CCNS
Concerned Citizens for Nuclear Safety

September 26, 2000

HAND DELIVERED

Steve Zappe
New Mexico Environment Department
2044 A Galisteo Street
Santa Fe, NM 87505

Re: Comments on the Department of Energy's Proposed Class 2 Modifications to the Waste Isolation Pilot Plant (WIPP) Permit

Dear Mr. Zappe:

Please find below the comments of Concerned Citizens for Nuclear Safety (CCNS) regarding the proposed July 21, 2000 Class 2 modifications by the Department of Energy (DOE) to the operating permit for the Waste Isolation Pilot Plant (WIPP) as issued by the New Mexico Environment Department (NMED). I made many of these points at the August 30, 2000 information meeting in Santa Fe.

1. DOE's Application is "Administratively Incomplete and Technically Inadequate." As noted in NMED's September 5, 2000 letter to DOE and its contractor, Westinghouse Waste Isolation Division, denying temporary authorization to receive or store waste as described in the proposed permit modification, NMED found through a preliminary analysis of the modification requests that the requests are both "administratively incomplete and technically inadequate compared to the standards specified in 20.4.1.500 NMAC (incorporating 40 CFR §264)." CCNS understands that the proposed permit modifications remain administratively incomplete and technically inadequate. Therefore, the Secretary should deny the proposed permit modifications.

2. Proposed Major Modifications to the Permit. DOE is proposing major modifications to the operating permit. No ruling should be made on a major modification without an opportunity for a public hearing at which all interested persons shall be given a reasonable chance to submit data, views or arguments orally or in writing and to examine witnesses testifying at the hearing. 74-4-4.2(H) NMAC. CCNS respectfully requests that the Secretary deny DOE's proposed modifications and grant a public hearing for all interested parties.

3. Class 3 Modification Process. The NMED Secretary should reclassify DOE's proposed Class 2 modifications to Class 3 procedures because there is significant public concern about the proposed modifications and the complex nature of the proposed changes require the more extensive Class 3 procedures. 40 CFR §270.42(b)(6)(i)(C). DOE is proposing major modifications to the permit. A public hearing with technical testimony and the opportunity for cross-examination of

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witnesses is required. CCNS respectfully requests that the Secretary grant a Class 3 public hearing on DOE's proposed modifications.

4. Long-term Stewardship Concerns. Long-term stewardship should be an integral part of all decisionmaking regarding modifications to the WIPP operating permit. "Long-term stewardship" is defined in the NRDC v. Richardson, Civ. No. 97-936 (SS) (D.D.C. 12/12/98) settlement as the DOE referring "to the physical controls, institutions, information and other mechanisms needed to ensure protection of people and the environment at sites where DOE has completed or plans to complete 'cleanup' (e.g., landfill closures, remedial actions, removal actions, and facility stabilization). This concept of long-term stewardship includes, *inter alia,* land-use controls, monitoring, maintenance, and information management."

Ultimately the WIPP site will be "cleaned up." Throughout the entire WIPP permitting and post-closure activities, NMED should retain all jurisdiction and enforcement powers over WIPP.

The August 7, 2000 National Research Council (NRC) *Long-Term Institutional Management of U. S. Department of Energy Legacy Sites* report, commissioned by the DOE, states that the government lacks the technology, money and management techniques to prevent contamination on DOE property from leaving the sites and that these sites may be toxic in perpetuity. (Please see enclosures.) WIPP is one of these sites. The NRC report also states that:

> The status of lands around a contaminated site, including the presence of other contaminated sites nearby, can strongly affect site disposition decisions. Often, however, the separation of sites for administrative purposes (e.g., into operable units or solid waste management units) conflicts with the logic suggested by a site's natural geography, hydrology, and geology. Changing land uses or resource consumption patterns beyond administrative boundaries of a site, but within its natural environment can both affect and be affected by the conditions of the site. Human-induced changes in hydrologic conditions, for example, may affect the ability of isolation technologies to keep soil contaminants out of groundwater. The combination of changing human demand for water, coupled with the induced change in the availability of contaminants to the same groundwater system, can thus create risks that might not otherwise exist. *Successful management of risks will require that the institutional management system be able either to anticipate and prevent such problems before they occur, or to detect and reverse the underlying changes before harm is done.*
> Summary p. 7.

