FEASIBILITY STUDY

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NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
Trenton, New Jersey

Final Feasibility Study Report:
REMEDIAL INVESTIGATION / FEASIBILITY STUDY
COMBE FILL SOUTH LANDFILL

January 1987

LAWLER, MATUSKY & SKELLY ENGINEERS
as Prime Contractor
in Association with
R.E. WRIGHT ASSOCIATES, INC.

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#455-106

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FINAL FEASIBILITY STUDY REPORT

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CHAPTER 1

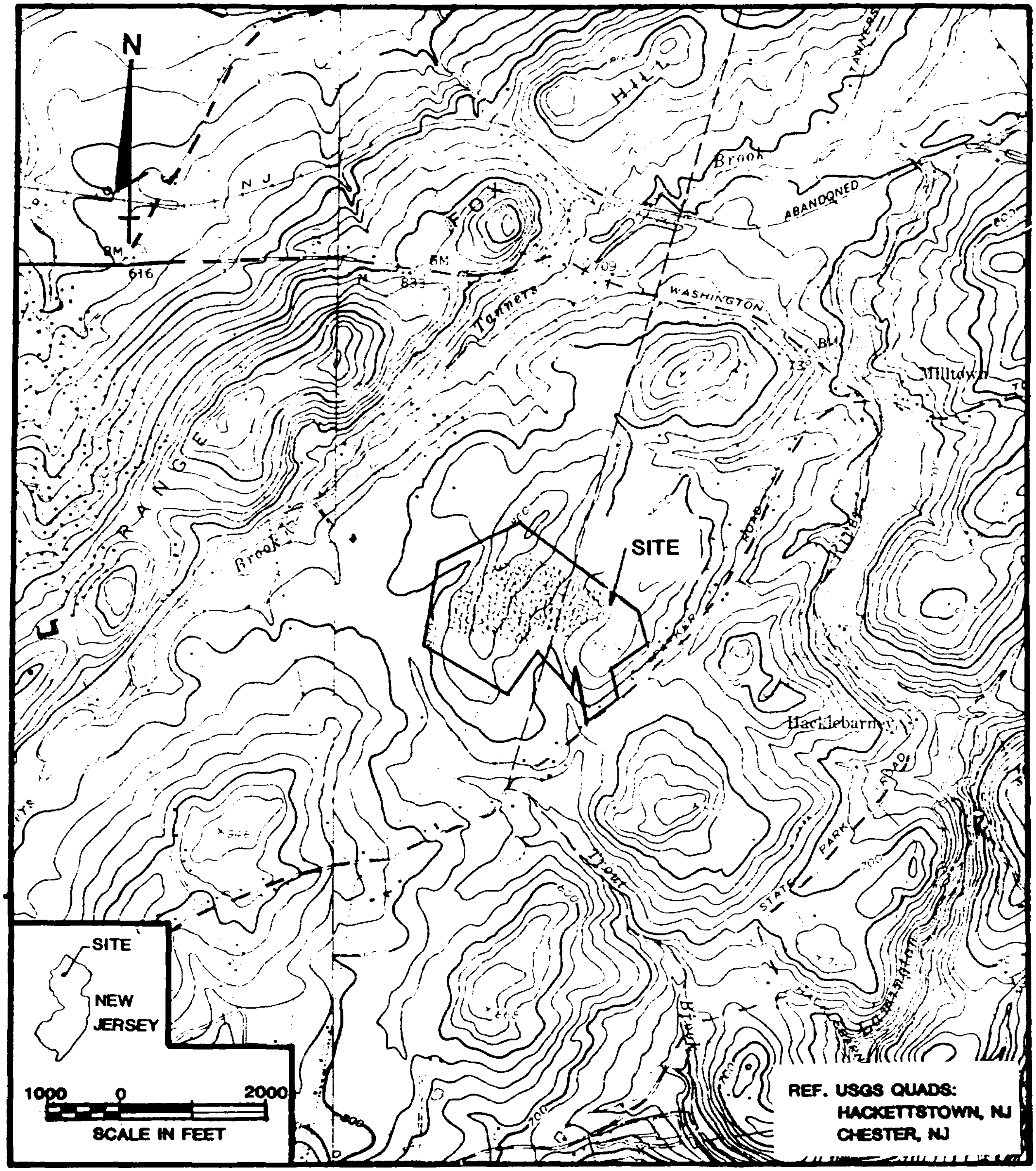
INTRODUCTION: SUMMARY OF REMEDIAL INVESTIGATION

1.1 SITE LOCATION

The Combe Fill South landfill study site is located in a semirural area of Chester and Washington townships, Morris County, NJ, approximately 20 miles west of Morristown (Figure 1-1). The inactive landfill site is located off Parker Road, about 2-1/2 miles southwest of the Borough of Chester. Of the 115-acre parcel owned by the Combe Fill Corporation, about 65 acres were actively used for the disposal of wastes. Two fields to the northwest and southeast of the landfill property, in which illegal waste disposal activities were suspected of having taken place, were also examined as part of the remedial investigation/feasibility study (RI/FS) for the Combe Fill South landfill.

1.2 SITE DESCRIPTION

The landfill is situated on a local topographic high such that surface waters drain almost radially from the site. Landfill leachate, groundwater, and surface water runoff from the southern portion of the site constitute the headwaters of the East and West branches of Trout Brook, which flows southeast toward the Lamington (known locally as Black) River. Southwest of the site, near the headwaters of the West Branch of Trout Brook, is a hardwood wetland. Much of the wetland that existed on the landfill property was cleared and possibly used for waste disposal by the landfill operator. Tanners Brook, located to the west and north of the landfill, flows northeast to its junction with the Black River. The Black River flows south through Hacklebarney State Park, about 1.5 miles southeast of the landfill, to its junction with the



COMBE FILL SOUTH LANDFILL RI/FS

GENERAL SITE LOCATION MAP

FIGURE 1-1

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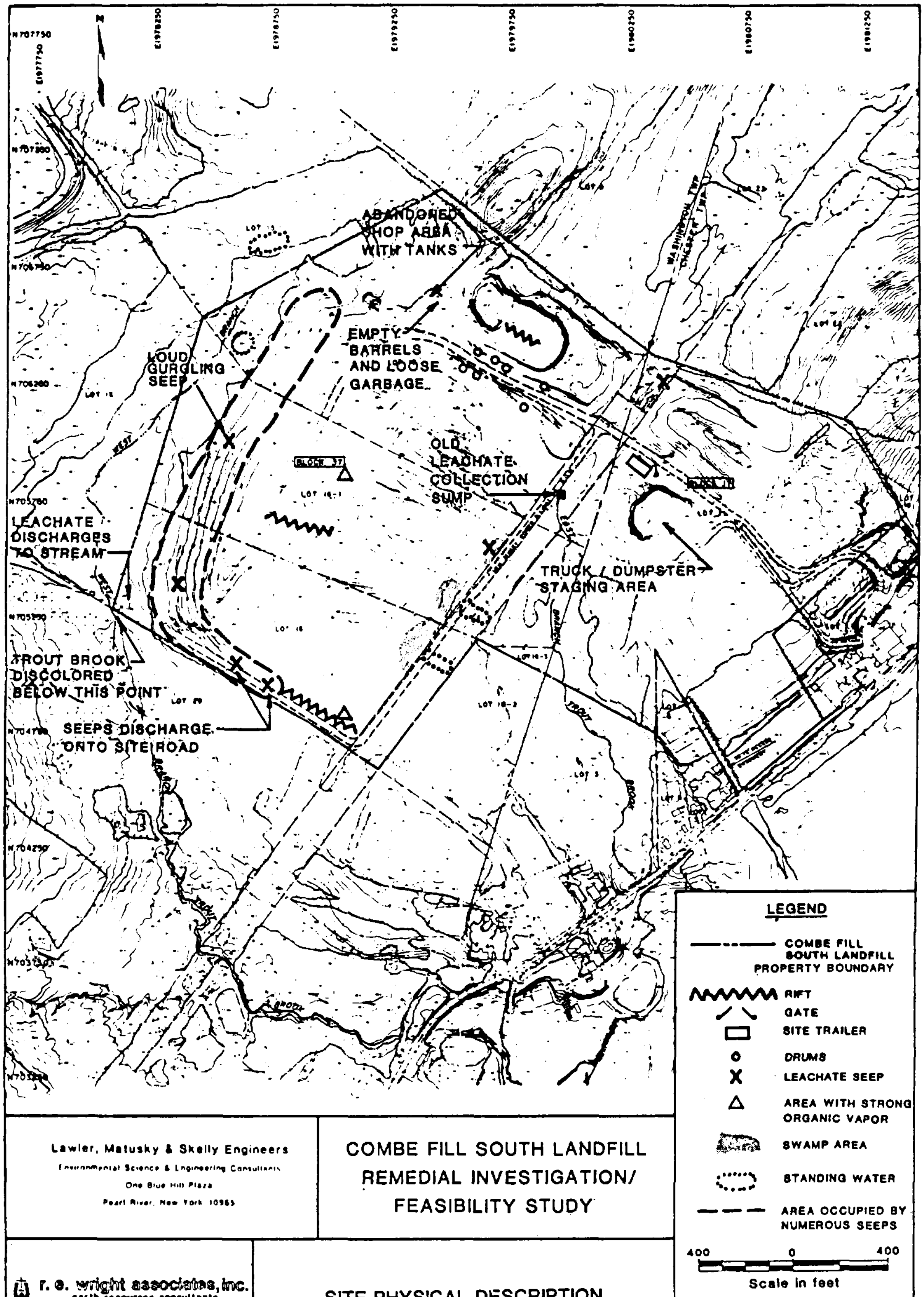
Raritan River, about 13 miles from the confluence of Trout Brook and the Black River.

The Combe Fill South landfill lies in the Piedmont Physiographic Province. The bedrock at the site is highly fractured. Natural unconsolidated deposits above bedrock are often very shallow and consist of local soils and granitic saprolite. Low permeabilities within the granite bedrock result in high groundwater levels, leaving a major portion of the waste in a saturated condition.

Access to the site is by a dirt road running primarily east-west to Parker Road (Figure 1-2). A locking gate is located about one-third of the way into the site on the dirt road. A New Jersey Power and Light Co. (NJP&L) 150-ft-wide right-of-way running primarily northeast-southwest bisects the site.

North of the east-west entrance road are older disposal and borrow areas rising steeply away from the road. The area is punctuated with rifts and leachate seeps flowing north from the site. South of the east-west dirt road, the newer landfill areas rise more gradually but exceed the height of the older fill areas. On either side of the dirt road are empty 55-gal drums and loose garbage. At the northern tip of the site the dirt road turns south and disappears within another 600 ft at the top of the newer landfill area. North of the bend in the road is an abandoned workshop area strewn with empty rusty tanks, barrels, and large pieces of rusty machinery.

Proceeding south onto the newer landfill areas, the ground descends steeply to the west and south toward what was once part of the wooded wetland area that is now punctuated by numerous leachate seeps that break out onto the surface and enter the intermittently dry streambed of the West Branch of Trout Brook. Numerous seeps of red, brown, and yellow, some with an oily sheen, occur along the



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COMBE FILL SOUTH LANDFILL
REMEDIAL INVESTIGATION/
FEASIBILITY STUDY

r. e. wright associates, inc.
earth resources consultants

SITE PHYSICAL DESCRIPTION

FIGURE 1-2

southern edge of the fill. Rifts occur along this southern border as well as at the top of the fill, and both areas are marked by strong organic vapors.

Proceeding north on the north-south dirt access road along the powerline right-of-way, east of the new fill area, numerous swampy areas, pools of standing water, and leachate seeps can be seen along either side of the road. About 400 ft south of the intersection of the two dirt roads is an old leachate collection sump that was once used as part of a leachate recycling system at the landfill.

Existing cover at the site consists of coarse and permeable local soils and crushed rock. Erosion has occurred in many areas, exposing wastes. Severe erosion has occurred along the eastern, southern, and western slopes of the new fill areas.

1.3 SITE HISTORY

The Combe Fill South landfill has been operated as a municipal refuse facility since the 1940s. In 1970 and 1971 the landfill was operated by Filiberto Sanitation Inc., a local refuse hauling firm. In December 1972 a "Certificate of Registration" by NJDEP was issued to Chester Hills Inc. to operate a sanitary landfill on the site. The certificate was based on a landfill design prepared in 1971, and it approved the site for nonhazardous municipal solid waste disposal.

In September 1978 the ownership and operation of the landfill were transferred from Chester Hill Inc. to the Combe Fill Corporation, which operated the landfill until October 1981, at which time they declared bankruptcy and ceased operation. The landfill remained open, accepted limited quantities of waste, and underwent some minor reclamation activity (i.e., soil cover) under the auspices of the local health offices and NJDEP. The Combe Fill South landfill closed officially in November 1981, although a bankruptcy hearing was not held until December 1982. The property is currently held by a trustee-in-bankruptcy.

During the time of the ownership of the property by Chester Hills Inc. and the Combe Fill Corporation, about 90 acres of the original property along the western edge of the site were sold, resulting in the site configuration described previously.

In August 1982 a Mitre Ranking Form for Combe Fill South was submitted by NJDEP to EPA. On 20 December 1982 Combe Fill South was proposed for inclusion on the National Priorities List ("Superfund" sites) and was officially listed on 8 September 1983. The RAMP for the site was prepared in December 1983, and a request-for-proposal was issued by NJDEP for an RI/FS in spring 1984. A contract to conduct the RI/FS was awarded in July 1984. Field investigations and analyses conducted by the contractor as part of the RI/FS, which form the basis of this feasibility study (FS) report, began in September 1984 and continued into 1985. The draft remedial investigation (RI) report was submitted in February 1986, and the final RI report in May 1986. The draft feasibility study was submitted in May 1986 and in July 1986 a public hearing was held. The draft report of the conceptual design of the recommended remedial action was submitted in September 1986.

1.4 WASTE DISPOSAL ACTIVITIES AND SOURCES OF CONTAMINATION

The Combe Fill South landfill was approved by NJDEP for the disposal of municipal and industrial wastes, sewage sludge and septic tank wastes, and chemicals and waste oils as part of its certificate of registration. However, few data are available to document either the type or volume of wastes disposed of at the site. Wastes known to have been disposed of at the site include pharmaceutical products, tea residue sludges, calcium oxide, crushed containers of paints and dyes, and aerosol product canisters.

According to NJDEP files, wastes that were accepted at Combe Fill South landfill included typical household wastes, industrial wastes, dead animals, sewage sludge, septic tank wastes, chemicals, and waste oils. The remedial investigation's field studies verified that the site was poorly covered, primarily with a thin veneer of crushed granitic rock. Numerous empty 55-gallon motor oil drums were scattered across the landfill surface. The majority of wastes encountered during field reconnaissance, drilling operations, and test pit excavations were typical household wastes (garbage bags, paper, appliances, etc.) and nonhazardous industrial wastes (plastic, wire, metal frames, etc.). Refuse encountered during the drilling of a well that penetrated the center of the landfill appeared to be highly decomposed rubbish. No visibly apparent evidence of hazardous materials at the surface was uncovered during field operations.

Based on the original landfill design drawings and records of waste volumes received on-site, approximately 5×10^6 yd^3 of waste are buried in the Combe Fill South landfill. There is no documentation or evidence to support local residents' complaints of disposal of unauthorized hazardous materials. Results of field investigations on the site reveal that the wastes are highly heterogeneous and that no "hot spots" or "source" of hazardous waste materials could be found. (High radioactive readings in a portion of the landfill at the headwaters of the East Branch of Trout Brook may be from a nonnatural source and would require further investigation to define.)

Based on the record of the landfill operation and site inspection reports by NJDEP, inappropriate operation of the landfill, rather than illegal disposal of hazardous wastes, is the cause of the current spread of contaminants in the groundwaters, surface waters, and air. NJDEP inspection reports from 1973 to 1981 noted numerous operating violations, including the absence of an initial layer of residual soil, which was to be placed on the bedrock prior to waste placement, and absent or inadequate final daily cover. Other frequent violations included uncontrolled litter, exceeding maximum allowable width of operating face, and excavation of previously deposited waste. Although not strictly a violation of the design parameters, the inspection reports also noted that excavation and breakup of the saprolite (the broken bedrock layer above competent bedrock) was done as part of trench excavation. These disposal practices encouraged the migration of contaminants into the underlying aquifers.

Furthermore, although a leachate collection and recycling system was in operation from 1973 to 1976, the collected data was not treated prior to discharge to Trout Brooks. Finally, when the landfill closed in 1981, little if any final cover was applied to the landfill, resulting in severe erosion of the landfill surface and contributing to the infiltration of leachate into the aquifers underlying the site.

1.5 REMEDIAL INVESTIGATION FINDINGS

1.5.1 Aquifer Characteristics

1.5.1.1 Groundwater Flow. On the landfill, depth to water table ranges from 5 to 65 ft. Since waste depths range from 10 to 80 ft, much of the waste is constantly saturated. There is a small downward vertical component to groundwater flow; however, the lower permeability of the bedrock results in a mounding of the groundwater in the saprolite overlying the bedrock. The predominantly lateral flow of groundwater in both the saprolite and bedrock aquifers has a directional preference to the northeast and southwest because of the orientation of the geologic features beneath the landfill. In the weathered and highly fractured bedrock, groundwater is stored and transmitted along discontinuities such as fractures and joints. The average groundwater flow in the upper aquifer has been estimated as 122,000 gpd; bedrock groundwater flow has been estimated at 14,000 gpd for a total groundwater of 136,000 gpd. Plate 1 (located in the back pocket of this report) summarizes the conceptualized groundwater flow paths in the upper and lower aquifers at the site.

1.5.1.2 Groundwater Quality. The pattern of contamination found in the shallow monitoring wells (six wells) confirms that the groundwater mirrors the surface topography as modified by the directional preferences of the saprolite and bedrock. The shallow well located in the southwest corner of the landfill had the highest concentration of priority organic pollutants (1556 ppb), consisting primarily of volatile organics, toluene in particular. The second highest concentration of priority organic pollutants (283 ppb), consisting mostly of benzene, toluene, and 1,1-dichloroethane, was detected in the shallow well located at the southern tip of the new fill area of the landfill. The lowest concentration of priority organic contaminants (7 ppb) was found in the shallow well just beyond the northern tip of the landfill.

Contamination in the deep monitoring wells (11 wells) showed even greater directional preferences than the saprolite aquifer. The highest concentration of priority organic contaminants (1293 ppb, consisting primarily of toluene) in the bedrock aquifer was found in the deep well at the southwest corner of the landfill. The second highest concentration of priority organic contaminants (530 ppb, consisting primarily of benzene and chloroform) was found in the deep well at the northeast border of the old fill area of the landfill. The third highest concentration (429 ppb, consisting primarily of chloroform and methylene chloride) was found in a deep monitoring well located 1200 ft northeast of the northern boundary of the landfill (toward Schoolhouse Lane).

Analyses of groundwater from off-site potable wells (25 wells) indicate that the contamination shown to be leaving the site in the groundwater to the northeast has impacted the potable wells along Schoolhouse Lane. Concentrations of priority organic contaminants in these wells range from 6 to 81 ppb and consist primarily of chloroform and 1,2-dichloroethane. Sporadic lower levels of organic contamination occur in other potable wells along Parker Road, particularly near the branches of Trout Brook (south of the landfill). Groundwater from the landfill does not flow toward the potable wells along East Valley Brook Road (northwest of the landfill), and the minor, if any, contamination found in these potable wells probably does not originate from the landfill.

1.5.2 Soils

Soil samples from selected borings (six samples) on and near the landfill, hand augered soil samples in the adjacent fields (12 samples), and test pits (four samples) were also analyzed. Two priority pollutant volatiles (chloroform and toluene) and one base/neutral extractable compound (di-n-butylphthalate) were found in all soil boring samples at individual concentrations as high as 6000 ppb. Analysis of three composite soil samples and one discrete sample from three separate test pits showed only the occurrence of bis (2-ethylhexyl) phthalate (up to 1300 ppb) and miscellaneous heavy metals, including arsenic (up to 71 ppm).

Surface soil samples were taken in the two fields near the landfill suspected of being used for illegal disposal of wastes and in one background field. In the field northwest of the landfill a white powdery substance suspected of being lime was found. This field also had slightly higher concentrations of heavy metals than the background field that; these field soil contaminants are suspected of being brought to the field by surface runoff from the landfill. The southeast field showed no significant difference in its chemistry from the background field.

1.5.3 Surface Water and Leachate

Leachate generated in the landfill by infiltration of rainfall through the landfill waste, moves contaminants to surface and groundwaters. Analyses of leachate seeps revealed concentrations of priority pollutant volatile organic compounds of 15 to 1084 ppb, consisting primarily of toluene, ethylbenzene, and benzene. Priority pollutant metals, in concentrations up to 3180 ppb, were also found in leachate seeps along with high concentrations of total phenols (up to 418 ppb).

As expected, soils/sediments sampled at the point of emergence of leachate seeps contained primarily base/neutral extractable organics and heavy metals. Total concentrations of priority pollutant base/neutral organics in these soils ranged from 186 to 69,836 ppb and consisted primarily of butyl/benzyl phthalate and bis(2-ethylhexyl) phthalate.

Generally, surface waters do not show the long-term impacts of any leachate discharge because pollutants are either volatilized, diluted, or chemically transformed or settle out into stream sediments. The total concentration of priority pollutant organics in surface water near the landfill ranged from 0 to 11 ppb, with the main stem of Trout Brook exhibiting the highest concentrations of pollutants. Where stream sediments have accumulated and not been washed away by heavy rains or streamflows, they show elevated concentrations of priority pollutant base/neutral extractable organics and heavy metals. The elevated (up to 6345 ppb) concentration of priority pollutant semivolatile organics, primarily base/neutral compounds, found in the downstream sediments of Tanners Brook are probably not associated with the landfill because neither surface waters nor groundwaters from the site appear to flow toward Tanner's Brook.

1.5.4 Air

The Combe Fill South landfill is a source of emission of methane and volatile organic compounds to the air. Total concentrations of volatile organics in the air on-site ranged from 28 to 756 g/m^3. However, downwind concentrations of total volatiles (30 to 78 g/m^3) were not significantly different from upwind concentrations (38 to 60 g/m^3), suggesting that the landfill does not have a significant impact on local air quality.

1.5.5 Radioactivity

Two areas of elevated radioactivity were found on the landfill. Elevated gamma radioactivity (up to 0.95 mR/hr) logged during the drilling of a monitoring well in the eastern portion of the landfill was suspected of originating from a natural source. Subsequent analysis of drill cuttings from this well by the New Jersey Geological Survey showed that isotopes were from naturally occurring thorium. The high gross alpha (up to 30 ± 17 pCi/l) and beta (up to 240 ± 24 pCi/l) radioactivity measured in two shallow wells and one leachate seep along the southeastern border of the new fill area near the powerline (in the vicinity of the headwaters of the East Branch of Trout Brook) may be of a nonnatural source related to the landfilled waste.

1.6 REMEDIAL INVESTIGATION CONCLUSIONS

Chemicals are being leached from contaminated soils and wastes in the landfill to the groundwater, which is subsequently used as a source of potable water. The groundwater pathway is probably the most important route of contaminant migration from the landfill. Air transport of volatilized organic compounds is also a likely contaminant and exposure pathway, but is of secondary importance.

Contamination in the groundwater aquifers has moved off-site, primarily northeast and southwest of the landfill, i.e., the directions in which most of the groundwater flows. Groundwater does not move northwest from the site, so contamination has not moved in this direction. The hydrogeological and chemical data suggest that the continuously flowing portions of Trout Brook (i.e., portions of the West Branch and the main stem of Trout Brook) act as a barrier to groundwater flow and contamination in the saprolite upper aquifer beyond (i.e., south of) the brook. The unnamed tributary northeast of the landfill may function in a similar capacity for groundwater flow and contamination moving northeast. Concentrations of contamination to the northeast (toward the unnamed tributary) and the southwest (toward Trout Brook) may increase in the future, in the same directions as the major groundwater flow paths. Contamination may also spread east of the landfill along the less significant groundwater flow paths leaving the site, which currently show little contamination.

The population experiencing the greatest and most immediate risk from the movement of landfill contaminants are the residents of Schoolhouse Lane; potable groundwater supplies in this area show elevated concentrations of contaminants linked to the landfill. Other residents within about 0.5 miles north, east, and south of the landfill, including the pupils of a day-care facility along Parker Road, are predicted to be at risk in the future from the contaminants leaving the site.

CHAPTER 2

DEFINITION OF GOALS AND OBJECTIVES AND SCREENING OF TECHNOLOGIES FOR DEVELOPMENT OF REMEDIAL ACTION ALTERNATIVES

2.1 OBJECTIVES

In response to the U.S. Environmental Protection Agency (EPA) policy on compliance with environmental statutes, remedial action alternatives must be developed in each of the following categories:

1. No or minimal action
2. Alternatives for treatment or disposal at an off-site facility approved by EPA
3. Alternatives that attain applicable and relevant Federal public health or environmental standards
4. Alternatives that exceed (do better than) applicable and relevant Federal public health or environmental standards
5. Alternatives that do not attain all applicable or relevant public health or environmental standards but will reduce the likelihood of present and future threats from hazardous substances

2.2 DEVELOPMENT OF REMEDIAL ACTION ALTERNATIVES

2.2.1 Introduction

Remedial action alternatives that achieve the objectives described above and that address site-specific problems are formulated in an iterative process that consists of screening remedial action technologies. This process consists of the following major steps:

1. Identify site problems and contaminant pathways. (These problems and pathways are identified as a result of the site investigations.)

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2. Develop a list of technical response categories that may be applicable to site problems, including no or minimal action.

3. Define specific technologies within each response category that may be applicable to site problems.

4. Screen specific technologies for their technical feasibility in relation to site and waste characteristics and limitations and general environmental and economic impacts.

5. Combine successfully screened technologies into alternative sets such that at least one alternative is developed to achieve each of the stated objectives.

6. Screen the alternatives for their technical feasibility and environmental and economic impacts using order-of-magnitude estimates.

7. Select final alternatives for detailed evaluation (at a minimum there must be an alternative that achieves each of the Federal objectives).

In this chapter, steps two through four in this process are summarized. Although originally developed prior to the completion of the final RI report, these technology screening steps have been reviewed to include any siginificant changes or findings made in the RI. Nevertheless, they are still reflective of the primary technology screening process used during this studies. Chapter 3 of this report discusses steps 5 through 7 of this alternative development process.

2.2.2 Site Problems and Applicable Response Categories

The results of the site investigations, sampling, and analyses indicate that the site conditions create several contaminated sources and pathways at the site (Table 2-1):

- Actual physical contact with landfill materials promoting possible physical injury

TABLE 2-1

SITE PROBLEMS AND POSSIBLE PATHWAYS OF CONTAMINATION

Combe Fill South Landfill

SITE PHYSICAL CONDITIONS

Exposed debris due to insufficient cover materials
Rifts caused by escaping gases and landfill subsidence
Leachate seeps
Swampy areas
Unrestricted public access
Steep slopes with no stabilization

CONTAMINANT - SOURCES/PATHWAYS

1. Air

- Methane and volatile organic emissions to atmosphere; dust and particulate emissions due to poor cover

2. Groundwater (Primary Path)

- Groundwater discharge to surface with leachate in leachate seeps
- Groundwater contamination in upper aquifer from leachate, possibly moving off-site
- Groundwater contamination of bedrock aquifer, possibly moving off-site

3. Surface Water

- Unrestricted surface water runoff moving contaminants off-site
- Leachate seeps and contaminated groundwater discharge to surface waters leaving site.

4. Soils/Sediment

- Stream sediment contamination from contaminated surface waters

- Air migration of methane, volatile organic compounds, contaminated dust, and particulate matter

- Off-site movement of contaminants in groundwater in the upper saprolite aquifer and deeper bedrock aquifer which used as a potable water supply

- Off-site movement of contaminants via surface waters

- Pockets of stream sediments contaminated from surface waters moving off-site

2.2.3 Technical Response Categories

Ten general response categories that may be applicable to the problems at Combe Fill South landfill have been formulated (see Table 2-2).

These response categories may address more than one problem or pathways and are summarized below.

No or minimal action may be taken. Minimal action may include a monitoring program to continue to assess site conditions. No remedial action does not preclude removal action under CERCLA.

Access restrictions such as security fencing, locking gates, warning signs, or, if necessary, security guards, can be effective in limiting direct physical contact with waste sources and pathways.

Containment of waste sources acts primarily to minimize interaction of the waste with its environment and subsequently reduce or eliminate its migration. Thus, containment actions that can be effective in reducing or eliminating leachate and reducing or eliminating migration of contaminants in groundwater, surface waters, and air can be implemented.

TABLE 2-2

GENERAL REMEDIAL RESPONSE CATEGORIES

Combe Fill South Landfill

RESPONSE CATEGORY	APPLICABILITY TO SITE
No or Minimal Action	Yes
Access Restrictions	Yes
Containment	Yes
Pumping	Yes
Diversion	Yes
Removal:	
Complete	Probably not
Partial	Yes
Collection and Treatment:	
On-site	Yes
Off-site	Yes
In situ	Probably not
Disposal:	
On-site	Yes
Off-site	Yes
Alternative Water Supply	Yes
Relocation	Yes

Pumping can be used to control liquid sources and pathways. At Combe Fill South landfill pumping can be used to control leachate, groundwater, and surface water.

Diversion mechanisms are generally associated with control of surface waters, including runoff, and would be suitable for use at Combe Fill South landfill.

Removal actions generally involve the physical relocation of such materials as drums, soils, sediments, or liquid wastes. Complete removal of the waste source, i.e., the entire landfill, would probably be economically infeasible and technically impractical. However, partial removal of specific waste areas may be practical for Combe Fill South landfill. For example, areas of highly contaminated soils or surface water sediments may be excavated.

Collection mechanisms can be utilized to concentrate waste streams prior to treatment and/or disposal and can be employed at the site for liquid and gas waste streams.

Treatment mechanisms to remove or reduce contaminants by chemical, physical, or biological means can be applied to the air, water, and soil pathways found at Combe Fill South landfill. Treatment mechanisms can be located on the Combe Fill South site or off-site, within certain geographic limits. Most treatment actions involve some method of waste collection with subsequent treatment at a centralized facility. However, in situ treatment mechanisms treat wastes where they lie. Application of in situ treatment methods are for the most part experimental and are not applicable to the Combe Fill South landfill because of the heterogeneous nature of the fill and the underlying fractured bedrock.

Disposal of treated or untreated wastes, or contaminated media, and any treatment by-products may be made either on- or off-site.

Providing alternative potable water supplies may be necessary for portions of the local population where contaminants have spread to the drinking water wells.

Although relocation of portions of the local population who are significantly at risk is also being evaluated for the site, it is unlikely that so drastic an action will be necessary.

2.2.4 Specific Remedial Technologies

Based on the previous discussion of general technical response categories, it is apparent that a broad range of technologies is possible at the Combe Fill South landfill. In this section, specific remedial actions are screened and their effectiveness is examined within the constraints imposed by the site's and waste's characteristics. Table 2-3 summarizes this technology screening for the Combe Fill South site.

