DOE/OR/20722-25

Formerly Utilized Sites Remedial Action Program (FUSRAP)
Contract No. DE-AC05-81OR20722

ENVIRONMENTAL MONITORING PLAN FOR THE MAYWOOD SITE

Maywood, New Jersey

September 1984

Bechtel National, Inc.
Advanced Technology Division

21888

LEGAL NOTICE

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SEP 5 1984

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Attention: E. L. Keller, Director
Technical Services Division

Subject: Bechtel Job No. 14501, FUSRAP Project
DOE Contract No. DE-AC05-81OR20722
Environmental Monitoring Plan for the Maywood Site
DOE/OR/20722-25
File No. 138, 148

Dear Mr. Keller:

Enclosed are 25 copies of the subject document, which incorporates comments received from DOE. Comments were also received from ANL. They have been reviewed and field activities will be responsive where appropriate, but no changes to the document are deemed necessary for the reasons cited in the attached comment resolution list.

Very truly yours,

Robert L. Rudolph
Project Director - FUSRAP

JMH:jm
Enclosures: As Stated

cc: J. Eastman, DOE/OR

Received by
SEP 4 1984
FUSRAP PDCC

CONCURRENCE

7538A

COMMENT RESOLUTION LIST

ENVIRONMENTAL MONITORING PLAN FOR THE MAYWOOD SITE*

Comment	Response
1	Figure 4-5, Proposed Groundwater Monitoring Locations at the MISS, does not depict the final size and shape of the storage pile area, which will ultimately be extended into the area in which ANL suggests that an additional pair of wells be located. It is, therefore, not considered appropriate to indicate wells in this area at this time. The locations of monitoring wells shown in the figure are not finalized; exact locations will be determined in FY 85 prior to well installation and in accordance with anticipated storage pile extensions.
2	The Instruction Guides for the Observation Well Monitoring Program for the site will address the issues raised in this comment. Pump or slug tests are a standard item in the BNI specifications issued to well drilling subcontractors.
3	The environmental monitoring program provides for the inclusion of those nonradioactive contaminants found to exceed guidelines in the regular monitoring activities.

*The Environmental Monitoring Plan for the Wayne Site was issued in final form on August 14. The comments received from ANL on this document have been reviewed and do not affect its contents. Field activities will be responsive where appropriate.

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DOE/OR/20722-25

ENVIRONMENTAL MONITORING PLAN

FOR THE

MAYWOOD SITE

SEPTEMBER 1984

Prepared for

UNITED STATES DEPARTMENT OF ENERGY

OAK RIDGE OPERATIONS OFFICE

Under Contract No. DE-AC05-81OR20722

By

Bechtel National, Inc.

Advanced Technology Division

Oak Ridge, Tennessee

Bechtel Job No. 14501

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1.0 INTRODUCTION

The Maywood Interim Storage Site (MISS) is located in Maywood, New Jersey, a highly urbanized area approximately 19 km (12 mi) north-northwest of downtown Manhattan (New York City), 21 km (13 mi) northeast of Newark, New Jersey, and 8 km (5 mi) east of Paterson, New Jersey (Figure 1-1). The MISS is on the Stepan Company (SC) (formerly the Maywood Chemical Works) property bounded by State Route 17 on the west; the New York, Susquehanna and Western railroad line on the north and east; and commercial/industrial areas on the south. The U.S. Department of Energy (DOE) will acquire 3.5 ha (8.7 acres) of the approximately 12-ha (30-acre) Stepan property for development of the MISS for interim storage of low-level radioactive materials (Figure 1-2).

These materials originated from the processing of monazite sand (thorium ore) at the Maywood Chemical Works for use in the manufacture of gas mantles. Recent radiological characterization of the former plant site indicated that thorium, uranium, and several of their daughter products are the principal contaminants in soil samples (Ref. 1). Several other properties in the Borough of Maywood and adjacent Rochelle Park Township have also been contaminated as a result of previous operations at the plant.

As part of the research and development project authorized by Congress under the 1984 Energy and Water Appropriations Act, Bechtel National, Inc. (BNI) will carry out remedial action at several of these vicinity properties under contract to DOE. The work will be conducted as part of the Formerly Utilized Sites Remedial Action Program (FUSRAP) administered by DOE. Contaminated material removed from these properties will be stored at the MISS until such time as a decision is made regarding their permanent disposition.

