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Rev. 0

Contamination Control Plan for the Luckey Formerly Utilized Sites Remedial Action Program Site Soils Operable Unit Remediation Project

U.S. Army Corps of Engineers
Buffalo District, Buffalo, New York

Applicability: Luckey Formerly Utilized Sites Remedial Action Program Site Soils Operable Unit Remediation Project	Effective Date: 11/07/2021	Owner: [redacted] Project Manager
		Signature: [redacted]

Completion of Independent Technical Review

This document has been produced within the framework of the North Wind Portage quality management system. As such, an independent technical review (ITR), appropriate to the level of risk and complexity inherent in the project, has been conducted. This included review of assumptions (methods, procedures, and material used in analyses), alternatives evaluated; the appropriateness of data used and level of data obtained; and reasonableness of the results, including whether the product meets the project objectives. Comments and concerns resulting from review of the document have been addressed and corrected as necessary.

ITR performed by: [redacted]	
Signature: [redacted]	Date: 09/24/2021

History of Revisions

Revision	Issue Date	Action	Description
0	11/03/2021	New document.	Initial issue.

SIGNATURE PAGE

Project: FUSRAP Luckey Remediation of Soils Operable Unit Project

Location: 21200 Luckey Road, Troy Township, Wood County, Ohio

North Wind Portage, Inc., (NWP) has developed this contamination control plan for the above-referenced project. This document has been developed for the United States Army Corps of Engineers (USACE), Buffalo District.

The following NWP personnel have prepared and approved this plan for implementation of the above-referenced work. Changes, revisions, and updates to this plan are to be reviewed and approved by NWP and submitted to the USACE for review and acceptance.

Plan Preparer:
[redacted]
Site Safety and Health Officer

Reviewed by:
[redacted]
Health and Safety Manager

[redacted]
Radiation Safety Officer

[redacted]
Project Manager

[redacted]
Deputy Project Manager

[redacted]
Work Control Manager

[redacted]

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ACRONYMS AND ABREVIATIONS

µCi	microcurie
µg	microgram
µSv	micro sievert
APP	accident prevention plan
AHA	activity hazard analysis
AL	action level
ALARA	as low as reasonably achievable
Be	beryllium
Bq	becquerel
BWP	beryllium work permits
BZ	breathing zone
CBDPP	chronic beryllium disease prevention program
CCP	contamination control plan
cm	centimeter
COC	constituent of concern
COR	contracting officer's representative
CRZ	contamination reduction zone
DAC	derived air concentration
DOT	Department of Transportation
dpm	disintegrations per minute
EPA	Environmental Protection Agency
ES&H	Environmental Safety and Health
EZ	exclusion zone
FUSRAP	Formerly Utilized Sites Remedial Action Program
g	gram
H&S	health and safety

HEPA	high-efficiency particulate air
IH	industrial hygiene
ITR	independent technical review
LAW	large area wipe
m	meter
mL	milliliter
mrem	millirem
NEA	negative exposure assessment
NWP	North Wind Portage, Inc.
OELs	occupational exposure limits
PAPR	powered air-purifying respirator
Pb	lead
PBZ	personal breathing zone
pCi	picocurie
PM	project manager
PPE	personal protective equipment
PWS	performance work statement
QAPP	quality assurance project plan
Ra	radium
Ra-226	radium-226
RCT	radiological control technician
RPP	radiation protection plan
RSO	radiation safety officer
RWP	radiation work permits
SAP	sampling and analysis plan
cm^2	square centimeters
SHM	safety and health manager
SOP	standard operating procedures

SSHO	site safety and health officer
SSHP	site safety and health plan
SZ	support zone
Th	thorium
Th-230	thorium-230
TSP	total suspended particulate
U	uranium
U-234	uranium-234
U-238	uranium-238
USACE	United States Army Corps of Engineers
WCM	work control manager
y	year

1. INTRODUCTION

This section provides summary information about the Luckey site. It includes a discussion on the purpose and scope of this Contamination Control Plan (CCP). The plan describes the processes and methods used to control the spread of contamination (i.e., beryllium, lead, and radioactive material) at the project site.

1.1 Project and Site Information

The United States Army Corps of Engineers (USACE), Buffalo District, has contracted North Wind Portage, Inc., (NWP) under Contract Number W912P4-21-C-0014 to remediate the Luckey Site located in Luckey, Ohio. NWP will complete this remediation under the USACE's Formerly Utilized Sites Remedial Action Program (FUSRAP), which was established to identify, investigate, and clean up or control sites previously used by the Atomic Energy Commission. This site has been identified as having materials contaminated with FUSRAP-related constituents of concern (COCs), which include beryllium (Be), lead (Pb), radium-226 (Ra-226), thorium-230 (Th-230), uranium-234 (U-234), and uranium-238 (U-238).

The primary objective of this remediation project is the timely and effective cleanup of the site in accordance with the *Luckey Site Record of Decision for Soils Operable Unit, Final* (USACE 2006) and the *Performance Work Statement, FUSRAP Luckey Remediation of Soils Operable Unit, Luckey Site* (Performance Work Statement (PWS); USACE 2021a). The selected remedial approach includes the excavation of impacted soils, including on-site and off-site contiguous soils where contamination has migrated through natural means, to achieve cleanup goals for unrestricted use by the critical group; for the Luckey site, this is the "subsistence farmer" model. NWP will place clean backfill and acceptable place-back soils in excavated areas. Excavated soil materials exceeding backfill and reuse criteria will be shipped off-site for disposal at a licensed/permitted disposal facility. This approach to obtaining remedial goals, satisfies the requirements while protecting human health and the environment and will comply with applicable or relevant and appropriate requirements. Remediation will be conducted in such a manner to provide a high level of protection to the public and remediation workers that is consistent with applicable exposure requirements and with the objective of maintaining chemical and radiological exposure as low as reasonably achievable (ALARA).

Positive control of site contaminants will be identified, implemented, maintained, and assessed to prevent the cross contamination of on-site work zones and off-site areas. This CCP describes the approaches used by NWP to reduce and minimize the inadvertent spread of contamination at the site. This plan has been prepared to satisfy the requirements specified in the PWS and will be updated periodically to reflect changes in site conditions, means and methods, or unplanned and unexpected contaminants.

1.2 Purpose and Approach

NWP is responsible for performing work in a manner which positively controls site hazards and protects the workers, public, and environment. Based on site conditions, NWP will execute remedial activities using primarily mechanical means and methods while implementing dust control measures (as needed). Contamination control measures will be achieved using administrative and engineering controls, supplemented with adequate personal protective equipment (PPE). This CCP provides the Luckey FUSRAP remediation team with guidance for controlling the potential spread of beryllium, lead, and radiological contamination.

The project work areas are delineated into Hazardous Waste Operations control zones. The purpose of utilizing control zones is to clearly delineate and control site areas where the contaminant cleanup goals are exceeded and to prevent contamination from migrating to uncontaminated areas. The exclusion zone (EZ) has COCs that exceed their cleanup goals. The contamination reduction zone (CRZ) is where personnel egress from the EZ, survey for radiological contamination, shower, and change clothes and enter into the support zone (SZ). Periodic wipe samples are taken of the PPE that exits the EZ to check for any loose contamination. Wipe samples are also taken off the powered air-purifying respirator (PAPR) hoods after decontamination to verify that no contamination exists above free-release criterion of 0.2 µg/100cm² prior to the employee having to wear the hood again. The CRZ is a buffer between the EZ and areas of the site that do not have contamination concentrations that exceed the cleanup goals. The SZ is not contaminated and includes a trailer area for administrative personnel, a parking area, access roads, and areas for support equipment/activities (water treatment, storage, truck scale).

This CCP delineates the following methods used for controlling contamination on the site and preventing contaminant spread to the SZ or outside the site boundaries:

- Workflow and contamination control for equipment and personnel.
- Engineering controls to prevent contaminant spread.
- Administrative controls, including procedures, site control, access/egress control to work zones, and personnel and equipment decontamination processes.
- Housekeeping of on-site temporary facilities.
- Surface sampling performed for surface contamination on materials and equipment, including decontamination as needed.
- Airborne contamination monitoring.
- Specifying surface contamination control limits and perimeter and work zone airborne contamination limits.