CCNS requests that NMED incorporate the principles and recommendations found in the NRC's report on Long-Term Institutional Management in all decisionmaking regarding DOE sites in New Mexico, including DOE's proposed modifications to the operating permit for WIPP.

5. Increase to Surface Storage Capacity. DOE is proposing to increase the surface storage capacity in the Waste Handling Building by 40 percent from 2,718 cubic

feet (77 cubic meters) to 3,795 cubic feet (107.4 cubic meters). This proposal is a major modification to the operating permit. 74-4-4.2(H) NMAC. CCNS respectfully requests that the Secretary deny DOE's proposed modification and grant a public hearing on this issue.

If a permittee plans to modify or add 25% increase in the facility's container storage, a Class 3 modification process is required. 40 CFR §270.42, Appendix I, F.1 and M.1. The Secretary should deny DOE/Westinghouse's proposed Class 2 modification and reclassify the request to a Class 3 modification process. CCNS respectfully requests a Class 3 modification process for this proposed modification.

6. Expand Storage Locations. DOE is proposing to add four new areas in the Waste Handling Building to allow characterization and storage activities. DOE's proposal is a major modification to the operating permit. 74-4-4.2(H) NMAC. CCNS respectfully requests that the Secretary deny DOE's proposed modification and grant a public hearing on this issue.

If a permittee proposes to modify or add to the surface impoundment units that result in increasing the facility's surface impoundment storage or treatment capacity, a Class 3 modification process is required. 40 CFR §270.42, Appendix I, §H.1. CCNS demands a Class 3 modification process for this proposed DOE modification.

7. Expand Duration of Storage. DOE is proposing to remove the 60-day limit for surface storage. DOE has requested an indefinite limit for storage. DOE's proposal is a major modification to the operating permit. 74-4-4.2(H) NMAC. CCNS respectfully requests that the Secretary deny DOE's proposal for indefinite storage and grant a public hearing on this issue.

DOE should not be allowed to have an indefinite limit for waste container storage. If NMED removes of the 60-day limit, CCNS strongly urges NMED to require a 90-day limit for surface storage. Public and environmental health and safety demands that WIPP not become a DOE surface storage area, or monitored retrievable storage area, or a surface assured isolation facility.

8. Centralized Waste Characterization at WIPP. The permit conditions for waste characterization at the site where the waste is generated and stored require that the sites actually examine the waste containers. DOE is proposing centralized waste characterization at WIPP. DOE's proposal is a material and substantial alteration and addition to the permit. The proposed condition is absent from the existing permit. DOE's proposal is a major modification to the operating permit. 74-4-4.2(H) NMAC. CCNS respectfully requests that the Secretary deny DOE's proposal for centralized waste characterization at WIPP and grant a public hearing on this issue.

It is unclear from the proposed modification what are the "small sites" for waste characterization. NMED should require DOE to list what it considers the "large" and "small" sites. The current wording is ambiguous. Such ambiguity could result in waste being shipped from Hanford, or another large site, for waste characterization at WIPP.

As evidenced at the 1999 public hearing for the WIPP permit, DOE's written records do not necessarily reflect what is in the waste containers.

If NMED allows waste characterization at WIPP, then each drum that is shipped to WIPP should have a message on it that says, "If this waste container does not meet the WIPP Waste Acceptance Criteria, then this container must be returned to sender within five working days." The permit should then provide stiff fines for any violation of the time limit. WIPP should not become a *de facto* surface waste storage facility, or monitored retrievable storage facility, or a surface assured isolation facility.

The proposed modification reverses the basic safety procedures at WIPP. Over the years, DOE and Westinghouse have said that WIPP would "start clean and stay clean." During the 1999 public hearing for the WIPP Permit, Robert F. Kehrman testified that "[w]e never open waste containers that are received from an offsite generator.... By not opening the waste, we can eliminate the possibility of spreading contamination throughout our facility. So not opening the containers, keeping the containers sealed, is a major -- a major strategy in our protection of human health and the environment." Opening the drums to characterize them at WIPP will dramatically increase the likelihood of workers being contaminated with radioactive and hazardous wastes.

