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ENGINEERING EVALUATION OF DISPOSAL ALTERNATIVES FOR RADIOACTIVE WASTE FROM REMEDIAL ACTIONS IN AND AROUND MAYWOOD, NEW JERSEY

Bechtel National, Inc.
Advanced Technology Division

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Prepared for

UNITED STATES DEPARTMENT OF ENERGY

OAK RIDGE OPERATIONS OFFICE

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By

Bechtel National, Inc.

Advanced Technology Division

Oak Ridge, Tennessee

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ABSTRACT

This report was prepared for the U.S. Department of Energy (DOE) by Bechtel National, Inc., to facilitate DOE decisions regarding the disposal of waste resulting from DOE actions to remedy radiological conditions in the area of Maywood, New Jersey.

The report compares three selected alternatives for the final disposal of 270,000 yd^3 of low-level radioactive (principally thorium) waste. These alternatives are (1) On-Site (Quasi-Passive Design) Above-Grade Disposal, (2) On-Site (Passive Design) Above-Grade Disposal, and (3) Transport to a New Jersey Disposal Site.

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ACRONYMS

ADM	Action Description Memorandum
AEC	Atomic Energy Commission
ALARA	As Low As Reasonably Achievable
BNI	Bechtel National, Inc.
CFR	Code of Federal Regulations
DOE	Department of Energy
EA	Environmental Assessment
EAC	Eberline Analytical Corporation
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ESAPP	Energy Systems Acquisition Project Plan
FUSRAP	Formerly Utilized Sites Remedial Action Program
MDS	Maywood Disposal Site
MISS	Maywood Interim Storage Site
MP	Maywood Project
NEPA	National Environmental Policy Act
NJDEP	New Jersey DEpartment of Environmental Protection
NJDS	New Jersey Disposal Site
NRC	Nuclear Regulatory Commission
ORAU	Oak Ridge Associated Universities
ORNL	Oak Ridge National Laboratory
RCRA	Resource Conservation and Recovery Act
SC	Stepan Company
SFMP	Surplus Facilities Management Program

ABBREVIATIONS

cm	centimeter
cm^2	square centimeter
cm/s	centimeters per second
dpm	disintegrations per minute
ft	foot
gal	gallon
gpm	gallons per minute
L.S.	lump sum
m^2	square meter
mi	mile
mg/cm^2	milligrams per square centimeter
mrad/h	millirad per hour
μR/h	microroentgens per hour
mrem	millirem
mrem/yr	millirem per year
m.s.l.	mean sea level
pCi/g	picocuries per gram
μCi/ml	microcuries per milliliter
pCi/l	picocuries per liter
$pCi/m^2/s$	picocuries per square meter per second
s	second
yd	yard
yd^2	square yards
yd^3	cubic yards
WL	working level

1.0 INTRODUCTION AND SUMMARY

The 1984 Energy and Water Appropriations Act directed the U.S. Department of Energy (DOE) to conduct a decontamination research and development project at four sites throughout the nation, including the site of the former Maywood Chemical Works and its vicinity properties in the Borough of Maywood, Township of Rochelle Park, and Borough of Lodi, New Jersey. Remedial action at these properties is being performed under the Formerly Utilized Sites Remedial Action Program (FUSRAP), a DOE effort to identify, decontaminate, or otherwise control sites where low-level radioactive contamination (exceeding current guidelines) remains from either the early years of the nation's atomic energy program (Ref. 1) or commercial operations causing conditions that Congress has mandated DOE to remedy. FUSRAP is currently being managed by the DOE Oak Ridge Operations Office. As the Project Management Contractor for FUSRAP, Bechtel National, Inc. (BNI) acts as DOE's representative in the planning, management, and implementation of FUSRAP.

This report compares three alternatives for the disposal of the low-level radioactive waste generated by the remedial actions in the Maywood area [Maywood Project (MP)]. Based on the current DOE Energy Systems Acquisition Project Plan (ESAPP) schedule (Ref. 2), the consolidation and storage of waste from vicinity properties in the Boroughs of Maywood and Lodi and the Township of Rochelle Park are scheduled to be completed in 1991.

Ocean disposal of this waste has not been considered because its viability is in question. Should it become a viable alternative in the future, a separate evaluation will be performed.

The first two alternatives described herein involve on-site disposal in an above-grade waste containment facility. Above-grade disposal of the waste, if accomplished at the site, is dictated by site geological and hydrological conditions that effectively eliminate below-grade disposal (i.e., fractured bedrock and the close proximity of the water table to the ground surface). Subsection 2.3 provides details of the site geology.

The third alternative is to transport all of the waste and dispose of it at a New Jersey Disposal Site (NJDS), assumed here to be approximately 100 mi distant.

In all instances, the waste containment facility would accommodate all of the waste that is currently being stockpiled in an interim configuration, the waste buried (by previous owners) on the DOE property, and the waste buried on the adjacent Stepan Company (SC) property. The total volume of the waste is presently estimated to be 270,000 yd^3.

On-site disposal in an above-grade waste containment facility (Alternatives 1 and 2) would require construction of an engineered earthen structure (dike, bottom, and cap) designed to have control and stabilization features that would ensure, to the extent reasonably achievable, an effective life of 1,000 years and, in any case, be durable for at least 200 years without maintenance. The site would become a DOE-managed, long-term disposal facility.

Alternative 1, is an on-site, above-grade disposal facility equipped with a leak monitoring system. The design minimizes the amount of land that would have to be acquired from the neighboring SC while still accommodating the estimated volume of waste. Implementation of this alternative would require a site of 16.7 acres [5 acres more than the DOE-owned Maywood Interim Storage Site (MISS)] and a perimeter concrete retaining wall 16 to 18 ft high. The height of the containment facility would be approximately 46 ft. The 5-acre extension would have to be acquired by DOE; it has been assumed for this document that the additional land could be obtained from the SC. Acquisition of the additional 5 acres would extend the eastern property line of the MISS to within 50 ft of existing SC process buildings. This design could interfere with the tentative widening of New Jersey

State Route 17, located immediately west of the MISS in that a 50-ft-wide buffer zone would be maintained around the facility to facilitate access to monitoring wells. The proposed retaining wall would require maintenance and replacement every 50 to 75 years, necessitating sustained institutional controls and continued expenditures. Since the design of the facility in Alternative 1 does not meet the requirements of durability for at least 200 years without maintenance, it cannot be considered a totally passive facility.

Alternative 2 is also an on-site, above-grade disposal facility equipped with a leak monitoring system, but is a totally passive facility. A 31.2-acre site would be required to implement this alternative, i.e., DOE would have to acquire the remaining SC plant (19 acres) plus 0.5 acre of adjacent property. In this alternative, the SC would have to relocate its operations. The height of the containment facility would be approximately 40 ft; the facility meets the requirements of durability for at least 200 years without maintenance. With the acquisition of the entire SC property, adequate easement for the widening of Route 17 would be available. A 100-ft-wide buffer zone would be maintained around the facility to facilitate surveillance of monitoring wells.

In Alternative 3, all waste would be transported off-site to the NJDS. No additional land would be required at the MISS, but land would have to be acquired elsewhere for the NJDS. At the MISS, 11.7 acres of land could be released for unrestricted use upon completion of waste removal.

Construction of the containment facilities for Alternatives 1 and 2 would require significant volumes of materials. Alternative 1 would generate the demand for approximately 354,000 yd^3 of construction materials, including concrete, cap materials, and backfill. Approximately 27,000 trips by heavy vehicles would be necessary over local roads to deliver these materials to the MISS. Alternative 2 would require approximately 742,000 yd^3 of similar construction materials; approximately 57,000 trips by heavy vehicles would be necessary over local roads. In Alternative 3, transport of waste and backfill for on-site restoration would involve the movement of approximately 270,000 yd^3 and 110,000 yd^3, respectively, necessitating approximately 29,000 trips. Material and resulting trips shown above represent the bulk of materials and do not include items such as pipe, fencing, and other miscellaneous site preparation materials.

Based on current DOE radiological guidelines, the radiological hazards to the general public and workers from the contaminated material would be minimal for all of the alternatives. However, the hauling activities associated with each of the alternatives would expose the general public to an increased risk of traffic accidents.

Water management for each of the alternatives requires the collection, storage, and treatment of water from surface and underground sources. Alternatives 1 and 3 would require the collection, storage, and treatment of approximately 2,000,000 gal of water. Alternative 2 would require management of approximately 2,250,000 gal.

Each of the alternatives would take approximately five construction seasons to implement. In Alternative 2, demolition of the SC plant would occur concurrently with site preparation activities and would not lengthen the schedule. Site selection, design, and construction schedules for the new SC plant are not considered part of the remedial action activities and are not part of this study; however, the estimated cost of such relocation is included in the cost of Alternative 2.

The total cost of Alternative 1 in 1985 dollars is $82,200,000. If the work commenced in 1991 and was completed in 1996, the escalated costs (6 percent per year through the period 1996) would be $124,300,000. Alternative 2 would cost $184,100,000 in

1985 dollars and $284,700,000 in escalated dollars. This figure includes the cost of land and buildings for a new SC plant. Alternative 3 would cost $105,100,000 in 1985 dollars and $149,100,000 in escalated dollars.

The design concepts presented and evaluated herein have their bases, in the performance sense, in relevant federal regulations and guidelines. Also, the concepts have been discussed with representatives of the New Jersey Department of Environmental Protection (NJDEP). However, inasmuch as New Jersey has not promulgated regulations for the permanent disposal of low-level waste, the NJDEP representatives were neither able to comment on the acceptability of the designs to the State of New Jersey nor to identify any concomitant permitting requirements.

2.0 SITE DESCRIPTION

2.1 LOCATION

The MP is being conducted in a highly developed area in the Borough of Maywood, the Township of Rochelle Park, and the Borough of Lodi approximately 13 mi northeast of Newark, in the County of Bergen, New Jersey (Figure 2-1). The population density of this area averages approximately 10,000 people per square mile. A temporary storage site [referred to as the Maywood Interim Storage Site (MISS)] occupies 11.7 acres of land that was leased from the SC by DOE until September 1985 when ownership was transferred to DOE. The MISS is located immediately west of the SC plant (formerly the Maywood Chemical Works). The MISS property is bounded by New Jersey State Route 17 on the west, a New York, Susquehanna, and Western Railroad line on the north, and commercial and industrial areas on the south and east (Figure 2-2). In addition, residential areas are located just north of the railroad and within 300 yd to the west along Grove Avenue. A high-rise nursing home is planned for construction between the Grove Avenue residential properties and Route 17, with construction scheduled to begin late in 1985. The nursing home will be located on what is known as the Ballod property, from which a substantial volume of contaminated soil was removed and transported to the MISS.

2.2 HISTORY

From 1916 through 1956, the Maywood Chemical Works processed thorium for use in the manufacture of a variety of items, including gas mantles for various lighting devices. During this time, process wastes from the operations were pumped to diked areas west of the plant.

Additional material was placed in two piles surrounded by earthen dikes (northern and southern diked areas) on property

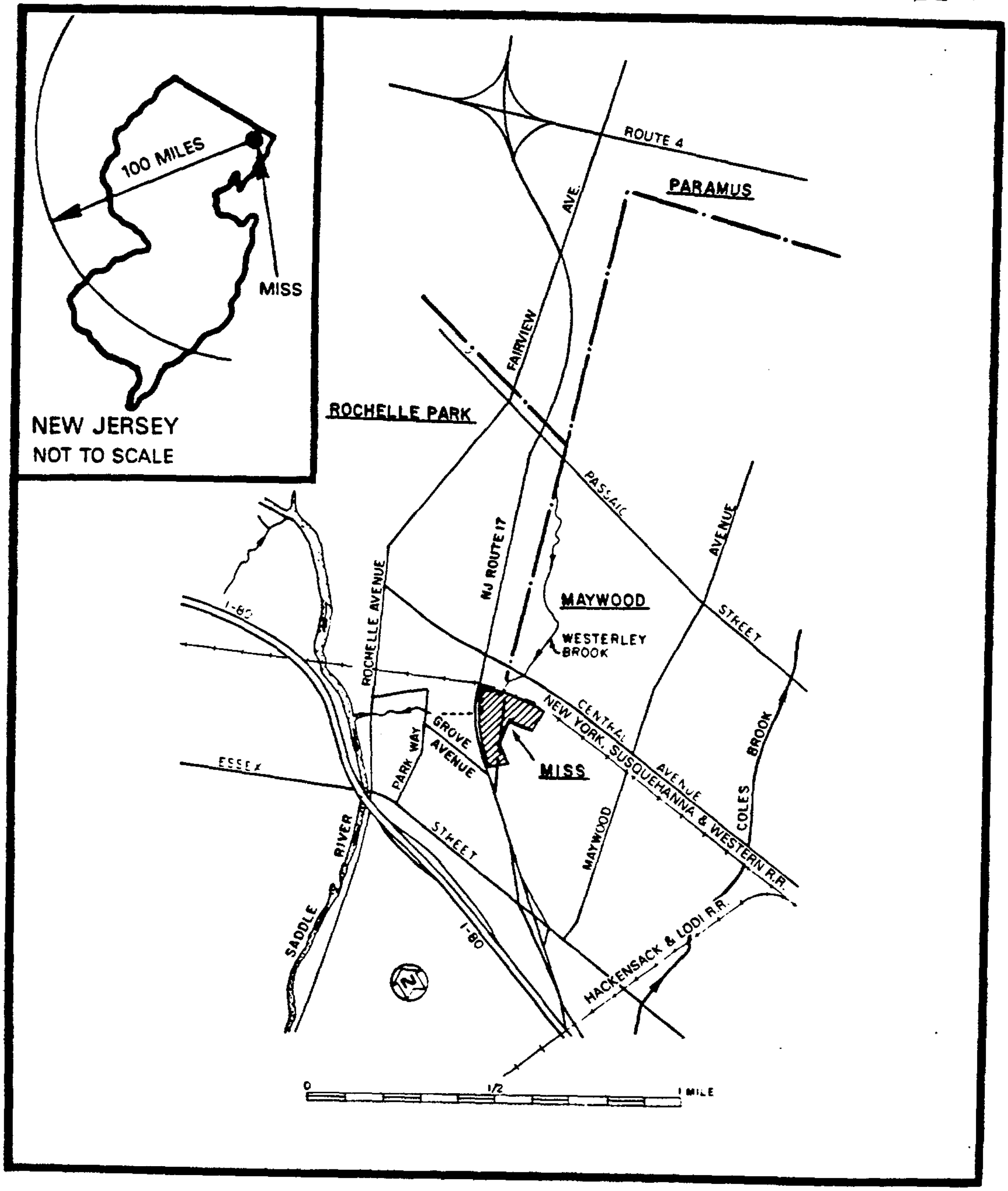

FIGURE 2-1 LOCATION OF THE MISS

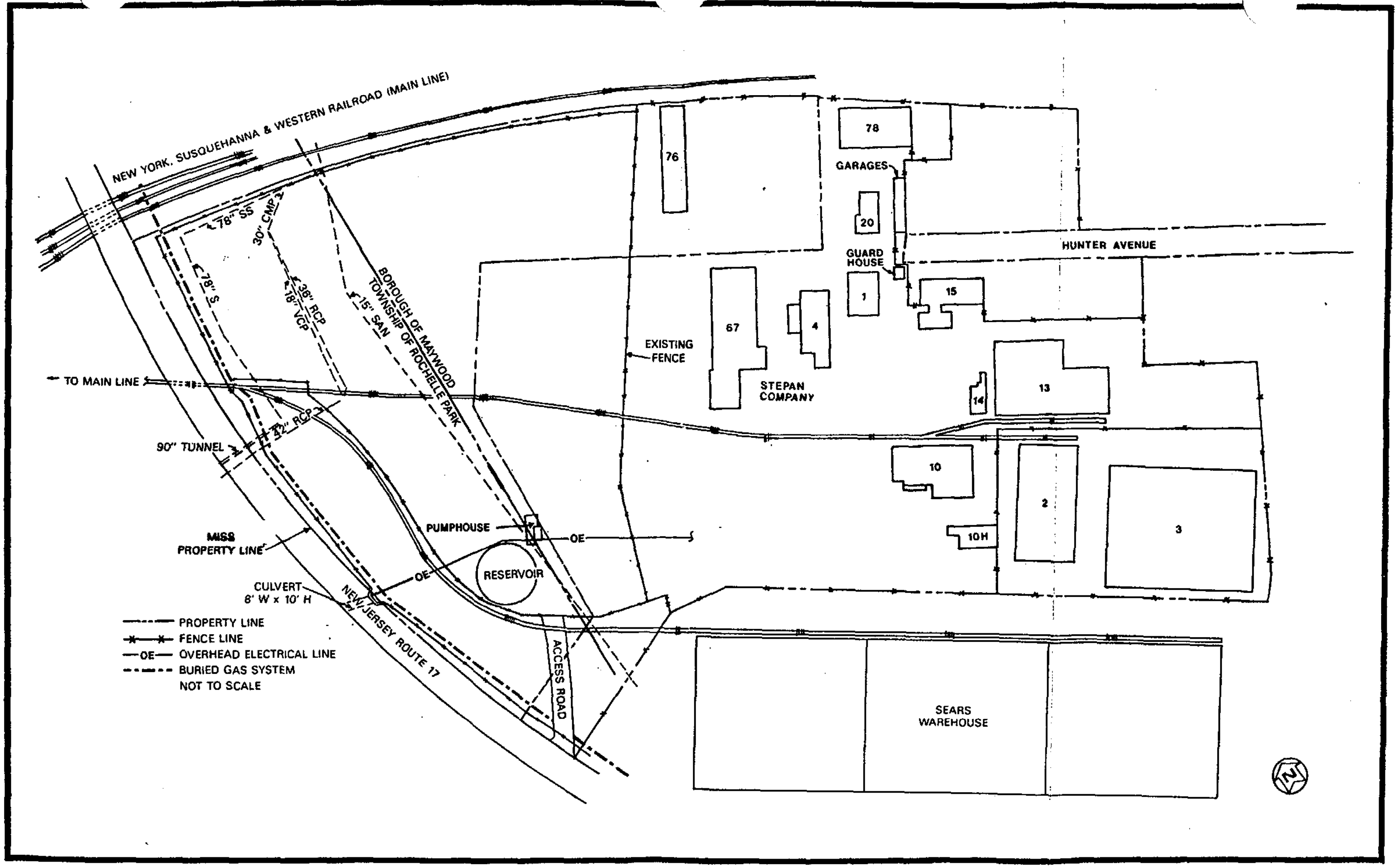

FIGURE 2-2 MAP OF THE MISS AND ITS IMMEDIATE VICINITY

now owned by Ballod Associates. In 1932, Route 17 was built through this disposal area.

In 1954, the Atomic Energy Commission (AEC) issued a license to the Maywood Chemical Works to possess, process, manufacture, and distribute radioactive materials. This license allowed manufacturing activities to continue under the Atomic Energy Act of 1954. The Maywood Chemical Works ceased thorium processing in 1956; the property was sold to the SC in 1959.

In 1961, the SC was issued an AEC radioactive materials storage license. Based on AEC inspections of and information related to the property on the west side of Route 17, the SC agreed to take remedial action in that area. In 1963, residues and tailings (also known as "slurry pile") on the property west of Route 17 were partially stabilized. In 1966, 8,358 yd^3 of waste were removed from the area west of Route 17 and were buried east of the highway (Burial Site No. 1) in an area that is now under a plant lawn. In 1967, 2,053 yd^3 of waste were removed from the same general area and buried under what is now a plant parking lot (Burial Site No. 2). In 1968, the SC obtained permission from the AEC to relocate additional waste from west of Route 17 and buried 8,600 yd^3 from the southern diked area in an area where a warehouse was later built (Burial Site No. 3) (Ref. 3). Figure 2-3 shows the approximate locations of these burial sites. The location of a former thorium processing area with buried waste is also shown.

At the request of the SC, a radiological survey of the current MISS and SC areas was made by the AEC in 1968. Based on the findings of that survey, clearance was granted for release of the property for unrestricted use. At the time of the survey, the AEC was not aware of waste material present in the northwest corner (the Ballod property). Late in 1968, the latter was sold by SC and in the late 1970s was resold to the current owners, Ballod Associates. The area has since been used for unauthorized trash disposal by the local residents. Access to the area has not been restricted to date.

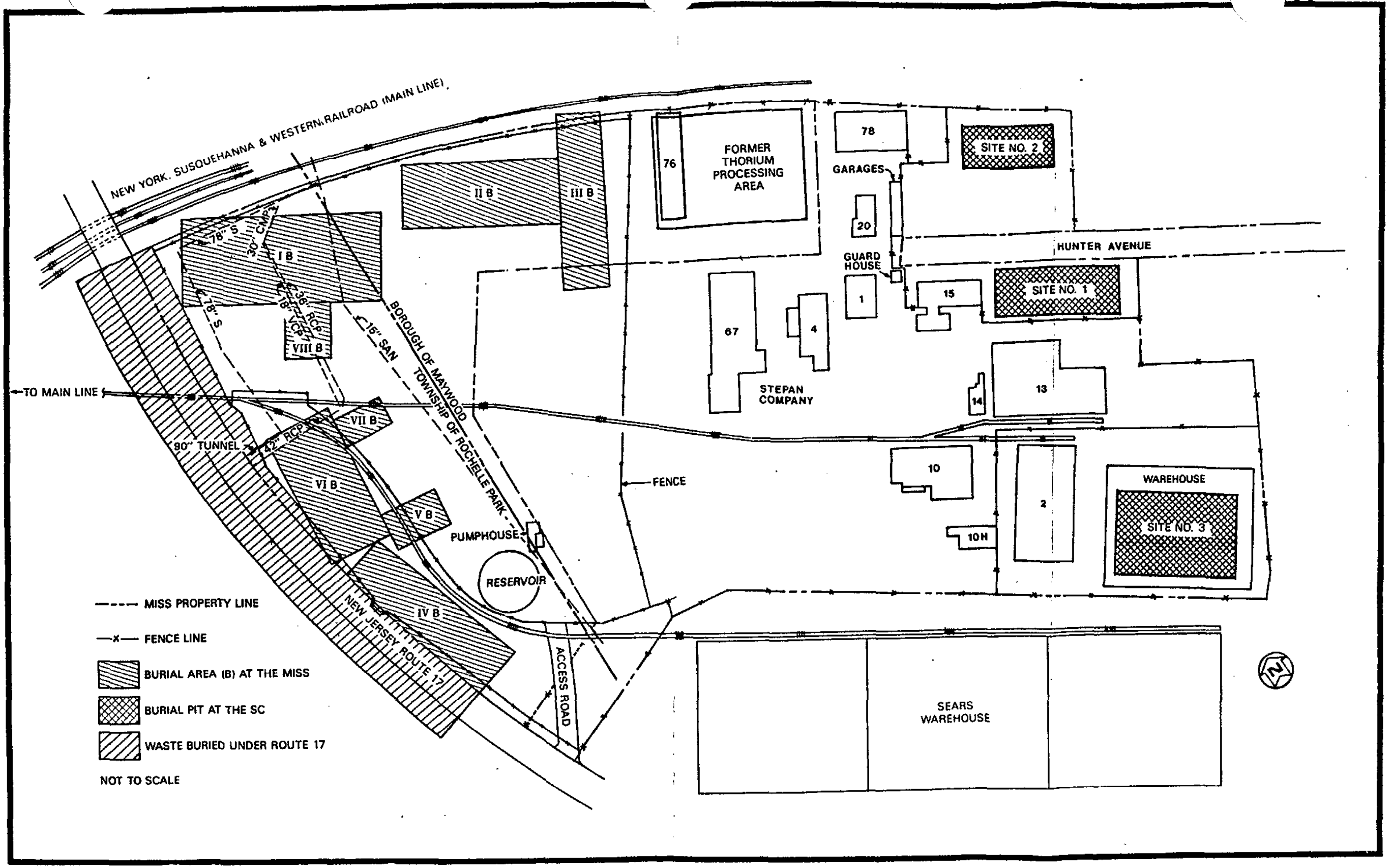

FIGURE 2-3 LOCATIONS OF BURIED WASTE DEPOSITS AT THE MISS AND SC

In 1980, the U.S. Nuclear Regulatory Commission (NRC) was notified of elevated radiation levels on the Ballod Associates' property. This information prompted the NRC to request a comprehensive survey to assess the radiological condition of the property. The survey was performed in February 1981 by Oak Ridge Associated Universities (ORAU) with the assistance of a representative from the Region I office of the NRC (Ref. 4). In addition, the NRC requested that an aerial radiological survey be conducted of the SC site, the Ballod Associates' property, and the surrounding area. This survey was conducted by EG&G Energy Measurements Group for the NRC in January 1981 (Ref. 5). This aerial radiological survey resulted in the discovery of other anomalies (i.e., readings distinctly higher than those of surrounding areas). Elevated gamma readings (in excess of the local background level) were detected directly over the SC and immediately to the west and south of it. Two other areas of elevated gamma radiation were detected approximately 0.5 mi from the center of the plant: one to the northeast and the other to the south. Followup ground surveys were performed to determine the nature of the anomalies at both locations (Refs. 6-13).

In 1984, Oak Ridge National Laboratory (ORNL) surveyed the Lodi area; several properties, known as the Lodi vicinity properties, were found to be contaminated with materials from the SC plant.

The 1984 Energy and Water Appropriations Act directed DOE to conduct a decontamination research and development project at the site of the former Maywood Chemical Works and properties in the vicinity. During that year, DOE negotiated a lease from the SC of the land on which to establish the MISS for the contaminated materials removed from these properties. The land was transferred to DOE ownership in September 1985 to provide an interim storage site for the waste from vicinity properties (other than the SC) until such time as decision is made regarding their final disposition.

