

Incorporation of Multiple Analytical Techniques and Data Streams to Accomplish Remedial Investigation Objectives: Determination of Nature and Extent of Radiological Contamination at the Guterl FUSRAP Site, Lockport, New York

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ABSTRACT

Radiological contamination at Formerly Utilized Sites Remedial Action Program (FUSRAP) sites requires proper characterization for effective decision making in the remedial action process. A Remedial Investigation (RI) performed in accordance with Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) guidance was conducted for the Guterl Specialty Steel site – to determine nature and extent of contamination and lay the groundwork for future decision making. Multiple radiological analytical techniques were employed to optimize the decision making process. The benefits of applying multiple radiological analytical techniques and data streams to delineate nature and extent of radiological contamination and refine the conceptual site model upfront in the initial characterization phase are increased confidence in the characterization, and optimized decision making and cost and schedule efficiencies.

INTRODUCTION

The Former Guterl Specialty Steel Corporation FUSRAP Site (the Guterl Site) is a FUSRAP site covering approximately 28 hectares and is located in Lockport, Niagara County, New York (NY). Figure 1 shows the location of the Guterl Site.

Site History

The Guterl Site was owned and operated by Simonds Saw and Steel Company (Simonds) from 1910 to 1966 to manufacture steel and specialty steel alloys (high-alloy) used in the production of saws and other tools. Simonds was acquired by the Wallace-Murray Corporation in 1966 (Delaware Secretary of State, 1966). Wallace-Murray Corporation continued to operate the plant as a specialty steel mill until 1978, when Guterl Specialty Steel Corporation acquired the site property [1]. Guterl Specialty Steel Corporation filed for Chapter 11 bankruptcy protection in 1982 (this was changed to a Chapter 7 bankruptcy in 1990) [2].

Records indicate Simonds processed between $1.1\text{E}+07$ and $1.5\text{E}+07$ kilograms of natural uranium (U) metal (i.e., processed uranium metal without enrichment supplied as metal ingots) and approximately $1.3\text{E}+04$ to $1.8\text{E}+04$ kilograms of thorium (Th) metal between 1948 and 1956[3]. The Th metal was comprised of equal fractions (50:50) of ^{232}Th and ^{232}Th [4]. Almost all naturally-occurring Th is ^{232}Th [5]; any source term for ^{230}Th would include only a small contribution from the processed Th metal.

Simonds performed work under the Atomic Energy Commission (AEC) contract (1948-1952) with an annual output of or nearly 312 rolling turns of metal. Each turn processed between $6.8\text{E}+03$ and $9.1\text{E}+03$ kilograms of uranium metal ingot, resulting in an average processing of approximately $2.1\text{E}+06$ to $2.8\text{E}+06$ kilograms of U metal per annum.

