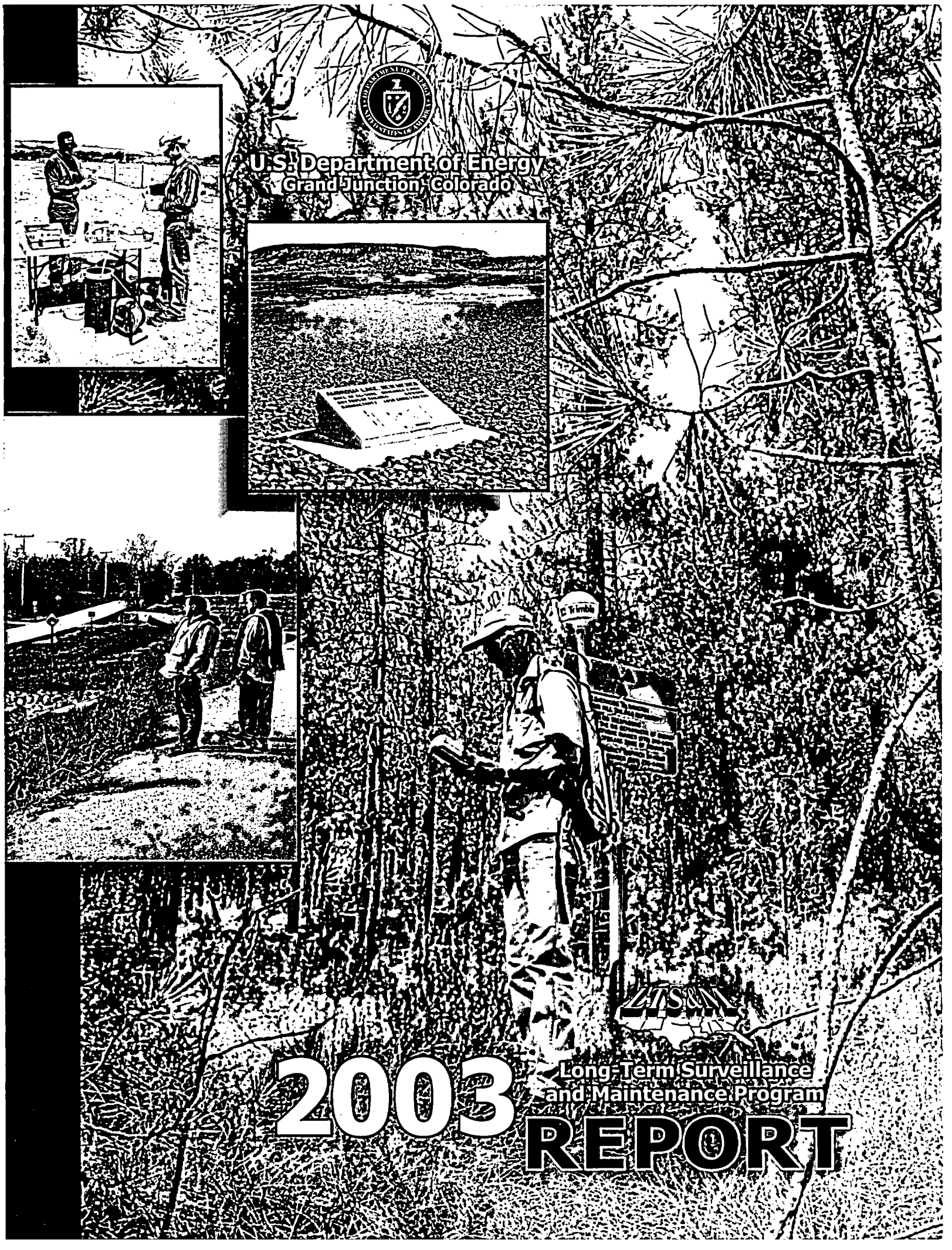

U.S. Department of Energy
Grand Junction, Colorado

LTS&M

2003 Long-Term Surveillance and Maintenance Program REPORT

DOE-LM/GJ548-2004

Long-Term Surveillance and Maintenance Program 2003 Report

U.S. Department of Energy
Grand Junction, Colorado

July 2004

Large front cover photograph:

A site inspector records a global positioning system location at the Sherwood, Washington, Disposal Site.

Cover insert photographs (clockwise from top):

Technicians collect ground water samples at the Grand Junction, Colorado, Processing Site.

This site marker, located on the disposal cell at Ambrosia Lake, New Mexico, provides information about the contents of the repository.

Inspectors view the upper end of the Southeast Drainage at the Weldon Spring, Missouri, Site.

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This report was prepared by the S.M. Stoller Corporation
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Acronyms

AEC	U.S. Atomic Energy Commission
BONUS	Boiling Nuclear Superheater [research reactor]
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980 or Superfund Program [42 *United States Code* (U.S.C.) 9601, *et seq.*]
CFR	*Code of Federal Regulations*
D&D	Decontamination and Decommissioning
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
FUSRAP	Formerly Utilized Sites Remedial Action Program
GEMS	Geospatial Environmental Mapping System
LM	Office of Legacy Management
LTS&M	Long-Term Surveillance and Maintenance [Program]
NRC	U.S. Nuclear Regulatory Commission
NWPA	Nuclear Waste Policy Act of 1982 (42 U.S.C. 10101, *et seq.*)
RCRA	Resource Conservation and Recovery Act of 1976 (42 U.S.C. 6901, *et seq.*)
UMTRA	Uranium Mill Tailings Remedial Action [Project]
UMTRCA	Uranium Mill Tailings Radiation Control Act of 1978 (42 U.S.C. 7901, *et seq.*)

Program Notes

I am pleased to present this *2003 Long-Term Surveillance and Maintenance (LTS&M) Program Report*. The LTS&M Program has provided surveillance and maintenance services since 1988 for remediated DOE sites that no longer support DOE's ongoing missions, disposal sites containing low-level radioactive material, and other sites transferred to the custody of DOE. During 2003, the LTS&M Program operated as part of the DOE Office of Environmental Management. As of December 15, 2003, the functions of this program were incorporated into the new DOE Office of Legacy Management.

The LTS&M Program was dedicated to addressing issues involved with the long-term care of legacy liabilities of former nuclear weapons production sites following environmental cleanup, such as sites that are associated with Manhattan Project and early U.S. Atomic Energy Commission activities. Because hazardous material is contained in disposal cells at many DOE sites, the Department must ensure continuing protection of human health and the environment. Even at sites that are released for unrestricted use, DOE must maintain records for future custodians.

LTS&M Program activities performed in 2003 included routine tasks such as conducting annual site inspections, performing site maintenance, continuing applied scientific research, and initiating new activities to improve stakeholder services and to broaden the Department's foundation for providing long-term management services to more sites in the future.

DOE inspected 31 sites in 2003 and provided environmental monitoring and maintenance for those sites. As a part of this process, site stewards evaluated monitoring results and site conditions to define appropriate monitoring and maintenance programs. Summaries of site conditions and management activities are presented in this report. More detailed information in fact sheets, compliance reports, environmental monitoring and mapping data, and site records is available on our Internet website at **http://www.gjo.doe.gov/LM**.

Conducting research and participating in projects funded by DOE and other federal agencies continued under the LTS&M Program in 2003. These activities provide data and identify lessons learned for designing improved waste impoundments and predicting encapsulation performance. Information and data management activities accelerated during 2003, and the Office of Legacy Management began development of a comprehensive post-closure records policy in late 2003.

The Office of Legacy Management is working closely with other DOE organizations to plan for acceptance of sites where remedial action is nearing completion, such as the former weapons production sites at Rocky Flats in Colorado and at Fernald and Mound in Ohio. The transition process from remediation to long-term management can extend over several years. DOE will ensure that essential knowledge of site conditions is captured and that site activities will continue seamlessly as remedial action is completed and the site enters the phase of post-closure care.

I am very excited about our future path under the Office of Legacy Management. Establishment of this new organization, and the Office of Land and Site Management organization within it, reflects DOE's commitment and vision for meeting the legacy responsibilities for effective and enduring care of remediated radioactively contaminated sites.

Donna Bergman-Tabbert
Director, Land and Site Management, LM–50
Office of Legacy Management

Chronicle of Low-Level Radioactive Waste: Legacy to Management

1910

1920

1914 to 1928—Western U.S. sandstones mineralized with both uranium and vanadium oxides are mined for their radium content. Most of the ore is processed in Denver, Colorado, and Canonsburg, Pennsylvania.

1920s—Demand increases for vanadium as a component of steel. Mines and mills open on the Colorado Plateau to produce the metal. Uranium is discarded as a waste mineral.

1930

1940

1946—Passage of the Atomic Energy Act (superseded by the Atomic Energy Act of 1954) establishes civilian control of nuclear power production and authorizes the U.S. Atomic Energy Commission (AEC) to possess radioactive materials and regulate their use.