2.3 SITE GEOLOGY AND HYDROLOGY

Maywood, Rochelle Park, and Lodi are located within the glaciated section of the Piedmont Plateau of north-central New Jersey. The terrain is generally level or slightly undulating. The present MISS slopes gently toward the Saddle River, located west of the site. The elevation of the MISS decreases from 62.0 ft m.s.l. to 54 ft m.s.l. except for a small area in the northwest corner, which slopes from elevation 61.0 ft m.s.l. to 52.7 ft m.s.l. northward to a storm drain system.

The MISS area is underlain by unconsolidated glacial till (a heterogeneous mixture of sand, silt, clay, gravel, cobbles, and occasional boulders) and, below that, by bedrock consisting of a fine-grained, well-cemented, reddish-brown sandstone, with some conglomerate and occasional interbeds of shale. Many of the unconsolidated deposits have been disturbed during operations at the SC plant and now contain sludges, construction materials and other debris. No regional groundwater flow is believed to be present in these unconsolidated deposits: only limited quantities of groundwater are present in discontinuous sand and gravel deposits in the till. The bedrock (Brunswick Formation) lies beneath the unconsolidated materials at depths ranging from 1.8 to 21.5 ft. The uppermost 15 to 20 ft of the bedrock often contains numerous vertical to near vertical, fresh to slightly weathered, open fractures. The formation is the major aquifer in the vicinity of the MISS. The groundwater level in the area is 7 to 10 ft below ground surface. Both the fractured bedrock and the proximity of the water table to the ground surface make near-surface or below-grade storage of waste at the MISS impractical.

Surface water runoff leaves the site via Westerley Brook and overland flow. Westerley Brook enters the MISS near the Maywood-Rochelle Park boundary (Figure 2-1). At this point it enters a 78-in.-diameter concrete pipe, which is covered with 2 to 5 ft of fill material on the MISS and the Ballod property. The brook flows west through the underground pipe and emerges at the surface approximately 655 ft west of the Ballod property. It eventually flows into the Saddle River. Neither the Saddle River nor Westerley Brook are currently used for drinking water.

2.4 RADIOLOGICAL CONDITIONS

To date, a comprehensive characterization of the radiological conditions at the MISS has not been performed. A radiological survey by Eberline Analytical Corporation (EAC), BNI's radiological support subcontractor, is scheduled for later in 1986. The most complete information presently available is found in a report generated by the SC (Ref. 3). The major areas of surface and subsurface contamination were identified in that report.

2.4.1 Buildings

Building 76 in the northeastern corner of the MISS property will be demolished during interim remedial action. Interim storage pile IIA (Figure 2-4) will be extended into this area. The SC reservoir, pumphouse, water distribution piping, and associated utilities near the southwestern corner of the MISS property would be relocated on SC property if Alternative 1 were implemented. Current data indicate that the pumphouse and reservoir are not contaminated. Implementation of Alternative 2 would require demolition of all SC plant buildings. As yet, no precise information is available on the radiological status of the buildings.

2.4.2 Grounds Contamination

In the SC report, eight major areas of subsurface contamination were identified (IB-VIIIB in Figure 2-3). BNI estimates that

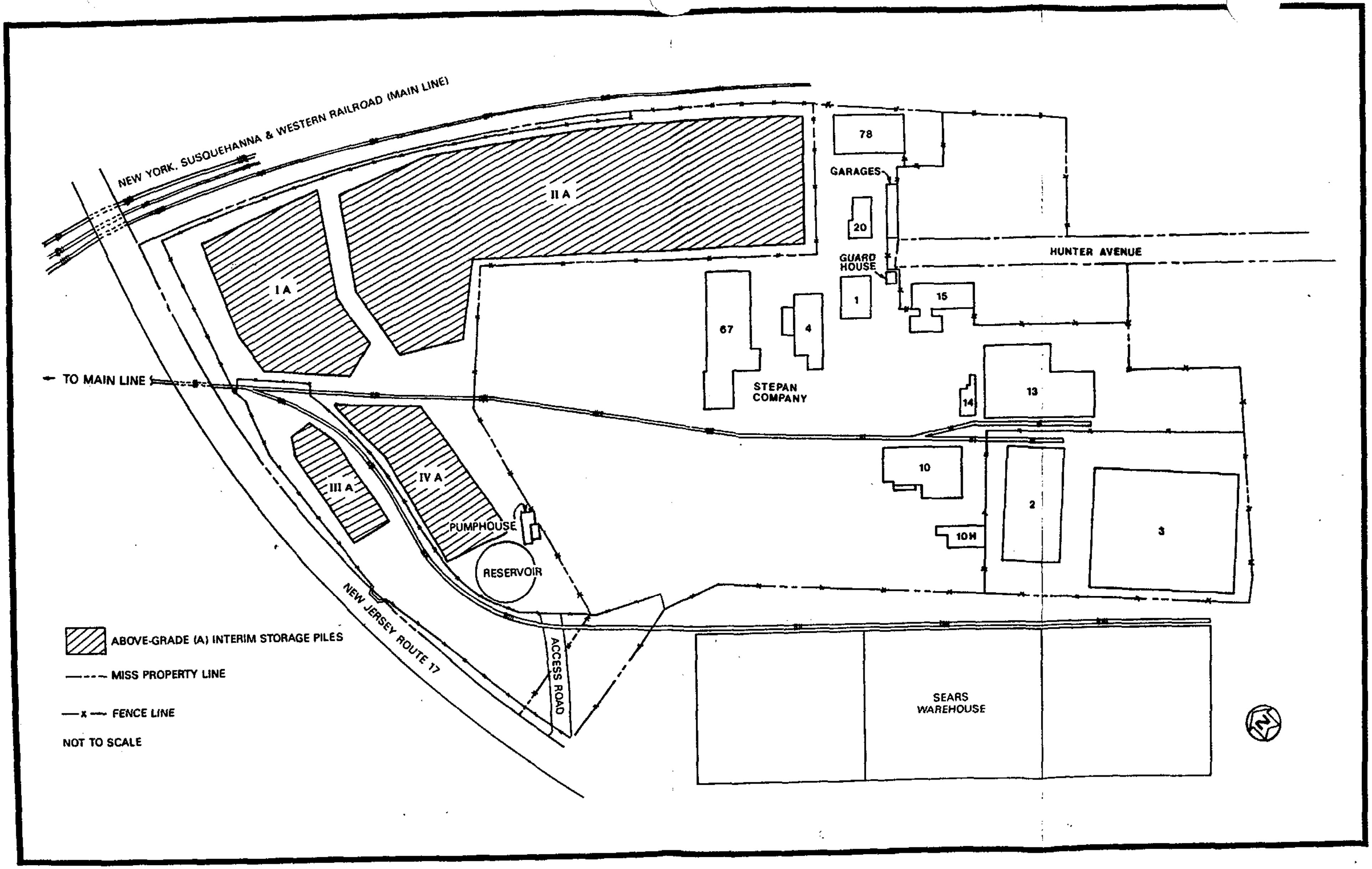

FIGURE 2-4 LOCATIONS OF THE INTERIM WASTE STORAGE PILES AT THE MISS

the volume of this material totals approximately 73,000 yd^3. Contamination in these areas is estimated to range from the ground surface to a depth of approximately 13 ft.

2.5 RADIOLOGICAL SURVEY PLANS

Characterization of the MISS will be performed in FY 1986 and possibly in FY 1987. The characterization will (1) determine the extent of activities necessary to decontaminate the MISS to conform to current DOE guidelines, and (2) refine the estimate of the volume of radioactive waste that will result from these decontamination efforts. Radiological characterization of the SC property will be performed at some point in the future.

2.6 CHEMICAL CONDITIONS

Present documentation does not indicate either the presence or absence of hazardous chemicals in the radioactively contaminated areas. To date, no chemical tests have been performed on the waste on the MISS and SC properties. Tests were performed on soil samples from the Ballod property prior to excavation on that area. Results revealed that no materials identified as hazardous by the Resource Conservation and Recovery Act (RCRA) were present. Therefore, this engineering evaluation assumes that no hazardous chemicals are mixed with the radioactively contaminated material. During the characterization of the MISS, samples will be taken to determine the validity of this assumption. Characterization of the SC buildings would also be necessary in the future to identify chemical wastes that might be encountered during the demolition of the buildings. Any cocontaminated (radioactive mixed) waste encountered during final site disposition activities would be disposed of in a manner consistent with appropriate regulatory requirements.

2.7 SITE CONDITIONS AT THE COMPLETION OF INTERIM REMEDIAL ACTION

At the completion of interim remedial action, 123,000 yd^3 of radioactively contaminated waste from vicinity properties (other than the SC) will have been consolidated and placed in four above-grade, engineered interim storage piles at the MISS as shown in Figure 2-4. Approximately 14,000 yd^3 of sand and synthetic liner material would be used in leachate collection systems under these piles (by requirement of the NJDEP). Approximately 73,000 yd^3 would remain in eight burial areas as shown in Figure 2-3. No buildings would be present on the MISS property except for the SC pumphouse, which is reported to be uncontaminated.

Approximately 40,000 yd^3 of waste would remain in Burial Sites Nos. 1-3 on the SC property (Figure 2-3). An additional 20,000 yd^3 of contaminated material would be present under the section of Route 17 that runs between the MISS and Ballod properties. The above volumes are presented in Table 2-1. They are based on ORAU, ORNL, and NUS Corporation surveys, and on supplemental radiological characterizations performed by EAC (Refs. 4 and 6 through 13).

For Alternative 1, it has been assumed that an additional 5 acres of land adjoining the eastern property line of the MISS would have been acquired from the SC prior to site preparation for constructing the containment facility. Further, it has been assumed that the SC reservoir, pumphouse, and associated utilities would be relocated on SC property.

Alternative 2 requires 31.2 acres of land and the relocation of the entire SC plant. It has been assumed for this document that the land acquisition and plant relocation would be complete prior to site preparation for construction of the containment facility.

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TABLE 2-1

WASTE VOLUME PROJECTIONS FOR THE MAYWOOD SITE*

Location			Volume (yd^3)
Maywood Interim Storage Site			
1. Above-grade interim storage piles (resulting from remedial action at the Ballod property; residences on Davison and Latham Streets, Grove Avenue, Parkway, Avenue F, Avenue C, and Trudy Drive; two Lodi commercial properties, the Sears and Scanel properties.			
Pile IA	26,500		
Pile IIA	85,600		
Pile IIIA	2,900		
Pile IVA	8,000	Subtotal	123,000**
2. Buried wastes at the MISS			
Site IB	26,500		
Site IIB	12,000		
Site IIIB	5,600		
Site IVB	7,400		
Site VB	2,900		
Site VIB	13,900		
Site VIIB	1,200		
Site VIIIB	3,500	Subtotal	73,000
3. Interim storage pile leachate collection system materials			14,000
Waste buried under Route 17			20,000
Stepan Company			
Burial Site No. 1	17,000		
Burial Site No. 2	5,000		
Burial Site No. 3	18,000	Subtotal	40,000
		TOTAL	270,000

*The volumes listed include allowances for expected increases due to normal excavation practices. A volume contingency has not been included.

**The interim storage piles could accommodate 176,000 yd^3 of waste if current remedial action activities required. However, such an increase would necessitate the relocation of both a 15-in. sanitary sewer line and the railroad spur that crosses the MISS property to the SC property.

For all alternatives, it has been assumed that access from Route 17 to the site would be via the DOE easement located near the southwestern corner of the property.

3.0 REMEDIAL ACTION

3.1 REMEDIAL ACTION GUIDELINES

The radiological guidelines established by DOE for the cleanup of radioactive materials under FUSRAP are summarized in Table 3-1. The Design Criteria for Formerly Utilized Sites Remedial Action Program (FUSRAP) and Surplus Facilities Management Program (SFMP) presents additional information regarding applicable federal regulations and guidelines (Ref. 14).

In all of the activities associated with remedial action at the MISS, the DOE policy to maintain radiation exposures to individuals and population groups as low as reasonably achievable (ALARA) will be followed. The radiological guidelines are considered as upper limits that are not to be exceeded for any 100-m^2 area on properties that are to be released for unrestricted use. For small areas of residual contamination, field procedures have been developed that ensure the adequacy of the decontamination, i.e., that the radiological guidelines for 100-m^2 areas are met and that contamination is removed to a level that is ALARA.

3.2 REMEDIAL ACTION ALTERNATIVES

The alternatives for disposal of MP waste that will be discussed in this document are:

- On-site (quasi-passive design), above-grade disposal for all the waste (Alternative 1)
- On-site (passive design), above-grade disposal for all waste (Alternative 2)
- Transport of all the waste to the NJDS (Alternative 3).

Preliminary investigations were made of other alternatives. One alternative considered on-site, above-grade disposal of part of the waste and transportation of the remainder to the NJDS. In this

TABLE 3-1

SUMMARY OF RESIDUAL CONTAMINATION GUIDELINES

FOR FUSRAP SITES

SOIL (LAND) GUIDELINES (MAXIMUM LIMITS FOR UNRESTRICTED USE)

Radionuclide	Soil Concentration (pCi/g) above background[a,b,c]
Radium-226 Radium-228 Thorium-230 Thorium-232	5 pCi/g, averaged over the first 15 cm of soil below the surface; 15 pCi/g when averaged over any 15-cm thick soil layer below the surface layer.
Other radionuclides	Soil guidelines will be calculated on a site-specific basis using the DOE manual developed for this use.

STRUCTURE GUIDELINES (MAXIMUM LIMITS FOR UNRESTRICTED USE)

Indoor Radon Decay Products

For Rn-222 and Rn-220 concentrations in buildings, the average annual radon decay product concentration (including background) due to uranium or thorium byproducts should not exceed 0.02 WL after remedial action. When remedial action has been performed and it would be unreasonably difficult and costly to reduce the level below 0.03 WL, the remedial action may be terminated and the reasons for termination should be documented. Remedial action shall be undertaken for any building which exceeds an annual average radon decay product concentration (including background) of 0.03 WL.

Indoor Gamma Radiation

The indoor gamma radiation after decontamination shall not exceed 20 microroentgen per hour (20 µR/h) above background in any occupied or habitable building.

Indoor/Outdoor Structure Surface Contamination

	Allowable Surface Residual Contamination[d] (dpm/100 cm^2)		
Radionuclide[e]	Average[f,g]	Maximum[f]	Removable[f]
Transuranics, Ra-226 Ra-228, Th-230, Th-228 Pa-231, Ac-227, I-125, I-129	100	300	20
Th-Natural, Th-232, Sr-90, Ra-223, Ra-224 U-232, I-126, I-131, I-133	1,000	3,000	200

TABLE 3-1

(continued)

Indoor/Outdoor Structure Surface Contamination (continued)

Radionuclide[e]	Allowable Surface Residual Contamination[d] (dpm/100 cm^2) Average[f,g]	Maximum[f]	Removable[f]
U-Natural, U-235, U-238, and associated decay products	5,000 α	15,000 α	1,000 α
Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above	5,000 β-γ	15,000 β-γ	1,000 β-γ

[a] In the event of occurrence of mixtures of radionuclides, the fraction contributed by each radionuclide to its limit shall be determined, and the sum of these fractions shall not exceed 1.

[b] These guidelines represent unrestricted-use residual concentrations above background averaged across any 15-cm thick layer to any depth and over any contiguous 100-m^2 surface area.

[c] Localized concentrations in excess of these limits are allowable provided that the average over 100 m^2 is not exceeded.

[d] As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

[e] Where surface contamination by both alpha- and beta-gamma-emitting radionuclides exists, the limits established for alpha- and beta-gamma-emitting radionuclides shall apply independently.

[f] Measurements of average contamination should not be averaged over more than 1 m^2. For objects of less surface area, the average shall be derived for each such object.

[g] The average and maximum radiation levels associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/h at 1 cm and 1.0 mrad/h at 1 cm respectively, measured through not more than 7 mg/cm^2 of total absorber.

alternative, it was assumed that the disposal facility would be built on the existing 11.7-acre site, that a passive design would be used, and that a 100-ft-wide buffer zone would surround the facility. Given these assumptions, it was determined that only 20 percent (approximately 50,000 yd^3) of the projected 270,000 yd^3 could be disposed of on-site. It was concluded that on-site storage of this relatively small volume was not economical since two separate disposal operations would occur along with high transportation costs.

Another alternative considered was in situ containment of the buried waste and above-grade disposal of the remaining waste in a passive design waste containment structure constructed on the existing 11.7-acre site. A bentonite slurry cutoff wall would have to be constructed around approximately 73,000 yd^3 of waste. Use of a slurry cutoff wall is, however, dependent on local geology. Geological investigations, performed during the installation of monitoring wells as part of interim remedial action at the MISS in 1984, indicated that in situ containment of the buried waste would not be suitable, primarily because of the many vertical fractures in the bedrock that would require grouting (Refs. 15 and 16). The costs that would have had to be incurred in grouting and in verifying that potential contaminant migration paths were not present in the bedrock were considered prohibitive; consequently, this alternative was also eliminated from further consideration.

Ocean disposal was not considered for the waste in question. Although the legislated moratorium placed on this means of disposal expired in January 1985, the U.S. Environmental Protection Agency (EPA) has not yet established either regulations governing disposal of low-level radioactive materials at sea or pertinent permit application procedures. If these are in place before the decision is made regarding final disposition of the waste in question, the ocean disposal option will be reevaluated.

Alternative 1 was recognized as not meeting current DOE design criteria since it is not a passive design: To accommodate 270,000 yd^3 of waste on only a portion of the SC plant property, a concrete retaining wall around the waste had to be included in the design. This wall would have to be replaced every 50 to 75 years, and, if institutional control were lost, the wall would represent a failure mode for the containment system and would not meet the requirement for durability for a minimum of 200 years without maintenance. The alternative was developed, however, as a possible approach to on-site disposal and to provide a comparison for the other two alternatives.

The containment structure in Alternative 2 is a completely passive facility requiring minimal, if any, maintenance.

The three alternatives selected for discussion in this document would require the handling of both above-grade and buried contaminated materials on the MISS, buried waste on the SC property, and the contaminated material under Route 17. Each alternative would require virtually the same support facilities and operational controls. The following subsections present details of each alternative.

3.2.1 On-Site (Quasi-Passive Design) Above-Grade Disposal (Alternative 1)

General

In this alternative the MISS would be developed as a long-term disposal site. However, to accommodate the projected 270,000 yd^3 of radioactively contaminated waste, the MISS property would have to be expanded by approximately 5 acres. As shown on Figure 2-2, expansion of the MISS is subject to certain restrictions. On the north, the site is confined by the existing New York, Susquehanna, and Western Railroad line. On the west, New Jersey State Route 17, with its elevated ramp for the mainline railroad crossing and the spur serving Sears and the SC, restricts expansion. To the south, however, the site would be expanded into the area presently occupied by the SC water storage reservoir and associated pipeline and electrical distribution system. It also appears possible that an approximately 400-ft-wide strip of SC land adjoining the MISS on the east could be used for expansion. It has, therefore, been assumed that expansion would be in these directions onto what is now SC property. It has also been assumed that a 50-ft-wide clearance would be maintained between the MISS property boundary and Process Building 67 to allow for continued operations at the building.

Alternative 1 assumes that the SC would permit the required modifications to its plant site and operations. It also includes the cost of relocating the railroad spur that presently runs through the MISS to the SC and Sears properties and the cost of relocating the SC warehouse erected over Burial Site No. 3. Site preparation and consolidation of all of the waste into an above-grade, engineered disposal facility would be divided into five construction seasons; a 7-month construction season extending from April through October has been assumed. The details of these acquisitions, modifications, and construction activities are discussed in subsequent subsections.

The use of a leak monitoring system is also assumed in Alternative 1. It would appear that such a system is not technically required for a passive design because waste placed in a disposal facility is required to be of such a nature that no primary leachate is formed; however, the NJDEP has required leachate collection systems under the interim storage piles at the MISS. It is, therefore, assumed that a similar requirement would be imposed on the development of a long-term waste disposal facility at the site. Given the required characteristics of wastes placed in disposal facilities, the leak monitoring system would be installed not to collect primary leachate but rather to monitor the disposal facility for secondary leachate. This leachate could result from rainwater entering the facility during construction and/or from possible infiltration of precipitation through the cap and into the waste after completion of the facility. It should be noted, however, that such infiltration could only occur in the unlikely event of a significant failure in the cap (settlement or cracking over large areas). Addition of the leak monitoring system would account for approximately 3 percent of the total cost of Alternative 1.

If Alternative 1 were selected for long-term management of the MISS, certain documents, investigations, and studies would have to be completed to permit development of a final design for the disposal facility. These would include, but not be limited to, the following:

- NEPA documentation
- Probable maximum flood study
- Seismic evaluation
- Geological investigation
- Hydrogeological investigation
- Closure plan
- Emergency response plan
- Permit applications

Site Preparation

Site Expansion. In the first year of construction the MISS would be expanded and developed in preparation for becoming a long-term disposal facility (the Maywood Disposal Site). A new property fence with construction access gates would be installed.

Construction and Washdown Facilities. It would be necessary to prepare construction laydown and stockpile areas and facilities at the site, including at least two washdown pads for decontaminating equipment, tools, and vehicles. The locations of the various construction and washdown facilities are shown in Figure 3-1. The spraying operation at the washdown facilities would utilize a recycled water system to minimize water usage. The MISS property is supplied with electricity from sources in the immediate vicinity.

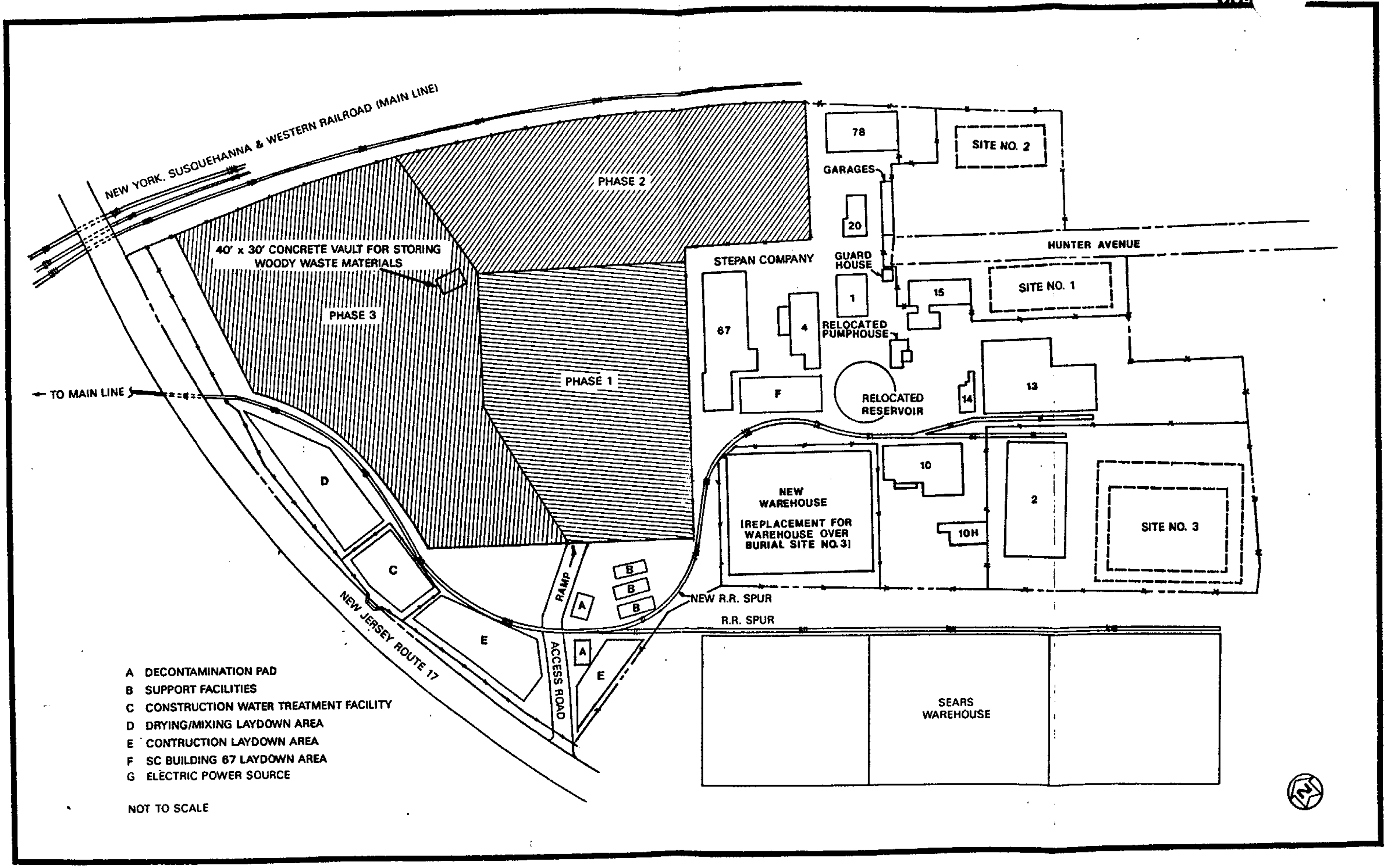

FIGURE 3-1 MAYWOOD DISPOSAL SITE CONSTRUCTION PHASES (ALTERNATIVE I)

Relocation of the SC Railroad Spur. The disposal pile configuration would necessitate the relocation of the railroad spur that crosses the MISS to the SC property. The spur would be relocated during the first year of construction. The new spur to the SC plant would utilize the existing Sears spur that is located south of the SC reservoir; a new switch and spur would be installed near the Sears property line and routed into the SC plant complex. The proposed location of the new spur is shown in Figure 3-2.