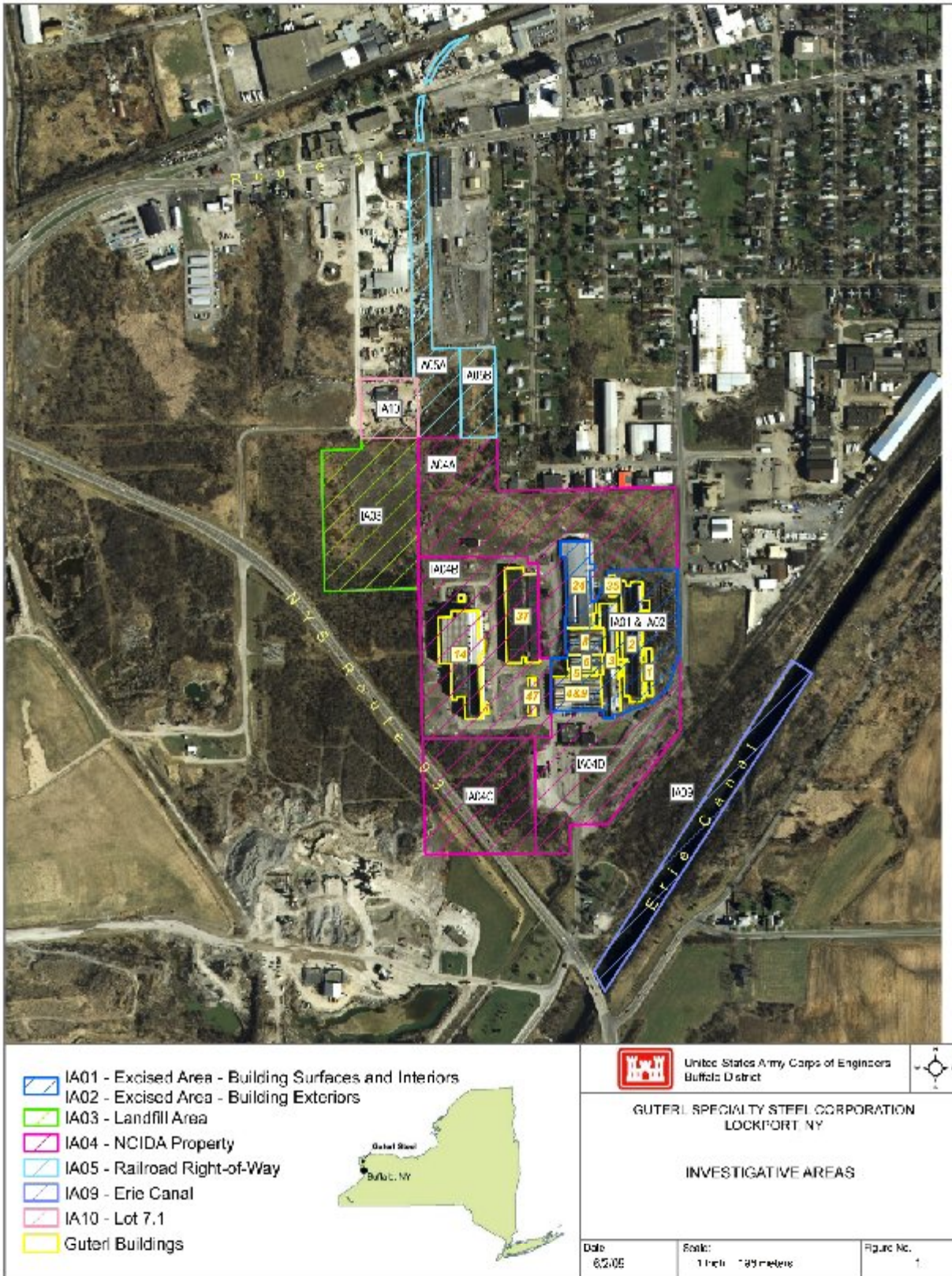


Figure 1. Site Location Map

Simonds continued the same type of work under a National Lead of Ohio contract and during 1953, 1954, 1955, and 1956 records indicate there was production of 29, 56, 58, and 22 turns of metal per year, respectively. The average annual production during this time frame would have been approximately $1.7\text{E}+05$ to $4.5\text{E}+05$ kilograms - assuming an average of $6.8\text{E}+03$ to $9.1\text{E}+03$ kilograms of U metal ingot per turn.

Reports have stated that more than 99 percent of all material processed at Simonds was natural uranium. There is also evidence to support that Simonds processed depleted uranium and enriched uranium (up to 2.5 percent) [4]. Recycled depleted uranium is known to be cross-contaminated with transuranic radionuclides; for this these would include neptunium (^{237}Np) and plutonium (^{239}Pu).

OBJECTIVE

The Guterl Site RI needed to generate data of known and sufficient quality and quantity, with quantitation levels low enough to meet pertinent standards, Applicable, Relevant and Appropriate Requirements (ARAR), and remediation goals - with the long-term objective being the selection of a protective remedy that satisfies CERCLA. Data quality needed to be sufficient to determine nature and extent of contamination, estimate risks to human and ecological receptors, and determine fate and transport of contaminants – all according to CERCLA guidance [6]. The project delivery team (PDT) believed the RI should produce data sufficient to develop preliminary volume estimates of contaminated media, and assist the development of project cost estimates to support the feasibility study. Data may also be used to identify appropriate disposal facilities for wastes generated during site investigation activities and during RA.

The initial list of constituents of potential concern (COPCs) as presented in the Data Gap Analysis Report (DGAR) [7] consisted of ^{234}U , ^{235}U , ^{238}U , and ^{232}Th . Additional site-specific COPCs were identified during development and review of project plans; the additional radiological isotopes were ^{228}Th and ^{230}Th , ^{226}Ra , and ^{228}Ra . These isotopes were added to the COPC list based on their being key daughter products of the initial COPC list; potential impurities in the raw materials processed at the Guterl Site; risk assessment needs; and experience at other recently investigated FUSRAP sites in the northeastern United States.

The final COPC list consisted of:

- Isotopic uranium (^{234}U , ^{235}U , and ^{238}U)
- Isotopic thorium (^{228}Th , ^{230}Th , and ^{232}Th)
- ^{226}Ra and ^{228}Ra .

Other constituents (not identified as COPCs) were evaluated in this investigation to confirm the nature of contamination at the site. Contaminants found in recycled uranium – such as ^{236}U , would signal the need to evaluate the potential presence of other recycled uranium contaminants such as ^{237}Np and ^{239}Pu .

FIELD INVESTIGATION AND RADIOLOGICAL METHODS

Multiple radiological analytical techniques were employed on samples collected from the Guterl Site to complete two of the main data quality objectives of the remedial investigation: establish nature and extent of contamination and provide data sufficient for risk assessment. Data quality objectives, analytical techniques, and method detection limits were established during the development of the project work plans. Sample locations were determined after completion of the historical data review and during development of project work plans.

A hierarchy of analytical methods was used to select different techniques for different purposes and data quality objectives. A site-wide gamma walkover survey (GWS) was performed first to guide soil sampling locations; afterward all soil samples were subjected to ex-situ gamma scanning via an automated soil core scanner and the selected surface and subsurface soil samples were then subjected to on-site gamma spectral analysis. This near real-time analysis had several advantages, including (1) allowing for the use of the Triad¹ approach in selecting further sampling locations for delineation of extent of contamination and (2) focusing the selection of only the most contaminated samples to be sent off-site for additional, more costly and time-consuming laboratory analyses to help refine the understanding of the nature of radiological contamination.

