Using Process Redesign to Improve DoD's Environmental Security Program

Remediation Program Management

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National Defense Research Institute

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RAND

PREFACE

The Department of Defense (DoD) faces a difficult cleanup challenge, with thousands of sites at active and closing installations and formerly used defense sites. Efforts to increase the efficiency of cleanup activities, by either reducing costs or accelerating the process, could have a substantial effect on DoD's ability to meet its cleanup obligations within an increasingly constrained budget environment.

The research reported here, which was conducted from late 1995 to early 1997, is part of a larger study. The larger study is examining the environmental management practices of commercial firms recognized as having the best practices in that field and drawing lessons that DoD could use to improve its own environmental management processes. The overall study is examining four areas of importance to DoD: designing weapon systems to have more cost-effective environmental performance; managing the industrial processes in central logistics activities; balancing environmental, military, and cost considerations in managing an installation; and remediation program management.

This report addresses remediation program management and should be of interest to officials concerned with remediation in both the public and private sectors.

This research was sponsored by the Office of the Deputy Under Secretary of Defense for Environmental Security and performed within the Acquisition and Technology Policy Center of RAND's National Defense Research Institute, a federally funded research and devel-

opment center supported by the Office of the Secretary of Defense, the Joint Staff, the unified commands, and the defense agencies.

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The Department of Defense (DoD) faces a difficult cleanup challenge, with thousands of sites at active and closing installations and formerly used defense sites (FUDSs). Efforts to increase the efficiency of cleanup activities, by either reducing costs or accelerating the process, could have a substantial effect on DoD's ability to meet its cleanup obligations within an increasingly constrained budget environment.

Corporate environmental management practices have become more proactive and innovative in recent years. The paradigm shift is from a corrective action perspective to one of prevention and includes self-auditing practices and the integration of environmental considerations into core business processes. While discussions in the literature regarding this "new" environmental management paradigm usually refer to compliance, pollution prevention, and conservation activities, there is no inherent reason that elements of the new environmental management paradigm cannot apply to remediation. For example, proactive remediation program management might include significant voluntary cleanup activities. The notion of going "beyond compliance" in the cleanup context might relate to voluntarily taking steps to enhance the process defined in regulations. It might also mean managing financial liabilities or environmental risks in such a way as to reduce them beyond what is required by standards and regulations. Open, public communication and stakeholder participation—foundations of the new environmental management practices—have been found to facilitate successful cleanup in both the public and private sectors. Similarly, the benefits of good relationships with regulators (e.g., increased flexibility) should theo-

retically accrue to cleanup activities in the same manner as pollution prevention or compliance would. Lastly, adding shareholder value, a core criterion for evaluating pollution prevention and other "beyond compliance" initiatives, enhances efficient property redevelopment and transfer, and cost-effective remedy selection and efficient execution in the cleanup context.

The research reported here, which was conducted from late 1995 to early 1997, is part of a larger study. The larger study's objective is to help DoD redesign its environmental security program and related processes to meet its environmental obligations with greater economic efficiency to promote DoD's core national security goals. Specifically, the Office of the Deputy Under Secretary of Defense for Environmental Security asked RAND to study the environmental management practices of commercial firms recognized as having the best practices in this field and to draw lessons that DoD could use to improve its own environmental management processes. This report focuses on remediation program management. The core of our approach is to use two in-depth industry case studies to analyze remediation program management implementation issues in contexts relevant to DoD.

According to one of the few studies that specifically focuses on remediation program management, private sector best practices in remediation management include six elements:[1]

- Building and maintaining a strong positive relationship with the regulatory community include open communications and an effort to understand the regulatory process, as well as communicating your process to the regulator.
- Proactive identification and management of remediation liabilities demonstrates responsible action to protect human health and the environment, and is also indicative of managing environmental issues in general from a broader business perspective.
- Risk-based decisionmaking to increase the cost-effectiveness of remedies requires that reasonable options for future land use be defined early in the remediation process. Regulators and other

[1]Arthur D. Little, Inc., 1995. See also Langseth and Lambe, 1995.

stakeholders (those in the community and shareholders) must be brought into the process early.

- Use of innovative technologies has the potential to reduce long-term costs associated with remediation activities and to improve their effectiveness.
- Managing remediation as a business process can be accomplished by ensuring that personnel with general business experience are closely involved in remediation program management. Viewing remediation as a value-added activity often involves generating cost reduction or avoiding costs through the use of innovative technologies and remedies that are more cost-effective for a given level of acceptable risk.
- Ensuring learning and continuous improvement involves capturing the experiences of both ongoing and completed remediation activities, and establishing a feedback process to ensure that past experience is disseminated and incorporated into the current process, as appropriate.

We examined the remediation-management programs of two large chemical companies, Olin Corporation and DuPont. These companies appeared to be among the best in private-sector remediation practice and had recently reorganized their remediation programs to facilitate the development and execution of more cost-effective remediation strategies. Their programs reflect the industry best practices listed above.

The critical program characteristics of DuPont's remediation-management processes are

- centralized management, with some decentralized execution
- integration of a business management perspective and approach
- use of risk-assessment and science-based evidence to influence remedy selection
- development and maintenance of cooperative relationships with the regulatory community by building trust and credibility and using a technical advocacy program

- cost-effective, risk-based strategies that address all urgent risks and off-site contamination immediately and then press for cost-effective containment.

The critical characteristics of Olin's remediation-management program are

- centralized management to ensure coordinated strategy and continuous improvement
- business process perspective, including extensive performance measurement
- a team management approach
- development and maintenance of cooperative relationships with the regulatory community and other stakeholders
- carefully managed use of external service providers.

The contrast between centralized and decentralized management deserves further discussion, since it is a core element of program management for both companies. A decentralized program management structure may be appropriate for managing a very large number of geographically disbursed sites. Financial and management responsibility resides with the business unit that created the problem. While this structure allows for increased responsiveness to variation in state/local regulatory environment, there is no central control, coordination, or standardization of processes. A centralized structure simplifies responsibility for costs and provides consistency in approach. Centralization does not mean isolation from line business units—site and plant representatives can be included in management teams, as well as other corporate functions (research and development, and legal).

The distribution of responsibilities between the central management group and the decentralized execution teams suggested by the case studies is significantly different from DoD's current processes. In particular, in the private sector, the central organization maintains strict control over costs and funding; in contrast, DoD's current policy allows the military services and defense agencies to maintain control of the majority of remediation funding. The current defense remediation funding policy—devolution—was initiated to facilitate

service buy-in and accountability for funding allocation decisions and to improve "end-user" (remediation agency) discretion in activity prioritization. The case studies argue for retracting DoD's recently implemented "devolvement" strategy.

Many of the specific approaches discussed in the case studies are potentially applicable and appropriate, in a slightly modified form, to DoD's remediation program. These approaches include centralized management with decentralized execution (DoD already has this structure, but not the specific distribution of responsibilities suggested by the case studies), adoption of a business process approach, more-focused use of performance measurement, proactive identification and management of potential liabilities, and improved stakeholder (regulator and community) interactions. DoD can tailor the lessons from the case studies to its own culture and organizational environment.

The issue of implementing the chosen reforms must be addressed at the time that remediation policy is developed. The firms overcame barriers to organizational change through

- reasonably clear vision of the desired future state
- strong leadership support
- centrally managed resources and problem solving in the initial phases of implementation
- iterative process improvements, incorporating feedback from employees and external stakeholders
- a team management approach
- performance evaluations of individuals and groups, with an emphasis on change.

Again, with some tailoring, these lessons are directly applicable to improving DoD's remediation program.

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A very special thanks goes to the remediation program officials at Olin and DuPont for participating in our research. These officials spent considerable time with us providing extensive information on their remediation processes. We greatly appreciate their openness in these discussions.

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Any errors are the sole responsibility of the authors.

ACRONYMS

ADL	Arthur D. Little
AOC	Area of concern
AFB	Air Force base
ARAR	Applicable or relevant and appropriate requirement
BRAC	Base Realignment and Closure
CAP	Community advisory panel
CEO	Chief executive officer
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CMA	Chemical Manufacturers Association
CR	Core Resources
CRG	Corporate Remediation Group
DERA	Defense Environmental Restoration Account
DERS	DuPont Environmental Remediation Services
DoD	Department of Defense
DoE	Department of Energy
EH&S	Environment, Health, and Safety
EMIS	Environmental Management Information System
ER&E	Environmental Remediation and Engineering
EPA	Environmental Protection Agency
ERG	Environmental Remediation Group
EVA	Economic value added
FASB	Federal Accounting Standards Board
FUDS	Formerly used defense site
FY	Fiscal year

HEART	Having Everything About Remediation Technologies
IPA	Independent Project Analysis, Inc.
IPT	Integrated product team
ISO	International Standardization Organization
ITP	Industry Toxics Program
LCA	Life cycle assessment
NOD	Notice of deficiency
NOV	Notice of violation
NPL	National Priorities List
PRP	Potentially responsible party
RA	Remedial action
RCRA	Resource Conservation and Recovery Act
RMB	Remediation Management Board
RMT	Remediation Management Team
ROD	Record of Decision
RPM	Remediation program manager
RTDF	Remediation Technology Development Forum
SARA	Superfund Amendments and Reauthorization Act of 1986
SEC	Securities and Exchange Commission
SHE	Safety, health, and environment
SWMU	Solid waste management unit
TRI	Toxic reporting inventory
TSD	Treatment, storage, and disposal
VOC	Volatile organic compound
VP	Vice president

Chapter One

INTRODUCTION

The Department of Defense (DoD) faces a difficult hazardous waste cleanup challenge, with thousands of sites at active and closing installations and formerly used defense sites (FUDSs). In fiscal year 1994 (FY94), approximately $2.4 billion was spent on cleanup activities through the Defense Environmental Restoration Account (DERA) and the Base Realignment and Closure Law (BRAC); in FY96, approximately $2.1 billion will be spent, slightly less than half of the total DoD environmental security budget. Efforts to increase the efficiency of cleanup activities, either by reducing costs or accelerating the process through simplification and streamlining, could have a substantial effect on DoD's ability to meet its cleanup obligations within an increasingly constrained budget environment.

Corporate environmental management practices have become more proactive and innovative in recent years. The change is in response to the increasing costs of environmental management and the need to develop and execute more cost-effective environmental management strategies. The paradigm shift is from a corrective action perspective to one of prevention and includes self-auditing practices and the integration of environmental considerations into core business processes. Discussions in the literature regarding this "new" environmental management paradigm usually refer to compliance, pollution prevention, and conservation activities and relate to current and future business operations. Interestingly, there is almost no

discussion of the application of these principles to remediation[1] of hazardous waste sites. The gap in the literature exists because no one has yet thought through the application of the new paradigm to cleanup.[2] There is no inherent reason that elements of the new environmental management paradigm cannot apply to remediation.

The application of proactive environmental management principles to remediation activities can be conceptualized as follows:

- A comprehensive environmental management system will include remediation activities (as well as pollution prevention and compliance) and integrate such activities into the overall environmental management policy and program, as well as core business functions.
- Remediation itself is a process generating waste streams that need to be managed.
- Remediation management is a complex process that can potentially be improved through management innovations.

For example, proactive remediation program management might include significant voluntary remediation activities. The notion of going "beyond compliance" in the remediation context might relate to voluntarily taking steps to enhance the process defined in regulations. It might also mean managing financial liabilities or environmental risks in such a way as to reduce them beyond what is required by standards and regulations. Open, public communication and stakeholder participation—foundations of the new environmental management practices—have been found to facilitate successful cleanup in both the public and private sectors. Similarly, the benefits of good relationships with regulators (e.g., increased flexibility) should theoretically accrue to cleanup activities in the same manner as pollution prevention or compliance would. Lastly, adding shareholder value, a core criterion for evaluating pollution prevention and other "beyond compliance" initiatives, suggests efficient property

[1]Throughout this report, we use the term "remediation" rather than the term "cleanup." Sites are rarely ever cleaned to their original state, so the term remediation better reflects the process that actually occurs.

[2]Some examples do exist. See Langseth and Lambe, 1995; Baker, 1995; and Lawrence and Cerf, 1995, pp. 48–54.

redevelopment and transfer, and cost-effective remedy selection and efficient execution in the cleanup context.

Remediation viewed as a process requiring program management suggests that most provisions of the emerging environmental management paradigm are applicable: clear policy statement, goals and metrics, a formal process with designated responsibilities, provisions for adequate resources, documentation, and quality assurance.

It would be proactive to view cleanup tasks as a value-added activity in its own right, including facilitating property development and transfer, providing feedback on material usage that might inform compliance and pollution prevention programs, and reducing the long-term costs of environmental management.

Current DoD remediation policy and practice supports this approach, and DoD leads the way in a number of areas. But commercial firms have experience in other areas that DoD can use to improve its current program. This research focuses on opportunities to learn from the private sector in the area of remediation program management. Areas of priority interest to DoD include application of business management principles to remediation, cost and liability estimation processes, resource allocation processes, determining information needs, monitoring performance, and interacting with regulators at local, state, and federal levels.

RESEARCH APPROACH

The research reported here, which was conducted from late 1995 to early 1997, is part of a larger study. The larger study's objective is to help DoD redesign its environmental security program and related processes to meet its environmental obligations with greater economic efficiency to promote DoD's core national security goals. Specifically, the Office of the Deputy Under Secretary of Defense for Environmental Security asked RAND to study the environmental management practices of commercial firms recognized as having the best practices in that field to draw lessons that DoD could use to improve its own environmental management processes.

The entire study focuses on environmental management in four DoD policy areas: weapon system development and modification, depot-

level logistics processes, integrated environmental facility management on installations, and management of remediation programs. RAND's research has four main tasks based on these policy areas:

1. *Weapon system development and modification* focuses on how innovative firms manage and incorporate environmental concerns into their state-of-the-art design processes for long-lived products and industrial processes. Special attention will be given to how they currently apply formal life cycle assessment (LCA) tools as part of these design processes. The study seeks implications for pollution prevention actions relevant to DoD design and modification of weapon systems.
2. *Depot-level logistics processes (concentrated on industrial processes)* focuses on how innovative plants with industrial processes like those in DoD manage compliance and promote cost-effective pollution prevention. The focus is on maintenance/repair and overhaul/remanufacturing processes. Also, the study will examine hazardous material management systems and will seek implications for DoD repair and overhaul facilities, shipyards, similar depot-level logistics centers, and other DoD installations with similar processes.
3. *Integrated environmental facility management on installations* focuses on how facilities with diverse activities develop integrated ways to comply with current regulations and prevent future pollution. The focus is on commercial efforts to implement integrated whole-facility planning and on innovative multimedia environmental management efforts. Such activities include commercial, residential, industrial, and natural resource management activities. The study seeks implications for DoD installations.
4. *Management of remediation programs* examines innovative remediation program management practices in the private sector to identify processes that can enhance DoD's program. The study is particularly interested in risk management and program-level decision processes, and the information systems supporting them.

This report focuses on the forth area, remediation program management.

The core of our approach is to use in-depth industry case studies to analyze remediation program management implementation issues in contexts relevant to DoD. We identify innovative private-sector processes that can be adapted to meet DoD's specific management challenges. Case studies allow the in-depth examination of processes and implementation procedures necessary to draw useful lessons for DoD. Please note that the case studies provide only a snapshot of the innovative environmental management practices reflected at the time of our interviews. These case studies are supplemented by a comprehensive review of the literature and discussions with industry and government officials involved in environmental management in the fourth area described above.

We are particularly interested in understanding the rationale for a process, and understanding how implementation actually works, including identifying process enablers. We are also interested in identifying constraints affecting implementation and understanding how those constraints were managed.

The cases were selected based on several criteria:

- A large industrial firm with multiple business units located in multiple geographical areas.
- Full or partial responsibility for managing remediation at a large number of geographically disbursed sites.
- Acknowledged as representative of industry best practice in remediation management.
- Core elements of the firms' remediation-management program responsive to DoD's areas of primary interest.

The first two criteria are meant to ensure broad comparability with the nature of DoD's environmental remediation challenge. The last two criteria are meant to ensure that lessons from the case studies can be usefully applied to areas of DoD's program that are considered important by DoD's environmental remediation community.

Our research approach necessarily raises issues of transferability between the public and private sectors—between DoD and specific industrial sectors in particular. Issues of particular relevance to transferability of best practices from the private sector to DoD include the

type of decisions to be made (what the information is used for), the information needed to inform those decisions, and the types of risks to be managed. Our working hypothesis is that broad remediation program management information needs and uses are generally similar between DoD and large private-sector firms.

ORGANIZATION OF REPORT

Chapter Two of this report introduces issues associated with remediation program management. Such issues as the inherent uncertainty of remediation, the need to cost-effectively manage liabilities, and regulatory and community relations are relevant in both the private and public sectors. Areas of special concern to DoD are then identified, as well as the particular management challenges facing DoD remediation managers.

Chapter Three reviews some general lessons on remediation management derived from publicly available sources and non–case study interviews with both private- and public-sector officials. Interestingly, while there is a vast literature on the technical, project level, and liability aspects of remediation, there is very little on program management. We attempt here to summarize briefly the available information and develop a framework for presenting the case studies.

Chapters Four and Five present the two case studies that are the heart of this research. The discussion is oriented around the framework developed earlier and includes concrete examples illustrating how innovative private-sector firms implement best practices in remediation management. The cases are sufficiently different that each emphasizes a fundamentally different approach to remediation program management at the specific issue level, but major commonalities exist at higher levels.

Chapter Six presents conclusions and recommendations for actions DoD could take to enhance its remediation program.