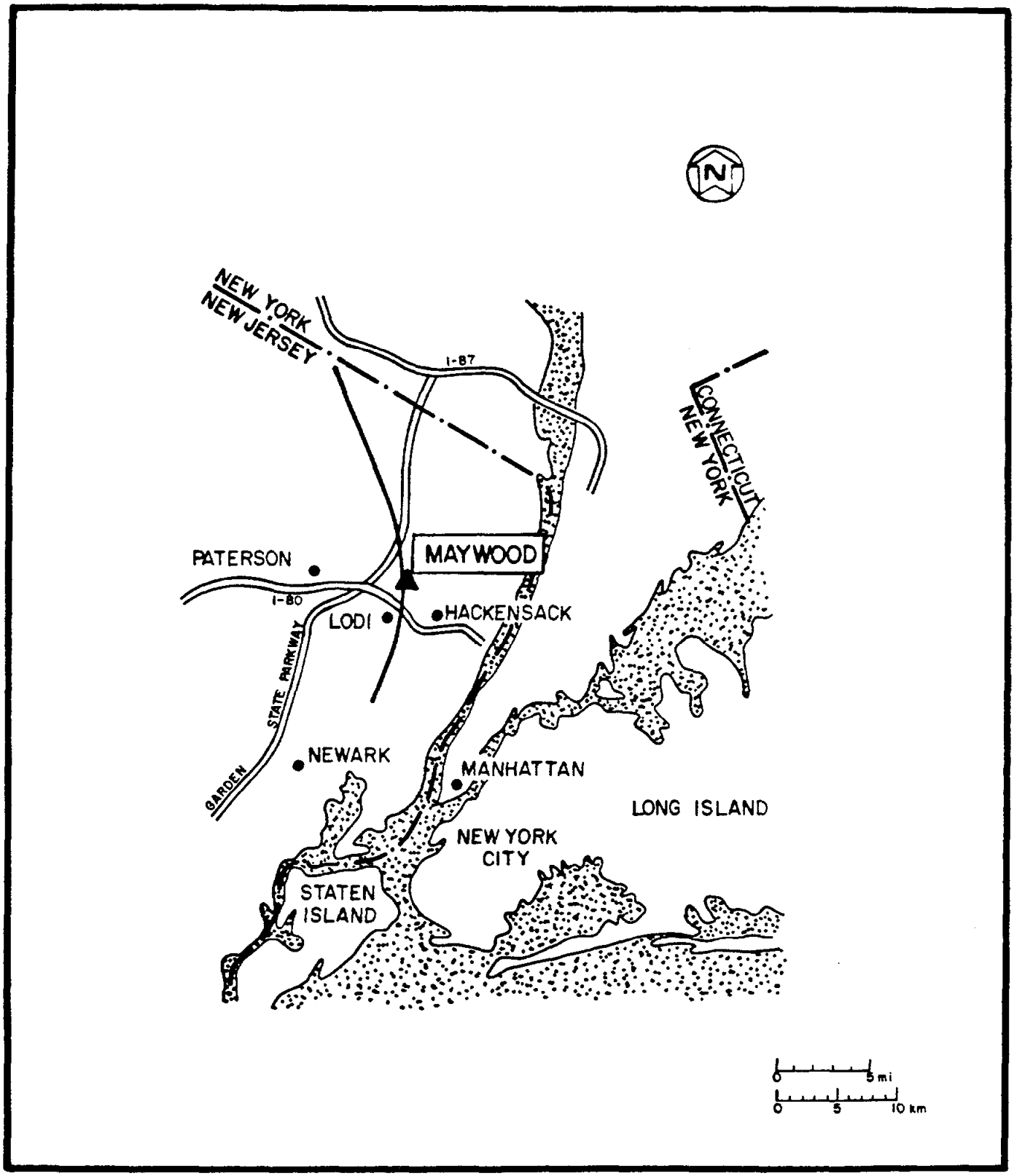

FIGURE 1-1 LOCATION OF MAYWOOD, NEW JERSEY

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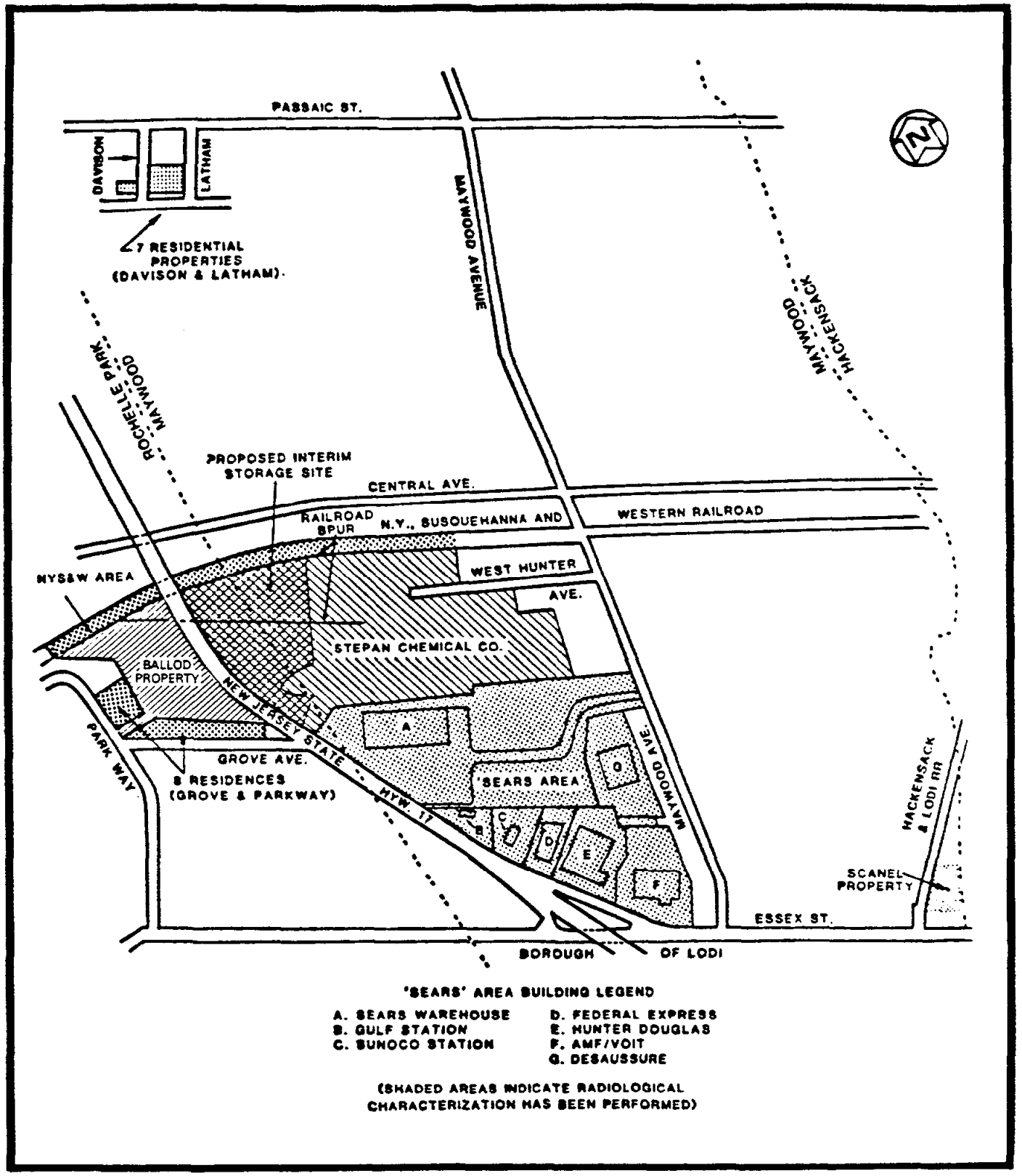

FIGURE 1-2 LOCATION OF THE MISS AND CONTAMINATED VICINITY PROPERTIES

Remedial actions at the MISS are designed and will be implemented to control radioactive and nonradioactive contaminants at the site. BNI will conduct an environmental surveillance monitoring program during the interim storage period. The primary purpose of this monitoring program is to ensure protection of public health and safety and the environment.

This document describes the surveillance monitoring program, which consists of monitoring at routine intervals for contaminants in air, surface water, sediments, and groundwater. External gamma radiation monitoring will also be conducted. The monitoring results will be compared with applicable regulatory guidelines. If there is evidence of new or increased off-site migration of contaminants, additional remedial action and sampling may be warranted. A construction monitoring program to ensure worker health and safety will be conducted for specific remedial action activities and is not addressed in detail in this document.

2.0 SITE DESCRIPTION

2.1 BACKGROUND

The Maywood Chemical Works was founded in 1895; from 1916 through 1956 monazite sand (thorium ore) was processed there for use in the manufacture of gas mantles for various lighting devices. During this time, processed wastes from the operations were pumped to diked areas west of the plant. Additional material was placed in two piles surrounded by earthen dikes (Ref. 2). In 1932, Route 17 was built through this disposal area. Thorium processing ceased in 1956 and the Maywood Chemical Works was sold to the Stepan Chemical Company -- now known as the Stepan Company (SC) -- in 1959.

In 1963, residues and tailings from the property to the west of New Jersey State Route 17 were partially stabilized. From 1966 to 1968, SC removed about 15,000 m^3 (19,000 yd^3) of radioactively contaminated wastes from that area to three burial sites on the main SC property. At the request of SC, a radiological survey of the area west of Route 17 was made by the U.S. Atomic Energy Commission in 1968. Based on the findings of that survey, clearance was granted for release of the property for unrestricted use. Late in 1968, SC sold 3.5 ha (8.7 acres) of property west of Route 17 to Mr. A. Baresi, who in turn sold it to Ballod Associates in the late 1970s (Ref. 2).

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 conditions on the property (Ref. 2). In addition, the NRC requested that an aerial radiological survey be conducted of the SC site, the Ballod Associates property, and the surrounding area. During this survey readings distinctly higher than those of surrounding areas were noted (Ref. 3). Gamma readings higher than local

background were detected over the SC plant and immediately to the west and south of it. In addition, elevated readings were detected approximately 0.8 km (0.5 mi) to the northeast of the center of the plant. The latter emanated from process wastes removed from the Maywood Chemical Works in 1928 for use as mulch and fill on nearby properties. The fill material included thorium processing wastes. Between 1944 and 1946 truckloads of fill were again removed from the plant and deposited at 464 Davison Street (then a vacant lot), primarily for fill in a ditch that traversed the back of several lots between Davison and Latham Streets (Figure 1-2). Several local residents used the material dumped at 464 Davison street in their gardens. The lot at 464 Davison street was subsequently sold, and a house was built on it in 1967 (Ref. 4). Contaminated material from these properties will be removed and transported to the MISS.

In 1984, DOE negotiated a lease from SC of 3.5 ha (8.7 acres) on which to establish the MISS (Figure 1-2) pending execution of an agreement with SC to donate the site to DOE. The location of the proposed storage pile is shown in Figure 1-3. The contaminated soils will be stored until such time as a decision is made regarding their final disposition.

2.2 CONTAMINATION AT THE MISS

The former Maywood Chemical Works is listed as a Superfund site by the U.S. Environmental Protection Agency (EPA) (number 129 on the national Superfund priority list) and by the State of New Jersey (number 24 in the state) (Ref. 5). Currently a Memorandum of Understanding (MOU) is being negotiated between the EPA and DOE regarding Superfund sites that are either partially or wholly under DOE jurisdiction for remedial action (Ref. 6). It is assumed for this monitoring plan that DOE guidelines specified in Table 2-1 will be followed when monitoring external gamma radiation and contaminant concentrations in air, water, and sediment at the MISS. These guidelines may be modified once the MOU is finalized.