9. Modification of the Audit and Surveillance Program for Waste Characterized for WIPP. DOE has asked to eliminate the audit and surveillance program. The audit and surveillance program should remain an integral part of the permit. DOE's proposal is a major modification to the operating permit. 74-4-4.2(H) NMAC. CCNS respectfully requests that the Secretary deny DOE's proposed modification and grant a public hearing on this issue.

DOE claims that NMED has 24-hour access to the WIPP permit. The permit requires only "reasonable" access. The issue of access to the WIPP site should be clarified.

Thank you for this opportunity to comment on DOE's proposed Class 2 modifications to the WIPP permit. Should you have any questions regarding our comments, please contact me.

Sincerely,

Joni Arends

Joni Arends
Waste Programs Director

Enclosure: Prepublication Copy of "Long-term Institutional Management of U. S. Department of Energy Legacy Waste Sites," National Research Council, August 7, 2000

LONG-TERM INSTITUTIONAL MANAGEMENT OF U.S. DEPARTMENT OF ENERGY LEGACY WASTE SITES

Committee on the Remediation of Buried and Tank Wastes

Board on Radioactive Waste Management
Commission on Geosciences, Environment, and Resources

National Research Council

PREPUBLICATION COPY

ADVANCE COPY

NOT FOR PUBLIC RELEASE BEFORE

Monday, August 7, 2000
5:00 p.m. EDT

PLEASE CITE AS A REPORT OF THE
NATIONAL RESEARCH COUNCIL

CONTENTS

SYNOPSIS

This study examines concerns raised by the U.S. Department of Energy (DOE) in its planning for transition from active waste site management and remediation to what the department terms "long-term stewardship." It examines the scientific, technical, and organizational capabilities and limitations that must be taken into account in planning for the long-term institutional management of the department's numerous waste sites that are the legacy to this country's nuclear weapons program. It also identifies characteristics and design criteria for effective long-term institutional management.

Of the sites in DOE's inventory, few will be cleaned up sufficiently to allow unrestricted use. At many sites, radiological and non-radiological hazardous wastes will remain, posing risk to humans and the environment for tens or even hundreds of thousands of years. In some cases, contaminants have migrated off-site or are likely to do so in the future. Future changes in the uses of sites and nearby areas make predicting risks even more difficult. In response to the technological, budgetary, and societal problems posed by these sites, DOE plans to rely on institutional controls and other stewardship measures to prevent exposure to residual contaminants following activities aimed at stabilization and containment. One message that emerges from this study, however, is that effective long-term stewardship will likely be difficult to achieve.

In this study it is argued that, while stewardship as defined by DOE is essential, a much broader-based, more systematic approach is needed. For any given site, contaminant reduction, contaminant isolation, and stewardship should be treated as an integrated, complementary system: one that requires foresight, transparently clear and realistic thinking, and accountability. Today's waste management actions should become an integral part of stewardship planning. Scientific, technical, and organizational deficiencies or knowledge gaps should be acknowledged frankly and, where possible, research investments should be made to correct them. The long-term institutional management plan for a legacy waste site should strive for stability, balanced by flexibility and provisions for iteration over time. No plan developed today is likely to remain protective for the duration of the hazards. Instead, long-term institutional management requires periodic, comprehensive reevaluation of those legacy waste sites still presenting risk to the public and the environment to ensure that they do not fall into neglect and that advantage is taken of new opportunities for their further remediation.

SUMMARY

It is now becoming clear that relatively few U.S. Department of Energy (DOE) waste sites will be cleaned up to the point where they can be released for unrestricted use. "Long-term stewardship" (activities to protect human health and the environment from hazards that may remain at its sites after cessation of remediation) will be required for over 100 of the 144 waste sites under DOE control (U.S. Department of Energy, 1999). After stabilizing wastes that remain on site and containing them as well as is feasible, DOE intends to rely on stewardship for as long as hazards persist—in many cases, indefinitely. Physical containment barriers, the management systems upon which their long-term reliability depends, and institutional controls intended to prevent exposure of people and the environment to the remaining site hazards, will have to be maintained at some DOE sites for an indefinite period of time.