Chapter Two

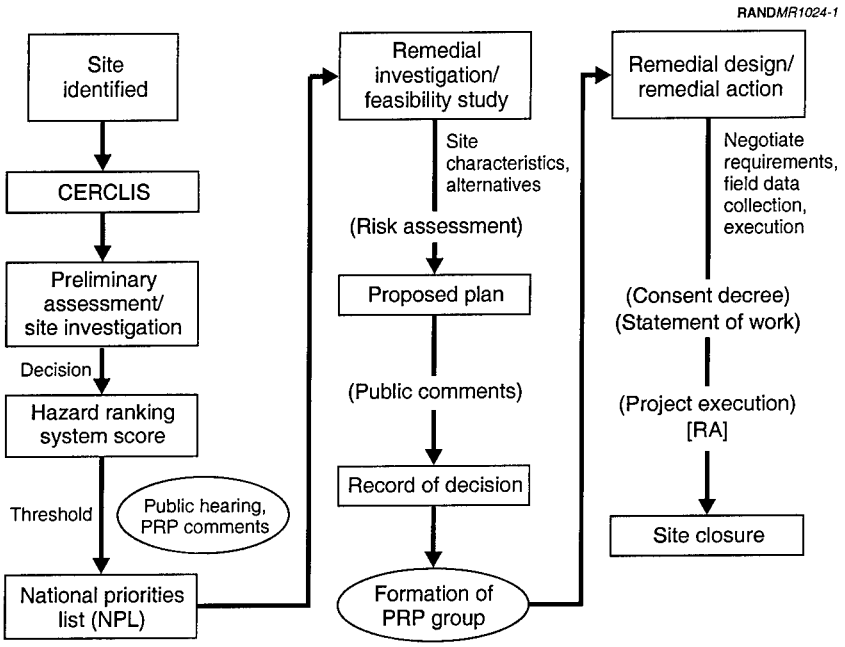
REMEDIATION PROGRAM MANAGEMENT ISSUES

This chapter presents a brief and simplified view of remediation program management. The purpose of this overview is to provide some context in which the importance of the various attributes of the remediation program management processes described in subsequent chapters can be interpreted.

MANAGING REMEDIATION PROGRAMS

Complexity, size, and inherent uncertainty pose difficult challenges for remediation program management. By program management, we refer to the management of many individual remediation-related projects at different sites. Large firms, particularly those in the chemical or energy industries, may be managing activities at several hundred sites at any one time. Each site is likely to have its own unique physical (contaminants and geology), economic, and political characteristics. Each site is likely to be at a different stage in the remediation process.

Figure 1 outlines the traditional Superfund cleanup process as defined by regulations. While specific to Superfund, the basic steps in the process would be similar in any remediation project, including those conducted under Resource Conservation and Recovery Act (RCRA) cleanup provisions, state regulations, and voluntary cleanups. Basic steps include site identification and characterization, risk assessment, remedy selection, remedial action, and long-term operations and monitoring.



NOTES: Boxes represent formal documentation and circles and parentheses represent important administrative or management processes and activities. CERCLIS = Comprehensive Environmental Response, Compensation, and Liability Information System. PRP = potentially responsible party. RA = remedial action. Brackets indicate ongoing action.

Figure 1—Outline of the Superfund Cleanup Process

The first column of activities shown in Figure 1 concerns site identification and listing on the National Priorities List (NPL). These activities are most often performed by the Environmental Protection Agency (EPA), although industry potentially responsible parties (PRPs) and other stakeholders may track the process and comment on decisions. The second column of activities concerns initial planning, detailed site characterization, and remedy selection. Risk assessment can play a role here. EPA, PRPs, or remediation service providers (contractors) can perform both the site characterization and risk assessment. Ultimately, the remedy is formalized in a Record of Decision (ROD). It is usually after the ROD has been pub-

lished that the PRP group officially forms. The activities in the last column are performed by the PRPs or their remediation service providers and involve detailed project design and execution. Even after site closure, there can be an extensive monitoring period to ensure that the remedy was successful.

The process outlined in Figure 1 is highly stylized: The actual process is much more complex. There are many opportunities for the various stakeholders to interact and reach interim agreements that either mitigate the need for some elements of subsequent phases or modify those phases. The process leading up to publication of the ROD can take many years. The actual remedial action may also take many years. The subsequent monitoring program can last decades.

The traditional cleanup management process results from strict adherence to regulations. The result is that innovation is not emphasized or encouraged. A firm's goal is often to minimize potential future liability. The required public participation (through hearings at certain points in the process) can result in some delay and tensions among the community, firms, and regulators. The Superfund process also has a clear preference for permanent treatment solutions. In short, the current system discourages risk taking and experimentation. Liability exposure and the government's relative inflexibility in enforcement contribute to the problem.[1]

Olin Corporation's perspective on the sources of uncertainty regarding remediation liabilities is representative of the industry's and includes the following:[2]

- Identification of new sites.
- Developments at sites resulting from investigative studies.
- Advances in technology.
- Changes in environmental law, regulations, and their application.
- Scarcity of reliable data pertaining to sites.

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[1]Porter and van der Linde, 1995.

[2]From *Olin 1995 Annual Report,* Norwalk, Conn.

- Difficulty in assessing involvement and financial capability of other PRPs.
- Ability to obtain contributions from other parties.
- Long time periods associated with remediation.

The multiple sources of uncertainty affecting remediation program management affect a firm's ability to manage efficiently. In general terms, these include the ability to characterize accurately the contaminants at a site, assess accurately exposure pathways for health and environmental effects, estimate remediation project costs, and adapt to changes in technology and regulatory environment. In many cases, the result is a great deal of inherent uncertainty regarding the cost-effectiveness of a selected remedy.

CHALLENGES FOR DOD

The challenges of managing remediation programs in large commercial firms and DoD are similar. These include the type of contamination (petroleum, oil and lubricants, solvents, heavy metals, paint, acid, asbestos, and pesticides) as well as the type of area contaminated (storage areas, underground storage tanks, landfills, other disposal sites, buildings, and lagoons and ponds). For the most part, DoD does not require any unique technologies to meet its needs, with the exception of buried ordnance and mixed hazardous and radioactive waste.[3] The chief difference is the absolute magnitude of the program in DoD: DoD clearly has many more sites and a much larger total volume of waste to account for than the largest chemical or oil companies.

DoD has made substantial progress in addressing its remediation problem and has a number of ongoing initiatives that relate, at least in part, to best practice in the private sector.[4]

A review of DoD's current remediation program and discussion with program officials suggest that DoD has the following areas of special

[3]Congressional Budget Office, 1995.

[4]See the statement of Clean Sites, Inc., president, Edwin H. Clark, 1996; see also Department of Defense, 1996.

interest in which lessons from the private sector would be particularly helpful:

- *Liability and cost estimating and control processes.* These include tools, models, skilled personnel and training, as well as monitoring and control. Liability and cost estimating have implications for budgets, internal and external politics, and relationships with stakeholders in DoD's remediation processes. DoD's need is to estimate costs more accurately and to reduce the overall costs (increase cost-effectiveness) of remediation strategies.
- *Management processes.* These include process control and mechanisms for continuous improvement. Establishing appropriate incentives to motivate the desired behavior is a particularly important element here. Given the size of the DoD remediation program, the application of variable oversight processes to focus management attention where it is needed is also of special interest. The ability to adapt to a changing regulatory and technical environment is another important need for DoD.
- *Resource allocation processes.* These include prioritization, risk management, risk-based decisionmaking, and establishing links between allocation processes and remediation activities. Dealing with the political process and existing regulatory commitments is also of concern.
- *Determining information needs.* This includes understanding the information needs of decisionmakers, the information generated by and required by decision processes, and information management and data transformation processes. Information flows to and from stakeholders are also important.
- *Monitoring performance.* This includes establishing goals, identifying metrics, collecting and organizing the necessary information, and providing for feedback and continuous improvement.
- *Interacting with regulators.* This includes establishing cleanup standards and remedy selection processes and criteria.

While the case studies and literature review cover all six topics, our research focuses on three: management processes, performance monitoring, and interactions with regulators.

Chapter Three

OVERVIEW OF INNOVATIVE COMMERCIAL REMEDIATION-MANAGEMENT PRACTICES

Remediation remains one of the largest environmental management problems for many commercial firms, especially for large chemical, petroleum, and manufacturing firms with production activities at many sites. These firms offer a reservoir of expertise on how to apply the new approach discussed in Chapter Two to the management of cleanup programs. Remediation program management practices in the private sector provide lessons that DoD can use to reduce costs and future liabilities through application of cost-effective strategies.

Several aspects of remediation program management in the private sector appear to be applicable to DoD's areas of priority interest:

- The use of innovative program management initiatives in specific process areas.
- Application of a business management perspective to cost and liability estimation.
- Resource allocation processes.
- Monitoring and performance incentives.
- Introduction of core organizational values into the remediation program management processes.
- Interactions with regulators and local, state, and federal levels.

This chapter briefly reviews some of the lessons on remediation program management that can be drawn from publicly available sources. However, the topic (remediation program management)

has not been extensively addressed in the literature, and innovations in this area are relatively new. We thus draw on only a few sources.

LESSONS FROM THE LITERATURE

The literature on remediation focuses on project- or site-level management and the technology associated with remediation. There is very little literature addressing program-level management issues for either government agencies or the private sector. Reviews of government agency programs tend to focus on simple metrics and are not particularly useful in terms of process improvement.[1] EPA produced a report in 1994 that benchmarked the environmental management systems of the military services, but remediation program management was not addressed specifically.[2] The Department of Energy (DoE) has recently examined its program more holistically[3] and has also begun to benchmark its processes against other government agencies and the private sector.[4] The literature on private-sector remediation processes tends to focus on reform of Superfund, rather than on management processes.

Although the literature is scarce, some commercial firms have invested in analyses intended to benchmark and improve their remediation programs. One prominent example is HAZRISK,[5] a research program sponsored by over a dozen large energy and chemical companies (and one government agency) to address cost and scheduling issues of remediation projects. Based on a unique, large database developed and maintained by Independent Project Analysis, Inc. (IPA), HAZRISK provides a set of tools useful in estimating the cost, schedule, and needed contingency for remediation projects. In October 1995, the HAZRISK database included 423 projects represent-

[1]See, for instance, Congressional Budget Office, 1994 and 1995; U.S. General Accounting Office, 1994a, 1994b, and 1996; and Department of Defense, 1995a.

[2]U.S. Environmental Protection Agency, 1994.

[3]National Research Council, 1995.

[4]Mallick et al., 1994; Department of Environment, 1994; and U.S. Department of Energy, 1993a.

[5]HAZRISK is the creation of Independent Project Analysis, Inc., Reston, Va. See the HAZRISK information pamphlet, Reston, Va.; *HAZRISK Newsletter,* 1996; Independent Project Analysis, Inc., 1995; and Painter, 1996.

ing $2.5 billion in total costs. While HAZRISK is focused on the project level, results from analysis of the database are applicable to program-level management concerns. For instance, HAZRISK tools can provide senior management with an improved understanding of the probability that the actual cost and schedule of individual projects will be close to the original estimates, and an understanding of the factors that affect cost and schedule outcomes.

HAZRISK is a benchmarking tool that has been used by DoE to compare the performance of its remediation projects with that of the private sector. This study concluded that cost and schedule outcomes (cost growth and schedule slip) for DoE projects are somewhat worse than similar projects in the private sector. Reasons for this disparity include poor project definition, redundancy and lack of control and accountability (because of the use of multiple prime contractors on individual projects), inappropriate contracting strategies, lack of closure on project objectives with regulators, and inadequate connection between project risk and contingencies in the project budget.[6] To the extent that DoE and DoD management practices are similar, the IPA study suggests considerable scope for improvement in a number of important areas related to program management: application of consistent guidance on project definition, improved allocation of contingency funds, improved relations with regulators, and more-efficient contracting strategies.

According to a study by Arthur D. Little, Inc. (ADL), one of the few studies that specifically focus on remediation program management, private-sector best practices in remediation management include six elements:[7]

- Building and maintaining a strong positive relationship with the regulatory community.
- Proactive identification and management of remediation liabilities.
- Risk-based decisionmaking to increase the cost-effectiveness of remedies.

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[6]U.S. Department of Energy, 1993b.

[7] Arthur D. Little, Inc., 1995. See also Langseth and Lambe, 1995.

- Use of innovative technologies.
- Managing remediation as a business process.
- Ensuring learning and continuous improvement.

Building a strong positive relationship with the regulatory community includes open communications and a real effort to understand the regulatory process, as well as communicating your organization's process to the regulator. Feedback and communication from all relevant regulators should be encouraged, including local, state, regional, and federal agencies. Over time, a relationship built on credibility and trust will emerge, facilitating the overall remediation process.

ADL describes proactive identification and initiation of remediation activities as intended in part to improve relationships with regulators by demonstrating responsible action to protect human health and the environment, but it is also indicative of managing environmental issues in general from a broader business perspective. Knowing the full extent of your organization's potential remediation liabilities allows improved long-term planning and resource allocation decisions. One potential downside to this strategy is the scenario in which remediation activities are initiated voluntarily by the firm, but the site needs to be revisited because of changes in regulations or standards.

ADL found that focusing remediation decisions on property reuse generally leads to more cost-effective and risk-based decisions regarding remedies. Best practice in this regard requires that reasonable options for future land use be defined early in the remediation process. Regulators and other stakeholders (those in the community and shareholders) must be brought into the process early.

The use of innovative technologies has the potential to reduce long-term costs associated with remediation activities, and improve their effectiveness. Since the current regulatory structure is not set up to facilitate the use of new technologies, the key is to work closely with regulators, building on a positive relationship.

Managing remediation activities as a business process is perhaps the most fundamental and important element of best practices, according to ADL. The notion is to move away from the purely technical or

regulatory-driven process toward one that contributes value to the company. A business perspective can be introduced into remediation management by ensuring that the remediation team includes personnel with general business experience. Viewing remediation as a value-added activity often involves generating cost reduction or avoiding costs through the use of innovative technologies and remedies that are more cost-effective for a given level of acceptable risk.

Others involved in remediation have advocated treating remediation as a business process.[8] The problem is that the traditional cleanup approach does not create shareholder value. A business approach to remediation would include using flexible contracting vehicles and terms and conditions, being responsive to customers, partnering with regulators and the community, treating risk as an "opportunity," and focusing on property redevelopment, reuse, and transfer considerations. In this interpretation, the business perspective requires the integration of the other elements of best practice.

ADL's last identified best practice is continuous improvement. This involves cumulative learning over time, capturing the experiences of both ongoing and completed remediation activities, and establishing a feedback process to ensure that past experience is disseminated and incorporated into the current process, as appropriate.

The ADL work identified other areas of concern in remediation management. These areas influence a company's ability to effectively implement the elements of best practices discussed above. These other areas include structuring remediation resources (managing external relationships and internal resources) and measuring quality and effectiveness (cost, performance, and communication of effectiveness).[9]

In the current best practice vernacular, there appears to be a growing consensus among leading firms that remediation is a process whose goal is systematic risk reduction. Best practice also includes engag-

[8]Gordon M. Davidson, presentation at the Federal Facility Cleanup Conference, Washington, D.C., May 1–3, 1996.

[9]Arthur D. Little, Inc., 1995, pp. 15–26.

ing employees to develop and apply innovative solutions through various reward and incentive structures.

These best practices in remediation management represent a change in perspective and culture that is fairly recent—within the last 5 to 10 years. The motivation for this change was the perception of rising costs and the need to develop more cost-effective strategies to regain some cost control. The change can be characterized as movement from a litigation-driven stance to a proactive management approach. The rationale for this change appears to be a recognition of some long-term benefits: improved regulatory and community relations, increased cost-effectiveness of remedies and value-added to the firm, and improved resource allocation through integration of remediation into the strategic planning process. Despite this economic rationale, the difficulty of changing established practices and organizations has meant that relatively few firms have made the change.

FRAMEWORK SUPPORTING CASE STUDIES

A synthesis of the available literature suggests a set of characteristics of a good program for management of remediation activities. These characteristics include

- flexibility to adapt to a changing environment (regulatory, economic, political conditions)
- explicit mechanisms for management control and oversight, as well as process improvement
- performance incentives for individuals and teams
- project and program manager accountability
- proactive identification and management of risks
- business focus (value-added, strategic action)
- management commitment and adequate provision of resources
- open and well-defined processes that accommodate stakeholder involvement.

These elements of best practices form the basis for the framework we use in the next two chapters to discuss the remediation program management case studies.

Chapter Four

CASE 1: REMEDIATION PROGRAM MANAGEMENT AT DUPONT

DuPont is a global research and technology company manufacturing products based on chemicals, polymers, fibers, and petroleum. Product markets include aerospace, agriculture, automotive, construction, electronics, packaging, refining, and transportation.[1] In 1994, DuPont had a net income of $2.7 billion on sales of $39.3 billion. The company has about 150 manufacturing facilities, 20 natural gas processing plants, and many product-handling and distribution facilities.[2]

DuPont's pollution prevention, compliance, and conservation-related activities are managed out of each business unit and the Safety, Health, and Environment Excellence Center. DuPont appears to have a strong corporate environmental ethic and a fairly comprehensive environmental policy. Remediation activities are managed separately through the Corporate Remediation Group (CRG). There appear to be limited links between remediation program management activities and pollution prevention and compliance activities.

The following description of DuPont's corporate environmental policy, practice, and performance draws mainly on publicly available information and secondary sources and is meant to provide context for the more thorough discussion of the company's remediation program. The discussion of DuPont's remediation program is based on

[1] *DuPont News Release,* Wilmington, Del., September 20, 1995.

