Department of Energy’s Legacy Management Program Development

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The U.S. Department of Energy (DOE) will conduct LTS&M (LTS&M) responsibilities at over 100 sites in the continental United States and Alaska. The newly formed Office of Legacy Management (OLM) ensures that human health and the environment are protected sustainably after cleanup is completed, sites are closed, waste is emplaced for disposal, or facilities are stabilized for long periods awaiting possible further remediation. OLM will ensure that sites are monitored to detect contaminant migration, site containment intrusion, and that maintenance of barriers and treatment facilities occur in a safe, timely and cost-effective manner. The Office will also be responsible for public outreach and stakeholder interactions, management of site records, and site real property transactions. Inherent in these responsibilities will be periodic reviews of remedy performance data to evaluate alternatives, as appropriate, which would provide more permanent remedies, and/or improved monitoring, and protectiveness.

LTS&M of a site with residual contamination must be viewed as a system made up of many interrelated and interacting components and activities. The essential functions of this system must perform are to contain the residual contaminants, monitor the site and the entire LTS&M system, communicate within and beyond the LTS&M system, and manage the system. The LTS&M “system” consists of 4 essential functions: (1) contain residual contaminants, (2) monitor the site and the system, (3) communicate within and beyond the system, and (4) manage the system. From this, flow seven key capabilities and 23 capability enhancements. The 28 targets closely follow the capability enhancements and provide a metric to evaluate progress.

A suite of versatile and effective tools is required to aid LTS&M planning, implementation, and management. Further technology development may be needed to ensure LTS&M is successful, resource-sustainable, and addresses the challenges of long-term monitoring, remedy maintenance and verification, decision-making, making land available, applying institutional controls and communicating risk and program progress over successive generations. OLM will periodically review LTS&M requirements and examine investment approaches to meet those needs.

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Legacy Management Program Built on Previous Experience with Site Stewardship

By 2010, the U.S. Department of Energy (DOE) Office of Legacy Management (LM) will have LTS&M (LTS&M) responsibilities at over 100 sites in the continental United States and Alaska. The Department currently conducts LTS&M at more than 30 sites, including Formerly Utilized Sites Remedial Action Program (FUSRAP) sites, Uranium Mill Tailings Radiation Control Act sites, and portions of departmental sites where active cleanup has been completed. As environmental remediation efforts are accelerated and facilities are cleaned and closed, its LTS&M responsibilities will increase, requiring a more comprehensive and effective management approach. The Office of Legacy Management will continue to improve the Department's LTS&M program, ensuring the continued protection of human health and the environment. Prior to the establishment of the Office of Legacy Management in December, 2003, LTS&M was referred to as long-term stewardship.

Each site is unique with regards to the type and extent of contamination, geophysical and biological attributes, the efficacy of the cleanup, future land use, and its political, regulatory and cultural aspects. LM has developed a Site Transition Framework (STF) that will be used to evaluate site management requirements pursuant to the transition from the Office of Environmental Management (EM) cleanup to the LTS&M. The purpose of the Site Transition Plan (STP) is to identify and guide the execution of the actions needed to move the site to a point where responsibility can be transferred from EM to LM.

The STP is developed through joint EM and LM agreement of the Site Transition Framework (STF). Normally this process is begun two years prior to the planned site transfer. The STF defines the end point criteria for declaring transfer complete and identifies the activities and associated schedules for those criteria that have not been met. The systematic and disciplined application of STF requirements is a critical part of developing a STP that includes all key transition activities. The STP is approved by EM-1 and LM-1, and the actions are jointly executed by EM and LM staff.

Transition is the process of accepting the post-closure management of the site and facilities after cleanup activities have been completed. As defined in DOE Manual 413.3-1, *Project Management*, transition is the progression of a project from implementation to turnover for operations. Thus, for EM and LM the transition is the passage from the phase during which engineered, near-term actions are taken to mitigate environmental and human health risks to the next phase where residual risks are maintained in a sustainable safe condition to allow beneficial use. Transfer, as described in *DOE Order 430.1B, Real Property Asset Management*, is referred to as the handoff of programmatic and financial responsibility from one program to another. Thus, upon completion, EM cleanup projects undergo transition (a process) to achieve transfer (a milestone).

The LTS&M plan includes the set of actions for managing facilities and land parcels with residual contamination, hazards, or other conditions that are projected to require post-closure LTS&M. The LTS&M plan includes actions to: maintain protection of human
health and the environment; manage the natural, cultural and historical resources for the site; and, conduct public outreach. Resources from agreed-upon activities are identified and transferred in the Program Budget Documents.

