M-704

Formerly Utilized Sites Remedial Action Program (FUSRAP)

ADMINISTRATIVE RECORD

for the Maywood Site, New Jersey

US Army Corps of Engineers®

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ARGONNE NATIONAL LABORATORY
9700 South Cass Avenue, Argonne, Illinois 60439

ACTION DESCRIPTION MEMORANDUM

INTERIM REMEDIAL ACTIONS AT MAYWOOD, NEW JERSEY

by

Energy and Environmental Systems Division

March 1987

work supported by

U.S. DEPARTMENT OF ENERGY
Oak Ridge Operations
Technical Services Division
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1. SUMMARY OF INTERIM REMEDIAL ACTIONS

In 1984, the U.S. Department of Energy (DOE) was directed by the U.S. Congress to conduct a decontamination research and development project at the Stepan Company site and various vicinity properties near Maywood, New Jersey (Figure 1.1). The site and vicinity properties are contaminated with radionuclides in the thorium-232 and uranium-238 decay series as a result of processing of thorium ores previously carried out at the site. In 1984, DOE leased a portion of the Stepan Company property for use as an interim storage site and began interim remedial actions on vicinity properties. In September 1985, DOE acquired ownership of 4.7 ha (11.7 acres) of Stepan Company's property for interim storage. The interim remedial actions consist of decontaminating selected vicinity properties and providing interim storage at DOE's Maywood Interim Storage Site (hereafter referred to as the Maywood site) until a permanent disposal site can be identified. It is expected that the cleanup of these selected vicinity properties will be completed by the end of 1990. These actions are being conducted under DOE's Formerly Utilized Sites Remedial Action Program (FUSRAP).

The vicinity properties that have been or will be decontaminated include residential, municipal, and commercial properties in the boroughs of Maywood and Lodi and the township of Rochelle Park, all of which are located in Bergen County (Figure 1.2). These remedial actions are subject to coordination with the municipalities involved. It is estimated that 88,500 m^3 (115,800 yd^3) of wastes will be stored above grade at the Maywood site; there are about 79,600 m^3 (104,200 yd^3) of existing wastes below grade at the site. The interim storage piles will be enclosed in 36-mil synthetic membranes.

The residential properties on Trudy Drive, Hancock Street, and Avenues C and F in Lodi were decontaminated in 1985. According to recent surveys, additional residential properties and a municipal property in Lodi are radioactively contaminated. These properties have been designated for remedial action. Additional radioactive surveys in this area of Lodi are continuing. The source of the contamination appears to be old Lodi Brook, an open brook that previously originated on the former Maywood Chemical Works site but has since been replaced along the majority of its length by an enclosed stormwater drainage system (Bechtel Natl. 1986d).

Interim remedial actions are carried out in compliance with all applicable regulations. Mitigative measures are employed to reduce environmental impacts to low levels. The environment is being monitored during the cleanup period and will continue to be monitored during interim storage to ensure conformance with all applicable requirements. Analysis of potential environmental impacts indicates that these interim remedial actions will have no significant impact on the local environment.

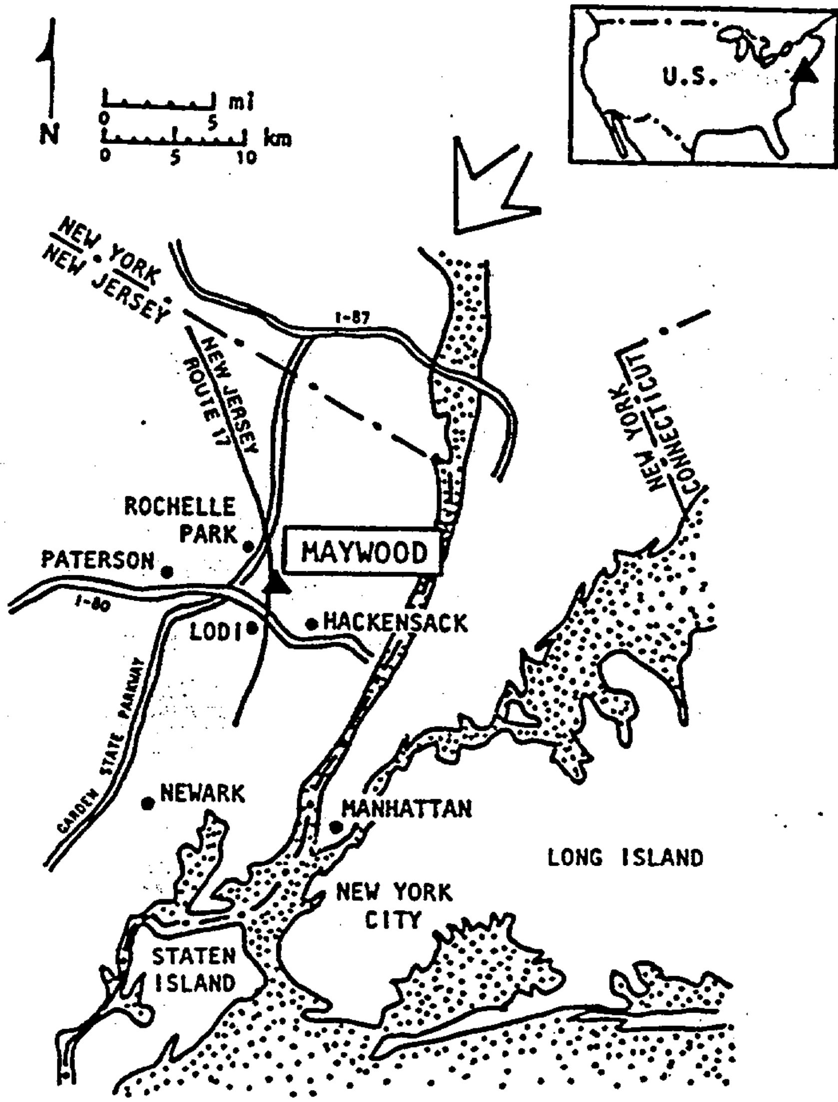

Figure 1.1. Location of Maywood, New Jersey. Source: Modified from Argonne National Laboratory (1984).

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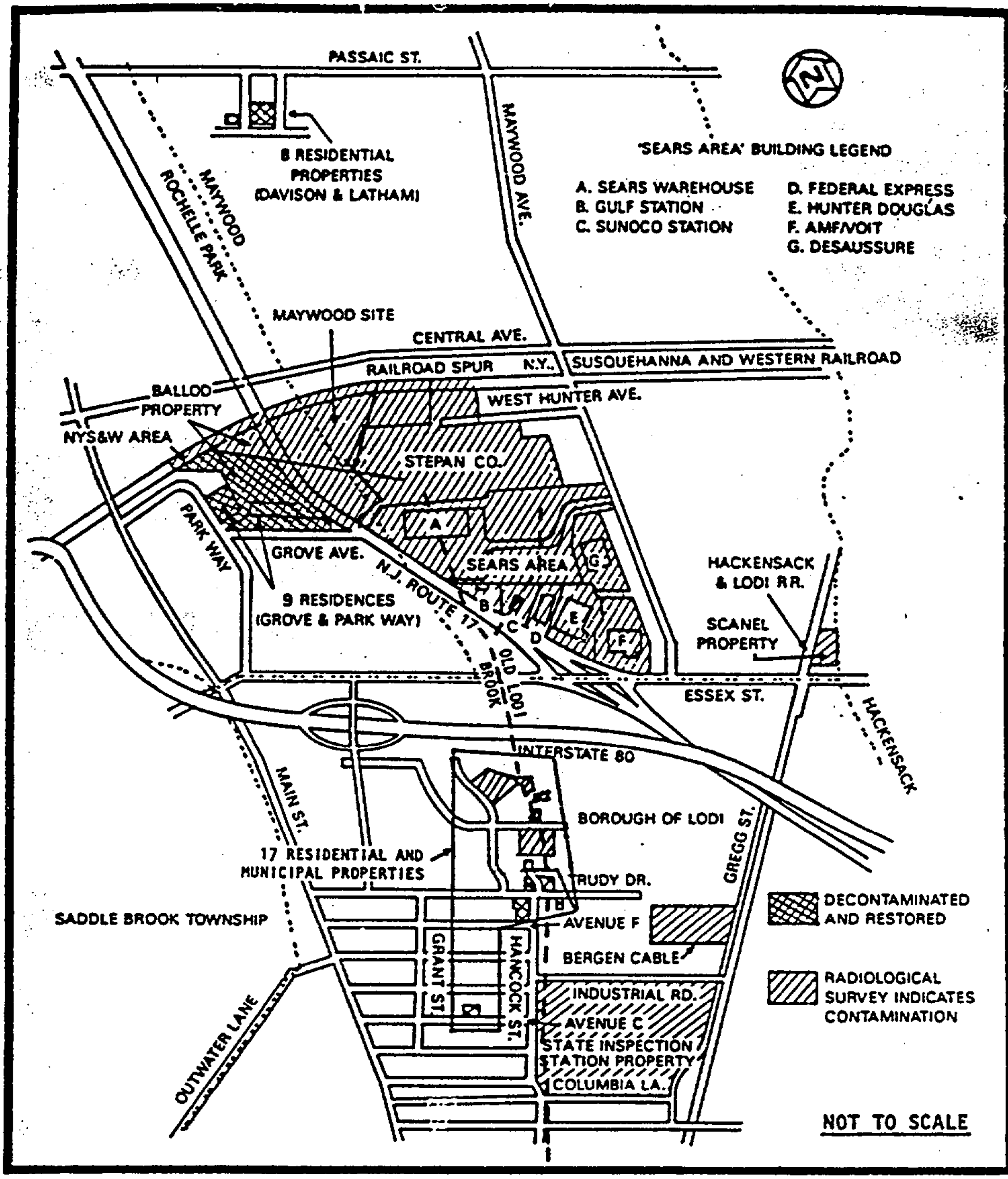

Figure 1.2. Location of the Maywood Interim Storage Site and Vicinity Properties.

2. HISTORY AND PLANNED FUTURE ACTIONS

2.1 GENERAL SETTING

The Maywood site is located approximately 19 km (12 mi) north-northwest of New York City, New York, and 21 km (13 mi) northeast of Newark, New Jersey (Figure 1.1). The site is in the borough of Maywood and the township of Rochelle Park, Bergen County, New Jersey. It is bounded by N.J. Route 17 on the west, a railroad line on the northeast, and commercial-industrial areas on the south and east (Figure 1.2). The site covers approximately 4.7 ha (11.7 acres) and is a fenced vacant lot.

The Maywood site and a number of vicinity properties were radioactively contaminated as a result of thorium ore processing at the Maywood Chemical Works (now owned by the Stepan Company). These properties are located in the borough of Maywood, Rochelle Park Township, and the borough of Lodi, New Jersey (Figure 1.2). The vicinity properties are (1) Stepan Company plant site; (2) Sears area properties; (3) Scanel property; (4) Ballod Associates property; (5) eight residential properties on Davison and Latham streets in Maywood; (6) nine residential properties on Grove Avenue and Park Way in Rochelle Park; (7) sixteen residential properties and a municipal park in Lodi; (8) a commercial property and a state-owned property in Lodi; (9) portions of the New York, Susquehanna and Western Railroad right-of-way; and (10) contaminated soils beneath N.J. Route 17 adjacent to the northern and western boundaries of the Maywood site (Argonne Natl. Lab. 1984; Bechtel Natl. 1986b). A major portion of the Ballod Associates property and 25 residential properties have already been decontaminated and the radioactive wastes transported to the Maywood site for interim storage (see Table 2.2).

2.2 HISTORY PRIOR TO DOE

From 1916 to 1956, monazite sands (thorium ores) were processed by the Maywood Chemical Works, which was located on what is now the Maywood site and on property now owned by the Stepan Company (Figure 1.2). Slurry containing processed wastes from the thorium operations was pumped to diked areas west of the plant. These diked areas include areas that are currently occupied by the existing eight burial areas on the Maywood site (Figure 2.1), two areas on the Ballod Associates property, and a portion of N.J. Route 17 (Bechtel Natl. 1986b). Wastes stored on the Ballod Associates property apparently migrated onto residential properties located on Grove Street and Park Way in Rochelle Park.

