Taking an Incremental Approach to Remediation and Final Status Survey of Class I Areas, When Appropriate, to Increase Remedial Efficiency, Minimize Impacts to Property Owners & Tenants, Exceed Goals for Remediation and Release of Accessible Areas, and Minimize Other Secondary Remediation-Related Costs - 11429

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ABSTRACT

Outdoor soil remediation teams must consider many factors that may constrain their ability to implement remediation in the most efficient and complete manner. This is particularly true when work area restraints, work sequence considerations, unfavorable environmental conditions, and safety considerations for nearby occupied commercial structures constrain a remedial design or excavation approach. The FUSRAP Maywood Team has identified how these constraints reduce efficiency, increase costs, and limit opportunities to release otherwise accessible areas. By implementing an incremental approach to remediation, final status survey and backfill, when appropriate; the Maywood Team overcomes these challenges while ensuring release criteria are met.

INTRODUCTION

The U.S. Army Corps of Engineers (USACE) and Shaw Environmental, Inc. are conducting a Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Remedial Action (RA) at the Formerly Utilized Sites Remedial Action Program (FUSRAP) Maywood Superfund Site (FMSS) located in Maywood, New Jersey (NJ)[1].

The FMSS is located in Maywood, NJ, approximately 13 kilometers west of New York City (**Figure 1**). The primary contaminant of concern at the Site is thorium-232 and its daughters, which was derived from monazite ore extraction that occurred from around 1916 to 1956. Some waste material was disposed of on site in holding ponds while other material was used as fill material on nearby residential and commercial properties or was spread by the nearby Lodi Brook. Due to the lack of control over disposal locations, much of the contamination at depth became situated in areas that now prove difficult to quickly remediate. Remedial actions taking place at the Site involve the excavation and off-site disposal of contaminated material.

In the urban setting in which the Site is located (**Figure 2**), excavation efforts can meet with significant challenges. Where contamination is present near utility corridors and buildings, the added caution required can hinder timely remediation. Local roadways and businesses have access requirements that may allow for only piece-wise remediation of contaminated areas. Weather and other site specific conditions can create hazardous and undesirable situations, including the accumulation of large amounts of waste water and the creation of additional safety hazards, when large areas are excavated and left uncovered for even short periods of time. The purpose of this paper is to document strategies to improve remediation efficiency while conducting remediation in such an environment. It is the expectation of the authors that other FUSRAP sites or CERCLA sites with similar environments and activities will benefit from understanding these approaches.

Figure 1 - Site Location

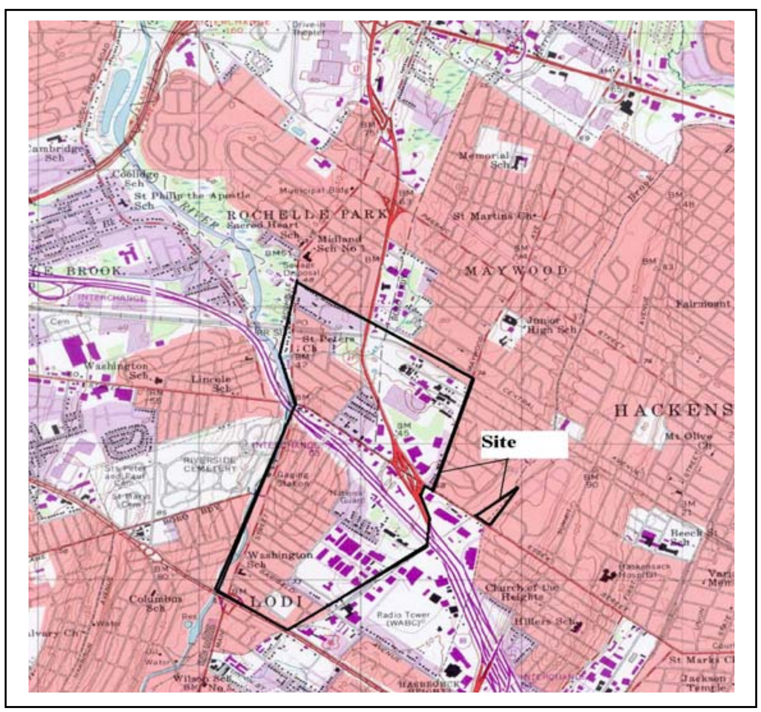

Figure 2 - FMSS Setting (Pink areas are housing developments and white areas are industrial)

KEY ASPECTS OF EFFICIENT REMEDIATION

There are many aspects of a remedial action that can impact the overall remedial efficiency while minimizing impacts to property owners and tenants. This paper focuses on just two of them, Construction and Final Status Surveys (FSS). It should be noted however, that other aspects such as those in place for the lab analysis of samples (use of a Ra-226 decay correction factor to correct data to equal that of a 21 day decay time prior to analysis) and a good project communication plan (for communication with both the public and with property owners) are important aspects to project efficiency as well. These and other project elements are not discussed in this paper.