2.2.4.1 Gas and Dust Migration Controls. Air carrying gases and dusts has been identified as a possible pathway for movement of contaminants from Combe Fill South landfill.

Spraying of polymers and water over the fill may be effective short-term dust control measures, but other, more effective, long-term measures whose primary benefits may lie in other areas (e.g., infiltration reduction from capping) are available.

Organic gases, including methane, are being generated by the landfill and discharged into the atmosphere. Gas collection, with or without subsequent treatment, may be an appropriate technology for the site. New Jersey regulations for closure of municipal landfills require, at a minimum, passive gas collection. Active gas

SCREENING OF REMEDIAL TECHNOLOGIES

Combe Fill South Landfill

ACTION	APPLICABILITY TO SITE	SITE/WASTE LIMITATIONS TO TECHNOLOGY
1. Gas and Dust Migration Controls	Yes	
A. Dust Control Measures	Yes	Temporary action only during construction; not effective for long-term remediation.
1. Polymers	Yes	
2. Water	Yes	
B. Gas Collection	Yes	Concentrations of methane leaving site may require active system, otherwise NJ requires at least passive for landfill closure.
1. Passive pipe vents	Yes	
2. Passive trench vents	Yes	
3. Active gas collection	Yes	
C. Capping	Yes	Capping is required by NJDEP for landfill closure.
1. Synthetic membrane	Maybe	Possible incompatibility with site wastes; slope considerations; maybe part of multimedia cap.
2. Clay	Yes	Probably as part of multilayered cap.
3. Asphalt	No	Rigidity unsuitable for unstable landfill environment; also may be incompatible with wastes.
4. Concrete	No	
5. Chemical additives/ stabilizers	Maybe	May be useful in reducing shrink/ swell behavior or neutralizing acid cover soils.
6. Multilayered cap	Yes	An effective solution.
D. Vertical Barriers (see Leachate Control for specific technologies)	Maybe	May not be effective in fractured bedrock layers.
2. Surface Water Controls		
A. Capping (see Gas and Dust Migration Control)	Yes	Slopes may restrict use of certain materials.

SCREENING OF REMEDIAL TECHNOLOGIES

Combe Fill South Landfill

ACTION	APPLICABILITY TO SITE	SITE/WASTE LIMITATIONS TO TECHNOLOGY
B. Grading	Yes	In conjunction with cap; not suitable by itself. Slope should be sufficient to promote runoff without erosion.
1. Scarification	Yes	Primarily used for preparing top cap layer for revegetation. Tracking used principally in steep slopes.
2. Tracking	Yes	
3. Contour furrowing	Yes	
C. Revegetation	Yes	Necessary to prevent erosion and desiccation of cap layers.
1. Grasses	Yes	
2. Legumes, shrubs, trees	No	Root systems would crack cap allowing infiltrataon.
D. Diversion and Collection Systems	Yes	
1. Berms and chutes	Yes	Particularly applicable during construction; should be used in conjunction with other controls in a permanent system.
2. Ditches, trenches and swales	Yes	Effective perimeter collection mechanisms.
3. Terraces and benches	Yes	Primarily used in conjunction with grading.
4. Downpipes	Maybe	Only if necessary during construction. Not long-term erosion control measure.

SCREENING OF REMEDIAL TECHNOLOGIES

Combe Fill South Landfill

ACTION	APPLICABILITY TO SITE	SITE/WASTE LIMITATIONS TO TECHNOLOGY
5. Seepage or recharge basins	Maybe	Possible for surface water diversion depending on permeability of soils.
6. Storage ponds	Yes	In conjunction with surface water collection systems can be used to dampen runoff flows from site.
7. Levee/flood walls	No	Not applicable to site surface water needs.
3. Leachate and Groundwater Controls		
A. Capping (see 1.C.)	Yes	
B. Barriers	Maybe	Geology of site may preclude effective placement of barrier except for upper glacial horizon. There is no impermeable layer into which a barrier can be tied. Leachate reaching bedrock exits via fractures - a media in which barriers may not be effective.
1. Location		
a. Downgradient	Yes	In upper layers. Regional groundwater flow has not been established.
b. Upgradient	Maybe	Depending on groundwater flow.
c. Horizontal (bottom sealing)	Maybe	Fracturing may be too extensive to form effective bottom seal.
2. Material/Construction		
a. Soil/bentonite slurry wall	Maybe	Voids and fractures may preclude effective placement. Could perhaps be used with grout anchors. May be chemically attacked by leachate resulting in greater permeability; strong acids or bases may dissolve soil/bentonite.

TABLE 2-3 (Page 4 of 12)

SCREENING OF REMEDIAL TECHNOLOGIES

Combe Fill South Landfill

ACTION	APPLICABILITY TO SITE	SITE/WASTE LIMITATIONS TO TECHNOLOGY
b. Cement/bentonite slurry wall	No	Extra strength provided by cement makes wall more permeable.
c. Grout curtains	Maybe	Grout can be mixed to set up fast enough to fill large voids, but is very expensive. May be chemically attacked by leachate.
d. Sheet piling (steel)	No	Rocky soils and bedrock may preclude placement or may damage during driving.
e. Synthetic membrane	Maybe	(See 1.C.1).
C. In situ Permeable Treatment Beds	No	Most treatment bed materials are not effective for organic contaminants. Volume of leachate generated at site would quickly surpass capability of beds.
D. Groundwater Pumping	Yes	Used in conjunction with capping and treatment. To lower groundwater and extract leachate/groundwater.
1. Function		
a. Extraction	Yes	
b. Injection(alone or with extraction)	Maybe	On-site shallow injection counterproductive to leachate reduction purposes of capping. Also, no effective control of leachate generated because of bedrock fractures. Deep well injection would require achievement of drinking water quality effluent because bedrock aquifer is used for potable water.
2. System options		
a. Well points or shallow wells	Maybe	Dependent on depth to which water level must be lowered. Best used at site perimeter.

SCREENING OF REMEDIAL TECHNOLOGIES

Combe Fill South Landfill

ACTION	APPLICABILITY TO SITE	SITE/WASTE LIMITATIONS TO TECHNOLOGY
b. Deep wells	Yes	May be alternative for perimeter leachate collection trench. High capacity pumping deep wells may be needed for bedrock plume management.
E. Subsurface Collection System	Yes	Effective leachate/groundwater collection mechanism for upper glacial aquifer. May require impermeable liners on downgradient side.
1. Drainage ditches/ trenches	Yes	May have clogging problems.
2. French drains/ tile drains	No	Easily clogged. Difficult to maintain.
3. Pipe drains (multimedia drains)	Yes	May require filter cloth envelopes to prevent clogging.
4. Excavation and Removal of Waste and Soil	Maybe	Although some excavation of waste and soil may be necessary as part of site grading, the volume of waste/soil at the site precludes complete removal/excavation, unless a new RCRA facility is created on site. Also, methane generation make such work, in the waste itself, dangerous
5. Removal/Containment of Contaminated Sediments		
A. Sediment Removal	Yes	Preferably done under dry weather flow conditions so that normal mechanical excavation equipment (i.e., backhoes, dozers, etc) can be used.
1. Mechanical	Yes	

SCREENING OF REMEDIAL TECHNOLOGIES

Combe Fill South Landfill

ACTION	APPLICABILITY TO SITE	SITE/WASTE LIMITATIONS TO TECHNOLOGY
2. Hydraulic	No	Site has no large standing or flowing water bodies to warrant such equipment.
3. Pneumatic	No	
B. Sediment/turbidity controls		
1. Silt curtains	No	Streams not large enough.
2. Cofferdams/sheet pile stream diversion/ barriers	Maybe	Use if cannot excavate during dry weather.
6. In situ Treatment	No	Generally unproven, experimental technologies often waste specific.
A. Extraction (soil flushing)	No	Complete capture of elutriate from flushing is not possible because of fractured nature of bedrock. Not compatible with capping for our purposes of leachate reduction.
B. Immobilization		
1. Sorption	No	Requires mixing of waste (i.e, landfill with adsorbents which is both dangerous [because of methane] and costly [because of landfill size]).
2. Ion exchange	No	Only on cation and anion species. Has similar limitations as sorption.
3. Precipitation	No	For metals precipitation only. Has mixing requirements and limitations as sorption.
C. Chemical Degradation		
1. Oxidation	No	Conceptual technology. Oxidation products may be more toxic than original contaminants.
2. Reduction	No	Little demonstrated use. Requires either soil mixing with problems described above or water solution applications with leachate capture problems.

SCREENING OF REMEDIAL TECHNOLOGIES

Combe Fill South Landfill

ACTION	APPLICABILITY TO SITE	SITE/WASTE LIMITATIONS TO TECHNOLOGY
3. Polymerization	No	Not fully demonstrated. Requires mixing and wetting with accompanying problems described previously.
D. Biodegradation	No	Requires optimal environmental conditions unlikely to be achieved because of landfill size. May require use of genetically engineered organisms. Success not completely demonstrated in landfill situations. Direct injection into bedrock fractures for groundwater treatment poses risks to human health because no effective control of groundwater flows in bedrock fractures leading to local potable wells.
E. Photolysis	No	Limited to soil surface treatments.
F. Attenuation	No	Requires mixing with clean soil resulting in problems associated with landfill methane. Also would increase landfill size requirements.
G. Reduction of Volatilization	No	Requires addition of water thus creating more leachate, or requires compaction which may be dangerous to unknown waste components and methane, or requires reduction in soil temperature not possible for size and depth of fill.

SCREENING OF REMEDIAL TECHNOLOGIES

Combe Fill South Landfill

ACTION	APPLICABILITY TO SITE	SITE/WASTE LIMITATIONS TO TECHNOLOGY
7. Waste Treatment		
A. Incineration/Destruction	Yes	
1. Rotary kiln	Yes	Applicable to specific wastes if found, or to effluents or sludges from other treatment processes. Historically used off-site for final disposal.
2. Fluidized bed	Yes	
3. Multiple hearth	Yes	
4. Liquid injection (liquid waste)	Yes	
5. Molten salt	No	Experimental/limited previous applications. Unproven techniques.
6. Pyrolysis	No	
8. Plasma arc pyrolysis	No	
B. Gaseous Waste Treatment	Yes	Can be used with active or passive collections.
1. Activated carbon	Yes	For organics and methane.
2. Flares	Yes	For methane control.
3. Afterburners	Yes	For both organics and methane.
4. Recovery/reuse	Maybe	May be applicable if sufficient methane generated.
C. Liquid Waste Treatment		
1. Biological treatment	Yes	Dependent on results of treatability study and in conjunction with other.
a. Activated sludge	Yes	Treatability study and/or pretreatment required.
b. Trickling filter	Yes	Treatability study and/or pretreatment required.
c. Rotating biological contactor	Yes	Can handle relatively low strength waste compared to activated sludge.
d. Aerated lagoons/ waste stabilization ponds	Maybe	Activated sludge and trickling filter more effective and take up less space.
e. Anaerobic filter	Maybe	Used as pretreatment for strong waste.

SCREENING OF REMEDIAL TECHNOLOGIES

Combe Fill South Landfill

ACTION	APPLICABILITY TO SITE	SITE/WASTE LIMITATIONS TO TECHNOLOGY
2. Chemical Treatment	Yes	In conjunction with other processes as determined by waste characterization and treatability study.
a. Precipitation	Yes	
b. Flocculation/ coagulation	Yes	
c. Aeration/oxidation	Yes	
d. Neutralization (pH adjustment)	Yes	
e. Chlorination	Yes	
f. UV/ozonation	Maybe	Not commonly used.
3. Physical Treatment	Yes	In conjunction with other processes as determined by waste characterization and treatability study.
a. Flow equalization	Yes	
b. Sedimentation	Yes	
c. Activated carbon	Yes	Applicable for effluent polishing.
d. Ion-exchange	Maybe	Effective but expensive process.
e. Reverse osmosis	Maybe	Expensive process in comparison to other suitable methods.
f. Liquid-liquid extraction	No	Expensive process in comparison to other suitable methods.
g. Oil-water separator	Maybe	Only if high in oils/grease.
h. Steam distillation	No	Expensive, not commonly used.
i. Filtration	Yes	
j. Air stripping	Yes	
k. Steam stripping	Maybe	Effective but more expensive than air stripping.
l. Dissolved air flotation	Yes	

TABLE 2-3 (Page 10 of 12)

SCREENING OF REMEDIAL TECHNOLOGIES

Combe Fill South Landfill

ACTION	APPLICABILITY TO SITE	SITE/WASTE LIMITATIONS TO TECHNOLOGY
4. Discharge to publicity owned treatment works	No	Closest POTW of sufficient capacity is more than 10 miles away.
D. Sludge Handling and Treatment	Yes	In conjunction with liquid waste treatment.
1. Thickening/Dewatering	Yes	For preliminary liquid treatment.
a. Screens	Yes	
b. Centrifuge	Yes	
c. Gravity thickening	Yes	
d. Flotation/ thickening	Yes	
e. Vacuum filtration	Yes	
f. Belt filter press	Yes	
g. Pressure filter	Yes	
2. Treatment		
a. On-site	Yes	Treatment facilities would have to be constructed.
b. At RCRA disposal facility	Maybe	Distance to site may be limitation.
c. Neutralization	Yes	
d. Incineration	Yes	May be appropriate at off-site POTW with capacity.
e. Oxidation/reduction	Yes	
f. Composting	Maybe	If waste not toxic.
E. Solidification/Encapsulation	No	All techniques require waste excavation and mixing which will be dangerous because of methane generation and expensive because of the quantity of wastes/soils on-site.

SCREENING OF REMEDIAL TECHNOLOGIES

Combe Fill South Landfill

ACTION	APPLICABILITY TO SITE	SITE/WASTE LIMITATIONS TO TECHNOLOGY
1. Solidification	No	In addition to excavation needs and mixing requirements most solidification processes result in significant increases in total waste volume thus requiring significantly more on-site or off-site landfill space.
a. Cement based	No	Organics will leach; cement is porous.
b. Lime based	No	Primarily used to stabilize waste for transportation. Organics not treated.
c. Thermoplastic	No	Not suitable for organics.
d. Organic polymers	No	Polymers may biodegrade and release waste.
e. Self-cementing	No	Wastes need high calcium sulfate/ sulfide to cement.
f. Glassification	No	Waste quantity (landfill) limits this technique; also high energy cost.
2. Encapsulation	No	No isolated waste on-site to make this technique applicable. Commercial processes off-site and expensive.
8. Land Disposal/Storage		
A. Landfills	Maybe	No RCRA off-site facility has landfill capacity. Would have to create new landfill on-site.
B. Surface Impoundments	No	Liquid wastes (leachate) could not be merely collected and stored. Would require treatment. Existing wastes are solids/semi-solids.
C. Land Application	No	Toxicity/hazardousness of waste precludes land application.
D. Waste Piles	No	Need further treatment/disposal.

TABLE 2-3 (Page 12 of 12)

SCREENING OF REMEDIAL TECHNOLOGIES

Combe Fill South Landfill

ACTION	APPLICABILITY TO SITE	SITE/WASTE LIMITATIONS TO TECHNOLOGY
E. Deep Well Injection	Maybe	Bedrock aquifer (deep), is used as potable water source so would require drinking water quality effluent from treatment facility. The EPA is currently investigating banning hazardous waste injection into deep wells if such disposable is not protective of human health.
F. Temporary Storage	Maybe	May be necessary dependent on final treatment/disposal mechanisms.
9. Contaminated Water Supplies		
A. Alternate drinking water supply	Yes	Where residential potable wells reveal concentrations above drinking water standards. Some temporary measures may be applicable as other long-term remedial actions are pursued.
1. Deeper wells	Yes	If water source not contaminated.
2. Cisterns or tanks	Maybe	But only if needed as short-term measure.
3. Municipal water system	Yes	Cost effective if the water supply system is nearby.
B. Individual Treatment Units	Maybe	If contamination isolated or if low levels of contamination.
10. Relocation	Maybe	Specific residents or business may require relocation based on an assessment of site impacts or if required to implement remedial action alternatives.
11. Access Restriction	Yes	Restricting access to site will reduce chances of physical contact with contaminants and reduce chances of normal personal injuries.
A. Signs	Yes	
B. Fencing	Yes	
C. Security guards	Maybe	Security guards may not be cost-effective.

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collection may be required if methane or other gas generation is substantial.

<u>Capping</u>, or sealing the surface, of the landfill with an impervious material may prevent or reduce the release of gases from the fill to the atmosphere, although the primary function of surface sealing is to prevent or reduce the infiltration of rainfall.

A synthetic membrane may be sufficiently impervious for such purposes, but may be difficult to properly install (i.e., sealing seams is important) and maintain, due primarily to tearing brought on by landfill subsidence. Natural clays or bentonites may also be used to seal the landfill. Clays, although easily desiccated, are easier to install and maintain than synthetic membranes. Asphalt and concrete are inappropriate surface sealers for landfills because they create a rigid surface that can crack easily during landfill subsidence, creating channels for escaping gases. Chemical sealants/stabilizers such as lime or fly ash contribute cementing properties to soils and help neutralize acid soils. However, they have limited effectiveness in reducing gaseous emissions and are best used for achieving infiltration-reduction objectives. A multilayered, multiobjective cap consisting of a gaseous ventilation layer (generally gravel) for collection and routing of gases and an impermeable layer, such as clay, that combines several of the above-mentioned technologies would be an effective solution to gas control and rainfall infiltration at the landfill.

<u>Vertical barriers</u> consisting of some impermeable material (clay or synthetic membrane) may be used to control horizontal migration of landfill gases, particularly methane. This technology will have limited effectiveness at the Combe Fill South site because there is no impermeable geologic (or manmade) unit beneath the site into which the vertical barrier can be attached, thus allowing the escape of gases underneath the barrier.

2.2.4.2 Surface Water Controls. Surface waters, including leachate, emanating from the site have been identified as pathways for contaminant migration. Therefore, surface water control technologies will play an important role in remediation of the site. By preventing infiltration of water into the fill and diverting it to a surface discharge paint, contaminant levels in surface waters can be reduced.

Capping, as discussed above, can be an effective technology for eliminating or reducing infiltration through the fill, thus reducing the amount of leachate being generated. The advantages and disadvantages, discussed above under gas migration control for different capping technologies, also apply to capping as a surface water control technology. In addition, the size and steepness of the fill areas, even after grading, may restrict the use of certain materials such as membranes. At the same time, a minimum slope must be maintained to promote controlled runoff and prohibit erosion of the cap and ponding or standing water.

Some amount of grading of the site, along with filling and compacting, will be needed to reshape the fill surface in order to promote controlled runoff. Grading can be conducted on the fill itself, but is most effective when used in combination with capping technologies. Scarification, tracking, and contour furrowing are all surface molding techniques that can be used to retard, channel, or otherwise control surface runoff. (Runon is not a problem for the site because it is a topographic high.)

Revegetation of the landfill surface, or preferably the top layer of a cap, is necessary to prevent future erosion and desiccation of such cap materials as clays and synthetic membranes. If grasses are planted they will assure a dense vegetative mat to which soil particles can adhere. Legumes, shrubs, or trees should not be used because their thicker and longer root systems may crack the surface layer, thus promoting unwanted infiltration.

Other short- and long-term surface water control mechanisms can be used to divert and collect runoff (or leachate or groundwater) at the Combe Fill South site. Chutes, downpipes, and berms can be effective short-term measures (during construction), but may require more maintenance/repair if used for long-term runoff control. Terraces and benches can be formed during site grading activities and can be effective long-term runoff control measures. Ditches, trenches, and swales can be effective runoff collection mechanisms, particularly at the site perimeter. Storage ponds can be constructed to dampen the peaks of large amounts of stormwater runoff collected and diverted from the site prior to discharge. Seepage or recharge basins may be used to reinfiltrate diverted uncontaminated runoff in areas outside the fill; however, their success will depend on soil characteristics. Finally, the small amount of surface water at the site makes such mechanisms as levees and flood walls unsuitable for runoff control.

2.2.4.3 Leachate and Groundwater Controls. Leachate and groundwater on the site have been shown to be contaminated and are pathways for off-site migration. Control of leachate and groundwater movement may be an effective remedial measure for the site.

Capping technologies, as discussed previously, prevent or reduce infiltration into the fill, thereby reducing the amount of leachate generated and entering the surface or groundwaters.

Underground barriers may be used to prevent groundwater movement onto a site, or groundwater and leachate movement off-site. The Combe Fill South site is closely located to a groundwater high and may therefore not require an upgradient barrier. A final decision on the desirability of an upgradient barrier would depend on the amount of upgradient groundwater influencing the landfill and other remedial measures being taken. The effectiveness of barriers at Combe Fill South may be limited because of the fractured nature of the bedrock. Vertical barriers are generally installed so that they connect to a horizontal barrier, such as a natural clay layer, so that groundwater flows are not diverted underneath the barrier. At Combe Fill South there is no natural impermeable horizontal barrier; the highly fractured bedrock has many channels for the off-site movement of groundwater. Construction of a manmade barrier underneath the fill, in a manner similar to the construction of vertical barriers, may also have limited effectiveness because the fractures may be too large or too numerous to seal effectively.

The materials that can be used to construct these barriers include soil/bentonite, cement/bentonite, grout, sheet piles, and synthetic membranes. Rocky soils and bedrock limit the placement of sheet piles, which would be damaged during driving. A soil/bentonite slurry wall may be constructed but may not be effective in plugging the fractures encountered in the bedrock; construction of a soil/bentonite slurry wall with grout anchors may alleviate some of the problems of effective placement of the wall. The additional support provided by a cement-bentonite slurry wall is not necessary at the site, and as it is more permeable and more expensive than a soil/bentonite wall, it is not appropriate for use at the Combe Fill South site. A synthetic membrane alone or in combination with a slurry wall may be used as a barrier; however, it may be eroded by direct contact with leachate and, if used, would probably be most effective if placed on the downgradient side of a soil/bentonite slurry wall. Grout, injected in formations known as curtains, may be suitable to form barriers at the site because grout hardens fast enough to fill large fractures without being "lost" into the voids. However, grout curtains are more expensive than slurry walls and may also be susceptible to chemical attack from direct contact with leachate.

Permeable treatment beds remove, by adsorption, precipitation, or neutralization, contaminants by routing the groundwater through such media as limestone, activated carbon or glauconite greensands placed in the ground downgradient of the groundwater flow. Except for activated carbon (which is expensive), most such materials do not effectively remove organic contaminants, which are a problem at Combe Fill South. Furthermore, the volume of leachate and groundwater flow and direction would require large-scale application of such beds, which would also be expensive. Finally, the highly fractured nature of the bedrock would make effective capture (and subsequent monitoring and control) of the effluent from such systems not possible unless each bed were lined with an impermeable material. If such large-scale measures are needed for effective management, cheaper and more controllable large-scale measures are available for the site.

Groundwater pumping may be used to lower the groundwater table, extract leachate and groundwater, and generally reduce and/or reverse the off-site flow of groundwater. For Combe Fill South, groundwater pumping in conjunction with leachate reduction mechanisms, such as capping, could be conducted if reduction or elimination of off-site migration is an objective of remediation. Once again, the highly fractured nature of the bedrock may preclude complete effectiveness of groundwater pumping because it would be impossible to determine whether all groundwater-bearing fractures are intercepted by the pumping well(s).

On-site shallow well injection of treated or untreated groundwater/leachate could be used in an effort to "flush" contaminants from the fill; however, effective monitoring and control of such a system would probably not be possible because the highly fractured bedrock may provide many avenues for groundwater leaving the site. Deep well injection would require an effluent meeting drinking

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water criteria because the bedrock aquifer is used as a drinking water source.

A well point system consisting of a group of closely spaced wells usually connected to a common header pipe and pump can be used to lower the water table at the site. Deep extraction wells can be used to maintain or contain a contaminant plume in the bedrock; however, there is no assurance that all contaminant-bearing fractures are being tapped, and therefore the system itself and groundwater must be frequently and intensively monitored. Any well pumping system is highly energy-intensive and will have high operation and maintenance costs.

Subsurface collection systems consisting of pipe drains, ditches, and trenches may be used to collect groundwater/leachate above the bedrock. The effectiveness of trench systems may be enhanced by placing an impermeable liner along the downgradient side of the trench to impede groundwater flow out of the trench; however, complete effectiveness of a trench is questionable because there is no impermeable layer into which the trench can be placed, and the bedrock fractures provide channels for groundwater movement below the trench. Drainage systems into the fill itself could consist of pipe drains lying in gravel-filled ditches with filter cloth envelopes to prevent clogging. French drains or tile drains, which are easily clogged and difficult to maintain, are therefore inappropriate for a landfill environment. The technical feasibility of constructing very deep trenches (i.e., >50 ft) may limit their effectiveness for the Combe Fill South south site.

2.2.4.4 Excavation and Removal of Waste and Soil. The continued presence of exposed waste and contaminated soil at the site constitutes health and safety hazards from direct physical contact and an indirect health hazard from dispersal of contaminants via air and water. Although some excavation of waste and soil may be necessary as part of site grading, the volume of waste/soil at the site precludes its complete excavation unless a new facility, approved according to the requirements of the Resource Conservation and Recovery Act (RCRA) is created on the site. In addition, the methane being generated by the landfill would make such work dangerous and expensive.

There is currently no RCRA facility with the capacity to accept the volume of waste/soil located at Combe Fill South. Any new RCRA facility built at or near the Combe Fill South site would require the installation of full RCRA liners, leachate alarm systems, and caps as mandated by the 1984 RCRA amendments.

2.2.4.5 Removal/Containment of Contaminated Sediments. Where contaminants from the landfill have been washed into nearby surface waters and settled into stream sediments, the opportunity exists for the resuspension of contaminants into the streams and further transport and contact with humans and organisms downstream. By removing the in-stream contaminated sediments, an additional source of future contamination can be eliminated. The streams on or near the landfill, except at times the Black River, have sufficient periods of dry-weather flow so that typical mechanical construction equipment (bulldozers, backhoes, etc.) can be employed without the aid of more sophisticated and expensive hydraulic or pneumatic equipment. However, as demonstrated in the remedial investigations, little contaminated stream sediments remain because heavy rains have washed most of these sediments away.

To prevent additional sedimentation into surface waters during remedial activities on site, or if stream flow is not low enough for easy use of mechanical equipment, streams can be temporarily diverted or sheetpile cofferdams constructed. Sheetpile barriers could also be used as part of a long-term remediation plan where slope stabilization is required near a streambed.

2.2.4.6 <u>In Situ Treatment</u>. Unlike other waste treatment techniques discussed in subsequent paragraphs, in situ methods treat wastes in place. These techniques are most practical where the wastes are well defined and homogeneous and where the contamination is at shallow depths and small in areal extent. None of these characteristics are applicable to the Combe Fill South landfill. Furthermore, the fractured bedrock at Combe Fill South makes complete capture of by-products generated by these methods and overall monitoring of their effectiveness extremely difficult. Additional information on seven general categories of in situ treatment technologies is provided below.

In <u>extraction</u> (soil flushing or solution mining), a solvent is used to flood the site; as it percolates through the waste, it dissolves or chemically reacts with specific contaminants. The elutriate from this flushing is then captured and further treated to recover, if possible, the solvent and dispose of the contaminants. Even assuming that an appropriate solvent is found (water or leachate could be used), this technique is not suitable for the Combe Fill South site because the fractured bedrock would limit effective capture of the elutriate.

<u>Immobilization</u> of contaminants by adsorbents, ion exchange, or precipitation requires that the waste be mixed with adsorbents, clays or resins, or precipitating agents in order to accomplish the immobilization; only sorption with a mixture of additives is effective for both the metals and organic constituents found at Combe Fill South. Such mixing is impractical in light of the size and depth of the landfill and may present serious safety hazards due to the release of methane.

In situ <u>chemical degradation</u> processes (oxidation, reduction, and polymerization) are primarily conceptual technologies with incomplete demonstrated effectiveness. Oxidation of organic contaminants may result in the production of more toxic by-products than the original contaminants. Reduction, particularly of toxic metals, requires either mixing the waste with metal powders or flushing the waste with an alkaline solution. (The difficulties associated with both mixing and capture of elutriate at the site have been previously discussed for other technologies.) Mixing and elutriate capture problems are also associated with polymerization.

Biodegradation utilizes microorganisms to break down contaminants in soils or water. Biodegradation has been successful in treating groundwater contaminated by spills and leaks of "pure products." Such is not the case at Combe Fill South, where a mixture of organic compounds and metals contaminate the soils and water. Maintenance of optimal conditions for site-wide application of biodegradation mechanisms at Combe Fill South would be extremely difficult as there is no identified "spill" area at the site to warrant a discrete application. Effective utilization of biodegradation for contaminant reduction in the bedrock aquifer is not feasible because fractures could easily channel untreated groundwater away from the site.

Photolysis utilizes light energy to drive a chemical reaction and is effective only for surface contamination. Attenuation reduces the concentration of contaminants to acceptable levels by mixing clean soil with contaminated soil. (The problems associated with such mixing are discussed above). In addition, the volume of clean soil needed may require significant additional land surfaces for the subsequent spreading of the resulting mixture. To reduce volatilization of organic compounds, the fill could be soaked with water, thus taking up the pore space in which volatilization could occur. This, however, results in the problems of inadequate elutriate capture as discussed previously.

2.2.4.7 Waste Treatment. Waste treatment, to separate and chemically and/or physically alter the contaminants in waste streams, at Combe Fill South may be used subsequent to collection or removal measures. The waste at the site to be treated may include direct waste streams, such as air, groundwater, leachate, soils, or solid wastes, or indirect waste streams including gaseous, liquid, and solid/semisolid by-products from other treatment processes.

Incineration or destruction measures are generally applied to low-moisture content solid/semisolid or liquid wastes and some gases. (Incineration of gases is discussed separately below.) Inert materials, i.e., soils, are not compatible with such processes. Unless the fill area is excavated for incineration of the previously landfilled waste, the most likely application of incineration at Combe Fill South is the incineration/treatment of sludges and waste products from liquid and gaseous treatment processes. Several incineration processes - rotary kiln, fluidized bed, multiple hearth, and liquid injection - have had extensive commercial application for the treatment of hazardous wastes and may be applicable for use at Combe Fill South or at an off-site incineration facility. Experimental techniques of unproven or previously limited application to hazardous wastes including starved air combustion/pyrolysis, molten salt injection, and plasma arc pyrolysis, are not recommended for further examination at Combe Fill South.

Gaseous waste treatment can be used at Combe Fill South in conjunction with gas collection systems and/or may be used to treat gaseous by-products from liquid waste treatment processes or incineration. Activated carbon can be used to absorb volatile organic contaminants and may be used in conjunction with other mechanisms such as flaring. In flaring, methane is used as the fuel source and is burned off; at the same time some volatile organics are also oxidized, although their combustion may be incomplete, resulting in smoke. Afterburners are generally high-flow rate incinerators for

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gases and vapors and provide more complete combustion than flaring, but are not effective for contaminants requiring very high oxidation temperatures. Depending on the amount and type of gases being emitted, recovery and reuse of the gases may be warranted. The most likely candidate for such recovery would be methane generated by the fill; however, recovery may not be cost-effective and will require further examination of the quantities of methane produced.