New Jersey Route 17 was constructed through the process waste disposal area in 1932, and Stepan Company purchased the Maywood Chemical Works in 1959 (Bechtel Natl. 1986a). In 1966 and 1967, Stepan Company removed contaminated

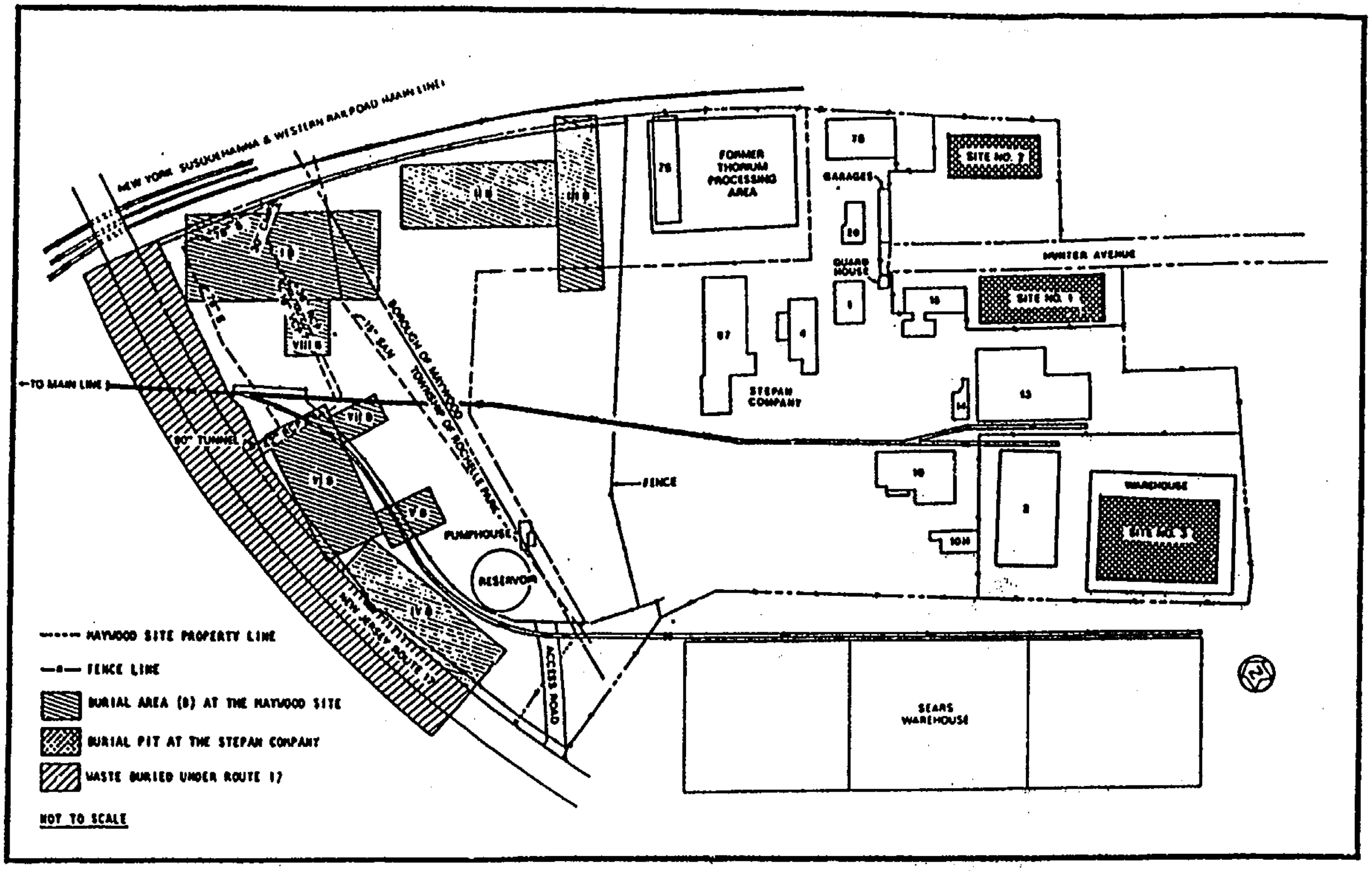

Figure 2.1. Locations of Existing Below-Grade Wastes at the Maywood Site and Stepan Company Property. Source: Modified from Bechtel National (1986b).

materials from the area east of N.J. Route 17 and disposed of them in Burial Site No. 1 (area currently under grass) and Burial Site No. 2 (area currently under a parking lot). The volumes of wastes are approximately 6,400 m^3 (8,400 yd^3) in Burial Site No. 1 and 1,600 m^3 (2,100 yd^3) in Burial Site No. 2. In 1968, approximately 6,600 m^3 (8,600 yd^3) of contaminated materials were removed from the southern portion of the Ballod Associates property and disposed of in Burial Site No. 3 (area currently under a warehouse) (Bechtel Natl. 1986c). These burial sites and the location of a former thorium processing area containing buried wastes are shown in Figure 2.1.

Following removal of the wastes to the burial sites, the Stepan Company requested that the south area of the property west of N.J. Route 17 be surveyed for radioactivity by the Atomic Energy Commission (AEC) (the regulatory responsibilities of the former AEC are currently carried out by the U.S. Nuclear Regulatory Commission--NRC). Based on that 1968 survey, clearance was granted for unrestricted use of this 3.5-ha (8.7-acre) area west of N.J. Route 17. This parcel of land was sold to a private citizen, who in turn sold it to Ballod Associates (Bechtel Natl. 1986c); at the time of the 1968 survey, the AEC was not aware of contaminated wastes present in the northeast area that is now incorporated into the Ballod Associates property (Figure 1.2). This northeast area remained undisturbed and undeveloped through 1984 and was largely used for unauthorized trash disposal by local residents and for a play area by local youths (Cole et al. 1981; Argonne Natl. Lab. 1984).

It is not known for certain how all of the vicinity properties became contaminated. The residential properties located on Grove Street and Park Way in Rochelle Park could have become contaminated as a result of migration of radioactive materials from wastes stored on what is now the Ballod Associates property. Some of the vicinity properties could have become contaminated as a result of the Maywood Chemical Works allowing process wastes to be removed from the processing site for use as mulch and fill. Such activities are known to have occurred around 1928 and again between 1944 and 1946 (Argonne Natl. Lab. 1984). A likely source of contamination in Lodi is old Lodi Brook, which previously originated on the former Maywood Chemical Works site. This open brook has since been replaced along the majority of its length by an enclosed stormwater drainage system.

In 1980, the NRC was notified that there were elevated radiation levels on the Ballod Associates property. A series of radiological surveys have since been conducted (Table 2.1) that have led to the identification of contaminated properties in Maywood, Rochelle Park, and Lodi. As of June 1986, the Maywood site is No. 157 on the National Priorities List (Superfund List) (U.S. Environ. Prot. Agency 1986).

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Table 2.1. Radiological Surveys of the Maywood Area

Area	Surveyor	Survey Date
Ballod Associates property	ORAU	1980
Stepan Company and Ballod Associates properties and surrounding area	EG&G	1981
Stepan Company plant site	NSA	1981
Seven residential properties on Davison and Latham streets	ORNL	1981
Sears warehouse property, Scanel property (including a Chinese restaurant and a car wash)	NUS	1983
Eight residential properties on Grove Street and Park Way	BNI	1984
Lodi area	ORNL	1984-1986

[a] ORAU = Oak Ridge Associated Universities
EG&G = EG&G Energy Measurements Group
NSA = Nuclear Safety Associates
NUS = NUS Corporation
BNI = Bechtel National, Inc.
ORNL = Oak Ridge National Laboratory

Source: Bechtel National (1986c).

2.3 DOE ACTIONS

In 1984, DOE obtained access to a portion of the Stepan Company property for use as an interim storage site for contaminated materials. DOE and the Stepan Company now have a cooperative agreement (Vaughan 1985) wherein the Stepan Company transferred approximately 4.7 ha (11.7 acres) to DOE for use as an interim storage site for radioactive wastes.

DOE has initiated a two-phase program for cleanup of all radioactively contaminated properties in the Maywood area. During Phase I, all residential and certain nonresidential properties in the vicinity of the interim storage site will be decontaminated to DOE guidelines for residual radioactivity (see Appendix A). The contaminated materials excavated during Phase I activities will be stored on an interim basis at the Maywood site for up to 25 years. Phase II consists of removing all contaminated materials to a permanent disposal site, including those stored at the Maywood site from Phase I activities, the existing below-grade wastes currently buried at the Maywood site, and below-grade wastes from off-site properties (as appropriate). Phase II cannot begin until a permanent disposal site has been designated.

2.3.1 Interim Remedial Actions

Cleanup began during 1984 at residential properties in Maywood and Rochelle Park as well as at the Ballod Associates property in Rochelle Park. About 3,600 m^3 (4,700 yd^3) of material was transported to the Maywood site for interim storage (Table 2.2). Fifteen groundwater monitoring wells and two boreholes were also drilled (Bechtel Natl. 1985b). During 1985, 23,100 m^3 (30,200 yd^3) of contaminated material was excavated and placed in interim storage; this material originated from portions of the Ballod Associates property and from the residential properties on Trudy Drive, Hancock Street, and Avenues C and F in Lodi (Table 2.2). No cleanup actions were scheduled for 1986. Decontamination of currently identified properties is scheduled for 1987 through 1990.

Various characterization studies are currently being carried out for the Maywood site. Site operations are being conducted under an emergency New Jersey Pollutant Discharge Elimination System (NJPDES) permit that allows for storage of up to 140,000 m^3 (180,000 yd^3) of contaminated material at the Maywood site (Permit No. NJ0054500). Granting of a full permit is under review by the state. The intent of the emergency permit is to prevent contamination of the groundwater in the Maywood area. One of the requirements of the emergency permit was the installation of groundwater monitoring wells at the Maywood site, which was completed in 1985. Analysis for more than 100 chemical contaminants is required according to the NJPDES permit (see Bechtel Natl. 1986c--Tables 4-1 and 4-2).

Radiological characterization surveys are being conducted for the Sears area properties; the New York, Susquehanna and Western Railroad right-of-way; part of N.J. Route 17; one commercial property; one state-owned property; and a number of residential and municipal properties in Lodi. Characterization surveys are also being conducted for those parts of the Maywood site not yet covered by the storage piles. Chemical characterization of selected boreholes has also been undertaken. The chemical parameters measured include volatile organics, acid and base/neutral extractable organics, metals, pesticides, PCBs, and mercury (Bechtel Natl. 1986a). The EPA has recently drilled 15 chemical sampling holes on the Sears area properties to determine the extent of chemical contamination on adjoining areas. DOE is cooperating with EPA in this effort.

The contaminated areas are excavated using conventional earth-moving equipment. The contaminated materials are transported to the Maywood site in covered trucks, unloaded at the storage area, and compacted using standard

Table 2.2. Estimated Volumes of Contaminated Materials to be Stored Above Grade at the Maywood Site

Location	Volume[a] m^3	Volume[a] yd^3	Date of Excavation
Ballod Associates property and New York, Susquehanna and Western Railroad right-of-way	1,200 22,700 9,200	1,600 29,700 12,100	1984 1985 1987-1990
Davison/Latham residences	1,600	2,100	1984
Park Way/Grove residences	800	1,000	1984
Lodi residences	400	500	1985
Lodi residential and municipal properties	2,100	2,800	1987-1990
Scanel property	4,600	6,000	1987-1990
Sears area properties	45,900	60,000	1987-1990
TOTAL	88,500	115,800	

[a] Volumes reported to nearest 100 m^3 or 100 yd^3. These volume estimates may increase as a result of ongoing radiological characterization studies.

construction equipment. The contaminated materials will be stored in four piles that will cover a relatively large portion of the site (see Figure 2.2). Each storage pile will have a maximum height of approximately 8 m (25 ft) and will be constructed in a manner to ensure good structural stability. Contaminated concrete, organic materials, and clothing and paper wastes (which are bagged) will be stored in separate areas of the storage piles. The actual dimensions of the storage piles are dependent upon the required volume, which will not be known until completion of Phase I. However, the storage capacity of the Maywood site is adequate for the waste volume anticipated from Phase I activities.

A reinforced synthetic membrane liner will be placed on top of the existing below-grade contaminated materials (under the new storage piles for above-grade contaminated materials). The liner will be underlain by a 15-cm (6-in.) layer of sand or fine soil. An additional 15 cm (6 in.) of sand will be placed on top of the liner to serve as a drainage medium for any leachate that may form after the storage piles are completed. A 30 cm (12 in.) layer of fine-grained contaminated material will be placed over the upper sand layer to protect it and the liner during the subsequent placement of contaminated materials.