²³²Th and ²³⁸U were the primary COPCs but other constituents could have been present due to other radiological contamination. Therefore, use of the GWS and on-site laboratory assisted in choosing samples that contained elevated radioactivity and most likely to identify other COPCs, if present on-site. For example, the limited but available evidence for the presence of recycled, depleted, or enriched uranium on-site indicated that the presence of recycled uranium constituents on-site could not be completely eliminated; however, it would be costly and time consuming to expand the analytical suite to look for those constituents in every sample. Likewise, the risk assessment, subsequent development of cleanup goals, and cleanup verification could be streamlined if all uranium on-site was found to be natural uranium, allowing for the use of ²³⁸U as a surrogate for total uranium. Using limited inductively coupled plasma - mass spectroscopy (ICP-MS) analysis on samples with elevated uranium, which would be the ones most likely to show evidence of enrichment or depletion, would assist in confirming the assumption of natural uranium at the site. If this confirmation could be made in the initial remedial investigative phase of the project, rather than obtaining this confirmation in later phases such as the feasibility study or remedial design, then site close-out decisions could be made in a more efficient manner.

Table I lists the types of radiological analyses (including ICP-MS for uranium isotopes) performed along with their respective analytes. The samples analyzed by these techniques included surface and subsurface soil, detritus (loose, anthropomorphic, non-soil material present on top of floor surfaces in some uranium/thorium metal handling buildings), surface water, sediment, groundwater, building material, and swipe samples. A more complete description of the rationale, purpose and use of these radiological analytical techniques is provided in the following sections. Data uses by method were as follows (not all COPCs were detected by each method; refer to Table I for COPCs detected by method):

- GWS data were used to support evaluation of COPC nature and extent.
- Ex-situ core scanning data were used to support evaluation of COPC nature and extent.
- On-site gamma spectroscopy data were used to support evaluation of COPC nature and extent.

¹ The Triad approach to decision-making for hazardous waste sites offers a technically defensible methodology for managing decision uncertainty that leverages innovative characterization tools and strategies. The Triad refers to three primary components: systematic planning; dynamic work strategies; and real-time measurement systems. [8]

- Off-site gamma spectroscopy data were used to support evaluation of COPC nature and extent and to verify on-site gamma spectroscopy data.
- Alpha spectroscopy data were used to support evaluation of COPC nature and extent as well as baseline risk assessment.
- Gas flow proportional flow counting (GFPC) data were used to support evaluation of COPC nature and extent as well as baseline risk assessment.
- ICP-MS data were used to support evaluation of COPC nature and extent as well as baseline risk assessment.

Table I. Summary of Matrices, Analytical Methods, Data Generated, and Data Uses

Radiological Method Use by Matrix^a :	Gamma walkover survey	On-site Gross α and Gross β^b	Ex situ core scanning	On-site gamma spectroscopy	Off-site gamma spectroscopy	Off-site alpha spectroscopy	Off-site gas flow proportional counting	Off-site ICP-MS^c
Detritus				X	X	X	X	
Surface Soil	X		X	X	X	X	X	X
Subsurface Soil			X	X	X	X	X	X
Surface Water						X	X	
Sediment					X	X	X	
Ground-water						X	X	
Building Materials					X	X	X	
Swipes		X						
Gross α		X					X	
Gross β		X					X	
Gross γ	X		X					
²²⁶ Ra					X		X	
²²⁸ Ra					X		X	
²²⁸ Th						X		
²³⁰ Th						X		
²³² Th				X	X	X		
²³⁴ U					X	X		X
²³⁵ U					X	x		X
²³⁶ U								X
²³⁸ U				X	X	X		X
Nature and Extent of Contamination	X	X	X	X	X	X	X	X
Human Health Risk Assessment						X	X	X
Screening Level Risk Assessment						X	X	X

Notes:

^a Not all samples for each matrix were analyzed for each method.

^b Swipes for removable alpha and beta activity were analyzed for gross alpha and beta activity using a Ludlum Model 2929 coupled with a Ludlum Model 43-10-1 detector (before the on-site laboratory was set up) and a Tennelec LB5100 Low Background Alpha/Beta gas-flow proportional counting with automatic sample changer afterwards.

^c Although ICP-MS is not a radiological analytical technique, it is included here because it was applied to three of the radiological COPCs (analytes).

α = alpha

β = beta

γ = gamma

The variety of media sampled and analytical methods employed were important in directing the field study while field efforts were going on. The use of surface water and sediment results to help direct further soil sampling enabled the PDT to make decisions while the team was still in the field. The focus of this paper is on the soil media.

Field Screening Analyses

Figure 2 illustrates how soil samples were selected for on-site gamma spectroscopy analyses. The initial step of the field data acquisition program included performance of a GWS to verify the appropriateness of pre-selected sample locations, as well as to provide information for the potential placement of biased sample locations as determined by review of the GWS data (e.g., previously undetected areas of elevated activity). Soil borings were completed using direct-push technology equipment and methods. An automated gamma core scanner was then used to scan each soil core in its entirety to screen intervals for further analyses. The core scanner contained two diametrically opposed 5.08-centimeter x 5.08-centimeter (commonly termed a “2 x 2” meter) sodium iodide (NaI) (TI) gamma scintillator detectors mounted in a unit with a calibrated track that advanced the core through the scanner in four-inch intervals. The GWS and core scanning screening techniques were useful for pinpointing locations or samples worthy of additional study with other techniques and, conversely, for identifying locations and samples that likely contain little or no radioactive contamination.