[2] *DuPont 1994 Annual Report,* Wilmington, Del., p. 34.

interviews with company remediation program officials and documentation provided during these interviews. Of special interest are the company's overall risk-based remediation strategy, the introduction of business values into remediation program management, the use of risk assessment in regulatory interactions, and the overall structure and operation of the Corporate Remediation Group, which facilitates these other attributes.

DuPont's environmental remediation liability derives mostly from RCRA corrective actions. To date, Superfund accounts for only about 20–25 percent of total liability (costs). There are 55 RCRA corrective action sites, and these receive the most management attention and resources. DuPont has been identified as a PRP at 77 NPL sites and faces potential liability greater than $1 million at 20 of these, with 3 to 4 posing significantly larger potential liability. DuPont incurs liability at approximately 180 other locations including state sites, orphan sites (acquired in the past), indemnification to owner of property sold by DuPont, and former explosive manufacturing facilities.

CORPORATE ENVIRONMENTAL POLICY AND PRACTICE

Prior to the mid 1980s, DuPont's environmental practices were characterized by policy that focused on, as a minimum, legal compliance; the company did not focus on more-proactive positions and practices to go beyond compliance until the late 1980s. After a 1989 public announcement in which the chief executive officer (CEO) claimed the title of "chief environmental officer," DuPont established specific goals in areas of waste minimization, pollution prevention, product stewardship, stakeholder interactions, and management compensation. These corporate goals are sometimes supplemented by more-specific goals adopted by the business units to better reflect their products and processes. An Environmental Leadership Council was formed, composed of senior vice presidents from staff functions and business units, to set policy, review performance, and facilitate change.

"It is the company's policy to comply fully with or exceed all legal requirements worldwide."[3] Today, many voluntary programs are in

[3] *DuPont 1994 Annual Report*, Wilmington, Del., p. 34.

place to minimize environmental risks from business operations. DuPont's corporate environmental policy[4] includes adherence to the highest standards of business operations and environmental protection; goals of zero waste discharges and zero injuries and illness; efficient use of resources; habitat conservation; continuous improvement of practices, processes, and products; open public discussion; input to public policymaking; management and employee commitment; and accountability. This latter element includes allocating adequate resources to meet the other substantive elements of the corporate policy.[5] Long-term policy objectives include the full integration of safety, health, and environment (SHE) concerns into business operations and building partnerships with stakeholders. A new "Safety, Health, and Environment Commitment" was adopted in 1994 and extends DuPont's zero injuries and illness standard to environmental issues.[6] By the end of 1995, DuPont expected to have implemented all management practices based on the Chemical Manufacturers Association's (CMA) Responsible Care program in areas of pollution prevention, employee safety, process safety, community awareness, and emergency response.[7] Product stewardship, the newest and most comprehensive element of Responsible Care, and international implementation lag somewhat.[8]

DuPont has published a set of corporate positions on 10 environmental issues.[9] In general, these positions suggest a proactive firm with a strong environmental ethic and a clear preference for risk-based decisionmaking to ensure the cost-effective use of scarce re-

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[4]The latest version, dated July 1994, replaced the November 1971 policy. Bill McEnroe, Manager, Safety, Health, and Environment (SHE) Information Management, DuPont, presentation at EMIS conference, April 16–19, 1996.

[5]*DuPont, Safety, Health, and the Environment 1995 Progress Report,* Wilmington, Del., p. 5.

[6]*DuPont 1994 Annual Report,* Wilmington, Del., p. 3.

[7]CMA adopted a program to improve environmental performance of member companies after a series of accidents in the late 1980s. The initiative was called Responsible Care and was intended to both change industry's decision processes and improve environmental performance. See Lois Ember, *Chemical and Engineering News,* May 29, 1995, pp. 10–17.

[8]*DuPont Safety, Health, and the Environment 1995 Progress Report,* Wilmington, Del., p. 8.

[9]*DuPont Views,* Wilmington, Del., 1996.

sources. DuPont advocates flexible regulatory regimes tied to specific risk-based standards. DuPont's belief that risk-based decision-making and flexible regulatory regimes lead to cost-effective solutions is also reflected in its remediation program.

Compliance and voluntary programs pose significant costs (see Table 1). About $400 million was spent in 1994 on environmentally related capital expenditures. Further significant capital expenditures are expected for solid and hazardous waste treatment, storage, and disposal (TSD) facilities and for compliance with the 1990 Clean Air Act Amendments. Estimated pretax environmental expenditures charged to current business operations totaled about $950 million in 1994, down from $1 billion in 1993. This includes remediation accruals. About 75 percent of total expenditures are related to U.S. operations.

Toxic reporting inventory (TRI) waste is down 27 percent from 1991. The recent delisting of hydrochloric acid and ammonium ion wastes will result in 1996 TRI reportable wastes of less than one-fourth of 1991 figures. Deepwell disposal waste is the largest contributor to DuPont's TRI waste.[10,11] The company believes that "class 1" underground injection in the appropriate geological formations

Table 1

DuPont Environmental Expenses (millions of then-year dollars)

	1991	1992	1993	1994
Total Pretax costs	900	900	1,000	950
Accrual for remediation	130	160	183	185
Expenditures for previously accrued activities	91	121	126	91
Accrued balance for future years	426	465	522	616

SOURCE: *DuPont Safety, Health, and the Environment 1995 Progress Report,* Wilmington, Del., p. 18.

[10] *DuPont News Release,* Wilmington, Del., December 11, 1995.

[11] EPA, Texas Natural Resource Conservation Commission, Louisiana Department of Environmental Quality, and Ohio EPA all advocate that deepwell disposal waste not be included in TRI since it misleads the public and is not a release to the environment. To obtain an EPA underground injection permit, the owner must show that there will be no release to shallow water acquifers in 10,000 years.

(typically 1–2 miles below the earth's surface) is the safest disposal practice for some waste streams. For the 17 chemicals tracked in EPA's "33/50" program, emissions have been reduced 58 percent, surpassing the 1995 reduction goal of 50 percent.[12]

DuPont has conducted four independent evaluations of the company's Environmental Audit Program, managed by the Safety, Health, and Environment Excellence Center. The most recent audit, conducted by Environmental Resources Management, Inc., concluded that DuPont's program is "generally consistent with and, in some cases, exceeds expectations of the established criteria." The program was evaluated against the International Standardization Organization (ISO) 14,000 environmental audit program guidelines, EPA criteria, and generally accepted audit standards and practices.

REMEDIATION PROGRAM POLICY AND PHILOSOPHY[13]

DuPont has a formal centralized program for managing remediation activities in a way that reflects corporate culture, business philosophy, and environmental policy. The remediation program has identifiable and distinct goals and processes. The basic emphasis is to add value to the corporation or at least minimize costs for the same effectiveness.

Corporate remediation policy is

> to be protective of human health and the environment, to be proactive where a plume may impact neighbors' property, to use risk assessment to assist in determining remedies and to advocate containment strategies wherever appropriate.[14]

Formally, DuPont's position on site remediation reads as follows:

> DuPont is involved in treating various sites as a present or former owner/operator or as one of a number of multi-party users of a site.

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[12]*DuPont Safety, Health, and the Environment 1995 Progress Report,* Wilmington, Del.

[13]In the following discussion, a "site" is composed of one or more solid waste management units as specified by regulations. A site is roughly equivalent to a DoD installation as a unit of analysis.

[14]DuPont, letter attachment, Wilmington, Del., August 23, 1994.

> In addition, DuPont may provide site remediation services through its wholly-owned subsidiary, DuPont Environmental Remediation Services.
>
> As part of the company's Commitment to Safety, Health, and the Environment, DuPont is dedicated to the protection of human health and the environment. The company emphasizes risk assessment methodology to guide the choice of remedy and is proactive where a site may have a contaminant situation harmful to human health and/or property value. In evaluating the remedy, DuPont seeks cost-effective containment systems to eliminate risk to human health and the environment. Source destruction or complete removal is rarely feasible, but is used where risk cannot be completely eliminated.
>
> DuPont continues to research better and more cost-effective remediation technologies, including in-ground destruction approaches such as bioremediation and bioventing, and above ground treatment such as soil washing.
>
> The company maintains an ongoing dialogue with the regulatory community and encourages cooperation among multi-stakeholder groups to effectively remedy sites.[15]

Interestingly, DuPont's remediation policy is not formally reviewed and approved by corporate management. However, the approach developed over the last several years appears to have been generally accepted throughout the corporation. The following are the elements of this [unofficial] policy:

- Protect human health and the environment.
- Develop cooperative relationships with regulators, not adversarial relationships.
- Be proactive where the risk is urgent.
- Emphasize risk-assessment methods to drive remedy selection.

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[15] *DuPont Views*, Wilmington, Del., 1996.

- Recognize that there are not enough dollars to achieve pristine conditions. Rather, move toward cost-effective containment where destruction or removal is not technically feasible or is extremely expensive.
- Develop lower-cost, effective remediation strategies.

In practice, this means developing reasonable cost-effective solutions, most often including some form of containment strategy.

Remediation activities intended for property redevelopment or transfer imply a different set of policy guidelines tied more to future use and liability concerns. Containment is typically not a viable strategy, in and of itself, for redevelopment of property that will be sold. The focus of the remediation strategy for these sites is to obtain a "no further action" required notice. With respect to sites that can be redeveloped, DuPont gets a regulatory release from further liability. If a site is transferred under regulations that apply generic standards, future use can be unrestricted. If it is transferred under regulations based on a risk assessment, deed restrictions are required to avoid practices that could increase the risk beyond that which cleared DuPont. Until DuPont gets regulatory relief from future liability, DuPont will not sell a site. It will lease it for long-term use. Such leases carefully limit site use to avoid any further problems. DuPont retains control over all future regulatory work on sites that it owns and leases out.

MANAGEMENT STRUCTURE AND RESPONSIBILITIES

The Corporate Remediation Group has full responsibility for remediation activities within DuPont. CRG is not part of DuPont's safety, health, and environment function, but rather is a distinct functional cost center. The CRG director reports to a business unit director, primarily for administrative purposes. Rising remediation costs and discontinued businesses justified creating a separate unit to control costs. Prior to this, operating business units handled their own remediation.

The CRG was established in 1992 and is composed of three organizations, each with specific responsibilities:[16]

- Remediation program managers (RPMs) are responsible for resource allocation and financial management, compliance strategy development, interactions with regulators, and program oversight. The RPM group consists of 11 RPMs, each responsible for a region roughly corresponding to EPA's 10 administrative regions, with two addressing remediation outside the United States. The RPMs report to the director of Remediation Programs. They are the business element of the CRG.
- Core Resources (CR) is responsible for technology development, technical support, risk assessment, and legislation/regulatory policy advocacy support. This group currently has a staff of 17.
- DuPont Environmental Remediation Services (DERS) is a wholly owned subsidiary responsible for project execution, including project management, studies and analyses, technical consulting, risk assessment, design, and construction management. DERS is currently in transition because the decision has been made to exit the broader market and to concentrate on managing DuPont's remediation liabilities.

Personnel in these groups spend their full time addressing remediation issues falling under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), RCRA, and similar state laws. Project management is conducted through teams that include representatives from all three groups. CRG accepts cost responsibility only for wastes that were generated and disposed of prior to 1990 (when DuPont's Groundwater Protection Policy was established). Business units are responsible for remediation costs caused by more-recent releases although they should work with CRG resources to correct the situation. Personnel from corporate legal, engineering, research and development (R&D), and financial functions supplement CRG resources as needed.

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[16]Briefing charts from DuPont, March 14, 1996. [There is a fourth group, Conoco Environmental Services Division, which appears to provide capabilities similar to DuPont Environmental Remediation Services for Conoco.]

Prior to 1992, the Legal Department, the Engineering Department, and individual plant sites/businesses typically were responsible for implementation and costs. The emphasis was on technical solutions negotiated with state and/or EPA officials without the benefit of detailed risk assessments. The business side, which paid the bills, had little expertise in remediation and generally did not question the program strategy and costs. There was no provision for documenting and transferring lessons learned across projects or business units.

The CRG was established because DuPont management observed steeply rising remediation costs (up to $170 million for 1992), projections of those costs suggested significant future expenses (fear that costs could double), and DuPont lacked sufficient business focus in managing the remediation process.[17] Management of the remediation program was very diffuse. Remediation management was frequently conducted by site SHE managers with limited experience in remediation, and the basis for decisionmaking was highly variable and sometimes inconsistent throughout the company. As such, the remediation program offered significant opportunity for optimization to yield more-consistent and cost-effective solutions.

The senior business management saw problems in this early management structure:

- Lack of definition of DuPont's responsibilities for environmental excellence in remediation.
- Inadequate integrated management of DuPont's remediation liability to ensure consistent protection of human health and the environment using risk-based, cost-effective approaches.
- Diffuse responsibility for remediation within DuPont.
- Poor integration of the disciplines/skills needed to address remediation issues.
- Difficulty tracking all costs of remediation on a regular basis.
- Contractors making recommendations and decisions without guidance from an overall vision from DuPont.

[17]A general rule of thumb says that DuPont requires about $1.5 billion in sales to generate enough revenues to cover $150 million in remediation costs.

- Poor communication of lessons learned within DuPont.

In 1991, a centralized approach embodied in what became CRG was proposed. Some members of the line business expressed concern they could lose control over their operations and community relations for which they would still be held responsible. CRG came into being in 1992. In the same year, DERS was reoriented to focus mainly on internal business.

CRG's inception was due to a number of perceived benefits over the previous, more-decentralized structure:

- Management could achieve more-consistent protection of human health and the environment.
- Overall business leadership could be provided and cost accountability clearly defined.
- Overall strategies and tactics could be developed into best practices.
- Superfund PRP procedures could be optimized using teams with business, technical, and legal representatives.
- Legal would have a defined client.
- Project authorization could be formalized and standardized.
- Better input to prioritize technical programs toward real DuPont issues could be provided.
- Allocation of costs among business units could be established so that more-predictable and less-variable costs would hit the business bottom line on a year-to-year basis.

The CRG was given total responsibility for remediation within DuPont. As a "business" unit, CRG's function was to centralize liability and cost accounting, develop and coordinate more cost-effective remediation strategies, and provide a business perspective to remediation management. CRG was also tasked with developing an internal cost/liability allocation procedure. DERS was included as part of the CRG with an in-house focus.

CRG has two key customers, broadly defined, each with different interests. Regulators, as a surrogate for the public, are one critical

customer, and much of CRG's activities are oriented toward satisfying and interacting with regulators. DuPont itself is also an important customer, and obviously, cost is a significant business factor. Thus, the CRG's task is to balance regulatory compliance and cost-effective remedial actions that protect human health and the environment.

With the creation of the CRG, DuPont business units no longer have direct remediation responsibility. However, since remediation activities occur at a plant site, and because the plant manager is responsible for community relations, plant representatives are included on project remediation-management teams. Rather than financial or technical support, the concern here is assurance that the community supports remedial decisions.

DuPont differentiates between remediation *program* management and remediation *project* management. The program manager is responsible for team organization, strategy development, and financial management. The project manager works toward a well-defined tactical outcome (defined by the strategy). There is no direct report authority between the remediation project manager and the DERS project manager.

Reporting to senior management is via periodic status updates written by the director of corporate remediation programs. These updates include accomplishments, projections, and key issues. There have been several reviews at the board-of-director level for the Environmental Policy Committee.

As intended, the CRG structure results in a highly centralized remediation program. General strategy development, policy formulation, and allocation of dollars occur centrally. However, considerable implementation flexibility is given to the regional RPMs. It is management's role to hire high-quality people, train them, provide guidance, and then allow their good judgment to be used.

The remediation project management team for an operating site (under RCRA corrective action) includes a site coordinator (plant representative), a DERS project manager, an attorney from the Legal Department, and the RPM for that region. The management team differs substantially for Superfund sites: It generally does not have a site coordinator, for lack of DuPont presence, but, for larger sites, has

a member from CR. While the composition of the two types of teams implies somewhat different approaches, the overall responsibilities of the two types of teams are the same: Develop the strategy for site investigation, develop proposed remedies that are protective and comply with applicable rules, and negotiate with the regulators.[18]

Plant managers collocated with CERCLA and RCRA sites have three responsibilities.[19] The first is to ensure that the plant complies with all applicable laws and regulations. Hence, CRG has to keep the plant manager satisfied about its remediation approach. This is the responsibility of the DERS project manager at each site. The second is to keep their employees focused on the corporate goals. In this case, that means reenforcing the corporate position that remediation policy is now a central and not a business-unit responsibility. The last is to communicate with and listen to the community regarding DuPont policy—both local and corporate policy. Even if the policy responsibility migrates to the corporate level, a local plant manager remains DuPont's principal source of information about the community and maintains DuPont's relationship with the community.

Remediation Program Managers

DuPont's RPMs form the critical link between its environmental decisionmaking and core corporate goals.

RPMs bring the perspective of business people to CRG to integrate remediation with the rest of the company. Its members come from nonremediation backgrounds in the business units of DuPont and typically have over 20 years of experience. RPMs have final responsibility to allocate resources and make decisions, and they rely on the other parts of CRG for support. Their business background is meant in part to give the business units confidence and make it easier for them to give up control to the CRG. In practice, the business per-

[18]"Corporate Remediation Group (CRG) Overview," December 29, 1994, DuPont internal memo, Wilmington, Del.

[19]Note that managers remain responsible [and liable] for other environmental issues. Wastewater, waste management (including pollution prevention), air pollution management, and community relations are the other main areas.

spective translates to concepts of protective, risk-based, and cost-effective remediation strategies.