- **Remedial (Construction) Aspects**

  The optimum remedial strategies are strategies that allow construction to take place as efficiently as possible with minimal impacts to property owners or tenants. A large unoccupied open area of several thousand square meters facilitates efficient construction. Construction costs in this setting can be as low as $200 per cubic meter of material excavated. This is rarely the case in an urban setting. Construction costs of over $1000 per cubic meter of material excavated are not uncommon in the urban setting. A loss of construction efficiency is therefore expected in the urban environment but its impact can be mitigated with planning. Dividing the property into construction phases (increments) based on area and other factors such as business hours, access requirements, etc., is crucial to planning efficient construction. Placement of backfill and restoration is also considered a part of this aspect. Negotiations with property owners should always address the issue of area to be unusable throughout the remediation effort.

- **Final Status Survey (FSS) Aspects**

  FSS are conducted in accordance with the *Master Final Status Survey Plan* [2] which is written in compliance with the *Multi- Agency Radiation Site Survey and Investigation Manual* (MARSSIM) [3]. The MARSSIM recommends dividing a property into smaller areas for FSS purposes, based on the area's potential for contamination in relationship to the clean up criteria. These FSS areas are called Survey Units (SUs). An SU that has had contamination removed because it exceeded the criteria is considered a Class 1 SU. MARSSIM recommends Class 1 SU not exceed 2,000 square meters. Typically a large area of excavation (at least 2,000 square meters) is optimal for design of a FSS. This provides minimal sampling costs and efficient use of resources. Smaller SU sizes are allowed and are often required in the urban setting. At Maywood the project team has found that smaller SU sizes are actually more efficient when ground water is expected to enter the excavation [4].

These two key aspects should be combined into one strategy to increase remedial efficiency, minimize impacts to property owners and tenants, exceed goals for remediation and release of accessible areas, and minimize other secondary remediation-related costs.

STRATEGIES

Since incremental construction and FSS methodology are based on dividing properties into manageable sizes based on area it may be advantageous to use SUs as construction increments or construction increments as SUs. This is one of several strategies employed at FMSS to increase remediation efficiency. Other strategies include:

- Focused Characterization During Construction
- Quick Backfill
- Immediate Backfill
- Partial SU remediation and FSS

The advantages and disadvantages of each of these strategies are briefly discussed below.

Use of Construction Increment as a SU

One of the easier and straight forward ways to implement incremental remediation is by defining the construction increment and the SU as one area. This strategy was employed during remediation of one FMSS vicinity property. The property is home to a large nationwide retail logistics center. The center could not stop operations to facilitate remediation. USACE and the property management negotiated an agreement that assured no more than six of the warehouse's loading bays would be unusable at any given time during remediation. Each block of six bays was defined as a construction increment and SU. This created several small SUs of approximately 450 square meters.

The creation of many small SUs situated around the buildings allows work to proceed with minimal impact to the business and avoids the need to perform off schedule work, such as evenings or weekends, which would increase remediation costs and cause work delays. The creation of small survey units can also assist project schedule, as some small remediated parcels allow for work to be entirely completed before long breaks due to holidays or other breaks in excavation work.

A drawback to the creation of small or oddly shaped SUs is that breaking down what may have been a large SU into several smaller ones requires multiple final status surveys for release. In this case, roughly four SUs (500 square meters each) were created out of what could have been one SU (2,000 square meters). Implementing four smaller SUs required the collection of additional systematic samples and increased the time that field crews spent collecting and processing gamma walkover data. The additional samples also increased the time spent collecting, processing, analyzing the samples, as well as increasing the volume of data to be reported and validated. The number of systematic samples required per SU on this property was 15. Thus, 45 additional systematic samples were required over what would have been done if one large SU had been agreeable. Additionally, bias sampling is also increased since small and unusual shaped SUs can create the drawback of systemic sampling locations falling into less than ideal configurations and/or at poor locations. It should be noted that USACE manages its own lab at the FMSS thus the sample analysis costs are typically less than that of commercial labs, and relatively small compared to costs of delays in construction.