On-site Radioanalytical Laboratory Analyses

A total of 1785 soil samples were analyzed by gamma spectroscopy at the on-site laboratory. The on-site gamma spectroscopic analyses and off-site spectroscopic analyses differed primarily in the turnaround times allowed for analyses. The on-site laboratory’s purpose was rapid turnaround times to help guide field activities; an important consideration, however, was that little or no time was available to allow buildup of progeny (primarily radon and its progeny) that would allow the on-site laboratory to accurately quantify radium concentrations. The off-site laboratory had time available to hold the samples for progeny buildup and so was able to report radium, in addition to thorium and uranium, concentrations.

On-site gamma spectroscopy analyses were performed by American Radiation Services (Baton Rouge, LA). The on-site gamma spectroscopy laboratory was used to analyze selected surface soil and subsurface soil samples for radiological COPCs. The primary purpose and benefit of the on-site gamma spectroscopy laboratory was to provide reliable near-real-time results to permit the survey team to locate and take additional samples where contamination was identified in order to ensure that the contamination was bounded to within an appropriate distance (less than 10 meters). The soil samples were subject to a limited amount of processing (drying and removal of rocks and large pebbles) prior to analysis in the on-site laboratory, although this processing was not as rigorous as the sample preparation techniques utilized by the off-site laboratory.