RPMs are required to "add value" to the company, in general, and to remediation activities, in particular. The notion of "adding value" with respect to the RPM function includes interpreting corporate policy, ensuring effective communication both internally and externally, using judgment to speed response times to deal with urgent risks, emphasizing cost-effectiveness and cost control, and negotiating with regulators to achieve risk-based, cost-effective remedies protective of the public and environment.[20]

Specific responsibilities of the RPMs include ensuring that each site has an effective, interdisciplinary remediation team; ensuring that the team develops cost-effective strategies consistent with corporate and regulatory policy and includes use of best practices and innovative technologies and technical approaches; leading teams in regulatory interactions; questioning overly conservative or outdated assumptions that lead to excess costs; and representing DuPont business interests in remediation activities.

RPMs generally stay out of the technical details of project management. Only for the largest sites, where an RPM oversees a very small number of remediation projects, do RPMs get involved in technical details. Each RPM is involved in up to 20 sites. Best use of their time is to ensure that strategies are developed, tactics are implemented, and cost factors are considered. They rarely have the time to become immersed in the finer technical nuances unless these are vital to strategy.

In the end, RPMs are judged on problem-solving performance and effective cost management.

Core Resources

Core Resources has a mix of responsibilities related to technical and regulatory expertise. CR is responsible for developing technologies specific to DuPont's needs. CR members enter into partnerships

[20]Briefing charts from DuPont, Wilmington, Del., March 14, 1996.

with government, academic, research, and other private-sector organizations (including other chemical industry firms) to leverage knowledge and technology resources. In general, CR's technology-development efforts are oriented at how to cost-effectively reduce risk.

CR's work is conducted predominantly through technology and advocacy teams. Technology teams are tasked to maintain a strong competency in their technology area, advocate preferred technology to regulators, and transfer technology to DERS project managers and other staff. The teams are interdisciplinary and cross-functional, including members from relevant CRG and other DuPont organizations (e.g., R&D, Engineering, Conoco). There are currently five technology teams:

- Bioremediation.
- Containment and transport modeling.
- In situ treatment.
- Pump and treat.
- Soil processing.

CR's technology-development work is not considered to be R&D by the CR personnel. Rather, it is much more applied research focused on specific DuPont remediation needs. Because of DuPont's emphasis on risk-based solutions, technology development and application focus on technologies that contribute to containment, stabilization/solidification, permeable reactive barriers, impermeable barrier improvement, pumping and treating, soil washing, bioremediation, and bioattenuation.

DuPont participates in the Remediation Technology Development Forum (RTDF), which includes both government (EPA, DoE, DoD) and other private-sector firms (e.g., Monsanto, GE, Dow). There are several specific development and demonstration projects under way through this partnership program. Results are disseminated among the partners and can be used at no cost to participants. Other non-partner organizations need to license the technology to be able to use it. Licenses are held by the RTDF group that developed the technology.

As an example, one of the partnerships DuPont is participating in is an RTDF Intrinsic Remediation Project at Dover Air Force Base (AFB). The group includes representatives from DuPont, Dow, Monsanto, Zeneca, Ciba-Geigy, General Electric, the U.S. Air Force, EPA, and DoE. The study, which began in February 1995, combines field and laboratory research on intrinsic remediation for a plume at Dover AFB. The study goals are to determine whether the contaminants are being destroyed at the site through bioremediation processes, identify the degradation mechanisms, and develop protocols for implementing intrinsic remediation at other sites.[21] This particular RTDF project illustrates two important aspects of DuPont's remediation program: forming partnerships to leverage resources and investing in research to support acceptance of more cost-effective, risk-based strategies.

A companion internal paper on intrinsic remediation concludes that for an example site, intrinsic remediation could lead to a cost savings of $1.2 million over the simplest pump and treat system.[22] For the two remedies in this example, the up-front investigation costs are assumed to be the same; the incremental cost of intrinsic remediation above the investigative costs is $100,000. DuPont has also surveyed over 50 of its own RCRA and CERCLA sites to gather evidence that bioremediation is in fact taking place. DuPont concludes that intrinsic remediation is a viable remedy under certain conditions and represents substantial avoided costs at no increase in risk if applied properly.

One of the more important functions and values of the technology teams is technical advocacy to get acceptance of more cost-effective remedies. Technical advocacy includes working with regulators to develop good science that can be translated into regulatory guidance.

The CRG has a formal advocacy program and team. Several CR staff are the main points of contact working with the Legal Department, External Affairs, and plant representatives. The focus of the advocacy program is to achieve (at both the state and federal level) leg-

[21]Ellis et al., undated.

[22]Ellis, undated. The savings assumes a 12 percent discount rate, 3 percent inflation, and a 30-year time horizon.

islative and regulatory provisions for remedies based on site-specific factors and risk. Risk is roughly defined as exposure to hazard that might harm human health or the environment. Individuals are developed as leaders in specific advocacy areas (e.g., Superfund reform, RCRA corrective action, human health risks, or ecological risk). Within the states, the effort is carried out in conjunction with State Chemical Industry Councils. At the federal level, work is conducted directly with EPA or through CMA and broader business coalitions.

DuPont Environmental Remediation Services

As the overall program leaders, the RPMs work closely with DERS project teams. DERS managers and scientists serve on teams developing the strategies. Through project management activities, DERS is responsible for executing the vision/strategy that RPMs develop at individual sites. It develops the details handed off to outside contractors for final execution. It also supports negotiation efforts with regulators. This alignment of a wholly owned subsidiary (as DERS is) is important in enhancing the outcome of negotiations. Even if this alignment entails higher costs than using an external source, the major portion of costs that will be incurred is determined by the up-front strategic direction rather than in the final execution of a remedy. DuPont has concluded that "front-end loading" during the planning stage will lead to the right outcome with the regulator and public and also to the right design for implementation. Having a captive resource group gives DuPont the management discipline that it could not get in the external market, making this internal provision preferable.

DuPont decided in June 1996 to focus DERS on in-house remediation services, thus exiting the external market place. The external market was determined to be too competitive and in a high state of flux. The decision resulted in a downsizing of the DERS organization from 300+ to about 160 employees. The main advantage of an in-house remediation service provider is the alignment with corporate objectives and strategy. In some cases, external consultants too often focus on billable hours; thus costs can increase significantly even when the hourly rate appears competitive. DERS performs essentially a technical consultant function, including studies and analyses, field tests and site characterization, remedy design, and procurement of

materials and services. The organization does not actually execute remedial actions, but rather acts as DuPont's project management organization, with substantial technical capability. DERS is fully responsible for up-front remedial design.

Legal Function

At DuPont, the legal "function" reports to the General Counsel. CRG and RPMs are important clients for the Legal Department: About 50 percent of the corporate environmental legal staff work on CRG-related issues (the equivalent of four full-time lawyers).

The legal function in support of remediation assists in interpreting laws and regulations and applying regulatory expertise in project negotiations. Legal staff attempt to be sensitive about how the regulations are implemented and to be more proactive and risk-based in compliance. In other words, legal staff search for opportunities and support the push for more-reasonable (risk-based) remedies. Being sensitive to the EPA site manager, for instance, requires awareness of his or her needs and the pressures influencing those needs and his or her behavior. DuPont attempts to demonstrate consistent credibility in its interactions with the regulatory community, including consistent follow-through on promises or commitments.

Even after initial agreements have been completed, the legal group helps DuPont remain active in the process to continually improve the remedy selection/design to be more cost-effective. This includes the value engineering process after a ROD is signed. Corresponding to DuPont's basic strategy, the idea is to make use of the uncertainty inherent in remediation to assure cost-effectiveness.

PROCESSES AND IMPLEMENTATION

A significant culture change began about five years ago with the creation of the CRG. The new culture emphasized identifying environmental liabilities and then managing those liabilities through cost-effective, risk-based strategies. This change was fairly significant, in terms of both the allocation of responsibilities and associated incentives facing key managers and corporate culture in general. This

change appears to have been successful. The following paragraphs describe the keys to the success of the change to the CRG process.

One key change in achieving acceptance by the business units was the shift in **budgeting responsibility** for remediation. In the past, each locale and related business unit budgeted for remediation of its own facilities. In 1992, CRG assumed responsibility for these costs. The variable component of a manager's compensation accounts for a significant portion of total compensation and reflects both corporatewide and business-unit performance. When budgeting responsibility is shifted from business units to the corporation, the effects of remediation performance on total corporate performance become remote enough that local managers are expected to and generally do focus their attention on the activities in the business unit that are within their control to affect and thus improve business results.

CRG experienced some resistance during the transition to this new system. Loss of control by plant management was an issue at three or four locations. Some had vested personal interests in the remedies they had chosen and had difficulty relinquishing control. Why did the views of these local managers continue to matter to them even after the shift in responsibility and budget to CRG? DuPont has a tradition of consensus management that discourages managers from pushing issues to higher levels for resolution. Managers are expected to work out local solutions among themselves, and it was likely difficult for some managers to relinquish this control.

The second key change was identifying an **experienced program manager** who grew up on the business side but who also had plant and a technical background and who would be held accountable for bringing DuPont's core values into the remediation arena. The core business experience, the seniority, and the values used to judge performance are important, both to the business units and to the CRG, in setting up and executing a new kind of approach. Perseverance and creativity are valued attributes of a good RPM, as are problem solving and a willingness to challenge conventional wisdom to implement solutions.[23] RPMs must feel comfortable with uncertainty

[23]CRG values a good negotiator, but notes the differences between traditional business negotiation and negotiation with a regulator. In business negotiation, either party can always step away, so mutual agreements are the only kind that survive nego-

and with problems that are not well defined—those "without boundaries." They must understand the cost of capital and the time value of money.

A third key has been letting the **scientists** in Core Resources focus on what they love—technology issues—rather than on trying to work the whole range of issues as they did before the CRG was formed. CR staff clearly revel in the technological issues that tend to dominate the literature on remediation. However, any technology work must not lose sight of DuPont's core remediation concerns.

A fourth key has been **working closely with lawyers on firm negotiations.** The first information the decisionmaker needs is a clear statement of what has to be done. More often than not, there is room to negotiate.

CRG appears to operate under the following set of principles:

- DuPont is an ethical company and wants to be perceived as an ethical company. It places a high value on human life and health and the environment and will do what is required to protect these.
- DuPont will execute its ethical responsibilities in a cost-effective manner. To the full extent possible, it will rely on scientific evidence to identify the effects of its actions and choose among the options that assure protecting human health and the environment most cost-effectively.
- DuPont will comply with applicable regulations, but it will not be passive about regulation. DuPont will strive to educate regulators and the public about the costs of alternatives and be as aggressive as possible about scientific evidence and cost-effectiveness during the formation and implementation of regulations.
- DuPont values creativity and perseverance in the personnel who implement its environmental policy. It values close interaction with regulators and the public at large to make its case. This is what it means by being proactive.

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tiation. In regulatory negotiation, the regulator will not—and cannot—go away. This calls for different skills, but CRG still wants RPMs who learned their negotiation skills in business, not regulation.

These operating principles clearly reflect DuPont's remediation policy and strategy.

The following are corollaries of these principles:

- Do not expect EPA to consider cost a high priority. In CERCLA actions, work with EPA closely throughout the process so that real risks are addressed and the most cost-effective equally protective remedy is chosen. Where DuPont has a large stake, get a DuPont representative in a leadership role and support that representative with scientific facts and risk analysis.
- Take steps to avoid creating a future liability for DuPont. These include, but are not limited to,
  - Immediately cleaning up spills
  - Dealing with groundwater plumes that might move off-site
  - Using best practices to protect groundwater, such as use of secondary containment where appropriate
  - Avoiding sending hazardous waste to any landfill that does not meet strict internal guidelines for design, compliance, and management
  - Not selling property that is contaminated because DuPont could be responsible for a remedy or exposure but not be in control of remedy selection or access.
- Be willing to press EPA into identifying all responsible parties. Be willing, if necessary, to sue all identified PRPs. Examine all available records to help establish shares. Encourage use of arbitration to establish cost allocations. DuPont's status as both a technology leader and a financially secure party gives it leverage as well as liability.
- Stay focused on the big money. Getting the right remedy is far more important than arguing the details about retroactive liability. In the long run, the best strategy is to keep the total cost down for all responsible parties.
- Insist on using realistic scientific evidence and reasonable assumptions in developing risk assessments. Collect the information you need to make your case. The CRG's view is if DuPont

has a contamination problem and it could cause a risk to human health and the environment, it needs to know about it. Current analytical data and strong transport and fate models help in defining risk.

- As long as no threat to life, health, or environment develops, and the other considerations above are covered, let the regulators dictate the timetable. Do not rush to remedies until the site is adequately understood. In some cases, it may make more sense to demonstrate the applicability of innovative technology.
- Do not encourage contractors to overdevelop work plans. This can lead to higher costs immediately and in the future. A contractor should not be judged unfavorably merely because EPA returns the work plan with a notice of deficiencies (NoDs). In fact, it may be a positive sign that the contractor is seeking a better remedy.
- Never give up if you feel that the regulator has taken an unjustified position. Good science combined with persistence pays off in the long run.

DuPont does not explicitly prioritize across sites or facilities, except by addressing any site that presents an immediate unacceptable risk. Sites are managed holistically, with some resource and emphasis trade-offs among waste units at a given site. The basic remediation policy is "no risk to health or property." Risks are clearly defined through risk assessments. Implementation of the policy has two parts:

1. The goal is for no plume to go off-site. Priority actions are taken to achieve this goal. In those few instances where a plume may already be off-site, DuPont takes immediate action to eliminate or substantially reduce any harm to human health or the environment.
2. Use risk-based in situ treatment and containment. This step is intended to fully contain the waste to DuPont property, with no risk off-site. This is where cost-effectiveness plays a key role in selecting the preferred remedy, but again, the risk assessment helps define the ability of alternative remedies to achieve the desired risk reduction.

The protocol is fairly clear, given the overall remediation strategy. Address off-site waste first, address waste units with the potential to release or migrate off-site next, and contain wastes from all units to within the site. DuPont does not have a strict budget for remediation activities. Rather, cost/expenditure projections are made based on the need to address urgent risks (off-site plumes) and comply with regulations.

Time generally is not as critical a factor in remediation processes after action has been taken to ensure the protection of health and the environment. A strategy to get remediation completed in a short time frame will not work well since the process is too complex and the result tends toward expensive treatment remedies rather than the more cost-effective risk-based strategies DuPont prefers.

DuPont's business necessarily includes the use of a variety of chemicals. However, it seeks to eliminate all leaks to the environment and works toward the goal of "zero" waste generation. CRG's role is limited to historic releases, and CRG is not involved in site management where line management is charged with eliminating releases. Each plant retains responsibility for the management of all solid wastes associated with ongoing activities. Under RCRA remediation of any spills after 1992, the plants/businesses have incentive to avoid spills from ongoing operations.

PERFORMANCE MEASUREMENT

DuPont does not have a "micro"-level view of remediation performance metrics. No performance metrics are used to track progress, status, or risk. Metrics are all aggregate:

- "All sites contained." This corresponds to the goal of ensuring that no plume leaves DuPont property.
- Dollars spent. The goal is to drive costs down over the long run as Superfund and RCRA corrective-action programs run their course.
- Avoided cost. This is the primary metric and is measured at the DERS project level, although all team members may contribute to identifying a lower-cost solution.

In general, there are few metrics used to make remediation-related trade-offs among remedy, investment, or resource-allocation cost decisions. On occasion, the up-front cost of removing a source versus the cost of containment will be compared on a present value basis using DuPont's cost of capital as a discount factor. Remediation is not a black and white process. It involves quality people using their judgment working toward accepted goals.

Only two metrics were identified as useful in measuring program performance:

- Number of sites where containment has not been achieved. Containment has been achieved at all but two and both are getting close attention.
- Spending on remediation. However, as mentioned several times earlier, DuPont's primary goal is to protect human health and the environment in a cost-effective manner.

REGULATORY AND COMMUNITY INTERACTIONS

Interacting with regulators at all levels is a critical element of DuPont's remediation strategy. The notion is to "push for reasonableness." DuPont recognizes that some regulatory project managers are inexperienced. Therefore, DuPont accepts the responsibility of working closely with EPA and other regulators on technical matters and challenging the assumptions that drive regulatory decisions. DuPont seeks to educate the regulators on the real risk present at a site and sometimes, on a non-site-specific basis, provides seminars on the efficacy of innovative remedial options.

Negotiating with regulators is characterized by the observation that the negotiating parties do not have equal standing. DuPont "can't walk away" from the negotiations if it does not agree with the regulations or does not like the way the regulations are implemented. Thus, DuPont will invest in up-front activities—good science, analyses, risk assessment—as leverage to use with regulators. In some cases, DuPont will "overinvestigate" sites to demonstrate a more cost-effective, risk-based remedy.

Our discussions with DuPont appeared to reflect an implicit understanding that CERCLA and RCRA environments are quite different. RCRA is more important to DuPont than CERCLA, and RCRA offers more flexibility. CERCLA's strong preference for permanence and treatment and the need to meet applicable or relevant and appropriate requirements (ARARs) contribute to the drive toward more-extreme and cost-ineffective remedies than does RCRA. Even when the CERCLA process includes a good risk assessment, that seldom is the basis for the remedy decision. RCRA has more-inherent flexibility, allows negotiation, and has a more flexible, less sequential process. RCRA can be interpreted to allow risk-based decisions. For example, plants typically have interim measures in place to manage groundwater contamination on DuPont property. Each measure requires a permit under RCRA, but DuPont retains a great deal of discretion about how to manage groundwater plumes as long as they do not leave DuPont property.[24]

Despite acknowledged differences in regulatory regimes, the same regulatory compliance approach is applied to both RCRA and CERCLA. The main difference is that under RCRA, DuPont is usually solely liable. Under CERCLA, DuPont is usually only one of many PRPs at a site.