2. ORGANIZATIONAL STRUCTURE

2.1 USACE Responsibilities

The USACE, Buffalo District, is responsible for oversight of all aspects of the Luckey project, including but not limited to project management, project engineering, health and safety, cost, and schedule.

2.2 NWP Responsibilities and Personnel

Key positions for contamination control are project manager (PM), safety and health manager (SHM), site safety and health officer (SSHO), radiation safety officer (RSO), work control manager (WCM), and site superintendent. The *Uniform Federal Policy Quality Assurance Project Plan for the FUSRAP Luckey Remediation of Soils Operable Unit Project, Luckey, Ohio, Sampling and Analysis Plan* (QAPP/SAP; USACE 2021b) and the *Accident Prevention Plan/Site Safety and Health Plan for the FUSRAP Luckey Remediation of Soils Operable Unit Project* (APP/SSHP) (USACE 2021c) provide a full list of responsibilities relative to the overall project activities. An organizational line of authority chart is illustrated in PLN-080240-5500 (*SOP),* Appendix A and *Contractor Quality Control Plan for the FUSRAP Luckey Remediation of Soils Operable Unit Project, Luckey, Ohio,* PLN-080240-5502 (USACE; 2021g), Figure 2-1. Specific NWP responsibilities for this CCP are provided below.

2.2.1 Project Manager

The PM is responsible for providing logistical and policy support to ensure that the requirements within the CCP are properly implemented.

2.2.2 Environmental Safety and Health (ES&H) Director

Where requested, the ES&H director will identify technical resources for supporting the site program manager (PgM), PM, and SHM in developing and overseeing the site-specific CCP program. He works closely with the SHM on programmatic aspects of the CCP and is consulted with on all significant policy and implementation issues.

2.2.3 Safety and Health Manager

The SHM is responsible for development and implementation of a comprehensive Safety Program for the Luckey project (represented by the APP/SSHP [USACE 2021c] and Chronic Beryllium Disease Prevention Program [CBDPP; USACE 2021e]). The SHM is responsible for ensuring that safety and the industrial hygiene (IH) procedures are complete, technical and field health and safety (H&S) personnel necessary to execute project tasks are trained and qualified

commensurate with assigned responsibilities, all project personnel are trained on safety-related topics commensurate with assigned duties and responsibilities, and H&S hazards and hazard controls are properly addressed in the design of new facilities or processes or modification of same (with emphasis on hazard elimination). The SHM is also responsible for ensuring that H&S hazards and hazard controls are identified during work planning; integrated hazard analyses/ controls are developed for each task; and safety and IH equipment, tools, and materials necessary for task execution are available, calibrated, and tested, as necessary.

NWP's SHM, and approved alternates, report to the NWP corporate ES&H director. The SHM must also be pre-approved by the USACE prior to assuming the position.

The SHM has the following authorities:

- Approve the person assigned as the SSHO or an acting SSHO prior to USACE submittal for project approval.
- Stop work for unsafe or quality-impacting conditions.
- Approve and enforce the APP/SSHP.
- Approve field changes to active activity hazard analyses (AHAs).
- Direct the SSHO and assign site safety personnel.

2.2.4 Site Safety and Health Officer

The SSHO is responsible for the overall conduct of a comprehensive safety program for the Luckey project (represented by the APP/SSHP [USACE 2021c] and CBDPP [USACE 2021e]). The SSHO ensures that an independent review of work practices, engineering controls, and monitoring results is performed during remediation activities at the project site. The SSHO works with the RSO to identify engineering controls and work practices that improve the effectiveness of the CCP. The SSHO implements non-radiological contamination controls — mostly for beryllium.

The SSHO is responsible for ensuring that work area inspections are performed before the start of work and periodically throughout task execution; exposure monitoring is conducted and personnel are informed of results; H&S records are generated and retained as required by the APP/SSHP; and program or performance issues are identified, corrected, and communicated.

2.2.5 Radiation Safety Officer

The RSO is responsible for ensuring that the radioactive contamination control and measurement requirements of the CCP are performed at the designated frequency. The RSO ensures that a

periodic review of engineering controls, work practices, and monitoring results is performed to assess program effectiveness for radiological contamination control.

2.2.6 Work Control Manager

The WCM works with the RSO and SSHO to identify engineering controls and work practices that improve the effectiveness of the CCP. Together they implement the engineering controls and work practices needed to ensure that the CCP is executed effectively. While either the RSO or SSHO may identify methods to improve contamination control practices, it is the WCM who ensures that project supervision and subcontractor management incorporate into project work plans the contamination control measures specified in this CCP.

2.2.7 Site Superintendent

The site superintendent works with the project team to ensure that engineering controls are put in place and are being maintained by site personnel and subcontractors.

2.2.8 Subcontractor Management

Subcontractor management is responsible for incorporating the provisions of this plan into their health and safety programs and ensuring the implementation of the plan with their staff. NWP is responsible to ensure subcontractor safety compliance.

3. CONTAMINATION CONTROL PROGRAM

The primary sources and routes for the migration of contamination is through the movement of people, equipment, materials, or airborne emissions during remedial activities. The purpose of the CCP is to identify the areas/materials with contamination, controlling access to these areas/ materials, and preventing the spread of contamination outside of the EZ. The contamination control zones and their locations are shown in Figure 3-1.

Contamination control is achieved through workflow and monitoring points, administrative controls, housekeeping, engineering controls, and PPE, as described in the following sections.

3.1 Workflow and Monitoring Points

The project will have contamination control zones established: the SZ, CRZ, and EZ (see Figure 3-1). The SZ will contain offices and laboratory trailers, remediation equipment parking, and an equipment storage yard. The main entrance and exit to and from the EZ/CRZ into the SZ will be through the Access Control Conex. However, project conditions and status may determine the need for additional transition points from the EZ/CRZ to the SZ. The location and the process for contamination controls will be established and documented in the work instructions for each evolution of work. If the work has an AHA, the AHA will be amended to reflect the change in conditions. The crews involved with the change will be briefed on the new procedures. Sampling will be performed routinely at the new locations to verify that the contamination controls put in place are effective.

Other situations will arise that will require modifications to the existing contamination control procedures. Each situation will be individually evaluated, and an appropriate approach will be developed. The number one goal is to prevent contamination from leaving the EZ in an uncontrolled manner. Every change in procedure will be monitored and sampled to verify that the controls put in place are effective.

3.1.1 Equipment Flow and Monitoring

Contaminated materials (e.g., soils) in the CRZ and/or EZ are removed primarily using heavy equipment (e.g., excavators, bulldozers, dump trucks). These excavated materials are loaded into covered articulating dump trucks and transported from the excavation areas or temporary staging area(s) to concrete pads in the Soil Staging Area(s). Based upon soil conditions, presence of thixotropic material (sludge slurry byproduct from processing beryl ore) and/or water; the soil may requiring conditioning (blending) with the use of Calciment® (or appropriate material) to ensure that packaged and transported materials meet waste acceptance criteria, compaction requirements, and Department of Transportation (DOT) requirements for transport. Generally, material conditioning is performed using heavy equipment (e.g., excavator) while using adequate dust suppression as necessary.

An excavator is used to load the contaminated material into IP-1 lined roll-off containers for shipping and disposal at an off-site facility. Once the containers are loaded, the IP-1 liners are closed, secured, and the attached tarp unfurled to cover the top of the loaded containers. A radiological control technician (RCT), working in the SZ side of the Soil Loadout Area, performs a large area wipe (LAW) survey on the exterior of the roll-off container to identify any radioactive contamination with a direct-read alpha/beta rate counting field instrument, and the results of the LAW survey are documented.