Relocation of the Sanitary Sewers. It would be necessary to relocate the section of the 15-in.-diameter sanitary sewer serving the Borough of Maywood and Township of Rochelle Park that crosses the MISS since the area in which the line is located would be covered by the disposal pile. The sewer would be relocated to a buried utility corridor on the west side of the facility. This sewer line would share an easement containing a 30-in.-diameter gas transmission line and a 78-in.-diameter storm drain that channels Westerley Brook around the MISS. The 10-in.-diameter sanitary sewer from the SC plant that discharges into the 15-in.-diameter sewer will also have to be relocated. The relocated utilities are shown in Figure 3-2.

Reservoir. The disposal pile and its buffer zone would encompass the area in which the SC reservoir is presently located. Therefore, a new reservoir with associated distribution system and service facilities would have to be constructed on the SC site. The new system would have to be in operation prior to demolition of the existing reservoir.

Site Drainage System. An increase in runoff can be expected to result from construction of the disposal facility. This increase would necessitate the upgrading of the drainage system at the site. Consequently, a 54-in.-diameter gravity storm drain with catch basins would be installed around the disposal pile. The gravity storm drain would in turn drain into a new, independent discharge drainpipe running from the MISS to the Saddle River. It is assumed that the discharge drainpipe would be located in the same easement

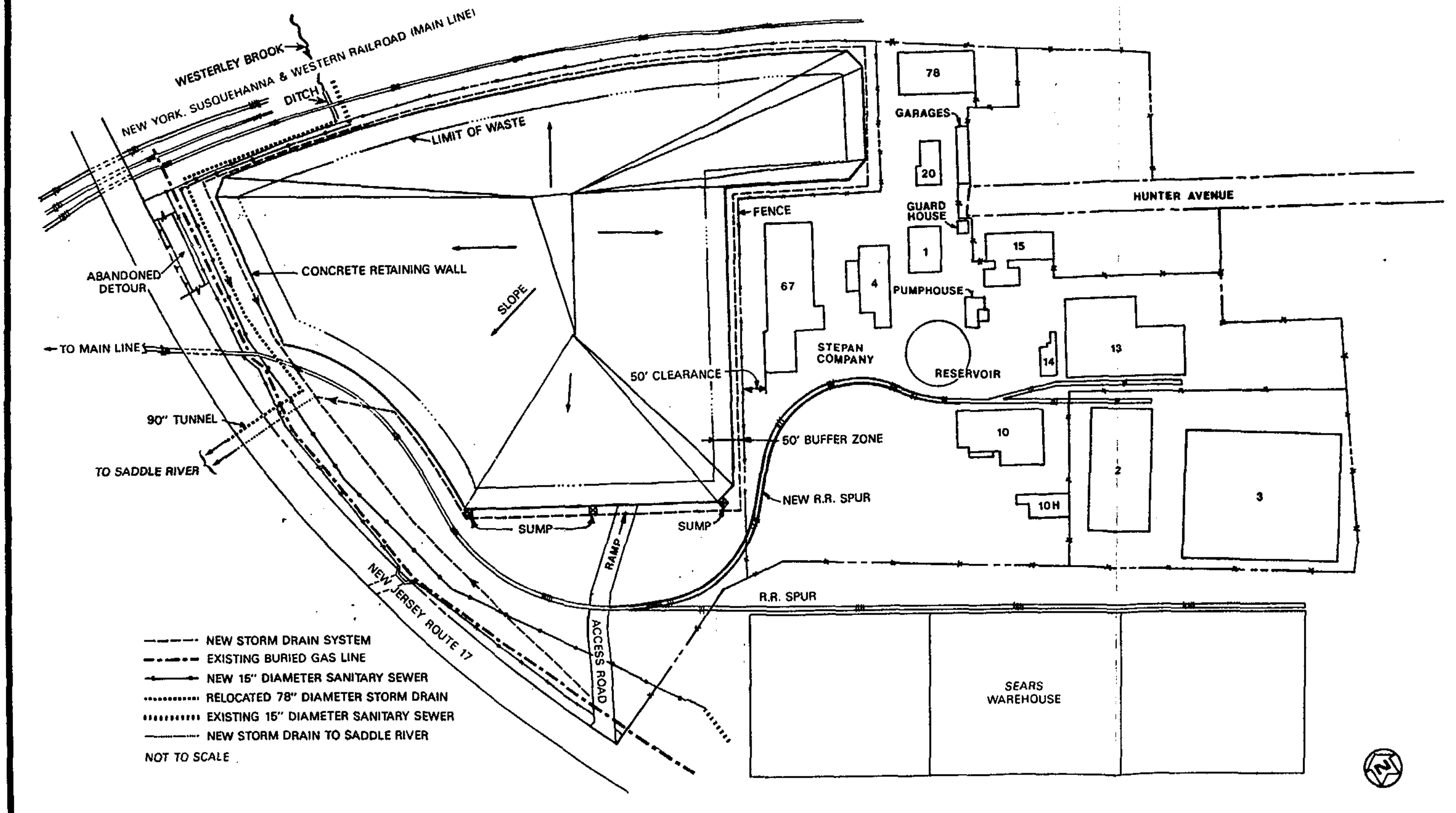

FIGURE 3-2 RELOCATION OF UTILITIES AND RAILROAD SPUR AT THE MAYWOOD DISPOSAL SITE (ALTERNATIVE I)

as is currently occupied by the 78-in.-diameter storm drain that channels Westerley Brook around the MISS. The existing 20-ft-wide easement would have to be widened to at least 30 ft. The existing 78-in.-diameter storm drain would be relocated beyond the 50-ft-wide buffer zone that would be created between the waste pile and the MISS property line. The locations of the storm drain and discharge drainpipe are shown in Figure 3-2. Part of the relocation work would be done during site preparation; the drainage system would be extended as work on the disposal facility progressed. The runoff channeled into the 54-in. drainage system would be controlled to ensure that treatment would not be required before discharge.

Water Storage and Treatment. Because excavation below the existing water table would be necessary to remove buried waste, a water storage and treatment facility would be required to process groundwater as well as rainfall and runoff that may become contaminated and wastewater from the washdown facilities.

Analyses of water samples from existing wells at the MISS have indicated that the concentrations of radioactive and chemical constituents do not exceed those permitted by DOE guidelines. However, since the existing wells are not located in areas where waste is buried, it has been assumed that water treatment would be required to reduce the concentrations of radioactive (thorium and its daughters) and chemical contaminants (trace organics and heavy metals from thorium ore) to below State of New Jersey discharge limits. A filter/demineralizer system would be used. In selecting the treatment process, it was assumed that no unusual requirements would be included in the New Jersey State Pollution Discharge Elimination System permit that would have to be issued by the New Jersey Department of Environmental Protection before discharge could commence. The peak water generation would be at a rate of 211,000 gal per month requiring treatment at a rate of 25 gpm. Treated water would be discharged into the municipal sewer system.

Based on current estimates of the depths of the buried waste deposits, a total of approximately 2 million gal of groundwater, rainwater, and construction water would have to be treated over a period of five construction seasons. The planned storage ponds and treatment facilities are shown as area C in Figure 3-1.

Disposal Facility Construction -- Phase 1

Phase 1 of disposal facility construction would commence during the second construction season. The area in which Phase 1 work would be done is shown in Figure 3-1. It essentially covers the 5 acres of land acquired from the SC. Since there is no reported buried contamination within the limits of the Phase 1 operation, it has been assumed that it would be possible to construct this section of the disposal facility without having to handle contaminated material.

The Phase 1 area would be stripped of existing topsoil, which would be stockpiled for future use. Approximately 2 ft of underlying soil would then be excavated to allow for placement of the bottom of the disposal facility, which would consist of 4 ft of imported clay having a placement permeability of 10^{-6} to 10^{-7} cm/s. It has been assumed that a 4-ft-thick clay layer would contain contaminant migration over the lifetime of the facility by means of adsorption by, and cation exchange with, the clay particles. This thickness of clay is also expected to adequately isolate the waste from a localized rise in the water table, which might occur due to alterations in the hydrostatic conditions as a result of construction of the disposal facility. These assumptions would be further examined during final design of the facility.

The inner berm of the dike around the facility would be constructed atop the outer edge of the clay bottom. It would consist of a 4-ft layer of clay with the same permeability characteristics as the bottom. The dike itself and the outer berm would consist of the material excavated in preparation for placing the clay bottom. A typical section of the facility is shown in Figure 3-3.

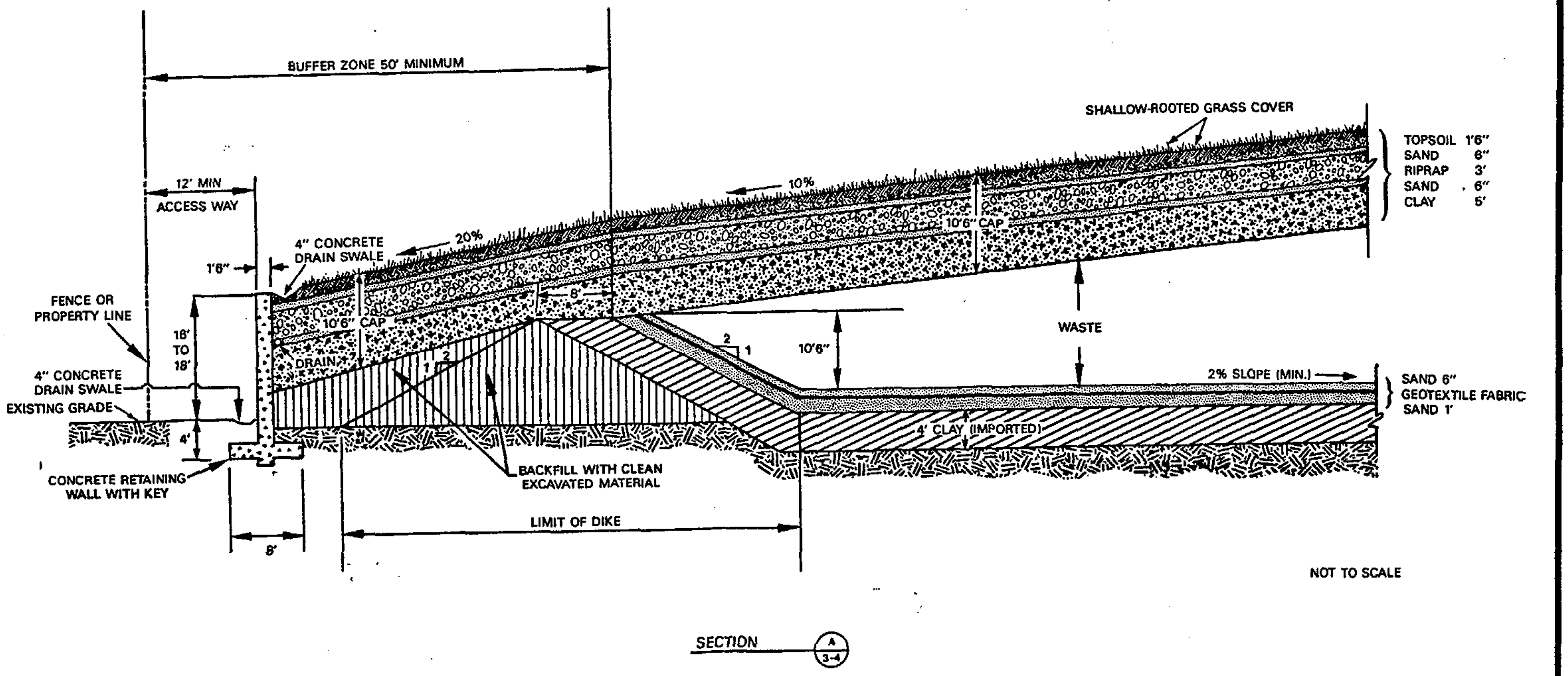

FIGURE 3-3 TYPICAL SECTION OF THE MAYWOOD DISPOSAL FACILITY (ALTERNATIVE 1)

The clay bottom of the facility and inner berm of the dike would be covered with a leak monitoring system consisting of sand layers and geotextile fabric. Secondary leachate infiltrating through the sand and fabric would drain along the surface of the clay bottom to sumps located along the southern edge of the facility as shown in Figure 3-2. This system is deemed fully adequate at this time. Provisions have been made, however, to add an additional flexible membrane liner between the clay bottom and sand layer in the event that regulatory agencies might require a multilayered leachate collection system.

It is expected that it would be necessary to monitor the sumps for a maximum of 5 years. This assumption is discussed further under Environmental Monitoring on page 40.

A concrete retaining wall, 16 to 18 ft high, would form the sides of the facility. The wall would be built in stages as each phase of construction progresses.

A ramp would be constructed at the southern boundary of the Phase 1 section of the facility to provide access to the storage area once the concrete wall had been erected around the perimeter of the facility.

The Phase 1 section of the disposal facility would accommodate approximately 92,000 yd^3 of waste. First, 67,400 yd^3 of waste from the eastern section of the MISS pile designated on Figure 3-1 as IIA would be placed in the Phase 1 section of the disposal facility. The synthetic membrane and sand layers from the leachate collection system for this part of pile IIA (7,000 yd^3), and 17,600 yd^3 of waste buried under the IIA area (i.e., areas IIB and IIIB on Figure 2-3) would also be disposed of in the Phase 1 section of the facility. (During excavation of the waste buried in area IIB and IIIB, dewatering sumps would be used to remove water to storage facilities for discharge and/or treatment, if necessary.) To minimize consolidation and subsidence, the waste would be placed in lifts and compacted to 90 percent of maximum dry density. A 1-ft lift of uncontaminated clay would be placed over the Phase 1 section of the disposal facility to form an interim cover. The clay would be funneled to maintain a clean runoff system so that management of this water would not be necessary. The clay would later be scarified, filled, and consolidated with approximately four additional 1-ft lifts to form the ultimate cap for the disposal facility.

As the waste was removed from areas IIB and IIIB, these areas would be backfilled so that the clay bottom of the disposal facility could be extended into this area in readiness for Phase 2 storage activities. The bottom would be extended as part of Phase 1 activities. The existing fabric cover from the eastern section of storage pile IIA would be used as a protective cover over this Phase 2 bottom during the winter.

Disposal Facility Construction -- Phase 2

During the third construction season, Phase 2 of the disposal facility would be completed, the bottom having been constructed during Phase 1.

The dike and concrete retaining wall around the northeast section of the disposal facility would be constructed; the remaining 18,200 yd^3 of waste in storage pile IIA, 26,500 yd^3 in pile IA, 4,300 yd^3 from the leachate collection systems for piles IA and IIA, and 30,000 yd^3 of waste buried in the northwest part of the property (areas IB and VIIIB) would be removed and placed in the Phase 2 section of the facility. Excavation and dewatering of the buried waste would proceed as in Phase 1. The excavated areas would then be backfilled, and the clay bottom of the disposal facility would be extended into the area formerly occupied by storage pile IA. Waste would be deposited on this extension during Phase 3. A 1-ft lift of clay would be placed over the waste in the Phase 2 section of the facility, and the extension to the clay bottom would be covered for the winter. During Phase 2, approximately 79,000 yd^3 of waste, including leachate collection system materials, would be deposited in the facility.

Disposal Facility Construction -- Phase 3

Phase 3 would be completed during the fourth and fifth construction season. It would involve removing the waste buried under Route 17 and in SC Burial Sites Nos. 1-3, and consolidating it in the long-term disposal facility along with the waste in interim storage piles IIIA and IVA. This would involve containment of approximately 99,000 yd^3 of waste.

Construction of the Phase 3 section of the facility would be done in two stages: a northern segment and a southern segment. The former would be the area north of the existing SC railroad spur and the latter the area south of it. In developing the northern segment, work would proceed in a sequence similar to the Phase 1 and 2 operations. Waste from interim storage piles IIIA and IVA (10,900 yd^3), 2,700 yd^3 from the leachate collection system for piles IIIA and IVA, and buried waste from areas IVB, VB, VIB, and VIIB (25,400 yd^3) would be piled onto the clay bottom prepared during Phase 2. Once the waste had been excavated from areas IVB through VIIB, these areas would be backfilled and the final extension made to the bottom, dike, and concrete retaining wall of the disposal facility. Waste from SC Burial Sites Nos. 1-3 (40,000 yd^3) as well as waste from under Route 17 (20,000 yd^3) would be deposited in the southern segment of the Phase 3 section of the facility. Following placement of the waste in both the northern and southern segments, a 1-ft-thick clay cover would be placed over the area for winterization and runoff control.

Contaminated trees and roots would also be disposed of in the disposal facility during Phase 3. The organic materials would be chipped into pieces with a maximum dimension of 3 in. The chips would be mixed with a grout material and placed in 55-gal drums, which would be placed in a prepared concrete vault located near the center of the disposal facility, as shown in Figure 3-1. The barrels would be grouted solid to preclude subsidence within and above the vault.

Excavation of the waste from SC Burial Site No. 3 would necessitate the demolition of the warehouse presently on that site. Several options were considered for the removal of the contaminated waste under the warehouse, ranging from underpinning the existing structure while excavating the waste to complete demolition and replacement of the building. The details of these options are outlined in a cost study developed by BNI in 1984 (Ref. 17). It was determined that demolition and replacement of the warehouse would be the most cost-effective approach. Figure 3-1 shows the proposed location of the new warehouse.

The preferred method of removing the waste buried under Route 17 would involve construction of a detour roadway and excavation by the open cut method. This approach, as well as other options studied, are described in detail in Appendix B. The projected waste volume under the highway is based on preliminary radiological characterization performed by EAC for BNI in 1985 during which gamma logs of two slant borings made under the road indicated that contamination was present approximately 2 to 4 ft below the built up ground surface at the normal grade elevation along the 900-ft segment of the approach ramps bordering the MISS property (Figure 2-3). In addition, it is known from aerial photographs and historical data on the former Maywood Chemical Works that Route 17 was built (in 1932) through an area in which radioactive waste ponds were located. Confirmatory investigations of the radiological conditions under Route 17 will be made by EAC in FY 1986.

It has been assumed, in estimating the cost of Alternative 1, that the waste under the road would be removed. Alternatively, it might be possible to monitor the waste in a restricted area, which would be deeded as such. However, given current information, it appears that migration of radionuclides from the waste could occur and that in situ containment might not be possible without an active groundwater pumping/water treatment operation for the design life of the waste containment structure around the highway embankment.

Disposal Facility Construction -- Phase 4

During the fifth construction season, the final cap would be installed over the entire disposal facility. In addition, restoration of Route 17 (see Appendix B) and erection of a replacement warehouse for the SC would be completed.

The design of the cap for the disposal facility is a generic design that has been accepted by DOE and planned for use at other FUSRAP sites. The thicknesses of the different layers of material in the cap can be varied to accommodate site-specific conditions and waste characteristics. Figure 3-3 depicts the conceptual design for the cap. It consists of the following components, listed in descending order: a shallow-rooted grass cover, 18 in. of topsoil, 6 in. of sand and gravel, 3 ft of riprap, another 6 in. of sand and gravel, and 5 ft of compacted clay. (The 1-ft-thick clay layer placed over the waste during earlier phases of work would be inspected to determine the exact thickness of new clay to be added for the final cap to bring the total thickness of clay to 5 ft. It has been assumed that 4 ft of new clay would be added.) To provide surface drainage, a minimum slope of 5 percent would be required on the top of the cap. The maximum slope on the sides of the containment would be 20 percent. The combined thickness of the multilayered cap would be 10.5 ft, which would more than ensure protection from gamma radiation, radon emanation, and beta-gamma activity from radon daughters within the containment. Based on amounts of radium-226 and radium-228 present in the waste, a significant buildup of radon gas (radon-222) would not occur during the design life of the disposal facility (at least 200 years). Emanation of radon-222 or radon-220 from the cap is unlikely in view of their short half-lives (3.8 days and 55 seconds, respectively).

The cap would be constructed first over the Phase 1 section of the disposal facility, followed by the Phase 2 section, and finally the Phase 3 section (northern segment followed by southern segment).

As part of cap construction, a drainage system would be installed between the dike and the concrete retaining wall for draining water that might infiltrate through the topsoil (Figure 3-3).

The Route 17 detour, constructed to permit excavation of waste from under the highway, would be abandoned in place. The excavations under the original roadway would be backfilled, graded to drain, and reseeded. The detour would be contoured and reseeded as necessary.

Approximately 354,000 yd^3 of construction materials such as concrete, cap materials, and backfill would be required for the containment facility. An estimated 27,000 trips by heavy vehicles would be necessary to transport these materials to the site. In addition, piping, fencing, and miscellaneous site preparation materials would have to be transported to the site. A detailed list of the quantities of materials to be handled during Alternative 1 is provided in Appendix C.

A typical plan and sections of the completed disposal facility are shown in Figures 3-4 and 3-5, respectively.

Surveillance and Maintenance

The design life of the long-term disposal facility is at least 200 years. To the extent possible, passive design features have been incorporated into the conceptual design of the disposal facility to minimize the need for sustained maintenance and surveillance. However, the problems associated with accommodating 270,000 yd^3 of waste on such a small disposal site necessitated the use of components with shorter design lives. For example, the concrete retaining wall and the site drainage system for channeling runoff to the Saddle River would have to be replaced approximately every 50

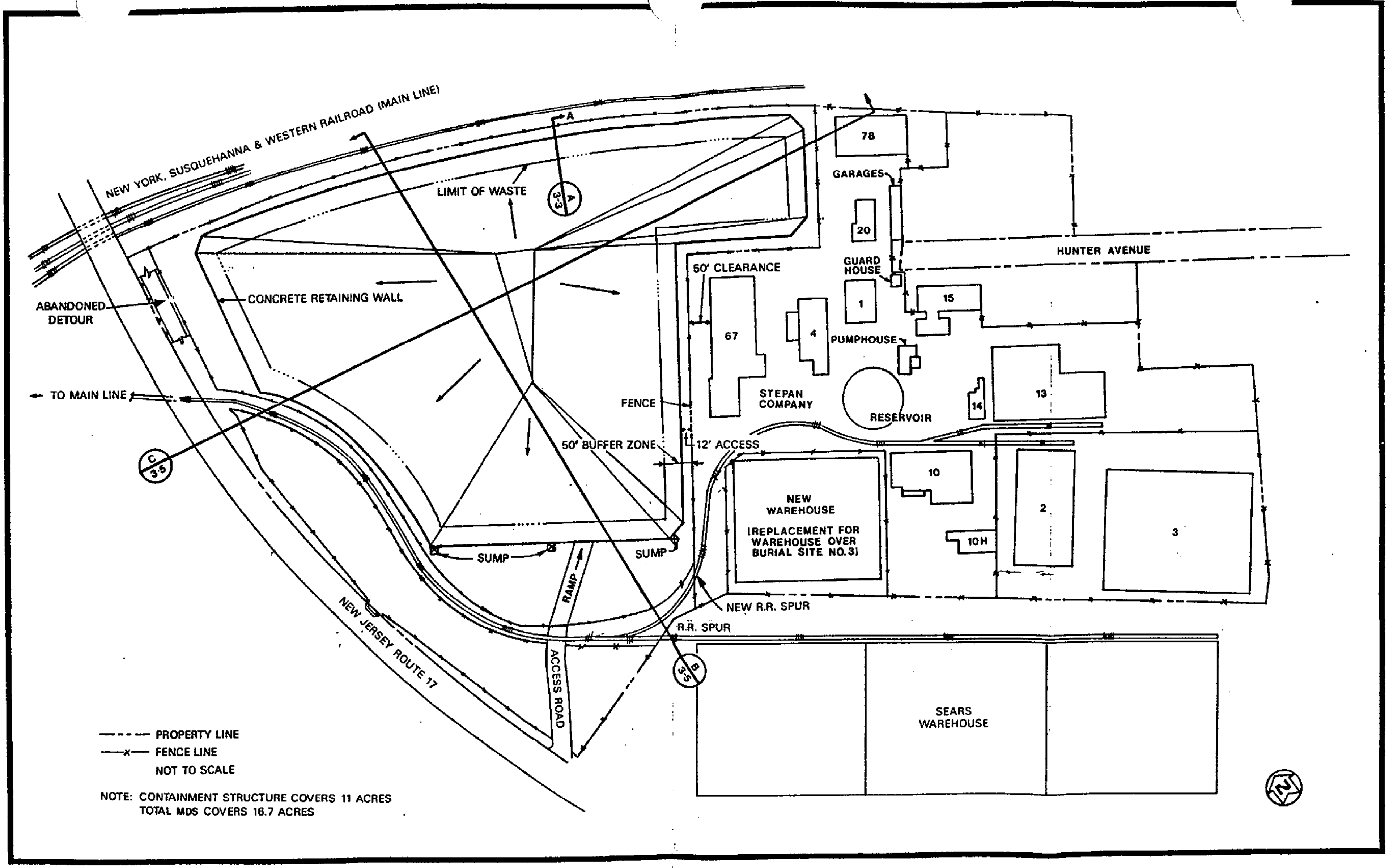

FIGURE 3-4 PLAN VIEW OF THE COMPLETED MAYWOOD DISPOSAL SITE (ALTERNATIVE I)

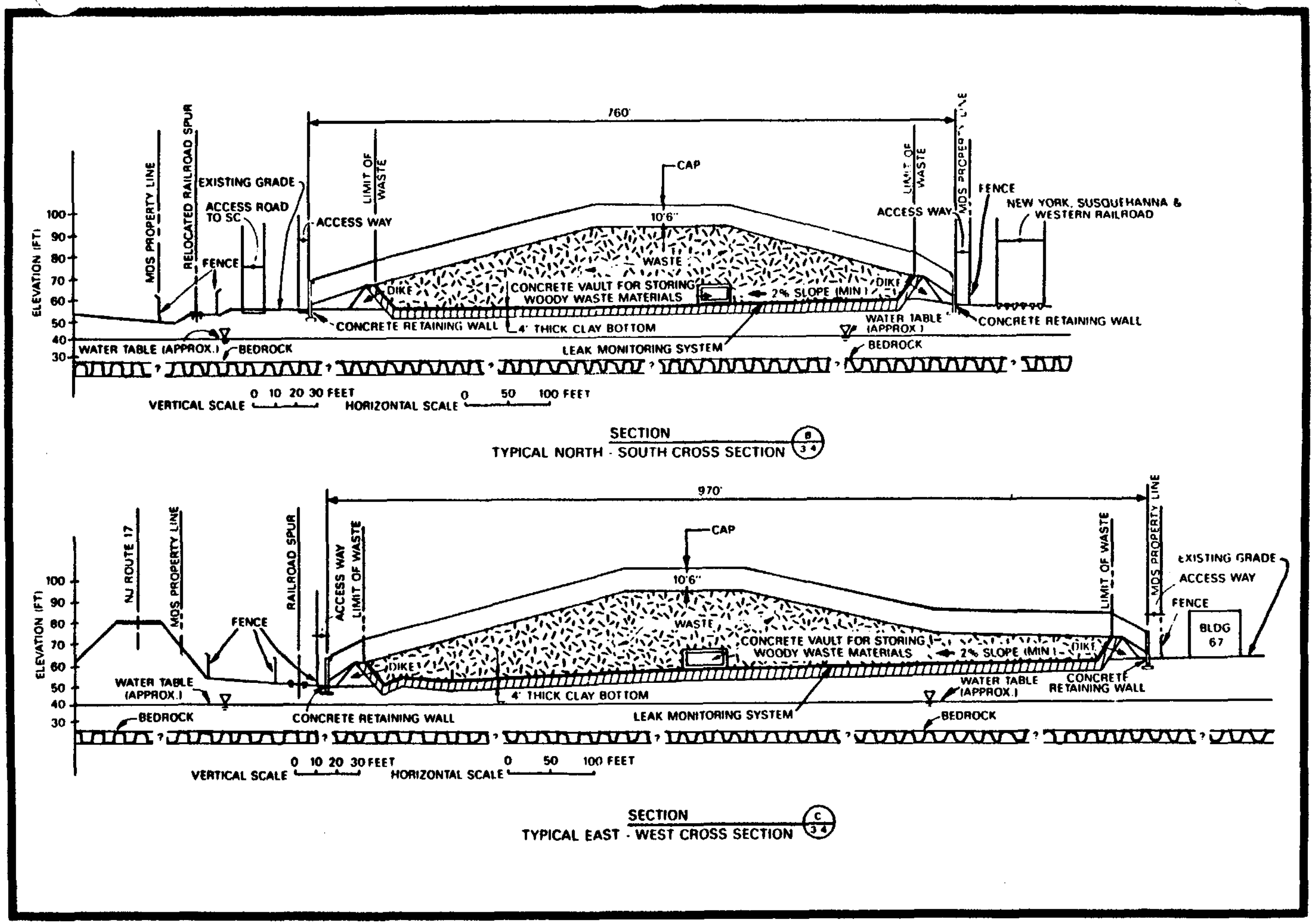

FIGURE 3-5 TYPICAL CROSS SECTIONS OF THE COMPLETED MAYWOOD DISPOSAL SITE (ALTERNATIVE 1)

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and 75 years, respectively. The associated costs have been included in the cost estimate for Alternative 1.

