3.0 ENVIRONMENTAL MONITORING ACTIVITIES FOR CY13

This section describes the periodic sampling and analysis selected for CY13 to achieve the objectives of the EMP. These activities will be implemented in conjunction with the program objectives defined in the EMG and program protocols described in the SAG. This section of the EMICY summarizes the monitoring locations, frequencies, and analytes of concern. Details of the specific monitoring and analytical protocols necessary for field implementation are provided in the SAG. Non-periodic monitoring activities are outside the scope of the EMICY and are implemented through issuance of work descriptions or other implementation plans and are not described herein.

3.1 AIR MONITORING AND DIRECT GAMMA RADIATION MONITORING

3.1.1 Rationales and Objectives for Air and Direct Gamma Radiation Monitoring

Objectives for air and direct gamma radiation monitoring are identified to:

- provide surveillance of public exposure routes through sampling and analysis;
- verify compliance with regulations;
- provide indication and methods to quantify release of radioactive materials from the site; and
- characterize trends in environmental radiation measurements, especially as they are affected by site RAs.

Measurement objectives to meet regulatory requirements are identified to:

- calculate the total effective dose equivalent (TEDE) to hypothetical maximally exposed members of the public from all complete and applicable pathways;
- calculate the effective dose equivalent from airborne particulate emissions (exclusive of radon) to the hypothetical maximally exposed member of the public;
- calculate outdoor radon concentrations at the fence line and/or at locations in the vicinity of excavation areas accessible to members of the public;
- proactively monitor indoor air for radon progeny concentrations (or equivalent) in occupied or habitable buildings where Ra-226 subsurface concentrations exceed 15 pCi/g; and
- determine background values for the parameters of concern at off-site locations.

Thermoluminescent dosimeters (TLDs), alpha track detectors (ATDs), and particulate air filters will be used in various combinations at the SLDS to monitor gamma exposure levels, radon, and airborne particulate radionuclide emissions (exclusive of radon). Data from these measurements will be converted into effective dose equivalent. Reports to the USEPA will be made to meet regulatory requirements.

3.1.2 Monitoring Locations

Monitoring locations for TLDs and ATDs are shown for the SLDS on Figure 3-1. Figure 3-2 provides the location of the SLS background gamma radiation, radon, and particulate air sampling stations. The type, frequency, and location of air particulate, radon, and gamma radiation monitoring are identified in Table 3-1. The SLS background sampling results are assumed to be representative of the entire St. Louis metropolitan area, including the SLDS.

Table 3-1. Air Particulate, Radon, and Gamma Radiation Monitoring

Site	Number of Monitoring Locations	Media/ Sample Type	Frequency	Parameters	Driver/Purpose [a]
Mallinckrodt	4	TLD	Quarterly	External gamma radiation	EMP – public exposure
	4	ATD	Semiannually	Radon and progeny	EMP – public exposure
	Varies [b]	Filter	During active excavations and loadout	Particulate radionuclides	EMP – NESHAP/public exposure
VPs	Varies [b]	Filter	During active excavations and loadout	Particulate radionuclides	EMP – NESHAP/public exposure
ISOU Buildings [c]	2	ATD	Semiannually	Radon and progeny	EMP – UMTRCA/public exposure
Background	1	TLD	Quarterly	External gamma radiation	EMP – public exposure
	1	ATD	Semiannually	Radon and progeny	EMP – public exposure
	1	Filter	Weekly	Particulate radionuclides	EMP – NESHAP/public exposure

[a] Public exposure monitoring requirements: 40 *CFR* 61 Subpart I; 10 *CFR* 20.1301; 40 *CFR* 192.02. Fence-line (or other appropriate monitoring location) levels and/or concentrations are used to calculate TEDE to the hypothetical maximally exposed critical receptor from the site.

[b] The environmental remediation contractor conducts particulate air sampling at appropriate locations around active excavations and at loadout areas. This data is used for NESHAP and public exposure evaluations.

[c] The monitored ISOU buildings include Plant 1 Building 26 and DT-4 North-South Storage Building.

