of ARARs. Applicable requirements principally include the Safe Drinking Water Act maximum contaminant levels, Clean Water Act water quality criteria, and Resource Conservation and Recovery Act (RCRA) alternative concentration limits. Relevant and appropriate requirements include standards, requirements, criteria, and limitations promulgated under Federal or State laws that address problems similar to those encountered at Superfund sites.

3. SCREENING OF REMEDIAL TECHNOLOGIES

A number of technologies for treating contaminated soil and for ground water recovery were subjected to, (1) technical screening and (2) environmental, public health, and institutional screening. Technologies that were retained for further consideration after these two kinds of evaluation were then used to develop specific alternatives (section 4 of this summary) that were subjected to detailed analyses (section 5). Technologies to treat contaminated ground water were not considered in the offsite feasibility study because it is assumed that any seepage from the LiPari Landfill or any ground water recovered from the Kirkwood aquifer will be transported to the onsite treatment facility for treatment as indicated in the intent of the September 30, 1985 ROD.

Technical Screening

To pass the technical feasibility screening, technologies had to be feasible for the location and had to present reliable means for solving specific problems.

Environmental, Public Health, and Institutional Screening

Technologies retained after technical screening were then screened to identify any adverse impacts on the environment or public health that would preclude their use in remediating the LiPari offsite area.

Cost Screening

Where two or more technologies have equivalent benefits in terms of overall remediation, they may be subjected to a comparative cost-screening analysis. This was not the case for the technologies just considered. However, costs associated with transportation and disposal at the various possible TSD facilities were compared. Only three of the TSD facilities under consideration reported themselves able to accept the waste; of these, Chemical Waste Management's disposal facility in Model City, New York, provided the most cost-effective option. The other facilities were screened from further consideration. A similar comparison for costs was performed for disposal of treated material as a non-hazardous waste.

4. DEVELOPMENT OF REMEDIAL ALTERNATIVES

Through the technical and the environmental, public health, and institutional screenings summarized above, appropriate technologies were identified from which specific alternatives were then formulated to remediate soil in Chestnut Branch marsh and sediments in Rabbit Run, Alcyon Lake, and Chestnut Branch and to recover seepage from the landfill slurry wall and ground water for treatment in the onsite facility.

Remedial alternatives for marsh soil have been developed under the assumption either that an offsite collection system will be in place before the selected alternative is implemented or that the collection system will begin operation in tandem with the implementation of the selected alternative.

So that the remedial action objectives, as outlined under SARA, of meeting or exceeding applicable or relevant and appropriate requirements (ARARs) and of protecting public health and the environment may be achieved, contaminants in the offsite LiPari Landfill area must be treated to reduce their toxicity, mobility, or volume, or exposure pathways must be eliminated to prevent exposure either by controlling the source of contamination or access to the contaminated areas by potential receptors. Candidate remedial alternatives for contaminated soils and sediments can be placed in four categories based on EPA draft guidance language:

I. Alternatives that offer a permanent solution and eliminate the need for long-term management

II. Alternatives with treatment or resource recovery as their principle element and that reduce toxicity, mobility, or volume of contaminants

III. Alternatives that rely on containment, with little or no treatment

IV. No action

Each remedial action falls into one or more of these categories. Monitoring to determine the effectiveness of the selected alternative(s) will be an integral part of the remedial design plan. The candidate recovery and remedial alternatives are as follows:

<u>Offsite Collection System Alternatives</u>

Alternative 1 - <u>Well points west of seepage face in Cohansey Sand</u>. Involves placing a line of well points in the Cohansey Sand aquifer between the landfill slurry wall and the seepage face to capture contaminated water and prevent its migration. This alternative would be implemented with marsh soil alternatives 4, 5, 6, 7, 8, 9, or 10.

Alternative 2A - <u>Drainage ditch near seepage face</u>. Involves placing a drainage (seepage) ditch along the run of the seepage face east of the slurry wall to capture contaminated water and to prevent its migration. This alternative would be implemented with marsh soil alternatives 4, 5, 6, 7, 8, 9, or 10.

Alternative 2B - <u>Drainage ditch near seepage face with cap</u>. Differs from alternative 2A only in that a cap is placed over the ditch and seepage face to prevent volatile emissions and to limit rain water infiltration.

Alternative 3 - <u>Well points east of seepage face in alluvium</u>. Involves placing a line of well points in the alluvium between the seepage face and Chestnut Branch/Rabbit Run to capture the seepage and associated contaminated water and to prevent its migration. This alternative would be implemented with marsh soil alternatives 4, 5, or 6.

Marsh Soil Remediation Alternatives

Alternative 4 - No action to remediate soil in Chestnut branch marsh. Involves taking no action to treat, contain, or remove contaminated soil in the marsh. Requires long-term monitoring to determine whether source control effected by the offsite collection system is stabilizing contamination in the marsh or allowing the marsh to cleanse itself naturally.

Alternative 5 - Complete or partial permeable soil cover to reduce public health risks. Involves placing a complete or partial permeable cover in the marsh to reduce VOC emissions and prevent exposure to contaminated soil. Construction would involve dewatering the work area, removal of vegetation and topsoil, grading underlying soils to achieve an even slope, emplacement of filter materials and permeable sand/gravel cover, and vegetation of the soil cover. Either cover would have sufficient permeability to transmit rain or ground water.

Alternative 6 - Complete or partial permeable soil cover with impermeable cap to reduce public health risks. Involves placement in the marsh of a complete or partial impermeable cap in addition to the permeable soil cover of alternative 5. Construction stages are the same as those listed under alternative 5 except that the impermeable geomembrane liner would be installed over the permeable cover before the area is revegetated. This alternative would reduce uncontrolled VOC emissions and prevent exposure to contaminated soil, and, because of the addition of the cap, would prevent runoff infiltration.

Alternative 7 - Soil excavation and removal to meet background cleanup guidelines and use of disposal option A or B (see below for explanations of disposal options). Involves excavating contaminated soil from the entire Chestnut Branch marsh and subsequent onsite or offsite disposal, without prior treatment, at a RCRA-permitted facility. Excavation activities include dewatering the area, clearing and grubbing vegetation, excavation, staging and disposal of contaminated soil, soil replacement and compaction, and revegetation of the marsh.

Alternative 8 - Soil excavation and removal to reduce public health risks from VOC emissions and use of disposal option A or B. Involves excavating contaminated soil only from zone 3--i.e., the zone identified as posing the greatest public health risks due to VOCs. Disposal would be at an onsite or offsite RCRA-permitted facility.

Alternative 9A - Soil excavation and removal to meet background cleanup guidelines, treatment to reduce VOCs, and disposal of soil back in the marsh. Differs from alternative 7 only in that soil would be treated to reduce VOCs and would then be disposed back in the marsh. Soil treatment would occur in a rotary dryer unit at temperatures sufficient to volatilize all VOCs present in soil.

Alternative 9B - Soil excavation and removal to meet background cleanup guidelines, treatment to reduce VOCs, and disposal of treated soil as a non-hazardous waste. Differs from Alternative 9A only in that soil would be disposed as a non-hazardous waste.

Alternative 10A - Soil excavation and removal to reduce public health risks from VOC emissions, treatment to reduce VOCs, and disposal of treated soil back in the marsh. Differs from alternative 9 only in that the amount of soil treated to reduce VOCs would be much less. As in alternative 8, contaminated soil would be removed only from zone 3.

Alternative 10B - Soil excavation and removal to reduce public health risks due to VOC emissions, treatment to reduce VOCs and disposal of treated soil as a non-hazardous waste. Differs from alternative 10A only in that soil would be disposed as a non-hazardous waste.

Lake Sediment Remediation Alternatives

Alternative 11 - No action to remediate sediments in Alcyon Lake. Involves taking no action to treat, contain, or remove contaminated sediments in Alcyon Lake. Public access to and recreational use of the lake would continue to be restricted. No monitoring program is proposed for this alternative since future contaminant levels will depend upon the success of the remedial alternative(s) selected for the Chestnut Branch marsh and the Kirkwood aquifer, and alternatives proposed for the marsh and the aquifer all include associated monitoring programs.

Alternative 12A - Dredging and removal of sediments from Alcyon Lake to meet background cleanup guidelines and use of disposal option A or B. Involves the hydraulic dredging of sediments from Alcyon Lake to meet cleanup criteria. To minimize the potential for increased turbidity downstream, a silt curtain would be installed before dredging activities begin and/or the water in the lake could be lowered to minimize flow over the spillway. Filter presses would be used to dewater the sediments. Dredged sediments would be disposed at an onsite or offsite RCRA-permitted facility.

Alternative 12B - Dredging and removal of sediments from Alcyon Lake to meet cleanup guidelines, treatment to reduce VOCs, and disposal of treated sediments as a non-hazardous waste. Differs from alternative 12A in that sediments would be thermally treated to reduce any VOCs, then disposed as a non-hazardous waste.

Rabbit Run Remediation Alternatives

Alternative 13 - No action to remediate sediments in Rabbit Run. Involves taking no action to treat, contain, or remove contaminated sediments in Rabbit Run. Changes in the contaminant levels in the stream would be monitored through annual surface water and sediment samples.

Alternative 14A - Dredging and removal of sediments from Rabbit Run to meet cleanup guidelines and use of disposal option A or B. Involves dredging sediments from Rabbit Run to meet cleanup guidelines. Sediments would be disposed in an onsite or offsite RCRA-permitted facility. Before dredging begins, a silt curtain would be constructed at the mouth of the stream to minimize increased turbidity in Chestnut Branch. Sediments would be mechanically dredged with a backhoe. Dewatering would be accomplished in dewatering basins.

Alternative 14B - Dredging and removal of sediments from Rabbit Run to meet cleanup guidelines, treatment to reduce VOCs, and disposal as a non-hazardous waste. Differs from alternatives 14A in that sediments would be thermally treated to reduce any VOCs, then disposed as a non-hazardous waste.

Kirkwood Aquifer Ground Water Recovery Alternatives

Alternative 15 - No action to pump and treat Kirkwood Aquifer. Involves taking no action to intercept contamination that may persist in the aquifer.

Alternative 16 - Pumping and treatment of Kirkwood Aquifer. Involves installing a series of wells to intercept contamination within the aquifer. Capture of the contaminant plume would be evaluated by monitoring piezometric levels and ground water quality at surrounding monitoring wells screened in the Kirkwood Sand.

Chestnut Branch Remedial Alternatives

Alternative 17 - No Action to remediate the sediments in Chestnut Branch below the spillway. Involves taking no action to treat, contain, or remove contaminated sediments from Chestnut Branch below the spillway at Alcyon Lake.

Alternative 18A - Dredging and removal of sediments from Chestnut Branch below the spillway to meet cleanup guidelines and the use of disposal option A or B. Involves the same action as that taken for alternative 14A except it would be performed at Chestnut Branch below the spillway.

Alternative 18B - Dredging and removal of sediments from Chestnut Branch below the spillway to meet cleanup guidelines, treatment to reduce VOCs, and disposal as a non-hazardous waste. Differs from alternative 18A in that sediments would be thermally treated to reduce any VOCs, then disposed as a non-hazardous waste.

Interim Measure for Chestnut Branch Marsh

Alternative 19 - Placement of a temporary marsh cap over zone 3, to reduce volatile emissions posing a potential public health risk. Involves taking interim action to place a cap over zone 3 only if a remedial action (other than the no action alternative) is selected but not implemented in a timely manner as determined by EPA. This alternative does not assume that any of the offsite collection system alternatives are in place.

Disposal Options

Option A - Construction of a RCRA-permitted landfill for disposal of contaminated soil and/or sediment. Involves obtaining a parcel of property in the adjacent Zee's Orchard on which to construct the facility. Construction would be in accordance with RCRA standards (including, among other features, a bottom liner, primary and secondary leachate collection systems, a final cover, and a methane venting system). The acreage and height of the landfill would be scaled according to the volume the landfill must contain. Soil excavated to make room for the landfill would be backfilled into Chestnut Branch marsh and used to construct a sediment basin.

Option B - Disposal of contaminated soil and/or sediment at an offsite RCRA-permitted facility. Involves containerizing and transporting (in dump trailers with protective linings and seals) the contaminated soil and/or sediment to Chemical Waste Management's RCRA-permitted TSD facility in Model City, New York. An analysis for RCRA parameters would be required before soils and/or sediments could be accepted by the facility.

Non-hazardous waste disposal options

These options involve determining that treated soils and sediments would be considered as non-hazardous waste. Once this determination was made, the material could be placed in locations/facilities besides a RCRA-permitted Title C TSD facility. The options considered in this study include Alcyon Racetrack, the Gloucester County Municipal landfill, the Montgomery County Suburban Landfill in Pennsylvania and on top of the LiPari Landfill.

5. DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

Each of the candidate remedial technologies was evaluated in detail to examine it against the broad factors of effectiveness, implementability, and cost.

Screening Requirements under SARA

The following paragraphs described the screening categories that were established to meet the technical, protectiveness, and institutional detail screening requirements under SARA.

Technical feasibility. This category considered factors such as the ability to construct an alternative, its short-term reliability, the ability to monitor its effectiveness, and the technology's ability to reduce toxicity, mobility, or volume or to provide a permanent solution.

Ability to meet ARARs or other Federal or State advisories or guidance. This category considered the ability of an alternative to meet ARARs. Because ARARs are not available for all circumstances that may be encountered at a Superfund site, the ability of an alternative to meet other State or Federal requirements was also considered. Only alternatives that meet ARARs and/or are able to reduce public health risks were considered more desirable than others. Alternatives that are able to achieve cleanup to background levels were not considered necessarily more desirable since there is no indication that cleanup guidelines based on background limits would be more protective of public health or the environment.

Environmental assessment. This category considered the potential adverse and beneficial impacts associated with implementation of the various alternatives.

Public health assessment. This category considered the degree of protection afforded to human health by each alternative, the risk to the community and to workers during remedial actions, the time until protection is achieved, the long-term reliability of each alternative, and the potential need for eventual replacement.

Community perception. This category considers the potential reaction of members of the local community to the implementation of each remedial alternative. The community's perception is affected by several variables, especially the timeliness of the response and the degree of protection it offers. (Timely responses that provide permanent solutions to contamination problems will obviously be perceived most favorably.)

Resource availability. This category considers resource availability since the ability to complete remediation within a reasonable amount of time ultimately depends upon the availability of equipment, materials, and trained personnel necessary for the task.

Costs

For each remedial action alternative, costs were estimated for initial capital investment and annual operations and maintenance (O&M). In order to be conservative, the highest level of worker protection that could possibly be required in remediating the hazardous environments of the offsite area was factored into the estimates. Peripheral costs such as mobilization, site security, and residue disposal were considered. A 35 percent allowance for engineering and contingencies was also included in the total capital costs. Annual ground and surface water monitoring costs were included in O&M for offsite collection alternatives, as were approximate treatment costs for water pumped from these systems to the onsite treatment plant. Contingencies of 10 percent and administrative costs of 10 percent were included in O&M costs. Additionally, a present-worth analysis was conducted for each alternative, assuming a 30-year lifetime and a discount rate of 10 percent in accordance with EPA guidance.

Table Summary of Evaluations and Cost Information for Each Alternative

The table that appears on the following pages summarizes the results of the detailed analyses of each of the ground water recovery and soil or sediment remediation alternatives and of disposal options A and B as well as the post-treatment locations. Cost information is also provided concerning each alternative and disposal option.

1.0 INTRODUCTION

1.1 PURPOSE

The purpose of this document is to identify response objectives and criteria and develop, screen and evaluate alternatives to remediate the offsite LiPari Landfill areas in accordance with Federal, State, and local statutes including the National Contingency Plan (NCP) and the Superfund Amendments and Reauthorization Act (SARA). The remedial alternatives were developed subsequent to a technical, environmental, public health, and institutional screening of technologies which could be used alone or in combination with other technologies or containment or disposal options to meet the remedial action objectives. A detailed evaluation was then performed of each candidate remedial alternative to determine its implementability, ability to meet the remedial action objectives, and relative cost-effectiveness.

1.2 BACKGROUND

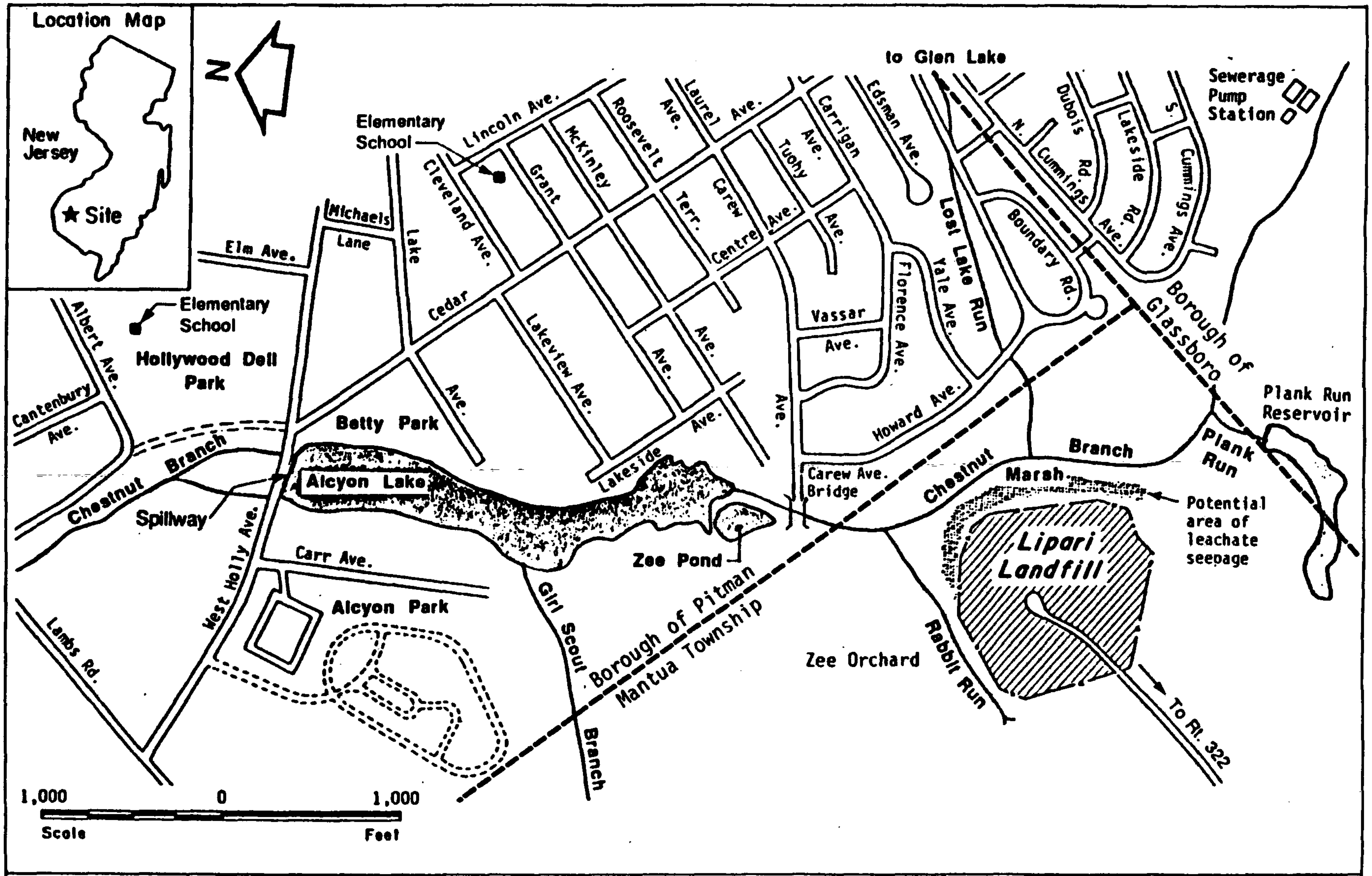
This offsite feasibility study addresses those geographical areas outside of the existing slurry wall/synthetic membrane encapsulation system of the LiPari Landfill. This system, referred to as the "onsite" portion of the LiPari Landfill, was constructed in 1983-1984 and effectively segregates those areas of formerly active landfilling from the surrounding environment, or "offsite" areas. This study is designed to complement the LiPari Landfill Offsite Remedial Investigation - Phase I and Phase II (CDM, June 1987; CDM, October 1987), and the Onsite Remedial Investigation/Feasibility Study (CDM, August 1985). These studies were performed by Camp Dresser & McKee Inc. (CDM) and the REM II team for the U.S. Environmental Protection Agency (EPA) under contract no. 68-01-6939. Although the study of the offsite area was originally a part of the onsite RI/FS, it was later designated as a separate study by EPA. This was considered to be warranted because of the presence of other point and nonpoint sources of pollution discharging into the offsite area in addition to contaminants from the LiPari Landfill. The offsite areas identified in this study are areas that have or are potentially impacted by the landfill. Other areas were investigated as part of this study to provide comparative or support data.

1.2.1 SITE DESCRIPTION

The LiPari Landfill was ranked number one on the October 1984 EPA National Priority List. The study area considered in this report encompasses a mix of agricultural and residential properties located in Mantua Township and the Borough of Pitman in Gloucester County, New Jersey (see figure 1-1, General Area Plan). The offsite area includes the drainage basin east-northeast of the landfill consisting of Alcyon Lake, the Chestnut Branch marsh area, and the streams of Chestnut Branch, Rabbit Run, Girl Scout Branch, and Lost Lake Run, as well as three public parks--Alcyon Park, Hollywood Dell Park, and Betty Park--that surround Alcyon Lake. The landfill borders the offsite area and is approximately 1,500 feet north of U.S. Route 322 and 1.5 miles west of Glassboro State College. Northeast of the site and just east of Chestnut Branch, there is a housing development of single family homes. Most of the area north of the landfill is surrounded by the Zee Orchard.

Streams and Lake

Several drainage systems occur in the area as shown in figure 1-1, General Area Plan. The main drainage system is Chestnut Branch, which has its headwaters south of the landfill area. After flowing past the northeastern border of the site, Chestnut Branch discharges into Alcyon Lake approximately 1,500 feet north of the landfill site. Rabbit Run, a small tributary of Chestnut Branch, derives its headwater flow from a small spring located adjacent to the landfill. This stream flows along the full length of the northwestern edge of the landfill before it discharges into Chestnut Branch just north of the site. Two other small streams of interest in the study area are Lost Lake Run and Girl Scout Branch. Lost Lake Run originates northeast of the LiPari Landfill within the residential area and discharges into Chestnut Branch directly east of the landfill. Girl Scout Branch originates northwest of the landfill and discharges into Alcyon Lake



CDM

environmental engineers, scientists, planners & management consultants

Figure 1-1

General Area Plan

LiPari Landfill, Gloucester County, New Jersey

north of the LiPari site. These streams are important because they serve as a basis of comparison for areas not impacted by the landfill.

Alcyon Lake is a manmade lake fed by Chestnut Branch and Girl Scout Branch. Previous offsite LiPari Landfill investigations, estimated that the lake has a surface area of 18.5 acres, a maximum depth of 6.4 feet, an average depth of 3.4 feet, a volume of 2.74×10^6 cubic feet, and about 4,800 feet of shoreline (Radian Corporation, 1983).

Previous investigators have also reported that the lake's natural recharge, (in addition to Chestnut Branch and Girl Scout Branch), originating from an artesian spring in the lake bottom, has been gradually impeded because of significant deposition of silt and organic overburden resulting in the reduction of the lake's depth. The geological origin of this spring is the Kirkwood Aquifer.

Storm sewer outfalls that discharge directly into the lake and its tributaries have contributed to the observed deterioration of the lake. The incorporation of the Borough of Pitman's sewage flow into the Gloucester County Utilities Authority (GCUA) wastewater treatment plant in the 1970s and subsequent construction of the Gloucester County sanitary sewer trunkline east of Chestnut Branch has helped to alleviate pollution from active septic tanks. However, the extent of the present problem attributable to the abandoned septic tanks is unknown. The remedial investigation findings supported previous findings indicating water quality in Alcyon Lake has deteriorated because of bacterial input. Current bacterial concentrations in Alcyon Lake exceed water quality standards.

Closely associated with the history of the Borough of Pitman since its development in the 1890s, Alcyon Lake was a public resource used for recreational activities such as swimming, boating, fishing, and ice skating. Such activities continued up to 1958 when the lake was first restricted as to its recreational usage due to bacterial contamination. Further discussions on the lake's recreational history is given in section 1.3, Site Features.

Public Parks

Three public parks border Chestnut Branch and Alcyon Lake: Betty Park, Alcyon Park, and Hollywood Dell Park. Betty Park on the east bank and Alcyon Park on the west bank border on about 2,400 feet of Alcyon Lake shoreline. Hollywood Dell Park is at the northern most end of the lake, and is directly separated from the lake shoreline by a spillway (flood control dam) and West Holly Avenue. Alcyon Park contains a walking trail, picnic area, and abandoned race track. Betty Park contains picnic areas and a small recreation area for children. Hollywood Dell Park contains picnic areas, a soccer field, baseball diamond, and a small recreation area for children. Historically these parks have been extensively used.

Residential Community

The residential community of Pitman--particularly the homes along Howard Avenue, Lake Avenue, Lakeside Avenue, and Lakeview Avenue--lies within a few hundred feet east of the LiPari Landfill and/or Alcyon Lake. Public access to Chestnut Branch, the marsh area, and Alcyon Lake is restricted by fencing and/or warning signs.

1.2.2 SITE HISTORY

History of Contaminant Sources

In the mid-1950s prior to the operation of the LiPari Landfill, Alcyon Lake began to show physical signs of an existing public health problem and deteriorating biotic environment. The Gloucester County Planning Department (GCPD, 1980) cited four primary reasons for the deterioration of Alcyon Lake during its early history.

- An increasing number of septic tank systems were installed within the lake's drainage area.
- Increased urban development and associated increases in storm water urban runoff discharges into Alcyon Lake and tributary streams by way of direct drainage inlets.

- Marginally effective severage collection and treatment facilities in the Boroughs of Pitman and Glassboro increasingly contributed fecal matter and bacteria into Alcyon Lake.
- Sedimentation resulting from urban and agricultural development activities sealed the natural springs in the bottom of the lake decreasing the turnover rate of fresh water.

Existing bacterial contamination led Gloucester County to close Alcyon Lake to swimming in 1958.

Severage and Storm Water Runoff. The first documented point source of pollution to Alcyon Lake was due to the Borough of Glassboro severage treatment plant. A series of malfunctions between 1958 and 1972 caused the discharge of raw effluent that flowed down Chestnut Branch and into Alcyon Lake. The Gloucester County Severage Authority (now known as the Gloucester County Utilities Authority) incorporated the Glassboro system in 1972 and effectively eliminated these discharges (GCPD, 1980). The Borough of Pitman severage system lift station also experienced mechanical malfunctions and storm-related overloadings, causing the facility to activate the overflow mechanism and discharge raw effluent directly into Alcyon Lake. These problems were corrected by the Borough of Pitman in 1977, although 50-year storm events have occasionally resulted in incidental overflow from the lift station (GCPD, 1980). Further land development in the area brought additional sources of contaminants.

In 1980 Gloucester County identified three major nonpoint sources of pollutants contributing to the water quality deterioration of Alcyon Lake: urban storm water runoff, agricultural runoff, and the LiPari Landfill (GCPD 1980). (Notably the LiPari Landfill could best be identified as a point source of pollution).

The County recognized that increased development increased the pollutant burden on storm water runoff. Storm water runoff is a significant source of pollutants, including oil and grease, hydrocarbons, trace heavy metals, and microorganisms. Storm water runoff from several hundred acres of the Boroughs of Pitman and Glassboro, including Collegetown Shopping Plaza and Glassboro State College, is now discharged and has been discharged over the past several years directly into Alcyon Lake and its tributaries through five drainage pipes (Borough of Pitman Department of Public Works, 1985) as shown in figure 1-2, Storm Water/Urban Runoff Drainage Inlets.

The 1980 Gloucester County report also suggests that adverse water quality impacts on Alcyon Lake were further caused by the continued discharge of agricultural runoff from approximately 1,000 acres of active agricultural land treated with pesticides, herbicides, and fungicides. However, specific studies to identify the mass loading of specific contaminants being contributed by urban and agricultural runoff were not performed. Consequently, the overall contribution and significance of these contaminants can not presently be quantified.

LiPari Landfill. The property was purchased by Nicholas LiPari in 1958 for use as a sand and gravel pit. This type of land use also made the property profitable for use as a landfill subsequent to excavation of the sand and gravel. As sand and gravel was removed Mr. LiPari accepted solid and liquid wastes for disposal. Approximately six acres of the site were used for these operations. It is documented by the U.S. District Court of New Jersey (USDC) that these excavations were in the western portion of the 15-acre parcel (USDC, 1981) as shown in figure 1-3, LiPari Landfill Site. A summary of the disposal history to be discussed below is summarized in table 1-1, Chronological Summary of Disposal and Remediation History.

The two business operations (excavation and landfilling) were integrated by backfilling the excavated portions of the land with municipal and household wastes, liquid and semisolid chemical wastes, and other industrial wastes. Between 1958 and 1971, liquid as well as semi-solid chemical wastes, and other industrial waste material were accepted and dumped at the landfill, and solid waste were disposed of until May 1971 when the site was closed by the New Jersey Solid Waste Administration (NJSWA). On Mr. LiPari's own initiative, liquid wastes were no longer landfilled after 1969 because of the concern about continued fire and explosion hazards. At least one explosion and two fires had occurred during that period of the operation (USDC, 1982).

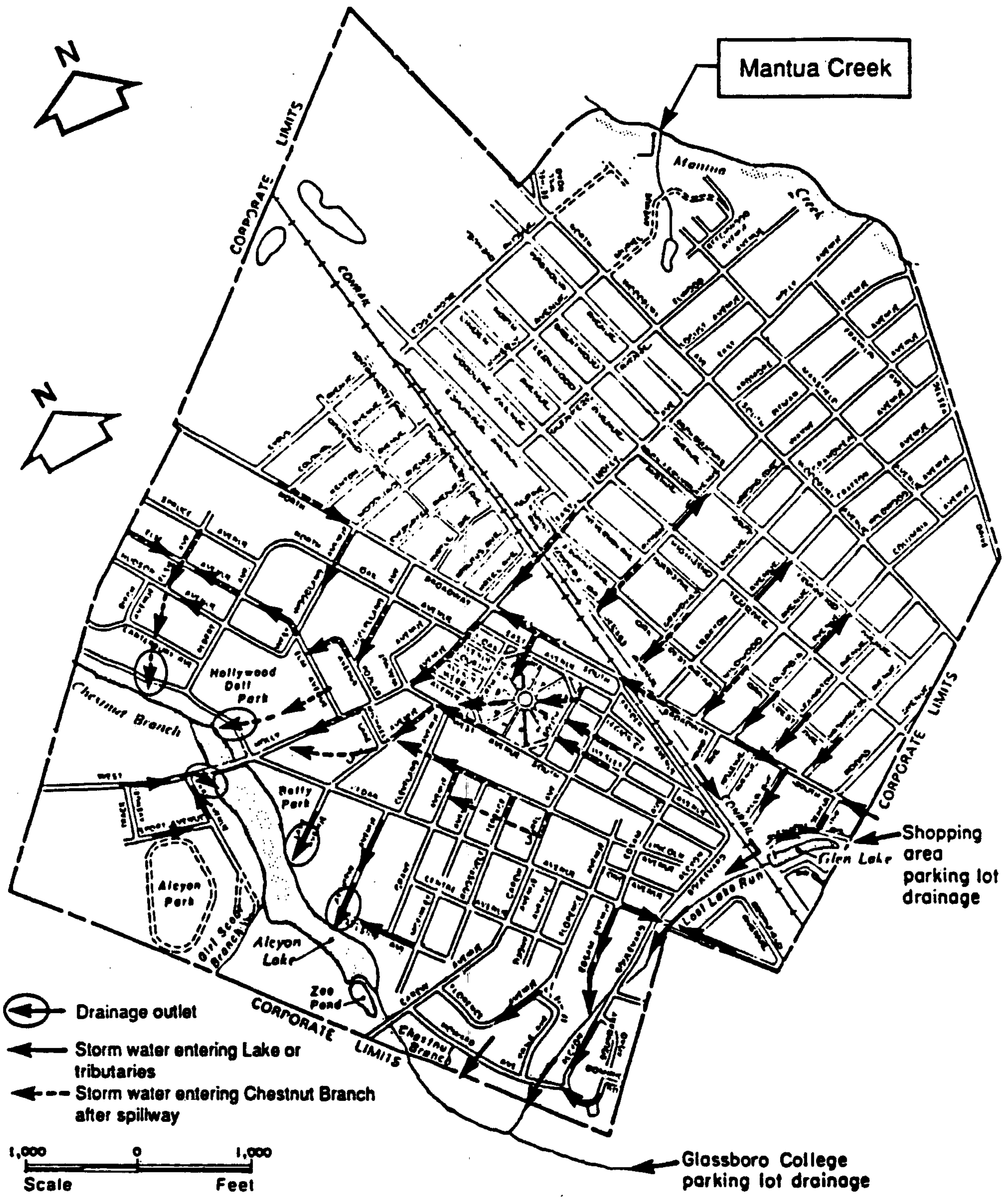


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Figure 1-2

Storm Water/Urban Runoff Drainage Inlets

LiPari Landfill, Gloucester County, New Jersey

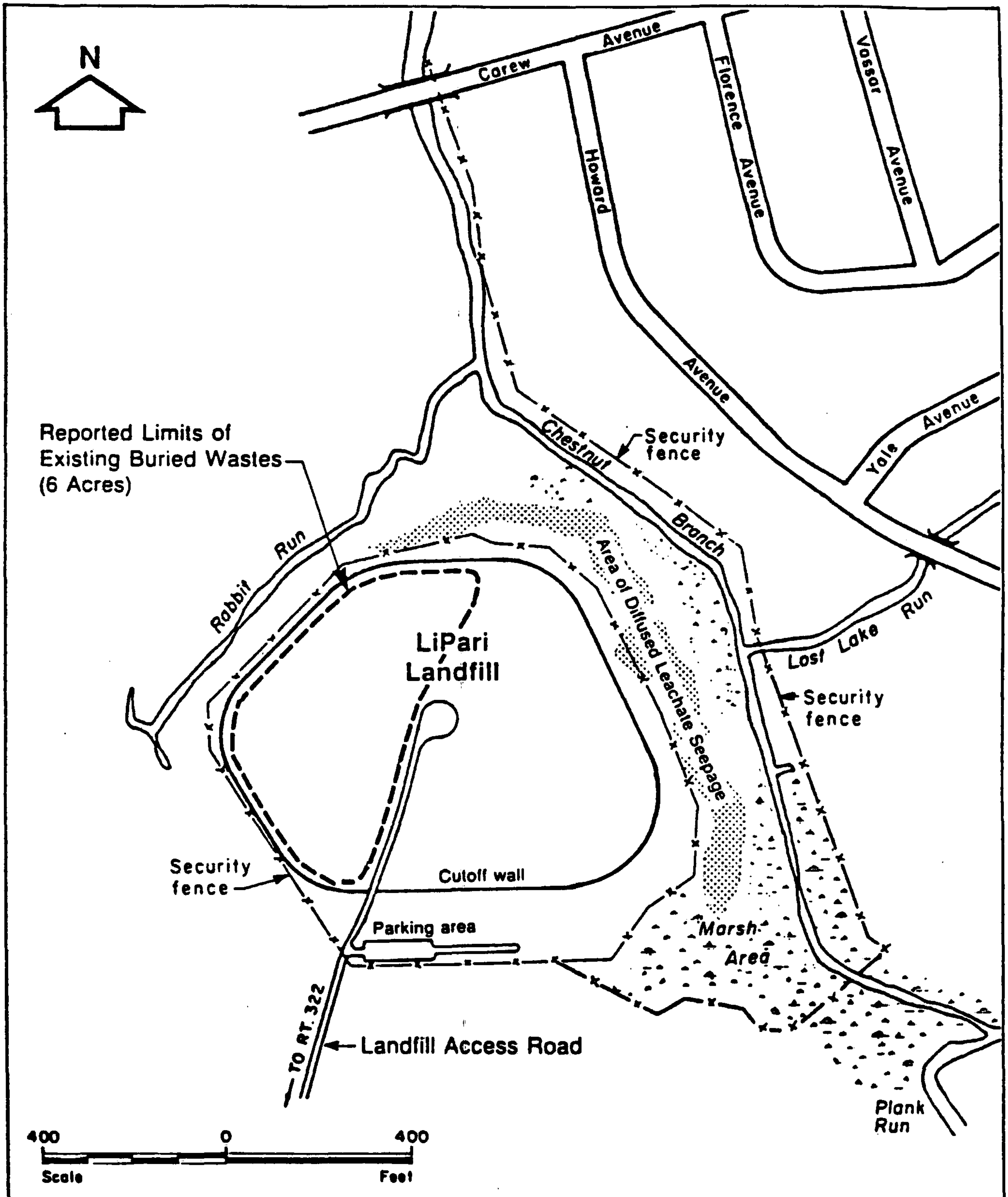

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Figure 1-3

LiPari Landfill Site

Lipari Landfill, Gloucester County, New Jersey

TABLE 1-1

CHRONOLOGICAL SUMMARY OF DISPOSAL AND REMEDIATION HISTORY

Date	Activity
1958	Sand, gravel, and landfill operations begin
1958/1971	Liquid as well as semi-solid chemical, industrial, and household waste disposal begins
1963	NJDOH periodically inspects site
1967/1969	Over 2-million gallons liquid waste disposed in landfill
1968/1969	Site receives acceptable ratings from NJDOH
1969	Two landfill fires caused by mishandling waste
December 1969	Liquid waste disposal ends
1970	NJDOH inspectors first observe and report leachate seeps along bluff overlooking Chestnut Branch
May 1971	Solid waste disposal ends
July 1971	NJDEP notifies Nick LiPari of his responsibility to clean up site
1972	NJDEP files suit against LiPari and requests cleanup of site
1972	LiPari implements remedial actions LiPari constructs drainage ditches, regrades, and spreads lime with little effect
1973	LiPari spreads lime and fills low areas with little effect
1974	LiPari ordered by court to clean up site
1974	LiPari implements additional remedial actions
August 1982	EPA issues Record of Decision I
1982	Fence installed around landfill site
August 1983	Second fence installed along Chestnut Branch

TABLE 1-1
(continued)

CHRONOLOGICAL SUMMARY OF DISPOSAL AND REMEDIATION HISTORY

Date	Activity
August 1983	Work begins on remedial actions, including slurry cutoff wall, surface cap, gas vents, and surface water runoff controls
December 1983	Slurry wall completed, surface cap installation begins
December 1983	Cold weather stops work on cap with only 70 percent of cap completed
March 1984	Work resumes on cap
May 1984	Water table rises to top of cutoff wall, affecting surface cap
September 1984	Temporary ground water dewatering and treatment system installed
October 1984	Pump-down completed
November 1984	Onsite work completed
September 1985	EPA issues Record of Decision II

(355/12)

The nature and quantity of the wastes that were received at the landfill are not known since detailed records were not maintained. Estimates based on parties known to have used the landfill indicate that 12,000 cubic yards of solid wastes and 2.9 million gallons of liquid wastes were buried. The liquids that were disposed of at the site are thought to be largely uncontained, but this matter is uncertain. It is also reported that liquids were emptied from salvageable containers and that only nonsalvageable drums containing liquids were buried. The wastes that were reported to have been dumped at the landfill included cleaning solvents, paint thinners, paints, dirty waste solvents, phenol or amine wastes and residues, and resins and ester press cakes (USDC, 1982). Generally household refuse was disposed into trenches, followed by disposal of the liquid chemical waste. Other chemical wastes in 55 gallon drums were buried in the trenches in the landfill (USCS 1982).

Government supervision or regulation of the landfill was minimal until 1971. While there was no permitting process for waste disposal operations prior to that time, the landfill was periodically inspected by the New Jersey Department of Health (NJDOH) and by the New Jersey Solid Waste Administration (NJSWA) beginning around 1963.

In 1970 the NJDOH observed leachate seeping out from the LiPari Landfill along the escarpment east of the site and discharging into Chestnut Branch and the adjoining marsh area. Leachate seeps were visible along the east and northeast slopes. They were brown and viscous in appearance and had a pungent irritating odor that was noticeable to area residents, particularly those residing along Howard Avenue. The landfill was closed in May 1971 by the NJSWA with the impetus of an affidavit, signed by local residents, that complained of intolerable odors, headaches, nausea, and the residents' inability to breathe.

In July 1971 the New Jersey Department of Environmental Protection (NJDEP) notified Mr. LiPari to correct the situation. Based on Mr. LiPari's consultation with engineers, he constructed surface water runoff diversions, regraded areas, and spread fresh dirt and lime to mitigate the problem; however, the effort was not effective. The NJDEP filed suit in 1972 against Nicholas LiPari for violation of the New Jersey Water Quality Act (NJSA 58:10-23.1 <u>et seq</u>).

Numerous investigators subsequently collected samples of the contaminated ground water beneath the LiPari Landfill site. Table 1-2, Leachate Characteristics of LiPari Landfill Samples, shows the contaminants and maximum observed concentrations found in samples of ground water collected from within the encapsulation at the LiPari Landfill up to 1985. The data provided in the table were the basis for the Onsite Feasibility Study (CDM 1985). The chemical contaminants found in the most recent REM II team analysis of the LiPari Landfill leachate and multimedia environmental samples outside the boundaries of the encapsulation system are discussed in later sections of this report.

History of Investigations

Various State, local, and municipal investigations and studies have taken place over the years, some of which have proved valuable in providing background information. The investigations performed prior to the REM II team's work to determine the extent and nature of the contamination in the LiPari Landfill offsite areas are summarized in table 1-3, History of Investigations. A detailed discussion on these investigations was given in the LiPari Landfill Remedial Investigation (Phase I). The term "leachate" has been loosely used by previous investigators. It was used to refer to samples collected in the leachate seepage areas of Chestnut Branch marsh, but also to samples collected from ground water wells at or near the landfill, or surface water samples from Rabbit Run or Chestnut Branch. When referring to the investigations performed by previous investigators, the term leachate has been retained as it was referred to in the original documents. However, in reporting REM II team findings, the term leachate refers to leachate seepage from the slurry wall.

TABLE 1-2

GROUND WATER CHARACTERISTICS OF LIPARI LANDFILL SAMPLES

Volatile organic contaminant	LiPari Landfill sampling					
	Radian Corp.					
	Field[a] 1983 (ppb)	Lab[b] 1983 (ppb)	JRB[c] 9/26/83 (ppb)	IT Corp[c] 9-10/84 (ppb)	JRB[c,d] 12/84-4/85 (ppb)	CDM[e,f] 3/85 (ppb)
Acrolein	NR	NR	NA	<500	NA	NA
Acrylonitrile	NR	NR	ND	<500	NA	NA
Benzene	3,000	4,500	5,900	2,200	29,000	1,371
Bromoform	NR	NR	<500[g]	<50	NA	<10[g]
Bromomethane	NR	NR	NA	NA	NA	<10[g]
Carbon tetrachloride	NR	NR	<100[g]	<50	NA	<10[g]
Chlorobenzene	18	<50	270	110	NA	1,005
Chlorobromomethane	NR	NR	<100[g]	<50	NA	<10[g]
Chloroethane	12	<50	47,<100[g]	<50	NA	<10[g]
2-Chloroethylvinyl ether	NR	NR	<250[g]	500	NA	<10[g]
Chloroform	8	48	760	<50	NA	750
Chloromethane	NR	NR	NA	NA	NA	<10[g]
Dichlorobromomethane	NR	NR	300	<50	NA	<10[g]
Dichlorodifluoromethane	NR	NR	<250[g]	<500	NA	<10[g]
1,1-Dichloroethane	54	<50	760	18	630	588
1,2-Dichloroethane	5,900	8,100	5,500,<69,000[h]	41,000	54,000	75,459
1,1-Dichloroethylene	4	<50	78	<50	NA	148
1,2-Dichloropropane	NR	NR	24,<50[g]	<50	NA	<10[g]
1,3-Dichloropropylene	NR	NR	7,<250[g]	50	NA	<10[g]
Ethylbenzene	1,000	420	4,400	2,000	NA	619
Methyl bromide	NR	NR	<500[g]	<500	NA	NA
Ethene dibromide	NR	NR	NA	NA	NA	<20[g]
Methyl chloride	NR	NR	<1,000[g]	<500	NA	NA
Methylene chloride	510	3,300	39,000	2,800	46,000	17,450
1,1,2,2-Tetrachloroethane	NA	NR	<500[g]	<50	NA	<10[g]
Tetrachloroethylene	7	<50	40,<100[g]	130	NA	92
Toluene	9,900	30,000	75,000	37,000	87,000	2,056
trans-1,2-Dichloroethene	26	<50	360	88	NA	219
1,1,1-Trichloroethane	1	<50	73,<100[g]	<50	NA	<10[g]
1,1,2-Trichloroethane	NR	NR	<250[g]	<50	NA	<10[g]
Trichloroethylene	14	<50	21,<100[g]	220	NA	177
Trichlorofluoromethane	NR	NR	<250[g]	<50	NA	699
Vinyl chloride	10	<50	96,<100[g]	<500	NA	<10[g]
Total volatile organic compounds	NR	NR	NA	NR	NA	176,962

TABLE 1-2
(continued)

GROUND WATER CHARACTERISTICS OF LIPARI LANDFILL SAMPLES

	LiPari Landfill sampling					
	Radian Corp.					
Extractable contaminant	Field[a] 1983 (ppb)	Lab[b] 1983 (ppb)	JRB[c] 9/26/83 (ppb)	IT Corp[c] 9-10/84 (ppb)	JRB[c,d] 12/84-4/85 (ppb)	CDM[e,f] 3/85 (ppb)
Acid extractables:						
2-Chlorophenol	NR	NR	<500[g]	<40	NA	22
2,4-Dichlorophenol	9	ND	15,<500[g]	13,<40	NA	14
2,4-Dimethylphenol	NR	NR	<500[g]	<40	NA	<10[g]
1,4-Dinitrophenol	NR	NR	NA	NA	NA	35
4,6-Dinitro-*o*-cresol	NR	NR	<5,000[g]	<40	NA	NA
2,4-Dinitrophenol	NR	NR	<5,000[g]	<40	NA	40
2-Nitrophenol	NR	NR	<500[g]	<40	NA	20
4-Nitrophenol	110	ND	<500[g]	<40	NA	NA
p-Chloro-*m*-cresol	NR	NR	<500[g]	<40	NA	<10[g]
2-Methyl-4,6-dinitrophenol	NR	NR	NA	NA	NA	<10[g]
Pentachlorophenol	NR	NR	<500[g]	<40	NA	NR
Phenol	11,000	22,000	22,000	9,000	NA	<10[g]
2,4,6-Trichlorophenol	NR	NR	<500[g]	<40	NA	20
Base-neutral extractables:						
Acenaphthene	NR	NR	<100[g]	<40	NA	<50[g]
Acenaphthylene	NR	NR	<100[g]	5.6,<40	NA	<50[g]
Anthracene	NR	NR	<100[g]	<40	NA	<50[g]
Benzidine	NR	NR	<1,000[g]	<160	NA	<100[g]
Benzo(a)anthracene	NR	NR	<1,000[g]	<40	NA	<50[g]
Benzo(a)pyrene	NR	NR	<1,000[g]	<40	NA	<50[g]
3,4-Benzofluoranthene	NR	NR	<100[g]	<40	NA	<50[g]
Benzo(g,h,i)perylene	NR	NR	<250[g]	<40	NA	<50[g]
Benzo(k)fluoranthene	NR	NR	<100[g]	<40	NA	<50[g]
bis(2-Chloroethoxy)methane	NR	NR	<200[g]	<40	NA	<50[g]
bis(2-Chloroethyl)ether	8,000	12,000	83,000	15,600	510,000	44
bis(2-Chloroisopropyl)ether	NR	NR	<200[g]	<160	NA	<50[g]
bis(2-Ethylhexyl)phthalate	NR	NR	65,<100[g]	<40	NA	<50[g]
4-Bromophenyl phenyl ether	NR	NR	<100[g]	<40	NA	<50[g]
Butylbenzyl phthalate	NR	NR	<100[g]	4.0,<40	NA	<50[g]
2-Chloronaphthalene	NR	NR	<200[g]	<40	NA	<50[g]
4-Chlorophenyl phenyl ether	NR	NR	<100[g]	<40	NA	<50[g]
Chrysene	NR	NR	<100[g]	<40	NA	<50[g]
Dibenzo(a,h)anthracene	NR	NR	<250[g]	<40	NA	<50[g]
1,2-Dichlorobenzene	150	ND	370,<400[g]	440	NA	49
1,3-Dichlorobenzene	NR	NR	<400[g]	<40	NA	27
1,4-Dichlorobenzene	NR	NR	190,<400[g]	3.0,<40	NA	1,619
3,3'-Dichlorobenzidine	NR	NR	<100[g]	<40	NA	<100[g]

TABLE 1-2
(continued)

GROUND WATER CHARACTERISTICS OF LIPARI LANDFILL SAMPLES

	LiPari Landfill sampling					
	Radian Corp.					
Extractable contaminant	Field[a] 1983 (ppb)	Lab[b] 1983 (ppb)	JRB[c] 9/26/83 (ppb)	IT Corp[c] 9-10/84 (ppb)	JRB[c,d] 12/84-4/85 (ppb)	CDM[e,f] 3/85 (ppb)
Base-neutrals, continued						
2,4-Dichlorotoluene	NR	NR	NA	NA	NA	5,018
m-Chlorotoluene	NR	NR	NA	NA	NA	3,983
Diethyl phthalate	10	<1	350	94	NA	<50[g]
Dimethyl phthalate	NR	NR	<100[g]	<40	NA	<50[g]
Di-*n*-butyl phthalate	6	<1	44	<40	NA	<50[g]
2,4-Dinitrotoluene	NR	NR	<100[g]	<40	NA	<50[g]
2,6-Dinitrotoluene	NR	NR	<100[g]	<40	NA	<50[g]
Di-*n*-octyl phthalate	NR	NR	<100[g]	<40	NA	<50[g]
1,2-Diphenylhydrazine (as azobenzene)	NR	NR	<100[g]	<40	NA	<250[g]
Ethyleneimine	NR	NR	NA	NA	NA	<50[g]
Fluoroanthene	NR	NR	<100[g]	<40	NA	<50[g]
Fluorene	NR	NR	<100[g]	<40	NA	<50[g]
Hexachlorobenzene	NR	NR	<100[g]	<40	NA	<50[g]
Hexachlorobutadiene	NR	NR	<200[g]	<40	NA	<50[g]
Hexachlorocyclopentadiene	NR	NR	<200[g]	<40	NA	<50[g]
Hexachloroethane	NR	NR	<400[g]	<40	NA	<50[g]
Ideno(1,2,3-cd)pyrene	NR	NR	<250[g]	<40	NA	<50[g]
Isophorone	180	160	<200[g]	<160	NA	<50[g]
Naphthalene	70	280	430	120	NA	<50[g]
Nitrobenzene	NR	NR	<200[g]	<40	NA	<50[g]
N-Nitrosodimethylamine	NR	NR	ND	<40	NA	<50[g]
N-Nitrosodi-*n*-propylamine	NR	NR	ND	<40	NA	<50[g]
N-Nitrosodiphenylamine	NR	NR	<100[g]	<40	NA	<50[g]
Phenanthrene	NR	NR	<100[g]	<40	NA	<50[g]
Pyrene	NR	NR	<100[g]	<40	NA	<50[g]
1,2,4-Trichlorobenzene	NR	NR	<200[g]	<40	NA	5,965
1,2-*bis*(2-Chloroethoxy) ethane	30-70,000	30-70,000	140,000	NA	1,600,000	NA
bis(Chloromethyl)ether	NR	NR	NA	<40	NA	NA
2,3,7,8-Tetrachlorodibenzo-*p*-dioxin	NR	NR	NA	<40	NA	NA
1,4-Diethylene dioxide	NR	NR	NA	NA	NA	<50[g]

TABLE 1-2
(continued)

GROUND WATER CHARACTERISTICS OF LIPARI LANDFILL SAMPLES

	LiPari Landfill sampling					
	Radian Corp.					
Pesticide/PCB contaminant	Field[a] 1983 (ppb)	Lab[b] 1983 (ppb)	JRB[c] 9/26/83 (ppb)	IT Corp[c] 9-10/84 (ppb)	JRB[c,d] 12/84-4/85 (ppb)	CDM[e,f] 3/85 (ppb)
Aldrin	NR	NR	<2[i]	<1	NA	<0.5[g]
BHC,alpha	NR	NR	<2[i]	<1	NA	<0.5[g]
BHC,beta	NR	NR	<2[i]	<1	NA	<0.5[g]
BHC,delta	NR	NR	<2[i]	<1	NA	<0.5[g]
BHC,gamma	NR	NR	2.2	<1	NA	<0.5[g]
Chlordane	NR	NR	ND	<10	NA	<0.5[g]
4,4'DDT	NR	NR	ND	1	NA	<0.5[g]
4,4'DDE	NR	NR	ND	<1	NA	<0.5[g]
4,4'DDD	NR	NR	ND	<1	NA	<0.5[g]
Dieldrin	NR	NR	ND	<1	NA	<0.5[g]
Endosulfan-alpha	NR	NR	2.1	<1	NA	<0.5[g]
Endosulfan-beta	NR	NR	2.1	<1	NA	<0.5[g]
Endosulfan sulfate	NR	NR	ND	<1	NA	<0.5[g]
Endrin	NR	NR	<2[i]	<1	NA	<0.5[g]
Endrin aldehyde	NR	NR	2	<1	NA	<0.5[g]
Endrin ketone	NR	NR	NA	NA	NA	<0.5[g]
Heptachlor	NR	NR	<2[i]	<1	NA	<0.5[g]
Heptachlor epoxide	NR	NR	2	<1	NA	<0.5[g]
PCB-1242	NR	NR	<25[g]	<10	NA	<0.5[g]
PCB-1254	NR	NR	<25[g]	<10	NA	<1.0[g]
PCB-1221	NR	NR	<25[g]	<10	NA	<0.5[g]
PCB-1232	NR	NR	<25[g]	<10	NA	<0.5[g]
PCB-1248	NR	NR	<25[g]	<10	NA	<0.5[g]
PCB-1260	NR	NR	<25[g]	<10	NA	<1.0[g]
PCB-1016	NR	NR	<25[g]	<10	NA	<0.5[g]
Toxaphene	NR	NR	ND	<10	NA	<0.5[g]
Methoxychlor	NR	NR	NA	<1	NA	<0.5[g]

TABLE 1-2 (continued)

GROUND WATER CHARACTERISTICS OF LIPARI LANDFILL SAMPLES

Volatile nonpriority pollutant	IT Corp[c] 9-10/84 (ppb)	Base-neutral extractable nonpriority pollutant	IT Corp[c] 9-10/84 (ppb)
Acetone	620	Aniline	<40
2-Butanone	100,<500	Benzoic acid	460
Carbon disulfide	<50	Benzyl alcohol	29,<40
2-Hexanone	23,000	4-Chloroaniline	5.2,<40
4-Methyl-2-pentanone	7,700	Dibenzofuran	<40
Styrene	1,100	2-Methylnaphthalene	2.1,<40
Vinyl acetate	<50	2-Methylphenol	180
o-Xylene	9,200	4-Methylphenol	100
Total xylenes	3,500	2-, 3-, 4-Nitroanilines	<40 each
		2,4,5-Trichlorophenol	<40

GROUND WATER CHARACTERISTICS OF LIPARI LANDFILL SAMPLES (continued)

Metal contaminant	Radian[a] 1983 (ppm)	JRB[c] 9/26/83 (ppm)	IT Corp[c] 9-10/84 (ppm)	CDM[e,f] 3/85 (ppm)
Antimony	<.005	<.20/.21[j]	<.001	<0.01[g]
Arsenic	<.003	.074 /.087[j]	.016	<0.002[g]
Barium	NR	NA	NA	.40
Beryllium	<.0005	<.05	<.001	<0.01[g]
Cadmium	<.005	.023/.068[j]	.011	.006
Chromium	<.001	5.1/51.0[j]	.050	<0.02
Copper	.062	.15/.20[j]	.25	<0.01[g]
Iron	86	NA	NA	NA
Lead	<.003	.12/.92[j]	.01	.06
Manganese	.20	NA	NA	NA
Mercury	<.0002	.013	.0042	<.001[g]
Nickel	.004	.30/.70[j]	.05	.07
Selenium	<.003	.21	.006	<0.01[g]
Silver	<.002	.026/.080[j]	.003	<0.01[g]
Thallium	<.003	.27	<.001	<0.002[g]
Zinc	.071	1.2/1.3[j]	3.96	.14
Cyanide	NR	.02	NA	4.95
Phenols	NR	18.4	NA	NA

TABLE 1-2
(continued)

GROUND WATER CHARACTERISTICS OF LIPARI LANDFILL SAMPLES

Conventional parameter	IT Corp[c] 9-10/84 (ppm)	DuPont[e] 3/85 (ppm)	CDM[e,f] 3/85 (ppm)
Dissolved organic carbon	NA	863	NA
pH	NA	6.3	6.3
Total suspended solids	NA	70	532[k]
Biochemical oxygen demand	NA	NA	1,319
Chemical oxygen demand	NA	NA	2,820
Ammonia-nitrogen	NA	NA	55.55
Total kjeldahl nitrogen	NA	NA	57.65
Phosphorous	NA	NA	NA
Phosphate	NA	NA	0.37
Total dissolved solids	NA	NA	1,536
Total volatile suspended solids	NA	NA	164
Volatile dissolved solids	NA	NA	490
Conductivity	NA	NA	1,900 umho/cm
Oil and grease	4.8	NA	7.7
Total organic carbon	240	NA	NA
Chlorides	NA	NA	318.2
Nitrates	NA	NA	0.03
Alkalinity	NA	NA	327
Hardness as $CaCO_3$	NA	NA	188

[a] Laboratory composite of samples from monitoring wells C-10a, C-6a, and C-4a.