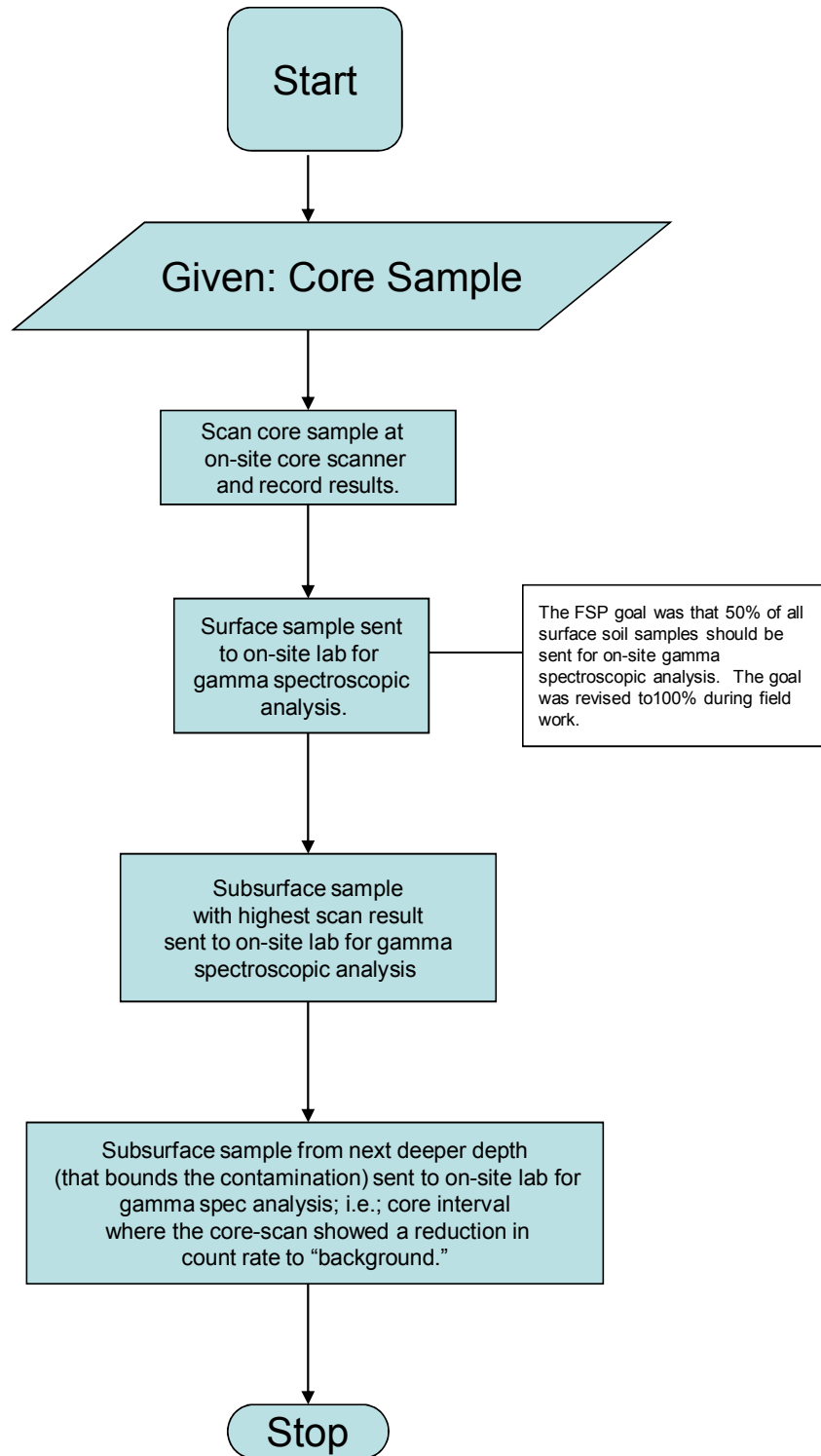


Figure 2. On-site Core Scan - Gamma Spectroscopy Decision Tree

Off-site Radiological Analyses

Off-site radiological analyses were performed by Severn Trent Laboratories, Inc., [STL], St. Louis, MO. Data quality objectives, analytical techniques, and method detection limits were established during the development of the project work plans. A brief discussion of the type, number, and RI purpose of each method is presented in the following paragraphs.

Gamma Spectroscopy

The RI Field Sampling Plan (FSP) [9] required 5 percent of the field screening laboratory (on-site) gamma spectroscopy soil samples (or a minimum of 100 samples, whichever was greater) be submitted for gamma spectroscopy analysis at the off-site analytical laboratory. The purpose of the off-site gamma spectroscopy analyses was to provide additional data to be used to assess nature and extent of COPCs, as well as to assess comparability with the on-site laboratory.

A total of 138 of the 1785 soil samples analyzed in the on-site laboratory (7.7 percent) were sent to the off-site laboratory for gamma spectroscopic analysis for COPCs. The soil samples selected for off-site gamma spectroscopy analyses were selected (1) to represent a variety of high and low on-site laboratory gamma spectroscopy values and (2) for vertical and horizontal distributions. The off-site laboratory results were used to corroborate and/or to correlate (provide a correction factor for) the field screening laboratory results.

Soil screening levels were established during work plan development. The soil screening levels for the Guterl Site are presented in Table II². Upon completion of on-site gamma spectroscopy analyses, soil data were evaluated using a “sum of fractions” approach to determine which samples contained COPCs above screening levels.

Table II. Soil Screening Levels for Guterl Site

Nuclide	Soil Concentration (pCi/g) ^a
²³⁸ U	14
²³⁵ U	8
²³⁴ U	13
²³² Th, ²²⁸ Ra	1.1
²²⁶ Ra	0.7

^a SOURCE: [10] US NRC, Table C2.3, NUREG-1727, *NMSS Decommissioning Standard Review Plan*, September 2000.

Alpha Spectroscopy

The selection of samples for off-site alpha spectroscopy analysis was dependent upon several factors. The arrangement of investigative areas (IA) was developed to approximate anticipated exposure units that would be evaluated during the risk assessment. An approximate total of 12 to 30 samples per IA (see Figure 1) and per medium (i.e., surface soil; subsurface soil, etc.), depending on the nature and size of the IA, were collected to accommodate risk assessment. Since alpha spectroscopy has generally lower uncertainty than gamma spectroscopy, alpha spectroscopy data were preferred over gamma spectroscopy for use in determining exposure point concentrations.

² The values presented in Table II represent surficial surface soil concentrations of individual radionuclides that would be deemed in compliance with the 25 mrem/y (0.25 mSv/y) unrestricted release dose limit in 10 CFR 20.1402. For radionuclides in a mixture, the “sum of fractions” rule applies; see Part 20, Appendix B, Note 4.

Samples for off-site alpha spectroscopy analysis were selected from those with the highest on-site gamma spectroscopy values. Samples for off-site alpha spectroscopy analysis were selected to ensure that each exposure unit/point was characterized at the surface [0 to 15.24 centimeter (0 to 6-inch) depth] and to full depth. Sample selections at depth were determined using a decision tree based on on-site gamma spectroscopy laboratory data (Figure 2).

A secondary purpose of these analyses was to obtain results from an accredited laboratory that can be used to corroborate and/or to correlate (provide a correction factor for) the on-site laboratory results.

A total of 524 soil samples were sent for off-site alpha spectroscopy analysis for isotopic uranium and thorium COPCs.

Gas Flow Proportional Counting

The FSP required that approximately 50 percent of the samples submitted to STL-St. Louis for isotopic uranium and thorium COPCs by alpha spectroscopy were to also be analyzed for ^{226}Ra and ^{228}Ra by GFPC methods. A period of 14 to 21 days was needed to allow for ingrowth (i.e., for the buildup of short-lived daughter products), so rapid turnaround time was not possible for isotopic radium analyses.

Two hundred seventy seven soil samples (approximately 53 percent of alpha spectroscopy analyses) were selected for radium COPC analyses using GFPC methods. The 277 soil samples for radium analyses were chosen from the top-half of the alpha spectroscopy sample SOR rankings (generated using on-site gamma spectroscopy data), taking into consideration vertical and horizontal coverage (i.e., if several samples fell in one boring, one sample was selected from that boring and the other samples were "biased" to the next lower SOR ranked sample).

Isotopic U as a Metal by ICP-MS

Additional data were collected to evaluate the presence of enriched, depleted, and recycled uranium. Presence of ^{236}U indicates recycled uranium; enhanced abundances of ^{234}U and ^{235}U indicate enriched uranium, and the enhanced abundance of ^{238}U indicates depleted uranium. In accordance with the FSP, 12 soil samples that displayed significantly elevated uranium concentrations as determined by on-site laboratory gamma spectroscopy analysis were selected for isotopic uranium by ICP-MS analysis at the off-site fixed laboratory.