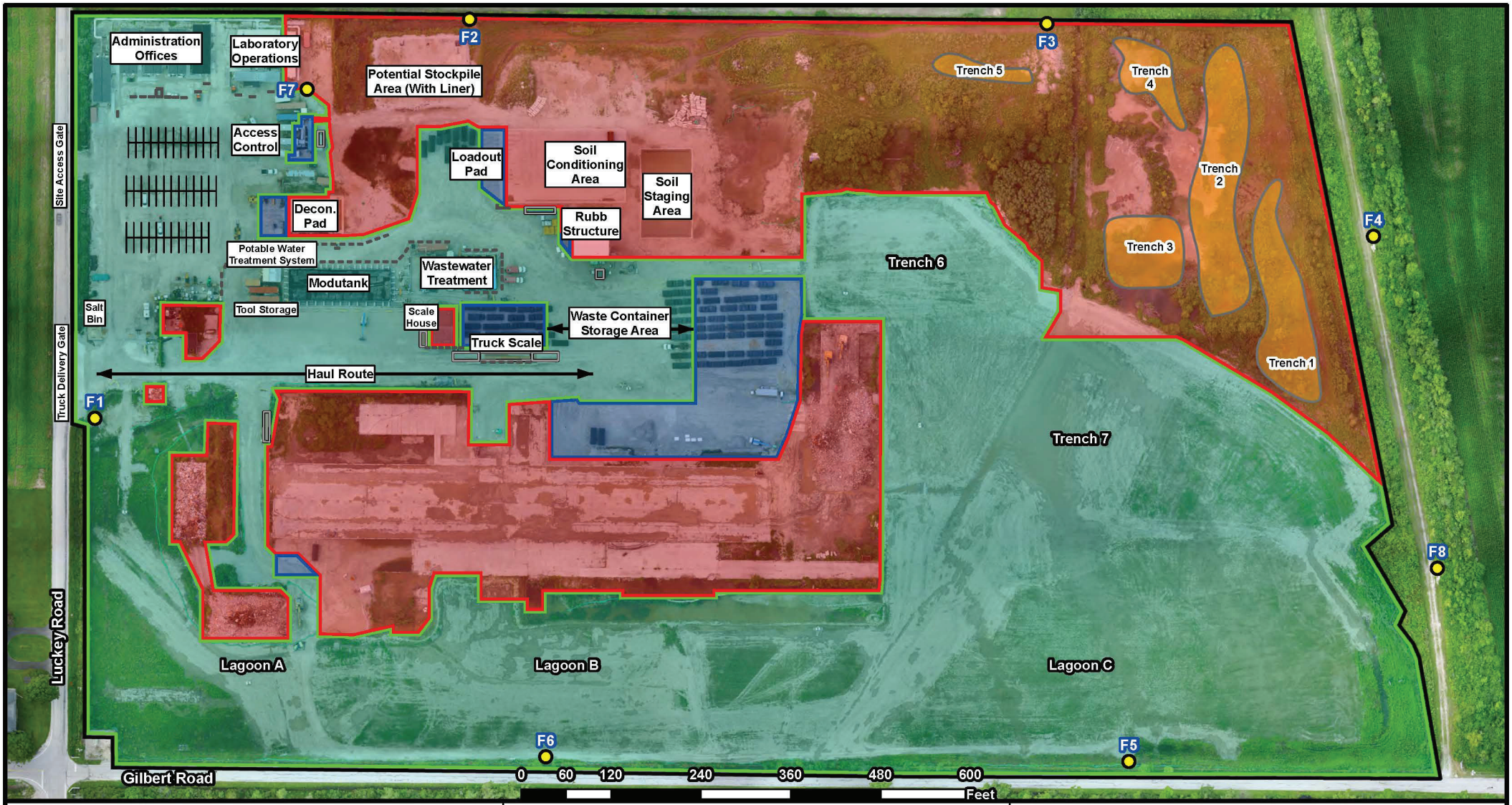

Figure 3-1. Contamination Control Zones

The loaded containers are transferred to the Waste Container Storage Area using a roll-off transport truck. Representative surface swipe samples (approximately 100 square centimeters [cm^2] each) are collected from the outside of the roll-off container to quantify removable radiological contamination (USACE 2021b). The surface swipe samples are considered contaminated when sample results are greater than the limits, specified in Section 5, of 60 disintegrations per minute per 100 cm^2 (dpm/100 cm^2) alpha OR 600 dpm/100 cm^2 beta (USACE 2021f). (Area reference as the size of a dollar bill or by using a dust template guide.) If radiological surface contamination is identified, the roll-off container is placed back into the EZ side of the Soil Loadout Area for decontamination and surveyed again for radioactive contamination. Roll-off containers that do not have identified radioactive contamination are stored in the Container Staging Area.

An industrial hygiene technician will collect representative beryllium surface samples (100 cm^2 each) from each of the roll-off containers in the Container Staging Area and the samples are analyzed at the on-site laboratory. Roll-off containers that have beryllium results less than the free-release criterion of 0.2 micrograms per 100 cm^2 (µg/100 cm^2) are documented and reported as approved to be shipped for disposal. If contamination levels above the free-release criterion are identified in sample results, the roll-off container is decontaminated and retested until it passes the free-release criterion for off-site use.

3.1.2 Personnel Flow and Monitoring

Personnel leave the EZ through the access control trailer located in a CRZ. As stated earlier, this location is the main transitioning area from the SZ to the CRZ/EZ. Due to the majority of traffic utilizing this location, a description of the personnel flow here is described in this section. Additional locations that are added during the evolution of the project will be described in the work instruction and the AHA for that particular task.

The CRZ is part of a trailer complex for doffing PPE, self-monitoring for radioactive contamination (frisk), showering, and changing clothes. Respirators are removed in the CRZ side of the IH Conex. The respirators are decontaminated using wet methods and are placed on the pass-over counter in the IH Conex for inspection. The respirator is visually inspected to ensure it meets visibly clean criteria. An RCT collects a LAW from the respirator for radiological contamination. The LAW is field counted using a survey meter prior to removing the respirator from the CRZ. Once released by the RCT, the IH technician collects a surface sample for beryllium from the respirator and places the respirator in a personal storage container. Individuals then exit the IH Conex into the Access Control Conex, where they doff the remainder of their PPE and frisk for radioactive contamination. Once determined that the individual does not have any radiological contamination concerns, he or she may then proceed to the decontamination showers and dress into street clothing in the SZ. If not exiting for the end of the

shift, or if the personnel was performing non-intrusive work while in the EZ, the personnel will not have to shower.

In the event of an emergency, loss of shower capabilities, or change in procedure that does not allow for personnel to shower after leaving the EZ/CRZ, the project team will develop alternative means for the decontamination of personnel. Those means will be developed with the availability of resources at the time of the event. (For example, during the early months of the COVID-19 pandemic, disinfecting wipes were severely limited in availability.) Sampling of personnel skin can be performed to verify effectiveness of the change in controls.

Radiological contamination surveys and surface wipe samples for beryllium are performed at the boundary of the EZ and the CRZ. This monitoring is performed to detect contamination to help assure that it is not transported to the SZ. The effectiveness of the contamination control program is assessed by monitoring in the CRZ and the SZ. Some contamination is expected to be found in the CRZ. Removable contamination discovered in the SZ may be an indication of cross-contamination and/or migration from the CRZ/EZ of contaminants; however, based on the low levels of beryllium for free release, it is not unlikely to see occasional exceedances. NWP has taken extraordinary housekeeping measures to mitigate activities that have proven to produce exceedances in results (e.g., road grime and salt removal from containers and vehicles, road base and imported material residue on vehicles and trailer surfaces). Exceedances are investigated and analyzed to evaluate the cause, extent-of-conditions, potential impacts, and potential corrective actions.

Based on the PWS and historical use of the site, lead has been identified as a COC and exposures to lead are possible during execution of the PWS. However, based on the stringent engineering and administrative controls required to maintain worker beryllium exposures below established occupational exposure limits (OELs), it is not anticipated that worker exposure to airborne lead will reach levels requiring the collection of surface samples. This will be confirmed by conducting initial and periodic work area/breathing zone (BZ) air sampling for lead and evaluation of the laboratory data by an IH. Lead surface samples will be collected if area/BZ air sampling data indicate that the results are greater than or equal to the action level (AL) of 30 $\mu g/m^3$.