DuPont's strategy for Superfund sites where it has a larger share of responsibility is to encourage leadership of the PRP technical steering committee by a Core Resources expert with a rational (risk-based) remedy. The DuPont RPM marshals necessary resources to defend DuPont's position so that it pays its fair share and does not subsidize other viable and responsible parties.

In some cases, an external affairs group helps with community/stakeholder participation. Community involvement includes education on science and risk. DuPont recognizes the need to be open, consistent, and patient. DuPont wants to create and retain an image of an ethical company and tasks its plant managers to communicate with neighbors and monitor community attitudes. Community involvement is high on some CERCLA sites, where neighbors

[24]RCRA is not the only consideration affecting DuPont's management of such plumes. Plumes that move off-site can cause community reaction. Even in the absence of RCRA, DuPont would try to maintain containment on-site.

are concerned about risks. Most of DuPont's sites fall under RCRA corrective actions, and problems are contained/limited to DuPont property.

The key to effective negotiation is credibility, and that is something DuPont tries to cultivate with both regulators and communities. Credibility involves intent, openness, expertise, and a demonstrated capability to follow through on promises. DuPont remediation managers attempt to achieve this credibility by working closely with their EPA/state counterparts. They try to be responsive and to avoid surprising the regulators and expect to be treated in a comparable manner.

COST AND FINANCIAL CONSIDERATIONS

Remediation liabilities are the costs associated with containing, treating, or removing contamination at properties with which DuPont is associated. Cost data are accumulated by project, and total corporate spending is documented and tracked centrally. Unit cost trend analysis is not formally done, although cost information is captured in a database to help estimate future projects more successfully.

DuPont accrues reserves for both CERCLA and RCRA remediation activities "when it is probable that a liability has been incurred and reasonable estimates can be made." Accrued liabilities are not discounted and, except when calculating shares at Superfund sites, do not include potential recovery from third parties. The company accrued $185 million in 1994 for remediation activities, $183 million in 1993, and $160 million in 1992. About 75 percent of the accrual is related to RCRA and 25 percent to CERCLA-related liabilities. Expenditures for previously accrued remediation activities were $91 million in 1994, $126 million in 1993, and $121 million in 1992 (see Table 2). In general, environmental remediation costs are charged to expense. Environmental costs are capitalized if costs increase the value of the property and/or mitigate or prevent pollution from future operations.[25]

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[25] *DuPont 1994 Annual Report,* Wilmington, Del., p. 44.

Table 2

DuPont Annual Expenditures Related to Remediation Activities (in millions of then-year dollars)

Remediation Expenditures	1991	1992	1993	1994
RCRA		103	90	70
CERCLA		18	36	21
Total	91	121	126	91

SOURCE: *DuPont 1994 Annual Report,* Wilmington, Del., pp. 34–35.; *DuPont Safety, Health, and the Environment 1995 Progress Report,* Wilmington, Del., p. 18.

Potential RCRA- and CERCLA-related liabilities are subject to uncertainty due to the complex process of generating estimates. Remediation activities occur over a relatively long time horizon, and costs vary across sites because of site characteristics, new remediation technologies, and the changing regulatory framework. DuPont's estimating process is continuous and attempts to account for changes in technology, regulations, remediation phase, and site characteristics. Remediation activities are in progress at various stages at 145 sites, and liabilities have been resolved (through completion or de minimis settlements) at an additional 48 mostly non-owned multiparty Superfund sites. Liabilities under CERCLA cannot be precisely estimated because of the large number of PRPs involved at any particular site, the scarcity of reliable data at these sites, uncertainty about how laws and regulations will be applied at each site, and uncertainty surrounding remedy selection and technologies.

CRG finances remediation costs as follows. CRG projects expenses each year. The funds to support expenses are allocated by applying a formula that charges about 65 percent to overall corporate overhead and about 35 percent to the 19 individual business units. Business units pay a proportion determined by a study conducted before CRG was set up.[26] That study identified all known sites and projected the potential share of costs (liabilities) out to between 30 and 40 years. These judgments were crude, but they carried enough weight inside

[26]Proportion calculations are actually more complicated. An estimate of future liability for each plant site provides the basis for a corporate reserve. CRG can draw down or add to that corporate reserve each year to iron out differences between expected and actual costs over the course of a year. Periodic reviews with both internal and outside auditors are held to ensure that this process is managed properly.

the company to induce a change in organization. With a few minor exceptions, the proportional share of the total budget assumed by each business has not changed substantially since the original study was completed. This allocation removes any incentive for business units to attempt to micromanage remediation efforts.

DuPont levies a tax on the business units so that they will maintain some awareness that remediation costs money. The 65/35 split apparently forces business units to reflect some portion of the cost in their prices without making them uncompetitive relative to younger firms with smaller remediation liabilities. But what they pay is not related to actual expenditures at their sites in a given year, so they have no site-specific interest in the decisions CRG makes on remedies. Business units are truly paying for only their past actions.

There is also a difference between accruals and expenditure in any given year. Annual accruals are determined based on liability projections and a determination of whether to draw down or increase the corporate environmental liability reserve. Expenditures are projections of costs to be incurred that year. If a decision is made to draw down the total liability pool, then accrual might be lower than expenditures for that year, with the balance made up by withdrawing from the corporate reserve.

Federal Accounting Standards Board (FASB) guidelines allow the accrual reserve to be the low-end estimate of a range. The range is estimated for every site where liability is expected to be about $1 million or more. DuPont then adds some extra to cover both uncertainty and miscellaneous costs that arise from smaller liabilities. A formula is not used to develop most probable numbers or uncertainty values.

DuPont's ratio of remediation dollars to revenues is fairly low. In 1994, this ratio was 0.0040 ($91 million in remediation costs/$23 billion in revenue). DuPont uses this rough calculation to informally compare itself with other firms.

OTHER ELEMENTS

Risk Assessment

As noted above, risk-assessment lies at the heart of CRG's vision to present a scientifically based cost-effective solution. DuPont maintains a high level of risk-assessment capability oriented toward educating regulators on the real risk at a site. This is part of the "advocacy" concept in which DuPont actively pushes for risk-based containment or in situ treatment strategies. DuPont relies on risk-assessment professionals who meet quarterly to compare notes across the company. Such communication helps keep the CRG members informed about the business units. CRG has eight risk-assessment professionals and others who support them with models.

The purpose of DuPont's risk-assessment process is to challenge overly conservative assumptions that lead to needlessly expensive remedies and to introduce more-realistic assumptions to deal with the uncertainties of remediation. For instance, Monte Carlo techniques for dealing with uncertainty produce more-reasonable (cost-effective) and yet protective remedies. The ideal is to use risk assessment to select the least-cost remedy that achieves an agreed-upon risk level, given an agreed-upon protocol (assumptions underlying risk calculations and levels). Some states allow this type of process (e.g., Texas and New Jersey), others do not. This process implies that there is no valid "generic" risk standard application.

Underlying DuPont's philosophy on risk assessment is the notion that it is better to be proactive when using this approach. This aggressive stance has yielded fruit in Texas, where DuPont, in a key support role with the Chemical Industry Council, has been successful in persuading the state to adopt more-realistic regulations. Under the Texas approach, firms do one of three things: clean up a site to background contaminate levels, clean up a moderately large/complex site to agreed-upon generic state standards, or perform a risk assessment for a more complex site and choose a remedy based on the resulting understanding of the risks posed by the contaminants through available pathways to a receptor population. Most DuPont sites are complex and DuPont clearly prefers the latter.

Risk assessment is a core element of DuPont's remediation strategy. The basic notion is to consider risk the predominant factor in build-

ing the remediation strategy for a site. This includes examining all possible pathways for contaminant movement. Risk assessment and remedy selection are conducted as holistically as possible. To the extent possible, remedies are linked across media (migratory pathways) and within media across contaminant types (a single remedy addresses more than one contaminant). Risk assessment applies mainly to the second step of the two-part process:

1. Address groundwater plumes that could move off-site.
2. Execute a risk-based containment strategy for remaining on-site waste.

The risk-assessment process and products DuPont uses meet standard academic/peer review criteria for validity.

The risk-assessment process is used to organize data and facilitate decisionmaking. There are two elements to this. First, identify the nature of the risk. Is there a release? What kind? How much? How does it migrate? Second, determine the data needs in support of all stakeholder concerns and develop a data collection strategy. The process includes iterative data collection and sampling. The second element ensures corporatewide (or at least CRG-wide) coordination, reduces duplication, and reduces last-minute additions or add-ons.

When pursuing a formal risk assessment, DuPont considers any regulatory assumption fair game for a challenge, particularly if it is overly conservative.

For the most part, DuPont will challenge the assumptions underlying toxicity indices for a particular type of chemical in general, but not on a site-by-site basis. When regulators decide to modify the toxicity standards for a chemical, DuPont designates a "chemical leader" to provide input to EPA and other relevant agencies.

Focusing on transport and fate dramatically reduces the uncertainty associated with risk assessments. Reasonable uncertainties about toxicity are probably higher than those anywhere else in the system—often spanning three orders of magnitude. DuPont effectively compromises on such uncertainty, accepting the conservative 95th percentile estimates from EPA. The focus of risk assessments becomes the transport and fate of the contaminant and realistic expo-

sure scenarios for receptors (e.g., who is exposed and where the receptor is located). The risk assessment provides a mechanism, similar to sensitivity analysis, to challenge the assumptions underlying pathway mechanisms, receptor behavior, etc.

Information Systems

DuPont uses a database to characterize solid waste management units (SWMUs) and "areas of concern" (AOCs). These are identified at plant sites under the first step of the RCRA process—a site assessment. This relational database of site characteristics facilitates sorting and provides a summary for a number of areas that may have to be addressed. The database is used to report the status (process step) of the RCRA corrective action process.

DuPont also maintains a database of basic information on all its Superfund sites.

HEART (Having Everything About Remediation Technologies) is a CD-ROM-based information system and technical library developed and maintained by CR. It is written in Turbo-PASCAL and has hypertext capability. Its primary purpose is to make technical information available to technology teams and DERS project staff. HEART helps ensure consistency and captures both internally and externally generated information relevant to remediation technology. It also helps bring new staff up to speed quickly.

HEART contains many levels of information, from brief overviews of technologies to specific technical or engineering information on particular aspects of a given technology application. The range of information in HEART includes the minutes from technology team meetings and published journal articles. HEART is a mix of text and graphical files. It has a database search capability, a tutorial, an online help function, and a limited summary statistical capability. It runs as a DOS executable program under Windows and uses hypertext to move around among subject areas, function, and files. A Web version is under development.

Substantively, HEART contains a wide range of material presented in several different ways. It has a "logic tree" function, which acts like a combination decision tree and decision support function that allows

a user to determine whether a particular technology can be usefully applied to a site with certain characteristics. For each technology team/substantive area, HEART includes technology initiatives, costs, the regulatory basis for the technology, relevant DERS projects, and reference and technical documents (both internal and external). The technology teams decide what information goes into the system.

One useful function is a technology selection matrix. Given the basic characteristics of a site and the proposed remedy—in situ versus ex situ; aerobic versus anaerobic processes—the matrix lists applicable technologies for a given medium (soil, groundwater, etc.) and contaminant type (volatile organic compounds (VOCs), organic chemicals, etc.).

This technology selection matrix can become part of the remedy selection process for a site. After the DERS project team selects a technical remedy, the assumptions underlying the decision and the alternatives considered are discussed with the RPM.

Because HEART contains both internal proprietary information and external copyrighted information, some system security is required. The number of CD-ROM disks has been limited to 100. All text files are encrypted. A special hardware key is also required to use the CD.

The dominant user groups appear to be DERS project management staff and the CR technology teams. RPMs do not use the system because the type of information and level of detail are not required for their function. User feedback appears generally positive. System upgrades attempt to incorporate user suggestions.

A case history review is DuPont's most valuable learning tool. The notion is to capture past experience. HEART has some case studies but is not intended as a management tool. Case studies include the full remediation strategy, technology, and regulatory interactions. DuPont has no formal model or format for documenting case studies, but capture of experience is encouraged.

LESSONS LEARNED

DuPont draws the following lessons from its remediation program management experience:

1. Maintain clear lines of communication with the regulator and build and maintain mutual credibility and trust.
2. Recognize the significant flexibility in the process. The following are examples:
   - Waivers on the ARARs.
   - Interpretation of responses to natural resource damage.
   - Design of remediation solutions to meet regulatory needs.
   - Interpretation of the scientific evidence to defend a point of view.
3. Avoid surprises wherever possible. They undermine trust and hurt any effort to develop a relationship in which EPA is willing to negotiate.
4. Do not hesitate to introduce ideas for technical change early. Give the regulator time to live with the ideas so it can get comfortable with them.
5. Be persistent about seeking improvement. It is never too late to suggest a change that will be mutually attractive.
6. Use good science (credible, objective research and evidence) applied to the particular circumstances at the site. This is what makes effective win-win negotiation with the regulator possible.
7. Look for every opportunity to negotiate a wiser deal. Constantly question the status quo. This is where the mature businessperson is most important to this process.

Chapter Five

CASE 2: REMEDIATION PROGRAM MANAGEMENT AT OLIN CORPORATION

Olin Corporation is a 104-year-old Fortune 500 company producing high-performance chemicals, microelectronic materials, metals, sporting ammunition, and defense and aerospace products. Olin's business philosophy is to conduct operations in an ethical and responsible manner. In 1995, Olin had sales valued at $3.1 billion and 13,000 employees.[1]

A new senior management team took office in January 1996. As part of a study of Olin's core businesses, the decision was made to spin off the ordnance and aerospace divisions as a separate entity.[2]

The following section on general corporate environmental management is intended to provide some context for understanding the details of Olin's remediation program. The elements of Olin's remediation program that warrant particular attention include overall program management structure and organization, process mapping, the use of a team management approach, and performance measurement. Customer feedback mechanisms, continuous process improvement strategies, and the rationale behind the restructuring of Olin's remediation program are also of interest.

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[1] *Olin Corporation 1995 Annual Report*, Norwalk, Conn.

[2] Formally announced October 10, 1996.

CORPORATE ENVIRONMENTAL MANAGEMENT POLICY AND PERFORMANCE

Olin's formal corporate environmental policy statement is fairly broad, covering items relating to ensuring the health and safety of workers and communities, minimizing environmental harm, and ensuring regulatory compliance.[3] Olin's corporate environmental management philosophy and program appear to be closely based on responsible care initiatives. These include a product stewardship program that requires chemical distributors doing business with Olin to have a formal "responsible distribution" process, thus extending the stewardship concepts to smaller customers.[4] Concern about its downstream exposure under product liability laws has prompted Olin to stop sales to firms that use its products unsafely. Olin is increasingly participating in the "rent-a-chemical" business. For example, Olin provides super-pure sulfuric acid to companies that use it in their own processes and then return it to Olin for reprocessing. Olin delivers the chemical directly to the vessel where it is applied and removes it afterward, taking full environmental liability responsibility for the chemical throughout the operation. Olin has instituted waste minimization and pollution prevention programs at its manufacturing sites to reduce the costs of compliance with various federal, state, and local environmental regulations.

Olin's pollution prevention program includes the traditional hierarchy of source reduction, including process and product redesign to minimize waste, recycling, treatment, and off-site disposal as a last resort.[5] Table 3 summarizes Olin's waste handling flows for 31 facilities, as of 1994. Olin recycles and treats approximately 77 million pounds of material and releases a total of 3.4 million pounds of material to the environment.

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[3] *Olin Corporate Responsible Care Manual,* "Environmental Health and Safety," RC Policy I-1, Norwalk, Conn., April 15, 1996.

[4] *Environment, Health, and Safety: The Olin Record,* Olin, Norwalk, Conn., 1995.

[5] *Environment, Health, and Safety: The Olin Record,* Olin, Norwalk, Conn., 1995.

Table 3

Olin Waste Streams, 1994

	Recycling/Treatment (in pounds)	Released to Environment (in pounds)
On-site recycling	477,000	
On-site treatment	59,000,000	
Off-site energy recovery	34,000	
Off-site recycling	17,000,000	
Off-site treatment	480,000	
Released to air		1,100,000
Released to water		165,000
Released to land		2,154,000
Total	76,991,000	3,419,000

SOURCE: *Environment, Health, and Safety: The Olin Record,* Olin, Norwalk, Conn., 1995.

Olin has reduced its total releases of EPA-reportable emissions by 61 percent from 1987 to 1994, including a 70 percent reduction in air emissions. The voluntary corporate goal is an 80 percent reduction in total emissions by 1998.[6]

Olin was one of the first firms to participate in EPA's Voluntary Industrial Toxics Reduction program (33/50 program). By 1994, Olin achieved a 70 percent reduction in releases of the 17 chemicals included in the program, earning an EPA Environmental Achievement Recognition Certificate. The current goal is now a voluntary reduction of 85 percent in releases for the 17 chemicals by 1998.[7]

Olin tracks eight corporate measures of environmental performance, one of which relates to remediation. These are Superfund Amendments and Reauthorization Act of 1986 (SARA) releases (air), SARA releases (all media), solid waste (hazardous), Industry Toxics Program (ITP) (33/50 voluntary program), wastewater, listed reportable emissions, waste management units, and remediation sites. Good performance is indicated by a downward trend in the metrics.

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[6] *Olin Corporation 1995 Annual Report,* Norwalk, Conn., p. 4.

[7] *Environment, Health, and Safety: The Olin Record,* Olin, Norwalk, Conn., 1995.

