Laboratory Testing Options for FUSRAP Projects - 15462

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ABSTRACT

Remediation projects within the Formerly Used Sites Remedial Action Program (FUSRAP) have many options to consider when evaluating their analytical testing needs. Factors that should be considered in determination of a project's analytical testing needs include which parameter results are considered time-critical, the potential savings in reduction of construction-related delays when time-critical samples are analyzed onsite (including screening) instead of offsite, control of data quality for onsite versus offsite data, and the value of additional knowledge gained by programs such as FUSRAP by employing onsite laboratories. The most important factor turned out to be reduction in construction-related delays.

We considered development of an optimum combination of onsite lab/offsite lab capability. This depends on:

i. Time critical parameters and the methods required;
ii. Estimated Cost for onsite lab construction or facility rental, maintenance, labor, chemicals (reagents and standards), and certification (if desired and deemed necessary)
iii. Ability, flexibility, and cost of offsite lab sample testing using project-desired TATs and methods that will meet project action levels
iv. Willingness of stakeholders, in particular regulators, in accepting some combination of onsite and offsite testing (for example, onsite screening followed by offsite confirmatory testing for certain parameters)

Due to the significant costs in construction of an onsite lab and development of sample testing capability and all which that entails, the recommendations made in this paper will aid other FUSRAP projects in finding an acceptable combination of onsite and offsite testing that is acceptable to all stakeholders.

INTRODUCTION

The costs of projects that require remediation of radiologically contaminated media are very significant due not only to the cost of transporting and disposing of radiologically-contaminated waste but also the cost to employ a project staff, many of whom have very specialized skill sets. This study evaluates the best value for analytical testing by considering both onsite and offsite laboratory testing and the various factors that add value to each. The study is important since one always wants to execute such projects as cost effectively as possible,

For the Formerly Used Sites Remedial Action Program (FUSRAP), project labor costs are often a significant fraction of the overall cost. At those sites with onsite laboratories, the labor cost of the laboratory may be as much as 10% to 20% of the overall labor cost depending upon the scope of the testing. At the FUSRAP Maywood Superfund Site (FMSS) in Maywood, NJ, an evaluation was performed assessing the cost effectiveness of constructing an onsite laboratory that would provide most of the testing needs of the project. Many factors were considered in that evaluation. The pros and cons for use of onsite versus offsite laboratories are discussed, and recommendations are made for possible onsite/offsite lab combinations that will provide acceptable data quality at the lowest cost.

DESCRIPTION/ DISCUSSION

Data Quality Objectives (DQO)

Every project will have contaminants of concern (COC) and associated health-based or ecologically-based action levels which define those levels or concentrations in a given matrix above which that media should be removed and disposed. Based upon these action levels, the stakeholder and Contractor shall set DQOs that define the objectives for accuracy, precision and minimum detection level for each COC. Action levels for a given parameter will vary, of course depending upon the city, State and/or County of the stakeholders and the regulations by which they are required to abide and/or enforce.

Analytical Options

Depending upon the COCs, the suite of analytical options will vary. For radiological parameters, this suite will depend upon the matrix (soil, sediment, surface water, groundwater, building materials, and/or particulates and gases in air), the source of the contamination and how well the activity ratios of certain isotope pairs are understood, the action levels/DQOs of the COCs, the accuracy, precision, susceptibility to interferences and minimum detectable activity (MDA) of a given analytical laboratory or field screening method, and the number of commercial laboratories possessing the required analytical capability, licenses and certifications (assuming commercial onsite and/or offsite laboratory testing is being considered for part or all of the testing). The option or more likely combination of options may include field screening using sodium iodide detectors, gamma spectroscopy, alpha spectroscopy, PERALS, gas proportional detection, ICP/MS, and may consider a variety of preparation techniques including grinding, acid digestion, ion exchange, fusion, and electrodeposition.

Time Critical Drivers for Field Operations

a. Collection of Final Status Survey (FSS) samples and waiting for results in order to commence backfilling. Under this scenario, the extra time associated with waiting for results translates to additional costs for excavator rental.
b. Waste Storage. If waste (soil and water) must be stored onsite, the extra time waiting for offsite lab results may translate to additional onsite storage requirements, such as a storage area or holding tanks for wastewater generated during remediation activities.

