Evaluating Suspect Sites
"To Clean or Not to Clean?"

by

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ABSTRACT

Within many large government reservations are many sites that are potentially contaminated from various uses such as experiments, material storage, or material processes. There also exist many smaller areas that, by proximity to contaminated sites, or due to work contracts, are likely to be contaminated. The party responsible for such sites must evaluate if remediation is required, based on current guidelines and future uses. The Departments of Defense and Energy have many sites and properties that are suspected of being contaminated or associated with operations that could cause contamination. In some cases the contaminants may have been adequately cleaned up, then decayed away, biodegraded, or dispersed to a nondetectable level. The decision to remove these sites from any further consideration of remediation or control must be based on historical data, potential contaminants, current analytical data, future uses, and the cost associated with managing the sites. This paper deals with the methodology for evaluating small sites and gives some case studies.

The Health Sciences Research Division of the Oak Ridge National Laboratory has performed numerous site evaluations which include recommended courses of action. Depending on the management environment, the site evaluations have also been known as scoping surveys, designation surveys, "no further investigation required" surveys and characterization surveys, each with its own twist. Each evaluation has been tailored to the specific site and the desired confidence level requested by the sponsoring organization. Typical surveys performed at both private properties and at DOE's Oak Ridge Reservation are presented in the following discussion, along with the lessons from each.
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Introduction

The Measurement Applications and Development (MAD) Group of the Oak Ridge National Laboratory (ORNL) has been involved in performing radiological surveys for the past 20 years. Most of the work has been sponsored by the Department of Energy's (DOE) Formerly Utilized Sites Remedial Action Program (FUSRAP), the Uranium Mill Tailings Remediation Act (UMTRA), and the Environmental Restoration (ER) program. While many sites are known to be contaminated and cleanup is inevitable, many suspect sites must be investigated to determine if contaminants are present in sufficient quantities to require cleanup. Commonly known as scoping surveys, these initial efforts are crucial and must be carefully planned and executed to determine whether or not remediation will be required. This paper discusses the planning, execution, and pitfalls of such surveys. While the techniques presented here are for radiological surveys, the philosophy can be adapted to other types of contaminants.

Survey Planning

Responsibilities

Team Leader

It is imperative that all individuals involved in the survey of a site understand their respective duties and responsibilities. The implementation is usually assigned to an experienced individual with ability and authority to organize resources, manage people, and make decisions in the field. This is the team leader. This individual must ensure that the rest of the team's members understand the nature and goals of the survey. He is also tasked with developing a survey plan and providing a safe work environment.
Analytical Staff
The analytical staff must be involved to the extent that when samples are returned for analysis, approved methods are in place for each contaminant of interest. If in-house laboratories are not used or cannot perform the needed analysis, the team leader must have provisions in place for sample processing and analysis by a qualified laboratory.

Survey and Sampling Technicians
The heart of any survey team is the technicians. These individuals must have a detailed knowledge of the sampling tools and radiological survey instruments used. They should have enough experience to assess problems and not to blindly follow procedures. Multiple skills are routinely required when surveying away from home; i.e., instrument repair, automotive repair, drafting, and civil surveying.

Project Management
The survey team’s management must be supportive and provide technical assistance and resources in a timely manner.

Document Review
A thorough review of all available documents pertinent to a site should be completed. The documents to consider may include:

- Site plats
- Site blueprints and drawings
- Site photographs
- Any previous radiological surveys
- Aerial photographs
- Maps
- Current site usage data
- Contracts and material transfer records
- Possible sources of contamination
- Reports of activities that caused contamination
These resources can provide clues to the possible contaminants and migration of contamination. The more puzzle pieces available prior to the survey increases the probability of understanding the nature of the contamination with minimal field work.

**Interviews**

**Site Owner/ Facility Manager**
Initially the site owner/facility manager should be contacted by the organization sponsoring the survey. After the initial contact the team leader should set up routine communications to keep the site owner informed of schedules, obtain legal permission to access the property, and ensure survey plans do not disrupt facility operations.

**Previous Owners/ Workers**
The site owner/ workers from the time when the site was contaminated may provide invaluable information about original locations of work areas, facility layout, quantities of material handled, etc. Over time facts sometimes become distorted, forgotten, or even enhanced to the point that only modest pursuit of such memories is recommended.