[b] Composite of sample drums upon receipt at laboratory.

[c] Highest value (worst case) is indicated.

[d] Limited sampling done by JRB Associates from December 10, 1984, to April 15, 1985. There were four sampling events performed during this period.

[e] Collected from production well PW-1 at conclusion of 24-hour pump test.

[f] Field measurements performed by Camp Dresser & McKee, Inc., in March of 1985 indicated leachate temperatures ranging from 10 to 16 °centigrade.

[g] Element is less than value given and not detected by the technique employed. Report with detection limit.

[h] Due to the high interference levels encountered, an unusually high detection limit exists. An undeterminable amount of results may be due to 1,2-dichloroethane.

[i] Below method detection limit. Quantitation and/or identification may be uncertain at this level.

[j] Highest value represents the maximum concentration found in shallow driven wells outside of containment system.

[k] May be low due to extended holding time of sample.

Notes: NR Not reported; NA Not analyzed; ND Not detected

TABLE 1-3

HISTORY OF INVESTIGATIONS FOR LIPARI LANDFILL OFFSITE AREAS

Date	Activity
5/71	LiPari Landfill closed
9/78-6/79	Rossnagel and Associates--water quality study on Alcyon Lake--soil, sediment and surface water samples collected and analyzed.
1/79	NJ Solid Waste Administration--sampled and analyzed leachate from Chestnut Branch marsh.
7/79-10/79	EPA Surveillance and Analysis-Technical Assistance Team (TAT)--leachate, surface water, sediment and private well sampling and analysis.
9/79	NJ Institute of Technology Air Pollution Research laboratory under direction of NJDEP--air monitoring samples taken from leachate seep areas and residential property.
9/79	NJ Department of Health--leachate samples collected and analyzed from the marsh.
12/79	NJ Department of Fish and Game under direction of NJ Toxic Substances Program--fish tissue analysis from Alcyon Lake.
10/80	Gloucester County Planning Department--Application to perform diagnostic and feasibility study under the Federal Clean Water Act.
1980	Gloucester County Planning Department--Rossnagel and Associates (1980) Federal Clean Water Act.
1980	Gloucester County Planning Department--Rossnagel and Associates contracted to perform water quality studies on Alcyon Lake and Chestnut Branch watershed area. Biotic inventory and bioassays performed. Municipal wells, ground water, soil, surface water, urban runoff, and agricultural runoff samples were collected and analyzed.
1981	TAT Survey--West of Chestnut Branch. Cross section profiles to define stratigraphy in the marsh.
12/81	EPA Field Investigation Team - FIT (Fred C. Hart) Site investigation surface water, sediment and soil, private well samples analyzed.
7/82	Radian Corporation--surface water, sediment, and biological samples collected and analyzed.
1983	Radian Corporation--Completed a two phase study to evaluate effects of remedial action activites at LiPari Landfill on Alcyon Lake.
7/84	NJ Division of Waste Management--conducted air quality surveys in basements of residents.
2/85-2/87	Present REM II prime contractor (Camp Dresser & McKee Inc.)--remedial investigation of the offsite areas surface water, sediment, soil, leachate, ground water, private wells, air samples, collected and analyzed.
6/86-9/86/ 10/87	TAGA studies by ERT & FIT Team Contractors for EPA

History of Remedial Actions

Remedial actions have taken place both onsite at the LiPari Landfill, as well as offsite in the immediate vicinity of the landfill. Onsite actions included construction of the containment system as previously described. Offsite actions included temporary measures, such as fence installation and posted signs to restrict public access to the marsh and Alcyon Lake. A summary of the remediation history to be discussed below is given in table 1-1, Chronological Summary of Disposal and Remediation History.

Public Access Restricted. Previous and ongoing investigations confirmed that there was a potential risk to the public health and environment associated with the LiPari Landfill. Action was taken under the authority of section 104(c) of the Comprehensive Environmental Response Compensation and Liability Act (CERCLA). In July 1982 an 8-foot high, chain-link-plus-barbed-wire fence was constructed around the main landfill site to restrict public access. In August 1983, a second chain link fence was installed along Chestnut Branch between the houses on Howard Avenue and east of Chestnut Branch to restrict public access to this area. The onsite and offsite areas restricted by fencing are shown in figure 1-4, Fence Installation.

Phase I Remedial Action Investigations. RE Wright (1981) evaluated several remedial alternatives intended as interim action until a comprehensive long-term solution was developed. Radian Corporation (1982) reviewed, at the request of EPA Region II, the environmental impacts regarding nine proposed phase I remedial action alternatives for the onsite portion of the LiPari Landfill study area. The preferred alternative consisted of a fully encompassing 360-degree slurry wall with an impervious cap over a 16-acre area, with final treatment of the contaminated ground water within the encapsulation at a publicly owned treatment plant. The EPA approved this preferred alternative for the onsite LiPari Landfill in a 1982 Record of Decision (ROD) and commenced construction in 1983. This remedial measure, presently referred to as phase I, was designed to diminish the flow of leachate and contaminated ground water from the landfill.

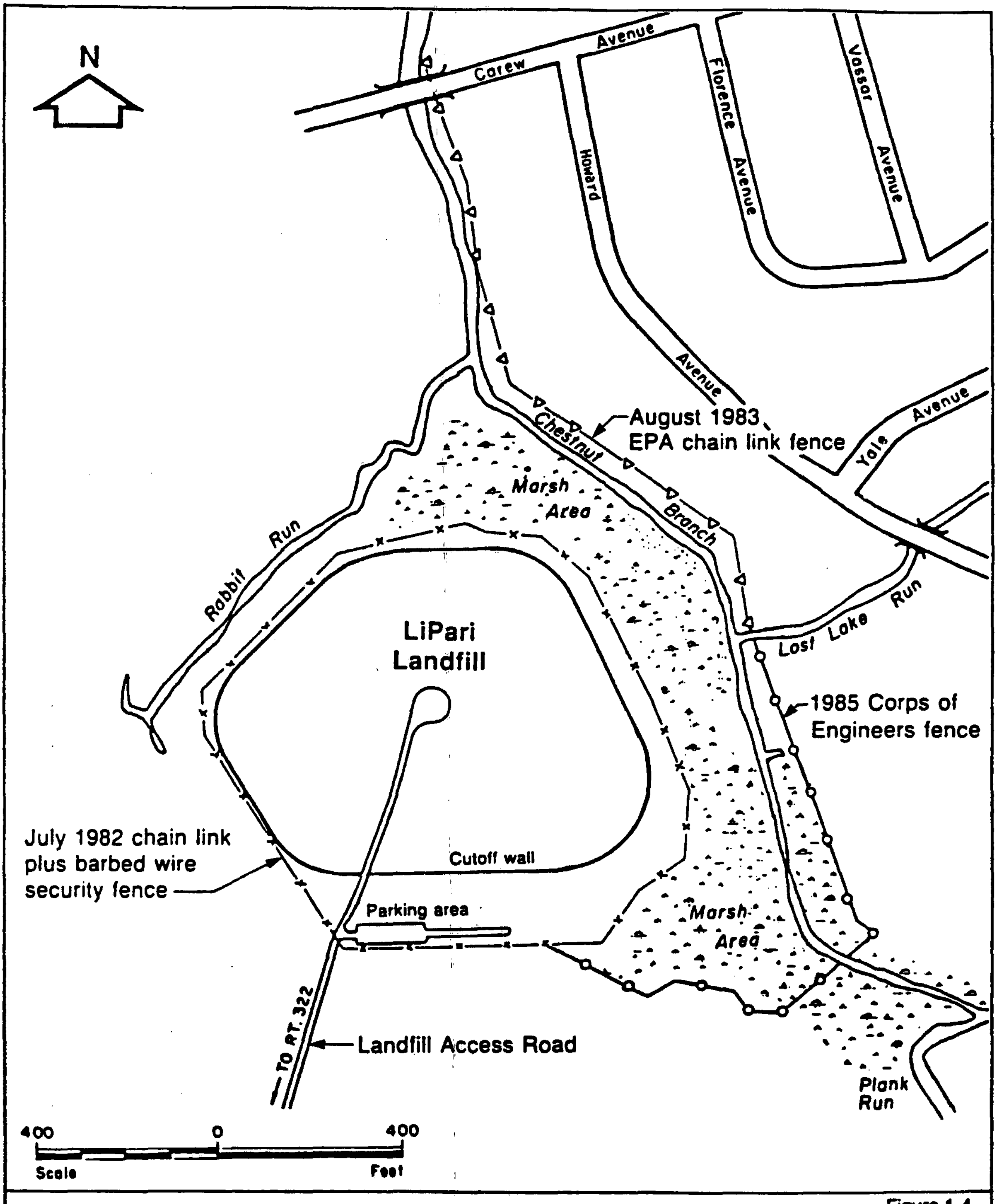

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Figure 1-4

Fence Installation

LiPari Landfill, Gloucester County, New Jersey

Phase II Onsite Remediation

The final draft Onsite LiPari Landfill RI/FS became the basis for the selection of a permanent remedial alternative as discussed in the EPA record of decision (ROD) dated September 30, 1985 (EPA 1985). The remedial alternative which was selected is commonly referred to as the "batch-flushing" alternative. The effectiveness of the onsite remedial alternative to be implemented directly affects the long-term success of any remedial action taken in the offsite areas. The onsite remedial alternative involves the installation of extraction and injection wells within the encapsulation system to dewater and flush water-borne contaminants for treatment at an onsite facility. Discharge for final treatment to the GCUA treatment facility is under negotiation. A remedial design study is currently being performed to determine the design parameters, particularly those that will allow the batch-flushing alternative to be completed within the desired time frame. While there is the potential for contaminants to seep through the slurry wall during flushing, the ROD specified that this problem would be mitigated by the offsite remedial action (such as an offsite collection system) developed under the offsite RI/FS and that implementation of the batch-flushing alternative would not begin until such an off-site collection system was in-place. Implementation of the onsite alternative requires implementation of the offsite collection system first.

1.3 SITE FEATURES

1.3.1 LAND USE

The offsite LiPari Landfill area consists of undeveloped wooded and recreational lands, with agricultural, residential, commercial, and institutional land uses. The area is located in the middle of Gloucester County, New Jersey (see figure 1-5) immediately southwest of the suburban community of Pitman (population 9,744), within one mile northwest of the suburban community of Glassboro (population 14,644), and within 15 miles of the Philadelphia, Pennsylvania metropolis to the north (Gloucester County Data Book, 1980).

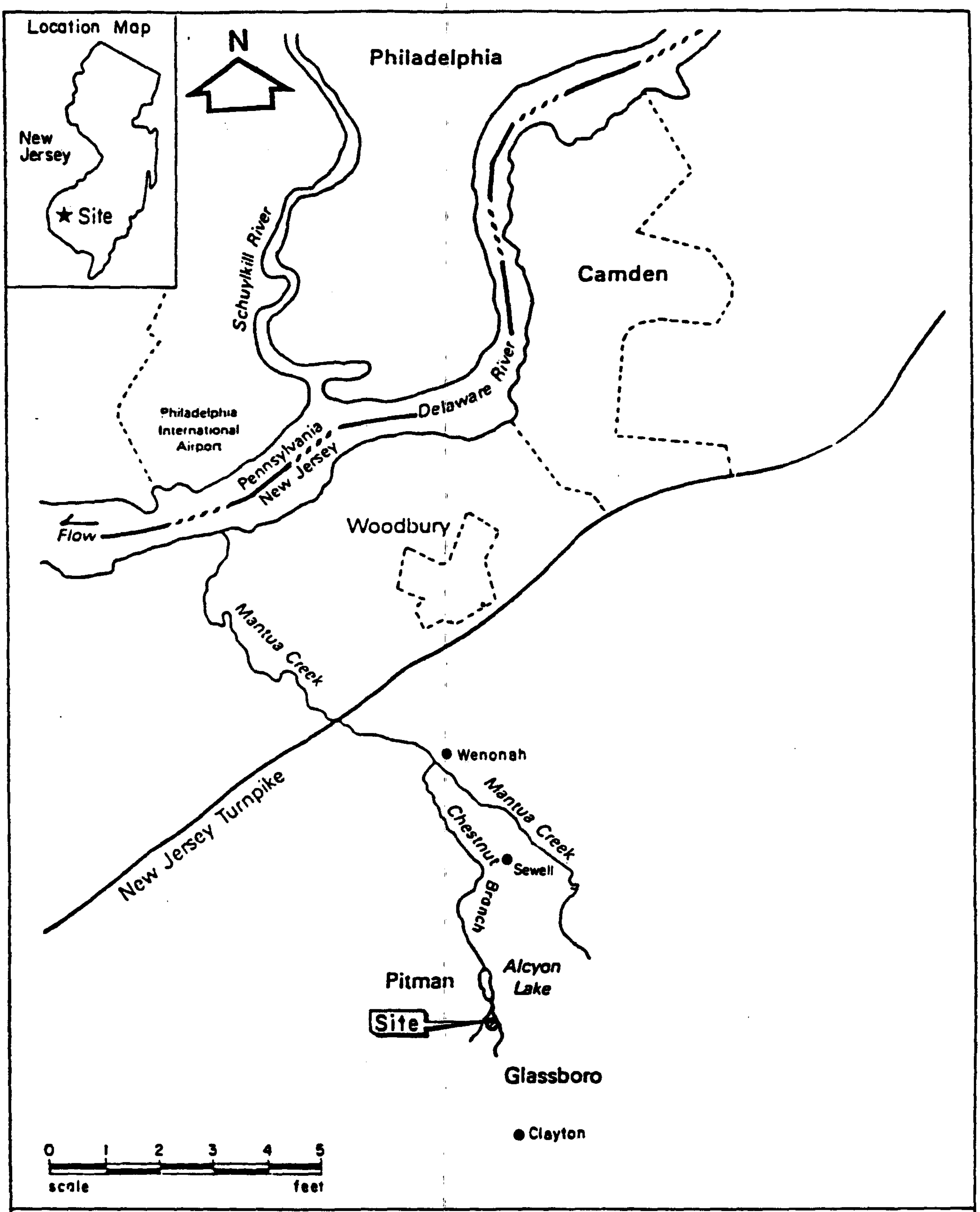

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Figure 1-5

LiPari Landfill Regional Location Map

LiPari Landfill, Gloucester County, New Jersey

The Borough of Pitman consists of 1,500 acres. Its early development is attributed, at least in part, to its accessibility to major transportation corridors. The New Jersey Turnpike is located 7 miles to the northwest and State Highway 42 is located 5 miles to the northeast. Each provide ready access to Philadelphia.

The Borough of Pitman is one of the county's older, more established residential communities. The area consists of predominantly medium density (greater than seven dwellings per acre) residential land use. Located immediately east of Chestnut Branch is a single family, medium density residential area. Located within one-half mile of the offsite area is a limited commercial zone along Holly Avenue and two elementary schools: Memorial School and Wells School (see figure 1-1, General Area Plan). Approximately 1/4 mile downstream of the onsite area, Chestnut Branch flows into Alcyon Lake.

Three public parks border Alcyon Lake: Betty Park, Alcyon Park, and Hollywood Dell Park (see figure 1-1). All parks contain picnic areas. Hollywood Dell Park and Betty Park contain picnic benches, children's playground equipment, and Hollywood Dell park additionally has a baseball field. Alcyon Lake has been closely associated with the history of Pitman since the development of Alcyon Park in the 1890s. In the early 1900s improvements for public recreational use of the park consisted of a boardwalk, a bathhouse, a merry-go-round, and bowling alleys. By 1938, 75 persons were employed there; rides and amusements, including canoeing and boating, were available. Fishing in Alcyon Lake was a popular sport. In 1945, the park and its amusement structures were sold. The park was subsequently purchased by and maintained for public park use by the Borough of Pitman.

Agricultural lands border the offsite area along the north, south, and west sides. Although agriculture consists of one-third of Gloucester County land use, it is of decreasing importance in the Pitman/Glassboro area (less than 3 percent of land use). Apple and peach orchards are the predominant agricultural land use adjacent to the site.

1.3.2 SOCIOECONOMIC

The Borough of Pitman includes primarily middle and working class households. The demographic data characterizing households in Pitman is summarized below (Gloucester County Data Book 1980):

Total population:	9,744	
Age profile:	0 to 4	6.5 percent
	5 to 13	13.8 percent
	14 to 64	65.1 percent
	65+	14.5 percent
Persons per household:	2.78	
Average household income:	$18,517 median $20,890 mean	

The primary economic base in the community is supported by the central business district and two major firms: Struthers & Dunn; and Andbro. Of the two firms, Struthers & Dunn does not pay taxes to the Borough of Pitman since it borders Mantua Township. Owens-Illinois and Crown Zellerbach are also major industrial facilities located near Pitman in Glassboro Township.

1.3.3 CLIMATE

The Appalachian Mountains to the west and the Atlantic Ocean to the east have a moderating effect on climate in the study area. The local climate is classified as humid continental. Most weather systems that affect the site develop in the midwest and are steered eastward by the prevailing westerly winds, or move northeastward parallel to the Atlantic coast. Climatological data for the area was reported by the National Oceanic and Atmospheric Administration in a summary report for 1951 to 1980 (NOAA, 1982) and annual reports for 1981, 1982, 1983 and 1984.

Average daily winter temperatures range between 25 °F and 42 °F, with an average low of about 10 °F. Average daily summer temperatures range between 82 °F and 86 °F with highs in the upper nineties. Sustained periods of very high or very low temperatures seldom last for more than 3 or 4 days as conditions change fairly rapidly. Below zero and above 100 degree readings are relatively rare. During the summer months when the area becomes engulfed with maritime air, high humidity can add to the discomfort of seasonably warm temperatures.

The average precipitation measured at Woodstown over the 34-year period of records from 1951 to 1984 is 43.20 inches as shown in table 1-5.

During 1965 (the driest year on record), 26.4 inches of precipitation were recorded, while 57.7 inches were measured during the wettest year, 1979. Average monthly precipitation as presented in table 1-5 demonstrates that precipitation is fairly evenly distributed throughout the year with maximum amounts occurring in the late summer months. Much of the summer rainfall is due to local thunderstorms that can result in 3 to 6 inches in a 24 to 48 hour period. Much of the heaviest snowfall occurs in January and February; mean snowfall during this period is 6.4 inches. In general, single storms of 10 inches or more occur about every 5 years. Expected extreme rainfall events are summarized in table 1-4 (GCPD, 1986).

TABLE 1-4

EXTREME RAINFALL EVENTS FOR GLASSBORO, NEW JERSEY
RAINFALL IN INCHES

Return period	6 hour duration	24 hour duration
2 years	2.4	3.3
10 years	3.7	5.2
25 years	4.4	5.9
50 years	4.8	6.6
100 years	5.3	7.5

The Borough of Pitman is an area of minimal flooding because the drainage channels generally have steep banks. Flood zone A in figure 1-6 shows that the 100-year-flood zone closely follows the borders of Alcyon Lake and its tributaries. Flooding into the adjacent parks is infrequent but under worst conditions most of Hollywood Dell Park and half of Betty Park may be flooded.

TABLE 1-5

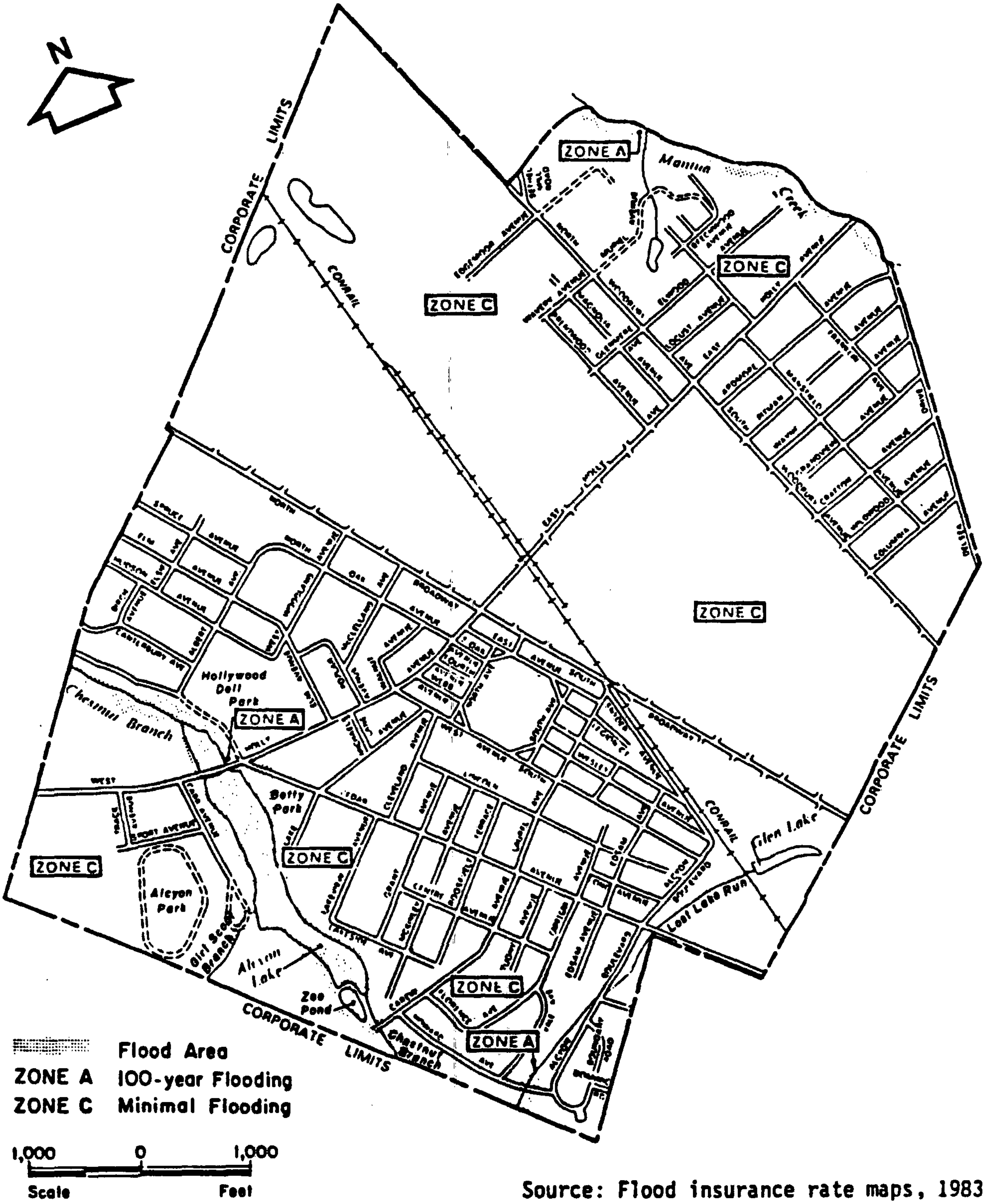
ANNUAL AND MEAN MONTHLY PRECIPITATION FROM 1951 TO 1984[a]

Year	Annual Precipitation (inches)	Year	Annual Precipitation (inches)	Month	Monthly Precipitation (inches)
1951	43.16	1969	43.49	Jan	3.15
1952	44.09	1970	39.97	Feb	2.97
1953	40.52	1971	56.77	Mar	3.89
1954	33.76	1972	57.06	Apr	3.86
1955	34.14	1973	44.59	May	3.51
1956	51.42	1974	39.52	Jun	3.64
1957	36.36	1975	56.56	Jul	3.98
1958	55.39	1976	37.10	Aug	3.97
1959	44.60	1977	41.38	Sep	3.50
1960	45.73	1978	44.44	Oct	3.27
1961	40.53	1979	57.66	Nov	3.71
1962	38.57	1980	36.43	Dec	3.75
1963	36.77	1981	41.03		
1964	34.47	1982	39.19		
1965	26.39	1983	54.87		
1966	39.09	1984	48.64		
1967	49.98				
1968	34.57	34 year average = 43.20 inches			

Sources: "Climatological Data--Annual Summaries for New Jersey" and National Oceanic and Atmospheric Administration

[a] For weather station 28-9910 located in Woodstown, New Jersey

(LiPari/29)



Source: Flood insurance rate maps, 1983

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Figure 1-6

Borough of Pitman Flood Zones

LiPari Landfill, Gloucester County, New Jersey

Prevailing winds during winter are from the west-northwest and average 8 miles per hour. Destructive velocities are fairly rare and occur mostly during summer thunderstorms. High winds occurring in the winter months, as a rule, come with the advance of cold air after the passage of a deep low pressure system. Only rarely have hurricanes in the vicinity caused widespread damage; however, this damage is primarily caused by flooding.

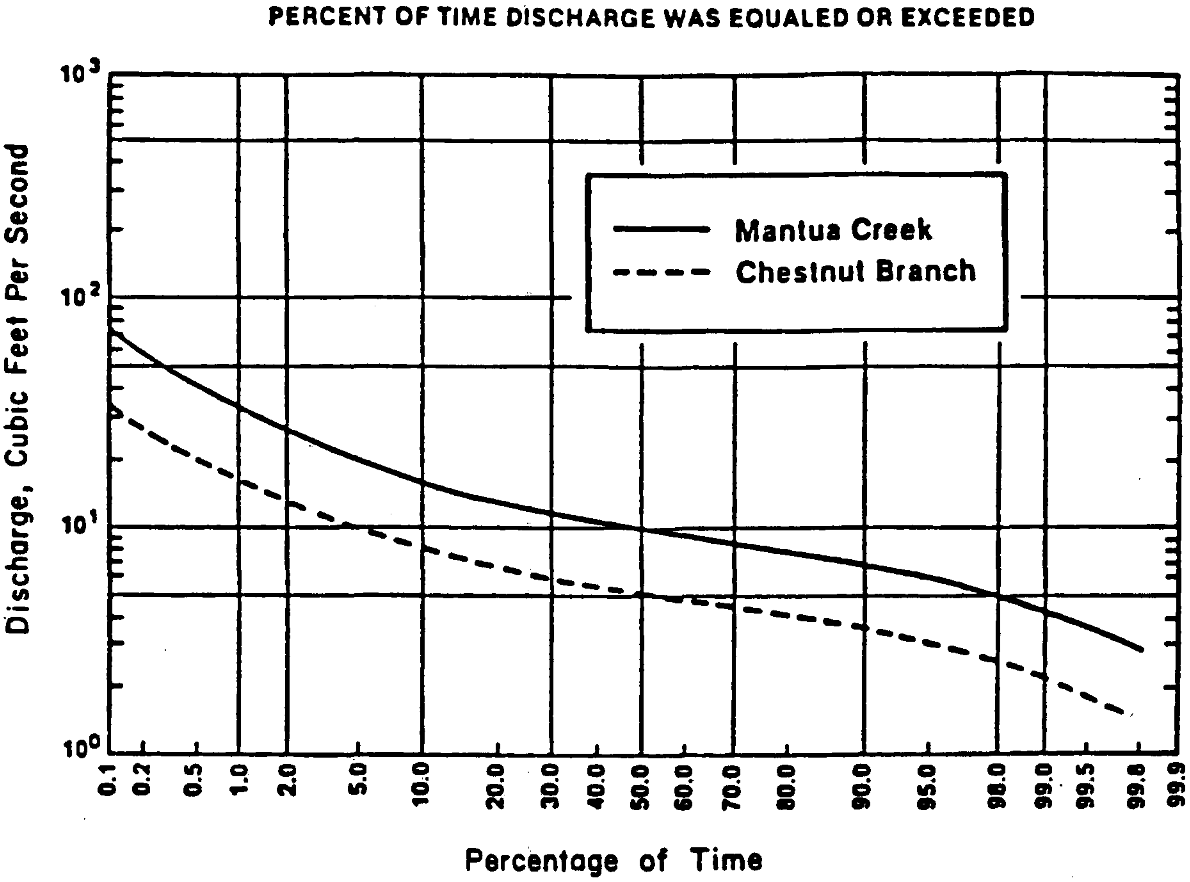
1.3.4 SURFACE WATERS

The LiPari Landfill is adjacent to Chestnut Branch, a major tributary to Mantua Creek (see figure 1-5). Chestnut Branch discharges into Mantua Creek at a point four miles north of Alcyon Lake. Mantua Creek is one of four major streams in the Delaware River Basin that discharge into the Delaware River. Chestnut Branch originates just east of Glassboro. Flow from Plank Run Reservoir discharges into Chestnut Branch by way of Plank Run prior to flowing into Alcyon Lake, 1,500 feet downstream from the landfill.

Chestnut Branch above the landfill has a drainage area of approximately three square miles and consists of urban and agricultural land use. Gaged stream flow records are available on nearby Mantua Creek, whose drainage area of 6.75 square miles is about twice as large as the drainage area upstream of the LiPari Landfill. Figure 1-7 shows a flow duration curve for Mantua Creek and an estimate of the flow in Chestnut Branch.

Base flow measurements approximately 200 feet from the inflow of Chestnut Branch to Alcyon Lake taken in February, 1980 indicated that the stream flows at a rate of 4-6 million gallons per day (or 6.2 to 9.3 cubic feet per second) (GCPD, 1980).

Smaller tributaries to Chestnut Branch occur between the LiPari Landfill and Alcyon Lake including Rabbit Run and Lost Lake Run. Rabbit Run derives its base flow from a small spring located adjacent to the landfill. It flows within a few feet and along the northwestern edge of the landfill. Lost Lake Run is a relatively small stream which drains the residential area directly east of the landfill prior to discharging into Chestnut



Source: Radian Corporation 1982

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Figure 1-7

Mantua Creek and Chestnut Branch Flow Duration Curves

LiPari Landfill, Gloucester County, New Jersey

Branch. Girl Scout Branch drains a quarter square mile area that consists of the agricultural property of Zee's orchard prior to discharging directly into Alcyon Lake.

Local marshes occur along the west bank of Chestnut Branch, at numerous locations between Plank Run Reservoir and Alcyon Lake. The marsh areas have damp to wet soil conditions year round due to local ground water seeps and stream overflow.

Alcyon Lake is a man-made body of water which resulted from the damming of Chestnut Branch at Holly Avenue. The lake's maximum depth, average depth and volume were reported in section 1.2.1, Site Description. Additional physical characteristics of Alcyon Lake are summarized below based upon field data provided in a United States Army Corps of Engineers (COE) 1981 inspection report pertaining to the adequacy of the dam spillway located in the northern end of the lake off West Holly Avenue. Note that the lake body is referred to as a "pool" in COE's report.

Physical Characteristics of Alcyon Lake

Drainage area	4 square miles
Pool area:	
Length of recreation pool	2,500 feet
Length of maximum pool	4,500 feet
Storage capacity:	
Maximum (top of dam)	150 acre-feet
Recreation pool	66 acre-feet
Elevation (above mean sea level):	
Top of dam maximum pool	87.0 feet
Stream bed	75± feet
Recreation pool	84.0 feet
Surface area:	
Recreation pool	19 acres
Maximum pool	37 acres

As previously discussed, the lake's natural recharge originating from an artesian spring in the lake bottom has been gradually impeded because of significant deposition of silt and organic overburden. Several point and nonpoint sources of pollution have contributed to the water quality degradation of the lake. Urban runoff and agricultural runoff also discharge directly into the lake through drainage pipes or overland flow.

1.3.5 SOILS

The offsite LiPari Landfill remediation area lies within the Atlantic Coastal Plain. In some of the areas adjacent to the site, the geologic formations are overlain by sand and gravel that were deposited at different times. These deposits and the underlying formations vary in characteristics, and, as a result, the soils that have developed over them vary considerably.

The soils in the area are important in that they influence the runoff (and, therefore, infiltration) of rainfall at the site and influence the ability of contaminants to migrate in the subsurface. Rainfall infiltration is the single most important mechanism by which buried contaminants are leached in the offsite areas out of the soil into the ground water. Additionally, soil characteristics affect the ability of the subsurface to mitigate the migration of contaminants. The effect of soil as either a source of a sink for contaminants is an important consideration in design of remedial alternatives. The following section characterizes each soil series in the vicinity of the landfill area. Permeability, soil classification and structure, and organic content of each soil series is discussed.

Gloucester county is divided naturally into nine general soil areas. Each area contains a characteristic pattern of soils, although some soils occur in more than one area (Soil Conservation Service, 1962). The area of interest in this study overlaps two of these general areas: the Westphalia-Nixonton-Barclay association and the Aura-Sassafras-Downer association (see figure 1-8).

The specific soils which dominate the area are the Aura, Downer, Sassafras, and Westphalia.

Aura

Aura soils are well-drained, occupying the highest areas in the County. They are redder and firmer with depth than the Sassafras and Downer soils.

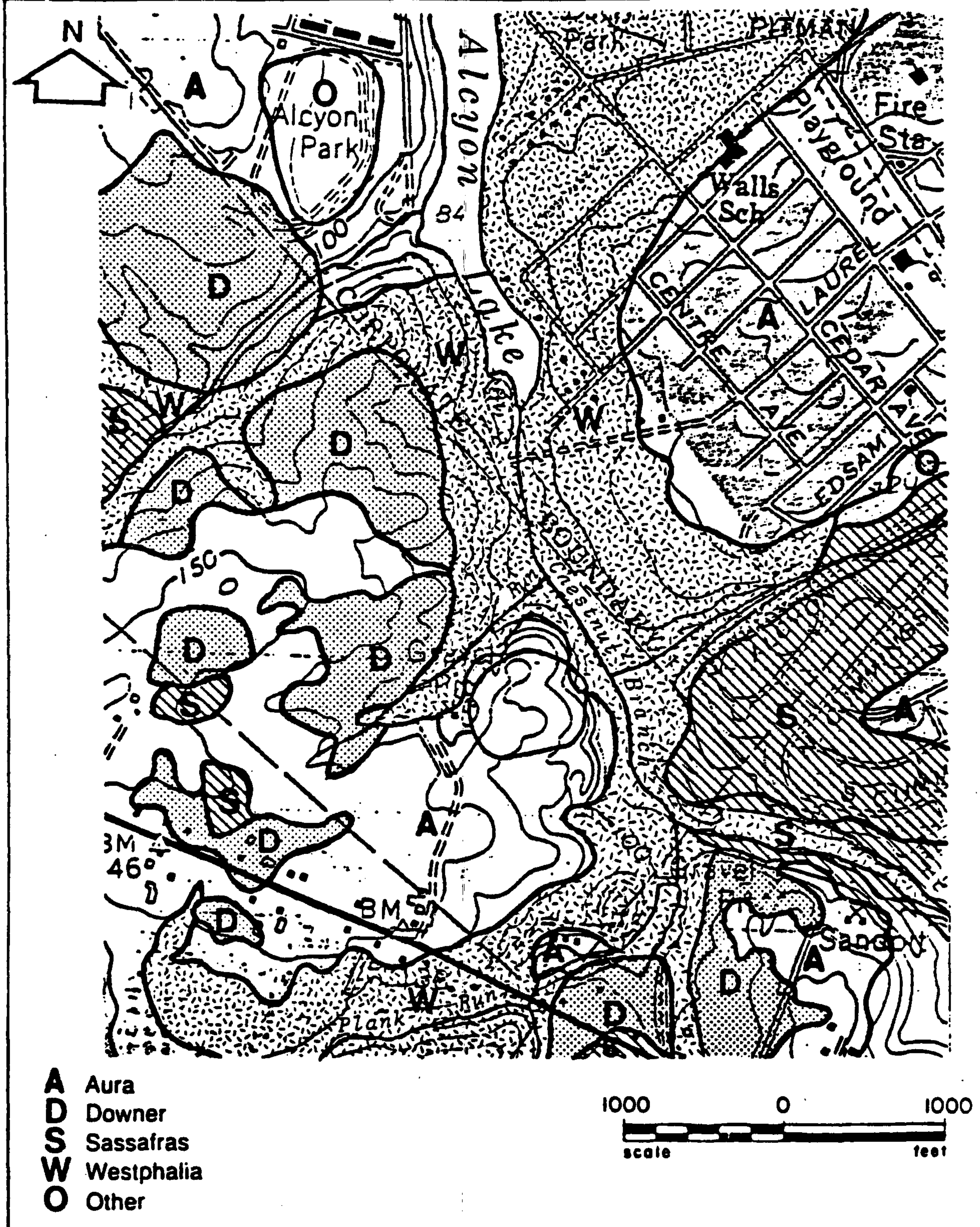

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Figure 1-8

Area Soil Types

LiPari Landfill, Gloucester County, New Jersey

Aura soils are moderately or moderately slowly permeable in the subsurface soil. Runoff is rapid, and erosion is a problem, even on gentle slopes. Few roots penetrate the firm deeper horizons, which hold little water that is available to plants. The soils are low in content of organic matter and low in natural fertility.

Downer

Downer soils lack the firm to very firm clay-coated sand and gravel of the Aura soils below depths of 20 to 36 inches and contain less clay in the subsoil than Sassafras soils. The Downer soils are low in organic matter, clay, and natural fertility. They are well drained and are subject to wind erosion if not protected.

Sassafras

These soils have a looser substratum than the Aura soils and are thicker and contain more clay in the subsoil than the Downer soils. They drain easily, are low in organic matter, relatively low in clay, and low in natural fertility.

Westphalia

Westphalia soils have a looser substratum than the Aura series. The Westphalia soils are well drained, low in natural fertility, and subject to wind erosion. When cultivated, they are also subject to water erosion.

1.3.6 GEOLOGY AND HYDROGEOLOGY

Regional Setting

Gloucester County is underlain by unconsolidated sand, gravel, silt, and clay sediments of Quaternary, Tertiary, and Cretaceous age. These sediments lie on a bedrock surface of metamorphic and igneous rocks of early Paleozoic age. All the unconsolidated formations dip to the southeast and thicken oceanward where each younger formation is, generally, more nearly horizontal than its predecessor (table 1-6 and figure 1-9).

The surface geology of Gloucester County is presented in figure 1-10. The Cohansey Sand outcrops over the southeastern portion of the county and dominates the surface geology of the area. The oldest sediments outcrop near the Delaware River along the west and northwest boundaries of the county and progressively younger sediments outcrop toward the central and southern portions of the county. In addition to the Cohansey Sand, the Kirkwood, Manasquan, and Mount Laurel-Wenonah Formations all outcrop within three miles of the LiPari Landfill.

The geology and hydraulic characteristics of the unconsolidated sediments are important when evaluating the potential migration of hazardous wastes through the water bearing zones. Therefore, the regional definition of aquifers and aquitards provides insight into identifying the formations which could potentially be contaminated with LiPari Landfill wastes. Regionally, the Potamic-Raritan-Magothy Formations, the Mount Laurel Sand and Wenonah formations, and the Cohansey Sands are considered major water supply aquifers because they produce significant amounts of ground water.

The Kirkwood, Vincentown and Englishtown Formations are considered minor water supply aquifers because the units produce ground water locally. The other formations, namely the Manasquan, Hornerstown, Navesink, Marshalltown, Woodbury and Merchantville Formations are considered aquitards which yield little or no water.

The formations potentially affected by the waste disposal activities at LiPari Landfill are in descending order, the Cohansey Sand, Kirkwood Formation, Manasquan Formation, and Vincentown Formation. The LiPari Landfill Remedial Investigation indicated that the Manasquan and Vincentown Formations are not jeopardized by the contamination from the LiPari Landfill. Deeper formations, including the Magothy-Raritan-Potomac Formation, Englishtown Sand, and Mt. Laurel-Wenonah Formations are not considered potentially affected because the vertical migration of contamination downward is hindered by the aquitards. Additionally, the

Era	System	Series	Formation	Lithology	Thickness (feet)	Water-bearing characteristics
Cenozoic	Quaternary	Holocene	Alluvium	Mud, black, silt and sand	0-40	No wells tap this formation
			Eolian deposits	Sand, white frosted	0-10	No wells tap this formation
		Pleistocene	Cape May Formation	Sand, gravel, and clay	0-40	Wells yield 10-50 gpm
			Unconformity			
			Pensauken Formation	Sand and gravel	0-30	Wells yield 10-30 gpm
			Unconformity			
			Bridgeton Formation	Sand and gravel	0-50	Wells yield 10-50 gpm
			Unconformity			
	Tertiary	Pliocene (?) and Miocene (?)	Cohansey Sand	Sand, clay and gravel, light colored	0-130	Wells yield up to 800 gpm
			Unconformity			
		Miocene	Kirkwood Formation	Sand, clay, and some gravel	50-160	Wells yield 10-50 gpm
			Unconformity			
		Eocene	Manasquan Formation (subsurface)	Sand and clay, glauconitic	0-25	No wells in this formation
		Paleocene	Vincentown Formation	Limy sand and limestone	0-55	Wells yield 10-150 gpm
			Hornerstown Sand	Clay and sand, glauconitic	0-30	Wells in sandy sections may yield 10-50+ gpm
			Unconformity			
Mesozoic	Cretaceous	Upper Cretaceous	Navesink Formation	Clay and sand, glauconitic	0-40	Wells in sandy sections may yield 10-50+ gpm
			Mount Laurel Sand Undifferentiated Wenonah Formation	Sand, medium to coarse, glauconitic Sand, fine to medium, micaceous	65-95	Wells yield up to 200 gpm
			Marshalltown Formation	Clay, sandy in places, glauconitic	10-40	Wells yield at least 40 gpm in some areas (Englishtown Sand included)
			Englishtown Formation	Sand, white and yellow, micaceous, slightly glauconitic	0-50	Wells yield 20-100 gpm
			Woodbury Clay	Clay, black, micaceous	50-80	No wells tap this formation
			Merchantville Formation	Clay, glauconitic, some sandy zones	45-70	Wells yield 15-100 gpm in some areas
			Unconformity			
			Magothy Formation Undifferentiated Raritan Formation	Clay, dark colored and sand, light colored (alternating) Clay and sand, variegated (alternating)	150-300+	Wells yield up to 1,400 gpm
			Unconformity			
Precambrian		Upper Precambrian(?)	Wissahickon Formation (subsurface)	Banded micaceous schist or gneiss	5,000-8,900	Wells yield little or no water

Source: Hardt and Hilton, 1969

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Table 1-6

Summary of Stratigraphic Units and Water-Bearing Characteristics in Gloucester County, N.J.

LiPari Landfill, Gloucester County, New Jersey

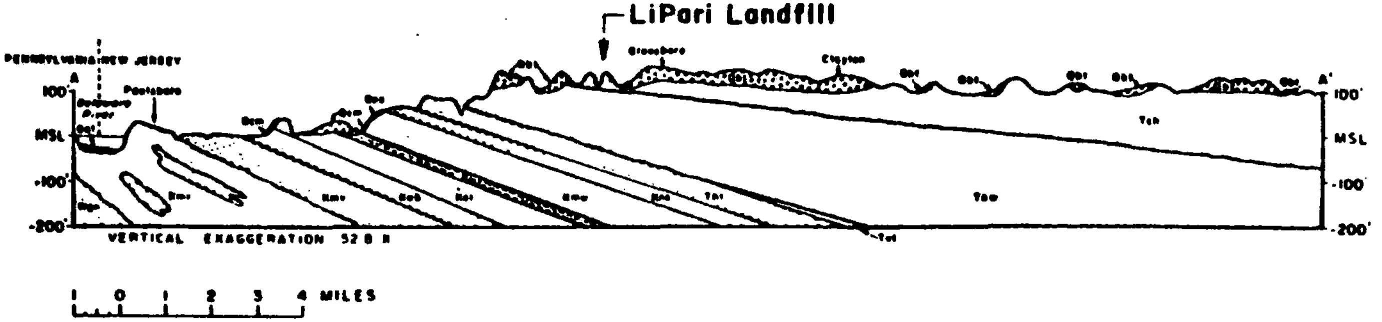
A-A' PROFILE LINE OF GENERALIZED GEOLOGIC SECTION

☐ Unit contains major aquifers

▒ Unit contains minor aquifers

░ Unit primarily an aquiclude

☐ Bedrock



Holocene	Qal	Alluvium	QUATERNARY
Pleistocene	Qcm	Cape May Formation	
	Qps	Pensauken Formation	
	Qbt	Bridgetown Formation	
		Pre-Quaternary	
Miocene (?) and Pliocene (?)	Tch	Cohansey Sand	TERTIARY
Miocene	Tkw	Kirkwood Formation	
Paleocene	Tvt	Vincetown Formation	
	Tht	Hornestown Formation	
Upper Cretaceous	Kns	Navesink Formation	CRETACEOUS
	Kmw	Mount Laurel Sand and Wenonak Formation	
	Kmt	Marshalltown Formation	
	Ket	Englishtown Formation	
	Kwb	Woodbury Clay	
	Kmv	Merchantville Formation	
	Kmr	Magothy and Raritan Formations	
Upper Precambrian	Wgn	Wissahickon Formation	PRECAMBRIAN

Source:
Hardt and Hilton, 1969

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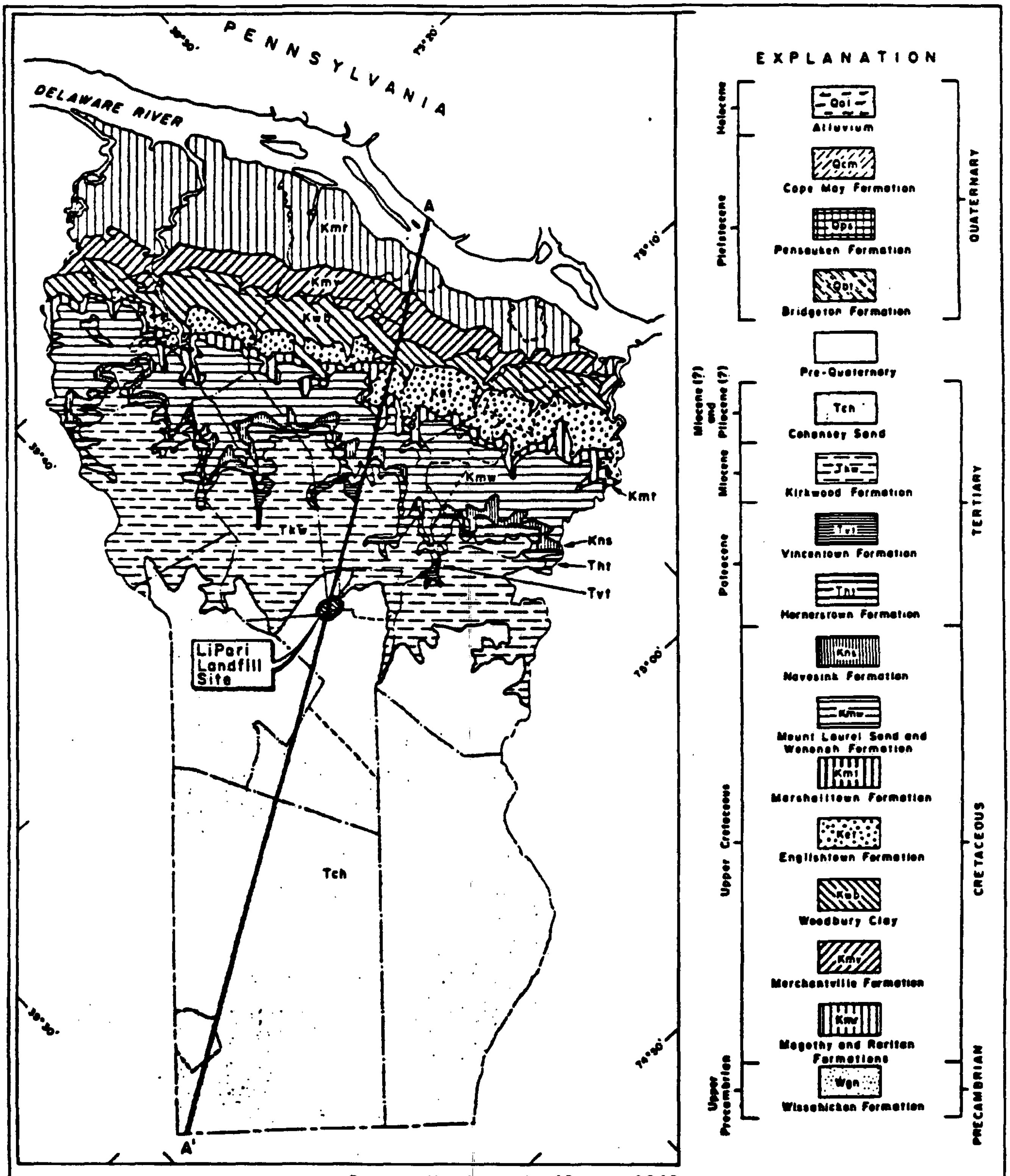
Figure 1-9

Generalized Geologic cross-section of Gloucester County, N.J.

LiPari Landfill, Gloucester County, New Jersey



Source Hardt and Hilton, 1969

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Figure 1-10

Gloucester County Pre-Quaternary Geologic Map

LiPari Landfill, Gloucester County, New Jersey

infiltrate which leaches contaminants out of the soil generally migrates more rapidly horizontally through the upper water bearing zones than vertically through the aquitards. Therefore, since the contamination has existed for less than 30 years and there are no wells withdrawing water from the Potomac-Raritan-Magothy Formation in the immediate vicinity of the landfill, the chance of deeper formation contamination is remote. The following section presents a discussion of each of the formations of concern.

Characterization of Area Stratigraphy

The Cohansey Formation. The Cohansey Sand is one of the most productive aquifers in the county. Wells less than 200 feet deep yield moderate to large amounts of water with static water levels usually less than 50 feet below the surface. However, the amount of water withdrawn is small compared to the quantity potentially available; thus, the aquifer is considered almost undeveloped. Locally, there may be more than one water-bearing zone present; however, the formation is generally regarded as a single hydrologic unit.

Artesian conditions exist locally in the Cohansey Sand because of lenses of clay which act as aquicludes for the more permeable parts of the formation. Pumping tests at Williamstown and Clayton indicate a coefficient of transmissibility of 60,000 gpd per foot and a permeability of nearly 1,000 gpd per square foot (Hardt and Hilton, 1969).

The Kirkwood Formation. The Kirkwood Formation is a minor aquifer in the county tapped mainly in its outcrop area, or in locations where the Cohansey and Kirkwood Sands are hydraulically connected. Records indicate that there are a few domestic wells, 25 to 100 feet deep which yield from 10 to 50 gpm (Hardt and Hilton, 1969). In and near the outcrop the formation consists largely of clay, silt, and fine sand of low permeability. Although the Kirkwood Formation is thicker and more permeable in the southern part of the county, it is not tapped by wells because water is more readily available from the overlying Cohansey Sand.

The Kirkwood Formation is of hydrological importance in Gloucester County because its large surface area can absorb precipitation which may be transmitted to the lower aquifers. Some recharge moves downdip to the more permeable parts of the Kirkwood Formation; however, much of the recharge on the outcrop is discharged to the nearby streams.

The Manasquan Formation. So far as known, no wells obtain water from the Manasquan Formation in Gloucester County since the overlying Cohansey and Kirkwood formations more readily produce water.

Vincentown Formation. The Vincentown Formation is a minor aquifer in Gloucester County, but probably is more productive than the Englishtown or the Kirkwood Formations. The aquifer is largely undeveloped because much of the area in which it is available for development is sparsely settled. Thus, it is tapped only by domestic and farm wells in a narrow band from Harrisonville through Pitman to Turnersville. Records of about 20 wells indicate yields ranging from 10 to 150 gpm from depths of 85 to 150 feet below land surface noting that pumpage in 1957 was probably less than 25,000 gpd (Hardt and Hilton, 1969). More recent data on this formation has not been published. The specific capacity of wells and a laboratory coefficient of permeability indicate moderate amounts of water may be available, particularly where solution openings in the limestone facies are large. Wells yielding between 50 to 100 gpm from the Vincentown Formation are mainly located near Sewell and Pitman.

Regional Ground Water Usage

Gloucester County consumes over 50 million gallons of ground water a day, 80 percent of their water comes from municipal water departments, municipal utility authorities, or privately owned and operated water supply companies. The vast majority of ground water used in the county is withdrawn from the Potomac-Raritan-Magothy (PRM) Formation through public and industrial wells. This formation supplies approximately 95 percent of all the water pumped by public water departments and companies. About 76 percent of the water in the county comes from this formation. Current water supply usage studies in the county have found that this formation is considerably over used (Noonan, 1984). Consequently, there is presently a moratorium on new ground water usage from this formation, and a 35% cutback in usage is being considered within fourteen months.

In Glassboro, Pitman, and Mantua Township, ground water withdrawal constitutes the major source of domestic, agricultural, and industrial water. All of the public and private water wells within a three mile radius of the LiPari Landfill are located on figure 1-11. Table 1-7 presents a listing of each well including the owner, the well completion date, the screened formation, the well depth, the general well location, and an observed static water level at some time during the well's history. The well data was obtained from existing NJDEP and U.S. Geological Survey Division of Water Resources well files, in addition to published data in Hardt and Hilton (1969). As can be seen from the table, the major ground water aquifers tapped by the area wells include the Cohansey/Kirkwood, Vincentown, Mount Laurel-Wenonah, and PRM Formations. Although more wells are developed in the Mount Laurel-Wenonah Formation (just over 60 percent of the wells tap this aquifer), the Magothy-Raritan-Potomac formation produces the most water. The two major water supply concerns within the study area--the Glassboro and Pitman Water Departments--both tap the latter formation and each withdraws a million gallons of ground water a day.

Regional Ground Water Quality

The overall chemical quality of the ground water in Gloucester County is good. The water generally meets the U.S. Public Health Service's (1962) suggested limits for dissolved solids; however, in some areas the water carries objectionable amounts of calcium and magnesium bicarbonate ("hardness") as well as iron and nitrate in solution and exhibits a low pH.