1943—The Manhattan Engineer District establishes a refinery at Grand Junction to concentrate uranium from vanadium slimes produced at mills in the region.

1950

1947 through 1970—AEC operates a uranium exploration and procurement program from the Grand Junction Area Office to encourage domestic uranium production. Milling research is conducted by AEC at the Grand Junction Area Office and at Monticello, Utah.

1950s through 1990s—Uranium is produced commercially for the Federal Government and the private sector. Because of changing demands, production is cyclical and tapers off to almost nothing from 1980 to the present. Many uranium mills are abandoned.

1960

1964—Passage of the Private Ownership of Special Nuclear Materials Act encourages civilian development of nuclear electricity generation. This action helps create a market for domestic uranium.

1974—U.S. Department of Energy (DOE) establishes the Formerly Utilized Sites Remedial Action Program (FUSRAP).

1970

1978—Passage of the Uranium Mill Tailings Radiation Control Act (UMTRCA) specifies remedial action at abandoned uranium ore processing mills and stewardship of the resulting disposal sites. UMTRCA provides a mechanism for active millsites to be reclaimed, owner licenses terminated, and the sites assigned to DOE for long-term management.

1975—AEC is reorganized into the U.S. Nuclear Regulatory Commission and the Energy Research and Development Administration, the precursor of DOE.

1980

1982—Passage of the Nuclear Waste Policy Act authorizes DOE to become custodian of designated civilian nuclear waste sites.

1980s—DOE establishes the Defense Decontamination and Decommissioning Program and Surplus Facilities Management Program to remediate sites contaminated with radioactive materials during the Manhattan Project and early AEC activities.

1990

1988—DOE establishes the Long-Term Surveillance and Maintenance Program at the DOE office in Grand Junction.

2001—DOE releases the *National Defense Authorization Act Report to Congress* that provides a comprehensive analysis of the Department's long-term site management obligation. DOE and the U.S. Army Corps of Engineers establish the FUSRAP Working Group to facilitate transfer of remediated sites to DOE for long-term management.

1999—DOE and the U.S. Army Corps of Engineers finalize a Memorandum of Understanding to transfer remediated FUSRAP sites to DOE for stewardship. DOE Headquarters establishes the Headquarters Office of Long-Term Stewardship. The U.S. Congress directs DOE to report on the total long-term management obligation for all DOE sites.

2000

2003—DOE establishes the Office of Legacy Management to allow for optimum management of DOE's legacy responsibilities and to ensure future protection of human health and the environment.

Introduction

Radioactive waste was created by the Federal Government and private industry at locations around the country in support of national defense, research, and civilian power-generation programs. If not controlled, much of this legacy waste would remain hazardous to human health and the environment indefinitely. Current technology does not allow us to render this waste harmless, so the available methods to control risk rely on consolidation, isolation, and long-term management of the waste. The U.S. Department of Energy (DOE) has an obligation to safely control the radioactive waste and to inform and train future generations to maintain and, perhaps, improve established protections.

DOE is custodian for much of the radioactive and other hazardous waste under control of the Federal Government. DOE established the Formerly Utilized Sites Remedial Action Program (FUSRAP) in 1974 and the Defense Decontamination and Decommissioning (D&D) Program and the Surplus Facilities Management Program in the 1980s. Congress passed the Uranium Mill Tailings Radiation Control Act (UMTRCA) in 1978. These federal programs and legislation were established to identify, remediate, and manage legacy waste.

Remedial action is considered complete at a radioactive waste site when the identified hazardous material is isolated and the selected remedial action remedy is in place and functioning. Radioactive or other hazardous materials remain in place as part of the remedy at many DOE sites.

Long-term management of radioactive waste sites incorporates a set of actions necessary to maintain protection of human health and the environment. These actions include maintaining physical impoundment structures in good repair to ensure that they perform as designed, preventing exposure to the wastes by maintaining access restrictions and warnings, and recording site conditions and activities for future custodians. Any actions, therefore, that will prevent exposure to the radioactive waste now or in the future are part of long-term site management.

In response to post-closure care requirements set forth in UMTRCA, DOE Headquarters established the Long-Term Surveillance and Maintenance (LTS&M) Program in 1988 at the DOE office in Grand Junction, Colorado. The program assumed long-term management responsibility for sites remediated under UMTRCA and other programs. Since its inception, the LTS&M Program has evolved in response to changing stakeholder needs, improvements in technology, and the addition of more DOE sites as remediation is completed.

The mission of the LTS&M Program was to fulfill DOE's responsibility to implement all activities necessary to ensure regulatory compliance and to protect the public and the environment from long-lived wastes associated with the nation's nuclear energy, weapons, and research activities. Key components of the LTS&M Program included stakeholder participation, site monitoring and maintenance, records and information management, and research and technology transfer. This report presents summaries of activities conducted in 2003 in fulfillment of the LTS&M Program mission.

On December 15, 2003, DOE established the Office of Legacy Management (LM) to allow for optimum management of DOE's legacy responsibilities. Offices are located in Washington, DC, Grand Junction, Colorado, Morgantown, West Virginia, and Pittsburgh, Pennsylvania, to perform long-term site management, land management, site transition support, records management, and other related tasks. All activities formerly conducted under the LTS&M Program have been incorporated into the Office of Land and Site Management (LM–50), as well as management of remedies involving ground water and surface water contaminated by former processing activities.

Long-Term Management Operations at DOE Sites

The U.S. Congress has identified environmental cleanup of contaminated DOE sites as one of the Department's fundamental roles. In many cases, historic operations involving radioactive ores and refined material contaminated individual sites. DOE has identified those sites where low-level radioactive contamination exists, and cleanup at many of those sites is under way or has been completed.

If a site can be remediated to a condition that poses no residual risk under any usage scenario, DOE can release it for unrestricted use. However, hazardous material must be left at many sites because of technological or economic constraints. At some sites, the processing areas are cleaned for unrestricted use and waste is placed in on-site disposal cells. For these sites, DOE establishes a long-term program of post-remediation care to protect human health and the environment from the hazards that remain. Such a program may include restricting certain future uses of the site, controlling access to the site, and keeping the public informed of remaining contaminants and associated hazards.

Contaminated DOE sites were remediated under different environmental restoration programs, each with its own regulations and standards. In each case, specific regulations, general environmental laws, and DOE orders establish standards and limits for protection of workers, the public, and the environment. The scope of long-term management operations for individual sites varies, depending on site conditions when remedial action was completed and on regulatory requirements. All locations that cannot be released for unrestricted use require long-term care. For sites that can be released for unrestricted use, DOE is responsible for records management tasks.

All contaminated sites must consider long-term management requirements when selecting a remedy because the scope and cost to maintain a site are dependent on the selected remedy. Because of the longevity of hazards at many DOE sites, a savings in remedy cost may be exceeded many times over by increased post-remediation care requirements.

Site Transition to Long-Term Management

Site transition to long-term management occurs when all required short-term response activities are complete (e.g., soil excavation, cell construction, building decommissioning); all required long-term response measures, such as ground water treatment systems, are constructed and determined operational; all necessary documentation is in place (e.g., engineering certifications and verifications, post-closure or operating permits, final site condition and configuration records); and the site is administratively transferred from the DOE Office of Environmental Management to the Office of Legacy Management or another federal, state, or private entity.

The LTS&M Program participated in the development of guidance establishing protocols for transition of remediated sites to long-term management. Essential site knowledge is transferred along with management responsibility for the site. An efficient transition process has been developed and continues to evolve through more than a decade of site transition experience.

Development of site-specific transition procedures may start years before completion of remedial action so that essential information is captured while knowledgeable remediation personnel are still available. Necessary records are identified and obtained to develop a long-term surveillance and maintenance plan or a long-term management plan for the site.

The LTS&M Program personnel, in coordination with the U.S. Army Corps of Engineers for some sites, supervised real property transfers or acquisition of site access. Site-handoff inspections allowed program

personnel to gain site knowledge from remediation personnel and ensure that the site complies with stipulated requirements.

Maintaining the Remedy

A hazardous waste site remedy is selected that ensures protection of human health and the environment and compliance with applicable laws and regulations. DOE will ensure that the sites remain protective and compliant. Systems and activities, formerly conducted by the LTS&M Program and continuing as part of the Office of Legacy Management, are designed to meet those goals.

LTS&M Program Activities

LTS&M Program personnel conducted site surveillance and monitoring activities in accordance with approved site-specific long-term surveillance and maintenance plans. Records of these activities are maintained for the benefit of future site stewards.

Inspections

DOE conducts periodic site inspections to assess site integrity and the effectiveness of institutional controls; to determine the need for maintenance, follow-up inspections, or other interventions; and to ensure regulatory compliance. Inspectors are selected on the basis of site characteristics and issues. For example, engineers will be included on inspection teams at sites with erosion or drainage concerns. Botanists will help inspect sites with revegetation or plant encroachment issues.