The cost estimate for the onsite lab using a purchased or rented trailer(s) included costs for:

- Purchase/rental of a trailer(s);
- Utilities;
- Lab staff salaries;
- Purchase and installation of lab equipment (cabinets, lab benches, fume hoods, ovens, safety equipment, waste tank or waste storage area, water purification system, desks, computers, etc.; some of these items may be included in the rental/purchase of the trailer);
- Purchase and installation of lab instrumentation including centrifuges, hot plates, filtration equipment, etc.;
- HVAC modifications and adjustments, if necessary;
- Glassware (beakers, volumetric flasks, pipettes, etc.), chemicals, and reagents;
- Data management software; and
- Cost to archive samples that have been tested

In addition to the costs shown above (except for the trailer rental or purchase), a lab building, if it were to be built, would incur the following additional costs.

- Cost of design and construction; and
- Capital cost of the plumbing, electrical, and HVAC installation

The key advantages of an onsite lab include better control and oversight of the lab which improves the overall quality control, and faster turnaround times (TAT). Disadvantages include the costs described above to build and get the lab started as well as costs for certification. In addition, onsite laboratories are typically not as efficient as offsite commercial labs in terms of throughput.

DISCUSSION

Establishing DQOs

The goal is to select the best and most cost-effective analytical services solution. As noted in the Description section, DQOs must first be established for the contaminants of concern. This may involve a person who is familiar with applicable Federal, State and local regulations, as well as specific conditions applicable to the contaminated site or sites of interest. Such a specialist uses what are known as Applicable or Relevant and Appropriate Requirements (ARARs) to establish acceptable cleanup levels. Once cleanup levels are established and accepted by stakeholders, DQOs can be established using some combination of field sampling, field screening and laboratory testing. These proposed analytical options are typically expressed within a Quality Assurance Project Plan (QAPP). Remedial projects overseen by Federal agencies use the Uniform Federal Policy Act QAPP (UFP QAPP). The UFP QAPP shall contain Standard Operating Procedures that will provide detailed step-by-step instructions of all aspects of the analytical process including field sampling, field screening, sample receipt at the laboratory, sample preparation, testing of samples and sample extracts, quality control, instrument maintenance, report preparation and sample disposal.

Selection of Analytical Options

Field screening tests are very desirable because they are quick and inexpensive. They potentially suffer from inaccuracies due to calibration that may be inappropriate for the matrix and/or specific contaminants. For screening of radiological contamination, it is helpful to understand the approximate percentage contribution from each radiological contaminant to the overall activity. This knowledge can then be used to establish action levels that help guide excavation and removal of contaminated media. DQOs typically establish accuracy, precision and minimum detectable activity (MDA) requirements that will dictate or at least narrow the analytical method options and method conditions to be employed for a given parameter.

Time Critical Drivers

- Guiding an Excavation

When contamination is removed or excavated, samples will often be collected during this process to confirm that contamination within a certain area of an excavation has been removed. These are called excavation control samples. If an onsite laboratory exists, these samples are analyzed and results submitted in about 6-8 hours. If these samples had to be sent offsite, the extra time due to shipping would contribute significant costs to the contamination removal process.

- Backfill Delays

When an onsite excavation crew is confident that most or all of the contamination has been removed, a FSS may be performed on a discrete excavated area called a survey unit. FSS are described within the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM). Once FSS testing has been completed and assuming results indicate that the FSS has passed, backfilling of the excavated area may commence. The time difference between the time it takes an onsite lab to analyze FSS samples and the time it takes to ship the samples and have them analyzed at an offsite lab create additional costs due to the idle time of the equipment and resources waiting to be given the go-ahead to backfill. If an excavator that is rented for $5500.00/month is idle for one work day, the loss in operation cost, assuming 22 workdays/month, is $250.00.

- Waste Delays

The longer it takes to receive lab results the longer wastes must be stored. Storage of solid wastes can be managed by modifying procedures and thus were not considered further. Wastewater storage was considered due to the need for increased storage facilities which incurs additional cost.

For these reasons, an all offsite laboratory analysis option was not considered. In the absence of other contributing factors, this option is attractive due to the low cost. However, since offsite laboratory testing would typically take longer due primarily to the time to package, ship and receive the sample, the cost incurred by the resulting construction delays eliminates this option. Some combination of onsite and offsite laboratory testing was still considered.

Cost Analysis

An analysis was performed that compared the costs of the following three options for a 7 year duration project and a 10 year duration project:

Option 1. Using an onsite lab staffed by the remediation contractor;
Option 2. Using an onsite lab staffed by a commercial laboratory; and
Option 3. Using an onsite lab staffed by a commercial laboratory for time critical tests and an offsite lab for all other tests

Due to the considerable costs associated with construction of a laboratory building at a project site, especially in areas with high labor costs, this option was not considered. The study assumes rental of trailers for the onsite laboratory.