External Gamma Monitoring

TLDs will be used to measure direct gamma exposure from background and residual radioactivity at the SLDS. TLD locations at the SLDS will be in the vicinity of excavation areas and/or representative of areas accessible to the public (including Mallinckrodt employees, who are not occupationally monitored for radiation exposure). Placement of TLDs in areas immediately surrounding Plant 5 will be avoided due to non-Manhattan Engineer District (MED)/AEC columbium and tantalum (C-T) processing. QC TLDs will include shipment blanks (to evaluate the exposure received in transit) and duplicate TLDs to evaluate measurement (field) precision.

Direct gamma radiation monitoring is not conducted at VP locations. The evaluations conducted at Mallinckrodt to determine exposure to a member of the public conservatively represent the highest likely exposures; therefore, direct gamma radiation monitoring is not necessary to demonstrate compliance with regulatory standards at VP locations.

A background monitoring location has been selected to measure the background gamma exposure rate. The background TLD monitoring station is currently located at the USACE Service Base on Arsenal Street (see Figure 3-2).

Outdoor Radon Monitoring

ATDs will be used to measure alpha particle emissions from radon (primarily Rn-222) and its associated decay products. The radon emissions are expected to increase during RAs such as excavation of soil. ATD results are reported as Rn-222 air concentrations in pCi/L and are then converted to dose equivalent. ATDs will be co-located with the TLDs.

Outdoor radon monitoring is not conducted at VP locations. The evaluations conducted at Mallinckrodt to determine exposure to a member of the public conservatively represent the highest likely exposure; therefore, outdoor radon monitoring is not necessary to demonstrate compliance with regulatory standards at VP locations.

The proposed outdoor radon monitoring locations will be identical to those described for external gamma radiation monitoring. Locations were chosen with consideration given to predominant wind direction and sources of contamination. Southerly winds predominate from May through November, and northwesterly winds predominate from December through April. The locations were selected in the vicinity of excavations and areas accessible to members of the public at the SLDS. The background location is currently located with the background TLD at the USACE Service Base on Arsenal Street (see Figure 3-2).

Indoor Radon Monitoring

One ATD will be located in Plant 1 Building 26 and one ATD will be located in the southwest corner of the DT-4 North-South Storage Building. The ATDs will be located in areas that represent the highest likely exposure from indoor radon. The indoor radon monitoring locations at the ISOU buildings are shown on Figure 3-1. Locations have been chosen with consideration given to known Ra-226 concentrations under the buildings and occupancy time at any one location within each building. Background indoor radon monitors are not necessary because the regulatory standard of 0.02 WLs includes background.

Particulate Air Monitoring

Particulate air samplers will be located around active excavation and loadout areas accessible to members of the public at the SLDS. Air samplers will be placed between the airborne source and areas accessible to members of the public during work activities that disturb soils and have a potential to generate airborne particulates. The locations of these air samplers will be downwind of the work activities. Airborne particulate radionuclide samples will be collected and subsequently analyzed for relevant radionuclides and/or gross alpha and gross beta activity.

The particulate air monitoring stations are expected to be affected mainly during periods of remediation when there is the greatest potential for generation of airborne particulate radionuclide emissions. Additional particulate air samplers will be placed around the perimeters of active work zones during RAs. The background air particulate station is currently co-located with the background TLD and ATD stations at the USACE Service Base on Arsenal Street (see Figure 3-2).

3.1.3 Monitoring Frequency

Monitors will remain in place to continuously monitor the sample locations. TLDs will be replaced and analyzed every quarter. Radon ATDs (indoor and outdoor) will be replaced and analyzed every six months. Particulate air samplers will operate continuously during active excavation and loadout, with samples usually being collected weekly but possibly more frequently because of operational considerations such as dust loading on the filters, which can reduce the sample flow. The number of samples/measurements and the frequency are illustrated in Table 3-1.

3.1.4 Field and Laboratory Analyses

Selection of the various monitoring parameters was based on the regulatory requirements with consideration of the radionuclides and their concentrations at the SLDS. The following sections summarize the rationales for analytes and the analysis methods.

