HAZARDOUS WASTE: QUICKER CLEANUP

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Tens of thousands of sites across the country are known to contain hazardous substances. Many pose a threat to human health and the environment. Cleanup of individual sites is taking far too long. Remediation actions at Superfund sites, for example, now average 10 to 12 years. Only 33 out of 1,200 sites on the Superfund roster had been cleaned up by mid-1991.

The sites range in severity from Department of Energy (DOE), Department of Defense (DOD), and industrial facilities where substantial releases of contaminants have been taking place for decades to gas stations and homes with leaking underground tanks.

Federal and state governments and the private sector have spent billions of dollars addressing the problem in the past decade, yet few sites have been cleaned up. And worse, more continue to be identified every year. The total cost of the cleanup is estimated in excess of one trillion dollars, and the task is not expected to be completed until sometime in the 21st century.

The largest chunk of time in a typical cleanup is devoted to investigating the nature and extent of contamination. This phase may last up to 10 years or more. During this period, interim cleanup measures are rarely undertaken, resulting in continued environmental degradation. Furthermore, once cleanup begins, companies and the government often are required to undertake remedial measures that cost much more than they return in benefits.

Why are investigations of sites so costly and time-consuming? And why have so few been cleaned up?

Issues of liability are one key factor. The Superfund law allows the government to hold deep-pocketed polluters responsible for the entire cleanup costs of a site that may have been used by thousands of firms. Companies are understandably reluctant to pay these costs. As a result, cleanups are often stalled until the relative liabilities of the various "potentially responsible parties" are resolved.

However, it is not just Superfund cleanups that take so long to complete. The problem is commonplace, irrespective of the funding party or the oversight

agency. The crux of the problem may be the process itself. State and federal regulations require that agencies approve virtually all actions, yet officials are hesitant to make critical decisions and be held accountable for them. Instead, they retreat into the process and demand that more studies be conducted before they make their decision.

The same desire to avoid risk also results in the selection of costly and redundant remedial options when equally effective but cheaper options exist. Finally, unlike other, more established disciplines, the hazardous-waste industry has discouraged, or at times prohibited, engineers and scientists from using the observational method as a basis for guiding site investigations and remediation projects. As a result, undue emphasis is placed on eliminating information gaps during the investigative phase, and too little authority is given to field personnel to respond to unanticipated conditions during the implementation of the remedial action.[1]

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STEPS IN PROCESS

Site characterization is the first phase in the cleanup of a hazardous-waste site. Groundwater, surface water, soil, sediment, air, and/or waste samples are collected from various locations on and adjacent to the site. Samples may be tested for a few or as many as several hundred different chemicals. Geotechnical testing also may be performed to determine the physical and engineering characteristics of surface and subsurface soils and rock. The purpose of this phase is to determine which media are affected and to assess the nature and distribution of the contaminants so a remedial design can be selected. At the conclusion of this phase, the potential risks to the public and environment are evaluated.

The second phase of a cleanup involves analyzing alternative remedial measures. Criteria include the long-term and short-term effectiveness of the remedy, the ability to implement it, cost, acceptance by the community and state, compliance with requirements, and the extent of reduction of the toxicity, mobility, and volume of the waste materials. The most important criterion, however, is the degree to which the measures protect human health and the environment. After weighing these criteria, one or more measures are selected and a design is developed.

The final phase of the process is implementation of the selected remedy. This phase takes from less than a year to three years, on average. Examples of typical remedies include stabilization/solidification of the waste materials; containment of the wastes through the construction of caps, liner systems, and slurry walls; construction of pump-and-treat systems to remove contaminants from groundwater; incineration; and off-site disposal.

The desire to reduce uncertainty about existing conditions is mostly responsible for the lengthy site investigations. Lawyers and their clients want to avoid lawsuits, and the public wants assurances that its health and the environment will be protected and the local economy will not be adversely affected.