It has been assumed that surveillance and maintenance, and performance monitoring of the engineered features of the facility would be conducted at regular intervals for 5 years following site closure and on a less frequent basis for the next 195 years. Table 3-2 specifies the schedule for each of the surveillance, maintenance, disposal facility performance monitoring, and environmental monitoring activities that are anticipated.

Environmental Monitoring

Monitoring wells would be installed around the site within the 50-ft-wide buffer zone to provide primary and secondary monitoring for radionuclide migration from the containment facility. One series of wells would monitor groundwater in the unconsolidated glacial till, and another series would monitor the aquifer in the Brunswick Formation. The pattern of these wells around the disposal facility is shown in Figure 3-6.

It is assumed that the wells would be monitored on a biweekly basis during the first year following site closure, on a monthly basis during the second year, and quarterly thereafter for 198 years. In addition to the monitoring wells, vibrating wire pressure transducers would be installed to monitor moisture conditions in the disposal facility for a minimum of 5 years. The data from these instruments would be evaluated to determine the elevation of saturation within the facility. The leak monitoring system sumps would be examined semi-annually for 5 years. If no leachate were found in them during that period, no further monitoring would be conducted. If, however, leachate were found in the sumps, appropriate corrective actions (e.g., repairs to the cap) would be investigated and implemented after which semi-annual monitoring would continue for as long as was deemed necessary.

TABLE 3-2
SURVEILLANCE, MAINTENANCE, AND MONITORING REQUIREMENTS
FOR THE MAYWOOD DISPOSAL FACILITY

Activity	Purpose	Indicator	Frequency	
			Years 1-5	Years 6-200
Groundwater Monitoring	Detect contaminant migration from containment facility	Water levels; radionuclide/ chemical content	Biweekly (Yr 1) Monthly (Yr 2) Quarterly (Yrs 3-5)	Quarterly
Walkover Survey	Detect distressed areas in cover	Depressions; cracks, biotic intrusion	Semi-annually	Annually
Grid Survey	Provide fixed points for measurements to locate anomalies in cover	Changes in positions/elevations of grid stakes	Semi-annually	Annually
Aerial Topographic Survey	Detect subsidence	Depressions, changes in topographic contours	Semi-annually	Annually
Visual Inspection	Detect distress to facility cover	Cracks; biotic intrusion	Monthly (May-November)	Monthly (May-November)
Mowing of Disposal Facility Cover	Prevent woody plant growth		Monthly (in growing season)	Monthly (in growing season)
Fence Maintenance	Prevent deterioration		Annually	Annual maintenance; replace every 25 years
Cover Maintenance	Prevent leaks; intrusion	Signs of distress or intrusion	As needed	As needed
Concrete Retaining Wall Maintenance	Prevent deterioration	Spalling and cracks	Annually	Annual maintenance; replace every 50 years
Runoff Drainage System Maintenance	Ensure proper operation	Signs of erosion		Replace every 75 years
Monitoring Well Maintenance	Ensure proper operation	Damaged casing; soil fill in well	As needed	Annual maintenance; replace every 75 years
Intra-Facility Saturation Monitoring	Determine saturation level inside containment facility and thus facility integrity	Pressure differential; shown by pressure transducer readings	Biweekly (Yr 1) Monthly (Yr 2) Quarterly (Yrs 3-5)	As needed
Monitoring Report Update	Document data and findings from monitoring activities		Annually	Annually

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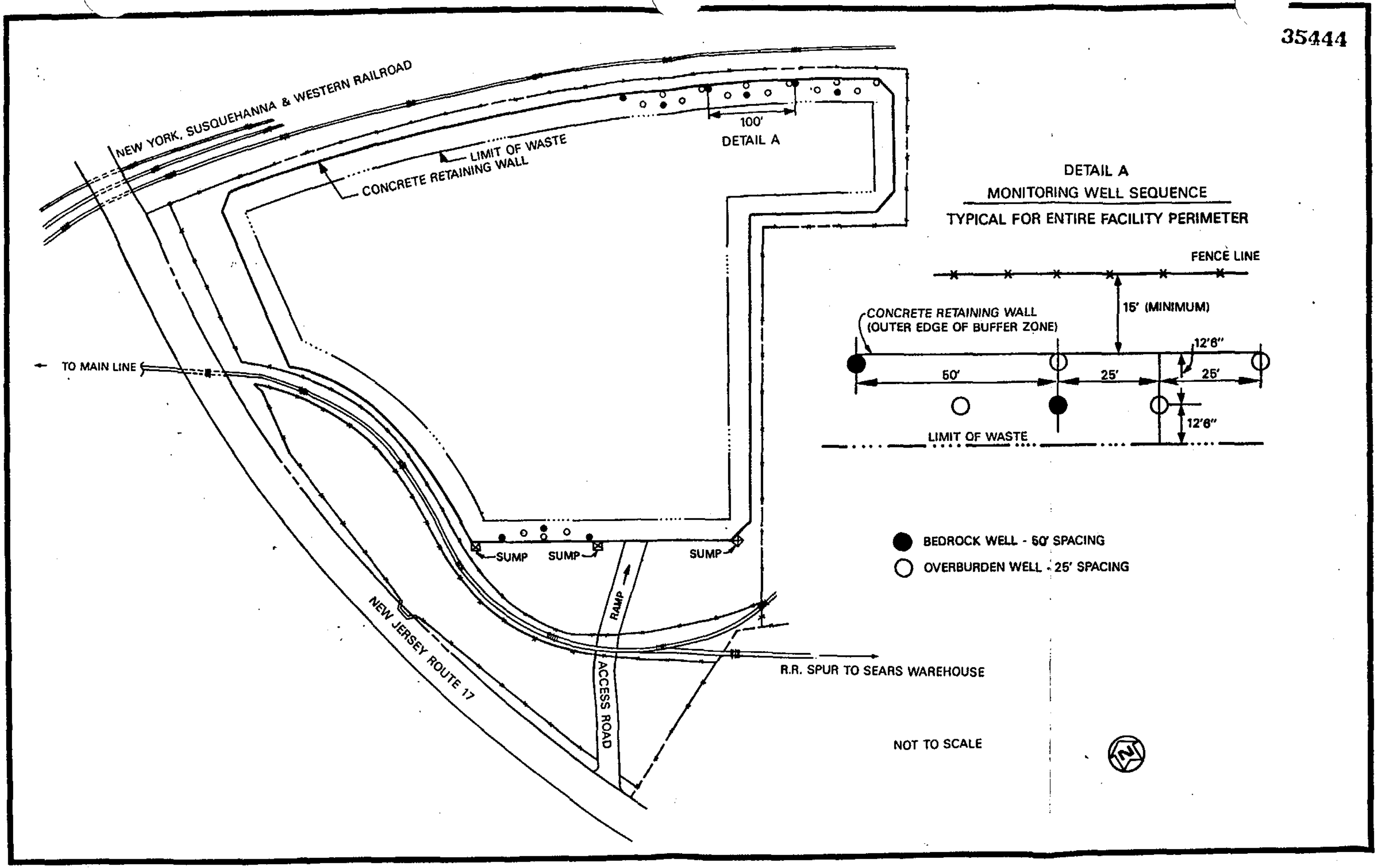

FIGURE 3-6 LOCATIONS OF MONITORING WELLS AT THE MAYWOOD DISPOSAL SITE (ALTERNATIVE 1)

3.2.2 On-Site (Passive Design) Above-Grade Disposal (Alternative 2)

General

Like Alternative 1, this alternative assumes use of the MISS as a long-term disposal site. The containment facility design for Alternative 2 is, however, totally passive. To accommodate the projected waste volume of 270,000 yd^3 within a totally passive facility, the entire 19-acre SC property would have to be acquired as well as approximately 0.5 acres of land adjoining the SC property to the east.

It has been assumed for Alternative 2 that the SC would agree to relocate its plant and that the new plant would be constructed before the existing plant was demolished. Site selection and acquisition and plant design and construction for the new plant would be done by others and is not within the scope of this report, although costs for the new plant, including land, have been included in the cost estimates for Alternative 2.

The containment facility for Alternative 2 occupies virtually the entire SC property, extending from just east of the railroad spur on the west to near the most easterly property line of the SC (Figure 3-7). All existing structures on the SC property would be demolished. As shown in Figure 3-8, the waste containment facility would have 100-ft-wide buffer zone between the edge of the waste inside the facility and the property line on the north, south, and east sides of the disposal site; a wider one would be created on the west to allow space for utility relocation, rail access to Sears, and for the future expansion of New Jersey Route 17.

Implementation of Alternative 2 would be accomplished in five 7-month construction seasons. Details of property acquisitions and construction activities are discussed in the following sections.

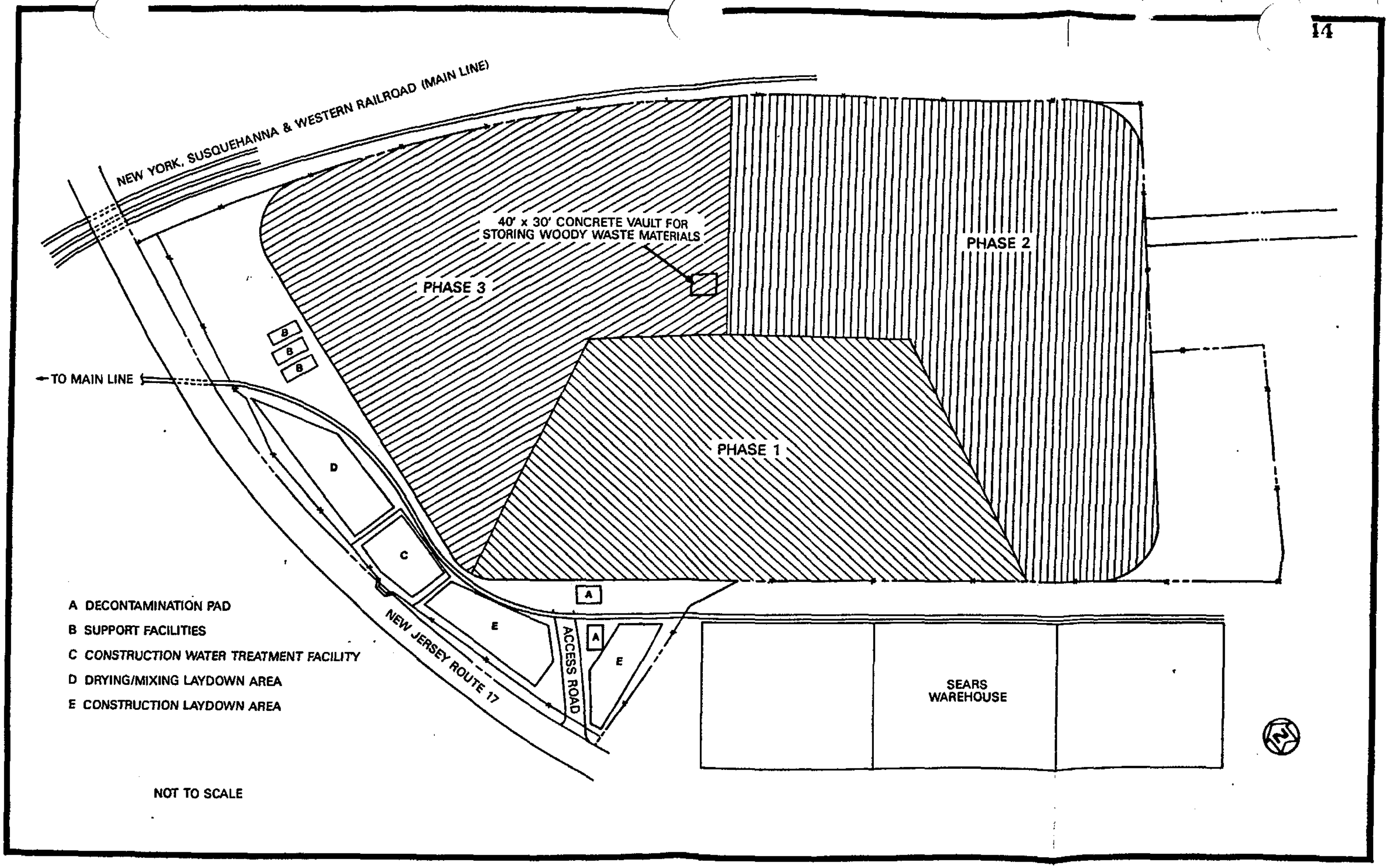

FIGURE 3-7 MAYWOOD DISPOSAL SITE CONSTRUCTION PHASES (ALTERNATIVE 2)

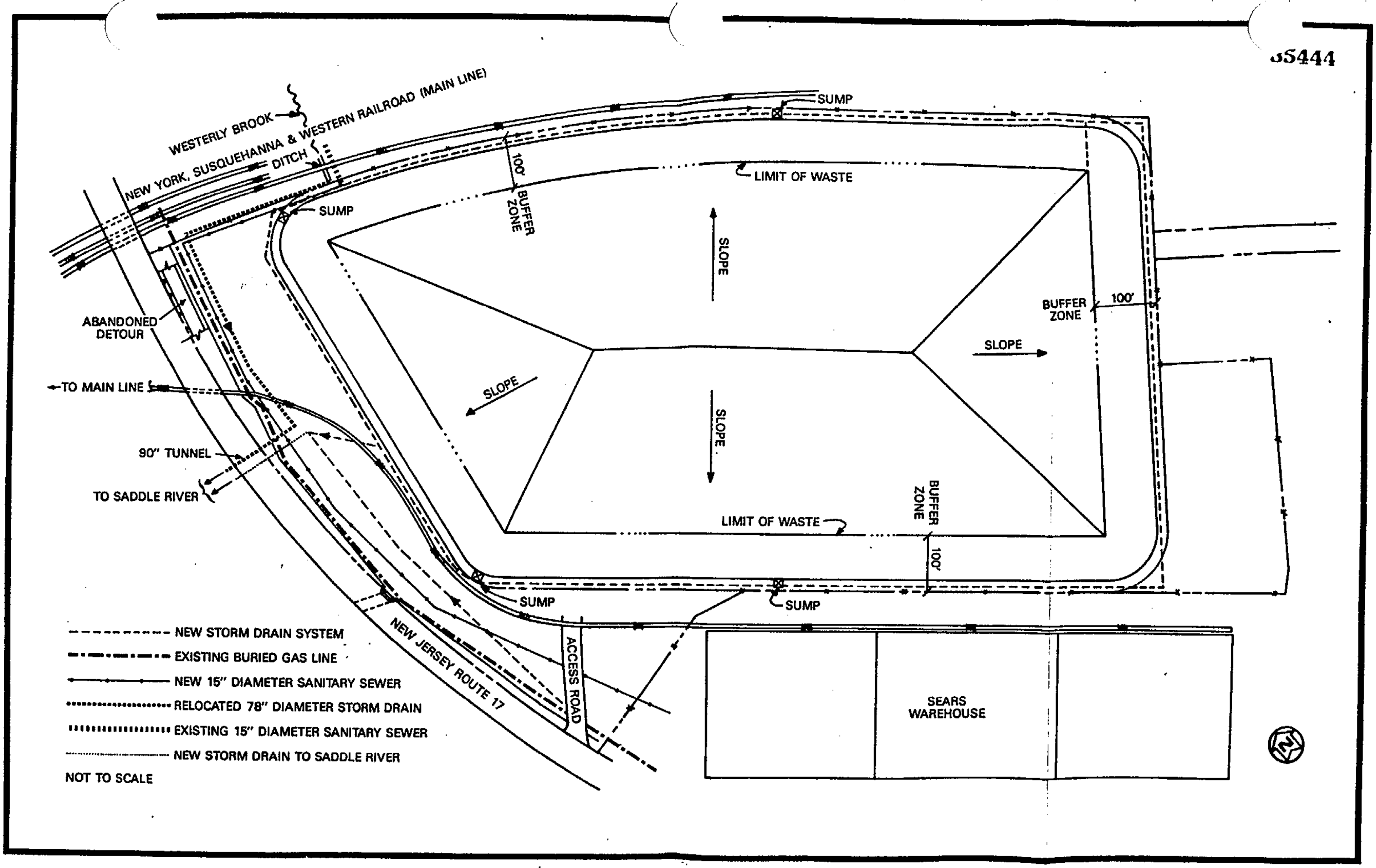

FIGURE 3-8 RELOCATION OF UTILITIES AT THE MAYWOOD DISPOSAL SITE (ALTERNATIVE 2)

As in Alternative 1, the use of a leak monitoring system is also assumed and would account for approximately 3 percent of the cost of Alternative 2, excluding the cost of the land and buildings for the new SC plant.

Selection of Alternative 2 for long-term disposal at the site would require documents, investigations, and studies similar to those for Alternative 1 to permit development of a final design for the disposal facility.

Demolition

Demolition of the SC Plant would commence during the first construction season, just prior to the start of site preparation, and would continue concurrently with site preparation activities. All above-grade structures would be demolished. If uncontaminated, the rubble would be transported to an off-site disposal area; if radioactively contaminated, it would be disposed of in the facility to be constructed on the site. If it were necessary to dispose of substantial volumes of rubble in the on-site facility, it would be possible, by increasing the top slopes of the cover over the facility from 7.5 percent to 10 percent to increase the capacity by approximately 25 percent to a total of 350,000 yd^3. The height of the facility would then be 47 ft.

Underground utilities and foundations would also be removed and disposed of as described above. Areas excavated to remove underground facilities would be backfilled and compacted. Any chemically contaminated waste would be disposed of in conformance with the appropriate regulatory requirements.

Site Preparation

Site Expansion. During the first year of construction, the site would be expanded in preparation for becoming a long-term disposal facility. Site preparation for this alternative would include essentially the same activities as required for Alternative 1. Fencing around the entire property would be replaced to provide proper security and would encompass newly acquired property.

Construction and Washdown Facilities. Construction facilities, including support buildings, laydown and stockpile areas, water storage and treatment facilities, and washdown pads would be the same as those in Alternative 1 and are shown in Figure 3-7.

Relocation of Utilities and Railroad Spur. Utilities would be relocated as in Alternative 1, although those within the SC plant and those underlying or conflicting with the waste containment structure would be removed. The relocated utilities are shown in Figure 3-8. The railroad spur serving the SC plant would also be removed. The railroad spur serving the Sears property would not have to be relocated.

Site Drainage System. The site drainage system for Alternative 2 would be similar but larger than the system proposed for Alternative 1. An independent discharge from the site to the Saddle River would be used, as in Alternative 1.

Water Storage and Treatment. Water storage and treatment requirements and facilities would be the same as for Alternative 1. A total of approximately 2.25 million gal of groundwater, rainwater, and construction water would have to be treated over a period of five construction seasons. The planned storage ponds and treatment facilities are shown as area C in Figure 3-7.

Disposal Facility Construction -- Phase 1

Phase 1 of disposal facility construction would commence during the second construction season. The location of Phase 1 work is shown in Figure 3-7. Since there is no reported contamination within the limits of Phase 1, it has been assumed that construction of this section of the disposal facility would be possible without handling contaminated material.

The process of constructing the Phase 1 section of the disposal facility would be exactly as described in Alternative 1. A typical section of the facility is shown in Figure 3-9. The clay bottom of the facility and inner berm of the dike would be covered with a leak monitoring system as described in Alternative 1. Sumps would be located along the northern and southern edges of the facility as shown in Figure 3-8. Monitoring of the system would be as described for Alternative 1.

The Phase 1 section of the disposal facility would accommodate approximately 100,500 yd^3 of waste. Above-grade waste from piles IA, IIIA, and IVA, (37,400 yd^3) would be placed first in this section. Thereafter, waste from burial areas IVB, VB, VIB, and VIIB (25,400 yd^3) and from Burial Site Nos. 1 and 3, (35,000 yd^3) would be placed in this section. As piles IIIA and IVA are excavated, the leachate collection systems for them, consisting of 2,700 yd^3 of synthetic membrane and sand, would also be placed in the Phase 1 section.

Areas IVB through VIIB would be backfilled with compacted material following removal of the waste buried there.

Waste would be placed within the disposal facility in lifts and compacted as in Alternative 1. A 1-ft layer of uncontaminated clay would be placed over the Phase 1 section to form an interim cover. The clay would be graded to maintain clean runoff so that management of this water would not be necessary. As in Alternative 1, the clay would later be scarified, shaped, and compacted before additional clay was placed to form the long-term cap for the disposal facility.

Disposal Facility Construction -- Phase 2

During the third construction season, Phase 2 of the disposal facility would be completed (Figure 3-7). The clay bottom, dike, and leak monitoring system for this section would be constructed in the same manner as those for Phase 1.