These 12 elevated activity samples were chosen because they had the best chance to produce statistically valid indications of whether the uranium they contained was enriched or recycled. The ICP-MS analysis determined the isotopic mass concentrations of ^{233}U , ^{234}U , ^{235}U , ^{236}U , and ^{238}U to evaluate the presence of recycled, depleted, or enriched uranium.

A total of 24 background reference area soil samples were also submitted for ICP-MS analysis. The laboratory data for background samples were not sufficient to determine the relative mass abundances of the uranium isotopes in them (i.e., generally only ^{238}U mass concentrations were reported above the ICP-MS sensitivity limits). However, the mass abundance ratio for $^{238}\text{U}:$ ^{235}U was indicative of natural uranium, where calculable.

Gross Alpha and Gross Beta Analysis

Gross alpha and gross beta analyses were performed on groundwater samples, background reference area soil samples, and a select subset of 12 elevated activity soil sample locations. These analyses provided general presence/absence of radionuclides in groundwater or soil samples, and confirmed previous data from landfill monitoring wells - indicating the presence of radionuclides at levels exceeding New York water quality standards.

Gross alpha and gross beta radiation analyses were compared with results from other analytical techniques to verify consistency of results. The gross alpha and gross beta results were found to be consistent with the COPC alpha and beta results. That is, the sum of all COPC concentrations for a sample was typically slightly less than the gross alpha (taking into account uncertainties). The same was true for gross beta with natural potassium-40 (^{40}K) making the relative difference larger than for gross alpha.

SUMMARY OF BENEFITS OF USING MULTIPLE DATA STREAMS:

Preliminary Planning: A number of preliminary planning steps were taken to ensure that the RI data acquisition phase would be successful. These steps included:

- Data quality objectives were determined prior to data acquisition to ensure that collected data could be used for the purpose intended.
- Data from prior investigations were used to provide preliminary guidance for the RI soil sampling program. The most reliable historical data were located in a 1999 site characterization report prepared for US Bankruptcy Court by Oak Ridge Institute for Science and Education (ORISE) [3]. The initial surface/subsurface soil sample locations were based on IA-specific data evaluations to minimize duplication of sampling at the historical ORISE locations.
- The existing data were evaluated and a Conceptual Site Model (CSM) was developed. The CSM was used to steer decisions regarding locations, types, analyses, and numbers of samples for assessment of nature and extent and risk assessment purposes. Inherent in this process was the development of “investigative areas” that were designed to approximate anticipated exposure units (EUs). A total of 19 IAs (including each of the 8 buildings considered as individual IAs) were designed for the field investigation (See Figure 1).
- Ground water, surface water, and sediment samples were also collected during the RI, however, these matrices and desired analytical methods (i.e., alpha spectroscopy and GFPC) were not amenable to on-site laboratory analyses. Therefore, the collection of samples for these matrices was scheduled to occur early in the RI field sampling program so that the off-site laboratory data could be received, verified, and evaluated while the field investigation was still ongoing. In this manner, additional bounding or characterization samples could be collected without incurring a separate mobilization. For groundwater samples, this also allowed for collection of samples during two separate seasons (mid-summer and early winter). Collection of groundwater samples across two separate seasons provided data that allowed the PDT to assess seasonal variations on groundwater quality and movement.

Phasing of Investigation: The FSP was designed to incorporate field screening data into the real-time decision making process during the execution of the RI. The first step in this process was to compare the preliminary GWS data and building scan data against the FSP-designed soil sampling locations. If the GWS or preliminary scan data identified previously unknown areas of concern, adjustments to surface and subsurface soil sample locations were made to investigate the newly identified areas. Execution in this manner minimized duplication of effort and reduced the likelihood that unanticipated data gaps would not be discovered after demobilization.

The second step in the process was to evaluate on-site gamma spectroscopy COPC analytical data to determine whether the nature and extent of contamination had been adequately characterized in the horizontal (x,y) and vertical (z) directions. To that end, two decision logic diagrams were developed to help guide the technical team in determining the most appropriate “next step” when evaluating surface and subsurface soil data. The previously introduced Figure 2 presents the decision path for determining

which intervals of a soil core should be selected for on-site gamma spectroscopy analysis for COPCs. Figure 3 presents the decision path for determining whether identified contamination had been adequately bounded.

The tolerable uncertainty for bounding contamination was set at 5 meters (m) to meet the project DQOs. An assumed location point G (for *greater* than screening levels) and an assumed location point L (for *lower* than screening levels) located a distance more than 10 m apart shows that a new boring location is required between point G and point L - to reduce the uncertainty for the limits of contamination above screening levels to less than half the distance between the two points (i.e., point P). It is important to note that the final point P is not confirmed as "below screening level." The final point P represents the assumed boundary, within tolerance, between "below screening level" and "above screening levels." The region between P and G is assumed "above screening level" and the region between P and L is assumed "below screening level." The real boundary, wherever it is, is less than the tolerable distance from P (≤ 5 m in this case), which is the intended goal of the biased sampling. Therefore, the error in calculating volume estimates for remediation will not be more than 5 m.