Overseeing the entire process are local, state, and/or federal regulatory agencies that must approve or reject the cleanup plan. Agencies that approve

a particular plan are, in essence, certifying that the plan will work. If the plan does not work (*i.e.*, attain the intended cleanup levels), the regulators will be held every bit as accountable as the plan's developers. It is not surprising, therefore, that regulators take refuge in the process by demanding more and more information on site conditions. It is less risky to require another study than to commit to a particular solution.[2]

The regulator's task is made more difficult by the regulations themselves. Words such as "minimize," "permanent," "cost-effective," and "overall protection of human health and the environment" are not backed by any meaningful criteria. In most cases, regulators must rely on their own interpretations. To protect themselves, they often seek the most extreme solutions—treating words like minimize as synonymous with eliminate, even though no environmental benefit may be gained by bringing contaminant levels to below detection limits.

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Regulators also commonly insist on systems with multiple levels of redundancy, even when one is sufficient. At one site, for example, contractors were asked to install a slurry wall around the perimeter of the site, although other measures, including an impermeable cap system, groundwater recovery trenches, and solidification/stabilization of sludges to meet leachability criteria, would have provided enough protection from additional releases.

On many occasions, the decision on remedial alternatives is delayed by technical and complex issues that have no single or right answer. Questions may regard the rate of migration of contaminants or the relative efficacies of different containment systems. Reaching consensus on issues such as these can take years. Meanwhile, significant levels of contaminants may remain in the environment, causing additional environmental degradation and potentially affecting the health of nearby residents.

Those involved in hazardous-waste cleanups fail to understand the disastrous consequences of dividing the program into an information-gathering phase, a decision-rendering phase, and an implementation phase. It is widely believed that a thorough understanding of the site is necessary before various remedial options can be evaluated. This inevitably leads to longer site investigations because of the vagaries in the distribution of contaminants and the heterogeneous nature of subsurface conditions. What is ignored in this approach is the potential usefulness of the implementation phase as a source of information on site conditions.

CONSEQUENCES OF DELAY

Higher than anticipated costs and widespread dissatisfaction with the rate of progress are two of the consequences of the current approach. Even worse, contaminants continue to spread, potentially endangering the health of those who live in the vicinity. Delays in implementing a remedial action plan until more is known on the site conditions can and often do result in a greater overall volume of contaminants being released to the environment.

The consequences of such delays become even more severe when the effects of a contaminant on human health and the environment are not directly proportional to the concentration of the contaminant and the duration of

exposure. Because of threshold effects, shorter periods of exposure to higher concentrations of a chemical can often have more severe health consequences than longer periods of exposure to lower concentrations.

A typical condition that demands an early remedial response is the existence of unlined ponds with hazardous liquids and sludges. Leaks through the bottoms of these ponds can introduce contaminants into the surrounding soils and groundwater. During periods of warm, dry weather, pollutants may be released into the atmosphere; during wet periods, potential exists for liquids to overflow the dikes and contaminate downstream surfacewater bodies. At such sites, it is imperative that all free liquids be removed and the remaining sludges be stabilized as quickly as possible. Remedial measures need not be delayed while extensive bench-scale tests are undertaken to determine the appropriate ratios and types of solidifying agents. Much of the necessary testing can be performed in the field during the actual cleanup. This is preferred, in fact, because conditions in the laboratory can never exactly match those in the field.

RESOLVING THE CRISIS

Significant changes are needed in the current approach for cleaning up hazardous-waste sites. This conclusion is shared by many both within and outside government. Recommendations have been offered by the nonprofit organization, Clean Sites, Inc., to improve the remedy-selection process in the Superfund program.[3] These include establishing national standards to simplify the selection of cleanup levels. Clean Sites suggests more weight be given to expected land use, with higher levels of residual contamination being permitted at sites where future use is minimal or restricted. Although the strategy marks an improvement, implementation would not substantially shorten the site investigation phase. Because this is the most time-consuming phase, changes inevitably must be made in this phase if we are to reduce the average length of a site cleanup.