Inspectors check surficial site characteristics because site concerns are often indicated by changes in surface conditions. For instance, changes in slope configuration (e.g., settling or slumping) or new vegetation patterns may indicate a modifying process to a disposal cell that should be investigated. Inspectors also evaluate site access restrictions, erosion resistance of reclaimed surfaces, cell covers and rock durability for erosion control, vegetation status, and the effectiveness of institutional controls.

Site conditions, trends, and regulatory requirements drive inspection frequency. Annual inspections are a condition of the general license under which DOE operates at UMTRCA Title I and Title II sites. When not established by regulation or Department policy and guidance, determination of inspection frequency is based on site-specific needs to maintain protectiveness and security.

Regulators are informed of site inspection schedules through direct correspondence and by posting schedules on the Internet at **http://www.gjo.doe.gov/LM**. Inspection results also are posted on this website for access by all interested stakeholders.

Monitoring

Ground water monitoring may be performed to assess disposal cell performance if specified in a site-specific long-term surveillance and maintenance plan. Monitoring may be conducted to evaluate the condition of vegetation with respect to slope stability or to monitor vegetation encroachment on cell covers and in drainage structures where vegetation must be controlled to maintain design performance. Radon monitoring may occur if a cell cover has been disturbed. Additional monitoring, such as rock durability or cell settlement, may be conducted in accordance with a long-term surveillance and maintenance plan or in response to site-specific circumstances.

Monitoring data are evaluated in conjunction with inspection results to assess the condition and performance of site containment systems or the progress of natural processes. Monitoring results are reviewed to ensure regulatory compliance, distributed to interested stakeholders, posted on the Internet for public access, and archived for reference.

Maintenance

Disposal sites are designed to require only minimal maintenance for the duration of their design lives. Currently, minor maintenance is all that is needed because most site structures are relatively new. As the sites age, however, they will require routine replacement of wear items such as fencing and signs. Several major maintenance interventions have been required to repair or improve erosion-control structures; in no case was the containment integrity of a disposal cell threatened.

Should a disposal site receive severe damage or should a cell sustain catastrophic failure, DOE will undertake the necessary corrective actions. Contacts with local law enforcement officials, who will notify DOE in case of an incident or emergency, are maintained near each site. Signs with the 24-hour phone number for contacting DOE's office in Grand Junction [(970) 248–6070] are posted at each site.

Institutional Controls

Institutional controls are legal or administrative mechanisms, such as deed restrictions, restrictive easements, or zoning laws, that limit exposure to site hazards. Typically, these mechanisms place restrictions on the use of land, ground water, or surface water at locations that cannot be released for unrestricted use. When invoked, institutional controls are often a critical part of the selected remedy package and must remain effective to ensure protectiveness. Site-specific institutional controls are assessed for effectiveness, usually at the time of the annual inspection. Assessment includes performing field inspections, ensuring that property owners and local officials remain aware of hazards and institutional controls, and keeping local law enforcement agencies informed of contact information for DOE personnel.

Records Administration

One of the primary functions of long-term stewardship is to preserve site knowledge by managing site records effectively. Activities at each site are documented and archived at the DOE office in Grand Junction for use by future stewards. Records with descriptions of baseline conditions are acquired from remedial action contractors before site transfer. Ongoing surveillance and monitoring results are preserved so that trends can be evaluated. Records are maintained in National Archives and Records Administration-compliant storage areas and are indexed and tracked with an electronic database.

Stakeholder Services

Stakeholder involvement is encouraged. Stakeholders consist of all interested parties for a given site, including local residents, regulators, elected officials, federal and state agencies, Native American Tribes, media, and the general public. Stakeholder services include responding to requests for information, providing easy access to information on the Internet, announcing events or the availability of key program documents through news releases, distributing key program documents to stakeholders, maintaining a database of stakeholders associated with each site, conducting site tours, and holding public meetings and work sessions during the development and implementation of stewardship activities. LTS&M Program services also included participating in national and international seminars and symposia and sharing technology and information with foreign stewardship programs.

Applied Research

More than 15 years of field experience with a wide variety of disposal sites has offered an opportunity to observe and monitor changes in site conditions over time, to study the interactions of disposal sites with their environments, and to evaluate existing and projected long-term performance of remedies. Access to full-scale containment systems provides a valuable source of lessons learned that can be incorporated into improved site management methods or designs for new disposal impoundments. This facet of long-term site management is presented in "Research Initiatives" on page 28.

Administrative Support

Accumulated cost and performance histories for site management and support of site transition activities since 1988 allowed the LTS&M Program to provide empirical data to DOE for development of long-term site management cost estimates, site transition processes, and policy and decision guidance.

Program Planning and Implementation

Program Management

LTS&M Program activities were conducted in accordance with the *Long-Term Surveillance and Maintenance Program Plan* (Program Plan) and site-specific plans. The Program Plan presents mission and objectives, establishes responsibilities, identifies regulatory requirements, and defines strategies for achieving program goals. Guidance for routine operations and extraordinary circumstances are presented. The Program Plan is posted on the Internet. With the assignment of LTS&M Program activities to the DOE Office of Legacy Management in December 2003, the scope of long-term site management activities will be expanded to include ground water monitoring and remediation tasks formerly conducted by the Uranium Mill Tailings Remedial Action (UMTRA) Ground Water Project at UMTRCA Title I processing sites.

Scope

Through 2003, the LTS&M Program was responsible for annual surveillance, monitoring, and maintenance of 34 sites remediated under UMTRCA Title I and Title II; the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); the Nuclear Waste Policy Act (NWPA) Section 151; the D&D Program; and FUSRAP. These responsibilities, in addition to ground water monitoring and remediation, will continue at these and future sites under the Office of Legacy Management.

By the close of fiscal year 2007, the Office of Legacy Management expects to provide long-term management services for 96 sites (see table below). At least 20 more sites could be transferred to the Office of Legacy Management after 2007. Descriptions of the remedial action programs and the sites governed by their respective regulations are provided in this report.

Calibration facilities for surface and downhole radiation detection instruments are also maintained and inspected annually. These facilities include borehole models at the DOE office in Grand Junction; calibration pads at Walker Field Airport in Grand Junction; and field calibration facilities in Casper, Wyoming, Grants, New Mexico, and George West, Texas.

Program Budget

Funding for long-term management of sites is acquired through an annual DOE budget request. Fulfillment of LTS&M Program activities cost approximately $6.6 million in fiscal 2003.

Projected Schedule for Transfer of Sites

	Fiscal Year				
Program or Site	**2003[a]**	**2004**	**2005**	**2006**	**2007**
UMTRCA Title I Sites	21	21	21	21	21
UMTRCA Title II Sites	3	11	15	20	21
FUSRAP Sites	2	29	30	32	32
D&D Sites	5	5	5	5	5
CERCLA/RCRA Sites	2	3	11	12	16
NWPA Section 151(c) Site	1	1	1	1	1
Total	**34**	**70**	**83**	**91**	**96**

[a]LTS&M Program sites.

Program Initiatives

National Contribution

LTS&M Program personnel have reviewed guidance and policy documents and agreements in support of DOE Headquarters. The Program has hosted national workshops and field demonstrations for American and foreign regulators and stakeholders involved in the long-term care of low-level radioactive disposal sites and former processing and weapons sites.

Long-Term Surveillance Plan Revisions

As conditions change at a site, the site-specific long-term surveillance plan must be revised to implement new or to eliminate unnecessary surveillance and monitoring requirements. Revisions to a plan require concurrence by regulators before implementation. The Lakeview, Oregon, Disposal Site long-term surveillance plan was revised to incorporate a recalculated minimum rock diameter for the protective riprap cover; this plan is being reviewed by the U.S. Nuclear Regulatory Commission (NRC) for concurrence. Long-term surveillance plans are also being revised to incorporate recommended ground water compliance strategies for disposal sites at Canonsburg, Pennsylvania (see page 13), Falls City, Texas (see page 14), and Green River, Utah (see page 15), and to discontinue cell performance ground water monitoring as a measure of cell performance and change vegetation control requirements on the cell at the Lowman, Idaho, Disposal Site (see page 16).

Public Information Through the Internet

DOE posted the initial Internet website for the LTS&M Program in 1999 and continues to incorporate new information as it becomes available. The website, located at **http://www.gjo.doe.gov/LM**, is designed to provide essential site information directly to stakeholders, along with several methods for contacting personnel for additional information and answers to specific questions.

One tool of the website is an interactive mapping and data format referred to as the Geospatial Environmental Mapping System (GEMS). Users can selectively query a database containing site-specific geographic information and data. Data layers that can be displayed on GEMS include the site and disposal cell boundaries, roads, fences, existing monitor wells, streams and ditches, bodies of water, annual site inspection photographs, aerial photographs, and U.S. Geological Survey quadrangle maps. Updated water quality and water level data are available for monitor wells, and the user can display and print these data in both table and graph formats.

A records tool for sites is also available. Users can search a suite of records and can select a document of interest to view, print, or download. Documents that cannot be viewed on the website can be requested during the same interactive session.