Sequencing of Field Screening and Laboratory Analyses: The next level of analysis on soil samples was an on-site laboratory gamma spectroscopy analysis. The results of these on-site analyses were used to help identify supplemental soil core/soil sample locations and to determine which samples should be sent off-site for:

- (a) alpha spectroscopy - to detect radionuclides not identified via gamma spectroscopy (such as ^{230}Th and potential recycled uranium contaminants),
- (b) more definitive gamma and alpha spectroscopy data set for risk assessment, and
- (c) ICP-MS analyses - to determine whether the uranium contamination contained significant recycled, depleted or enriched uranium.

Use of these various analytical techniques (on-site gamma spectroscopy, confirmatory off-site gamma spectroscopy, off-site alpha spectroscopy and off-site ICP-MS analyses) allowed for a more efficient determination of the nature and extent of contamination on site.

The use of ICP-MS data for isotopic uranium allowed for the determination of relative mass abundances for the 12 biased, high activity samples calculated from the mass concentrations. One of the 12 samples appeared to show ^{235}U and ^{238}U relative mass abundances indicative of depleted uranium. The remaining samples appear to be natural uranium but the possibility of blends of natural, depleted, and enriched uranium cannot be ruled out. Three of the samples show traces of ^{236}U , which is present only in recycled uranium. However, these results were enough confirmation of the original assumption that the vast majority of the uranium on-site is natural uranium, and that assumption can be used to develop a cleanup goal for total uranium as the project progresses to a feasibility study.

Use of On-site Radioanalytical Laboratory: American Radiation Services (ARS) provided a Department of Defense Accredited On-site Laboratory capable of providing a 24 hour Turn-Around-Time (TAT) on up to 40 soil samples per day. The On-site Laboratory was staffed with a Laboratory Manager and two Laboratory Technicians. Two Hyper-Pure Germanium based gamma spectroscopy units, one gas-flow proportional unit and other miscellaneous laboratory equipment were used. A custom drying suite was developed to dry large quantities of samples during daily operations. The laboratory used a fully tested and implemented Laboratory Information Management System to facilitate data validation, quality assurance and sample reporting and data were reported daily in both hard copy and electronic versions. All instrument and process quality assurance protocols were implemented.