Rationale for Analytes

The radionuclides found at the SLDS are mainly uranium (U)-series nuclides. Each property has radionuclides in the U-series that may be predominant (such as Ra-226, thorium [Th]-230, or U-238); thus, each radionuclide must be assessed separately. Some areas at the SLDS show

higher concentrations of Ra-226, Th-230, and U-238. The relative concentration levels for individual radionuclides can be found in the *Feasibility Study for the St. Louis Downtown Site, St. Louis, Missouri* (USACE 1998b). Therefore, previous soil sampling results from each monitoring site have been used to determine source concentration ratios of the individual radionuclides for use in evaluating gross alpha and gross beta air particulate sampling results. Additionally, radon is a component of the U-series nuclides and many radionuclides at the SLDS emit gamma radiation.

Analysis Methods

Details regarding the analytical testing methods to be used for analysis of TLDs, ATDs, and particulate radionuclide air samples are presented in the SAG. Analysis of the various media will be accomplished with qualified laboratories or through analysis at the U.S. Department of Defense (DOD) Environmental Laboratory Accreditation Program (ELAP)-accredited Hazelwood Interim Storage Site (HISS) laboratory using the Laboratory QA Plan and standard operating and analysis procedures.

A summary of the type of radiological samples, analysis methods, and target detection levels for the proposed radiological sampling in CY13 is provided in Table 3-2. Justification for the detection levels is based in part on the capabilities of the instrumentation and in part on meeting a lower value than the desired regulatory standard.

Table 3-2. Summary of Laboratory Analysis Methods and Target Detection Levels

Detector/Sample Medium	Analytes Measured	Analysis Method	Target Detection Levels
TLD	Direct external gamma exposure from residual contamination and background	Processed by a qualified vendor	0.1 millirem (mrem)/quarter
ATD	Airborne Rn-222 and alpha emitting progeny that originate from Ra-226	40 *CFR* 61, Appendix B, Method 114, Method A-7, Rn-222 ATDs detectors	0.2 pCi/L
Particulate Air Filter	Airborne particulate radionuclides: gross alpha and gross beta	40 *CFR* 61 Appendix B, Method 114, Method A-4, Direct Alpha Counting, and Method B-4, Gross Beta Counting	3.4E-15 microcuries per milliliter (µCi/mL) (gross alpha) 2.2E-12 µCi/mL (gross beta)

The TLD target detection level of 0.1 millirem (mrem)/quarter is approximately 0.3 percent o the annual background dose equivalent rate from external exposure and well below the regulatory limit for members of the public of 100 mrem/yr.

The ATD target detection level of 0.2 pCi/L is the level achievable at the laboratory. This level i below the 0.5 pCi/L standard contained in 40 *CFR* 192 Subpart A for locations outside a site.

A radon progeny level of 0.02 WL is equivalent to a radon concentration of 4.0 pCi/L whe radon is in 50 percent equilibrium with its progeny. In an indoor environment, radon is expecte to be in approximately 50 percent equilibrium with its progeny. Therefore, the 0.2 pCi/L targe detection limit for indoor radon is adequate as compared to 4.0 pCi/L.

The target detection level concentrations for the uranium and thorium isotopes in particulate ai samples are based on three analytical methods found in 40 *CFR* 61, Appendix B, Method 114 Since radionuclide-specific concentrations have already been established, Method A-4, direc alpha counting (gross alpha determination) and Method B-4, direct beta counting (gross bet determination) will be used to routinely evaluate activity levels of samples. These methods wil determine alpha activity of the sample without extraction and separation of isotopes. Detectio

levels of 3.4E-15 microcuries per milliliter (μCi/mL) for gross alpha and the detection level of 2.2E-12 μCi/mL for gross beta will provide adequate minimum detection levels for dose assessment estimates. Method G-1, high-resolution gamma spectroscopy, will be used as needed to evaluate samples on a case-by-case basis.

3.1.5 Field QC Samples

Two types of QC samples will be collected or used during environmental radon air monitoring and direct gamma radiation monitoring. The types of QC samples include duplicates and trip blanks.

