St. Louis Fusrap Lessons Learned

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Abstract

The purpose of this paper is to present lessons learned from fours years' experience conducting Remedial Investigation and Remedial Action activities at the St. Louis Downtown Site (SLDS) under the Fomerly Utilized Sites Remdial Action Program (FUSRAP). Many FUSRAP sites are experiencing challenges conducting Remedial Actions within forecasted volume and budget estimates. The St. Louis FUSRAP lessons learned provide insight to options for cost effective remediation at FUSRAP sites. The lessons learned are focused on project planning (budget and schedule), investigation, design, and construction.

Introduction

The SLDS comprises approximately 2 square miles in a heavily industrialized area north of Downtown St. Louis. Mallinckrodt Inc (MI), formerly Mallinckrodt Chemical Works, was contracted by the Manhattan Engineering District (MED) during the 1940's to refine methods of concentrating uranium ore in the early stages of the development of the atomic bomb. These activities were continued by MED's successor the Atomic Energy Commission (AEC). The AEC's role and responsibilities were enhanced to include more than the development of atomic energy and the department's title was changed to the Department of Energy (DOE). Activities in the MI facility were not confined to a specific portion of the facility. The MI facility covers approximately 45 acres. The refinement processes were conducted over two-thirds of the facility.

Refinement processes were in the development stage, therefore, handling and disposal practices were not up to current standards and practices. Handling and disposal practices were lacking in the sense of environmental impacts and future liabilities to remedial actions. Several remedial actions were undertaken prior to the late 1990's. The first remedial action was undertaken and directed by the AEC. Cleanup standards were again not up to current standards and practices. The second remedial action was undertaken and directed by the DOE. This second remedial action was limited to a small portion of the MI facility and used current standards and practices. The DOE also performed a remedial investigation (RI) of a limited portion of the SLDS. This is the basis of the current feasibility study and proposed plan (FSPP) to remediate the SLDS.

The DOE RI and FSPP were used to develop the Record of Decision (ROD) for the SLDS. During the early 1990's Congress appointed the United States Army Corps of Engineers (USACE) to manage the sites formerly utilized by the MED and the AEC to develop and refine uranium for the atomic energy program. These sites are known as Formerly Utilized Sites Remedial Action Program (FUSRAP). The USACE developed the ROD for the SLDS and it is the principal guiding document that defines remedial actions. It presents the cleanup standards and the relevant and appropriate regulations for remedial actions and goals.

The SLDS project currently requires the remediation of 13 contaminated areas and the investigation of approximately 30 vicinity properties (VPs) to determine if remediation is required. Remediation will be complete at four areas and investigation will be complete at two VPs by the end of 2002. The remainder of this paper will review lessons learned at the SLDS and efforts to improve remediation efforts.

Lessons Learned

Lessons Learned at SLDS are separated into the following:

1. Project Planning
2. Design-Build Efficiencies
3. Predesign Investigation
4. Remedial Designs
5. Guided Excavation

Each of the above topics will be discussed with a brief case study example, the lesson learned, and the success (or failure) from implementing the lesson learned.

Project Planning

The planning process to define budgets and set performance milestones is important for the contractor and the USACE. The ability to forecast excavation volumes is a function of the quantity and quality of existing data and historical information (e.g. utilities). Early remedial investigations at the SLDS had poor correlation with existing RI information. The poor correlation is a result of limited subsurface data and historical information. Subsequent remedial activities have included the collection of additional data/information to supplement the RI results to develop a design robust enough to plan and execute construction activities. Better design information has improved project-planning efforts to forecast budgets and milestones.

Early data collection was justified as a way to improve site knowledge of where to excavate and to distinguish subsurface material above cleanup criteria from material below cleanup criteria. The cost of transportation and disposal is a significant motivator to minimize excavation volumes. The SLDS has struggled to balance the investment in supplemental investigation with the value of having an accurate design, realistic budgets and milestones. Construction efforts four years ago used only information from the RI and resulted in five fold budget variances and schedule delays of nearly 2 years (Table 1). Construction efforts from the last two years have included an investment in supplemental data collection. Construction budget and schedule variances have not improved from the supplemental data collection. Lessons learned focused on what data would have better defined the excavation and improved variances (See the predesign investigation lessons learned). Recent changes to the type and quantity of supplemental data used to support remedial construction are expected to improve budget and schedule variances. The first site to benefit from improved data collection will be remediated in late 2003.