3.2 Administrative Controls

As part of the health and safety hierarchy of controls, administrative controls consist of:

- Training and qualifying personnel commensurate with their duties and the hazards they are likely to encounter. Work in the EZ requires Radiological Worker Training and Beryllium Worker Training.

- Signs and postings to warn personnel of entry into contaminated areas.
- Radiation work permits (RWPs), beryllium work permits (BWPs), and AHAs that describe the safety controls to be employed for specific tasks.
- Work practices to minimize contact with contaminants; such work practices include avoiding kneeling or sitting in contaminated areas and limiting stay times.
- Limiting the number of personnel in a work area to the minimum needed to complete the task safely.

Movement of contaminated equipment and waste from one zone to another (e.g., from the EZ to CRZ, and CRZ to SZ) must be coordinated with project management team. For personnel, the transition from the CRZ to SZ is through an access control point.

3.3 Housekeeping

Perhaps the most important element involved in contamination control is effective housekeeping. Housekeeping efforts are maintained site-wide, while the primary emphasis is the SZ and transitional areas of the CRZ. The goals and objectives of housekeeping are clear. They entail performing routine surface cleaning of all surfaces for successfully controlling surface level contaminants including, but not limited to, beryllium, radiological material, and biological pathogens such as the COVID-19 virus. Surface housekeeping is performed routinely in the SZ and transition (step-off pads) at the CRZ. In support of routine cleaning and decontamination, surface areas are sampled and monitored consistent with monitoring requirements (Section 4) to ensure that established criteria are maintained. If sampling and monitoring results exceed the established action levels (Section 5), additional housekeeping and decontamination efforts are taken to reduce these surface levels to meet surface level requirements.

Equipment and material used in the EZ and CRZ (e.g., heavy equipment, trailers, utility vehicles) are decontaminated using a variety of methods, including wet methods, high-efficiency particulate air (HEPA) vacuum, and tacky cloth. Waste from the EZ and CRZ will be minimized and managed as contaminated waste. Inspection and assessment for surface contamination following decontamination is performed following the decontamination and inspection process. Surface smears are taken prior to releasing items from the EZ or CRZ and mobilizing them into the SZ.

General housekeeping equipment and materials used in the SZ (administrative trailers) typically include HEPA-filtered vacuums, mops, wet wipes, disinfecting wipes, and floor buffers. Waste materials generated in the administrative trailers will be disposed of as general trash.

3.4 Engineering Controls

Engineering controls are designed into work activities whenever appropriate to minimize exposure to contaminants. “Wet methods” and applying water through the use of fog cannon, water truck, and other acceptable means are used routinely for managing fugitive dust emissions and dust control. Engineering controls also include routine use of stabilizing agents such as Gorilla Snot on exposed surfaces where additional control is required (e.g., on-site routes, parking areas, and other high-traffic areas; and soil/debris piles, which may be undisturbed for extended weekends or anticipated adverse weather conditions). Areas may also be enhanced utilizing geofabric, which is then covered with clean stone. On-site haul trucks also use a tarping system, which prevents dust and fine particles from inadvertently being ejected from the truck. Decontamination activities are also performed for equipment and materials that are planned to be moved between zones. NWP also utilizes total suspended particulate (TSP) monitors around the project site, which measure the amount of suspended solids in the air at any given time and run 24 hours a day, 7 days per week. Additional engineering controls include but are not limited to:

- TSP Monitors.
- Decontamination of surfaces before disturbance.
- Wetting agents during activities that may produce dust.
- Encapsulating agents to bind dust to prevent it from becoming airborne (e.g., Gorilla Snot).
- Tarping system on dump trucks.
- Laboratory hood vents.
- Decontamination pads.
- HEPA-filtered vacuums.
- Geofabric.
- Clean stone for cover.

Dust control within excavation areas may be supported by using a water truck when conditions warrant this practice. In general, the excavated soils contain a fair amount of water and do not become dry or produce dust unless they have been exposed to winds and warmer weather for some time. A water truck provides dust suppression for the haul routes and disturbed areas on the existing grade.

3.5 Personal Protective Equipment

Personal protective equipment (PPE) is the final level on the hierarchy of controls. PPE is only to be utilized when engineering controls and administrative controls are incapable to adequately protect the worker. Specific PPE requirements for work on the Luckey FUSRAP Project will be identified in the scope of work and AHA for that particular work.

Beryllium-contaminated or radiologically contaminated PPE and clothing must be handled in a manner to prevent the contamination from becoming airborne; it must not be shaken, air-cleaned, or otherwise disturbed. Workers are trained on proper PPE donning, doffing, decontamination, and disposal processes for safely performing these tasks.

Disposable PPE is placed into lined waste containers. Full bags within containers are promptly closed, j-sealed (goose-necked), and removed. Workers are trained to never push doffed PPE into disposal bags to prevent forcing contaminated air outward into their breathing zones.

PPE items that are reused (e.g., hard hats, gloves, muck boots) are cleaned and stored in the CRZ for future use. These PPE materials are placed in containers for safe storage and segregation from other items pending reuse. These containers (plastic totes, poly bags, etc.) are properly labeled with a beryllium warning label and radiological tag.

4. MONITORING

This section discusses means and methods utilized at the site for monitoring and controlling contamination. Surface monitoring is performed for beryllium and radioactivity. Air monitoring at the potential point of generation (workplace monitoring) and at the site perimeter is performed for beryllium, lead, particulates, gross alpha radiation, and gross beta radiation by using a combination of PBZ, low-volume particulate samplers, and TSP monitors (USACE 2021b).

4.1 Surface Contamination Monitoring

Surface contamination control measurements for radioactivity and beryllium are performed at the site to ensure the safety of personnel. Surface sampling is performed on routine basis and as needed for spot-checks or release of equipment and materials. Surface contamination monitoring includes but is not limited to:

- Trucks when they leave the EZ and the CRZ.
- Incoming equipment.
- SZ trailers (routine surveys).
- Materials and equipment leaving the EZ and the CRZ.

- Waste containers exiting the EZ, CRZ, and SZ.
- Individuals exiting the EZ.
- EZ and CRZ egress locations, including shower trailer, industrial hygiene (IH) trailer, and access control point (routine surveys).
- Roadways (routine surveys).
- On-site laboratory trailers (routine surveys).

4.1.1 Personnel Radioactive Contamination Monitoring

Personnel decontamination procedures are provided in the APP/SSHP, identified in training, and discussed with workers and in work instructions. Workers exit the EZ through the CRZ. Showers are provided, and personnel who have performed intrusive work (e.g., active remediation) in the EZ are required to shower before they exit the EZ/CRZ for the day. However, as stated prior in this document, certain events may alter this procedure.

Personnel exiting the EZ self-perform a radiological controls "frisk" of their hands, feet, and face for gross alpha and beta radioactivity in the CRZ and step into the SZ if uncontaminated. NWP has collected industrial hygiene data for beryllium, lead, and radiation from start of the project through all work performed to date. At the conclusion of 2019, an evaluation was performed on the mature data that was collected on the radiological studies that were performed at the site. The NWP CHP and RSO concluded that a whole body frisk for radioactivity was no longer necessary and was not required. Based on the potential for changing site conditions, this will be monitored and, if required, will be reinstituted. A Geiger-Mueller pancake detector is used for personnel frisking and the detector has an analog display and an audible signal alarm. The detectors are held ¼ to ½ inch from the body and moved at a speed of 1 to 2 inches per second. Individuals pause the frisk if there is an audible response that may exceed the natural background detector count rate. The pause is long enough to determine if contamination is present or if there is just a normal fluctuation in natural background. Uncontaminated workers sign out on the access control register to document that they are uncontaminated and have left the zone. Workers who suspect they may be contaminated notify the RCT on duty for direction and supported monitoring.