The Committee on Remediation of Buried and Tank Wastes finds that much regarding DOE's intended reliance on long-term stewardship is at this point problematic. The details of long-term stewardship planning are yet to be specified, the adequacy of funding is not assured, and there is no convincing evidence that institutional controls and other stewardship measures are reliable over the long term. Scientific understanding of the factors that govern the long-term behavior of residual contaminants in the environment is not adequate. Yet, the likelihood that institutional management measures will fail at some point is relatively high, underscoring the need to assure that decisions made in the near-term are based on the best available science. Improving institutional capabilities can be expected to be every bit as difficult as improving scientific and technical ones, but without improved understanding of why and how institutions succeed and fail, the follow-through necessary to assure that long-term stewardship remains effective cannot reliably be counted on to occur.

Other things being equal, contaminant reduction is preferred to contaminant isolation and the imposition of stewardship measures whose risk of failure is high. While DOE can do much to assure that stewardship considerations become more pervasive in all aspects of DOE operations, many of the limitations in current capabilities pointed to in this report will likely require higher-level attention. Prominent among these are assured funding for long-term institutional management. Moreover, the current regulatory framework for waste site remediation appears to encourage a constrained and piecemeal approach that makes it difficult to assure that the broader needs of effective long-term institutional management get the consideration they deserve.

This study examines the capabilities and limitations of the scientific, technical, and human and institutional systems that compose the measures that DOE expects to put into place at potentially hazardous, residually contaminated sites. The committee finds that, at a minimum, DOE should plan for site disposition and stewardship much more systematically than it has to date. At many sites, future risks from residual wastes cannot be predicted with any confidence, because numerous underlying factors that influence the character, extent, and severity of long-term risks are not well understood. Among these factors are the long-term behavior of wastes in the environment, the long-term performance of engineered systems designed to contain wastes, the reliability of institutional controls and other stewardship measures, and the distribution and resource needs of future human populations.

Because uncertainty is inherent in many of these areas, and because DOE's preferred solutions—reliance on engineered barriers and institutional controls—are inherently failure-prone. step-wise planning for DOE legacy sites must be *systematic*, *integrative*, *comprehensive*, *and iterative* in its execution through time, *adaptive* in the face of uncertainty, and *active* in the search for new and different solutions. Planning for long-term institutional management should commence

while remediation is underway. Ideally, its needs are taken into account as facilities are being designed and waste management operations initiated.

To the extent that long-term stewardship imposes costs and risks on future generations, questions of intergenerational equity are raised that should be recognized in current planning. Waste site remediation is appropriately left to future generations if risks are low, if it is impractical with currently available technology, or if it would impose unacceptable costs on society were it to be undertaken today. Remediation is inappropriately left to future generations if the risks are such that what is a tractable remediation problem today becomes much less so in the future as a result of events or changes in conditions that could reasonably have been foreseen. Unfortunately, for most waste sites, little information is presently available that facilitates well- considered examination of such tradeoffs. To the extent that long-term institutional management becomes a logical extension of today's waste management activities, as the committee believes it should, the need to confront such difficult tradeoffs should lessen. Developing new facilities and managing today's wastes with the needs of long-term stewardship in mind is an important aspect of the integrative approach embodied in the committee's framework for long-term institutional management.

This study uses the term *long-term institutional management* to refer to a planning and decision-making approach that strives to achieve an appropriate balance in the way it employs contaminant reduction measures, engineers barriers that isolate residual contaminants from the human environment and retard their migration, and places reliance on institutional controls and other stewardship measures. Decisions are guided by consideration of contextual factors that include:

- risks to members of the public, workers, and the environment;
- legal and regulatory requirements;
- technical and institutional capabilities and limitations, and the current state of scientific knowledge;
- values and preferences of interested and affected parties;
- costs and related budgetary considerations; and
- impacts on and activities at other sites.

To the extent that the above contextual factors constrain decisions, a well-functioning long-term institutional management system works to curtail those constraints that compromise the basic goal of containing and minimizing the risks that prevent unrestricted release of DOE sites.