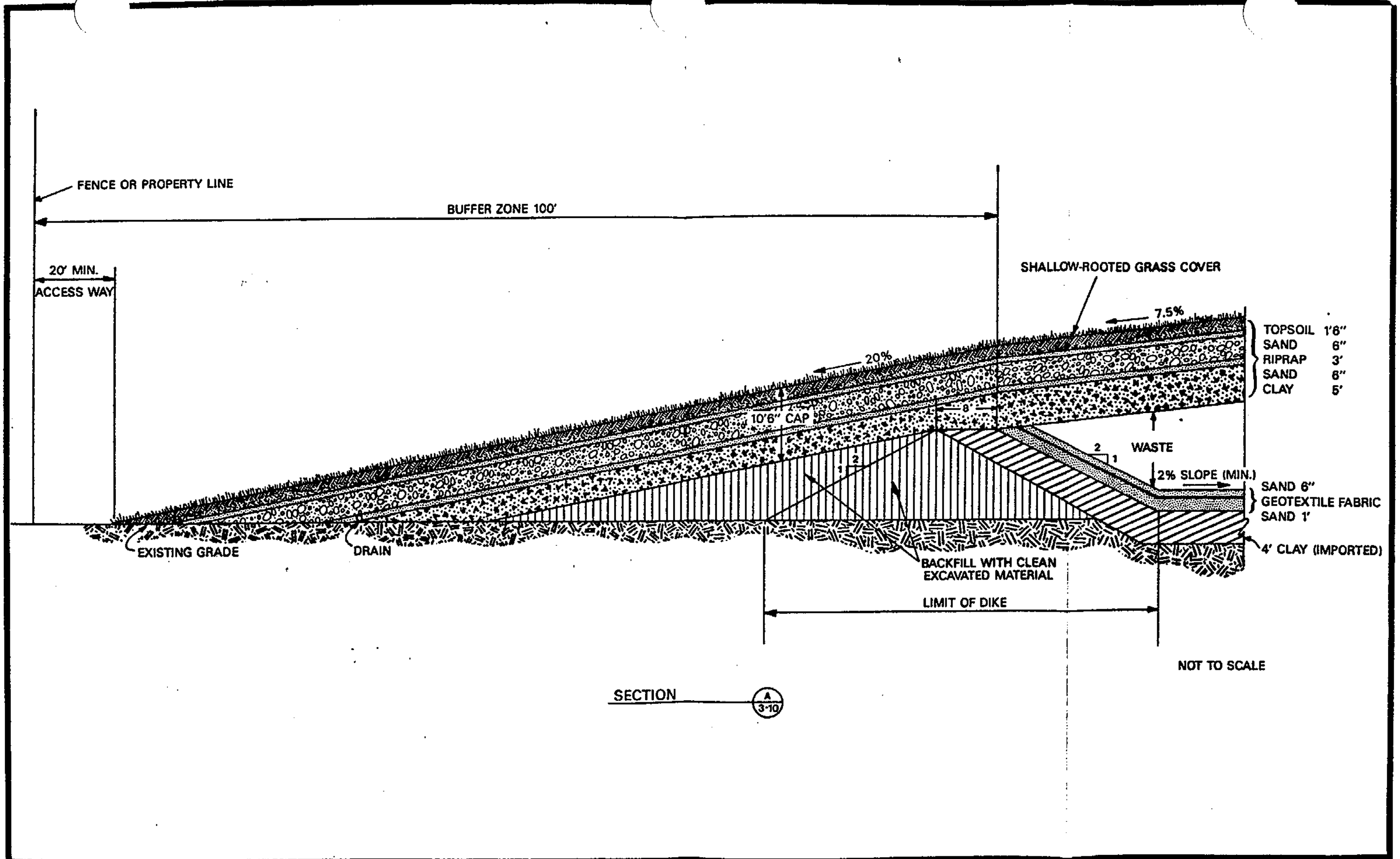

FIGURE 3-9 TYPICAL SECTION OF THE MAYWOOD DISPOSAL FACILITY (ALTERNATIVE 2)

Phase 2 of the waste disposal facility would contain approximately 102,700 yd^3. Waste pile IIA would be partially excavated to permit excavation of the waste buried in area IIB. Approximately 39,000 yd^3 would be excavated from pile IIA and placed in the disposal facility. Waste from burial areas IB, IIB, and VIIIB (42,000 yd^3) and Burial Site No. 2 (5,000 yd^3) would also be placed in the Phase 2 section of the facility. Materials from the leachate collection systems for pile IA and part of IIA (2,700 yd^3 and 4,000 yd^3, respectively) would also be placed in this section of the facility.

During excavation of waste in burial areas IB, IIB, and VIIIB, dewatering sumps would be used to remove water to storage facilities for discharge and/or treatment as required. Backfill of buried waste areas would be as described in Phase 1.

Excavation of the waste buried under Route 17 would commence during Phase 2 as described in Alternative 1. Approximately 10,000 yd^3 of this waste would be placed in the Phase 2 section of the facility.

An interim cover of clay would be placed over the Phase 2 section of the facility and graded to drain as in Phase 1.

Disposal Facility Construction -- Phase 3

Phase 3 would be completed during the fourth construction season. The clay bottom, dike, and leak monitoring system for this section of the disposal facility would be constructed, and the remaining waste buried under Route 17 and in burial area IIIB would be consolidated in this section along with the remaining waste and leachate material in interim storage pile IIA. Woody waste materials would also be disposed of in the facility during Phase 3, and Route 17 would be restored.

Approximately 66,800 yd^3 of waste would be placed in the Phase 3 section. This total comprises 46,600 yd^3 remaining in pile IIA, 5,600 yd^3 from burial area IIIB, 10,000 yd^3 from under Route 17, and approximately 4,600 yd^3 of leachate collection system materials.

Buried waste would be dewatered and backfilled as in Phases 1 and 2. Route 17 would be excavated and restored as in Alternative 1. Contaminated trees and roots would be disposed of in the facility, as described in Alternative 1. The location of the concrete vault in which these woody materials would be placed is shown in Figure 3-7.

Following placement of the waste in the Phase 3 section of the disposal facility, a 1-ft-thick layer of clay would be placed over the waste and graded to drain as in Phases 1 and 2.

Disposal Facility Construction -- Phase 4

During the fifth construction season, the final cap would be constructed over the entire disposal facility.

The design of the cap for the disposal facility is the generic design described in Alternative 1. Figure 3-9 depicts the conceptual design for the cap. Components of the cap are the same as for Alternative 1. The 1-ft-thick clay layer placed over the waste during earlier phases of work would be inspected to determine the exact thickness of new clay required for the long-term cap to bring the total thickness of clay to 5 ft. As in Alternative 1, it has been assumed that 4 ft of new clay would be added. To obtain the required pile capacity, a slope of 7.5 percent would be used for the top of the cap. The maximum slope on the sides of the facility would remain 20 percent as in Alternative 1. The combined thickness of the multilayered cap would also remain 10.5 ft, as in Alternative 1. Each layer of the cap would be placed over the entire facility before placement of the next layer began.

As part of cap construction, a drainage system would be installed outside the perimeter dike for draining water that might infiltrate through the topsoil (Figure 3-9).

As in Alternative 1, the Route 17 detour, constructed to permit excavation of waste from under the highway, would be abandoned in place. The excavations under the original roadway would be backfilled, graded to drain, and reseeded. The detour would be contoured and reseeded as necessary.

Approximately 742,000 yd^3 of construction materials would be required for the containment facility. An estimated 57,000 trips by heavy vehicles would be necessary to transport these materials to the site. A detailed list of the quantities of materials to be handled during Alternative 2 is provided in Appendix C.

A plan and cross sections of the completed disposal facility are shown in Figures 3-10 and 3-11, respectively.

Surveillance and Maintenance

The design life of the long-term disposal facility is at least 200 years. Passive design features have been incorporated into the conceptual design of the disposal facility to minimize the need for sustained maintenance and surveillance.

As in Alternative 1, it has been assumed that surveillance and maintenance, and performance monitoring of the engineered features of the facility would be conducted at regular intervals for 5 years following site closure and on a less frequent basis for the next 195 years. Table 3-2 specifies the schedule for each of the surveillance, maintenance, disposal facility performance monitoring, and environmental monitoring activities that are anticipated.

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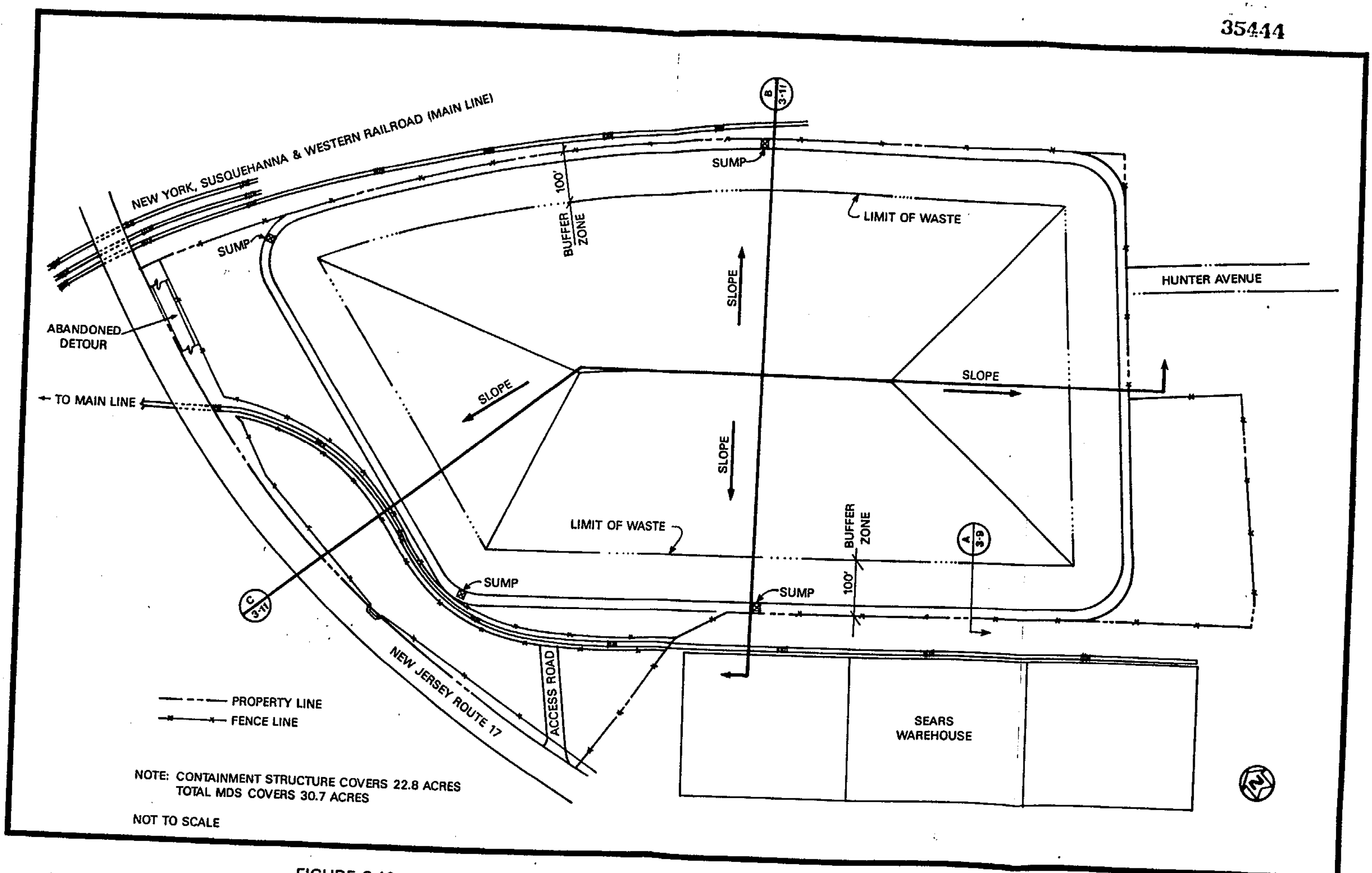

FIGURE 3-10 PLAN VIEW OF THE COMPLETED MAYWOOD DISPOSAL SITE (ALTERNATIVE 2)

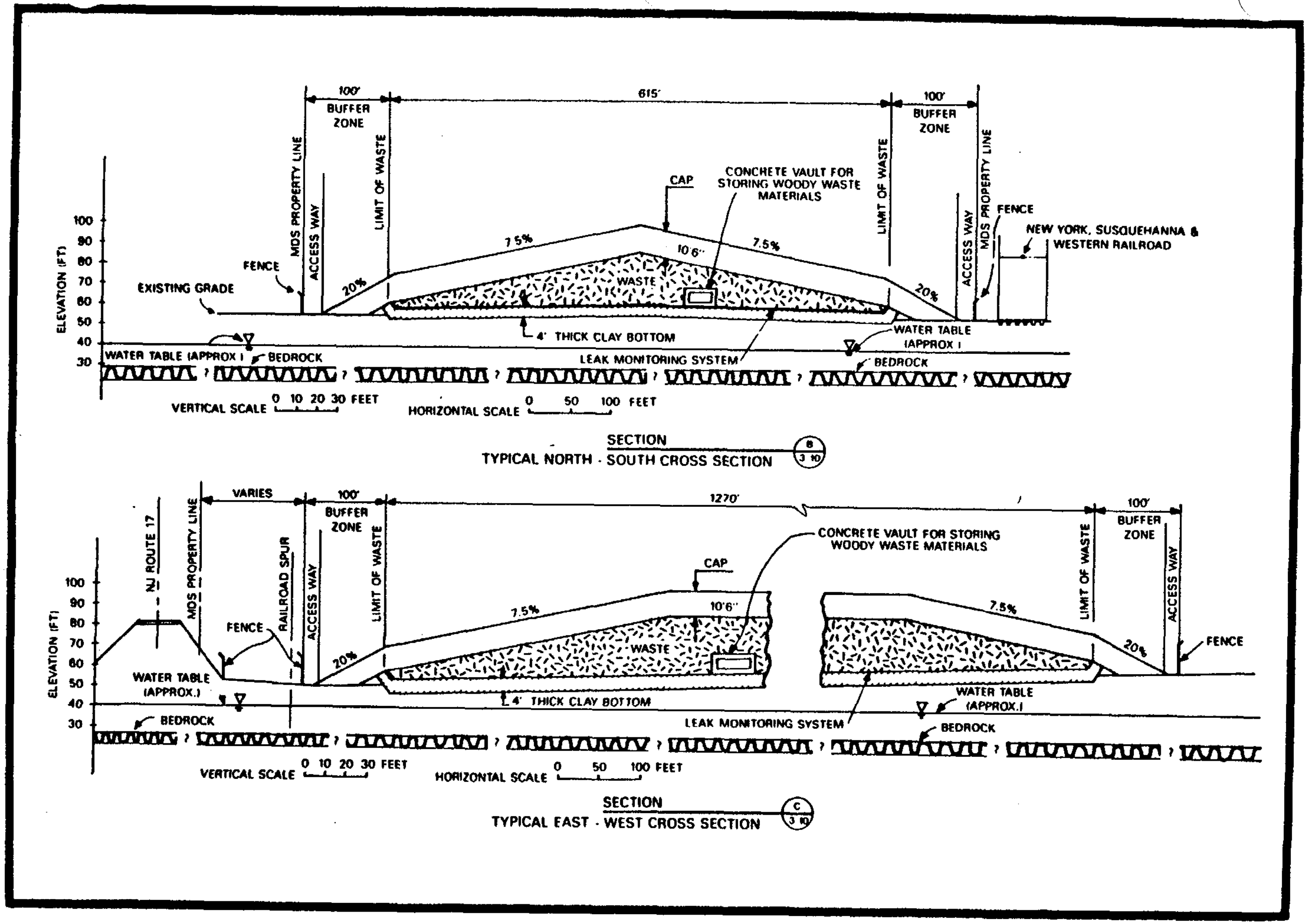

FIGURE 3-11 TYPICAL CROSS SECTIONS OF THE COMPLETED MAYWOOD DISPOSAL SITE (ALTERNATIVE 2)

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Monitoring wells would be installed around the site within the 100-ft-wide buffer zone to provide primary and secondary monitoring for radionuclide migration from the containment facility. One series of wells would monitor the upper groundwater aquifer in the unconsolidated glacial till, and another series would monitor the lower groundwater aquifer in the Brunswick Formation. The pattern of these wells around the disposal facility is shown in Figure 3-12. The monitoring schedule for these wells would be the same as that for Alternative 1.

Vibrating wire pressure transducers would also be installed, as in Alternative 1. The leak monitoring sumps would be monitored as described in Alternative 1.

3.2.3 Transport to the New Jersey Disposal Site (Alternative 3)

General

In this alternative, the above-grade, interim storage piles and buried waste at the MISS, the waste buried under Route 17, and the waste buried in SC Burial Site Nos. 1-3 would be removed to the extent necessary to bring these areas into compliance with DOE radiological guidelines for release of the properties for unrestricted use (Appendix A). The collected waste would be transported via truck to the NJDS for long-term disposal. It has been assumed that the NJDS could receive cocontaminated waste, although to date no evidence of cocontamination has been found.

Following removal of the waste, the excavated areas would be backfilled (as necessary to restore the site as nearly as possible to its original contours), sloped to drain, and seeded to provide a grass covering.

Transportation of the waste to the NJDS would be divided into five construction seasons, commencing after completion of interim storage

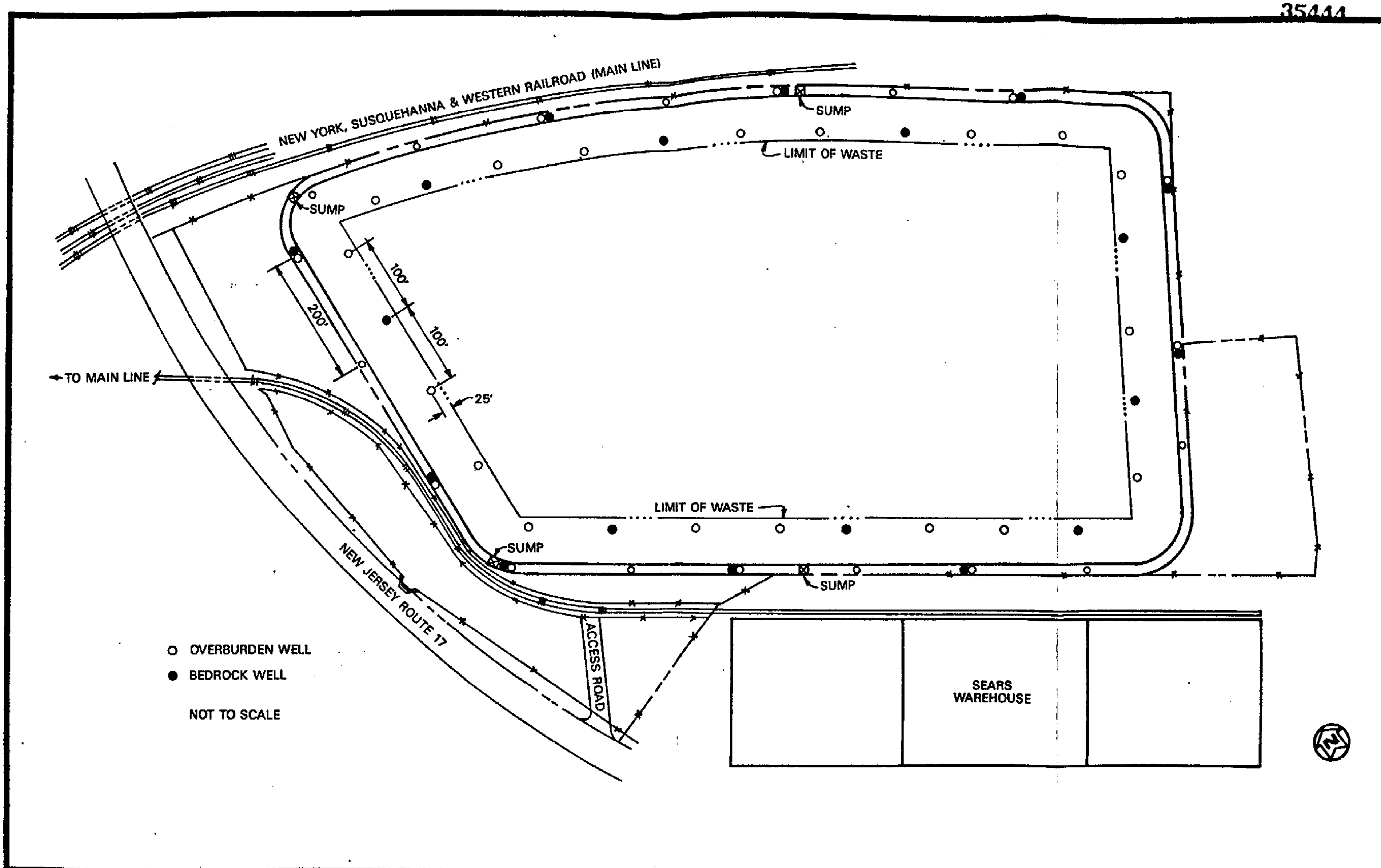

FIGURE 3-12 LOCATIONS OF MONITORING WELLS AT THE MAYWOOD DISPOSAL SITE (ALTERNATIVE 2)

actions. It is expected that 36 trucks would leave the site each day. At this rate, and assuming a 7-month construction season, approximately 65,000 yd^3 of waste could be transported to the NJDS each year for 4 years and 20,000 yd^3 in the last year.

Site Preparation

Site preparation activities would take place during the first construction season and would be essentially the same as those for Alternative 1.

Construction and Washdown Facilities. Two washdown facilities would have to be provided for decontaminating equipment, tools, and trucks. The MISS property is supplied with electricity from sources in the immediate vicinity. The locations of the various construction and washdown facilities are shown in Figure 3-1.

Site Access. It is assumed that access to the site from Route 17 would be via the DOE easement near the southwestern corner of the MISS property. It is expected that movement of trucks onto and off of the site would occur between 9:30 a.m. to 3:30 p.m. to minimize interference with rush hour traffic. The impact of this schedule has been evaluated as part of the cost analysis for this alternative.

Wet Waste Drying Area. It may be necessary to dry waste excavated from burial areas below the water table before transporting it from the site. An area would be reserved for sun drying and aeration of excavated waste (see Figure 3-1).

Water Storage and Treatment. The water storage and treatment requirements for Alternative 3 are the same as those described for Alternative 1, except that the depleted resins used in the water treatment would be transported to the NJDS for disposal.

Sanitary Sewers and Storm Drains. In Alternative 3 the sanitary sewers and storm drains running through the site would not have to be permanently relocated. Instead, the section of the sewer line traversing waste burial areas IB, VIB, and VIIIB would be isolated and the sewage stream would be rerouted while excavation is in progress. Following removal of the waste from these areas, this section of sewer would be replaced and the area around it backfilled.

The storm drains would be maintained in place. Excavation and backfilling around them would be done in a manner that would preclude pipe failure (i.e., excavation of small sections and use of supports and shoring).

Reservoir. In this alternative the SC reservoir, its associated distribution system, and service facilities would not have to be relocated.

The 12-in.-diameter water supply line from the reservoir to the SC plant crosses waste burial area IVB. During excavation of area IVB, this section of water line would be isolated and the water stream rerouted. Following removal of the waste, the water line would be replaced and the area around it backfilled.

As the excavation of waste neared the utility poles supporting the overhead electrical lines from the pumphouse, the lines would be transferred to utility poles previously erected in clean areas. The existing utility poles would be removed, decontaminated if required, and disposed of.

Haul Route

Although the location of the NJDS has not yet been established, it is assumed to be within 100 mi of the MISS. The haul route assumed in this document transports the waste via the closest federal interstate highway, Interstate 80 (Figure 2-1). This would involve the following route:

- o Enter Route 17 northbound through the DOE easement at the southeastern corner of the MISS.
- o Enter the southbound lanes of Route 17 at the cloverleaf at Route 4 (Figure 2-1).
- o Exit southbound Route 17 onto Interstate 80 at exit 63.

From Interstate 80 trucks could proceed in a north/south or east/west direction to the NJDS.

Transportation Method

The waste would be transported in trucks with a 20-yd^3 load capacity. However, weight restrictions would limit the volume of waste in each truck to approximately 13 yd^3. The trucks would have sealed tailgates, and the waste would be covered during transport to ensure that no leakage and/or airborne migration occurred. Approximately 36 trucks per day would be used.

Removal of Above-Grade Wastes

The 123,000 yd^3 of waste in the interim storage piles would be removed from the MISS prior to excavation of the buried waste. In addition, 14,000 yd^3 of material from the leachate collection systems for the various piles would have to be transported from the site. Figure 2-4 shows the locations of the interim storage piles at the MISS.

Excavation of Buried Waste

During excavation of the buried waste, dewatering sumps would be used to remove water to storage facilities for discharge and/or treatment, if necessary. The wastes would be sun dried and aerated, as required, before being loaded onto the trucks. Figure 2-3 shows the locations of the buried waste on the MISS and SC properties, and beneath Route 17. Table 3-2 specifies the projected volume of waste at each location.

Transportation of Waste -- Phase 1

Transportation of waste to the NJDS would commence, in conjunction with site preparation, in the first construction season. All of storage pile IA (26,500 yd^3), 3,500 yd^3 from the leachate collection system for pile IA, and 35,500 yd^3 from pile IIA would be removed. The impermeable cover and leachate collection system of pile IIA would be maintained until all the material from that pile had been removed.

Transportation of Waste -- Phase 2

During the second construction season, the remainder of storage pile IIA (50,100 yd^3), all of storage pile IIIA (2,900 yd^3), and 9,500 yd^3 from the leachate collection systems for piles IIA and IIIA would be removed to the NJDS.

Transportation of Waste -- Phase 3

During the third construction season, the 8,000 yd^3 of waste in storage pile IVA and 1,000 yd^3 from the leachate collection system for pile IVA would be removed, and excavation of the buried waste would commence. Deposits in areas IB (26,500 yd^3), IIB (12,000 yd^3), VIB (13,900 yd^3), and VIIIB (3,500 yd^3) would be transported to the NJDS during this phase.

Clean backfill, obtained off-site, would be used to restore the excavations to their original contours. The new SC warehouse would also be constructed during this season.

Transportation of Waste -- Phase 4

During the fourth construction season, the buried waste from areas IIIB (5,600 yd^3), IVB (7,400 yd^3), VB (2,900 yd^3), and VIIB (1,200 yd^3) would be removed. In addition, SC Burial Site No. 1 (17,000 yd^3), No. 2 (5,000 yd^3), and No. 3 (18,000 yd^3) would be excavated and the waste transported to the NJDS. The excavations would be backfilled and returned to their original contours. Prior to excavating Burial Site No. 3, the contents of the SC warehouse erected over that area would be transferred to the new warehouse (Figure 3-2) and the present warehouse would be demolished to allow access to the waste in Burial Site No. 3. The construction of the Route 17 detour (Appendix B) would commence during this construction season, and approximately 6,500 yd^3 of waste would be removed from under it, using the open cut method (see Appendix B), and transported to the NJDS.

Transportation of Waste -- Phase 5

During the fifth construction season, the balance of the waste buried under Route 17 (13,500 yd^3) would be removed and transported to the NJDS.

Site Closure

After the waste had been removed from the MISS and SC properties and from under Route 17, the MISS and SC properties would be restored to their original contours. The Route 17 detour, constructed during Phases 4 and 5 to permit excavation of the waste from under the highway, would be abandoned in place. The excavations under the original roadway would have been backfilled, graded to drain, and reseeded. The detour would be contoured and reseeded as necessary. The area would then be released for unrestricted use.

The cost estimate for this alternative includes the removal of the waste from under Route 17. However, this area could potentially be deeded as a restricted area since development on or near the roadway embankment is highly unlikely. As noted in Alternative 1 and in Appendix B, a pumping system would be required to prevent migration of radionuclides downgradient should in situ containment of the waste be selected.

