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ENVIRONMENTAL MONITORING PROGRAM FOR DOE
MIDDLESEX, NEW JERSEY SITE

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1.0 INTRODUCTION

The Middlesex Sampling Plant Site (MSPS) is a United States Department of Energy (DOE) owned facility formerly used for processing and storage of radioactive materials, and currently utilized for interim storage of low level radioactive residues resulting from the cleanup of surrounding properties. The site occupies 9.61 acres of industrial property at 239 Mountain Avenue in the Borough of Middlesex, New Jersey (Fig. 1).

As a result of work done at the site from 1943 to 1955, in processing uranium and thorium ores and concentrates, the site, as well as a number of properties in the vicinity, has been contaminated with radioactive residues. The MSPS and associated properties were given high priority for cleanup under the DOE's Formerly Utilized MED/AEC Sites Remedial Action Program (FUSRAP), and late in 1979 NLO, Inc. was named Program Management Contractor by DOE to initiate remedial action work.

Phase I of the cleanup commenced in FY-1980 with the construction of an impervious asphalt storage pad and drainage system at the plant site, followed by decontamination activities at four of the vicinity properties. Phase II, involving the remaining 30 properties adjoining the plant site, commenced in FY-1981. At the start of FY-1982 (October 1, 1981) management responsibilities at the MSPS were assumed by Bechtel National, Inc., the Program Management Contractor for FUSRAP.

Among the contract management responsibilities for the MSPS is the requirement to maintain adequate environmental monitoring and surveillance programs to assure the safety of the general public and the environment.

FIGURE 1 • SITE LOCATIONS

The purpose of this report is to describe environmental surveillance/monitoring programs previously and currently conducted at the MSPS. This information will be essential for interpretation of current data, and for developing and implementing future monitoring programs at the site.

The program of environmental monitoring is divided into two phases: 1) Routine long-term surveillance and 2) non-routine monitoring during remedial action. In the pre-remedial action period and during the time following remedial work, only routine surveillance of the site is necessary to ensure against contamination of offsite areas. While decontamination work is actually in progress, several changes in surveillance strategy are necessary. There is an increase both in parameters measured, as well as in frequency of measurements. Often this includes the addition of many new sampling stations, and parameters to be sampled, often on a one time only, or very limited basis. More detailed descriptions of the monitoring program conducted during remedial actions can be found in the final reports on Phase I activities at Middlesex during 1980-81.^{1,2}

Most of the environmental monitoring program at the Middlesex site to date has been carried out by NLO's Health Physics/Environmental subcontractor, Eberline Instrument Corp. (EIC), Santa Fe, New Mexico. In addition to NLO/EIC, monitoring activities have been conducted by DOE's Environmental Measurements Lab (EML), Oak Ridge National Lab (ORNL), Mound Laboratories, and the New Jersey Department of Environmental Protection (NJDEP).

2.0 SITE DESCRIPTION

2.1. Site History and Radiological Inventory.

Because deliveries of Belgian Congo ore for the Manhattan Engineering District (MED) project far exceeded the capacity of existing processing plants, on October 27, 1943, the MED leased a warehouse in Middlesex, New Jersey. Here storage, sampling and assaying facilities were established close to the Port of New York. The property was taken by right of entry on this date, and a lease later signed.³ In 1946, after several supplements were added to the lease, the MED requested that the property at the MSPS be purchased. The owners, the American Marietta Corporation, refused to sell the property and condemnation proceedings were initiated on September 12, 1946. The U. S. Government won the verdict and was awarded the property by condemnation and the American Marietta Corporation was paid \$197,000.00 for the property and buildings thereon. Later, additional property which was necessary for a drainage ditch was purchased from private individuals. The area of this addition was 0.23 acre.

The function of the Middlesex Sampling Plant was to thaw, crush, dry, screen, sample, weigh, assay, store and/or ship various types of uranium-bearing ores and beryl ores; and to maintain storage of thorium and beryllium ores which were purchased by the Atomic Energy Commission (AEC).⁴ Materials were received from both foreign and domestic sources. After the ores were processed through the sampling operation, the ores were packaged in air-tight drums, weighed and shipped to the Mallinckrodt Chemical Works in St. Louis, the Brush Beryllium Company at Luckey, Ohio,

and other locations, or stored for later shipment.

Typical ores processed at MSP included Q-11 (pitchblende ore), MGX (magnesium precipitates) and beryllium ore. In addition to these, other uranium and thorium bearing materials were received in small quantities, and were weighed and sampled by hand. Included in this category are black oxides from Vitro Manufacturing Corporation and Eldorado, small lots of uranium bearing compounds, thorium nitrates, thorium sludges, and other thorium bearing compounds. Such materials came to the MSPS primarily for storage purposes.

All ores received underwent a similar processing which consisted of thawing, if necessary, drying in a rotary kiln, crushing and screening. All oversize material was directed to a secondary crusher. Samples were taken for assay from the collection hoppers under the screens.