The limitations of "hardware" systems and supporting scientific understanding are amplified by the inherent fallibility of the human and organizational systems upon which stewardship ultimately depends. For this reason, emphasis is placed in this report on the management systems for long-term planning and decision making at individual DOE sites. The report recommends that DOE apply five planning principles to the management of residually contaminated sites: 1) plan for uncertainty, 2) plan for fallibility, 3) develop appropriate incentive structures, 4) undertake necessary scientific, technical, and social research and development, and 5) plan to maximize follow-through on phased, iterative, and adaptive long-term institutional management approaches. For this purpose, a long-term commitment to both basic and applied research is needed. This research must address not only improvement of technical and human systems performance, but also basic scientific questions about the behavior of wastes in the diverse environments of the nation's nuclear waste sites. While there is no assurance that management systems will continue to be effective for the future, even short-term effectiveness cannot be assured without continued, adequate funding.

Numerous measures are necessary to assure that the integrity of engineered barriers intended to isolate wastes from the environment is maintained, that the behavior of unconfined wastes in the environment is as expected, and that unanticipated exposure pathways to humans or other sensitive species do not develop. Experience to date, both at DOE sites and at hazardous waste sites elsewhere, suggests that the tools available for these purposes are of doubtful technical effectiveness. The building of an effective long-term program for DOE legacy waste sites poses a substantial challenge to "remediation technology," broadly construed. It challenges the basic science upon which technological advance depends, as well as the knowledge of organizational and human behavior upon which our ability to design effective long-term management systems ultimately rests.

The committee believes that the working assumption of DOE planners must be that many contamination isolation barriers and stewardship measures at sites where wastes are left in place will eventually fail, and that much of our current knowledge of the long-term behavior of wastes in environmental media may eventually be proven wrong. Planning and implementation at these sites must proceed in ways that are cognizant of this potential fallibility and uncertainty.

How site planning and management should proceed, given this working assumption, is a primary focus of this report. DOE has not as yet developed in any detail the institutional arrangements through which long-term site management would be implemented. Nor have these arrangements been discussed very much among DOE and its partners in state and federal regulatory agencies, site host communities, affected Indian tribes, and environmental organizations. It is important that DOE involve its Site Specific Advisory Boards in its long-term stewardship planning as early as possible. Although the rationale for long-term stewardship at DOE waste sites has been put forward in a general way in several recent studies (Probst and McGovern, 1998; U.S. Department of Energy, 1999), no coherent framework for long-term planning at individual DOE waste sites has as yet emerged. This report tackles the question of the character of the management systems that the committee believes are necessary, applying information gleaned from numerous sites to develop a general conceptual approach that can be applied on a site-specific basis. While complex-wide integration and planning are also needed, the committee's framework is intended to apply primarily on the individual, site-specific level.

What is Long-Term Institutional Management of Waste Sites?

Long-term institutional management is the committee's conception of an approach to planning and decision making for the management of contaminated sites, facilities, and materials. It represents the framework in which tradeoffs among contaminant reduction, reliance on contaminant isolation, and stewardship measures are made. The framework represents a synthesis of the committee's examination of what is and is not likely to work in long-term waste site management. It incorporates the measures available to site managers as remediation or stewardship planning moves forward, the factors that influence the site management choices made at particular points in time, and the iterative character of decision making through time as new information emerges or planned site end state goals are adjusted.

The committee's metaphor for balancing the three basic elements that waste-site managers have at their disposal—contaminant reduction, physical isolation of residual contaminants, and deployment of stewardship activities—is a "three-legged stool." These three basic sets of measures are represented by the stool's "legs." The goals or end state they are trying to achieve are represented by the stool's "seat," and the contextual factors listed earlier that constrain their use are represented by the "rungs." Metaphorically, the rugged terrain upon which the stool rests represents the variability of contamination scenarios within and among sites. This framework is developed in anticipation of the numerous questions DOE will face as it develops long-term plans for contaminated sites. *In all cases reviewed by the committee, current DOE remediation planning and planning for post-remediation stewardship can fit within the conceptual framework developed in this* *study. In no case, however, was planning and management as highly developed as the committee's framework suggests it should be.*

Why Is Long-Term Institutional Management Necessary at DOE Waste Sites?