The project team must balance the time and cost savings of survey unit management with the potential additional effort created. In this case, the additional FSS costs were mitigated by the increased efficiency in construction (minimal delays due to schedule impacts and minimal overtime) and overall by allowing construction to take place at all (since a large SU was untenable to the property's management).

Focused Characterization During Construction

Focused characterization, while not a strategy that will necessarily result in release of property, can increase both construction and FSS efficiency by placing spatial bounds on expected excavation and FSS requirements. At the FMSS, test pits are used to identify boundary limits both laterally and vertically (outside a designed excavation) during the excavation. This reduces the remedial action scan survey time by setting rough limits on the excavation and facilitates the FSS design and execution. As an example: on a FMSS vicinity property, contamination extended beyond the limits of a designed excavation and SU. This potentially impacted the agreed-to schedule with the property owner. To evaluate the potential impact and to facilitate meaningful discussions with the property owner, test pits were done outside the design limits to further characterize the lateral extent of contamination and to modify design and schedule accordingly. This also resulted in a redesign of the FSS as the spacing between sample locations had to be increased. An alternate approach could have been to keep the original sample spacing and collect the additional samples.

Tests pits have also been employed prior to the start of full-scale excavation to confirm the extents of contamination that were determined during pre-design investigation(s). The additional characterization gained allows for precise staging of heavy equipment to ensure that no accessible contamination is left behind once excavation begins and the heavy equipment is moved beyond reach of the initial starting location. In an urban setting where myriad factors limit access and mobility of heavy equipment, if contamination is inadvertently left behind the scheduling delays can be significant.

In these examples, focused characterization prior to and during excavation saved time by allowing the construction and FSS design to be modified while the excavation was initiated or in progress. It also facilitated the efficient scheduling of project resources to meet schedules and property owner expectations.

Quick Release Backfill

Quick Release Backfill (QRB) is defined as releasing an area and backfilling based on preliminary scan and lab data. After an area of excavation is complete and the FSS is conducted, samples are analyzed at the lab and results reported with quick turnaround times, typically 24 hrs. The area is then backfilled with just a comparison of the lab data to the clean up criteria and a review of the gamma walkover survey. While this method provides some level of confidence that the SU will pass full evaluation, it does have some inherent risks. These risks include the rejection of lab data due to some bias or problem that results in the data not being acceptable when compared to the FSS data quality objectives, and the potential failure of quality control samples such as field duplicates, laboratory replicates, and sample equipment blanks. More significant is the potential that the data set does not possess enough power (statistical strength) as determined by the MARSSIM-recommended retrospective systematic sample frequency evaluation. In this case, if additional samples were required to achieve sufficient confidence, then backfilled areas would have to be re-excavated or sampled via direct-push soil probe (Geoprobe®). In an effort to mitigate some of these risks at FMSS we typically collect additional bias samples above what would normally be required.

QRB is employed at FMSS under certain conditions such as: when leaving the excavation open for normal sample turnaround and full evaluation would pose a safety issue (stability of structures and utilities), increase costs such as labor to control groundwater infiltration, or result in schedule delays. QRB of a SU has also been used to allow for the movement and staging of excavation equipment to reach contaminated soils that would otherwise be difficult or impossible to access without backfill. To date the full evaluation of areas released under QRB strategy has not resulted in any area having to be readdressed at FMSS.

Immediate Backfill

Immediate Backfill (IB) carries more risk than QBR and differs from QRB in that once the designed FSS is complete the area is backfilled (prior to sample analysis and gamma walkover survey evaluation). This has the risk that sample analysis may demonstrate that an area is not suitable for release as well as the risk of missing elevated areas of contamination that may not be identified until all gamma data is evaluated statistically. IB also limits the ability of using the Elevated Measurement Criteria process as discussed in MARSSIM, since any additional scanning or samples that may be required could not be easily accomplished once the area is backfilled. IB also carries all the risks associated with QRB discussed above. Again, additional bias sampling is typically conducted to mitigate some of these risks, but the bias samples are collected without the benefit of plotting the entire gamma walkover dataset; instead, locations are determined in the field by FSS technicians noting areas of elevated gamma activities.