DOE will cost-effectively monitor, maintain and manage the cleanup remedy emplaced at its sites. Currently, many departmental facilities can not be remediated to levels that would allow for unrestricted use because of technical or economic limitations, worker health and safety challenges, or collateral ecological damage caused by remediation. These facilities are, or will be, required to meet regulatory standards to ensure that engineered and institutional controls employed as part of the remedy protective of human health and the environment. LM will ensure that these remedies remain effective. Given the long-lived nature of radionuclides and other residual hazards, it is reasonable to assume that, at some facilities, LTS&M will be required for hundreds or even thousands of years.

**Implementation of New Technologies Will Help Reduce LM Costs of Ownership**

LM has a need to conduct its mission cost-effectively. New developments in environmental monitoring and sensor technologies may help reduce the costs of the periodic sampling and analyses that are attendant with long-term site management responsibilities. A draft Long-Term Stewardship Roadmap recommends science and technology (S&T) pathways to provide a system of integrated capabilities needed to systematically develop and implement knowledge and tools that will offer significant cost savings and performance improvements (Table 1). The S&T proposed by the Roadmap can also be used to leverage existing research at other governmental agencies and provides a basis to work cooperatively and coordinate S&T efforts with similar objectives.

The draft LTS Roadmap’s scope was limited to S&T that will help near-term closure sites cost-effectively meet their closure schedules. The time span of the roadmap (2003-2012) provided insights into near-term improvements to reduce the long-term costs of LTS&M. DOE may need to review LM program needs in a few years to ensure that future LTS S&T developments are supportive of the LTS&M requirements resulting from site acceleration cleanup plans.

Following are other examples of LTS&M capability enhancements that were examined, but deferred by the LTS Roadmap committees until later:

- Monitoring and contaminant control methods to detect and stop contaminant migration at the source to reduce public and environmental risk

- DOE missions/activities/facilities that will minimize LTS risks and improve remedy performance

- Strategies and technologies that will promote beneficial land use and reduce the cost of the LTS footprint
Table 1. The LTS “system” (as proposed in the draft LTS S&T Roadmap) consists of 4 essential functions (boldfaced below). From this flows seven key capabilities and 23 capability enhancements. The 28 targets closely follow the capability enhancements and provide a metric to evaluate progress.

CONTAIN Residual Contaminants

Key Capability 1. Site Conceptualization and Modeling Tools
- Enhancement 1.1 Improve geologic-hydrologic-biological-chemical-thermal conceptual modeling for long-term forecasting
- Enhancement 1.2 Provide tools for long-term forecasting of environmental conditions relevant to predicted end states
- Enhancement 1.3 Provide tools for modeling the community at risk
- Enhancement 1.4 Conceptualize and predict containment/control system performance, including potential failure modes and levels of failure

Key Capability 2. Contamination Containment and Control Systems
- Enhancement 2.1 Engineer the geologic-hydrologic-biological-chemical-thermal environment to limit contaminant toxicity and mobility
- Enhancement 2.2 Design, build, and operate alternative (next-generation) containment and control systems

MONITOR the Site and the LTS System

Key Capability 3. Sensors and Sensor Systems for Site Monitoring
- Enhancement 3.1 Identify contaminant monitoring needs for all media of potential transport or exposure and fill sensor technology gaps where monitoring solutions are needed
- Enhancement 3.2 Establish site-specific parameters for environmental exposure routes and for both occupational (on-site) and non-occupational (community at risk) human routes of exposure
- Enhancement 3.3 Improve sensors and sensor systems for monitoring active and passive safety systems

COMMUNICATE Within and Beyond the LTS System

Key Capability 4. Preservation and Communication of Site Information
- Enhancement 4.1 Provide components for an integrated information visualization and display system
- Enhancement 4.2 Provide an information system module for communicating system performance data
- Enhancement 4.3 Provide options for intergenerational information archiving

Key Capability 5. Site–Community Relations
- Enhancement 5.1 Improve understanding of what affects public trust and confidence
- Enhancement 5.2 Involve the community in the conduct of site stewardship
- Enhancement 5.3 Identify and solve problems that can undermine reliability and constancy in LTS institutions

MANAGE the LTS System

Key Capability 6. LTS System Performance Verification and Monitoring
- Enhancement 6.1 Provide techniques and technologies to improve planning, design, implementation, and decision-support capabilities of Contamination Containment and Control systems and their associated monitoring systems
- Enhancement 6.2 Improve tools to verify performance of contamination containment and control and monitoring subsystems
- Enhancement 6.3 Provide tools to verify and monitor the overall (technical and non-technical) performance of the LTS system
- Enhancement 6.4 Integrate preventive maintenance requirements into site subsystems
- Enhancement 6.5 Improve tools for collecting, analyzing, evaluating, and disseminating performance data
- Enhancement 6.6 Develop science to ensure continuous improvement in stewardship implementation