For reasons that are technical, social, fiscal, and political, most DOE sites will not be cleaned up well enough to allow unrestricted release of the land. In a few cases the rationale for leaving contaminants in place includes a judgment that the collateral environmental damage of available remediation technologies outweighs the benefits likely to be achieved. According to recent departmental estimates, 109 of the 144 DOE waste sites, including its largest sites (such as the Hanford Site in Washington, Oak Ridge Reservation in Tennessee, Savannah River Site in South Carolina, and Idaho National Engineering and Environmental Laboratory) are unlikely to become available for site-wide unrestricted use (U.S. Department of Energy, 1999). *The large inventory of sites requiring long-term management, the nature and complexity of many of these sites, coupled with the limitations of subsurface science, requires comprehensive and systematic planning that embraces the principles of long-term institutional management described in this report.*

The fiscal limitations that preclude more complete remediation are largely a matter of national policy. At some sites the preferred land uses following completion of DOE's mission are still being debated, while at others the future roles of the sites in national defense preparedness or new to non-defense missions are under discussion (Probst and Lowe, 2000). Total cleanup costs are very sensitive to the nature of the cleanup end states selected, with large increments in estimated costs associated with moving sites from a restricted-access "iron fence" condition to the point where they can be released for unrestricted use (U.S. Department of Energy, 1996). Roughly $50 billion has been spent on remediation to date; a recent report prepared by the U.S. Department of Energy (2000b) estimates that the life-cycle costs yet to be incurred are approximately $151 to $195 billion.

By contrast, DOE officials view the long-term stewardship efforts, which are likely to rely heavily on land control, site surveillance, monitoring, maintenance, record keeping, and related activities, as inherently low cost. *The real long-term costs of site stewardship cannot be estimated with any confidence, however. Even after the details of a comprehensive long-term institutional management plan are in place, large uncertainties are likely to cloud true economic costs. In addition, equating long-term management costs with the costs of the specific stewardship activities envisioned over as long a peroid as several thousands of years fails to account for the societal costs of stewardship system failures (e.g., aquifers becoming contaminated by residual wastes whose propensity for offsite migration was not understood at the time active remediation ended). A well-designed long-term institutional management system should have as a goal the anticipation of stewardship failures and minimization of the costs and risks associated with them. It accomplishes this through investment in improving the management system itself, and in improved scientific understanding and improved remediation technology, each of which is capable of reducing these potentially large costs and risks to society in the future.*

At the larger DOE sites where local economic, political, and environmental factors already exert a strong influence on site decision making, the necessity for an integrated and forward-looking approach to long-term planning becomes especially clear. For example, growth in the Denver metropolitan region that is encroaching upon the Rocky Flats site, or the rapidly growing Las Vegas area that might one day look to areas around the Nevada Test Site for water. A different approach to long-term institutional management planning might be appropriate for sites where significant changes in the pattern of future uses are less likely. However, projections of future land uses and the values of members of the public must receive careful consideration, no matter where the site is located. At some sites, subsurface contaminants are now known to be migrating further from their sources than originally predicted, with future consequences that are not well understood at present.

Implications of Scientific, Technical, and Institutional Capabilities and Limitations for Long-Term Institutional Management

The site management measures that DOE has at its disposal, whether they are the "hardware" systems used for waste remediation and containment or the institutional systems under which all site activities occur, share the characteristic of being limited in what they can accomplish. Were contaminant reduction efforts able to perform at anything like their theoretical ideal, many of the site custodianship problems that DOE now faces would disappear. As a general rule, however, the greater the degree of decontamination, the greater the cost and, in some cases, the greater the worker risk and adverse environmental effects. Groundwater contamination is pervasive at DOE sites, and "pump and treat" operations, whether intended to reduce contamination levels or to retard migration, are expected to run for decades—or even centuries—to achieve their desired results.