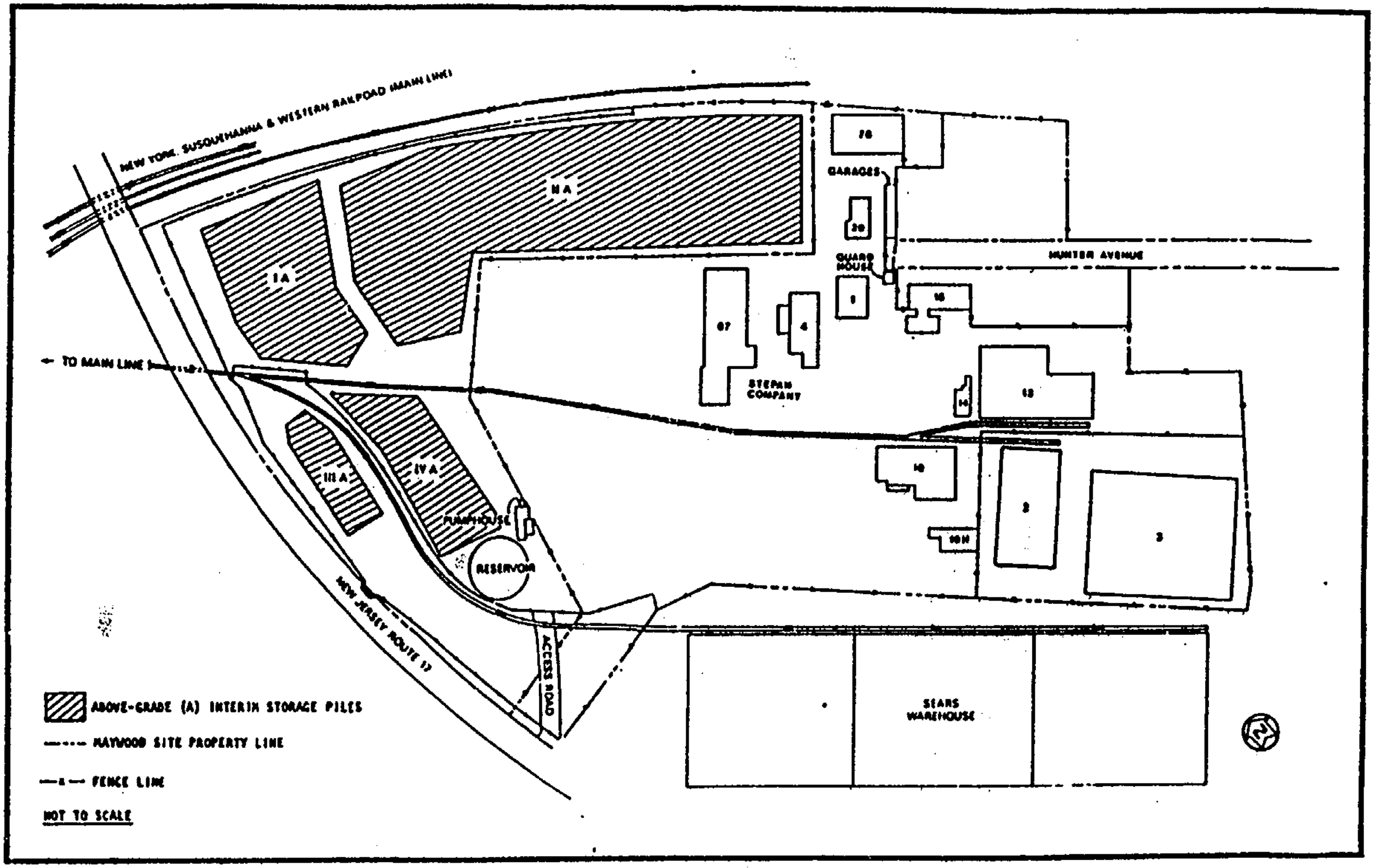

Figure 2.2. Proposed Interim Storage Piles At the Maywood Site.
Source: Modified from Bechtel National (1986b).

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Each of the four above-grade interim storage piles will be covered with a synthetic membrane that will be sealed to the bottom liner and held down by cement blocks. The covers will be routinely inspected and repaired, if necessary, during the interim storage period. The environment will be monitored during the cleanup period and during interim storage to ensure conformance with all applicable requirements.

After cleanup, the vicinity properties will be surveyed to verify that DOE guidelines are met. Property owners will be given a "statement of certification" that provides assurance that unrestricted use of their property will result in no radiation exposure above applicable standards to members of the general public.

2.3.2 Long-Term Management Options

An engineering evaluation of long-term management alternatives for the wastes was carried out by Bechtel National (1986b), including all of the wastes that will eventually be located at the Maywood site following Phase I activities and any remaining radioactive wastes in the vicinity. The engineering evaluation considered two on-site above-grade disposal alternatives and an alternative involving transport of all wastes to a permanent disposal site in New Jersey (not yet designated). DOE plans to implement the off-site disposal alternative. The schedule for establishment of the permanent disposal site is not firm at this time.

It is DOE policy that where large volumes of wastes need disposal, these wastes should be disposed of within the state of their origin (Vaughan 1986). DOE has requested that New Jersey officials select candidate sites in New Jersey. After identification of potential disposal sites, DOE will select the most suitable site for permanent disposal after completing the environmental review required by the National Environmental Policy Act. A total of 5 to 6 years will be required to establish a disposal site once the selection of candidate sites has started and Congress has appropriated funds for the acquisition and construction of the permanent disposal site.

3. AFFECTED ENVIRONMENT

3.1 RADIOLOGICAL CONDITIONS

The Maywood site and vicinity properties are contaminated with radionuclides of the thorium-232 and uranium-238 decay series (Figures 3.1 and 3.2). The major radioactive contaminants in the wastes are thorium-232 and its radioactive decay products. Based upon previous radiological surveys and assessments (Morton Tech. Consult., Undated-c, Undated-d; NUS Corp. 1983; Argonne Natl. Lab. 1984), the radionuclides in the thorium-232 and uranium-238 decay series are generally in secular equilibrium.

Radioactive materials existing on the Maywood site prior to DOE interim remedial actions are located primarily in eight burial areas (IB through VIIIB) and the former thorium processing area (Figure 2.1). It is estimated that the total volume of contaminated materials below grade at the Maywood site is 79,600 m^3 (104,200 yd^3); the estimated average concentrations of the major radionuclides in these materials are 100 pCi/g uranium-238 and its radioactive decay products and 300 pCi/g thorium-232 and its radioactive decay products. In the former thorium processing area, the estimated average concentrations in the below-grade materials are 600 pCi/g uranium-238 and its radioactive decay products and 2,000 pCi/g thorium-232 and its radioactive decay products (Table 3.1). In addition to these major areas of radioactive contamination, it is estimated that there may be up to 3,100 m^3 (4,100 yd^3) of below-grade radioactive materials in miscellaneous areas throughout the site. The average concentrations of radionuclides in these areas are estimated to be 30 pCi/g uranium-238 and its radioactive decay products and 100 pCi/g thorium-232 and its radioactive decay products.

A leachate collection system will be installed beneath each interim storage pile. This collection system consists principally of sand and a synthetic membrane liner. The sand, which serves as the leachate transport medium, is expected to become radioactively contaminated during the years of interim storage as contaminated leachate is collected. When the contaminated materials from the Maywood site are removed for permanent disposal, this sand will become further contaminated as a result of mixing that will occur when the radioactive materials above and beneath it are removed. When the leachate collection system is removed for disposal as radioactive waste, the concentrations of radionuclides in the system are estimated to be 10 pCi/g uranium-238 and its radioactive decay products and 30 pCi/g thorium-232 and its radioactive decay products.

About 88,500 m^3 (115,800 yd^3) of contaminated materials (primarily soils) from the vicinity properties will be placed in the four above-grade storage

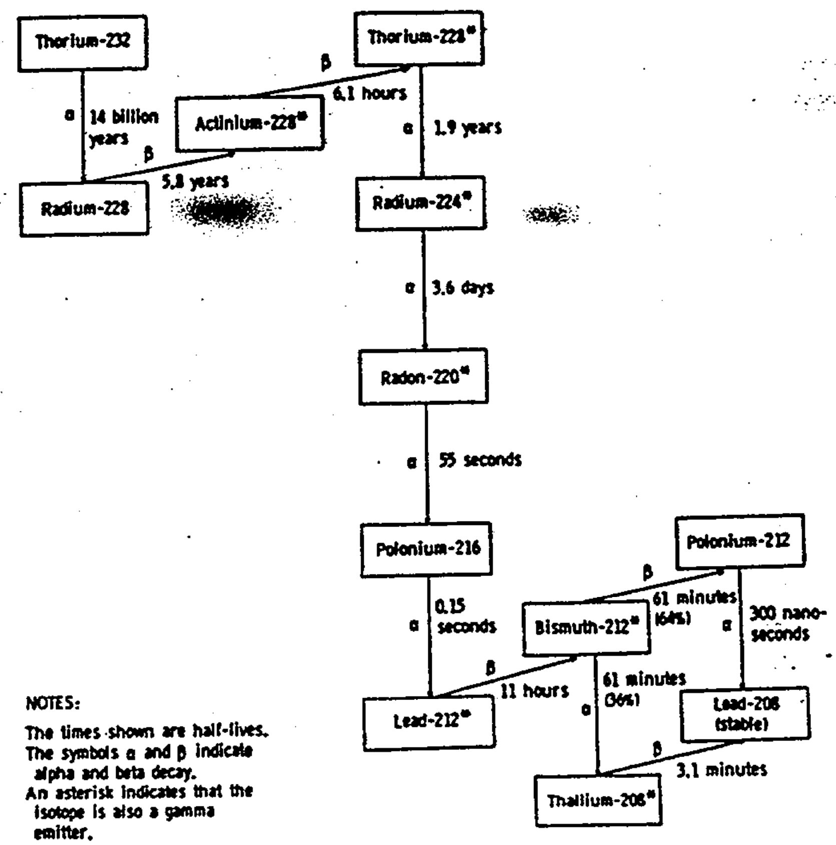
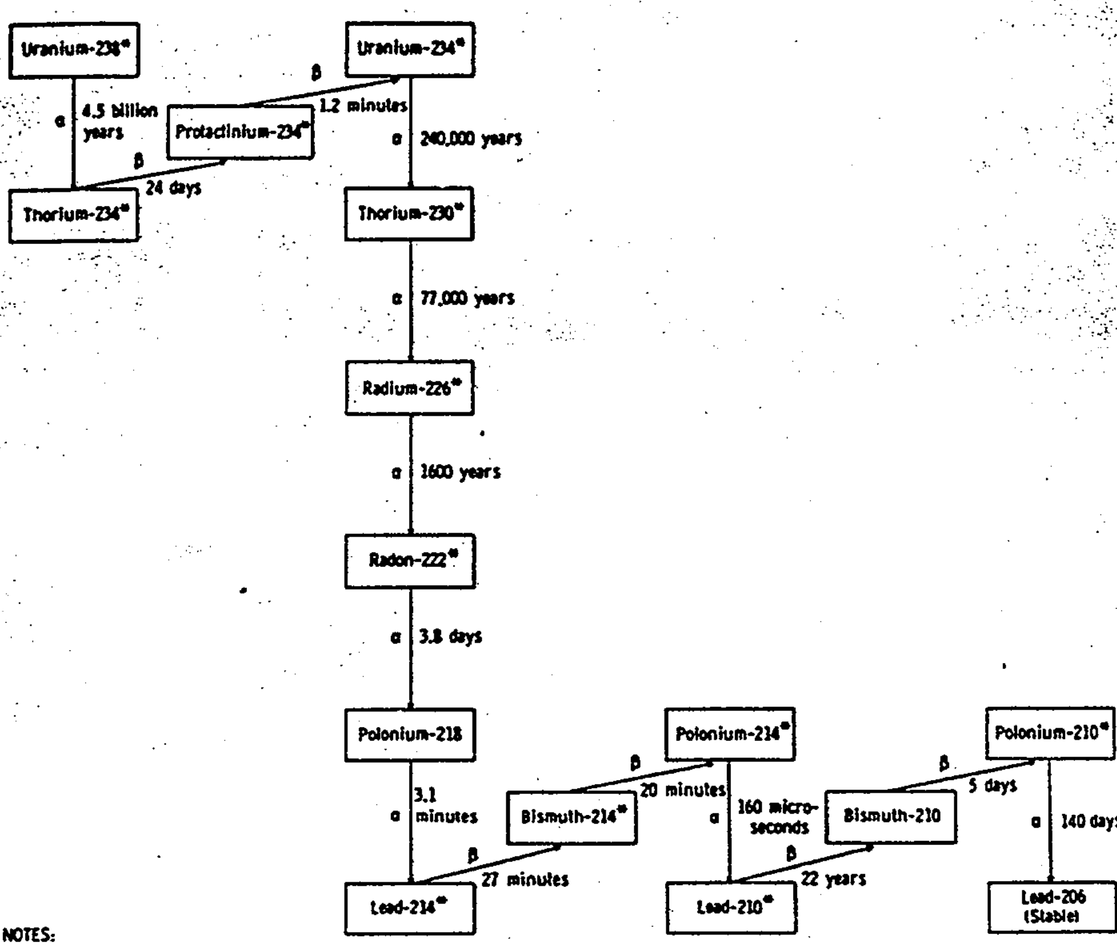


Figure 3.1. Thorium-232 Radioactive Decay Series.