Historically, the concentration of dissolved solids in ground water from the Cohansey Sand is usually less than 100 mg/l. The iron concentration is generally less than 0.5 mg/l and hardness is 50 mg/l or less. The most undesirable feature of the water is the iron content for which the water must be treated to be rendered suitable for many uses. A Cohansey well

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Figure 1-11

Water Wells in Study Area

LiPari Landfill, Gloucester County, New Jersey

Table 1-7

Area Water Well Data Inventory

LIPARI LANDFILL 08/27/86

AREA WATER WELL DATA INVENTORY

WELL PERMIT #	CDM ID	OWNER	DATE INSTALLED	SCREEN FORMATION	DEPTH TO BOTTOM OF SCREEN (feet)	DATE W.L. READ	W.L. ELEV.	SURFACE ELEV.	LOCATION
31-18450	101	RAYMOND BATTLE	11/09/81	COHANSEY/KIRKWOOD	55	NA	NA	130	RTE.322, RICHWOOD
31-20223	102	JOSEPH DALEY	07/15/83	COHANSEY/KIRKWOOD	55	1983	129	160	HARRISON, LOT:6 BLOCK:22
31-1890	103	RAY E. CLARK	05/02/55	COHANSEY	59	NA	NA	160	0.5 MILE EAST OF RICHWOOD
31-13578	104	MERLE YOUNG	06/30/78	NA	NA	NA	NA	130	RTE 322 GLASSBORO
31-19903	105	ROBERT A. COOKE	08/04/83	COHANSEY	60	1983	133	165	HARRISON, LOT:10 BLOCK:22
31-17886	106	WILLIAM CORRELA	04/24/81	COHANSEY	50	NA	NA	175	RTE 322, HARRISON
31-15783	107	JOSEPH BURKE	10/02/79	VINCENTOWN	170	1979	72	125	HARRISON
31-1476	108	GEORGE GUTLOFF	7/26/54	VINCENTOWN	130	1954	79	115	PITMAN
31-12587	109	MIKE MAYBROOK	04/25/78	VINCENTOWN	140	1978	95	130	HARRISON
USGS:23	110	GEORGE REUTER	NA	VINCENTOWN	NA	NA	NA	NA	LAT. 39-43, LONG.75-10
NA	111	L. RAMBO	NA	COHANSEY	NA	NA	NA	NA	RTE. 322, GLASSBORO
31-13795	201	WALTER LAUREN	07/21/78	MT. LAUREL/WENONAH	180	1978	84	130	RICHWOOD-BARNSBORO RD., MANTUA TWP.
31-1582	202	TING LAI CHENG	06/09/79	MT. LAUREL/WENONAH	174	1979	67	130	RICHWOOD-BARNSBORO RD., MANTUA TWP.
31-16223	203	MARILYN BOOTH	10/08/79	MT. LAUREL/WENONAH	73	1979	103	121	TYLERS LAKE RD., MANTUA
31-13293	204	ASSEMBLY OF GOD CHURCH	02/12/79	MT. LAUREL/WENONAH	131	1979	76	120	MANTUA BLVD. & LAMBS RD., MANTUA TWP.
31-11689	205	JACOB RUBIN	NA	MT. LAUREL/WENONAH	117	NA	56	120	MANTUA
31-1416	206	JOHN MILLER	07/10/54	MT. LAUREL/WENONAH	120	1954	50	110	MANTUA
31-1413	207	WILLIAM SHAW	06/08/54	MT. LAUREL/WENONAH	130	1954	59	110	MANTUA
31-1220	208	RALPH MILLER	01/26/55	MT. LAUREL/WENONAH	125	1955	95	120	MANTUA
31-2292	209	WILLIAM DENNIS	04/17/56	NAVESINK	135	1956	61	130	RICHWOOD-BARNSBORO & JEFFERSON-PITMAN RDS.
31-1473	210	B.W. HENDERSON	07/22/54	MT. LAUREL/WENONAH	145	1954	75	90	WASHINGTON
31-1514	211	NA	01/27/77	MT. LAUREL/WENONAH	145	1977	93	120	RTE.322, RICHWOOD
31-13892	212	DAVID BENTIANE	09/13/78	MT. LAUREL/WENONAH	171	1978	100	140	RTE.322, HARRISON
31-19478	213	BEALE	06/01/83	MT. LAUREL/WENONAH	240	1983	74	130	RTE.322, HARRISON
31-10641	214	NA	02/28/77	MT. LAUREL/WENONAH	222	1977	72	140	RICHWOOD, HARRISON TWP.
31-19990	215	HARRIS KINLADE	04/10/83	MT. LAUREL/WENONAH	215	1983	96	120	HARRISON, LOT:3 BLOCK:18
31-19594	216	MT PLEASANT ORCHARDS	11/03/82	MT. LAUREL/WENONAH	230	1982	90	120	RICHWOOD-ELMER RD., HARRISON TWP.
31-11318	217	EUGENE MOBRAY	06/14/77	NA	223	1977	123	153	EWAN RD., HARRISON TWP.
31-12005	218	NA	09/15/77	MT. LAUREL/WENONAH	195	1977	87	150	RTE.322, RICHWOOD
31-16415	219	MRS. JOHN CARTER	01/17/80	NA	213	1980	63	140	PITMAN-RICHWOOD RD., PITMAN
31-16395	220	ELAINE LADDEN	11/14/79	MT. LAUREL/WENONAH	200	1979	77	143	PITMAN-RICHWOOD RD., MANTUA
31-17921	221	RALPH D HUGHES	03/05/81	MT. LAUREL/WENONAH	220	1981	93	160	RTE.322, 7 AURA RICHWOOD RD., HARRISON TWP.
31-27663	222	CLAIRE DUFFIELD	03/03/81	MT. LAUREL/WENONAH	223	1981	32	130	PITMAN-RICHWOOD RD., RICHWOOD
31-2258	223	GLASSBORO	01/01/56	MAGOTHY/RARITAN/POTOMAC	612	NA	-16	150	DEPTFORD & HARVARD RDS., GLASSBORO
NA	224	GLASSBORO	12/26/62	NA	NA	NA	NA	150	GLASSBORO
31-14683	225	JON BAIN	03/20/78	NA	195	1979	85	150	RTE.322, GLASSBORO
31-10445	226	ROBERT ROWAND	04/08/82	MT. LAUREL/WENONAH	225	1982	95	130	GREEN TREE RD., GLASSBORO
31-12274	227	JOHN CLENDENNING	01/08/79	MT. LAUREL/WENONAH	220	NA	NA	165	RTE.322, RICHWOOD
31-16873	228	NA	06/13/80	MT. LAUREL/WENONAH	80	1980	73	150	ELLIS & DEPTFORD RD., GLASSBORO
31-13973	229	THOMAS MACDUCH	08/28/78	MT. LAUREL/WENONAH	80	1978	60	98	TYLER LAKE RD., MANTUA
31-16873	230	WILLIAM V. OWENS	06/10/81	MT. LAUREL/WENONAH	80	1980	61	89	TYLER LAKE RD., MANTUA
31-15619	231	JOSEPH BERRY	08/15/79	MT. LAUREL/WENONAH	110	1979	55	90	BARNSBORO-PITMAN RD., MANTUA
31-1694	232	LLOYD WEAN	11/11/54	MT. LAUREL/WENONAH	115	1954	97	120	MANTUA
31-14101	233	ROBERT G MOORE	10/18/78	MT. LAUREL/WENONAH	76	1978	61	91	WOODBURY-GLASSBORO RD., BARNSBORO

(Continuous)

Table 1-7
Area Water Well Data Inventory

AREA WATER WELL DATA INVENTORY

WELL PERMIT #	CDR ID	OWNER	DATE INSTALLED	SCREEN FORMATION	DEPTH TO BOTTOM OF SCREEN (feet)	DATE W.L. READ	W.L. ELEV.	SURFACE ELEV.	LOCATION
31-17282	234	RICHARD PRUETT	09/17/80	MT. LAUREL/WENONAH	85	1980	59	86	TYLERS MILL RD., MANTUA
31-19416	235	LUCY LEWIS	10/01/82	MT. LAUREL/WENONAH	110	1982	60	90	MANTUA-PITMAN RD., MANTUA
31-15997	236	LOUIS MANNUM	08/15/79	MT. LAUREL/WENONAH	132	1980	64	100	LAMBS RD. & LAUREL DR., MANTUA
31-2844	237	EVERETT BROWN	09/27/56	MT. LAUREL/WENONAH	115	1956	72	120	MANTUA
US65182	238	HARRY MADERA	01/01/67	MT. LAUREL/WENONAH	NA	NA	NA	NA	LAMBS ROAD, MANTUA TWP.
NA	239	ZEE FARMS	NA	MT. LAUREL/WENONAH	205	NA	NA	NA	LOT 78. BLOCK 2
NA	240	ZEE FARMS	NA	ENGLISHTOWN	330	1966	NA	NA	LOT 80, BLOCK 2
US65[illegible]2	241	J.W. ZEE	01/01/66	MT. LAUREL/WENONAH	NA	NA	NA	NA	LAT 39,43', LONG 75,8.31'
US65124	242	HERITAGE AND SONS	01/01/67	MT. LAUREL/WENONAH	NA	NA	NA	NA	LAT 39,43', LONG 75,10.02'
US65126	243	MR. LEONARD	11/07/57	MT. LAUREL/WENONAH	NA	1958	NA	NA	LAT 39,43', LONG 75,10.18'
NA	244	PITMAN WATER DEPT.	CIRCA 38	MAGOTHY/RARITAN/POTOMAC	524	1937	5	140	LAUREL & WESLEY AVES, PITMAN
NA	245	PITMAN WATER DEPT.	03/01/26	MAGOTHY/RARITAN/POTOMAC	514	1926	0	140	NORTH SUMMIT & EAST HOLLY AVES, PITMAN
NA	246	PITMAN WATER DEPT.	08/01/47	MAGOTHY/RARITAN/POTOMAC	515	1947	-14	130	ESPLANADE AVE., PITMAN
NA	247	GLASSBORO WATER DEPT	11/01/27	MAGOTHY/RARITAN/POTOMAC	654	1927	0	145	MAIN & HIGH ST.S, GLASSBORO
NA	248	GLASSBORO WATER DEPT	08/01/47	MAGOTHY/RARITAN/POTOMAC	602	1947	-9	145	MAIN & DELSEA DR., GLASSBORO
NA	249	VIOLA ALEXANDER	NA	MT. LAUREL/WENONAH	150	NA	NA	NA	ROUGH ACRES, GLASSBORO
NA	250	ZEE	NA	MAGOTHY/RARITAN/POTOMAC	606	NA	NA	NA	GLASSBORO
NA	251	ZEE	NA	MT. LAUREL/WENONAH	NA	NA	NA	NA	GLASSBORO
NA	252	LEADEYE	NA	MT. LAUREL/WENONAH	178	NA	NA	NA	LOT 11, BLOCK 1
NA	253	ZEE	NA	MT. LAUREL/WENONAH	40	NA	NA	NA	GLASSBORO
NA	254	ZEE FARMS	NA	ENGLISHTOWN	415	NA	NA	NA	LOT 78, BLOCK 2X

KEY:
NA- NOT APPLICABLE OR NOT AVAILABLE

sampled in 1981 was consistent with the records of past water quality with an iron content of 0.43 mg/l and a pH of 5.8.

Two wells in the outcrop area of the Kirkwood Formation near Richwood and Turnersville contained dissolved solids of 64 and 62 mg/l, iron 0.55 and 0.43 mg/l, nitrate 22 and 14 mg/l, and hardness of 28 and 20 mg/l (as total calcium and magnesium), respectively.

Wells sampled from the Vincentown Formation up to 15 miles away from the site showed that the dissolved solids historically ranged from 86 to 173 mg/l, iron concentrations ranged from 0.16 to 2.4 mg/l, and hardness ranged from 66 to 138 mg/l. Results of chemical analyses performed by the USGS on nine water samples from the Venonah Formation and Mount Laurel sand indicated that the dissolved solids ranged from 46 to 386 mg/l, iron ranged from 0.2 to 5.6 mg/l, and hardness ranged from 14 to 174 mg/l. Six analyses of these nine samples indicated concentrations of dissolved solids and iron less than 130 and 0.6 mg/l, respectively, and five of the nine analyses indicated between 70 and 100 mg/l of hardness. The concentrations of the individual chemical constituents in these waters varied considerably and, from the data available, no single analysis may be considered typical of water from these formations (Hardt and Hilton, 1969).

As part of the onsite remedial design source water investigation; ground water from the PRM and Mt. Laurel aquifers were sampled and analyzed. The ground water from these aquifers were found to be within the same range found in the previous USGS chemical analysis. The data indicates the water is suitable for drinking water use (CDM 1987).

Gloucester County performed a drinking water analysis of tap samples from the Borough of Pitman municipal water supply well No. 4 (see figure 1-12) in May, 1979. Samples were analyzed for all parameters relative to the Safe Drinking Water Act, as well as supplemental pesticides. All parameters analyzed were determined to be within applicable maximum contaminant levels (MCLs).

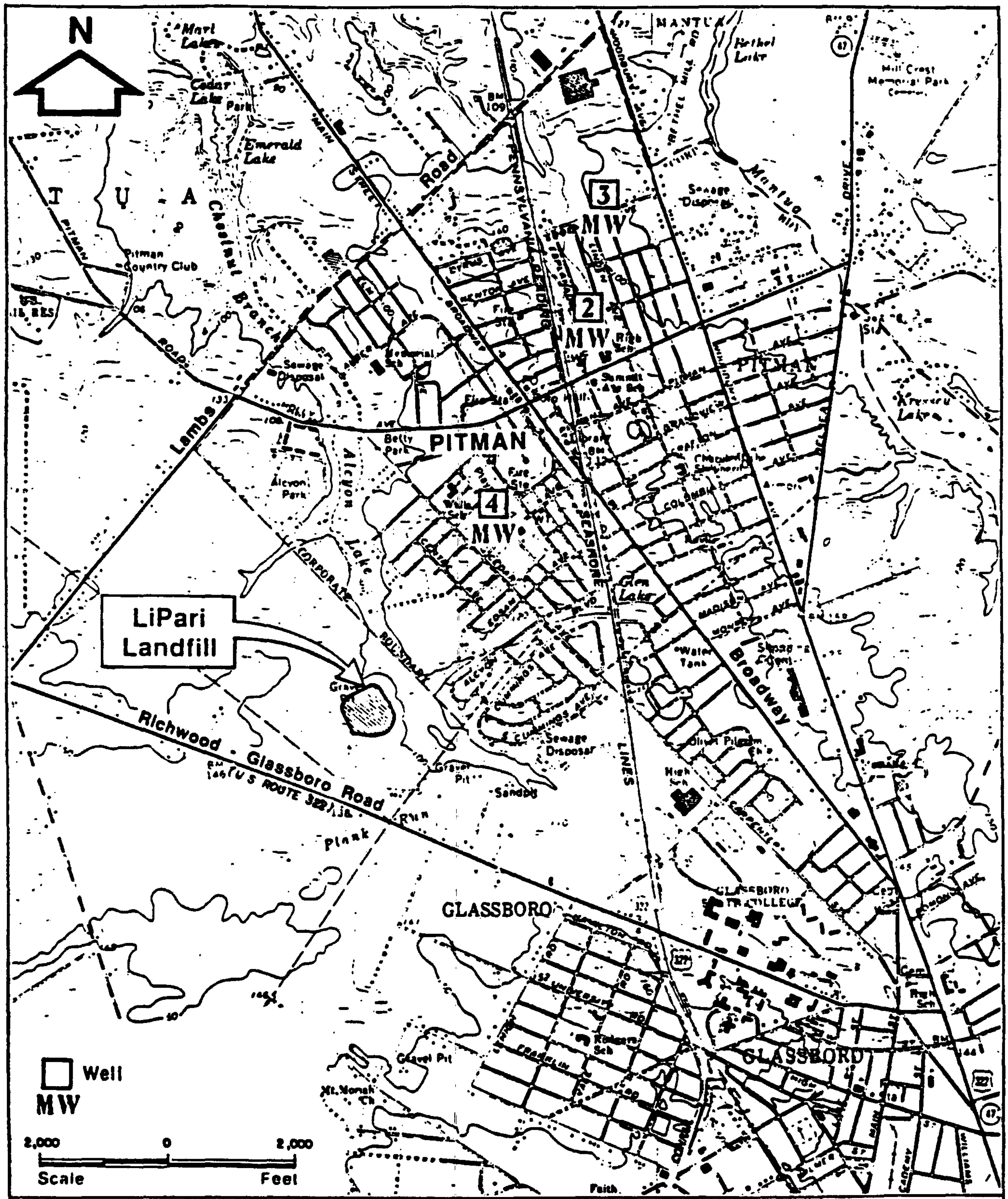

Figure 1-12

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Pitman Municipal Water Supply Wells

LiPari Landfill, Gloucester County, New Jersey

The Technical Assistance Team (TAT) performed subsequent sampling of area drinking water wells for EPA priority pollutants in 1979 and found no contamination evident at any location.

In September, 1983, five private wells in Pitman and two private wells in Glassboro were sampled and analyzed by the Gloucester County Department of Health. These results indicated that primary drinking water standards for iron were exceeded in two of the Pitman wells and one Glassboro well and manganese limits were exceeded in one Pitman well. One additional private well was sampled in October 1983 by the County Department of Health. This well was on a rental property identified only as being in the Rough Acres Campground. Analytical results from this well showed that none of the primary drinking water standards were exceeded. In addition, no volatile organic compounds were detected.

1.3.7 BIOTIC COMMUNITY

The biotic community in the offsite area is comparable to most of Gloucester County that is identified as having a rural suburban land use. The most ecologically sensitive area in the county is the Pine Barrens located to the southeast. The offsite area consists of streams, a lake, and parks. These biotic habitats, although limited in size, are designated by definition of the Gloucester County Development Management Plan as environmentally sensitive (Gloucester County Planning Department 1982). These types of habitats are important for many reasons including their support of fish and wildlife. Although the offsite area is limited in size, its environmental importance is increased because of the open space adjacent to the area in the form of agricultural lands.

Flora

The marsh in Chestnut Branch maintains a riparian habitat. Willow trees are characteristic and predominant along the stream; but smaller trees, shrubs, and grasses are also closely aligned with them. Tree growth is generally closely spaced. Similar to other riparian environments, ground cover retains dead twigs and leaves that are occasionally washed out by the stream. Prior ecological surveys reported, and present surveys confirm, the existence of large, dead trees in the marsh, and speculate that the trees have been stressed due to contaminants in the soil and water.

Alcyon Park, Hollywood Dell Park and Betty Park contain typical suburban park vegetation consisting primarily of lawn ground cover and a limited number of ornamental shrubs and trees, such as pine, oak, maple, sycamore, and elm. The moderate density residential area to the east of the offsite areas similarly maintain ornamental shrubs and trees. Agricultural lands, including Zee's orchards, occur to the west and consist of apple and peach tree orchards.

Vascular aquatic plants are generally limited to spatterdock (Nuphar) in Alcyon Lake and milfoils in Zee Pond. Seasonal phytoplanktonic algal surveys performed by Rossnagel & Associates (1979) concluded that samples contained low species diversity and quantity, indicating poor water quality. The plant genera identified are generally associated with excessive nitrate enrichment in water bodies. The Radian Corporation (1982) report conflicted with the previous investigation. It showed that the phytoplankton populations exhibited high diversity and moderate-to-high densities. Plant blooms of pollution-tolerant species were not observed. The conflicting results may be partially explained due to the difference in the methodology, biotic population during the years that were surveyed, and the lack of an ecologic comparative tool such as a "diversity index." A diversity index provides a direct comparison between biotic communities based on a comparison of the numbers of different types of specific species and the sum total population numbers of all different species.

Fauna

The faunal populations in the offsite area are qualitatively similar to other stream and lake environments located in the rural suburban setting of the Delaware River watershed. Two aquatic investigations of Alcyon Lake have identified the common carp as the most dominant species in the lake. No one investigative tool is optimal to adequately determine the number and diversity of aquatic species such as fish. Three generally used techniques (seining, electrofishing, and gill netting) have been employed to identify the fish populations in Alcyon Lake. The data show that a variety of fish are supported by Alcyon Lake. However, the common carp is not only more populous, but also constitutes the greatest total biomass. Bluegill sunfish, pumpkinseed sunfish, and gizzard shad are also numerous. Game fish, specifically large-mouthed bass, are present in the lake. The bass are reported to originate from the overflow pipe to Zee Pond. Bass spawning in Alcyon Lake was not observed, and the lack of adequate plant cover precludes spawning (Rossnagel & Associates 1979). In addition, an over population of carp will adversely affect bass spawning. Table 1-8 below shows the observations made during these investigations.

TABLE 1-8

ABUNDANCE AND AVERAGE WEIGHT OF FISH IN ALCYON LAKE

	Rossnagel & Associates		Radian Corporation		
Species	1979 Total[a]	Percentage of relative abundance	1982 Total[b]	Percentage[c] of relative abundance	Average weight (grams)
American eel	2	0.1	12	10.5	
Gizzard shad	None	None	8	7.0(30.5)	215(200)
Common carp	1,232	68.9	14	12.3(61.1)	447(257)
Brown bullhead	None	None	5	4.4	437
Creek chubsucker	None	None	2	1.8	5
Large-mouthed bass	7	0.4	7	6.1	130
Bluegill sunfish	451	25.2	43	37.7	4
Pumpkinseed sunfish	91	5.1	16	14.0	4
Black crappie	None	None	7	6.1	84
Calico bass	5	0.3	None	None	None
Catfish	1	<0.1	None	None	None

[a] Total number seined.

[b] Combined numbers based on electrofishing and gill netting.

[c] Percentages in parentheses are revised estimates based on overnight gill netting, with the remaining percentage distribution of other fish not reported.

The predominance of the common carp over other fish may be attributed to a number of factors. Common carp are generally considered a nuisance fish, especially in areas where efforts are being made to introduce new game species. In other cases, it is difficult to maintain game fish where common carp have become prevalent. Carp have a relatively high reproductive capacity. They are also more tolerant of nutrient enrichment and exhibit benthic feeding behavior that disturbs sediments, clouding the water and disturbing other organisms sharing their habitat. The accumulation of silt and sediment promotes the establishment of carp fish. Diminished ground water recharge from artesian springs below the lake also limit the volume of fresh recirculated water. There is also a lack of protective vegetative cover. The continued seepage of LiPari Landfill contaminants into Alcyon Lake and continued eutrophic conditions further contribute to water quality that is not optimal for the support of a more diverse lake fauna.

The predominance of carp in Alcyon Lake is indicative of poor water quality conditions. However, the history of point and nonpoint contaminant sources makes it difficult to attribute the cause for the predominant establishment of carp in the lake to any one factor. However, once carp are established, re-establishing other fish without a carefully monitored water management plan is difficult.

Semiaquatic and terrestrial invertebrate organisms found in the offsite areas are listed in table 1-9.

Threatened and endangered species that could potentially use habitats in the Borough of Pitman area have not been observed. Environmental disturbances and perturbations associated with man's use of the land have likely driven them away or destroyed their habitat, if they ever occupied these local habitats.

TABLE 1-9

TERRESTRIAL AND SEMIAQUATIC INVERTEBRATE ORGANISMS IN ALCYON LAKE

Amphibian	Bird	Mammal	Reptile
Bullfrog	Canada goose	Chipmunk	Garter snake
Leopard frog	Mallard duck	Eastern cottontail	Water snake
Tree frog	Domestic white duck	Grey squirrel	Black snake
	White egret	Opossum	King snake
	Great blue heron	Raccoon	Painted turtle
	King fisher		Musk turtle
	Starling		Snapping turtle
	Mourning dove		
	Sparrow		
	Blackbird		
	Woodpecker		

Source: Rossnagel & Associates 1979

1.4 OFFSITE REMEDIAL INVESTIGATIONS

The remedial investigation for the offsite LiPari Landfill area was undertaken to obtain the data needed to define the nature and extent of offsite contamination and to support the development and evaluation of offsite remedial alternatives as part of the offsite feasibility study necessary to complete offsite remedial action at the LiPari Landfill.

1.4.1 REMEDIAL INVESTIGATION OBJECTIVES

The field work associated with the REM II team's offsite remedial investigation was conducted in two phases. The first phase was conducted between February and July 1985 after the completion of a review and summary of all available data to detail the following:

- Chronological history of operations, response actions, and enforcement actions at the site
- Information on environmental setting of the site
- Nature and extent of the problem at the site
- Known or potential problems with existing data
- Data gaps

The second field investigation phase was conducted between the spring of 1986 and 1987, subsequent to the identification of further data gaps caused, in part, by laboratory error and subsequent to public request for additional information during public meetings held on July 12, 1984, January 23, 1985, and December 18, 1985, and the public availability session held December 19, 1985.

For environmental and public health purposes, a list of indicator contaminants were identified during the preparation of the onsite RI/FS as representative of the leachate observed within the LiPari Landfill.

In the offsite RI, several types of media were sampled; thus a new list of indicator chemicals was developed (see table 1-10, Chemicals of Concern). The indicator list was revised, in part, to reflect multimedia transport behavior that was not applicable during the onsite remedial investigation/ feasibility study. The indicator chemicals for the offsite risk assessment were selected in accordance with methodology developed by EPA (EPA, 1986) to conduct health assessments for Superfund sites. To select the appropriate indicator chemicals, chemicals present above background levels were identified. Additional selection criteria included toxicity, mobility, and persistence in the environment. Offsite data collected during CDM's remedial investigation were evaluated and the chemicals were selected based on indicator scores, frequency of occurrence of the contaminant in the sample, the chemical behavior in the environment, and the importance of the media in which the contaminants were found with respect to potential exposure. Because there are other contributing sources of contamination in the vicinity of the LiPari Landfill, the indicator chemical selection for this offsite study included only chemicals that were detected on site of the landfill. The new offsite RI included a list of fourteen indicator chemicals, which was similar to the onsite list except that ethylbenzene, xylene, chloroform, 4-methyl-2-pentanone, and zinc were included and methylene chloride, phenol, selenium, and silver were excluded. These indicator chemicals were used to trace the transport of LiPari Landfill-related contaminants to the offsite areas considered in the field remedial investigations.

TABLE 1-10

CHEMICALS OF CONCERN

Chemical	Carcinogen	Use	Entry route
Volatile organics:			
Benzene	Known human	As a solvent; manufacture of detergents, explosives, pharmaceuticals, dyestuffs; constituent in motor fuels	Inhalation, ingestion, skin and eye contact
Chloroform	Suspected human Known animal	Fluorocarbon refrigerants, fluorocarbon plastics, solvent, fumigant, insecticides	Inhalation, and ingestion
1,2-Dichloroethane	Suspected human Known animal	Used as a solvent and cleaning and degreasing agent	Inhalation, ingestion, skin and eye contact
Ethyl benzene	No	As a solvent; intermediate in styrene production	Inhalation, ingestion and absorption irritant to skin and eyes
4-Methyl-2-pentanone (methyl isobutyl ketone)	Unknown	Used as a solvent for paints, varnishes, and nitrocellulose lacquers	Inhalation, ingestion
Toluene	No	Manufacture of benzene; paints and coatings; component of automobile and aviation fuel	Inhalation, solvent for percutaneous absorption of liquid ingestion, skin and eye contact
Xylene	No	Aviation gasoline, solvent for alkyl resins, lacquers, rubber cement	Inhalation, ingestion
Base-neutral extractable:			
bis(2-chloroethyl)ether	Suspected human Known animal	Used in the manufacture of paint, varnish, lacquer, and finish remover; solvent	Inhalation, percutaneous absorption, ingestion, skin and eye contact

TABLE 1-10
(continued)

CHEMICALS OF CONCERN

Chemical	Carcinogen	Use	Entry route
Arsenic	Yes	Used as insecticide and in manufacture of pharmaceuticals; used in pigment production and the manufacture of glass, used as an alloying agent-often with copper	Inhalation and ingestion
Inorganic metals:			
Chromium	Yes, if valence is +6. No, if +2 or +3.	Used in plating operations; copper stripping, aluminum anodizing, as a catalyst, in organic synthesis and in photography	Inhalation, ingestion, eye and skin contact
Lead	No	Used as pigment in paints and varnishes, used in petroleum industry, used in halogenation, sulfonation, extraction and condensation processes	Inhalation of dust or fumes, skin and eye contact
Mercury	No	Used in plating operations, in paints and pigments, in the preparation of drugs and disinfectants in the pharmaceutical industry, and as a chemical reagent	Inhalation, skin absorbtion, eye and skin contact
Nickel	Known animal	Used in electroplating, anodizing, casting operations; in manufacture of magnetic tapes, batteries, enamels, ceramics; used as an intermediate in the synthesis of acrylic esters for plastics	Inhalation of dust or fumes, ingestion, eye and skin contact
Zinc	No	Alloys, galvanized iron and other metals, automatic parts, fungicides, electroplating	Inhalation of mists or fumes; ingestion, eye and skin irritant

(47)

The investigation categories are briefly summarized below.

Surface Water, Sediment, and Soil Investigations. Chestnut Branch, the adjacent marsh, Rabbit Run, and Alcyon Lake are currently contaminated with a variety of pollutants originating from the LiPari Landfill, and other point and nonpoint sources. Therefore, surface water and sediment samples were collected from Zee Pond, Alcyon Lake, upstream and downstream tributaries, control locations upgradient of Alcyon Lake, and Glen Lake (an upgradient source of water that drains into Alcyon Lake).

The objectives of these investigations were to determine the extent of contamination and to differentiate between LiPari Landfill and other contaminant sources.

Surface and subsurface soil samples were collected in the marsh west of Chestnut Branch to generally determine the extent of contamination in this area. A nonintrusive geophysical survey further delineated the areal and vertical extent of contamination. However, confidence in the geophysical data was low therefore the volume estimate was based on soil, ground water, and air data results. Control soil samples were taken from upgradient areas east of Chestnut Branch and from park soils.

In addition, previously uninvestigated areas of concern were identified. Alcyon Park and Betty Park lake frontages, along with Hollywood Dell Park and the marsh area east of Chestnut Branch, were identified as potential contamination sources resulting from the overflow of contaminated surface water (lake or stream origin) during flooding seasons. Accordingly, surface and subsurface soil samples were collected at each of these locations. Subsequent to a recommendation from the Agency for Toxic Substances and Disease Registry (ATSDR 1985), the EPA FIT obtained additional samples from the parks and the lake frontage residential properties since pesticides unrelated to the LiPari Landfill had been detected (NUS 1986, ATSDR 1986).

The GCUA sewer trunkline was identified as a potential contaminant source east of Chestnut Branch because of the potential for pipeline exfiltration. Additionally, the trunkline gravel bed could also serve as a conduit for transporting LiPari Landfill-contaminated ground water. The trunkline wells were installed to determine the potential for contamination and define the local ground water flow regime.

The contaminants identified during the investigation were subsequently evaluated on the basis of risk to public health and the environment.

Hydrogeological Investigation. Contaminants from the LiPari Landfill have been identified in the Cohansey and Kirkwood aquifers beneath the landfill. The objectives of the hydrogeological investigations were to establish the extent of offsite contamination in the Cohansey and Kirkwood aquifer, to further define the ground water flow regime, and to establish the potential for contamination of lower aquifers. Numerous field activities were performed to meet the objectives including soil boring sampling and stratigraphic interpretation; installation and sampling of monitoring wells in the marsh east and west of Chestnut Branch, along Howard Avenue, and north of the confluence of Chestnut Branch and Rabbit Run; ground water and surface water elevation measurements; and field and laboratory hydrogeological tests to define soil permeabilities.

Water Well Supply Investigation. The objectives of the private well and municipal well investigation were to identify the water wells in the area and to determine whether priority pollutants exist in these local water well supplies. If contaminants were detected in the wells samples, the concentrations were compared to applicable drinking water standards to determine whether a potential risk to public health or the environment exists. The water in each of the wells sampled was found to comply with existing state and federal water quality criteria.

Air Quality Investigations. Several potential emission sources occur on the onsite and offsite boundaries of the LiPari Landfill. The onsite air quality investigations were to have been addressed in the onsite RI/FS. However, the results were not available in time for inclusion in that report. Accordingly, this area of the investigation is addressed in the offsite RI/FS. The objectives of the air quality investigations are listed below:

- Measure toxic volatile organic substances and emission rates released from the onsite landfill gas vents and determine whether they exceed applicable NJDEP air quality standards.
- Estimate contaminant concentrations in adjacent residential areas under a variety of meteorological conditions by conducting air dispersion modeling. This was to be accomplished by estimating the emission rates of potential volatile organic compounds (VOCs) originating from the Chestnut Branch marsh and Alcyon Lake over a limited monitoring period (2 weeks). The preliminary data were to be evaluated on the basis of potentially acute and chronic public health risk to determine the need for a comprehensive long-term monitoring program.
- Determine the difference in emission rates from the marsh and exposure concentrations at selected receptors caused by potential remediation practices, such as excavation (soil disturbance), so that remediation contingencies can be established to offset potential public health risks.

The contaminant exposure assessments resulting from the air quality dispersion computer modeling were used in the "no action" risk assessment report to evaluate the potential public health risk from the inhalation of airborne contaminants, in the event that present conditions continued to exist with no remedial actions.

1.4.2 REMEDIAL INVESTIGATION CONCLUSIONS

Contamination of the offsite areas was evaluated with respect to the offsite RI indicator chemicals listed in table 1-10. These chemicals of concern were detected on the LiPari site, and their presence in offsite areas indicates contamination potentially attributable to the LiPari Landfill. When evaluating the level of contamination relative to background, concentration values which were above background were considered significant enough to attribute it to potential contamination from LiPari.

Surface Water, Sediments, and Soil

Chestnut Branch Marsh. Soil samples were collected from Chestnut Branch marsh. The sites of the soil samples are illustrated in figures 1-13 and 1-14. Two soil samples were collected at sampling locations WCB 1-5 at depths of 0 to 6 inches and 18 to 24 inches, and at 6-12 inches for samp-

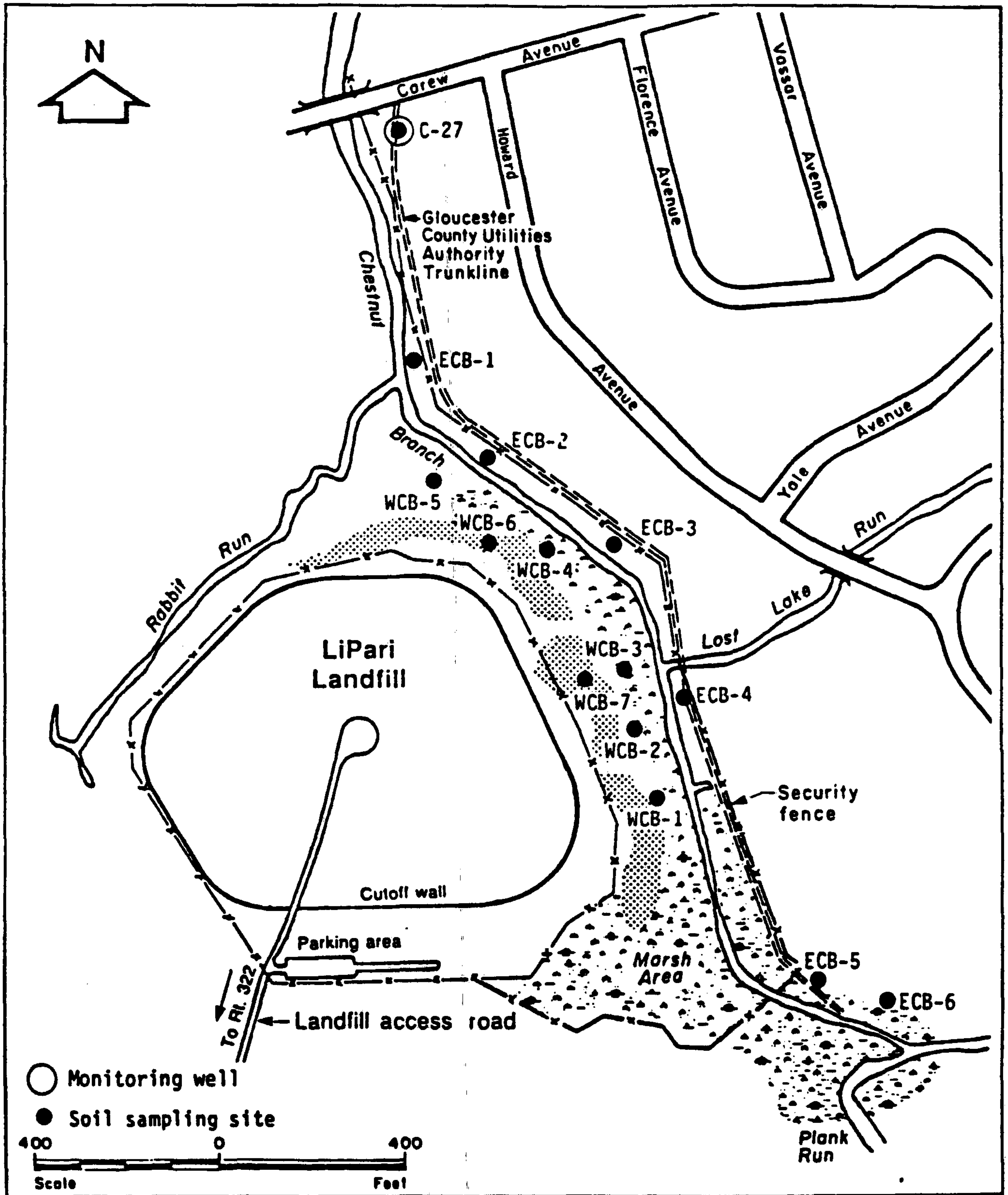

Figure 1-13

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Chestnut Branch Marsh Soil Sampling Sites

LiPari Landfill, Gloucester County, New Jersey

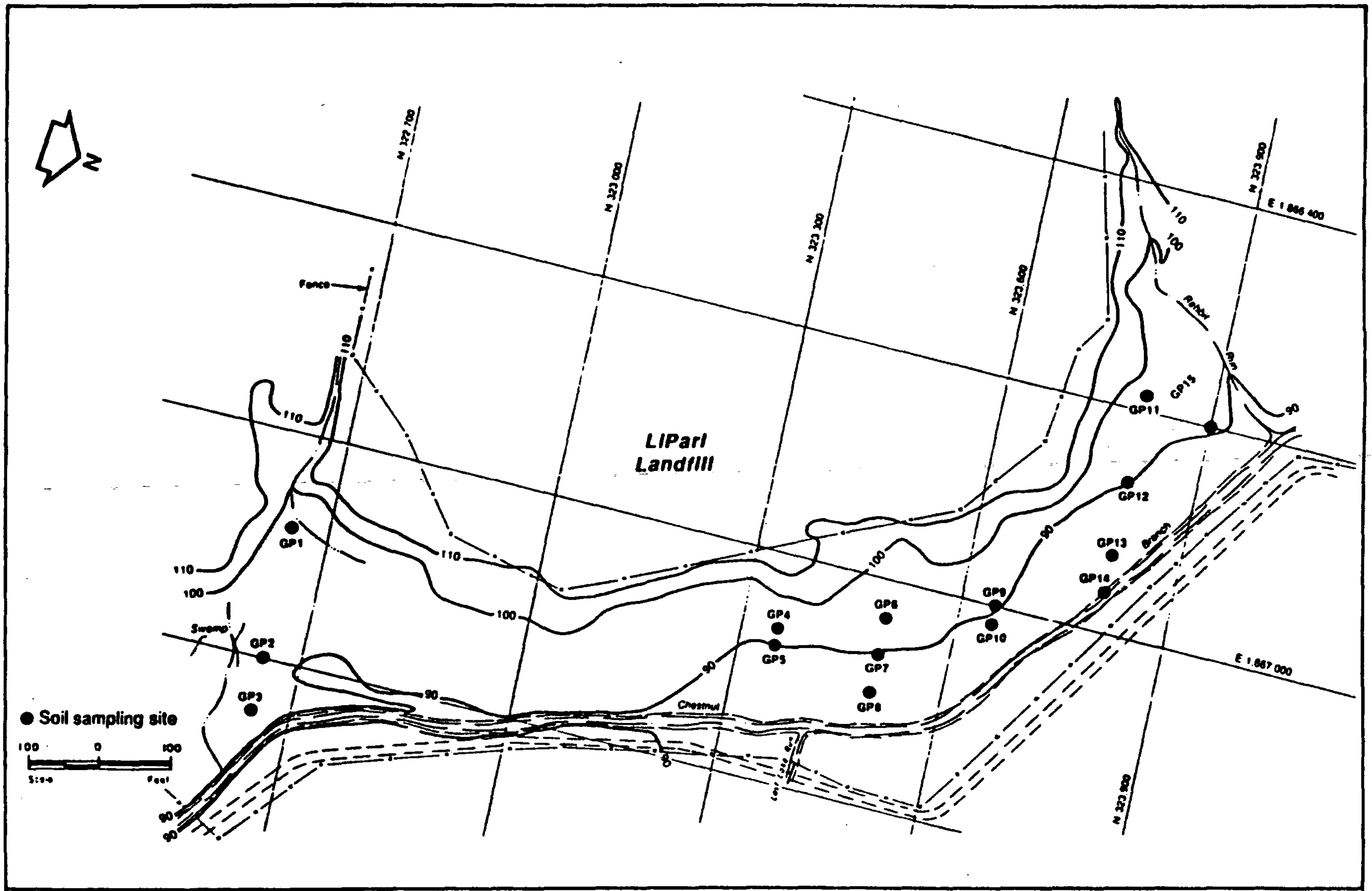

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Figure 1-14

Chestnut Branch Marsh Soil Confirmatory Sample Sites

LiPari Landfill, Gloucester County, New Jersey

ling stations GP 1-15. This type of sampling event delineates the extent of vertical contamination of soil in the offsite area. Table 1-11 indicates the organic compounds detected in the marsh soils above background conditions were benzene, chloroform, bis(2-chloroethyl)ether (BCEE), 1,2-dichloroethane, ethylbenzene, 4-methyl-2-pentanone, toluene, and total xylenes. Toluene and 4-methyl-2-pentanone were also detected in background soils. The indicator inorganic compounds found in the soils exceeding the overall mean concentration for background soils consisted of zinc, lead, mercury, nickel, and arsenic. Notably, all the indicator metals were detected in background soils. In the public health evaluation, ingestion of arsenic was identified as posing a risk under a reasonable maximum exposure scenario. The REM II risk assessment also suggested a potential carcinogenic risk greater than 10^{-6} was associated with chronic exposure (70 years of inhalation) to benzene, BCEE, and 1,2-dichloroethane through inhalation. A discussion on the public health evaluation follows in section 1.5.

Chestnut Branch. Surface water and sediment samples for Chestnut Branch were collected upgradient and downgradient of the leachate seepage from the LiPari Landfill. The location of these samples is illustrated in figures 1-15 and 1-16. A summary of surface water and sediment sample results are given in tables 1-12 and 1-13. bis(2-Chloroethyl)ether, chromium, zinc, and lead were detected at sample station SW-06, the confluence of Chestnut Branch and Rabbit Run. Lead exceeded the ambient water quality criteria (MCL = 50 ug/l) for human health; it was not considered a risk, however, since the stream is not for drinking water.

In the sediment analysis, the presence of indicator organic compounds was not confirmed in the stream between the landfill and Alcyon Lake. Benzene was detected downgradient of the spillway. However, it was also present in the same order of magnitude at the upgradient sampling location. The indicator inorganic compounds of concern that were elevated above background were chromium,

TABLE 1-11

LIPARI LANDFILL INDICATOR CHEMICALS ELEVATED ABOVE BACKGROUND - CHESTNUT BRANCH MARSH SOILS

Indicator chemicals	Background Sampling Site BP-1&2/AP-1/ECB-5 & 6 [a] 6 Inches	 18 Inches	 Max [b]	Marsh Sampling Site WCB-1-5/GP - 1-15 6 Inches	 18 Inches	 12 Inches	 Mean	 Max
Organics:	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)
Benzene	ND	ND	ND	59	2	0.5	12.4	100
Chloroform	ND	ND	ND	ND	ND	2.9	1.9	14
bis(2-Chloroethyl)ether	ND	ND	ND	ND	1375	1384.5	1094.7	7400
1,2-Dichloroethane	ND	ND	ND	ND	ND	5.7	3.4	99
Ethylbenzene	ND	ND	ND	56	26	ND	16.4	160
4-Methyl-2-pentanone	0.4	ND	2	3.5	5.2	ND	1.7	19
Total xylenes	ND	ND	ND	103.3	141.9	0.2	46.9	600
Toluene	0.2	ND	1	ND	ND	0.9	0.5	6
Metals:	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Chromium	11.2	109	400	27	(4.4)	RD	15.7	78
Nickel	ND	11.4	41	71.6	28.6	3.1	21.9	112
Lead	30.7	38.4	130	156.6	(52.1)	89.3	95.6	424
Mercury	ND	RD	RD	0.13	(0.1)	0.1	0.1	0.5
Arsenic	0.8	5.5	22	14.3	(2.4)	11.9	10.5	65.5
Zinc	16.4	14.7	36	90.8	35.2	110.5	91.5	325

[a] Background soil samples include samples taken east of Chestnut Branch and in the non-flood zone areas of Alcyon Lake Park and Betty Park.

[b] Maximum concentrations represent the highest concentration detected at 6 and 18 inches. The marsh maximum includes the 12 inch sample as well.

( ) - Did not exceed background.
ND - Not detected
RD - Rejected data

*All numbers represent means except maximums. The mean is calculated by summing the sample concentrations within a specified area divided by the number of samples taken in the area. Duplicate samples are counted as one sample and the average of the two concentrations is used in calculating the mean. Nondetected chemicals were counted as zeros in calculating the mean.

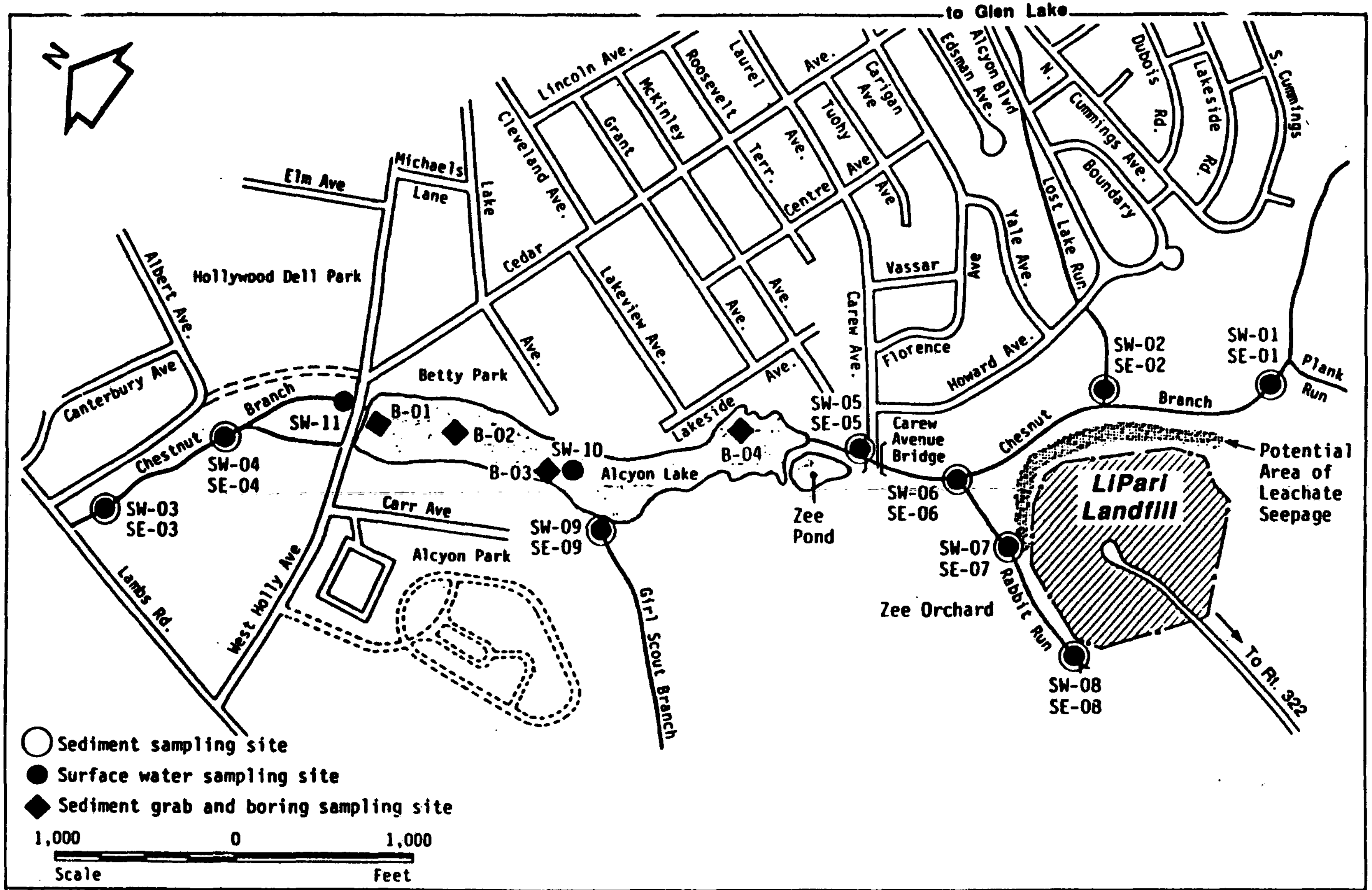

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Figure 1-15

Stream Grab and Lake Grab/Boring Sampling Sites

LiPari Landfill, Gloucester County, New Jersey

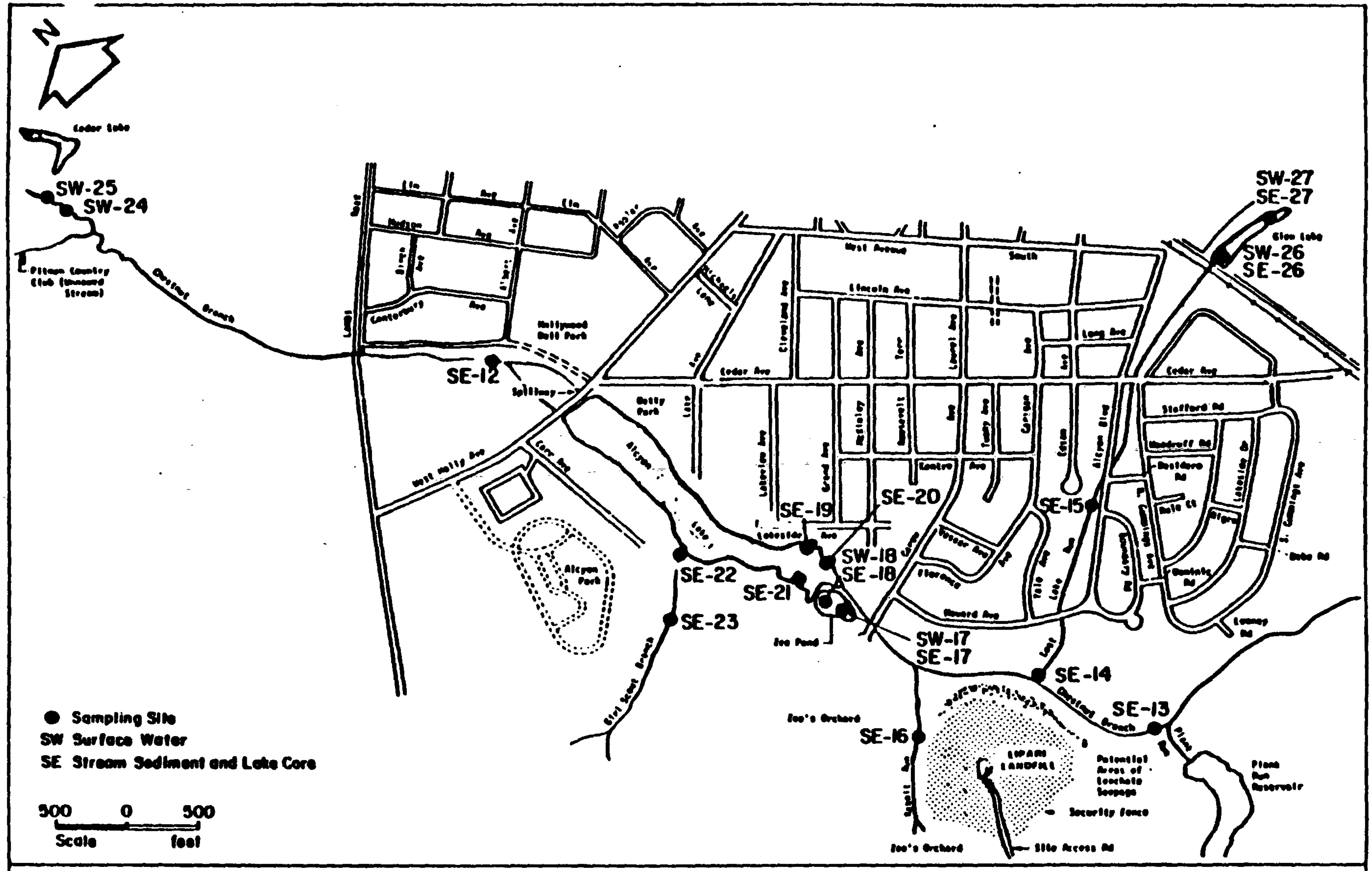

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Figure 1-16

Lake and Stream Surface Water, Stream Sediment, and Lake Core Sampling Sites

LiPari Landfill, Gloucester County, New Jersey

TABLE 1-12

LIPARI LANDFILL INDICATOR CHEMICALS ELEVATED ABOVE BACKGROUND - LAKE AND STREAM SEDIMENTS

Indicator Chemicals	Background -Streams Sampling Site SE-01/02 & 09 Mean*	Background -Streams Sampling Site SE-01/02 & 09 Max	Chestnut Branch Sampling Site SE-05 & 06 Mean	Chestnut Branch Sampling Site SE-05 & 06 Max	Rabbit Run Sampling Stite SE-07 & 08 Mean	Rabbit Run Sampling Stite SE-07 & 08 Max	Background -Lakes Sampling Site SE-26 & 27 Mean	Background -Lakes Sampling Site SE-26 & 27 Max	Alcyon Lake Sampling Site SE-19-21 B1-B4 (0-6 In.) Mean	Alcyon Lake Sampling Site SE-19-21 B1-B4 (0-6 In.) Max
Organics:	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)
Benzene	9.1	9.6	★	★	★	★	ND	ND	ND	ND
Chloroform	ND	ND	ND	ND	ND	ND	ND	ND	1.5	11
bis(2-Chloroethyl)ether	ND	ND	★	★	62.5	250	ND	ND	ND	ND
1,2-Dichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Methyl-2-pentanone	ND	ND	ND	ND	ND	ND	ND	ND	•	•
Total xylenes	ND	ND	ND	ND	ND	ND	11	22	ND	ND
Toluene	★	★	ND	ND	★	★	★	★	ND	ND
Metals:	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Chromium	2.3	6.0	6.3	12	(2.1)	4.2	75	93	38	156
Nickel	1.8	11	ND	ND	ND	ND	45	70	17.1	77
Lead	39.6	187	45.2	129	(14.9)	38	951	1,440	109.1	597
Mercury	ND	ND	ND	ND	0.06	0.12	ND	ND	0.22	1.1
Arsenic	ND	ND	ND	ND	ND	ND	ND	ND	6.6	67
Zinc	9.4	14	18.9	36	15.3	33	853	1,090	193.2	522

*The mean is calculated by summing the sample concentrations within a specified area divided by the number of samples taken in the area. Duplicate samples are counted as one sample and the average of the two concentrations is used in calculating the mean. Samples that did not pass QA/QC were not included in calculating the mean. Nondetected chemicals were counted as zeros in calculating the mean. If only two samples were collected the mean reported is actually the lowest concentration detected.

( ) - Did not exceed background
ND - Not detected
• - Did not pass QA/QC

TABLE 1-13

LIPARI LANDFILL INDICATOR CHEMICALS ELEVATED ABOVE BACKGROUND - LAKE AND STREAM SURFACE WATER

Indicator Chemicals	Background - Streams Sampling Site SW-01/02/09 Mean*	Max	Chestnut Branch Sampling Site SW-05 & 06 Mean	Max	Rabbit Run Sampling Site SW-07 & 08 Mean	Max	Background - Lakes Sampling Site SW-26 & 27 Mean	Max	Alcyon Lake Sampling Site SW-10 Mean	Max
Organics:	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(µg/l)
Benzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroform	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
<u>bis</u>(2-Chloroethyl)ether	ND	ND	9.4	30	45.4	87	ND	ND	7.7	12
1,2-Dichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Methyl-2-pentanone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total xylenes	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	ND	ND	★	★	★	★	ND	ND	ND	ND
Metals:										
Chromium	ND	ND	2.8	14	1.0	5.8	9.7	9.8	★	★
Nickel	1.6	14	(1.3)	8	ND	ND	ND	ND	ND	ND
Lead	3.9	17	18.1	82	9.3	28	7	14	15	17
Mercury	ND	ND	ND	ND	ND	ND	ND	ND	0.07	0.2
Arsenic	ND	ND	ND	ND	1.7	10	ND	ND	ND	ND
Zinc	8.1	8.1	90	90	34.3	49	★	★	★	★

*The mean is calculated by summing the sample concentrations within a specified area divided by the number of samples taken in the area. Duplicate samples are counted as one sample and the average of the two concentrations is used in calculating the mean. Nondetected chemicals were counted as zeros in calculating the mean.

( ) - Did not exceed background.
ND - Not detected
★ - Did not pass QA/QC

lead, and zinc. However, no sample exceeded the maximum value observed in the background samples. Mercury was detected in the sediments downgradient of the spillway.

Rabbit Run. Organic and inorganic contaminants were detected in the water and sediments of Rabbit Run. The sites of the samples collected are illustrated in figures 1-15 and 1-16. bis(2-Chloroethyl)ether, lead, chromium, zinc, and arsenic were found in the water in concentrations exceeding background levels (see tables 1-12 and 1-13), bis(2-chloroethyl)ether and mercury were not detected in any of the background samples. The presence of bis(2-chloroethyl)ether in the sediments and surface water indicates Rabbit Run has been impacted by the LiPari Landfill.

Alcyon Lake. The location of sediment samples obtained for Alcyon Lake are illustrated in figures 1-15 and 1-16. The investigation at Alcyon Lake included a surface and subsurface sediment analysis to determine the depth of contamination present at the lake bottom. Indicator organic compounds detected at the sediment bottom of the lake above background concentrations include chloroform (see table 1-12). The inorganic indicator chemical compounds arsenic and mercury were found in downgradient sites, but not upgradient sites. These metals were also detected in the background subsurface soils. Therefore, while these metals could be transported locally to sediments by soil erosion, it is likely that they are not characteristic of the sediments in the area not impacted by the landfill.

Mercury and lead and other metals were also found in the water samples of Alcyon Lake along with bis(2-chloroethyl)ether. The LiPari Landfill appears to be contributing these contaminants, however, lead is also introduced into the lake through urban runoff and upgradient streams. Mercury is present at levels that violate Federal Water Quality Criteria for surface waters.

Surface water concentrations of mercury and BCEE exceeded the human health criteria for consumption of fish. The risk assessment performed by the REM II team, however, was based on assumptions for fishing specific to this community, and it concluded that a potential risk exists for consumption of BCEE contaminated fish, but not for mercury. The risk assessment indicated that sediments do not pose a public health risk.

Parks Surrounding Alcyon Lake. Soil samples were collected at 6- and 18-inch intervals in Betty Park, Alcyon Park, and Hollywood Dell Park from areas that could be affected by Alcyon Lake flooding. The collection sites are identified in figure 1-17. The only park in which indicator organic compounds were detected was Betty Park (see table 1-14). Toluene and xylene were detected in one subsurface soil sample, but not at the surface. Toluene also exists in background streams discharging to Alcyon Lake. The absence of indicator organic compounds an order of magnitude above background and the presence of certain PAHs and pesticides in the flooded areas of the three parks suggests the origin of the organic contaminants cannot be definitely linked with the landfill.