IB is employed at FMSS under certain conditions such as; when leaving the excavation open for QRB would pose a safety issue (stability of structures or utilities), greatly increase costs such as labor to control groundwater infiltration, or result in significant schedule delays. Backfill placed under the IB strategy is also limited to that which will remove the requirement to immediately backfill (e.g. if a subsurface utility can be adequately protected by placing backfill to 4-feet below ground surface, the additional four feet of fill would not be placed until a full FSS evaluation is completed). In doing so the amount of backfill that would have to be removed should an issue with the data be found is kept to a minimum. To date the sample analysis and full evaluation of areas released under the IB strategy has not resulted in any area having to be readdressed at FMSS.

Partial SU Remediation and FSS

Partial SU Remediation and FSS (Partial SU) is another strategy employed at FMSS. It is the piecewise remediation of otherwise full survey units. The FSS design is not a consideration nor changed; however, the construction approach is incremental. This option has been used in survey units that are relatively small (less than 1,000 square meters) but include sensitive structures, utilities, owner considerations, or other critical aspects that require the excavation to be incremental. These SU would not fit well into the other strategies discussed. This approach allows for FSS efforts to be minimal while maximizing construction flexibility.

By partial excavation, the chance of damage to critical structures is lessened, potential safety concerns are mitigated, and schedule delays can be avoided. Often partial remediation occurs in areas where some soils may be considered inaccessible (under a building). In addition to additional bias sampling, document control samples are often taken to delineate what contamination may remain when the partially excavated survey unit is backfilled. It is also used in areas where roads and surfaces are used for daily activities, where excavation may interrupt or halt either local business operations or the remediation efforts.

The Partial SU strategy has the advantage of full data review, however, not the entire SU data set is available. In addressing a Partial SU the FSS is only completed for that part of the excavation that is currently open. This results in risks that, should the remainder of the SU contain residual contamination that causes the SU to ultimately fail in meeting the data quality objectives or be deemed not ready for release, the first Partial SU area may have to be readdressed.

As an example: At a FMSS vicinity property, a 550 square meter excavation and SU (15 FSS samples required) existed in a lot between warehouse bays, with a pipeline running through the center of it. The area for excavation is constrained by an agreement with the property owner for continued access to the building.

In order to address the SU, pipeline, and access requirements, the construction aspect was divided into two increments. The first increment included areas outside the area of the pipe, and the second increment was the pipe area. Designing two approximately 300 square meter excavations makes sense; however, it did not make sense to double the number of samples for the FSS. The shape of the resulting SU, if the SU was divided into smaller SU, was a concern as well. In this case, developing a partial SU approach helped facilitate construction given the constraints, provided for backfilling based on fully evaluated data, and ensured data requirements were not excessive. **Figure 3** shows the gamma survey after completion of the first increment. The scanned areas were backfilled based on the ten sample points and gamma scans within them. The area in the middle (in vicinity of the pipeline) was the second construction increment.