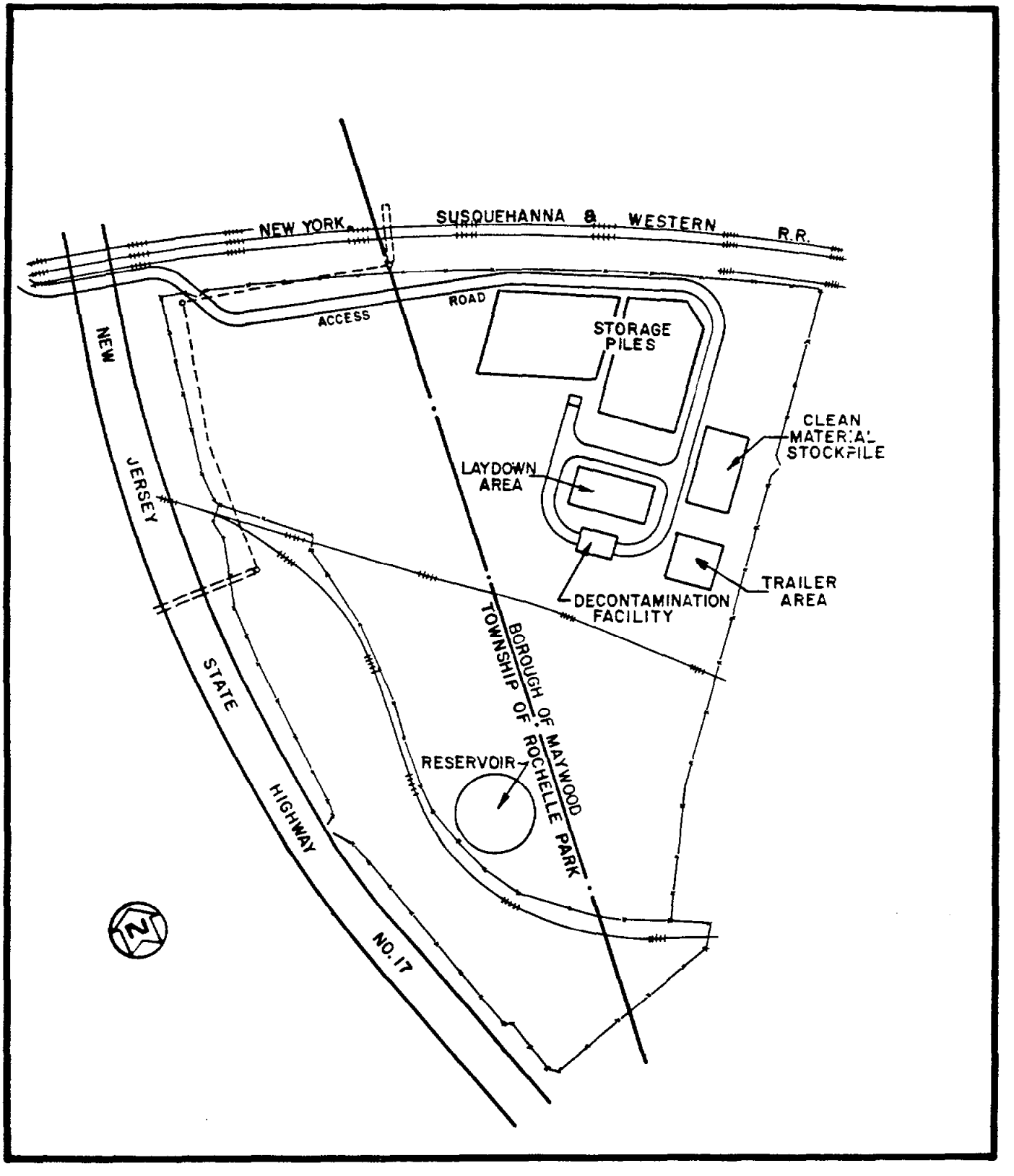

FIGURE 1-3 PROPOSED STORAGE PILE AT THE MISS

TABLE 2-1

CONTAMINANT GUIDELINES

Mode of Exposure/ Contaminant	Guideline/ Standard	Source	Description
Air			
Radon-222	3.0 pCi/l	DOE Order 5480.1A	Maximum permissible concentrations above background for uncontrolled areas
Radon-220(Thoron)	10.0 pCi/l		
Surface Water and Groundwater			
Uranium-238	600 pCi/l	DOE Order 5480.1A	Maximum permissible concentrations above background in water released to uncontrolled areas
Thorium-232	2000 pCi/l	DOE Order 5480.1A	
Thorium-228	7000 pCi/l	DOE Order 5480.1A	
Radium-226	30 pCi/l	DOE Order 5480.1A	
Radium-226/228	5 pCi/l	EPA, 1983	Primary drinking water standard (40 CFR 141)
Sediment and Soil[1]			
Natural Uranium	75 pCi/g	U.S. Department of Energy Interim Planning Guidelines and Criteria for Residual Radioactive Materials at Formerly Utilized Sites Remedial Action Program (FUSRAP) and Remote Surplus Facilities Management Program (SFMP) Sites	Maximum limits above background for unrestricted use
Uranium-238	150 pCi/g		
Thorium-232[2]	5/15 pCi/g		
Radium-226[2]	5/15 pCi/g		
External Radiation			
Gamma Dose Rate	500 mrem/yr (60 μrem/h)	DOE Order 5480.1A	Radiation protection standards for external exposure of individuals in the public

TABLE 2-1

(continued)

Mode of Exposure/ Contaminant	Guideline/ Standard	Source	Description
Structures			
Indoor Radon Decay Products			
For radon-222 and radon-220 concentrations in buildings, the average annual radon decay product concentration (including background) due to uranium or thorium byproducts should not exceed 0.02 working level (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 that exceeds an annual average radon decay product concentration (including background) of 0.03 WL.	U.S. Department of of Energy Interim Planning Guidelines and Criteria for Residual Radioactive Materials at Formerly Utilized Sites Remedial Action Program (FUSRAP) and Remote Surplus Facilities Management Program (SFMP) Sites	Maximum permissible concentrations above background for unrestricted use	
Indoor Gamma Radiation			
The indoor gamma radiation after decontamination shall not exceed 20 microroentgens per hour (20 μR/h) above background in any occupied or habitable building.			

[1]Guidelines for sediment are assumed to be the same as those for soil.

[2]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.

2.2.1 Radioactive

To locate near-surface deposits of radioactive material at the MISS gamma radiation measurements were conducted during previous radiological surveys (Ref. 1). The radiation is associated with residue deposits from earlier monazite processing. Although the residues contain primarily thorium-232 and its decay products, uranium-238 and its decay products as well as certain rare earth elements may also be present in the residues (Ref. 7).

Elevated gamma exposure rates ranging from 10 to 46 μR/h were observed in the southwestern portion of the MISS between Route 17 and the rail spur paralleling it, along a dike adjacent the rail spur leading into the plant, in an area in the northwestern quadrant of the MISS, and along part of the northern fence boundary. These areas are shown in Figure 2-1. Readings along the fenceline surrounding the MISS did not exceed 200 μR/h and in most locations were much lower (Ref. 1).

Thorium-232 levels exceeding the guideline given in Table 2-1 were observed at the MISS. Maximum concentrations in the southern portion of the MISS ranged from about 170 to 700 pCi/g in near-surface soil samples. Concentrations decreased to 5 pCi/g or less at depths of 1 to 2 m (4 to 6 ft). Maximum thorium-232 levels in the northern portion of the MISS were found at depths between 0 and 2 m (6 ft). They were generally less than 200 pCi/g except for a peak concentration of 3,000 pCi/g at 1.1 m (3.5 ft) deep in one location. Thorium sludge was once retained in the northeastern portion of the MISS in a pile surrounded by earthen dikes. The pile has been removed and the ground covered with earth fill. Peak thorium-232 concentrations ranging from about 10 to 2,000 pCi/g were observed between 0.6 and 2.4 m (2 and 8 ft) deep in this area.