The indicator metals arsenic, chromium, nickel, lead, and zinc were also detected in the flooded (as well as nonflooded background soils) areas of the park. Mercury was not detected in the park soils. The mean soil concentrations of samples in the flood-prone areas exceed the background concentrations for nickel, lead, arsenic, and zinc in Alcyon Park and Hollywood Dell Park. Only zinc was exceeded in Betty Park. Chromium was not exceeded in any of the parks. Unlike Chestnut Branch marsh where soils are in the direct path of contamination, the soils of the three parks investigated are not similarly affected. The flood zone for Alcyon Lake did indicate that contamination of the parks from flooding is possible. However, flooding in the area is very infrequent; thus the opportunity for soil to be contaminated is minimal. The absence of contaminants such as bis(2-chloroethyl)ether and mercury indicate that there is no definite indication that the parks have been contaminated as a result of flooding with contaminated surface water from Alcyon Lake.

The risk assessment performed for the parks identified a risk associated with an exposure to arsenic in the soil under both the average and reasonable maximum exposure scenario. In addition, an inadequate margin of safety may exist for exposure to lead in the parks under the maximum

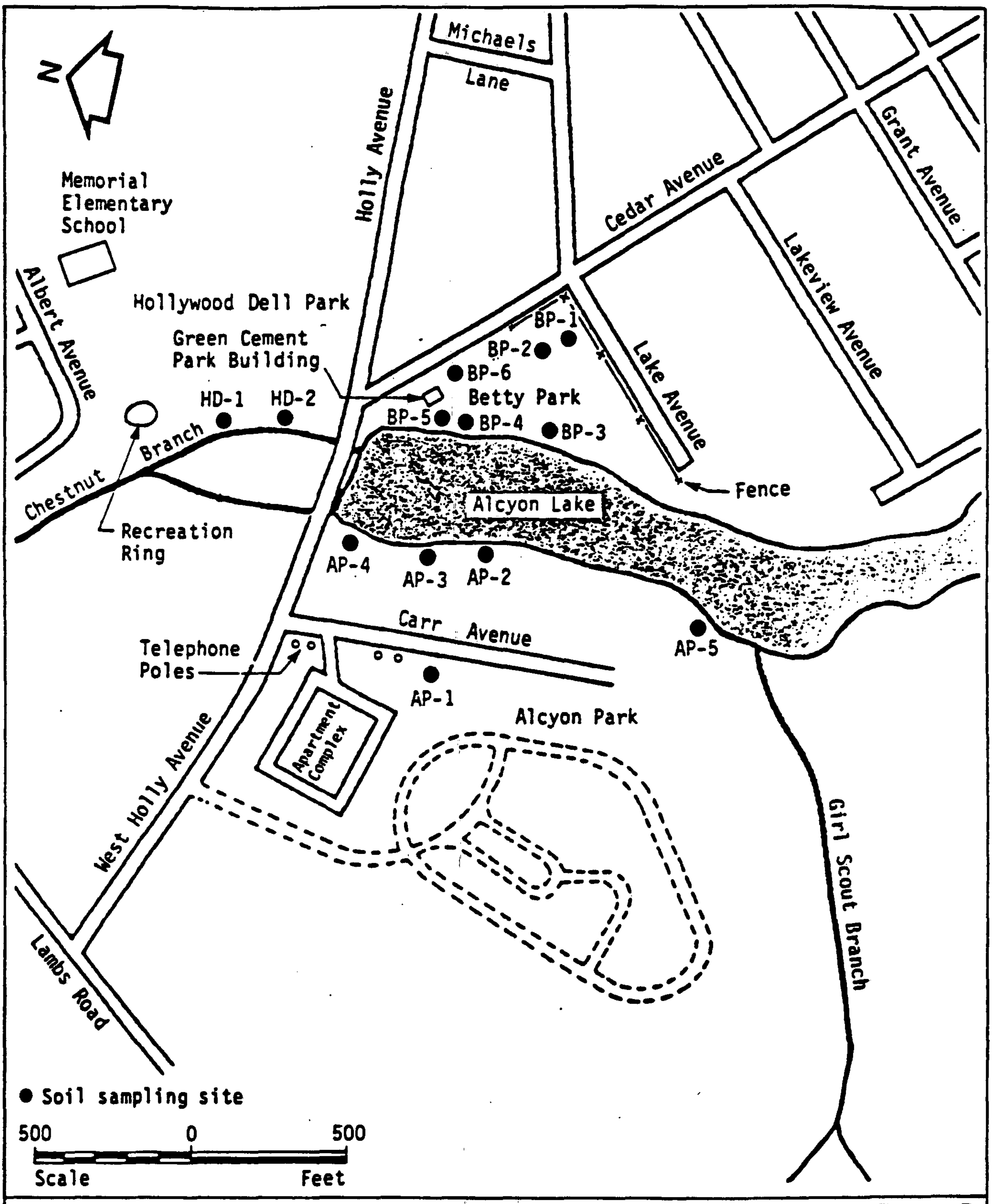

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Figure 1-17

Park Soil Sampling Sites

LiPari Landfill, Gloucester County, New Jersey

TABLE 1-14

LIPARI LANDFILL INDICATOR CHEMICALS ELEVATED ABOVE BACKGROUND - PARK SOILS

Indicator	Background			Betty Park			Alcyon Park			Hollywood Dell Park		
	Sampling Sites BP-1 & 2/AP-1/ECB-5 & 6			Sampling Sites BP-3/4/5/6			Sampling Sites AP-2/3/4/5			Sampling Sites HD-1 & 2		
Chemicals	6 Inches	18 Inches	Max •	6 Inches	18 Inches	Max	6 Inches	18 Inches	Max	6 Inches	18 Inches	Max
Organics:	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)	(µg/kg)
Benzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chloroform	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
<u>bis</u>(2-Chloroethyl)ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Methyl-2-pentanone	0.4	ND	2	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total xylenes	ND	ND	ND	ND	0.8	3.0	ND	ND	ND	ND	ND	ND
Toluene	0.2	ND	1	ND	0.3	1	ND	ND	ND	ND	ND	ND
Metals:	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Chromium	11.2	109	400	13	(22)	20	33.3	(20.8)	41	29	(47.3)	69
Nickel	ND	11.4	41	1.95	1.48	7.8	7.1	(5.5)	22	8	15.3	31
Lead	30.7	38.4	130	(24.3)	(17.1)	43	72	(28.7)	190	78.5	(23.9)	115
Mercury	ND	★	★	ND	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	0.8	5.5	22	1.23	ND	4.9	20.3	11.2	61	32	10.3	64
Zinc	16.4	14.7	36	50	(9.4)	132	63.4	31.5	131	30	(9.6)	60

• Maximum concentrations represent the highest concentration detected at 6 and 18 inches.

( ) - Did not exceed background
ND - Not detected

*<u>ALL NUMBERS REPRESENT MEANS EXCEPT MAX.</u> The mean is calculated by summing the sample concentrations within a specified area divided by the number of samples taken in the area. Duplicate samples are counted as one sample and the average of the two concentrations is used in calculating the mean. Nondetected chemicals were counted as zeros in calculating the mean.

exposure scenario. Comparable risks associated with these metals also exist in the background soils, indicating that the problem is no greater than in soils not impacted by the LiPari Landfill.

Hydrogeology

The LiPari Landfill and the surrounding offsite area are underlain by strata dipping gently towards the southeast. The near surface stratigraphy consists of alternating layers of sand, silt, and clay represented by the Cohansey, Kirkwood, Manasquan and Vincentown Formations. Distinct zones have been identified in the Kirkwood and Cohansey Formations based upon textural differences. These units consist of the Kirkwood Sands and Clay, and the upper and lower Cohansey Sands. A geologic cross-section depicting the stratigraphy from west of the landfill to Chestnut Branch is illustrated in figures 1-18 and 1-19.

The Cohansey and Kirkwood Sands are aquifers with horizontal and vertical flow components in the site vicinity. The low transmissivity of the Kirkwood, however, limits its effectiveness as a source of ground water. The hydraulic connection between the Cohansey and the Kirkwood aquifers occurs across the Kirkwood Clay, which acts as an aquitard. The hydraulic gradient is downward under the landfill containment system and upward in the marsh. A conceptualization of the ground water flow pattern is found in figure 1-20. As is evident from this figure and the cross-section, the upper and lower Cohansey Sands are no longer present in the vicinity of Chestnut Branch. This is the result of the meandering of the stream which eroded these geologic units and deposited alluvium. Ground water discharges along the seepage face east of the landfill from the Cohansey Sands. In addition the Cohansey/alluvium is saturated by ground water as a result of the upward hydraulic gradient in the marsh. Ground water in the Cohansey/alluvium both east and west of Chestnut Branch flows toward the stream.

Ground water samples taken at the marsh indicate that contamination exists in the Cohansey and Kirkwood aquifers. Figure 1-21 shows the onsite and offsite ground water wells present in the study area. A summary of the

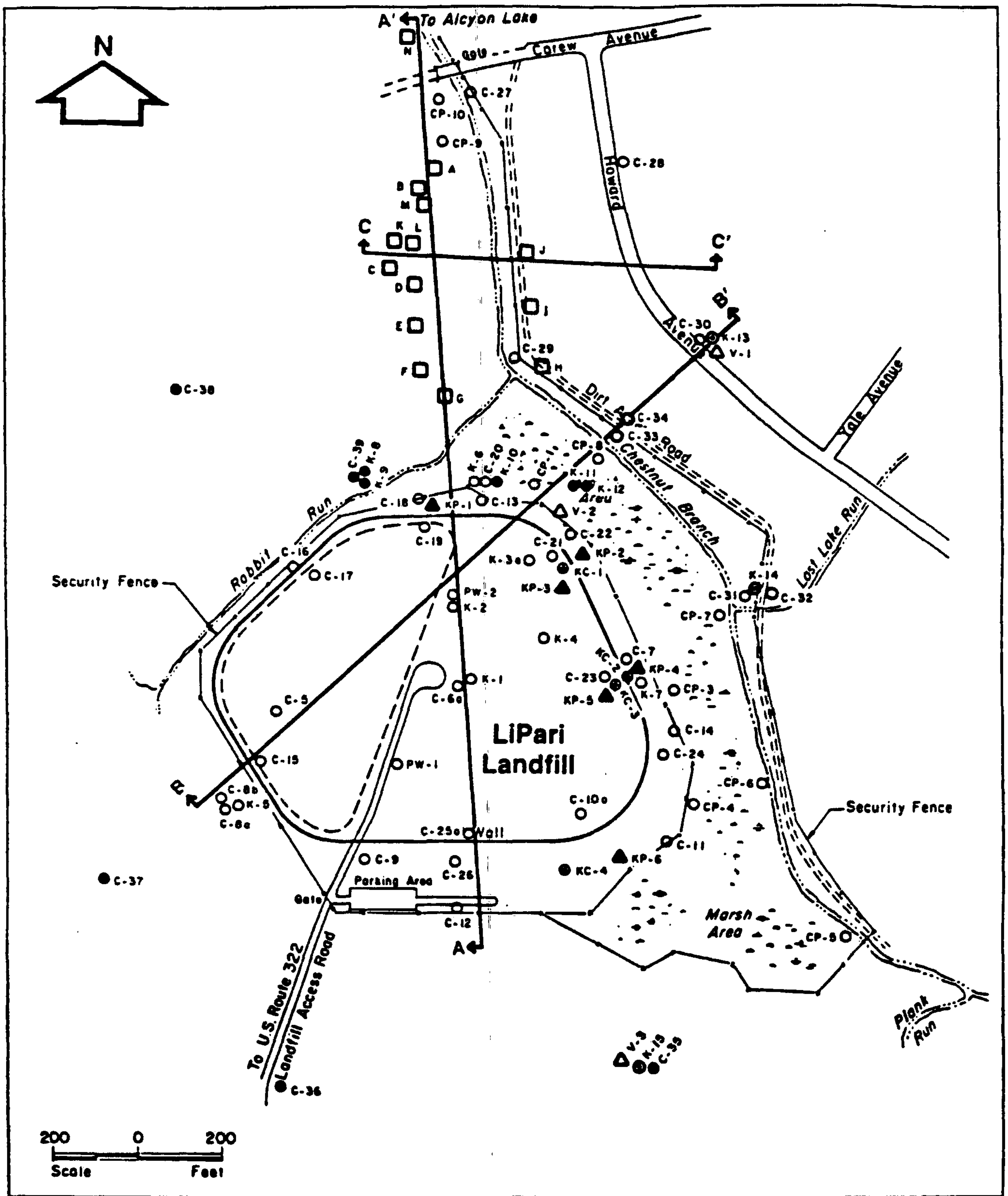

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Figure 1-18

Location of Stratigraphic Cross-Sections

LiPari Landfill, Gloucester County, New Jersey

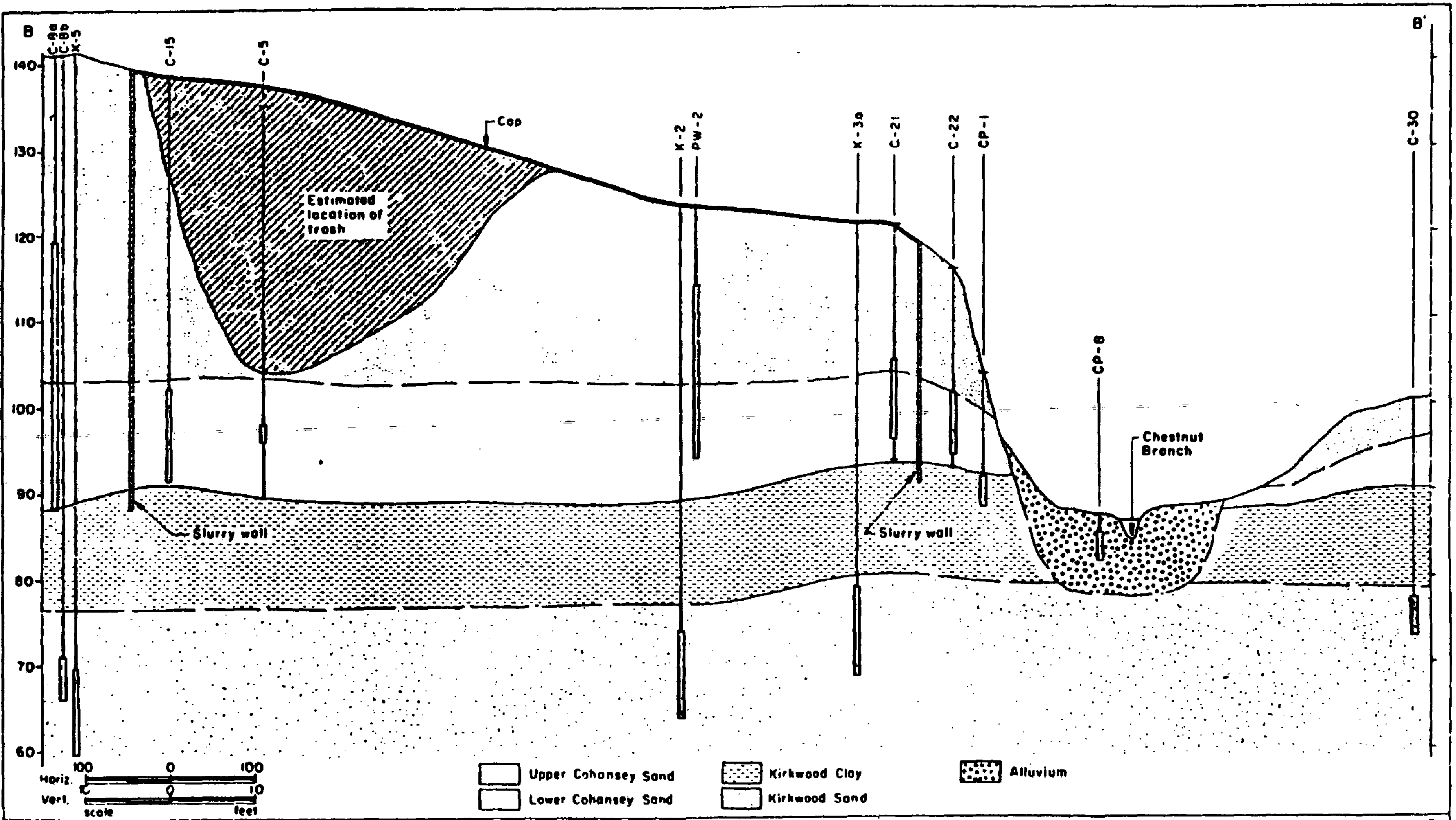

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Figure 1-19

Geologic Cross-Section B-B'

LiPari Landfill Gloucester County, New Jersey

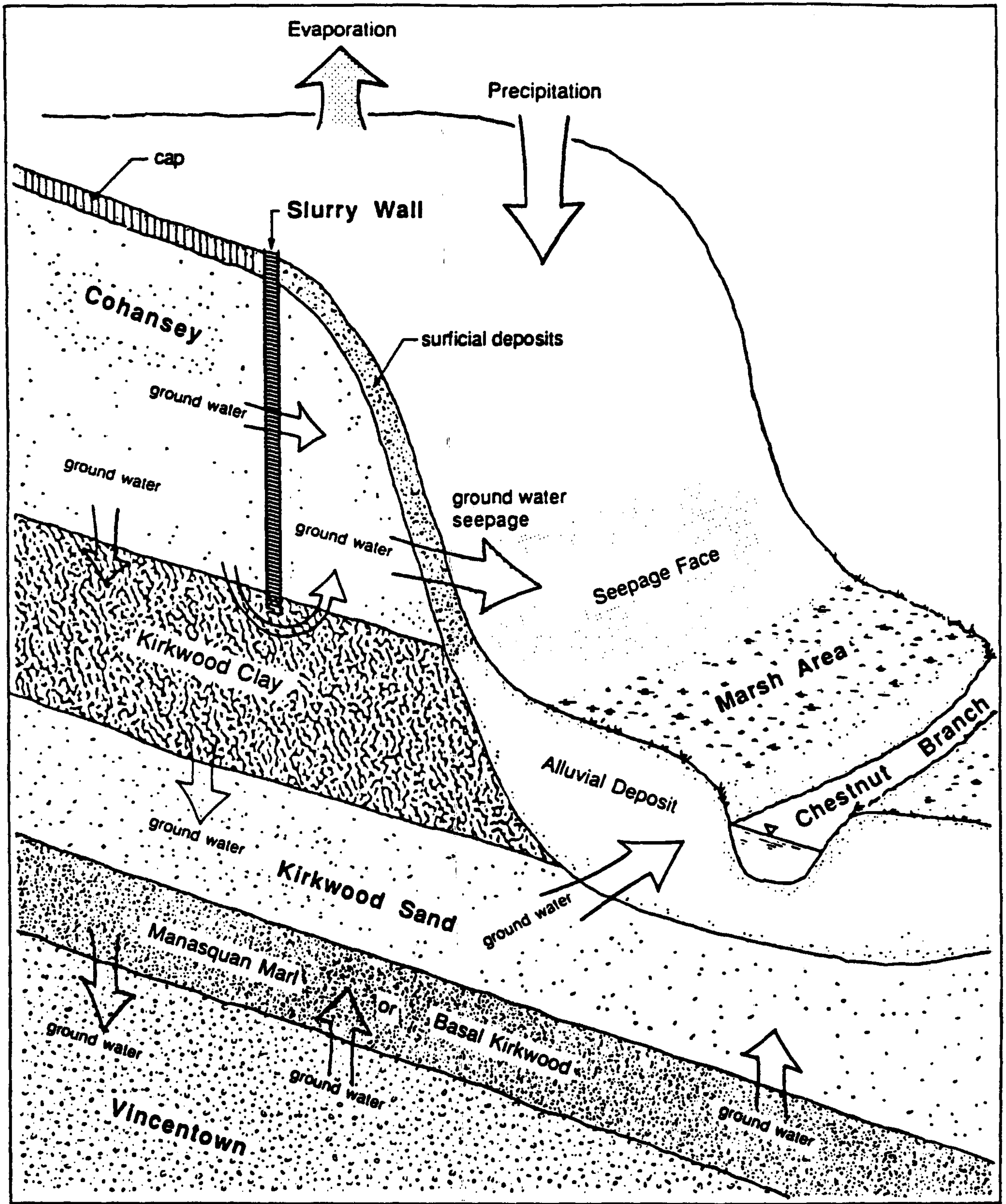

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Figure 1-20

Conceptual Diagram of Groundwater Flow Pathways

LiPari Landfill, Gloucester County, New Jersey

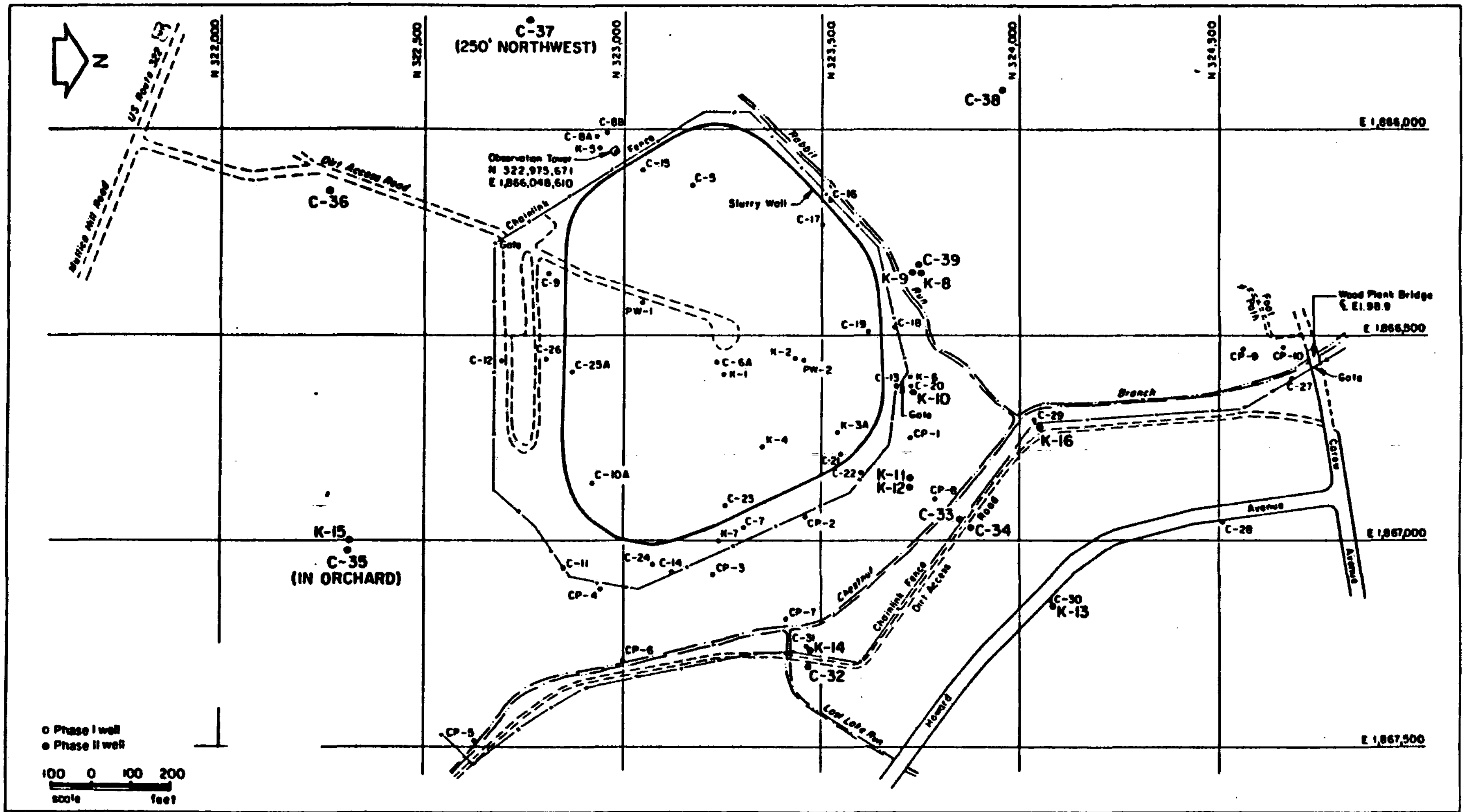

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Figure 1-21

Existing Monitoring Well and Piezometer Sites

LiPari Landfill, Gloucester County, New Jersey

ground water quality analysis of contaminants detected in the offsite wells is presented in table 1-15. The summary table lists the maximum observed chemical concentration for Cohansey and Kirkwood wells in the area west of Chestnut Branch, east of Chestnut Branch including Howard Avenue wells, and north of Rabbit Run.

Organic compounds present in the Cohansey wells which are attributable to the LiPari Landfill are BCEE, chloroform, 1,2-dichloroethane, and 4-methyl-2-pentanone, toluene and xylene. The extent of contamination in the Cohansey is limited to the marsh. The only Kirkwood well east of Chestnut Branch with contamination typical of the landfill was well C-29. Well C-29 is located at the confluences of Rabbit Run and Chestnut Branch. Rabbit Run is apparently introducing contaminants to Chestnut Branch at this point (see surface water/sediment results). Previous discussions had centered on the likelihood that localized diffusion in this area as being the cause of the presence of contaminants in well C-29. Widespread contamination of the Kirkwood Sand east of Chestnut Branch is unlikely however, since measured heads east of Chestnut Branch indicate flow toward the river.

Water Well Supply

The remedial investigation concluded that water quality in the Pitman municipal wells and the private wells sampled is in compliance with Federal Safe Drinking Water Act standards. As discussed in section 1.3.6 the remedial investigation indicated that the Manasquan and Vincentown Formations are not jeopardized by contamination from the LiPari Landfill. There is no indication that the contamination from the landfill has migrated down to the deeper formations in the study area from which potable water is drawn. Future contamination of the lower aquifers is remote since they are overlain by several confining layers. The sites of the private and public wells sampled are shown in figure 1-22.

TABLE 1-15
A SUMMARY OF GROUND WATER QUALITY DATA
MAXIMUM CONCENTRATIONS OBSERVED IN OFFSITE WELLS

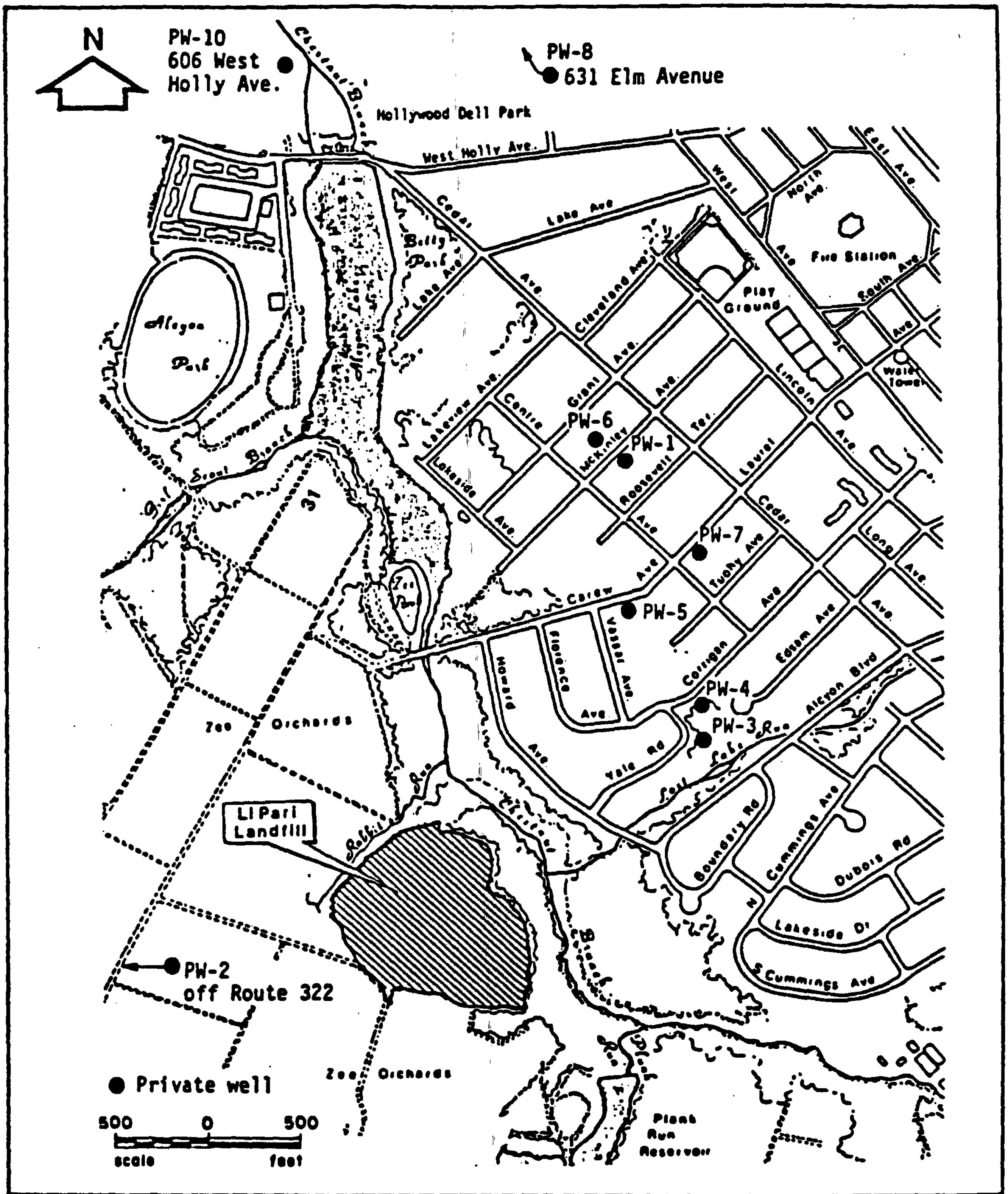
	Cohansey Wells - Sampling Station															
	West of Chestnut Branch					East of Chestnut Branch						North of Rabbit Run			Howard Ave.	
	CP-5	CP-6	CP-6(d)	CP-7	CP-8	C-27	C-31	C-32	C-33	C-33(d)	CP-34	CP-9	CP-10	C-39	C-28	C-30
						CONTRACT LABORATORY										
	BB534	BB539	BB535	BB532	BB531	BB541	BB529	BH184	BH187	BG461	BH188	BB512	BB542	BH194	BB543	BB545
Indicator Chemicals	(μg/l)	(μg/l)	(μg/l)	(μg/l)	(μg/l)	(μg/l)	(μg/l)	(μg/l)	(μg/l)	(μg/l)	(μg/l)	(μg/l)	(μg/l)	(μg/l)	(μg/l)	(μg/l)
Organics:																
Benzene	--	--	--	--	--	--	•	5U	5U	5U	5U	--	--	5U	--	--
bis(2-Chloroethyl)ether	--	--	<20	290	8J	--	--	10U	10U	10U	10U	--	--	10U	--	--
Chloroform	--	--	--	--	66J	--	--	5U	5U	5U	5U	--	--	5U	--	--
1,2-Dichloroethane	--	--	--	--	8,500	38	--	5U	5U	5U	5U	--	--	5U	--	--
Ethylbenzene	--	--	--	--	--	--	2J	5U	5U	5U	5U	--	--	5U	--	--
4-Methyl-2-pentanone	430	5J	8J	--	8,300	77B	6J	10U	10U	10U	10U	--	--	10U	--	•
Toluene	--	--	--	•	130J	--	3JB	5U	5U	5U	5U	--	6B	5U	--	--
Xylene	--	--	--	--	830	--	4J	5U	5U	5U	5U	--	--	5U	--	--
						CONTRACT LABORATORY										
	MBB785	MBB784	MBB787	MBB779	MB778	MBB775	MBB773	BH484	BH485	BH823	BH486	MBB953	MBB776	BH492	MBB799	MBB941
	(μg/l)	(μg/l)	(μg/l)	(μg/l)	(μg/l)	(μg/l)	(μg/l)	(μg/l)	(μg/l)	(μg/l)	(μg/l)	(μg/l)	(μg/l)	(μg/l)	(μg/l)	(μg/l)
Metals:																
Arsenic	3UR	[6.1]R	10UR	12	43R	[8.9]	3UR	10U	10U	10U	10U	91	[4.3]R	10U	12	104
Chromium	14R	•	•	477	108R	106	[9.4]R	18	41	34	268	147	406R	20	•	486
Lead	•	•	•	1,140	•	•	•	•	•	•	231J	•	•	5UR	•	•
Nickel	[10]	•	•	394	103	•	[8.9]	25U	33	25U	278	135	206	[31]	82	222
Mercury	•	•	•	•	•	•	•	0.16UR	0.16UR	0.16UR	0.75R	•	•	0.16UR	•	•
Zinc	•	94	90	•	91	•	•	19U	33	35	139	•	88	19U	•	•

B Analyte was found in the blanks as well as the sample.
R Indicates spike sample recovery was not within control limits
J Indicates an estimated value for tenatively identified compound
U Compound was analyzed for but not detected. Detection limit reported.
• Data did not pass EPA quality assurance requirements.
[ ] The result is greater than the instrument detection limit, but less than the detection limit required by the contract.

TABLE 1-15
A SUMMARY OF GROUND WATER QUALITY DATA
MAXIMUM CONCENTRATIONS OBSERVED IN OFFSITE WELLS

	Kirkwood Wells - Sampling Station								
	West of Chestnut Branch			East of Chestnut Branch			North of Rabbit Run		Howard Ave.
	K-10	K-11	K-12	C-29	K-14	K-16	K-8	K-9	K-13
				CONTRACT LABORATORY					
Indicator Chemicals	BH196 (µg/l)	BH197 (µg/l)	BH198 (µg/l)	BB528 (µg/l)	BH189 (µg/l)	BH190 (µg/l)	BH192 (µg/l)	BH193 (µg/l)	BH191 (µg/l)
Organics:									
Benzene	25U	2600J	5U	100J	5U	5U	5U	5U	5U
bis(2-Chloroethyl)ether	13	55,000	10U	--	10U	10U	10U	10U	10U
Chloroform	25U	5,000U	5U	--	5U	5U	5U	5U	5U
1,2-Dichloroethane	25U	14,000	5U	--	5U	5U	5U	5U	5U
Ethylbenzene	25U	5,000U	5U	--	5U	5U	5U	5U	5U
4-Methyl-2-pentanone	39J	10,600	10U	8,800	10U	10U	10U	10U	10U
Toluene	25U	5,700	5U	--	5U	5U	5U	5U	5U
Xylene	25U	5,000U	5U	--	5U	5U	5U	5U	5U
				CONTRACT LABORATORY					
	BH494 (µg/l)	BH495 (µg/l)	BH496 (µg/l)	MBB800 (µg/l)	BH487 (µg/l)	BH488 (µg/l)	BH490 (µg/l)	BH491 (µg/l)	BH489 (µg/l)
Metals:									
Arsenic	10U	19	10U	3UR	10U	10U	10U	10U	10U
Chromium	60	7.8U	7.8U	106R	16	20	7.8U	13	16
Lead	•	5UR	5UR	•	5UR	5UR	5UR	5UR	5UR
Nickel	[38]	[28]	25U	77	25U	[31]	25U	25U	25U
Mercury	0.16UR	0.16UR	0.16UR	•	0.16UR	0.16UR	0.16UR	0.16UR	0.16UR
Zinc	19U	220	51	•	19U	19U	19U	19U	19U

R Indicates spike sample recovery was not within control limits
J Indicates an estimated value for tenatively identified compound
U Compound was analyzed for but not detected. Detection limit reported.
• Data did not pass EPA quality assurance requirements.
[ ] The result is greater than the instrument detection limit, but less than the detection limit required by the contract.



CDM

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Figure 1-22

Borough of Pitman Private Wells Downgradient of LiPari Landfill

LiPari Landfill, Gloucester County, New Jersey

Air Quality

Chestnut Branch Marsh. Volatile air emission measurements were performed in the marsh. The emission measurements were used to calculate the potential maximum long-term concentration at the fenceline boundary east of Chestnut Branch by using the Point Area Line (PAL) and Industrial Source Complex Long Term (ISCLT) air models.

The predicted concentrations at the fenceline are listed below.

Organic compound	Maximum Long-Term Concentration (g/m^3)
Benzene	2.5×10^{-6}
Toluene	1×10^{-6}
Ethylbenzene	1.4×10^{-6}
Xylene	3.2×10^{-6}
1,2-Dichloroethane	1.5×10^{-7}
Tetrachloroethane	2×10^{-6}
bis(2-Chloroethyl)ether	2.0×10^{-6}
1,1,1-Trichloroethane	2×10^{-6}
Methylene chloride	5×10^{-8}

The predicted concentrations of benzene, bis(2-chloroethyl)ether, and 1,2-dichloroethane show a potential public health risk greater than 10^{-6} over a 70 year lifetime of exposure.

Landfill Gas Vents. The remedial investigation results indicated that emissions measured from the on-site gas vents were within NJ Administrative Code air standards for toxic volatile organic substances of 0.1 lb/hr. Accordingly, based upon this field investigation, remediation of these vents does not appear warranted. An increase in emissions may occur during the implementation of batch-flushing. However, control measures to address that scenario will be addressed by the remedial design team. Consequently, the gas vents will not be discussed further in this offsite feasibility study.

1.5 PUBLIC HEALTH EVALUATION

1.5.1 BACKGROUND

A baseline or "no action" risk assessment was performed to determine the potential risks and hazards to human health from the LiPari Landfill off-site areas in the absence of remediation of the area. The risk assessment utilized methodologies and guidance provided by EPA in the Superfund Public Health Evaluation Manual (EPA 1986). The first step is a screening process that selects indicator chemicals--those chemicals judged likely to contribute substantially to potential risks--from the large number of chemicals that were detected at the site. The second step is a detailed assessment of exposures. For each exposure pathway, an exposure scenario is developed and is used to predict the extent, frequency, and duration of exposures to the indicator chemicals. The third step is a risk assessment, in which potential exposures are compared with relevant health criteria to yield estimates of potential public health risks.

For potential carcinogens, the risks are estimated as probabilities. A risk range of 10^{-4} to 10^{-7} is used by EPA in Superfund risk assessments. The risk level 10^{-6} is often used by EPA as a bench mark. The risk represents an excess risk assuming all individuals are exposed (i.e. 10^{-6} equals one excess case in one million exposed individuals). The risk is related to intake at low levels of exposure. For chemical mixtures, the carcinogenic risks for individual chemicals are considered additive.

To assess noncarcinogenic effects from exposure to multiple chemicals, a hazard index approach was used (EPA 1986). The hazard indices are not absolute measures of the potential risk to humans, but they do provide an indication of the relative risk associated with exposure to a mixture of chemicals. A hazard index of <1 indicates that endangerment of human health is unlikely to result from a given exposure; an index greater than 1 suggests a potential cause for concern.

1.5.2 POTENTIAL RECEPTORS AT RISK

Exposure of humans to indicator chemicals released from the LiPari Landfill is assessed by identifying the concentrations of indicator chemicals in environmental media and estimating the dose to a human receptor from each medium. The potential hazards posed by chemicals released into the environment are dependent upon the extent of contact between the receptors and the chemicals. The potential for exposure is influenced by where, when, and how much of the chemical contaminants are released, and in their movement and changes in air, water, soil, and biota relative to the location of the receptors. Although institutional or site access controls such as fencing exist, the public health evaluation was performed under the assumption that these controls are not effective.

The public health risks associated with exposure of human receptors to offsite LiPari indicator chemicals are estimated based upon the following exposure pathways: direct contact with leachate-seep-area soils, direct contact with park soils, swimming in Alcyon Lake, ingestion of fish from Alcyon Lake, and inhalation of ambient air downwind from the leachate seep area. The exposure pathways were defined using conservative assumptions (i.e., assumptions that tend to overestimate exposure), so that the final estimates of exposure will be near to or higher than (often much higher than) the upper end of the range of actual exposures. For this reason, the risk estimates are unlikely to underestimate the actual risk, and may considerably overestimate risk.

1.5.3 PUBLIC HEALTH EVALUATION CONCLUSIONS

The total risks (carcinogenic and noncarcinogenic) associated with the exposure pathways are summarized in table 1-16. A potential for excess lifetime cancer risks (upperbound) greater than 10^{-6} is posed by exposure to the maximum concentration of arsenic detected in one soil sample in the marsh west of Chestnut Branch. The results of the organic chemical sampling and analysis indicate that the park soils have probably not been contaminated by the LiPari Landfill. Arsenic is present in the soils of all three parks at concentrations posing risks greater than 10^{-6} under

TABLE 1-16

RISKS ASSOCIATED WITH EXPOSURE TO OFFSITE LIPARI LANDFILL INDICATOR CHEMICALS

	Exposure scenario			
	Average		Reasonable maximum	
Exposure pathway	Lifetime excess cancer risk (upperbound)	Hazard index of noncarcinogenic risk	Lifetime excess cancer risk (upperbound)	Hazard index of noncarcinogenic risk
Direct contact with soils:				
Leachate seep area	2×10^{-8}	.0002 (<1)	4×10^{-6}	.04 (<1)
Parks (screening assessment)	1×10^{-5}	.1 (<1)	8×10^{-4}	4
Background Exposure to arsenic in local soils	4×10^{-6}	NQ	3×10^{-4}	NQ
Swimming in Alcyon Lake	1×10^{-7}	.004 <1)	3×10^{-7}	.009 (<1)
Consumption of fish from Alcyon Lake	5×10^{-7}	.04 (<1)	4×10^{-6}	.3 (<1)
Inhalation of ambient air near the Howard Avenue security fence	NQ(a)	NQ(a)	6×10^{-4}	.006 (<1)

NQ - Not quantified

[a] The average scenario was not quantified due to the conservative assumptions used for the dispersion modeling and for the exposure conditions. See text for details.

(28)

conditions and assumptions used for the maximum exposure scenarios, and for Alcyon Park under the average scenario. However, the lifetime excess cancer risks (upper bound) posed by exposure to arsenic in park soils are roughly equivalent to risks posed by exposure to background soil concentrations under similar conditions. In Alcyon Park and Hollywood Dell Park (but not Betty Park), the maximum concentration of lead could present a diminished margin of safety for exposure to lead, assuming the conditions presented for the reasonable maximum exposure scenario. In addition, lead is ubiquitous in the soils of an urban environment.

Consumption of fish containing BCEE from Alcyon Lake would result in excess lifetime cancer risk (upperbound) greater than 10^{-6} only under the assumptions of the reasonable maximum exposure scenario. This scenario is somewhat conservative, however, due to the lack of a sport fish population in Alcyon Lake and the closing of the lake to fishing in 1979.

Inhalation of ambient air containing volatilized organic indicator chemicals was modeled for receptor points near Howard Avenue and the fenceline east of Chestnut Branch. This preliminary modeling for screening indicated that a risk greater than 10^{-6} would result from lifetime inhalation of volatilized compounds, based upon the conditions and assumptions of the modeling and the conservative exposure scenario. The PHE indicated potential public health risks exist for BCEE, 1-2,-dichloroethane, and benzene. BCEE was predominantly responsible for elevating the risk. The ATSDR (1985) indicated that based on the data reviewed for the Health Assessment, additional characterization for the potential for human exposure to atmospheric contaminants should be performed to evaluate the potential for long term public health threats. Additional air monitoring was performed by the EPA Field Investigation Team (FIT) to address these concerns. The results from the first season (summer) of air monitoring indicated that no significant contaminants have impacted the downwind residential areas (NUS 1987, Pritchett 1987), however the second season monitoring indicated organic compounds were detected including BCEE at 1 to 4 ppb (Pimentel per. comm. August 22, 1987).

1.6 REMEDIAL ACTION CRITERIA

SARA requires that fund-financed and enforcement remedial actions comply with requirements or standards under Federal and State environmental laws. The requirements that must be complied with are those that are legally applicable or relevant and appropriate to the substance or the circumstances of the release. The EPA is currently developing a guidance manual that would identify the potential applicable or relevant and appropriate requirements (ARARs) in the major Federal environmental statues (Federal Register, 1987). Interim guidance to define the nature, scope, and use of ARARs are discussed below.

- Applicable requirements. These pertain to those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law specifically addressing a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a Superfund site. In particular, the Safe Drinking Water Act maximum contaminant level goals, Clean Water Act water quality criteria, and Resource Conservation and Recovery Act (RCRA) alternative concentration limits are identified as applicable requirements.
- Relevant and appropriate requirements. These pertain to those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law addressing problems or situations sufficiently similar to those encountered at a Superfund site. For example, RCRA regulations for capping a waste may be considered relevant and appropriate.

ARARs are site-specific and must be determined on a site-by-site basis. Therefore ARARs are identified with increasing certainty as the remedial investigation/feasibility study for the site progresses. For this identification process, it is useful to group ARARs into three general categories:

- Chemical specific. These requirements are usually health- or risk-based numbers limiting the concentration or amount of a chemical that may be discharged into the ambient environment. They are independent of the location of the discharge, but may be related to the intended use of the environmental media.

- o Location specific. These restrictions are generally placed upon chemical concentrations or releases, or upon conduct of activities solely because they are in a particular location.
- o Action specific. These ARARs will be triggered by the remedial actions selected for the site. They are based upon the implementation of particular technologies or actions.

For the purpose of this review, chemical- and location-specific requirements are grouped together as ARARs affecting selection of cleanup levels. Action specific ARARs are considered separately as those potentially affecting implementation of remedial actions. The NJDEP has provided a list of state statutes and guidelines that may be interpreted as ARARs (Gaston, 1987).

The offsite LiPari Landfill terrain consists of undeveloped, wooded, and recreational land, as well as land having agricultural, residential, commercial, and institutional uses. There are no local, State, or Federal statutes identifying specific land within the study area for special designated land use or ecological protection status. Chestnut Branch, Alcyon Lake, and associated tributary streams do comprise a stream corridor that is zoned as a preservation area by the Gloucester County Planning Commission and the Delaware Valley Regional Planning Commission. This zoning is designed to protect fish and wildlife, surface water, and ground water from the effects of uncontrolled development leading to the destruction or pollution of habitats. However, local planning commission zoning have limited applicability with regard to the selection of remedial criteria for contaminated soil, surface water, sediments, and ground water resulting from a hazardous waste site. Consequently the remedial criteria will be established on the basis of Federal and State standards or guidelines.

The EPA Record of Decision (ROD) dated September 30, 1985, selected batch-flushing as the preferred onsite remedial alternative. This alternative involves the installation of extraction and reinjection wells within the encapsulation system to dewater and flush water-borne contaminants. The contaminated ground water will be pretreated at an onsite facility. Presently negotiations are being conducted with GCUA to arrange for final treatment to occur at the GCUA treatment plant. The offsite feasibility study will screen technologies for development of an offsite collection system to capture any potential seepage from the onsite containment system that may result from the implementation of the batch-flushing alternative.

Any contaminated ground water or surface water that is collected as part of an offsite remedial action or from the offsite collection system will be transported to the onsite treatment facility. The onsite treatment facility is being designed to treat ground water from the batch-flushing to meet pretreatment requirements for discharge to the GCUA treatment facility. Consequently, any ARARs relative to the implementation of remedial actions that apply specifically to the treatment goals of the facility or the effluent generated from the facility will not be discussed since they have already been considered as part of the onsite feasibility study and remedial design study. The 1985 ROD indicated that leachate seepage from the landfill should be collected to prevent discharge to Chestnut Branch, particularly since the seepage could increase during the maximum fill stages of batch-flushing.

There are three basic approaches to selecting cleanup levels for remedial actions, which may be considered if chemical-specific standards or guidelines have not been established under State or Federal statutes for contaminants found at a hazardous waste site. Each of these approaches will be considered to establish cleanup since they are intended to provide a means to protect public health and the environment. Non-promulgated advisories or guidance documents issued by state or federal governments do not have potential ARAR status. However, they may be considered in determining an appropriate, protective remedy.

Cleanup to Background

This approach requires an extensive data base of chemical concentrations in environmental samples to develop a statistically valid range of background concentrations. This approach should only be applied to compounds, such as metals normally found in nature. For man-made compounds the cleanup level would become "zero," which in practice means as a minimum the detection limit of the analytical method in use. However, for a man-made compound that is persistent and widespread, an alternate cleanup level based upon ambient concentrations of the chemical in the study area may be an alternative approach.

Cleanup to Analytical Detection Limits

Under this approach the objective becomes cleanup to nondetectable concentrations of contaminants (pristine conditions). Achievable detection limits are currently decreasing as new analytical methods are developed. The detection limits used in the study were established under the Contract Laboratory Program (CLP). Although method detection limits are generally lower than the CLP program detection limits, the latter serve as a consistent guideline. Detection limits vary depending on the sample in accordance with interferences associated in part with the media or other chemicals. The quality assurance/quality control program is designed to rigorously control the sample collection and analytical method to ensure the best possible detection limit required under CLP. This guideline should only be applied to man-made compounds, as naturally occurring chemicals (e.g., metals) in uncontaminated environments will frequently be found in concentrations well above achievable detection limits.

Cleanup to Levels Set by Risk Assessment Methodology

This common approach has been used by regulatory agencies to set standards and criteria for chemicals in drinking water and surface waters. In risk assessment, a distinction is made between carcinogens and noncarcinogens, in that carcinogens are assumed to have no threshold concentration below which a cancer risk does not exist, while noncarcinogens are assumed to have a "safe" threshold concentration below which there is no toxic risk. Therefore permissible concentrations for carcinogens are set at "zero" (detection limit) while noncarcinogens may have a measurable permissible concentration. EPA guidance on ARARs indicates that while chemical-specific advisory levels such as carcinogenic potency factors are not actually ARARs, they may factor significantly into the establishment of protective cleanup levels (Federal Register, 1987).

1.6.1 REVIEW OF ARARS AND OTHER REQUIREMENTS OR CRITERIA (NON-ARARS)

This section addresses ARARs and other requirements or criteria affecting the selection of remedial criteria. ARARs and other requirements or criteria are presented with respect to the particular media they address.

Soil

To date, Federal and State standards for cleanup of soils contaminated with metals or organic compounds other than polychlorinated biphenyls (PCBs) are unavailable. The Toxic Substances Control Act (TSCA), promulgated in 1976, requires the removal of soil if it is contaminated with PCBs above 50 parts per million (ppm). PCBs were not detected in either the onsite or offsite study area of the LiPari Landfill.

Guidelines Used by NJDEP for Soil Cleanups. NJDEP has established internal cleanup guidelines for soil, which will be used in evaluating remedial plans. These guidelines presented in table 1-17, have been used when evaluating ECRA cleanup plans for industrial establishments, but are also considered by NJDEP to be ARARs for general application with remedial actions at hazardous waste sites (Gaston 1987). Notably these guidelines do not apply to sediments; therefore, they will be considered separately.

The objectives guiding development and application of these guidelines are as follows:

- Protect human health from risks due to direct contact with contaminated soils.
- Protect ground water from degradation caused by leaching of contaminants from soils.
- Protect surface water from degradation caused by migration of contaminated soil.

Cleanup levels for inorganic compounds are based upon typical New Jersey and United States background levels. The guidelines are generally set at one to three times expected background levels, based upon the toxicity of

TABLE 1-17

NJDEP GUIDELINES FOR SOIL CLEANUPS

	Concentration levels				
	Pitman area Background soil		ECRA		
Chemical	maximum (ug/kg)	mean (ug/kg)	Cleanup guideline (ug/kg)	New Jersey background (ug/kg)	United States background (ug/kg)
Volatile organics[a]	140	NA	1,000	NA	NA
Base-neutrals	1,400	NA	10,000	NA	NA
Petroleum hydrocarbons	NA	NA	100,000	NA	NA
Arsenic[b]	22,000	3,150	20,000	NA	1,100-16,700
Cadmium	ND	ND	3,000	1,000-4,000	10-1,000
Chromium[b]	400,000	60,500	100,000	5,000-48,000	1,000-1,500,000
Copper	288,000	42,200	170,000	500-53,600	2,000-200,000
Cyanide	1,360	113	12,000	NA	90
Lead[b]	130,000	34,500	250,000 to 1,000,000	1,000-180,000	2,000-200,000
Mercury[b]	1,300	137	1,000	NA	10-4,600
Nickel[b]	41,000	5,700	100,000	11,100-86,500	8,000-550,000
Selenium	ND	ND	4,000	10-4,000	10-5,000
Silver	ND	ND	5,000	NA	10-5,000
Zinc[b]	36,000	15,520	250,000	4,500-168,000	10,000-3,000,000

ND - Not detected.

NA - Not available/applicable.

[a] Methylene chloride and acetone are not included under volatile organics because they are common laboratory contaminants.

[b] Indicator metal.

(24)

the compound. Exceptions to these guidelines are allowed under the following circumstances:

- Background concentrations for the site are greater than the typical range upon which the guidelines were based.
- Outside sources contribute to the soil contamination at the site.
- The elevated concentrations result from an area-wide contamination problem.
- The remedial plan for the site includes encapsulation of the soils.

Cleanup action levels for organic compounds were developed by NJDEP using risk assessment methodologies based upon ingestion of soil. These action levels were set for three classes of compounds:

- Volatile organic compounds.
- Semivolatile organic compounds.
- Petroleum hydrocarbons.

The values listed in the table are not intended for use as cleanup levels but are used to indicate the need for a risk assessment to estimate permissible concentrations for specific compounds detected at the sites. They are set at conservative levels to be protective of human health.

If cleanup of Chestnut Branch marsh were based upon NJDEP guidelines for soil cleanup, none of the volatiles or base-neutrals (BCEE representing the later group exclusively) would require cleanup. The sum total of either the mean or the maximum soil concentration of organics meets the cleanup guideline.

The metals would also not require cleanup based upon NJDEP guidelines since the guideline is within the mean concentration for any given metal. If the guideline is to apply on a sample-specific basis then arsenic, nickel, and zinc are exceeded as follows:

Nickel - 1 station exceeds (112 mg/kg) NJDEP guideline 100 mg/kg

Arsenic - 4 stations exceed (27-65.5 mg/kg) NJDEP guideline 20 mg/kg

Zinc - 2 stations exceed (256-325 mg/kg) NJDEP guideline 250 mg/kg

NJDEP guidance for use of the soil guidelines indicate that they should only be used to determine whether a risk assessment should be performed. The risk assessment performed as part of the RI/FS indicated that only arsenic showed a slightly elevated potential risks from ingestion (4 x 10^{-6}). Nickel and zinc do not pose a risk thus cleanup may not be required under application of NJDEP guidelines if the decision is weighed on the basis of public health risks as is implied by the State's guidance documents.

In regard to BCEE contamination, the need to perform a risk assessment would not have been required if NJDEP guidelines had been used in the strictest sense. The risk assessment performed indicated BCEE emissions in the marsh may cause a potential public health risk.

The parks surrounding Alcyon Lake are not considered to have been impacted by the LiPari Landfill. Nonetheless, the soil concentrations of the indicator chemicals were compared with NJDEP soil cleanup guidelines. On the basis of the guidelines the total volatile concentration of 4 µg/kg existing only in Betty Park is considerably under the 1,000 µg/kg guidelines for total volatiles. Base-neutrals were not detected. All of the maximum observed metal concentrations, except for arsenic, were within NJDEP soil cleanup guidelines. Arsenic exceeded the 20,000 µg/kg NJDEP cleanup guideline at one station each in Hollywood Dell Park and Alcyon Park at both sampling depths. With the exception of arsenic, use of the guidelines indicates that these parks would not have to be remediated. However, background soils exceeded the NJDEP criteria of 20,000 µg/kg. The PHE indicated that both arsenic and lead exist at concentrations that under conservative assumptions could pose a potential public health risk. However, background concentrations also pose an equivalent risk, indicating that the levels are representative of widespread conditions.

<u>Background Concentrations</u>. Surface soil samples were collected at offsite locations to determine background concentrations of HSL contaminants. These concentrations shown in table 1-18, may be used to establish cleanup to background guidelines.

An indicator chemical was considered to be elevated if the downgradient stations were elevated above the background mean or maximum concentrations. Under these considerations Chestnut Branch marsh exceeded background concentrations for all organic indicators (benzene, chloroform, BCEE, 1,2-dichloroethane, ethylbenzene, 4-methyl-2-pentanone, total xylenes, and toluene) and for the metals nickel, lead, mercury, arsenic, and zinc.

<u>Guidelines Based upon Risk Assessment Methodology</u>. For chemicals that do not have published criteria, it may be "relevant and appropriate" to use concentration limits derived from estimates of risk to potential receptors.

An acceptable set of guidelines can be derived to estimate the contaminant concentration value for soil that no longer poses a public health risk exceeding one cancer incidence per million persons exposed. The exposure pathway for soil would assume that risks were only due to inadvertent and direct contact with soil. In the marsh west of Chestnut Branch, the maximum concentration of arsenic poses carcinogenic risks (upper bound) of 4×10^{-6}.