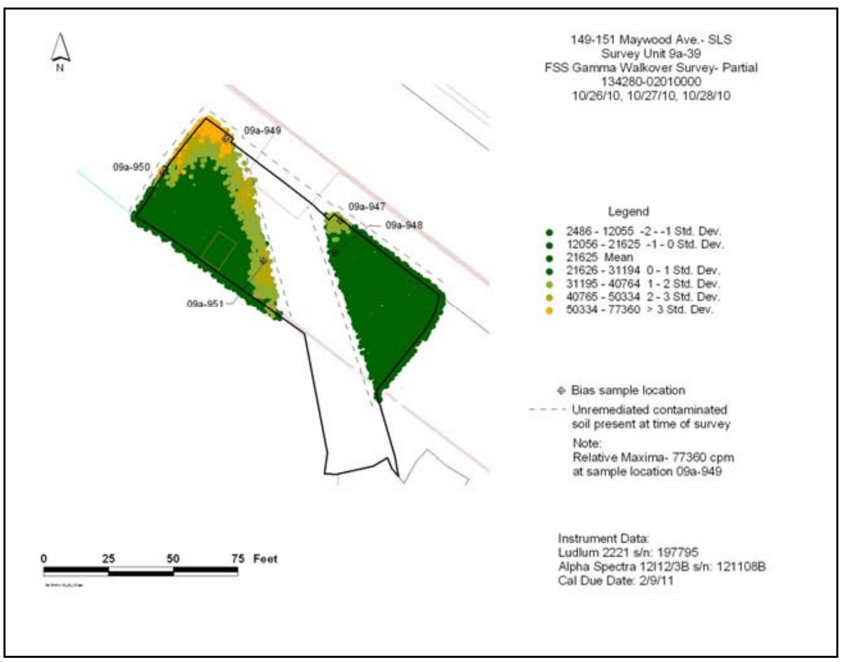

Figure 3. Partial SU Strategy Example, Gamma Scan of increment 1

While sometimes employed at FMSS the Partial SU strategy is not preferred over other strategies discussed herein. Additional problems and risks are created with use of the Partial SU strategy. One such risk is an increase in sample numbers due to excavation growth in the yet to be excavated portion of the

SU. Since the sample spacing is set on the previously backfilled portion it must be maintained on the current portion. Thus if the excavation grows in size the sample number will grow due to the spacing restraint. At FMSS this has happened occasionally.

Another issue that is common with the Partial SU strategy is with presenting the gamma scan data. Since only a part of the SU is released and backfilled, shine from un-remediated portions may result in elevated gamma counts in the remediated portion. Once backfilled and the excavation completed on the other portion, the gamma data is combined into one graphic for the full SU. The shine detected in the first portion cannot be removed, thus it appears that contamination may remain in the SU. This problem is illustrated in **Figure 4**, which shows the complete gamma walkover data for the partial SU illustrated in **Figure 3**. The elevated gamma counts from point 9A-949 through 9A-951 represent shine from contamination in the center portion of the SU. Once the center was excavated the shine would not exist. Thus, **Figure 4** shows what could be considered a band of contamination that does not exist. Care should be taken to collect additional bias samples in areas of shine to mitigate the risk of having to install borings later to address this issue.

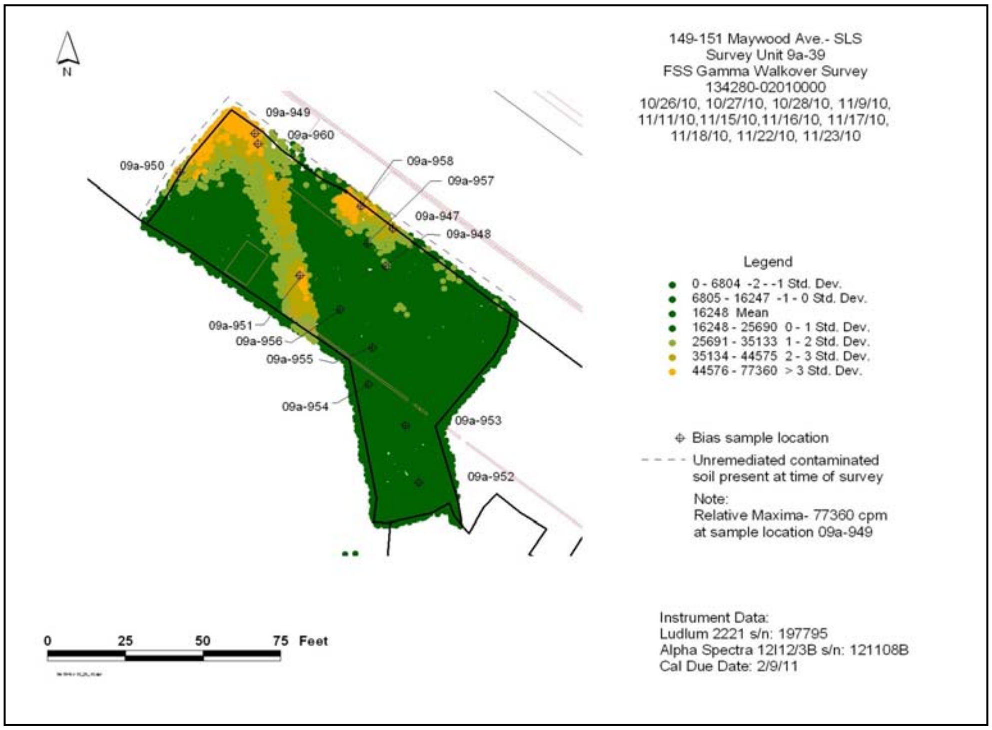

Figure 4 – Partial SU Strategy Gamma Scan Display Issue

DISCUSSION

The objective of performing incremental construction and FSS strategies is to reduce or eliminate schedule delays, to avoid additional project cost due to external considerations, and to ensure that local property owners and businesses are minimally impacted by remedial efforts while ensuring that enough quality data is collected to ensure that there are no concerns regarding whether or not the final survey unit meets the MARSSIM-derived release criteria.