REMEDIATION POLICY

Context and General Management Philosophy

Olin defines the universe of remediation sites into two categories—"known" sites and potential sites. Known sites include active, closed/active, and closed/inactive waste sites. As of 1996, Olin has identified 182 known sites, either through company investigation, regulatory notice, or lawsuits (toxic torts or third-party suits). Eighty-four of these are inactive or "closed," defined as either a completed remedial action or a determination that no remaining liability exists. Regulators may disagree with these judgments; EPA continues to review closed sites once every five years. Fifteen sites on the closed/active list require long-term operation and monitoring, including pump and treat operations. The remaining 83 sites are active.

Potential sites include all other sites that Olin has owned, where it has operated manufacturing facilities, or where it has disposed of waste: joint ventures, tolling arrangements,[8] old facilities, transport operations, and landfills (municipal or other). Olin does not have a complete list of these potential sites, but the company is conducting a survey of potential sites through legal and other document searches. Site visits are also made to potential sites for a first-cut characterization of risk.

The apparent purpose of this survey of potential sites is to ensure that the company understands the extent of any potential liabilities and can handle them effectively.[9] The current remediation management program strategy places a positive value on identifying potential problems before they become actual problems. Olin's remediation sites mostly fall under CERCLA. RCRA Corrective Actions are mostly completed, and operating divisions are responsible for future problems.

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[8]Olin made heavy use of tolling, in which it sends intermediate chemicals to a firm with processing capacity and pays to have these chemicals converted into a final product. Olin retains ownership of the chemicals through this whole process and hence is responsible for any waste generated by the process. Tolling is especially important for pesticides. Apparently Olin was a dominant producer of pesticides.

[9]Langseth and Lambe, 1995, p. 105.

Olin has a set of criteria for determining action at potential sites, which includes indication of risk to public health or the environment, the ability to avoid community or public relations problems, the ability to avoid government agency enforcement actions, and the ability to mitigate third-party health or damage claims.[10] Olin will take voluntary action at potential sites if a problem or advantage in any of these areas is identified, even in the absence of a regulatory requirement. To justify voluntary actions, Olin believes that the problem at the site has to be well understood, and regulatory agency approval must be obtained. This appears to be a fairly proactive stance that places value on early identification of sites and associated risks. Olin has voluntary actions under way at six to seven sites today. Olin recognizes a potential downside to voluntary actions in that the regulatory agencies may ask for more. An example is a site at which Olin began a bioremediation project to avoid the installation of a more expensive pump-and-treat system. The regulator required Olin to do both rather than substituting one for another.

Occasionally, regulators encourage a voluntary action that shifts jurisdiction from one regulator to another or mitigates a problem enough to avoid formal regulation. In one case, even though Olin had no relationship with the state regulators, they approached Olin to take additional action at a site that would allow the state to certify a risk assessment that verified a relative lack of risk, and thereby keep it off the NPL list. Olin took this action.

Olin's basic remediation policy is that real off-site risk be addressed immediately. Olin believes that its currently identified sites do not pose any risks to human health and the environment; all identified risks have been addressed. Olin makes no effort to prioritize sites. Typically, each locale has only one site (operable unit), and circumstances at each site drive the basic strategy and resources needed. Trade-offs occur among strategies at a site but not about resources across sites, beyond the creation of site teams.

Olin's formal corporate environmental policy statement includes remediation:

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[10] *Olin Remediation Process Notebook,* Charleston, Tenn., 1996.

> Focus technology and resources at Olin remediation sites to reduce present and future risks to human health and the environment; and conduct long term corrective actions pursuant to applicable laws and regulations.[11]

Olin's vision is that "the environmental remediation organization and process will be recognized, both internally and externally, as the 'best of the best.'" The mission of the environmental remediation group is to define Olin's responsibilities and liabilities, and cost-effectively manage the firm's environmental remediation exposure. The goal is to manage risk at minimum long-term cost to the company, while complying with all relevant regulations and with regard to stakeholder interests.[12]

Olin's former vice president for Environment and Regulatory Affairs, Chuck Newton, has stated that viewing remediation as an ongoing business process is critical to successfully managing remediation activities and reducing costs.[13] This was recognized as a significant cultural change from the past litigation-based approach that most companies had adopted, including Olin. Most companies, again including Olin, did not go through this cultural change until several years ago. The focus on cost-effective remediation solutions has reduced Olin's estimated liabilities by 30 percent over the past five years.

Olin's remediation-management strategy includes assigning a multidisciplinary team (legal, project management, remediation experience) to manage remediation activities at sites estimated to cost over $200,000. Olin has mapped its remediation decision process to identify decisionmakers and time frames, and reduce overlapping efforts. Olin has also established 15 metrics and mechanisms, ranging from surveys to milestones, for measuring progress and reporting that progress to stakeholders. These metrics are also used in annual reports to the board of directors regarding remediation program per-

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[11] *Olin Corporate Responsible Care Manual,* "Environmental Health and Safety," RC Policy I-1, Norwalk, Conn., April 15, 1996.

[12] *Olin Remediation Process Notebook,* Charleston, Tenn., 1996.

[13] Baker, 1995, pp. 20–21.

formance.[14] An important part of Olin's strategy is to identify who the remediation customers are for any particular activity.

Program Management Structure, Roles, and Responsibilities[15]

The director of Environmental Remediation and Engineering (ER&E) has primary remediation program management responsibility. He reports to the senior vice president for Corporate Affairs, who in turn reports to Olin's chief executive officer (CEO). ER&E is not part of the corporate Environment, Health, and Safety (EH&S) organization, but rather is at the same level in the management structure and reports to the same office.

The ER&E includes four groups:

- The Environmental Technology Group has a staff of five and appears to include some administrative functions that are relevant to all of ER&E.
- The Environmental Remediation Group (ERG) has a staff of 11. Most of the environmental remediation specialists are located in this group and provide remediation expertise to site teams.
- Central Group Engineering has a staff of 13. This group is composed of project engineers who provide project engineering expertise to the site teams.
- Environmental Sites has a staff of 17 who provide operations and monitoring services (e.g., running pump-and-treat operations).

Total ER&E staffing, including the director, is 47. Thirty-seven of these, including four from the engineering group, work remediation issues full time. This group of 37 is also known as the ERG. Interestingly, ERG's formal goal is to perform itself out of business by addressing and resolving all corporate remediation issues. Staff reductions have already been programmed in expectation of movement

[14]Langseth and Lambe, 1995, p. 111.

[15]This discussion is based on material in the "Roles and Responsibility" section of the *Olin Remediation Process Notebook*, Charleston, Tenn., 1996.

toward this goal, and staff training includes skills that are valued elsewhere in the company. It is understood, however, that remediation issues will never be fully resolved, so the more-practical expectation is that staff assigned full time to remediation will become significantly reduced over the long run.

The Olin organizations and individuals who play key roles in the remediation-management process include (in order of precedence)

- the Corporate Responsibility Committee (a committee of the Board)
- the chairman, president, and CEO
- the Remediation Management Board (RMB)
- the Remediation Management Team (RMT)
- the site teams.

ERG interactions with senior Olin management (the Corporate Responsibility Committee, the president, and the CEO) are mostly informational and include discussions of the major sites, regulatory reform activities, and other regulatory activities of concern. The purpose of ERG interactions with senior management is threefold:

- Demonstrate that Olin has a well-defined process for remediation management, thus making senior managers comfortable with the overall process.
- Make senior management aware of the risks facing the company with respect to remediation activities.

The result of these interactions appears to be consistent support for ERG activities and appropriate problem-solving attention when needed.

The RMB is chaired by the senior vice president for Corporate Affairs and includes the executive vice president, the chief financial officer, the vice presidents for Public Affairs and Manufacturing & Engineering (the latter from the chemical division), the deputy general council, and the ER&E director. Thus, the RMB is a senior management board with legal, operations, financial, and public relations functions represented. The RMB represents the broader corporate perspective

and ensures integration of remediation management with other corporate activities and processes. The RMB provides oversight, assists in developing remediation policy, reviews and provides direction for strategic decisions (risk, costs, and benefits) at significant sites, and advises the remediation process owner.[16] The RMB plays a strategic role and acts as a sounding board for site strategies. It does not directly address risk issues very often. It meets quarterly, and for special concerns or events as required.

The RMT is the primary group responsible for remediation program management. It is chaired by the ER&E director and includes all ER&E group managers, the chief counsel (environmental), and the senior vice president (VP) for Corporate Affairs. The RMT is responsible for ensuring performance measurement, continuous improvement, stakeholder communication, and regular process monitoring to make Olin's process the "best of the best." All individuals on the RMT also act as site leaders for at least one site. Thus, the RMT has considerable practical experience in site-level remediation management.

The RMT meets for a two-day period each month. The first day is a general staff meeting. The second day involves strategy and oversight of larger sites. The senior VP for Corporate Affairs sits in for the second day of these meetings. The meetings are open to all in remediation, who generally attend when they are in town and a topic concerning them is under discussion. These monthly meetings are an important vehicle for continuous process improvement, raising issues, and identifying solutions. The RMT reviews enable and enforce a business perspective in site management strategies.

There are several links between remediation activities and other EH&S programs. A developing role for the ERG is to become more involved in Olin's life-cycle/product stewardship programs. The notion is to include considerations of ultimate disposal in the design of products. Product stewardship is often defined as "cradle to grave"; this developing notion would be to include "what goes into the grave" as a design parameter. A significant element of this effort

[16]The director, ER&E, is the overall process owner. The site team leader is the process owner at the site level.

would be to educate the product divisions regarding up-front versus future costs.

As of January 1997, operating facilities are being held responsible for any on- or off-site waste, including remediation liabilities. The ERG will consult and educate but will not be formally responsible for remediation activities at operating facilities. The ERG will focus exclusively on "orphan" sites (sites with no current Olin owner).

The site team leader is the designated process owner and is responsible for team interactions, decisionmaking, and overall performance, as well as interacting with the RMT. Site team leaders may come from any organization or function within Olin and do not necessarily need extensive remediation experience. Team leaders are selected based on the unique situation and needs of the site and in the past have included purchasing and plant management personnel. The team leader must develop the site remediation strategy, including stakeholder relations, and request funding for activities.

The site team is responsible for defining how to implement the remediation strategy, executes that plan, manages external and internal resources (funds and staff expertise), and forecasts costs. The site team is also responsible for understanding and responding to customer expectations. Site team members are expected to perform within a team management framework, which includes full participation in team responsibilities and representing functional expertise (not the functional organization). Teams are self-directed after the initial authorization (approval of strategy) and are given considerable authority to perform. Milestone or funding changes are reported to the RMT. Teams are not necessarily located on the site.

Each of the 96 active sites (active/active and closed/active categories) that Olin has identified has a site team.[17] A few teams manage several similar sites. Team size ranges from 1 to 7 members, depending on the characteristics and needs of the site. The composition of the team (mix of skills and functions) varies depending on site characteristics. Both team size and composition can vary over time as the site

[17]Our notes indicate 92 sites/92 teams, but this is not equal to 169 known sites less 73 inactive.

progresses through stages of remediation. At Olin-owned sites (generally larger sites), the team will consist of at least a project engineer, environmental assessment specialist, and public relations personnel, as well as the site team leader. Legal representation (from an outside firm) is included if needed. On multiparty sites, the team may be smaller. Team members will participate on both the steering and technical committees of the PRP group.

New teams need to be set up for about 5 to 10 new sites a year.[18] Individuals are assigned to major sites based on experience, skills, and staff development concerns. There is a high cross-fertilization of value-added information and ideas because individuals work on multiple teams and carry lessons-learned information. Further, a review of a site's strategy is performed by the RMT periodically, providing an opportunity to convey lessons for management and value-added ideas.

The ERG/Central Engineering organizations provide modest technical capability to the site teams. Technical specialists are included on site teams as needed and often work with contractors (e.g., design of site cap).

Corporate functional managers ensure that competent expertise is available, promote team work by understanding other functions' roles, and empower site team members. This appears to be a management and resource support role, in which functional managers "own" the personnel who get matrixed into site teams.

The foundation of Olin's remediation-management process is its team structure. The team management concept is based on reaching consensus-based decisions, where all team members at least "agree to disagree" on a particular action. In other words, all team members must support a decision, either actively or in the sense of not objecting. Inability to reach agreement is resolved either through the RMT or functional managers. Such problems are relatively infrequent, given the number of teams Olin has working at any particular time.

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[18]Olin identifies approximately 5–10 new sites per year.

Key process elements include management team and management board concepts, empowerment of teams and team members, emphasizing the process over functional organizations, mechanisms for conflict resolution, a formal measurement scheme (see below), identified customers with feedback mechanisms, and individual performance evaluations tied to performance within the team. The process is composed of two sequential processes: strategy development and implementation.

Remediation strategy development is initiated in two ways. One way begins with management review of the list of potential sites and assignment of a site or set of sites to an individual or team within the ERG for further investigation. Based on this investigation, the ERG makes a recommendation to management, which decides whether further action is required. The second way strategy development is initiated is through formal agency notification of a site. The notice goes to the internal corporate legal department and is distributed to appropriate organizations within Olin (the remediation-management team and the site team (if it exists)). The ERG and the Legal Department then review the notice and make a recommendation for further action.

After initiation, the process is essentially the same for all sites. If a site team is needed, management either assigns the responsibility to an existing team or develops a new team who develops a strategy for action. If a site team is not needed, then the ERG review team develops a strategy directly. In both cases, management reviews the strategy and obtains business agreements and RMB approval if needed. Once the strategy is approved, the implementation process begins.

Implementation is the responsibility of the site team. The process includes oversight and approval by company management and the relevant government regulatory agency. Steps in implementation include defining the scope of the effort and associated funding requirement, obtaining those resources (a management responsibility), further investigation and identification of alternatives, recommendation of preferred action, and issuance of the ROD (agency responsibility). If a decision is made to challenge the remedy selection in the ROD, the site team (with management support) attempts to change the ROD. After final agreement is reached on the remedy, remedial design and action are performed. Oversight and monitor-

ing continue to ensure the effectiveness of the remedy or to develop alternatives if the remedy proves ineffective.

Site Management

Olin recognizes that the investigation phase strongly influences remedy selection. Olin structures the investigation to collect data and define risks to support the preferred remedy. The investigation phase is thus considered an important part of the site remediation strategy. Detailed modeling may be used during this phase. Since the selected remedy is often based on specific assumptions, Olin personnel are encouraged to question those assumptions and the solutions (remedies) they lead to. Since contractors are often used for the investigation phase, Olin sometimes brings in consultants as a mechanism to monitor the contractor and also question assumptions.

If Olin determines that there is a potential for contamination of private wells, samples are taken from each well and tested overnight. If contamination is found, alternative supplies are provided. If feasible, Olin applies carbon filters to the wells immediately. Any private well between the Olin site and an Olin test well that displays contamination is assumed to be contaminated and suitable for filtering. This is an example of a proactive response to a potential problem.

A general operating rule for Olin is to avoid surprises. This means proactive site identification, use of good assumptions for planning and estimating, and promptly informing the RMT or RMB of major changes to a site strategy.

Olin's remediation-management process includes a ranking of sites based on estimated liability. Higher-liability sites have relatively larger site teams with the full mix of functions.

- Category A: liability greater than $10 million. These sites have full site management teams.
- Category B: liability between $1 million–$10 million. These site teams include at least the site leader, an environmental specialist, a technical person, and legal representation.

- Category C: liability between $100,000 and $1 million. These teams consist of an environmental specialist and legal representation.
- Category D: liability less than $100,000. These teams consist of an environmental specialist and legal representation.
- Category E: no information available to estimate liabilities.

As a rule, Olin does not believe that deferral of costs or action is an effective component of strategy. Delay generally degrades regulatory relationships. The cost of carrying attorneys and consultants, either internal or external, outweighs any potential benefits.

Use of External Sources for Services

Olin's culture favors aggressive use of the external market. Olin appears very comfortable contracting out significant aspects of its remediation program, including legal functions and some studies and analyses. Olin uses contractors for detailed tasks and activities, including detailed remedial design, risk assessment, and construction. Olin developed a preferred list of contractors in 1992, broken down by functional specialty. The list includes three to four contractors for each substantive area (investigation, design, construction, treatment, and risk assessment). Site teams may use any contractor they wish that is on the preferred list. Waivers, documenting a strong rationale, must be obtained to use contractors not on the list. Contractors on the list generally have an umbrella contract with Olin, and site teams simply request work under that mechanism and negotiate the specific task. Olin uses a "fixed bid" for a specific scope of work to mitigate the cost maximization incentive often found in remediation services contracting. Olin carries environmental impairment insurance policies that cover all contractors.

All legal functions are contracted out. The ERG has only one internal legal staff member who sits on the RMT. This is a change from the previous process: Prior to 1990, most legal work was conducted by in-house lawyers who tended to be fairly conservative with respect to risk taking.

Olin is currently considering reducing the number of contractors on the preferred list to generate economy-of-scale efficiencies, facilitate

standardizing Olin's practices, provide for a deeper understanding of Olin's needs in each contractor, and facilitate transfer of ideas and lessons across sites. Olin is bringing in all contractors on the current list and asking them to identify their value-added contribution to Olin and to candidly critique Olin's remediation process.

Interestingly, Olin has observed that the choice of contractors or consulting firms matters to the EPA regions. Over time, credibility between contractors and EPA regional personnel has developed. Olin is sensitive to such considerations in choosing contractors for particular jobs.