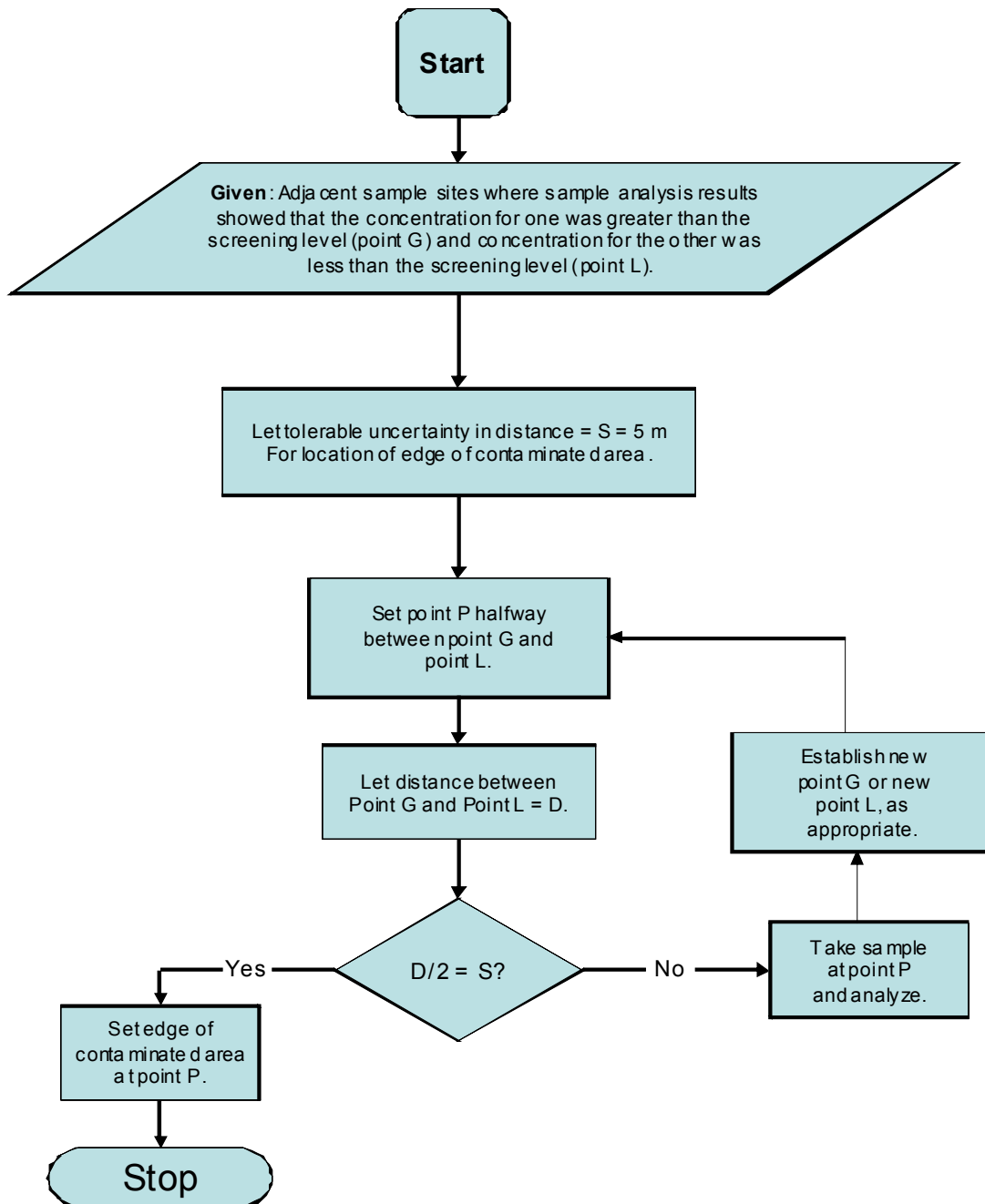


Figure 3 – Biased Sampling Location Decision Tree

Benefits (On-site Laboratory)

- True 24 hr TAT
- No shipping
- Real-Time Unexpected results consulting
- Real-Time re-Analysis
- Provides for immediate H&S reporting
- Real-Time data reporting and review
- Set up and analysis of swipe samples included in weekly laboratory rate

Draw-Backs (Off-Site Laboratory)

- 24 hr TAT requires a 3x multiplier on base cost
- 24 hrs required for shipping
- 48 hr required for responses (Unfamiliar with site conditions)
- Often requires up to 72 hrs before request can be made
- Minimum 48-72 hr TAT
- Data reporting slowed by TAT
- Additional cost and time delay for swipe samples

Total Field Samples:

1785 Gamma-Spectroscopy Soils for Uranium/Thorium/Other
4654 Gross Alpha/Beta Swipes

Total QC samples (Approximately 10%):

179 Gamma-Spectroscopy Soils
465 Gross Alpha/Beta Swipes

Total Samples:

1964 Gamma-Spectroscopy Soils for Uranium/Thorium/Other
5119 Gross Alpha/Beta Swipes

Note: Sample quantities don't include standard Health and Safety, General Housekeeping, and regulatory required sample workload, such as daily swipe and air filter samples

Estimated Cost Savings:

- On-site Laboratory - Gamma Spectroscopy, Soils, 24 hr TAT:
 - \$295,637 divided by 1964 samples = \$150 per sample
- Off-Site Laboratory – Gamma Spectroscopy, Soils, 3 day TAT + 1 day Shipping:
 - 1964 Gamma Spectroscopy Soils @ \$220 + \$5 (Shipping) = \$225 per sample or \$441,900

Considering the savings on Gamma Spectroscopy soil sample analysis and negating the other benefits such as improved TAT and improved Triad application, the on-site laboratory saved approximately \$146,000 over the fixed laboratory option. The cost benefit of having the on-site laboratory available to support the real-time assessment of RI data outweighed the use of an off-site fixed laboratory, standard TAT.

TIME SAVINGS:

Defining nature of contamination: A wide look at all possible COPCs at the beginning of the remedial investigation phase, using focused analytical techniques to best utilize available funding, answered questions upfront regarding the potential presence of other COPCs on-site. This elimination of potential COPCs from further analysis in later phases of the remedial investigation or even in later phases of the CERCLA project (such as feasibility study) incorporated lessons learned from other FUSRAP sites, where multiple phases of investigation added time and cost to the projects. Since the additional analyses were performed while the project was still undergoing a comprehensive investigation, the project team is assured that the smaller number of samples that were subjected to additional analysis were the most appropriate samples to use in fully characterizing nature of contamination on-site.

The project delivery team's expectations were that using an on-site core scanner and gamma spectroscopy laboratory would lead to increased site characterization and direction without the need for supplemental characterization that is common in these types of projects.

RESULTS

The horizontal and vertical extent of MED/AEC materials in surface and subsurface soil was successfully bounded in all areas of the site. Delineation was accomplished in a more efficient manner through the use of the core scanning and on-site gamma spectroscopy analyses, thus avoiding the necessity of relying on more expensive and time consuming off-site analyses. The nature of the contamination was defined by using the more definitive off-site analytical methods. Results were consistent with the CSM showing that uranium and thorium were the main constituents of potential concern detected above screening levels. The nature of the contamination was further refined by utilizing ICP-MS for isotopic uranium analysis of twelve soil samples that displayed significantly elevated uranium concentrations as determined by the on-site laboratory gamma spectroscopy analysis. One sample showed ^{235}U and ^{238}U relative mass abundances indicative of depleted uranium while the remaining samples appear to be natural uranium.

SUMMARY

Multiple analytical techniques supported a more efficient and complete determination of nature and extent during the Remedial Investigation at the Guterl Steel FUSRAP Site. The range of analytical techniques employed at the on-set of the investigation yielded a more thorough and efficient evaluation of all potential radiological constituents in site media. Uncertainty in the CSM has been reduced which will lead to improved decisions in the feasibility study.

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