Biological, chemical, and physical treatment of liquid waste streams including leachate, groundwater and surface water can be an effective remedial technology for use at the Combe Fill South landfill. Such treatment may, however, have to be done at the landfill site because there is no publicly owned treatment works (POTW) in either Chester or Washington Townships or sufficient capacity to handle the groundwater/leachate quantities generated at the site. The final selection of any specific treatment process should be contingent upon a waste characterization and treatability study. A combination of physical, chemical, and biological processes would probably provide for the maximum removal of contaminants.

Biological treatment processes more likely to be applicable to the site include activated sludge, trickling filter and rotating biological contactor (RBC). Aerated lagoons and stabilization ponds (which take up more space) are not as effective as the other processes. Anaerobic filters are generally used as a pretreatment mechanism for strong waste and may not be applicable to the site's waste contaminants or concentrations.

Chemical liquid waste treatment mechanisms that may be applicable to the site in conjunction with other processes include precipitation, flocculation/coagulation, aeration/oxidation and neutralization. Ultraviolet treatment and ozonation as disinfectants are not commonly used; chlorination is the more common disinfectant.

Physical treatment processes for liquid waste streams generally applicable to hazardous waste treatment include flow equalization, sedimentation, filtration, air stripping, and activated carbon adsorption. The cost of an activated carbon system generally limits its application to effluent polishing after other waste treatment processes. Some liquid treatment processes such as ion-exchange, reverse osmosis, and steam stripping are technically feasible measures but are more costly than other methods. Liquid-liquid extraction and steam distillation are inappropriate technologies because they are considerably more expensive than other equally suitable methods. Oil-water separation may be necessary only if the influent contains large quantities of oils or greases.

Sludge handling and treatment processes would be required in conjunction with a liquid treatment system. Thickening/dewatering mechanisms are used to reduce the volume of the sludge prior or subsequent to treatment or ultimate disposal. These thickening mechanisms include the use of screens (used early in the liquid treatment system to remove larger objects), centrifuges, gravity thickeners, flotation thickeners, vacuum filters, belt filters, and pressure filters. Sludge thickening would probably be conducted on-site while treatment and disposal may be conducted either on- or off-site.

Depending on the physical/chemical composition of the sludge, additional treatment/disposal processes may include neutralization, oxidation/reduction, and incineration. Composting, although technically feasible, may not be possible if the waste is toxic, particularly from concentrations of heavy metals.

Solidification/encapsulation techniques are generally utilized for "pure products" or relatively small quantity, highly concentrated wastes. Most of these techniques require the excavation and/or mixing of the waste with some other media. At Combe Fill South, the mix of contaminants and combined waste/soil volume usually makes direct utilization of solidification/encapsulation techniques impractical and potentially dangerous because of the explosive potential of methane. Solidification techniques involve the mixing of the waste with some binder or stabilizer. The resultant volume of binder and waste may be up to twice the original volume, thus requiring an increase in the capacity (size) of the landfill. Expansion of the landfill beyond its present boundaries is not desirable.

Specific solidification techniques have other disadvantages, such as:

- Cement, which is porous, may leach organics that are not as effectively bound as other materials.
- Lime merely stabilizes the waste and does not treat organic contaminants.
- Thermoplastic binders, such as asphalt and paraffin, liquify under high temperatures and are not suitable binders for organic solvents.
- Organic polymers may biodegrade, thus releasing contaminants.
- Self-cementing solidification requires that the waste have high sulfate or sulfite concentrations, which are not found at Combe Fill South.
- Glassification combines waste with molten glass and is a very energy intensive and costly process.

Encapsulation physically encloses the waste in such materials as high-density polyethylene. Although suitable for highly contaminated sediments and sludges, most commercial applications are at centralized facilities and are very expensive.

2.2.4.8 Land Disposal/Storage. Land disposal/storage of treated or untreated wastes may be possible at Combe Fill South. However, land disposal is being phased out as an acceptable treatment and disposal mechanism for hazardous waste under the RCRA program.

Landfilling of excavated wastes from the site at an off-site location may be impossible because no RCRA permitted facility has the capacity to accept such large quantities of waste. Therefore, if landfilling is pursued, it must be accomplished by the creation of a new RCRA facility at the present landfill site. In order to achieve RCRA design requirements for landfills, substantial amounts of land would have to be acquired adjacent to the present landfill.

Surface impoundments used merely as storage/holding facilites (not as part of a treatment process as previously discussed) would provide no further treatment of the waste sources on-site and would therefore not be an effective remedial measure. Waste piles have similar limitations.

Deep well injection, of treated waste only, may be unacceptable from a public health standpoint because the bedrock aquifer is used as a potable water source by the community. The individual components of waste collection and treatment prior to such disposal may not be able to provide assurances that wastes are adequately collected, treated, and monitored to meet drinking water criteria.

On-site temporary storage of some waste products may be necessary prior to subsequent treatment or disposal. Temporary storage facilities may include lagoons/impoundments, drums, containers, or diked waste piles, depending on the nature of the waste and subsequent treatment or disposal processes being used.

2.2.4.9 Contaminated Water Supplies. Since potable wells near the landfill revealed concentrations of contaminants which may pose a health risk, permanent alternative sources of drinking water should be considered. Such actions, however, do nothing to remediate the causes or sources of the waste problems on the site. Temporary alternate drinking water sources may be necessary while other source-specific remedial actions are taken.

Drilling deeper wells for individual residences or perhaps for a new public supply may be possible if the tapped aquifer is not contaminated, however, this is not the case for the Combe Fill South site. Connecting affected residents to the municipal water system may also be possible if the system has the capacity to accept additional hookups and if the water supply lines are within a few miles of the site. Cisterns, tanks, and bottled water may be used to provide potable water on a short-term basis but are not effective long-term measures.

If contamination levels are low or isolated, individual home water treatment units may be acceptable remedial measures. However, not all contaminants are amenable to such individual treatment units and reliance on homeowner operation and maintenance may not be institutionally acceptable.

2.2.4.10 Relocation. Relocation of portions or all of the affected nearby community may be necessary if sufficient health risks from specific contaminant pathways exist or if required to implement specific remedial actions. For example, the construction of a new RCRA landfill on-site would probably require the purchase of nearby vacant property and the relocation of some residences and/or businesses. Relocation, like providing alternative drinking water supplies, does nothing to remediate the source of the problem.

2.2.4.11 Access Restriction. Several cost-effective mechanisms exist that can restrict access to the site, thereby limiting the problems of direct contact with the wastes. Warning signs, fences, and locking gates can provide some barriers to the site, although the determined trespasser may still gain entrance. Security guards or other more intensive and costly site security measures may be warranted, depending on the nature of the wastes found or the remedial actions finally selected but are probably not appropriate for the Combe Fill South site.

CHAPTER 3

SCREENING OF PRELIMINARY REMEDIAL ACTION ALTERNATIVES

3.1 INTRODUCTION

Candidate remedial actions successfully passing the initial screening of technologies are then combined into alternative action sets that achieve or attempt to achieve one or more of the remedial federal and site objectives. These preliminary alternatives and their components are then evaluated for their general environmental and public health impacts and rough costs. Based on this evaluation, final alternatives are selected for detailed evaluation; at least one alternative formulated to meet each of the five federal objective categories will be evaluated in detail. Individually successful technologies originally grouped in an unsuccessful alternative set can be regrouped for subsequent evaluation with other successful technologies or be evaluated as separate "add-on" components to another basic alternative. Some alternatives may fall into more than one objective category or may overlap categories.

In addition to formulating and identifying the remedial alternatives to achieve stated objectives, these remedies are also classified as being either source control or management of migration actions. Source control remedies prevent or minimize the migration of hazardous substances from the source material (in this case, from the boundaries of the landfill property) by attempting to remove, stabilize, and/or contain the hazardous substances. Management of migration actions are used when hazardous substances have migrated beyond the original source of the contamination and pose a significant threat to public health, welfare, or the environment. Alternatives may combine both source control and management of migration remedies.

3.2 DEVELOPMENT AND EVALUATION OF PRELIMINARY ALTERNATIVES

In developing the following set of preliminary alternatives, actions appropriate to long-term responses are generally emphasized. Actions that play a role primarily in short-term construction-related remediation (i.e., dust control with polymers or water, runoff flow control during construction using berms or downspouts, etc.) are not specifically considered in this preliminary screening. Where appropriate, these construction-related remedies are evaluated later as part of the detailed evaluation of alternatives or conceptual design of the selected remedial action.

Cost estimates for these preliminary alternatives are based on costs provided in "Remedial Action at Waste Disposal Sites, Revised" (EPA October 1985), "Draft Compendium of Cost of Remedial Technologies at Hazardous Waste Sites" (Environmental Law Institute May 1985), and other recent RI/FS studies. A health and safety surcharge of 70% is applied to all labor associated with work on the fill itself because it is assumed that Level C safety protection will be necessary. Total capital costs for each alternative include direct capital expenditures, engineering and design costs at 15% of direct costs, legal and administrative costs at 5% of direct costs, and an engineering contingency of 25% of the direct costs. Present worth calculations for this stage of alternatives analysis use a discount rate of 10% over a 30-yr project life. (Present worth calculations for the final set of alternatives examined in detail used the new federally mandated rate of 8 5/8%). Alternative cost estimates provided at this level of alternatives screening are generally accurate within a range of -50% to +100%.

Table 3-1 summarizes the 10 preliminary alternatives developed for this screening, and describes for each alternative:

TABLE 3-1 (Page 1 of 2)

PRELIMINARY REMEDIAL ALTERNATIVES
Combe Fill South Landfill

OBJECTIVES ACHIEVED	ALTERNATIVE	SOURCE CONTROL (SC) OR MANAGEMENT OF MIGRATION (MM)	TECHNICAL COMPONENTS
1. No remedial action	No Action	-	Security fence, gate, and warning signs Groundwater monitoring
2. Off-site disposal at EPA approved facility	A. Disposal at Off-site RCRA Landfill	SC	Excavate contaminated soils and waste Grade and revegetate site Transport to and disposal at RCRA landfill Groundwater monitoring
Disposal at EPA approved facility	B. New RCRA Landfill	SC	Excavate contaminated soils and waste Construct new RCRA landfill on and near site to meet RCRA landfill requirements Security fence, gate, and warning signs RCRA monitoring
3. Attain applicable or relevant and appropriate requirements	A. Cap, Trench, and Treat	SC, MM	Fill and grade Cap (no membrane) Leachate collection trench Leachate treatment and discharge to Trout Brook Surface water controls Passive gas collection and discharge Security fence, gate, and signs RCRA monitoring Temporary bottled water
	B. Cap, Trench, Deep Pump, and Treat	SC, MM	Fill and grade Cap (no membrane) Leachate trench Deep pump groundwater flow path No. 6 impacting Schoolhouse Lane Leachate and groundwater treatment and discharge to Trout Brook Surface water controls Passive gas collection and discharge Security fence, gate, and signs RCRA monitoring Temporary bottled water
	C. Cap, Shallow and Deep Pump, and Treat	SC, MM	Fill and grade Cap (no membrane) Shallow pumping wells for leachate collection Deep well pumping of groundwater impacting Schoolhouse Lane Leachate and groundwater treatment and discharge to Trout Brook Surface water controls Passive gas collection and discharge Security fence, gate, and sign RCRA monitoring Temporary bottled water

TABLE 3-1 (Page 2 of 2)
PRELIMINARY REMEDIAL ALTERNATIVES

Combe Fill South Landfill

OBJECTIVES ACHIEVED	ALTERNATIVE	SOURCE CONTROL (SC) OR MANAGEMENT OF MIGRATION (MM)	TECHNICAL COMPONENTS
4. Exceed applicable or relevant and appropriate requirements	Exceed Requirements	SC, MM	Fill and grade Cap (with membrane) Upgradient barrier Leachate collection trench Deep pumping wells in all groundwater paths Treatment of leachate and groundwater and discharge to Black River Surface water controls Active gas collection and treatment Security fence, gate, and signs RCRA monitoring Extension of public water to Schoolhouse Lane and Parker Road Temporary bottled water Permanent alternate water supply
5. Achieve some but not all applicable or relevant and appropriate requirements	A. Cap, Circumferential Barrier, Short-Term Pump, and Treat in Groundwater Flow Path No. 6	SC, MM	Fill and grade Cap (no membrane) Temporary pump and treat (with air-stripping tower) groundwater in flow path no. 6. Discharge to unnamed tributary Circumferential barrier Surface water controls Passive gas collection and discharge Security fence, gate, and signs RCRA monitoring Temporary bottled water
	B. Clayless Cap	SC, MM	As per Alternative 3A but cap does not have clay layer
	C. Cap Only	SC	Fill and grade Cap (no membrane) Surface water controls Passive gas collection and discharge Security fence, gate, and signs RCRA monitoring Temporary bottled water

- The technical components
- The objective(s) achieved
- Whether it is a source control and/or management of migration remedy

Table 3-2 summarizes the environmental and public health impacts and costs associated with these preliminary alternatives.

3.2.1 No-Action Alternative

An alternative that achieves the objective of no action is defined here as one that does not include any Superfund financed remedial activities, as defined by the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) and the National Contingency Plan (NCP November 1985). This does not preclude the implementation of actions deemed as "removal" activities under CERCLA, such as security fencing and warning signs, and is assumed not to preclude state or locally financed actions as long as they are in accordance with the findings of the RI/FS.

Therefore, the no-action alternative for the Combe Fill South landfill includes the installation of a security fence with locking gate and warning signs around the landfilled property. Also included is a quarterly monitoring program to assess the quality of groundwater at two on-site and three off-site locations. Although direct access to contaminated soils and wastes on the landfill will be restricted, the no-action alternative does not prevent or minimize the continued contravention of the federal primary drinking water standards, as described in the RI, nor does it prevent or minimize the continued off-site movement of the groundwater contaminant plume. Erosion of the essentially unvegetated landfill surface would continue. Leachate from the landfill would continue to enter the groundwater flow systems, impacting adjacent groundwater quality and streams. On the other hand, because no on-site

TABLE 3-2 (Page 1 of 2)

ENVIRONMENTAL AND PUBLIC HEALTH IMPACTS AND COSTS OF PRELIMINARY ATLERNATIVES

Combe Fill South Landfill

ALTERNATIVE OR TECHNICAL OPTION	ENVIRONMENTAL AND PUBLIC HEALTH IMPACTS	COSTS ($1000) CAPITAL	PRESENT WORTH[a]
1. No Action	Limits direct physical contact with landfill Long-term adverse impacts from continued release of contaminants to surface, groundwaters, and air	152	535
2A. Disposal at Off-site RCRA Landfill	Significant short-term impacts to environment and and public health and safety during excavation No mitigation or reduction of current groundwater contamination	3,378,283	3,378,612
2B. New RCRA Landfill	Significant short-term impacts to environment from excavation of wastes and refilling of new waste wells No mitigation of current groundwater contamination (thus may not meet federal requirements) Long-term mitigation of environmental and public health impacts by removal of contaminant source Requires an additional 135 acres of land to meet RCRA design requirements	215,843	219,313
3A. Cap, Trench, and Treat	Long-term benefits from reduction (by 90%) and treatment of contaminated groundwater; however, leachate may continue to enter and move in bedrock groundwater Continued short-term contaminant migration toward Schoolhouse Lane; may also have continued migration in uncontrolled bedrock aquifer Short-term beneficial benefits to the public receiving temporary bottled water for drinking Adverse short-term construction-related impacts	38,762	43,784
3B. Cap, Trench, Deep Pump, and Treat	As per Alternative 3, plus pumping of bedrock groundwater in flow pathway impacting Schoolhouse Lane provides additional direct management of plume migration and therefore may provide additional reduction of contamination in the groundwater Other deep groundwater migration pathways may still experience groundwater flow off-site in the deep bedrock	38,931	44,190
3C. Cap, Shallow and Deep Pump, and Treat	As per Alternative 3B; shallow pumping wells merely substitute for collection trench More long-term energy and maintenance needs for shallow pumping system	37,016	46,178
4. Exceed Requirements	As per Alternative 3B but provides for additional contaminant plume management and contaminant reduction, but at much higher energy and maintenance costs because of deep wells in all flow paths Beneficial impacts from gas treatment in reducing air contaminants Provides all residents on Schoolhouse Lane and Parker Road with permanent alternate water supply Reduces impacts to Trout Brook by discharging treated effluent to Black River, but at same time results in additional temporary short-term impacts from constructing longer outfall More short-term impacts related to construction than either Alternative 3A or 3B including construction of outfall to Black River	53,875	60,442

[a]Present worth calculated using 10% discount rate over 30-year project life.

TABLE 3-2 (Page 2 of 2)

ENVIRONMENTAL AND PUBLIC HEALTH IMPACTS AND COSTS OF PRELIMINARY ATLERNATIVES

Combe Fill South Landfill

ALTERNATIVE OR TECHNICAL OPTION	ENVIRONMENTAL AND PUBLIC HEALTH IMPACTS	COSTS ($1000) CAPITAL	PRESENT WORTH[a]
5A. Cap, Circumferential Barrier, Short-Term Pump, and Treat in Flow Path No. 6	Long-term benefits from reduced infiltration because of cap and management of groundwater flow in shallow aquifer as in other alternatives Some short-term benefits from temporary management and treatment of groundwater flows in flow path no. 6. Possible short-term adverse impacts to unnamed tributary from temporary treatment discharge Some adverse impacts from no long-term management or treatment of groundwater flows Significant short-term adverse construction impacts associated with barrier	48,119	50,380
5B. Clayless Cap, Trench, and Treat	As per Alternative 3A except some additional infiltration through cap will require treatment of larger flows for longer period of time Increases possibility of continued contaminant migration	30,853	36,581
5C. Cap Only	Long-term benefits from reduction of infiltration, which will reduce leachate production and contaminant movement from the site, but benefits not as great as with alternatives that also manage and treat groundwater Additional short-term adverse impacts from contaminant migration in groundwater since no management or treatment of plume Fewer short-term construction-related impacts	33,567	35,814

[a]Present worth calculated using 10% discount rate over 30-year project life.

remedial action takes place, it is the only alternative that does not adversely impact the wetlands in the headwaters of Trout Brook. Groundwater on and near the landfill would be monitored quarterly from the shallow and deep wells used during the remedial investigation and private potable wells nearby.

The approximate total capital cost of implementing this alternative is $152,000. Operation and maintenance costs are primarily those associated with the quarterly sampling and chemical analysis of the groundwater. The present worth of this preliminary no-action alternative is $535,000.

3.2.2 Alternatives That Provide Off-Site Storage, Destruction, Treatment, or Secure Disposal of Hazardous Substances At An EPA-Approved Facility

To achieve this objective, the contaminant source (i.e., landfilled soils/wastes) and/or contaminant transport media (e.g., groundwater) would be collected and then transported off-site for treatment and/or disposal. Off-site treatment of contaminated groundwater at a publicly owned treatment works (POTW) is evaluated in subsequent paragraphs describing alternative waste treatment remedies, and is not included in either of the following landfilling alternatives.

Complete excavation, transport and disposal of contaminated soils/wastes at an approved off-site RCRA landfill disposal facility would provide long-term benefits to the local environment and public health by removing the initial source of contamination, i.e., the waste itself. Violations of drinking water standards in groundwater would continue into the future until sufficient quantities of uncontaminated groundwater flowing through the remediated site can dilute and flush out the current contamination. Possibly significant adverse impacts to public health and safety may result from the excavation and transport of the landfilled wastes, which have not been precisely defined or characterized. Excavation activities will also adversly impact the wetlands at the headwaters of Trout Brook. The present worth of this waste excavation and transportion and disposal at a RCRA-approved landfill in Buffalo consists primarily of capital costs (particularly the "tipping" fee at the landfill), and is estimated at $3.4 billion.

Currently, neither the Buffalo landfill nor any other RCRA-approved landfill has the capacity to accept the large volume ($5x10^6$ yd^3) of contaminated soils/wastes that may be present in the Combe Fill South landfill. Therefore, a possible alternative would be to construct a RCRA-approvable landfill on and near the existing landfill. A RCRA-approvable facility would require phased excavation of all wastes on-site while new, lined, and capped waste cells are constructed and filled. Approximately 135 acres of land next to the existing landfill property (115 acres) would be needed to meet RCRA requirements for such a landfill. The present worth of such a facility is $219 million, and is mostly influenced by the capital costs of construction, which are $216 million.

3.2.3 Alternatives That Attain Applicable Or Relevant And Appropriate Requirements

In addition to drinking water, surface water, and ambient air criteria used to assess site conditions in the remedial investigation, CERCLA and RCRA requirements are assumed to be applicable in the development of remedial alternatives. Because contaminants have migrated from the landfill (primarily in the groundwater), remedial alternatives must provide for some form of management of this contaminant migration in order to attain applicable requirements.

As shown in Table 3-1, three preliminary alternatives (3A, 3B, and 3C) have been formulated that may attain federal requirements. Each alternative provides mechanisms for source control and management of contaminant migration, and provides some means of mitigating the adverse impacts in each of the contaminated media identified including groundwater, surface water, air, and soils. Each alternative provides for control of surface water runoff; passive gas collection and discharge; security fencing (including locking gates and warning signs); post-closure RCRA monitoring of groundwater, surface water, and air; and temporary bottled water for residents at risk. A multilayer, multimedia cap is the primary remedial source control action used in all three alternatives and is similar to a full RCRA cap except that it does not include a synthetic membrane. (In each alternative, construction of this cap will result in adverse impacts to the wetlands in the headwaters of Trout Brook.) All three alternatives also provide for control of contamination in the groundwater but differ as to the nature and degree of the control they provide.

Alternative 3A includes a leachate collection trench bordering on approximately three-quarters of the landfill along the northeast, southeast, and southwest to collect landfill leachate and contaminated groundwater in the shallow aquifer. This contaminated water would receive physical/chemical/biological treatment on-site, and the treated effluent would be discharged to Trout Brook. Off-site treatment of the contaminated groundwater at a POTW was not considered reasonable for further evaluation because a 10-mi interceptor/force main (or operationally intensive truck tankage) would have to be constructed to carry the wastewater to the nearest facility (i.e., Hackettstown STP) having sufficient hydraulic capacity to handle the wastewater. The leachate/groundwater collection trench would have to be constructed down to competent bedrock to provide effective control of groundwater in the shallow aquifer, which accounts for approximately 90% of the total groundwater flow at the site. Groundwater in the deeper bedrock, which accounts for 10% of the total groundwater flow from the site, will not be directly controlled. Current groundwater contamination that has moved off-site would also not be mitigated in this alternative.

The major costs of this alternative are associated with the capital costs of cap construction; however, there is also a substantial amount of capital and O&M cost associated with the implementation of on-site treatment. The total present worth of this alternative is $43,784,000, of which capital costs account for $38,762,000.

Some control of the deeper groundwater contaminant plume is attempted in Alternative 3B. In addition to providing all the remedial actions described for Alternative 3A, this alternative would pump out groundwater in the groundwater flow path that intersects the western end of Schoolhouse Lane (identified as No. 6 in the RI) and treat it at the on-site treatment facility prior to discharge to Trout Brook. This flow path accounts for 7% of the total bedrock groundwater flow, or slightly less than 1% of the total groundwater flow. In this way, an attempt is made to mitigate the contaminant plume that apparently has moved off-site and poses the most significant threat to public health. Nevertheless, even this direct pumping may not be completely effective in controlling the groundwater in flow path No. 6 because of the highly fractured nature of the bedrock; there would be no assurance that the deep wells are actually tapping all of the groundwater-carrying fractures. Also, groundwater in the deep aquifer would continue to move off-site in the other direction. (This alternative could be expanded to include pumping of one or more flow paths; pumping and treating deep groundwater flow in all flow paths is described in Alternative 4.) The capital construction costs (particularly the cap) are the main cost items for Alternative 3B, and are $38,931,000. The total present worth of this alternative is $44,190,000. O&M costs for Alternative 3B are primarily associated with the operation of the treatment facility and are somewhat higher than those of Alternative 3A because of the additional O&M and treatment needs from pumping the one deep groundwater flow path.

Alternative 3C is identical to Alternative 3B except that a shallow well system is used to pump groundwater from the shallow aquifer instead of a collection trench. Because such a pumping system is more difficult to operate and maintain than the trench and uses a substantial amount of electricty the O&M costs of this alternative are substantially greater than those of Alternative 3B, although the initial capital construction costs are less. The capital costs and present worth for Alternative 3C are $37,017,000 and $46,178,000, respectively.

3.2.4 Alternative That Exceeds Applicable Or Relevant And Appropriate Requirements

The alternative developed in an attempt to achieve this objective includes substantially more remedial activities for all possible waste sources and pathways. As described in Tables 3-1 and 3-2, this alternative includes filling and grading of the site, followed by construction of a full RCRA cap (i.e., including a synthetic membrane as one of the cap layers) to minimize rainfall infiltration and reduce leachate production. As described previously, construction of any cap will result in adverse impacts to the wetlands on and next to the landfill property. An upgradient groundwater barrier, probably a bentonite-soil slurry wall, would be constructed down to bedrock to divert around the fill the small amount of groundwater moving on-site, and thereby further reduce leachate production in the fill and help minimize contaminant migration. Leachate and contaminated groundwater in the shallow aquifer would be collected in the leachate trench described for Alternative 3A. Deep pumping wells in each of the groundwater flow paths identified for the site are included in an attempt to control contaminant migration in the deeper aquifer. Leachate and contaminated groundwater from the shallow and bedrock aquifers would be treated at an on-site physical/chemical/biological treatment system. Treated effluent would be discharged to the Black River to minimize possible impacts to Trout Brook from the treated effluent. (At the same time, however, construction of this outfall to the Black River will result in additional construction-related impacts along the length of the outfall.) An active gas collection and treatment system, including flaring, would be provided to reduce the emission of methane and other landfill gases to the air. Like Alternatives 3A, 3B, and 3C, Alternative 4 will control surface water runoff on the site. Access to the site will be restricted by the use of security fencing, locking gates and warning signs. Monitoring of the air, surface, and groundwater on and near the site will be in accordance with RCRA guidance. Finally, in addition to providing temporary bottled water for the residents of Schoolhouse Lane and Parker Road near the site, these areas would also receive a permanent alternate water supply.

These additional remedial activities will provide some additional benefical impacts to long-term public health and the environment, although adverse short-term construction-related impacts will be greater, as will long-term O&M requirements. Whether these additional actions will actually result in proportionally greater remediation than other alternatives for the level of efforts expended is uncertain at this stage of the analysis. The capital costs and present worth of Alternative 4 are $53,875,000 and $60,442,000, respectively. A detailed analysis of the costs vs benefits of these additional remedial activities are provided as part of the subsequent detailed analysis of alternatives.

3.2.5 Alternatives That Do Not Attain Applicable Or Relevant Public Health Or Environmental Standards But Will Reduce The Likelihood Of Present Or Future Threats From Hazardous Substances

Three alternatives (5A, 5B, and 5C) were developed in this final category. Each of these alternatives provides for fewer, or less complex remedial actions than the preceding alternatives while still attempting to mitigate the impacts from the major contaminant sources and pathways. At this stage of alternatives analysis it is uncertain whether these alternatives achieve applicable requirements.

As shown in Tables 3-1 and 3-2, Alternative 5A includes filling, grading, and capping of the site (as in Alternative 3A) to reduce infiltration through the landfill, reduce leachate production, and limit further migration of contaminants in the groundwater. The cap, in combination with a passive gas collection system, will control and reduce contaminant migration into the air. Other components of Alternative 5A that are identical to those described previously for Alternative 3A include surface water controls, security fencing, RCRA monitoring, and temporary bottled water. Unlike Alternative 3A however, this alternative does not provide long-term collection and treatment of contaminated groundwater. It does provide for the short-term (less than five year) pumping, treating, and surface discharge of groundwaters from the groundwater flow path impacting the western half of Schoolhouse Road (about 13,600 gpd of shallow and deep bedrock groundwater flow). This short-term pump and treat action may be able to remediate the most significant groundwater contaminant pathway until the long-term action, i.e., a circumferential grout barrier can be constructed. Unlike many other alternatives, this alternative relies on the passive protection of the barrier rather than the active remediation of collection and treatment. A bentonite-soil barrier constructed down to competent bedrock and almost entirely encircling the site would essentially eliminate the lateral groundwater and contaminant movement in the shallow aquifer from the site. However, groundwater and contaminant movement into and through the deeper groundwater aquifer, will be enhanced by this alternative particularly in years of higher rainfall when the groundwater table is higher. Because this alternative does not include actions that require substantial long-term operation and maintenance the present worth ($50,380,000) of this alternative is due almost entirely to capital construction costs ($48,119,000), which in turn are primarily a function of the cap and barrier.

Alternative 5B is identical to Alternative 3A except that the proposed landfill cap would not include a 2-ft clay layer. Eliminating the clay considerably lowers the capital costs of the alternative at the expense of additional infiltration through the cap and additional leachate production. In order to handle this additional leachate the on-site treatment facility must treat higher volumes of leachate and groundwater over a longer period of time, thus raising the O&M costs of the alternative. The capital costs and present worth of this alternative are $30,853,000 and $36,581,389, respectively.

The primary remedial action in Alternative 5C is a cap (with a clay layer) and its accoutrements (i.e, filling and grading, surface water controls, passive gas collection and discharge). This alternative, while significantly reducing the production of leachate in the future, does not mitigate the current on- and off-site groundwater contamination and results in greater continued off-site movement of contamination than other alternatives. The capital costs of this alternative are primarily those associated with construction of the cap and are $33,567,000. The present worth of the alternative is $35,814,000.

CHAPTER 4

ALTERNATIVES FOR DETAILED EVALUATION

4.1 SELECTION OF ALTERNATIVES FOR DETAILED EVALUATION

The preliminary remedial alternatives, developed in the alternatives screening process, were reviewed and evaluated by a team of representatives from NJDEP and EPA, Region II. Based on this review, a final list of eight remedial alternatives, and their technical options, was prepared. These alternatives are summarized in Table 4-1 and are described in this chapter.

The eight final alternatives are grouped into the five federal objective categories described in Chapter 2, including:

1. No or minimal action
2. Alternatives for treatment or disposal at an off-site facility approved by EPA (new RCRA landfill).
3. Alternatives that attain applicable and relevant Federal public health or environmental standards
4. Alternatives that exceed (do better than) applicable and relevant Federal public health or environmental standards
5. Alternatives that do not attain applicable or relevant public health or environmental standards but will reduce the likelihood of present and future threats from hazardous substances

In Chapter 5 these alternatives are evaluated in detail for their technical, environmental, and cost impacts. Based on this evaluation, a preferred remedial alternative is selected, and a conceptual design is prepared. The selected remedial alternative may

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TABLE 4-1

COMPONENTS OF REMEDIAL ACTION ALTERNATIVES
COMBE FILL SOUTH LANDFILL

COMPONENT	ALTERNATIVES 1 NO ACTION	2 NEW RCRA LANDFILL	3 ACHIEVE FEDERAL STANDARDS A	3 B	3 C	4 EXCEED STANDARDS	5 ACHIEVE SOME BUT NOT ALL STDS A	5 B
1. Security fencing	X	X	X	X	X	X	X	X
2. Environmental monitoring	X	X	X	X	X	X	X	X
3. Access road(s)			X	X	X	X	X	X
4. Grading, filling, and general site preparation			X	X	X	X	X	X
5. Multilayered, terraced cap								
A. With clay			X	X	X	X	X	
B. No clay								X
6. Gas venting								
A. Passive								
1. Trench			X	X				X
2. Pipe vents					X		X	
B. Active						X		
7. Gas treatment						X		
8. Surface water controls			X	X	X	X	X	X
9. Leachate collection trench			X	X		X		X
10. Shallow aquifer pumping					X			
11. Deep aquifer pumping								
A. Flow path No. 6				X	X			
B. All flow paths						X		
12. Groundwater barrier wall								
A. Circumferential							X	
B. Upgradient						X		
13. Groundwater/leachate treatment and disposal								
A. With discharge to Trout Brook			X	X	X			X
B. With discharge to Black River						X		
14. Creation of on-site RCRA landfill		X						
15. Alternate water supply	X	X	X	X	X	X	X	X

consist of an alternative as originally formulated, or may consist of regrouped successful technologies that may originally have been part of unsuccessful alternative group.