In another discussion of the Superfund program, Clean Sites proposes that the Environmental Protection Agency (EPA) limit data collection at sites with generic problems, develop model remedies for recurrent site conditions, and strengthen its commitment to early site action through the expanded use of removal actions.[4]

In addition, use of early site actions should be enlarged to include not only removal, but also treatment and containment actions. Adopting a more aggressive, interventionist approach is apt to reap the same benefits that come from the early treatment of a cancer. Early removal or destruction of malignant cells offers the highest probability of a cure. Patients who wait too long to seek medical help must undergo lengthier, more expensive, and more invasive treatments, particularly if the cancerous cells have metastasized. Similarly, the key to an effective cleanup program is to isolate or remove the sources and stop the spread of the contaminants as quickly as possible. Delaying action lessens the probability of containing the contaminants, increases the risk of adverse health impacts, and increases the cost and duration of the cleanup.

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It makes little sense to study a site for six or seven years to identify a remedy if one that is nearly as effective can be put in place in much less time. Can an effective remedial program be developed in two or three years, rather than five to 10? Yes, if the observational method becomes the cornerstone of our nation's remedial action programs. Steps in the method, when adapted for use in site cleanups, are as follows:

- Conduct an investigation to establish the general characteristics of a site.
- Assess the most probable conditions and the most likely deviations from them.
- Develop a remedial design based on the most probable conditions.
- Determine what course(s) to take if actual conditions deviate substantially from the predictions.
- Assess the actual conditions during construction.
- Modify the remedial design, as necessary, to suit the actual conditions.

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Key to the success of this method is that the construction phase serves as an additional source of information on site conditions. During the cleanup, tests are run to determine whether actual conditions differ substantially from those encountered initially. If so, steps are taken to modify the original design. Such feedback reduces the probability that the completed design will fail due to improper characterization of site.

Adoption of the observational method requires that engineers and supervisors in the field be given greater decision-making power regarding alternative courses of action when conditions deviate from predictions. If consensus is reached beforehand on the appropriate steps to take when anomalous conditions are encountered, there should be little need to interrupt the cleanup while waiting for approvals for specific courses of action.

In fact, the role of regulatory agencies should be redefined as part of a radical overhaul of the nation's cleanup programs. Currently, regulatory agencies must approve nearly every work product and action. Such involvement is unnecessary to protect human health and the environment and may, in fact, result in additional environmental degradation and adverse health effects when cleanups are delayed.

What, then, is the proper role of a regulatory agency? Regulators should limit themselves to the approval of cleanup goals and standards. A schedule should be set to ensure that remedial actions are completed in a timely manner. Specifics of meeting the agreed-upon goals and standards would be left to industry.

Changes also should be made in the regulations themselves. Currently, regulations pertaining to remedial measures cite not only the degree of protection to be attained, but also the types, properties, and/or thicknesses of materials that must be used. References to construction materials should be dropped. Including material specifications in the regulations restricts the engineer's ability to propose alternative designs that may work equally well or better or be easier or less costly to implement. They also hamper introduction of new technologies; new types of barrier materials cannot be used, for example,

when the regulations specify that all caps be constructed with a two-foot-thick clay layer.

If these changes are implemented, the average length of a site cleanup would be shortened significantly. No longer would projects be put on hold for weeks or months while a work plan or report underwent agency review. These changes, while benefiting industry, would not come without a price. Businesses would have to become more accountable for their actions. If one set of remedial measures does not meet the cleanup standards, the parties involved would have to accept responsibility for their failure and be prepared to implement another plan.

There also is some risk to the public in this approach. Some companies may take advantage of the looser regulatory oversight and do nothing until brought to court. Others may implement plans that have little chance of success. Still, given the dismal failures of our current programs, there is little risk in trying something different.

If the proposed changes reduce the average duration of an investigation and result in more cleanups, the public and the environment will be better served for it.

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NOTES

1. See N. Duplancic and G. Buckle, "Hazardous Data Explosion," *Civil Engineering 59* (December, 1989), pp. 68-70.
2. Many of these same arguments are made by C. D. Willis in "Dealing With Government Regulators," *Environmental Waste Management* (August, 1990), pp. 32-36.
3. D.J. Samo, "Making Cleanup Decisions at Hazardous Waste Sites: The Clean Sites Approach," *Journal of the Air and Waste Management Association* 41 (September, 1991), pp. 1172-1175.
4. Clean Sites, *Making Superfund Work. Recommendations To Improve Program Implementation*, (Alexandria, VA: Clean Sites, January, 1989).