4.1.2 Contamination Monitoring on Equipment and Materials

Vehicles and large equipment used in the EZ are decontaminated on the decontamination pad prior to being moved from zone to zone. The designated decontamination pad is a concrete pad with drainage systems to the site wastewater treatment plant. Other decontamination areas may be established in the field based on need and existing site conditions. For instance, washing off dirt and debris from an excavator in the EZ prior to moving to the decontamination pad is a best

management practice and reduces the potential for tracking and spreading contaminants across the site. Tools and small equipment may be decontaminated in designated locations or the decontamination pad prior to transfer to the CRZ. Surveys are performed on tools and equipment prior to transfer from the EZ or CRZ into the SZ to ensure that free-release limits have been met.

Materials and equipment used in the EZ are checked for total radioactive contamination, removable radioactive contamination, and removable beryllium before release from the EZ. Surfaces that have the highest rate of personnel exposure to contaminants are preferentially checked.

Total radioactive contamination measurements are made with dual alpha/beta scintillators. Scans are performed as discussed above for personnel monitoring. Results are converted to disintegrations per minute per 100 cm^2.

Measurements for removable beryllium are made using a pre-moistened surface sample medium wiped with moderate pressure in an "S" pattern, over a surface area of 100 cm^2. The surface samples are analyzed via optical fluorescence with a BeFinder® detector or inductively coupled plasma mass spectrometer.

Results of both total and removable contamination measurements are compared to the Radiological Levels for Clearance found in the RPP (USACE 2021f) and shown in Section 5. Results of removable beryllium measurements are compared to a limit of 0.2 µg/100 cm^2. Materials and equipment that exceed these values are not removed from the EZ until decontaminated, resurveyed, and demonstrated to meet the release criteria.

4.1.3 Routine Contamination Monitoring in the CRZ and SZ

The potential transfer of radioactivity and beryllium into the CRZ and SZ is monitored routinely in accordance with the CBDPP (USACE 2021e) and RPP (USACE 2021f). Measurements for removable radioactivity and beryllium are taken to evaluate whether contamination is being tracked out of the EZ. Emphasis is placed on high-traffic areas and horizontal surface locations where equipment is stored.

Monitoring is performed in the CRZ side of access control and the IH Conex. Inspections generally include surfaces such as but not limited to: floors, tabletops, shelves, and fixed equipment or materials in the area. If contamination above the beryllium housekeeping limit of 3 µg/100 cm^2 is detected, additional housekeeping efforts are taken and the area is decontaminated and reported for trending. If radioactive contamination is found in excess of 60 dpm/100 cm^2 it is likewise decontaminated (see Section 5 for the contamination limits).

Monitoring is also performed in multiple areas of the SZ. When routinely assessing available surface spaces in the administrative trailers, the following surfaces are smeared and checked for removable contamination: floors, desks, tables, shelves, fixed equipment, and window ledges. Contamination is not expected to be found in the SZ, and if found, this indicates a potential breakdown in site contamination control practices. These findings are shared with the project management team and employees for awareness and enhancing work practices as necessary. Additionally, USACE is also notified if contamination is found in the SZ.

Travel paths in the SZ for roll-off traffic and west of the loadout area are checked monthly for radioactivity. This is done using the same sensitive gamma radiation detectors as used during gamma walkover surveys (e.g., Ludlum Model 2221 and Model 44-20 Detectors) in the EZ.

4.2 Air Monitoring

Air monitoring is performed to assess airborne contamination, as summarized in Table 4-1 and Figure 4-1. The air monitoring requirements are designed to provide early detection of potential contaminant emissions. The contamination control evaluation and decision process is shown in Figure 5 of USACE (2021b).

Dust, radionuclides, lead, beryllium, and meteorological data have been used to assess and establish baseline conditions (background) and are used to interpret/verify conditions during remedial activities. If there is an exceedance of TSP in a monitor upwind of operations, the exceedance and the wind direction are logged, and work continues. If there is an exceedance in both the upwind and downwind samplers with similar concentrations, it is noted, and work continues. If there is a significant exceedance at a downwind location but not in the upwind location, and emission-generating activities are scheduled to continue, additional controls are implemented. As noted during historical work and monitoring, the TSPs are very sensitive and have been impacted by exterior influences such as fog, smoke, and adjacent farming activities.

Table 4-1. Air Monitoring Program Summary

Requirement/*Objective*	Basis	Locations and Contaminants	Frequency
Air monitoring during remediation, which includes on-site perimeter plus work area monitoring – gross alpha/beta, individual radionuclides, Be, Pb, and TSP. *Provide early detection and notification of potential for exceedance of limits and action levels. See Worksheet 11, Section 5 of USACE (2021b).*	PWS, Appendix B, Section 01 35 29.13, Health Safety, and Emergency Response Procedures for Contaminated Sites and Uniform Federal Policy Quality Assurance Project Plan/Sampling and Analysis Plan (USACE 2021b), Worksheets 11 & 17 (Contamination and Exposure Control Monitoring)	Eight perimeter air monitoring locations. Three portable air monitoring stations around each excavation area and four portable air monitoring stations around the soil processing area. Each station will consist of a TSP monitor and two low-volume air samplers. Both fixed perimeter and mobile work area air monitoring locations and quantities may be adjusted to support project needs.	Weekly perimeter air monitor samples. Daily mobile air monitor samples. Continuous TSP with 15-minute averages.
Exposure monitoring and air sampling program – gross alpha/beta, radionuclides, Be, Pb, and TSP. *Protect worker health and safety.*	PWS, Appendix B, Section 01 35 29.13, *Health, Safety, and Emergency Response Procedures for Contaminated Sites* Subsection 1.13, Exposure Monitoring/Air Sampling Program Worksheet 11 & 17 (USACE 2021b).	General work area and worker breathing zone air monitoring (of similar exposure groups for representative sampling) are conducted in the EZ, CRZ, and SZ. Exposure assessments are conducted, as needed.	Daily, shift, and/or activity as needed for gross alpha/beta, Be, and Pb.

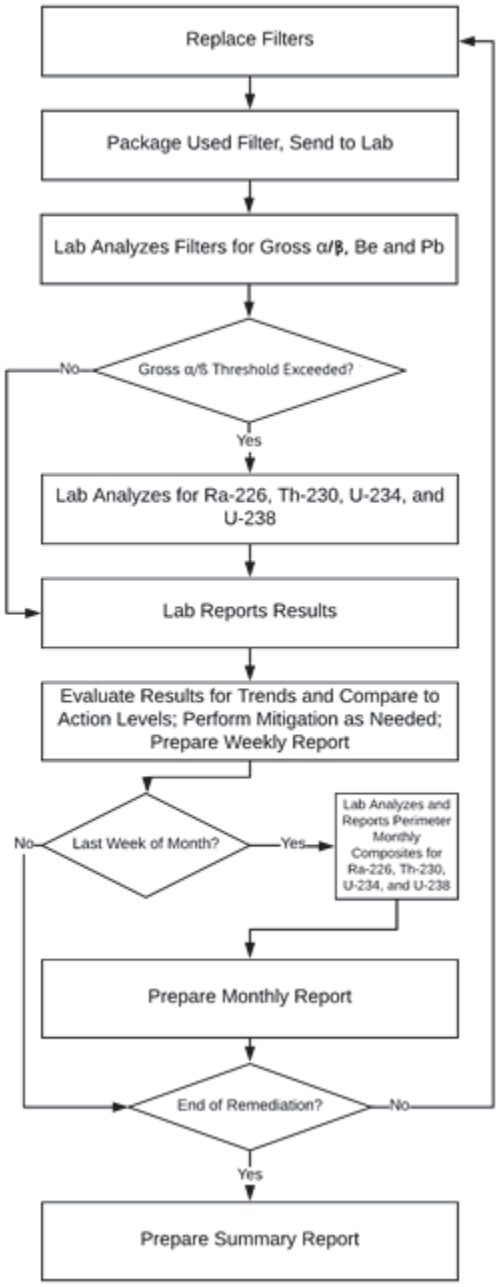

Figure 4-1. Air Filter Flowchart

4.3 Perimeter Air Monitoring Plan

Perimeter air sampling is performed around work areas and at the site perimeter to measure airborne particulate concentrations. The purpose of the air monitoring is to determine if the contamination exceeds permissible exposure control parameters during intrusive activities, including excavations, soil handling, transportation, container movement, and decontamination efforts.