Several alternatives and technical components included in the preliminary screening of alternatives were not selected for additional detailed evaluation and were eliminated from further consideration for site remediation. These screened-out actions include:

- Complete excavation of contaminated soils and waste with transport to an off-site RCRA-approved landfill

  As described in the screening of alternatives, there is no RCRA-approved landfill with the capacity to accept the volume of wastes suspected of being in the Combe Fill South landfill. Even if such an off-site facility were available, the costs of this method of remediation are prohibitively expensive because of the high tipping (user) fee charged by such facilities and the large volume of wastes at the landfill to be disposed.

- Excavation and off-site disposal of contaminated "hot spots"

  Results of field investigations conducted during the RI revealed that the wastes on-site are highly heterogeneous and no "hot spots" or "source" of hazardous waste materials could be found. Therefore, excavation and off-site disposal of contaminated "hot spots" has been eliminated from further consideration. As described in subsequent paragraphs, excavation is still considered as part of the site grading activities.

- Temporary pumping and treating, with air-stripping, of groundwater in the groundwater flow path (labeled No. 6 in the RI) impacting western Schoolhouse Lane

  During the preliminary screening of alternatives, this technology was included because its rapid

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implementability (from a technical viewpoint) could be used to provide almost immediate remediation (reduction) of impacts from groundwater contamination to those residents at greatest risk. However, such an action may be institutionally difficult to implement quickly because of restrictive air and surface water discharge permitting requirements. Therefore, a more institutionally acceptable action, i.e., development of a permanent alternative water supply in conjunction with temporary bottled water has been substituted in all alternatives. These alternative water supply actions provide the greatest long-term remediation of adverse public health impacts from contaminated drinking water.

- Use of capping as the only significant remedial action, i.e., no remediation of groundwater contamination

  This preliminary alternative relied primarily on capping (and its accompanying technologies such as site grading, gas venting, and surface water control) to provide site remediation. During the screening process, this alternative was eliminated from further consideration because it lacked measures that would directly remediate contamiated groundwater, although the cap indirectly remediates contaminated groundwater by reducing future leachate production and infiltration.

Use of a synthetic membrane as part of a multilayered cap. RCRA guidance for the construction of new hazardous waste landfill cells suggests the use of a synthetic membrane as part of the covering cap in order to provide additional impermeability in the cap. Effective placement and functioning of such a membrane may be restricted by slope limitations, which cannot be met on the site without the utilization of a significant (i.e. greater than 100 acres) amount of land surrounding the site or the employment of a more expensive slip-resistant membrane. In addition, waste subsidence, chemical and physical deterioration, and installation difficulties associated with adequate sealing of the liner edges may impair the long-term effectiveness of a synthetic membrane.

Since a desirable final cover permeability (1×10^{-7} cm/sec) can be achieved with other cap layer materials, the use of a synthetic membrane at the Combe Fill South landfill has been eliminated from further consideration. Therefore, since the objective of a RCRA cap is primarily to achieve a desired impermeability, the use of an impermeable membrane, as part of a cap is considered only as a possible optional technology in the remaining analyses of alternatives, a final decision as to its need can be made during final design.

In addition to the components and alternatives which have been screened out for further evaluation, one action, i.e., provision of permanent alternate potable water to residents at risk, is now included in all alternatives being evaluated in detail. In the preliminary alternatives only temporary alternate potable water was included in the remedial alternatives until the other actions become effective (except alternative 4 which included both temporary and permanent alternate potable water). Provision of a permanent alternate water supply is the most direct and only completely effective way to mitigate the most serious impacts of contaminated groundwater, i.e., those to the local potable water supply. Such an action however addresses the symptoms and not the cause of groundwater contamination.

4.2 ALTERNATIVE NO. 1: NO REMEDIAL ACTION

A no action alternative has been included in the list of final alternatives in order to comply with Federal requirements that a no action alternative be evaluated. For this site, a no action alternative has been formulated that does not include any Superfund financed remedial activities but does include "removal" activities, defined by CERCLA and the National Contingency Plan (NCP) as immediate but short-term remedial actions that are required to reduce site risk, but must be limited to a funding ceiling of $1,000,000 and six months of activity. In addition, state-financed site monitoring and supervision is also assumed to be available.

As shown in Table 4-1, the no remedial action alternative includes:

- Installation and maintenance of an 8000-ft long, 6-ft high, chain-link fence with locking gate and warning signs, bordering the perimeter of the waste filled areas

- Installation of monitoring wells (four shallow and four deep) and 30 years of quarterly sampling and analysis of air, surface waters, and groundwaters on and near the site

- Permanent alternate water supply for residents along Parker Road and Schoolhouse Lane near the landfill. A feasibility study of this permanent alternate water supply has concluded that extension of the Washington Township Municipal Utilities Authority (WTMUA) is the most feasible way of supplying alternate water to the residents at risk around Combe Fill South landfill.

4.3 ALTERNATIVE NO. 2: CREATION OF AN ON-SITE RCRA-APPROVED HAZARDOUS WASTE LANDFILL

Because complete excavation and off-site disposal of wastes at a RCRA landfill is not technically, economically, or environmental viable, the only alternative to such an action that would achieve the same objective is the creation of a new RCRA-approvable landfill on and near the existing landfill, which could accept and contain all the wastes currently on-site. Such a facility would be created exclusively for the purpose of accepting only wastes from the Combe Fill South landfill; no hazardous wastes from other sites would be accepted.

The major components of this alternative are outlined in Table 4-1 and include:

- Fencing, locking gates, and warning signs (similar to those described for the no action alternative), which would encircle the entire new facility (estimated to be over 200 acres in size)

- Installation of monitoring wells and 30 years of quarterly sampling and analysis of air, surface water, and groundwater samples

- Purchase of additional adjacent vacant property for the construction of the facility (estimated at over 100 additional acres)

- Construction of the new RCRA landfill facility, which would require staged excavation of existing waste, excavation of new landfill cells, installation of landfill cell liner systems, filling of cells with excavated wastes, capping of landfill cells, and operation and maintenance of the capped facility for 30 years

- Construction of a permanent alternate water supply to service the residents along Parker Road and Schoolhouse Lane near the landfill

4.4 ALTERNATIVES THAT ACHIEVE FEDERAL STANDARDS

The following three alternative action sets attempt to achieve all applicable and relevant federal requirements. The principal applicable federal requirements with which RI/FS studies and subsequent hazardous waste response actions must comply are summarized in Table 4-2. These applicable federal regulations include, but are not limited to the National Environmental Policy Act (NEPA), CERCLA, NCP, and RCRA. Other applicable regulations include Occupational Safety and Health Administration (OSHA) requirements, the Wild and Scenic Rivers Act, Executive Orders related to Floodplains (11988) and Wetlands (11990), the Coastal Zone Management Act, and

TABLE 4-2

PRINCIPAL APPLICABLE FEDERAL REGULATIONS

Combe Fill South Landfill

FEDERAL REGULATION	ISSUES
1. National Environmental Policy Act (NEPA)	Full and adequate consideration of environmental issues and adequate consideration of alternatives. Adequate opportunity for public participation.
2. Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)	Actions taken in response to release of hazardous substances shall be in accordance with National Contingency Plan (NCP) of Section 311 of the Clean Water Act (CWA).
3. National Contingency Plan (NCP 1985)	Subpart F - Hazardous Substance Response. Definition of appropriate remedial action. Remedial actions must be consistent with permanent remedy to prevent or minimize the release of hazardous substances, pollutants, or contaminants so they do not migrate to cause substantial danger to present or future public health, welfare, or the environment.
4. Resource Conservation and Recovery Act (RCRA 1984)	Subtitle C - Hazardous Waste Management; particulary those sections defining closure and post-closure technological monitoring requirements.

other federal regulations dealing with the handling, transport and disposal of hazardous waste, and their impacts to public health and the environment.

Each alternative provides mechanisms for source control and management of contaminant migration and provides some means of mitigating the adverse impacts in each of the contaminated media identified including groundwater, surface water, air, and soils. These three alternatives differ primarily in the method and amount of control they provide for contamination in the groundwater.

4.4.1 Alternative 3A: Cap, Trench, and Treat

The objectives of this alternative are to achieve CERCLA goals of minimizing present and future migration of hazardous waste and protecting human health by remediating the major pathways of contaminant migration. The major technical components of this alternative include a multilayered clay cap covering existing waste areas, a groundwater and leachate collection trench, and on-site treatment and disposal of collected leachate. These and other technical components of this alternative are summarized in Table 4-1 and are shown in schematic plan view in Figure 4-1.

Prior to capping, the existing waste areas must be partly excavated and regraded. Wastes within the right-of-way of the New Jersey Power and Light Company (NJPLC) power line will be excavated and graded into the major waste piles located east or west of the line. A total of approximately 210,000 yd^3 of waste/soils will be excavated and regraded throughout the site. Upon completion of the waste regrading, about 85% (60 acres) of the waste-filled areas will be suitably contoured for the placement and proper functioning of the cap, i.e., a finished slope of 5-18% for the final cap sur-

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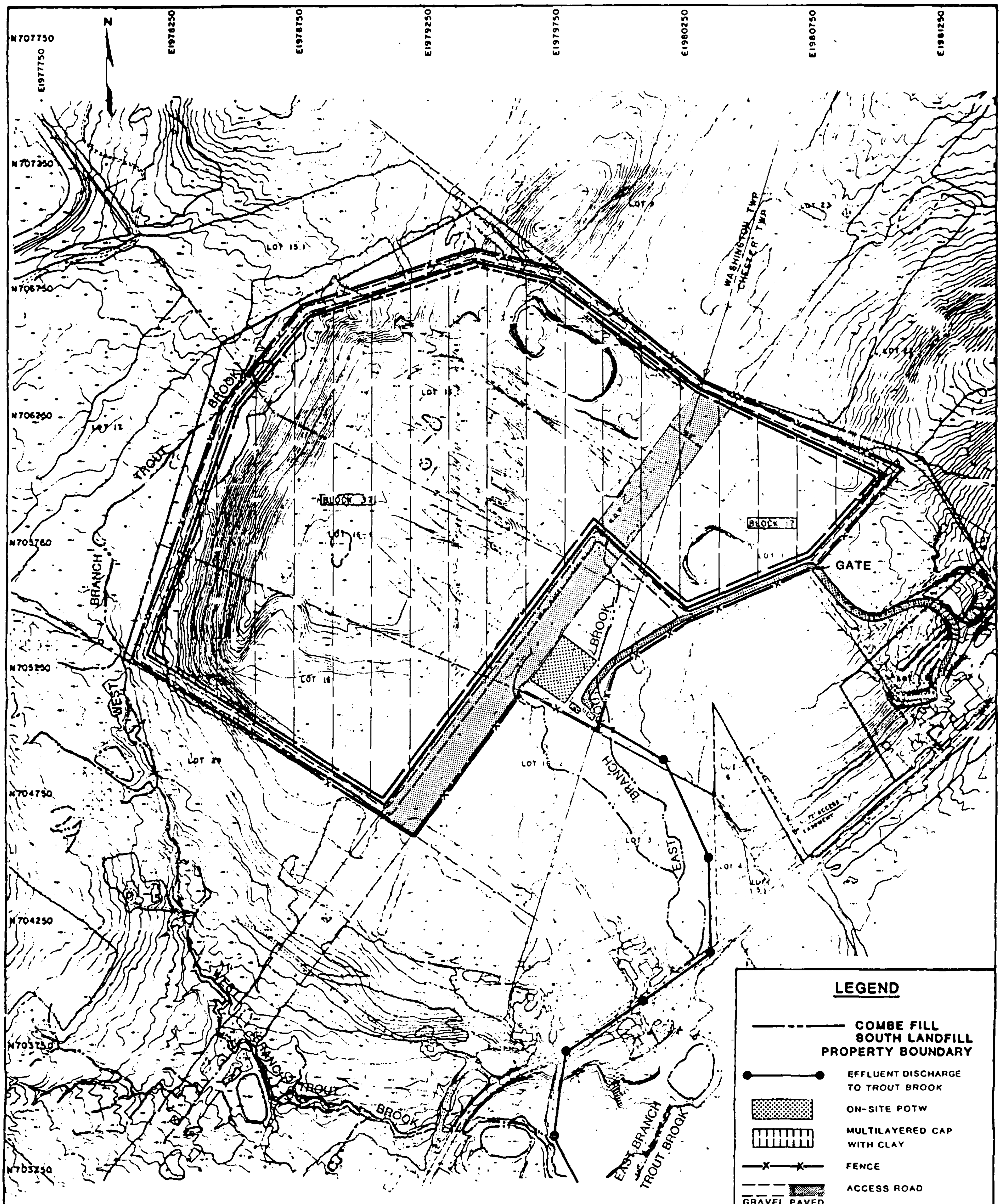

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SCHEMATIC PLAN VIEW
ALTERNATIVE No. 3A
ACHIEVE STANDARDS WITH CAP,
TRENCH, AND TREAT

FIGURE 4-1

400082

4-7A

face. The remaining 15% of waste areas will require additional contouring with terraces as part of the cap itself.

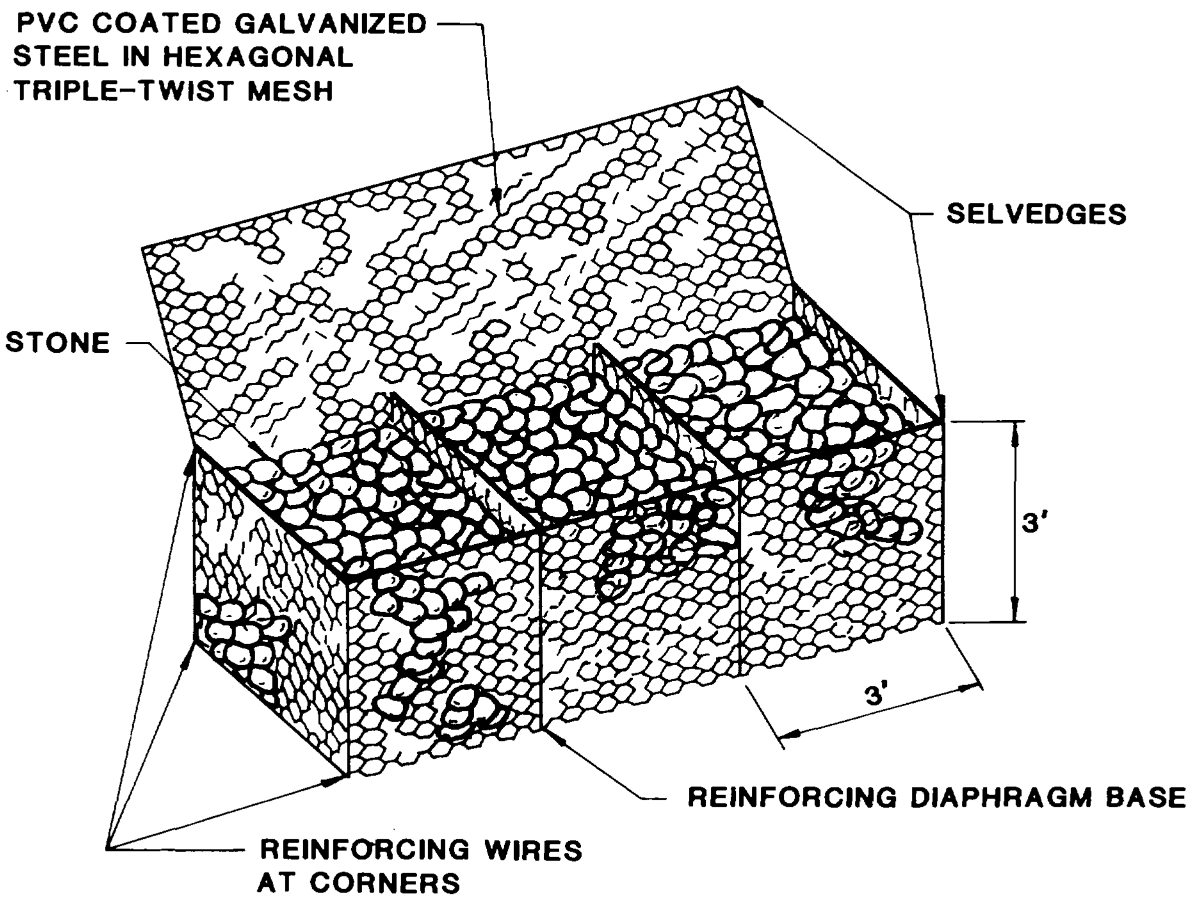
The cap to be constructed on top of the regraded waste area will cover approximately 72 acres and will encompass the power line right-of-way where wastes will have been excavated. For this alternative the cap will also extend at least 25 ft beyond the leachate collection trench which borders the downgradient sides (about 6800 ft) of the waste piles. The somewhat regraded, but still too steep, waste areas (11 to 12 acres) along the western edge of the landfill will require the construction of gabion terraces, shown in Figure 4-2, as part of the cap in order to achieve a sufficient reduction in cap slopes so as to minimize the potentials for significant erosion of the cap or slippage of cap layers.

The multilayered cap, shown in Figure 4-3, will be designed to directly remediate the air, soil, and surface water contaminant pathways and indirectly remediate the groundwater pathway by reduction of infiltration and subsequent reduction of leachate. The 6-ft cap will consist of:

- 1 ft of gravel, placed on the regraded waste, to be used as part of a passive gas venting system
- 2 ft of clay, graded and compacted to achieve a permeability of 1×10^{-7} cm/sec or less
- 1 ft of sand, with a permeability of 1×10^{-3} cm/sec, to be used as a drainage layer
- a geotextile filter fabric placed above the drainage layer to prevent clogging from fines percolating through the top cap layers
- 18 in. of local borrow and 6 in. of topsoil as a final cover, which will be revegetated with grasses to help prevent surface soil erosion

FIGURE 4-2

GABIONS



NOT TO SCALE

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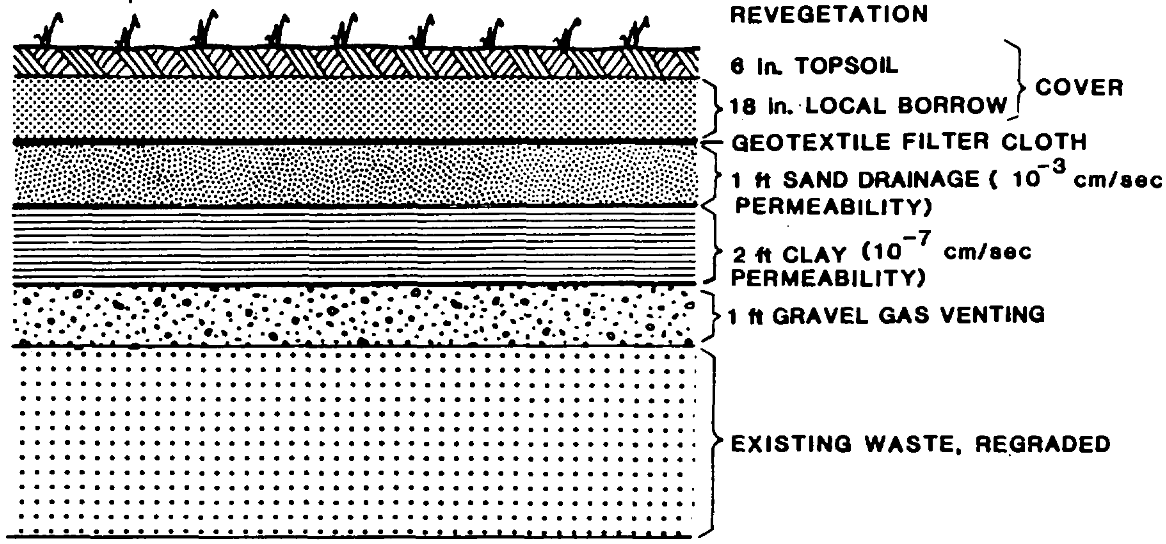
FIGURE 4-3

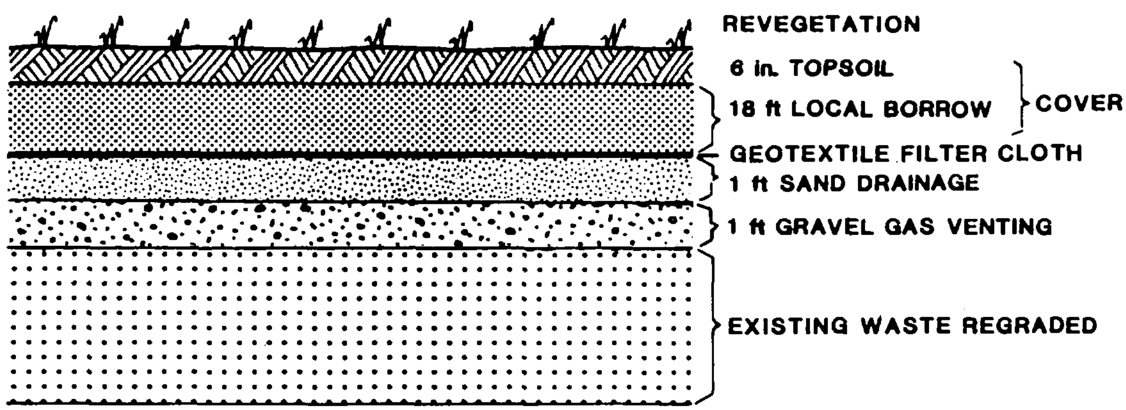
CAP

SECTION VIEWS [a]

CLAY CAP



CLAYLESS CAP



[a] NOT TO SCALE

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Passive gas venting, shown in Figure 4-4, consisting of the gas venting layer of the cap and a perimeter trench that encircles the waste area, will be used to control and regulate the emission of methane and other landfill gases. On the downgradient sides (6800 ft) of the waste, the leachate collection trench, shown in Figure 4-5, will also function as the passive gas collection trench. On the upgradient sides of the waste (1100 ft) a separate passive gas collection trench, measuring 3 ft wide and averaging 20 ft deep, will be constructed. Relief pipe vents will be placed in the trench every 50 ft along the entire perimeter.

Because of regrading and recapping activities, surface water controls on the remediated site will deal primarily with runoff management. In addition to general cap contouring, specific mechanisms to control runoff will include:

- Terraces, as previously described, along the western edge of the fill
- Earthern berms at the cap surface along the eastern face of the larger fill area, near the power line
- Reinforced drainage chutes in both the terraced and bermed areas to channel high velocity flows, and paved drainage ditches encircling the cap along the access roads. The chutes and drainage ditches will be directed to discharge locations near the natural drainage channels of the East and West Branches of Trout Brook.

These are shown in Figure 4-6.

The leachate/groundwater collection trench will be constructed down to bedrock along the downgradient sides of the cap. This 3-ft wide trench averaging 40 ft in depth, but reaching depths of 80 ft, will capture and channel the leachate/contaminated groundwater moving

FIGURE 4-4

PASSIVE GAS VENTILATION

SECTION VIEW [a]

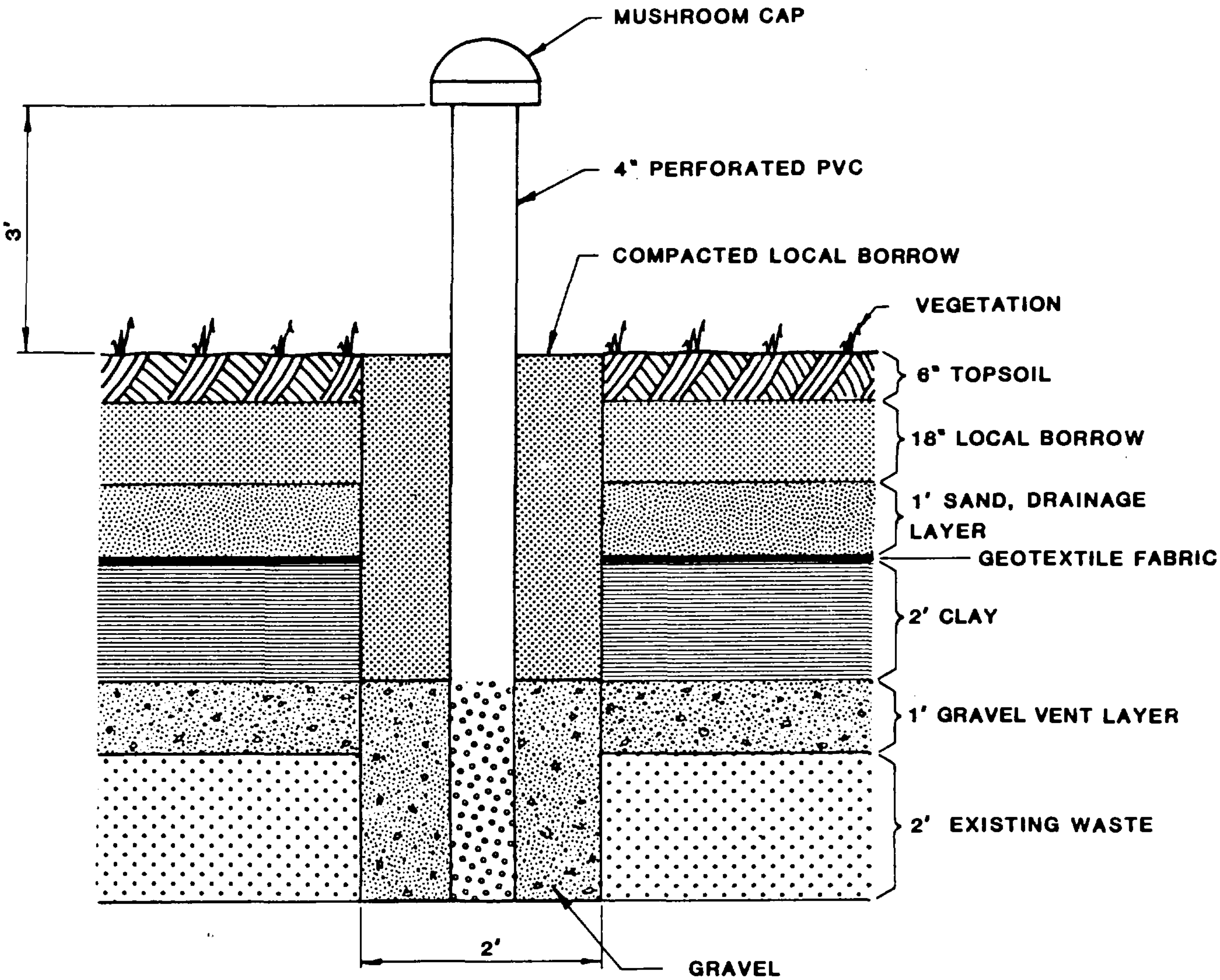

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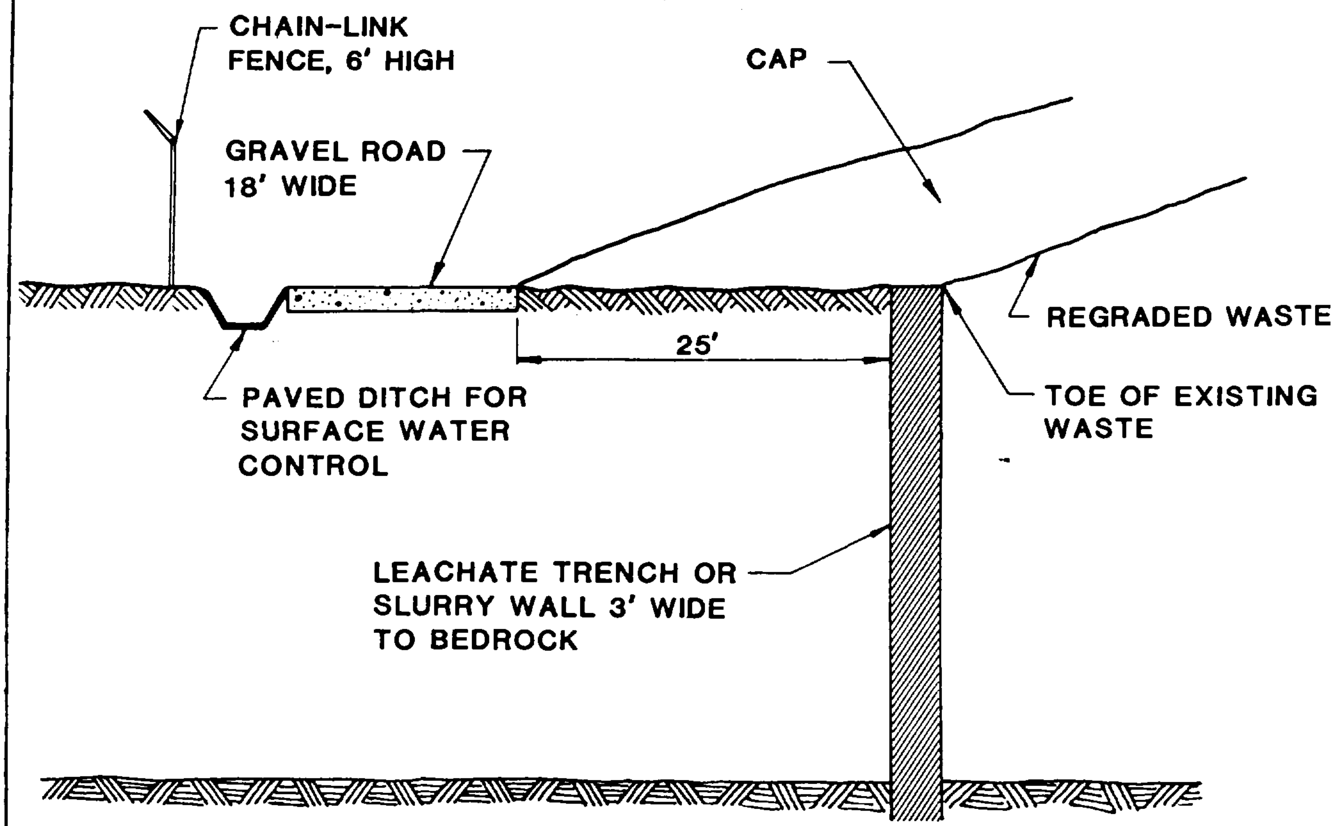
FIGURE 4-5

