DYNAMIC WORKPLANS & FIELD ANALYTICS:

The Key to Cost Effective Site Cleanup

Produced by TUFTS UNIVERSITY

(Title Screen: HANSCOM AIR FORCE BASE, 1996)

MALE VOICE: They know we have a problem.

FEMALE VOICE: Typical of a federal facility, multi-sites.

ROBERT SPELFOGEL, RESTORATION SECTION, HANSCOM AFB: We have ground-water contamination, and we found that contaminants are in the aquifer.

BOB LIM, EPA PROJECT MANAGER: There are still unanswered questions.

THOMAS BEST, RESTORATION PROJECT MANAGER, HANSCOM AFB: The current process has been frustrating. It's like a snowball coming down a hill. It just got bigger and bigger. So I'm looking at finding a way to expedite the cleanup to get more for my money.

NARRATOR: Today, tens of thousands of hazardous waste sites on the Superfund, RECRA, and Brownfields lists await characterization and cleanup. At a small percentage of these sites, the tip of the iceberg, remediation is already underway. To date, billions of dollars have been spent on the traditional phased engineering approach, in which samples are collected, shipped off-site for analysis, and the data returned long after the sample collection crews have gone.

STEVE LUFTIG, DIRECTOR, EPA OFFICE OF REMEDIAL RESPONSE: The cost of soil assessment has to come down.

ANDREW BELIVEAU, EPA QUALITY ASSURANCE: We have lots of sites that aren't being worked on because of budget.

DAN TOWMEY, FIELD CHEMIST/SITE WORKS: The industry now says look, we have X dollars. We have big problems. We are tired of study, study, study. Let's get moving. Let's get these things done.

MR. LUFTIG: We need a balanced program that recognizes that there are field analytic methods that work.

BOB CAMPBELL, ENVIRONMENTAL ANALYST, MA DEP: Anytime you find a technology which will shorten the amount of time it takes to remediate a site, it is always looked on with some favor.

NARRATOR: Field Analytics provides a process for dynamic site characterization and cleanup with a workplan that is not etched in stone, but that can be changed or modified as results from the field are evaluated in real time. Decisions as to which sample should be analyzed and for what contaminants can be made in the field, allowing for a faster and more effective site characterization process.

DYNAMIC WORKPLANS & FIELD ANALYTICS:

THE KEYS TO COST-EFFECTIVE SITE CLEANUP

NARRATOR: Like many Air Force sites, from the early 1940's to the mid-1970's, Hanscom Field generated a wide range of waste oils, fuels, solvents, and chemicals from operations, maintenance, and fire training activities. Previous disposal practices for many of these chemicals have caused contamination of the adjacent ground water. Between 1987 and 1988, the Air Force removed all visibly contaminated soil in drums from three sites in an effort to stem the pollution. Unfortunately, considerable amounts of hazardous waste had already migrated to the water table.

In 1991, a ground-water collection, recharge, and treatment system was placed in operation to remediate the effected sites and contain the plumes of contaminated ground water. Ultimately, the Hanscom sites were added to the National Priorities List in 1994. Overall, over $25 million has been spent at Hanscom on traditional hazardous waste site investigations and clean up.

MR. BEST: In the late '80's we went in and we removed the basic sources, the drums, and any visibly contaminated soil, and we put in a treatment system. And that treatment system came on-line in '91. We have been operating it for over five years now. We have treated over 500,000,000 gallons of water.

MR. BELIVEAU: Some of the monitoring wells show that it is still there. In fact, several of the monitoring wells shows that there is very, very high contamination down below which isn't being pulled from the ground.

MR. SPELFOGEL: Pump and treat hasn't been working very efficiently, and right now we are trying to go after the sources that we haven't been collecting.

MR. BEST: The previous investigations I don't think have given us any answers.

RICH LANDRY, CHIEF OPERATOR, METCALF & EDDY: We know it's out there. It's just getting into a treatment facility.

MR. BEST: I just cannot see the light at the end of the tunnel. Am I ever going to complete this cleanup or not?

NARRATOR: Given the readings from the wells and treatment facility, it became clear that there was still a need to determine the location and extent of contaminated materials remaining in the ground. In 1996, as part of President Clinton's Environment Technology Initiative, a grant was awarded to Professor Albert Robbat of the Tufts Center for Field Analytical Studies and Technologies.

Dovetailing with the ETI's strategic plan for developing and commercializing promising new environmental technologies, the Tufts project was directed at two key objectives identified in the strategic plan. First, to strengthen the capacity of technology developers and users to succeed in environmental innovation. And two, to strategically invest EPA funds in the development and commercialization of promising new environmental monitoring, control, and remediation technologies.

Tufts and several commercial companies sought to demonstrate their field analytical instrumentation in the context of a dynamic workplan which relies on an adaptive sampling and analysis strategy. The goal was to better characterize the Hanscom site so that a more effective collection and treatment system could be developed, and to determine the potential risk of contaminated soil to ground water. Based on the ETI project, a guideline was prepared for implementing dynamic workplans employing innovative field analytical instrumentation.