SLDS Planned Versus Actual Excavation Volume, Budget, and Schedule						
Site Excavated	Planned			Actual		
	Volume	Budget	Duration	Volume	Budget	Duration
City Property	2,742	$764,702	5 months	4,589	$1,039,367	10 months
Plant 2	6,810	$4,496,061	12 months	9,659	$7,793,177	16 months
Plant 1	1,385	$1,969,245	6 months	3,712	$4,007,014	16 months
DT-7	408	$327,677	3 weeks	3,367	$1,149,945	18 months
Plant 6EH	3,302	$2,247,484	6 months	16,115	$21,220,900	16 months

The USACE is currently evaluating the value of planning future work based on supplemental data collection versus using contingency factors for budget and milestone planning. The USACE is concerned with the cost to develop accurate designs because the volume of soil requiring removal will be the same with, or without the cost of collecting the predesign information. The USACE is concerned with the need for large budget and schedule contingencies where remediation on properties with active operations is required. Property owners are resistive to the USACE construction schedules with large contingencies.

Design/Build Efficiencies

The USACE is using a Total Environmental Restoration Contract (TERC) vehicle for SLDS remedial activities. The TERC is a cost reimbursable contract that includes the ability for the contractor to provide investigation, design, and construction services as part of the contract scope of work. This type of contract is valuable where the scope of work is expected to evolve (or the full scope is not defined sufficiently for a fixed price contract), the USACE has sufficient resources to provide sufficient contractor oversight, and has local Contracting Officer Representative (COR) authority to manage and direct the contractor. The above combination allows the USACE and the contractor to define scope as the project proceeds and allows scope change flexibility during project execution to adapt to changing conditions without work stoppage or shutdown.

The St. Louis USACE has demonstrated the value of design/build project execution through the following cost benefit actions. First, the USACE and contractor design teams are utilized throughout the construction process and allows the engineers to personally experience the success and failures of the design during construction. This involvement allows the entire project team to actively incorporate lessons learned for constructability issues and inadequate design assumptions. Second, the dual use of design engineers as field engineers allows the USACE flexibility in resource leveling the project staff and provides the design team institutional site knowledge. As individual remediation areas are completed, the USACE/contractor project teams gain efficiency through consistency for work processes and communications. The incorporation of lessons learned from one remediation effort to the next will improve project performance and the working relationship between the USACE and the contractor. Third, and most important, strong USACE leadership is critical to minimize the impact from work disruptions due to changed site conditions or USACE priorities. The SLDS USACE project engineer and construction COR are stationed at the project site and have interest in the success of the project. The USACE and the contractor routinely approach problem solving by evaluating the cost of the solution versus the risk that the solution will not be successful. The USACE's support in sharing risk provides the ability to consider creative and more cost effective solutions than a client relationship that is risk adverse.

Predesign Investigation

The DOE conducted RI activities at the SLDS. The RI was limited to the MI facility and several surrounding VPs. Several hundred subsurface samples were collected which demonstrated that the previous remedial actions were incomplete or simply did not remove contamination to current day standards. Current day standards for cleanup activities are much more stringent than those employed in the past.

The RI's primary focus was to determine the magnitude of the contamination in areas where MED/AEC operations took place. A secondary focus was the immediately surrounding VPs. As previously stated, the RI was inclusive of the main MI facility and the surrounding VPs. Today's investigations have expanded the boundaries investigated by the DOE to encompass approximately two square miles.

The original method employed by the USACE for investigative activities was to view the investigation from a surficial statistical point of view. This method of investigation appeared successful for development of remedial designs in the main part of the MI facility where contamination release was tied to a processing building with surface contamination. Sampling included the surface down to several feet at elevated areas. If contamination was detected at depth, deeper samples were obtained sufficient to bound the contamination. Larger areas of contamination were bounded laterally. This approach was used throughout the MI facility and at several VPs. The sample results were used to develop excavation boundaries.