Olin has a formal policy statement that specifies the criteria used to select off-site waste disposal organizations and facilities. The criteria include valid permits, no deep-well injection, and no use of sites on the NPL list. The procedures and associated criteria allow Olin to continually assess off-site waste service providers and limit Olin's long-term liability related to waste handling and disposal.[19]

Olin's formal off-site disposal policy includes a list of approved sites and contractors. Financial viability analysis and inspections/audits are part of the process through which contractors are rated for approval. The decision to use off-site disposal is made at the division (product) level; remediation management is not directly involved. Nevertheless, the corporate goal is to reduce the number of sites used for disposal, thus minimizing the number of sites with potential future liability. Olin uses "iron-clad" contracts for indemnification to minimize risk. Olin believes that off-site disposal should be minimized, but careful use under the formal policy presents no added risk.

The director of Environmental Remediation and Engineering is developing proposals to give divisions incentives to reduce the use of off-site disposal. For instance, a fee could be charged to the divisions. A nominal fee might be $100,000 per use, not enough to prevent off-site disposal, but enough to get their attention.

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[19] *Olin Corporate Responsible Care Manual,* "Waste Management Unit Assessment" RC Policy III-2, Norwalk, Conn., April 15, 1996.

Performance Measurement and Incentives

Olin places a high value on measuring and tracking the performance of the remediation program. Performance measures are used both as a way to identify process areas needing improvement as well as to directly affect the performance evaluations used as input to incentive pay calculations.

Everyone in ER&E receives a portion of their pay as variable pay based on two factors: the total size of "economic value added" for Olin as a whole and their performance relative to others at Olin. "Economic value added" is after-tax profits less debt and equity capital charges. Any action that anyone in ER&E takes to reduce costs for Olin increases this number.

The variable pay portion of an individual's salary represents 7–8 percent of base pay. Olin's corporate performance accounts for 20 percent of the incentive pay, remediation group performance for 30 percent (this is ER&E generally), and site team performance for 50 percent. There are seven sets of factors, each with specified relative weights, used to evaluate site team performance:

- *Cost management* includes subfactors of quality of assumptions, identification of planned activities, and quality of spending projections. Relative weights for these are 0.20, 0.15, and 0.10, respectively. In practice, these factors relate to the quality of upfront planning. The quality of assumptions is weighted the highest of any individual factor.
- *Management of spending projection changes* compares actual spending to budget and total year estimates on a quarterly basis, and also evaluates the timeliness with which the team recognized the need for change. The weight factor is 0.15.
- *Communication and effective relationships* assess the teams interactions with stakeholders, including agencies, community, PRPs, and contractors. Information flows and the conduct of contractor evaluations are included. The weight factor is 0.15.
- The *actual results of the site team survey* are aggregated and included as an index number. The weight factor is 0.05.

- *Publicity* incidents, both positive and negative, community outreach (if applicable), and an assessment of whether any negative publicity was preventable. The weight factor is 0.05.
- *Significant accomplishments,* including innovative approaches, value-added items, and cost recovery. The weight factor is 0.10.
- Extraordinary *adverse events* include unanticipated lawsuits, notices of violation (NOVs), and public outcry against Olin's interest. The team is expected to manage these appropriately. The weight factor is 0.05.

The weights heavily favor more-accurate management of costs. They give little direct attention to actual value added by the teams. Value added affects compensation very indirectly by affecting economic value added (EVA). That is, remediation people share any value added they create with everyone participating in the EVA variable pay. Since remediation-related activities are a very small fraction of the firm as a whole, the connection between performance and pay through this channel is near zero.

Quality planning, effective and timely communication, and value-added contributions are rated more heavily and so are assumed to be relatively more important to Olin. The formal process for evaluating site team performance and incorporating the results into incentive pay calculations is relatively unique. It appears to be quite effective in motivating desirable employee behavior and ensuring that Olin's remediation policy and process are effectively executed. Note that many of these factors are related directly to Olin's performance measurement system used to monitor overall remediation group performance.

The ERG performance metrics are similar to the site team metrics but are evaluated at a different level. Objectives include managing spending to $30 million–$40 million annually, reducing the number of remediation sites by 5 percent per year, keeping department (ERG) spending within budget, senior management survey showing continuous improvement, site team survey showing continuous improvement, implementing quality plan (conducting process review and completing action items), offering no surprises to the RMB, and demonstrating that the value-added items exceed Olin direct costs for remediation by "multiples."

The incentive pay provision relates to Olin's EVA decision criterion applied to all company activities. A pool is generated based on EVA outcomes, and the incentive pay is allocated as a percentage of the pool. Thus, actual dollar amounts can be relatively larger or smaller depending on EVA performance. In effect, site teams compete against each other for a portion of the incentive pool.

The first year of incentive pool payout was 1996. The concept, though identified early in the reengineering process as useful, was not implemented immediately in order to avoid disincentives affecting individuals who are not as readily adaptable to the team culture as others, and to develop appropriate mechanisms for measuring team performance. An initial pilot to test implementation of the incentive pay concept in 1995 was aborted because of ambiguity in measures relating to site team performance.

There is a recognition that no set of measures perfectly captures the management goals of the program: risk reduction and effective and efficient expenditure of funds. Olin continuously reviews the adequacy of its performance metrics and drops or adds measures as needed. Olin's performance metrics are generally considered "diagnostic" metrics since they relate to the status of remediation processes; they are measures of how the process is working. Those metrics that affect the incentive pay calculation can also be considered as inputs to a motivational metric.

The following is a brief description of each of the current measures that Olin uses and expectations regarding the preferred direction of change. Costs (*M1a-M1g* below) are calculated as a four-month rolling average. The expectation for the direction of change in cost trends varies as a function of the specific metric and also the life-cycle stage of the process at any given site. Olin's sites will be in various stages of cleanup at any given time.

- *Investigation costs (M1a):* costs of outside (external contractor/consultant) site investigations. Actual costs per site vary widely. The trend should be downward as Olin moves the total population of sites through the remediation life-cycle and activities transition from investigation to remedial actions.

- *Remediation costs (M1b):* costs of outside (contractor) remedial actions. Olin expects these to increase in the near to medium term as more sites transition from the investigation phase.
- *Legal expenses (M1c):* costs of outside legal support. Olin expects these costs to decrease since it is Olin's policy to be cooperative and use alternative dispute resolution or business settlements whenever possible. Olin has not observed net benefits to a legalistic approach to remediation disputes. Current trend is up because of one bad case (lawsuit).
- *Direct costs (M1d):* Olin internal costs, including ERG, project management, site team leaders (who do not necessarily work in the ERG), and other process costs. Olin expects and intends to reduce these costs over time through completion of remedial actions, elimination of staff and non-ERG site team leaders, and changes to the ERG and remediation-management processes.
- *Subtotal remediation costs (M1e):* aggregate of M1a–M1d. Calculated as a four-month rolling average. It is not apparent whether this metric should trend up or down, given the mix of inputs. It is simply used to track costs, not set goals.
- *Operating and monitoring costs (M1f):* costs associated with long-term operations of remedial actions (e.g., pump and treat systems and periodic site evaluations). The goal is to drive these costs down over time.
- *Total costs (M1g):* total of M1a–M1f. Olin expects these costs to fall over the long term.
- *Cost versus budget (M2):* environmental costs versus estimated budget, compared on a quarterly basis. This metric is intended to measure the ability to forecast costs. Results so far indicate that calendar year expenditures are hard to predict.
- *Large sites within 25 percent of budget (M3):* Percentage of sites with expenditures greater than $100,000 that came in within 25 percent of their budgets. Similar to M2, this metric suggests the difficulty in estimating site remediation costs and annual expenditures.

- *Number of closed sites reopened (M4):* "reopened" in the sense that spending has occurred after the site was closed (remedial action complete). Olin's goal is to keep this number very low.
- *Site reduction (M5):* number of sites moved into the inactive (closed) category from the 1989 baseline. The baseline is adjusted for new sites. The expectation is an increasing trend, with a goal—established as part of Olin's Responsible Care program—of 45 percent reduction by 1998.
- *Recovered cost (M6):* cash in hand recovered from buyout settlements, litigation, insurance, and sales of remediation services to third parties (other PRPs). Olin's goal is to increase this number over time.
- *Value added (M7):* perhaps the most important performance measure and the only one tied directly to Olin's bottom line and EVA calculations. Value added falls into one of three categories:
  - Cost avoidance: changes to plans and actions that reduce costs over the original plan. A change made to avoid an expenditure.
  - Cost savings: actions that reduce the cost of implementing an existing plan. These are costs included in the budget but that were not spent.
  - Cost recovery: third-party recovery of costs (e.g., insurance and other PRPs).
- *Print media coverage (M8):* number of positive (neutral) and negative mentions of Olin sites in the print media. Calculated on a four-month rolling average basis, the metric yields a list of citations with a favorable/unfavorable rating on each one. This metric is used as an indicator of what Olin could have done to improve the process. For each bad article, Olin tracks the article back to specific instances and asks if Olin could have handled these better.
- *Site team survey (M9):* the site teams' self-rating. This metric is part of the incentive pay calculation, and so there is some concern of bias in the results. The aggregate measure should tend toward indicating that the team is performing well.

- *Management survey (M10):* Results should indicate the satisfaction of senior management with the process and results. The purpose of the survey is to understand whether the ERG is adequately communicating the process and risk. The form of the survey and people surveyed is still changing over time to focus the recipients and make sure they get the information they need on remediation.
- *Agency survey (M11):* sent to individuals within the regulatory agencies designated by the site team. The aggregate results should trend toward indicating that the agencies are satisfied with site team performance and communication.
- *Olin evaluation of contractor (M12):* performed by the site team for each phase of the project and used to monitor performance of contractors.

For the three surveys listed above, aggregate measures are formally tracked. The RMT uses the more detailed survey results as part of feedback and process improvement efforts.

Value-added metrics are given particular emphasis at Olin. Site teams propose value-added items at quarterly reviews. To claim a value-added item, a team submits a one-page summary of the action with a simple justification of the savings. The simplest items use a copy of a check to document the savings. Others describe the action and results on a spreadsheet calculation. Each is different; no standard format is required. The RMT provides a critical review of these proposals based on the rationale for the calculation of value added. This ensures the credibility of the value-added numbers. While cost savings and cost recovery amounts are more tractable, cost avoidance is an estimate, generally based on past experience. For instance, Olin has observed that on average, litigation at most sites costs about $100,000. This value is used as the estimate for most litigation-avoidance value-added items. Some value-added activities are innovative in terms of process or technology. These are noted on the tables generated for the quarterly RMT review.

The ERG has a minimum goal of generating $8 million in value-added per year. This goal represents a two-for-one return on the direct costs of the ERG (2 × $4 million in annual direct costs). This goal is not imposed from above and appears to be somewhat

informal. The target value has been consistently exceeded, often by a significant amount.

Strategies to generate the value-added items are proposed initially in the site management strategy. These strategies indicate the actions needed to generate the value added. The incentives for a site team to generate value added include job security (need to demonstrate value added to the corporation), addition to the EVA pool (affects incentive pay), and the inclusion of the value-added metric in site team evaluations and incentive pay calculations.

Examples of value-added items include

- avoided litigation ($100,000)
- avoided allocation payment ($40,000)
- reduced final construction costs ($100,000)
- reduced sediment amount and no incineration ($600,000)
- reduction of assigned allocation ($170,000)
- reduced remedial scope ($5,000,000)
- use of natural attenuation ($991,000)
- ROD remedy with no excavation/stabilization ($14,900,000).

The 1995 and 1996 value-added items are predominantly cost avoidance, usually in the form of either avoided litigation or changes in the remedy. Cost savings are generated through process changes in executing an existing remedy. There are generally few cost-recovery items listed.

Olin has an incentive pay policy applicable to all ER&E managers and staff. The idea for the policy came out of the 1990 remediation program reengineering effort, but it was not fully developed until 1995. The development process was iterative as useful metrics to measure individual and site team performance were developed.

Stakeholder Interactions

Community Interactions. Olin has identified three groups of stakeholders for remediation-management processes: regulatory agen-

cies at federal, state, regional, and local levels; communities affected by specific sites; and company shareholders. The company itself (e.g., senior management at corporate or division headquarters and facilities) is not directly identified as a stakeholder. Rather, the real representatives of Olin interests are the shareholders, and their interests are represented by EVA. Nevertheless, the survey of senior corporate management conducted as part of the performance measure scheme implies that senior management is used to represent the interests of shareholders.

Part of Olin's remediation-management process is stakeholder outreach. The notion here is to be proactive, anticipate future changes, and build trust and credibility over time. Stakeholder outreach includes quarterly EPA region meetings, agency surveys (part of performance measurement scheme), and community advisory panels.

Olin's remediation site management teams are encouraged to have a community outreach program if the circumstances warrant. As with most site management issues, there is considerable flexibility in Olin's general remediation policy to tailor the outreach program to site-specific characteristics. However, the RMT does review the need for a community outreach program as part of a site's strategic review, and effective communication with the community is a component of the site team evaluation used in the incentive pay calculations.

A briefing documents Olin's basic approach to community outreach and identifies specific components of an outreach program.[20] The outreach programs are site specific. The purposes of the program include maintaining communication with the community, avoiding surprises, and assuring community support when needed. A strategy is developed that explicitly identifies the goals of the program, the roles of the key players, and the processes for obtaining and conveying information. A work plan is developed to implement the strategy. This includes identification of key audiences, development of the key messages that Olin wishes to convey, and notional question and answers. Several vehicles of communication can be used, each fulfilling a different purpose:

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[20] *Community Outreach,* briefing charts, Olin, Norwalk, Conn., September 18, 1996.

- targeted dialog meetings for one-on-one discussion with key community leaders
- fact sheets to quickly summarize relevant information
- newsletters to report status and current issues
- public meetings
- community liaison panels, which might include a professional facilitator
- media briefings and press releases to keep media informed and up to date
- prepared visuals (charts, drawings, and photographs) to be used in a presentation or as handouts.

Contingency plans and a media work plan are also developed. Olin encourages periodic assessment of the effectiveness of the community outreach program through telephone or mail surveys, focus groups, and other sources. Such an assessment is an integral part of the site team evaluation. Site teams can draw on a range of resources to develop and implement an outreach program, including Olin's internal public affairs and government affairs staff, consultants and outside experts, legal advisors (generally outside firms), and agency personnel.

Site teams are encouraged to take an active interest in the community because the community affects remedy selection and the remedy is the dominant cost driver. Olin's experience has been that community involvement results in a lower-cost remedy being selected. Generally, the community just wants to be assured that they are protected from risks associated with the site and remediation activities. Communities generally do not favor incinerators, for instance.

Olin also has a formal process for community interactions that is founded on community advisory panels (CAPs).[21] The main purposes of the CAP include avoiding "surprises" with respect to com-

[21]These CAPs are not the same as the community advisory panels for operating plants required under CMA's Responsible Care program.

munity interests, developing long-term relationships and building credibility, and conveying good technical information into remedy discussions.

The process for developing a CAP includes contacting community leaders and asking for either their direct participation or recommendations of other individuals. A core group of individuals representing an appropriate crosscut of community interests is identified and invited to participate. At the discretion of the group, a third-party facilitator may be involved in both group formulation and operation. Each CAP develops its own bylaws: member rotation, meeting frequency, publishing minutes, etc. Olin pays for the CAP but does not run or lead the group or set the agenda. Each CAP runs independently based on the unique interests and concerns of the community. Each CAP sets its own agenda. Olin allows only one company representative on a CAP, who is selected by the site team and who could be either a technical or public relations person, depending on the needs of the CAP and site characteristics. Olin considers its role on the CAP to provide quality information; it is just one of many participants. The fact that CAPs are integral to the site decisionmaking process puts Olin at the forefront of community relations.

Olin gathers its facilitators, project managers, and site managers once a year to discuss CAP policy at a conference. EPA has chosen not to become a permanent member of the CAPs but does make presentations as needed.

The value of CAPs and good community relations is illustrated by the following example. The remedy selected for a particular site included incineration of wastes. However, the community was concerned about the trucks transporting the wastes rather than incineration per se. In addition, the community received approval from regulators to install a carbon filtration unit to remediate the contamination to a well used for drinking water, making this one of the few examples of cleanup to drinking water standards. Olin and another PRP paid for this remedy.

Olin has formal community relations training programs for ERG staff. The basic notion is to assume that the site is in your own backyard and to consider what information you would require to be comfortable. The training includes a media course and a refresher media

course every two years. The course includes on-camera behavior, press relations, and conducting panels. There is also a community dialog course for CAP participants.

Olin considers good relations with regulators critical to a successful remediation program, and considerable effort is expended to develop and maintain these good relations, as well as to manage problems with officials. Regulatory interactions are guided by the principle of providing complete information to help the regulator make decisions favorable to Olin. Close interaction with the community also facilitates favorable decisions.

Regulator Interactions. Olin considers the EPA project manager at a site the key official, recognizing the significant flexibility this official has in enforcing regulations. Maintaining good relations with the EPA project manager is critical. Olin conducts agency surveys of individual regulators involved in particular sites and holds periodic meetings with the deputy administrator of the EPA regions where Olin has facilities. These are important efforts at building and maintaining good relations. Nevertheless, Olin will challenge an agency on occasion. For instance, at one capped site, since no leaching is occurring and there is no risk to groundwater, Olin has mounted a major campaign challenging the remedy selected for this site.

In general, Olin perceives that there are advantages to working with state regulatory agencies rather than EPA. There is less oversight and associated costs, and more flexibility in the regulations and in enforcement.

Brownfield remediation programs create positive advantages to cleanup under traditional state regulations. Cleanup standards are usually lower, given the planned land use, and the process is generally easier and faster.

Voluntary action is one area in which Olin's efforts to build and maintain good relationships with regulators is important. Olin's relationship-building efforts include surveys of agencies, inviting regulators to site team meetings, and periodic meetings with the deputy administrators of the relevant EPA regions. The purpose of these high-level regional meetings is to introduce Olin's remediation pol-

icy and process to senior regulators; this is not the forum in which grievances or other regulatory problems/issues are aired.