**Important Questions**

**Historical Information**

1. *Who did the original work?*
   

2. *What were the starting materials, intermediates, and the end products?*
   
   If a process was involved, the different stages may produce unique materials radiologically and chemically.

3. *Where was the process located on the site?*
   
   In many of the early projects secrecy may have prevented “outsiders” from knowing the true location(s).

4. *Where were the raw material, product, and waste storage areas?*
   
   All of these areas are potentially contaminated, and there may be several different locations as the process evolved.

5. *What was the production flow path of radioactive material through the site?*
This includes process lines/pipes, drains, ditches, and haul roads.

6. **What buildings and equipment were used in the process?**

7. **Is there a possibility of off-site contamination?**
   - Airborne, surface runoff, worker clothing, reuse of waste, and salvage of old equipment are all possible sources of off-site contamination.

8. **Have there been any decontamination activities? What were the results?**
   - Earlier decontamination activities may have been inadequate at the time or may not meet current standards. Records of such activities should provide insight into locations of contamination and types of contaminants present.

9. **Could there have been any co-contaminants?**
   - In many research projects short-lived isotopes were used; however, impurities in the isotope mixture may have left a co-contaminant. For example, $^{134}$Cs was frequently used because of its short half-life of 2 years; however, $^{137}$Cs, with a half-life of 30 years, may have been as much as 10 percent of the original activity.

10. **What were the transportation routes?**
    - Haul routes to and from the site should be investigated.

11. **Is the site location exactly known?**
    - In much of the early ecology research, plots of land were purposely contaminated and abandoned when the funds ran out. Unfortunately, location descriptions may only be accurate to within a few hundred meters.

**Survey Plans**

Armed with as many answers as possible, the next set of questions should lead to the development of the survey plan.

1. **Which property area(s) are to be surveyed?**
   - If the primary reason for the survey is to decide if cleanup is necessary, then a limited survey may be all that is required to draw that conclusion.

2. **Which building(s)/room(s) are to be surveyed?**
   - Same rationale as No.1, except to add that if the facility is still in operation, the survey need not interrupt daily activities.
3. **What are the guidelines for residual contamination or cleanup?**

   Crucial. Knowing the guidelines for cleanup determines the types of survey instruments, scanning speeds, number of samples to take, and the analytical methods to use.

4. **What types of measurements should be taken?**

   Always survey with the instruments capable of detecting the primary radiation emitted. However, the possibility of co-contaminants, “midnight dumping,” or other unanticipated/Unauthorized activities are good reasons to at least perform a cursory survey for other common types of radiation.

5. **Where should the measurements be made?**

   Floors, floors, and floors. Cracks, joints, holes, drains, thresholds, and entrance ways associated with floors will collect a disproportional amount of the contamination. Ceilings, walls, roofs, exhaust fans, downspouts, change rooms, and soils near the facility should be surveyed. Samples and direct measurements should be collected as appropriate. Testing for transferable contamination on surfaces in areas where the gross contamination exceeds the transferable limits.

6. **What analyses should be performed on the samples?**

   If the contaminant isotope is certain, gross type analyses may be appropriate. In most situations, gamma spectroscopy will provide the most information at the lowest cost. For pure alpha or beta emitters, more specific analyses are required.

7. **Who will have a need to use the survey results?**

   Certainly the sponsoring organization will use the results. Once the survey results are made available, a wide variety of interested parties will make their own evaluations/interpretations of the results. These may include the property owner, sponsor, EPA, State, media, community action committees, lawyers, the Centers for Disease Control, Agency for Toxic Substances and Disease Registry, and others with little appreciation for exactly what the results really mean.

8. **What special equipment may be required?**
A drill rig is required for deep subsurface sampling. A hole saw may be needed for accessing soil under concrete. A man-lift may be needed to reach roof exteriors and interior trusses.

9. **How large of a survey team, mix of talents, and length of survey is required?**

These considerations will depend on the distance from home base, the size of the site, potential safety problems, on-site capabilities needed, time constraints, weather, etc.