Monitor Well Documentation and Decommissioning

Monitor well information has been entered into an electronic database to manage well access, permit, and status information. DOE began decommissioning unneeded monitor wells in 2000 and will continue to decommission wells as regulators approve ground water compliance plans for processing sites and as cell performance monitoring requirements are reduced. Approximately 900 unneeded monitor wells are expected to be decommissioned, which reduces liability for DOE and results in cost savings where ground water sampling and analyses are no longer required and access fees are no longer paid.

Noxious Weed Control

In recent years, DOE has implemented a number of weed management programs at its sites that contain noxious weeds to meet the requirements of Executive Order 13112, "Invasive Species" (February 3, 1999). This order applies to federal agencies whose actions may affect the status of invasive species and includes authorization for the use of relevant programs and authorities to ". . . detect and respond rapidly to and control populations of such species in a cost-effective and environmentally sound manner." All states have adopted lists of noxious weeds specific to each state and have passed laws that require control of the weeds. When noxious weeds are identified at a site, state and local agencies and specialists are consulted to determine the best methods of control (see sidebar).

A botanist demonstrates to site inspectors and regulators how spotted knapwood at the Sherwood, Washington, Disposal Site will be controlled by the release of knapweed root weevils (shown in bottom photograph).

DOE Targets Noxious Weeds

Noxious weeds are non-native plants that have no natural enemies, spread rapidly, crowd out native plant species, and resist control. The spread of noxious weeds has become a national problem and a concern at many DOE disposal sites. A goal of site maintenance is to eradicate or limit the spread of noxious weeds at each site and to support county and state programs in preventing loss of valuable agricultural and wild lands to noxious weed infestations.

Weed Identification

When weeds are identified at a DOE disposal site, the state Department of Agriculture is contacted to determine if the weeds are considered noxious in that state. If a site contains noxious weeds, local weed scientists, extension specialists, or county weed boards are consulted to determine the best methods of control. Once weed growth has been controlled, the affected area may need to be reseeded with desirable plant species.

Weed Control Methods

Mechanical (mowing), chemical (herbicides), and biological (insects) methods are used to target specific plant species. Often, a combination of methods is selected for weed control. For example, at the Canonsburg and Burrell, Pennsylvania, sites and the Parkersburg, West Virginia, site, mowing programs were implemented to help control weeds such as poison hemlock, spotted knapweed, and Canada thistle. Spot spraying with herbicides is also necessary for weeds that are resistant to control by mowing or are not accessible by mowing equipment.

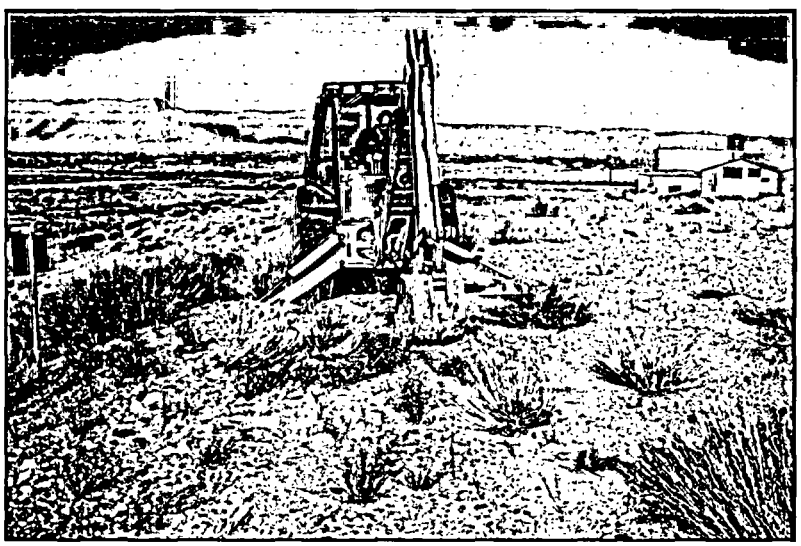
At the Durango, Colorado, and Sherwood, Washington, sites, biological methods are being used to control noxious weed populations. Noxious weeds are dispersed among desirable plants in large areas at both sites, making chemical control expensive and impractical; neither site is easily accessible by mowing equipment. Two species of insects were released at the Durango site in 2002 and 2003 to control musk thistle. Six species of insects were released at the Sherwood site in 2003 to control diffuse knapweed, spotted knapweed, and Dalmatian toadflax. All released insects have been studied and approved by the U.S. Department of Agriculture to ensure that they target only the specific host plant and have no effect on other plant species. A program to monitor the effectiveness of biological control measures at the Sherwood site will be implemented in 2004.

Program Accomplishments

The LTS&M Program has been responsible for providing site management services for remediated DOE sites. All sites assigned to the DOE office in Grand Junction for long-term management continue to be protective of human health and the environment and in compliance with applicable laws, regulations, and policies. The following accomplishments are highlights of LTS&M Program activities in 2003.

Routine Inspection, Maintenance, and Monitoring

- Inspected 31 sites and prepared reports of site conditions. Conducted monitoring of ground water quality, ground water levels, vegetation, precipitation, radon, and permit compliance as required by long-term surveillance plans or according to best management practices.
- Performed routine maintenance at 25 sites, including replacing signs, repairing or replacing damaged monuments, repairing fences, cutting encroaching vegetation, mowing grass, and controlling noxious weeds.



Erosion repair was necessary to protect a perimeter sign at the Green River, Utah, Disposal Site.

- Repaired erosion damage to two drainage ditches at the Grand Junction, Colorado, Disposal Site.
- Repaired and stabilized erosion damage at several locations at the sites in Green River and Monticello, Utah.
- Repaired and stabilized erosion damage in reclaimed areas at the Weldon Spring, Missouri, Site.
- Conducted radon monitoring at the Slick Rock, Colorado, Disposal Site after removal of two standpipes from the cell and at the open cell at the Grand Junction, Colorado, Disposal Site.
- Continued to operate treatment cells at the Durango, Colorado, Disposal Site to test the effectiveness of using zero-valent iron to remove uranium and other contaminants from transient drainage water.
- Released insects for biological control of noxious weeds at the disposal sites at Durango, Colorado, and Sherwood, Washington.

Nonroutine Maintenance

- Removed a damaged access gate at the Burrell, Pennsylvania, Disposal Site because it was no longer needed for site security.
- Removed a silt fence at the Lowman, Idaho, Disposal Site because a reclaimed area had stabilized.
- Reconstructed the storm-damaged outflow channel and replaced a washed-out boundary monument and a section of the security fence at the Shiprock, New Mexico, Disposal Site (see sidebar on page 19).
- Constructed a removable roof for a temporary storage facility located near the repository at the Monticello, Utah, Disposal Site.
- Seeded 150 acres to establish a native grassland prairie environment adjacent to the Weldon Spring, Missouri, Disposal Site (see sidebar on page 27).

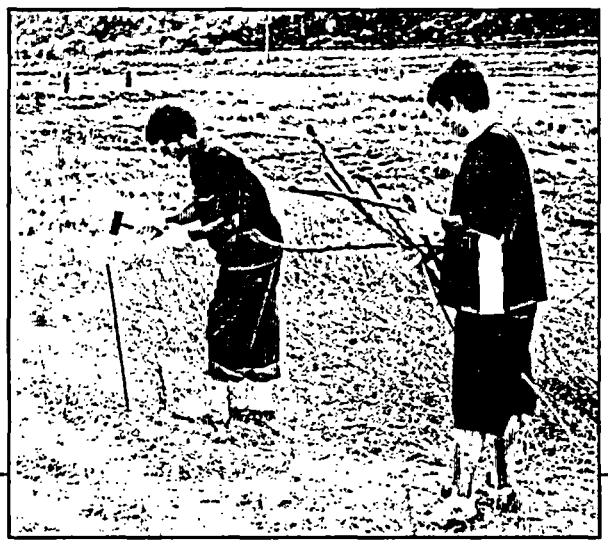
Transition of New Sites to Long-Term Management

The LTS&M Program continued to provide assistance in transferring sites for long-term management. Significant activities in 2003 included assisting UMTRCA Title II site licensees in final preparations for expected transfers in 2004 of the former uranium ore-processing sites at Shirley Basin South, Wyoming, Bear Creek, Wyoming, and L-Bar, New Mexico; preparations to transfer approximately 27 FUSRAP sites in 2004; and preliminary work to transfer 3 former weapons production sites in the next few years.