An additional function of the Middlesex Sampling Plant was to prepare contaminated wastes for shipment and disposal at sea. The dumping at sea was performed by personnel of the U. S. Navy Depot at Earle, New Jersey.

The waste water from outdoor and plant storage areas was sent to a settling tank and the liquor decanted. The waste water from

the laundry and showers was sent to special treatment tanks and the filtrate passed on to the main drainage system. The collected sludge was dumped at sea.

In 1955, operations at the MSPS were terminated, with all work transferred to the Feed Materials Production Center (FMPC) at Fernald, Ohio. The site was later used by the AEC mainly for storage and some sampling of thorium residues. All AEC work ended in 1967 with the decontamination of on-site structures and certification of the site for unrestricted use. The site was occupied until March 1979 by the Sixth Motor Transport Battalion of the U. S. Marine Corps and served as a reserve training center. Following termination of AEC activities at the site in 1967, no further activities involving radioactive materials occurred until the start of remedial action.

In June of 1980, cleanup of the affected vicinity properties was initiated by NLO, Inc. These properties included residences, commercial establishments and vacant lots. Most of the nearby or adjacent properties were contaminated by windblown or water-carried radioactive materials (Fig. 2). Two properties (both within one mile of the site) were contaminated when material from the site was used as landscaping fill. The drainage ditch leading from the site and the small stream into which it flows were also contaminated. The site and associated properties are relatively flat at an elevation of approximately 55 feet above sea level (Fig. 3).

FIGURE 2
GENERAL AREA OF CONTAMINATION

Cleanup of the contaminated properties during 1980 and 1981 necessitated the construction of a storage area for above grade stabilization of the contaminated materials (Fig. 4). Current inventories of stored materials from both Phase I and Phase II are given in Table 1. The amount of radioactivity (curies) present in the 10,646 cubic yards of Phase I material is estimated to be one half curie, while the approximately 30,000 cubic yards estimated from Phase II contains approximately one and one half curies. The final above grade stabilized pile will be composed of about 41,000 cubic yards of low level contaminated soil with a total activity of approximately 2 curies. The total amount of radioactivity present in the site structures and in the soil beneath the site is not known, nor can it be accurately estimated from existing data.

FIGURE 4 · LOCATION OF STORAGE AREA

TABLE 1
STORED VOLUMES OF CONTAMINATED SOIL

	<u>SOURCE</u>	<u>QUANTITY (Yd³)</u>	<u>TOTAL RADIOACTIVITY (CURIES)</u>
PHASE I	Site (Resulting from Construction of Storage Pad)	1,225	
	Rectory	4,160	
	Rectory Playground	156	
	William Street Property	1,246	
	Rosamilia Property	3,726	
	Kays Property	<u>133</u>	
	Phase I Total	10,646*	0.5
PHASE II	Phase II Total	<u>30,000**</u>	<u>1.5</u>
TOTAL:		40,646	2***

*This figure represents the final compacted volume of the Phase I pile and has been verified by FBDU field engineers.¹

**Estimated quantity based upon excavation through October 1, 1981.

***Estimated activity based upon projected Phase II quantities and upon estimated average ²²⁶Ra concentration of 40 pCi/g and soil density of 2800 lb/yd³.

2.2 Demographics

A map of the general area around the DOE-MSPS (Central New Jersey) is presented in Figure 1. The area surrounding the site is a mixture of industrial, commercial, and residential property (Fig. 5). Ford, Bacon & Davis, Utah (FBDU)⁵ estimated in 1979 that there were approximately 9,700 people living in some 2,750 dwellings within a one mile radius of the Sampling Plant (Fig. 6). The population of a few communities in the vicinity of the MSPS are listed in Table 2. Census figures from 1980 and 1970 are compared.

TABLE 2 LOCAL DEMOGRAPHICS

<u>Community</u>	<u>1980</u>	<u>1970</u>	<u>Change</u>
Middlesex (Borough)	13,480	15,038	-10.36%
Middlesex (County)	595,893	583,813	+ 2.03%
Piscataway	42,223	36,418	+13.75%
Dunnellen	6,593	7,072	- 6.77%

LEGEND

- RESIDENTIAL
- COMMERCIAL
- INDUSTRIAL
- PUBLIC
- VACANT

FIGURE 5 • LAND USE

(ADAPTED FROM FORD, BACON & DAVIS UTAH, Inc. 1979)

NOTE: NUMBERS REPRESENT POPULATION ESTIMATES PER SECTOR

FIGURE 6 · POPULATION DISTRIBUTION AROUND SITE
 (ADAPTED FROM FORD, BACON & DAVIS UTAH, Inc. 1979)

Because little unimproved or vacant land is available for residential or industrial development, land use patterns in Middlesex are not expected to change drastically. This is also true because this is not an area of rapid population increase or decline. To the south of Middlesex, in Piscataway Township, there has been less development, and more vacant lands exist. This is due primarily to the absence of good railroad and highway connections which Middlesex enjoys. However, with the completion of Interstate 287, the area has become more attractive, and future activity will likely include more development of residential areas south and southeast of the site. This will also probably include some industrial development approximately one half to one mile south/ southwest of the site.