NOTES:

Only the dominant decay mode is shown.
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 3.2. Uranium-238 Radioactive Decay Series.

Table 3.1. Estimated Volumes and Radionuclide Concentrations at Maywood, New Jersey

Source of Material	Volume[a] m^3	Volume[a] yd^3	Average Radionuclide Concentration (pCi/g)[a] Uranium-238[b]	Average Radionuclide Concentration (pCi/g)[a] Thorium-232[c]
Above Grade in Storage Pile[d]				
1984	3,600	4,700		
1985	23,100	30,200	30	100
1987-1990	61,800	80,900		
Subtotal	88,500	115,800		
Below Grade under Storage Pile				
Burial Areas IB-VIIIB	55,800	73,000	100	300
Former thorium processing area[e]	10,000	13,100	600	2,000
Other miscellaneous areas[e]	3,100	4,100	30	100
Leachate collection system beneath interim storage pile	10,700	14,000	10	30
Subtotal	79,600	104,200		
TOTAL ON STORAGE SITE	168,100	220,000		
Below Grade Off-site				
Stepan Company plant[f]:				
Burial Site 1	7,700	10,000		
Burial Site 2	1,900	2,500	300	1,000
Burial Site 3	7,900	10,300		
Beneath Route 17	15,300	20,000	30	100
Some nonresidential properties[g]	5,600	7,200	30	200
Subtotal	38,400	50,000		
TOTAL WASTES	206,500	270,000		

[a] All radionuclide concentrations reported to one significant figure; volumes reported to nearest 100 m^3 or 100 yd^3.

[b] All uranium-238 decay products are assumed to be in secular equilibrium with uranium-238.

[c] All thorium-232 decay products are assumed to be in secular equilibrium with thorium-232.

[d] These materials result from decontamination of vicinity properties in the year indicated; they are or will be stored above grade at the Maywood site.

[e] These volumes were included with the volumes for Burial Sites 1, 2 and 3 on the Stepan Company property in Bechtel National (1986b).

[f] Volumes include wastes licensed by NRC for burial (U.S. Nucl. Reg. Comm. 1981a) plus 20% to allow for contaminated soils surrounding the buried wastes. Volumes given in Bechtel National (1986b) for the three NRC-licensed burial sites include the volumes for the former thorium processing area (now part of the Maywood site) plus some allowance for other miscellaneous areas. These volumes have been separated in this table and are included in the below-grade portion of the Maywood site.

[g] Some nonresidential properties that do not pose an immediate health risk based on their current usage may not be decontaminated during Phase I, but will be decontaminated during Phase II activities.

Sources: Morton Technical Consulting (Undated-a, Undated-c), U.S. Nuclear Regulatory Commission (1981a), NUS Corporation (1983), Argonne National Laboratory (1984), Bechtel National (1986b).

piles. The estimated average concentrations of radionuclides in these materials are 30 pCi/g uranium-238 and its radioactive decay products and 100 pCi/g thorium-232 and its radioactive decay products (Table 3.1).

The contaminated areas that are not scheduled for cleanup during Phase I will be decontaminated in accordance with DOE guidelines for residual radioactivity during Phase II activities. These below-grade contaminated areas include approximately 79,600 m^3 (104,200 yd^3) of contaminated materials under the Maywood site storage piles (Burial Sites IB through VIIIB, former thorium processing area, other miscellaneous areas, and leachate collection system) and approximately 38,400 m^3 (50,000 yd^3) of off-site contaminated materials (under N.J. Route 17, the three NRC-licensed burial sites on Stepan Company property, and certain nonresidential properties). The estimated average concentrations of radionuclides in the below-grade wastes are given in Table 3.1.

3.2 CHEMICAL CONDITIONS

The main chemical constituents of the ores processed at the Maywood Chemical Works were rare earth oxides and thorium oxide. The wastes from ore processing consist primarily of insoluble compounds of rare earths and thorium; and, considering the nature of the reagents used in such processing, these compounds are probably oxides, hydroxides, sulfates, and carbonates. DOE is continuing to gather information on the chemical nature of the radioactive materials associated with the Maywood site in order to evaluate acceptable disposal alternatives.

Soil samples from the Ballod Associates property were analyzed prior to excavation, and no materials were detected that have characteristics that would classify them as being hazardous according to regulations under the Resource Conservation and Recovery Act (RCRA). DOE is currently conducting a subsurface investigation at the Maywood site to determine the concentrations and locations of priority pollutant chemicals. Chemical characterization of the wastes in the burial sites on the Stepan Company property will be necessary in the future to identify any chemical contaminants.

Since 1985, chemical analyses have been performed on samples collected from the groundwater monitoring wells shown in Figure 3.3. Wells 1A, 4A, 5A-1, and 7A were dry during 1986 sampling periods. Wells designated "A" are shallow (approximately 3 m [10 ft] deep) whereas "B" wells are deep (approximately 24 m [80 ft] below grade) and extend into the Brunswick formation bedrock aquifer. Groundwater flows from northeast to southwest in both the overburden and the bedrock aquifer; therefore, Wells 2A and 2B are the upgradient wells for the site.

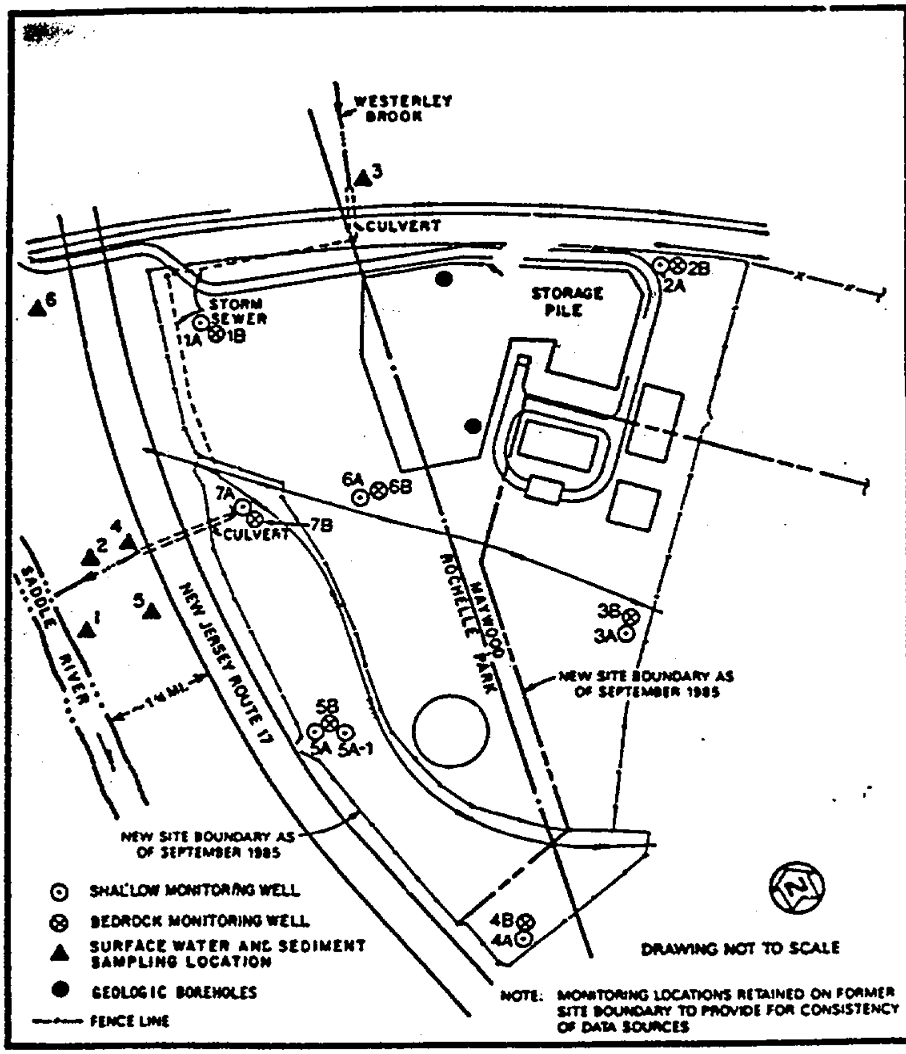


Figure 3.3. Surface Water, Groundwater, and Sediment Sampling Locations at the Maywood Site. Source: Adapted from Bechtel National (1986c).

Samples collected from the groundwater monitoring wells are analyzed for various chemical constituents. They are analyzed quarterly for pH, total organic carbon, total organic halides, and specific conductance; and are analyzed annually for New Jersey priority pollutants. Many of the parameters for which analyses are required by the NJPDES permit had concentrations below the sensitivity limit of the analytical method in 1986 and were therefore not detectable. Generally, the highest concentrations of chemicals were in deep, upgradient wells; the highest concentrations of total organic carbon and total organic halides were detected in Well 2B.

In the shallow (overburden) wells, the highest concentrations of chemicals were detected in Wells 2A (the upgradient well for the site) and 3A. Methylene chloride and toluene were the only specific organic compounds detected in shallow wells. Concentrations tended to decrease across the site to the southwest, in the primary direction of groundwater flow. This may indicate that the principal source of contamination is off-site. Measurements of water level and water quality are ongoing in order to provide additional information on groundwater gradient and flow direction.

3.3 GEOLOGY AND HYDROLOGY

The Maywood site is located in the glaciated section of the Piedmont Plateau of north-central New Jersey. The terrain is generally level, with intermittent shallow ditches and slight mounds (Cole et al. 1981). The surface of the Maywood site slopes gently to the west and is poorly drained. Runoff from the Maywood site currently empties into the Saddle River via Westerley Brook (Figure 3.4). The brook flows under the Maywood site through a concrete storm drain, passes under N.J. Route 17, and eventually empties into the Saddle River. Neither the Saddle River nor Westerley Brook are used as a source of drinking water (Jacobsen 1982).

The bedrock underlying the area is the Brunswick Formation of Triassic Age, which consists of reddish-brown to gray, thin-bedded shales, mudstones, and sandstones. The Brunswick Formation has a thickness of 1,800 to 2,400 m (6,000 to 8,000 ft) and is overlain by unconsolidated sand, gravel, silt, and clay deposits -- primarily of glacial origin. The glacial deposits are variable in depth and are generally thickest in present-day valleys and absent on hill crests. At the Maywood site, the 0.55 to 6.6 m (1.8 to 22 ft) of unconsolidated glacial materials overlying the Brunswick Formation bedrock is comprised largely of stratified drift that exhibits considerable variability both areally and with depth. Borings indicate that considerable amounts of fill material have been placed on the Maywood site during its many years of industrial use (Morton, Undated-b).