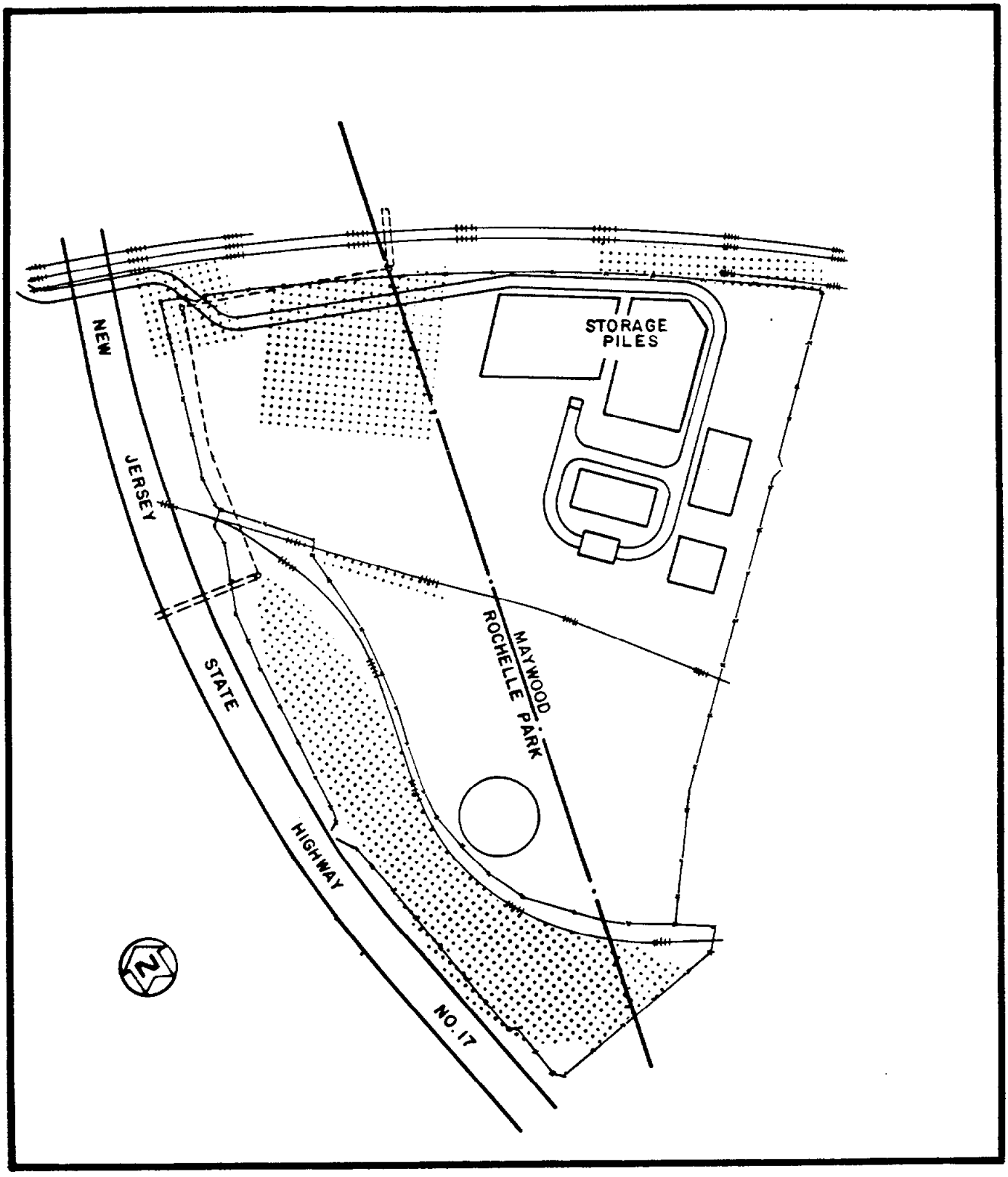

FIGURE 2-1 APPROXIMATE LOCATION OF CONTAMINATED AREAS AT THE MISS

Reported uranium-238 and radium-226 concentrations at the MISS ranged from 0.7 to 71 pCi/g and 0.3 to 31 pCi/g, respectively (Ref. 1). The higher concentrations were found in the southern portion of the MISS.

Thorium-232, uranium-238, and radium-226 surface soil contamination and gamma dose rates exceeding the guidelines presented in Table 2-1 are present on the vicinity properties scheduled for remedial action. Estimated volumes of contaminated materials to be stored at the MISS from vicinity property cleanup are 2,400 m^3 (3,100 yd^3) for 1984, 47,600 m^3 (62,200 yd^3) for 1985 and 1986, and 86,400 m^3 (113,000 yd^3) beyond 1986 (Ref. 8). The amount of contaminated material currently buried on the MISS is approximately 49,000 m^3 (64,000 yd^3).

Several municipal wells in the adjoining Borough of Lodi are located downgradient southwest of the MISS and the burial grounds on the SC property. One of these wells, the "Home Place" well [about 3.2 km (2 mi) southwest of the site], has elevated levels of radioactivity. The gross alpha concentration in water from this well was 58.7 and 130.9 pCi/l in September and December 1983, respectively. Gross alpha concentrations in five other wells in the vicinity ranged from 4.76 to 12.4 pCi/l (Ref. 9). Samples collected in 1981 from two upgradient domestic wells showed concentrations of gross alpha (1.2 - 2.0 pCi/l) (Ref. 10).

It is not known whether the elevated levels of radioactivity in the Lodi wells result from leaching of radioactive contaminants from the buried wastes on the SC property, from leaching of contaminated soils on the MISS and Ballod property, or from natural sources. The New Jersey Department of Environmental Protection (NJDEP) has proposed a monitoring program with recommended well locations to study this situation (Ref. 11). DOE is assisting NJDEP in this effort. DOE will perform a

mobile scan of the Lodi area to try to locate other areas of contamination and will participate in the sampling and analysis of water from existing wells in the Lodi/Maywood area. Results from previous analyses indicate that natural uranium is the radionuclide responsible for the elevated gross alpha levels observed.

2.2.2 Nonradioactive

The MISS area has not been characterized for hazardous chemicals. However, residues from the processing of monazite sand may contain rare earth and other heavy metals normally found with thorium ores. The metallurgical extraction of monazite concentrates for producing mantle grade thorium usually consists of digestion with sulfuric acid. The resultant mass is diluted with water which dissolves the thorium, uranium, and rare earths, leaving unreacted monazite, silica, rutile (TiO_2), and zirconium silicate ($ZrSiO_4$). Neutralization of the liquid precipitates thorium phosphate, leaving uranium and most of the rare earths in solution (Ref. 7). Therefore heavy metals (e.g., tin and zirconium) and selected rare earth metals (including cerium, lanthanum, and ytterbium) may be significant in the residues.

The Maywood Chemical Works also manufactured various lithium compounds, especially lithium hydroxide and lithium chloride (Ref. 12). The lithium wastes were disposed of primarily in the northwest portion of the MISS.

3.0 SITE ENVIRONMENT

3.1 GEOLOGY AND HYDROLOGY

The MISS and vicinity properties are located within the glaciated section of the Piedmont Plateau of north-central New Jersey. The terrain is generally level, with shallow ditches and slight mounds (Ref. 2). The MISS slopes gently toward the Saddle River, located west of the site. It is underlain by the sedimentary sandstone, mudstone, and siltstone of the Brunswick Formation (Refs. 1 and 13). The bedrock lies close to the surface and is overlain by 0.9 to 4.6 m (3 to 15 ft) of weathered bedrock and unconsolidated glacial deposits of clay, silt, sand, and gravel. The depth of the glacial deposits varies considerably in the vicinity of the site. In addition, fill materials were placed on the site during its many years of industrial use (Ref. 1).

Groundwater in the Maywood area is available primarily from a bedrock aquifer and from unconsolidated surficial deposits. The bedrock aquifer within the Brunswick Formation is generally considered to be the more significant groundwater resource. Industrial and municipal wells with depths of 92 m (300 ft) or more can produce flows as high as 32 l/s (500 gpm) from the Brunswick aquifer (Ref. 1). Wells drawing from the unconsolidated surficial deposits usually have low yields and are used for domestic purposes. However, some high-yielding wells have been developed for industrial and public use in the thicker surficial deposits of stratified glacial drift.

The groundwater gradient is low at the site and the water table is generally shallow--within 2.1 to 3.0 m (7 to 10 ft) of the surface (Ref. 1). The near-surface aquifer in the unconsolidated glacial materials is interconnected with the lower Brunswick aquifer (Ref. 9). The groundwater flows

southwest through the bedrock along fractures that tend to be most developed along the northeast-southwest strike of the Brunswick Formation (Ref. 9).

The MISS is located within the Saddle River drainage basin (Figure 3-1) about 0.8 km (0.5 mi) east of the Saddle River (a tributary of the Passaic River) and about 1.6 km (1 mi) west of the drainage divide of the Hackensack River basin (Ref. 1). At the Lodi gauging station, located approximately 1.3 km (0.8 mi) southwest of the site (Figure 3-1), the Saddle River has a drainage area of about 140 km^2 (55 mi^2). Based on 59 years (1923-1982) of flow data at the Lodi station, the minimum daily flow is 0.17 m^3/s (6.0 ft^3s), the maximum flow is 130 m^3/s (4,500 ft^3/s), and the mean flow is 2.8 m^3/s (100 ft^3/s) (Ref. 14). The MISS is not located in the 100-year floodplain of the Saddle River (Ref. 15).

Surface water runoff leaves the site via Westerley Brook and overland flow. Westerley Brook enters the MISS near the Maywood-Rochelle Park boundary (Figure 3-1). At this point it enters a corrugated metal pipe, which is covered with 0.6 to 1.5 m (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 about 200 m (655 ft) west of the Ballod property (Ref. 2). It eventually flows into the Saddle River. Both the MISS and the Ballod property are poorly drained, as indicated by abundant stands of reed (Phragmites communis). Neither the Saddle River nor Westerley Brook are used for drinking water (Ref. 16).