Stakeholder Services

The LTS&M Program involved stakeholders in the process of transitioning sites to long-term management. Some of these stakeholder involvement activities include preparing site-specific fact sheets, issuing news releases, conducting public meetings, and posting information on the Internet. In 2003, public meetings and/or briefings with local and state officials were held at numerous sites. Occasionally, DOE has the opportunity to involve stakeholders in a more unique and interactive way that can have long-term effects, such as the "pole planting" conducted at the remediated uranium ore-processing site near Rifle, Colorado (see sidebar). Other services performed during 2003 include

- Conducted a third focused public work session to discuss stakeholder comments on the draft long-term stewardship plan for the Weldon Spring, Missouri, Site. The previous two work sessions were held in 2002.
- Posted 47 documents in the Weldon Spring, Missouri, Site Ground Water Administrative Record as viewable documents on the Internet.
- Published notices and issued a fact sheet explaining the partial deletion process for deleting 22 of 34 properties from Operable Unit II of the Monticello, Utah, Mill Tailings Site from the U.S. Environmental Protection Agency's (EPA's) National Priorities List.



Rifle and DeBeque, Colorado, high school students plant cottonwood and willow cuttings for restoration of a wetland area.

Colorado Students Participate in Wetland "Pole Planting"

In April 2003, some western Colorado high school students received a hands-on science lesson in wetland vegetation as they worked side by side with representatives from the DOE office in Grand Junction, Colorado, planting cottonwood and willow cuttings in the wetland area at a remediated uranium ore-processing site near Rifle, Colorado. The activity provided high school students from Rifle and nearby DeBeque the opportunity to learn about wetlands and some history of the remedial action at the Rifle site.

Members of the River Watchers Club at Rifle High School and some of their parents spent an afternoon cutting cottonwood and willow shoots from another part of the site. The following morning, after a field lecture about wetland reconstruction and planting instructions, the high school students planted approximately 1,200 willow and 150 cottonwood cuttings, or "pole plants," in a 34.2-acre area along the south boundary of the Rifle site. The area was set aside to replace a wetland lost during the remediation of the processing site.

DOE plans to have the students from the Rifle River Watchers Club help monitor the wetland vegetation growing at the site. Anthony Rossilli, science teacher at Rifle High School, is pleased that his students will continue to be involved in the wetland project. "This is a wonderful opportunity for students to practice science applications, to contribute to the community, and to begin what I am hoping will be a project that students can continue to monitor and study for years to come," said Rossilli.

Replacement of a sign at the Durango, Colorado, Disposal Site is part of the routine maintenance performed at remediated sites.

- Published a Notice of Availability for the *Proposed Plan for the Surface and Ground Water Operable Unit of the Monticello, Utah, Mill Tailings Site.*
- Maintained the Internet website (**http://www.gjo.doe.gov/LM**). Maintenance of the website includes posting site-specific information, such as fact sheets, long-term surveillance plans, annual inspection reports, and 5-year review reports (as appropriate), and maintaining the electronic records system and GEMS. Visitors to the website can also obtain inspection schedules, program plans, annual compliance reports, technical reports, and news releases and can access DOE Headquarters websites. New web pages are created for sites as they are transferred to long-term management.

Applied Research

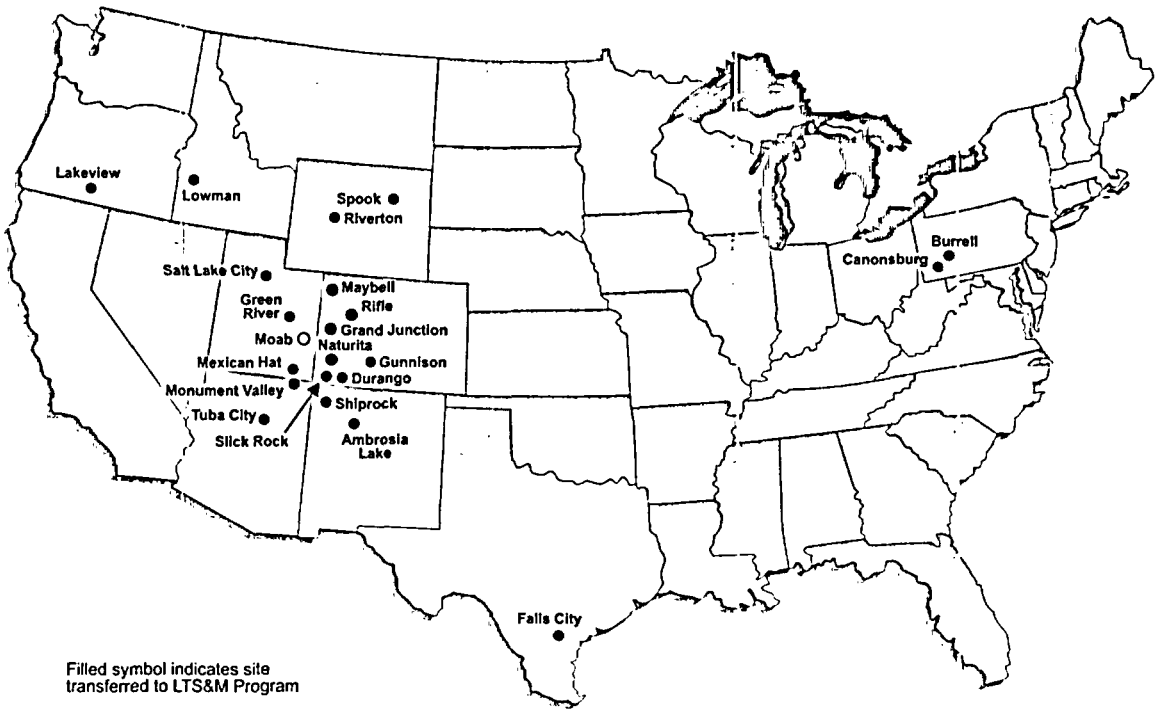
- Continued collaboration with the EPA Alternative Cover Assessment Program through the EPA National Risk Management Laboratory on analysis of water balance data from caisson lysimeters and a 7.5-acre repository cover lysimeter at Monticello, Utah.
- Continued collaboration with EPA Region 8 on a study of evapotranspiration covers and capillary barrier designs using small weighing lysimeters at Monticello, Utah.
- Completed field investigations for a study of the soil water balance, ecology, and long-term performance of the cover at the Lakeview, Oregon, Disposal Site.
- Completed a study of phytoremediation and bioremediation of contaminated soils at the former Monument Valley, Arizona, uranium millsite in collaboration with the Environmental Research Laboratory, University of Arizona.
- Completed a study of ground water phytoremediation using desert phreatophytes at the former Monument Valley, Arizona, uranium millsite in collaboration with the Environmental Research Laboratory, University of Arizona.
- Completed a study of the permeability of the cell cover at the Tuba City, Arizona, Disposal Site.
- Contributed to the DOE Science and Technology project, Monitored Natural Attenuation and Enhanced Passive Remediation, by participating in a National Technology Working Group focused on providing scientific and policy guidance for implementing appropriate passive remediation and cost-effective monitoring strategies.
- Contributed design and site environmental data for a probabilistic, risk-based model of current and potential future performance of the cell at the Lakeview, Oregon, Disposal Site in cooperation with DOE Sandia National Laboratories.

- Began an evaluation of potential detrimental as well as beneficial consequences of woody plant establishment and succession on the rock cover of the cell at the Shiprock, New Mexico, Disposal Site.
- Began a study of plant root intrusion into and permeability of the cell cover at the Grand Junction, Colorado, Disposal Site.
- Began an investigation of passive phytoremediation as a component of the remediation strategy for the ground water nitrate plume at the Tuba City, Arizona, Disposal Site.

Publications, Presentations, and Reports

- Co-authored "Engineered Containment and Control Systems: Nurturing Nature" in the journal *Risk Analysis*.
- Co-authored "Chapter 20: Ecosystem Restoration" in the textbook *Environmental Monitoring*, Academic Press.
- Submitted for publication "Phytoremediation of Nitrate-Contaminated Ground Water by Desert Phreatophytes" (co-author).
- Submitted for publication "Rapid Nitrate and Ammonium Loss from a Contaminated Desert Soil" (co-author).
- Presented "Design and Monitoring of an Evapotranspiration Cover at the Monticello, Utah, Superfund Site," at the Fifth Environmental Technology Symposium and Workshop, Interstate Technology Regulatory Council.
- Presented "Evolution and Performance of Disposal Cell Covers for Uranium Mill Tailings" at a workshop on alternative covers organized for the Hanford (Washington) Advisory Board.
- Prepared the technical report *Characterization of the Environmental Envelope for the Design of Long-Term Covers (TTP ID02SS21): Closeout Report.*
- Presented a seminar on "Ecology, Design, and Long-Term Performance of Evapotranspiration Covers" to EPA Region 8 personnel and consultants working on remedies for the Rocky Mountain Arsenal near Denver, Colorado. Presented a similar seminar to a graduate school class from Utah State University.
- Participated in the National Technology Working Group that authored "Natural and Passive Remediation of Chlorinated Solvents: Critical Evaluation of Science and Technology Targets."