Using the current EPA estimate of the cancer potency of arsenic, a target risk of 10^{-6}, and the worst case marsh soil exposure scenarios presented in the PHE, a risk-based guideline of 15 mg/kg is calculated for arsenic (see Appendix A). The contaminated soils are also a potential release source of chemicals to other environmental media (e.g., volatilization to air, erosion to surface water, or leaching and percolation to ground water). Public health concerns and cleanup goals will be developed to control potential exposures to released chemicals in air, surface water, or ground water. The goal of remediation based on public health risk would be to intercept the exposure pathway. The pathway may be intercepted by either removing, destroying, containing, or demobilizing the contaminant source. Arsenic has mobilized from the soil to surface water, sediments, and ground

TABLE 1-18

OFFSITE LIPARI LANDFILL AREA BACKGROUND SOIL CONCENTRATIONS

LiPari Landfill indicator chemical	BP-1		BP-2		AP-1		ECB-5		ECB-6	
	0-6	18-24	0-6	18-24	0-6	18-24	0-6	18-24	0-6	18-24
Organics:	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)
Benzene	-	-	-	-	-	-	-	-	-	-
Toluene	-	1 J	-	-	-	-	-	-	-	-
bis(2-Chloroethyl)ether	-	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane	-	-	-	-	-	-	-	-	-	-
Ethylbenzene	-	-	-	-	-	-	-	-	-	-
Xylene	-	-	-	-	-	-	-	-	-	-
4-Methyl-2-pentanone	-	-	-	-	-	-	-	-	2 J	-
Metals:	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Chromium	5.8	[3.6]	5.3	[3.5]	13 RJT	102 RJT	20 R	40 R	12 R	400 R
Nickel	-	-	-	-	11	41 RJ	-	-	-	[16]
Lead	77.8	-	10.5	-	[41] RJ	31 RJ	11	31	13	130
Mercury	-	-	-	-	-	-	.06 UR	.07 R	.07 UR	1.3 R
Arsenic	5.7 UR	5.6 UR	5.7 UR	5.6 UR	[3.9] R	22 RJ	-	-	-	[5.6]
Zinc	18	[5.3]	8.9	[3.0]	36 RJ	20 RJ	[9.4]	13	[9.6]	32

Footnotes appear on last page of table.

TABLE 1-18
(continued)

OFFSITE LIPARI LANDFILL AREA BACKGROUND SOIL CONCENTRATIONS

	Sampling Station and Sampling Depth in Inches				
	BP-1/2/AP-1/ECB-5/6				All Stations
	0-6	18-24	0-6	18-24	0-6/18-24
LiPari Landfill indicator chemical	mean[a]	mean	maximum[b]	maximum	mean
Organics:	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)
Benzene	-	-	-	-	-
Toluene	0.2	0	1	0	0.1
bis(2-Chloroethyl)ether	-	-	-	-	-
1,2-Dichloroethane	-	-	-	-	-
Ethylbenzene	-	-	-	-	-
Xylene	-	-	-	-	-
4-Methyl-2-Pentanone	-	-	-	-	0.2
Metals:	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	
Chromium	11.2	109.8	20	400	60.5
Nickel	2.2	11.4	11	41	5.7
Lead	30.7	38.4	77.8	130	34.5
Mercury	-	-	-	-	-
Arsenic	3.1	7.8	5.7	22	6.4
Zinc	16.4	14.7	36	32	15.2

TABLE 1-18
(continued)

[a] The mean is calculated by summing the sample concentration within a specified area divided by the number of samples taken in the area. Duplicate samples are counted as one sample and the average of the two concentrations is used in calculating the mean. Samples that did not pass QA/AC were not included in calculating the mean. Nondetected chemicals were counted as zeros in calculating the mean.

[b] The average of the duplicate sample concentrations is the number used when comparing the sample concentrations to determine maximum concentration.

Laboratory Designations:

· Element analyzed for but not detected in the sample.

* Data did not pass EPA quality assurance requirements.

[] If the result is a value greater than or equal to the instrument detection limit, but less than the contract-required detection limit, the value is reported in brackets.

U Indicates element was analyzed for but not detected. Report with detection limit values.

R Indicates spike sample recovery not within EPA-specified quidelines

J Indicates estimated value.

T Indicates duplicate analysis is not within EPA-specified guidelines.

(LiPari/26)

water. Volatiles have been transported to these same media as well as air. The transport from soil to surface water/sediments and soil to air has been fairly well defined. The exposure pathway from soils to ground water to the exposure point is complex, and the mechanisms of transfer of contaminants from soil to ground water are poorly defined. Therefore, the threat to ground water is seldom quantified. It was not quantified in this study since contamination is mainly in the Cohansey and discharges into surface water, where contaminant concentrations have already been quantified.

No potentially elevated risks were identified for the sediments of Chestnut Branch, Rabbit, Run, or Alcyon Lake. The public parks have arsenic and lead concentrations that pose a potentially elevated risk, but as previously discussed the contaminants posing risk are widespread at equivalent concentrations, and the problem has not been definitively linked with the landfill.

Ground Water

ARARs for ground water are listed below. The discussion in the following section suggests that it is more appropriate to use ground water or surface water criteria whichever is more stringent since the ground water/surface water interface is in the marsh and all water discharges to Chestnut Branch.

National Ground Water Protection Strategy. Under the Ground Water Protection Strategy (GWPS), EPA has defined three aquifer classes.

- Class 1, Special Ground Waters, include those aquifers highly vulnerable to contamination and either irreplaceable sources of drinking water or ecologically vital.
- Class 2, Current and Potential Sources of Drinking Waters Having Other Beneficial Uses, includes all other ground water currently used or potentially available for drinking water or other beneficial uses.
- Class 3, Ground Water Not Considered a Potential Source of Drinking Water and of Limited Beneficial Use, includes saline or otherwise contaminated ground water beyond the level of cleanup currently employed in public water system treatment.

> The ground water must not migrate to Classes 1 or 2 or discharge to surface water and cause further degradation.

Under the national GWPS, the Cohansey and Kirkwood aquifers, would be designated as Class 2. Ground water should meet drinking water standards or levels that protect human health. However, in the study area the Cohansey formation is eroded and rapidly thins out in Chestnut Branch marsh. It is completely eroded in the vicinity of Chestnut Branch, and is no longer considered an "aquifer" in this immediate area. The Kirkwood aquifer is not a current or projected drinking water source in the vicinity of the site and its projected beneficial use is minimal because of low yields. However, because of the existing discharge path from the Kirkwood aquifer to surface waters in Chestnut Branch and Alcyon Lake, it could be classified as a Class 2 ground water. Ground water remediation criteria for both the Cohansey and Kirkwood aquifers should be established to ensure that ground water discharged to surface water bodies meet background conditions and existing surface water quality criteria in accordance with designated beneficial uses. An alternative concentration level (ACL) consistent with surface water quality criteria would be appropriate for either or both aquifers to ensure the protection of local surface water quality.

New Jersey Ground Water Quality Standards (NJAC7:9-6.1 et seq). The NJDEP has classified ground water in New Jersey in accordance with suitable designated uses based upon total dissolved solids (TDS) quality criteria. The ground water aquifers within the study area of concern are the Cohansey and Kirkwood. These aquifers are classified as Class GW2 ground water, since they have a natural TDS concentration of 500 mg/l or less. Thus they are considered suitable for potable, industrial, or agricultural water supply and for continual replenishment of surface waters to maintain the quantity and quality of the surface waters in New Jersey; and other reasonable uses.

As a general regulation, NJDEP may require that the water quality be restored or upgraded, or that contamination be contained within boundaries determined by NJDEP. NJDEP's decision is to be guided by considering whether the degradation constitutes a threat to public health or safety or interferes with potential or present uses of the water.

TABLE 1-19
OFFSITE LIPARI LANDFILL
REMEDIAL CRITERIA REVIEWED FOR CONTAMINATION IN GROUND WATER

	Contract[a] Detection Limit (µg/l)	New Jersey Ground Water Quality Standards For Class GW 2 (µg/l)	Federal Safe Drinking Water Act		Maximum Contaminant Level (µg/l)	Maximum Contaminant Level Goal C (µg/l)	New Jersey Proposed Drinking Water Standards MCL (µg/l)	NJPDES Toxic Effluent Limitations for Protection of Potable Water		New Jersey Div. of Water Resources Current Policy on Ground Water Cleanup (µg/l)
			Primary (µg/l)	Secondary (µg/l)				10^{-6} Cancer Risk (µg/l)	Toxicity (µg/l)	
Volatile Organic Compounds:										
Acetone	10	—	—	—	—	—	—	—	—	—
*Benzene	5	—	—	—	5	0	1	0 66	—	5
2-Butanone	10	—	—	—	—	—	—	—	—	—
Carbon disulfide	5	—	—	—	—	—	—	—	—	—
Carbon tetrachloride	5	—	—	—	5	0	2	0 40	—	5
*Chlorobenzene	5	—	—	—	—	60[c]	4	—	488	b
Chloroethane	10	—	—	—	—	—	—	—	—	b
*Chloroform	5	—	—	—	—	—	—	0.19	—	5
Chloromethane	10	—	—	—	—	—	—	—	—	b
1,2-Dichlorobenzene	10	—	—	—	750	620[c]	600	—	400	—
1,4-Dichlorobenzene	10	—	—	—	750	750	6	—	400	—
*1,2-Dichloroethane	5	—	—	—	5	0	2	0 94	—	5
1,1-Dichloroethene	5	—	—	—	7	7	2	0 33	—	5
1,2-Dichloropropane	5	—	—	—	—	6	—	—	—	b
*Ethylbenzene	5	—	—	—	—	—	—	—	1,400	b
Methylene chloride	5	—	—	—	—	—	2	—	—	5
4-Methyl-2-pentanone	10	—	—	—	—	—	—	—	—	—
Styrene	5	—	—	—	—	140[d]	—	—	—	—
*1,1,2,2,-Tetrachloroethane	5	—	—	—	—	—	—	0 17	—	5
*Tetrachloroethene	5	—	—	—	5	0	1	0 8	—	5
*Toluene	5	—	—	—	—	—	—	—	14,300	b
1,1,1-Trichloroethane	5	—	—	—	200	200	26	—	18,400	200
*Trichloroethene	5	—	—	—	5	0	1	2 7	—	5
Xylenes, total	5	—	—	—	—	—	44	—	—	—

* - Contaminant of concern selected during public health examination

\- - Not detected / Not listed / Not applicable

a - Contract detection limit is generally above method detection limits, but contract detection limit is a consistent guideline

b - An action level of 50 ppb is recommended as the maximum total permissible concentration for these compounds plus those with 5 ppb maximum individual concentrations

c - Safe Drinking Water Act MCLs are the same as Federal RCRA regulations

d - Proposed MCLG

TABLE 1-19
OFFSITE LIPARI LANDFILL
REMEDIAL CRITERIA REVIEWED FOR CONTAMINATION IN GROUND WATER

	Contract[a] Detection Limit (μg/l)	New Jersey Ground Water Quality Standards For Class GW 2 (μg/l)	Federal Safe Drinking Water Act		Maximum Contaminant Level C (μg/l)	Maximum Contaminant Level Goal (μg/l)	New Jersey Proposed Drinking Water Standards MCL (μg/l)	NJPDES Toxic Effluent Limitations for Protection of Potable Water		New Jersey Div. of Water Resources Current Policy on Ground Water Cleanup (μg/l)
			Primary (μg/l)	Secondary (μg/l)				10^{-6} Cancer Risk (μg/l)	Toxicity (μg/l)	
Semivolatile Compounds:										
Acenaphthene	10	—	—	—	—	—	—	—	—	—
Anthracene	10	—	—	—	—	—	—	c	—	—
Benzoic acid	50	—	—	—	—	—	—	—	—	—
*Benzo(a)anthracene	10	—	—	—	—	—	—	c	—	—
*Benzo(b)fluoranthene	10	—	—	—	—	—	—	c	—	—
Benzo(k)fluoranthene	10	—	—	—	—	—	—	c	—	—
Benzo(g,h,i)perylene	10	—	—	—	—	—	—	c	—	—
*Benzo(a)pyrene	10	—	—	—	—	—	—	c	—	—
Benzyl alcohol	10	—	—	—	—	—	—	—	—	—
*bis(2-Chloroethyl)ether	10	—	—	—	—	—	—	0 03	—	—
bis(2-Isopropyl)ether	10	—	—	—	—	—	—	—	—	—
Butylbenzyl phthalate	10	—	—	—	—	—	—	—	—	—
2-Chlorophenol	10	—	—	—	—	—	—	—	—	—
*Chrysene	10	—	—	—	—	—	—	c	—	—
Dibenzo(a,h)anthracene	10	—	—	—	—	—	—	c	—	—
Dibenzofuran	10	—	—	—	—	—	—	—	—	—
Di-n-butylphthalate	10	—	—	—	—	—	—	—	34,000	—
Diethylphthalate	10	—	—	—	—	—	—	—	350.000	—
Di-n-octylphthalate	10	—	—	—	—	—	—	—	—	—
2-4 -Dimethylphenol	10	—	—	—	—	—	—	—	—	—
bis(2-Ethylhexyl)phthalate	10	—	—	—	—	—	—	—	15.000	—
Fluoranthene	10	—	—	—	—	—	—	—	42	—
Fluorene	10	—	—	—	—	—	—	c	—	—
*Indeno(1,2,3-cd)pyrene	10	—	—	—	—	—	—	c	—	—
Isophorone	10	—	—	—	—	—	—	—	5.200	—
2-Methylnapthalene	10	—	—	—	—	—	—	c	—	—
*2-Methyphenol	10	—	—	—	—	—	—	—	—	—
*4-Methylphenol	10	—	—	—	—	—	—	—	—	—
Naphthalene	10	—	—	—	—	—	—	—	—	—
4-Nitrophenol	50	—	—	—	—	—	—	—	—	—
N-nitrosodiphenylamine	10	—	—	—	—	—	—	4.9	—	—
Pentachlorophenol	50	—	—	—	—	220[d]	—	—	1.010	—
Phenanthracene	10	—	—	—	—	—	—	c	—	—
Phenol	10	3500	—	—	—	—	—	—	3.500	—
Pyrene	10	—	—	—	—	—	—	c	—	—
2,4,5-Trichlorophenol	50	—	—	—	—	—	—	—	2.600	—

* - Contaminant of concern selected during public health evaluations
\- - Not detected / Not listed / Not applicable
a - Contract detection limit is generally above method detection limits, but contract detection limit is a consistent guideline
b - Safe Drinking Water Act MCLs are the same as the Federal RCRA regulations
c - Limit for total PAH (10^{-6} cancer risk) is 2.8 ng/1
d - Proposed MCLG

TABLE 1-19
OFFSITE LIPARI LANDFILL
REMEDIAL CRITERIA REVIEWED FOR CONTAMINATION IN GROUND WATER

	Contract[a] Detection Limit (µg/l)	New Jersey Ground Water Quality Standards For Class GW 2 (µg/l)	Federal Safe Drinking Water Act		Maximum Contaminant Level[c] (µg/l)	Maximum Contaminant Level Goal (µg/l)	New Jersey Proposed Drinking Water Standards MCL (µg/l)	NJPDES Toxic Effluent Limitations for Protection of Potable Water		New Jersey Div. of Water Resources Current Policy on Ground Water Cleanup (µg/l)
			Primary (µg/l)	Secondary (µg/l)				10^{-4} Cancer Risk (µg/l)	Toxicity (µg/l)	
Pesticides and PCBs:										
*DDD	0.10	d	—	—	—	—	—	—	—	—
*DDE	0.10	d	—	—	—	—	—	—	—	—
*DDT	0.10	d	—	—	—	—	—	0.000024	—	—
*Aldrin	0.05	0.003	—	—	—	—	—	0.000074	—	—
Endosulfan I	0.05	—	—	—	—	—	—	—	74	—
Endrin	0.10	0.004	0.2	—	—	—	—	—	1	—
*Heptachlor	0.05	—	—	—	—	0	—	0.00028	—	—
Heptachlor-Epoxide	0.05	—	—	—	—	0	—	—	—	—
PCB-1254	1.0	0.001[b]	—	—	—	—	0.5[b]	0.000079[b]	—	—

* - Contaminant of concern selected during public health evaluation
\- - Not detected / Not listed / Not applicable
a - Contract detection limit is generally above method detection limits, but contract detection limit is a consistent guideline
b - Concentration limit for total PCBs
c - Safe Drinking Water Act MCLs are the same as Federal RCRA regulations
d - Total for DDT and its metabolites is 0.001 ug/l

TABLE 1-19
OFFSITE LIPARY LANDFILL
REMEDIAL CRITERIA REVIEWED FOR CONTAMINATION IN GROUND WATER

	Contract[a] Detection Limit (μg/l)	New Jersey Ground Water Quality Standards For Class GW 2 (μg/l)	Federal Safe Drinking Water Act		Maximum Contaminant Level (μg/l)	Maximum Contaminant Level Goal (μg/l)	New Jersey Proposed Drinking Water Standards MCL (μg/l)	NJPDES Toxic Effluent Limitations for Protection of Potable Water		New Jersey Div. of Water Resources Current Policy on Ground Water Cleanup (μg/l)
			Primary (μg/l)	Secondary (μg/l)				10^{-6} Cancer Risk (μg/l)	Toxicity (μg/l)	
Metals and Radiation										
Aluminum	200	—	—	—	—	—	—	—	—	—
Antimony	60	—	—	—	—	—	—	—	—	—
Arsenic	10	50	50	—	—	—	—	0.0022	—	—
Barium	200	1,000	1,000	—	—	—	—	—	—	—
Beryllium	5	—	—	—	—	—	—	—	—	—
Cadmium	5	10	10	—	—	—	—	—	10	—
Calcium	5,000	—	—	—	—	—	—	—	—	—
*Chromium[d]	10	50	50	—	—	—	—	—	50	—
Cobalt	50	—	—	—	—	—	—	—	—	—
Copper	25	1,000	—	1,000	—	—	—	—	—	—
Iron	100	300	—	300	—	—	—	—	—	—
*Lead	5	50	50	—	—	—	—	—	50	—
Magnesium	5,000	—	—	—	—	—	—	—	—	—
Manganese	50	50	—	50	—	—	—	—	—	—
Mercury	0.2	2	2	—	—	—	—	—	0.144	—
Nickel	40	—	—	—	—	—	—	—	13.4	—
Potassium	5,000	—	—	—	—	—	—	—	—	—
Selenium	5	10	10	—	—	—	—	—	—	—
Silver	10	50	50	—	—	—	—	—	50	—
Sodium	5,000	10,000	—	—	—	—	—	—	—	—
Tin	—	—	—	—	—	—	—	—	—	—
Vanadium	50	—	—	—	—	—	—	—	—	—
Zinc	20	5,000	—	5,000	—	—	—	—	—	—
Gross Alpha (pCi/l)[b]	—	5	—	5	—	—	—	—	—	—
Gross Beta (pCi/l)[b]	—	50	—	50	—	—	—	—	—	—

* - Contaminant of concern selected during public health evaluation

\- - Not detected / Not listed / Not applicable

a - Contract detection limit is generally above method detection limits, but contract detection limit is a consistent guideline

b - Dissolved fraction for comparison with drinking water requirements

c - Safe Drinking Water Act MCLs are the same as Federal RCRA regulations

d - Hexavalent Chromium (Cr (VI) NJDES toxicity criterion for Cr(III) is 170,000 ug/l

TABLE 1-19
OFFSITE LIPARI LANDFILL
REMEDIAL CRITERIA REVIEWED FOR CONTAMINATION IN GROUND WATER

	Contract* Detection Limit (µg/l)	New Jersey Ground Water Quality Standards For Class GW 2 (µg/l)	Federal Safe Drinking Water Act		Maximum Contaminant Level$_c$ (µg/l)	Maximum Contaminant Level Goal (µg/l)	New Jersey Proposed Drinking Water Standards MCL (µg/l)	NJPDES Toxic Effluent Limitations for Protection of Potable Water		New Jersey Div. of Water Resources Current Policy on Ground Water Cleanup (µg/l)
			Primary (µg/l)	Secondary (µg/l)				10^{-6} Cancer Risk (µg/l)	Toxicity (µg/l)	
Conventional Parameters [b]										
Cyanide	5	200	–	200	–	–	–	–	200	–
Total Organic Carbon	–	–	–	–	–	–	–	–	–	–
Alkalinity (as $CaCO_3$)	–	–	–	–	–	–	–	–	–	–
BOD_5	–	3000	–	–	–	–	–	–	–	–
COD	–	–	–	–	–	–	–	–	–	–
Hardness	–	–	–	–	–	–	–	–	–	–
Ammonia -N	–	500	–	–	–	–	–	–	–	–
TKN	–	–	–	–	–	–	–	–	–	–
TSS	–	–	–	–	–	–	–	–	–	–
TDS	–	500,000	–	500,000	–	–	–	–	–	–
Nitrate -N	–	10,000	10,000	–	–	–	–	–	–	–
Chloride	–	250,000	–	250,000	–	–	–	–	–	–
Phosphate	–	700	–	–	–	–	–	–	–	–
pH	–	5-9	–	6.5-8.5	–	–	–	–	–	–
Sulfate	–	250,000	–	250,000	–	–	–	–	–	–

* - Contaminant of concern selected during public health evaluation
– - Not detected / Not listed / Not applicable
a - Contract detection limit is generally above method detection limits, but contract detection limit is a consistent guideline
b - Background samples not analyzed for conventional parameters
c - Safe Drinking Water Act MCLs are the same as Federal RCRA regulations

The numerical criteria of the New Jersey Ground Water Quality Standards for the Class GW2 ground water are listed in table 1-19. These standards are considered to be applicable to setting ground water cleanup levels.

New Jersey Pollutant Discharge Elimination System (NJPDES) (NJAC7:14-1.1 et seq). NJPDES values for the determination of Permit Toxic Effluent Limitations for the protection of potable water are presented in table 1-19. These maximum chemical-specific values are based upon assessment of risks to public health and do not take technological feasibility into account. Therefore, they should be indicative of the maximum concentrations of contaminants allowable in the ground water, consistent with its potential use as a potable water supply. These values are not promulgated and thus do not have the status of ARARs; although they may be considered in determining an appropriate remedy.

New Jersey Proposed Drinking Water Standards. Assembly Bill A-280 (amendments to the New Jersey Safe Drinking Water Act) requires that the NJDEP develop MCLs for organic compounds in drinking water. These MCLs have recently been made public and are likely to be promulgated before the start of remediation. Therefore, they are proposed as relevant and appropriate requirements for setting ground water cleanup levels, in view of the potential use of the aquifer as a ground water supply. The proposed MCLs are shown in table 1-19.

Federal Safe Drinking Water Act. Table 1-19 lists the Primary and Secondary Drinking Water Standards according to the Federal Safe Drinking Water Act of 1974 (PL93-523), as amended in 1977. These values have the regulatory function of defining quality criteria for public drinking water supplies at the tap as specified in 40 CFR 141 and 143 of the Safe Drinking Water Act. The primary standards address health considerations, while the secondary standards address organoleptic effects (e.g., taste, odor, color). The maximum contaminant level goals (MCLGs) and MCLs were developed to define acceptable volatile organic and inorganic concentrations in drinking water that would result in no known or anticipated adverse health effects. In addition to addressing health factors, an MCL is required by law to reflect the technical and economic feasibility of removing the contaminant from the water supply. The limit set must be feasible, given the best available technology and treatment techniques. MCLGs are generally lower than MCLs and are solely health-based guidelines. For this reason, only MCLs are considered enforceable standards for drinking water quality. EPA's stated policy is that presently only MCLs are to be considered relevant and appropriate (Thomas 1987).

New Jersey Division of Water Resources Policy on Ground Water Cleanup. New Jersey Division of Water Resources (DWR) has established a policy (Division Order No. 64) for determining ground water corrective action criteria for volatile organic compounds (VOCs). The Division has assigned each of 28 VOCs to one of three categories. Demonstrated carcinogens are assigned to group A. Compounds that have not been demonstrated to be carcinogens and that have no State or Federal MCLs are in group B-1. Compounds that have not been demonstrated to be carcinogens, but that do have State or Federal MCLs, are assigned to group B-2. The corrective action criteria require that the ambient concentration of any individual compound in group A shall not exceed 5 parts per billion (ppb) in ground water, that the total ambient concentration of all compounds from groups A and B-1 shall not exceed 50 ppb in ground water, and that the ambient concentration of any compound in group B-2 shall not exceed its MCL in ground water.

Additionally, DWR has asked its monitoring and planning element to evaluate priority pollutant/base/neutral organics (46 compounds) and acid and extractable organics (11 compounds) for inclusion in groups A, B-1 and B-2. As the criteria for these compounds become available, they should be compared with current criteria to determine their impact on the proposed remedial alternatives.

The criteria developed by the DWR are listed in table 1-19. These criteria are chemical-specific, but not location-specific, and are independent of the projected uses of ground water. Exemptions may be appropriate "when background values exceed other corrective action criteria and sites situated on aquifers that do not have the potential to supply drinking water" (McCann 1986). These criteria are intended to be evaluated alongside other sets of criteria to determine appropriate corrective actions on a site-specific basis. They are interim guidelines that will remain in effect until legal standards are promulgated.

<u>Guidelines Based Upon Risk Assessment Methodologies</u>. Regulatory criteria for ground water are generally based upon assessments of risk to human health. Guidelines that are specific to contamination at the LiPari Landfill site could also be set by this approach. These target concentrations would be estimated by using appropriate toxicity and chemical intake data defined in EPA guidance documents and by back-calculating chemical concentrations for the ground water. This conservative approach assumes low-dose additivity of carcinogenic risk and ensures that a risk of 10^{-6} will not be exceeded if the target concentration are attained. This approach is based upon the potential use of the ground water as a drinking water source.

The contamination is confined to a narrow band near Chestnut Branch. Local hydraulic conditions make it unlikely that appreciable horizontal or vertical migration will occur outside of the present zone of contamination. The local residents receive drinking water from the public water supply. As discussed in section 1.3.6 Geology and Hydrogeology, the deep formations including the PRM aquifer which serves as the communities drinking water supply, are not considered potentially affected because vertical migration is hindered by several aquitards. Therefore, drinking water exposure to ground water contaminated by the LiPari Landfill is unlikely. Risk-based guidelines are not calculated due to the absence of exposure.

The risk assessment approach could be used in setting alternate concentration limits (ACLs) based upon human exposures at points where the ground water discharges to surface water bodies. SARA allows the use of ACLs for exposure points that are within the facility boundary. Points of human exposure outside of the facility boundary may be used if all three conditions cited in SARA section 121d(2)(B)(ii) are met.

(I) there are known or projected points of entry of such ground water into surface water; and

(II) on the basis of measurements of projections, there is or will be no statistically significant increase of such constituents from such ground water in such surface water at the point of entry or at any point where there is reason to believe accumulation of constituents may occur downstream; and

(III) the remedial action includes enforceable measures that will preclude human exposure to the contaminated ground water to any point between the facility boundary and all known and projected points of entry of such ground water into surface water.

Surface Water

Surface water bodies in the area of the LiPari Landfill depend upon the ground water and surface runoff for the total flow. The quality of the surface water will be influenced, therefore, by the quality of discharge from ground water and the seepage from the landfill. As surface waters in the study area are contaminated, surface water criteria would be used as cleanup levels, as well as for establishing criteria for the evaluation of impacts of proposed remedial alternatives on surface water bodies. A review of the surface water ARARs is given below, followed by a summary of the contaminants that meet or exceed the ARARs.

New Jersey Pollutant Discharge Elimination System (NJAC7:14-1.1 et seq). NJPDES values for determination of Permit Toxic Effluent Limitations for the protection of aquatic life in surface waters are presented in table 1-19. An environmental assessment must be performed to obtain a discharge allocation certificate prior to applying for an NJPDES permit. The environmental assessment must demonstrate that discharges meeting the effluent limitation values will not have an adverse impact on the environment. These values are relevant and appropriate to setting ground water and leachate seepage cleanup levels.

New Jersey Surface Water Quality Standards (NJAC7:9-4.1 et seq). Alcyon Lake, Chestnut, Branch and Rabbit Run are classified as freshwater Class 2 nontrout (FW2-NT). Under the NJSWQC standards, the water quality of FW2-NT waters shall be maintained to protect the existing designated uses of water and protect the water from changes that are detrimental to attainment of designated uses [NJAC7:9-4:14(c)].

FW2-NT waters have designated uses for maintenance, migration, and propagation of natural and established biota: primary and secondary recreation, industrial or agricultural water supply, and public potable water supply after treatment as required by law.

Toxic substances water quality standards exist for lakes and streams classified as FW2-NT. Table 1-20 lists these standards. The toxic substances refer to those substances that upon exposure to, ingestion of, inhalation of, or assimilation into any organism will cause death, disease, cancer, behavior abnormalities, genetic mutations, and physiological malfunctions.

TABLE 1-20

SURFACE WATER QUALITY CRITERIA FOR FRESHWATER CLASS2--NONTROUT

Toxic substance	Maximum concentration (ppb)	Toxic substance	Maximum concentration (ppb)
Aldren/dieldrin	0.0019	Endosulfan	0.056
Ammonia, un-ionized[a]	50	Endrin	0.0023
Total arsenic	50	Heptachlor	0.0038
Total barium	1,000	Total lead	50
Benzidine	0.1	Lindane	0.080
Total cadmium	10	Total mercury	2
Chlordane	0.0043	PCB	0.014
Total residual chlorine	3.0	Total selenium	10
Total chromium	50	Total silver	50
DDT and metabolites	0.0010	Toxaphene	0.013

[a] 24-hour average

Federal Water Quality Criteria (FWQC). Federal water quality criteria, established under the Clean Water Act, are values developed for the protection of aquatic life and human health (see table 1-21). These values are used by the states to establish enforceable standards with respect to the

TABLE 1-21

FEDERAL WATER QUALITY CRITERIA[a]

Chemical	Fresh water aquatic life: Fresh acute criteria L.O.E.L. (ug/l)	Fresh water aquatic life: Fresh chronic criteria L.O.E.L. (ug/l)	Human Health: Water and fish ingestion (ug/l)	Human Health: Fish consumption only (ug/l)
Acenaphthene	1,700	520	20	-
Acrolein	68	21	320	780
Acrylonitrile	7,550	2,600	0.058	0.65
Aldrin	3	-	0.074	0.079
Alkalinity	-	20,000	-	-
Ammonia Total	15.7	3.9	-	-
Ammonia un-ionized	0.092	0.022	-	-
Analine	-	-	-	-
Antimony	9,000	1,600	146	45,000
Arsenic	360	190	2.2	17.5
Arsenic(V)	850	48	-	-
Arsenic(III)	44	40	-	-
Asbestos	-	-	30 kfl/1*	-
Barium	-	-	1 mg	-
Benzene	5,300	-	0.66	40
Benzidine	2,500	-	0.12 ng	0.53 ng
Beryllium	130	53	3.7 ng	64.1 ng
BHC	100	-	-	-
bis(2-Chloroethyl)ether	-	-	0.03	1.36
Cadmium	39	11	10	-
Carbon tetrachloride	35,200	-	0.4	6.94
Chloralkyl ethers	238,000	-	0.0038 ng	1.84 ng
Chlordane	24	0.0043	0.46 ng	0.48 ng
Chlorinated benzenes	250	50	-	-
Chlorinated naphthalenes	1,600	-	-	-
Chlorinated phenols	500,000	970	-	-
Chlorine	19	11	-	-
Chloro-4 methyl-3 phenol	30	-	-	-
Chloroform	28,900	1,240	0.19	15.7
Chlorophenol-2	4,380	2,000	-	0.1
Chromium (VI)	16	11	50	-

TABLE 1-21
(continued)

FEDERAL WATER QUALITY CRITERIA[a]

Chemical	Fresh water aquatic life		Human Health	
	Fresh acute criteria L.O.E.L. (ug/l)	Fresh chronic criteria L.O.E.L. (ug/l)	Water and fish ingestion (ug/l)	Fish consumption only (ug/l)
Chromium (III)	1,700	210	-	-
Copper	18	12	170 mg	3,433 mg
Cyanide	22	5.2	200	-
DDE	1,050	-	-	-
DDT	1.1	0.001	0.024 ng	0.024 ng
Demeton	-	0.1	-	-
Dichlorinated ethanes	11,800	20,000	-	-
Dichlorobenzenes	1,120	763	400	2.6 mg
Dichlorobenzidines	-	-	0.0103	0.0204
Dichloroethylene	11,600	-	0.033	1.85
Dichlorophenol 2,4	2,020	365	-	0.3
Dichloropropane	23,000	5,700	-	-
Dichloropropene	6,060	244	87	14.1 mg
Dieldrin	2.5	0.0019	0.071 ng	0.076 ng
Dimethyl phenol 2,4	2,120	-	-	400
Dinitrotoluene 2,4	330	230	0.11	9.1
Dioxin	0.01	0.0056	-	-
Diphenylhydrazine	270	-	0.46 ng	0.56 ng
Dissolved oxygen	6,500	4,000	-	-
Endosulfan	0.22	0.056	74	159
Endrin	0.18	0.0023	1	-
Ethylbenzene	32,000	-	1.4 mg	3.28 mg
Fecal Coliform	-	-	-	-
Fluoranthene	3,980	-	42	54
Guthion	-	0.01	-	-
Haloethers	360	122	-	-
Halomethanes	11,000	-	0.19	15.7
Hardness	-	-	-	-
Heptachlor	0.52	0.0038	0.28 ng	0.29 ng
Hexachlorobenzene	250	30	-	-

TABLE 1-21
(continued)

FEDERAL WATER QUALITY CRITERIA[a]

	Fresh water aquatic life		Human Health	
Chemical	Fresh acute criteria L.O.E.L. (ug/l)	Fresh chronic criteria L.O.E.L. (ug/l)	Water and fish ingestion (ug/l)	Fish consumption only (ug/l)
Hexachlorobutadiene	90	9.3	0.45	50
Hexachlorocyclohexane (lindane)	2	0.08	9.2 ng	31 ng
Hexachlorocyclopentadiene	7	5.2	260	-
Hexachlorinated Ethanes	980	540	1.9	8.74
Iron	1,000	-	0.3 mg	-
Isophorone	117,000	-	5.2 mg	520 mg
Lead	8.2	3.2	50	-
Malathion	-	0.1	-	-
Manganese	-	-	50	100
Mercury	24	0.012	144 ng	146 ng
Methoxychlor	0.012	0.03	100	-
Mirex	-	0.001	-	-
Napthalene	2,300	620	-	-
Nickel	1,800	96	13.4	100
Nitrates	-	-	10 mg	-
Nitrobenzene	27,000	-	30	-
Nitrophenols	230	150	13.4	7.65 g
Nitrosamines	5,850	-	0.8 ng	1.24 ng
Parathion	-	0.04	-	-
PCBs	2	0.014	0.079 ng	0.79 ng
Pentachlorinated Ethanes	7,240	1,100	-	-
Pentachlorophenol	55	3.2	1.01 mg	-
pH range	-	6.5-9	5-9	-
Phenol	10,200	2,560	30	-
Phthalate Esters	940	3	15 mg	55 mg
Polychlorinated Diphenyl Ethers	-	-	-	-
Polynuclear Aromatic Hydrocarbons	-	-	2.8 ng	31.1 ng
Selenium	260	35	10	-
Silver	4.1	0.12	50	-
Solids Dissolved	-	-	250 mg	-

TABLE 1-21
(continued)

FEDERAL WATER QUALITY CRITERIA[a]

	Fresh water aquatic life		Human Health	
Chemical	Fresh acute criteria L.O.E.L. (ug/l)	Fresh chronic criteria L.O.E.L. (ug/l)	Water and fish ingestion (ug/l)	Fish consumption only (ug/l)
Sulfide-Hydrogen Sulfide	-	2	-	-
TDE	0.6	-	-	-
Tetrachlorinated Ethanes	9,320	2,400	-	-
Tetrachlorobenzene 1,2,4,5	250	50	38	48
Tetrachloroethylene	5,280	840	0.8	8.85
Tetrachlorophenol 2,3,4,6	-	-	1	-
Thallium	1,400	40	13	48
Toluene	17,500	-	14.3 mg	424 mg
Toxaphene	1.6	0.013	0.71 ng	0.73 ng
Trichlorinated Ethanes	18,000	9,400	0.6	41.8
Trichloroethylene	45,000	21,900	2.7	80.7
Trichlorophenol 2,4,5	-	-	1	-
Trichlorophenol 2,4,6	-	970	1.2	3.6
Vinyl Chloride	-	-	2	525
Zinc	320	47	5 mg	-

[a] USEPA Quality Criteria for Water 1986 (EPA 440/5-86-001).
* kf/l - kilofibers/liter.
mg - milligrams per liter.
ng - nanograms per liter.
L.O.E.L. - Lowest observed effect level.

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intended uses of each water body. SARA requires that the Federal criteria be applied to cleanups where they are relevant and appropriate. They are relevant and appropriate to cleanups in the offsite LiPari Landfill area, both for surface water and for ground water contaminants not covered by enforceable standards. Water in Alcyon Lake should be protected under fish consumption, but not both water and fish. The lake is used only for fishing and not as a drinking water source.

Background Concentrations. The background concentrations of indicator chemicals detected in surface water were presented in table 1-13. An indicator chemical was considered to be elevated if the downgradient stations were elevated above the background mean or maximum concentrations. Under these considerations Chestnut Branch exceeded background concentrations for chromium, mercury, and zinc; Rabbit Run for chromium, lead, arsenic, and zinc; and Alcyon Lake for lead and mercury. However, it is more appropriate to use existing criteria for these metals since they are available.

Guidelines Based upon Risk Assessment Methodologies. The Public Health Evaluation indicates that direct exposure to surface water contaminants in Alcyon Lake by swimming is not likely to pose an appreciable public health risk. Indirect exposure to contaminants by periodic ingestion of fish from Alcyon Lake could pose an excess cancer risk (upperbound) greater than 10^{-6} due to accumulation of bis(2-chloroethyl)ether in fish tissues. Using a 10^{-6} risk level, the EPA cancer potency factor for bis(2-chloroethyl)ether, and the worst case fish exposure scenario presented in the PHE, a risk-based guideline of 3 µg/liter BCEE in surface water is calculated (see Appendix A).

A summary of the relevant and appropriate criteria for surface water is provided in table 1-22. BCEE exceeds FWQC for fish consumption. No other organic indicator chemicals were detected. Arsenic, chromium, and nickel meet their criteria. Lead exceeds NJSWQC. Lead also exceeds FWQC and NJPDES criteria, however, in this area background concentrations of lead also exceed the criteria. Mercury exceeds all criteria. Zinc exceeds FWQC and NJPDES criteria.

TABLE 1-22

SUMMARY OF SURFACE WATER CRITERIA FOR INDICATOR CHEMICALS

Indicator chemical	Background mean (ug/l)	Background max (ug/l)	Contract detection level (ug/l)	NJPDES[a] (ug/l)	NJ SWQC (ppb)	Proposed FWQC chronic (ug/l)	Water and fish ingestion (ug/l)	Proposed FWQC fish consume (ug/l)
Benzene	ND	ND	5	5,300	-	5,300	0.66	40
Chloroform	ND	ND	5	28,900	-	1,240	0.19	15.7
1,2-Dichloroethane	ND	ND	5	-	-	-	-	-
Ethylbenzene	ND	ND	5	32,000	-	-	1.4 mg	3.28 (mg/l)
4-Methyl 2-pentanone	ND	ND	10	-	-	-	-	-
Toluene	ND	ND	5	17,500	-	-	14.3 mg	424 (mg/l)
Xylene	ND	ND	5	-	-	-	-	-
bis(2-Chloroethyl)ether	ND	ND	10	-	-	1	0.03	1.36
Arsenic	ND	ND	10	440	50	190	2.2	17.5
Chromium	ND	ND	10	44 (0.29)	50	210	50	-
Lead	3.9	17	5	0.75	50	3.2	50	-
Mercury	ND	ND	0.2	0.00057	2	0.012	144 ng	146 (ng)
Nickel	1.6	14	40	56	-	96	13.4	100
Zinc	8.1	8.1	20	47	-	47	5 mg	-

- No criteria established.

- See table 1-13 for surface water values in Alcyon Lake, Chestnut Branch and Rabbit run with reference to background.

[a] The NJPDES concentration numbers were not intended to be used at face value, but rather as constants in an equation designed to establish site specific permitted discharge concentrations.

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Sediments

The Public Health Evaluation indicates that sediments do not pose an appreciable public health risk. No plausible scenarios for periodic human exposures to sediments that would result in significant intakes of chemical contaminants were identified.

Background Concentrations. The background concentrations of indicator chemicals detected in sediments were presented in table 1-23. An indicator chemical was considered to be elevated if the downgradient stations were elevated above the background mean or maximum concentrations. Under these considerations Chestnut Branch exceeded background concentrations for nickel and zinc, Rabbit Run for mercury and zinc, and Alcyon Lake for mercury and arsenic. Only the concentration of mercury and arsenic were considered to be significant, since they were not detected in background sediments, whereas nickel and zinc were detected in background sediments within the same order of magnitude.

Guidelines Based upon Risk Assessment Methodologies. The public health evaluation determined that sediments in Chestnut Branch, Rabbit Run, or Alcyon Lake do not pose an elevated public health risk.

Air

Air quality standards for the contaminants of concern are not available. Consequently, cleanup criteria have been established on the basis of background or risk-based criteria.

Background Concentrations. Air emissions from the marsh exceed background. Furthermore, recent air monitoring by the TAGA unit during one out of five days of sampling performed by EPA in 1987 detected BCEE at 1 to 4 ppb in the residential areas. The marsh should be remediated to reduce all volatile emissions to nondetectable levels.

1-23

INDICATOR CHEMICALS
NATURE AND EXTENT OF EXCEEDING BACKGROUND CONCENTRATIONS[1] AND INCIDENCES OF POTENTIAL RISKS GREATER THAN 10^{-6}

Chestnut Branch Marsh Soil

Indicator chemical	Background Mean*	Background Max.	Chestnut Branch Mean	Chestnut Branch Max.	Unacceptable risk Ingestion (volatiles in soil)	Unacceptable risk Inhalation (volatiles in soil)	Air concentrations (g/m^3)
Organics:	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)			
Benzene	ND	ND	12.4	100	No	Yes	2.5×10^{-6}
1,2-Dichloroethane	ND	ND	3.4	99	No	Yes	1.5×10^{-7}
Ethylbenzene	ND	ND	16.4	160	No	No	1.4×10^{-6}
4-Methyl-2-pentanone	0.2	2	1.7	19	No	No	NA
Xylene	ND	ND	46.9	600	No	No	3.2×10^{-6}
bis(2-Chloroethyl)ether	ND	ND	1094.7	7400	No	Yes	2.0×10^{-6}
Metals:	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)			
Arsenic	3.2	22	10.5	65.5	Yes	No	NA
Lead	34.6	130	95.6	424	No	No	NA
Nickel	5.7	41	21.9	112	No	No	NA
Zinc	15.6	36	91.5	325	No	No	NA
Mercury	*	*	0.13	0.5	No	No	NA

[1] Estimated volume of contaminated soil: 71,500 cubic yards (excavation below 96 MSL); 20,000 cubic yards (inhalation risk in zone 3); 71,500 cubic yards (ingestion risk due to arsenic). Area of contamination: 4.5 acres (below 96 MSL); 1.2 acres (zone 3); 4.5 acres (ingestion risk).

[2] Estimate of air concentrations at fenceline receptors as modeled in the offsite remedial investigation.

NA - Not available.

ND - Not detected.

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TABLE 1-23
(continued)

Rabbit Run Sediments

Indicator chemical	Background		Rabbit Run		Unacceptable risk
	Mean*	Max.	Mean	Max.	Ingestion
Organics:	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	
bis(2-Chloroethyl)ether	ND	ND	62.5	250	No
Metals:	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	
Mercury	ND	ND	0.06	0.12	No

Estimated volume of contaminated sediment: 400 cubic yards.

Alcyon Lake Sediments

Indicator chemical	Background		Alcyon Lake		Unacceptable risk
	Mean*	Max.	Mean	Max.	Ingestion
Organics:	(ug/kg)	(ug/kg)	(ug/kg)	(ug/kg)	
Chloroform	ND	ND	1.5	11	No
Metals:	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	
Arsenic	ND	ND	6.6	67	No
Mercury	ND	ND	0.22	1.1	No

Estimated volume of contaminated sediment: 139,800 cu/yds. Area of contamination: 19 acres.
Flow rate: 2,700 gpm.

ND - Not detected

*The mean is calculated by summing the sample concentration within a specified area and dividing by the number of samples taken in the area. Duplicate samples are counted as one sample and the average of the two concentrations is used in calculating the mean. Samples which did not pass QA/QC were not included in calculating the means. Nondetectable contaminants were counted as zeros in calculating the mean.

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Guidelines Based Upon Risk Assessment Methodologies

Inhalation of volatile contaminants released from the marsh west of Chestnut Branch posed excess lifetime cancer risks (upperbound) greater than 10^{-6}. The greatest potential risks were caused by exposure to BCEE. Using the EPA cancer potency factor for BCEE, a risk of 10^{-6}, and the lifetime exposure scenario presented in the PHE, a risk-based guideline of 0.003 $\mu g/m^3$ BCEE in ambient air of the residential neighborhoods was calculated. Of the air emissions from the marsh, BCEE, benzene, and 1,2-dichloroethane were found to pose a potential, long-term public health risk. The estimated guideline air concentration levels are below existing detection limits; therefore, emissions of volatile organic compounds from the marsh should be reduced such that predicted concentrations at the receptors are within acceptable limits.

1.6.2 REMEDIAL ACTION ARARS

Other than SARA, the major requirements impacting the design, construction, and operation of remedial actions come under RCRA, the Federal Clean Water Act amendments, and the State programs authorized under those Acts. Regulations promulgated by agencies other than EPA and NJDEP will also affect performance of the remedial action. The requirements to be considered in developing and evaluating remedial alternatives for the offsite LiPari Landfill are referenced below. Each set of requirements is applicable to some component of one or more remedial alternatives. The remedial action ARARs that apply to each candidate remedial alternative will be identified in section 3.0.

RCRA and Hazardous Solid Waste Amendment Standards

Remedial activities that involve the excavation or removal of hazardous substances, onsite management of these substances, or removal to offsite facilities must be in compliance with standards under RCRA and amendments to RCRA enacted through the HSWA standards and with the requirements of the State standards authorized under RCRA.

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The following RCRA sections appear to be applicable to the development of remedial alternatives for the offsite LiPari Landfill:

- Identification and Listing of Hazardous Wastes (40 CFR 261)
- Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities (40 CFR 264), in particular:

  Subpart B - General Facility Standards
  Subpart F - Releases from Solid Waste Management Units
  Subpart G - Closure and Postclosure
  Subpart J - Tanks
  Subpart L - Waste Piles
  Subpart N - Landfills
  Subpart O - Incinerators

- Interim Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities (40 CFR 265), in particular:

  Subpart B - General Facility Standards
  Subpart F - Ground Water Monitoring
  Subpart G - Closure and Postclosure
  Subpart J - Tanks
  Subpart L - Waste Piles
  Subpart N - Landfills
  Subpart O - Incinerators
  Subpart P - Thermal Treatment
  Subpart Q - Chemical, Physical, and Biological Treatment

- Interim Standards for Owners and Operators of New Hazardous Waste Land Disposal Facilities (40 CFR 267)

HSWA prohibits the continued land disposal of hazardous waste beyond certain specified dates, unless they meet certain treatment standards or contaminant levels. Standards were established to set levels or methods of treatment to substantially diminish the toxicity of the waste or restrict its migration so that short-term and long-term threats to human health or the environment are minimized. Wastes that meet treatment standards are not subject to land disposal prohibitions. CERCLA-generated waste (solvents and dioxins) have a 43-month statutory exemption from the November 8, 1984, enactment of HSWA. By May 8, 1990, EPA is mandated to establish treatment standards for types of waste to qualify for land disposal, identify types of waste that will absolutely be land banned, or review types of waste on a case-by-case basis to qualify for an exemption to the land ban restriction, particularly where there is no treatment capacity. To date, existing HSWA standards have not impacted the selection of remedial alternatives, but future establishment of standards may do so.

New Jersey Solid and Hazardous Waste Management Regulations (NJAC7:26-1.4 et seq and 7:14A-4.1 et seq)

These regulations affect all aspects of solid waste management, both on site and off site. Since New Jersey administers RCRA standards, State and Federal waste management rules must be compared and the more stringent adopted.

Subchapters 10 through 12 of NJAC7:26 contain requirements for construction and operation of hazardous waste facilities. Location of facilities is addressed as well as standards for tanks; surface impoundments; incinerators; landfills; thermal treatment; and chemical, physical, and biological treatment units. Sections under NJAC7:14A address effluent and ground water monitoring and responses.

New Jersey Air Pollution Control Regulations

These regulations (NJAC 7:27-1.1 et seq) control the emissions of combustion by-products and chemical vapors into the atmosphere.

The subchapters addressing incineration (Subchapter 11) and ambient air quality standards (Subchapter 13) may be directly applicable in evaluating the feasibility of onsite incineration, where they are not superseded by provisions of the Solid and Hazardous Waste Management Regulations dealing specifically with incineration of hazardous waste.

Subchapters 16 and 17 address the control and prohibition of air pollution by volatile organic substances and toxic substances, respectively. These regulations address the storage, handling, and direct discharge of volatile compounds and appear to be relevant to emissions from a ground water treatment operation. Some provisions of the subchapters may be relevant to the development of schemes to control emissions of volatile compounds during excavation of contaminated soils. The air quality standards limit the emissions of any single or sum total of the following toxic volatile organic substances (TVOS) in excess of 0.1 pounds (45.4 grams) per hour.

Toxic Volatile Organic Substances

Benzene (Benzol)
Carbon tetrachloride (Tetrachloromethane)
Chloroform (Trichloromethane)
Dioxane (1,4-Diethene dioxide)
Ethylenimine (Aziridine)
Ethylene dibromide (1,2-Dibromoethane)
Ethylene dichloride (1,2-Dichloroethane)
1,1,2,2-Tetrachloroethane (Tetrachloroethane)
Tetrachloroethene (Perchloroethene)
1,1,2-Trichloroethane (Vinyl trichloride)
Trichloroethylene (Trichloroethene)

New Jersey Pollutant Discharge Elimination System (NJAC 7:14A-1.1 et seq)

Several of the remedial alternatives to be evaluated will consider ground water reinjection as a mechanism to divert ground water flow or as part of a ground water flush and treat option. Ground water reinjection will be governed by a NJPDES permit. The State's authority to regulate reinjection of ground water is derived from the New Jersey Water Pollution Control Act and is in compliance with the National DES provisions of the Federal Clean Water Act amendments. The conditions of the NJPDES permit will be decided based on data particular to conditions at the offsite LiPari landfill.

New Jersey State Soil Conservation Committee (SCC)

Guidelines for construction activities in which soil is disturbed or where surface water bodies may be impacted are regulated by the SCC. The guidelines will be particularly relevant to any remedial activities in the offsite area.

USDOT and NJDOT Hazardous Material Transportation Rules. Offsite transportation of hazardous materials will be governed by Federal and State Department of Transportation (DOT) regulations. These requirements are incorporated by reference into RCRA regulations and the New Jersey Solid and Hazardous Waste Management regulations.

A permit would be needed to generate or transport hazardous solids, liquids, or sludges. The LiPari Landfill is technically considered a "generator" because it is the source of hazardous waste or materials that may be transported off site for disposal. Generator requirements are found under 49 CFR 172 and 177, 40 CFR 263, and NJAC 7:26-7.1 et seq.

NJDEP administers both RCRA and USDOT regulations. Waste transported out of the State must be handled by a licensed hauler/transporter, who will need a NJDEP permit for in-state movements and Federal or State permits for out-of-state transport to secure landfills or incineration depots. The hauler/transporter must operate in compliance with State and Federal regulations on driver training; waste identification; container marking, labeling, and placarding; and transport papers. Packing and shipping must be performed in accordance with 40 CFR Part 262.3 and 49 CFR Part 173.

<u>Occupational Safety and Health Administration (OSHA) Regulations</u>. All OSHA requirements are applicable to workers implementing the remedial alternatives. Of particular concern will be exposures to particulates and VOCs in the air, as well as direct contact with contaminated materials and hazardous chemicals used in treatment processes.

SARA requires that the Secretary of Labor promulgate standards for the health and safety protection of employees engaged in hazardous waste operations pursuant to Section 6 of the Occupational Safety and Health Act of 1970.

Final regulations under this section shall take effect one year after they are promulgated. Until then, hazardous waste operations are governed by interim regulations that provided no less protection for workers, employed contractors, and emergency response workers than the protections contained in the Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities (NIOSH 1985) and existing standards under the Occupational Safety and Health Act of 1970, found in subpart C of 29 CFR 1926.

1.7 NATURE AND EXTENT OF CONTAMINATION

The purpose of defining the nature and extent of contamination in offsite areas attributable to the LiPari Landfill is to provide the basis for remedial alternatives to mitigate the hazards posed by the contamination and for evaluating in detail the proposed remedial alternatives that pass screening. Delineating the distributions of the contaminant source on the basis of air, soils, water, sediments, and boring samples of the Chestnut Branch marsh, Alcyon Lake, Chestnut Branch, Rabbit Run, and the parks will also serve to estimate areas and volumes of soil, sediment, and water requiring treatment or removal.

Specific off-site areas have been identified as contaminated and requiring remedial action based upon the media exceeding background concentrations and/or presenting public health and environmental risks. If samples exceeded the mean but not the maximum value of a chemical, the contamination was still considered significant. These contaminated media are the Chestnut Branch marsh soils and the sediments underlying Rabbit Run, Alcyon Lake, and Chestnut Branch downstream of the spillway. In addition, an estimate of the total volume of contaminated media requiring treatment is provided. Several samples were taken during the offsite remedial investigation. Any additional sampling would only have the potential to yield a more accurate determination of actual contaminated soils and sediments.

1.7.1 CRITERIA FOR IDENTIFYING CONTAMINATION

The criteria used to determine the extent of contaminated media requiring remedial action is based upon regulatory requirements, consideration of background concentrations, and public health evaluation procedures. The basis for these criteria was discussed in section 1.6.

For chemicals or media that do not have specific concentration criteria promulgated for contaminants present in the offsite area, the extent of contamination has been estimated using background concentrations and concentration limits estimated by public health evaluation procedures.

Background concentration limits were established from the analytical results of surface soil, sediments, surface water, and ground water from background (upgradient) locations in the vicinity of the offsite LiPari Landfill area. Analytical results of the samples from potentially impacted areas were compared against background values given in section 1.4.2 to determine the presence of significant contamination. A contaminant concentration was only considered to be significant if it was elevated above background or if it was not detected in any of the background samples. New Jersey soil cleanup criteria are generally set based upon one-to-three times expected background levels.

The public health evaluation only estimated risks associated with certain exposure scenarios for indicator chemicals. This approach was taken because remedial actions that could effectively remove or treat the indicator chemicals would also remove or treat other contaminants. The indicator chemicals are representative of a full range of chemicals with various physical characteristics. These properties are important to knowing the effectiveness of specific treatment processes. If the public health evaluation indicated that a particular contaminant in a media posed a public health risk, only then was an upper-limit concentration calculated. These upper limits are considered to be the risk-based cleanup guideline.

Chestnut Branch Marsh

The remedial investigation report indicated that soil is contaminated with the organics benzene, BCEE, 1,2-dichloroethane, ethylbenzene, 4-methyl-2-pentanone, toluene, and xylenes (total), as well as with the metals zinc, mercury, lead, nickel, and arsenic. These contaminants have contaminated the entire marsh area considered in the study. The organics BCEE, benzene, and 1,2-dichloroethane pose a risk associated with the inhalation of a predicted concentration of these contaminants at the marsh fenceline and along Howard Avenue homes. Of all the contaminants, only arsenic poses a risk due to ingestion. However, the risks due to arsenic are no greater than risks in background soil. Consequently, the most significant risk associated with the marsh soil are those associated with volatile emissions. On the basis of NJDEP soil cleanup guidelines remediation of marsh soil is probably not required with the exception of arsenic, since it exceeds the maximum observed, but not the mean observed, NJDEP cleanup guideline for arsenic. Volume estimates of contaminated soil were based upon cleanup to background or detection limit specification if the compound was not detected in background soil.

The volume of contaminated soil present in the marsh area was calculated on the basis of figure 1-23. The soil samples taken in the marsh were generally not greater than 18 to 24 inches in depth. Consequently, to determine the maximum depth of soil that could potentially be contaminated, the ground water data were also used to define maximum depth. The ground water contamination will be discussed in more detail in subsequent paragraphs. What is important to discuss with regard to soil contamination, however, is the contamination of the Cohansey aquifer. The marsh has an alluvial topsoil layer along the stream banks which was sampled; the samples did not extend beyond 24 inches.

The top soil is organically rich and, as such, is adsorptive and likely to retain contaminants on the soil particles. Leachate seepage has probably contaminated the Cohansey Sand/alluvium and Kirkwood Clay. The remedial investigation determined that Kirkwood Clay did not exist in areas north of the landfill near Chestnut Branch; therefore, any sort of remedial action would have to reflect this fact. In areas where no Kirkwood Clay exists, the alluvial soil layer is resting over the Kirkwood Sands. Under the assumption that only the Cohansey Sands and alluvium are contaminated, the volume of contaminated soil is estimated to be approximately 71,500 cubic yards. This volume in Chestnut Branch marsh was estimated from the approximate seepage face at 96 feet (MSL) to the bank of Chestnut Branch using figure 1-23. The results of the calculations are presented below in table 1-24. However, these volume estimates represent the maximum theoretical quantity of contaminated soil, limiting the areas to consider for remediation. Actual excavation volumes would be less due to considerations of Chestnut Branch, the offsite collection system, and the clay barrier to the Kirkwood aquifer.