3.2 METEOROLOGY

New Jersey averages about 120 days of precipitation per year, and the mean annual precipitation is approximately 120 cm (48 in.). August is the wettest month, with an average of 12 cm

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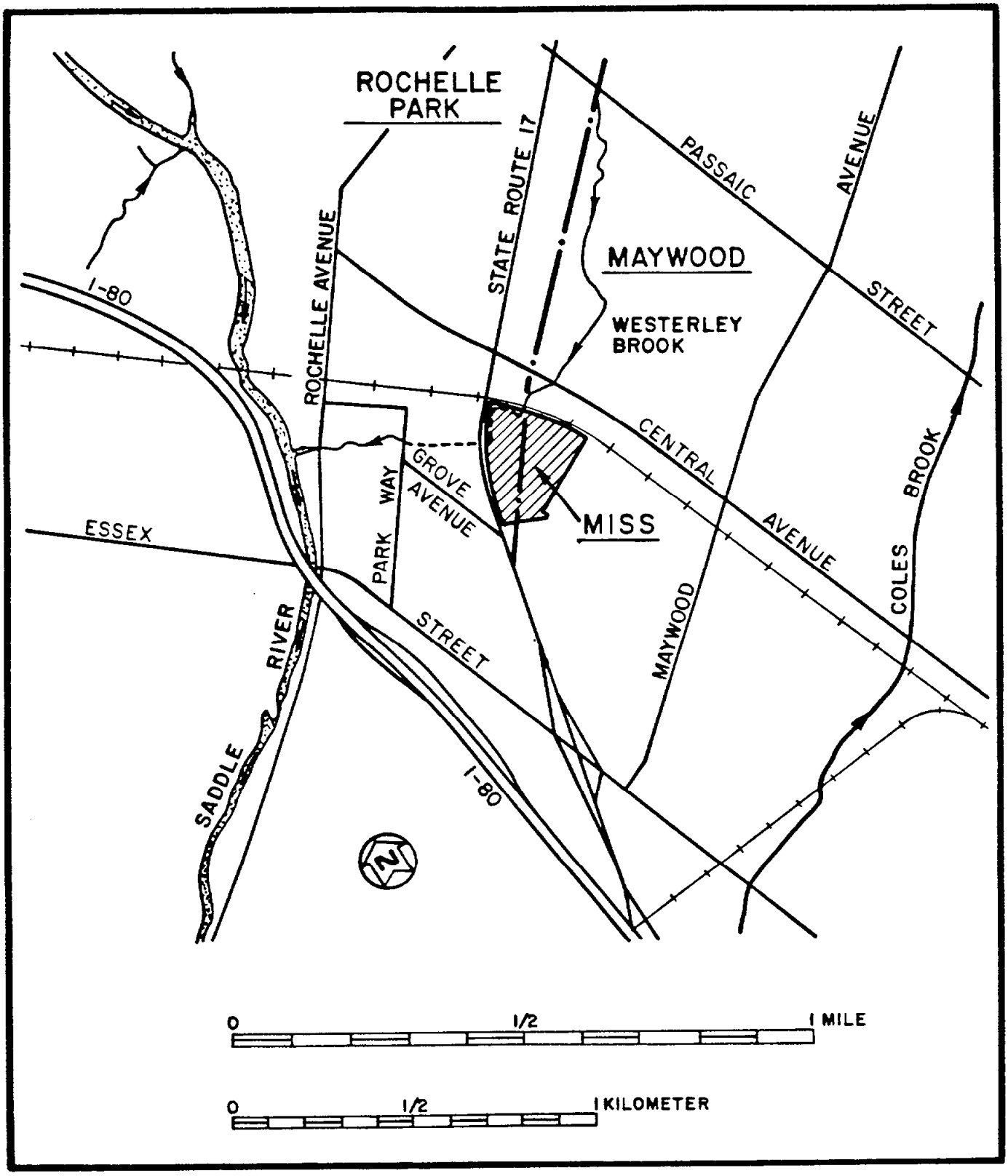


FIGURE 3-1 SURFACE DRAINAGE IN THE VICINITY OF THE MISS

(4.8 in.) of precipitation measured at Little Falls, about 14 km (8.4 mi) southwest of Maywood (Ref. 17). The maximum precipitation recorded for a single day is 25 cm (9.8 in.), and the highest monthly total is 40 cm (15 in.). The prevailing winds are from the northwest from October through April and from the southwest during the summer months.

3.3 LAND USE

The MISS is a fenced vacant lot; the rest of the SC property is also enclosed by a fence and is currently used for chemical processing activities. The MISS is zoned commercial and industrial.

A combination of industrial and residential land use characterizes the immediate vicinity. With the exception of one house located on the east border of the SC property, the area to the east and south of the MISS is used for industrial and commercial purposes. The New York, Susquehanna and Western Railroad runs along the northern border of the MISS. Route 17 separates the Ballod property and the storage site. Much of the land within several miles of the MISS is zoned for residential housing (one-family) and limited light industrial use. A few nearby lots are zoned for restricted commercial business.

4.0 SCOPE OF THE MONITORING PROGRAM

Surveillance monitoring will be conducted at designated sample points on a scheduled basis during interim storage of contaminated materials at the MISS. The monitoring will be undertaken to determine the effectiveness of remedial action at the site and to ensure protection of the public and the environment. The monitoring program will be initiated around the storage pile containing 2,400 m^3 (3,100 yd^3) of contaminated soils removed from properties decontaminated during 1984 (Figure 1-3). The contaminated soils will be placed directly on the ground to form a pile covering approximately 2,380 m^2 (25,600 ft^2) and will be covered with a low permeability membrane (Hypalon) until such time as a decision is made regarding their final disposition.

Monitoring will continue throughout the interim storage of the contaminated material at the MISS. Analyses for radionuclide contaminants will be undertaken in air, surface water, sediment, and groundwater samples. External gamma radiation monitoring will also be conducted. Both on- and off-site sampling locations will be included in surveillance monitoring. Monitoring will be conducted in accordance with the requirements of the NJDEP under the State Pollutants Discharge Elimination System.

Priority pollutant analyses will be conducted on a limited number of surface water, sediment, and groundwater samples during baseline monitoring. These analyses may provide information on the presence or absence of various nonradioactive contaminants at the site. Should elevated concentrations be detected, a decision will be made as to the inclusion of these parameters in routine surveillance monitoring.

Construction monitoring will be conducted by Eberline Instrument Corp. when remedial action is being carried out at the MISS and

vicinity properties. This monitoring will be conducted to monitor the effectiveness of control measures used to limit the movement of contaminants (e.g., dust suppression, surface water collection, and sediment control). As part of construction monitoring, samples of surface water will be collected at routine (e.g., daily or weekly) intervals when there is site drainage. These samples will be submitted to a radiochemistry laboratory for analysis of radionuclides known to be present at the site. Air samplers will be deployed at points surrounding the work area and operated continuously. Filters will be collected from these samplers on a 24- to 48-hour basis and analyzed for long-lived gross alpha activity.

The following subsections describe the proposed monitoring of air, surface water and sediment, groundwater, and external gamma radiation. Applicable regulatory criteria and guidelines are summarized in Table 2-1. A summary of sampling locations, parameters, and frequencies is shown in Table 4-1.