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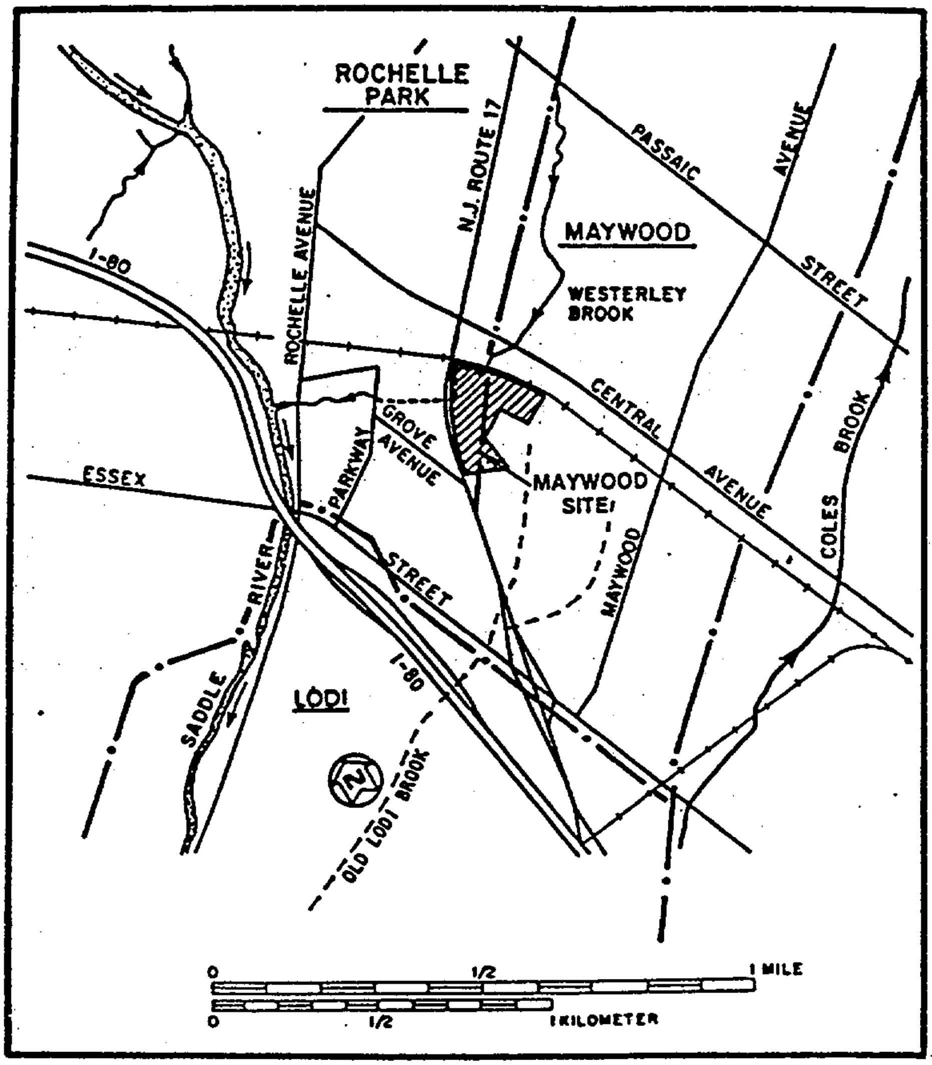

Figure 3.4. Surface Drainage in the Vicinity of the Maywood Site. Source: Modified from Bechtel National (1986c).

The majority of the groundwater utilized in the area comes from the Brunswick Formation, which occurs at depths ranging from 0.55 to 6.6 m (1.8 to 22 ft) in this area (Bechtel Natl. 1986b). The uppermost 4.6 to 6.1 m (15 to 20 ft) of the Brunswick Formation often contains numerous vertical to near vertical, fresh to slightly weathered, open fractures; storage and movement of groundwater within the formation is mainly confined to these openings (Bechtel Natl. 1985b). Both high-yielding industrial and municipal wells, with yields as high as 1,900 L/min (500 gpm), and small domestic wells have been developed in the Brunswick Formation in the area. Water quality is generally good, but elevated hardness is not uncommon, particularly from deep wells (Morton, Undated-b).

Some groundwater is available from the unconsolidated deposits. However, because of the nature of the deposits, well yields are variable. Silt and clay deposits normally yield small quantities of water, and sand and gravel deposits can yield usable quantities of water. Wells screened in these deposits are commonly low-yielding domestic wells; however, some high-yielding wells used for industrial and public supplies have been developed in the thicker surficial deposits of stratified glacial drift (Morton, Undated-b).

The groundwater table at the Maywood site is generally shallow, lying 2 to 3 m (7 to 10 ft) below the ground surface. Based on measurements of groundwater levels by Bechtel National (1985b), the groundwater gradient in the area is low. Flow in both the unconsolidated deposits and the bedrock generally is to the southwest.

Bechtel National (1985b) has drilled 15 monitoring wells (Figure 3.3) and two boreholes on the Maywood site and in the immediate vicinity. Field tests have been conducted in the boreholes at selected depths and intervals to determine the hydraulic conductivity of the various subsurface materials. Because of the reworked nature of much of the soil at the Maywood site, no consistent value could be determined for the conductivity of the overburden. Hydraulic conductivities calculated from field tests varied from 1.6×10^{-2} to 5.3×10^{-6} cm/s for the overburden. Bedrock conductivities varied from 1.0×10^{-3} to 8.3×10^{-5} cm/s.

3.4 METEOROLOGY

New Jersey averages about 120 days of precipitation per year, and the mean annual precipitation is about 120 cm (48 in.). August is the wettest month, with an average of 12 cm (4.8 in.) of precipitation measured at Little Falls, New Jersey, about 14 km (8.4 mi) southwest of Maywood (Gale Res. Co. 1980). The highest amount of precipitation recorded for a single day is 25 cm (9.8 in.), and the highest monthly total is 40 cm (15 in.). Floods frequently accompany heavy rains that are sometimes associated with storms of tropical origin. Short droughts occur during the growing season, but prolonged droughts are rare -- generally occurring only once every 15 years (Gale Res. Co. 1980). The prevailing winds are from the northwest from October through April and from the southwest during the summer months.

3.5 ECOLOGY

Maywood is located within the glaciated area of the Appalachian Oak Forest Section of the Eastern Deciduous Forest Province (Bailey 1978). This forest section is characterized by tree species, including oak, hickory, maple, elm, willow, and ash. However, because the Maywood site and vicinity properties are within an urban setting and are developed or surrounded by industrial and residential properties, no forest habitat is present.

Prior to remedial actions, the Maywood site and Ballod Associates property were dominated by early successional and/or landscape species, mostly grasses and forbs with scattered shrubs and trees (e.g., maple, aspen, willow, elm, and oak). Both sites contained abundant stands of reed phragmites (indicative of poorly drained or moist soils). The introduced (non-native) tree-of-heaven (*Ailanthus altissima*) was also common on the Maywood site (Argonne Natl. Lab. 1984).

As a result of remedial actions to date, most of the Ballod Associates property has been cleared and excavated. A private development project (nursing home) has been subsequently initiated on this portion of the property. Similarly, much of the Maywood site has been cleared of vegetation and prepared for waste storage on an interim basis.

The residential sites contain plant species common to landscaped yards such as grasses (fescue and blue grass), garden vegetables and/or flowers, evergreen shrubs, and trees (Argonne Natl. Lab. 1984). For residential properties that have been decontaminated, the vegetation within the excavated areas was destroyed. Following decontamination, the excavated areas were landscaped consistent with property-owner agreements.

Commonly occurring wildlife species in the Maywood area are those that are adapted to suburban/urban encroachment. Bird species include house sparrow, red-winged blackbird, common crow, common grackle, starling, mourning dove, robin, and wood thrush. In Westerley Brook and the Saddle River, surface-feeding ducks such as mallard and black duck commonly occur. Mammal species expected to occur in the site vicinity include Norway rat, house mouse, meadow vole, white-footed mouse, raccoon, eastern cottontail rabbit, eastern gray squirrel, and short-tailed shrew. Woodchuck burrows were observed at the Maywood site prior to the start of remedial actions (Argonne Natl. Lab. 1984). Only a few reptile and amphibian species that are partially adapted to urban habitats are expected to occur at the contaminated properties, e.g., the eastern garter snake and American toad.

Aquatic habitats are limited to drainageways, small temporary ponds, and Westerley Brook. However, Westerley Brook does not actually occur as aquatic habitat at the Maywood site and Ballod Associates property because it is encased in concrete in that area (Section 3.3). Mosquito larvae, beetles and bugs, snails, isopods, midges, aquatic worms, and other invertebrates typical to small streams and standing water in urban areas may occur in the aquatic habitats.

No threatened or endangered species occur in the Maywood site vicinity (Fairbrothers and Hough 1973; N.J. Dept. Environ. Prot. 1975).

3.6 LAND USE AND SOCIOECONOMICS

3.6.1 Land Use

The Maywood site and the Stepan Company and Ballod Associates properties are encompassed within an area that was initially developed in the late 19th Century as a chemical plant (Mueller and Gunn 1981). The Maywood site was a fenced vacant lot when it was acquired by DOE in 1984. The rest of the Stepan Company property is also enclosed by a fence and is currently used for chemical processing activities. A nursing home is being constructed on the portion of the Ballod Associates property that has been decontaminated. The Ballod Associates property is zoned for residential and industrial use; the Maywood site is zoned for limited light industrial and general industrial use (Bergen Co. Zoning Off. 1986).

A combination of industrial and residential land use occurs within the immediate vicinity. With the exception of one house located along the east border of the Stepan Company property, the area to the east and south of the Maywood site is used for industrial purposes. Several residences are located along the south and west borders of the Ballod Associates property (Grove Avenue residences). The New York, Susquehanna and Western Railroad property lies on the northern border of the Maywood site. New Jersey Route 17 divides the Ballod Associates property from the Maywood site.

Much of the land within several kilometers of the Maywood site is zoned for residential housing (one-family) and limited light industrial use. A few nearby lots are zoned for restricted commercial business. Districts zoned for garden apartments and residential two-family housing are also located within several kilometers of the site.

3.6.2 Socioeconomics

Housing characteristics in Maywood and Rochelle Park (compiled in 1980) are similar. Median home values were $67,600 for the borough of Maywood and $67,700 for the township of Rochelle Park (U.S. Bur. Census 1984) [approximately $9,000 less than the median home value for all of Bergen County].

No churches, schools, hospitals, municipal buildings, or other institutional facilities are currently located immediately adjacent to the contaminated properties. However, these types of facilities occur within 1.6 km (1 mi) of the contaminated areas (U.S. Nucl. Reg. Comm. 1981b) and along the routes that are used for transport of contaminated materials to the Maywood site.

The estimated 1984 populations for the borough of Maywood and Rochelle Park Township were 9,884 and 5,488, respectively (U.S. Bur. Census 1986), representing a 0.1% increase for Maywood and a 2.1% increase for Rochelle Park from 1980. For Bergen County as a whole, the population decreased by 0.4% during 1980 to 1985 (from 845,385 to 842,200).

Radioactive wastes from decontamination of a number of vicinity properties were transported to the Maywood site during 1984 and 1985. Local residents have expressed concerns about (1) the effects of the location of the wastes on residential property values, (2) bringing contaminated materials onto the Maywood site from other communities (e.g., Lodi), and (3) the possibility that the Maywood site could be designated as a permanent disposal facility for radioactive wastes in New Jersey. The local residents are also concerned about past and present health risks associated with the wastes. However, the site is currently being monitored by DOE, and the levels of radioactivity detected in the air and groundwater do not present a health hazard.

4. ENVIRONMENTAL CONSEQUENCES AND MITIGATION

4.1 RADIOLOGICAL

4.1.1 Estimated Impacts

The radiological impacts associated with the proposed interim remedial actions at the Maywood site are summarized in this section. The predominant pathways by which radionuclides could reach nearby workers and members of the general public during the proposed actions are (1) internal dose from inhalation of radioactive gases (radon-220 and radon-222) and their decay products, (2) internal dose from inhalation of radioactive dust particles, (3) external dose from submersion in a cloud of radioactive dust, and (4) external dose from radioactive particles deposited on the ground. This analysis indicates that the inhalation of radioactive gases and particulates would contribute more than 99% of the dose. The dose from ingesting contaminated food or water would not contribute significantly to the total.

The analysis of potential doses to nearby individuals and to the general public within an 80-km (50-mi) radius of the Maywood site is based on the following:

- Radionuclides in each of the two separate decay series (Figures 3.1 and 3.2) are assumed to be present in equilibrium with the parents thorium-232 and uranium-238.

- The average concentrations of radionuclides in the contaminated materials to be excavated and stored are 100 pCi/g for the thorium-232 decay series and 30 pCi/g for the uranium-238 decay series (Table 3.1).

- The average concentrations of radionuclides in the existing below-grade contaminated materials range from 100 to 2,000 pCi/g for the thorium-232 decay series and from 30 to 600 pCi/g for the uranium-238 decay series (Table 3.1).

- The density of the waste materials is assumed to be 1.8 g/cm^3.

- The leachate collection system that will be installed beneath the interim storage piles is assumed to eventually become contaminated with uranium-238 and thorium-232 decay series radionuclides. This system will then require disposal as radioactive waste during Phase II. The concentrations of radioactive contaminants in the leachate collection system at the time of disposal are assumed to be 30 pCi/g for

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thorium-232 decay series radionuclides and 10 pCi/g for uranium-238 decay series radionuclides (Table 3.1).