2.3 Meteorology

Listed below are meteorological data from the U. S. Weather Service, gathered at the Newark International Airport, Newark, New Jersey. This is 40 miles northeast of the Sampling Plant. All averages are for the period 1951-1970 (1961-1980 data not yet available).

TABLE 3

LOCAL METEOROLOGY

Average Annual Precipitation	41.45"
Average Days of Measurable Precipitation	123
Average Wind Speed*	10.2 MPH SW
Average Temperature	53.9°F.
Average High Temperature	62.5°F.
Average Low Temperature	45.2°F.
Record High Temperature	105°F., July 1966

(TABLE 3 Continued)

Record Low Temperature	1°F., Jan. 1968
Average Number of Clear Days	96
Average Number of Partly Cloudy Days	113
Average Number of Cloudy Days	156
Average Number of Days Temperature Goes Below Freezing	84

*See Figure 7 for Wind Rose

The terrain around Newark is described as relatively flat and marshy, with ridges rising generally to the north. The drying effect from downslope winds accounts for the few convection thunderstorms in summer. Considerable amounts of precipitation occur as a result of northeasterly winds off the Atlantic Coast. These are most common in the Fall and Winter. On average these storms last a minimum of two days and leave one to two inches of precipitation. In summer, periods of hot weather lasting weeks at a time are the result of westerly winds which have a long trajectory overland. Extremes of cold in winter are related to northerly winds from Hudson Bay, with coast winds acting to moderate temperatures.

Very little meteorological data are presently included with environmental data, despite the large effect meteorology may have, particularly on radon results. Wind direction and speed play a large role in the level of radon gas found at any given location. Also, moisture has been found to significantly reduce radon flux. Therefore, meteorological data

**FIGURE 7 - NEWARK AIRPORT SURFACE WIND ROSE
(CUMULATIVE DATA FROM 1951 THROUGH 1960)**

(ADAPTED FROM FORD, BACON & DAVIS UTAH, Inc. 1979)

should include temperature, precipitation, and wind data (most easily presented in the form of a wind rose). The effects of these dynamic meteorological conditions on both radon emissions and measurements have been well documented. For this reason, surveillance data should be presented as a relative indication of radon concentration for the sampling period, and not extrapolated to make long range average emission level predictions. The data collection should be over as long a period as possible to eliminate short-term perturbations. Also, as many sampling locations as possible should be used, to eliminate local perturbations. Long term averages also tend to smooth out statistical measurement uncertainties.

Currently meteorological data are collected from a weather station located atop the Process Building at the MSPS. This station, installed in September 1980 as part of the Mound Laboratory radon monitoring network, measures temperature, wind speed, wind direction, dew point, relative humidity, precipitation, and solar radiation. Data from this station are collected by Rutgers University and are reported directly to Mound where they are compiled in quarterly reports to DOE-HQ (EP) for dissemination.

3.0 ENVIRONMENTAL SURVEILLANCE/MONITORING PROGRAM

The environmental monitoring program at the MSPS involves sampling or measuring gaseous and particulate radioactive contaminants in air, soluble and insoluble radionuclides in surface and groundwater, direct (gamma) radiation, and other parameters such as biological uptake or radionuclides in sediments. The monitoring program is summarized in Table 4.

3.1 Program Elements

3.1.1. Air Monitoring

An air monitoring program is necessary at the MSPS to measure gaseous and particulate radioactivity released into the air from stored materials and contaminated areas on the site, and also as a result of remedial action activities.

Particulates

Air particulate releases from the site and from associated properties result primarily from disturbance as a result of earth moving activities during remedial action. Since all excavated material is stored in a covered mode, and all undisturbed areas are stabilized by vegetative or asphalt cover, particle resuspension by wind is not a normal concern except during remedial action.

TABLE 4

MIDDLESEX SITE ENVIRONMENTAL MONITORING PROGRAM

Medium/Pathway	SAMPLE COLLECTION			SAMPLE ANALYSIS
	NUMBER & LOCATION	METHOD	FREQUENCY	
Air Particulates	*4 - One at each cardinal compass point on boundary of storage site	Continuous, low volume, glass fiber filter	Weekly filter exchange (48 hour filter exchange during excavation)	On-site screening of individual filters by gross alpha count after 7 days (to allow for radon progeny decay) - and - Monthly composite by sample location for ^{226}Ra , ^{230}Th , ^{210}Pb , total U, and stable Be
	*1 - At background location			
	*4 - At boundaries of each excavation site		(during excavation)	
	*Occasionally from vehicle following loaded truck along entire route	High volume	Occasional	
Radon Gas	*Same sites as air particulate samplers	Pulse pump and mylar bag, 48 hr. integrated sample	Weekly (during excavation)	^{222}Rn by onsite alpha scintillation counting of daughters after 3 hour ingrowth period
	6 - At onsite points surrounding storage area	PERM (Mound Labs)	Weekly	
	21 - Offsite concentric network surrounding storage site	PERM (Mound Labs) 5 sites also have indoor PERM'S	Quarterly	

(Cont'd.)