The following assumptions and conditions were used in establishing the costs and cost comparisons:

a. The onsite laboratory operated by the prime subcontractor (Option 1) for the project of interest was used to establish baseline cost for the onsite option.
b. Costs were prepared for the gamma spectroscopy only case, gamma spectroscopy and alpha spectroscopy, or gamma spectroscopy, alpha spectroscopy and gas proportional detection (GPD).
c. Two project durations were considered: seven years or ten years.
d. The tests performed by alpha spectroscopy are isotopic thorium, isotopic uranium and Ra-226; the tests performed by gas proportional counting are gross alpha/gross beta (GA/GB) and Ra-228. The price for a gamma spectroscopy scan is typically fixed regardless of parameters unless special scanning conditions are requested.
e. Three sample loads were considered for gamma/alpha/GPD: 2000/500/500, 2500/750/750, and 3000/1000/1000. The lab capacity was assumed to be at or near the highest sample load totals.
f. For the offsite laboratory per sample cost, in addition to a 100% markup for a 24 hour turnaround time (TAT), the following activities required by the remediation contractor increased the per sample cost by 10%: contacting the lab to request bottles, coolers, etc. and the time required to package the samples and ship the coolers. In addition, the cost for the offsite accelerated TAT analyses was assumed to take one day longer than onsite analyses. Note that 24 hour TAT is from time of sample receipt, and the time for packaging and shipping the samples makes the actual time from time of shipment to receipt of results closer to two days. Due to this extra day, the cost of construction delays was added to the cost of the offsite analysis to provide a true measure of the actual cost. Construction delay costs were assumed to consist of: the equivalent one day cost for rental of an excavator (based upon rental rate of $5500/month and 22 work days/month) of $250.00, divided by the typical number of samples in one survey unit or decision unit (18). Additional labor cost is certainly incurred but workers could be given other tasks so additional labor costs were not considered.

g. Staffing: for gamma only, assume one lab manager and one technician; for gamma plus alpha spec, assume one lab manager, three technicians, and one half-time QA Officer; for gamma spec, alpha spec and gas proportional counting, assume one lab manager, four technicians, and one half-time QA Officer.
h. For the cost of utilities, the electricity cost far outweighs the water cost and so only electrical was included in the calculation.

A spreadsheet calculation was prepared that included the following costs associated with an onsite lab:

- Mobilization;
- Demobilization;
- Purchase or rental of a mobile trailer or trailers;
- Analytical equipment purchase or rental;
- Analytical equipment maintenance;
- Labor costs;
- Lab supplies including small equipment such as hot plates, centrifuges, etc., glassware, compressed gases, standards and chemicals;
- Certification; and
- Utilities

Table I shows a comparison of the onsite and offsite laboratory costs for various annual sample loads. Since staff was augmented for addition of test parameters and not for increases in sample load associated with a given set of testing capabilities, it is not surprising that the cost per sample dropped dramatically as sample loads increased. This was especially true for the gamma plus alpha, and gamma, alpha and GPD cases. For gamma plus alpha, as the number of sample parameters increased from 2500 to 4000, the cost per sample dropped by about 45% for both the 7 year and 10 year cases. For gamma, alpha and GPD, the cost per sample dropped by about 46.5% for both the 7 year and 10 year cases as the number of sample parameters increased from 3000 to 5000.

Table 1. Cost per Sample for Onsite Laboratory Testing versus Offsite Laboratory Testing

		ONSITE LABORATORY			OFFSITE LABORATORY		
Project Duration (yrs) (1)	**Annual Sample Parameter Load (2)**	**Gamma only**	**Gamma and Alpha**	**Gamma, Alpha and GPD**	**Gamma only**	**Gamma and Alpha**	**Gamma, Alpha and GPD**
7	2000, 500, 500	$160.14	$885.16	$1,175.25	$190	$1015	$1230
7	2500, 750, 750	$129.29	$621.40	$813.08	$190	$1015	$1230
7	3000, 1000, 1000	$108.71	$485.18	$628.67	$190	$1015	$1230
10	2000, 500, 500	$154.78	$869.12	$1,154.39	$190	$1015	$1230
10	2500, 750, 750	$125.00	$610.46	$798.79	$190	$1015	$1230
10	3000, 1000, 1000	$105.15	$476.91	$618.10	$190	$1015	$1230

1. Any increases in lab costs over the 7 or 10 year period are assumed to be linear and apply to both labs and so were not considered a significant factor
2. The numbers shown represent the number of samples analyzed by gamma spectroscopy, alpha spectroscopy and GPD, respectively

The cost per sample is most sensitive to changes in labor costs, since labor represents the largest contributor to the overall cost, about 78% for the gamma plus alpha case, and 81% for the gamma/alpha/GPD case. Fixed costs such as the analytical instrumentation and the mobilization/demobilization contribute less to the overall percentage the longer the project duration. The second largest contributor is supplies, at about 8.0%.