This statistical approach was not successful in defining the limits of excavation for several reasons. First, the approach did not consider the presence of preferential pathways such as subsurface utilities, building foundations and piles, the presence of former building foundations at depth, and geologic features. Detection of these pathways is hit or miss with the statistical approach. A common lesson learned was the designed extent of excavation being bounded by several uncontaminated borings and the remediation experience of "chasing" contamination along a preferential pathway that went between, or beneath, the uncontaminated borings was incorrect and inefficient. Another lesson was the ability for foundations and piles to provide a vertical pathway for contamination to pass through confining material (clayey fill) into coarser fill materials below. Current predesign investigations incorporate a review of building as-built drawings and ground truthing surveys to locate preferential pathway features. Trenching and test pits are the preferred method to investigate these types of features.

Second, the SLDS is located on the Mississippi flood plain in urban St. Louis. The area has 200 years of industrial activity including being the dumping ground for fill materials to raise the ground elevation along the river. Fill material at the SLDS is heterogeneous and consists of building debris, road material, cinders, ash, clay rich fill, and coarse grained fills. The statistical approach to delineate lateral and vertical contamination through the fill materials was hit or miss. The primary lesson learned from investigating contamination in the fill material was the need to delineate fill types that represent potential contamination pathways. If sampling results indicated contamination near the pathway, follow up sampling would be conducted in the pathway fill material.

Third, the statistical approach did not consider how contamination was released to the environment. The MI facility is mostly buildings and paved areas. Much of the surrounding area is either undeveloped, or abandoned property. Air deposition is a reasonable contamination transport mechanism. The MI facility processes employed crude bag house technology to remove particulates from vent stacks. Deposition of contamination within the MI facility would have been washed away into storm sewers. Contamination deposition onto surrounding VPs could have collected on the ground surface and potentially concentrated in topographic low areas. Most air dispersed contamination probably occurred during the 1940's and 1950's. Since that time, additional fill was added to the surrounding area and the contamination was either buried or reworked into the added fill.

The statistical approach is based on detection of surface, or near surface, contamination. Buried contamination would not be detected and reworked contamination might be missed. The primary lesson learned is the importance of considering alternate contaminant transport mechanisms and the historical topography of the area. The SLDS excavation at a VP adjacent to the MI facility included a predesign investigation using the statistical approach. Remedial design required spot removal of several hundred cubic yards of contamination. Actual excavation resulted in the "discovery" of a contaminated soil horizon several feet thick. The contamination was not detected during the predesign investigation and the excavation grew to nearly 5,000 cubic yards. Historical information reveals a former topographical surface at an elevation consistent with the depth of contamination. Current predesign efforts now incorporate historical review to determine if ground elevation has changed or drainage features are present in the area.

Current predesign investigations at the SLDS include consideration of preferential pathways, the type of fill material, and contaminate transport. This investigation approach started in mid-2002 and the first design using the approach is scheduled for late 2003.

Remedial Design

Remedial designs completed to date were based on Pre-Design Investigations conducted using the statistical approach. In the MI facilities, the remedial designs have had limited success because the original designs did not include the issues presented above in the predesign investigation lessons learned.

Remedial designs define the areas requiring remediation based on the results of the predesign investigation. The design limits of excavation are presented with certainty. SLDS designs include potential contingencies that may be required during remedial action. Active remedial actions at the SLDS have shown that the original PDI was not accurate in assessing the areas of contamination or the volume soil requiring off site disposal. An example is the current VP undergoing remediation. The original designed volume was approximately 400 cubic yards, to date the volume of soil removed for off site disposal is approximately 4,700 cubic yards. Historical information could have been better utilized to investigate areas for suspect contamination. The investigation would have detected the buried contamination that has attributed to the excavation volume growth.