4.0 EVALUATION OF ALTERNATIVES

4.1 BASIS

Each alternative has been evaluated on the basis of four general factors: (1) advantages/disadvantages; (2) radiological and safety hazards; (3) schedule; and (4) cost. The quantities of materials on which the cost estimate for each alternative has been based are listed in Appendix C.

4.2 ON-SITE (QUASI-PASSIVE DESIGN) ABOVE-GRADE DISPOSAL (ALTERNATIVE 1)

4.2.1 Advantages/Disadvantages

One of the primary advantages of an above-grade disposal facility is that it can be used at sites where the water table is close to ground surface (as is the case at the MISS). Since it is above grade, direct monitoring of the facility itself is feasible, in conjunction with monitoring the subsurface environment around it, to assess containment performance. Another advantage of permanently storing the waste at the present MISS is that movement of the contaminated material over public roads during transit to the NJDS would be avoided.

There are, however, several disadvantages to Alternative 1. These include:

- The need to acquire (as a minimum) an additional 5 acres of land to accommodate the waste
- The restriction on future use of the property
- The relatively high profile that the storage facility would present (approximately 45 ft above existing grade)
- The nonpassive design because of the inclusion of a concrete retaining wall that would have to be replaced every 50 years

- Heavy truck traffic necessitated by hauling construction materials over local roads
- The susceptibility of the facility cover to erosion
- The limits imposed on the capacity of the disposal facility by practical restrictions affecting its vertical and areal expansion

4.2.2 Radiological and Safety Hazards

Based on current DOE guidelines (Ref. 14), the excavation and storage of the contaminated material at the Maywood Disposal Site would not constitute a health hazard to either the general public or the workers. Continuous environmental monitoring of the site would be conducted to ensure that no contaminant migration occurred. External radiation exposures from the pile itself would result in an estimated whole-body dose of less than 20 mrem/yr (less than one chest x-ray). However, the transportation of an estimated 354,000 yd^3 of clean construction materials (concrete, cap materials, and backfill) over local roads to the site would necessitate roughly 27,000 trips by heavy vehicles, with a corresponding increase in safety hazards to the general public.

4.2.3 Schedule

The schedule for Alternative 1 is presented in Figure 4-1. The activities for this alternative can be divided into preconstruction and construction phases. For the purpose of developing a schedule, it has been assumed that the NEPA process for long-term on-site disposal would require about 28 months, at the end of which appropriate NEPA documentation would be issued. NEPA activities would be the critical task in the preconstruction phase; delays in the NEPA process would delay implementation of field activities.

Based on a 7-month-long construction season each year and 270,000 yd^3 of waste, a total of 35 construction months would be required for the construction phase. If the construction period

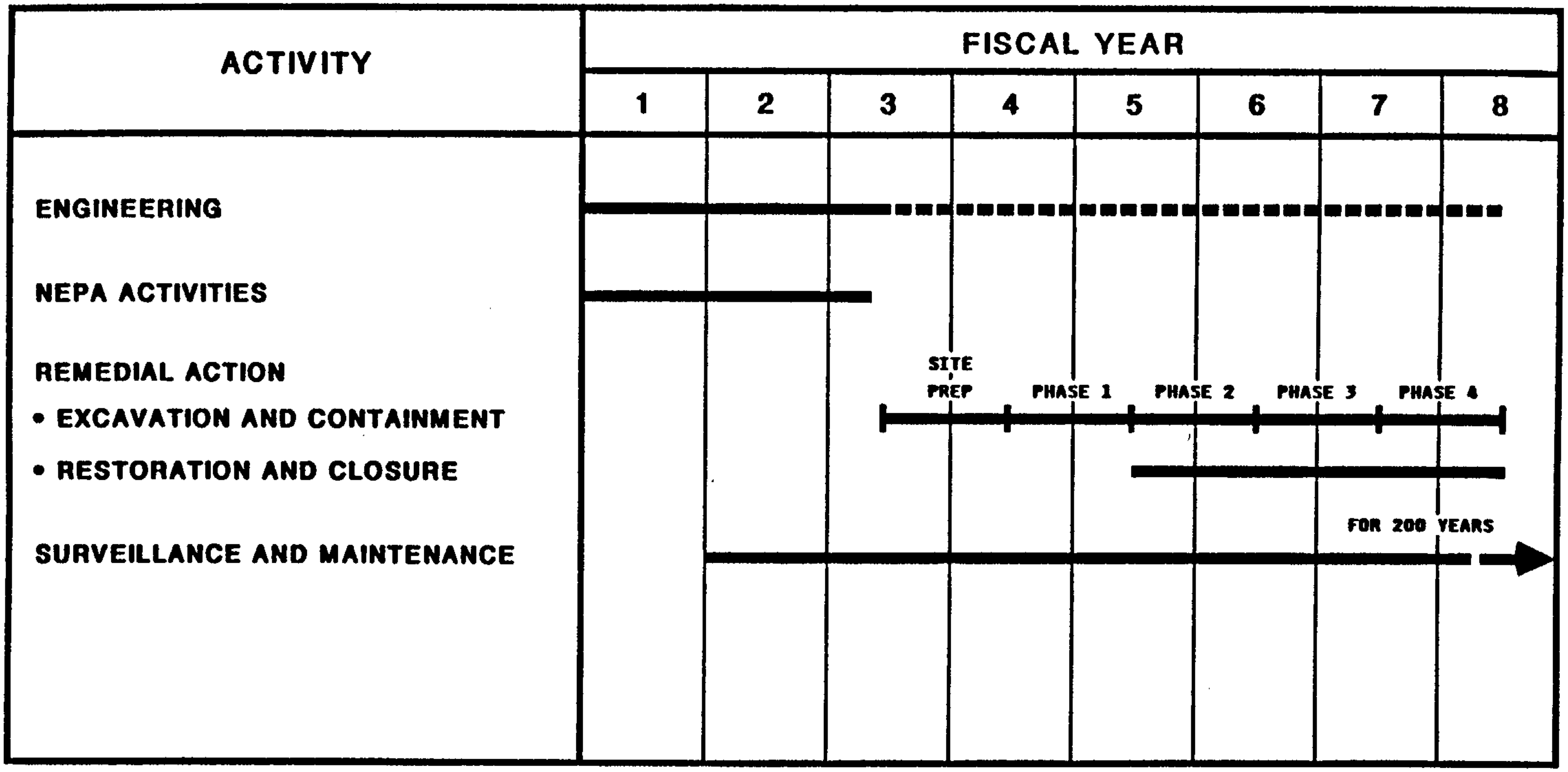

FIGURE 4-1 SCHEDULE FOR ON-SITE (QUASI-PASSIVE DESIGN) ABOVE-GRADE DISPOSAL AT THE MAYWOOD DISPOSAL SITE (ALTERNATIVE 1)

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were less than 7 months per year, the schedule would lengthen and project costs would consequently increase. Similarly, if funding were inadequate to support the construction schedule, the schedule would lengthen and project costs would increase. It is possible that problems encountered in excavating the buried waste could result in delays in the schedule. Consequently, excavation of these wastes would be the critical path item for this alternative.

Surveillance and maintenance are considered to be required for a minimum of 5 years following site closure and possibly for the entire design life of the disposal cell (at least an additional 195 years).

4.2.4 Cost

Table 4-1 details the costs of implementing Alternative 1 based on the waste volumes assumed earlier in this document. For comparison purposes, these costs are also listed as they were presented in the DOE Energy Systems Acquisition Project Plan (ESAPP), Rev. 1, April 1985, an earlier estimate.

Costs shown are in millions of dollars and represent the total project cost, which includes the costs for prior years through 1984, interim remedial actions, final disposition, all participants, general project costs, and contingency.

Assumptions and Qualifications

The assumptions and qualifications used in developing the cost estimate are listed below:

TABLE 4-1

COST ESTIMATE FOR FINAL DISPOSITION OF THE MISS

($ Millions)

	Earlier Estimate	Alternative 1 On-Site (Quasi-Passive Design) Above-Grade Disposal	Alternative 2 On-Site (Passive Design) Above-Grade Disposal	Alternative 3 Transport to NJDS
WASTE VOLUME (yd^3)	218,000	270,0000	270,000	270,000
Above-Grade Storage	100,000	137,000	137,000	137,000
Buried	118,000	133,000	133,000	133,000
DIRECT COST (1985 DOLLARS)				
Prior Years (Through FY 1984)	$ 2.3	$ 2.3	$ 2.3	$ 2.3
Site Characterization	0.9	1.3	2.6	1.1
NEPA	0.5	0.6	1.0	0.5
Design Engineering	1.7	2.5	4.9	2.0
Remedial Action	22.8	46.9	109.1	30.5
Transportation	8.7	-	-	10.5
Disposal Cost	18.5	-	-	22.9
Final Report	0.3	0.4	0.5	0.3
Surveillance and Maintenance, Environmental Monitoring	1.6	2.6	2.6	1.8
TOTAL DIRECT COST	$ 57.3	$ 56.6	$123.0	$ 71.9
INDIRECT COST				
Technology and Systems Studies Project and Program Support, Capital Equipment	10.7	10.6	22.6	13.4
TOTAL DIRECT AND INDIRECT COST	$ 68.0	$ 67.2	$145.6	$ 85.3
CONTINGENCY	14.9	15.0	38.5	19.8
TOTAL COST - 1985 DOLLARS	$ 82.9	$ 82.2	$184.1	$105.1
ESCALATION	30.1	31.2	92.3	44.0
SUBTOTAL - YEAR OF EXPENDITURE	$113.0	$113.4	$276.4	$149.1
POST-REMEDIAL ACTION MONITORING AND MAINTENANCE				
5-Year Intensive Program in 1985 Dollars	-	1.7	1.7	-
Escalation	-	1.9	1.9	-
195 Years' Inspection and Maintenance*	-	7.3	4.7	-
TOTAL COST - YEAR OF EXPENDITURE	$113.0	$124.3	$284.7	$149.1

*This figure is calculated using a $50,000 annual cost, in addition to the cost of replacing the fence, concrete retaining wall, drainage system, and monitoring wells at selected intervals over a 195-year period, and computing the present value of these combined costs at a real interest rate of 3 percent.

- A total volume of 270,000 yd^3 of contaminated material would be located at the disposal site (113,000 yd^3 of buried waste, 137,000 yd^3 of above-grade materials, and 20,000 yd^3 under Route 17).
- No allowance is included for special handling of cocontaminated material.
- The length of the construction season would be 7 months.
- Approximately 2.0 million gal of water would require treatment.
- Backfill material would be locally available.
- Materials required for construction of the containment structure (e.g., clay, granular material, and riprap) would be available within a 30-mi radius.
- The disposal facility would contain a leak monitoring system designed to meet local and state requirements.
- Existing SC Warehouse No. 3 would be demolished, the contaminated waste buried underneath would be excavated, the excavation would be backfilled, and a new building would be erected.
- Excavation of the waste buried beneath Route 17 would proceed by the open cut method.
- Major utility work would be required.
- An allowance is included for road repair.
- No allowance has been included for modification of the disposal site for other purposes after the end of its design life.
- The additional 5 acres of land obtained from the SC have been priced at $60,000 per acre.
- Annual cost escalation rate would be 6 percent (per ESAPP, Rev. 1).
- No government funding restraints would be experienced.

4.3 ON-SITE (PASSIVE DESIGN) ABOVE-GRADE DISPOSAL (ALTERNATIVE 2)

4.3.1 Advantages/Disadvantages

The advantages of Alternative 2 are the same as those listed under Alternative 1, except that the facility has the added advantages of being totally passive, and being able to accommodate a 25 percent increase in capacity if the cap slope were increased from 7.5 to 10 percent. Furthermore, the design would not interfere with the widening of Route 17 because sufficient area would be available for this on the western side of the facility.

Disadvantages of Alternative 2 are:

- o The need to acquire an additional 19 acres of SC land and 0.5 acres of adjacent land to accommodate the waste disposal facility, thereby eliminating the entire SC plant
- o The restriction on future use of the property
- o The relatively high profile that the storage facility would present (approximately 40 ft above existing grade)
- o Heavy truck traffic necessitated by hauling construction materials over local roads
- o The susceptibility of the facility cover to erosion

4.3.2 Radiological and Safety Hazards

Radiological and safety hazards for Alternative 2 are similar to those for Alternative 1. The transportation of an estimated 742,000 yd^3 of clean construction materials (cap materials and backfill) over local roads to the site would necessitate roughly 57,000 trips by heavy vehicles, with a corresponding increase in safety hazards to the general public.

4.3.3 Schedule

The schedule for Alternative 2 is presented in Figure 4-2. The activities for this alternative can be divided into preconstruction and construction phases. Relocation of the SC plant would be a major undertaking. Acquisition of a suitable site and construction of a new plant is assumed to occur during the preconstruction phase concurrent with engineering and the NEPA process. Site selection

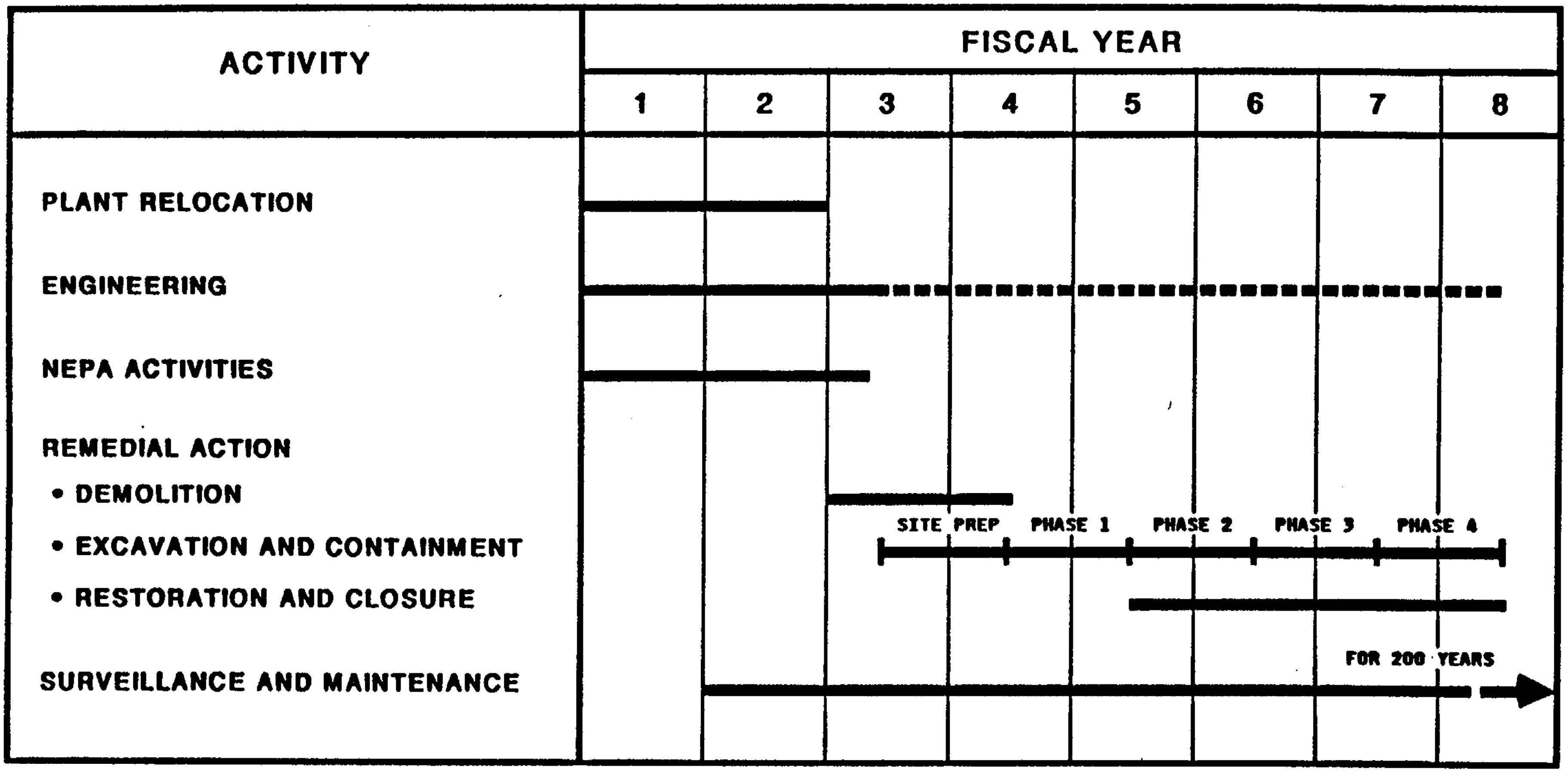

FIGURE 4-2 SCHEDULE FOR ON-SITE (PASSIVE DESIGN) ABOVE-GRADE DISPOSAL AT THE MAYWOOD DISPOSAL SITE (ALTERNATIVE 2)

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and plant construction will be undertaken by others and would not be part of the final disposition activities. The NEPA process for long-term on-site disposal would require approximately 28 months and be similar to Alternative 1. NEPA activities would be a critical task with any delays in the process being reflected in the start of field activities.

Construction will commence with the demolition of the SC plant. Based on a 7-month-long construction season each year and 270,000 yd^3 of waste to be disposed of, a total of 35 construction months would be required, as for Alternative 1. If the construction period were less than 7 months per year, the schedule would lengthen and project costs would consequently increase. Similarly, if funding were inadequate to support the construction schedule, the schedule would lengthen and project costs would increase. It is possible that problems encountered in excavating the buried waste could result in delays in the schedule. Consequently, excavation of these wastes would be the critical path item for this alternative.

Surveillance and maintenance are considered to be required for a minimum of 5 years following site closure and possibly for the entire design life of the disposal cell (at least an additional 195 years).

4.3.4 Cost

Table 4-1 details the costs of implementing Alternative 2 based on the waste volumes assumed in this document. The elements of the cost estimate for Alternative 2 are the same as those for Alternative 1, except that Alternative 2 includes the cost of demolishing the existing SC plant and related facilities, and of purchasing land for and building a new plant elsewhere.

Assumptions and Qualifications

The assumptions and qualifications used in developing the cost estimate are the same as those used for Alternative 1 with the following exceptions and additions:

- The cost of demolishing the existing SC plant has been included.
- The cost of purchasing land, relocating to a new plant site, and building a new plant within the Maywood area has been included.
- The additional 19 acres of SC land and 0.5 acre of adjacent land has been priced at $60,000 per acre.
- Approximately 2.25 million gal of water would require treatment.

4.4 TRANSPORT TO A NEW JERSEY DISPOSAL SITE (ALTERNATIVE 3)

4.4.1 Advantages/Disadvantages

There are two advantages to decontaminating the site and transporting the waste to the NJDS: no long-term maintenance would be required, and the land could be released for unrestricted use.

4.4.2 Radiological and Safety Hazards

There is minimal radiological danger to the general public and workers from the contaminated material or the transport thereof to the NJDS.

The possibility of traffic accidents does, however, exist: Given the 270,000 yd^3 total waste volume, and a 13-yd^3 capacity for each truck, approximately 20,700 trips would be required. Assuming an average round-trip of 200 mi, approximately 4,150,000 miles would be driven. Using national highway accident rate statistics, transport of these materials would have associated expected values of 7.1 accidents and 0.20 fatalities (Ref. 18). These statistics reflect averaging of both good and bad weather conditions.

The bulk waste would be transported in covered tractor trailer dump trucks with gasketed tailgates. These precautions (i.e., sealed tailgates and covered trailers) and procedural controls such as frequent inspection of the trucks, would ensure that no leakage of contaminated material occurred. Any major release (e.g., the result of an accident or mechanical failure) would be promptly cleaned up. These steps would obviate the need for extensive radiological monitoring along the travel route.

4.4.3 Schedule

The schedule for Alternative 3 is presented in Figure 4-3. Less extensive NEPA documentation would be required for this alternative than for Alternative 1 or 2. Extensive NEPA documentation would, however, have to be prepared for the NJDS, although that effort will be required in any event for other New Jersey waste and is, therefore, not part of the scope of work addressed by this document.

The preconstruction phase of Alternative 3 would be limited to radiological characterization of the site, engineering, and procurement activities, requiring a total of approximately 12 months. Excavating and transporting the 270,000 yd^3 of waste would require 35 construction months. This alternative is greatly dependent on the availability of suitable trucks (a vehicle shortage would lengthen the construction schedule). The impact of a shortened construction season due to inclement weather could be mitigated by stockpiling the material in good weather and continuing to transport it during the winter months. If funding were inadequate to support the construction schedule, the schedule would lengthen and project costs would consequently increase.

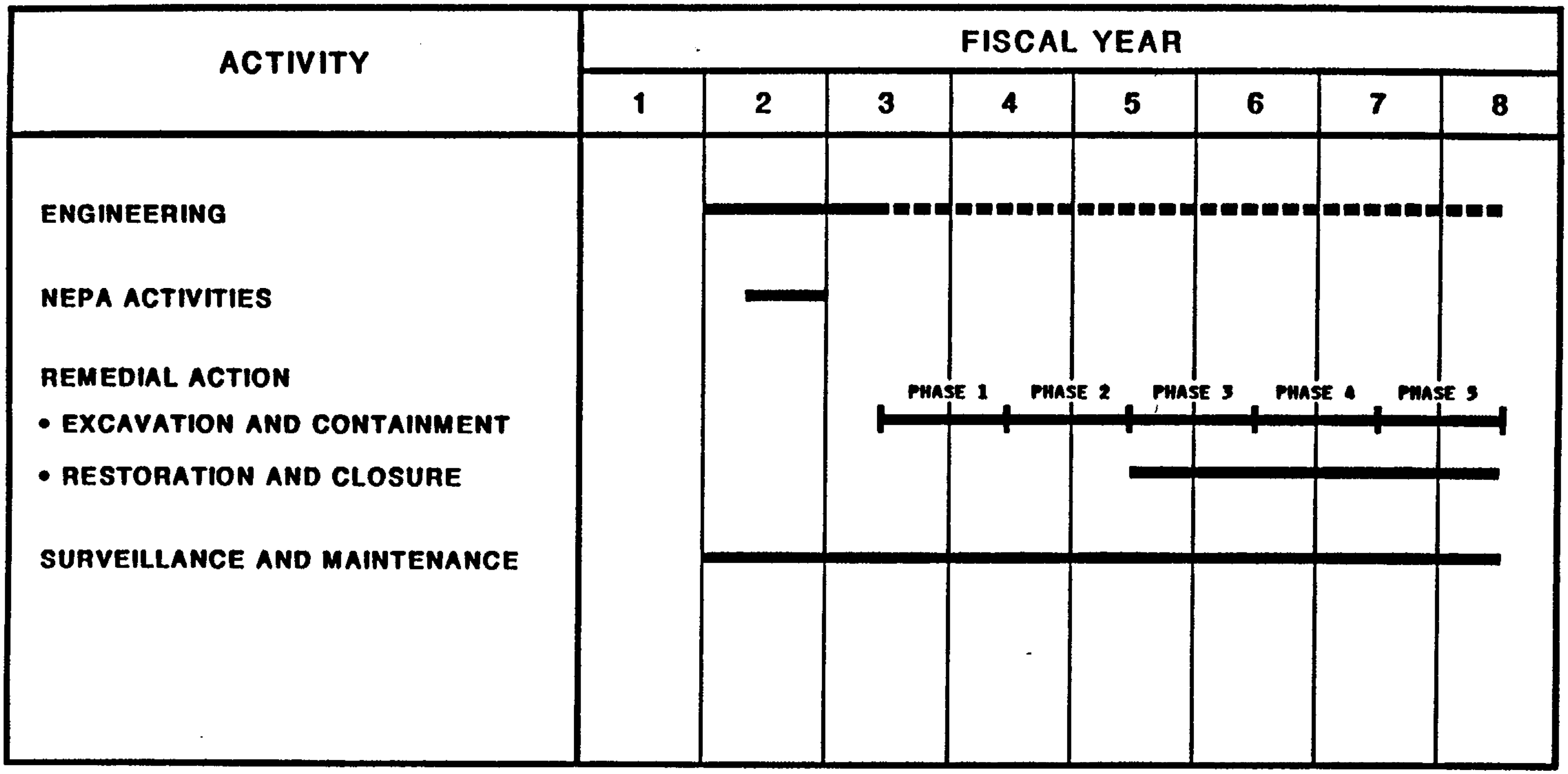

FIGURE 4-3 SCHEDULE FOR REMOVAL AND TRANSFER OF WASTE FROM THE MISS TO THE NJDS (ALTERNATIVE 3)

4.4.4 Cost

The elements of the cost estimate for Alternative 3 are essentially the same as for Alternatives 1 and 2, except that costs for the transport of the waste have been included, as well as allocated disposal site development costs.

Assumptions and Qualifications

The assumptions and qualifications used in developing the cost estimate are the same as those used for Alternative 1 with the following exceptions and additions:

- Transportation and disposal costs are based on unit prices developed in the ESAPP (Rev. 1).
- The NJDS would be within 100 mi of the MISS.
- The disposal site would be available to accept material on arrival.
- Each truck would have a hauling capacity of 13 yd^3.
- Each truck would make one round-trip per day to the disposal site.

4.5 OTHER COST CONSIDERATIONS

In arriving at the final disposition decision other cost elements that are beyond the scope of this evaluation would have to be considered. Among these is a penalty for reduced use of the NJDS. In this regard, should Alternatives 1 or 2 be selected, it is conceivable that a portion of the waste management cost for developing the NJDS would be imposed as a penalty for not permanently disposing of the waste from the MISS at the NJDS. Imposition of such a penalty is possible because the cost of developing the NJDS would likely be divided among the various users thereof on the basis of the volume of waste to be contributed by each of them; it is assumed that the 270,000 yd^3 from the MP would represent a significant fraction of the waste volume to be stored at the NJDS and that the prorated fixed development costs assessed for other users would consequently increase substantially if the MP waste were not disposed of there. This would increase the total cost to DOE for disposal of New Jersey waste. Since the volume from the MP is approximately 50 percent of the total volume of waste from presently identified FUSRAP sites in New Jersey, the reduced-use penalty could be approximately 50 percent of the NJDS fixed construction and operation costs.