TABLE 4 (Continued)

MIDDLESEX SITE ENVIRONMENTAL MONITORING PROGRAM

Medium/Pathway	SAMPLE COLLECTION			SAMPLE ANALYSIS
	NUMBER & LOCATION	METHOD	FREQUENCY	
Surface Water	4 - One at each Surface Stream Sampling location: Upstream Confluence Downstream Outfall	1 liter grab sample (4 liters when isotopic analysis is to be done)	Monthly for 1 quarter; quarterly thereafter *Monthly *Monthly *Weekly *Twice Weekly	On-site gross alpha counting of residue after evaporation 10% of samples isotopically analyzed for ^{226}Ra 2% for total U 1% for ^{230}Th , ^{210}Pb , ^{210}Po
	*3 - One at each onsite surface water sampling location: Pad runoff sump Decon trailer septic tank Pad runoff settling tanks		Monthly and after significant rainfall	
Sediments	*1 - Site outfall drain pipe	Approx. 2000g grab sample	Monthly	^{226}Ra , ^{230}Th , ^{210}Pb and total U
	*1 - Downstream water sampling location			

(Cont'd)

TABLE 4 (Continued)

MIDDLESEX SITE ENVIRONMENTAL MONITORING PROGRAM

Medium/Pathway	SAMPLE COLLECTION			SAMPLE ANALYSIS
	NUMBER & LOCATION	METHOD	FREQUENCY	
Ground Water (Shallow System)	12 - Shallow wells up-and downgradient from the storage area	1 liter grab samples by bailing	Monthly for 1 year (may be varied, depending upon results); semi-annual thereafter	226Ra and 238U (dissolved and suspended)
(Deep System)	8 - Deep wells up-and downgradient from the storage area			
	14 - Drinking water wells in the Middlesex - Piscataway area	(by State of New Jersey)		
Direct Radiation (Gamma)	8 - Outdoor locations surrounding the storage area	TLD	Change TLD's quarterly	Gamma
	2 - Indoor locations in frequently occupied buildings onsite			

*Additional monitoring during Remedial Action Activities

During Phase I and Phase II remedial action, air particulate samples were collected continuously at four opposite access control boundaries per site and at one remote area background station (Fig. 8, 9). The weather-protected low volume (40 ± 10 liters/min.) samplers were run continuously during the complete operation to provide initial, operational, and post operational air particulate data.

Filters were exchanged every 48 hours or as dictated by dust loadings. Filters were inspected frequently to observe visible buildup of dust. If filters were "dirty" they were exchanged so as to prevent dust on the filter face from shielding the alpha particles being emitted.

The remaining potential air particulate pathway was dust generation from loaded haulage trucks. Engineering design such as water spray and a tarpaulin covering was employed to restrict the quantity of dust released. To monitor the effectiveness of the dust containment methods employed in hauling the materials, samples were occasionally collected continuously along the entire length of the route by samplers mounted on a vehicle following the haul trucks. These mobile units were battery operated high volume samplers capable of operating at about 20 scfm.

FIGURE 8
AIR PARTICULATES SAMPLING LOCATIONS

Grid layout in meters

- LEGEND**
- [RM] - Radon Sampler
 - - TLD Location
 - * - RAS Location

FIGURE 9
TYPICAL ENVIRONMENTAL
SAMPLING LOCATIONS FOR EXCAVATION SITES

Air particulate filters were analyzed on site by gross alpha counting with an Eberline SAC-4 scintillation detector. To allow for radon progeny decay, filters were counted at least three days after collection. By use of the flow rate, collection duration, and deposited activity, the gross average air concentration in uCi/cc was determined. This calculated value was compared with the maximum permissible concentration (MPC) for ^{230}Th in airborne releases to unrestricted areas set forth in DOE Manual, Chapter 0524.⁶ This isotope has the most restrictive MPC of the ^{238}U alpha emitting long-lived progeny, being 8×10^{-14} uCi/cc. MPC's established by the NRC⁷ and by the New Jersey Bureau of Radiation Protection⁸ for ^{230}Th are identical to the DOE criterion, however, MPC's for other radionuclides differ somewhat. MPC's from the NRC and from New Jersey are compared in Table 5 to the MPC's established by DOE which are the appropriate guidelines for the DOE-owned MSPS.

Composites of all filters by location were isotopically analyzed monthly for Th-230, Ra-226, Pb-210 and total uranium at Eberline's Albuquerque laboratory to determine the average isotopic air concentration.

Data from the air particulate sampling generally indicate a positive correlation between excavation activities and airborne radionuclide concentration. However, isotopic analysis of filter composites showed that even for ^{230}Th , concentrations were generally less than 1/100 of the MPC, with the highest being .0009 pCi/m³.