- The duration of the activities involving cleanup of contaminated areas and construction of the interim storage piles will be a total of 24 months during 1984-1990. It is assumed that at any time during the action period, the exposed working surface on any one of the storage piles will be about 3,700 m^2 (40,000 ft^2).

- Both gaseous and particulate emissions can occur while materials are being excavated and placed on the storage piles, but only gaseous emissions would occur thereafter because the storage piles will be covered and maintained.

- Particulate emissions from excavation activities are assumed to be 0.001% of the material to be moved (U.S. Environ. Prot. Agency 1977). Particulate emissions from the exposed portions of the storage piles during the 24 months required for construction of the four piles (constructed one at a time) are assumed to be 0.13 $kg/m^2 \cdot mo$ (0.60 tons/acre·mo); this value, which is one-half of that reported elsewhere (U.S. Environ. Prot. Agency 1977; Argonne Natl. Lab. 1982), is assumed because the soil will be kept damp to minimize dust generation during remedial action activities. Based upon these assumptions, the total radioactive particulate emissions during the action period would be 0.0014 Ci for thorium-232 and its radioactive decay products and 0.00041 Ci for uranium-238 and its radioactive decay products. Particulate emissions are expected to be minimal during interim storage because the wastes will be covered with a synthetic membrane.

- Radioactive gas emissions include both "puff" emissions when the contaminated soils are disturbed during excavation and "steady" emissions from the storage piles and below-grade wastes. Puff emissions are assumed to be 20% of the radon (radon-222) gas inventory and 10% of the thoron (radon-220) gas inventory; the rest remains trapped within the contaminated particles. Steady emissions account for most of the emissions and are calculated based on the following assumptions: (a) the synthetic membrane cover over the stored wastes reduces the radon gas emissions by a factor of 10 and the thoron gas emissions by a factor of 100, (b) the wastes have a gaseous diffusion coefficient of 0.0036 cm^2/s, (c) the below-grade wastes on the Maywood site are exposed at the ground surface, and (d) the conditions of the below-grade wastes in the three NRC-licensed burial sites at the Stepan

Company property are as follows: Burial Site No. 1 is exposed at the surface, Burial Site No. 2 is covered with pavement, and Burial Site No. 3 is covered with 23 cm (9 in.) of concrete. The estimated thoron and radon fluxes and emission rates shown in Table 4.1 were calculated according to the method of analysis given in a report of the U.S. Nuclear Regulatory Commission (1983).

- To estimate total radon and thoron emissions during the action period (1984-1990), it is assumed that the rate of emission from below-grade wastes at the Maywood site is reduced linearly as the waste materials are placed above grade over the existing below-grade wastes. Radon emissions will therefore be reduced linearly from 50 to 5.7 Ci/yr and thoron emissions from 6,100 to 620 Ci/yr as wastes are moved to the site for interim storage (see Table 4.1). Radon and thoron emissions from the three burial sites on the Stepan Company property are time independent. The total radon and thoron emissions during the 7-year action period are estimated to be 24,000 Ci thoron and 190 Ci radon.

- The population distribution for the 15 million people within 80 km (50 mi) of the Maywood site is estimated based on 1980 county census data.

- Meteorological conditions at Maywood are assumed to be similar to those at Newark, New Jersey, for which meteorological data are available.

- Radiation doses are reported as effective dose equivalents (i.e., weighted dose equivalents) as recommended by ICRP Publication 26 (Int. Comm. Radiol. Prot. 1977). For radiation doses resulting from inhalation of radon and thoron decay products, effective dose equivalents are calculated based on recommendations of ICRP Publication 32 (Int. Comm. Radiol. Prot. 1981).

- Population doses are evaluated in terms of the 100-year environmental dose commitment (EDC). The 100-year EDC is the integrated dose over 100 years resulting from continuous exposure to the radionuclides released either during the 24 months of remedial actions or during each subsequent year of interim storage.

Potential doses to nearby individuals are predicted to be relatively small during both the interim remedial action period and the interim storage period (Table 4.2). The predicted effective dose equivalents are only a relatively small fraction of the dose received from exposure to background sources of radiation (Table 4.3).

Table 4.1. Estimated Radon and Thoron Gas Emissions at and near the Maywood Site

Location and Type of Wastes	Area (m^2)	Radon (Rn-222) Flux ($pCi/m^2 \cdot s$)	Radon (Rn-222) Emission Rate (Ci/yr)	Thoron (Rn-220) Flux ($pCi/m^2 \cdot s$)	Thoron (Rn-220) Emission Rate (Ci/yr)
Prior to Interim Remedial Actions					
Maywood Site, Below-grade wastes only	31,000	46	45	5,700	5,500
Stepan Property, NRC-licensed burial areas	8,000	19	4.8	2,400	610
Total Release Rate			50		6,100
After Interim Remedial Actions					
Maywood Site, Above-grade and below-grade wastes	31,000	0.94	0.91	12	12
Stepan Property, NRC-licensed burial sites	8,000	19	4.8	2,400	610
Total Release Rate			5.7		620

The estimated effective dose equivalents to the general public are presented in Table 4.4. After the remedial actions have been completed, the population near the Maywood site will continue to be exposed to thoron and radon gases, primarily from the three burial sites on the Stepan Company property. These doses should be considerably less near the Maywood site than they were prior to the interim remedial actions because placement of the less contaminated materials above grade over the more contaminated below-grade wastes and placement of all the above-grade wastes beneath synthetic membrane covers will greatly reduce the radon and thoron emissions (Table 4.1). Such actions will not affect radioactive gas emissions from the adjacent Stepan Company property. These doses are very small compared with doses the same population receives from background sources of radiation (Table 4.4).

Table 4.2. Estimated Annual Doses to Nearby Individuals Resulting from Remedial Actions[a]

Individual/ Location	Distance and Direction from Center of Storage Pile	Effective Dose Equivalent (mrem/yr)			
		During Interim Remedial Actions[b]		During Interim Storage[c]	
		Particulates	Radon Gas	Particulates	Radon Gas
Resident on Central Avenue	0.2 km NE	7.3	11	–[d]	2.2
Worker at Stepan Company	0.1 km SE	1.4	1.4	–[d]	0.26
Worker at Sears warehouse	0.3 km S	0.53	4.8	–[d]	0.091
Resident on Grove Street	0.3 km W	3.3	1.9	–[d]	0.37
Resident at nursing home currently under construction	0.2 km NW	–[e]	–[e]	–[d]	0.083

[a] Bases for radiological analysis are given in the text.

[b] These doses are incurred during the 7-year action period.

[c] These doses are incurred while the wastes remain in interim storage at the Maywood site.

[d] No particulates will be released because the wastes will be covered with a synthetic membrane during interim storage.

[e] The resident is assumed to move into the nursing home following completion of interim remedial actions.

Radionuclides in the radioactive wastes currently located below grade are not predicted to migrate off-site during the interim storage period. The synthetic membranes sealed around the above-grade wastes (which, in turn, will be placed over the below-grade wastes) will effectively eliminate water infiltration into the below-grade wastes. The groundwater monitoring program for the Maywood site will determine if off-site migration is occurring, and corrective actions will be taken if significant concentrations are detected.

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Table 4.3. Comparison of Doses to Nearby Individuals Resulting from Remedial Actions with Doses to Nearby Individuals Resulting from Background Sources

Maximum Annual Effective Dose Equivalent from Remedial Actions (values from Table 4.2)	Comparable Annual Dose
18 mrem/yr	200 mrem/yr dose due to external radiation exposure and radon gas from background sources in the Maywood, New Jersey, area
11 mrem/yr due to radon gas emissions only	90 mrem/yr effective dose equivalent received from background sources of radon gas in the New Jersey area[a]

[a] Source: United Nations Scientific Committee on the Effects of Atomic Radiation (1982).

Table 4.4. Estimated Annual Doses to the General Public

Source of Dose	Effective Dose Equivalent (person-rem/yr)[a]
Emissions during remedial actions	44
Continuing gaseous emissions from the storage pile and burial sites on the Stepan Company property	3.2
Background radiation	2,800,000[b]

[a] Reported as the 100-year environmental dose commitment to the population within 80 km (50 mi) of the Maywood site.

[b] Includes dose from external radiation exposure and radon gas.

Work practices and procedures have been developed to ensure that doses to workers are controlled and limited to doses that are less than those specified by DOE regulations for occupational doses (i.e., whole-body doses of 3,000 mrem/qtr or 5,000 mrem/yr). Workers are trained with regard to radiation risks and proper health-physics procedures. Occupational doses are expected to be only a relatively small fraction of the allowable dose.

Because the major contaminants at the vicinity properties are thorium and radium, the decontamination criteria (see Appendix A) provide the appropriate guidance for the cleanup activities. DOE believes that these criteria are conservatively low for considering potential adverse health effects that might occur in the future from any residual contamination. The dose contributions from uranium and any other radionuclides not numerically specified in these criteria are not expected to be significant following decontamination. In addition, because the vicinity properties will be decontaminated in a manner to reduce future doses to levels that are "as low as reasonably achievable" (ALARA), DOE will ensure that most of the radioactivity present at these vicinity properties will be removed during the cleanup.

4.1.2 Monitoring and Mitigative Measures

An environmental monitoring program is being conducted that meets DOE requirements to ensure that the radioactively contaminated materials are stored in a safe and secure manner. The monitoring program includes measurement of (a) uranium, radium, and thorium concentrations in surface water, groundwater, and sediments; (b) radon and thoron gas concentrations in air; (c) external radiation dose rates; and (d) chemical concentrations in groundwater. The results are documented in published annual environmental monitoring reports (Bechtel Natl. 1985a, 1986c). Environmental measurements are reported as percentages of the applicable derived concentration guide (DCG), and the calculated doses are expressed as percentages of the applicable radiation protection standard (100 mrem/yr). Exposure to 1 DCG of any radionuclide continuously for 1 year will result in an annual effective dose equivalent of 100 mrem/yr to the affected individual.

The environmental monitoring program is conducted to determine compliance with DOE's concentration guides and radiation protection standards. During 1985, radon and thoron gas concentrations were less than DOE guides at all monitoring stations (which are located on-site near the existing interim storage pile and at the perimeter of the Maywood site). Annual average radon concentrations ranged from 7 to 17% of the DCG, and annual average thoron concentrations ranged from less than 1 to 32% of the the DCG. For comparison, in 1985 the annual average background radon concentration in the vicinity of the Maywood site was 13% of the DCG, and the annual average thoron concentration was less than 1% of the DCG (Bechtel Natl. 1986c). After completion of the interim remedial actions and placement of wastes beneath synthetic membrane covers, the radon and thoron gas emissions from the Maywood site are expected to be greatly reduced.

The concentrations of radionuclides in surface water and groundwater were monitored at several locations in the vicinity of the Maywood site in 1985, and the measured concentrations were only small fractions of DOE guides. All measured concentrations of uranium, radium-226, and thorium-232 in surface water samples at the Maywood site were less than 1% of the applicable DCGs. In groundwater, all measured concentrations of radium-226 and thorium-232 were less than 1% of the DCGs. The uranium concentrations were somewhat larger relative to their DCG, but all were within allowable levels. The highest uranium concentration measured in groundwater at an on-site well was 11% of the DCG. Although there are no concentration guides for stream sediments, the measured concentrations of radium-226 and thorium-232 in sediments were below residual contamination limits for soil (see Appendix A) (Bechtel Natl. 1986c).

The external exposure rate at various locations along the Maywood site perimeter is higher than that allowed for continual exposure to any member of the general public. However, the Maywood site is secured and public access is limited. In addition, the dose from external radiation decreases rapidly with distance. An individual walking along the western boundary of the Maywood site (the peripheral location having the highest external exposure rate) twice per day for 1 year would receive an annual dose of about 1 mrem/yr, which is 1% of the DOE radiation protection standard. For comparison, the annual background radiation dose due to external radiation in the Maywood area is about 108 mrem/yr (Bechtel Natl. 1986c).

Several measures are being implemented during cleanup to prevent the spread of radioactive materials and to protect workers and nearby residents from exposure to radiation. To minimize dust, all excavations and work areas are maintained in a damp condition. To keep uncontaminated areas clean, trucks are draped with tarpaulins before being loaded. If the truck is parked on a clean area while it is being loaded, the ground is also covered with a tarpaulin. In addition, the trucks are covered before the wastes are hauled to the Maywood site and again before returning empty to the excavation area.