4.1 AIR MONITORING

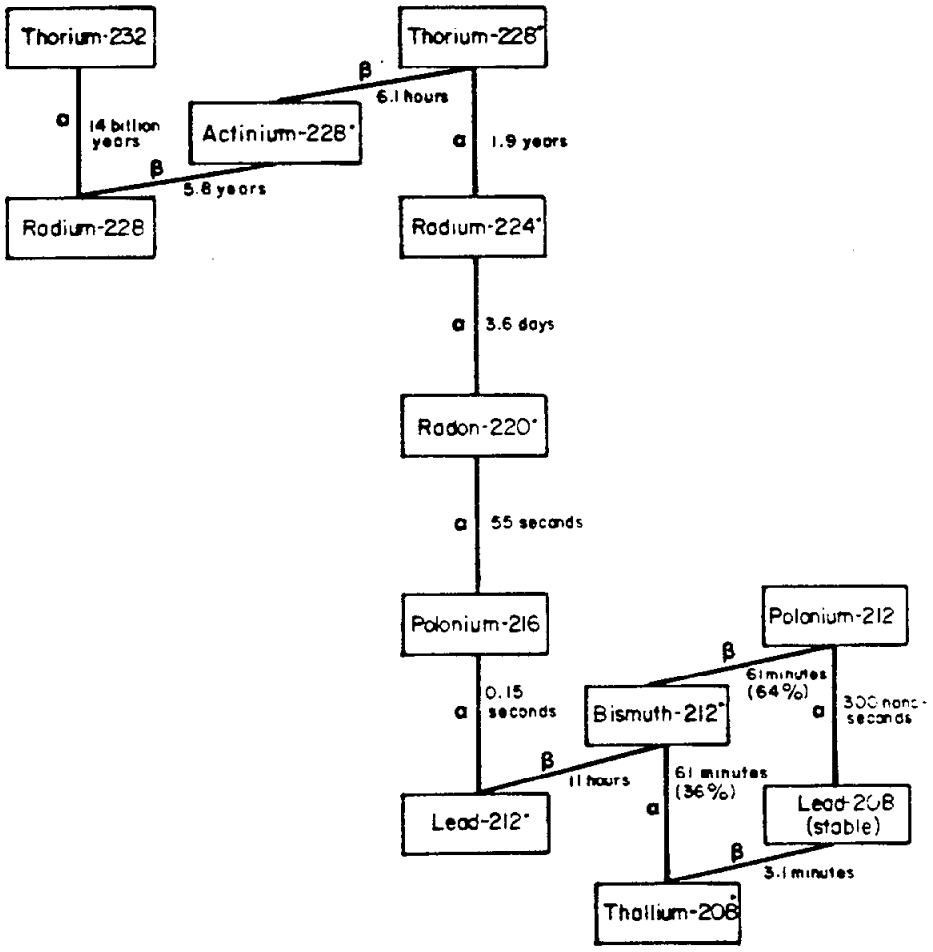
Several radionuclide descendants of uranium-238 and thorium-232 are present at the MISS, including radioactive products from the decay of thoron gas (radon-220) and radon gas (radon-222). The air monitoring program will record possible releases of thoron and radon to the atmosphere. Only gaseous releases will occur during interim storage, because the storage pile will be covered and maintained. Radionuclides in each of the two separate decay chains (Figures 4-1 and 4-2) are assumed to be present in equilibrium with thorium-232 and radium-226. The average concentrations of nuclides in the contaminated materials to be excavated and stored during 1984 are 100 pCi/g for the thorium-232 decay chain and 23 pCi/g for the uranium-238 decay chain.

TABLE 4-1

MONITORING PROGRAM FOR THE MISS

Sample Type	Sample Locations[1]	Parameters	Sampling Frequency
Air			
Terradex Track Etch Detectors (Type-M and Type-F)	6 On-site Around Storage Pile 6 Along Perimeter Fence of Site 1 Off-site Background	Radon 222 Radon 220	Quarterly
Surface Water			
Grab Sample	1 Upstream of Site in Westerley Brook (Background) 1 Channelized Outfall of Westerley Brook 1200 m (660 ft) west of site 1 Drainage Ditch in Southeastern Portion of Site 1 Westerley Brook at the Saddle River Standing Water Around Storage Pile (if present during time of sampling)	Uranium (Total), Thorium 232, Radium 226, EPA Priority Pollutants	Quarterly Baseline
Sediment			
Grab Sample	Same as Surface Water	Uranium (Isotopic), Thorium 232, Radium 226, EPA Priority Pollutants	Annually Baseline
Groundwater[2]			
	1 Shallow Well Upgradient of Storage Pile (Background) 1 Bedrock Well Upgradient of Storage Pile (Background) 4 Shallow Wells Downgradient of Storage Pile 4 Bedrock Wells Downgradient of Storage Pile	Uranium (Total), Thorium 232, Radium 226, EPA Priority Pollutants	Quarterly Baseline
External Gamma Radiation			
	6 On-site Around Storage Pile[3] 6 Along Perimeter Fence of Site[3] 1 Off-site Background[3]	Gamma Exposure Rate	Quarterly

[1]See Figures 4-3 to 4-5 for approximate station locations.
[2]Final sampling locations will be determined after a site survey. Wells will be installed during FY 1985.
[3]Terradex detectors and dosimeters will be placed at the same locations.



NOTES:
The times shown are half-lives.
The symbols α and β indicate alpha and beta decay.
An asterisk indicates that the isotope is also a gamma emitter.

FIGURE 4-1 THORIUM-232 RADIOACTIVE DECAY CHAIN

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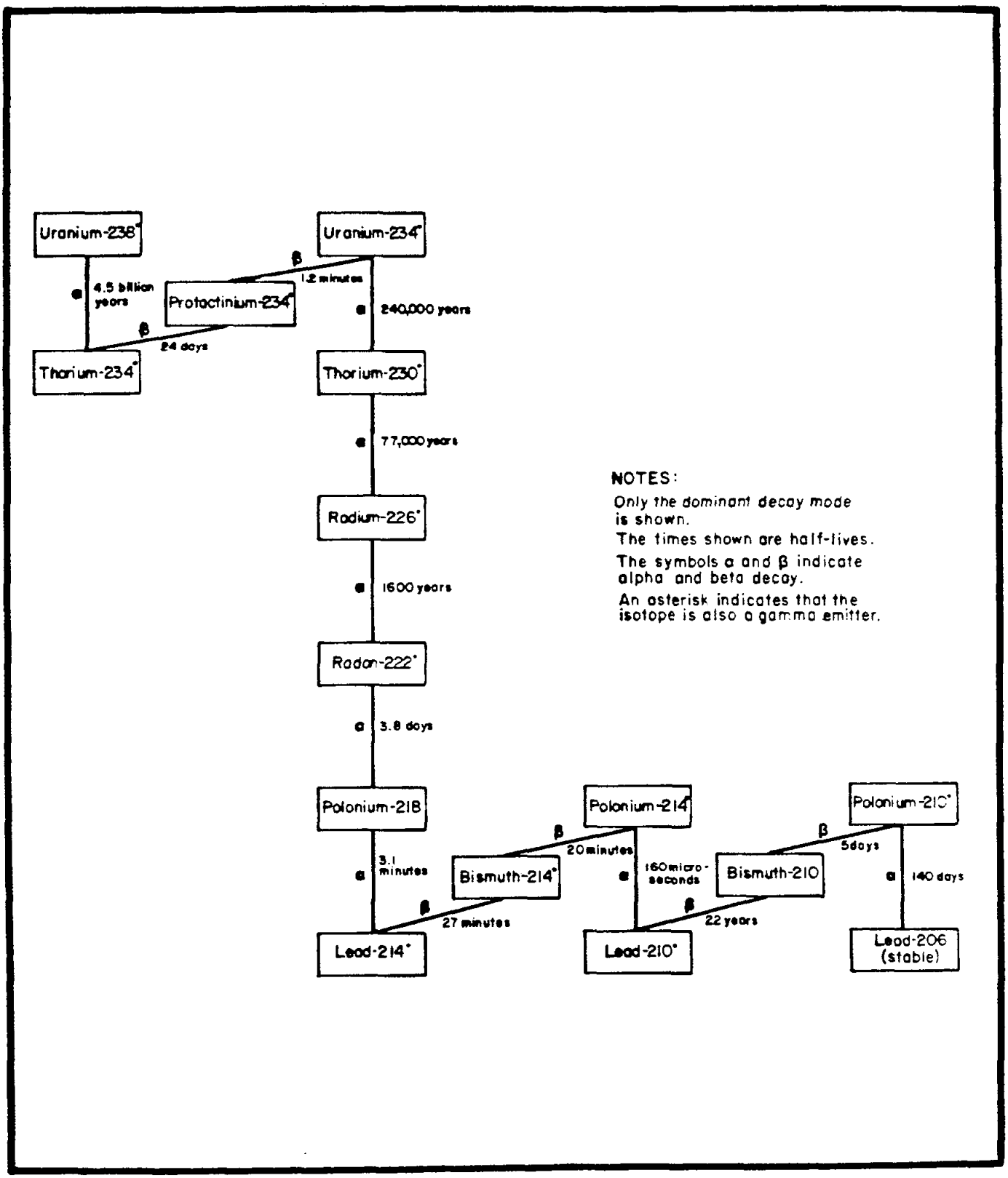

FIGURE 4-2 URANIUM-238 RADIOACTIVE DECAY CHAIN

The radon gas monitoring program will consist of an experimental technique using Terradex paired Type-F and Type-M Track-Etch detectors. Although experimental, this is the only commercially available technique for monitoring thoron at environmental levels. To obtain the thoron concentration in the presence of radon, the Type-M reading is subtracted from the Type-F reading and multiplied by a constant derived from the thoron and radon calibration factors for the two types of detectors (Ref. 18). Detectors will be placed at the approximate locations indicated in Figure 4-3. In placing these detectors, consideration will be given to prevailing wind directions (northwest in winter and spring, southwest in the summer and fall). It is anticipated that twelve paired on-site detectors will be used as well as one off-site detector that will function as a background monitor. Several additional detectors will be deployed for quality assurance purposes. Detectors will be collected quarterly and will be returned to the Terradex Corporation for analysis. Guidelines for radon and thoron concentrations in air at the MISS will be those specified in DOE Order 5480.1A, Chapter XI (Ref. 19).