During the period between Phase I and Phase II (November 1980 - July 1981) the samplers were recalibrated to a flow rate of 25 l/min., and filter exchanges were made weekly. Following Phase II, all excavated material will be isolated within the EPDM-covered storage pile, and air particulate monitoring should no longer be required on a routine basis.

TABLE 5
ENVIRONMENTAL STANDARDS FOR
DOE MIDDLESEX SITE

RADIONUCLIDE		CONTROLLED AREAS						UNCONTROLLED AREAS					
		WATER			AIR			WATER			AIR		
		DOE	NRC	NJ	DOE	NRC	NJ	DOE	NRC	NJ	DOE	NRC	NJ
Ra-226	(s)	400	<----->		.03	<----->		30	<----->		.003	<----->	
	(i)	9x10 ⁵	<----->		.05	<----->		3x10 ⁴	<----->		.002	<----->	
Rn-222					100	30	30				3	3	1
Rn daughters					1WL	.3WL	.3WL				.015WL*	.03WL	.01WL
Th-230	(s)	5x10 ⁴	<----->		.002	<----->		2000	<----->		8x10 ⁻⁵	<----->	
	(i)	9x10 ⁵	<----->		.01	<----->		3x10 ⁴	<----->		.0003	<----->	
U-238	(s)	1x10 ⁶	1x10 ⁶	2x10 ⁴	.07	<----->		4x10 ⁴	4x10 ⁴	600	.003	<----->	
	(i)	1x10 ⁶	<----->		.1	<----->		4x10 ⁴	<----->		.005	<----->	
U natural	(s)	5x10 ⁵	1x10 ⁶	2x10 ⁴	.07	.1	.07	2x10 ⁴	3x10 ⁴	600	.003	.005	.003
	(i)	5x10 ⁵	1x10 ⁶	5x10 ⁵	.06	.1	.06	2x10 ⁴	3x10 ⁴	2x10 ⁴	.002	.005	.002

MPC's expressed in pCi/l except Rn daughters which are in WL (annual averages)

DOE = DOE Manual Chapter 0524⁶

NRC = 10 CFR 20, Standards for Protection Against radiation⁷

NJ = New Jersey Administrative Code, 7:28 - 6.5⁸

* = 40 CFR 192, Proposed Cleanup Standards for Inactive Uranium Processing Sites

s = soluble

i = insoluble

<-->= same as DOE standard

Radon

Gaseous releases are in the form of radon-222 (^{222}Rn) which is the decay product of radium-226 (^{226}Ra). Both are part of the uranium decay series. The maximum permissible concentration (MPC) of ^{222}Rn is 3.0 pCi/l annual average for uncontrolled areas beyond the perimeter of the site, per DOE Manual, Chapter 0524. For controlled areas, such as within the site, the MPC for ^{222}Rn is 100 pCi/l. NRC and New Jersey MPC's for ^{222}Rn are more restrictive (Table 5), however, the DOE limit is the appropriate guideline for the DOE-owned MSPS.

The MPC for radon decay products proposed by the U. S. EPA for cleanup of inactive uranium processing sites is 0.015 working levels (WL) for uncontrolled areas (40 CFR 192, Proposed Cleanup Standards for Inactive Uranium Processing Sites). The DOE controlled area MPC is 1.0 WL, and is the appropriate guideline for on-site considerations. NRC and New Jersey MPC's for radon decay products are 1/100 of the numerical value of the ^{222}Rn MPC expressed in WL (see Table 5).

Background levels of radon and radon decay products were measured in dwellings in the Middlesex area (within 50 mi.) during a two year survey conducted by the

Environmental Measurements Laboratory (EML) from 1976 to 1978.⁹ The average background concentration of radon in basements was found to be 2.7 pCi/l, and the average radon daughter concentration in dwellings was 0.009 WL. Outdoor background levels of radon daughter concentration averaged 0.002 WL.

Several radiological surveys of the MSPS and surrounding area were conducted by EML and Oak Ridge National Laboratory (ORNL) during the period from March 1976 until remedial actions were begun by NLO in June 1980.^{10,11} These surveys included measurements of indoor and outdoor radon and radon daughter concentrations both onsite and in dwellings and commercial buildings near the site. Prior to the initiation of remedial action activities at Middlesex, EML's radon monitoring responsibilities were assumed by Mound Laboratories. In May 1980, Mound instituted a program of on and offsite monitoring for indoor and outdoor radon and radon daughter concentrations during remedial action. The program included six onsite Passive Environmental Radon Monitors (PERM's) surrounding the storage pile (Fig. 10), as well as monitors at the excavation sites (Fig. 9), and along the transport routes.

During both Phase I and Phase II remedial action, NLO/EIC conducted radon and radon daughter monitoring as part

of the environmental, health, and safety program. Forty-eight (48) hour composite air samples were collected with pulse pumps in 44 liter mylar bags on a weekly schedule at the air particulate sampling stations (Fig. 10). Samples were analyzed onsite by scintillation alpha counting. Radon sensitivity is about 0.02 pCi/l. Radon daughter measurements were made weekly in all areas occupied by project personnel. Radon daughter sensitivity is 0.01 $\pm$ 4.2% WL using the modified Kusnetz method.