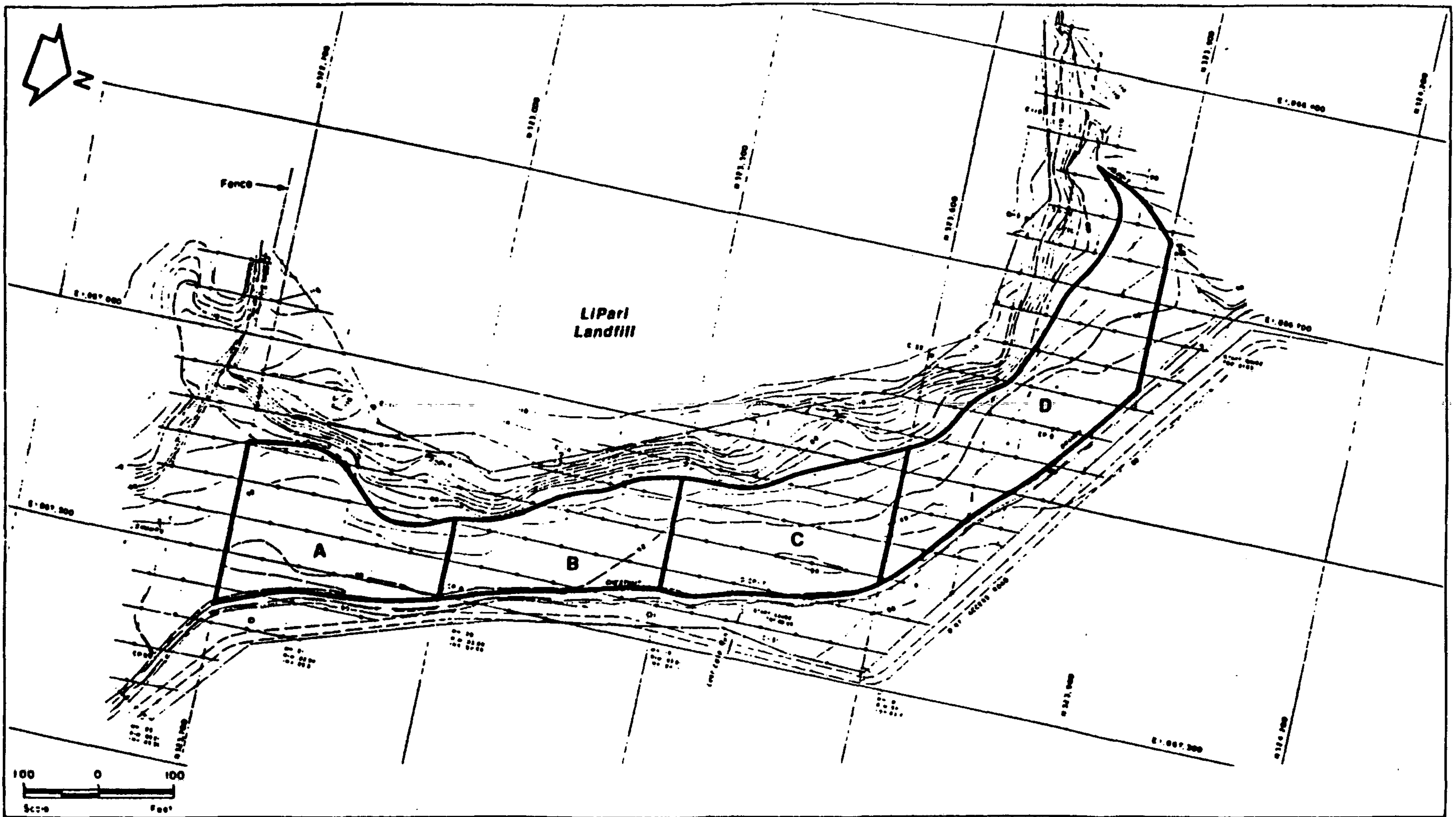

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Figure 1-23

Location of Areas for Volume Estimates in Chestnut Branch Marsh

LiPari Landfill, Gloucester County, New Jersey

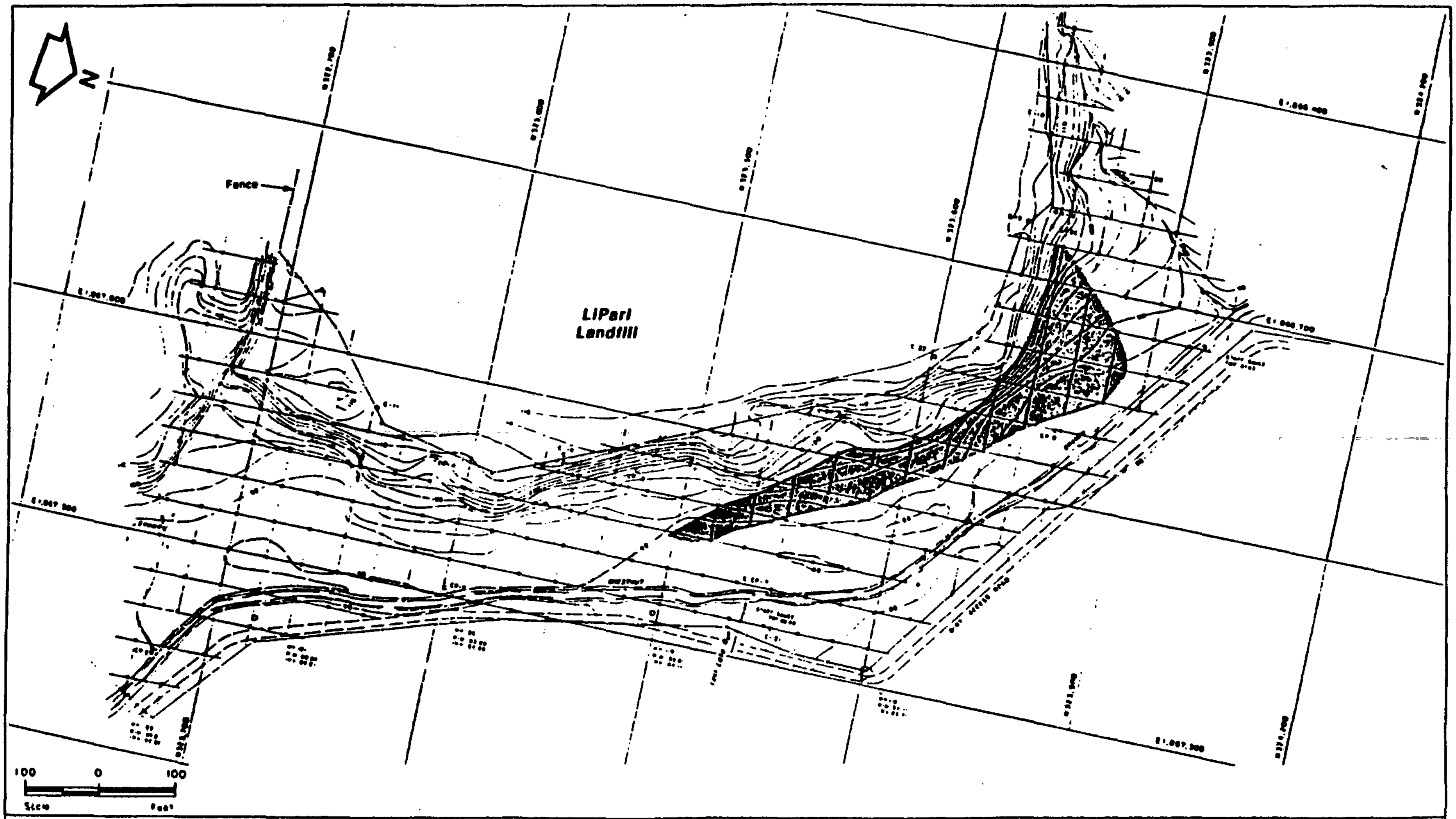

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Figure 1-24

Location of Marsh Air Emission Zone 3 Considered for Partial Excavation

LiPari Landfill, Gloucester County, New Jersey

TABLE 1-24

ESTIMATED VOLUME OF CONTAMINATED SOIL IN CHESTNUT BRANCH MARSH

Map area	Marsh Area (ft^2)	≈ Depth to Kirkwood Clay[1] (ft)	Volume (ft^3)
A	43,906	10	439,060
B	37,344	10	373,440
C	46,250	10	462,500
D	65,469	10	654,690
TOTAL VOLUME			1,929,690 or 71,475 cu/yds

[1] Notably the clay has eroded in some parts of the marsh.

On the basis of volume estimates of soils posing risk due to inhalation of volatiles, zone No. 3 shown in figure 1-24 was identified as contributing the greatest emission rates. Consequently, the volume of soil identified for remediation on the basis of inhalation risks only is estimated as 19,918 cubic yards.

Leachate seepage from the encapsulation system will continue to contaminate the marsh area until the seepage is contained via the offsite collection system. Once this control is put in place and no further remedial action is performed, a gradual natural flushing of the marsh soil will continue to occur. Over time the flush water will contain lower concentrations of contaminants. An estimate of the time frame required to naturally remediate the soils is unknown. It will depend on flushing, volatilization, and physical and biological degradation rates. The PHE provided a theoretical estimate of the time required to volatilize chemicals from the marsh ranging from 3-4 days for some to a few months for compounds such as BCEE after leachate seepage is controlled. However, these are only gross estimates, the actual rates will probably vary (CDM 1987).

The lake and streams rapid turn-over rate of 2 to 3 weeks is expected to result in the displacement of the contaminated water in these surface water bodies. Consequently, the long-term remediation for these surface water bodies is contingent upon remediation at the discharge source (i.e., seepage across slurry wall as well as ground water). Leachate seepage rates were calculated to identify the volumes necessary to design the offsite collection system. These estimates are discussed subsequently within this section.

Chestnut Branch

As previously discussed, contaminated surface waters will be displaced eventually in accordance with the streams rapid turnover rate; thus surface water remediation will not be considered further. Discharge to surface water should meet surface water quality criteria identified in section 1.6. The data do not indicate that the stream's sediments are contaminated. This may be attributed in part to the flow rate that varies between 900 and 4,400 gallons per minute (gpm) and is in comparison to Alcyon Lake, much faster. The lesser retention time, contaminants and potentially greater seasonal erosion of stream bottom sediments may account for less opportunity for contaminated sediment to accumulate. Under the scenarios for the potential public uses associated with streams such as Chestnut Branch and Rabbit Run, the public health evaluation did not identify potential risks associated with either surface water or sediments. Since neither contamination above background level nor potential health risk occurs in Chestnut Branch, the stream between Lost Lake Run and Alcyon Lake does not require remediation and, therefore, it is not considered in this feasibility study for remedial action. However, additional sampling should be performed in this area, particularly between Lost Lake Run and Rabbit Run subsequent to any remedial action taken in the marsh. Soil disturbance during remediation in the marsh may contaminate the stream sediments.

The area of Chestnut Branch below the lake spillway has stream sediments contaminated with metals above background. Remediation of this area will thus be considered. The assumption is that contamination exists as far as the last sample location (SE-03) taken in the vicinity of this spillway and that contamination is relatively shallow. A volume of 850 cubic yards will be considered for remediation; based on a cross-sectional area 1 foot deep and 9 feet wide.

Rabbit Run

The presence of contaminants in Rabbit Run sediments appears to be due to contaminant migration that occurred prior to the installation of the slurry wall, and persistence due to intermittent and low flow in the stream. Unlike Chestnut Branch, stream flow in Rabbit Run is seasonally intermittent. Indicator chemicals found in Rabbit Run sediments were identified as BCEE and mercury, chromium, lead, and zinc. These chemicals with the exception of mercury were also found in the surface waters of Rabbit Run. Additionally, arsenic was found in the surface water of Rabbit Run. The organic contaminant BCEE is positively associated with the LiPari Landfill. As previously indicated, public health risks associated with Rabbit Run were not identified; thus volume estimates based upon risk alone were not performed. Cleanup to background or method detection limit specifications were used to estimate contaminated soil volumes.

Contamination was assumed to extend through the entire length of the stream, which is approximately 1,200 feet. The volume of contamination was estimated to be 400 cubic yards based upon a cross-sectional area 3 feet wide and 3 feet deep.

Alcyon Lake

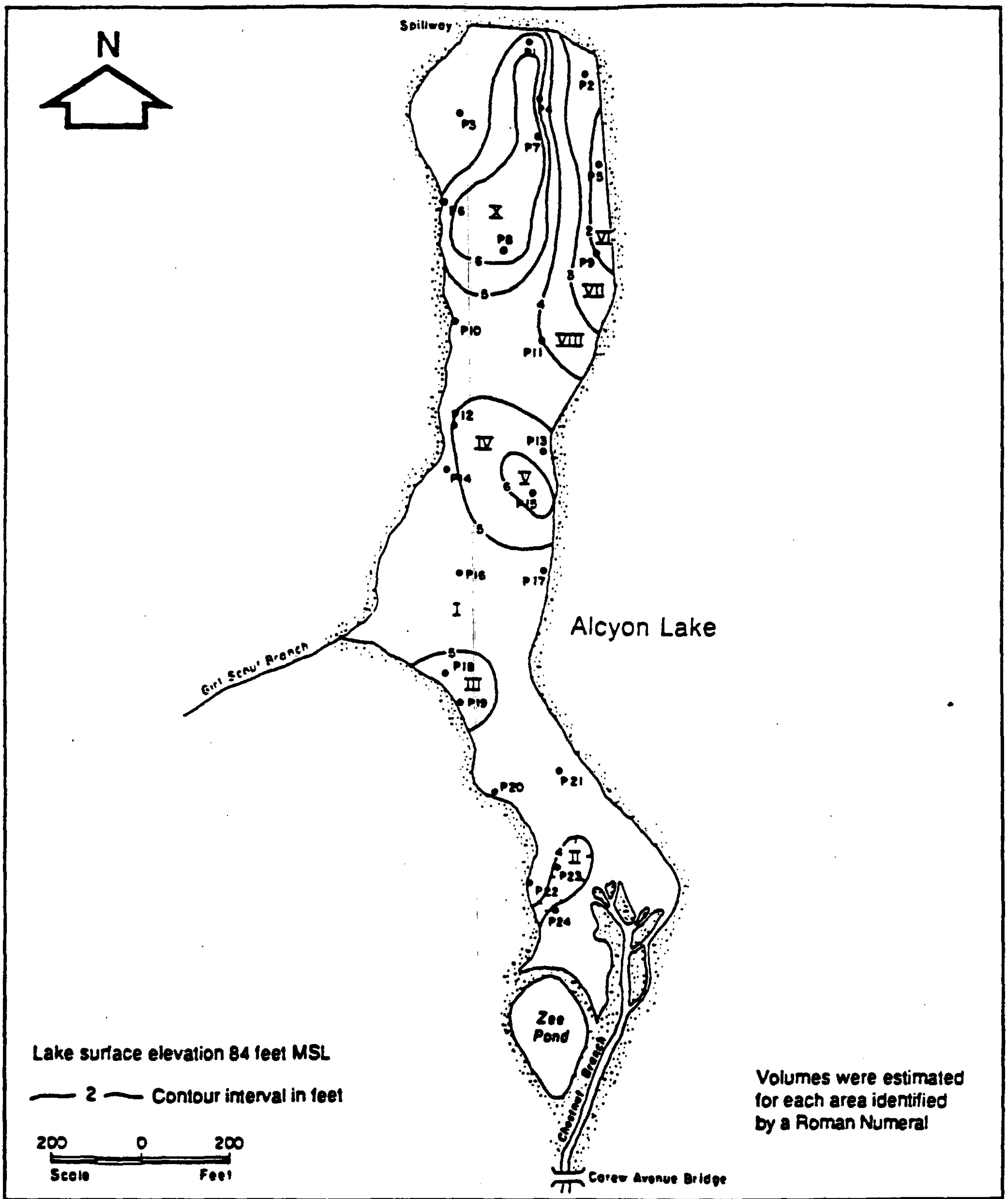
The remedial investigation report indicated that surface water was contaminated with BCEE. Any remedial action that prevents further leachate seepage from discharging into Chestnut Branch and Rabbit Run will then eliminate the contamination in Alcyon Lake. The lake's contaminants should be discharged in accordance with its rapid turnover rate, which is estimated to be 2 to 3 weeks.

The organic indicator chemical most expected to be observed in lake sediments was BCEE. Several other contaminants observed in the marsh could presumably be transported in soil particles generated as part of the normal erosion process in the marsh. However, all of the other organic contaminants in the marsh are relatively more volatile than BCEE. The organic contaminants including BCEE, however, have less of an affinity for natural organic-rich sediments than the contaminants such as polycyclic aromatic hydrocarbons, pesticides, and phthlates, which were detected in lake sediments, but have not been definitively associated with the landfill. Furthermore, BCEE is relatively more soluble than the other contaminants observed in the sediments. Therefore, it is not unexpected that BCEE or other organic indicator chemicals are not detected in the lake sediments.

In contrast, the lake sediments are a collection basin for contaminants such as metals that tend to sorb more tightly to organic-rich sediments and are considerably less soluble than the organic contaminants. The remedial investigation found that only arsenic and mercury were detected above background in Alcyon Lake sediments. They were undetected in Glen Lake, a background lake, and in the upgradient streams. All other metal contaminants were within the same order of magnitude or less than background lake sediments. Interestingly, lead and zinc were much higher in the background lake, but they were not higher than the mean concentrations for the streams. The public health evaluation did not identify any risks associated with ingestion of sediments under conditions where they would be resuspended in the water column. Cleanup to background were used to estimate contaminated soil volumes.

The surface of the lake was estimated at 14.6 acres by the REM II remedial investigation team. Because previous surface estimates were as much as 19 acres, this number will be used for conservative estimates of contamination. The volume estimates were based upon the assumption that the entire muck layer is contaminated. The muck layer is defined as all the organic matter and sediment down to the lake's competent strata. Soil borings indicated that the outcrop is from the Kirkwood Sands.

Apparently the Kirkwood Clay has been eroded in the lake as well as in the marsh. The muck layer was assumed to be contaminated as long as either arsenic or mercury was detected at any level. The soil borings essentially indicated that arsenic or mercury is distributed throughout the lake's sediment. Figure 1-25 illustrates an isopach map of muck thickness. On the basis of the isopach map and a surface area of 19 acres, a volume estimate of 139,500 cubic yards is estimated for the muck and presumed to be contaminated (see table 1-25). Were the lake to be capped, an area of 19 acres would be involved.



Lake surface elevation 84 feet MSL

—— 2 —— Contour interval in feet

Volumes were estimated for each area identified by a Roman Numeral

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Figure 1-25

Isopach Map of Alcyon Lake Muck Thickness

LaPari Landfill - Gloucester County, New Jersey

TABLE 1-25

ALCYON LAKE AREA AND VOLUME ESTIMATES OF CONTAMINATED SEDIMENTS[a]

Area	Surface (ft^2)	Depth (ft)	Volume (ft^3)
I	482,514	4.5	2,171,313
II	15,229	4.0	60,916
III	23,505	5.0	117,525
IV	64,556	5.0	322,780
V	14,070	6.0	84,420
VI	15,229	2.0	30,458
VII	44,610	3.0	133,830
VIII	51,645	4.0	206,580
IX	57,521	5.0	287,605
X	58,680	6.0	352,080
	827,559 ft^2 or 19 acres		3,767,507 ft^3 or 139,500 yd^3

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[a] The thickness of the muck in Alcyon Lake is used as a boundary condition for estimating the depth of the dredging operation. The volume to be dredged is then calculated by multiplying the area times the depth.

(19)

Arsenic and mercury were not detected in either the sediments or surface water from the background lake or upgradient streams, these metals are present in background soils east of Chestnut Branch. These metals could conceivably be transported from background soil particles during periods of intense rain, which is conducive to erosion. However, mercury was detected in only one subsurface (18"-24") sample. Furthermore the data indicate that the presence of these metals in the Chestnut Branch marsh appears to indicate that the marsh is the most likely source contributing to arsenic and mercury contamination in Alcyon Lake. Thus the conclusion that these lake sediments have potentially been impacted by the landfill and therefore, should be considered for remediation. Other metals (e.g. lead and zinc) present in Alcyon Lake may also be contributed via sources other than the landfill. Consequently, remedial action may not be appropriate until a watershed management program is implemented to minimize continued discharge from nonpoint sources.

Parks

The remedial investigation report concluded that a potential transport pathway does exist, that could contribute to contamination of the park soils. However, BCEE, the strongest indicator chemical associated with the LiPari Landfill was not detected in the park soils. Furthermore, organic or inorganic contaminants that were detected in the parks were also detected within an order of magnitude of background concentrations or less in upgradient surface water, sediment, or soil sampling site. The public health evaluation identified potential risks due to the presence of lead and arsenic in the soils. However, the risks are not considered to be greater than those associated with background soils. Therefore, remediation of the parks will not be considered in this feasibility study, since the parks have not been considered to have been impacted, as demonstrated by lack of significant contamination above background, or public health risks greater than for background areas.

1.8 REMEDIAL ACTION OBJECTIVES

The remedial action objectives under SARA state that "Alternatives must be protective of human health and the environment." In addition, a remedial action must meet or exceed "applicable or relevant and appropriate requirements" (ARARs). The ARARs specific to the offsite LiPari Landfill were discussed in section 1.6.

ARARs are established requirements that must be met to assure cleanup levels that will be protective of public health and the environment. Where there are no specific ARARs for a chemical or given situation, the PHE can be used to develop risk-based cleanup guidelines. The PHE determined whether the existing air, soil, and ground water concentrations pose public health risk. Soil-leachability rate data would be required to determine concentration levels of the chemicals of concern that can leach into the ground water without posing a risk, therefore these risks were not calculated.

Potential public health risks were found in downgradient areas that may have been impacted by the LiPari Landfill as demonstrated by proven transport pathways or by detection of indicator chemicals above background. Contaminants in the soil in Chestnut Branch marsh were found to show a potential health risk associated with ingestion and inhalation. Contaminants present in fish in Alcyon Lake were associated with potential health risks via ingestion of the fish.

Consequently, a no-action alternative would not meet the remedial action objectives required to protect public health and the environment. To meet the remedial action objectives, contaminant concentrations must be reduced such that they no longer pose a public health risk, or the exposure pathways posing a risk as described in the public health evaluation must be controlled.

To meet the remedial action objectives, a remedy must to protective of public health as well as the environment (i.e. terrestrial, aquatic, atmospheric). As previously discussed, the PHE will be used to determine public health risk-based guideline. Existing statutory laws and guidelines serve to protect the biotic environment. The NJPDES sets limits to protect aquatic life in surface waters, the NJSWQS FW2-NT waters have designated uses for maintenance, migration, and propagation of natural and established biota. The Federal Water Quality Criteria were developed for the protection of aquatic life and human health. Where ARARs do not exist for chemicals detected at the sites, the detection of man-made or naturally occurring chemicals in concentrations above background levels (established for the site vicinity) provides a basis for determining potential environmental impact.

To meet the remedial action objectives (meet or exceed ARARs and protect public health and the environment), the chemicals existing in the offsite LiPari Landfill area must be treated to reduce their toxicity, mobility, or volume, or the exposure pathway must be circumvented to prevent exposure by controlling the source or the receptor. Under SARA, the following objectives must be considered in developing remedial action alternatives.

- Providing a permanent solution so that long-term management including operations, maintenance, or monitoring is not required.
- Using a treatment technology as a principal element to permanently and significantly reduce toxicity, mobility, or volume. The alternative should use innovative or resource recovery technologies to the maximum extent possible if they show sufficient promise of providing a permanent solution when existing technologies will not.
- Using containment with little or no treatment, which provides protection of human health and the environment by preventing exposure or reducing mobility of the contaminated waste.
- Following a no action alternative.

The remedial action goals provided within these categories are not mutually exclusive. In fact, alternatives may be developed that incorporate the goals of more than one remedial action category.

Alternatives must also be cost-effective. More than one alternative may be protective, but these may vary in their environmental and public health benefits.

(12)

2.0 SCREENING OF REMEDIAL TECHNOLOGIES

The environmental and public health risks posed by the presence of contaminated soil and ground water in the offsite LiPari Landfill study area may be reduced or eliminated by placing barriers along the route available for human exposure or by treating contaminated soil and ground water to permanently or significantly reduce the toxicity, mobility, or volume of the hazardous substances.

Although technologies to treat contaminated soil will be discussed herein, technologies to treat contaminated ground water will not since ground water treatment technologies were previously examined in the Onsite Feasibility Study (CDM, 1985). It is assumed that seepage from the LiPari Landfill slurry wall during the flushing operation as well as ground water recovered from the Kirkwood Aquifer will be transported for treatment to the onsite pretreatment facility currently under design. Therefore, various technologies available for ground water recovery have been addressed.

Technologies listed in table 2-1 were selected because of their potential use in developing alternatives to meet the remedial action objectives defined in section 1.7. They have been grouped into general response categories for technical screening. Each candidate remedial action may incorporate technologies from several response categories.

Soil Media Response Actions

Source Control and Containment - Technologies in this category leave contaminated soils (sediments) in the off-site areas and rely on engineering barriers (i.e., slurry walls, caps) to reduce or eliminate exposure or the mobility of the waste so as to protect public health and the environment. A ground water monitoring program would be implemented in conjunction with this soil response action to track any future contaminant movement from the site.

TABLE 2-1

CANDIDATE REMEDIAL TECHNOLOGIES FOR TECHNICAL SCREENING

I. Source Control and Containment

- A. Surface Capping
- B. In-situ Control of Sediments
- C. In-situ Bottom Liners
- D. Sheet Piles
- E. Slurry Walls
- F. Grout Curtains
- G. Synthetic Membrane Liners
- H. Pumping Wells
- I. Passive Collection Systems

II. Insitu Treatment

- A. Solidification/Fixation
  - -- Cement
  - -- Thermoplastics
  - -- Organic Polymers
  - -- Metal Organo-Chemical Fixation
- B. Chemical Oxidation
- C. Biodegradation
- D. Soil Flushing
- E. Enhanced Volatilization
  - -- Vacuum Vapor Extraction
  - -- Thermal Vapor Extraction
- F. Delivery and Recovery Technologies

III. Treatment

- A. Excavation
- B. Dredging
- C. Soil Staging
- D. Incineration
- E. Enhanced volatilization
- F. Cement/Lime-based Fixative
- G. Vitrification
- H. Soil Washing
- I. Bioreclamation

IV. Construct New Landfill for Disposal

- A. Construct Landfill
- B. Construct Landfill over Existing LiPari Landfill Cap

V. Disposal at Existing RCRA Facility

VI. Disposal as a non-hazardous material

VII. Offsite Collection System

VIII. Ground Water Recovery Systems

(LiPari/8)

In-Situ Treatment - Using these technologies, contaminated soil (sediments) would be chemically, physically, or biologically treated in place to reduce contaminant levels. In situ treatment minimizes the need for extensive soil disturbances, such as excavation, and is in itself a means to reduce public risk due to unnecessary exposures. A ground water monitoring program would also be implemented to track any future contaminant movement from the site.

Treatment - Using these technologies, contaminated soil (sediments) is excavated and then chemically, physically, or biologically treated onsite to reduce contaminants to whatever level is technically feasible. If low enough levels can be achieved, the treated soils might be placed back into their original locations or other suitable locations without engineering controls. In the event contaminant levels still pose a threat to public health and the environment after treatment, the soil would be returned to the site for containment with engineering controls similar to those available for the source control and containment alternative, or the soils could be disposed at an offsite treatment facility. If treated soil is disposed back on the site, a ground water monitoring program would be implemented to track any future residual contaminant movement from the site.

Disposal on Newly Constructed Landfill - Contaminated soil (sediments) would be excavated to allow the construction of a secured landfill meeting RCRA, HSWA, and state requirements. The contaminated soil would subsequently be disposed into the new landfill for long-term containment. A ground water monitoring program would be implemented to track contaminant movement from the site in accordance with RCRA monitoring requirements.

Disposal at Existing RCRA Facility - Contaminated soil (sediments) would be either excavated and subsequently chemically, physically, or biologically treated at an offsite RCRA-permitted facility; excavated and transported to a temporary storage facility until final disposition of the waste is identified; or excavated and disposed at an offsite RCRA-permitted facility.

Ground Water Media Response Actions

Offsite Collection System - In accordance with the September 1985 Record of Decision for the Onsite LiPari Landfill, an offsite collection system will be installed to collect seepage from the north and northeast section of the landfill slurry wall. The system will be designed to collect any excess seepage through the slurry wall that may result from the batch-flushing remedial action. The seepage water will be pumped to the onsite pretreatment facility currently under design. The offsite collection system should be installed and operational by the time the batch-flushing program is ready to begin. The offsite collection system is in itself a separate remedial action that will be implemented regardless of, and independently of, any remedial action taken to address the offsite areas of concern, namely, the Chestnut Branch marsh, Rabbit Run, and Alcyon Lake.

Ground Water Recovery System - In this response, contaminated ground water from the Kirkwood Aquifer is recovered for treatment in the onsite LiPari Landfill ground water pretreatment facility.

Each of the technologies under consideration in the aforementioned response actions will be briefly described and screened for their technical feasibility, impacts to public health and the environment, institutional constraints and acceptability, and relative cost-effectiveness. A summary table will be provided at the end of the screening to identify the advantages and disadvantages as a justification for screening out certain technologies. The technologies that remain after the screening process are assembled into candidate remedial alternatives that are then carried over for detailed analysis in section 3.

2.1 TECHNICAL SCREENING

In order to pass through the technical screening, technologies must be feasible for the location and must represent a reliable means of addressing the problem. The criteria considered in the technical screening process include reliability, ability to implement, operation and maintenance requirements, and safety.

2.1.1 SOURCE CONTROL AND CONTAINMENT

The technologies identified under this category use engineering barriers to control the migration of contaminants in soil or ground water and prevent direct exposure to the public. Typical technologies include structural barriers such as surface caps, mechanical barriers such as adjustment of the ground water table, and solidification of the wastes and contaminated soil. This section gives a description of the aforementioned technologies and technically screens the alternatives to be considered for isolation of the contaminated soils in the marsh area and contaminated sediments in Rabbit Run and Alcyon Lake.

The two major categories presented are horizontal and vertical barriers. Horizontal barriers include surface or bottom seals. Vertical barriers include slurry walls, sheet piling, grout curtains, and impermeable membrane liners.

Marsh Soil Capping

Capping is usually a necessary option for the remediation of a site where materials are left in place. It is often used in conjunction with other containment/encapsulation technologies in order to isolate contaminated areas. The primary purpose of a cap is to minimize infiltration of rain water and preclude contact with the emplaced wastes.

The use of surface capping in the offsite marsh area will be evaluated as a technology for physically isolating the soils to minimize the risks to the surrounding public. Two types of cover systems are evaluated for use in a containment remedial alternative. The first cover system involves total encapsulation of the marsh area with an impermeable cover system consisting generally of a combination of natural and synthetic geomembranes. The second type of cover system is a permeable cover system consisting of soil placement in the marsh area. Both covers could be used to minimize risks associated with direct contact, ingestion of soils, and inhalation of volatiles emitted from the marsh soil. These two types of cover systems are discussed below.

Impermeable cover. Impermeable covers comprise two basic designs: multilayered and single-layered caps. The multilayered caps are required by the RCRA land disposal regulations of 40 CFR 264, subparts K through N. However, a single-layered cap may be acceptable when a site is being temporarily covered, in an area where evapotranspiration far exceeds rainfall and there is little or no ground water, or when there is absolute assurance that the integrity of such a cap will be continuously maintained. Use of a single layer cap will be considered only on the assumption that the cap would be continuously maintained, since the other criteria could not be met for this site.

Multilayered caps generally consist of a three-layered system, as shown in figure 2-1. The vegetative layer usually exceeds 2 feet in thickness, but may be greater depending on the frost depth, the maximum depth of root penetration, and the rate of anticipated soil loss. The drainage layer should consist of material with greater than 10^{-3} cm/sec permeability in order to minimize contact of infiltrating rain water with the low permeability supportive layer. The low permeability layer can be composed singly or in combination with natural soil, admix soil, or a geomembrane liner. RCRA regulations specify permeabilities of less than or equal to 10^{-7} cm/sec for the cap. When a single-layered cap is appropriate any of the low permeability materials mentioned above can be used. Natural soil and admixes are not recommended, however, because they are disrupted by the freeze/thaw cycle and because exposure to drying causes them to shrink and crack. The thickness of these liners is dependent on the amount of anticipated settling and the local weather conditions. The equipment and technology required to install both multi- and single layer caps a surface cap are widely available in the construction industry. Finally, it should be noted that where generation of gases within the contained site is likely, a gas collection and vent system should always be incorporated. The vented gas should be monitored and treated if emissions exceed state or federal regulations.

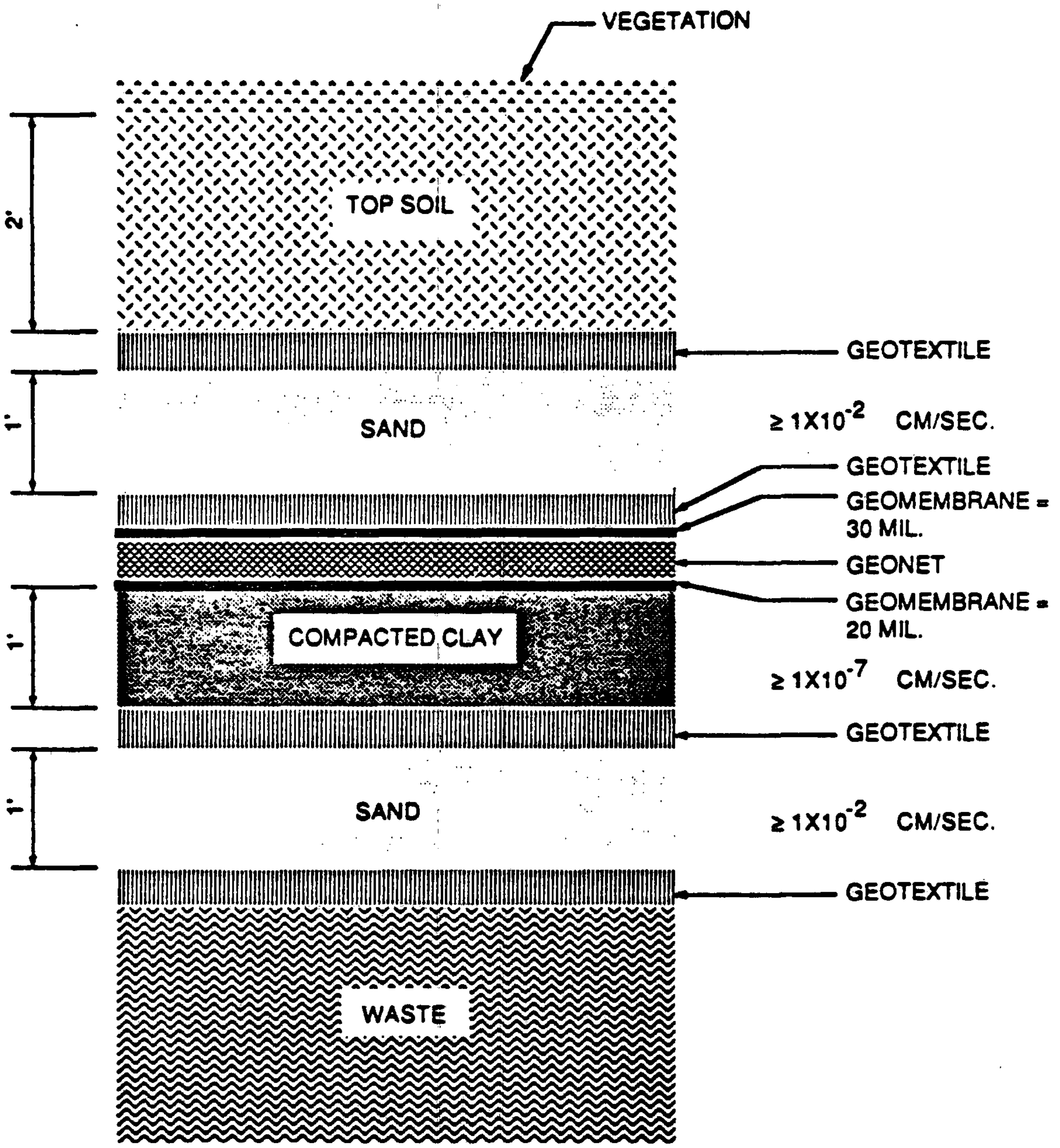

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Figure 2-1

Multimedia Cap

LaPari Landfill - Gloucester County, New Jersey

Use of an impermeable cover system in the marsh area would consist of a multilayered cap with a vegetative layer, drainage layer, and low permeability layer. The top layer consists of a vegetative cover of topsoil 6 inches thick, below which lie 18 inches of vegetative baling soil underlain by a filter fabric and a 1-foot-thick sand drainage layer.

The bottom low-permeability zone would consist of a 2-foot compacted clay layer or a geomembrane. Geological analyses are necessary to determine if the soils in the marsh area are structurally capable of supporting the weight of the cap. Sands and gravel present in the marsh area may be combined with lime and fly ash to improve the pozzolin (cementing) properties of the marsh soils resulting in the optimization of the grain size distribution and to reduce shrinking and swelling behavior. A geomembrane will be considered as the low permeability layer in the marsh since it would not be possible to adequately compact the clay to achieve the low permeability necessary. Use of a geomembrane will also reduce the cap thickness, a positive feature since excess thickness would displace water volume capacity in the marsh creating a flood problem.

Properly designed hydraulic control systems would need to be incorporated to alleviate the upward pressure on the cap, thereby reducing the stress on the cover and prolonging the life of the encapsulation. The cap could be designed with a gramage net under the cap to divert water flow the stream.

Construction and placement of an impermeable cover system would require a major effort in the marsh area. The vegetation would need to be cleared and grubbed and proper run-on and runoff systems would have to be incorporated as part of this remedial activity. Additionally, long-term operations, maintenance, and monitoring (such as inspection for erosion and settlement) are required throughout the life of the cover system.

Encapsulating the marsh area would not eliminate the flow of water to the stream banks. However, natural flushing would be minimized since precipitation would be diverted. The encapsulation system will direct surface water in a different direction. If a multilayered cap is used, the elevation of the marsh area would be raised by approximately 3 feet, thus displacing some water volume capacity in the marsh. Consequently, proper flood control systems would need to be designed to control flooding east of Chestnut Branch. However, this would not be necessary if an equal volume of soil would have to be removed to properly place the cap over the marsh soil surface. This technology will be retained for further screening in this feasibility study.

Permeable Cover. This alternative, like the impermeable cover system, would reduce the risk to the surrounding public. Under this scenario, the majority of the vegetation would be cleared from the marsh area, proper run-on and runoff measures would be incorporated, and the marsh would be covered with approximately 3 feet of clean soil. A geotechnical analysis would be performed in order to determine the stability of the marsh soils and their ability to withstand the load of this type of cover. Geotextiles could be used to separate the clean soil from the existing marsh soil.

It is assumed that ground water from the Cohansey Aquifer (i.e. leachate seepage from the slurry wall) will be collected in the offsite collection system for treatment. The heads would be lowered during operation of the offsite collection system, making recontamination of upper soils unlikely. The uncontaminated ground water would be able to fluctuate in level, and it, along with natural rainfall, would assist in flushing the more readily water transportable contaminants present in the marsh area. The organic indicator chemicals of concern would in all probability be readily flushed since they do not adsorb strongly to soil, however, the indicator metals would not be expected to desorb readily from the marsh soils. The Cohansey formation provides a less favorable environment than the marsh soils for metals to adsorb.

Minimal operation and maintenance is required for this type of cover system. This type of cover would have to be graded so as to incorporate proper surface runoff control such as dikes, berms, terraces, and benches, to minimize erosion.

The permeable cover system minimizes risk, allows natural flushing to occur, requires minimal operation and maintenance, and less hydraulic controls than the impermeable cover system. The permeable cover system will be retained for further screening.

Interim Cover

The placement of an impermeable or permeable cap in the marsh will involve some soil regrading, thus disturbing surface soils and enhancing the possibility that volatile organics will be released. Two technologies can be used either to suppress volatile organic releases or to contain their emission.

Foams. Volatile organics, obnoxious odors, and hazardous solid particulates can be effectively suppressed and controlled with water-based foam systems. One such foam has been manufactured and has been tested for commercial use by 3M Corporation (Pollution Engineering, 1987). The foam systems have been used at the PJP Landfill site in Jersey City, New Jersey as part of an NJDEP remedial action. These systems consist of application equipment, water, foam concentrates, and stabilizers. These foams are used directly in the active zone of soil disturbance (i.e., excavation, regrading) or on soil or waste piles to directly suppress the release of volatile organics. Foams are available for both temporary or long term needs. The temporary foam suppresses vapors for at least 20 minutes when applied at a thickness of one inch. The longterm foam suppresses vapors for 24 hours or more when applied at a thickness of one inch. The foams are easily applied, and they spread quickly over the surface area. The use of foams should be particularly considered during periods of warm weather or temperature inversions coinciding with active soil grading activities. The foams have been effective at suppressing volatile representatives from a wide variety of chemical compounds including aromatic hydrocarbons and ethers. Their effectiveness on bis(2-chloroethyl)ether has not been specifically tested, but they are anticipated to be effective since they have been shown to be so for the general class of ethers. This technology will be retained since it can be utilized during implementation of several types of remedial actions that result in soil disturbance.

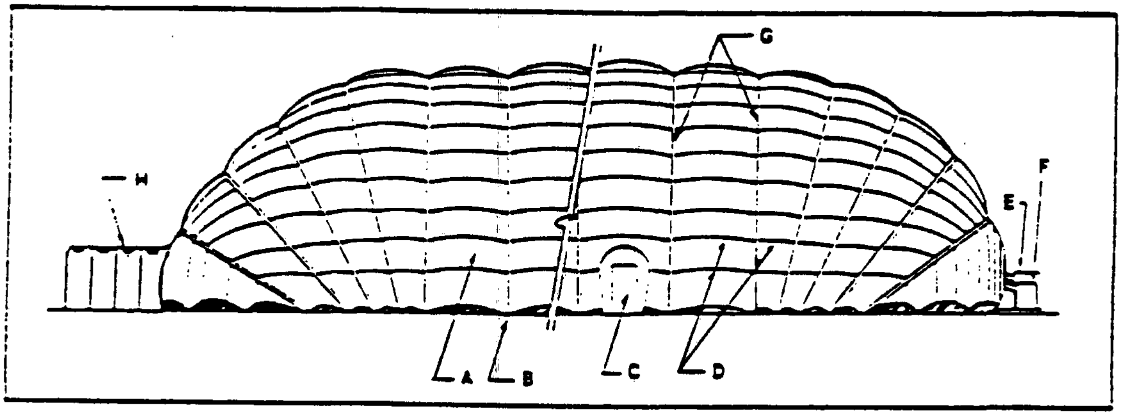
Tents. Tentlike covers should be considered when there is a need for temporary control of volatile emissions during soil disturbing activities (figure 2-2). Large equipment can function within the confines of the tents, which are maintained under negative pressure. The air is passed through a carbon adsorption unit prior to exiting. The use of tents is advantageous if large areas of soil are being graded and it is not practical to cover immediately with foams. Such tents, (or bubble structures, as generally described) have been used at hazardous waste remediation sites such as Nyanza in Massachusetts to control emissions during excavation (Levy, per. comm. 1987). The use of tent structures is a proven technology that will be retained for consideration in this feasibility study.

Lake Sediment Capping

In situ control and containment measures for sediments are intended to reduce dispersion and leaching of contaminants to other areas of the waterway. These measures may include caps or in situ grouting.

Contaminated sediments may be contained and/or controlled in situ by the use of cover materials designed to minimize leaching of the contaminants and prevent erosive transport of contaminated sediments. Cover materials include inert materials, such as silt, clay, or sand, and active materials or additives, which react with the contaminants to neutralize or decrease their mobility or inherent toxicity. Examples of active materials include limestone, green sand, gypsum, ferric sulfate, and alum for either neutralization or metal precipitation.

The first approach involves the application of a layer of clay to form a surface seal. Because the bottom sediments of Alcyon Lake are unconsolidated with a high water-to-solids ratio, a permeable geomembrane liner would be installed over the muck layer to stabilize these sediments before application of the clay layer. The clay layer would be approximately 2 feet thick and would be capped with 6 inches of gravel to reduce erosion or disturbance by people using the lake for recreation. Stabilization of the



A. VINYL COATED POLYESTER MATERIAL
B. ANCHORAGE SYSTEM
C. PERSONNEL ACCESS
D. HEAT SEALED CONSTRUCTION METHOD
E. INFLATION AND HEATING SYSTEMS
F. AUXILIARY STAND-BY SYSTEM
G. REDUCED STRESS RELIEF SYSTEM
H. VEHICLE ACCESS

Source: Thermo-Flex

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Figure 2-2

Air-Supported Structure

LaPari Landfill - Gloucester County, New Jersey

sediment to allow compaction of the clay layer will require a large volume of backfill, which along with the clay layer, will considerably increase the cap thickness and reduce the lake depth. In the second approach, concrete, quicklime, or grout is mixed with the contaminated sediments to fix the sediments. Mixing can be accomplished using rubber-tire or crawler-type rotor or trencher mixing equipment. Both approaches require draining the lake, but incorporate technologies that are considered feasible for the site and will therefore be retained for further screening. However, they will have environmental limitations (to be discussed in the next section) because of the reduction in lake depth after such a cap is emplaced.

The draining of Alcyon Lake and the subsequent capping activity will produce odors associated with the decomposition of the bottom organic matter. Odor suppressors such as those normally used in municipal landfills may be used. Sealing methods that do not include flow diversion would eliminate the problem of odors but would contribute to increased turbidity of the water.

Diversion of surface water from Alcyon Lake involves either the rechannelization of Chestnut Branch and Girl Scout Branch or the placement of a large-diameter temporary pipe to accommodate flow during lake capping. The channels would have to be designed to accommodate a 100 year flood or a special permit may be attained because of the temporary nature of the measure.

Similar grouts and sealants can conceivably be applied to cover or cap-top contaminated sediments without diverting stream flow. Such methods include concrete pumps, grouting preplaced aggregate and submerged diffuser systems. The alternatives, however, have a number of drawbacks. The applied grout or sealant may impact the overlying water, application rates would be slow, and it may be difficult to obtain complete coverage. In addition, these methods are applicable to only deep waters, and Alcyon Lake is rather shallow. These technologies have not been proven to be feasible, therefore they will not be considered any further in this feasibility study.

Geomembrane liners can be used to give a uniform seal independent of soil conditions. However, they require that the liner be placed over a compacted bottom surface and, usually covered with 12 inches of aggregate or of backfill. These liners have been used in industrial holding ponds. However, their use in settling basins at wastewater treatment facilities indicates that the liners tend to bubble up, resulting in a "turtle" effect. The reasons for this effect have not been thoroughly investigated but it is believed to result either from gas generated from the organic rich substance beneath the liner or from undercurrent flow. These types of lake caps will not be considered further because (1) the lake's bottom cannot be compacted without the addition of backfill to accommodate the liners and (2) undercurrent flow or gas may cause such liners to bubble, resulting in ineffective functioning.

In Situ Bottom Liners

Bottom liners are low-permeability barriers constructed *in situ* and are installed below the contaminant source. The bottom liner would be used in conjunction with a surface permeability barrier to encapsulate the contaminated soil in the marsh. These barriers are usually constructed by injecting a grout mixture below the contaminated source at specified locations. The grout mixture coalesces to form a barrier to contaminant migration. In this respect, the technology is similar to a grout curtain. The technology has not, however, been field tested. Furthermore the discontinuity with the geology in the marsh would make the controlled injection of the grout mixture within the marsh difficult. In areas where the clay is absent the grout would not be stable. For these reasons, primarily that this is an unproven technology and that the subsurface in the marsh area is of an heterogeneous nature, horizontal bottom seals are not considered to be an effective method for containing the waste source in the offsite marsh area at the LiPari Landfill, and, therefore, will not be considered any further in this feasibility study.

Slurry Walls

Slurry walls are low permeability barriers such as that at the Lipari Landfill that direct horizontal ground water flow. A slurry wall would be used in combination with other containment systems such as impermeable covers to encapsulate contaminated soil in the marsh. Constructed using such media as bentonite and water slurry to support the sides, the slurry wall is usually keyed to an impervious layer in order to stop ground water flow (see figure 2-3). A continuous clay layer does not exist in the marsh area. Although a hanging slurry wall may be constructed, it would have to include hydraulic controls to lower the water table. Because both the excavation slurry and backfill will flow under stress, the trench must be within a few degrees of level. However, this would pose some difficulties in the marsh area because of the steep slope and wet ground surface conditions. This problem could be alleviated by grading the trench line level prior to construction or by placing the slurry wall below the 92-foot MSL contour or the flatter part of the marsh area.

The emplacement of the slurry wall around the marsh area would need to be incorporated in combination with surface capping to contain the contaminated soil and prevent further volatilization of the organics. The slurry wall would be more difficult to implement under the steep grades existing in the marsh. This type of encapsulation barrier does not offer a significantly better type of containment alternative than the systems such as the permeable cover previously described. Any excess stress placed on the existing slurry wall would require ground water and surface water hydraulic controls as well as flood control measures to prevent flooding in homes adjacent to the marsh. While these measures are potentially possible, they are quite extensive. For these reasons, this alternative is eliminated from further screening.

Sheet Piles

Sheet piles are assembled into a series of interlocking panels that are driven into the ground to form a subsurface barrier. They are intended to function as a slurry wall. The panels can be constructed of wood,

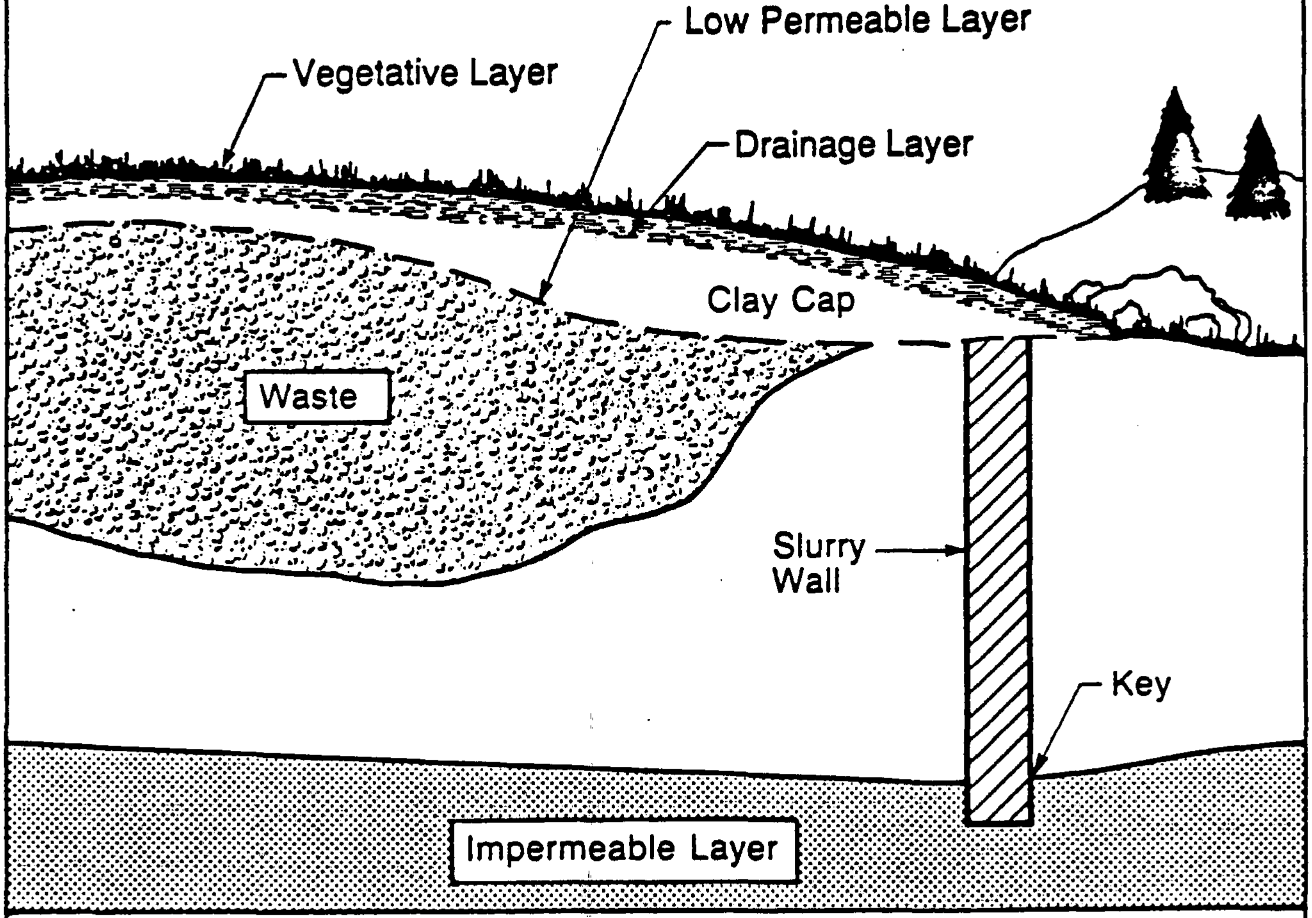

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Figure 2-3

Typical Slurry Wall Section

LiPari Landfill, Gloucester County, New Jersey

concrete, or steel. Wood, however, is generally not used for waste containment because it is an ineffective barrier to ground water movement. Steel sheet piles are most commonly used because of the relative ease of installation, and they provide the lowest permeability of the three materials.

Depending on the soil type, sheet piles can be installed to a maximum depth of approximately 40 feet below ground level. In the steeper area of the marsh adjacent to the existing onsite LiPari Landfill slurry wall, the depth exceeds 40 feet. The barriers are used much the same as slurry walls, and can be "keyed in" to a natural low-permeability layer, or installed as a "hanging" barrier. Generally they are neither very effective nor reliable as hydraulic barriers. As previously discussed in the section on slurry walls, a continuous clay layer does not exist in the marsh and the geology in the area where the clay is absent will not support a "hanging" wall. Steel sheet piling, the most commonly used type of sheet pile, can last between 7 and 40 years with little or no maintenance. To date, steel sheet piling has often been proposed as a means to control ground water, but applications have been minimal.

A containment system that uses sheet piles in conjunction with surface covers to encapsulate the contaminated soil in the marsh is not technically feasible since the marsh area requiring containment exceeds 40 feet in depth and furthermore sheet piles would not remain stable since they could not uniformly be keyed into a clay layer. A marsh soil cap system provides a technically feasible alternative that meets the remediation objectives. Therefore, this technology will not be considered for further screening.

Grout Curtains

This type of low-permeability barrier is constructed by injecting one of a variety of special fluids or grout into a rock or soil formation. As these fluids set or gel, the permeable voids in the formation are sealed. This technology is particularly effective when used in rock formations where grout is injected into fractures. It is rarely used in unconsolidated formations because the construction of a grout curtain can be three times as costly as a slurry wall. Previous discussion stated that the use of slurry walls in the marsh is not appropriate. Grout curtains like slurry walls, are subject to chemical decomposition in highly contaminated environments. Furthermore they are very ineffective and unreliable for creating hydraulic barriers. Since this type of technology is also rarely used in unconsolidated formations as in the case of the marsh area of LiPari Landfill, it has been eliminated from further screening.

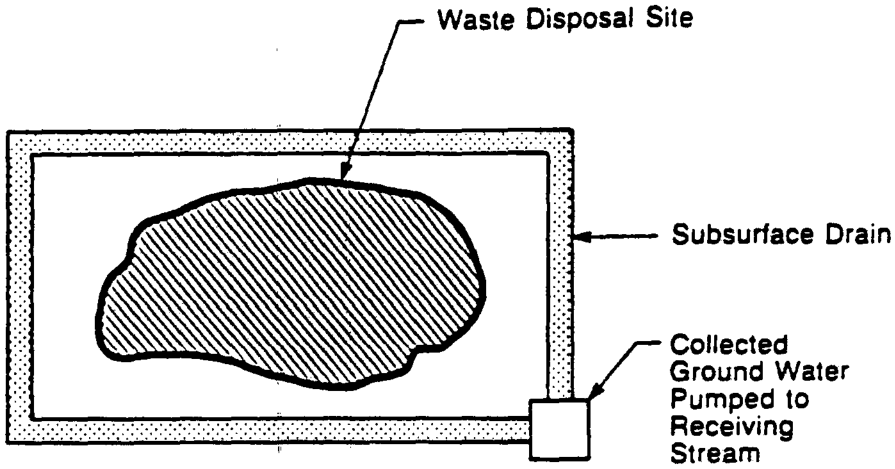
Synthetic membrane liners

Synthetic liners can be used in conjunction with other subsurface low-permeability barriers to reinforce the integrity of the barrier and reduce the chance of failure resulting from chemical attack of natural low permeability materials. However, the liners are difficult to incorporate into slurry wall construction and would require complete excavation of contaminated soils to be used as a barrier to vertical contaminant migration. As previously stated, low-permeability barriers--including slurry walls--will not be considered in this feasibility study as a source control technology. Therefore, this technology will not be considered for further screening and application.