Program Sites



Locations of UMTRCA Title I Sites

UMTRCA Title I Disposal and Processing Sites

For Uranium Mill Tailings Radiation Control Act (UMTRCA) Title I disposal sites in the LTS&M Program, DOE becomes a licensee to the U.S. Nuclear Regulatory Commission (NRC). Inspection, reporting, and record-keeping requirements are defined in Title 10 *Code of Federal Regulations* (CFR) Part 40.27, "General License for Custody and Long-Term Care of Residual Radioactive Material Disposal Sites." The general license for long-term custody is indefinite in duration. Usually, title for the land is assigned to an agency of the Federal Government, and the land is administratively withdrawn from unrestricted public use. Sites located on tribal land revert to tribal control, and DOE obtains a site access agreement with the tribe that allows DOE to fulfill its custodial responsibilities.

Title I of UMTRCA designated 22 inactive uranium ore-processing sites for remediation. Remediation of these sites resulted in the creation of 19 disposal cells that contain encapsulated uranium mill tailings and associated contaminated material (see page 32). Approximately 40 million cubic yards of low-level radioactive material is contained in engineered UMTRCA Title I disposal cells.

Standards for UMTRCA remedial action, cell performance, and ground water quality are established by the U.S. Environmental Protection Agency (EPA) in 40 CFR 192 "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings." Upon NRC concurrence that remedial action has been completed and acceptance of the site-specific long-term surveillance plan, each disposal site comes under the general license for long-term care by DOE. If ground water at a particular site was contaminated by former site activities, NRC will accept only the surface improvements under the general license; the site will not be fully licensed until ground water quality meets the applicable regulations. The NRC license mandates annual inspections of the disposal cells.

All but one of the Title I disposal sites are under the general license. A portion of the cell at the Grand Junction, Colorado, Disposal Site will be left open to receive additional contaminated materials and is managed by the LTS&M Program.

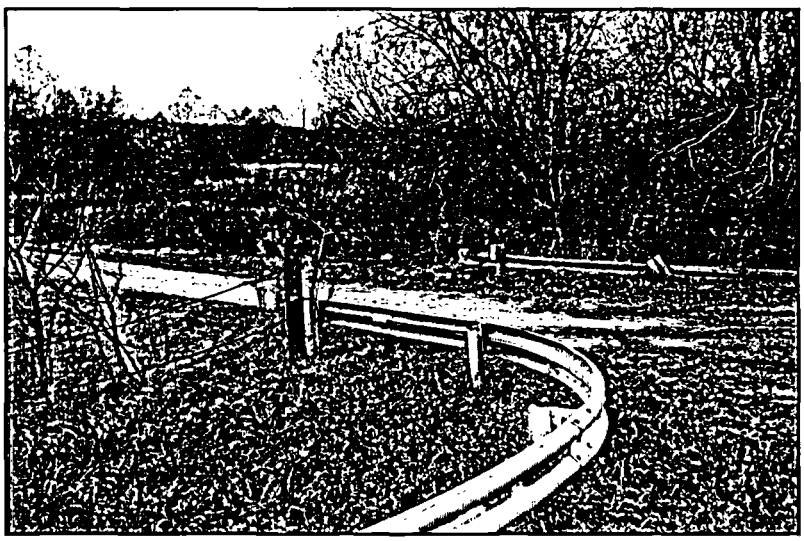
Residual radioactive material was removed from some of the Title I processing sites to off-site disposal locations. NRC does not require a license for remediated processing sites that do not have disposal cells but is the regulator if contaminated ground water remains.

Ground water compliance action plans, with compliance strategies that range from natural flushing to active remediation, have been or are being developed by DOE for processing sites that have contaminated ground water. These plans require approval by NRC and concurrence by the state and Native American tribe (when applicable). To date, ground water remedies have been approved and implemented at several former uranium ore-processing sites.

A summary of the status of each UMTRCA Title I site is presented in this report; annual compliance reports and fact sheets are available on the Internet at **http://www.gjo.doe.gov/LM** or from the DOE office in Grand Junction.

Ambrosia Lake, New Mexico

Contaminated material was consolidated and encapsulated on the existing tailings pile. The riprap-armored disposal cell was closed in 1995 and came under the general license issued by NRC in 1998. NRC concurred that ground water quality conforms to the requirements of 40 CFR 192 through the application of supplemental standards; ground water monitoring is not required to determine compliance or cell performance at this location. At the request of the State of New Mexico, however, DOE samples two monitor wells once every 3 years and reports the analytical results to the state; sampling was not required in 2003. DOE is monitoring a small shallow depression on the cell top; to date, the depression is not affecting the performance of the cell.



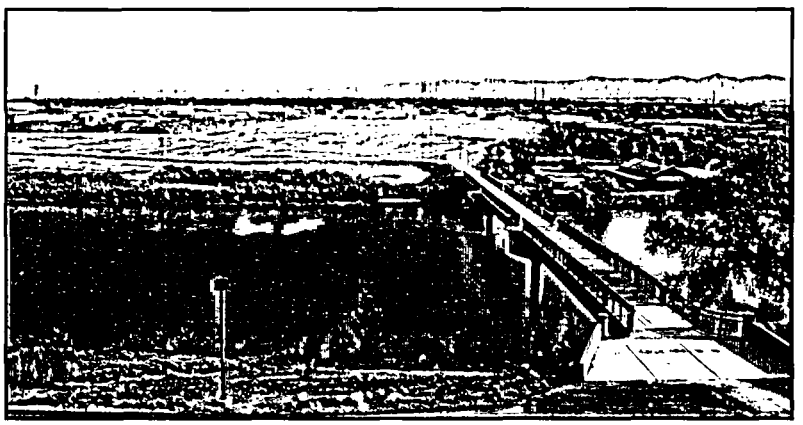
Access to the Burrell, Pennsylvania, Disposal Site was improved by removing a damaged and unneeded gate.

Burrell, Pennsylvania

Mill tailings were hauled to this location from the Canonsburg, Pennsylvania, site for use as fill. Because of the large volume of tailings on the Burrell site, a disposal cell was constructed on that site and is protected by a rock cover. The disposal site was accepted under the NRC general license in 1994. In 2003, DOE removed a damaged access gate that was no longer needed for site security and began developing a weed control plan for new infestations of noxious and undesirable plants (see sidebar on page 7).

Canonsburg, Pennsylvania

DOE encapsulated low-level radioactive material from a former millsite and 163 vicinity properties in an engineered disposal cell in 1985. NRC accepted the site under the general license in 1996. NRC approved the application of alternate concentration limits to contaminated ground water beneath the site in 2000, and limited ground water and surface water monitoring continues. Layers of rock and soil protect the radon barrier of this urban disposal cell; the cover surface was seeded with grass. Custodial maintenance at the Canonsburg Disposal Site includes fertilizing and mowing the grass within the site boundary, thus ensuring the success of the grass cover and



This bridge across the Colorado River provides access to a trail system that crosses a remediated area that was formerly a uranium ore-processing site in Grand Junction, Colorado.

helping to prevent erosion. DOE identified noxious weeds and other undesirable plant species at the site in 2003 and is developing a plan to control them (see sidebar on page 7).

A remediated parcel of land between the site and the adjacent Chartiers Creek, known as Area C, is owned by the Commonwealth of Pennsylvania but is monitored by DOE because of historically contaminated ground water and two locations of thorium contamination left in place at depth. Area C is for sale by the Commonwealth of Pennsylvania, and DOE is working with the Commonwealth to ensure that the property transfer carries a deed restriction prohibiting use of the contaminated ground water, limiting excavation to avoid encountering the thorium-contaminated soil, and preventing the parcel from being used for residential purposes. Sale of the property requires NRC concurrence.

Durango, Colorado

DOE removed tailings, contaminated building debris, and soil from a former uranium ore-processing site located near the Animas River and from associated vicinity properties. The low-level radioactive material was encapsulated in the cell at the Durango Disposal Site in 1990. NRC accepted the disposal site under the general license in 1996. A vegetated rock-and-soil matrix layer protects the top slope of the cell; the side slopes are covered with riprap to protect against wind and water erosion. Deep-rooted plants are removed to prevent damage to the radon barrier under the cell cover. Chemical and biological methods are being employed to control noxious weeds at the site. Insects that target a specific weed were released for the second consecutive year (see sidebar on page 7).

Ground water is monitored annually to confirm cell performance, and DOE continues to operate treatment cells at the site to test the effectiveness of using zero-valent iron to remove uranium and other contaminants from disposal-cell transient drainage water. Treatment cell results have been used to design and install permeable reactive barriers at the former mill tailings site at Monticello, Utah, and at Travis Air Force Base in California. Ground water at the former processing site was contaminated, and a compliance strategy is under development. A portion of the processing site has been transferred to the City of Durango and is used for a park, and another portion is being used for a major irrigation project that is under construction in the area.

Falls City, Texas

Tailings from seven locations were combined in a disposal cell on the original millsite. NRC concurred that this disposal cell conformed to EPA standards, and the surface improvements were brought under the general license in 1997. The cell top is grass covered and is mowed each year to discourage growth of deep-rooted plants on the cover. Vegetation on the riprap-armored side slopes is controlled by cutting and application of herbicides.