CAPPING EDGE WITH TRENCH OR SLURRY WALL [a]



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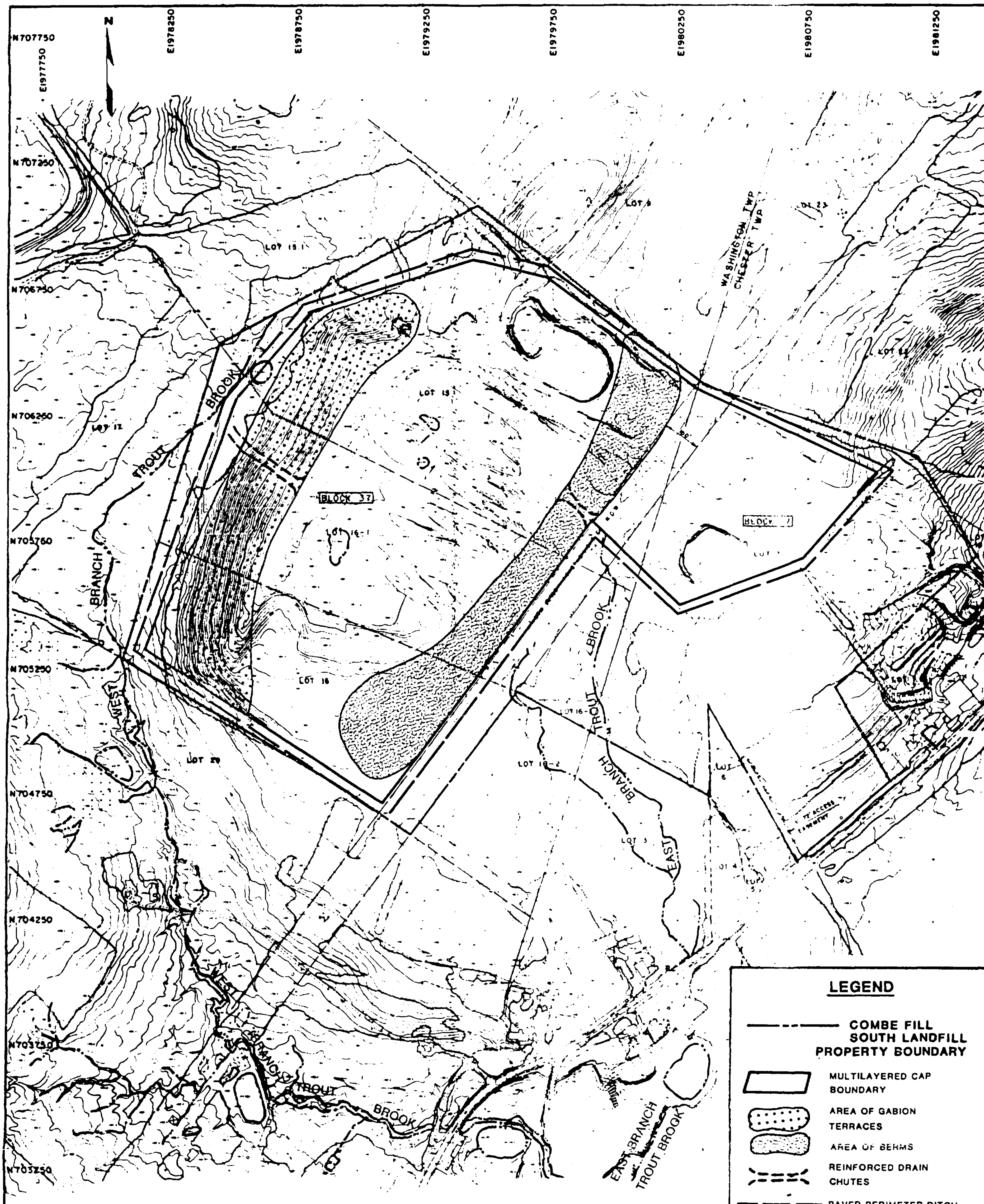

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CAP GABION TERRACING
AND SURFACE WATER CONTROLS

FIGURE 4-6

400089

off-site in the upper (saprolite) aquifer. The saprolite groundwater flow that will be captured by the trench will initially average about 102,000 gpd, or about 90% of the total groundwater flow leaving the site. The upgradient side of this trench will be lined with a filter fabric to prevent clogging and the clay cap will be extended over the trench to minimize infiltration of precipitation and clean runoff and precipitation. PVC piping at the bottom of the gravel-filled trench will collect and transport the leachate to the on-site leachate treatment facility. Water levels in the trench and piping will be maintained with a series of manholes and pumps, which will pump the leachate to the treatment facility. As described above, the upper portion of this trench will serve the additional function of a passive gas collection trench.

The collection trench directly controls and remediates leachate/groundwater flow in the saprolite, i.e., it remediates more than 90% of the groundwater flow leaving the site. As the groundwater in the saprolite is collected and channelled to the on-site treatment facility the saprolite water levels will decline thereby lowering the hydraulic head of the groundwater. This in turn reduces the flow of groundwater from the saprolite into the bedrock aquifer. Thus, mitigation and reduction of the saprolite groundwater flow indirectly mitigates groundwater flow and contaminant movement in the bedrock aquifer.

The collected leachate and contaminated groundwater will be treated at an on-site treatment facility located at the current headwaters of the East Branch of Trout Brook. Discharge of treated effluent will be to the continuously flowing portion of Trout Brook below the confluence of the East and West Branches. The 135,000 gpd treatment facility, which includes a 30% safety factor for flow fluctuations, consists of a series of physical, chemical, and biological treatment processes that may be required to meet discharge limitations and will include:

- Equalization/storage to reduce wasteload fluctuations
- Chemical precipitation and sedimentation to remove solids and heavy metals
- Removal of organic compounds (as measured by BOD_5) and ammonia with a biological treatment process such as a rotating biological contactor (RBC) or an activated sludge system
- Carbon absorption to remove trace organics, preceded by dual media filtration to remove suspended solids
- Sludge holding tank, for transportation of sludge to a local POTW for final treatment and disposal

The suitability of these treatment processes and appropriate sludge handling procedures have not been defined at this stage of alternatives analysis and will require additional investigation as part of a groundwater treatability study. The conceptual design of the treatment facilities in the recommended aternative is based on the draft effluent limitations issued by the NJDEP for this site. This preliminary flow sheet is based on an assessment of the data indicating that:

- Effluent BOD_5 and total suspended solids (TSS) must be in the range of secondary treatment quality
- Nitrification must be achieved
- Activated carbon may be needed to reduce the concentration of volatile and semi-volatile organics
- Disinfection is not needed, since it is believed that no pathogens will be in the wastewater

- The sludges (both chemical and biological) will be nonhazardous

The design capacity of the treatment facility is based on an assessment of the reductions in leachate/groundwater flow which would occur after the cap is in place. Using a design permeability of 10^{-7} cm/sec, leakage through the cap plus flow on-site in the saprolite from upgradient areas is calculated to reach a maximum equilibrium flow of about 15,000 gpd 12 years after the cap is in place. (The maximum equilibrium leakage through the cap of 5 gpm is calculated by assuming a worst-case condition of saturation of the entire clay layer which, with proper drainage, should not occur). Assuming conservatively that at least 15 years would be required to reach this maximum equilibrium flow and apply a 30% safety factor, benchmark flows are estimated as:

YEAR	FLOW (1000 gpd)
1	135
5	60
10	27
15+	20

Access roads to major site components will include a gravel road that will circle the perimeter of the cap and a paved road to the on-site treatment facility. A 6-ft high chain-link fence, with locking gate and warning signs, will encircle the site including the treatment facility. Quarterly monitoring of the air, surface water, and soils will be conducted in conformance with RCRA post-closure monitoring requirements.

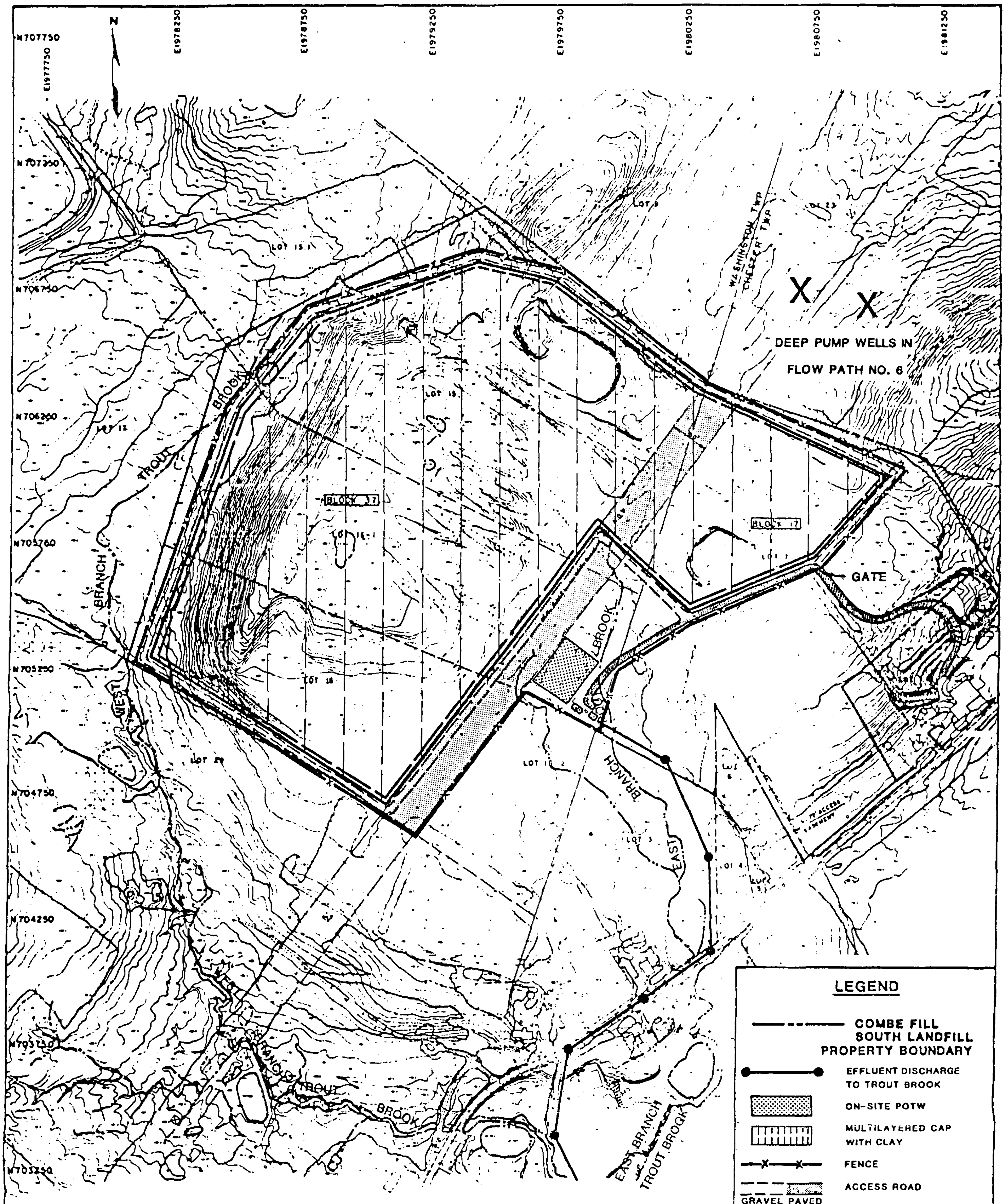
Finally, as in all other alternatives, an alternate water supply will be provided to residents at risk. Although this action provides the most effective means of remediating the adverse impacts to public health from contaminated groundwater, it does nothing to remediate the contamination itself.

4.4.2 Alternative 3B: Cap, Trench, Deep Pump in Groundwater Flow Channel No. 6 and Treat

As shown in Table 4-1 and Figure 4-7, Alternative 3B is identical to Alternative 3A except that it attempts to provide some amount of direct control and remediation of the contaminated groundwater in the granite bedrock. This deeper aquifer contamination represents the most significant impact to public health because the bedrock aquifer is the source of potable water for local wells. As described previously, the leachate collection trench used in Alternative 3A does not directly remediate the migration of contamination in the deep bedrock. However, by reducing the amount of contaminated groundwater in the upper aquifer and thereby reducing the downward vertical migration of groundwater, the trench indirectly contributes to the reduction in contamination in the deeper bedrock.

In Alternative 3B, direct remediation of the contaminated bedrock groundwater in the area defined hypothetically as flow channel No. 6 is attempted with the use of 2 deep (175 ft) pumping wells. These wells would pump an average of 920 gpd (i.e., the estimated amount of groundwater flow in the bedrock in flow channel no. 6) of contaminated groundwater from the bedrock to the on-site treatment facility for treatment and surface discharge. Although the bedrock groundwater flow in this pathway accounts for only 7% of the deep groundwater flow (and 0.7% of the total groundwater flow), it contributes to the most significant and demonstrable adverse public health impact (i.e. contaminate drinking water) associated with the landfill. Because the bedrock flow in flow path No. 6 is so small, the treatment plant is kept at the same size as in Alternative 3A.

400093



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SCHEMATIC PLAN VIEW
ALTERNATIVE No. 3B
ACHIEVE STANDARDS WITH CAP,
TRENCH, DEEP PUMP, AND TREAT

FIGURE 4-7

400094

Alternative 3B, like all other alternatives, includes the provision of a permanent alternate water supply for residents at risk.

4.4.3 Alternative 3C: Cap, Shallow Pump, Deep Pump in Groundwater Flow Channel No. 6, and Treat

Alternative 3C is similar to Alternative 3B except that it substitutes an active technology (pumping) for a passive technology (the leachate collection trench) in order to remediate the contamination in the shallow saprolite aquifer. The deep well pumping for remediation of the contaminated bedrock aquifer in flow channel No. 6, previously described for Alternative 3B, is also included in this alternative. Similarly, a permanent alternate potable water source is provided for residents at risk.

A saprolite aquifer pumping system consisting of 48 shallow wells, spaced 100 ft on center along the northeast, east, and southern perimeters of the waste as shown in Plate 2 would be used. This shallow aquifer pumping system substitutes for the leachate trench in collecting and transporting the contaminated shallow groundwater to the on-site treatment facility. Plate 2 shows the location of the shallow pumping wells.

Like the leachate trench, the objective of the shallow well pumping system is to lower the groundwater table in the capped landfill below the waste pile so that the waste no longer lies in groundwater leaching contaminates. Also, like the leachate trench, the shallow well pumping system indirectly mitigates the deeper bedrock aquifer contamination by reducing the hydraulic head in the saprolite.

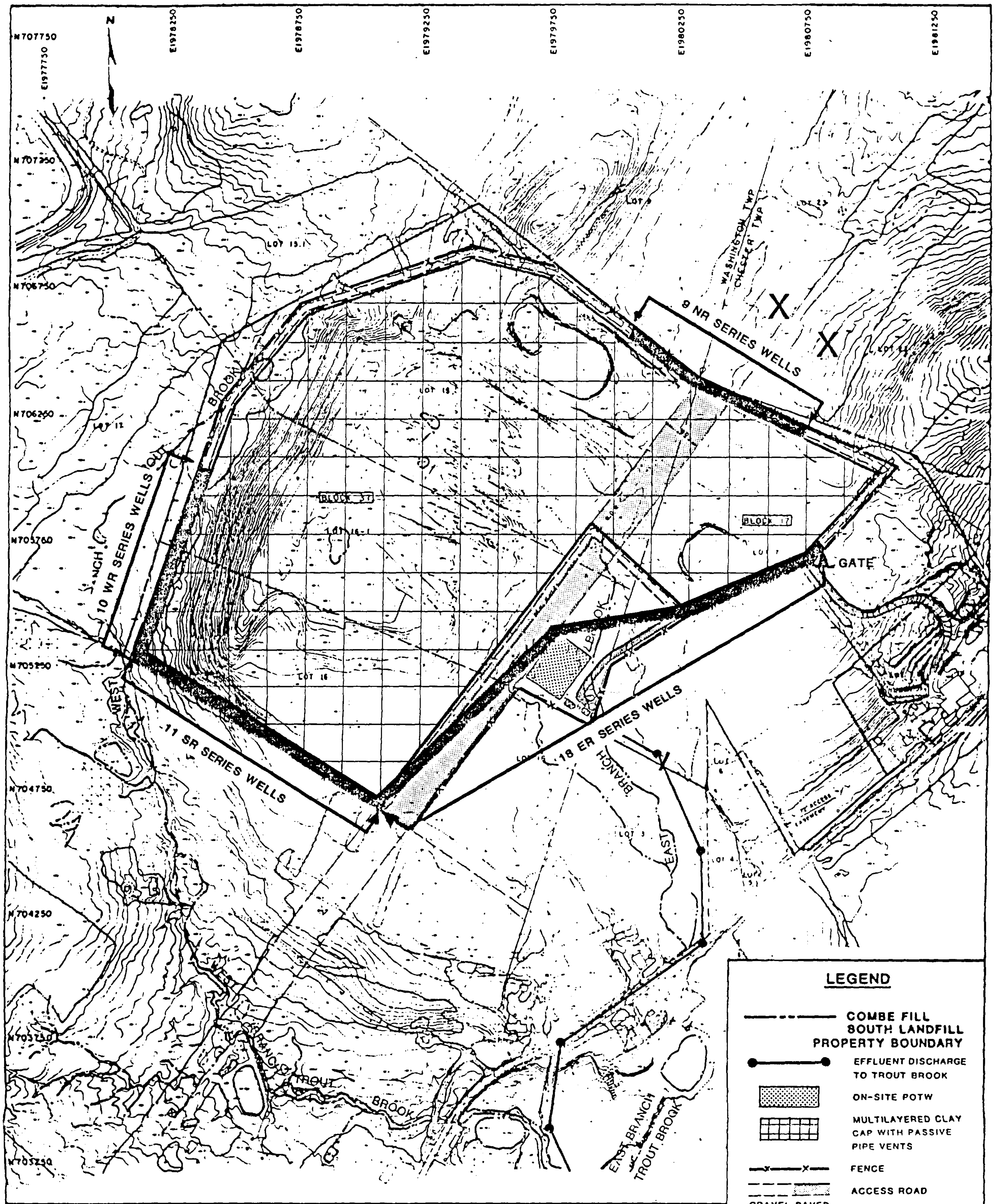
With the elimination of the leachate collection trench, the major portion of the perimeter passive gas venting system will also be eliminated. Therefore, an interior, i.e., in the waste areas, grid of passive gas extraction wells is used in this alternative for gas collection. In this system, 1058 gas extraction wells, consisting of 4-in. perforated PVC pipes in gravel packs, are spaced 50 ft apart in a grid pattern in the capped waste area. The vent pipes are constructed to the top of the existing waste and will funnel gas from the waste and gas vent layer to the surface of the cap where the gases are discharged to the air.

The other components of this alternative are identical to those described for Alternative 3A and are listed in Table 4-1 and shown in schematic plan view in Figure 4-8.

4.5 ALTERNATIVE THAT EXCEEDS FEDERAL STANDARDS

The objective of this alternative is to provide remediation above and beyond the goals established by applicable federal legislation. This alternative attempts to achieve this objective by the inclusion of a number of additional remedial activities beyond those included in Alternatives 3A, 3B, and 3C; in particular, it includes actions that attempt to control and remediate all contaminated groundwater and to treat the collected gas.

The components of Alternative 4 are enumerated in Table 4-1 and shown schematically in Figure 4-9. Several components of this alternative are identical to those described previously for Alternative 3A, including security fencing, access roads, environmental monitoring, site grading and excavation, multilayered clay cap with terraces, surface water controls, leachate collection trench, onsite leachate/groundwater treatment and a permanent alternate potable water supply.



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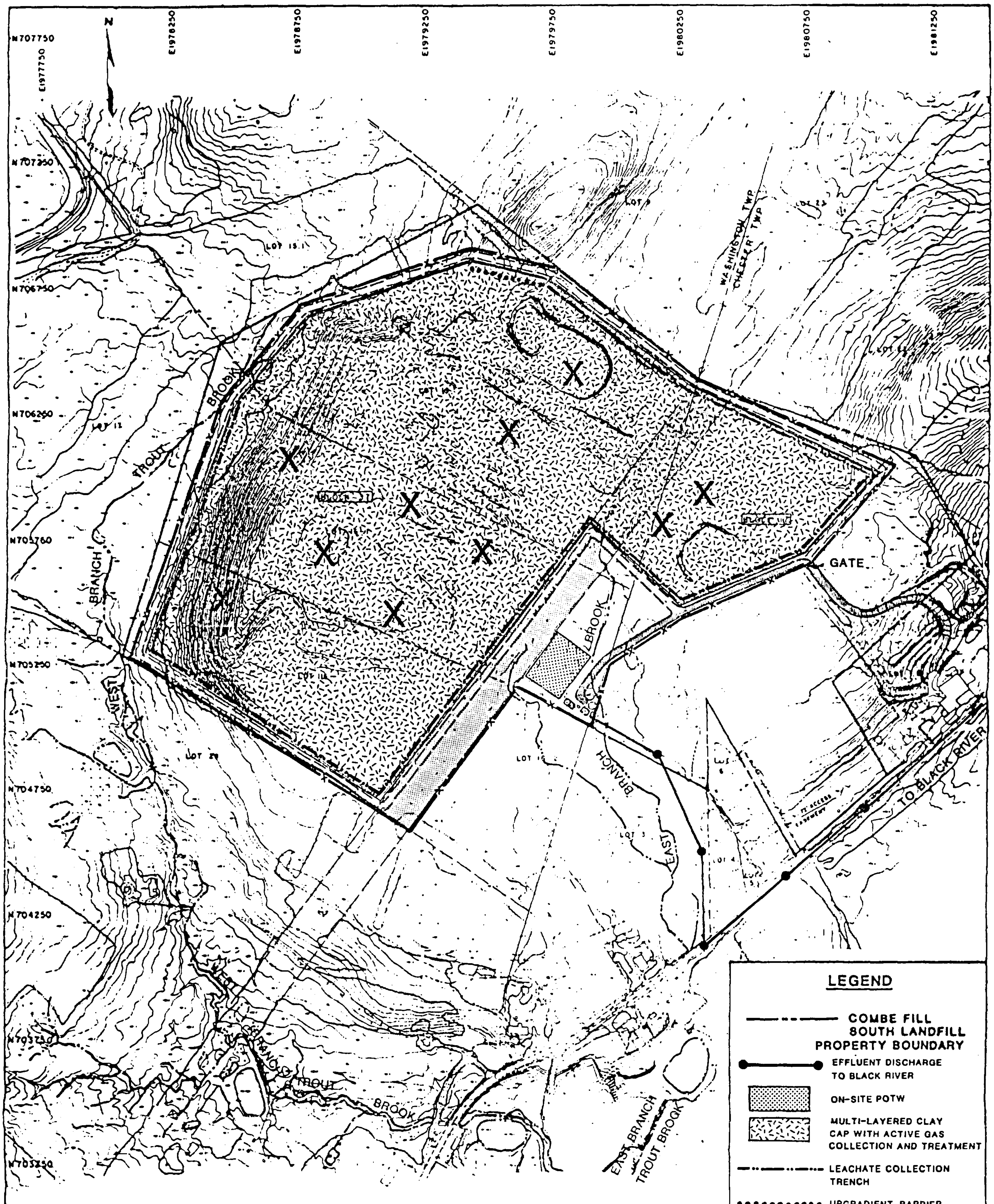
SCHEMATIC PLAN VIEW
ALTERNATIVE No. 3C
ACHIEVE STANDARDS WITH CAP,
SHALLOW AND DEEP PUMP, AND TREAT

FIGURE 4-8

400097



LEGEND

- COMBE FILL SOUTH LANDFILL PROPERTY BOUNDARY
- EFFLUENT DISCHARGE TO BLACK RIVER
- ON-SITE POTW
- MULTI-LAYERED CLAY CAP WITH ACTIVE GAS COLLECTION AND TREATMENT
- LEACHATE COLLECTION TRENCH
- UPGRADIENT BARRIER
- FENCE
- ACCESS ROAD (GRAVEL, PAVED)
- EXCAVATED WASTES MOVED TO MAIN AREAS UNDER CAP
- X DEEP PUMPING WELLS

400 0 400

Scale in feet

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SCHEMATIC PLAN VIEW
ALTERNATIVE No. 4

EXCEED STANDARDS

FIGURE 4-9

400098

4-15B

The additional or different technical components used in Alternative 4 include:

1. An active gas collection and treatment system

   Landfill gases in this alternative are collected by a network of 65 gas extraction wells (similar to those described for the passive interior venting system of Alternative 3C), connected by a flexible PVC piping system and common collection headers to a vacuum blower facility. In this manner, gases are actively collected to a centralized location near the leachate treatment facility where flares are used to burn off landfill-generated methane and some volatile organics.

2. Deep aquifer pumping

   In addition to the collection and treatment of contaminated groundwater in the upper saprolite aquifer via the leachate collection trench described previously, the collection and subsequent treatment of all the deep bedrock contaminated groundwater is attempted in this alternative. A series of 10 deep pumping wells are located within the boundaries of the landfill on the northeast, east and south borders of the waste, as shown on Plate 2. The wells will be sized to pump the average bedrock groundwater flow currently generated at the site, i.e., a total of 11,000 gpd although the effectiveness of these wells to capture all the deep aquifer groundwater flow is uncertain because of the fratured nature of the bedrock. Because this flow is only an additional 11% of the saprolite flow, and the treatment plant is sized with about 30% excess capacity, this alternative uses the same size treatment plant as Alternatives 3A, 3B, and 3C.

3. Effluent discharge to the Black River

   In this alternative treated effluent is discharged via a one-mile pipeline to the Black River, east of the landfill, in order to attempt to minimize impacts to Trout Brook. The route of this outfall is similar to that of the outfall to Trout Brook (used in other alternatives) except that there is an additional 2800 ft of pipeline, primarily along Parker Road, to the discharge point at Black River.

The Black River, like Trout Brook is an FW-2 Category 1 stream, meaning that an effluent must have the same constituent concentrations as the River itself upstream of the effluent discharge point. Because the water quality of these two streams is similar, based on available information (previously published plus this study), it is expected that the effluent limitations for either discharge point will also be similar. In keeping with the objective of Alternative 4, though, the dilution afforded to the effluent in the Black River would provide some added environmental protection, even if it cannot be measured.

4. Upgradient groundwater barrier

   Although the site is essentially in a region of a groundwater high, such that groundwater flows away from the site there is a small (1400 gpd or about 1% of the total groundwater flow) amount of groundwater moving on-site from the area located just to the north of the landfill border (see Plate 1). In order to prevent this groundwater from moving on-site, an upgradient barrier is included in this alternative. By preventing groundwater from moving on-site, the barrier will further help lower the groundwater table on the site and reduce leachate production. The barrier would be a soil-bentonite slurry wall, 300 ft long, 3 ft wide and constructed down to bedrock (average depth of 50 ft). The clay cap would extend over the wall to prevent its desiccation.

4.6 ALTERNATIVES THAT ACHIEVE SOME BUT NOT ALL FEDERAL STANDARDS

The two alternatives in this category, while not attaining all applicable or relevant public health or environmental standards, do reduce the likelihood of present and future threat from hazardous substances. Furthermore, because both alternatives also include

400100

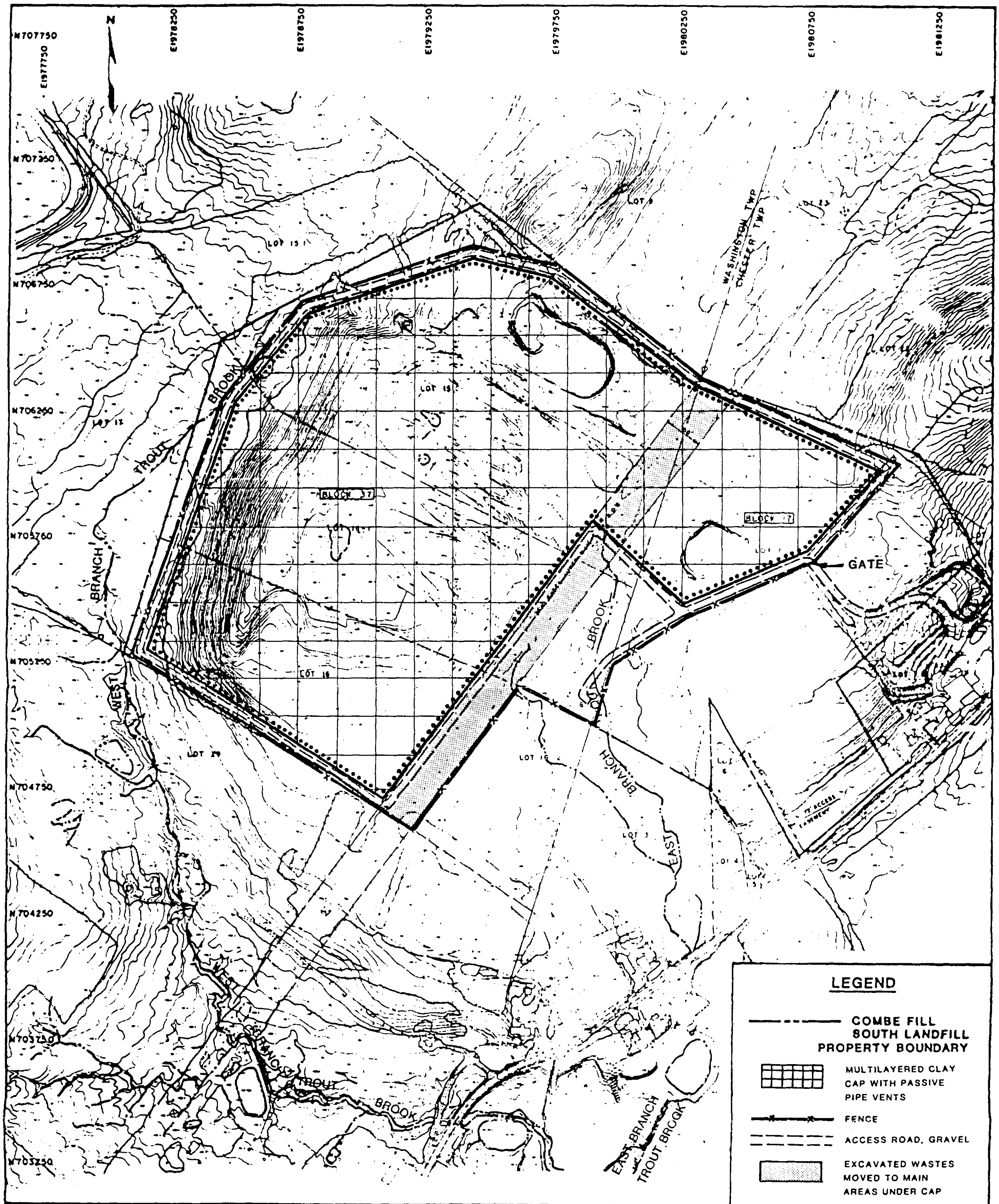
the provision of a permanent alternate water supply, they meet the CERCLA objective of adequate protection for public health.