Key Capability 7. Effective and Survivable Land-Use Controls
- Enhancement 7.1 Develop legal pathway modules to help identify potential legal strategies, assess established agreements, and develop draft alternative legal instruments
- Enhancement 7.2 Provide intergenerational archive options for maintaining land-use control information.
Federal LTS-Related S&T Investment into Capability Enhancements

Based on a cursory survey of Federal investment into long-term stewardship-related research and technology developments, capability enhancement areas (2-Contamination, Containment, and Control Systems; 3-Sensors and Sensor Systems; and 6-LTS System Performance Verification and Monitoring) appear to be under-funded compared to the estimated investments in the LTS S&T Roadmap. Capabilities 4, 5, and 7 are funded at approximately the levels recommended by the roadmap; though, the S&T projects do not specifically cross-walk. The shortfall in Capability 2 may be related to the lack of funding dedicated for natural cover systems. Likewise, the shortfall in Capability 6 funding may reflect the lag in funding of the fairly new area of monitoring optimization.

Figure 1 examines the notional levels of Federal agencies’ funding of LTS Roadmap-identified capability enhancement targets: green indicates that sufficient funding is applied, with yellow and orange meaning that increasingly less funding is being applied to the targets. Mainly targets 4 and 5 (right lower corner) display a fairly secure funding profile; other funding for LTS S&T is minimal, at best. This disparity could affect the timely development of certain capability enhancements that could reduce the cost of operation of LM sites. As more is learned about the funding of the LTS-related S&T by other agencies, a clearer picture of DOE’s leveraging opportunities and future investments will evolve.

Figure 1. Relationships between capability enhancements for long-term stewardship science and technology investments.
Summary

The following principles will guide the development and implementation of the LM mission:

- Legacy Management is a Department-wide responsibility.

As a whole, the Department is committed to the protection of human health and the environment in all of its actions. To ensure success, all departmental elements must consider legacy management as an integral part of the Department's mission.

- Legacy Management is a component of all aspects of departmental decision-making.

It is the responsibility of sites and Headquarters offices to ensure that legacy management is considered in each decision that impacts DOE cleanup and long-term surveillance and maintenance. This responsibility extends from the identification of remediation alternatives, remedial design, construction, and operation and through all relevant decisions made over the lifetime of the hazards.

- The Department is a trustee of natural and cultural resources.

Residual hazards should be managed within the larger context of federal land management, which includes trusteeship for ecologically and culturally important areas. The Department will manage these hazards in accordance with applicable regulatory requirements.

- Legacy management responsibilities, especially long-term surveillance and maintenance, should be incorporated into relevant departmental policies, practices, and systems.

Legacy Management's long-term surveillance and maintenance program will be most effective when integrated into existing departmental processes and management systems. As these DOE policies, practices, and systems (such as Life-Cycle Asset Management, Integrated Safety Management, and Environmental Management Systems) are reviewed and/or implemented, a broad range of long-term surveillance and maintenance activities and needs may be incorporated. This approach will facilitate the establishment of long-term surveillance and maintenance as an essential element of all facets of departmental missions.

- An intergenerational approach is needed for legacy management

Legacy management is an enduring commitment by the federal government. Due to the longevity of hazards, the ramifications and costs of current and future decisions and missions will be experienced by generations to come. As these generations' land use...
practices and local community structures change over time, current assumptions that guide departmental policy may require reevaluation and modification.

- Legacy management policy must provide a consistent framework and acknowledge sites' need for flexibility.

Although a consistent framework for legacy management responsibilities is required for complex-wide management, Headquarters and sites must be responsive to site-specific requirements (local, tribal, state, regional, and federal). Therefore, Departmental legacy management policy must be sufficiently flexible to enable sites to perform necessary long-term surveillance and maintenance functions within their individual regulatory frameworks and communities.

- The involvement of stakeholders and state, local, and tribal governments is critical to legacy management.

The Department has the responsibility to consult with these affected parties on legacy management issues. Ongoing interaction and exchange increases public awareness. In turn, heightened public awareness facilitates informed decision-making and increases the likelihood of successful implementation of legacy management responsibilities.

Further technology development may be needed to ensure LTS&M costs are reduced, consistent with protection of human health and the environment. A suite of versatile and effective tools is required to aid LTS&M planning, implementation, and management. Site experience with LTS&M implementation should drive S&T investments. Although sufficient funding is applied to the broad categories identified in the draft LTS S&T Roadmap, S&T funding is not currently focused by DOE on the management and social science research. More social science tools are needed for LTS&M, particularly investments in intergenerational social communication and cooperation as well as the management of records and information. LM will periodically review LTS&M requirements and examine S&T investment approaches to meet those needs.