A database option was added to the baseline costs and increased the cost per sample (for the gamma plus alpha case) by about 3% for the 7 year project duration and by about 2% for the 10 year project duration. So the cost of adding a database when considered on a cost per sample basis over the life of the project was relatively small.

Option 2 evaluated the cost of operating an onsite laboratory using a commercial laboratory. For the gamma spectroscopy, alpha spectroscopy, and gamma/alpha/GPD cases, the cost was 15.5%, 10.4% and 9.4%, respectively higher on average (for seven and ten year duration) than the onsite laboratory operated by the remedial subcontractor. These results were calculated for the highest sample loading case and were due almost exclusively to the higher labor rates for the onsite commercial laboratory lab manager and QA Officer.

Option 3 considered the use of an onsite lab only for time-critical tests and an offsite lab for all other tests. How time-critical is defined is obviously very important. If there is a need to obtain results, say within 24 hours if possible, those tests are considered time-critical. Although there are a number of possibilities for the specific parameters to be determined and which are or are not time critical, for this discussion, we present one case where the gamma spectroscopy test is considered time-critical and the alpha spectroscopy and GPD tests are not considered time critical.

Shifting a parameter to non-time critical status lowers the cost substantially as it transfers the test to an offsite lab with a normal turnaround time (and therefore much cheaper cost), and eliminates any cost due to construction delays. The cost for offsite analyses with a normal turnaround time and no cost added due to construction delays are as follows. Please note that the 10% markup described by assumption f on page 5 above is added to the cost of the offsite analysis:

Alpha spectroscopy:

Isotopic uranium: $137.50
Isotopic thorium: $137.50
Ra-226: $137.50

GPD:

GA/GB: $82.50
Ra-228: $137.50

The results of this option are shown in Table 2 for two cases: one in which gamma spectroscopy is performed onsite and the alpha spectroscopy tests (isotopic uranium, isotopic thorium and Ra-226) are performed offsite, and one in which gamma spectroscopy is performed onsite and the alpha spectroscopy and GPD (GA/GB and Ra-228) tests are performed offsite.

Table 2. Onsite Gamma Spectroscopy Testing combined with Offsite Lab Testing for Other Parameters

Project Duration (yrs) (1)	**Annual Sample Parameter Load (2)**	**Onsite Gamma Spectroscopy and Offsite Alpha Spectroscopy tests**	**Onsite Gamma Spectroscopy and Offsite Alpha Spectroscopy and GPD tests**
7	2000, 500, 500	$572.64	$792.64
7	2500, 750, 750	$541.79	$761.79
7	3000, 1000, 1000	$521.21	$741.21
10	2000, 500, 500	$567.28	$787.28
10	2500, 750, 750	$537.50	$757.50
10	3000, 1000, 1000	$517.65	$737.65

1. Any increases in lab costs over the 7 or 10 year period are assumed to be linear and apply to both labs and so were not considered a significant factor
2. The numbers shown represent the number of samples analyzed by gamma spectroscopy, alpha spectroscopy and GPD, respectively

For the highest sample loads, the onsite/offsite option is more expensive than the onsite lab only option by 7.4% (7 year) and 8.5% (10 year) for the gamma onsite/alpha offsite case and by 17.9% (7 year) and 19.3% (10 year) for the gamma onsite/alpha + GPD offsite case. It is noted, however, that for the medium sample load case, the onsite lab only option becomes more expensive by 14.5% (7 year) and 13.6% (10 year) for the gamma onsite/alpha offsite case and by 6.7% (7 year) and 5.5% (10 year) for the gamma onsite/alpha + GPD offsite case.

CONCLUSIONS

Cost analysis shows that the cost per sample is very sensitive to labor costs and to how close to capacity the lab is operating. The analysis shows that if time critical tests are required, the best alternative is to analyze the time critical parameters at an onsite laboratory, and the non-time critical parameters at an offsite laboratory unless the project team can be confident that the onsite laboratory will operate at or near capacity, in which case the all onsite lab testing option becomes slightly more attractive. Project planning should carefully estimate the anticipated sample load so that an onsite laboratory can be staffed appropriately. As expected, the goal is to staff a lab such that it will operate at or near capacity. This is obviously most efficient and helps to minimize cost.