JAMIE MAUGHAN, CH2M HILL: Today we have put together a data collection program for one of the sites out at Hanscom, and there are still some areas that we need to iron out where different people have different impressions of how the samples should be collected, when they should be collected. So we are going to iron out those and then set up the logistics, so we can move forward and start the sampling here in just two weeks.

MR. SPELFOGEL: We are just fine-tuning the project, make sure that everybody understands what they need to be doing in the field.

DYNAMIC WORKPLAN GUIDELINE

NARRATOR: The following six steps can be used as a guideline to develop a typical dynamic workplan.

1. Select Core Technical Team to Prepare Workplan.

NARRATOR: The technical team should possess expertise in analytical chemistry, geophysics, geology, hydrogeology, and risk analysis. At least one member of the technical team should be on site at all times and have a working knowledge of all aspects of the investigation.

2. Develop Initial Conceptual Model and Decision Making Framework.

NARRATOR: The initial conceptual model contains the best available information at the start of the project. It depicts the three dimensional site profile based on vadose zone and ground-water flow systems that can exert influence on contaminant movement. The initial conceptual model is based on the data quality objectives for the site. The DQO process involves a series of planning steps designed to ensure that the type, quantity, and quality of environmental data used in decision-making are appropriate for answering site-specific scientific and engineering questions.

3. Prepare Standard Operating Procedures for Adaptive Sampling and Analysis Program.

NARRATOR: Standard operating procedures should be developed for sample collection and analysis to answer site-specific questions. Field analytical instrumentation may not be amenable to typical CLP or SW-846 methods, QC procedures, or data reporting formats. Supporting data for innovative field analytical instrumentation should be provided to document data quality.

4. Develop Data Management Plan.

NARRATOR: Critical to the success of the dynamic investigation process is the ability to manage and easily use all data produced in the field. Protocols for sample logging, analysis, data reduction, and site mapping should be established with rules and responsibilities defined prior to mobilization.

5. Develop Quality Assurance Project Plan.

NARRATOR: The quality assurance project plan describes the procedures to be used to monitor conformance or deviation from the SOPs. The overall goal is to ensure that data of known quality has been produced to support the decision-making process.

6. Prepare Health and Safety Plan.

NARRATOR: The health and safety plan is produced to protect both workers and the community during a site investigation and cleanup. This diagram illustrates the adaptive sampling and analysis strategy for a hypothetical soil screening site investigation whose goal is to determine contaminant risk to ground water and human health. The figure shows the decision-making flowchart for the investigation.

Typically, several sampling rounds are required before confidence in the conceptual model can be obtained. The number of sampling rounds made during the same mobilization is dependent upon the DQO specifications for confirming the absence or presence of contaminants. If contaminants are present, the extent, direction, concentration, rate of contaminant migration, volume of contaminated soil, and its risk to ground water and human health should be determined prior to concluding the investigation.

Once the conceptual model has been verified, each site investigated should fall within one of three categories: the site is clean or poses acceptable risk, no further action required; the site is highly contaminated and well above action levels for acceptable risk, remedial action begins; or the site poses marginal risk, a cost/benefit analysis determines that an immediate cleanup is not warranted. The core technical team determines whether future action is needed.

When developing a dynamic workplan, regulators should be included as part of the core technical team to ensure effective decision-making in the field. Stakeholders should agree at the beginning on the most likely kinds of actions to be taken as a result of the field data. The field team should implement the appropriate actions on a daily basis as data is generated, and take new directions when the data suggests deviations from the conceptual model.

MR. CAMPBELL: Cleaning up a site of hazardous waste is not a simple thing. It requires some time. It takes planning.

MR. LIM: It's important to look at new technologies because there is definitely a possibility of saving a lot of time and money in the investigation process.

MR. MAUGHAN: It's a new, innovative approach.

MR. TOWMEY: People don't expect that you can move high-tech equipment or analytical equipment to the field. The analytical techniques and the science you are doing is the same science no matter what location you are in.

UNIDENTIFIED MALE: You can collect a lot of samples quickly, have them analyzed, and then make changes in your sampling program based upon what you see in the field.

MR. BELIVEAU: We are not having a huge drill rig go down and bore a big, thick hole. We have got a smaller drill rig going down and taking smaller samples. And you can take ten times more samples than you do with a big drill rig.

MR. TOWMEY: It is very fast at getting soil samples and getting water samples.

UNIDENTIFIED MALE: You can chase a plume, you can quickly define the limits of the contamination.

NARRATOR: At the Hanscom site, the core technical team employed a geoprobe for rapid sample collection and field laboratories for the rapid screening and quantitative analysis of chlorinated solvents, gasoline constituents, polychlorinated biphenyls, PCBs, polycyclic aromatic hydrocarbons, PAHs, as well as the target analyte list of metal contaminants and organics.