Outdoor radon concentrations at the excavation sites generally showed a decline after excavation and removal of the material from each property. Outdoor radon levels at the Sampling Plant site fluctuated between 0.2 and 1.0 pCi/l during the project. This fluctuation resulted from excavation/construction activities at various times on the site, and from the dumping, compacting, and sealing activities associated with building the storage pile. In no case did the measured radon level exceed the limit for unrestricted areas (3 pCi/g).

During the period between Phase I and Phase II (December 1980 to July 1981) Mound initiated an offsite radon monitoring network with 21 outdoor and five indoor PERM locations at varying directions and distances surrounding the site, including the Rectory and 432 William Street.

FIGURE 10
RADON SAMPLING LOCATIONS

ORNL also continued monitoring in the Rectory basement.

Post Phase II radon and radon daughter monitoring will consist of Mound Lab's onsite (six outdoor PERMS) and offsite (21 outdoor + five indoor PERMS) monitoring program. The New Jersey Department of Environmental Protection (NJDEP) will also monitor radon daughter levels with a network of Terradex samplers.

3.1.2. Water/Sediments Monitoring

The MSPS is contaminated with radioactive residues, and all rainfall runoff is away from the property. Because of the potential for these contaminants to be carried offsite by aqueous vectors, a program for monitoring surface and ground water is necessary. Maximum permissible concentrations are the same for surface and ground water (Table 5). MPC's established by the NRC and by the New Jersey Bureau of Radiation Protection differ somewhat from those put forth by DOE, however, the DOE limits (Manual Chapter 0524) are the appropriate criteria for the DOE-owned MSPS. For water samples from drinking water wells included in the monitoring program, the EPA Primary Drinking Water Standards (40 CFR 141) for the radionuclides of concern are:

^{226}Ra	5 pCi/l
Gross alpha	15 pCi/l
Gross beta	50 pCi/l

Surface Water

With the initiation of remedial action activities at the MSPS, NLO/EIC instituted a program of monitoring surface water at several locations on and off site (Table 6, Fig. 11). This monitoring program served as a check on offsite migration of contamination via surface water during construction and earthmoving activities.

TABLE 6

LOCATIONS OF SURFACE STREAM SAMPLE POINTS

<u>SAMPLE POINT</u>	<u>LOCATION</u>
Site Outfall	South of South Boundary Fence, Downstream of Rock Fill in Drainage Ditch.
Upstream	Off Mountain Avenue, approxi- mately 200 yds. South of William Street Intersection, in Main Stream near Street.
Confluence	At end of Drainage Ditch South of Site, at Government Boundary Fence.
Downstream	Main Stream on North Side of Possumtown Road Bridge, approximately 2200 ft. Down- stream from Confluence.

FIGURE 11
SURFACE STREAM SAMPLE POINTS

One liter water grab samples were collected daily from the south fence drain pipe; weekly from the confluence of the central drainage ditch with Main Stream; twice per week (later changed to bi-weekly) from the pad runoff settling basin, from Main Stream at a point approximately one-half mile downstream from the site and a point a short distance upstream; occasionally from the septic tank holding the access trailer shower drainage; and from all sampling points after any significant rainfall (Table 4).

Prior to Phase II, all water samples were returned to Eberline's Albuquerque laboratory for analysis. Upgrading the onsite lab in preparation for Phase II made possible onsite analysis for determination of compliance with discharge criteria. At least 10% of all water samples were still sent to Eberline's Albuquerque lab for isotopic analysis.

Onsite analysis consists of evaporation of 300 to 500 ml of the water sample, and alpha counting of the dried residue with an Eberline SAC-4 scintillation alpha counter. If necessary, the sample is first filtered to remove sediments and organic material which can be counted and reported separately using the same gross alpha technique.

Of the water samples sent offsite for isotopic analysis, 100% were analyzed for ^{226}Ra concentration, with approximately 20% isotopically analyzed for total uranium, and 10% for ^{230}Th , ^{210}Po . Monthly the soluble and suspended ^{226}Ra components of the samples were determined. When isotopic analyses are required, four liter samples are collected.

Results from the surface water sampling show that the DOE limits for release to unrestricted areas were not exceeded during the project. At the site outfall, which flows into a ditch within a restricted access area, uranium and radium concentrations fluctuated due to increased activities on the site and also as a result of increases in waterflow (both natural and project-related) from the site.

Uranium and dissolved and total radium concentrations at the outfall were recorded as high as 599 pCi/l, 100 pCi/l, and 250 pCi/l respectively, however, the filter dams and/or dilution effectively reduced these concentrations in the water by the time it entered Main Stream. Uranium concentrations in the stream reached 82 pCi/l, but were generally less than 1/100 of the limit for release

(40,000 pCi/l). The concentrations of ^{226}Ra in the stream were also above the upstream background levels, but were all below the limits - 30 pCi/l dissolved and 30,000 pCi/l total.