5.0 COMPARISON OF ALTERNATIVES

Table 5-1 provides a summary comparison of the three alternatives. Alternative 1 requires the acquisition of a minimum of 5 acres of land to permit construction of an above-grade (quasi-passive) disposal facility large enough to accommodate the projected 270,000 yd^3 of waste. Alternative 2 requires acquisition of 19.5 acres for a similar above-grade passive disposal facility. Access agreements with adjacent property owners, including the New Jersey Department of Transportation (Route 17 access), would be required for both alternatives. Alternative 3, on the other hand, would not involve the acquisition of additional property except at the NJDS. Should widening of Route 17 be contemplated by the New Jersey Department of Transportation, such proposals would have to be coordinated with planned activities for any one of the alternatives.

Under Alternative 1, expansion of the MISS property is limited to 5 acres under current assumptions. Given this limitation, a totally passive containment facility could not be designed, because the side slopes of a facility large enough to contain 270,000 yd^3 of waste would have extended beyond the 16.7-acre site. Instead, a concrete retaining wall has been included in the design to overcome this problem. Periodic maintenance of the wall would be necessary, and it would have to be replaced every 50 years, contrary to the intent of current FUSRAP design criteria that a disposal facility be durable for at least 200 years without maintenance.

In Alternative 2, on the other hand, does comply with FUSRAP design criteria since it is a totally passive containment facility. However, 31.2 acres would be required to accommodate the facility.

NEPA documentation would be required for each of the alternatives, but that necessary for Alternative 3 would involve significantly less effort: 4-6 months as opposed to approximately 28 months for Alternatives 1 and 2. Also associated with Alternatives 1 and 2 is

TABLE 5-1

COMPARISON OF ALTERNATIVES FOR FINAL DISPOSITION OF THE MISS

Item	On-Site (Quasi-Passive Design) Above-Grade Storage	On-Site (Passive Design) Above-Grade Storage	Transport to NJDS
<u>Advantages/Disadvantages</u>			
NEPA	Appropriate Documentation	Appropriate Documentation	Appropriate Documentation
Public Opinion	Negative	Negative	Positive
Site Use	Restricted	Restricted	Unrestricted
Additional Land Required	Yes	Yes	No
Meets Current Design Criteria (Passive Design)	No	Yes	Not Applicable
<u>Radiological Hazard</u>			
Occupational	Negligible	Negligible	Negligible
Public	Negligible	Negligible	Negligible
<u>Schedule</u>			
	5 yrs (7-month work season)	5 yrs (7-month work season)	5 yrs (7-month work season)
<u>Cost (x $1000)</u>			
Year of Construction	$124,300	$284,700	$149,100

the requirement for additional engineering and environmental studies, as outlined in Subsections 3.2.1 and 3.2.2, which would not be necessary for Alternative 3.

Expected radiological health hazards -- minimal in all cases -- would be approximately equal. However, public opinion in the affected Boroughs and Township would be more likely to favor Alternative 3 than Alternatives 1 and 2.

The construction schedules for all alternatives are of essentially equal duration (5 years). However, Alternatives 1 and 2 are more weather-dependent than Alternative 3. They are also subject to schedule delays that could result from difficulties in obtaining necessary permits for construction activities. The schedule for Alternative 3 could be shortened by using a larger fleet of trucks.

The total cost of Alternative 3 is $36.1 million greater than the ESAPP (Rev. 1) cost estimate. The increase is due primarily to the projected increase of 52,000 yd^3 in the volume of waste material to be disposed of and corresponding increases in handling costs.

Direct cost comparisons between the ESAPP (Rev. 1) and estimates for Alternatives 1 and 2 should not be made because the ESAPP estimate is based on transportation of all the waste to the NJDS whereas Alternatives 1 and 2 assume the transformation of the MISS into a disposal facility for all the waste. The cost of Alternative 1 is $11.3 million greater than the ESAPP cost and the cost of Alternative 2 is $171.7 million greater than the ESAPP cost.

As shown in Table 4-1, the costs of Alternatives 2 and 3 exceed the cost of Alternative 1 by $160.4 million (229 percent) and $24.8 million (20 percent), respectively. However, the additional cost consideration outlined in Subsection 4.5 would have to be evaluated as well when determining which of the alternatives would ultimately be the most cost-effective.

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5. EG&G Energy Measurements Group. An Aerial Radiologic Survey of the Stepan Chemical Company and Surrounding Area, Maywood, New Jersey, NRC-8109, Oak Ridge, TN, September 1981.

6. Oak Ridge National Laboratory. Results of the Radiological Survey at 459 Davison Avenue, Maywood, New Jersey, Oak Ridge, TN, September 1981.

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14. U.S. Department of Energy. Design Criteria for Formerly Utilized Sites Remedial Action Program (FUSRAP) and Surplus Facilities Management Program (SFMP), 14501-00-DC-01, Rev. 2, Oak Ridge, TN, March 1986.

15. Letter, P. E. Neal, Bechtel National, Inc., to E. L. Keller, DOE Oak Ridge Operations Office. "Preliminary Evaluation of In-Situ Waste Storage, Maywood, New Jersey," CCN 24784, January 4, 1985.

16. Bechtel National, Inc. Report on Drilling and Well Installations at the Maywood Interim Storage Site, DOE/OR/20722-75, Oak Ridge, TN, October 1985.

17. Letter, R.L. Rudolph, Bechtel National, Inc., to E.L. Keller, DOE Oak Ridge Operations Office. "Maywood Site Order-of-Magnitude Cost Estimate for Stepan Warehouse No. 3," CCN 16817, January 20, 1984.

18. U.S. Nuclear Regulatory Commission. Final Environmental Statement on the Transportation of Radioactive Material by Air and Other Modes, NUREG 0170, Springfield, VA, December 1977.

APPENDIX A
RADIOLOGICAL GUIDELINES
FOR THE FINAL DISPOSITION OF THE MISS

APPENDIX A

RADIOLOGICAL GUIDELINES FOR THE FINAL DISPOSITION OF THE MISS

Table A-1 summarizes the current radiological guidelines for the MISS. This summary is drawn from the Design Criteria for Formerly Utilized Sites Remedial Action Program (FUSRAP) and Surplus Facilities Management Program (SFMP) Project, Rev. 1, prepared by the U.S. Department of Energy, Oak Ridge Operations Office, Oak Ridge, TN, and issued in September 1985.

TABLE A-1

RADIOLOGICAL GUIDELINES FOR THE FINAL DISPOSITION OF THE MISS

Subject	Guidelines	Source
Control of Wastes		
Longevity of waste containment area	Up to 1000 years to the extent reasonably achievable, but at least 200 years.	40 CFR 192.02[a]
Radon emissions from waste containment area	20 pCi/m^2/s or 0.5 pCi/l in air outside of the waste containment area	DOE Design Criteria[a] (Appendix C, Rev. 1)
Water Protection		
Surface water discharge (uncontrolled areas)	Uranium-238 - 600 pCi/l Radium-226 - 30 pCi/l Radium-228 - 30 pCi/l Thorium-230 - 2000 pCi/l Thorium-232 - 2000 pCi/l	DOE Order 5480.1A (Chapter XI) (Converted from µCi/ml)
In community water systems	Radium-226 and Radium-228 - 5 pCi/l	40 CFR 141.15[a]
Soil Decontamination		
adium-226 adium-228 Thorium-230 Thorium-232	5 pCi/g in the 15-cm surface layer[b] 15 pCi/g in any 15-cm layer beneath the surface layer	40 CFR 192.12[a] DOE Design Criteria[a,c]
Building Decontamination		
Indoor radon decay products	0.03 working level (WL) in any habitable area within the structure; to the extent practicable, achieve 0.02 WL	40 CFR 192.12[b]
Facilities/Equipment Surface Decontamination	0.2 mrad/h (average) 1.0 mrad/h (maximum)	NRC Guidelines[d]
Transport of Wastes		
Exposure rates	Not to exceed 10 mrad/h at a distance of 2 m (6 ft) from the vehicle side and 2 mrad/h at any normally occupied position.	49 CFR 173
Transport containers	For design and licensing	DOE Order 5480.1A (Chapter III) DOE Order 1540.1

TABLE A-1

(continued)

Page 2 of 2

Subject	Guidelines	Source
Waste Disposal Site		
Maintenance and surveillance[e]	Includes maintenance, surveillance, and environmental monitoring	DOE Order 5480.1A (Chapter XI)[f]

[a]U.S. Department of Energy. Design Criteria for Formerly Utilized Site Remedial Action Program (FUSRAP) and Surplus Facilities Management Program (SFMP), 14501-00-DC-01, Rev. 2, Oak Ridge Operations Office, Oak Ridge, TN, March 1986.

[b]Above background level.

[c]Keller, E. L. Letter, DOE Oak Ridge Operations Office, to R. L. Rudolph, Bechtel National, Inc., "Criteria for cleanup of sites contaminated with thorium and decay products," Oak Ridge, TN, July 10, 1984.

[d]U. S. Nuclear Regulatory Commission ,Division of Fuel Cycle and Material Safety. Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material, Washington, DC, 1982.

[e]Assumed to continue for the design life of the waste containment area.

[f]Although not specifically addressed, the need for maintenance and surveillance is implied.

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APPENDIX B

OPTIONS FOR REMOVAL OF RADIOACTIVE WASTE BURIED UNDER NEW JERSEY STATE ROUTE 17

APPENDIX B

REMOVAL OF RADIOACTIVE WASTE BURIED UNDER NEW JERSEY STATE ROUTE 17

Radioactive contamination has been tentatively identified under New Jersey State Route 17. Historical information and radiological measurements made in 1985 indicate that a layer of thorium contamination at least 2 to 4 ft thick is present under a section of Route 17 (approximately 150 ft wide by 900 ft long) between the MISS and Ballod properties. The contamination extends approximately from the New York, Susquehanna and Western Railroad line to near the Grove Avenue intersection with Route 17.

The contamination resulted from operations at the former Maywood Chemical Works; Route 17 was constructed in 1932 through an area in which several of the company's former process ponds were located.

Further radiological characterization is planned for early FY 1986 to accurately determine the limits of contamination. The current environmental monitoring program will be expanded in FY 1986 to generate data required for detailed environmental and engineering evaluations.

Several preliminary options for mitigating the potential effects of the radioactive contamination under Route 17 have been considered. These options are:

- Open cut Route 17 under one of the following conditions:
  - Redirect all Route 17 traffic onto local streets
  - Redirect all Route 17 traffic to a detour over MISS waste pile(s)
  - Redirect all Route 17 traffic to a detour adjacent to the present roadway
  - Redirect only two lanes of Route 17 at one time to a detour adjacent to the present roadway

- o Tunnel under Highway 17:
  - Jack pipes parallel with the roadbed through the layer of waste; excavate waste from within each pipe
  - Tunnel perpendicular to roadway through the layer of waste using conventional methods
- o Restrictive certification with in situ stabilization
- o Restrictive certification

Open Cut Options

Route 17 is recognized as a major north-south arterial transportation route. Open cutting of the embankment to remove underlying waste materials would be a major construction effort necessitating the diversion of Route 17 traffic for at least 14 construction months.

Diverting Route 17 traffic would be a major undertaking. It is estimated that the traffic volume is in the order of 30 to 40 thousand cars per day. Diverting such a volume onto local streets, although possible, would place a severe strain on local facilities and habits. Heavy deterioration of street pavements and utilities would be expected.

For the above reasons and since public acceptance of such a detour would be highly unlikely, diverting Route 17 traffic onto local streets is not recommended.

Diverting Route 17 traffic to a detour over the MISS waste pile(s) would entail construction of bridges over railroad spurs and mainline tracks, and embankments over buffer zones. Maintenance of detour alignments over tracks and waste piles with adequate safety zones to protect the integrity of the waste containment systems would contribute significantly to the cost of this option. Construction of the waste pile(s) in a timely manner to coincide with detour construction does not appear possible. Rerouting

Highway 17 traffic to detour over MISS waste piles is not recommended.

Constructing a detour immediately adjacent to Route 17 would maintain driving alignment and would facilitate exit and entry between the detour and highway. Two bridge crossings would be required over railroad spur and mainline tracks, and one culvert extension would be required. As proposed, the detour would be located on the east side of Route 17, as discussed below. Diverting traffic onto a detour on the west side of Route 17 would possibly require acquisition of residential/commercial (Ballod) property.

Diverting of only two lanes of Route 17 at any given time does not appear to yield any particular advantage.

Figures B-1 through B-3 depict open cutting of the Route 17 embankment with a detour immediately to the east. This approach would require that the wastes be excavated in two stages. First, the portion of Route 17 embankment that would support the detour would be excavated and the waste removed from beneath it. As proposed, the detour does not impinge upon the waste pile(s) on the MISS property. Once the detour was operational, the remaining Route 17 embankment could be excavated and the wastes removed from beneath it.

As the first stage in constructing the detour, soldier piles would be drilled or driven into place along the outside of the eastern edge of the existing pavement. The piles would be of sufficient length to permit excavation of the embankment and waste and still maintain the existing driving lanes. Once the piling was in place, excavation of the embankment east of the piles could commence. Lagging between the soldier piles would support the existing lanes of Route 17 as excavation progressed.

Bridges would be constructed over the main line of the New York, Susquehanna and Western Railroad and the spur serving the Sears

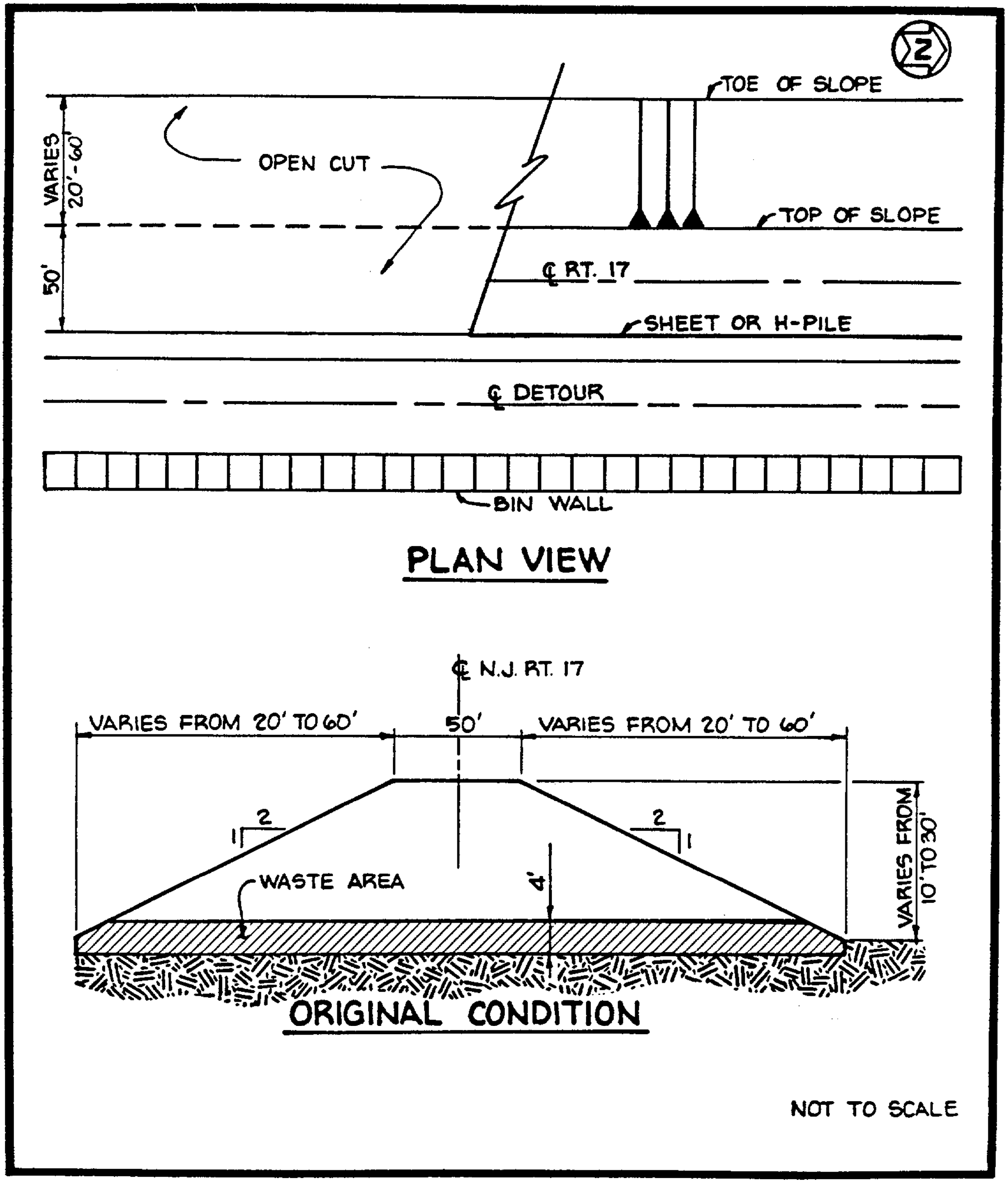

FIGURE B-1 REMOVAL OF RADIOACTIVE CONTAMINATION UNDER ROUTE 17 USING THE OPEN CUT METHOD

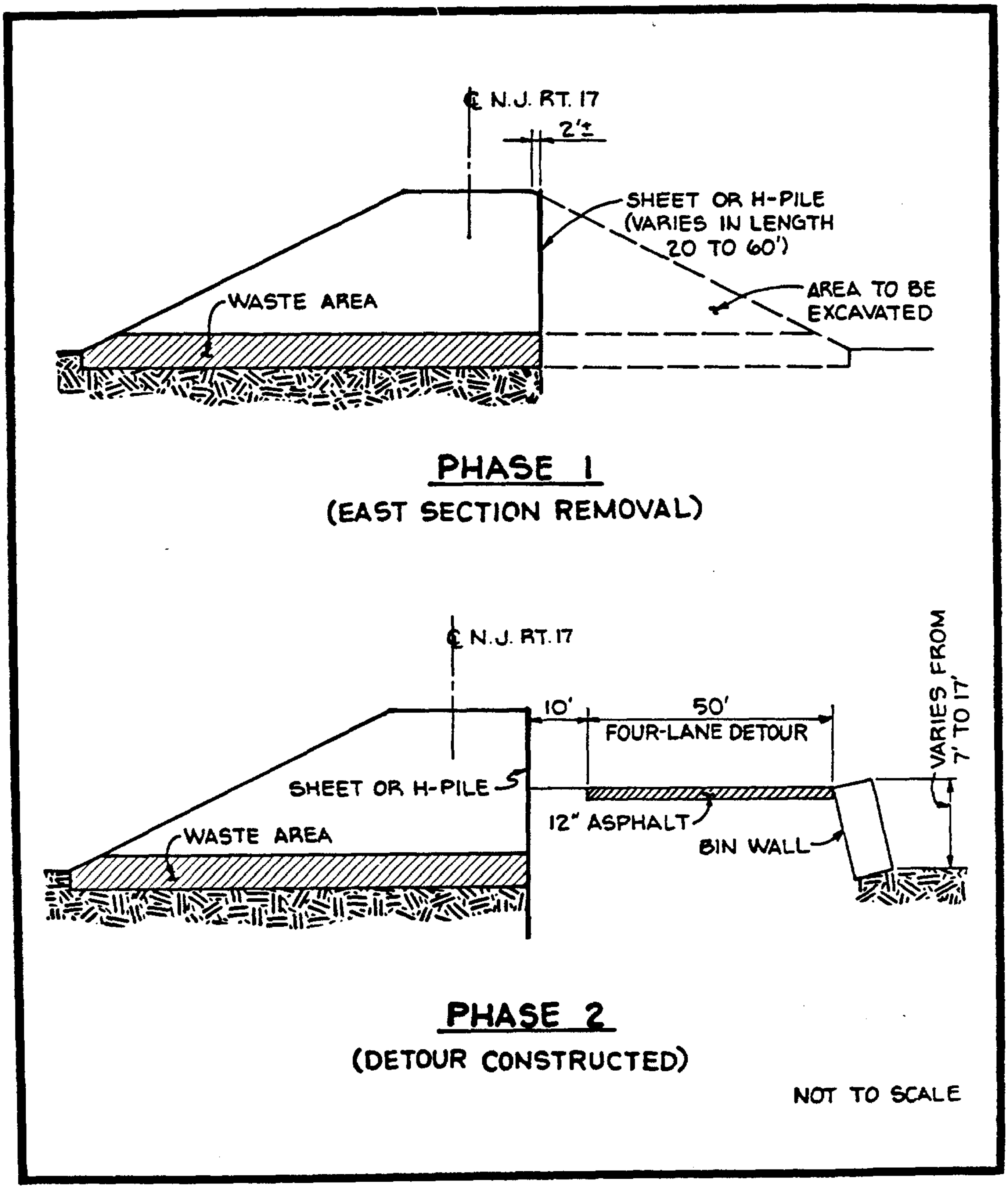

FIGURE B-2 REMOVAL OF RADIOACTIVE CONTAMINATION UNDER ROUTE 17 USING THE OPEN CUT METHOD

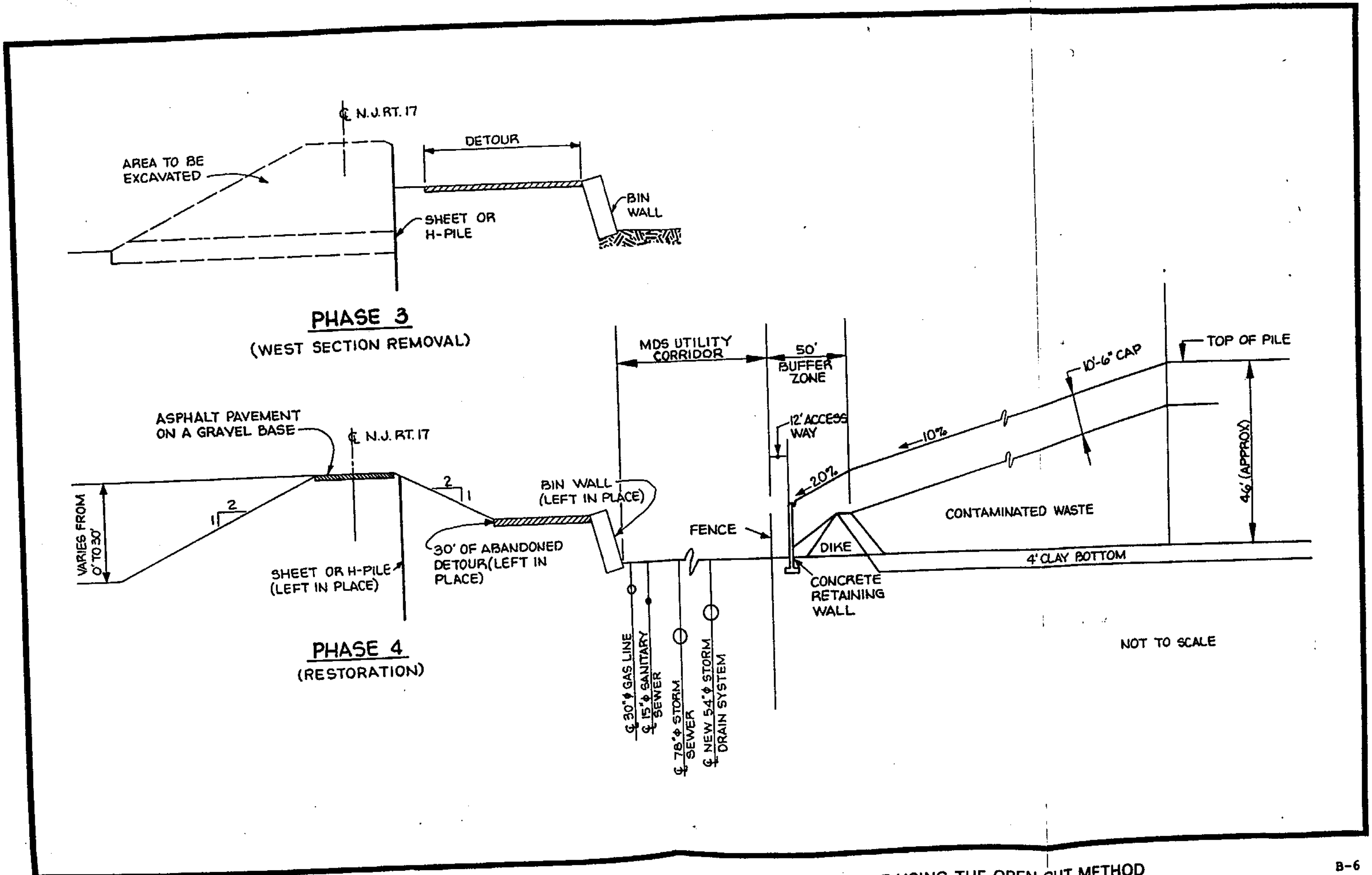

FIGURE B-3 REMOVAL OF RADIOACTIVE CONTAMINATION UNDER ROUTE 17 USING THE OPEN CUT METHOD

property. The bridge over the mainline railroad would allow for detour transition to the main highway.

Existing drainage structures would be lengthened to the east as required. Other utilities would not be modified because the detour would be used for a relatively short period.

Once the waste materials were removed, the embankment would be constructed to the grade of the detour and retained on the east side by a bin-type retaining wall. Pavement marking and signing would be installed.

Open cutting of the western embankment and removal of waste from beneath it would commence once the detour was operational. The western embankment would then be replaced and pavement replaced in the original alignment of Route 17.