A more accurate or precise design could minimize the volume growth of excavated soil requiring disposal and assist with the remedial action budget and schedule planning process. It would also provide the necessary information about the volume of clean overburden requiring stockpiling and management. Also this design would improve the ability of the field crew to determine the level of personal protective equipment and radiological monitoring during remedial actions. These built in contingencies can minimize rushed engineering evaluations or downtime during remedial actions. The downtime can be a function of unknown chemicals or higher than expected contaminant concentrations. Obtaining dosimetry or chemical resistant coveralls can bring a project to a screeching halt.

Remedial designs to date have focused on minimizing the area impacted. They have also been greatly influenced by the cost of remediation. By limiting the area to be remediated, they have understated the costs of excavation and transportation and disposal (T&D). This understatement of the actual costs and schedule impacts can have devastating consequences for the client and the contractor. By using the statistical method of investigation contingencies such as rerouting utilities, installing foundation protection and preferential pathways, previous remedial designs understated the costs associated with remediation.

Another pitfall of the previous remedial designs has been the prescriptive method of remediation activities. Areas requiring remediation were minimized by false constraints of the PDI. These constraints overlooked preferential pathways that allowed the migration of contaminants. By including the presence or contribution to the remediation process in the remedial design, built in construction flexibility is provided.

An example of not investigating preferential pathways or not anticipating their existence increasing remediation costs is the MI Plant 1. During the remediation, several buried utilities acting as preferential pathways allowed the migration of contaminants to areas that were not investigated in during the PDI process. These isolated areas grew from a couple of yards requiring remediation to tens of yards requiring remediation. The inability of the design to predict the volume to be remediated caused significant cost and schedule impacts. The schedule was lengthened and the costs grew ten-fold due to the presence of preferential pathways. Which resulted in several engineering challenges during the remediation process.

The current method employed for the PDI should allow for more accurate designs that will better define total remediation costs. It will also allow for the creation of areas set aside for stockpiled materials. These materials can be re-used as backfill or disposed an industrial landfill thus minimizing T&D costs.

Guided Excavation

Guided excavation uses the ability to radiologically scan ahead of the excavation to determine if insitu material requires excavation. Ideally, a radiological technician would work in conjunction with the excavator operator to monitor excavation progress. The technician would scan the excavation bottom (or sidewalls) and evaluate the depth of the next layer of removal. A combination of field instruments (real time monitoring) and on-site laboratory analysis (one-hour turnaround time) are used to provide excavation progress information. The on-site laboratory analyses are more sensitive than field methods and the analysis provides isotope specific information. Excavation production is impacted by the time and labor expended between each pass of the excavator to perform field screening, or to obtain on-site laboratory results. The additional labor expense and lower production rate to minimize T&D volumes were estimated to be more cost effective than gross excavation and the larger T&D volumes. This cost efficiency was based on ideal site conditions.

The cost benefit of guided excavation to minimize excavation volumes is diminished by several uncertainties. The RI information at the SLDS is not sufficient to distinguish contamination areas that can be gross excavated to a target depth followed by guided excavation to reach uncontaminated material. The collection of supplemental soil samples has improved subsurface knowledge and the ability to delineate contamination. Field methods and on-site gamma spec laboratory analysis are sensitive to the detection of radium isotopes and less sensitive to uranium isotopes and thorium-230. The ability for guided excavation to be efficient and successful depends on radium being collocated with other radiological contaminants. Several SLDS excavations found uranium and thorium-230 contamination without sufficient radium concentrations to allow efficient guided excavation control. Difficulty in detecting thorium-230 with field instrumentation has resulted in repeated clean up failures and re-excavation. Thorium-230 is best detected using an alpha spec method. The turn-around-time for alpha spec analyses requires a day, or more, and the inefficiencies from waiting on results (standby cost) reduce the value of guided excavation.

Guided excavation works best where site contaminants can be field screened at activity levels that are consistent with clean up goals.

Conclusions

The SLDS project is four years into a projected ten-year project. Pit falls experienced from investigation approaches, restrictive designs, and approaches to minimize the volume of contamination requiring T&D. Lessons learned at the SLDS were the result of good intentions and less than desirable results. The implementation of the lessons learned will lead to process improvements and greater productivity for the project. Lessons learned are ongoing and continual improvement should be the goal for any project.