QC Duplicates

Duplicate samples or measurements will be collected using the same protocol and procedures used for obtaining the initial samples and measurements. Duplicate samples/measurements are used to evaluate the field precision of the sampling and measurement process. Duplicate analysis of the same measurement device may be performed at the laboratory to evaluate the reproducibility of the counting technique.

At least one duplicate TLD will be designated at the SLDS for QC purposes. Duplicate TLDs will be installed, collected, and analyzed at the same time as the sample TLD at that location.

At least one duplicate radon ATD will be designated at the SLDS for QC purposes. Duplicate ATDs will be placed, collected, and analyzed at the same time as the actual sample at that location.

Trip Blanks

TLD trip blanks will be used to evaluate the integrated dose to the dosimeter when the dosimeters are not in the monitoring locations. These trip blanks will measure the dose while the dosimeters are in storage and in transit to the processing laboratory.

3.1.6 Equipment and Sampling Methods

3.1.6.1 Equipment

The following sections describe the types of detectors that will be used to quantify radioactive emissions from the SLDS. The types of detectors and/or sample collection devices include TLDs, ATDs, and airborne particulate samplers.

External Gamma Monitoring

External gamma exposure rates are measured using environmental TLDs (aluminum oxide) housed in the polyvinyl chloride (PVC) holders/shelters positioned in the vicinity of excavation areas accessible to members of the public at the SLDS. Each TLD measures a cumulative dose over the period of exposure and is expressed in mrem/quarter. The measurements must be corrected for shelter absorption, background, fading, and time of exposure to normalize the measurement to exactly one quarter of exposure.

When exposed to gamma radiation, the TLD stores a portion of the energy. When the TLD is heated, the stored energy is emitted as light that can be amplified, measured, and used to calculate dose equivalent. The TLD shelters are located approximately three feet above the ground surface at all monitoring locations.

Indoor and Outdoor Radon Monitoring

Rn-222 gas concentrations are measured using ATDs that are designed to record alpha emissions within the sensitive element of the detector. These detectors contain film that, when exposed to

alpha particles from the radioactive decay of radon, create submicron damage tracks on the film. After exposure, the detectors are returned to the manufacturer for processing. The film is placed in a caustic etching solution that amplifies the damage tracks, which are counted using a microscope or automated counting system. The number of tracks per unit area is correlated to the radon concentration in air. ATDs are purchased from various USEPA-approved manufacturers.

Particulate Air Monitoring

Airborne particulate samplers provide a means to collect particulate radionuclides from the ambient air. Low-volume air pumps, with typical flow rates of 30 to 50 liters per minute draw ambient air through a 0.45-micron particulate filter. The filter has a high efficiency for removal of submicron particles. The air pumps are equipped with calibrated measurement devices (i.e., rotometers) to monitor air flow rates. Air flow rates can also be measured externally with portable rotometers. Average flow rates are calculated using before/after sample loading data. At the end of the sample period, the filters are removed from the housing and sent to a laboratory for analyses.

3.1.6.2 Sampling Methods

The following section describes the field sampling methods for direct gamma radiation and air monitoring at the SLDS. It is not intended to replace the detailed guidance contained in project instruction guides. The chain-of-custody protocols, sample labeling, identification and shipment procedures, and field logbooks/documentation described in the SAG are applicable to each of the following sampling methods.

External Gamma Monitoring

TLDs will be placed in each ambient-air monitoring station at the beginning of each monitoring period. These TLDs will be replaced and analyzed after approximately 3 months. The location, date of installation, and date of removal for each detector will be logged. A control/background TLD will accompany the exposed dosimeter during shipment to detect any exposure incurred by the dosimeter during shipment.

Indoor and Outdoor Radon Monitoring

Unexposed, preassembled detectors packaged in sealed foil will remain sealed until they are placed in the detector housings. At the time of deployment, the location, date, and type of the detector will be recorded. The new, unexposed detector will be placed in the detector housing with the air inlet holes unobstructed. At the end of the exposure period (approximately 6 months), a self-adhering circular seal (available from the manufacturer) will be placed on the exposed detector, covering the air inlet holes. The seals are used to prevent further exposure of the detector from radon or thoron during transport to the laboratory. The removal date will be logged. The exposed detectors will then be packaged in resealable plastic storage bags and sent to the laboratory.