In some cases, the lack of sufficient pre- or post-remediation characterization of either the wastes or the environments into which they have been placed can render realistic estimation of the effectiveness of contaminant reduction measures nearly impossible. A key question for each site must be "How much characterization is sufficient to overcome this impasse?" A major concern is the adequacy of understanding of the physical and chemical properties of the environment in which contaminants reside and their transport through the environment over time. Mathematical modeling of contaminant fate and transport is an essential tool for long-term institutional management, but its track record to date at DOE sites, particularly where contaminants reside in the unsaturated, or "vadose" zone, has been mixed. This necessitates integration of a science and technology program into both site remediation planning (National Research Council, 2000b) and the activities that follow after remediation activities cease.

In situ engineered barriers are likely to be widely applied as the need for them is closely coupled to the extent to which contaminant reduction measures are effective. Once in place, the ongoing effectiveness of the systems that are emplaced to isolate and prevent the movement of contaminants depends on institutional management, typically in the form of monitoring and maintenance. Knowledge of the effective lifetimes of the materials and systems used in barrier design is limited, however, and comparatively little performance monitoring data exists. *The lack of experience with the long-term performance of engineered barriers, coupled with the heavy reliance being placed upon them at DOE sites, is another factor that necessitates an approach to long-term institutional management that actively seeks out and applies new knowledge.*

In situ barriers used to isolate long-lived contaminants from the environment will have to be not only maintained, but in some instances completely replaced. Initial emplacement of barrier systems must therefore take that possibility into account. *Irrespective of the management systems put in place in support of other aspects of long-term stewardship programs, physical barrier systems to keep hazardous wastes in isolation will require their own on-going support from the institutional management system.*

Stewardship in its broadest sense includes all of the activities that will be required concerning potentially harmful contamination left on-site following the completion of remediation. The issues for long-term institutional management include not only what will be done, but how, and when, and by whom. Institutional controls, often especially important elements of stewardship, consist mainly of land use or access restrictions, and they can take the form either of legal restrictions imposed through covenants, easements, and the like, or of physical restrictions, such as fences, warning signs, or the posting of guards. Stewardship is not limited to institutional controls, however. It also includes information management and dissemination, oversight and enforcement, monitoring and maintenance, periodic reevaluation of protective systems, and cultivating new remediation options.

Without constant attention, stewardship measures imposed today are not likely to remain effective for as long as residual contamination presents risks. It will, however, be very difficult to assure that proper attention continues over time. This means that stewardship and science—both basic science and applied science and technology research and development—are interdependent and must be managed together. *Site stewardship that includes the monitoring and encouragement of emerging new technologies and scientific breakthroughs for their relevance to further reducing the risks associated with residual contaminants would, over the long run, decrease the potential consequences of stewardship failures.*

Many weaknesses in institutional controls and other stewardship activities stem from inherent institutional fallibilities. Understanding and predicting the nature and pervasiveness of institutional fallibility, particularly where long-term attention to mission is required, is essential if the organizations charged with long-term management of waste sites are to be designed in ways that make them resistant to failures that compromise the safety of sites with residual wastes. *Because the organizational systems charged with long-term care and custodianship of hazardous materials and for some types of public goods have proven so fallible in the past, the research and development efforts that are part of long-term institutional management needs to extend to the social, institutional, and organizational aspects of long-term management systems as well.*

"Bigger Picture" Factors That Argue for a Long-Term Institutional Management Approach

Long-term institutional management decisions are often constrained by contextual factors not easily controllable by site managers. These include risks, the state of scientific understanding, technical and institutional capabilities, costs, laws and regulations, the views of interested and affected parties, and activities at other sites. The latter includes nearby contaminated sites, nearby lands outside the facility, receptor sites, and similar sites, particularly similar sites within the DOE complex.

The status of lands around a contaminated site, including the presence of other contaminated sites nearby, can strongly affect site disposition decisions. Often, however, the separation of sites for administrative purposes (e.g., into operable units or solid waste management units) conflicts with the logic suggested by a site's natural geography, hydrology, and geology. Changing land uses or resource consumption patterns beyond the administrative boundaries of a site, but within its natural environment, can both affect and be affected by the conditions of the site. Human-induced changes in hydrologic conditions, for example, may affect the ability of isolation technologies to keep soil contaminants out of groundwater. The combination of changing human demand for water, coupled with the induced change in the availability of contaminants to the same groundwater system, can thus create risks that might not otherwise exist. *Successful management of risks will require that the institutional management system be able either to anticipate and prevent such problems before they occur, or to detect and reverse the underlying changes before harm is done.* Whether either of these can be done reliably over the long term is open to question.