Sediment samples were collected monthly from the drain pipe and downstream water sampling locations. Samples were analyzed for Ra-226, Th-230, Pb-210 and total uranium.

Following Phase I and throughout Phase II, surface water monitoring was continued, utilizing the same sampling locations, but on a less frequent sampling basis than during Phase I (Table 4). Samples were collected twice weekly from the site outfall, weekly from the downstream location, monthly from the confluence and upstream, and monthly from the pad runoff, the settling tanks, and the settling sump. Samples were also taken after significant rainfall.

Following Phase II, sampling should continue at the four surface stream sampling points (Fig. 11) on a monthly basis for an initial monitoring phase, which may be revised upon evaluation after a period of at least one quarter. Less frequent sampling (quarterly or semi-annual) should be maintained as a check on the

integrity of the storage pile for as long as material is stored on the site.

Ground Water

The groundwater beneath the MSPS could potentially be contaminated as a result of contaminants migrating as leachates from material remaining beneath the surface of the site, or from the aboveground stored material in the event of failure of the storage pad. In May 1980, a system of groundwater monitoring wells was drilled on the site by Roy F. Weston, Inc., under contract to ORNL. Results of Weston's initial sampling identified both shallow (5-10 ft.) and deep (15-25 ft.) ground water regimes underlying the site.¹² Both regimes are potential routes for radionuclide migration; therefore, both systems must be monitored in order to fully assess the integrity of the storage pad.

The Weston program consisted of 15 shallow (10 ft.) and five deep (up to 50 ft.) test wells at selected points on the site (Fig. 12). Design and depths of these wells are shown in Fig. 13 and Table 7. Each boring was cased with four inch diameter schedule 40 PVC pipe. In the shallow borings, the casing was slotted to within three to five feet of the surface and set into bedrock. Casing in the deep borings was set into bedrock and was not slotted.

All borings were sealed at the top to prevent infiltration of surface water.

Water has been collected from these wells monthly by bailing, and analyzed for ^{226}Ra (dissolved and suspended). Results from the test well monitoring show that the shallow (5-10 ft.) ground water system is contaminated from contact with radionuclide bearing materials under the site's asphalt surface. The deeper groundwater system is not contaminated (one well, 6A, from which contaminated water was sampled may have been cross-contaminated from the surface).

In response to recommendations by ORNL and Weston, and as a result of elimination of several wells when the storage pad was expanded for Phase II, four new deep and two new shallow monitoring wells were drilled on the site in July 1981. These wells were basically the same configuration as the first set of 15 drilled prior to Phase I (see Fig. 14, 15 for construction details). The new wells were located (Fig. 12) so as to allow detection of any new flow routes which may have developed during or following pad construction. At the same time that the new wells were drilled the old wells eliminated by pad expansion (well nos. 6, 6A, and 10) were grouted and plugged and those remaining were refurbished by cleaning out

FIGURE 12
 GROUNDWATER MONITORING WELLS AT MIDDLESEX SITE

FIGURE 13
MONITORING WELL INSTALLATION DETAIL
PHASE I

TABLE 7

DEPTHS OF GROUNDWATER MONITORING WELLS - MSPS

<u>Phase I Wells</u>		<u>Phase II Wells</u>	
<u>Well No.</u>	<u>Depth (ft)</u>	<u>Well Type</u>	<u>Depth (ft)</u>
1	10	2 Shallow Wells	10
1A	50	4 Deep Wells	50
2	10		
3	10		
3A	50		
4	10		
4A	30		
5	10		
5A	50		
6	10		
6A	45		
7	10		
8	10		
9	10		
10	10		
11	10		
12	10		
13	10		
14	15		
15	5		

obstructions and installing protective concrete collars to prevent damage from vehicles (Fig. 16).

The current ground water monitoring system, therefore, consists of 8 deep and 12 shallow onsite wells. It is Weston's recommendation that following Phase II these wells be sampled on a bi-weekly, monthly, or less frequent basis, depending on water quality detected in initial sampling, for a period of one year. Periodically, pump tests should be run on each well. During the pump tests, samples should be collected from the pumped effluents as well as from the initial well influent. Pumped effluents with contaminants above ALARA levels should be temporarily stored until acceptably disposed of.

The network of wells to be sampled and the sampling frequency may be revised upon evaluation of data from initial monitoring. Less frequent (semi-annual or annual) sampling should be maintained as a check on the integrity of the storage pad for as long as the material is stored on the site.

Additional information on ground water quality in the vicinity of the MSPS is being provided to the Health Inspector of Middlesex Borough by the State of New Jersey Department of Environmental Protection (NJDEP),

FIGURE 14
SHALLOW MONITORING WELL
INSTALLATION DETAIL
 (PHASE II)

FIGURE 15
DEEP MONITORING WELL
INSTALLATION DETAIL
 (PHASE II)

FIGURE 16
DETAILS FOR REPAIRING AND
SEALING OF OLD MONITORING WELLS
 (PHASE II)

which began sampling drinking water wells in the Middlesex area in December 1977. The wells sampled by NJDEP include domestic wells, community supply wells, and wells for private industry (Table 8). Samples are analyzed for gross alpha, gross beta, and ^{226}Ra concentrations. To date, NJDEP has not reported radioactivity concentrations in any of these wells in excess of U. S. EPA limits for drinking water.