**Cleanup Guidelines**

The guidelines are used to establish what is "clean" or "acceptable" should be well-defined and easy to apply. Not so. For soil contamination, only a few isotopes have codified cleanup standards; the majority of isotopes have "derived" guidelines. The derived guidelines are influenced by risk analysis, pathway analysis, future use, generally applied conservative factors, politics, cost, etc. Even after a final guideline is agreed upon by all interested parties, the application of the guideline during cleanup is subject to interpretation and inconsistent use. This is because the guidelines are usually defined in terms of concentration per unit depth averaged over a two-dimensional area; i.e., 30 pCi/g in a 6-inch layer, not to be averaged over any 100-m² area. Exactly what does this mean? A 100-m² area, 6 inches deep can all be 30 pCi/g, or a 50-m² area, 6 inches deep can be 60 pCi/g if the other 50 m² are clean. Since it would be unreasonable for all the activity to be in 1 m² and the other 99 m² clean, and then declare the area meets the guidelines, a "Hot Spot" criteria was established to limit the activity in small areas as a function of the size of the spot. Remember, so far only the top six-inch layer is being considered. The next six-inch layer is treated independently.

Try picturing this concept being implemented under field conditions. Not surprisingly, questions arise when low-level spotty contamination is found. Just deciding the shape and orientation of the 100-m² areas is not straightforward. The size and concentration of hot spots is equally bewildering. Throw in further complications such as contaminated pipes, contaminated soil under concrete slabs, contaminated vegetation, or multiple contaminants, each with their own cleanup guideline, and now there is a real mess. Enough about soils, inside surfaces should be easy.
Surface contamination guidelines are usually defined in terms of activity/unit area, not to be averaged over a larger unit area; i.e., for uranium the numbers are 5,000 disintegrations per minute (dpm)/100 cm², not to be averaged over 1 m², with no one 100-cm² area to exceed 15,000 dpm/100 cm². This would work fine except for floor cracks where contamination tends to congregate, contamination under floor tiles or carpet, or overhead trusses where it is hard enough to define a 100-cm² area, much less a 1-m² area. Throw in ALARA (as low as reasonably achievable) and the world is a better place. Transferable surface contamination guidelines are defined in the same terms as above, except there cannot be as much. The guidelines are further complicated in that collecting and analyzing transferable contamination is more of an art than a science. Enough said.

Execute the Survey

This is where the fun starts. The survey team at this point should be familiar with the site layout and commence with the survey plan. For outdoors this usually means a walkover scan looking for hot spots or other anomalies. For inside work, a scan of the floors and walls should be first. After the scan is complete, the team should further investigate any areas that show elevated radiation readings. The ability to accurately perform walkover scans comes only after much experience. While any warm body can carry a radiation detector and watch to see if the needle moves, an experienced technician can listen to the audible count rate and detect subtle changes, and still be vigilant for visual clues that point to possible contamination.

Once a good overall perspective has been developed, the collection of samples should begin. Samples usually fall into two categories, systematic and biased. Systematic samples are those collected in some regular pattern irrespective of any other information such as direct radiation readings. Biased samples are those collected because of some trigger such as elevated radiation readings or discolored soil. All sampling operations should be controlled under a QA program, including a “Chain-of-Custody.” If possible, a portion of each sample should be analyzed by laboratory quality instruments while the sampling team is on the site. Lab quality screening can be extremely valuable in that these methods are much more sensitive than the walkover measurements. If low levels of contamination are discovered, then additional samples or measurements can be obtained immediately.
As soon as enough data is available to make an assessment, the interested parties should be informed. If contamination has been found in areas where no one expected it, the team leader must be prepared to first defend his observations and secondly, answer a lot of questions. The ability to anticipate possible questions and have good answers is essential. The site owner should always be one of the first to be notified.

Remember, the mission of the scoping survey is twofold, first to determine if the site has residual contamination requiring cleanup, and also to determine if the contamination in its present state is a significant health hazard. Once the mission is complete, pack up and go home.
WHAT CAN GO WRONG

✧ Unexpected contaminants, including chemicals
✧ Wrong location
✧ Site has been disturbed
✧ A lot more contamination than expected
✧ Unexpected help
✧ Change in the cleanup guidelines.

LESSONS LEARNED

✧ When unsure, take more samples.
✧ Don’t depend on just one source of information unless that’s all there is.
✧ Communicate. Communicate. Communicate. Make sure everyone involved understands their responsibilities, and the right people are updated as survey results are made available.
✧ Cleanup guidelines should be established prior to the survey.
✧ Consider more than just the cleanup guidelines when deciding to clean up.

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