Continuous air sampling is performed at the vicinity properties being decontaminated to monitor radionuclides in the air. Air sampling stations are also located around the storage site. During the cleanup activities conducted to date, none of the measured airborne concentrations exceeded the DOE guides.

4.2 GEOLOGY AND HYDROLOGY

The effects of the remedial actions on the geology and hydrology of the site are expected to be minor. Disturbed areas are subject to wind and water erosion, with subsequent increases in turbidity, sedimentation, and dissolved solids in nearby receiving streams (e.g., Westerley Brook and Saddle River). The greatest potential for such temporary impacts occur during the thunderstorm season. The magnitude of these impacts depends primarily on the amount of disturbed area exposed during a large storm. These potential short-term impacts will be minimized by mitigative measures such as limiting the operation of construction vehicles and other equipment during unfavorable weather conditions; erecting sediment barriers and fences around the storage areas; minimizing the time that the contaminated areas are exposed; using swales, berms, and sediment barriers downslope from the excavation areas; and seeding and mulching the areas as soon as possible. No noticeable change in water quality is expected as a result of the proposed actions.

The proposed remedial actions are not expected to affect the quality of the bedrock aquifer. However, during construction, localized contamination of groundwater in the surficial aquifer (unconsolidated glacial material) is possible (but unlikely) if construction equipment is improperly handled or refueled. Proper management to contain any spills or releases of oils, fuels, greases, and other potentially contaminating materials will minimize this impact.

There is a potential for the groundwater in the surficial aquifer to become radioactively contaminated due to seepage from the existing and newly stored contaminated materials. However, the above-grade contaminated materials at the Maywood site will be sealed within synthetic membranes, eliminating infiltration of precipitation into the wastes and the consequent leaching of contaminants. Any contaminants leached from the wastes by moisture contained in the wastes during placement will be collected in the leachate collection system and should not contribute to groundwater contamination. Water infiltration into the below-grade wastes will also be greatly reduced because the above-grade wastes and synthetic membranes will be placed over these materials. The synthetic membrane covers will be maintained during the interim-storage period.

An on-site groundwater monitoring program has begun, including the installation of monitoring wells. Various physical and chemical parameters are being monitored, including concentrations of radionuclides in both the thorium-232 and uranium-238 decay series. The purposes of this monitoring program are to characterize the existing groundwater conditions at the site, including the extent of any existing contamination, and to monitor any future migration of contaminants during interim storage. DOE will take remedial actions at the Maywood site if significant concentrations of contaminants are detected in the groundwater as a result of waste storage at the site.

The durability of the interim-storage piles could be affected by frost. Frost penetrates to a depth of about 38 to 50 cm (15 to 20 in.) in the Maywood area (Geraghty et al. 1973), and frost heave could cause the synthetic cover to rupture -- resulting in infiltration of snowmelt and rainwater, saturation of the pile, and leaching to groundwater. However, frost heave damage is unlikely because the membranes are flexible and the stored materials are not saturated (leachate will be collected in the leachate collection system). Routine inspection will identify any cover damage so that infiltration and pile saturation would be very localized if damage did occur. In addition, the bottom liner and leachate collection system would prevent any leaching to groundwater.

The drainage characteristics of the Maywood site will be significantly altered as a result of the interim remedial actions. Most of the site will be covered by the interim storage piles (Figure 2.2), which will be enclosed within synthetic membranes. During heavy rainfall, water running off the storage piles could cause erosion of the areas between the piles that are not covered with the synthetic membranes, resulting in potential off-site transport of below-grade contaminants. This problem is unlikely because the drainage paths will have a very gentle slope and, although runoff volume may increase, the velocity of the water will be low.

Several measures will be employed during the interim storage period to mitigate this potential problem. The site will be contoured to direct surface water runoff in a controlled manner. Drainage paths will be protected from erosion through the use of vegetative cover or erosion-control blankets. Runoff water will be passed through sediment barriers to trap any waterborne particulates. This system should reduce to a minimum the potential for off-site transport of any contaminants by runoff water. Additional mitigative measures will be used if surface water runoff proves to be a problem during interim storage.

Water from the Stepan Company plant will be used for equipment decontamination at the site. A steam/high-pressure water system will be used to minimize water use, and water will be recirculated through filters as much as possible. Contaminated water will be stored in a bladder tank and used for dust control on the interim storage piles. Water in excess of the on-site storage capacity will be monitored to verify that it does not contain significant concentrations of radionuclides (above DOE release limits) and will be removed for treatment and disposal. Alternatively, the water could be discharged if it is determined that discharge of such water complies with state requirements.

Construction of access roads requires consumption of sand and gravel resources. These resources are generally available locally, and supplies will not be unduly strained by the demands of this project.

4.3 ECOLOGY

The interim remedial actions are expected to have minimal effects on the terrestrial biota in the Maywood area. Vegetation will be destroyed in the areas where wastes are removed or stored. Such loss of vegetation on undeveloped sites (e.g., remainder of Ballod Associates property to be decontaminated) is not significant because the plant species are not unique or restricted in distribution and they readily repopulate disturbed areas. Decontaminated residential properties are landscaped to near-existing conditions as soon as contaminated materials are removed, as specified in landscape agreements.

Wildlife currently inhabiting the contaminated areas will be displaced (larger and/or more mobile species) or destroyed (smaller and/or less mobile species). Displacement of wildlife into unaffected areas could decrease the number of individuals due to competitive interactions. However, the migratory nature of a number of bird species and the low abundance of most resident wildlife species is expected to result in either the successful relocation of wildlife or in no noticeable impact on local populations. The adverse effects of dust, noise, and construction traffic during the period of waste excavation and transfer to storage will be minimal due to (1) the paucity of wildlife, (2) the location of properties in urban areas where such impacts currently exist, and (3) the plan to keep the spatial and temporal extent of the disturbance to a minimum.

Wildlife species similar to those that occurred prior to remedial actions are expected to become reestablished on the decontaminated areas, especially on the residential properties. However, temporary storage of wastes under synthetic membrane covers at the Maywood site will eliminate most of that site as wildlife habitat during the period of interim storage. After the wastes and associated cover materials are removed and the site is reclaimed, biota are expected to become reestablished at the site. The type of biotic community that would become established depends upon the ultimate use of the site and the type of landscaping conducted, ranging from a community currently existing over much of the site (i.e., old field) to that found in neighboring urban areas (i.e., associated with landscaped lawns).

Remedial actions (and subsequent private developments) will eliminate most or all surface drainageways and small temporary ponds on the remaining contaminated portion of the Ballod Associates property. The species contained in these aquatic habitats are not unique and have widespread distributions;

therefore, adverse environmental impacts related to their elimination are expected to be localized and insignificant. Similar impacts would occur to aquatic biota in other surface water bodies affected by remedial actions.

No impacts to endangered or threatened biota are anticipated because their habitats do not correspond to those found on the affected areas.

Biota can adversely affect the long-term integrity of the stored wastes due to root or burrow intrusion into the wastes followed by mobilization and dispersal of the contaminants via both physical and biological pathways. During the interim storage period, the synthetic membrane covers will be inspected and maintained. If necessary, a pest-control program will be implemented. Thus the potential for biointrusion into the wastes is expected to be much less after than prior to the interim remedial actions when there were no controls in effect.

4.4 LAND USE AND SOCIOECONOMICS

The proposed interim remedial actions are not expected to significantly influence local economy or trends in population growth. However, short-term and long-term adverse effects could occur with respect to property values, visual quality, and traffic levels in the Maywood area. Short-term effects could also occur with respect to noise levels.

It is not known at this time whether residential and commercial property values in the area have been influenced by the existence of the contaminated materials because detailed studies have not been performed. However, previous research on property values at a comparable site indicate that short-term negative effects on property values could occur, particularly for those residences located closest to the site (Payne et al. 1985). The contaminated soils from nearby residential properties will be removed and stored at the Maywood site. This temporary resolution of the problem may have a favorable short-term impact on property values (although data are not available to confirm this contention). Long-term effects on property values are unpredictable, but previous research indicates they are greatly influenced by the existence of negative publicity.

An issue that could influence property values and land-use patterns in the area is the expressed concern for the possibility that the Maywood site could change from a temporary to a permanent location for the wastes. If it is indeed a temporary storage site, as planned by DOE, then the cleanup activities, characterization of the site, and stabilization of the site are all likely to be seen as positive steps that will reduce public concerns about health, safety, and property values. However, as long as the contaminated materials remain at the Maywood site, there is the potential for this issue to remain politically and socially sensitive. Such heightened sensitivity could have long-term adverse impacts on property values and land-use patterns in the area. Eventual removal of the wastes to a permanent disposal facility and decontamination of the Maywood site would likely be viewed as positive steps with regard to this public concern.

A major political problem associated with the remedial action in the borough of Lodi is related to the different views of the municipalities of Lodi and Maywood. Residents in Maywood do not want to have wastes resulting from decontamination of Lodi properties brought to the Maywood site; conversely, residents in Lodi believe it is appropriate for the radioactive contaminants be returned to their place of origin, i.e., to the Maywood site. DOE is working with the municipalities involved to reach an equitable compromise.

The interim remedial actions could result in increased local traffic congestion, especially during rush hours, but such impacts will be mitigated by providing flagmen, as necessary, and by avoiding heavily traveled roads, when possible. Some adverse impacts could result from elevated noise levels due to the close proximity of residences to the areas being decontaminated. Noise impacts can be somewhat mitigated by minimizing the period of disturbance and restricting construction activities to daylight hours.

It is also expected that the storage piles will have a visual impact on the surrounding area because of the size and location of the interim storage piles and the potential visibility of the piles to local residents from a major secondary road (N.J. Route 17) as well as the nursing home (when it is completed). This impact will be minimized by leaving in place trees growing on the east road embankment to serve as visual screening.

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6. LIST OF CONTRIBUTORS

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APPENDIX A. DOE GUIDELINES FOR RESIDUAL RADIOACTIVITY

U.S. DEPARTMENT OF ENERGY GUIDELINES FOR RESIDUAL RADIOACTIVITY AT FORMERLY UTILIZED SITES REMEDIAL ACTION PROGRAM AND REMOTE SURPLUS FACILITIES MANAGEMENT PROGRAM SITES

(Rev. 1, July 1985)

A. INTRODUCTION

This document presents U.S. Department of Energy (DOE) radiological protection guidelines for cleanup of residual radioactive materials and management of the resulting wastes and residues. It is applicable to sites identified by the Formerly Utilized Sites Remedial Action Program (FUSRAP) and remote sites identified by the Surplus Facilities Management Program (SFMP).* The topics covered are basic dose limits, guidelines and authorized limits for allowable levels of residual radioactivity, and requirements for control of the radioactive wastes and residues.

Protocols for identification, characterization, and designation of FUSRAP sites for remedial action; for implementation of the remedial action; and for certification of a FUSRAP site for release for unrestricted use are given in a separate document (U.S. Dept. Energy 1984). More detailed information on applications of the guidelines presented herein, including procedures for deriving site-specific guidelines for allowable levels of residual radioactivity from basic dose limits, is contained in a supplementary document--referred to herein as the "supplement" (U.S. Dept. Energy 1985).

"Residual radioactivity" includes: (1) residual concentrations of radionuclides in soil material,** (2) concentrations of airborne radon decay products, (3) external gamma radiation level, and (4) surface contamination. A "basic dose limit" is a prescribed standard from which limits for quantities that can be monitored and controlled are derived; it is specified in terms of the effective dose equivalent as defined by the International Commission on Radiological Protection (ICRP 1977, 1978). Basic dose limits are used explicitly for deriving guidelines for residual concentrations of radionuclides in soil material, except for thorium and radium. Guidelines for

*A remote SFMP site is one that is excess to DOE programmatic needs and is located outside a major operating DOE research and development or production area.

**The term "soil material" refers to all material below grade level after remedial action is completed.

residual concentrations of thorium and radium and for the other three quantities (airborne radon decay products, external gamma radiation level, and surface contamination) are based on existing radiological protection standards (U.S. Environ. Prot. Agency 1983; U.S. Nucl. Reg. Comm. 1982). These standards are assumed to be consistent with basic dose limits within the uncertainty of derivations of levels of residual radioactivity from basic limits.

A "guideline" for residual radioactivity is a level of residual radioactivity that is acceptable if the use of the site is to be unrestricted. Guidelines for residual radioactivity presented herein are of two kinds: (1) generic, site-independent guidelines taken from existing radiation protection standards, and (2) site-specific guidelines derived from basic dose limits using site-specific models and data. Generic guideline values are presented in this document. Procedures and data for deriving site-specific guideline values are given in the supplement.