Particulate Air Monitoring

Siting of the particulate monitoring stations around active excavation and loadout areas accessible to the public is done carefully so that appropriate measurements of particulate concentrations in an area are collected. Typically, at least one air monitoring location should be located downwind of work activities.

Data collection will consist of logging the sample location, date, and time that the sample collection is started and the initial flow rate of the air pump. At the end of the sampling period, the date and time that the sample collection is ended and final flow rate of the air pump will be logged. If the initial air flow rate is different than the final flow rate, the average of the two values will be

used to determine the total flow volume over the sampling period. Calibrated rotometers will be used to establish initial and final flow rates. Rotometers will be calibrated annually.

As the filter is removed from the filter housing, care will be taken not to disturb the collected particulate. The filter will be placed in a suitable container such that sample integrity is not lost during transport to the laboratory.

The length of time between filter change-out can vary depending on the activities at the site. For example, if no RAs are being conducted, it is recommended that filter change-out occur weekly. However, during RAs, more dust could be generated, requiring more frequent filter change-out.

3.1.6.3 Field QC Sampling Procedures

Duplicate samples will be collected in association with the TLD and ATD measurements. Duplicates will be collected using the same equipment and sampling methods as defined in Section 3.1.6.2.

3.1.6.4 Field Decontamination

The sampling techniques described above are one time use/dedicated sampling media. Therefore, field decontamination is not required for the samples obtained for direct radiation exposure and air (radon and air particulate) monitoring equipment.

3.2 EXCAVATION-WATER DISCHARGE MONITORING

Excavation-water monitoring is considered a principal component of the EMICY at the SLDS. RAs at the site could result in discharges that are covered under MSD discharge requirements. Monitoring will be conducted to meet permit or ROD conditions. Parameters for the SLDS can be found in Table 3-3, along with sampling locations and sampling frequencies. The purpose of excavation-water discharge sampling is to meet requirements set forth in the MSD discharge authorization letter dated October 30, 1998, and modified in letters dated July 23, 2001; October 13, 2004; June 19, 2006; May 22, 2008; May 10, 2010; and May 24, 2012, for the SLDS (MSD 1998, 2001, 2004, 2006, 2008, 2010, and 2012). Copies of these letters are included in Appendix A.

Table 3-3. Excavation-Water Monitoring Locations, Frequencies, and Parameters

Site	Monitoring Location	Sample ID/ Outfall	Media/Sample Type	Frequency	Parameters	Driver/ Purpose	Status	Comments
SLDS	MSD Sewer	MSD Inlet 17D3-022C [a]	Runoff/ground water, excavation water, or treated ground water	Per Batch	Various [b]	MSD	Active	Sampling is batch-dependent and, therefore, conducted on a non-routine basis. MSD discharge authorization letter dated October 30, 1998, from MSD; revised July 23, 2001; October 13, 2004; June 19, 2006; May 22, 2008; May 10, 2010; and May 24, 2012.

[a] MSD Inlet 17D3-022C is the primary discharge location; however, manholes 17D3-017C, 17D3-019C, 17D4-331C, 17D4-333C, 17D4-334C, 17D4-353C, 18D1-393C, 18D1-413C, and 18D1-417C may be used.

[b] Per the October 30, 1998, and July 23, 2001, MSD letters, effluent must be tested for pH, suspended solids, chemical oxygen demand (COD) and total metal parameters having numeric limits in Ordinance 8472 Article V, Section 2B. Also identified are volatile organic compounds (VOCs); semi-volatile organic compounds (SVOCs); polychlorinated biphenyls (PCBs); gross alpha radioactivity; gross beta radioactivity; U-235; U-238; Ra-226; Ra-228, Th-230, and Th-232.

Objectives for the SLDS

SLDS excavation-water discharge monitoring is conducted in accordance with the MSD authorization letter dated October 30, 1998, and revised in letters dated July 23, 2001; October 13,