Indoor monitoring for radon may be conducted where occupied structures are affected. This monitoring would be conducting as part of a construction monitoring program in which radon levels are determined before, during, and after the remedial action activity. Guidelines for indoor concentrations are provided in Table 2-1.

4.2 SURFACE WATER MONITORING

Surface water flow at the MISS is minimal because of the generally low relief of the area. A total elevation difference of 3 m (9 ft) [16-19 m (54-63 ft) above sea level] exists across the site. To monitor the potential release of contaminants into surface water and sediments these media will be sampled at the following locations:

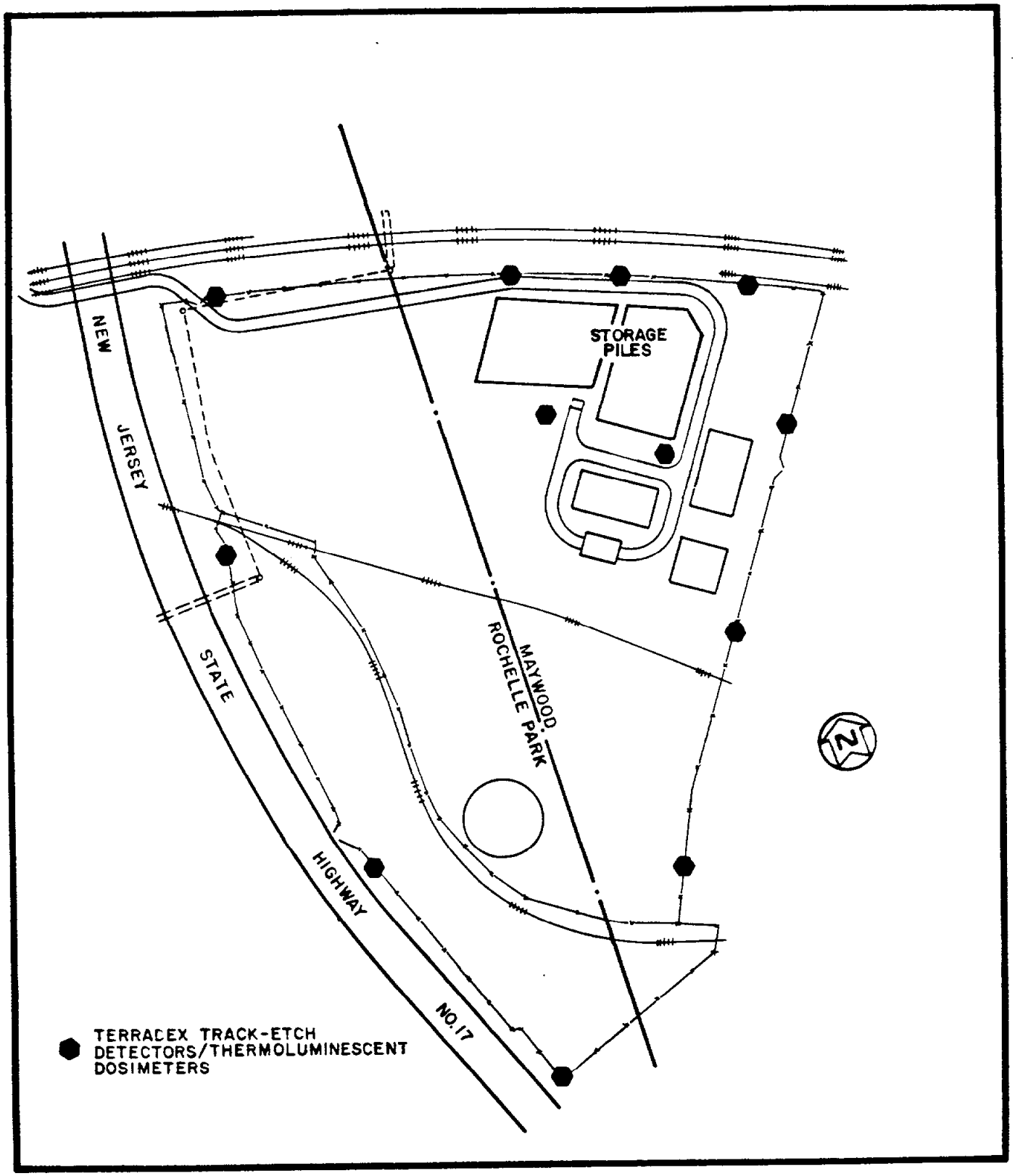

FIGURE 4-3 AIR AND EXTERNAL GAMMA RADIATION MONITORING LOCATIONS AT THE MISS

- Upstream of site in Westerley Brook
- Downstream of the site at the outfall of Westerley Brook
- Within the small drainage ditch in the southeastern portion of the site
- Standing water, which may appear after rainfall, near the interim storage pile

Standing water is anticipated after rainfall, because of the low site relief and the minimal surface water flow across the site. Standing water observed near the interim storage pile will be sampled during routine monitoring since it may contain leached contaminants that could percolate into the vadose zone or directly into groundwater.

Surface water will be analyzed for total uranium, thorium-232, and radium-226; sediment will be analyzed for isotopic uranium, thorium-232, and radium-226. In addition to radionuclides, a baseline analysis of EPA priority pollutants will be conducted in selected surface water and sediment samples. Water and sediment samples will be analyzed as necessary for any of these pollutants present at significant concentrations relative to background.

Sampling locations are shown in Figure 4-4. Surface water samples will be collected quarterly, while sediment samples will be collected annually. DOE Order 5480.1A and other pertinent guidelines identified in Table 2-1 will provide applicable concentration guidelines (Refs. 19 and 20).

4.3 GROUNDWATER MONITORING

The groundwater monitoring program is designed to detect potential migration of radionuclides from the MISS during interim storage of contaminated soils. Groundwater from unconsolidated and consolidated material will be sampled to determine the extent and temporal variation of contamination.