4.6.1 Alternative 5A: Cap and Circumferential Barrier

As seen in Table 4-1 and Figure 4-10 this alternative contains the site preparation and capping components previously described for Alternative 3B, and includes security fencing, environmental monitoring, access roads, site grading and excavation, multilayered clay cap with terraces, passive interior pipe venting, surface water controls and permanent alternate water supply for residents at risk.

However, this alternative does not provide for the collection and treatment of groundwater as in the previous alternatives. Instead, it encircles the site with a soil-bentonite slurry wall (see Figure 4-5), to merely block the further off-site migration of groundwater in the saprolite. The 3-ft wide slurry wall will be constructed to bedrock (at average depths of 50 ft) and will entirely encircle the waste areas (about 8000 ft). The clay cap will extend over the wall to prevent its desiccation. While the slurry wall will prevent the movement of contaminated groundwater in the shallow saprolite aquifer off-site, it will not provide any remediation of the movement of contamination in the bedrock aquifer and will not treat the present groundwater contamination. In addition, by preventing the off-site movement of the saprolite groundwater, the slurry wall may result in an increased vertical hydraulic gradient which in turn may increase the downward vertical migration of contaminated groundwater.

Because there is no on-site treatment facility there is no need for the paved access road segments previously described; a gravel road



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SCHEMATIC PLAN VIEW
ALTERNATIVE No. 5A
ACHIEVE SOME BUT NOT ALL
STANDARDS WITH CAP AND
CIRCUMFERENTIAL BARRIER

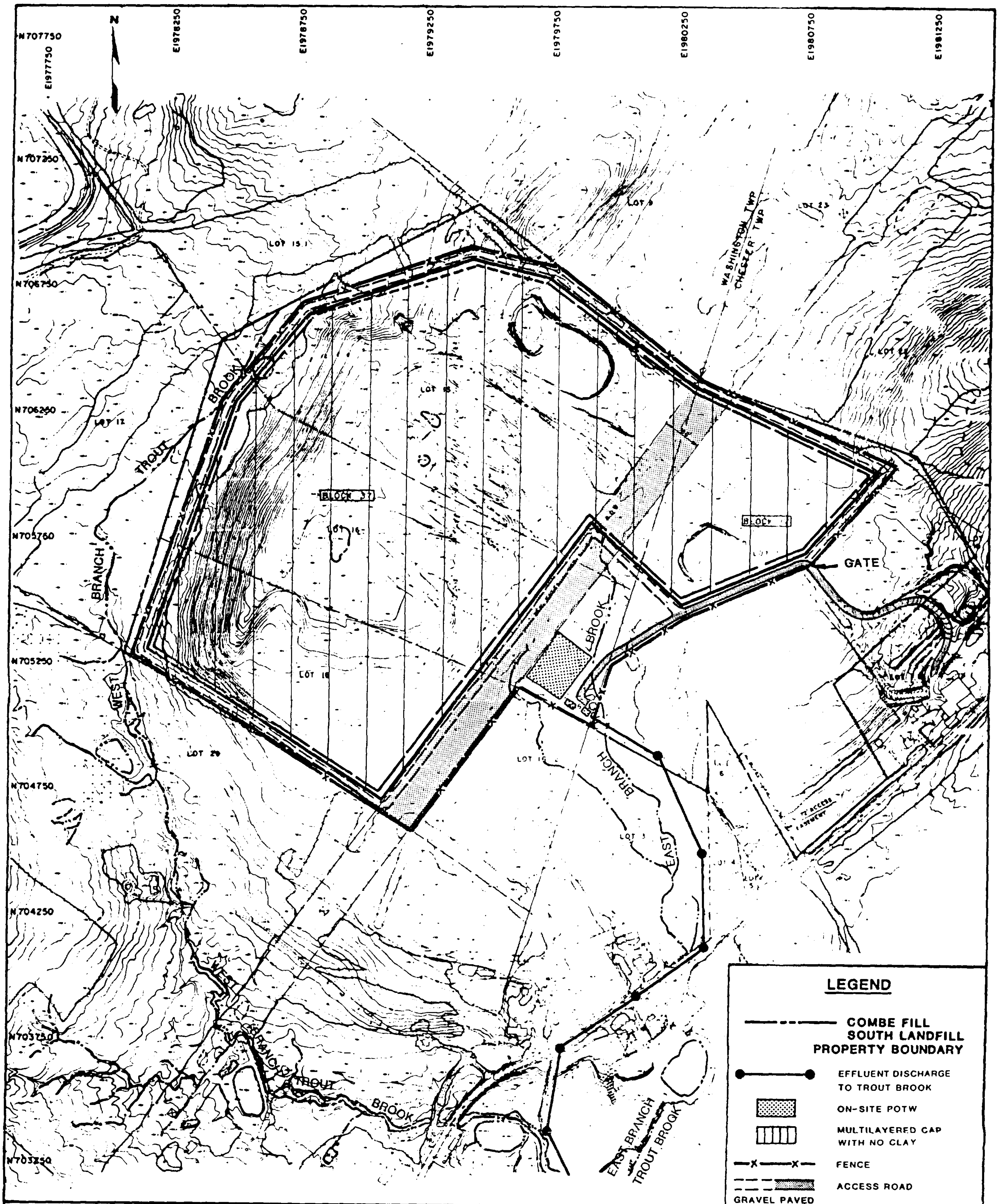
400 0 400
Scale in feet

FIGURE 4-10

around the cap border will be adequate. Likewise, the site fencing is somewhat less extensive than in other alternatives.

4.6.2 Alternative 5B: Clayless Cap, Trench and Treat

This alternative, as summarized in Table 4-1 and shown in Figure 4-11, is identical to Alternative 3A except that the multilayered cap does not include a clay layer (see Figure 4-3). As discussed later in Chapter 5, a significant cost of the cap is the clay layer required to achieve the desired cap permeability of $1x10^{-7}$ cm/sec. Eliminating the clay layer in the cap will result in savings of construction time and money, but may require the treatment of higher groundwater flows at the on-site treatment facility for a greater period of time because of greater infiltration through the cap. Leachate production and groundwater flow rates will not as sharply or rapidly decline without the clay as with the clay because of the increased permeability of the clayless cap.



LEGEND

- COMBE FILL SOUTH LANDFILL PROPERTY BOUNDARY
- EFFLUENT DISCHARGE TO TROUT BROOK
- ON-SITE POTW
- MULTILAYERED CAP WITH NO CLAY
- FENCE
- ACCESS ROAD (GRAVEL, PAVED)
- EXACAVATED WASTES MOVED TO MAIN AREAS UNDER CAP
- LEACHATE & PASSIVE GAS COLLECTION TRENCH
- PASSIVE GAS COLLECTION TRENCH

400 0 400
Scale in feet

Lawler, Matusky & Skelly Engineers
Environmental Science & Engineering Consultants
One Blue Hill Plaza
Pearl River, New York 10965

COMBE FILL SOUTH LANDFILL
REMEDIAL INVESTIGATION/
FEASIBILITY STUDY

r. e. wright associates, inc.
earth resources consultants
harrisburg pennsylvania

SCHEMATIC PLAN VIEW
ALTERNATIVE 5B
ACHIEVE SOME BUT NOT ALL
STANDARDS WITH CLAYLESS CAP,
TRENCH AND TREAT

FIGURE 4-11

CHAPTER 5

EVALUATION OF ALTERNATIVES

In this chapter, the alternatives described in Chapter 4 are evaluated according to their technical, health and environmental, and cost characteristics. The chapter is structured to consider each of these three major characteristics for each of the alternatives described in Chapter 4.

5.1 FEASIBILITY, IMPLEMENTABILITY AND RELIABILITY OF ALTERNATIVES

Each of the remedial alternatives is evaluated in this section in terms of the feasibility, implementability and reliability, of its technical components. Feasibility is evaluated in terms of the ability of the technologies to perform a required function over their design life. Implementability is evaluated in terms of the ability and time to construct an alternative based on site limitations. Reliability is evaluated in terms of operation and maintenance (O&M) requirements and previous performance history.

5.1.1 Alternative 1 - No Remedial Action

This alternative provides little mitigation any of the impacts created by the site, but does provide some measures of safety for the public, as well as information about the future concentration and movement of chemicals from the site. Security fencing and locking gates will be an effective barrier to most members of the general public, but will not deter the determined trespasser or vandal. Fencing can be installed quickly and requires little maintenance and only minor repairs in its projected 30-year life.

Installation of monitoring wells is guided by established hydrogeological and engineering procedures. Strict quality assurance/quality control (QA/QC) guidelines should be followed during installation to ensure the future reliability of groundwater monitoring data. The wells should be marked and provided with locking caps.

Sampling of groundwater, surface water and air should follow strict QA/QC guidelines to assure the reliability of the monitoring data. Labor costs associated with their quarterly sample are small; however, the cost for analytical laboratory services is substantial during the 30 years of this program.

Alternate water supply for the residents at risk around the Combe Fill South landfill is evaluated under a separable study (LMS 1986) which has determined that the most feasible source of alternate potable water is the Washington Township Municipal Utilities Authority (WTMUA) supply. Residents along Parker Road, from approximately the Washington Township/Chester Township border to Schoolhouse Lane, and Schoolhouse Lane itself constitutes the minimum service area to receive permanent alternate potable water. The expansion of the public water system should be implementable within the two year future period allowed in the formulation of this and all other alternatives and, because it will continue to meet N.J. State standards for public supply it should continue to have reliable quality.

5.1.2 Alternative 2 - New RCRA Landfill

Components of Alternative 2 that are common to Alternative 1, i.e., security fencing, environmental monitoring, and alternate water supply, are not discussed in the following analyses.

- Feasibility. A new RCRA landfill is considered feasible, in that this technology, properly applied, should perform its required function over the life of the project. The required function is to encapsulate the waste, keep it encapsulated, and to treat leachate collected internally in the waste cells. Because this alternative prevents migration of contaminated water to the local groundwater system (once it is in place), it provides the best isolation of the waste from the environment of all the remedial alternatives.

- Implementability. This project is an enormous one, involving the purchase of more than 100 acres of local land; the excavation and replacement of about 5 million cy of material, probably at Level B safety protection; and the importing of large amounts of borrow for cell construction. In comparison to other smaller-scale action alternatives, this action must be ranked low in implementability, considering site constraints and the time it will take to build this project. For example, at an expenditure rate of $40 x 10^6 per year, which is a very large construction project, it would take more than 5 years to build.

- Reliability. Although the specifications for RCRA landfills are relatively new, they have been carefully formulated, and are expected to produce a reliable result, one that does prevent the migration of contaminants. (There are only a few relatively newly installed facilities of the nature described for the Combe Fill South site, and their reliability has not yet been fully assessed.) There will be operation and maintenance requirements to keep the shell of the fill in good condition, to collect and treat leachate, and to monitor performance. With respect to reliability, this alternative ranks equal to or above the other action alternatives.

5.1.3 Alternatives That Achieve Federal Standards

The following discussion, of the feasibility implementability and reliability of the three alternatives which attempt to achieve federal standards, emphasizes those characteristics that differentiate 3 alternatives. Items in common with the no-action alternative, and technically straightforward actions, such as the access road and general site preparation, are not germane to the comparison of the alternatives and are therefore not included in the discussion below.

5.1.3.1 Alternative 3A - Cap, Trench, and Treat. In addition to technologies included in the no-action alternative, Alternative 3A includes:

- Multi-layered, terraced cap with clay
- Leachate collection trench
- Passive gas venting using the leachate collection trench around most of the cap and a separate gas trench where there is no leachate trench
- Surface water controls consisting of berms, reinforced chutes, and paved ditches
- On-site groundwater/leachate treatment, with discharge to Trout Brook

5.1.3.1.1 Cap.

Feasibility. The function of the cap is to prevent the infiltration of rain water into the fill and to channel and regulate the release of gases from the fill. In order to maintain its intergrity and fulfill its primariy objectives, the cap must be designed to minimize and control surface runoff. Also, subsidence, i.e., vertical shifting of the fill mass due to decomposition of the waste, may result in cracking of the important clay layer therby permitting unwanted infiltration of rain and runoff down into the waste. The proposed multi-layered cap contains what are generally believed to be the elements needed to meet these goals, although there is no 30-year performance history with caps of this type.

Erosion is prevented mainly by careful attention to grading, terracing, topsoil placement, seeding, maintenance, and ancillary surface water controls to carry off collected rain water. Once the cap is in place, the two main variables which effect cap performance are the maintenance program and the degree of subsidence. The maintenance program must be adjustable to the degree of subsidence, which will tend to channelize runoff in unwanted patterns and may erode some or all layers of the cap.

In order for the cap to function as designed, the clay used should meet the 10^{-7} cm/sec permeability specification. This type of construction specification has only recently been used and is best applied during final design and construction. Because the permeability of a given clay source is not known, the subsequent alternative cost estimates use prices obtained from a clay supplier near Chester having sufficient clay of an unspecified permeability. There are other New Jersey clay sources, 12 to 70 miles from the site, with reported permeabilities in the order of 10^{-7} cm/sec. Judgments on the feasibility of capping as a remedial technology assume that the proper clay is available at a reasonable cost.

Some specific elements of the Combe Fill South cap that may improve its feasibility over some other applications include:

- Maximum slope of 18%, which will reduce problems in material placement, maintenance, and in the development of erosion channels
- Inclusion of a geotextile cloth to maintain the lower drainage layer open. The drainage layer, located above the clay layer, is designed to carry off any filtration.

A nonstandard feature of the proposed cap is the gabion terracing on the steep western side of the fill. Terracing was chosen to reduce the amount of fill required to bring the final graded slopes within the 18% objective and to help minimize erosion and pulling of the cap surface. Because gabion terracing, as part of capping, may be regarded as more complex than plain capping, it may be considered as less feasible. However, gabion terracing is itself a common technology and should not significantly add to the complexity of cap construction. Careful detailed design and construction supervision should allow the terraced portion to function as well as the rest of the cap.

A feature of this alternative that avoids some problems with loss of integrity of the clay, is the capacity of the on-site leachate/groundwater treatment system. It is designed to handle the initial flows from the fill, which are estimated to be 6-7 times the maximum equilibrium flow expected to be reached after 12-15 years after implementation of the alternative. Thus, there is the in-place capability to handle further leakage that may occur due to subsidence or other breaks in the cap. This improves the feasibility of the cap and treat alternatives over Alternative 5A, which does not have a leachate/ groundwater collection and treatment system.

Implementability

Capping is a large-scale project, requiring 250,000-350,000 cy of clay, plus the associated quantities of other materials. It is expected that the work will be done at Level C safety protection, at least until the clay is placed, which will add to implementation time. In comparison to Alternative 2, though, it is much easier to implement. At a significantly lower level of construction effort, it will probably only take in the order of two years to complete. Use of the terraced system on the west side is also expected to reduce implementation time because less time will be expanded in regarding the wastes.

The site appears to be without special constraints with respect to close neighbors and staging areas. Dust control during construction will be an important part of the project specifications, but it should not be especially difficult to keep dust from impinging on the local properties. There should be ample room at the site entrance area for construction offices, equipment staging, and material stock-piling.

Reliability

The reliability of the cap will depend mainly on its maintenance program, which will include maintenance of the vegetative cover and any repairs to the cap and the gabion terraces caused by subsidence. Subsidence generally does not directly cause a separation or breach of the clay layer, but channelizes runoff, which can eventually erode the clay. Repairs to the cap, therefore, are expected to include regrading, plus restoration of the topsoil and vegetative cover; maintenance of the vegetative cover is an essential element in protection of the cap. The cost estimates also allow for maintenance of the gabions, which may subside independently of the cap material or with it. To keep the surface runoff control system working properly, the gabion system should be kept true in line and grade; this may require insertion of new gabions portions from time to time.

These are not high technology maintenance items and, therefore, are considered reliable, even though there is no 30-year experience with caps of this kind, with or without gabions. What is required is a well organized, appropriately funded program to which the responsible parties pay close attention.

5.1.3.1.2 Leachate collection trench.

Feasibility. Leachate collection trenches are, in general, a proven technology for the interception of groundwater/leachate. In the case of Combe Fill South, however, there are two major factors that bring its feasibility into doubt:

- Although the trench averages 40 to 50 ft deep, it can be as deep as 80 ft depending on the depth of the saprolite aquifer (i.e., the depth to bedrock). Although the literature says this can be done, it is a major undertaking, requiring special equipment and, probably, the fabrication of equipment especially for this site. The placement of geotextile on the upgradient side, as is recommended, will only add to the complications, especially with regards to withdrawing the sheet piling without damaging thisfabric.
- The trench does not tie into an underlying impermeable barrier; the underlying fractured bedrock still allows for the escape of contaminants underneath the trench. This loss may be minimal, because the trench will affect a lowering, with time, of the water table.

In comparison to shallow aquifer pumping, the other method of controlling shallow groundwater flow used in Alternative 3C, this approach is less feasible.

Implementability. There are few special site constraints that make construction of the trench less implementable than at other sites, other than the extreme depth required here. The soil, which is non-clayey, will exert greater side pressures on the trench shoring than would clayey soils, and boulders may make driving the shoring difficult. Again, in comparison to installing wells, this method is less implementable.

Reliability. If the system can be built, it probably can function well for the 30-year life. Clogging of the geotextile fabric with time may be a problem; although these fabrics are claimed to be reliable, they do not have a 30-year history of application, in landfills or otherwise. There is a possibility that chemical or biochemical reactions at the fabric could clog it, in which case it cannot be easily unclogged. In this respect, it must be considered less reliable than shallow aquifer pumping.

5.1.3.1.3 Passive gas venting. In this technology, the bulk of the passive gas collection system is combined with the leachate collection system, since the basic design of the two is the same; i.e., a gravel filled lined trench connected to the cap's gravel vent layer and punctuated with periodically spaced pipe vents. A length of about 1100 ft in the northwest part of the site, where there is no leachate collection trench, has a separate 20 ft deep trench for passive gas collection.

Feasibility. The function of the passive gas collection trench is to channel and control the emission of gases from the site and to relieve pressure under the cap. Its function is based on the assumption that the gases will move laterally when pressure exceeds atmospheric levels, and this should occur, both through the fill material and under the cap. If treatment of the gases, such as flaring, were found to be needed, the trench also provides the function of a fairly easily convertible collection mechanism to bring gases to a central location.

As envisioned in this alternative, of course, its feasibility is tied to that of the leachate collection trench, which, as discussed above, is questionable. In comparison to the other method of passive gas venting, pipe vents as in Alternatives 3C and 5A, it is probably of equal feasibility, taken on its own (i.e., separately from the leachate collection trench).

Implementability. Except for the problems associated with the construction of the leachate collection trench already described, there are no particular site constraints to implementing this method of gas collection and venting.

Reliability. Once the system is in place, it should operate reliably. To our knowledge, there should be no chemical reactions occurring at the geotextile fabric or in the PVC pipe vents with the landfill gases; so there should be no problem with fabric clogging, however, materials testing during design may be warranted.

5.1.3.1.4 Surface water controls.

Feasibility. Site regrading, the berm and chute method of runoff control for the cap surface, and the paved ditches near the access road, are all standard surface runoff control technologies. The gabion section as previously described is also fairly straightforward. With careful design and construction, there is no reason why the system should not function as intended.

Implementability. There are no unusual site characteristics preventing the implementation of this surface water control system.

Reliability. As a part of the cap system, the surface water controls are also sensitive to subsidence and the surface water control system will require careful maintenance to assure its proper functioning. Breaks in the design flow paths must be corrected quickly to avoid accelerating deterioration of the cap and loss of control of surface water runoff. There is no real alternative to such careful maintenance.

5.1.3.1.5 On-site Groundwater/leachate treatment with discharge to Trout Brook. As described in Chapter 3, on-site complete treatment and discharge of leachate/groundwater was determined to be more cost-effective than either tank hauling or piping of pretreated wastewater from the site to the nearest POTW having sufficient capacity (i.e., the Hackettstown STP, 10 miles from the site). A choice remained however as to the point of discharge, with Trout Brook or the Black River both being possible receiving waters for the treated leachate; since both surface waters are identically classified and have identical effluent limitations. Nevertheless, the alternatives as defined here provide a basis for evaluating some of the characteristics of the options available.

Feasibility. The proposed treatment system must be capable of functioning over widely varying hydraulic and, probably, contaminant loading conditions. Once the cap is in place, flows will diminish from an initial average rate of about 115,000 gpd to an equilibrium value of less than 20,000 gpd. As flow rate diminishes, influent contaminant concentrations are also expected to be reduced.

Biological treatment of the groundwater/leachate with an RBC process was selected as the most likely candidate for such work because of the great variability in expected flow rates and because:

- It is easier to operate on a part-time basis, an advantage in small scale systems
- A given size RBC unit(s) can provide a required level of treatment over a wider range of flows than activated sludge, because it does not have to be "balanced" the way activated sludge does
- It is more easily built and operated in modular units, meaning that parts of its capacity can be turned off when no longer needed

Other physical and chemical treatment processes are less sensitive to diminishing flows than biological treatment and should all function better than designed at lower flows.

None of the proposed treatment processes included in this process flow sheet are experimental and their performance can be measurably well predicted, except possibly for ammonia removal. The ammonia concentrations in the leachate are significant and because the ammonia effluent limits have not yet been determined a treatability study should be conducted. Depending on the options available for sludge handling, a treatability study would also be valuable in determining design parameters for the other systems components.

Overall, the feasibility of this treatment system is similar to all such small scale systems, i.e., if carefully designed and constructed, its ability to function depends on its operation and maintenance.

<u>Implementability</u>. There are no particular site constraints which make this system unimplementable.

Reliability. The amount of mechanical equipment, and the number of treatment steps involved, although all small scale, indicate that O&M is an important aspect of this system. In the event of failure of a treatment unit, the system can be designed to shut down, thereby preventing release of contaminants to surface water. However, there is no substitute for a carefully designed and executed O&M program to see that the system accomplishes its objectives. This becomes more important as the complexity of the system increases.

5.1.3.2 Alternative 3B - Cap, Trench and Treat, Including Deep Aquifer In Flow Path No. 6. This alternative is identical to 3A, except that it adds some control over the deep aquifer in flow path No. 6, in the direction of Schoolhouse Lane. This discussion will consider only this added technology.

- Feasibility. This is a relatively straightforward technology, consisting of drilling and installation of two deep bedrock wells tied into a common header (force main) to the treatment system. With provision for proper testing during the installation, so that performance (area of influence as function of flow and drawdown) can be accurately calculated, the system should theoretically achieve its objective, interception of the estimated bedrock groundwater flow in this area. Despite the theoretical feasibility of this pumping scheme, the fractured nature of the bedrock makes it impossible to determine with certainity if all fractures carrying contaminated groundwater are being tapped by the pumping wells. Contaminated bedrock groundwater may continue to move off-site in flow path No. 6 in fractures not connected to the pumping wells.

- Implementability. There are no constraints to installing these two deep wells.

- Reliability. As long as the O&M program is efficiently designed and implemented, this system should be reliable. Pump replacement and monitoring of drawdown and pumped water quality are the major items determining the mechanical reliability of these pumping wells.

5.1.3.3 Alternative 3C - Cap, Pump and Treat. This alternative is similar to 3B, except that it replaces the passive leachate collection trench with a shallow aquifer pumping system, and uses a network of internal pipe vents for passive gas venting, rather than the circumferential trench vent. These two differences are discussed below.

5.1.3.3.1 Shallow aquifer pumping system.

Feasibility. This system must be carefully designed to accomplish its function. This will require testing the system as it is installed to determine the appropriate well spacing to achieve the objectives. The proposed well spacing described in Chapter 3 assumes that the initial pumping rate (i.e., about 5 gpm) will be required to dewater the landfill and that the long-term pumping rate (about 2.0 gpm) will prevent future groundwater discharges from the landfill and establish an equilibrium condition within the landfill. Using the theis method, well spawnings were calculated to assure an overlap of the cones of influence exerted by the wells. Given this method of installation, based on performance specifications, it should function as designed. There will probably be some clogging of the pumps and perhaps the well screens due to chemical and/or biochemical reactions in the well environment. However, in comparison to solving such clogging problems in the leachate collection trench, the well system is much easier to maintain because the parts likely to be clogged are more accessible for physical or chemical corrective measures. The installation of the well system is also more feasible than for the trench system, because drilling and installing wells at the depths required is common and is based on standard technologies.

Implementability. There are no site constraints and the wells will be similar to ones already drilled during the RI.

Reliability. This well pumping system will consist of approximately 48 wells, each with its own pump, motor, level controls, flow controls, and electrical wiring. Therefore, such a system requires more O&M than the less complicated trench system that has just a few pump stations and maintenance manholes. The O&M program must be well planned and adequately funded to allow for frequent maintenance tours and the expectation that pumps and other parts will need frequent replacement.

5.1.3.3.2 Passive Internal Gas Pipe Vents

Feasibility. This network of passive gas vents should accomplish the primary objective of relieving gas pressure under the cap, over the life of the project. Subsidence may have some effect on their functioning, but this method is standard technology on landfills, and should be as effective as the trench system.

Implementability. No site constraints.

Reliability. Regular appropriate maintenance is the key to reliability of this passive gas venting system.

5.1.4 Alternative 4 - Exceed Federal Standards

Components of this alternative that differ from those in Alternatives 1, 2, 3A, 3B, or 3C include:

- Active gas venting
- Gas treatment

- Deep aquifer pumping
- Upgradient groundwater barrier
- Discharge to Black River

5.1.4.1 Active Gas Venting and Treatment.

- Feasibility. Active gas venting, with or without treatment such as flaring are relatively standard technologies that have been used widely in municipal landfills. As with passive gas collection, feasibility is tied to the integrity of the cap. However, subsidence should have less affect on the active venting system than the passive system because there are fewer vents, and the suction system should force gas movement even if the gas collection layer in the cap is damaged by subsidence. Gas handling equipment, including supplemental fuel equipment, is relatively standard and should pose no problems.

- Implementability. There are no site constraints to implementing this gas system.

- Reliability. As with all mechanical equipment, O&M is important; however, because this system consists of only a few pieces of mechanical equipment, this is not a severe drawback. Since treatment mechanisms, such as flaring, also require additional O&M, an active gas venting system with treatment of gases will probably demonstrate somewhat less reliability than a passive one.

5.1.4.2 Deep Aquifer Pumping

- Feasibility. A bedrock pumping system would be expected to function as well or better than the shallow system, since it would not be expected to suffer as much clogging. Less clogging is expected because the pumped bedrock water quality is expected to be better than that in the saprolite, and because less water will be pumped per well. A deep aquifer pumping system would reduce the upward hydrostatic head of the bedrock aquifer beneath the shallow aquifer perhaps thereby enhancing the rate of shallow aquifer dewatering.

* Implementability. These deep wells would be drilled through the fill itself, a procedure that has inherent risks of failure due to obstructions and injury due to fire or explosion. However, this can be done successfully with the use of appropriate equipment and safety precautions.

* Reliability. The factors affecting reliability of the shallow pumping system are also present in the deep aquifer system, except to a lesser degree: there are only 10 wells instead of 48, and they should be less subject to clogging. In addition, the deep well piping system as proposed is primarily above ground requiring greater winterization, and heating and subsequently more O&M. Nevertheless, assuming that an appropriate O&M program is employed, this system should be considered relatively reliable.

5.1.4.3 Upgradient Groundwater Barrier Wall.

* Feasibility. The purpose of this wall is to prevent about 1400 gpd of clean groundwater from passing under the site and becoming contaminated. The wall, of soil bentonite, will be relatively deep, about 50 ft, but this should not be the technological problem that the deep trench would be. There should be little chance of chemical attack of this wall, once leachate water levels are reduced, but such attack is a possibility in the early years of operation. The wall should allow almost no penetration of upgradient water.

* Implementability. No special site constraints. A relatively small slurry wall project.

* Reliability. This wall should function without O&M.

5.1.4.4 Discharge to Black River. This discharge line is somewhat longer than the one to Trout Brook, and therefore presents more possibility for implementation problems and short-term environmental impacts. However, outfalls in general are quite feasible and reliable, and there should be no special site problems making this line unimplementable. Therefore, this component is technically sound, very slightly less than the discharge line to Trout Brook.

5.1.5 Alternatives That Achieve Some But Not All Standards

5.1.5.1 Alternative 5A - Cap and Circumferential Barrier. This alternative consists of the site preparation and capping components previously described for Alternative 3B but eliminates all groundwater collection and treatment and uses instead a circumferential barrier, not found in any other alternative. Its design function is to prevent off-site migration of chemicals in the saprolite, but not in the bedrock.

- Feasibility. Slurry walls have become a somewhat standard technology and therefore function well in general. However, in this alternative,there is no induced reduction in groundwater/leachate level behind the wall and therefore the wall will be contact with leachate, even after equilibrium levels are reached creating a "bath tub" of contaminated groundwater. This condition definitely makes the feasibility of this alternative questionable. The situation could be overcome by installation of a groundwater pumping system, but then the need for a barrier wall becomes mute.

- Implementability. A slurry wall would be difficult to construct without encroachment on, or destruction of, the wetland to the west of the site because of the size of the operating arena and surface slopes required for installation.

- Reliability. There is little that can be done to operate or maintain a slurry wall except to insure initial approximate cover to prevent its dessication.

5.1.5.2 Alternative 5B - Clayless Cap, Trench and Treat. This alternative is identical to Alternative 3A discussed above, but eliminates the clay from the cap. This allows for relatively high continued infiltration of rain through the cap and therefore continued high flows to the leachate treatment plant.

5.1.5.3 Clayless Cap.

- Feasibility. The function of the cap in this alternative is mainly to prevent erosion of the landfill cover material, and to reduce infiltration somewhat from the existing levels. As discussed under Alternative 3A, subsidence is expected to have a greater effect on the erodibility of the surface of the cap than on the clay layer integrity. Therefore, in terms of cap erosion and surface water control, both caps are equally feasible.

- Implementability. A capping project is less involved without the clay and is therefore more implementable.

- Reliability. A clayless will require the same careful O&M program as the one with clay.

5.2 HEALTH AND ENVIRONMENTAL EVALUATION

Because the alternatives and components within those alternatives have been formulated to meet relatively specific environmental goals, the comparative evaluation of them is fairly straightforward. The discussion herein mainly concerns itself with the degree of achievement of a specific objective by each alternative, or component, in comparison to the other alternatives or components. The evaluation is summarized on Table 5-1.