The air monitoring program consists of:

- Real-time meteorological parameters and TSP.
- Radionuclides (gross alpha/beta), Be, and Pb.
- Monthly samples for individual radionuclides (Ra-226, Th-230, U-234, and U-238).

4.3.1 Fixed Perimeter Air Monitoring

Eight fixed perimeter air monitoring stations are installed on stands and placed at breathing zone height (approximately 5 ft above the ground surface) at the locations illustrated in Figure 3-1. These locations were selected based on the proximity of remediation activities to the site perimeter and wind direction frequency, which is based on measurements collected at the National Weather Service site at the Toledo Express Airport.

Air monitoring locations are equipped with a pair of low-volume particulate matter air sampling systems — one for radionuclides, the other for beryllium and lead. All perimeter locations are equipped with real-time particulate matter air sampling systems. This real-time monitoring allows timely evaluation of potential for site releases that could impact public health.

4.3.1.1 Low-Volume Sampling Systems

The low-volume particulate matter air sampling systems collect samples for radionuclides (gross alpha/beta), beryllium, and lead (see Figure 3-1). The fixed perimeter monitoring stations consist of the following equipment:

- F&J Specialty Products, Inc., LV-22 Environmental Low-Volume Air Sampler, or equivalent.
- Met One ES-642 TSP monitoring system, or equivalent.

These samplers are operated continuously and collected weekly during site remediation activities. The sampling period may be adjusted as needed in consideration of holidays or adverse weather conditions that prevent sampling change-out. The filters are analyzed each week

for gross alpha/beta radiation and Be/Pb. Each month the gross alpha/beta radiation filters are composited into one sample for each sampling location. If gross alpha and beta threshold concentrations shown in Table 5-1 are exceeded, the monthly filter composites are then radio-chemically analyzed for the individual radionuclide contaminants of concern: Ra-226, Th-230, U-234, and U-238.

The low-volume fixed perimeter TSP monitors operate continuously, except during routine maintenance, calibrations, and power outages. Routine maintenance, including sample media exchange, takes significantly less than the downtime of 20 percent as permitted by Section 2.2 of Appendix A to the Environmental Protection Agency's "Guidance on Implementing the Radionuclide NESHAPs" (Environmental Protection Agency (EPA) 1991). Backup monitors/systems are readily available for use, should it be determined that the down-time could exceed the 20 percent for maintenance on a specific monitor. If a power outage occurs, intrusive/dust-producing activities are stopped until power is restored and the monitors are operational. These air monitors have been outfitted with a red strobe light that is left on during its operation and provides a visual aid to personnel working in and around the area. If the strobe light is off, work is paused to investigate why the light is off. Additionally, TSP alerts are sent via e-mail notification to select personnel, which further enhances timely notification and responses by site personnel.

4.3.1.2 Real-Time Sampling Systems

Eight real-time dust monitors (MetOne ES-642, or equivalent) are used to determine TSP concentrations. The monitors run continuously, and the maximum 15-minute average concentrations are recorded. This data is automatically relayed to a site computer that can readily be evaluated.

4.3.2 Portable On-Site Air Monitoring

On-site monitoring is performed during excavation and soil-handling activities. The portable monitoring stations consist of the following equipment:

- F&J Specialty Products, Inc., LV-22 Environmental Low-Volume Air Sampler, or equivalent.
- Met One ES-642 TSP monitoring system, or equivalent.

Three portable air monitoring stations are used around each excavation area and four portable air monitoring stations are used around the soil processing area. The excavation area monitors are located upwind, downwind, and crosswind of each active work area. The soil processing area monitors are located north, south, east, and west of the active work area.

The air filters from each low-volume air monitor pair are changed daily. The filters from one of the sampler pairs are analyzed for gross alpha/beta radioactivity. These filters are saved for potential analysis of individual radionuclides, depending on the results of the gross alpha/beta analysis (i.e., any that are significantly elevated). The filter from the second of the monitor pairs are analyzed each day for beryllium and lead.

The real-time TSP monitors are equipped with data loggers to measure the maximum 15-minute air concentrations of TSP.

Portable real-time instruments (e.g., TSI AM520) are also used to measure TSP wherever needed (e.g., by walking the site or excavation perimeter).

The locations of the portable monitors are selected by the SSHO/designee when needed, through careful consideration of current and forecasted meteorological conditions and scheduled activities for the day. The location of each portable station, the work zone(s), and wind direction are recorded for each day. Exceedances of action levels shown in Table 5-1 for any COCs must be immediately reported to the SSHO, PM, and the USACE contracting officer's representative (COR).

4.3.3 Occupational Air Monitoring

Personal breathing zone monitors (PBZs) are placed on selected workers to evaluate potential exposures to radionuclides, beryllium, and lead during remediation. Personnel breathing zone pumps are worn on field personnel (e.g., equipment operators, waste technicians, and laborers) who all wear PAPRs with a protection factor of 1000 and a full ensemble of PPE while also wearing the PBZs. Those individuals working with potentially contaminated material or in the closest proximity to the material are assumed to represent the worst-case scenario for potential exposure, regardless of PPE and other controls that further reduce exposure potentials. As such, workers are selected for inclusion in the occupational air monitoring program based on their proximity to the material in question and/or job tasks involving working with the material. Detailed information is documented on how the occupational air sampling data is used.

4.3.4 Meteorological Monitoring

A meteorological station (Campbell Scientific CR1000) equipped with a solar panel and battery for remote operation is placed along the site perimeter on the west side of the site (see Figure 3-1). The system measures wind speed, temperature, wind direction, relative humidity, and barometric pressure. The system records 15-minute average values for each parameter (wind speed and direction, temperature, relative humidity, and barometric pressure), and the data is maintained in an on-site database. Additionally, the station has a rain gauge to determine inches of rain in a 24-hour period. The station has been hardwired to operate on line power and the battery serves as a backup power supply, thereby supporting uninterrupted operation of the station. The station is also designed with wireless capability for data download.

4.3.5 Sample Designation and Sample Identification Codes

Samples collected are assigned unique sample identification numbers. These numbers are necessary to identify and track each of the samples collected for analysis during completion of the project. Each sample is identified by a unique alpha numeric code to maintain consistency and comparability of sample location identification for the duration of the project. In addition, the sample identification numbers are used to identify and retrieve the analytical results received from the laboratory as well as other data related to the samples. The sample identification nomenclature is defined in Worksheet #18 of the QAPP/SAP (USACE 2021b).

4.3.6 Instrument/Equipment Testing, Inspection, and Maintenance

Table 4-2 identifies the equipment and maintenance required to ensure system operability. Calibration and maintenance frequencies must be in accordance with manufacturer requirements and the QAPP/SAP (USACE 2021b).