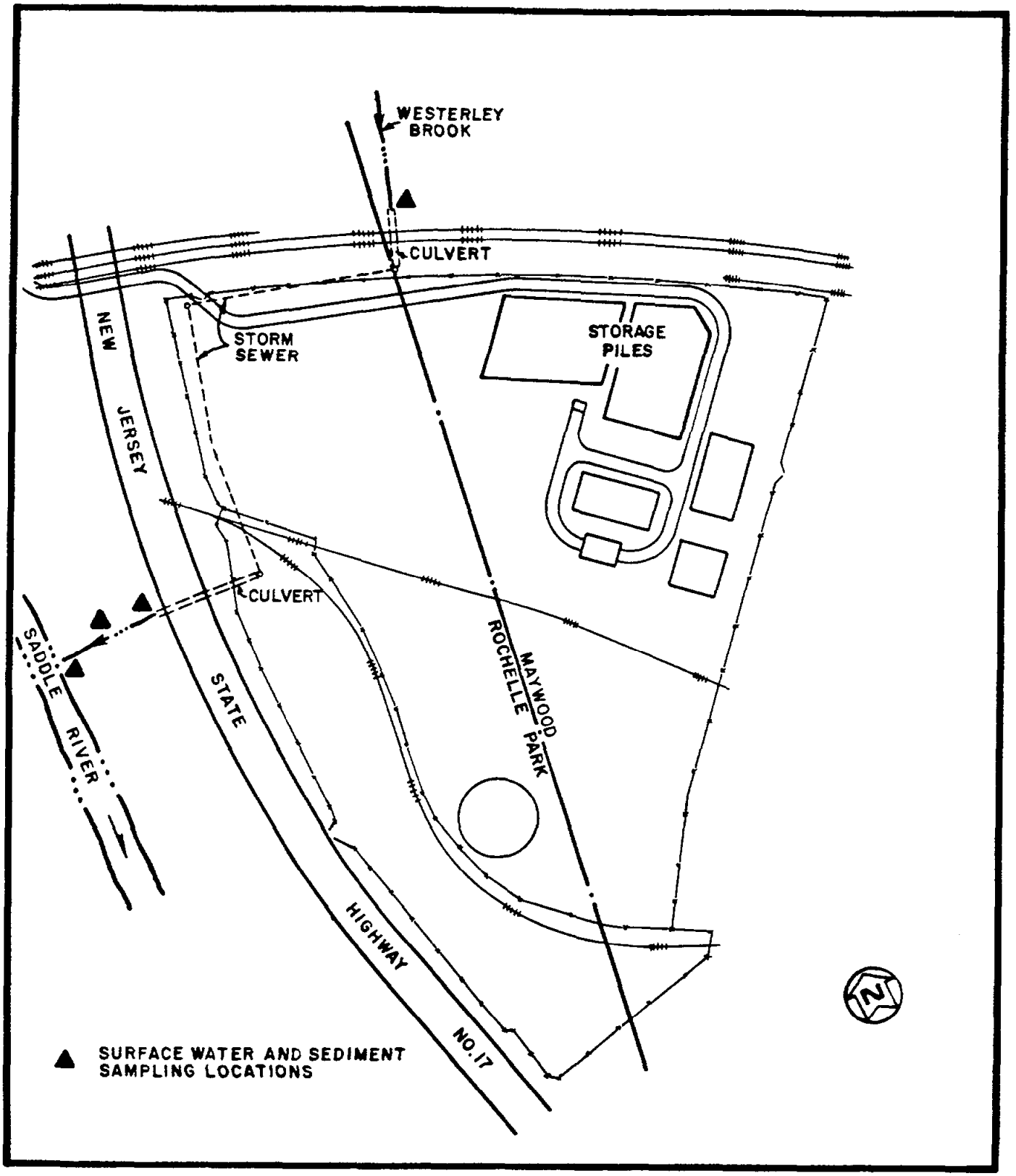

FIGURE 4-4 SURFACE WATER AND SEDIMENT MONITORING LOCATIONS AT THE MISS

Ten groundwater monitoring wells will be installed around the MISS (Figure 4-5). Well locations selected are based on recommendations from the NJDEP (Ref. 11). Specific locations will be established in the field. To avoid potential cross-contamination, five of the wells will be installed in the overburden materials above bedrock and five in the top 6 m (20 ft) of the bedrock. The wells will be installed as paired systems in adjacent holes at each location. The shallow wells will monitor the groundwater having the highest potential for contact with the storage pile. Since there are indications of radioactive contamination in the vicinity of the MISS, the deep wells will draw from the same formation as the Lodi wells to monitor possible contaminant migration from the MISS.

One pair of wells will be located on-site upgradient of the storage pile to serve as a background for monitoring; the other four pairs will be downgradient. During drilling operations the well holes will be geologically logged, samples will be collected at selected depths, and permeability tests will be made.

Groundwater will be sampled and analyzed for total uranium, thorium-232, and radium-226. Baseline analyses will be conducted for EPA priority pollutants as discussed in Subsection 4.2. If it is determined that contamination in the surveillance wells exceeds DOE Concentration Guidelines for water (see Table 2-1), additional action will be taken to evaluate the potential for migration and the environmental significance thereof. If deemed appropriate, action will be taken to minimize the potential for off-site migration. Sampling will be conducted quarterly for radioactive contaminants and as necessary for selected EPA priority pollutants.

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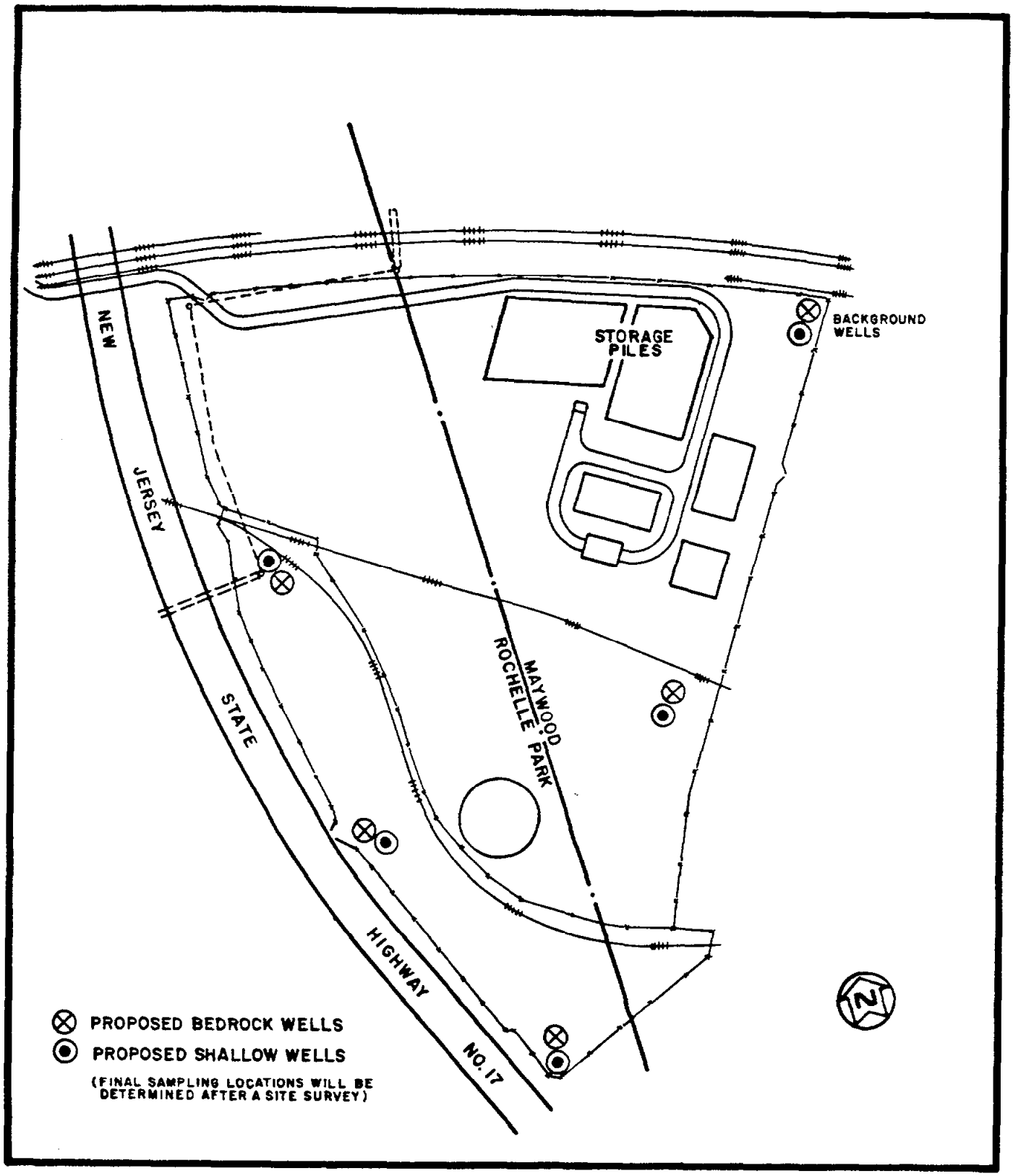

FIGURE 4-5 PROPOSED GROUNDWATER MONITORING LOCATIONS AT THE MISS

4.4 EXTERNAL GAMMA RADIATION MONITORING

External gamma radiation monitoring at the MISS will provide a baseline from which changes in radiation exposure rates can be evaluated. Gamma exposure rates will be measured by lithium-fluoride thermoluminescent dosimeters (TLDs). Each dosimeter will contain five matched chips, the responses of which will be averaged. Twelve dosimeters will be placed on-site in conjunction with Terradex detectors (See Subsection 4.1) at the approximate locations indicated in Figure 4-3. Two background monitoring stations will be located in the general vicinity of the MISS. Dosimeters (and Terradex detectors) will be collected quarterly. DOE Order 5480.1A will provide applicable guidelines for external gamma radiation monitoring at the MISS.

5.0 PROCEDURES

Procedures for the various types of sampling to be carried out at the MISS will be prepared by BNI. Radiological analyses will be performed by Eberline Instrument Corp. Recommended chemical analyses will be performed by another subcontractor.

6.0 REPORTING

Results of all sample analyses will be reported by BNI to DOE on an annual basis. Results of sample analyses for any given quarter will be available for review within 60 days after each quarterly sampling. Following a review of quarterly analytical results, any data that reflect conditions judged to be anomalous or abnormal will be reported immediately to DOE in a letter report. If there is evidence of new or increased off-site migration of contaminants resulting from failure of some aspect of the remedial action at the MISS, additional sampling may be warranted.

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