Financial Costs

Olin budgets on a quarterly basis and five years into the future. To the extent that expenses beyond five years in the future are known, budgets include these as well. In this budgeting activity, Olin uses a strict set of rules. The following are examples:

- Do not include a claim until you know the liability. Some firms project likely liabilities; Olin does not.
- Do not credit a cost recovery until you have it in hand (disclosure rule).

Budget numbers are used to manage three processes:

- Cash management, especially toward the end of the year.
- Updating and drawdown of the "cash reserve." The Securities and Exchange Commission (SEC) requires that Olin maintain a cash reserve that reflects potential future liabilities. Olin manages its cash without regard to how it might be used in any particular year. But managing an account that tracks a reserve helps Olin comply with SEC regulations about future liabilities and also helps it plan for longer-term cash management.
- Supporting site team efforts to improve their planning activities.

There are two budgets requiring management attention. The first is the budget for site-level activities. This represents the bulk of the funding needs in any given year. The budget is an aggregate of site team estimates. Funding comes from reserve accrual in prior years.[22] The Olin comptroller, CEO, and general counsel generally sign funding requests.

[22]The reserve accrual is for SEC reporting purposes only; Olin does not use those estimates for management purposes since, by regulation, they do not include certain costs that should be included for comprehensive management.

The second budget is the department budget (the ERG and Central Engineering). This includes wages, travel, etc. and requires formal approval.

Olin has recently mapped its remedial project cost management process.[23] This process map also assigns roles and responsibilities for estimating and approving remediation costs.

All remediation spending is charged to the reserve. The reserve account is funded by a "remediation assessment" paid by the product divisions. The allocation formula is very complicated and not really rational since the amount paid is not necessarily associated with the liabilities resulting from past waste practices or ability to pay for orphan sites. There is a monthly accrual to the reserve and an end-of-year adjustment based on the difference between expenditures and budget estimates to keep the reserve balanced and reflecting Olin's total liabilities.

Olin gives high attention to the difference between budgeted and actual cost. Any time a difference exists, a team must explain why. If good reasons exist, they are off the hook; if not, it affects the team's performance assessment, especially if they used the wrong assumptions. Olin weights planning problems equally with execution problems. The same team is responsible for both and is held accountable for failure at either end. But the emphasis on getting assumptions right and other discussions suggest that the real emphasis is on doing good enough planning to avoid surprises down the road.

Table 4 summarizes Olin's environmental expenditures for the last three years and provides an estimate for 1996. Remediation costs as a percentage of total environmental costs were 47 percent, 45 percent, and 35 percent in 1993, 1994, and 1995, respectively. Total environmental cash outlays in 1996 are estimated to be $85 million: $34 million for remediation, $17 million for capital projects, and $34 million for plant operations.[24] Olin generally expects environmental cash outlays of $85 million–$100 million annually over the next several years.

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[23]Draft dated August 23, 1996. *Olin Remediation Process Notebook,* Charleston, Tenn., 1996.

[24]*Olin Corporation 1995 Annual Report,* Norwalk, Conn., p. 22.

Table 4

Olin's Environmental Expenditures (in millions of nominal dollars)

	1993	1994	1995	1996
Remedial and investigatory	44	37	25	34
Capital spending	11	11	9	17
Plant operations	38	34	36	34
Total	93	82	70	85

SOURCE: *Olin Corporation 1995 Annual Report,* Norwalk, Conn., p. 21.

Capital and plant operations environmental costs are charged to income in the year expenses are incurred. These costs are associated with waste disposal and the operation and maintenance of pollution control equipment to ensure compliance. Olin has historically paid for compliance costs through cash flow and expects to continue this funding mechanism.[25]

Remediation and site investigation costs are "provided for in accordance with generally accepted accounting principles governing probability and the ability to reasonably estimate future costs."[26] Much of the $44 million spent in 1993 was associated with the discovery of additional contamination at one particular site undergoing remediation, and more-definitive data regarding the nature and extent of contamination at other sites. Cash outlays for remediation are not charged to income, but rather to a reserve established to cover such costs identified and expensed to corporate income in prior years. Such prior year charges were $85 million, $17 million, and $25 million in 1993, 1994, and 1995, respectively.

Over the period 1986 to 1993, Olin increased spending on "construction and remediation" activities from 60 percent to 70 percent of total remediation budgets, while holding studies and analysis costs to 16 percent.[27]

The decrease in remediation costs shown in Table 4 from 1993 to 1995 is an accurate reflection of the variability in annual remediation

[25] *Olin Corporation 1995 Annual Report,* Norwalk, Conn., p. 21.

[26] *Olin Corporation 1995 Annual Report,* Norwalk, Conn., p. 21.

[27] Langseth and Lambe, 1995, p. 111.

costs, as is the increase in 1996. The variation is driven by a few large sites and the uncertainty associated with actual expenditures in any one year. Estimated 1996 expenditures included $36 million for remedial actions, $4 million for legal expenses, and $3 million for plant demolition.

On average, Olin estimates annual expenditures of $30 million–$40 million per year. Actual annual costs may vary significantly from this estimate as a result of the inherent uncertainty of the remediation process. In particular, the timing of agency approvals for actions is difficult to predict. Also, only certain costs can reasonably be estimated at certain points in the process. For instance, during preliminary investigations, the costs of remedial actions cannot be determined since appropriate remedies have not yet been identified.

Future remediation costs are subject to additional uncertainties, including identification of new sites, advances in technology, changes in laws and regulations, changes in how those regulations are applied, data scarcity and reliability problems, the difficulty of estimating the financial responsibility of other involved parties, and the ability to obtain those financial contributions from other parties.[28] As a result of these uncertainties, Olin has estimated additional contingent liabilities as of 1995 at $28 million.

Despite the inherent uncertainty, budget and cost estimating processes and outputs are used both for planning purposes and as management tools. Budget numbers are used for cash flow determinations and reserve accounting (annual accrual). The accuracy of cost estimates are considered as part of a team's performance evaluation. The cost estimating process also forces a team to think though processes, uncertainties, and assumptions.

Olin's environmental liability at the end of 1995 was associated with 74 sites. Thirty-four of these are on the NPL, and 11 of these account for 80 percent of total liability.[29] Three of these 11 sites are in the investigation stage, a ROD (or equivalent) has been issued at another 3 sites, and the remaining 5 sites have both ROD and investigatory activities ongoing concurrently. These 11 sites are all former manufac-

[28] *Olin Corporation 1995 Annual Report,* Norwalk, Conn., p. 22.

[29] *Olin Corporation 1995 Annual Report,* Norwalk, Conn., p. 21.

turing facilities or disposal sites containing waste generated by those facilities.

Future environmental remediation liabilities were estimated at $111 million in both 1994 and 1995. These future liabilities are carried on Olin's financial balance sheet and do not take into account discounting, third-party recoveries, or future advances in technology. As a rule, this estimate includes known liabilities only; contingency liability estimates are not included.

A probabilistic cost/liability estimating model developed by Woodward-Clyde is currently being considered as a means to enhance the budget and cost estimating processes. The model uses commercially available software (Crystal Ball and Excel). The model, appropriately tailored to Olin's site characteristics and planning assumptions, can be used as a sensitivity analysis tool for management and provides insight into the probabilities associated with different cost outcomes. Olin is working with Woodward-Clyde to develop improved cost estimating for sites, including improved accuracy and taking probabilities into account.

There are three perceived benefits from this model: (1) determining site costs and associated probabilities, (2) identifying issues/cost drivers at a site, and (3) aggregating site costs to total program costs and associated probabilities. The model also forces the site team to think through assumptions at both the general-model and site-specific level.

ORGANIZATIONAL CHANGE

Olin has formally mapped its remediation process, specifying actors (internal and external agency), roles, responsibilities, and decision points.[30] Process mapping was done at other Olin organizations as well, as part of a corporatewide reengineering effort. The goal was to eliminate functional barriers through the use of teams.

Prior to 1990, Olin's remediation processes were functionally oriented (legal, technical, etc.). The functions did not work well to-

[30]The most recent process maps are dated July 31, 1996, and appear to update earlier 1992 versions. *Olin Remediation Process Notebook,* Charleston, Tenn., 1996.

gether. For instance, there were conflicts between the project engineering and environmental groups. Poor communication and frequent surprises characterized the process. Remediation spending was increasing with only limited visibility into what it was being spent on, why the spending was necessary, and what benefits were being produced. There was no coherent strategy and no forecasting capability. These problems, together with the "reengineering" management initiative of the late 1980s, created a climate for a fundamental change in Olin's approach to remediation management. Olin had also taken ISO 9000 seriously. Interestingly, there was no perceived external or regulatory pressure to change, and only moderate competitive pressure (to do more with less).

Olin began reengineering its remediation processes in 1990. The first step was to decide to operate as a *team.* The basic belief was that group decisionmaking leads to better-quality decisions. This led to the notion of consensus that underlies Olin's team interactions. Ultimately, this would require finding individuals who were comfortable operating in the new team culture, a very different work environment than in the previous process. Another premise underlying the reengineering effort was the need to split the remediation function out of the environmental, health, and safety group to provide more visibility. An initial task force of 12 was created in 1990 to develop the new processes and associated structures. This group included representatives of all the functions who participate in remediation: site leaders, and legal, public relations, environmental assessment, and construction and engineering specialists. Notionally, the goal was to set up remediation as a business function with the objective of eventually achieving zero spending. The basic ideas developed by the task force were reviewed by the version of the RMT in existence at that time. The key characteristics of the revised management program would include formal process mapping, team management with clear roles and responsibilities, and incentive pay.

There appear to have been two factors that enabled this fundamental process change. First, all relevant resources were "owned" by a single senior manager who could direct initial changes. Second, most participants at all organizational levels and functions were dissatisfied with the existing process.

The new process was not well received by all affected staff. There were personality conflicts, and the new culture demanded behavioral changes that required difficult adaptations. It took several years for the new process to become accepted. Implementation included team dynamics training, team discussions in repetitive meetings defining roles and strategy, and management support in the sense of demonstrating openness and consensus building, core elements of the new culture. Introducing a business perspective into remediation management—a fundamental goal of the process change—was accomplished through personnel assignments: The director of ER&E is a former plant manager, and initial site team leaders had general business management experience.

More generally, Olin's remediation process changes reflect a strong interest in improving general business practices. The change in remediation policy in 1990 reflects a broader corporate interest in business process reengineering.

Olin's remediation processes are continually changing as more is learned about what works best and as regulatory and other environmental factors change. The motivation for the ongoing 1996 change was in part driven by a change in senior management at Olin, and in part by the perceived opportunity for improvement that the change allowed.

Olin is an ISO 9000 firm and has investigated ISO 14000 for all its environmental management processes, including remediation. Olin believes that there is no reason to distinguish remediation from any other part of EH&S in terms of management approach and applies "responsible care" concepts to remediation, even though responsible care has no formal remediation program.

Olin is the only firm we have identified that has thought about applying ISO 14000 Environmental Management System standards to a remediation program. This was part of a larger evaluation by Olin focused on determining whether ISO 14000 certification made sense for the corporation; the ERG followed. When the company made the decision not to pursue certification, the ERG did not explore the concept further. The decision was based on a determination that there was no value added to certification at this time: EPA and state agencies are not yet willing to relax regulatory oversight for certified firms,

and Olin's customers (regulators) are not yet asking for ISO 14000 certification.[31]

LESSONS LEARNED

The main lessons that can be derived from Olin's remediation program experience include the following:

- Development and maintenance of good relationships with regulatory and other stakeholders facilitates the remediation process.
- Performance measurement is critical to both monitoring status and ensuring high quality. Measures should include both internal program/project and external (stakeholder) metrics and be tied to both team and individual performance evaluations.
- Team management and consensus building will allow for a smoother process. Teams should reflect all management levels as appropriate.
- External service providers can be cost-effective if carefully managed.
- Centralized management facilitates strategy coordination and dissemination of lessons learned.

[31]Olin is ISO 9000 certified.

Chapter Six

CONCLUSIONS

Although each of the cases presented here reflects differences in the implementation of remediation-management processes, the substantial similarities of the two firm's remediation programs are clearly apparent. Many of the differences can be attributed to differences in management style and culture between the two firms. Despite these differences, the underlying remediation policies and goals, management processes, and key characteristics of the implementation processes are similar. We do not advocate or argue that one approach is better than another, only that these different approaches are based on fundamentally similar principles. Ultimately, the specific implementation processes must be tailored to the organizational environment and culture of the implementing organization. Thus, it is the fundamental principles underlying the firms' remediation processes that should be of concern to DoD. Lessons drawn from these principles can be tailored and applied to DoD's environmental remediation program.

The critical program characteristics of DuPont's remediation-management processes include

- centralized management, with some decentralized execution
- integration of a business management perspective and approach
- use of risk-assessment and science-based evidence to influence remedy selection
- development and maintenance of cooperative relationships with the regulatory community by building trust and credibility and using a technical advocacy program

- cost-effective risk-based strategies that address all urgent risks and off-site contamination immediately and then press for cost-effective containment.

The critical characteristics of Olin's remediation-management program include

- centralized management to ensure coordinated strategy and continuous improvement
- a business process perspective, including extensive performance measurement
- a team management approach
- development and maintenance of cooperative relationships with the regulatory community and other stakeholders
- carefully managed use of external service providers.

These lists of critical program characteristics parallel the "best practices" discussed previously. In particular, centralized policymaking and resource allocation, building strong positive relationships with the regulatory community, risk-based decisionmaking, and business management are common to all three lists.

The contrast between centralized and decentralized management deserves further discussion, since centralized management is a core element of program management in both cases. A decentralized program management structure (i.e., Exxon[1]) may be appropriate for managing a very large number of geographically disbursed sites. Financial and management responsibility resides with the business unit that created the problem. While this structure allows for increased responsiveness to variation in the state/local regulatory environment, there is no central control, coordination, or standardization of processes. A centralized structure simplifies responsibility for costs and provides consistency in approach. Centralization does not mean isolation from line business units—site and plant representa-

[1]Each business unit in Exxon manages its own remediation program (personal communication with Rick Harley, Technical Manager, Site Remediation, Exxon, June 5, 1996).

tives can be included in management teams, as well as other corporate functions (e.g., R&D and legal).

The distribution of responsibilities between the central management group and the decentralized execution teams suggested by the case studies is significantly different from DoD's current processes. In particular, in the private sector, the central organization maintains strict control over costs and funding; in contrast, DoD's current policy allows the military services and defense agencies to maintain control of the majority of remediation funding. The current remediation funding policy—devolution—was initiated to facilitate service buy-in and accountability for funding allocation decisions, and to improve "end-user" (remediation agency) discretion in activity prioritization. The case studies argue for retracting DoD's recently implemented "devolvement" strategy.

Many of the specific approaches discussed in the case studies are potentially applicable and appropriate, in a slightly modified form, to DoD's remediation program. These include centralized management with decentralized execution (DoD already has this structure, but not the specific distribution of responsibilities suggested by the case studies), a business process approach, performance measurement, proactive identification and management of potential liabilities, and stakeholder interactions.

We make the following recommendations to enhance DoD's remediation program:

- Centrally manage resources to remove counteractive incentives at all organizational and field levels. This includes policymaking and resource allocation processes. The result would be a more consistent application of best practices (embodied in newly created standard operating procedures) and a prioritized set of program objectives.
- Use the team management concept, similar to the integrated product teams (IPTs) in acquisitions. This includes emphasizing team performance in individual performance evaluations.
- Use the "cost-as-an-independent-variable" policy to help introduce business values into remediation management. This policy essentially raises cost to a level commensurate with performance

and encourages cost-performance trade-offs to obtain the most cost-effective strategy.

- Maintain an assertive, proactive relationship with the regulatory community based on high-quality science.
- Fully and openly incorporate relevant stakeholders into decision processes. This recommendation supports DoD's already significant effort and accomplishments in this area.[2]

These recommendations are similar to those emerging from a separate study conducted by Clean Sites for the Deputy Assistant Under Secretary of Defense (Cleanup).[3]

DoD's remediation program is very large and complex; there is considerable organizational inertia and political interests that are barriers to effective implementation. Similar problems of implementing change were encountered at both Olin and DuPont. The firms both overcame such barriers in similar ways. Observed implementation process enablers include

- a reasonably clear vision of the desired future state
- strong leadership support
- centrally managed resources and problem solving in the initial phases of implementation
- iterative process improvements, incorporating feedback from employees and external stakeholders
- a team management approach
- performance evaluations of individuals and groups emphasizing change.

Evidence from the case studies, as well as the general implementation literature, suggests that establishing and maintaining these attributes at the beginning of the change program will facilitate successful implementation of the desired reforms.

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[2]See Restoration Advisory Board Workshop, 1994; and Federal Facilities Environmental Restoration Dialogue Committee, 1993.

[3]See Clark, 1996.

However, DoD cannot merely transfer lessons from the private sector because DoD faces specific management challenges as a public-sector organization. These challenges include

- the congressional budget process and annual review of the program
- multiple, conflicting program goals[4] and changes in public priorities
- a conservative regulations-based organizational culture
- the lack of market forces facilitating measurement of organizational effectiveness
- a dispersed ownership of problems, resources, and accountability.

These challenges make it difficult, but not impossible, to apply some of the major lessons from our review of best practices from two commercial firms. Nevertheless, the same process enablers (listed above) that helped the firms implement changes to their remediation program can be effective in the DoD operating environment as well.

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[4]See Rubenson and Anderson, 1995.

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