Table 4-2. Equipment Maintenance Schedule

System/Component	Maintenance Activity	Frequency	Responsibility	Position
Personal sampling pumps	Flow rate calibration	Daily	Site	Safety & health technician or radiological control technician (RCT)
Low-volume sampler flowmeter (F&J Specialty Products, Inc., LV-22)	Flow rate verification	Weekly	Site	RCT
	Calibration	Semiannual	Site	RCT
Total suspended particulate monitor (Met One ES 642 TSP Monitoring System)	Visual inspection of filters and replacement as necessary	Semiannual	Site	RCT
	Flow check (three points)	Monitored real time on 15-minute averages	Site	RCT
	Calibration	Semiannual	Site	RCT
Meteorological instruments (Campbell Scientific CR1000)	Calibration	Biannual	Vendor	N/A
Personal aerosol monitor (TSI AM520)	Calibration	Annual	Vendor	N/A
Air flow calibrator	Calibration	Annual	Vendor	N/A

4.3.7 Program Assessments and Response Actions

If an air monitoring result shows elevated levels (at or above the action level), field personnel are notified by the SSHO. The meteorological data (e.g., wind direction/speed, temperature, humidity) is evaluated as part of this response. In addition, adjacent off-site activities (e.g., agricultural, vehicle traffic) and the location of the site activities are considered as part of this response. The following actions are taken, as appropriate:

- If action levels or limits are exceeded, perform the following:
  - Review the preliminary data for validity and if valid promptly suspend or, for action level exceedance, modify the operations.
  - For limit exceedance, promptly review notification requirements to determine if notification of off-site personnel and organizations is required.
  - Promptly investigate the cause of the event and determine if mitigation is required, ensuring that all potential on-site sources are adequately investigated.
  - Document events caused by non-site-related sources, such as plowing and harvesting, high humidity affecting the instruments, exhaust emissions from operating equipment, or other factors unrelated to the site activity.
  - If the situation requires any mitigation, document the event and summarize the data, the cause of the measured value(s), and any corrective measures implemented as a result of the event. The PM performs these follow-up actions.

Upon collection of sufficient surface contamination and airborne analysis data, a negative exposure assessment (NEA) is utilized to demonstrate that changes to the frequency and type of sampling can be made. The NEA is to follow SOP #2 guidelines established by NWP and USACE Certified Industrial Hygiene Managers. NWP submits NEAs to the USACE for review and approval. NEAs are used to indicate that controls are sufficient and the environment is acceptable to allow for downgrading of PPE in an area. Additionally, exposure assessments (EAs) are used to indicate that controls are sufficient and the environment is acceptable to allow for downgrading of boundaries in an area. The EA is to follow Standard Operating Procedures (SOP) #3 guidelines established by NWP and USACE Certified Industrial Hygiene Managers. A site map indicating the area of the NEA as well as activities reflected in the NEA is included in the assessment.

4.3.8 Documentation and Records

4.3.8.1 Field Log

Throughout performance of the project, field logs are maintained. Information to be recorded in these logs/forms includes:

- A description of remediation activities associated with any elevated air monitoring measurements.

- Locations of each fixed and portable air monitoring station and handheld monitoring locations for the day.
- Any corrective actions conducted due to elevated real-time air monitoring concentrations.
- Sample media collection and receipt dates, conditions, and numbers.
- Copies of chain-of-custody forms.
- Sampling equipment installation, operation, and removal dates.
- Sampling equipment calibration dates and results.
- General weather conditions.
- Any unusual situations that may affect the samples or sampling.
- Start and stop times.

4.3.8.2 Data Management

Surface samples, swipe samples, and air monitoring data are obtained from a variety of sources, including real-time monitoring, handheld and observational monitoring, particulate sampling, and laboratory analyses.

The following measurements require management:

- Real-time particulate matter (TSP) at background, fixed, and portable monitoring locations (datalogger).
- Filter samples for radionuclides (gross alpha/beta), beryllium, and lead at fixed and portable monitoring locations.
- Filter samples for individual radionuclides (Ra-226, Th-230, U-234, and U-238) at fixed and portable monitoring locations.
- Handheld real-time particulate matter at portable monitoring locations.
- Personal air monitors.
- Real-time meteorological parameters at meteorological monitoring location (datalogger).

4.3.9 Reporting

This section discusses the data reporting program. It includes reporting on exceedances of action levels, weekly data summaries, monthly data summaries, and reporting at conclusion of perimeter monitoring.

4.3.9.1 Exceedances

Monitoring results are immediately reported to the PM, RSO, SSHO, and the USACE (i.e., COR and resident engineer) when action levels and/or limits have been exceeded, to discuss prompt evaluation and response to potential emissions.

The RSO, SSHO, and PM, in consultation with USACE, will decide when shutdown and startup criteria have been met.

4.3.9.2 Weekly Data Summaries

NWP presents USACE the following weekly data summaries for the meteorological station, fixed perimeter monitoring stations, and portable monitoring stations:

- Maximum 15-minute average concentrations of real-time TSP.
- Average 15-minute wind speed, wind direction, relative humidity, and air temperature data.
- Site activities, including monitoring, that triggered a response action.
- Air monitoring station locations.

4.3.9.3 Monthly Data Summaries

Monthly PBZ and General Area reports will include all data for that time frame as well as an explanation and/or action for any data exceeding the action level. NWP provides USACE the following monthly data summaries in electronic format for the fixed perimeter monitoring stations and portable monitoring stations:

- Maximum 24-hour average concentrations of TSP, radionuclides (gross alpha/beta), beryllium, and lead from low-volume filter samples.
- Maximum 24-hour average concentrations of individual radionuclides (Ra-226, Th-230, U-234, and U-238).
- Site activities, including monitoring, that triggered a response action, if any.
- Air monitoring station locations.

As a separate report, NWP provides monthly data summaries electronically, in a format acceptable to USACE, for beryllium and lead personal air monitoring, and beryllium surface sampling.

4.3.9.4 Reporting at Conclusion of Perimeter Monitoring

NWP will provide to USACE an air monitoring report at the conclusion of the perimeter air monitoring program. The report shall provide:

- All real-time air monitoring results in a database or spreadsheet. This includes statistical summaries (tabulated mean, standard deviation, percentiles by monitor location and month) and graphical summaries.
- All filter sampling and analytical results in a database or spreadsheet. This includes statistical summaries (tabulated mean, standard deviation, percentiles by monitor location and month) and graphical summaries.
- All meteorological data in a database or spreadsheet. This includes statistical summaries (tabulated mean, standard deviation, percentiles by monitor location and month) and graphical summaries (such as boxplots by monitor location and month).
- A summary of air monitoring results above the action levels and limits, if any, corresponding site activities, and response actions taken.
- Figures that identify fixed and portable air monitoring stations associated with each remediation area.

4.3.10 Training

The SHM, RSO, and SSHO ensure that the following instructions specific to this project have been presented to site project personnel implementing this plan:

- Overview of the air monitoring plan.
- Organization responsibilities, lines of communication, and authorities.
- Sample handling and chain-of-custody.
- Quality control considerations.
- Documentation requirements.
- Response actions.
- Notification requirements.

5. LIMITS

The housekeeping criterion for beryllium of 3 µg/100 cm^2 is used to identify areas where additional housekeeping procedures should be implemented in the CRZ and EZ. Areas where the housekeeping criterion is being applied include the CRZ side of the Access Control Conex and the CRZ side of the IH Conex. The CRZ side of the Access Control Conex and the CRZ side of the IH Conex are where personnel working in the EZ begin the doffing process (i.e., PAPRs, Tyvek, nitrile gloves, and rubber boots). The surface contamination action level for the SZ, and for the release of items from governmental control, to off-site locations, is 0.2 µg/100 cm^2. Areas in the SZ that exceed the free-release criterion will indicate that additional housekeeping procedures should be implemented in those areas. Equipment being released to off-site locations but remaining in governmental control will fall under the housekeeping criterion of 3.0 µg/100 cm^2. This equipment will be sampled periodically to ensure it is being maintained at the housekeeping criterion.

Radiological limits for acceptable levels of surface contamination (Pamphlet DA PM 385-24 [U.S. Army 2015], Table 5-3, “Screening levels for clearance”) are presented in Table 5-2 and are applied to equipment and material release. The surface screening values are for total contamination. Removable contamination screening values are set at 10 percent of those for total contamination. The purpose of this goal is to maintain contamination levels and personnel exposures ALARA. As a general practice, Army organizations do not release volumetric radioactively contaminated materials or items for unrestricted use.