NRC fully licensed the site in 1998 after concurring with DOE's ground water compliance plan for the contaminated aquifer beneath the site. Compliance was attained by applying supplemental standards to site ground water that is contaminated by natural uranium ore-bearing strata and by former uranium exploration and milling operations. Monitor wells are sampled to assess cell performance and the extent of a processing-related contaminant plume.

Grand Junction, Colorado

Uranium mill tailings and associated mill building debris and ore-processing wastes were removed from the former uranium ore-processing site located along the

Colorado River in Grand Junction and transported to the Grand Junction Disposal Site located south of the city. The processing site was also the staging location for uranium mill tailings-contaminated material removed from more than 4,000 vicinity properties in the Grand Junction area. Removal of staged materials and surface remediation activities were completed in 1994. The 114-acre site is now owned by the City of Grand Junction.

The uppermost aquifer at the former processing site is of limited use because of naturally occurring uranium and selenium and contamination from former uranium ore-processing activities. DOE expects the processing-related contaminants in the ground water to attenuate through natural flushing. The contaminated ground water is managed through application of supplemental standards, institutional controls, and monitoring to ensure the protection of human health and the environment. NRC concurred with this ground water compliance strategy in 1999. The site is inspected annually to ensure that institutional controls have not been violated.

A portion of the cell at the Grand Junction Disposal Site will remain open until as late as 2023 to receive additional radioactive material from Grand Junction vicinity properties, other UMTRCA locations, and the Monticello, Utah, CERCLA sites. This action was taken to provide a disposal location for incidental low-level radioactive material, such as might be removed from utility trenches and from beneath streets as those structures are rebuilt. Approximately 2,450 cubic yards of material from Grand Junction and Monticello removal actions and water treatment activities at the Tuba City, Arizona, Disposal Site was placed in the cell in 2003. Additional material from Monticello was stockpiled and stabilized at the site late in the year because the Monticello Temporary Storage Facility was nearly full.

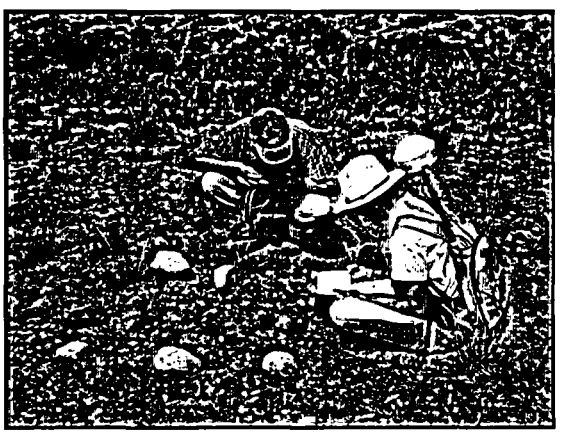
Weekly inspections of the Grand Junction Disposal Site are conducted to verify that the site is secure, and radon is monitored continuously to ensure that the cell is protective of human health and the environment. Provisions of the long-term surveillance plan address all aspects of the Grand Junction Disposal Site except the open portion of the cell. Ground water monitoring has not detected any seepage from the cell. The encroachment of deep-rooted plants on the rock-armored cell cover is controlled through cutting and treating with herbicides. Minor erosion damage to two drainage ditches was repaired in 2003.

Green River, Utah

Tailings, contaminated soil, and building debris were encapsulated in an on-site disposal cell in 1989. NRC accepted the Green River Disposal Site under the general license for UMTRCA Title I sites in 1998. In addition to annual inspections, ground water is monitored to evaluate cell performance, trends of contaminant levels, and the relationship between local precipitation and ground water flow. The underlying aquifer contains naturally elevated levels of selenium and is not used as a drinking water source; however, the aquifer was also locally contaminated by former uranium ore-processing operations at the site. A ground water compliance strategy has been developed and is being reviewed by the State of Utah.

Gunnison, Colorado

Uranium mill tailings and contaminated material from demolished mill structures formerly located near the Gunnison River and from vicinity properties in Gunnison were relocated to the Gunnison Disposal Site in 1995. NRC licensed the site in 1997. Ground water monitoring is required at six point-of-compliance wells; analytical results of ground



The vegetative cover is documented at a test plot on a reclaimed haul road near the Gunnison, Colorado, Disposal Site.

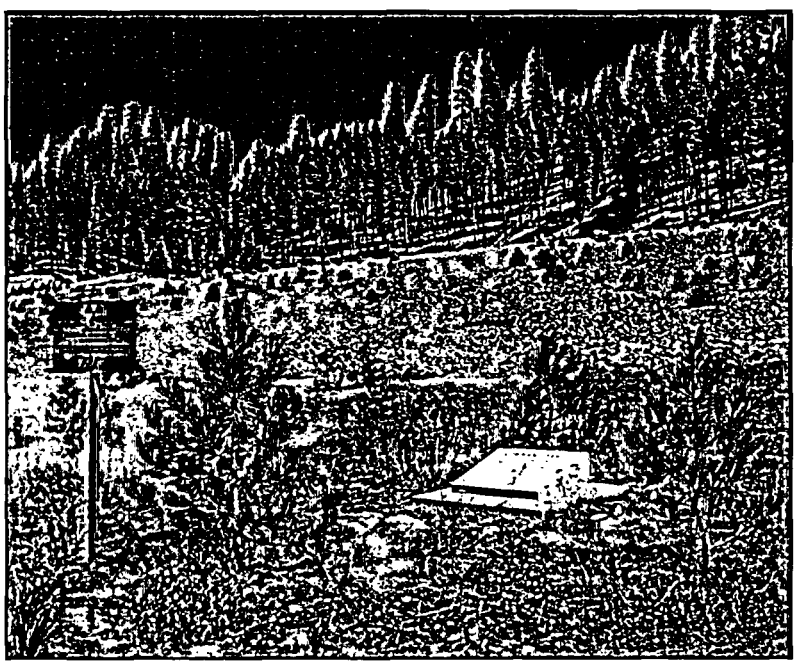
water samples continue to confirm that the cell is performing as designed. Riprap durability is monitored at key locations around the base of the cell because of freeze–thaw conditions; no degradation of the riprap is evident. The expansion of an adjacent county landfill is monitored to ensure that no activities adversely affect the disposal site. Monitoring of revegetation success continues on portions of two reclaimed haul roads that were used during disposal cell construction.

NRC concurred that surface remediation at the former uranium ore-processing site was complete when the cell was licensed; however, contaminated ground water remains at the site. DOE has proposed a ground water compliance strategy for the contaminated aquifer consisting of natural flushing, monitoring, and institutional controls. Currently, DOE is negotiating institutional control requirements with local government entities.

Lakeview, Oregon

Surface remedial action was completed at the Lakeview Processing Site in 1989, and NRC placed the off-site disposal cell under the general license in 1995. The disposal cell side slopes are armored with riprap, and the top slope is covered with riprap, overlain with soil, and planted with native grasses. The riprap is monitored annually for signs of accelerated weathering and consequent reduction in size; the riprap continues to protect the cell from erosion. Ground water beneath the disposal cell is sampled once every 5 years to verify that contaminants are not leaching from the cell; sampling was not required in 2003. DOE continues to investigate the effects of deep-rooted plants on the permeability of the cell cover.

Ground water at the former uranium-ore processing site remains contaminated from processing activities and from geothermal activity in the area. DOE has proposed application of supplemental standards, monitoring, and institutional controls as the ground water compliance strategy for the site. Part of the compliance strategy includes an upgrade to the local municipal water distribution system and implementation of ground water use restrictions.



A pine forest is encroaching on the disposal cell at Lowman, Idaho.

Lowman, Idaho

In 1992, DOE consolidated radioactive material from processing operations and from vicinity properties onto existing radioactive sand piles and encapsulated the material beneath an engineered cell cover. NRC licensed the disposal site in 1994. Ground water monitoring is required to confirm cell performance. On the basis of analysis of the ground water quality and the chemistry of the encapsulated material, DOE will request concurrence from NRC to discontinue monitoring the ground water. Control of the encroachment of vegetation on the cell, which allows surface water to infiltrate the cell, is also required. However, the encapsulated material generally is insoluble and resistant to leaching, and natural plant community succession could proceed without increased risk to human health or the environment. DOE will also request concurrence from NRC to discontinue controlling vegetation on the cell except to cut large trees to prevent damage that would occur to the cell cover if the trees were blown down and their root systems were unearthed. Because of successful erosion stabilization, a silt fence was removed from the site in 2003.