An "authorized limit" is a level of residual radioactivity that must not be exceeded if the remedial action is to be considered completed. Under normal circumstances, expected to occur at most sites, authorized limits for residual radioactivity are set equal to guideline values. Exceptional conditions for which authorized limits might differ from guideline values are specified in Sections D and F. A site may be released for unrestricted use only if the residual radioactivity does not exceed guideline values at the time remedial action is completed. Restrictions and controls on use of the site must be established and enforced if the residual radioactivity exceeds guideline values. The applicable controls and restrictions are specified in Section E.

DOE policy requires that all exposures to radiation be limited to levels that are as low as reasonably achievable (ALARA). Implementation of ALARA policy is specified as procedures to be applied after authorized limits have been set. For sites to be released for unrestricted use, the intent is to reduce residual radioactivity to levels that are as far below authorized limits as reasonable considering technical, economic, and social factors. At sites where the residual radioactivity is not reduced to levels that permit release for unrestricted use, ALARA policy is implemented by establishing controls to reduce exposure to levels that are as low as is reasonably achievable. Procedures for implementing ALARA policy are described in the supplement. ALARA policies, procedures, and actions must be documented and filed as a permanent record upon completion of remedial action at a site.

B. BASIC DOSE LIMITS

The basic limit for the annual radiation dose received by an individual member of the general public is 500 mrem/yr for a period of exposure not to exceed 5 years and an average of 100 mrem/yr over a lifetime. The committed effective dose equivalent, as defined in ICRP Publication 26 (ICRP 1977) and calculated by dosimetry models described in ICRP Publication 30 (ICRP 1978), shall be used for determining the dose.

C. GUIDELINES FOR RESIDUAL RADIOACTIVITY

C.1 Residual Radionuclides in Soil Material

Residual concentrations of radionuclides in soil material shall be specified as above-background concentrations averaged over an area of 100 m^2. If the concentration in any area is found to exceed the average by a factor greater than 3, guidelines for local concentrations shall also be applicable. These "hot spot" guidelines depend on the extent of the elevated local concentrations and are given in the supplement.

The generic guidelines for residual concentrations of Th-232, Th-230, Ra-228, and Ra-226 are:

- 5 pCi/g, averaged over the first 15 cm of soil below the surface
- 15 pCi/g, averaged over 15-cm-thick layers of soil more than 15 cm below the surface

These guidelines take into account ingrowth of Ra-226 from Th-230 and of Ra-228 from Th-232, and assume secular equilibrium. If either Th-230 and Ra-226 or Th-232 and Ra-228 are both present, not in secular equilibrium, the guidelines apply to the higher concentration. If other mixtures of radionuclides occur, the concentrations of individual radionuclides shall be reduced so that the dose for the mixtures will not exceed the basic dose limit. Explicit formulas for calculating residual concentration guidelines for mixtures are given in the supplement.

The guidelines for residual concentrations in soil material of all other radionuclides shall be derived from basic dose limits by means of an environmental pathway analysis using site-specific data. Procedures for deriving these guidelines are given in the supplement.

C.2 Airborne Radon Decay Products

Generic guidelines for concentrations of airborne radon decay products shall apply to existing occupied or habitable structures on private property that are intended for unrestricted use; structures that will be demolished or buried are excluded. The applicable generic guideline (40 CFR 192) is: In any occupied or habitable building, the objective of remedial action shall be, and reasonable effort shall be made to achieve, an annual average (or equivalent) radon decay product concentration (including background) not to exceed 0.02 WL.* In any case, the radon decay product concentration (including background) shall not exceed 0.03 WL. Remedial actions are not required in order to comply with this guideline when there is reasonable assurance that residual radioactive materials are not the cause.

C.3 External Gamma Radiation

The average level of gamma radiation inside a building or habitable structure on a site to be released for unrestricted use shall not exceed the background level by more than 20 μR/h.

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*A working level (WL) is any combination of short-lived radon decay products in one liter of air that will result in the ultimate emission of 1.3×10^5 MeV of potential alpha energy.

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C.4 Surface Contamination

The following generic guidelines, adapted from standards of the U.S. Nuclear Regulatory Commission (1982), are applicable only to existing structures and equipment that will not be demolished and buried. They apply to both interior and exterior surfaces. If a building is demolished and buried, the guidelines in Section C.1 are applicable to the resulting contamination in the ground.

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

[a] 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 measured by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

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

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

[d] The average and maximum dose rates associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/h and 1.0 mrad/h, respectively, at 1 cm.

[e] The maximum contamination level applies to an area of not more than 100 cm^2.

[f] The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and measuring the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of surface area less than 100 cm^2 is determined, the activity per unit area should be based on the actual area and the entire surface should be wiped. The numbers in this column are maximum amounts.

D. AUTHORIZED LIMITS FOR RESIDUAL RADIOACTIVITY

The remedial action shall not be considered complete unless the residual radioactivity is below authorized limits. Authorized limits shall be set equal to guidelines for residual radioactivity unless: (1) exceptions specified in Section F of this document are applicable, in which case an authorized limit may be set above the guideline value for the specific location or condition to which the exception is applicable; or (2) on the basis of site-specific data not used in establishing the guidelines, it can be clearly established that limits below the guidelines are reasonable and can be achieved without appreciable increase in cost of the remedial action. Authorized limits that differ from guidelines must be justified and established on a site-specific basis, with documentation that must be filed as a permanent record upon completion of remedial action at a site. Authorized limits differing from the guidelines must be approved by the Director, Oak Ridge Technical Services Division, for FUSRAP and by the Director, Richland Surplus Facilities Management Program Office, for remote SFMP--with concurrence by the Director of Remedial Action Projects for both programs.

E. CONTROL OF RESIDUAL RADIOACTIVITY AT FUSRAP AND REMOTE SFMP SITES

Residual radioactivity above the guidelines at FUSRAP and remote SFMP sites must be managed in accordance with applicable DOE Orders. The DOE Order 5480.1A requires compliance with applicable federal, state, and local environmental protection standards.

The operational and control requirements specified in the following DOE Orders shall apply to interim storage, interim management, and long-term management.

a. 5440.1B, Implementation of the National Environmental Policy Act

b. 5480.1A, Environmental Protection, Safety, and Health Protection Program for DOE Operations

c. 5480.2, Hazardous and Radioactive Mixed Waste Management

d. 5480.4, Environmental Protection, Safety, and Health Protection Standards

e. 5482.1A, Environmental, Safety, and Health Appraisal Program

f. 5483.1, Occupational Safety and Health Program for Government-Owned Contractor-Operated Facilities

g. 5484.1, Environmental Protection, Safety, and Health Protection Information Reporting Requirements

h. 5484.2, Unusual Occurrence Reporting System

i. 5820.2, Radioactive Waste Management

E.1 Interim Storage

a. Control and stabilization features shall be designed to ensure, to the extent reasonably achievable, an effective life of 50 years and, in any case, at least 25 years.

b. Above-background Rn-222 concentrations in the atmosphere above facility surfaces or openings shall not exceed: (1) 100 pCi/L at any given point, (2) an annual average concentration of 30 pCi/L over the facility site, and (3) an annual average concentration of 3 pCi/L at or above any location outside the facility site (DOE Order 5480.1A, Attachment XI-1).

c. Concentrations of radionuclides in the groundwater or quantities of residual radioactive materials shall not exceed existing federal, state, or local standards.

d. Access to a site shall be controlled and misuse of onsite material contaminated by residual radioactivity shall be prevented through appropriate administrative controls and physical barriers--active and passive controls as described by the U.S. Environmental Protection Agency (1983--p. 595). These control features should be designed to ensure, to the extent reasonable, an effective life of at least 25 years. The federal government shall have title to the property.

E.2 Interim Management

a. A site may be released under interim management when the residual radioactivity exceeds guideline values if the residual radioactivity is in inaccessible locations and would be unreasonably costly to remove, provided that administrative controls are established to ensure that no member of the public shall receive a radiation dose exceeding the basic dose limit.

b. The administrative controls, as approved by DOE, shall include but not be limited to periodic monitoring, appropriate shielding, physical barriers to prevent access, and appropriate radiological safety measures during maintenance, renovation, demolition, or other activities that might disturb the residual radioactivity or cause it to migrate.

c. The owner of the site or appropriate federal, state, or local authorities shall be responsible for enforcing the administrative controls.

E.3 Long-Term Management

Uranium, Thorium, and Their Decay Products

a. Control and stabilization features shall be designed to ensure, to the extent reasonably achievable, an effective life of 1,000 years and, in any case, at least 200 years.

b. Control and stabilization features shall be designed to ensure that Rn-222 emanation to the atmosphere from the waste shall not: (1) exceed an annual average release rate of 20 $pCi/m^2/s$, and (2) increase the annual average Rn-222 concentration at or above any location outside the boundary of the contaminated area by more than 0.5 pCi/L. Field verification of emanation rates is not required.

c. Prior to placement of any potentially biodegradable contaminated wastes in a long-term management facility, such wastes shall be properly conditioned to ensure that (1) the generation and escape of biogenic gases will not cause the requirement in paragraph b of this section (E.3) to be exceeded, and (2) biodegradation within the facility will not result in premature structural failure in violation of the requirements in paragraph a of this section (E.3).

d. Groundwater shall be protected in accordance with 40 CFR 192.20(a)(2) and 192.20(a)(3), as applicable to FUSRAP and remote SFMP sites.

e. Access to a site should be controlled and misuse of onsite material contaminated by residual radioactivity should be prevented through appropriate administrative controls and physical barriers--active and passive controls as described by the U.S. Environmental Protection Agency (1983--p. 595). These controls should be designed to be effective to the extent reasonable for at least 200 years. The federal government shall have title to the property.

Other Radionuclides

f. Long-term management of other radionuclides shall be in accordance with Chapters 2, 3, and 5 of DOE Order 5820.2, as applicable.

F. EXCEPTIONS

Exceptions to the requirement that authorized limits be set equal to the guidelines may be made on the basis of an analysis of site-specific aspects of a designated site that were not taken into account in deriving the guidelines. Exceptions require approvals as stated in Section D. Specific situations that warrant exceptions are:

a. Where remedial actions would pose a clear and present risk of injury to workers or members of the general public, notwithstanding reasonable measures to avoid or reduce risk.

b. Where remedial actions--even after all reasonable mitigative measures have been taken--would produce environmental harm that is clearly excessive compared to the health benefits to persons living on or near affected sites, now or in the future. A clear excess of environmental harm is harm that is long-term, manifest, and grossly disproportionate to health benefits that may reasonably be anticipated.

c. Where the cost of remedial actions for contaminated soil is unreasonably high relative to long-term benefits and where the residual radioactive materials do not pose a clear present or future risk after taking necessary control measures. The likelihood that buildings will be erected or that people will spend long periods of time at such a site should be considered in evaluating this risk. Remedial actions will generally not be necessary where only minor quantities of residual radioactive materials are involved or where residual radioactive materials occur in an inaccessible location at

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which site-specific factors limit their hazard and from which they are costly or difficult to remove. Examples are residual radioactive materials under hard-surface public roads and sidewalks, around public sewer lines, or in fence-post foundations. In order to invoke this exception, a site-specific analysis must be provided to establish that it would not cause an individual to receive a radiation dose in excess of the basic dose limits stated in Section B, and a statement specifying the residual radioactivity must be included in the appropriate state and local records.

d. Where the cost of cleanup of a contaminated building is clearly unreasonably high relative to the benefits. Factors that shall be included in this judgment are the anticipated period of occupancy, the incremental radiation level that would be effected by remedial action, the residual useful lifetime of the building, the potential for future construction at the site, and the applicability of remedial actions that would be less costly than removal of the residual radioactive materials. A statement specifying the residual radioactivity must be included in the appropriate state and local records.

e. Where there is no feasible remedial action.

G. SOURCES

Limit or Guideline	Source
Basic Dose Limits	
Dosimetry Model and Dose Limits	International Commission on Radiological Protection (1977, 1978)
Generic Guidelines for Residual Radioactivity	
Residual Concentrations of Radium and Thorium in Soil Material	40 CFR 192
Airborne Radon Decay Products	40 CFR 192
External Gamma Radiation	40 CFR 192
Surface Contamination	Adapted from U.S. Nuclear Regulatory Commission (1982)
Control of Radioactive Wastes and Residues	
Interim Storage	DOE Order 5480.1A
Long-Term Management	DOE Order 5480.1A; 40 CFR 192

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