Table 5-1. Air Monitoring Limits

Contaminant of Concern	Location	Action Level	Limit	Units	References
Be	Perimeter	None	0.01	$\mu g/m^3$	1
Be	Work area/ breathing zone (BZ)	0.1	0.2	$\mu g/m^3$	2
Pb	Perimeter	None	0.15	$\mu g/m^3$	3
Pb	Work area/BZ	30.0	50.0	$\mu g/m^3$	4
Radioactivity, gross alpha	Work area/BZ	6E-13	3E-12	µCi/mL	5
Radioactivity, gross alpha	Perimeter	4.0E-15	2.0E-14	µCi/mL	5
Radioactivity, gross beta	Work area/BZ	2.0E-11	1.0E-10	µCi/mL	6
Radioactivity, gross beta	Perimeter	1.2E-14	6E-13	µCi/mL	6
Respirable particles not otherwise specified (TSP)	Work area/BZ	1.5	3.0	mg/m^3	7
Respirable silica, crystalline – quartz and cristobalite	Work area/BZ	0.0125	0.025	mg/m^3	8
Ra-226 derived air concentration (DAC)	Work area/BZ	6.0E-11	3.0E-10	µCi/mL	8
Ra-226	Perimeter	1.8E-13	9.0E-13	µCi/mL	9
Th-230 (DAC)	Work area/BZ	6E-13	3.0E-12	µCi/mL	8
Th-230	Perimeter	4.0E-15	2.0E-14	µCi/mL	9
U234 (DAC)	Work area/BZ	4E-12	2E-11	µCi/mL	8
U-234	Perimeter	1E-14	5E-14	µCi/mL	9
U-238 (DAC)	Work area/BZ	4E-12	2E-11	µCi/mL	8
U-238	Perimeter	1.2E-14	6E-14	µCi/mL	9

References:

1. 40 CFR 61 Part C, National Emission Standard for Beryllium. NESHAPS ambient air standard for beryllium production facilities, 30-day average.
2. USACE Buffalo District Occupational Exposure Level for Beryllium 7 July 2020, approved waiver from USACE Engineering Manual 385-1-1 (Safety and Health) requirement by USACE Headquarters Safety Office. To be applied within the personal breathing zone of site workers; averaged over 8 hours, with action triggered at half this level.
3. Ohio Administrative Code 3745-25-02 (F), Ohio Ambient Air Quality Standard for lead, arithmetic mean concentration over 3-month period.
4. Occupational Safety and Health Administration permissible exposure limit (29 CFR 1910.1025).
5. 10 CFR 20, Appendix B, Values for Th-230, Class W used as most conservative surrogate for alpha activity. Derived Air Concentration, occupational value for inhalation, assumes exposure limited to 2000 hours/year. Most conservative inhalation properties assumed of radionuclide, controls dose to the public, annual average.
6. 10 CFR 20, Appendix B, Value for Pb-210 Class W because it is the long-lived beta-emitting radionuclide with the most restrictive occupational and effluent limits. Derived Air Concentration, occupational value for inhalation, assumes exposure limited to 2000 hours/year. Most conservative inhalation properties assumed of radionuclide, controls dose to the public, annual average.
7. American Conference of Governmental Industrial Hygienists threshold limit value 2015.
8. 10 CFR 20, Appendix B, Values for individual radionuclides, Derived Air Concentration, occupational value for inhalation, assumes exposure limited to 2000 hours/year.
9. 10 CFR 20, Appendix B, Values for individual radionuclides, effluent limit for annual dose to the public, annual average, action level at 20% (ALARA requirement).

Table 5-2. Radiological Screening Levels for Clearance

Radionuclide Groups[1]	Total Contamination Screening Levels (S.I. Units)[2] becquerels per square centimeter or becquerels per gram (Bq/cm^2 or Bq/g)[3]	Total Contamination Surface Screening (Conventional Units)[2] disintegrations per minute (dpm/100 cm^2)	Volume Screening (Conventional Units)[2] (pCi/g)
Group 1 Radium, Thorium, and Transuranics: ^{210}Po, ^{210}Pb, ^{226}Ra, ^{228}Ra, ^{228}Th, ^{230}Th, ^{232}Th, ^{237}Np, ^{239}Pu, ^{240}Pu, ^{241}Am, ^{244}Cm and associated decay chains[4], and others[1]	0.1	600	3
Group 2 Uranium and Selected High Dose Beta-Gamma Emitters: ^{22}Na, ^{54}Mn, ^{58}Co, ^{60}Co, ^{65}Zn, ^{90}Sr, ^{94}Nb, ^{106}Ru, ^{110m}Ag, ^{124}Sb, ^{134}Cs, ^{137}Cs, ^{152}Eu, ^{154}Eu, ^{192}Ir, ^{234}U, ^{235}U, ^{238}U, Natural Uranium[5], and others[1]	1	6,000	30
Group 3 General Beta-Gamma Emitters: ^{24}Na, ^{36}Cl, ^{59}Fe, ^{109}Cd, ^{131}I, ^{129}I, ^{144}Ce, ^{198}Au, ^{241}Pu, and others[1]	10	60,000	300
Group 4 Other Beta-Gamma Emitters: ^{3}H, ^{14}C, ^{32}P, ^{35}S, ^{45}Ca, ^{51}Cr, ^{55}Fe, ^{63}Ni, ^{89}Sr, ^{99}Tc, ^{111}In, ^{125}I, ^{147}Pm, and others[1]	100	600,000	3,000

1. To determine the specific group for radionuclides not shown, a comparison of the effective dose factors, by exposure pathway, listed in Table A.1 of National Council on Radiation Protection and Measurements Report No. 123 (NCRP 1996) for the radionuclides in question and the radionuclides in the general groups above are performed and a determination of the proper group made, based on similarity of the factors.
2. Rounded to one significant figure.
3. The screening levels shown are used for either surface activity concentration (in units of Bq/cm^2) or volume activity concentration (in units of Bq/g). These groupings were determined based on similarity of the scenario modeling results, as described in Annex B of ANSI N13.12.
4. For decay chains, the screening levels represent the total activity (that is, the activity of the parent plus the activity of all progeny) present.
5. Where the Natural Uranium activity equals 48.9% from U-238, plus 48.9% from U-234, plus 2.25% from U-235.

6. EXTENDED SHUTDOWN

If site activities are shut down for an extended period of time, then additional steps are taken to ensure that no inadvertent contaminant migration occurs. These additional measures address work areas, equipment, tools, and facilities, as follows:

- Work areas are stabilized, and if remediation is not complete in a disturbed area, clean cover or fixative is applied to provide a barrier for contamination control.
- Tools and equipment are decontaminated to the extent necessary; if leaving the site, then tools and equipment must meet the free-release criteria. For tools and equipment that are stored in the EZ during the shutdown, the housekeeping standard for the EZ applies. Contamination surveys are performed and documented for the as-left condition. Any equipment or tools with elevated levels of contamination are covered or have fixative applied to provide a barrier for contamination control.
- Facilities are cleaned, and a final round of contamination surveys performed. Facilities in the SZ must meet the release criteria, while facilities within the EZ or CRZ may exceed the release criteria, provided that areas with contamination are covered or have fixative applied. In addition, these facilities (or areas within) must be properly posted/labeled.

Air monitoring continues for a minimum of one week after all site activities with contaminated materials are complete. If air monitoring results are all below criteria, then the site is shut down with no additional monitoring until activities resume.

7. REFERENCES

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USACE, 2021b, *Uniform Federal Policy Quality Assurance Project Plan for the FUSRAP Luckey Remediation of Soils Operable Unit Project, Luckey, Ohio, Sampling and Analysis Plan*, PLN-080240-5503, U.S. Army Corps of Engineers, Luckey, Ohio.

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USACE, 2021d, *Site Operations Plan for the FUSRAP Luckey Remediation of Soils Operable Unit Project*, PLN-080240-5500, U.S. Army Corps of Engineers, Luckey, Ohio.

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USACE, 2021f, *Radiation Protection Plan for the FUSRAP Luckey Remediation of Soils Operable Unit Project,* PLN-080240-5513, U.S. Army Corps of Engineers, Luckey, Ohio.

USACE, 2021g, *Contractor Quality Control Plan*, PLN-080240-5502, U.S. Army Corps of Engineers, Luckey, Ohio.

U.S. Army, 2015, *The Army Radiation Safety Program*, Pamphlet DA PAM 385-24, U.S. Army, November 30, 2015.