5.2.1 Alternative 1 - No Action

This alternative achieves only the objective of limiting site access; all other existing environmental and public health problems remain. At the same time, since no large scale construction will

TABLE 5-1 (2 of 2)

SITE PROBLEMS AND POSSIBLE PATHWAYS OF CONTAMINATION WITH ALTERNATIVES ENVIRONMENTAL EVALUATION

Combe Fill South Landfill

	ENVIRONMENTAL OBJECTIVE ACHIEVEMENT		
ALTERNATIVE	4	5A	
	CAP, TRENCH, TREAT, ACTIVE VENT/TREAT PUMP DEEP, UPGRADIENT BARRIER, (BLACK RIVER)	CAP, CIRCUMFERENTIAL BARRIER	CLAYLESS CAP, TRENCH, TREAT (TROUT BROOK)
SITE PHYSICAL CONDITIONS			
Exposed debris due to insufficient cover materials. Rifts caused by escaping gases and landfill subsidence. Leachate seeps, swampy areas, unrestricted public access, steep slopes with no stabilization.	Full control	Full control	Full control
CONTAMINANT - SOURCES/PATHWAYS			
1. Air			
Methane and volatile organic emissions to atmosphere; dust and particulate emissions due to poor cover	Full control. Eliminates methane emissions and some VOCs	Same as 3A, 3B, 3C	Less control than others
2. Groundwater (Primary Path)			
Groundwater discharge to surface with leachate in leachate seeps	Full control	Full control	Same as 3A, 3B, but flow does not diminish over time
Groundwater contamination in upper aquifer from leachate, possibly moving off-site	Same as 3A and 3B but long-term flow is slightly less	" " " "	" " " "
Groundwater contamination of bedrock aquifer, possibly moving off-site - especially toward Schoolhouse Lane	Adds some deep aquifer control	Does not control, but will diminish over time	Less control than 3A and 3B
3. Surface Water			
Unrestricted surface water runoff moving contaminants off-site	Full control	Same	Same
Leachate seeps and contaminated groundwater discharge to surface waters leaving site.	Full control. Black River provides greater dilution than Trout Brook	Eliminates (no treatment required)	Same as 3A, 3B, but flow does not diminish over time
4. Soils/Sediment			
Stream sediment contamination from contaminated surface waters	Full control	Same	Same

TABLE 5-1 (1 of 2)

SITE PROBLEMS AND POSSIBLE PATHWAYS OF CONTAMINATION WITH ALTERNATIVES ENVIRONMENTAL EVALUATION

Combe Fill South Landfill

	ENVIRONMENTAL OBJECTIVE ACHIEVEMENT				
ALTERNATIVE	1	2	3A	3B	3C
	NO ACTION	NEW RCRA FILL	CAP, TRENCH, TREAT (TROUT BROOK)	CAP, TRENCH, TREAT PUMP PATH No. 6 (TROUT BROOK)	CAP, SHALLOW PUMP, TREAT, PASSIVE VENT, PUMP PATH No. 6 (TROUT BROOK)
SITE PHYSICAL CONDITIONS					
Exposed debris due to insufficient cover materials. Rifts caused by escaping gases and landfill subsidence. Leachate seeps, swampy areas, unrestricted public access, steep slopes with no stabilization.	Prevents access - no other benefit	Full control when complete	Full control	Full control	Full control
CONTAMINANT - SOURCES/PATHWAYS					
1. Air					
Methane and volatile organic emissions to atmosphere; dust and particulate emissions due to poor cover	No benefit	" " Some increase during construction	Controls location of gaseous emissions, but no treatment. Provides centralized collection for possible future gas treatment. Eliminates dust.	Same	Same, except no centralized collection
2. Groundwater (Primary Path)					
Groundwater discharge to surface with leachate in leachate seeps	No benefit	Full control, when complete	Full control	Same	Same, by different method
Groundwater contamination in upper aquifer from leachate, possibly moving off-site	" "	Existing chemicals will continue to move	Complete Control	Same	" "
Groundwater contamination of bedrock aquifer, possibly moving off-site - especially toward Schoolhouse Lane	" "	" "	Substantial overall control	Same but add control in flow path No. 6	Same
3. Surface Water					
Unrestricted surface water runoff moving contaminants off-site	" "	Full control, when complete	Full control	Same	Same
Leachate seeps and contaminated groundwater discharge to surface waters leaving site.	" "	" "	Controls discharge to Trout Brook to meet NJDEP Standards	Same	Same, by different method
4. Soils/Sediment					
Stream sediment contamination from contaminated surface waters	" "	" "	Full control	Same	Same

be involved in this alternative there will be no short-term construction impacts associated with action alternatives.

5.2.2 <u>Alternative 2 - New RCRA Fill</u>

Alternative 2 achieves all remedial objectives when construction is completed. Any contaminants that are presently in the bedrock and shallow aquifers will continue to move away from the site because no direct remediation of contaminated groundwaters is undertaken. This alternative is at a disadvantage in comparison to alternatives that may be implemented sooner and those that establish positive control over contaminant movement.

This alternative will result in larger construction-related impacts than any other alernative. Construction under this alternative will be noisier, dustier, closer to residents and last longer than in other alternatives. Large pieces (100 acres) of nearby land will be required for the siting and construction of the RCRA landfill. Construction will also result in substantial off-site, heavy-duty traffic (from material-supply vehicles) for a longer period of time.

It can also be expected that the excavation of the fill will, at times, increase the level of methane and other gaseous and particulate emissions from the site in comparison to the existing condition or the other action alternatives. These emissions cannot practically be controlled.

5.2.3 <u>Alternatives that Meet Federal Standards</u>

5.2.3.1 <u>Alternative 3A - Cap, Trench, Treat, Discharge to Trout Brook</u>.

- <u>Cap</u>. The clay cap will accomplish the objective of virtually eliminating, over time, the production of leachate in the fill. In this respect, it affords a measure of protection that the clayless cap (a component of Alternative 5B) does not. Although it is theoretically possible to capture all the contaminated groundwater, as is attempted by several other alternative components, reduction of infiltration by means of a clay layer prevents contamination of the groundwater in the first place and thus provides an added measure of protection. Prevention of groundwater contamination is the major objective to be accomplished at Combe Fill South. The lowered groundwater table created by the landfill cap, particularly in conjunction with the action of a groundwater flow control mechanism (such as a trench or pumping system) will have long-term impacts to the wetlands bordering the site. As groundwater elevations decline during the implementation of the remedial action, the wetlands will be gradually replaced by upland species more tolerant of drier soil conditions. Therefore, this and all alternatives which provide a cap and/or some groundwater control system will have an impact on the wetlands. The more impermeable the cap and/or the more groundwater control exerted, the more rapid these impacts will be felt by the wetlands. Therefore this alternative's impacts to the wetlands are more gradual than those in Alternatives 3B, 3C, and 4 and quicker than those of Alternatives 5A and 5B.

The construction impacts of the clay cap, especially dust emissions, will be relatively short-term (2-3 years) and will be mostly confined to the site itself. There will also be heavy duty traffic impacts hauling materials to the site which cannot be effectively mitigated.

- <u>Surface Water Controls</u>. This alternative and all those incorporating an impermeable clay cap (Alternatives 3B, 3C, 4, and 5B) result in an increase in total surface water runoff volume from the remediated site, but with dampened peak stormflow velocities. A combination of site regrading/contouring, site revegetation and such permanent surface water control mechanisms as berms, reinforced chutes and gabion terraces reduce stormflow velocities thereby preventing scouring and gullying of the cap and at the surface water discharge points (particularly the West and East Branches of Trout Brook). Assuming complete impermeability of the 65-acre cap, the total additional amount of surface water runoff would be about 19.6 x 10^6 gal/yr (total of about 40 x 100) most of which would be discharged directly to either the West or East Branch of Trout Brook, thus these stream segments would have generally consistently higher baseflows than presently measured. Surface waters channeled from the cap to the streams could be routed to regulated release detention basins to provide additional control of these waters, however such detection basins are not intrinsically necessary to the proper functioning of the cap itself. Where necessary, stream channels could also be widened at storm water discharge points in order to insure adequate stream channel volume.

- Leachate/Groundwater Trench. If the trench can be successfully built (see 5.1.3.1.2), it should establish complete control over downgradient movement of chemicals in the shallow aquifer. In addition, because the piezometric head in the bedrock aquifer will be greater than that in the shallow aquifer, once the trench is in operation, some bedrock groundwater will move upward into the saprolite where it will be collected by the trench. Therefore the trench also establishes at least some control over the bedrock contaminant movement. This technology thus accomplishes most of the major site objective, i.e., control of groundwater contamination movement.

  The main construction related impacts of the trench will be the noise of driving the sheet piling, which will be noticeable in the local residential areas, and may last for several months. This impact is not mitigable, but can be reduced by limiting working hours. These construction impacts are greater than the alternative method of shallow aquifer control, i.e., the shallow well pumping system Alternative 3C.

- Gas Venting. The leachate trench in this alternative also serves the function of controlling gaseous emissions by controlling the point(s) of discharge of the gas. There is no treatment of landfill gases in this alternative; air emissions have not been identified as causing significant offsite impacts so that a need for treatment has not been demonstrated, and Alternative 3 only addresses demonstrated impacts. Trench collection of the landfill gas is probably as effective as the other passive system considered, (i.e., internal cap vents in Alternative 3C), although it does depend on the build up of enough pressure to cause horizontal movement to the perimeter trench. The trench has an advantage over the internal cap vent system if treatment of gases were to become necessary in the future, since it could probably more easily be converted to a centralized control (active) system.

- Leachate/Groundwater Treatment and Discharge. Full evaluation of treatment and discharge components of this and all other alternatives will require the completion of a bench-scale treatability study. However, the basic on-site complete treatment system proposed in this alternative is expected to achieve effluent limitations with perhaps the use of some unconventional (and therefore more expensive) components. As discussed previously, because of the remote location of suitable POTWs complete on-site treatment has been proposed for all alternatives except 5A where no treatment is proposed at all. In all these alternatives the components are identical in location, size, type, and treatment objective thus their impacts are likewise identical.

  Discharge in this alternative and in Alternatives 3B, 3C, and 5B is to Trout Brook at the confluence of its East and West Branches. The initial 5-yr treated discharge volume of 100 gpd (or .0002 cfs) is insignificant in comparison to the current volume surface water runoff entering the brook (about 84,000 gpd or 0.13 cfs).

  Trout Brook is classified as an FW-2, Category One, nondegradation water by NJDEP. Draft effluent limitations for discharge here are stringent and well beyond the limits that conventional secondary treatment processes can achieve. They are achievable by other available but more expensive and currently unquantified treatment technologies. Until a treatability study is conducted therefore, the costs estimates for leachate treatment in any alternative may be considered to be minimum costs.

This and all other alternatives which discharge to Trout Brook have fewer short-term construction impacts than Alternative 4 where the discharge outfall is at the Black River, more than a mile from the site.

5.2.3.2 Alternative 3B - Cap, Trench, Treat, Pump Flow Path No. 6, Discharge to Trout Brook. The only difference between this alternative and Alternative 3A is that it attempts to provide direct control over the bedrock groundwater flow in Flow Path 6; this is the suspected flow path by which chemicals from the fill have reached the drinking water wells on Schoolhouse Lane. Although some control of groundwater in Flow Path No. 6 may be established in Alternative 3A, because of piezometric head relationships in the rock and saprolite, Alternative 3B attempts to provide more direct, and therefore, greater assurance of such control. Although all alternatives include alternative water supply to current and future affected wells such action does not mitigate the current migration of contaminations in the deep groundwater; this alternative provides some mitigation of this mitigration. Because the movement of chemicals from the landfill to the drinking water wells is the major identified impact of Combe Fill South, Alternative 3B is judged to offer additional environmental benefits over Alternative 3A. This deep groundwater pumping in Flow Path No. 6 will not however, assure complete capture of the bedrock flow because of the fractured nature of the bedrock.

There are no special construction impacts associated with the construction of the bedrock well, pumps, and pipeline to the on-site treatment facility.

5.2.3.3 Alternative 3C - Cap, Shallow Pump, Treat, Pump Flow Path No. 6, Discharge to Trout Brook, Interior Passive Gas Vents. The main difference between this alternative and Alternative 3B is that the approximately 48-well saprolite pumping system is substituted for the collection trench. Because the leachate collection trench is eliminated, the passive gas collection method is changed to one of internal pipe vents in the cap. With the elimination of the combined functioning trench, internal pipe vents are cheaper than a separate trench designed only for gas control.

The shallow well pumping system has the same environmental benefit as the trench: both will fully control the shallow aquifer, and probably establish at least partial bedrock flow control. However, the shallow well pumping system provides greater assurance of groundwater control since it is an active rather than passive system. Although the pumping system will have fewer construction impacts than the trench, it is more time consuming and costly to maintain.

The passive pipe vent gas control system will be at least as effective in protecting the cap against internal pressure damage as the trench system. It may possibly be more effective in that the lateral migration distances for gas to reach the pipe vents are far less than for the trench. This system has the disadvantage that future treatment of the gases, if that became desirable, would be more difficult. There are no special construction impacts associated with either the trench's gas collection portion (top 10 ft - 20 ft of the collection trench) or the internal network of pipe vents.

5.2.4 Alternative 4 - Exceed Federal Standards

Components in this alternative that are not included in Alternatives 3A, 3B, and 3C include:

- Active Gas Venting with Flaring. Although there is no demonstrated off-site need for this system, it will have a minor benefit to maintenance workers of reducing the possibility that respiratory protection will be needed on-site. That need, without flaring, would diminish in probability over time. This component does have the generic benefit of reducing emissions to the atmosphere.

With an active gas venting system, landfill gas treatment and reuse options can be more easily exercised than in a passive system. The limited air sampling and analyses work done during the RI is insufficient to make final determinations as to the need for treatment or the possibilities for gas reuse. Although not included in this evaluation, landfill gases could be treated via carbon adsorption if substantial removal of volatile organics is deemed necessary. Likewise, methane, as one of the principal landfill gases, could be collected and reused directly as full gas for steam generator or for eleectrical generation depending on the quality (methane content) and quantity of landfill gases collected.

There are no special construction impacts associated with this sytem as presently proposed although operational maintenance may be hampered by substantial subsidence which may dislodge or displace connecting pipes.

- <u>Bedrock Aquifer Flow Control in All Flow Paths</u>. The benefit of this component is that it extends direct positive control of bedrock flow to all flow paths, not just No. 6. This control would be more direct than the passive bedrock control that is expected to result from control of the saprolite. Although there is no current demonstrated off-site contaminant movement in bedrock other than flow path No. 6, such problems may develop in the future and these wells would provide active control over this movement.

  Like the bedrock wells in Flow Path No. 6, these wells will not assure complete capture of bedrock groundwater leaving the site because of the fractured nature of the bedrock. However, their location within the fill and their number provide greater assurance of such capture.

  A possible complication of these deep pumping wells may occur early in the start-up of the remediation: i.e., these wells may interfere with passive control of the saprolite aquifer (via the trench) because the deep pumping may alter the saprolite flow and perhaps even draw down additional contamination into the deep bedrock.

Installing these deep wells through the fill is complicated by the possibility of fire or explosion, but these impacts can be mitigated by careful design and execution of the drilling program.

- Upgradient Groundwater Barrier. This barrier would be a soil-bentonite slurry wall. This upgradient barrier would curtail the on-site movement of about 5,000 gpd, or roughly a minimum of one-third of the equilibrium flow to the treatment system, after 10-15 years. In the early years of operation, this would be less than 5% of total flow. This is a minor benefit, in that the treatment plant would have to remain in operation in any event, and the difference in discharge nitrogen, at, 13,000 gpd and 10,000 gpd would be negligible in terms of impact on the receiving water.

  Construction of this wall, although requiring a minimal working area and confined to specific ground slopes, has no special construction impacts.

5.2.5 Alternatives That Achieve Some But Not All Standards

5.2.5.1. Alternative 5A - Cap, Circumferential Wall. The primary difference between this and all other alternatives is that there is no collection and treatment of groundwater/leachate. Instead, a slurry wall, identical in dimension and depth as the upgradient barrier used in Alternative 4, is constructed around the entire cap. While preventing the continued off-site migration of the contaminated groundwater in the saprolite, the wall may create hydraulic heads within the fill which encourage further downward movement of contaminants into the bedrock aquifer. This constraint in conjunction with the possible deterioration of the wall by the contaminated groundwater it is containing combined to make this a less attractive alternative. In addition, the construction of such a circumferential wall will be hampered by slope (i.e., too great) and working area (i.e., not enough) limitations.

5.2.5.2 Alternative 5B - "No Clay" Cap, Trench, and Treat. The only difference between this alternative and Alternative 3A is that the cap does not have the 2-ft clay layer. Therefore it will be substantially more permeable and result in the continued production of leachate and need to treat larger groundwater flows over a longer period of time. Although substantially less expensive than a clay cap, this alternative does not address one of the fundamental objectives of remediation, prevention of infiltration, and therefore prevention of the formation of additional leachate.

5.3 COST

The capital and operating costs of each alternative are presented, in order, in Tables 5-2 through 5-9. These costs and their present worth, are summarized in Table 5-10.

5.4 COST EFFECTIVENESS

The cost effectiveness analysis summary of the eight alternatives is given in Table 5-11. This table gives the two major elements of cost (i.e., capital and present worth) and highlights the most salient concerns and achievements under the environmental/health, mitigation, and technical evaluation criteria. Table 5-11 also provides some understanding of the variation in effectiveness with cost. Because the alternatives are made up of many components, the cost effectiveness can be more truly assessed by examining differences in components of the alternatives. The following paragraphs discuss the main issues that were evaluated on the cost effectiveness analysis of these alternatives.

TABLE 5-2

ALTERNATIVE 1

NO REMEDIAL ACTION
COST ESTIMATE

	COSTS ($)
A. CAPITAL COSTS	
1. Direct	
a. Fence, locking gate, warning signs	111,000
b. Monitoring wells installation (4 shallow, 4 deep)	108,000
c. Alternate water supply	
1. Temporary bottled water	69,000
2. Permanent alternate water supply	500,000*
Subtotal Direct Capital Costs	788,000
2. Indirect	
a. Engineering and Design @ 15%	118,000
b. Legal/Administrative @ 5%	39,000
c. Contingency @ 25%	197,000
TOTAL CAPITAL COSTS	1,142,000
	COSTS ($/yr)
B. O&M COSTS (30-YEAR LIFE)	
1. Monthly fence inspection	6,500
2. Fence repair and gate replacement	500
3. Quarterly sampling of monitoring locations: wells, air, and surface water and analysis of data	9,600
4. Analytical laboratory services as part of monitoring	101,000
5. Alternative water supply service charges	10,000
TOTAL O&M COSTS	127,600

*Alternate water supply evaluated in separate study.

TABLE 5-3 (Page 1 of 2)

ALTERNATIVE 2

NEW RCRA LANDFILL
COST ESTIMATE

	COSTS ($)
A. CAPITAL COSTS	
1. Direct	
a. Excavate waste on-site	21,250,000
b. Excavate new cells on-site	12,500,000
c. Construct new cells as per RCRA regulations with double liners, leak collection and detection system, and multi-layered cap	110,250,000
d. Additional property (150 acres) needed to construct landfill cells	4,725,000
e. Fencing and security	200,000
f. RCRA monitoring	110,000
g. Alternate water supply*	
1. Temporary bottled	69,000
2. Permanent alternate supply	500,000
Subtotal Direct Costs	149,604,000
2. Indirect Costs	
a. Engineering and design @ 15%	22,441,000
b. Legal and administrative @ 5%	7,480,000
c. Contingency @ 25%	37,401,000
TOTAL CAPITAL COSTS	216,926,000

*Alternate water supply evaluated in separate study.

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TABLE 5-3 (Page 2 of 2)

ALTERNATIVE 2

NEW RCRA LANDFILL
COST ESTIMATE

	COSTS ($/yr)
B. O&M COSTS (30-YEAR LIFE)	
1. Maintenance of liners, alarm system, leachate pumping and treating, caps inspection and maintenance	300,000
2. Access road and fence maintenance	8,000
3. Analytical services and monitoring	110,000
4. Alternative water supply service costs	10,000*
TOTAL O&M COSTS	428,000

*Alternative water supply evaluated in separate study.

TABLE 5-4 (Page 1 of 3)

ALTERNATIVE 3A

ACHIEVE FEDERAL STANDARDS: CAP, TRENCH AND TREAT
COST ESTIMATE

	COSTS ($)
A. CAPITAL COSTS	
1. Direct	
a. Fence, locking gate, warning signs	111,000
b. Monitoring wells installation (4 shallow, 4 deep)	108,000
c. Access road segments	300,000
d. Site preparation	
1. General waste grading	1,497,000
2. Cap perimeter cleaning and grading	72,000
3. Excavate wastes in powerline ROW	767,000
e. Capping, terracing and revegetation	
1. Multilayered clay cap and revegetation	21,162,000
2. Gabion terracing	1,015,000
f. Passive gas venting with perimeter trench	681,000
g. Surface water controls	
1. Cap berms and reinforced chutes	185,000
2. Cap perimeter paved ditches	336,000
h. Leachate collection trench	14,148,000
i. Wastewater treatment (RBC) and discharge to Trout Brook	1,364,000
j. Alternate water supply*	
1. Temporary bottled water	69,000
2. Permanent alternate supply	500,000
Subtotal Direct Capital Costs	42,315,000

*Alternate water supply evaluated in separate study.

TABLE 5-4 (Page 2 of 3)

ALTERNATIVE 3A

ACHIEVE FEDERAL STANDARDS: CAP, TRENCH AND TREAT
COST ESTIMATE

	COSTS ($)
A. CAPITAL COSTS (Continued)	
2. Indirect	
a. Engineering and design @ 15%	6,347,000
b. Legal and administrative @ 5%	2,116,000
c. Contingency @ 25%	10,579,000
TOTAL CAPITAL COSTS	61,357,000

TABLE 5-4 (Page 3 of 3)

ALTERNATIVE 3A

ACHIEVE FEDERAL STANDARDS: CAP, TRENCH AND TREAT
COST ESTIMATE

	COSTS ($/yr)
B. O&M COSTS (30-YEAR LIFE)	
1. Monthly fence inspection, repair fence, replace gates	7,000
2. Monitoring	
a. Quarterly sampling of monitoring wells, air, and surface water and data analysis	10,000
b. Analytical services for quarterly sampling	101,000
3. Access road maintenance and repair	2,000
4. Cap maintenance and repair	
a. Inspections, runoff and subsidence repairs	43,000
b. Vegetation mowing, fertilizing, reseeding	47,000
c. Gabion terrace maintenance and repair	14,000
5. Passive gas venting maintenance and repair	10,000
6. Surface water control maintenance & repair	6,000
7. Leachate collection trench maintenance and repair	36,000
8. Wastewater treatment and disposal	
Year 1-5 @ 100 gpm	89,000
Year 6-10 @ 35 gpm	53,000
Year 11-30 @ 20 gpm	38,000
9. Alternative water supply service charges	10,000*
TOTAL: Year 1-5	375,000
Year 6-10	339,000
Year 11-30	324,000

*Alternate water supply evaluated in separate study.

TABLE 5-5 (Page 1 of 3)

ALTERNATIVE 3B

ACHIEVE FEDERAL STANDARDS: CAP, TRENCH, DEEP PUMP IN FLOW CHANNEL NO. 6, AND TREAT COST ESTIMATE

	COSTS ($)
A. CAPITAL COSTS	
1. Direct	
a. Fence, locking gate, warning signs	111,000
b. Monitoring wells installation (4 shallow, 4 deep)	108,000
c. Access road segments	300,000
d. Site preparation	
1. General waste grading	1,497,000
2. Cap perimeter cleaning and grading	72,000
3. Excavate wastes in powerline ROW	767,000
e. Capping, terracing and revegetation	
1. Multilayered clay cap and revegetation	21,162,000
2. Gabion terracing	1,015,000
f. Passive gas venting with perimeter trench	681,000
g. Surface water controls	
1. Cap berms and reinforced chutes	185,000
2. Cap perimeter paved ditches	336,000
h. Leachate collection trench	14,148,000
i. Wastewater treatment (RBC) and discharge to Trout Brook	1,364,000
j. Deep pump in flow channel No. 6	76,000
k. Alternate water supply*	
1. Temporary bottled water	69,000
2. Permanent alternate supply	500,000
Subtotal Direct Capital Costs	42,391,000

*Alternate water supply evaluated in separate study.

TABLE 5-5 (Page 2 of 3)

ALTERNATIVE 3B

ACHIEVE FEDERAL STANDARDS: CAP, TRENCH, DEEP PUMP
IN FLOW CHANNEL NO. 6, AND TREAT
COST ESTIMATE

	COSTS ($)
A. CAPITAL COSTS (Continued)	
2. Indirect	
a. Engineering and design @ 15%	6,359,000
b. Legal and administrative @ 5%	2,120,000
c. Contingency @ 25%	10,598,000
TOTAL CAPITAL COSTS	61,468,000

TABLE 5-5 (Page 3 of 3)

ALTERNATIVE 3B

ACHIEVE FEDERAL STANDARDS: CAP, TRENCH, DEEP PUMP IN FLOW CHANNEL NO. 6, AND TREAT COST ESTIMATE

	COSTS ($/yr)
B. O&M COSTS (30-YEAR LIFE)	
1. Monthly fence inspection, repair fence, replace gates	7,000
2. Monitoring	
a. Quarterly sampling of monitoring wells, air, and surface water and data analysis	10,000
b. Analytical services for quarterly sampling	101,000
3. Access road maintenance and repair	2,000
4. Cap maintenance and repair	
a. Inspections, runoff and subsidence repairs	43,000
b. Vegetation mowing, fertilizing, and reseeding	47,000
c. Gabion terrace maintenance and repair	14,000
5. Passive gas venting maintenance and repair	10,000
6. Surface water control maintenance & repair	6,000
7. Leachate collection trench maintenance and repair	36,000
8. Wastewater treatment and disposal	
Year 1-5 @ 100 gpm	89,000
Year 6-10 @ 35 gpm	53,000
Year 11-30 @ 20 gpm	38,000
9. Deep pump in flow channel no. 6	15,000
10. Alternative water supply service charges	10,000*
TOTAL O&M: Year 1-5	390,000
Year 6-10	354,000
Year 11-30	339,000

*Alternate water supply evaluated in separate study.

TABLE 5-6 (Page 1 of 3)

ALTERNATIVE 3C

ACHIEVE FEDERAL STANDARDS: CAP, SHALLOW PUMP, DEEP PUMP IN FLOW CHANNEL NO. 6, AND TREAT COST ESTIMATE

	COSTS ($)
A. CAPITAL COSTS	
1. Direct	
a. Fence, locking gate, warning signs	111,000
b. Monitoring wells installation (4 shallow, 4 deep)	108,000
c. Access road segments	300,000
d. Site preparation	
1. General waste grading	1,497,000
2. Cap perimeter cleaning and grading	72,000
3. Excavate wastes in powerline ROW	767,000
e. Capping, terracing and revegetation	
1. Multilayered clay cap and revegetation	20,507,000
2. Gabion terracing	1,015,000
f. Passive gas venting with pipe vents	1,233,000
g. Surface water controls	
1. Cap berms and reinforced chutes	185,000
2. Cap perimeter paved ditches	336,000
h. Shallow aquifer pumping	1,296,000
i. Deep pump in flow channel No. 6	76,000
j. Wastewater treatment (RBC) and discharge to Trout Brook	1,364,000
k. Alternate water supply*	
1. Temporary bottled water	69,000
2. Permanent alternate supply	500,000
Subtotal Direct Capital Costs	29,436,000

*Alternate water supply evaluated in separate study.

TABLE 5-6 (Page 2 of 3)

ALTERNATIVE 3C

ACHIEVE FEDERAL STANDARDS: CAP, SHALLOW PUMP, DEEP PUMP IN FLOW CHANNEL NO. 6, AND TREAT
COST ESTIMATE

	COSTS ($)
A. CAPITAL COSTS (Continued)	
2. Indirect	
a. Engineering and design @ 15%	4,415,000
b. Legal and administrative @ 5%	1,472,000
c. Contingency @ 25%	7,359,000
TOTAL CAPITAL COSTS	42,682,000

ALTERNATIVE 3C

ACHIEVE FEDERAL STANDARDS: CAP, SHALLOW PUMP, DEEP PUMP IN FLOW CHANNEL NO. 6, AND TREAT COST ESTIMATE

	COSTS ($/yr)
B. O&M COSTS (30-YEAR LIFE)	
1. Monthly fence inspection, repair fence, replace gates	7,000
2. Monitoring	
a. Quarterly sampling of monitoring wells, air, and surface water and data analysis	10,000
b. Analytical services for quarterly sampling	101,000
3. Access road maintenance and repair	2,000
4. Cap maintenance and repair	
a. Inspections, runoff and subsidence repairs	43,000
b. Vegetation mowing, fertilizing, and reseeding	47,000
c. Gabion terrace maintenance and repair	14,000
5. Passive gas venting maintenance and repair	19,000
6. Surface water control maintenance & repair	6,000
7. Shallow pumping maintenance and repair	151,000
8. Deep pumping of flow channel No. 6 maintenance and repair	15,000
9. Wastewater treatment and disposal	
Year 1-5 100 gpm	89,000
Year 6-10 @ 35 gpm	53,000
Year 11-30 @ 20 gpm	38,000
10. Alternative water supply service charges	10,000*
TOTAL O&M: Year 1-5	504,000
Year 6-10	468,000
Year 11-30	453,000

*Alternate water supply evaluated in separate study.

TABLE 5-7 (Page 1 of 3)

ALTERNATIVE 4

EXCEED FEDERAL STANDARDS
COST ESTIMATE

		COSTS ($)
A.	CAPITAL COSTS	
	1. Direct	
	a. Fence, locking gate, warning signs	111,000
	b. Monitoring wells installation (4 shallow, 4 deep)	108,000
	c. Access road segments	300,000
	d. Site preparation	
	1. General waste grading	1,497,000
	2. Cap perimeter cleaning and grading	72,000
	3. Excavate wastes in powerline ROW	767,000
	e. Capping, terracing and revegetation	
	1. Multilayered clay cap and revegetation	21,162,000
	2. Gabion terracing	1,015,000
	f. Active gas collection and treatment	1,763,000
	g. Surface water controls	
	1. Cap berms and reinforced chutes	185,000
	2. Cap perimeter paved ditches	336,000
	h. Leachate collection trench	14,148,000
	i. Deep pumping in all flow channels	519,000
	j. Wastewater treatment (RBC) with discharge to Black River	1,465,000
	k. Upgradient slurry wall	302,000
	l. Alternate water supply*	
	1. Temporary bottled water	69,000
	2. Permanent alternate water supply	500,000
	Subtotal Direct Capital Costs	44,319,000

*Alternate water supply evaluated in separate study.

TABLE 5-7 (Page 2 of 3)

ALTERNATIVE 4

EXCEED FEDERAL STANDARDS
COST ESTIMATE

	COSTS ($)
A. CAPITAL COSTS (Continued)	
2. Indirect	
a. Engineering and design @ 15%	6,648,000
b. Legal and administrative @ 5%	2,216,000
c. Contingency @ 25%	11,080,000
TOTAL CAPITAL COSTS	64,263,000

TABLE 5-7 (Page 3 of 3)

ALTERNATIVE 4

EXCEED FEDERAL STANDARDS
COST ESTIMATE

	COSTS ($/yr)
B. O&M COSTS (30-YEAR LIFE)	
1. Monthly fence inspection, repair fence, replace gates	7,000
2. Monitoring	
a. Quarterly sampling of monitoring wells, air, and surface water and data analysis	10,000
b. Analytical services for quarterly sampling	101,000
3. Access road maintenance and repair	2,000
4. Cap maintenance and repair	
a. Inspections, runoff and subsidence repairs	43,000
b. Vegetation mowing, fertilizing, and reseeding	47,000
c. Gabion terrace maintenance and repair	14,000
5. Active gas venting and treatment maintenance and repair	67,000
6. Surface water control maintenance & repair	6,000
7. Leachate collection trench maintenance and repair	36,000
8. Deep pumping in all flow channels maintenance and repair	266,000
9. Wastewater treatment with discharge to Black River	
Year 1-5 @ 100 gpm	93,000
Year 6-10 @ 35 gpm	55,000
Year 11-30 @ 20 gpm	39,000
10. Alternative water supply service charges	10,000*
TOTAL O&M: Year 1-5	702,000
Year 6-10	664,000
Year 11-30	648,000

*Alternate water supply evaluated in separate study.