TABLE 8

DRINKING WATER WELLS MONITORED BY STATE OF NEW JERSEY

1. Puritan Packaging Co., Egel Ave. & Blackford
2. Marine Base Water Supply, Elizabethtown Water Co.
3. M. DeWitt Industrial Co., Mountain Ave. near South Ave.
4. Elizabethtown Water Co., Well #7, Sebring Mills Well Field
5. Elizabethtown Water Co., Public Supply
6. 15 Baltimore Ave., Piscataway Twp.
7. Phillips Lens Co., Cedar Ave.
8. 110 Blackford Ave., Piscataway
9. Elizabethtown Water Co., Well #6, Sebring Mills Well Field
10. Ianiero, 233 Mountain Ave.
11. Al's Boiler Shop
12. Tobey, 21 Boston Ave., Piscataway Twp.
13. 611 Williams St.
14. 36 Wayne Street, Piscataway

3.1.3 Direct Radiation Measurement (Gamma)

The environmental monitoring program for the Middlesex Sampling Plant Site includes measurement of gamma radiation from radioactive sources onsite and along the site perimeters so that exposure rates may be estimated and an assessment made of the risk to the public due to radiation from residues on site.

Criteria established by DOE⁶, the NRC⁷ and the State of New Jersey⁸ limit exposures of persons in uncontrolled areas to not more than 0.5 rem/yr, and of radiation workers within controlled areas to not more than 5 rem/yr or a maximum of 3 rem/quarter.

Environmental gamma radiation is measured by thermoluminescent dosimeters (TLD's). Environmental TLD's have been implaced since the beginning of Phase I at 10 onsite locations including the four particulate air monitoring locations, and inside several buildings (Fig. 17). All environmental TLD's were changed quarterly. During remedial action, TLD's were implaced at the air particulate sampling locations at the boundaries of each excavation site (Fig. 9). In addition, individual exposures were measured with TLD badges worn by all personnel during remedial action.

Results of the environmental TLD monitoring demonstrate that exposure rates at each of the sites during the remedial action operations averaged about 2 mRem per week. Exposure rates at points on the Sampling Plant site are greater than the offsite locations, as would be expected.

3.1.4 Miscellaneous Monitoring

Biological

The purpose of a biological sampling program is to determine the ultimate fate of site contaminants in the local ecosystem. However, the Sampling Plant and all associated properties consist of only about 20 acres. Also, there are no large tracts of vacant land in the vicinity of the site. Therefore, this lack of natural areas with large water impoundments or room for terrestrial wildlife habitats precludes the possibility of large ecosystems in the vicinity of the site. A meaningful examination for contaminants at various trophic levels could not be performed.

Some sampling and analysis of vegetation along the drainage ditch and Main Stream was conducted in support of cleanup operations during Phase I. However, there is no need for further biological sampling unless failure of residue containment is reported.

3.2 QUALITY ASSURANCE

To draw valid, legitimate conclusions from the results of an environmental monitoring program, there must be built into that program certain guarantees that proper procedures were followed and appropriate parameters tested at all times. These guarantees take the form of a quality assurance program. This program can identify inadequacies in the sampling and measurement processes so that corrective action can be taken, in addition to making qualitative and quantitative statements regarding the confidence of results. Closely related to quality assurance is quality control to assure reproducible results.

Quality control measures are implemented to ensure validity of data resulting from the monitoring programs. These measures include duplicate sampling (10% of all samples) and sample splitting for analysis at separate facilities (NLO/EIC field lab, Eberline's Albuquerque Lab, NLO's Fernald Lab, ORNL, and NJDEP). Included among the various interlaboratory quality assurance practices are daily calibrations of instrumentation and routine analyses of blanks, standards, and spiked sample aliquots. Both NLO and Eberline participate in the DOE quality assurance program which is conducted by the DOE Environmental Measurements Lab (EML). Eberline also participates in quality assurance programs conducted by the U.S. EPA and the IAEA.

3.3 REPORTING

Reporting of results is of vital importance to an environmental monitoring program. Data for each of these programs are collected on a regular basis as described, and plotted with previous data as soon as they are received. This allows for immediate evaluation and early detection of trends and perturbations which may be indicative of environmental releases and spread of contamination. Interpretation and reporting of these data should be on a semi-annual or annual basis.

At present there are a variety of agencies with responsibilities for different aspects of environmental monitoring at the MSPS. The semi-annual or annual report should utilize and incorporate data from these other programs to provide a comprehensive environmental report.

In the event that MPC's or other criteria are exceeded, or when anomalies exist within the data, reporting should be done immediately.

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