Once traffic flow had been restored on Route 17, the detour would be removed to the extent practicable. Soldier piles and lagging would remain in place and the embankment would be finished to grade on the eastern side of Route 17.

Tunneling Options

Tunneling under Route 17 could be accomplished by pipe jacking and excavation or by basic tunneling methods.

Pipe jacking and excavation would involve a series of large-diameter parallel pipes jacked either parallel to or perpendicular to Route 17 and passing through the wastes beneath the embankment. Rectangular pipes would be used to minimize the volume of unexcavated wastes at the top and bottom of the contact zones between the pipes.

Pipe jacking excavation was rejected as a method of waste removal for the following reasons:

- The lubricating medium outside the pipes would spread the wastes and contaminate materials not now contaminated.
- Direct inspection of the excavation would not be possible since the excavation surface would always be covered by the jacked pipe.
- No method would be available to remove wastes in irregularities at the base of the excavation.
- A loss of ground would occur, causing pavement irregularities on Route 17.
- Special excavating equipment would be required with high one-of-a-kind fabrication costs.

Basic tunneling methods, shown in Figure B-4, use a series of abutting tunnels to remove the wastes from beneath the Route 17 embankment. This excavation method would permit removal of the wastes without traffic interruption or diversion. This method would also permit detailed inspection and scanning of the excavation base to ensure that waste in irregularities in the base of the excavation was fully removed.

The initial activity in the basic tunneling approach consists of the installation of a series of abutting steel pipes (crown spiles) transverse to the road alignment, 18 in. (minimum) above the top of the wastes and entirely through the embankment. The transverse pipes would be placed in a single - or an offset double layer; they would be in contact, or nearly so, and be side-by-side from the south end of the contaminated section of the embankment north to the existing railroad underpass. The pipes would be installed by auger and hydraulic jacking. Once the pipes were in place, each would be filled with concrete. The pipes would have a slight incline downward from the drilled end to facilitate concrete placement and to minimize voids in the concrete.

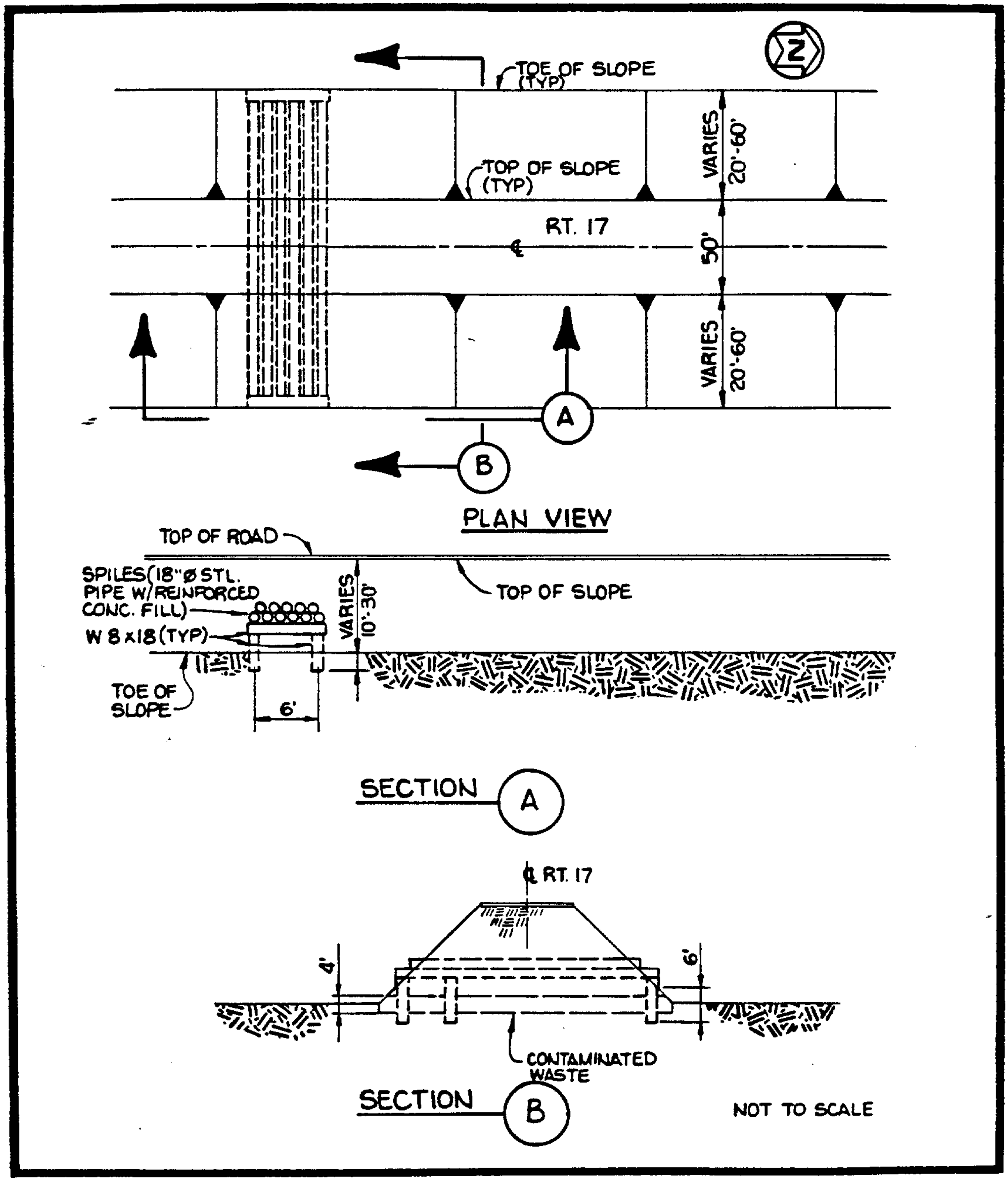

FIGURE B-4 REMOVAL OF RADIOACTIVE CONTAMINATION UNDER ROUTE 17 USING BASIC TUNNELING METHODS

The second stage of the tunnel excavation is the installation of steel posts and cross beams under the exposed ends of the pipes, beginning on one side of the roadway. The cross beams between posts would be perpendicular to the pipe alignment and span a distance of approximately 12 ft.

The third stage of excavation is the removal of the waste materials. The space between support posts (beam span distance) would be excavated using a tunnel tramming bucket loader if the embankment materials are loose and easily excavated. A compacted embankment would be excavated using a road header excavator with internal conveyor. A second conveyor (enclosed screw type) would transport the excavated materials to outside the embankment.

As the excavation face advanced, new posts and cross beams would be installed at intervals of 10 ft to support the crown spiles.

The fourth stage begins after two tunnel excavations have progressed entirely through the embankment and the wastes have been removed. Tight-fitting panels would be erected between the support posts, parallel with the direction of tunnel excavation, to isolate the first excavation.

Hydraulic sand fill, placed through a crown pipe, would be used to fill the excavation; the transport water would be decanted for reuse. The crown space above the top of the sand would be filled with sand/cement grout. The backfill operation would always lag the excavation by two panels.

Restrictive Certification Options

It would be possible to leave the waste under Route 17 and deed the embankment as a restricted area. If left in place, the waste could be stabilized. However, in situ stabilization does not prevent degradation of groundwater systems. Two techniques of stabilization were considered, but the nature of the waste materials and underlying strata preclude successful in situ stabilization in this instance. The two techniques considered were modification of the waste for immobilization and construction of a containment system to retain the waste.

Modification of the waste by injection of a stabilization agent such as grout is limited by the average particle size of the waste. The waste, described as equivalent to silt and fine sand in size, would not accept a cement grout. Therefore, only a chemical grout could be used. The life span of chemical grout is not known, but under certain conditions it is known to be limited to tens of years. No grouting agent is known that would be effective and have a suitably long life span (200-1000 years).

Construction of a containment system around the waste to prevent the migration of contaminants was also considered (see Figure B-5). The containment considered consisted of cutoff walls around the perimeter of the wastes. The walls would be socketed into the sound bedrock below, but unless all fractures in the rock that contact the contained area were sealed, the waste would continue to contribute to degradation of circulating groundwater. To minimize the degradation of groundwater by flow through the fractured bedrock, the groundwater would have to be continually pumped from within the contained area. The pumping would ensure that water flow through the rock fractures would always be toward the waste materials. The pumped water would require storage and/or treatment prior to discharge. The estimated volume of water to be pumped is 33.5 gpm for the first year and 31.6 gpm thereafter. Equipment in use during interim storage would be used for water treatment. Discharge of the effluent would be to the relocated storm sewer.

Given the disadvantages cited above, stabilization does not appear to be a totally effective approach to dealing with the waste under Route 17.

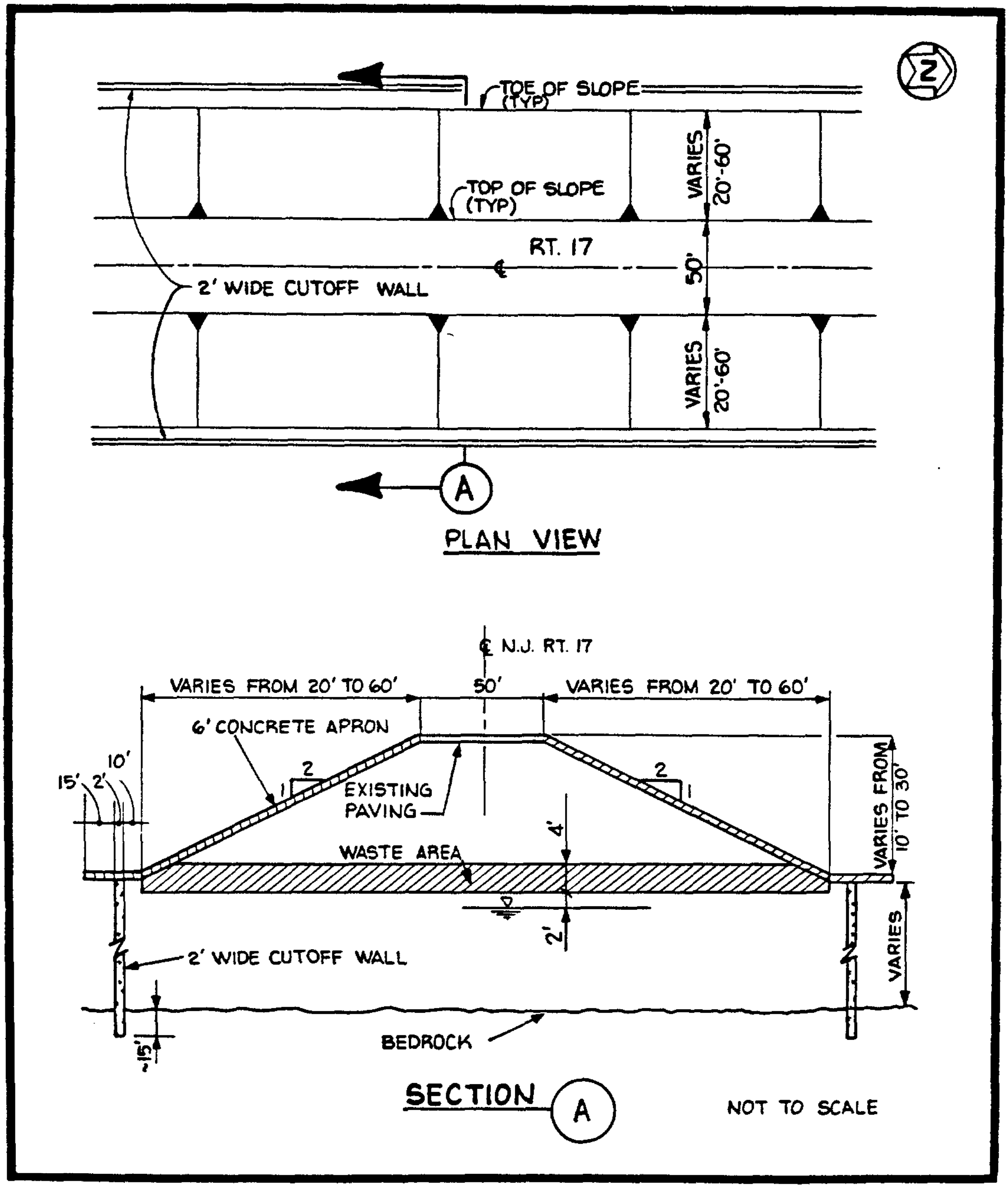

FIGURE B-5 CONTAINMENT OF RADIOACTIVE CONTAMINATION UNDER ROUTE 17 USING A CUTOFF WALL

The minimum action and least costly action that could be initiated with regard to the wastes buried under Route 17 would be to place restrictive certification on the affected property without taking action to stabilize the waste.

Comparison of Options

Of the options considered, open cutting the Route 17 embankment coincident with an adjacent detour would be the most cost-effective means of removing all the waste from under the highway. Costs for this option total $8.6 million in 1985 dollars.

Tunneling under Route 17 with basic tunneling methods would be the most costly approach to removing the waste. The cost estimate for this option is $33.4 million in 1985 dollars.

Stabilization of the waste with the use of cutoff walls would cost an estimated $6.0 million in 1985 dollars and would require an annual expenditure of $35,000 per year for 200 years.

Therefore, for the purposes of the cost comparison for Alternatives 1 and 2, the open cut option was assumed.

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APPENDIX C
QUANTITIES OF MATERIALS HANDLED
DURING FINAL DISPOSITON OPERATIONS

APPENDIX C

QUANTITIES OF MATERIALS HANDLED DURING FINAL DISPOSITION OPERATIONS

Table C-1 summarizes the quantities of materials assumed in developing cost estimates for the three disposition alternatives: [On-Site (Quasi-Passive Design) Above-Grade Disposal (Alternative 1), On-Site (Passive Design) Above-Grade Disposal (Alternative 2), and Transport to the NJDS (Alternative 3)].

TABLE C-1

MATERIALS FOR FINAL DISPOSITION OPERATIONS

Item	Unit	Alternative 1 Site Prep. (Year 1)	Phase 1 (Year 2)	Phase 2 (Year 3)	Phase 3 (Year 4)	Phase 4 (Year 5)
Waste Volume						
- Above Grade	yd^3		74,400	49,000	13,600	
- Below Grade	yd^3		17,600	30,000	65,400	
- Route 17	yd^3				6,500	13,500
Site Preparation						
- Washdown Facilities - Install	L.S.	x				
- Operate	L.S.	x	x	x	x	x
- Fencing - Remove	ft	3,000	x			
- Install	ft	5,000	x			
- Sanitary Sewer						
- Remove (15")	ft	1,120	x	x	x	
- Remove Miscellaneous	L.S.					
- Install (15")	ft	1,500				
- Storm Drain Installation (54")	ft	2,400	x	x	x	x
- 78"	ft	630				
- 12"-30"	L.S.	3,000	x	x	x	
- Remove 78"	ft	630				
- Remove Miscellaneous	L.S.					
- Runoff and Erosion Control						
- 4" Perforated Pipe	ft					6,180
- 6" Perforated Pipe	ft					
- Concrete Swale	ft					3,800
- Electrical Line						
- Remove	ft					
- Miscellaneous	L.S.					
- Railroad Spur						
- Remove	ft					
- Gas and Water						
- Remove	L.S.					
- Walks and Pavements						
- Remove	L.S.					
Demolition	L.S.					
Earthwork						
- Above-grade waste	yd^3		74,400	49,000	13,600	
- Below-grade waste	yd^3		17,600	30,000	65,400	

TABLE C-1

(continued)

Item	Unit	Alternative 1 Site Prep. (Year 1)	Phase 1 (Year 2)	Phase 2 (Year 3)	Phase 3 (Year 4)	Phase 4 (Year 5)
- NJ State Route 17	yd^3				48,700	114,500
- SC Site No. 3	L.S.				18,000	
- SC Site Nos. 1 and 2	yd^3			22,000		
- Backfill for Waste Excavation	yd^3		26,250	28,100	99,750	
- Excavation Below Waste Containment	yd^3		20,200	18,000	20,900	
Waste Containment Foundation						
- Clay Bottom	yd^3		19,000	16,700	18,500	
- Clay Dike	yd^3		10,400	16,300	18,500	
- Leak Monitoring System	yd^2		14,200	12,600	13,800	
Waste Containment Cap						
- Clay	yd^3		6,050	6,300	7,000	85,200
- Sand	yd^3					21,285
- Riprap	ton					100,080
- Topsoil	yd^3					32,340
- Seeding	yd^2				18,000	36,000
Concrete Vault	L.S.				x	
Retaining Wall	ft		700	1,100	1,250	
Railroad Spur Relocation (600 ft)						
- Strip 1' Depth	yd^3	70				
- Backfill	yd^3	1,500				
- Ballast	ton	750				
Local Road Repair	L.S.				x	
Extension to Facility						
- Relocate Reservoir and Pumphouse	L.S.				x	
- Retaining Wall						
- Containment Bottom, Dike, and Cap						

TABLE C-1

(continued)

Item	Unit	Alternative 1 Site Prep. (Year 1)	Phase 1 (Year 2)	Phase 2 (Year 3)	Phase 3 (Year 4)	Phase 4 (Year 5)
Railroad Spur Remove and Reinstall						
Use existing rail and ties	ft					400
Ballast	ton					650
Land Acquisition						
- SC Property	acres	5				
- Adjacent Property	acres					
Water Treatment						
- Surface Water	gal	53,000	125,000	129,000	218,000	53,000
- Groundwater (Waste Dewatering)	gal		29,000	131,000	1,262,000	
- Treatment System - Install	L.S.	x				
- Particulate Filter						
- Carbon Filter						
- Complex Resin Unit						
- Ion Exchange Unit						
- Holding Ponds (70,000 gal)						
- Operate	L.S.	x	x	x	x	x
- Remove	L.S.					x
Restoration						
- Topsoil	yd^3					4,900
- Seeding	acres					5.7
Environmental Monitoring						
- Construction	L.S.	x	x	x	x	x
- Post-Closure	L.S.					5 yrs
NJ Route 17						
- Open Cut Option	L.S.				x	x

TABLE C-1

(continued)

Item	Unit	Alternative 2 Site Prep. (Year 1)	Phase 1 (Year 2)	Phase 2 (Year 3)	Phase 3 (Year 4)	Phase 4 (Year 5)
Waste Volume						
- Above Grade	yd^3		40,100	45,700	51,200	
- Below Grade	yd^3		60,400	47,000	5,600	
- Route 17	yd^3			10,000	10,000	
Site Preparation						
- Washdown Facilities - Install	L.S.	x				
- Operate	L.S.	x	x	x	x	x
- Fencing - Remove	ft	6,800				
- Install	ft	6,750				
- Sanitary Sewer						
- Remove (15")	ft	1,120				
- Remove Miscellaneous	L.S.	x	x			
- Install (15")	ft	1,500				
- Storm Drain Installation (54")	ft	2,400				
- 78"		630				
- 12"-30"	L.S.	4,800	x	x	x	
- Remove 78"	ft	630				
- Remove Miscellaneous	L.S.	x	x			
- Runoff and Erosion Control						
- 4" Perforated Pipe	ft					
- 6" Perforated Pipe	ft				3,500	1,500
- Concrete Swale	ft					
- Electric Line						
- Remove	ft	450				
- Miscellaneous	L.S.	x	x			
- Railroad Spur						
- Remove	ft	1,900				
- Gas & Water						
- Remove	L.S.	x	x			
- Walks & Pavements						
- Remove	L.S.	x	x			
Demolition	L.S.	x	x (165,000 ft^2)			

TABLE C-1

(continued)

Item	Unit	Alternative 2: Site Prep. (Year 1)	Phase 1 (Year 2)	Phase 2 (Year 3)	Phase 3 (Year 4)	Phase 4 (Year 5)
Earthwork						
- Above-grade waste	yd^3		40,100	45,700	51,200	
- Below-grade waste	yd^3		60,400	47,000	5,600	
- NJ State Route 17	yd^3			48,700	114,500	
- SC Site No. 3	L.S.		18,000			
- SC Site Nos. 1 and 2	yd^3		17,000	5,000		
- Backfill for Waste Excavation	yd^3		66,500	51,700	6,200	
- Excavation Containment	yd^3		18,000	17,000	15,000	
Waste Containment Foundation						
- Clay Bottom	yd^3		40,000	35,000	26,700	
- Clay Dike	yd^3		2,700	2,700	2,600	
- Leak Monitoring System	yd^2		26,000	26,000	24,300	
Waste Containment Cap						
- Clay	yd^3		28,000	28,000	13,000	133,700
- Sand	yd^3					40,600
- Riprap	ton					238,000
- Topsoil	yd^3					68,800
- Seeding	yd^2					110,400
Concrete Vault	L.S.				x	
Retaining Wall	ft					
Railroad Spur Relocation (600 ft)						
- Strip 1' Depth	yd^3					
- Backfill	yd^3					
- Ballast	ton					
Local Road Repair	L.S.					x
Extension to Facility						
- Relocate Reservoir and Pumphouse	L.S.					
- Retaining Wall						
- Containment Bottom, Dike, and Cap						

TABLE C-1

(continued)

Item	Unit	Alternative 2 Site Prep. (Year 1)	Phase 1 (Year 2)	Phase 2 (Year 3)	Phase 3 (Year 4)	Phase 4 (Year 5)
Railroad Spur Remove and Reinstall						
Use existing rail and ties	ft					400
Ballast	ton					650
Land Acquisition						
- SC Property	acres	19				
- Adjacent Property	acres	0.5				
Water Treatment						
- Surface Water	gal	103,000	175,000	179,000	268,000	103,000
- Groundwater (Waste Dewatering)	gal		100,000	250,000	400,000	672,000
- Treatment System - Install	L.S.					
- Particulate Filter						
- Carbon Filter						
- Complex Resin Unit						
- Ion Exchange Unit						
- Holding Ponds (70,000 gal)						
- Operate	L.S.	x	x	x	x	x
- Remove	L.S.					x
Restoration						
- Topsoil	yd^3					7,100
- Seeding	acres					8.4
Environmental Monitoring						
- Construction	L.S.	x	x	x	x	x
- Post-Closure	L.S.					5 yrs
NJ Route 17						
- Open Cut Option	L.S.			x	x	

TABLE C-1

(continued)

Item	Unit	Alternative 3 Phase 1 (Year 1)	Phase 2 (Year 2)	Phase 3 (Year 3)	Phase 4 (Year 4)	Phase 5 (Year 5)
Waste Volume						
- Above Grade	yd^3	65,500	62,500	9,000		
- Below Grade	yd^3			55,900	57,100	
- Route 17	yd^3				6,500	13,500
Site Preparation						
- Washdown Facilities - Install	L.S.	x				
- Operate	L.S.	x	x	x	x	x
- Fencing - Remove	ft	x		325		
- Install	ft	x		325		
- Sanitary Sewer						
- Remove (15")	ft			200		
- Remove Miscellaneous	L.S.					
- Install (15")	ft			200		
- Storm Drain Installation (54")	ft					
- 78"	ft					
- 12"-30"	L.S.					
- Remove 78"	ft					
- Remove Miscellaneous	L.S.					
- Runoff and Erosion Control						
- 4" Perforated Pipe	ft					
- 6" Perforated Pipe	ft					
- Concrete Swale	ft					
- Electrical Line						
- Remove	ft					
- Miscellaneous	L.S.					
- Railroad Spur						
- Remove	ft					
- Gas & Water						
- Remove	L.S.					
- Walks & Pavements						
- Remove	L.S.					
Demolition	L.S.					
Earthwork						
- Above-grade waste	yd^3					
- Below-grade waste	yd^3					

TABLE C-1

(continued)

Item	Unit	Alternative 3 Phase 1 (Year 1)	Phase 2 (Year 2)	Phase 3 (Year 3)	Phase 4 (Year 4)	Phase 5 (Year 5)
- NJ State Route 17	yd^3				48,700	114,500
- SC Site No. 3	L.S.				18,000	
- SC Site Nos. 1 and 2	yd^3				22,000	
- Backfill for Waste Excavation	yd^3					
- Excavation Below Waste Containment	yd^3					
Waste Containment Foundation						
- Clay Bottom	yd^3					
- Clay Dike	yd^3					
- Leak Monitoring System	yd^2					
Waste Containment Cap						
- Clay	yd^3					
- Sand	yd^3					
- Riprap	ton					
- Topsoil	yd^3					
- Seeding	yd^2					
Concrete Vault	L.S.					
Retaining Wall	ft.					
Railroad Spur Relocation (600 ft)						
- Strip 1' Depth	yd^3					
- Backfill	yd^3					
- Ballast	ton					
Local Road Repair	L.S.					
Extension to Facility						
- Relocate Reservoir and Pumphouse	L.S.					
- Retaining Wall						
- Containment Bottom, Dike, and Cap						

TABLE C-1

(continued)

Item	Unit	Alternative 3 Phase 1 (Year 1)	Phase 2 (Year 2)	Phase 3 (Year 3)	Phase 4 (Year 4)	Phase 5 (Year 5)
Railroad Spur Remove and Reinstall						
Use existing rail and ties	ft				400	
Ballast	ton				650	
Land Acquisition						
- SC Property	acres					
- Adjacent Property	acres					
Water Treatment						
- Surface Water	gal	53,000	53,000	53,000	209,000	209,000
- Groundwater (Waste Dewatering)	gal				341,000	1,081,000
- Treatment System - Install	L.S.	x				
- Particulate Filter						
- Carbon Filter						
- Complex Resin Unit						
- Ion Exchange Unit						
- Holding Ponds (70,000 gal)						
- Operate	L.S.	x	x	x	x	x
- Remove	L.S.					x
Restoration						
- Topsoil	yd^3					10,000
- Seeding	acres					11.7
Environmental Monitoring						
- Construction	L.S.	x	x	x	x	x
- Post-Closure	L.S.					
NJ Route 17						
- Open Cut Option	L.S.				x	x

x - Required in designated construction year.