One way to attempt to overcome both technical and institutional limitations is to forge links between technical and institutional capabilities. The two can be mutually reinforcing in (1) the periodic reevaluation of site disposition decisions, and (2) the development of new technologies that lessen the dependence on fallible institutional arrangements that were necessitated by the technical limitations of the past.

Designing and Implementing a Site's Institutional Management System

General design criteria exist that can help assure that a site's system of institutional management reflects an appropriate balance in the reliance it places on each of the three "legs" of the long-term institutional management "stool." Nine such criteria (discussed in Chapter 8) emerge from this study.

- *Defense in depth* refers to layering by using more than one measure to accomplish basically the same purpose, and redundancy by having more than one organization responsible for basically the same task.
- *Complementarity* refers to the support that each measure provides to the others.
- *Foresight* refers to the ability, despite uncertainties, to anticipate how the components of the system will or will not work individually and as a whole. Adjustments are then made beforehand or contingencies planned for accordingly.
- *Accountability*, which extends to both the public and government authorities, requires both a willingness to be made answerable and the technical means to identify and correct performance defects.
- *Transparency* means that the basis for site management decisions is clear and that the public has the opportunity to review and comment on these decisions before they are finalized. Transparency lays the groundwork for accountability.
- *Feasibility* refers to having an institutional management system that is technically, economically, and institutionally possible to implement within a specific time period.
- *Stability through time* refers to the likelihood that, based on reasonable estimates, the individual components of the site management system and the system as a whole will continue to perform as initially configured.
- *Iteration* refers to the concept that the whole system requires periodic reexamination to determine whether the various parts of a site's protective system are functioning as expected and whether system performance can be improved.
- *Follow-through* and *flexibility* refer to a commitment to taking innovative action to correct or redirect a site's management system when a need is identified.

In addition to these design criteria, there are other characteristics that institutional management systems should have that fall into the category of implementation criteria—that is, attributes of the system that, if included, increase chances that it will be successfully implemented and maintained over time. These include:

- *Clear objectives* and a desire on the part of those responsible for institutional management to carry out those objectives with *diligence over time*.
- A *clear system of governance* that specifies what is to be done and by whom and is founded on precepts that are enduring on the one hand and flexible on the other.
- An *integrated overall approach* that coordinates activities across the responsible entities and assures that site management measures are complementary rather than conflicting.
- *Incentives* both within and outside the institutional management organization to encourage diligence in carrying out mission objectives.

The mechanisms for creating and implementing effective long-term institutional management do not necessarily have to be created "from scratch." Some mechanisms with at least some of the attributes mentioned here already exist, both within and outside of DOE, and others, such as the program within the DOE Environmental Management Office of Long-Term Stewardship, are coming into being. Nevertheless, a systematic approach is needed for the many challenges that such mechanisms will have to face to be overcome. By the same token, a number of other factors that do not appear as specific characteristics of institutional mechanisms are essential to maintain their effectiveness through time. These include, for example, positive incentive structures that encourage system personnel to behave in ways that reinforce the management system's basic purpose, and stable funding through time.

In conclusion, given that unrestricted use will not be possible for many DOE legacy waste sites, and given that decisions that affect sites' futures are often made under conditions of considerable uncertainty, the best decision strategy overall appears to be one that avoids foreclosing future options where sensible, takes contingencies into account wherever possible, and takes seriously the prospects that failures of engineered barriers, institutional controls, and other stewardship measures in the future could have ramifications that a good steward would want to avoid. A forward-looking strategy is essential because today's scientific knowledge and technical and institutional capabilities are insufficient to provide much confidence that sites with residual risks will continue to function as expected for the time periods necessary. "Cookbook" approaches are unlikely to be successful, and there is no "one size fits all" formula for successful institutional management. In designing long-term institutional management systems, flexibility, equity, efficiency, and environmental and human health protection objectives must be attended to, more or less simultaneously. Management strategies that are iterative and provide "follow-through" on these objectives over time enhance the chances that the ultimate health and safety objectives will be met.