TABLE 5-8 (Page 1 of 2)

ALTERNATIVE 5A

ACHIEVE SOME BUT NOT ALL FEDERAL STANDARDS: CAP AND CIRCUMFERENTIAL SLURRY WALL
COST ESTIMATE

	COSTS ($)
A. CAPITAL COSTS	
1. Direct	
a. Fence, 4 gates, warning signs	111,000
b. Monitoring wells installation (4 shallow, 4 deep)	108,000
c. Access road segments	2,044,000
d. Site preparation	
1. General waste grading	1,497,000
2. Cap perimeter cleaning and grading	72,000
3. Excavate wastes in powerline ROW	767,000
e. Capping, terracing and revegetation	
1. Multilayered clay cap and revegetation	21,162,000
2. Gabion terracing	1,015,000
f. Passive gas venting with pipe vents	1,233,000
g. Surface water controls	
1. Cap berms and reinforced chutes	185,000
2. Cap perimeter paved ditches	336,000
h. Circumferential slurry wall	8,870,000
i. Alternate water supply*	
1. Temporary bottled water	69,000
2. Permanent alternate water supply	500,000
Subtotal Direct Capital Costs	37,969,000
2. Indirect	
a. Engineering and design @ 15%	5,695,000
b. Legal and administrative @ 5%	1,898,000
c. Contingency @ 25%	9,492,000
TOTAL CAPITAL COSTS	55,054,000

*Alternate water supply evaluated in separate study.

TABLE 5-8 (Page 2 of 2)

ALTERNATIVE 5A

ACHIEVE SOME BUT NOT ALL FEDERAL STANDARDS: CAP AND CIRCUMFERENTIAL SLURRY WALL
COST ESTIMATE

	COSTS ($/yr)
B. O&M COSTS	
1. Monthly fence inspection, repair fence, replace gates	7,000
2. Monitoring	
a. Quarterly sampling of monitoring wells, air, and surface water and data analysis	10,000
b. Analytical services for quarterly sampling	101,000
3. Access road maintenance and repair	2,000
4. Cap maintenance and repair	
a. Inspections, runoff and subsidence repairs	43,000
b. Vegetation mowing, fertilizing, and reseeding	47,000
c. Gabion terrace maintenance and repair	14,000
5. Passive gas venting maintenance and repair	19,000
6. Surface water control maintenance & repair	6,000
7. Alternative water supply service charges	10,000*
TOTAL O&M COSTS	259,000

*Alternate water supply evaluated in separate study.

TABLE 5-9 (Page 1 of 3)

ALTERNATIVE 5B

ACHIEVE SOME BUT NOT ALL FEDERAL STANDARDS:
"NO CLAY" CAP, TRENCH, AND TREAT
COST ESTIMATE

	COSTS ($)
A. CAPITAL COSTS	
1. Direct	
a. Fence, locking gate, warning signs	111,000
b. Monitoring wells installation (4 shallow, 4 deep)	108,000
c. Access road segments	300,000
d. Site preparation	
1. General waste grading	1,497,000
2. Cap perimeter cleaning and grading	72,000
3. Excavate wastes in powerline ROW	767,000
e. Capping, terracing and revegetation	
1. Multilayered clayless cap and revegetation	15,031,000
2. Gabion terracing	1,015,000
f. Passive gas venting with perimeter trench	681,000
g. Surface water controls	
1. Cap berms and reinforced chutes	185,000
2. Cap perimeter paved ditches	336,000
h. Leachate collection trench	14,148,000
i. Wastewater treatment (RBC) and discharge to Trout Brook	1,364,000
j. Alternate water supply*	
1. Temporary bottled water	69,000
2. Permanent alternate water supply	500,000
Subtotal Direct Capital Costs	36,184,000

*Alternate water supply being evaluated in separate study.

TABLE 5-9 (Page 2 of 3)

ALTERNATIVE 5B

ACHIEVE SOME BUT NOT ALL FEDERAL STANDARDS:
"NO CLAY" CAP, TRENCH, AND TREAT
COST ESTIMATE

	COSTS ($)
A. CAPITAL COSTS (Continued)	
2. Indirect	
a. Engineering and design @ 15%	5,428,000
b. Legal and administrative @ 5%	1,809,000
c. Contingency @ 25%	9,046,000
TOTAL CAPITAL COSTS	52,467,000

ALTERNATIVE 5B

ACHIEVE SOME BUT NOT ALL FEDERAL STANDARDS:
"NO CLAY" CAP, TRENCH, AND TREAT
COST ESTIMATE

	COSTS ($/yr)
B. O&M COSTS (30-YEAR LIFE)	
1. Monthly fence inspection, repair fence, replace gates	7,000
2. Monitoring	
a. Quarterly sampling of monitoring wells, air, and surface water and data analysis	10,000
b. Analytical services for quarterly sampling	101,000
3. Access road maintenance and repair	2,000
4. Cap maintenance and repair	
a. Inspections, runoff and subsidence repairs	43,000
b. Vegetation mowing, fertilizing, and reseeding	37,000
c. Gabion terrace maintenance and repair	14,000
5. Passive gas venting maintenance and repair	10,000
6. Surface water control maintenance & repair	6,000
7. Leachate collection trench maintenance and repair	36,000
8. Wastewater treatment and disposal:	
Year 1-30 @ 100 gpm	89,000
9. Alternative water supply service charges	10,000
TOTAL O&M COSTS: Year 1-30	365,000

TABLE 5-10

COST SUMMARY:

COMPARISON OF PRESENT WORTH FOR EACH ALTERNATIVE

ALTERNATIVE	CAPITAL COST ($)	O&M YEAR	O&M No. YRS	O&M COST ($/YR)	O&M PRESENT WORTH ($)	TOTAL PRESENT WORTH ($)
1	1,142,000	1-30	30	127,600	1,202,874	2,344,874
2	216,926,000	1-30	30	428,000	4,034,719	220,960,719
3A	61,357,000	1- 5	5	375,000	1,421,545	64,639,957
		6-10	5	339,000	797,932	
		11-30	20	324,000	1,063,481	
					3,282,957	
3B	61,468,000	1- 5	5	390,000	1,478,407	64,892,361
		6-10	5	354,000	833,238	
		11-30	20	339,000	1,112,716	
					3,424,361	
3C	42,682,000	1- 5	5	504,000	1,984,464	47,275,298
		6-10	5	468,000	1,215,107	
		11-30	20	453,000	1,519,727	
					4,593,298	
4	64,263,000	1- 5	5	702,000	2,667,132	70,614,004
		6-10	5	664,000	1,562,910	
		11-30	20	648,000	2,126,961	
					6,351,004	
5A	55,054,000	1-30	30	259,000	2,441,571	57,495,571
5B	52,467,000	1-30	30	365,000	3,440,824	55,907,824

Note: Interest rate = 10%.

TABLE 5-11 (Page 1 of 2)

COST EFFECTIVENESS SUMMARY

ALTERNATIVE/ COMPONENT	COST ($1000) CAPITAL	COST ($1000) PRESENT WORTH	HEALTH/ ENVIRONMENTAL CONCERNS	MITIGATION CONCERNS	TECHNICAL CONCERNS
1-No action	1,142	2,345	Prevents access only. Continued migration of chemicals in ground and surface waters.	-	-
2-New RCRA landfill	216,926	220,961	Continued release during long construction period. Ultimate full control.	Substantial construction impacts.	-
3A-Clay cap Leachate/trench Treat and discharge to Trout Bk. Passive perimeter gas vent	61,357	64,639	Leachate production diminishes over time. Chemical release to shallow aquifer eliminated. Does not treat gas. Probable partial control over bedrock flow.	Some construction impacts, especially noise.	Trench construction difficult; not standard technology. May not be fully feasible.
3B-Clay cap Leachate/trench Pump, flow path No. 6 Treat and discharge to Trout Bk. Passive perimeter gas vent	61,468	64,892	As in 3A, but adds some control over bedrock flow in path No. 6.	Same as 3A.	Same as 3A.

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TABLE 5-11 (Page 2 of 2)

COST EFFECTIVENESS SUMMARY

ALTERNATIVE/ COMPONENT	COST ($1000) CAPITAL	PRESENT WORTH	HEALTH/ ENVIRONMENTAL CONCERNS	MITIGATION CONCERNS	TECHNICAL CONCERNS
3C-Clay cap Shallow pumping Pump path No. 6 Treat and discharge to Trout Bk. Passive internal gas vents	42,682	47,275	Same as 3B.	Same as 3A.	Shallow pump more feasible than trench.
4-Clay Cap Leachate/trench Active gas vent/treat Pump deep aquifer Upgradient wall Treat and discharge to Black River	64,263	70,614	Flares methane and destroys some VOCs. Possible additional groundwater control, but not without complications	-	-
5A-Clay cap Circumferential barrier Passive internal gas vents	55,054	57,496	Continued migration in bedrock.	-	Probable chemical attack of barrier.
5B-Clayless cap Leachate/Trench Treat and discharge to Trout Brook Passive perimeter gas vent	52,467	55,908	Undiminished leachate production. Continued migration in bedrock. Others same as 3A.	-	-

- Is no action acceptable? This alternative allows the continued migration of chemicals in the groundwater, some of it toward drinking water wells. It will also continue the contamination of wetlands and Trout Brook, and the erosion of the landfill.

- Is a new RCRA fill warranted? This alternative costs $150,000,000 more than the next most expensive alternative, but its effectiveness is not necessarily greater. It eventually results in full or near-full control of adverse impacts, but allows them continuation during construction, which will be longer than for other action alternatives. Its construction related impacts will also be greater than for the other action alternatives.

- Should the cap have a clay layer? The total present worth of providing the clay cap is the present worth of the clay part of the cap minus the savings in treatment costs that the clay cap realizes because it reduces flow to the treatment system over time. This cost is $\$8.89 \times 10^6$ minus $\$.62 \times 10^6$, or $\$8.27 \times 10^6$.

  The benefits of this expenditure are:

  - The clay layer helps control release of gases from the fill.

  - The clay affords greater assurance of control over leachate chemicals, because it prevents infiltration of rainfall and thereby helps prevent the transfer of chemicals from the fill to the water environment. The migration of chemicals in the groundwater can be controlled via other mechanisms such as the trench or pumps, but prevention of the chemicals reaching the groundwater is a more secure means of preventing contaminant release and migration in the first place.

- Should an impermeable membrane be included in the cap? Cap designs for RCRA landfill cells call for the inclusion of an impermeable membrane between the sand drainage layer and the clay layer of the cap shown in Figure 4-3. Although legislatively not required for remediation caps, should such a membrane be used in the cap for Combe Fill South.

Because most of the slopes even in the regraded site are too steep for placement of such a membrane, only about 16.2 acres of the cap where slopes are between 0-7% could have such a membrane. The costs to install a 36-mil Hypalon membrane as part of the cap within this area would be approximately $\$1.6 \times 10^6$ which is about 8% greater than the costs for a clay cap alone. Cap subsidence and interactions with volatile organics will likely result in tears, displacement, and deterioration of the membrane which will require about $100,000 in O&M costs every 10 years.

Assuming complete impermeability of the membrane under a worst-case scenario of complete saturation above the membrane or clay, the membrane can provide an additional 2% reduction of infiltration.

- <u>Should the shallow aquifer be controlled by a trench or by multi-well system</u>? The additional cost of providing a trench is measured by its greater capital cost minus savings in O&M. Including the cost of providing gas venting in both cases (which slightly distorts the analysis in favor of the trench, because only the incremental cost of gas venting is identifiable) the trench costs $\$18.2 \times 10^6$ more in capital costs and saves $\$1.2 \times 10^6$ in O&M, for a total extra cost of $\$17 \times 10^6$ for the trench.

  Of the two options, the active shallow well-pumping system is somewhat more effective than the passive trench on controlling groundwater migration. Although well pumping will require more O&M, its construction feasibility is considerably better than that for the trench.

- <u>What level of bedrock aquifer control should be used</u>? The choice here is among the secondary control afforded by the shallow aquifer control exercised by either the trench or the well pumping system, some direct control of flow in path No. 6 only, and some direct control of all bedrock flow paths. The total present worth of the bedrock controls are:

Secondary	- 0
Flow Path No. 6	- $\$0.27 \times 10^6$
All paths	- $\$3.30 \times 10^6$

The actual cost of control in all flow path would be slightly higher because of the greater flow to the treatment plant not accounted for in this analysis.

Some direct control of flow in path No. 6 will help prevent the movement of contaminants toward the most directly impacted drinking water wells. Expanding this control to all flow paths provides additional positive control over groundwater movement in other directions, where although no demonstrated movement has occurred, but is expected in the future without control.

Such expanded control may not be without some adverse impacts in terms of installation and additional start-up. The secondary bedrock groundwater control afforded by the trench or the shallow well pumping system may also provide overall control of the bedrock flow. The active shallow well pumping system would provide some additional amount of control over the bedrock aquifer as compared to the passive trench.

Because impacted residents will be connected to public water there are no public health reasons to remediate the bedrock contamination directly. A deep bedrock control system can be installed at a later stage in the remediation process if monitoring indicates such a need.

- Is an upgradient groundwater barrier necessary? This component costs $430,000 in capital expenditure, and prevents the flow of about 5,000 gpd to the treatment system. Although the incremental cost of treating this water has not been identified in the cost tables, it has a present worth in the order of $60,000-70,000, i.e., providing the barrier has a net cost of about $375,000.

  The benefit of this barrier is that it prevents about 5000 gpd of upgradient groundwater from moving downgradient into the fill and into the treatment plant. As time goes on, this becomes a greater percentage of the total, up to about 30%. The barrier cannot reduce flow needing treatment to zero.

- Is a circumferential barrier necessary? In the alternatives as currently formulated, this component appears only in Alternative 5A, which has no groundwater control, but it could be combined with options that independently control groundwater levels, e.g., it could be placed outside the shallow aquifer well system. This placement would eliminate the drawback of chemical deterioration of such a wall.

As currently formulated, the slurry wall costs about $13 x 10^6$ and has a present worth of $15 x 10^6. Its effectiveness is limited by probable chemical attack, and at best it controls flow, only in the shallow aquifer. Shallow aquifer control is much less expensively obtained by the pump or trench and treat system.

- Should treated effluent be discharged to Trout Brook or Black River? Since the effluent limits are the same for discharge to either Trout Brook or the Black River, there will be no difference in the level of treatment afforded effluent discharged to either located. However, because of the greater flow in the Black River, impacts to the river will be less because of greater dilution. The most obvious difference in these two discharge options are the costs and impacts associated with the effluent outfall. The additional cost for discharge to the Black River of $150,000 is coupled with some additional construction impacts because of the longer pipeline installation.

CHAPTER 6

SELECTION OF RECOMMENDED ALTERNATIVE

The remedial action alternatives described in Chapter 4 were evaluated as described in Chapter 5, and from this evaluation a recommended alternative was formulated which consisted of remedial components from several alternatives. The following paragraphs discuss the rationale used in selecting the particular remedial components which are summarized in Table 6-1.

Like all the remedial alternatives considered, the recommended alternative includes providing permanent public water to the residents at risk, with interim use of bottled water till the new permanent source is provided. The RI has demonstrated, based on hydrogeological investigations and groundwater quality sampling, the off-site movement (primarily northeast and southwest) of contaminants in the drinking water aquifer at concentrations which may be a threat to public health. The alternate water supply study concluded that the most feasible alternate water supply source is the Washington Township Municipal Utilities Authority (WTMUA). Although a final service area has not yet been delineated, at a minimum, public water would be provided to those residents on Schoolhouse Lane and those on Parker Road from the vicinity of Trout Brook to the intersection of Schoolhouse Lane and Parker Road.

Security fencing with a locking gate would be installed around the perimeter of the remediated fill area and the on-site treatment facility (see Chapter 4 for a description of this fence). Although not a deterent to the determined trespassers, the fence will prevent most direct physical contact with the general public.

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TABLE 6-1

RECOMMENDED REMEDIAL ALTERNATIVE
COMBE FILL SOUTH LANDFILL

- Public potable water supply for affected residents
- Security fencing
- Grading, filling, site preparation and access road
- Multilayered terraced cap
- Active gas venting and treatment
- Surface water controls
- Shallow aquifer pumping
- On-site treatment of leachate/groundwater with discharge to Trout Brook
- Expanded environmental monitoring
- Supplemental feasibility study to evaluate the need for remediation of the deep aquifer

Grading, filling, and general site preparation activities including the installation of a paved access road to the on-site treatment facility and a dirt access road around the fill perimeter are the necessary precusssors to the construction of the multi-layered cap. Chapter 4 describes these site preparation activities in greater detail.

A multi-layered, terraced cap with a clay layer having a permeability of 10^{-7} cm/sec will be constructed over the regarded fill surfaces, including the areas under the powerline right-of-way. The total cap area is approximately 65 acres. Where technically possible, the multi-layered cap will include an impermeable membrane as described in Chapter 5. This membrane would cover about 16 acres of the fill area and is included in this remedial component because its use is consistent with established EPA policy to fully comply with RCRA in remediating CERCLA sites. Additional review of the cost-effectiveness and feasibility of such a membrane is necessary.

Active gas venting and treatment, consisting of a network of 65 gas extraction wells connected to vacuum blowers, will provide positive control over landfill gases. Proposed treatment technologies include flaring for removal of methane and some volatile organics. However, further examination of the issues of landfill gas reuse is necessary.

Permanent surface water controls including berms, reinforced drainage chutes, gabion terraces and a circumferential drainage ditch will be needed to direct and control stormwater runoff at the remediated site. Final design may incorporate such additional surface water control measures as detention basins if warranted. Temporary surface water control measures must also be employed during construction at the site.

Contaminated groundwater/leachate will be controlled with a <u>shallow aquifer pumping</u> system as described in Chapter 4. This system is less expensive, more feasible, and probably more effective than its counterpart the leachate trench, in controlling the movement of contaminated groundwater in the saprolite aquifer wherein most of the groundwater flow occurs. Questions concerning the actual effectiveness, demonstrated technical need, and potential adverse impacts of a bedrock pumping system should be addressed in a <u>supplemental feasibility study to evaluate the need for remediation of the deep aquifer</u>.

The shallow aquifer pumping system will send contaminated groundwater to an <u>on-site treatment facility</u> for complete physiochemical/biological treatment prior to <u>discharge to Trout Brook</u>. On-site treatment with discharge to Trout Brook is more cost-effective than either off-site final treatment with on-site pretreatment or treatment with discharge to Black River.

An <u>expanded environmental monitoring program</u> that provides for extensive monitoring of the shallow and deep groundwaters on- and off-site should be undertaken both during and after construction of the remedial components. Such monitoring information is necessary to further define the extent, speed, and direction of contaminant movement off-site so that decisions can be made as to the need for additional remediation e.g., deep aquifer pumping or further extension of public water. Details of the monitoring program will be provided in the conceptual design.

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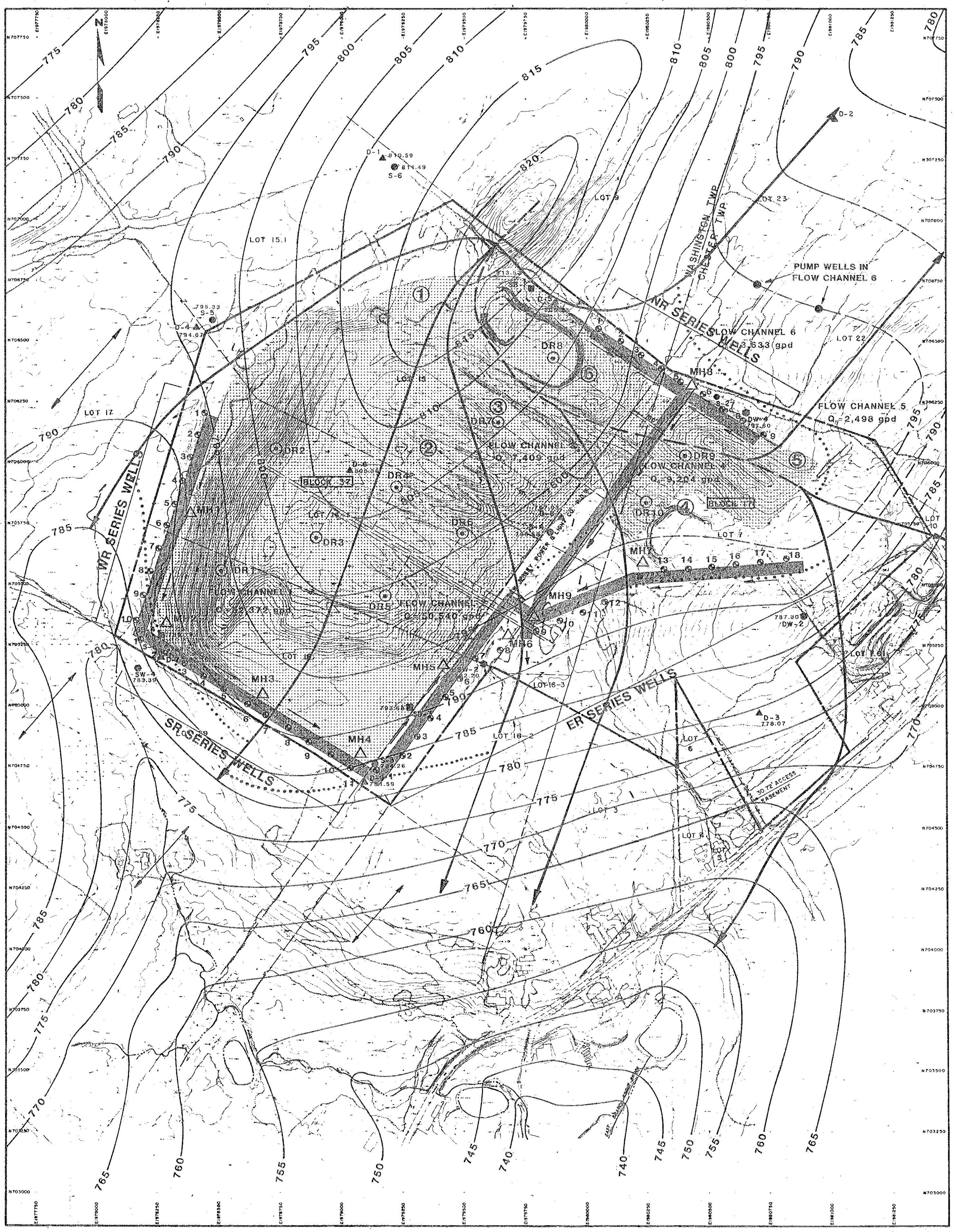


LEGEND

- TREE AREA
- BRUSH
- POLE
- HYDRANT
- L.P. — LIGHT POLE
- FENCE
- PROPERTY BOUNDRY OF COMBE FILL SOUTH LANDFILL
- S — SIGN
- STREAM
- WE 100.0' — POND - LAKE
- INDEX / INTERMEDIATE / INDEX / DEPRESSION — CONTOURS
- SHALLOW WELLS
- DEEP WELLS
- SOIL BORING / ROCK CORING PIEZOMETER
- EXISTING MONITORING WELLS

NOTE: DASHED CONTOURS INDICATE AREA OF OBSTRUCTED VIEW

NOTE:
PROPERTY LINES OBTAINED BY FIELD METHODS (LOCATION OF EXISTING PROPERTY CORNERS) DEEDS AND MAPS OF RECORD.

- 760 — ELEVATION OF WATER TABLE IN FEET ON 8/28/85 DASHED WHERE APPROXIMATE
- PERENNIAL STREAM
- GROUND WATER FLOW DIRECTION AND FLOW CHANNEL BOUNDARY UNDER 2.5:1 PERMEABILITY CONTRAST
- DIRECTION OF MAXIMUM PERMEABILITY
- FLOW CHANNEL CROSS SECTION LINE
- LANDFILLED AREAS
- RECOVERY WELL LOCATION / SAPROLITE-UNCONSOLIDATED AQUIFER
- UTILITY AND PIPING TRENCH, SHALLOW WELL SYSTEM
- △ MH1 — TRENCH LINE CONTROL CENTER (MANHOLE)
- ⊙ DR3 — BEDROCK AQUIFER RECOVERY WELL
- ABOVE GRADE RIGID 4" PVC OUTER CASING / INNER 1" PVC BLACK COIL FLUID CONDUCTOR, BEDROCK WELLS SYSTEM

PLATE 2

r. e. wright associates, inc.
earth resources consultants
middletown pennsylvania

200 0 200 400
scale feet

DESIGNED	DATE Rev. 5-28-86
DRAWN DLB	DATE 11-8-85
CGB	Rev. 5-28-86
CHECKED HEF	DATE 11/14/85
APPROVED	DATE

NO. ZONE REVISIONS DATE BY APPD.

DATE

Lawler, Matusky & Skelly Engineers
Environmental Science & Engineering Consultants
One Blue Hill Plaza
Pearl River, New York 10965

Vep Associates, Inc.
Consulting Engineers-Planners
1140 Bloomfield Avenue
West Caldwell, New Jersey 07006

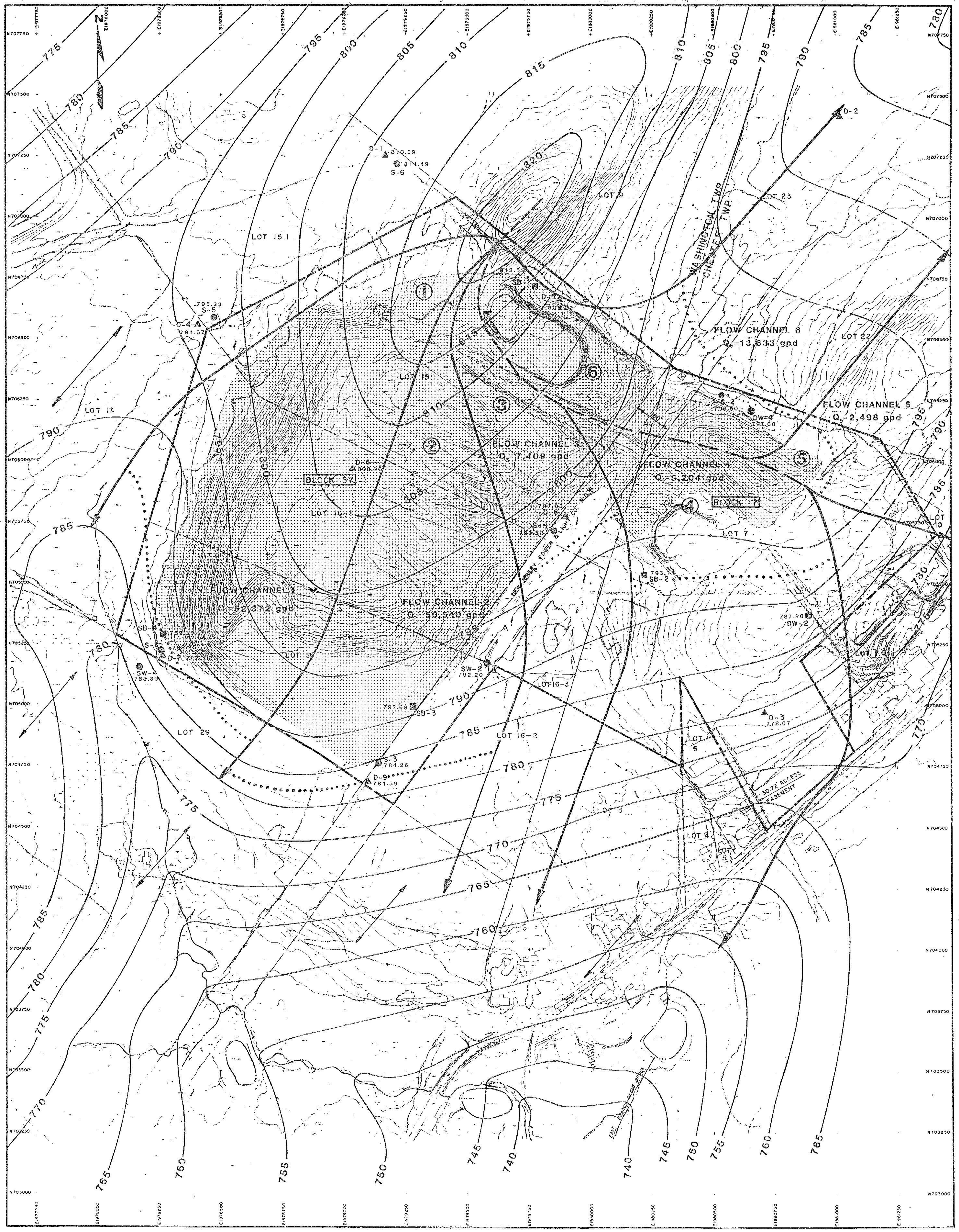
COMBE FILL SOUTH LANDFILL
REMEDIAL INVESTIGATION/FEASIBILITY STUDY

400169

GROUNDWATER RECOVERY SYSTEMS:
REMEDIAL ALTERNATIVES EVALUATION

DATE

DWG. NO.
8455-012-D



LEGEND

- TREE AREA
- BRUSH
- POLE
- HYDRANT
- L.P. — LIGHT POLE
- —x—x—x— FENCE
- PROPERTY BOUNDRY OF COMBE FILL SOUTH LANDFILL
- S — SIGN
- STREAM
- POND - LAKE
- INDEX / INTERMEDIATE CONTOURS / INDEX DEPRESSION
- SHALLOW WELLS
- DEEP WELLS
- SOIL BORING / ROCK CORING PIEZOMETER
- EXISTING MONITORING WELLS

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- DIRECTION OF MAXIMUM PERMEABILITY
- FLOW CHANNEL CROSS SECTION LINE
- LANDFILLED AREAS

PLATE 1

r. e. wright associates, inc.
earth resources consultants
middletown pennsylvania

scale 200 0 200 400 feet

NO	ZONE	REVISIONS	DATE	BY	APP'D

DESIGNED ______ DATE ______
DRAWN DLB DATE 11-8-85
CHECKED HEF DATE 11/14/85
APPROVED ______ DATE ______

______ DATE ______

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COMBE FILL SOUTH LANDFILL

REMEDIAL INVESTIGATION/FEASIBILITY STUDY

400186

WATER TABLE CONTOURS OF 8/28/85
AND FLOW NET ANALYSIS
USING 2.5:1 PERMEABILITY CONTRAST

DATE

DWG.NO.
8455-007-D