When a QRB, IB, or partial SU strategy is desirable to avoid lost time, lost materials, or other concerns, additional bias sampling and vigorous scrutiny during walkover scanning is required to ensure data collection of sufficient quality and quantity to support release of the SU.

Often a combination of strategies will be employed on a given property and even within a given SU. As an example: the approach taken in the partial SU example case also used the QRB strategy for the middle pipe section (construction increment 2, **Figures 3** and **4**). This allowed the pipe area to be backfilled promptly, mitigating potential safety concerns with the pipe, while maintaining building access required by the property owner.

SURVEY UNIT RELEASE EVALUATION

When the strategies discussed herein are employed at a site it is important that the final objective of property release be kept in mind. The best data to support release comes from complete SU FSS designs and full data evaluation, complying with the MARSSIM guidelines. Any survey strategy or technique short of this introduces some risk of having to readdress areas. As discussed, these risks can be mitigated by additional sampling or design considerations.

At FMSS all data from an SU is validated prior to use in a report documenting the final status of the property. If data is found to be valid and meets the data quality objectives, it is then used to evaluate the SU per MARSSIM. Until the full evaluation is complete the potential exists for an area to have to be readdressed. The mitigated risk of readdressing an area is weighed against the benefit of incremental strategies prior to their use. Once all SU are fully evaluated and meet the criteria for release, the property can be released.

SPECIFIC EXAMPLES

In addition to the examples already discussed, the following specific examples are briefly discussed here and will be discussed in more detail as part of the oral presentation of this paper.

Cluster 5C

The creation and management of smaller survey units tied to construction increments and situated around the building allowed work to proceed with minimal impact to the business and avoided the need to perform off schedule work, such as evenings or weekends, which would have increased remediation costs and possibly caused work delays.

SU 10A-12

A tank farm pad was present at this SU and complete excavation around the concrete pad may have compromised its stability. In order to avoid potential concerns, remediation at this survey unit was implemented as a series of small excavations dug from south to north, followed by IB.

SU 10A-13

This parcel was remediated in two parts due to the necessary removal of a mission-critical drain pipe at the property. Due to its functionality, the drain pipe could not be deactivated or rerouted for more than 72 hours. Much of the soils under the drain pipe were deemed inaccessible due to concerns over compromising the drain pipes integrity. As such, partial SU remediation allowed for accessible soils to be quickly removed without leaving sections of the drain pipe exposed for extended periods of time.

SUs 10A-14 and15

These SU areas included a section of gravel roadway used by property owner personnel to access an adjacent pumping station essential to plant operations. Also, FMSS Project personnel use the access road to move soils, equipment, and personnel from adjacent properties to the soil staging area. In order to maintain constant access through the area, the remediation of SU 10A-14 was implemented in three steps requiring partial releases of the SU after each step. This phasing plan was implemented in order to maintain haul road access through the area and allow property owner personnel access to the reservoir pumping station.

CONCLUSIONS

By utilizing the incremental remediation and final status survey strategies discussed herein, the Maywood Project Team has been able to increase remedial efficiency, minimize impacts to property owners and tenants, exceed goals for remediation and release of accessible areas, and minimize other secondary remediation-related costs. Our relationships with property owners have also benefitted from this overall strategy.

REFERENCES

1. United States Army Corps of Engineers, *Record of Decision for Soils and Buildings at the FUSRAP Maywood Superfund Site, Maywood, New Jersey*, prepared by Shaw Environmental, Inc. (August 2003).

2. United States Army Corps of Engineers, *Master Final Status Survey Plan*, prepared by Shaw Environmental, Inc. (November 2001).

3. U.S. Environmental Protection Agency. *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) EPA 402-R-97-016-Rev 1*. August 2000.

4. Walnicki, Winters, and Hays, *OPTIMIZING SURVEY UNIT DESIGN TO MITIGATE THE POTENTIAL IMPACTS OF WASTEWATER ON REMEDIAL COSTS AND FINAL STATUS SURVEY UNIT INTEGRITY – 10153*, Waste Management Symposia 2010.