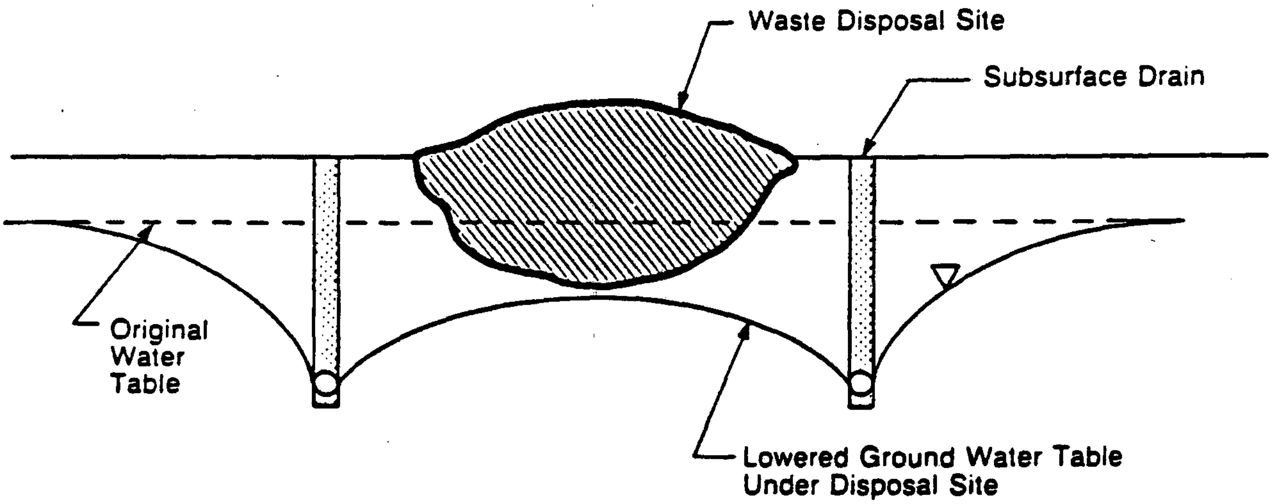
Pumping Wells

Wells, along with a surface cap and/or a barrier wall, are capable of isolating a site and thus prevent migration of contaminants. A series of wells along with the existing wells outside the onsite slurry wall can be used to lower the water table and prevent further migration of contaminants in the marsh area (figure 2-4). An additional well-point system may be installed in the marsh area encompassing the 92-foot MSL perimeter. This would effectively capture any leachate existing in the marsh area and pump it to the onsite treatment system. This well-point system can be further used to capture any leachate that may not be effectively captured by the offsite collection system.

Installation of wells typically consists of opening the borehole, installing a casing, completing the well by installing screens, filters, pumps,



PLAN VIEW



CROSS SECTION

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Figure 2-4

Typical Passive Drainage System

LiPari Landfill, Gloucester County, New Jersey

and grout and developing the well by removing the fine soil materials from in and around the screen. When aquifer depths are shallow, approximately 20 feet or less, as in the case of the marsh area at the LiPari Landfill, suction wellpoint systems connected to a common header may be effective. In either case, water table adjustment involves continuous pumping and subsequent treatment of the contaminated water on-site.

The pumping system will serve to prevent further migration of water transportable contaminants; however, the water table adjustment system alone will not prevent further public health risks since the source is not contained. Public health risks would still exist as long as an ingestion and inhalation exposure route remains at the site. Consequently, pumping to adjust the water table and prevent further migration of contaminants will not meet all the remedial objectives. The offsite collection system will consider pumping as a mechanism to capture and control further migration of leachate seepage from the slurry wall. The technologies to be considered in the design of an offsite collection system will be discussed in section 2.1.6. This technology will be retained for further screening as applied to its use in the design of an offsite collection system discussed in section 2.1.6.

2.1.2 IN-SITU TREATMENT

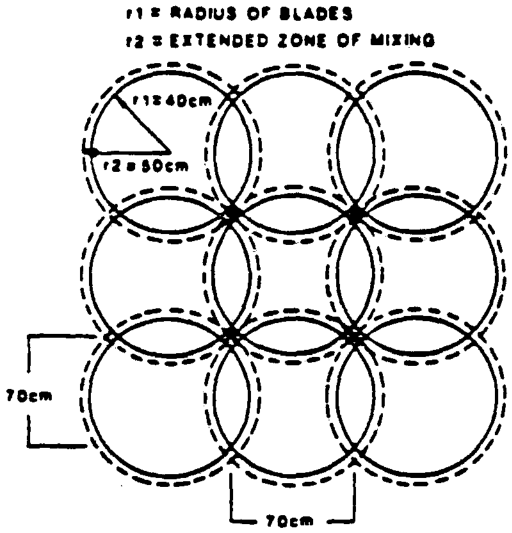
In-situ treatment involves the application of a technology to treat, in this case, soil or sediment with little or no disturbance of the medium, unlike onsite treatment processes that involve removal and sometimes containerization within the existing fenced boundary of the landfill. There can be certain health, safety, and economic advantages to in situ treatment. Disadvantages are generally associated with less control of the treatment process and verification to ensure that effective treatment was performed.

The purpose of treatment is to immobilize, reduce, detoxify, or destroy organic and inorganic (metal) contaminants of concern. Notably, the need to treat metals to make them less mobile is questionable since samples from both the marsh soil and lake sediments passed the RCRA EP-toxicity tests for metals and pesticides, (although the later group have been of little consequence at this site). RCRA analysis for soils and sediments are given in Appendix A. Marsh soils, stream sediments and lake sediments potentially require treatment for organics and metals. A technology to immobilize metals appear unnecessary. Immobilization may be useful for treating organics present in the marsh soil.

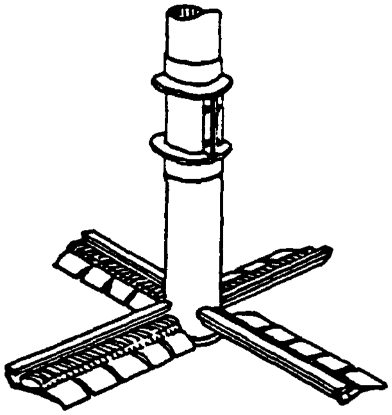
Solidification/Fixation

Currently, technologies are designed to fix or encapsulate wastes in a solid matrix product. The fixation or stabilization processes chemically or physically bind the wastes with the intent of rendering the hazardous constituents into their least soluble or toxic form. Solidification or encapsulation physically surrounds the wastes with a solidifying matrix agent (see figure 2-5). The ratio of contaminated soil to fixative required will need to be determined as part of a bench-scale treatability study. These processes may limit the solubility or detoxify the hazardous constituents contained in the wastes. These technologies are generally solidified or fixed into blocks suitable for disposal or storage. The process usually requires a working environment where the necessary application and mixing of the acting agents is readily controlled. In either case, the solidification/fixation mix formulas must be optimized for leach resistance by binding to the matrix rather than just improving structural integrity. This application requires that the soil or waste material be excavated and subsequently treated. This approach is discussed in a following subsection. Under certain conditions these technologies may also be applied to in-situ containment as will be discussed in this subsection (Sim and Bass, 1984). Otherwise it can be applied as a post excavation treatment and buried at the site.

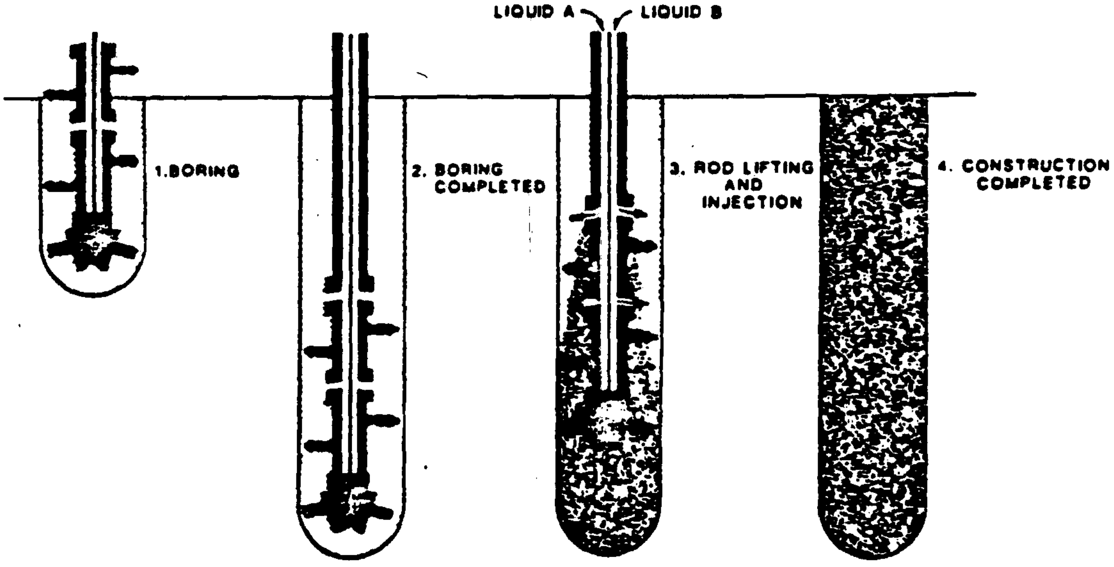
Several industries combine the use of common (Portland) cement and silicates to "fix" waste contaminated with heavy metals. Some of these technologies have been used by the radioactive waste disposal industry and they have paralleled their application to the non-nuclear hazardous waste industry. The most commonly used and potentially applicable methods are listed below and subsequently discussed in this subsection:



Top View of In Situ Treatment Columns



Toxic Treatment, Inc.
Treatment Injection Blade



International Waste Technologies
Treatment Injection Blade

Source: Toxic Treatment and International Waste Technologies

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Figure 2-5

In-Situ Stabilization/Fixation Treatment Units

LiPari Landfill, Gloucester County, New Jersey

- Cement/lime-based
- Thermoplastics
- Organic Polymers
- Vitrification
- Metal Organo-Chemical Fixation

Cement/Lime-Based. Sealing in a matrix of Portland cement or lime based agent (siliceous material, lime, and water) solidifies the soil waste (Spencer, et al. 1983). The method is suitable for fixing metals, since at the pH (9 to 11) of the cement, most metals are insoluble. However, because the solidifying matrix is a porous solid, it is not suitable for all organic contaminants since they will leach out over time. The set, cure, and permanence of the solid matrix is less stable in certain soil types including some with natural organic matter, silts, and clays. Consequently, this technology would need to be used in conjunction with an encapsulation system in order to ensure the integrity of the fixative. An in situ application of this technology would not be appropriate since stabilization of the wastes would require uniform mixing of the stabilizing agent and subsequent drying. Machinery is not currently available to perform insitu treatment under the saturated soil and steep slope conditions existing in the offsite marsh area (Hazardous Waste Consultant, 1987; Pimentell per. comm. 1987). This process could only be effectively carried out by excavation and then solidification. A typical waste process will generate twice the weight and volume of the original, thus twice the space will be required for reburial or storage/disposal elsewhere. The ground water hydrology in the marsh area would be altered by the incorporation of a relatively impervious material. This type of technology is not considered to be technically feasible as an in-situ containment technology in the marsh area but it will be re-screened as a post-excavation treatment scheme. The "fixed" soil can then be disposed of either onsite or at an offsite RCRA-permited treatment, storage, and disposal ((TSD) facility. This alternative is eliminated therefore from further consideration as an in-situ containment option, but will be retained for further technical screening as part of an onsite treatment option.

Thermoplastics. In treatment by thermoplastics waste is mixed in a matrix of asphalt bitumen paraffin, or polyethylene and heated from 130 to 230 °C (EPA, 1985). Temperature and application of the waste stabilizer is difficult to control. The process requires special equipment and highly trained operators. Metal contaminants can be sealed in the matrix. The method is not considered suitable for some organics since the heating process may volatilize or alter their structure. Volatilized organics could be physically treated by incineration if captured in the off-gases; such technology is currently feasible. Long-term leaching of waste has been shown to be slower than cement or lime solidified waste (Stewart and Herter, 1976). The stabilizers themselves are also sources of organic contaminants such as polycyclic aromatic hydrocarbons. The features that make this technology unsuitable for in situ applications are the uniform mixing of the thermoplastics is not not readily controlled, the technology for treatment is not proven for both organics and metals of concern in the marsh area at LiPari Landfill, and the fixative is a source of contaminants. Consequently, the application of this technology will no longer be retained for further screening in this feasibility study.

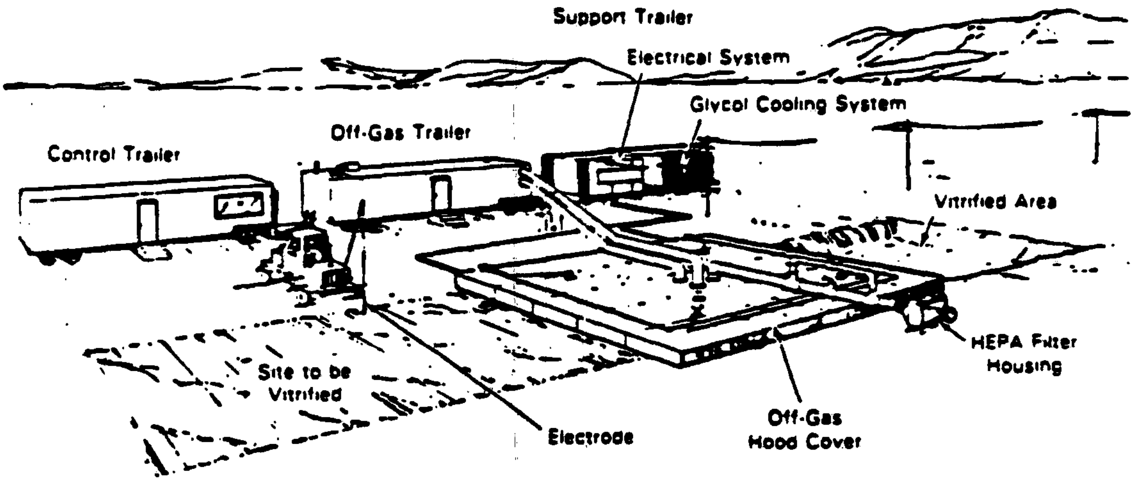
Organic Polymers. Contaminated soil is mixed with urea-formaldehyde or other resins and catalysts in reactors or in disposal receptacles (EPA, 1985). The process is simple and the technology well developed. The method is suitable to reduce leachability of metal contaminants in soil, but volatile organics may be volatilized as a result of the highly exothermic reaction. Volatiles would need to be collected in the off-gases and physically treated by incineration or adsorption. Such technology is currently feasible.

However, the technology is not suitable for in-situ applications because the process requires highly regulated temperature and chemical application controls which can only be accomplished in batch reactors. There are several organic contaminants in the soil that need to be addressed. Organic polymers that are contaminant specific would have to be developed. This would entail extensive research to determine the treatability of each contaminant with specific organic polymers. The process is not well developed to address the organics in the soils at the LiPari Landfill. Its application to in situ or treatment following excavation will no longer be considered in this feasibility study, since it does not provide greater benefits than other technologies still retained for further screening.

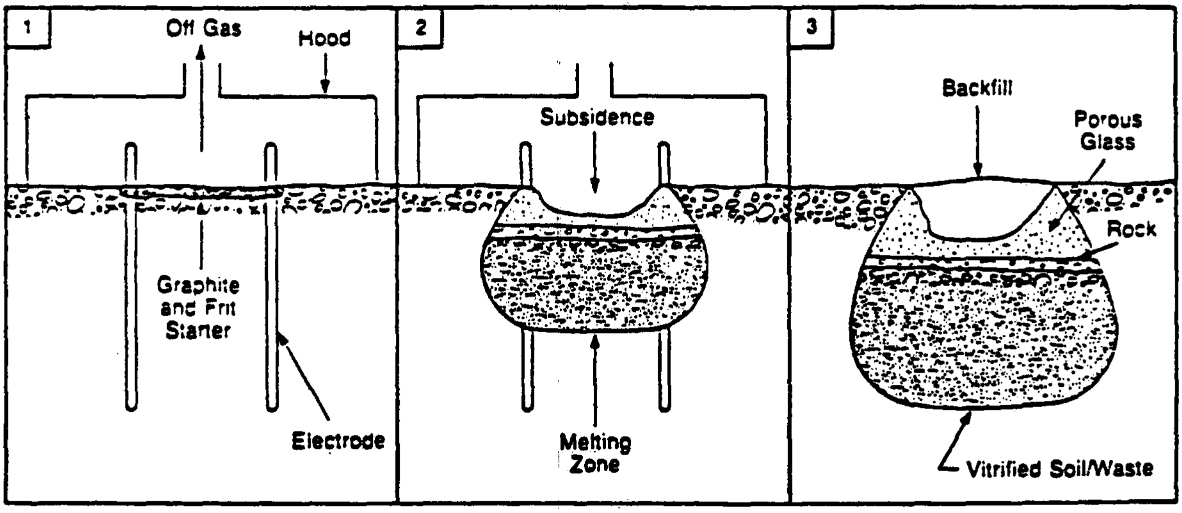
Vitrification. This process involves converting contaminated soil into a stable glass-like solid mass (Fitzpatrick et al. 1986). This is achieved by passing electrical current through four graphite electrodes set up in a square array embedded into the ground to the desired depth (see figure 2-6). The electrical resistance heating melts any substance within the defined area of the four electrodes. Upon melting, the contaminants are distributed throughout the molten material. After cooling, what remains is a vitrified mass that is more stable relative to leaching. A temporary structure with a negative pressure system placed over the processing area can capture volatiles and physically treat them by incineration. However, because of the saturated and steep slope of the marsh area, installation of the unit there would be impossible. Only pilot-scale testing has been performed and a commercial sized unit is currently unavailable. In addition, the saturated alluvium soil in the marsh is not readily vitrified and volatiles in the soil may escape laterally during treatment. Lateral escape of volatiles may result in contamination of otherwise clean soils as well as result in potential public health concerns. Consequently, this alternative is technically unfeasible for the site and is thus not retained for further screening in this feasibility study.

Metal Organo-Chemical Fixation

Metal contaminants can be immobilized within the soil at the site, or the technology can be combined with post-excavation treatment options. Heavy metal immobilization can be enhanced by either sorption, ion exchange, or chemical precipitation. Many heavy metals have a strong affinity for organic matter. Metals are complexed by a variety of functional groups in organic compounds that include phenolic, alcoholic, and carbonyl. The stability of these metal organic complexes may be controlled to prevent leaching of the metals into the ground water. Theoretically, addition of organic matter to a contaminated soil should adsorb the metals from the



Treatment Unit



In-Situ Vitrification Process

Source: Battelle Memorial Institute

Figure 2-6

In-Situ Vitrification and Off-Gas Treatment Unit

LiPari Landfill, Gloucester County, New Jersey

soil solution and prevent further migration. Organic materials that can be added to the soil include agricultural products and by products, as well as activated carbon. However, the natural mineralization of the organic materials, particularly in a marsh environment, may result in future desorption of metals. Metals may also react with organic compounds to form stable metal chelates or inorganic compounds, such as sulfides, carbonates, or hydroxides, to form precipitates.

Common concerns with the application of either biological or chemical agents for in-situ treatment includes the ability to distribute the agent throughout the site at prescribed dosage rates, the need to continuously control field conditions so that immobilized levels initially achieved will persist in the future, and the control of dosage methods to prevent additional contamination of the applied chemical agents. Because of the inability to effectively control the application of the agent in the soil and the potential for future desorption of the contaminants and associated byproducts, this technology will no longer be retained for further screening in this feasibility study.

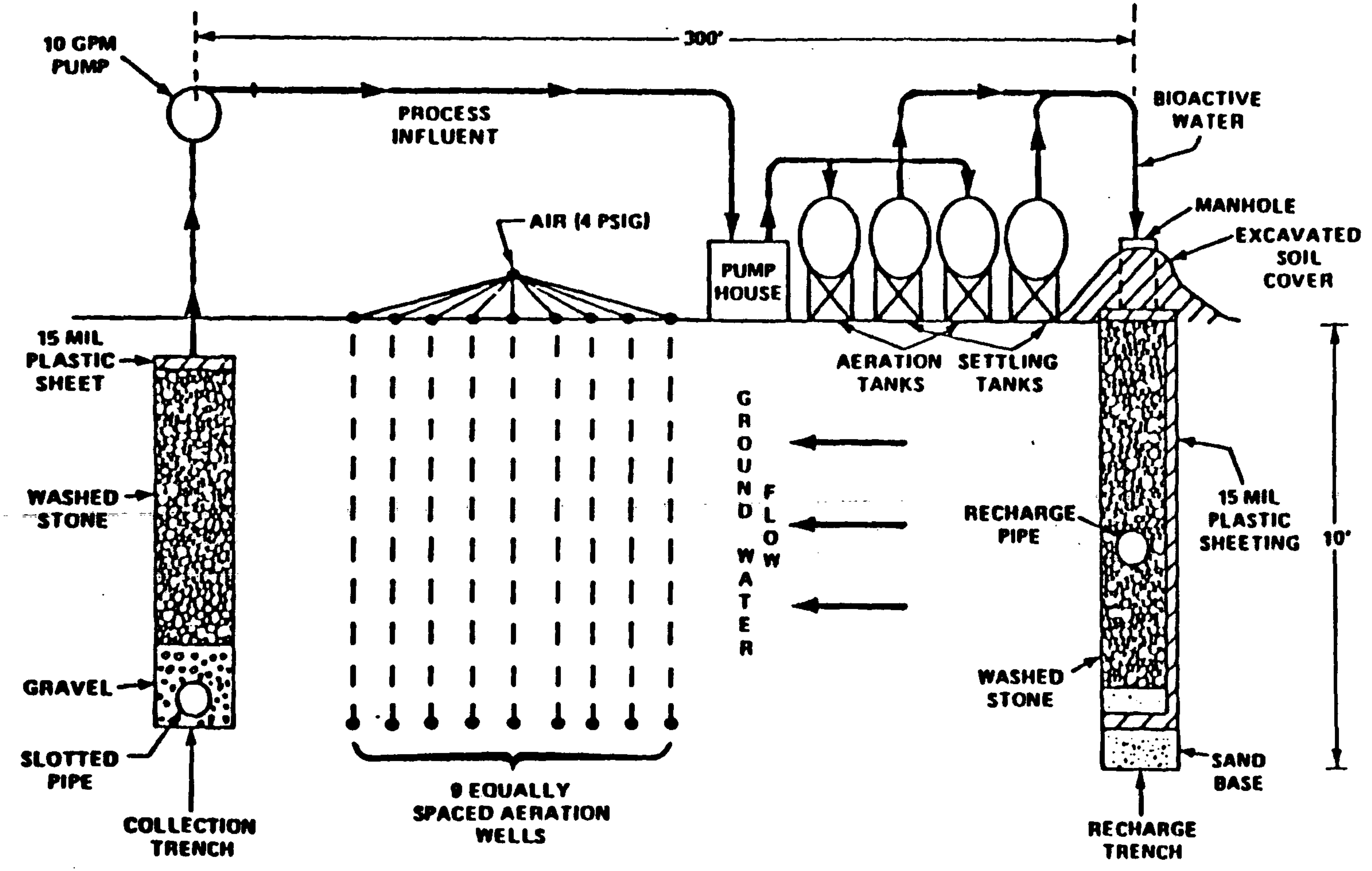
Chemical Oxidation

Chemical oxidation through the addition of an oxidizing agent to the soil such as hydrogen peroxide, ozone, and hypochlorites, is another method for in-situ treatment of soils in the marsh area. Oxidation reactions may detoxify, decompose, or render organics more amenable to biological degradation. Chemical oxidation, therefore, may be the first step in the decomposition of the organic contaminants, which will be completed with subsequent biological activity. A disadvantage of oxidation is that the chemical agents used do not discriminate as to the substances that they will oxidize in the soil, therefore much of the oxidant added is wasted on reacting with nontarget compounds. Furthermore, treatment with oxidizing agents may sometimes result in production of degradation products more toxic than parent compounds. Another disadvantage of this type of technology is that very limited field information is available indicating its effectiveness. Consequently, this technology will not be retained for further screening in this feasibility study.

Biodegradation

Field experience and research indicate that under certain conditions biodegradation could play an important role in the treatment of hazardous waste (Abelson, 1986, and Pimentell, 1987). In-situ biological degradation of the organic compounds requires an active population of micro-organisms which usually depends on soil conditions such as moisture, oxygen content, pH, organic and nutrient content and temperature. Soil moisture can be controlled at or near the optimal level using an irrigation and drainage system, as required. The oxygen content in surface soils can be controlled primarily through the use of tillage equipment or aeration wells. Aeration of soils deeper than approximately 2 feet can be accomplished by either air injection through well points or injection of chemicals such as hydrogen peroxide or pure oxygen (see figure 2-7). An in situ biodegradation system under NJDEP supervision has been successful in reducing ground water contaminants at a plant site in Waldwick, New Jersey (Jhaveri and Mazzacca, 1985). Various delivery systems are discussed later in this section. The soil pH can be controlled to favor a particular segment of the microbial population that may be effective for the specific chemicals of interest. Biological growth rate is also affected by the availability of the nutrients such as nitrogen and phosphorus. If the ratio of organic C:N:P is wider than about 300:15:1 and the available (extractable) inorganic forms of N and P are not insufficient to achieve this ratio, then supplemental N and/or P should be added. Soil temperature is one of the most important factors that control microbiological activity and may be regulated to some degree by controlling the incoming and outgoing radiation or by changing the thermal properties of the soil. However, the ultimate level of treatment depends on the biodegradability of the contaminants, and the above environmental controls need to be regulated for optimization purposes. A bench scale study of the soil matrix and chemicals present in the marsh area would need to be conducted prior to selection of this technology.

The treatment alternatives described above may be effective in the decomposition of the organic contaminants found in the soil. However, they are



Source: Groundwater Decontamination Systems, Inc.

Figure 2-7

CDM

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Biodegradation Treatment System Basic Process Flow Diagram

LiPari Landfill, Gloucester County, New Jersey

not designed to remove metals. The concern with heavy metal contamination involves both the element itself and all its associated compounds. Although this type of in-situ treatment can be combined with active or natural soil flushing, the water treatment is not expected to be effective in removing heavy metals. Furthermore, the saturated and low-permeability conditions in the marsh soil will make it difficult to maintain the soil sufficiently aerated to maximize biodegradation. Natural flushing of the contaminants appears to be an effective means of removing organics if not inorganics, and provides more reliable results. Consequently, biodegradation will no longer be retained for further screening in this feasibility study.

Soil Flushing

The organic and, to some extent, the inorganic chemicals of concern can be removed from the contaminated soils by means of an extraction process that is usually referred to as soil flushing or solution mining (Thomsen et al. 1985). In soil flushing, water or an aqueous solution is injected into the area of contamination and the contaminated elutriate is collected in a series of wells or subsurface drains. Effective collection of the elutriate is necessary to prevent uncontrolled contaminant migration through uncontaminated soils and possibly into previously clean ground and/or surface waters. The collected elutriate is pumped to the surface for offsite disposal or for onsite treatment with subsequent disposal or reinjection. Flushing of contamination soil is less effective in the unsaturated zone. Flushing of a soil mobilizes and removes sorbed contaminants, resulting in a soil with a degree of decontamination that is partly a function of the flushing solution.

Flushing solutions with the greatest potential for decontaminating soils included the following:

- Water
- Basic and Acidic Aqueous Solutions

- o Complexing and Chelating Agents
- o Surfactants (Anionic, Cationic, or Non-Ionic)

Water is used to flush water-soluble or water-mobile organics and inorganics. Organics that can readily be removed by water flushing can be identified by their octanol/water partition coefficient. Water flushing should be effective in removing the lower-molecular-weight alcohols, phenols, carboxylic acids, medium-molecular-weight ketones, aldehydes, and aromatics and lower-molecular-weight halogenated hydrocarbons such as trichloroethene (TCE) and tetrachloroethene (PCE). Most of the contaminants of concern in the marsh area are readily flushed with water, as has been demonstrated by their migration from the landfill. Inorganics that can be flushed from soil with water are soluble salts such as the carbonates of nickel, zinc, and copper. Metals of concern in the marsh such as arsenic, chromium, and lead may not be readily flushed since the silty clay-alluvium soil adsorbs metals strongly.

Basic and acidic aqueous solutions and/or complexing and chelating agents are used primarily to remove metals. Acidic solutions may also enhance the removal of basic organic constituents including amines, ethers, and anilines.

The heavy metals present in the marsh may be strongly adsorbed to iron oxides in soils. Iron is naturally high in the Cohansey formation. Reduction of the metal oxides may be needed as a first step in the mobilization of the heavy metals. Treatment agents which may be suitable for this purpose include hydroxylamine together with an acid. Once a heavy metal is released, chelating agents can then be used to keep it in solution. However, the metals of concern will not be preferentially desorbed. The sludge will contain metals that are more readily desorbed, such as iron, while recovering a smaller percentage of metals that are of concern such as mercury, since they do not desorb as readily.

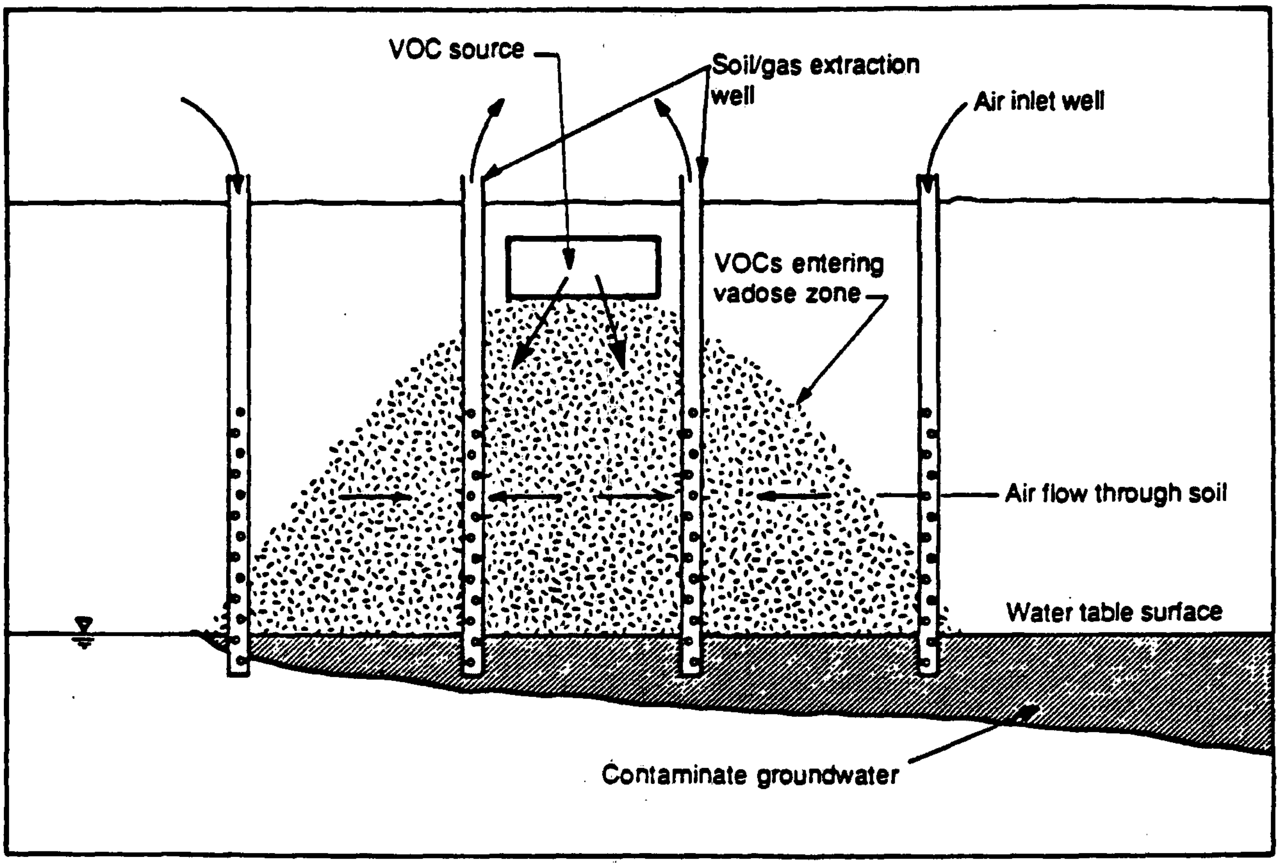
Surfactants can be used to improve the removal of organic contaminants from soil. Once removed, surfactants also improve their transportability by aqueous solutions through soils. There are numerous surfactants commercially available; however, their use for cleaning up contaminated soils has been limited to laboratory research.

Soil washing/flushing is an attractive feature if the contaminated water is extracted through a collection system of drains or wells and treated on site, and the clean water reinjected back into the ground. The contaminants present in the marsh soil are water-transportable; this is demonstrated by their transport to the marsh area in the leachate solution. However, the rate of contaminant removal is unknown and cannot be determined in the absence of leachability data. An extraction/injection flushing system in the offsite marsh area seems to be a feasible way of enhancing the flushing process to remove contaminants in the soil. Soil flushing will be retained for further screening.

Enhanced Volatilization

Enhanced volatilization for *in situ* removal of organics can be performed by either vapor vacuum extraction or thermal treatment technology. It is limited to the treatment of volatile organics and a small number of semivolatiles present in an unsaturated soil; it is considered here for treatment of the marsh soils. However, the process performs best in homogeneous soils unlike those present in the Chestnut Branch marsh.

Vacuum Vapor Extraction. Vapor extraction by a vacuum system has been successfully employed for the removal of organics that are volatile in ambient temperature and in soils with a permeability in the range of 10^{-4} to 10^{-8} cm/sec (Bennedsen, 1987). The soils on the site have an estimated permeability of 10^{-5} cm/sec. However, it varies depending on the mix of sand, silts, and clays present in the marsh. The technology involves the installation of vapor extraction system (VES) wells, as shown in figure 2-8. The vapor is extracted by inducing a vacuum to create a subsurface pressure gradient and to allow the flow of organic vapors. The vapors may be released without pretreatment or collected for treatment by carbon



Not to scale

Source: Pollution Engineering Feb. 1987

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Figure 2-8

Soil Gas Vapor Extraction System

LiPari Landfill, Gloucester County, New Jersey

absorption to meet air emission standards. However, short-circuiting may render the VES process ineffective, allowing it to draw air only from the surface. The potential for short-circuiting appears to limit the application of the VES wells to depths of ten feet or more, unless low permeability covers are used at the ground surface. The soils requiring treatment in the marsh are generally less than 10 feet in depth. However, a more critical limitation on use of this technology is that the soil is saturated; therefore, it is not possible to obtain good air circulation to enhance volatile emissions. Consequently, this technology will not be considered further.

Thermal Vapor Extraction. Enhanced volatilization may also be accomplished by thermal treatment. In this process, steam is injected into the contaminated zone, and the superheated vapors enhance volatilization of organics or cause their thermal decomposition. A vapor recovery system is necessary for this type of system, in order to capture volatile organics and comply with air quality standards. Toxic Treatments, Inc. (TTI), has developed an enhanced volatilization system using thermal treatment. The unit consists of a drill rig, steam injector, and vapor-recovery treatment system (see figure 2-6). Short-circuiting is greatly minimized in this system since the air stream travels through the low-resistance path created by the drill paddles rotating the soils. Performance and reliability data on this unit are limited to pilot-scale studies; the implementability of this technology and the cost-effectiveness of this unit cannot be determined. Site constraints may make it difficult to maneuver the unit under the variable site topography existing in the marsh. The TTI unit will not be considered further since there are site constraints on its use and insufficient performance data are available for detailed screening.

Delivery and Recovery Technologies

The in-situ treatment soil flushing technology discussed in this section will need to have an efficiently designed delivery and recovery system. Table 2-2 outlines various delivery/recovery systems. A discussion of these technologies and of their potential applications in the marsh area is presented below. These same technologies will also be considered in section 2.1.6 as they are also applicable in the design of an offsite collection system.

TABLE 2-2

DELIVERY AND RECOVERY TECHNOLOGIES FOR SOIL FLUSHING

System/Category	Method
Delivery:	
Gravity	Flooding; ponding; ditch; surface spraying; infiltration gallery; infiltration bed
Forced	Injection pipe (open end or slotted)
Recovery:	
Gravity	Open ditch; buried drains
Forced	Well point with vacuum; well point without vacuum; deep well

<u>Delivery Technologies</u>. Delivery systems introduce water or reactant solutions into waste deposits to react with contaminants in the waste deposits or to flush contaminants from the deposits to the ground water table. Flushed contaminants can subsequently be collected and treated above ground. The available delivery methods are grouped into two generic categories: gravity and forced. <u>Gravity</u> methods apply the flushing or reactant solution directly over the waste deposit (if the waste deposit is at the surface) or deliver the solution through the surrounding soil to the waste deposit. <u>Forced</u> delivery methods inject the flushing or reactant solution directly into the waste deposit or surrounding soil through pipes by means of applied pressure. When considering any delivery or recovery method the reactant and ground water flow should be modeled (using conven-

tional flow-net analysis or mathematical models) so that design parameters can be tested and proper delivery of reactant and recovery of spent solution can be assured.

Gravity delivery methods: A gravity delivery method is applicable at or near the ground surface and can be classified into two groups: surface and subsurface spreading. The selection of a particular gravity delivery method depends on the infiltration rate and soil hydraulic conductivity of the waste disposal and overlying soil, location of the waste disposal with respect to the ground surface, the topography of the waste disposal site, and the climatological influences (frost penetration depth) at the affected area. A brief discussion of the applicable gravity delivery method is presented below.

Ditches: The ditch method of surface spreading uses relatively flat-bottomed ditches to transport the solution over the application surface providing the opportunity for percolation. Generally, ditches are relatively shallow and narrow (1 to 2 meters or 3 to 6 feet wide) and make use of both the bottom and side surfaces for infiltration of liquid to the ground.

The offsite marsh area consists of uneven terrain that is not well suited for the placement of the ditches. The variable terrain and the propensity for ditches to silt does not assure the longevity of ditches over infiltration galleries considered below; therefore; the use of unprotected ditches is eliminated from further screening.

Infiltration Gallery: An infiltration gallery consists of a trench that is filled with gravel or stones. The solution fills the void spaces in the gallery and is distributed to the surrounding soils and waste deposit. Infiltration occurs in both horizontal and vertical directions. The recommended packing of fill medium for use in this system is either gravel or crushed rock, sized 2 to 6 cm (0.8 to 2.5. inches) in diameter.

The solution can be introduced into the gallery by injection in different locations along the length of the gallery or through perforated distribution pipes. The pipe used for the distribution can be constructed of the following materials: clay, bitumized fiber, concrete, plastic (acrylonitrile-butadiene-styrene), polyvinyl chloride styrene rubber plastics or polyethylene. The perforation size in the pipes, spacing of holes along the pipes and spacing between galleries will depend on site-specific conditions.

Infiltration galleries provide effective gravity application methods in circumstances where other methods may not be feasible, such as in areas of steep slopes and uneven terrain. This type of system will function essentially in the same manner as ditches and can be installed in the marsh area using all terrain vehicle construction equipment. This type of delivery system seems to be technically feasible for introduction of in-situ treatment solutions in the marsh area at the LiPari Landfill and, therefore, will be retained for further screening.

Sprinkler Irrigation: An irrigation system can be designed to enhance flushing of contaminated soils. The system is usually limited by the infiltration capacity of the soil. If the capacity of the site is limited by a relatively impermeable subsurface layer or by a high ground water table, underdrains can be installed to increase the loading. The irrigation must be adjusted as necessary, to accommodate increases or decreases in surface water flow resulting from local climatic conditions. Sprinkler irrigation involves minimal technology and can be installed easily. This technology will be retained for further consideration.

Forced Delivery System: A forced delivery system, unlike the gravity system, is conceptually independent of surface topography and climate and can be designed to accommodate any of the waste deposit configurations that have been discussed. Forced injection is the process in which a fluid under pressure is forced into the waste deposit and surrounding soil through pipes that have been strategically placed to deliver the solution to the zone requiring treatment.

Since the applicability and design of this type of system depends heavily on the site geohydrological conditions, the site must be investigated by means of test borings with field hydraulic conductivity testing, as well as laboratory geotechnical testing. A detailed geohydrological investigation would provide information on maximum injection pressures at which the treatment solution may be applied into the contaminated zone. This type of delivery system may be designed in a similar way as infiltration galleries and be located at a higher elevation in the marsh area to be effective. A forced delivery system combined with a containment and recovery method is a technically feasible option for in-situ treatment of contaminated soils and will be retained for further screening.

Recovery Technologies. Recovery systems are utilized in order to effectively extract the waste stabilization by-products, generated as part of the in-situ treatment of soils, from the zone of contamination. The extracted solution is subsequently treated above ground or disposed. The available recovery technologies, like delivery technologies, can be grouped into two categories consisting of gravity and forced methods. Gravity recovery depends upon interception of the ground water downgradient from the waste deposit. Thus, after applied treatment solutions pass through the waste deposit and enter the ground water, the resultant fluid is collected in an interceptor system (for example, open ditch or buried drain) by simple gravity flow. Forced recovery systems use well points, deep wells, or vacuum well points located downgradient of (or radial to) the waste deposit to remove spent solutions by mechanical means.

Gravity recovery of spent solution and reaction products from a waste deposit can be accomplished through the use of open ditches or buried perforated pipes. The flow to the gravity recovery system is governed by the same factors that control flow to a well (for example, hydraulic conductivity and hydraulic gradient). Whereas hydraulic conductivity is a function of the waste disposal and surrounding soil, hydraulic gradient can be controlled by appropriate placement of the gravity recovery system in relation to the waste deposit and ground water table. A discussion of various gravity recovery methods is presented below.

> Open Ditch: Open ditches, consisting simply of a ditch or trench excavated into the ground water table, have been used successfully for the collection and transport of ground water from shallow aquifers. The recovered liquid is ultimately conveyed to a sump from which it can be either returned to the delivery system, collected for disposal, or further treated.
>
> Ditches can be installed on moderately steep terrain (slopes less than 25 percent). Because ditches and trenches are designed to transport the spent solution in addition to recovering it, they should be designed with a cross section of adequate area and relatively gentle slope (1 to 5 percent) to control water velocities, reducing friction losses and erosion of the side slopes. Because of the topography associated with the offsite marsh area, this type of a recovery method will be difficult to employ. Furthermore, this method is not

significantly more effective than other methods and, therefore, is not retained for further screening in this feasibility study.

Seepage Ditch: Buried drainage pipes containing either slots, perforations, or open joints are another type of gravity collection method similar to the infiltration galleries described previously. The drainage systems are constructed by excavating a trench and laying steel, concrete, asbestos-cement, clay, or plastic drainage pipes at the bottom. The trench is then backfilled with gravel or other porous material to a designated depth (up to the saturated water level), and the rest of the trench is backfilled with soil. Often the gravel is covered with fabric to prevent fine soil from entering the gravel from above and clogging the drain. An impermeable barrier (liner or slurry trench) may be required on the down-gradient end of the trench to prevent the flowthrough of the intercepted and contaminated ground water if the surrounding materials have a moderately high permeability. It is technically feasible to excavate a trench to almost any depth desired. Although hydraulic backhoes can excavate to depths of about 50 feet, for economic reasons, the trench depth for ground water recovery from a waste disposal site should be limited to about 16 feet below ground level. The velocity in the pipe should be maintained above 1.5 feet per second to prevent settling of any materials and should be less than 3 feet per second to prevent high friction losses and uneven distribution of the drawdown over the length of the drainage pipe. The water collected in the ditch would be pumped to the onsite treatment facility. This type of recovery system, combined with a containment system, is technically feasible to use in the LiPari Landfill marsh area and, therefore, will be retained for further screening.

Well Point System: Forced recovery is the process by which a fluid is pumped from pipes or wells. A conventional well point system is such a recovery system. It consists of one or more stages of well points (wellpoints connected to a header at a common elevation), which are installed in a line, a ring, or radially around the waste deposit at spacings of from 1 to 5 meters (3 to 15 feet). The well points are attached to riser pipes connected to a common header pumped with one or more wellpoint pumps. The well points are small well screens composed of either brass or stainless steel mesh, slotted brass or plastic pipe, or wire wrapped on rods to form a screen. Well points generally range in size from 2 to 4 inches in diameter and 15 to 25 feet in length, and are constructed with either closed ends or self-jetting tips, with optional filter attachments. A wellpoint pump is a combined vacuum and centrifugal pump which is connected to the header and pumps water from the well points. Generally, a stage of well points would be capable of draining a deposit about 16 feet thick. Draining a deposit that is greater than 16 feet thick generally requires a multi-stage installation of well points or use of a deep well with turbine or submersible pump.

The efficiency of both conventional and vacuum well point recovery systems is limited by the soil and waste deposit hydraulic conductivities. With a low hydraulic conductivity, the pumping period required for recovery of treatment solution may exceed the time frame established to accomplish the remediation of the waste deposit. Under these conditions, the well spacing may also have to be very close, resulting in an unacceptable capital and operating cost. This is a technically feasible recovery system and will be discussed further in the next section.

2.1.3 TREATMENT

Soil or sediments may be excavated and subsequently treated by one of the selected technologies described below.

- Incineration
- Solidification/Fixation
- Metal Immobilization
- Soil Wash
- Biodegradation

These technologies apply to the excavation of the soils in Chestnut Branch marsh and dredging of the sediments in Rabbit Run, Chestnut Branch, and Alcyon Lake. Prior to discussing the application of these technologies, the feasibility of excavation, dredging, and soil staging will be discussed since the treatment technologies are only applicable after soil or sediments have been removed.

Excavation

Conventional removal of the contaminated soil with earth moving equipment such as bulldozers, backhoes, front-end loaders, and scrapers is technically feasible for this project. Techniques for removing contaminated soils by conventional excavation have been proven at other sites such as Krysowaty Farms in Hillsborough and the D'Imperio site in Hamilton Township, New Jersey.

There are a number of activities that must be performed prior to and as part of any excavation and removal activities in the marsh area of the LiPari Landfill.

- Collection of all appropriate permits needed for excavation in the marsh area.
- Construction of gravel access roads to and from the affected area.
- Implementation of volatile emission controls to minimize releases and protect worker safety and the general public.
- Dust and surface runoff control.
- Turbidity control.
- Clearing and grubbing of the vegetation to alleviate the difficulty of excavation.
- Dewatering of the marsh area (french drains, pumping wells).
- Design and construction of site operating and staging areas.
- Excavation of the marsh area.
- Stockpiling or containerization and transportation of the excavated material.
- Replacing soils and revegetation of the marsh area.

All of the activities listed above are critical to achieving a successful excavation and removal operation in the marsh area. Figure 1-23 in section 1.0 illustrated the topography in this area. The slope is level below the 92-foot MSL, but increases sharply above it. The complete removal alternative will be difficult to implement in the LiPari Landfill marsh area because of the steep terrain and the instability of the ground surface. However, use can be made of all terrain vehicles or track-mounted excavation equipment in order to perform the complete removal alternative in the marsh area. The maximum volume of excavation in the marsh area is 71,500 cubic yards, assuming excavation down to the Kirkwood Clay. While this is a major excavation and removal activity, it is nonetheless technically feasible and will be considered for environmental/public health screening.

Dredging

The removal of contaminated sediments in Alcyon Lake, Chestnut Branch and Rabbit Run will require two different dredging approaches consisting of mechanical and hydraulic dredging. Both approaches are commonly used to dredge lakes in New Jersey (Parrish and Pimentell, per. comm., October 28, 1987).

Mechanical dredging is a method considered for low, shallow flow areas (such as Rabbit Run) or lake bottoms with clay or firm sediment. Equipment such as backhoes, draglines or clamshells can be used to excavate areas of the stream bed where sediments are contaminated. However, because of the direct mechanical force imparted on the stream bed, sediment resuspension and, therefore, turbidity is often high. Consequently, stream dredging should include, where possible, stream diversion or turbidity control techniques to hydraulically isolate the area of sediment removal. This will not only reduce stream turbidity but will minimize the amount of dewatering that would be necessary. Turbidity can also be minimized by performing work during seasonal low flow periods.

Hydraulic dredging is a method unlike mechanical dredging, which can be used to dredge sediments from areas with appreciable flow velocity and depth such as Alcyon Lake. This type of dredging is generally performed in water bodies that can not or should not be drained because of health, environmental, or economic reasons. Sediments are removed in a liquid slurry of generally 10 to 20 percent solids by wet weight. Large debris resting on the lake bottom will result in pipe clogs. The slurries may be pumped to a floating or pontoon-supported pipeline to a dredge-material treatment/storage area. The usually barge-mounted, diesel- or electric-powered centrifugal pumps have discharge pipes in sizes from 6 to 48 inches in diameter. The low solids-to-water ratio recovery requires a comparatively larger settling dewatering area than mechanical dredging. The dewatering can be alternately performed by using a mobile filter press or a centrifuge to separate the solids from the liquids to minimize the amount of liquid in the dredged material. The area required for dewatering is less than that required for dewatering by use of a sediment basin. The filtrate or any other pretreatment water can be treated onsite before discharge.

Hydraulically dredging Alcyon Lake to remove the muck would mean the removal of approximately 140,000 cubic yards of contaminated sediment. This dredging process is a major effort and alone generates high turbidity, thus requiring turbidity control techniques. Silt barriers can be installed in down-flow locations. The barriers consist of low-permeability floating barriers that extend vertically from the surface water to a specified depth. However, they are only recommended for flow velocities that are 1.5 feet per second or less. The flow velocities in Alcyon are generally less than 1 foot per second. The silt barrier can be used to trap the silt in the vicinity of a generally small area for later collection. However, the silt barriers are not completely effective in trapping clay size particles, therefore, some turbidity could still exist. Minimizing flow over the spillway would help ensure that suspended particles are not transported downstream. This could be achieved by raising the weir or lowering the water level in the lake during dredging operations.

Lake dredging can also be performed after draining the lake to minimize turbidity and resuspension of the contaminants. The lake can be drained by diverting the stream flow to remove lake sediments. Stream flow diversion for sediment removal can be accomplished by using two cofferdams and a diversion channel, using a single cofferdam and directing the flow around it or providing a drainage pipe with a pump to adjust flow velocity during a period of increased flow due to rainstorms. Any type of stream flow diversion has to be designed to account for a 100-year flood unless a waiver is given because of the interim need for diversion. Stream diversion and draining of Alcyon Lake would allow for mechanical dredging of the bottom sediments. This technology produces a lower water content in the dredged sediments than hydraulic dredging, eliminating interim turbidity problems. However, the use of a mobile filter press or centrifuge prior to disposal will still be required since lake sediments will still have a large percentage of water. Draining the lake will generate odors from decomposing organic matter on the bottom of Alcyon Lake.

In summary, dredging of the contaminated sediments in Alcyon Lake, Chestnut Branch and Rabbit Run, using either mechanical or hydraulic dredging constitutes a major effort but is technically feasible. This technology will be retained for further screening.

Soil Staging

To remediate the offsite LiPari Landfill site, it may be necessary to remove the contaminated soil to a nearby soil staging area prior to treatment. This area would be designed to comply with RCRA regulations regarding temporary waste piles (40 CFR, Part 264, subpart L). These regulations call for the installation of a double synthetic liner and a double leachate collection system for any waste piles that are placed on clean soil. In addition, if the piles are in contact with the water table, a ground water monitoring system must also be established. Temporary waste piles also require a decontamination area for vehicles leaving the site as well as runoff and run-on protection and a wind abatement control system.

Incineration

High temperature thermal treatment is one of the remediation technologies (CDM, 1987). The process of incinerating hazardous waste involves oxidizing toxic organic chemical compounds at temperatures approaching 2,200 °F thereby reducing them to innocuous substances such as carbon dioxide, water, and inorganic ash. Generally, incineration results in substantial volume reduction of the bulk feed stream, but when treating soil virtually no volume reduction occurs. The process generates an ash by-product. Metals will be oxidized during the incineration process. Metal ash byproduct will still require separate handling and treatment for final disposal. Incineration may be applicable to the marsh soil. Rabbit Run has BCEE in the sediments but the levels and the volume may be too low to consider incineration as a practical option. Alcyon Lake also contains volatile organics at relatively low concentrations.

There are several factors that affect the suitability of a waste for treatment by incineration, as well as the method of incineration. These factors include BTU content, viscosity, water content, halogen content, and ash content. High water content reduces the heating value of the soil, as would be the case if the marsh soils were incinerated. A maximum water value may be specified. Contaminated soils from the marsh would, in some cases, require dewatering prior to incineration.

Incineration is a feasible technology for the treatment of hazardous materials. The operational temperature of the incinerator unit will be governed by the temperature necessary to destroy PCBs and its combustion products which by law is a minimum of 2,200 °F. PCBs have not been detected in any of the LiPari Landfill samples onsite or offsite. One setback of incineration is its inability to treat inorganics. Theoretically metals could be segregated from the ash if the organics and target metals were selectively volatilized by raising the temperature above what is required just to burn the organics and electro-statically collecting the metal particles. However, as yet the technology has not been piloted, and thus selective metal collection is not considered a demonstrated technology. Technologies such as stabilization/fixation may be required to treat the inorganic content in the ash product before it will meet landfill requirements. The most concentrated organics in marsh soil are ethylbenzene, xylenes, and BCEE. The organics of concern in the marsh area are all relatively volatile. They can be treated by volatilization technologies that would be equally effective and more readily implemented. Consequently, incineration will not be retained for further screening in the feasibility study.

Enhanced Volatilization

Enhanced volatilization can be accomplished through thermal treatment or mechanical aeration on soils that have been excavated. The objectives are the same as those described for in situ treatment by enhanced volatilization.

Thermal Treatment. The direct heat rotary dryer is a well proven thermal treatment unit and has been used for many years by the asphalt industry. The dryer commonly operates on a continuous basis and consists of a cylindrical shell, slightly inclined to the horizontal, through which the preheated gas flows in a direction countercurrent or concurrent to the flow of the product. The rotary kiln dryer operates at a temperature of about 315.5° C (600° F). This process will be generally effective for the volatile and semi-volatile contaminants of concern. However, other compounds including PAHs and pesticides would also be treatable. The volatilization efficiency of a specific compound with respect to a treatment unit increases as its boiling point is approached. However, it is not a prerequisite for treatment but rather it is more relative to the retention time required to achieved volatilization. At 315.5°C, the boiling point of compounds such as chloroform (61.2°C), BCEE (178.5°C), chlordane (175°C) and benzo(a)pyrene (312°C) has been exceeded. Additionally, at the proposed operating temperatures other compounds such as PAHs whose boiling point exceeds the treatment temperature would be treatable. The volatilized compounds could be captured in an afterburner or trapped in an activated carbon filter. There are some variations on the thermal treatment unit design involving heat exchange, and treatment of volatilized organic compounds by thermal combustion or granular activated carbon adsorption.

A thermal treatment process was successfully piloted at the McKin Superfund site in Gray, Maine (Webster 1986) and as part of a pilot-scale demonstration project by the U.S. Army Toxic and Hazardous Materials Agency (Noland et al 1986). The pilot study results indicated volatile organics were successfully reduced to nondetectable levels.

Mechanical Aeration. This treatment process has been demonstrated to enhance the removal of volatile organic contaminants from soils. Excavation of contaminated soils followed by the land separating and mechanical agitation of the soil with machinery similar to a rototiller is the simplest approach. Mechanical aeration is most effective when used on dry granular soils. Moist soils and soils with high clay content are not as easily treated because volatilization may be hampered. The marsh soils are primarily saturated silts and clays, therefore even after dewatering mechanical aeration may be impeded by the soil texture. Also, this treatment process is most effective in less humid areas.

Both treatment processes may require air treatment to meet State or Federal air emission regulations. Off-gas control would be difficult during mechanical aeration, but could be accomplished with a thermal treatment unit by treating off-gases by vapor-phase activated carbon. Both these processes should treat all the volatiles and semivolatiles of concern that have been detected. Enhanced volatilization is a demonstrated technology that is readily implemented, and less restricted by institutional requirements than incineration. Thermal treatment is retained in preference of mechanical treatment because it would be more reliable in assuring complete volatilization of organics. Consequently, thermal-enhanced volatilization technologies will be retained for further screening in this feasibility study. Treatment by mechanical aeration will no longer be retained in this feasibility study.

Cement/Lime-Based Fixative

Contaminated soils may be mixed with a suitable concentration of the solidifying substance to form a non-leachable, monolithic material that can be stacked for storage or encapsulated in a landfill. As previously discussed in the section on in situ treatment technologies, cement/lime-based fixatives stabilize metals, but not organics such as those readily volatile and water transportable organics of concern from the landfill. However, even if the organics were removed by thermal treatment, the soil and sediments passed the RCRA EP-toxicity leachability test; therefore, treatment to reduce leachability is not considered to be necessary. The metal contamination is best addressed by encapsulating soil or sediment so that they are not in contact with the environment or in the case of arsenic not available for ingestion.

Vitrification

Vitrification was also considered as a post-excavation technology. The technology, as discussed in the section on in situ treatment, may also be used to vitrify soils contaminated with organics or metals. The process is intended to convert the soil and contaminants present into a chemically inert glass-like matrix, which eliminates the potential of leaching. However, the process will result in the emission of organics although these emissions can be captured and thermally treated. In this case, the organics of concern are highly volatile thus the vitrification process would retain only the metals in the vitrified mass. Thermal treatment with a rotary dryer has been retained as a treatment option for removal of the organics. Treatment by vitrification, therefore is a more complex process that virtually guarantees no leaching of metals, as well as treatment of the soils. However, thermal treatment is a more proven and reliable technology to treat organics. The treated soils could be encapsulated in a separately constructed landfill or replaced over the marsh and capped.