The team reviewed the data as it was produced in a separate trailer where data collection and analysis was performed. Site maps were produced illustrating the extent of subsurface contamination. Subsurface soil samples were collected in four foot tubes. At one-foot intervals, an incision was made with a direct measuring, fast, GCMS soil probe placed over the incision. Each four foot tube was screened to determine which section of the tube, if any, should be further analyzed by quantitative GCMS in the field to confirm screening results and to select the next round of soil samples to be collected. Fast screening tools like GCMS and in situ fiber optic sensors allow for real-time on site decision making.

MR. TOWMEY: You can quickly map out what concentrations of contaminants at a site, and you can get the job done in one field session, a week or so, typically, for a site like this.

NARRATOR: As an example, three rounds of soil samples were typically collected. At site two, only two rounds of soil samples were necessary to determine the boundaries of subsurface soil contamination. Tufts also provided quantitative GCMS for VOCs PCBs, and PAHs. This data was used to support risk analysis for soil-to-ground-water contamination.

DR. ALBERT ROBBAT, JR., TUFTS UNIVERSITY CHEMISTRY DEPARTMENT, DIRECTOR, CFAST/ETI PROJECT MANAGER: The total line current mass spectral signal shown here is from an oil-contaminated soil extract. The heart of the technology is a set of mathematical algorithms called the ion fingerprint detection. The software extracts target compound ions, typically four ions per compound, and calculates, from the signals extracted, characteristic patterns that are used to identify and quantitate the target compounds. Both PCBs and PAHs present in the sample were analyzed in under ten minutes with no sample cleanup prior to analysis.

Really, it is a productivity enhancing tool. What it means is that we can analyze many more samples per day than traditional laboratory instruments. We can do it at less cost, which means we get more data for the same amount of money. All of that tied together means we get more information about the nature of the site. It is this software that allows us to rapidly analyze samples and obtain the data from those samples to make decisions in the site. It is the core technology that will allow us to bring the next generation of instruments to the field.

NARRATOR: In the metals trailer, soil analysis is performed via ICP. Extraction of the metals out of the soil prior to ICP is done through a Tufts-developed microwave digestion procedure. Specially adapted laboratory equipment with lock-down optics is used in the closely monitored, controlled environment. All of the sample data is electronically transferred to the data management trailer, where it is processed and developed into computer-based site visualization maps.

The combination of ion fingerprint detection software and thermal absorption GCMS provided instantaneous measurement of 600 soil samples and quantitative analysis of another 180 soil samples for VOCs, while 70 soil samples were analyzed quantitatively for PCBs and PAHs. Both the VOC and PCB/PAH analyses were accomplished in ten minutes per sample. Over 100 soil samples were analyzed on site by field ICP for the target analyte list metals. All in all, nearly 1,000 analyses were performed over a two-week period.

A number of VOCs were found in each of the three sites in varying concentrations. No PCBs or PAHs were found above the risk-based soil screening levels, while at one site, cadmium and lead concentrations were found above the levels established for the investigation. Calculations were made to estimate the volume of contaminated soil with the field data used to support the on site decision-making process.

MR. BEST: That is the benefit that I see, to complete in two weeks what it would normally, I would program it at least 18 months to two years to do.

MR. SPELFOGEL: Congress wants us to streamline the whole process.

MALE VOICE: It is important to embrace new technologies.

MR. BEST: To use them will allow us to do this site characterization faster, quicker, cheaper.

MR. BELIVEAU: This idea of having to get quick turnaround analyses will save a lot of money.

MR. BEST: I am very pleased with this project. We are collecting an awful lot of samples and data and I think it was very successful for all parties involved.

MR. CAMPBELL: The technology has been proven. I think what has to happen is that the information that is generated from this report has to go public so that people understand that it is a technology that works.

MR. LUFTIG: Tufts has been a real leader in developing and getting real equipment used that really implements what the Environmental Technology Initiative was intended to accomplish. Here, we have got methods that can literally be seconds instead of weeks, pennies instead of hundreds of dollars. And I think that has to get everyone's attention.

MR. BELIVEAU: We have to get it out to EPA nationally, say this is what you can do.

MR. LUFTIG: It is frustrating to know that all of our project managers in all of our regions and all of the states aren't yet fully on board with the use of the methods.

MR. BELIVEAU: Right now, the consultants have got to get into the program.

MR. LUFTIG: The consultants and the regulatory agencies can save a great deal of money and time on each site and get onto the other sites, and just get more done.

LINDA MURPHY, DIVISION DIRECTOR, EPA REGION ONE, OFFICE OF SITE REMEDIATION & RESTORATION: Every dollar that we spend on site characterization is a dollar that we can't spend on site cleanup. Every month that we spend on characterization is a month that we should be spending cleaning up the site. We want to move these sites out of the study stage, out of the characterization/study stage, and into the cleanup stage.

NARRATOR: Dynamic investigations employing field analytical instrumentation and methods provide a host of benefits. To federal and state regulators, by obtaining more information about the hazardous nature of a site, reducing the uncertainties associated with risk-based decision-making. To site owners and their consulting engineers, by completing the investigation process in a more timely and cost-effective manner. And to the community itself, with increased knowledge about the site ensuring faster, better, cheaper site remediation.