Soil Washing

The process consists of a mobile unit that can extract various contaminants from excavated soils on site. Basically, contaminated soil is vigorously mixed with an extraction agent in solution. The absorbed contaminants solubilize into the surrounding solution. The "clean" soil is separated from the solution, dried, and removed for disposal. The wash solution, saturated with contaminants, must undergo chemical-specific treatment prior to discharge. The process does not result in the destruction of the waste; rather, it concentrates and reduces the volume of the contaminants and produces a reusable soil product.

A number of extraction agents have been proposed and experimented with, however, ethylenediaminetetracidic acid (EDTA), a powerful chelating agent has received the greatest attention and most field testing. Although EDTA treatment of soil contaminated with heavy metals theoretically appears promising, the current level of knowledge does not provide sufficient information to accurately estimate process capabilities and limitations, reagent quantities, and equipment dimensions. It is not known how effective EDTA is at removing metals that are less soluble than lead (such as mercury and arsenic).

A strong acid, such as sulfuric acid would be required to solubilize the metals absorbed onto the soil particles. There is limited data available regarding the quantity or concentration of acid needed to solubilize metals under different conditions. The spent acid would create additional disposal difficulties and require a separate storage system. This system is potentially effective but would require considerable piloting to determine optimal operating conditions such as acid concentration, retention time, and subsequent method recovery from the solution.

The removal of organics from soil may similarly be removed by soil washing, except that the washing solution would consist of water or water with additions, such as surfactants, which would concentrate the organic contaminants, similar to the metals soil washing process. The removal of organics at low concentrations such as those in the offsite area, have not been piloted to determine the effectiveness of such decontamination systems on a large scale. This alternative will not be retained for further screening in this feasibility study because the effectiveness of this system cannot be determined, the reliability of the unit is unknown, and the availability of the unit is limited.

Bioreclamation

Land treatment is a technique which uses microorganisms naturally occurring in the soil to biodegrade organic waste. The land is plowed periodically to increase oxygen needed by the microorganisms to effectively biodegrade the waste. The technique is also known as land spreading, sludge farming, and solid incorporation. The advantages of implementing land treatment are listed below.

- Minimum energy is required to dispose of the waste;
- The process is relatively odorless;
- The application of waste can be repeated safely at frequent intervals.

Although the land farming of certain oily waste and some organic sludges is acceptable as a waste management technology, this technology has not been applied to most hazardous waste and is certainly not applicable for highly persistent, toxic waste, and waste containing high concentrations of heavy metals. If applied to the offsite LiPari Landfill areas most of the organics would eventually be decomposed but the inorganics would remain in the waste and soil. Consequently, the use of this technology will require a compromise, since organics would be treated in preference of metals. Cold to cool temperatures will minimize the effectiveness of the microorganisms resulting in a reduced time frame in which the process will occur or requiring supplemental heat to regulate the temperature. Treatment by volatilization is a technology that has been retained and potentially provides equivalent or better results. Because of the uncertainty involved in implementing this technology for hazardous waste, and the potentially better performance results of the other technologies, this technology will not be retained for further screening.

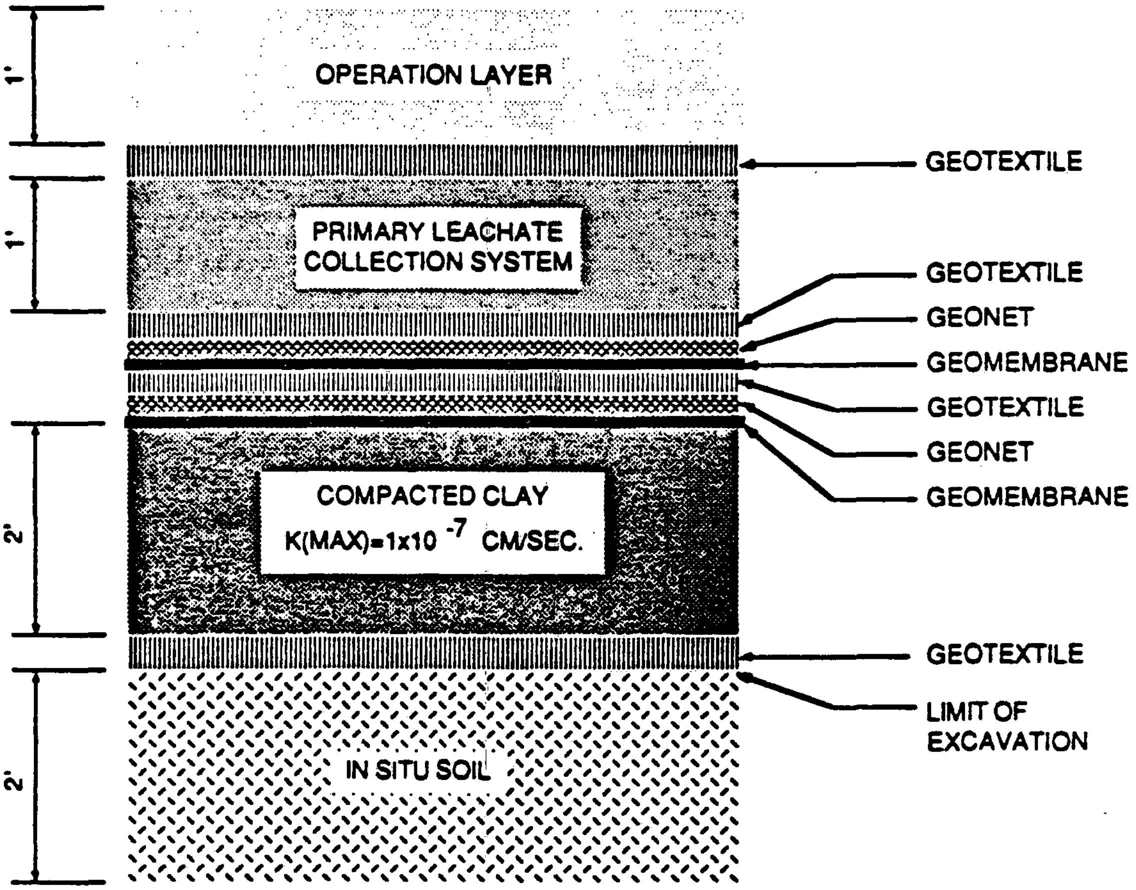
2.1.4 CONSTRUCT NEW LANDFILL FOR DISPOSAL

Two onsite disposal options were considered for disposal of contaminated soil (or sediment): disposal at a newly constructed landfill and disposal on top of the existing LiPari Landfill.

Construct Landfill

This option requires that a secured landfill meeting RCRA and state requirements be constructed to contain the contaminated soil or sediment. The organic contaminated soils could be disposed with or without prior thermal treatment. As mandated by 40 CFR 264 subpart N, the landfill must

- be constructed on a liner of natural or synthetic material that is designed, constructed and installed to prevent any migration of wastes out of the landfill into the adjacent subsurface soil, ground water, or surface water (see figure 2-9)
- be constructed entirely above the seasonal high water table
- contain a leachate collection and removal system
- be protected by an impermeable cover to provide long-term minimization of migration of liquids through the closed landfill
- include maintenance and monitoring systems throughout the postclosure period or design life of the landfill



CDM

environmental engineers, scientists, planners & management consultants

Figure 2-9

Landfill Liner System Detail

LaPari Landfill - Gloucester County, New Jersey

Construction of a landfill designed to meet Federal and State requirements is technically feasible and thus will be retained for further consideration. The design and construction of a landfill is considered technically feasible. Institutional considerations in acquiring a land parcel to construct the landfill will determine whether or not this alternative can actually be implemented.

Construct Over Existing Landfill

Disposal and encapsulation at the already existing landfill of contaminated soil or sediment resulting from the offsite excavation was considered. This alternative involves the design and construction of a RCRA-type landfill facility on top of the already existing landfill facility. The existing landfill has already been encapsulated and the placement of the additional material would greatly diminish the integrity of the cap. Furthermore, it is not feasible to build a leachate drainage system to meet RCRA design specifications. The existing landfill will continue to undergo differential settling. The required liner for the leachate drainage system would experience differential settlement; therefore, the system could not be guaranteed to function properly. This option is not considered to be technically feasible and will therefore not be considered further.

2.1.5 DISPOSAL AT EXISTING RCRA FACILITY

Soils and sediments may be excavated (as discussed in section 2.1.3) and then transported to a staging area where they would be dewatered, stockpiled, and/or containerized for transport to RCRA approved offsite treatment, storage, and disposal (TSD) facility. Containerization of the soil sediments may be preceeded by a solidification/fixation process to minimize any potential hazards that may be associated with the transportation of wet contaminated sediments. The above-mentioned technologies will not only minimize the potential hazards but in some cases may be necessary for the TSD facility to accept the contaminated soil/sediments. All necessary manifests for the hazardous cargo would be approved before shipping. All vehicles leaving the site would be decontaminated to avoid spreading of contamination to the public or environment along the route of travel to the

TSD facility. Offsite disposal of the contaminated soil sediments would be at one of the following RCRA permitted disposal facilities:

GSX Service, Inc., Pinewood, South Carolina
Chemical Waste Management, Model City, New York
Fondessy Landfill, Toledo, Ohio
Wayne Disposal Site, Wayne, Michigan
Chemical Waste Management, Emmele, Alabama
SCA Chemical Services, Inc., Fort Wayne, Indiana
Chemical Waste Management, Adams, Indiana

Waste profiles consisting of analysis for RCRA parameters, including testing for TCLP and possibly PCBs, cyanide, dioxin, sulfides, phenols, pH, and color, would be required before permitted facilities would accept the waste. It is important to note that the soils and sediments in the offsite area passed the EP-tox method test: PCBs and dioxins were not detected.

Three modes of transportation -- truck, rail, and -- barge are available for shipment of contaminated soil to a suitable RCRA-permitted facility. Access to major transportation is good because of the area's proximity to the Philadelphia and New York metropolitan centers, whose highways, railroads, and shipping ports provide connections with with major routes across the country.

Trucking may be the most desirable option for carrying soil or sediment directly to a RCRA disposal facility. Other shipment means will require transport to a loading/unloading transfer station for subsequent shipments by rail or barge, thus involving more safety and handling concerns.

The excavated materials would be placed on trucks with a 20 to 25 cubic yard capacity for shipment to an approved RCRA facility for ultimate disposal. Transporting of the contaminated soils would be in compliance with all State and Federal regulations governing the transportation of hazardous waste. The technology exists to excavate and transport contaminated soils to an offsite TDS facility, therefore it will be retained for further screening.

2.1.6 DISPOSAL AS A NON-HAZARDOUS MATERIAL

Soils and sediments may be excavated, dewatered and treated to a level where they would be eligible for consideration as a non-hazardous material. Present EPA policy indicates that material generated from remedial actions at Superfund sites should be handled as a RCRA waste and disposed of at a RCRA permitted facility. However, mechanisms exist such as the EP-toxicity test and formal RCRA delisting, for classifying materials as non-hazardous. Once classified as non-hazardous material could then be disposed of as fill material.

Three offsite locations were evaluated as potential disposal options for non-hazardous fill. These locations are Alcyon Racetrack, the Gloucester County Municipal Landfill and Montgomery County Sanitary Landfill in Montgomery County Pennsylvania. Additionally, placement of material on top of the existing Lipari Landfill was evaluated. The costs associated with each option is discussed separately. The availability of each location for placement of fill is uncertain. Institutional considerations exist for using Alcyon Racetrack including procurement of the land by EPA, the State of New Jersey or the Borough of Pitman from the present owner. It would be necessary to demonstrate to the community that thermal treatment is an effective process and that residual metals do not present an environmental or public health concern. The level of metals present in the lake sediments and marsh soils are indicative of U.S. and New Jersey background conditions, meet ECRA guidelines for soil cleanup, and are below present guideline levels for sludge disposal on land. EP-toxicity testing and/or TCLP testing should be provided on treated material prior to land application to ensure that no leachability characteristics are present. Furthermore grading of the racetrack, a cover of top soil and seeding would be required to prevent erosion.

Disposal of non-hazardous material at either the Gloucester County or Montgomery County landfills, is uncertain. Landfill space in the New Jersey area is considered a scarce resource. Disposal of material at either site would compete with other demands on a limited resource. The technology exists to excavate, dewater and treat the soils and sediments. Processes exist to determine if the treated material is non-hazardous. The technology exists to dispose of non-hazardous materials, therefore it will be retained for further screening.

Another option for disposal as a non-hazardous material would be to place the material on top of the existing LiPari Landfill site. Section. 2.1.4 discussed the technical difficulties that would be encountered in construction of a RCRA TSD facility on top of the existing site. Material that was non-hazardous would not require such stringent measures as a leachate collection system and double liners.

The material could be placed as fill on top of the existing site. Consideration would have to be given regarding impacts on the construction and/or operation of the onsite facility. It is likely that onsite operations would be interrupted by onsite disposal of lake, stream, and marsh materials. Furthermore EPA has maintained that if flushing does not achieve desired cleanup goals and/or further action upon completion of flushing is desired, additional actions would be undertaken. Under SARA remedial actions must be evaluated every 5 years for effectiveness. The presence of material on top of the existing containment system may hinder future efforts. While this option has drawbacks, it will be considered for further evaluation.

2.1.7 GROUND WATER MEDIA RESPONSE TECHNOLOGIES

Offsite Collection System

Seepage from the LiPari Landfill containment site passes through the northeastern section of the slurry wall into the marsh. The rate of seepage is determined by the difference in hydraulic head across the slurry wall and by the resistance of the wall. During the proposed batch flushing, the hydraulic head will be changing continuously, causing the seepage rate to vary. Seepage rates through the slurry wall, were estimated in the offsite remedial investigation phase II report (CDM 1987) for varying interior heads. In addition to the relatively short-term changes in flow rate, the concentration of the contaminants in the seepage should decrease with time as flushing cleanses the containment site.

The seepage from the landfill would be collected by an offsite collection system. The construction of an offsite collection system will involve the use of a passive collection system or pumping wells, as discussed in section 2.1.1, and of recovery technologies, as discussed in section 2.1.2. The location for the offsite collection system should consider the distance to the slurry wall that will optimize leachate collection without impacting the wall's structural integrity. It is assumed that leachate will contain contaminants in levels as high as those observed in the offsite ground water wells. The seepage must be collected and ultimately discharged to the onsite treatment facility currently under design.

2.1.8 KIRKWOOD GROUND WATER RECOVERY SYSTEM

Ground water pumping is most effective when the hydraulic conductivity of the aquifer is high. As was discussed in section 2.1.1 (Onsite Source Control and Containment), water table adjustment involves continuous pumping and subsequent onsite treatment of the contaminated water. By adjusting the pumping rate so that the cones of depression of each well overlap, the ground water can be collected for treatment and the ground water table can be lowered to prevent further migration into clean ground or surface water. The technologies can be applied to develop a remedial action alternative to address contamination in the Kirkwood aquifer.

2.2 ENVIRONMENTAL, PUBLIC HEALTH, AND INSTITUTIONAL SCREENING OF REMEDIAL TECHNOLOGIES

Each of the technologies retained after the technical screening has been screened to identify any adverse impacts on the environment or public health that may preclude their use for remediation at the site. Alternatives that have significant adverse impacts or that do not adequately protect the environment and public health have been eliminated. A remedial alternative must adequately address all contaminant migration pathways and points of exposure. Only those alternatives that effectively contribute to the protection of public health, welfare, or the environment will pass through this screen. Technologies that are equivalent to others in terms of meeting a remediation goal but that result in more adverse public health or environmental risk will be eliminated.

2.2.1 MARSH SOIL COVER

Permeable Cover

Surface capping of the contaminated marsh soil with a permeable soil cover will eliminate the public health risk associated with the ingestion of arsenic. The release of volatile organic emissions would also be reduced. Contaminants would continue to be leached from the marsh soils by rainfall when the intensity and duration of the rain are significant enough to permit infiltration through the cap and into the marsh soil. The contaminant concentration should decrease with time as soil flushing removes the mobile constituents. This assumes that leachate seepage through the slurry wall will be controlled via the offsite collection system and that contaminated Kirkwood ground water will be prevented from recontaminating the clean fill. The ground water controls would also be necessary to avoid recontamination of the clean fill with that of the underlying contaminated soil.

If, as expected, the marsh soil contaminants continue to flush from the soil, they will continue to be discharged into surface water in Chestnut Branch and Alcyon Lake. A ground water/surface water recovery system could be constructed downgradient (or radially) of the flow to prevent discharge into surface waters. The recovery system could be designed to operate in conjunction with the offsite collection system. Contaminated water collected in the recovery system would be transported for treatment in the onsite treatment facility along with leachate seepage from the slurry wall. Whether the contaminated water will be recovered for treatment will depend on the anticipated concentration and time frame of the discharge. The contaminant discharge is expected to decrease with time. At this time, however, and in the absence of soil leachability data, the time frame for operating a recovery system can not be estimated.

Recontamination of the clean soil used as a permeable cover should not occur via contaminated ground water if the operation of the offsite collection system considerably lowers the heads. It is possible that even with ground water controls to preclude recontamination of the clean fill some soil may be recontaminated by organics wicking to the surface. The organic contaminants in Chestnut Branch marsh are subject to wicking since they are relatively mobile, while the metals are not. The metals should remain strongly sorbed to the soil and thus will not readily migrate to the surface. However, the wicking effect may be minimized or eliminated altogether by using a sandy soil layer as part of the permeable cover.

The no action risk assessment predicted that all organics of concern except BCEE would volatilize from the surface in approximately 3 to 4 days, whereas BCEE would volatilize in a few months. This prediction was based on a complete cut-off of the source to the seepage areas, and no migration of existing subsurface contaminants. The placement of a soil cover over the marsh would decrease the rate of volatilization. The concentrations of the organics would be reduced both by flushing and volatilization, although, as stated, the cover will prevent a significant degree of volatilization. Public health risks associated with inhalation of the organics are expected to be significantly less than presently exist. Nonetheless, air monitoring is recommended until the contaminants are reduced to an acceptable level.

In constructing the cover, permits will be required for the construction of an access road and for surface grubbing and excavation of the vegetation. The marsh vegetation and debris would be disposed at a hazardous waste RCRA-facility, unless the State grants an exemption allowing disposal at a municipal facility. The earth-moving activities will disturb surface soils and contribute to enhanced volatilization of existing organic contaminants. These activities will also generate some particulate dust, although this will probably be minimal because the inherently damp nature of the marsh soil will serve to minimize it. The disturbance of the contaminated soil will temporarily increase the public health risk to residents and workers. Therefore, air monitoring will be required to assess air quality, and personal protection will be required to minimize exposure to volatile organics (as well as organics and metals retained on fugitive dust particles). Health and safety procedures should follow standard practices to protect workers in accordance with CERCLA Section III (c) (6) as well as those regulations provided in the Occupational Safety and Health Administration (OSHA) and the National Institute of Occupational Safety and Health (NIOSH) on appropriate equipment and clothing.

To minimize erosion, the permeable soil cover will require revegetation for surface runoff control. The revegetation and placement of the cover will require that most of the existing vegetation be removed. Dead trees in the marsh should be removed. Most of the short-to-medium-sized shrubs and grasses would have to be removed to effectively cover the contaminated soil, properly regrade the area to minimize future erosion, and provide proper surface water flow to prevent flooding and inappropriate sedimentation. The marsh area is expected to become drier during the operation of the offsite collection system and the pumping of the Kirkwood, should this latter option be selected. Consequently, the ecologic character of the existing marsh will change. However, once leachate collection and/or Kirkwood pumping is no longer required, the resumed water flow conditions will, over a period of several years restore the marsh.

Institutional controls and maintenance will be required to maintain the integrity of the permeable cover. Part of this control will be to limit public access to the marsh at least until the volatiles have been flushed from the soils to an acceptable level. The existing soil should not pose a long-term ingestion risk from metals since the ground cover will contain them beneath the surface. (The existing organics present in soil do not pose an ingestion risk although they do pose a risk from volatile emissions.) There are some uncertainties concerning the long-term life of the cap because of the potential for deterioration from natural weathering. However, proper design and long-term management of the marsh should result in minimal maintenance needs. Erosion of the soil cover will occur unless the permeable cover is properly maintained. Although surface capping will reduce threats to public health and the environment, this technology is institutionally less desirable since it does not meet the goals of SARA to achieve a permanent solution. However, this technology will still be retained for further evaluation because it offers a containment option as required under the remedial action objectives.

Impermeable Cover

In lieu of a permeable cover, the marsh could be covered with an impermeable geomembrane cover. The impermeable cover like the permeable cover, would be installed to prevent exposure to contaminated soils and to minimize or eliminate volatile emissions. There are advantages and disadvantages to the use of each.

Soil flushing in the marsh will be minimized by either cover since the ground water levels will be reduced during operation of the offsite collection system, but the impermeable cover still allows some flushing to occur over time. Furthermore, use of a geomembrane limits revegetation to low ground-cover plants such as grasses. (In actuality, this is really no different than what would occur should a permeable cover be used, since the low water table will preclude as wide a variety of vegetation as currently exists.)

The advantage of using a geomembrane rather than a natural permeable cover is that the former is more durable and would be more effective in preventing volatile emissions from the soil surface. The geomembrane cover would be designed with a drainage layer beneath it to divert marsh flow to the stream and thus minimize pressure against the cover during periods of flooding. This technology will be retained for further consideration.

2.2.2 LAKE SEDIMENT CAPPING

The Public Health Evaluation (PHE) indicated that the lake sediments do not have contaminant concentrations attributable to the Lipari Landfill that pose a potential public health risk. Arsenic and mercury were detected in Alcyon Lake sediments but were not detected in the background lake (Glen Lake) nor in any of the upgradient stream sediments. The maximum concentrations observed were arsenic at 67 mg/kg and mercury at 1.1 mg/kg. Notably the surface water has mercury concentrations exceeding the FWQC.

The accumulation of these metals is consistent with their fate and transport characteristics. Sediments generally remove dissolved metals and are adsorbed particularly to iron and aluminum oxides. Organisms can bioaccumulate organometallic arsenic or mercury. However, only mercury shows a propensity to biomagnify through the food chain. Because of complex multimedia exchange of arsenic and mercury in the transport cycle and the natural differences between air, soil, and water systems, it is difficult to quantify the degree of transport. We do know that the metals are sorbed by biota and sediments/soil and are maintained at low concentrations in water and air. The general flow processes are understood, but the rates of resuspension, desorption, and volatilization and the collective effects of environmental parameters controlling those rates are little understood (Woolson 1977). Only recently has the importance of transfer at the water-sediment interface become better understood (Reuber 1987). It is thought that the lack of research on sediment, compared to research on the soil-air interface, has been due to its relative inaccessibility and because there is less economic need to understand transfer occurring there. In general, sediments play a beneficial role in limiting the bioavailability of metals to the aquatic environment. However, the sediments may be capped to preclude contact or resuspension into the water column. Another option is to remove the sediments completely. This section will discuss the impacts of covering the lake sediments. The impacts of sediment removal will be discussed in a following section.

Surface capping can only be accomplished by draining Alcyon Lake. This will require that the discharge from streams and urban runoff outlets be temporarily routed to a downgradient discharge point until capping is completed. Water flow from Chestnut Branch and Girl Scout Branch would have to be diverted around Alcyon Lake in order to drain the lake. This could be accomplished by channeling or piping. The discharge outlet beyond the lake spillway would have to be protected to minimize erosion due to excess drainage at that point. Institutional concerns may arise in obtaining the easements necessary to construct the channels or pipes on private land.

The devatering of Alcyon Lake vill expose the the bottom organic muck layer to the air, precipitating the release of odors characteristic of decayed organic matter. The odors could be controlled to some extent by placing "liquid slime", a substance commonly used in sanitary landfills, to suppress the biological activity that causes the odors. The timing of this event is important; it should coincide vith a period of lov precipitation and humidity and high solar radiation. These conditions vill promote the most rapid conditions for devatering the sediment but vill also promote greater odor problems. Particle dust generated during the construction of the surface cap should be minimal because of the dampness of the sediments, vhich vould serve to suppress dust. Nonetheless air monitoring should be performed to assess the air quality.

Surface capping and stream diversion vill have environmental impacts on the aquatic life. The flora and fauna (particularly fish and benthic organisms) in the lake vould be temporarily or permanently displaced. Some of the existing aquatic organisms are expected to be fully restored by natural restocking from stream aquatic organisms, particularly those in Glen Lake and Plank Run Reservoir. Restocking of the lake vill diminish the environmental impact of this remedial action. Hovever, the topography and loss of surface vater depth due to placement of a minimum of 2 feet of surface capping vill cause greater long-term environmental damage. Alcyon Lake's existing surface vater depth is already limited. The decrease in the lake's depth vill also reduce available habitat. The vater column vill be more susceptible to fluctuations in vater temperature. The consequences of these combined changes may impact biota such that certain aquatic organisms may not survive even if they are restocked or naturally introduced. The past history of this lake indicates that the lake's depth has already been naturally reduced. A program to maintain the lake's depth should probably have been implemented some time ago to have prevented reductions in lake depth. The lake vill continue a natural progression that vill eventually result in a marsh habitat unless it is periodically dredged. Capping the lake vill greatly accelerate this process. Installing a surface cap vould preclude any consideration of future dredging since dredging operations after capping very likely destroy the integrity of the cap.

There are some uncertainties associated with the long-term life of the cap and its long term benefits. Currents in Alcyon Lake are essentially negligible with regard to potential long-term erosion of the surface cap. However, long-term maintenance of the cap would still be required. Institutional measures would be required to implement maintenance and restrict recreational uses of the lake that might degrade the cap (e.g., motor boats).

The long-term benefits of the cap are questionable since discharge of contaminants present in background sources, particularly urban runoff, will still occur. Consequently, metals (particularly lead and zinc) would continue to be discharged into Alcyon Lake, resulting in a new accumulation of metals within the lake sediments. Unless upgradient streams and urban runoff outlets contributing metals and bacteria are controlled, the problem of unacceptable water quality will recur. Consequently, the implementation of this type of remedial action is only recommended as long as a watershed management plan to control water quality is implemented simultaneously.

The PHE indicated that public health risks were not associated with the contaminated sediments in Alcyon Lake; therefore, the primary benefit associated with this remedial action is the reduced exposure to the biotic community with the contaminated sediments. However, as indicated, the primary benefits would be short-lived unless background contaminant sources are eliminated or the lake is periodically dredged of contaminated sediments.

The overall environmental impact resulting from capping the lake is adverse rather than beneficial. This technology does not meet the goals of SARA to achieve a permanent solution. Although SARA requires that a containment option be considered where it is technically feasible, the site-specific characteristics indicate that it is not technically feasible to cap the lake without raising unacceptable environmental and institutional concerns. Therefore surface capping of Alcyon Lake will not be considered further.

2.2.3 SOIL FLUSHING

Section 2.2.1 discussed the impacts in the marsh associated with placement of a marsh soil cover. One of the benefits identified in the placement of an impermeable cover is that natural flushing would still occur. This section discusses soil flushing as a treatment option. The no action risk assessment predicts that volatilization of organics would cease after three to four days for all volatile contaminants except BCEE. BCEE would volatilize after a few months. However, these are only theoretical estimates presented in the PHE and actual values may differ. The flushing rate for contaminants is not known, but, as previously discussed, they are readily mobile in water. This section reviews the impacts associated with installing an infiltration and recovery system to enhance the flushing process.

The application of enhanced soil flushing in the marsh will result in temporary public health and environmental impacts because of soil disturbances during the installation of the delivery and recovery system. Excavation of the soil to install infiltration galleries and/or french drains will lead to increased emissions of volatile organic compounds and the necessity to dispose of the contaminated soil. The soils could be regraded over the marsh soil for treatment along with the other soils in the marsh. Installation of injection and/or extraction wells would require permits from the NJDEP Division of Water Resources.

Air monitoring will be required to determine air quality, particularly since the excavation process will temporarily increase volatile emissions. Health and safety procedures should be followed as previously discussed in section 2.2.1, Permeable Cover. The use of vapor suppressing foam or other measures may be used to mitigate the release of volatiles resulting during excavation. The water extracted from the marsh will be treated in the onsite treatment facility.

The benefits of implementing enhanced flushing are that the contaminants would be more rapidly flushed than if flushing were performed by natural precipitation alone. If this option is combined with placement of a permeable cover in the marsh, then long-term public health risks would be reduced. This technology may win greater institutional acceptance if it provides greater opportunity to minimize the time associated with remediation of the marsh. This technology provides minimal advantage over natural flushing when combined with a permeable cover except for the difference in cleanup time. The incremental benefit that is provided by placement of a system to promote continuous controlled flushing is unknown. Other factors, such as biological or chemical degradation, may exert a more significant or equivalent role in cleansing the marsh. Soil flushing without a permeable cover to preclude accidental ingestion of contaminated soil would not meet the goals of SARA since it would not be protective of public health. Enhanced flushing will be retained since it provides the opportunity to expedite cleanup in the marsh.

2.2.4 EXCAVATION

The excavation of contaminated soil is required to implement soil thermal treatment, offsite disposal in a TSD facility, disposal as a non-hazardous material or onsite disposal and encapsulation in a RCRA facility. Temporary public health and environmental risks are associated with the process regardless of whether partial or complete excavation of the contaminated soil is considered.

Prior to excavation of the contaminated marsh soil, dewatering of the marsh will be required. Either a drainage system or extraction wells could be used for dewatering. Excavation will require the construction of a soil staging area to maintain the soil until it is treated or otherwise disposed. The soil staging area will have to be constructed to comply with the design criteria specified by the RCRA regulations for temporary waste piles (CFR part 264 subpart L). The waste pile requires the installation of a double synthetic liner and a double leachate collection system. Leachate from the waste pile will be treated onsite. The use of heavy equipment for excavation may require temporary fuel storage. Appropriate fuel-oil-storage spill prevention control and contingency measures will also be required in accordance with Section 311 of the Clean Water Act (40 CFR part 112).

The earth-moving activities associated with excavation and dewatering will generate particle dust and enhance volatilization of existing organic contaminants. Therefore, air monitoring to assess air quality and personal protection will be necessary to minimize worker exposure to contaminants. Environmental and public health risks may also result from increased erosion of sediments and surface runoff unless appropriate measures are implemented. Turbidity controls and careful grading of the excavation area should prevent direct contamination (due to earth-moving activities) of Chestnut Branch and Rabbit Run. However, it would be prudent to sample these areas upon completion of activities to ensure that contaminant migration did not occur as a result of activities in the marsh. The landscaping of the marsh with clean soil and new vegetation will eventually lead to the restoration of the wetland environment.

Complete excavation of contaminated soil will meet the goals of SARA for a permanent solution. Partial excavation will partly meet the goals of SARA. Partial excavation would be designed to preclude public health risks. Some contaminants would still remain but presumably, would not pose a risk. However, the remedy cannot be considered altogether desirable if the soil is disposed in another site, where problems may arise in the future. Disposal with or without treatment is being considered. Treatment options were retained for the organic contaminated soil. The technology screening did not consider metals to be treatable because they are at relatively low concentrations and apparently not readily leachable as demonstrated by the EP-tox test. They would therefore be disposed without specific treatment for metals.

Excavation will be retained, particularly since it is required to implement other treatment and disposal alternatives that are institutionally necessary to meet SARA goals. Complete excavation and offsite disposal at a TSD facility offers the possibility of a permanent solution, and since this is a required goal under the remedial action objectives, it will be retained for this reason as well.

2.2.5 DREDGING

The removal and disposal of the contaminated sediment from the bottom of Alcyon Lake, Chestnut Branch and Rabbit Run will address concerns regarding potential adverse environmental impacts. Compounds found in the sediments that are attributable to the LiPari Landfill were not found to pose a public health risk; therefore, their removal would not be required based solely on potential adverse public health risks. Potential disposal options will be discussed separately.

Dredging will result in temporary public health and environmental impacts. Hydraulic dredging without draining the lake will cause resuspension of sediments leading to increased turbidity and, possibly, particle-borne or water-soluble contamination. Hydraulic dredging can be performed carefully enough that the disturbance it creates will be minimal. The amount of suspended particles would be rather limited, and generally would not impact more than 10 to 15 feet away from the disturbance point before particles settle. The aquatic life in Alcyon Lake and in the downstream waters would be minimally impacted.

The environmental impacts and institutional constraints will be much greater if the lake is drained so that mechanical dredging can be performed. Draining the lake would completely eliminate the surface water biota. Benthic biota would be impacted due to the dredging process regardless of which option is chosen. Although the impact on the biota may not be a permanent or long-term event, it is much more severe than that caused by increasing surface water turbidity alone (as would occur by hydraulic dredging).

As discussed in section 2.2.2, Lake Sediment Capping, there are institutional concerns regarding the ability to obtain the easements necessary to construct the channels or pipes on private land to divert stream water in order to drain the lake. In addition, draining the lake would expose the bottom sediments and generate odors. While these odors could be suppressed by timing the event so that it occurs under conditions that are less favorable for generating odors, climatic conditions cannot be easily incorporated into a field construction schedule.

Consequently, hydraulic dredging will be retained over mechanical dredging since the former does not require draining the lake. Draining the lake has many more adverse environmental impacts and institutional constraints than dredging without draining the lake.

Dredged sediments will have a high percentage of water, thus they will require dewatering before treatment and/or final disposal. The dewatering area's design should incorporate runoff control measures to prevent migration of sediments prior to disposal. The filtrate can be treated onsite and discharged into the GCUA trunkline, eliminating any hazards related to the removed water. Handling the sediment may present workers with minimal public health risks. While there are volatile organics associated with the sediments, they are present at low concentrations, thus respiratory protection may be necessary only to prevent dust-particle exposure, although this should not be a great concern since the wet soils will release little or no dust. Compounds such as PAHs, chlordane, and DDT and its metabolites were also detected in the sediments, therefore, health and safety for them should also be considered. Protective clothing and air monitoring will be incorporated into the dredging activity. Institutional controls to limit access to Alcyon Lake, Chestnut Branch, Rabbit Run, and the dewatering and/or treatment area will also be necessary. Odors generated by exposed surface sediments will require the use of odor-suppression technology. Removal and/or treatment of contaminated sediments will meet SARA's goal for a permanent solution with regard to removal of contaminants potentially contributed to the lake by the leachate from the LiPari Landfill. As previously discussed, the problem will recur unless watershed management techniques are employed. Disposal of the contaminated sediments in an onsite or offsite disposal location is not, in itself, desirable if the contamination will then present a problem at the disposal site. However, the sediments passed the EP-toxicity test, thus indicating that they should present little or no problem in terms of future leachability. Thermal treatment for organics would further insure that this material would not pose future environmental concerns. This technology will be retained to meet the remedial action objectives of a permanent solution.

2.2.6 VOLATILIZATION

Volatilization is a predisposal treatment option for organic hazardous waste. The marsh soils and bottom sediments contain both organic and metal contaminants, but only the organics will be treated by volatilization. This will reduce the threats to the public and the environment posed by the volatile organic compounds in the marsh, but not by the arsenic. Volatilization must therefore be used in conjunction with a disposal technique that will remove the threat of the ingestion of metals or their migration to ground water. The environmental, public health, and institutional impacts identified for excavation also apply to volatilization since excavation is required to implement this alternative.

Removal of volatile organic compounds from the soils or sediments can be accomplished by thermal treatment. The release of volatile organic compounds into the air must be controlled so that the New Jersey Air Quality Control Standards are not exceeded and worker safety is assured. If thermal treatment is employed, the off-gases may be effectively controlled by use of granular carbon adsorption.

Disposal of the treated soil can be accomplished at an offsite RCRA facility or through the construction of an onsite RCRA landfill or if the material is classified as a non-hazardous waste at a municipal landfill at Alcyon Racetrack. The public health, environmental, and institutional concerns of these disposal options are discussed separately.

Volatilization does not by itself meet the goals of SARA for a permanent solution. However, its use in conjunction with a disposal option does qualify it for further evaluation as a treatment alternative; therefore it will be retained.

2.2.7 CONSTRUCT NEW LANDFILL FOR DISPOSAL

This remedial alternative involves the excavation of the contaminated soil and/or sediment for redisposal in a landfill constructed adjacent to the site in accordance with RCRA design criteria for hazardous waste landfills.

Onsite disposal in a secure landfill would preclude public exposure to contaminants. The public health, environmental, and institutional controls identified for excavation apply here. Ground water monitoring is required to assess the effectiveness of the containment system. Gas vents installed to release stress caused by the accumulation of gases such as methane may require an NJDEP air emission permit.

The design of an onsite disposal containment system will have a leachate seepage collection system as required under RCRA. The construction of another landfill will have institutional concerns related to adverse public perception regarding disposal of contaminated soil and the construction of yet another landfill in the community.

Onsite disposal may not be institutionally acceptable under the Land Ban Act. The goals of the Land Ban Act are to exclude the land disposal of hazardous waste if wastes can be treated or, at a minimum, treated to reduce their leachability. Effective November 8, 1986, and July 8, 1987, wastes identified in the Land Ban Act (solvents, dioxins, and "California List" wastes) are prohibited from disposal unless they pass the Toxicity Characteristic Leaching Procedure, which determines whether treatment is required. These waste categories should not impact the disposal of wastes from the offsite areas at either the landfill or another TSD facility. If EPA fails to set a treatment criterion (or criteria) to determine whether treatment of a particular waste category is necessary prior to land disposal by May 8, 1990, then all such wastes are prohibited from disposal except by special petition. It is not known at this time whether specific performance criteria for the treatment will also be established. However, both contaminated marsh soil and lake sediments passed the RCRA EP-toxicity test, indicating that contaminants have a low leachability potential and will most probably pose minimal or no adverse impact to ground water in the future.

Interim public health risks associated with this alternative are high and are primarily related to excavation in the marsh because of the potential for release of volatiles and exposure to contaminated sediments. The long-term impacts are considered to be low because of the low leachability of the soil and sediments. This remedial action does not meet the goals of SARA for a permanent solution; however, it does provide an alternative to offsite disposal at a RCRA facility, and, because transport to an offsite facility would not be required, the onsite containment system involves fewer risks. Therefore, this technology is being retained for detailed evaluation.

2.2.8 DISPOSAL AT AN EXISTING RCRA FACILITY

The disposal of the contaminated soil at TSD facility will result in the long-term benefit of removal of the contamination from the site. Treatment of the soil prior to containerization may be necessary, contributing to related public health and environmental risks and institutional constraints. Containerization will require careful monitoring of the soil staging area and the handling procedures in order to protect workers and to prevent offsite migration of contaminants.

All three modes of transportation of contaminated soil are acceptable from an environmental or public health perspective. Transportation of the contaminated soil is regulated by the Department of Transportation, EPA, and the State. Decontamination of the vehicles should be performed prior to their leaving the property, in order to prevent spreading of the contaminants. Risks to the public continue during transport because of the possibility of an accident. The risks associated with the handling, transportation, and final offsite TSD location must be evaluated to determine that the risks are no greater than the risks associated with retaining the wastes onsite. Public perception of this remedial alternative is likely to be positive because the contamination will be permanently removed.

The offsite TSD facility must be RCRA-permitted, meeting all RCRA standards and guidelines. As discussed in the previous section, an institutional concern is the Land Ban Act. Treatment standards or criteria to determine whether treatment of a particular waste category is necessary are not currently available for the wastes present in the offsite areas, but once they are established, they may impact the implementation of an offsite disposal alternative. Whether this alternative would meet the goals of SARA depends on the final disposition of the materials at the TSD facility. This alternative is being retained for further detailed evaluation.

2.2.9 DISPOSAL AS A NON-HAZARDOUS WASTE

Disposal of soils and sediments after excavation, dewatering, and treatment could occur in several locations. Material could be placed back into the marsh, or back into the original sediment locations. Upon meeting institutional and technical requirements discussed in earlier sections, materials could also be placed on Alcyon Race track, a municipal landfill, or on top of the existing LiPari Landfill site. All options are technically feasible, and the resources required to implement the various options exist. Any of the alternatives would be protective of the environment and public health.

Removal, dewatering and treatment for organics of marsh soils would eliminate the present environmental and public health risks associated with organic contaminants in the marsh soils. Disposal back into the marsh may be less desirable due to the presence of metal contaminants. The damp environment of the marsh may be more conducive to transport of metals than a drier environment. However, most of the metals present in the marsh soils are also present at comparable levels in background soils. Mercury is a notable exception.

Removal, dewatering and treatment for organics of sediments will eliminate present environmental risks. No public health risks were associated with the sediments. Organic contaminants associated with the LiPari Landfill have been detected in the sediments of Rabbit Run, Chestnut Branch past the spillway, and Alcyon Lake. After treatment for organics, metals present in the treated material could continue to pose an environmental risk if disposed of back into the lake and streams. Furthermore, replacing the sediments would lead to resuspension of sediments and particle migration to clean areas. Replacement would additionally diminsh the availability of the streams and lakes as a resource. Metals may again migrate from the sediments to the water column. Metals in a sediment/water interface are considered much more mobile than metals in a dry soil environment. For these reasons, replacement of sediments will no longer be considered.

Alcyon Racetrack as a disposal option is likely to be protective of human health and the environment. Removal of organics will eliminate health risks associated with organics in Chestnut Branch marsh soils. Metals in the soil and sediments would now be in a dry area elevated above the existing water table. Alcyon Racetrack is built up above the surrounding area. Engineering studies to determine the compatability of this location for an addition of soil would be required. Landfarming techniques for materials with higher metal contents exist and are in practice, along with an extensive history of proper soil practices to limit erosion and metal transport. Furthermore, metals concentrations are equivalent to background soils. Demonstration of the suitability of this area, along with further testing prior to, and after treatment will be required to demonstrate that this material will not present environmental or public health risks due to contact and mobility in the environment.

Municipal landfills exist that would be suitable disposal locations for treated material. Costs are discussed separately. Institutional considerations are the same for any municipal facility. The two were selected based on proximity to the site. Availability for space and concern over receiving treated material are likely to be major concerns for a municipal facility. Permits for transportation and disposal would be required. The availability and timeliness for acceptance of treated material cannot be determined at this time. It is possible that treated material would have to be stored prior to final disposal in a municipal landfill.

The disposal in a municipal facility would be protective of the environment. Municipal facilities are permitted and practice monitoring techniques to ensure that adverse environmental impacts do not result from the disposal of materials at the facility. While it is unlikely that treated soils and sediments would require monitoring, their presence in a municipal facility would be incorporated into the facility wide monitoring plan. This option is technically feasible and meets environmental, public health and institutional goals, therefore it will be retained for further analysis.

2.2.10 OFFSITE COLLECTION SYSTEM

Installation of an offsite collection system for any potential seepage from the onsite batch flushing is mandated by the EPA record of decision (ROD) dated September 30, 1985.

The collection system will require either a series of wells or an underground drainage system. The public health and environmental impacts and institutional concerns associated with soil disturbance caused by the installation of either of these systems were discussed in section 2.2.3, Soil Flushing. Impacts beyond those discussed are associated with the hydraulic changes that will result from installation of the offsite collection system. The drawdown required to collect leachate seepage will dry out the marsh area to such an extent that marsh vegetation will not survive. The shallow-rooted vegetation that does survive will generally consist of grasses able to tolerate less saturated soils. Deep-rooted trees will not survive. The marsh as it now exists will disappear when the offsite collection system is emplaced and in operation. The seepage collected will be treated at the onsite treatment facility before final disposal. Long-term air and ground water monitoring will be required to ensure that the collection system is capturing and containing the seepage. This monitoring will be required even before batch flushing begins. This remedial action is being retained for further detailed evaluation because it is required under the 1985 ROD and because it is required to implement several offsite remedial actions under consideration.

2.2.11 KIRKWOOD GROUND WATER RECOVERY SYSTEM

A pump and treat option for the Kirkwood Aquifer will have some impacts similar to those for the offsite collection system. Existing Kirkwood monitoring wells may be used to pump the aquifer. The drawdown caused by pumping will cause some additional seepage through the Kirkwood Clay; however, only a minor increase will occur, beyond the seepage that would have occurred without Kirkwood pumping. Another minor effect is that such pumping may further dry the marsh in areas where the Kirkwood aquifer is discharging upwards. Pumping the Kirkwood will capture contaminated ground water that would otherwise discharge into the marsh or Chestnut Branch, thus contributing to the improvement of off-site soil and surface water quality. Treating contaminated ground water will have beneficial overall impacts and there are no apparent constraints on its implementation.

2.3 COST-SCREENING

Cost may be used as a preliminary screening step when there are several technologies that have equivalent benefits in the overall remediation. None of the remedial action categories considered more than one technology that could accomplish the same end point. However, several RCRA-permitted facilities are available for offsite disposal of contaminated soil and/or sediment. Several municipal and private landills are also being considered for offsite disposal if following thermal treatment of the soil and/or sediment, it could be classified as a non-hazardous waste.

Cost screening is applicable to ascertaining the most cost-effective RCRA-approved offsite disposal facility for the contaminated soil and sediment projected for removal under the offsite treatment, storage, or disposal remedial technology for Chestnut Branch marsh, Alcyon Lake, and Rabbit Run.

Three offsite RCRA-permitted disposal facilities remain under consideration after others, which are presently unable to accept the waste, are eliminated. These facilities are Chemical Waste Management in Model City, New York; GSX Services, Inc., in Pinewood, South Carolina; and Chemical Waste Management in Emmele, Alabama. Transportation and disposal costs were based upon telephone conversations with representatives of the disposal facilities. All three facilities require a chemical waste profile prior to disposal; the profile includes RCRA parameters, PCBs, cyanide, dioxin, sulfides, and phenols, as well as physical characteristics, e.g., pH and color. GSX Services, Inc., also requires a full priority pollutant scan.

The costs of transportation and disposal of the soil and sediment for both the RCRA-permitted and the non-hazardous waste disposal facilities are presented in table 2-3.

From this table it is apparent that Chemical Waste Management's waste disposal facility in Model City, New York, is the most cost-effective RCRA-permitted facility for the disposal of contaminated soil and sediment removed from the offsite LiPari area. Because this cost advantage will persist regardless of the quantity of soil/sediment collected, both GSX Services, Inc., and Chemical Waste Management are being screened out of further consideration. Note that this does not mean that Model City is the choice. At the time of any offsite disposal, a contractor will be obtained in accordance with the Federal Acquisition Regulations. Furthermore, the non-hazardous waste disposal facilities are being retained for offsite disposal costing considerations. Any disposal site will need to be in compliance with EPA's offsite disposal policy.

2.4 SUMMARY

Summary table 2-4 is provided to explain the advantages and disadvantages of each remedial technology screened. It also references whether the remedial technology was retained after the technical, public health, and environmental screening was complete.

(lipari/7)

TABLE 2-3

UNIT COST ANALYSIS OF OFFSITE DISPOSAL FACILITIES FOR CONTAMINATED SOIL AND SEDIMENT

Cost parameter per cubic yard	RCRA-Disposal Facility			Non-hazardous Waste Disposal Facility		
	Model City, NY	Pinewood, SC	Emmele, AL	Alcyon Racetrack or Lipari Landfill	Gloucester County Municipal Landfill	Montgomery County Suburban Landfill
Transportation cost	$83	$127	$171	$4	$7	$9
Disposal cost	$147	$118	$118	0	$60	$60

(83)

TABLE 2-4

REMEDIAL TECHNOLOGIES SCREENING SUMMARY

Technology	Advantages	Disadvantages	Passed screening category	
			1*	2*
SOURCE CONTROL AND CONTAINMENT	Control migration or contain waste to prevent vertical or horizontal migration of leachate; and prevent public and environmental exposure.	Potential future deterioration source control or containment barriers.		
o Structural containment				
<u>Marsh</u>				
- impermeable surface cover	Prevents direct rain infiltration; prevent inhalation and ingestion exposure.	Minimizes natural flushing. Requires long-term maintenance and monitoring.	Yes	Yes
- permeable surface cover	Minimize inhalation and ingestion exposure; allows direct rain infiltration that enhances natural flushing.	Hydraulic controls of the ground water required where contaminants exist to minimize recontamination. Requires long-term maintenance and monitoring.	Yes	Yes
<u>Lake</u>				
- sediment capping	Reduce erosion and leaching of contaminated sediments.	Grout or sealant may impact overlying water. Coverage may be incomplete. Limited to protected bodies of water. May require prior compaction of bottom sediments.	Yes	No

TABLE 2-4
(continued)

REMEDIAL TECHNOLOGIES SCREENING SUMMARY

			Passed screening category	
Technology	Advantages	Disadvantages	1*	2*
<u>Marsh</u>				
- bottom liner	Reduce vertical migration of leachate.	Technology not feasible. Varying geology across the marsh increases difficulties involved in application of the liner.	No	No
- slurry walls	Contain waste.	Requires hydraulic controls. Most effective when keyed into natural clay bottom liner which, however, does not exist in marsh. Requires level terrain not present in marsh.	No	No
- sheet piles	Provide lowest permeability of horizontal flow barriers available when properly sealed.	Geology will not support a "hanging" wall. Depth for containment exceeds length of piles.	No	No
- grout curtains	Minimizes contaminant migration.	Rarely used in unconsolidated formations. Subject to chemical decomposition.	No	No
- synthetic membrane liners	Minimizes rain infiltration and subsequent contact with waste to reduce migration of leachate.	Difficult to incorporate into slurry wall construction. Requires complete excavation of contaminated soils.	No	No

TABLE 2-4
(continued)

REMEDIAL TECHNOLOGIES SCREENING SUMMARY

Technology	Advantages	Disadvantages	Passed screening category 1*	2*
- pumping wells offsite collection and collect seepage from marsh.	Active control of contaminant migration by lowering water table below source.	Source is not contained. Ingestion and inhalation risk still exist. Considered under other remedial action categories.	Yes	No
- subsurface drains offsite collection	Passive system to collect water down-gradient of source. Low maintenance and operation.	Source is not contained. Ingestion and inhalation risks still exist. Limited to shallow depths. Considered under other remedial action categories.	Yes	No
<u>IN SITU</u> TREATMENT				
o Solidification/Fixation				
- cement/lime-based	Suitable to reduce leachability of metals and some organics.	Must be used in conjunction with encapsulation system. Machinery not available to perform process in saturated soil and steep slope conditions.	No	No
- thermoplastics	Suitable to reduce leachability of metals and some organics.	Not suitable for volatile organics. Stabilizers also source of organic contaminants. In-situ mixing not readily controlled.	No	No

TABLE 2-4
(continued)

REMEDIAL TECHNOLOGIES SCREENING SUMMARY

Technology	Advantages	Disadvantages	Passed screening category 1*	2*
- organic polymers	Suitable to reduce leachability of metals and some organics.	Application to all organics not demonstrated. Not suitable to in-situ application due to need to regulate reactor temperatures.	No	No
- vitrification	Converts contaminants within a soil matrix into a stable immobile glass-like solid mass.	Alteration of ground water hydrology. Requires temporary structure over the processing area which is not possible in steep slopes using existing technology.	No	No
- chemical fixation	Metal immobilization can be enhanced by use of organic additives that increase sorption, ion exchange or precipitation.	Difficult to control dosage rates of additives; biodegradation of organic fixatives may render compounds leachable in the future.	No	No
o Chemical oxidation	Oxidation reactions that may detoxify, decompose, or render organics more amenable to biodegradation.	Chemical agents do not discriminate between substances. May result in production of toxic degradation products. Limited field information.	No	No
o Biodegradation	Intended to biologically degrade organics to carbon dioxide, water, and non-toxic by-products.	Not effective in removing metals. Difficult to maintain aerobic conditions in the marsh.	No	No

TABLE 2-4
(continued)

REMEDIAL TECHNOLOGIES SCREENING SUMMARY

Technology	Advantages	Disadvantages	Passed screening category 1*	2*
o Soil flushing	Accelerates leaching of water soluble contaminants under controlled conditions; decreases total quantity of contaminants suseptible to transport.	Low solubility compounds remaining after flushing may be released if environmental conditions change; efficiency decreases as decontamination proceeds; large volumes of leachate are produced requiring treatment.	Yes	Yes
o Enhanced Volatilization				
- vacuum vapor extraction	Removes volatile organics in ambient temperatures	Short-circuiting results in withdrawal of only air. Requires unsaturated conditions.	No	No
- thermal vapor extraction	Enhances volatilization of organics or their thermal decomposition	Requires vapor recovery system. Limited to pilot-scale studies. Implementability uncertain. Uneven topography limits applicability.	No	No
o Delivery and recovery technologies				
- ditches	Simple means to promote water percolation through subsurface soil.	Not suitable for steep or uneven terrain as in the marsh. Prone to clogging.	No	No
- infiltration gallery	Provide effective gravity application of water to affected area. Suitable in variable terrain.	Function similar to ditches, but less suseptible to clogging.	Yes	No

TABLE 2-4
(continued)

REMEDIAL TECHNOLOGIES SCREENING SUMMARY

Technology	Advantages	Disadvantages	Passed screening category 1*	2*
- sprinkler irrigation	Simple means to promote water infiltration over soil surface/ subsurface soil.	Water freezes in pipes. Limited by soil permeability and rate of evaporation.	Yes	Yes**
- forced delivery system	Provide effective application of water to affected area. Independent of site topography.	Must understand hydrogeology to calculate maximum injection pressures.	Yes	Yes
- open ditch	Simple means to collect and transport water.	Not suitable for steep uneven terrain.	No	No
- seepage ditch (buried drains)	Provide effective means to collect and transport water. Can be designed for a range of depths.	Greater volume of water collected in a ditch system due to lack of control associated with rainfall water.	Yes	Yes**
- well point systems	Active pumping system. More effective means of increasing withdrawal of water than drains.	Must understand hydrogeology to calculate number of wells. Limited to shallow depths and soils with moderate hydraulic conductivity.	Yes	Yes**
TREATMENT				
o Excavation	Excavate soil and treat to reduce toxicity, mobility, or volume of waste. Reduce environmental and public health risks.	Excavation and replacement of soil required. Metals will still require long-term containment. Requires volatile emission controls.	Yes	Yes

TABLE 2-4
(continued)

REMEDIAL TECHNOLOGIES SCREENING SUMMARY

Technology	Advantages	Disadvantages	Passed screening category 1*	2*
o Dredging				
- mechanical dredging	Removes contaminated sediments.	Limited to shallow, low flow areas. Must drain lake and provide firm bottom support.	Yes	No
- hydraulic dredging	Removes contaminated sediments. Can be accomplished without surface water drainage.	Low solids to water ratio requiring dewatering. Turbidity increases.	Yes	Yes
o Soil staging	Necessary as part of dredging/excavation alternative.	Increases chance of soil erosion and contaminant migration.	Yes	Yes
o Incineration	Reduces wastes to inorganic ash.	Metals require separate handling and treatment for final disposal. High water content of soils reduces heating value and may require dewatering. Will provide minimal reduction in bulk volume.	No	No
o Volatilization				
- thermal treatment	Proven technology to promote volatilization in solid media; volatiles captured for treatment.	Metals are not treated. Requires careful monitoring of VOC emissions.	Yes	Yes

TABLE 2-4
(continued)

REMEDIAL TECHNOLOGIES SCREENING SUMMARY

Technology	Advantages	Disadvantages	Passed screening category	
			1*	2*
- mechanical aeration	Proven technology to promote volatilation.	Not as effective on all organics. Hampered by wet soils. Off-gas control is difficult.	No	No
o Cement/Lime-based fixative	Form non-leachable mono-lithic material.	Not as effective on moist soils. Stabilizes metals but not organics.	No	No
o Vitrification	Converts soil and contaminants into chemically inert matrix.	Requires capture of off-gases.	No	No
o Soil Washing	Process transfers soil contaminants to a liquid phase for treatment or disposal.	Unproven technology for treatment of mixed waste. Generates large volumes of leachate for disposal or treatment.	No	No
o Bioreclamation	Minimum energy and the process is odorless. Degrades organic wastes to carbon dioxide and water.	Not applicable to wastes containing metals. Not a proven technology for all mixtures of hazardous wastes.	No	No
DISPOSAL				
- Construct landfill	Excavation and landfilling allows the opportunity to construct a secure landfill; prevent public and environmental exposure.	Institutionally difficult to implement.	Yes	Yes

TABLE 2-4
(continued)

REMEDIAL TECHNOLOGIES SCREENING SUMMARY

Technology	Advantages	Disadvantages	Passed screening category 1*	2*
- Construct over existing landfill	Excavation and landfilling allows the opportunity to construct a secure landfill; prevent public and environmental exposure.	Institutionally difficult to implement. Diminished integrity of present cap. Not possible to maintain leachate system to specifications due to differential settling.	No	No
DISPOSAL AT EXISTING RCRA FACILITY	Transfers waste source to a facility for offsite treatment, storage, or disposal; no future public health or environmental risk at the site.	Adequate TDS facility will need to be identified such that public health risks are not just displaced to another facility.	Yes	Yes
DISPOSAL AS A NON-HAZARDOUS MATERIAL	Treated materials removed from impacted areas. No future release of contaminants to the environment.	Availability of Racetrack and/or municipal landfills uncertain. Disposal on top of Lipari Landfill may impact onsite cleanup.	Yes	Yes

*Screened collectively for use under soil flushing, as well as the offsite collection and ground water recovery system technology categories.

Screening category:

* Pass 1 - Passed technical screen

* Pass 2 - Passed environmental, public health, institutional screen.

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