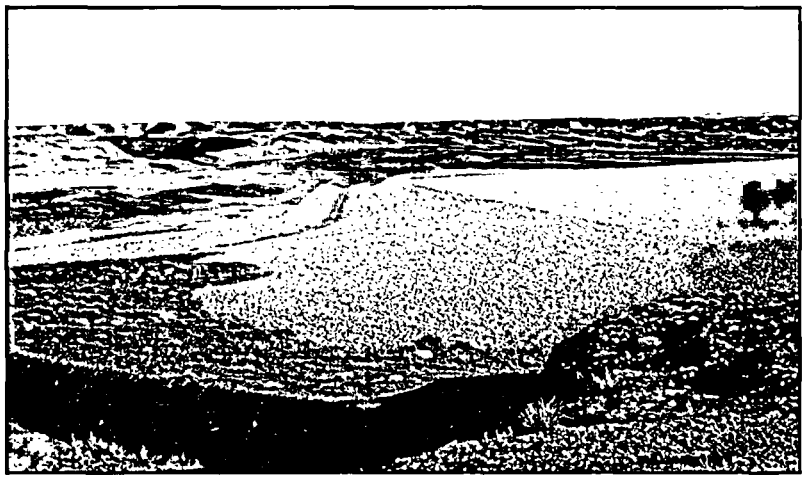
Maybell, Colorado

Tailings and process-related waste were consolidated on the existing tailings pile and were encapsulated in 1998. NRC concurred that remediation was complete and accepted the site under the general license in 1999. The site is situated in a former uranium-mining district and several abandoned mines and a remediated UMTRCA Title II processing site are located nearby. Because a large quantity of moist material was encapsulated in a portion of the cell, settlement plates installed on top of the cell are surveyed annually to detect potential differential settlement. No significant settlement has occurred, and surveying requirements are expected to be completed in 2004.

Local ground water was contaminated by uranium mineralization and from mining activities. DOE achieved compliance with ground water standards in 40 CFR 192 through the application of supplemental standards; therefore, ground water quality is not monitored at the site. DOE monitors water levels upgradient and downgradient of the cell to assess disposal cell performance.

Mexican Hat, Utah

The cell at the Mexican Hat Disposal Site contains mill tailings and waste from former uranium ore-processing facilities at Mexican Hat, Utah, and at Monument Valley, Arizona. NRC accepted the Mexican Hat Disposal Site under the general license in 1997. The Navajo Nation retains title to the land. Processing operations at the site did not affect the ground water in the uppermost aquifer; however, water containing processing-related contaminants remains in shallow perched zones at this site. The perched zones are recharged by local precipitation and are not used as a water supply. On the basis of the quantity and quality of the water that emerges from these perched zones as seeps, the seeps do not pose unacceptable human or ecological risk. However, DOE monitors six seeps on an annual basis to assess cell performance as required by the long-term surveillance plan.



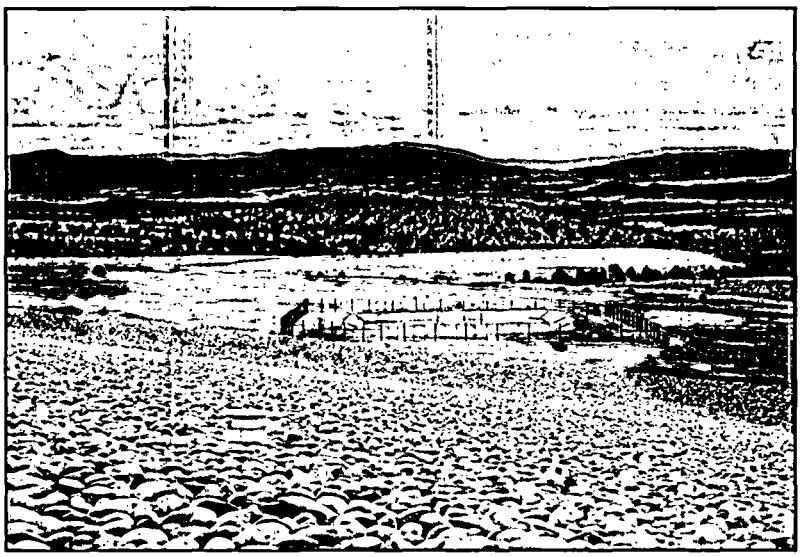
The Mexican Hat, Utah, Disposal Site contains mill tailings from processing activities at the site and from the Monument Valley, Arizona, Processing Site.

Monument Valley, Arizona

The Monument Valley Processing Site, located on 90 acres along Cane Valley Wash on Navajo Nation land, is the former location of uranium mining and milling operations. Contaminated material, consisting of two uranium mill tailings piles, mill building foundations, and contaminated soil, was relocated to the Mexican Hat Disposal Site. Surface remedial action was completed in 1994, and no residual soil contamination remains on site. Former milling operations contaminated ground water in the alluvial aquifer beneath the site; the contaminants of concern are nitrate, sulfate, and uranium. DOE is developing a plan to remediate the contaminated alluvial aquifer.

Naturita, Colorado

Contaminated soil and building debris from a former uranium ore-processing site adjacent to the San Miguel River near Naturita, Colorado, were relocated to a sandstone quarry near an UMTRCA Title II site at Uravan, Colorado, and were encapsulated beneath an engineered cover. NRC licensed the repository as the Naturita Disposal Site in 1999. Laboratory analyses of ground water samples from shallow water-bearing formations at the disposal site confirm that the cell is performing as designed. U.S. Bureau of Land Management right-of-way permits for the two disposal cell



Transient drainage water is pumped from the Rifle, Colorado, Disposal Cell to an evaporation pond.

toe-drain outlets (the drains extend beyond the property boundary), originally set to expire in 2004, were modified as perpetual easements in 2003.

Ground water is contaminated at this former processing site but water in the San Miguel River has not been degraded. DOE has proposed natural flushing of the aquifer, continued monitoring of ground water quality, and institutional controls until compliance is attained. Regulator approval is pending.

Rifle, Colorado

In 1996, DOE relocated wastes from two former uranium and vanadium ore-processing sites near the Colorado River and waste from remediated vicinity properties to the Rifle Disposal Site located north of Rifle. NRC accepted the disposal site under the general license in 1998. The cell design prevents precipitation from infiltrating through the cover, but the waste materials were saturated when placed into the cell. Water has been migrating out of the waste materials to the low point in the cell in a process called transient drainage.

Two wells installed in the deepest part of the cell have been used to monitor the accumulation of transient drainage water. To prevent this water from rising high enough to saturate the cell embankment, water is being pumped from one of the wells to an evaporation pond that was constructed in 2001. The solar-powered pumping operation halted the rise of water and has kept the water level below the action level stipulated in the long-term surveillance plan. Pumping will continue until the water level in the cell stabilizes at a specified elevation, indicating that dewatering of the cell contents is complete.

Contaminated ground water remains in the alluvial aquifer beneath the former processing sites. Ground water compliance strategy will be a combination of natural flushing and application of alternate concentration limits for contaminants that exceed EPA standards or pose a health risk. DOE will continue to monitor ground water quality and control ground water use, drilling, and other intrusive activities. DOE funded an extension of the municipal water system to serve properties affected by the contaminated ground water.

Riverton, Wyoming

Uranium and vanadium mill tailings and associated mill building debris and ore-processing wastes were removed from the former millsite located near Riverton and transported to the UMETCO Gas Hills, Wyoming, UMTRCA Title II site. Surface remedial action was completed in 1989, and no residual soil contamination remains on the site. The 140-acre site is privately owned and is located within the Wind River Indian Reservation. Milling operations contaminated the shallow alluvial and bedrock aquifers beneath the former millsite. Contaminants of concern include chromium, molybdenum, radium, selenium, and uranium. NRC concurred with natural flushing as the ground water compliance strategy in 1999; a long-term management plan is being prepared to ensure that institutional controls, such as restricting ground water use, remain effective.

Salt Lake City, Utah

The State of Utah completed remedial action of the former uranium and vanadium ore-processing site in 1987 under the direction of DOE. A local wastewater treatment district owns the former processing site. In 2000, NRC concurred with the ground water compliance strategy for the site, and DOE transferred site responsibility to the LTS&M Program.

Contaminated ground water and small pockets of contaminated soil remain at the former processing site. Ground water in the uppermost aquifer is not a current or potential source of drinking water because of naturally poor water quality and because the processing-related contamination cannot readily be remediated using conventional methods. The soil contamination does not pose an unacceptable risk to human health or the environment. Ground water compliance and control of the contaminated soil are achieved through application of supplemental standards and deed restrictions. DOE annually monitors ground water and surface water at this location and verifies that site development activities are in accordance with deed restrictions.

Mill tailings and associated contaminated material were relocated from the Salt Lake City Processing Site to the Salt Lake City Disposal Site. The disposal site, located about 80 miles west of Salt Lake City, is surrounded by an active commercial low-level radiological waste disposal facility. NRC licensed the disposal site in 1997. The existing ground water is classified as limited use because of its naturally poor quality; therefore, ground water monitoring is not required. Access to the site is coordinated through the commercial operator of the nearby waste disposal facility that also provides an escort along the access route because of ongoing haul and disposal activities adjacent to the site.

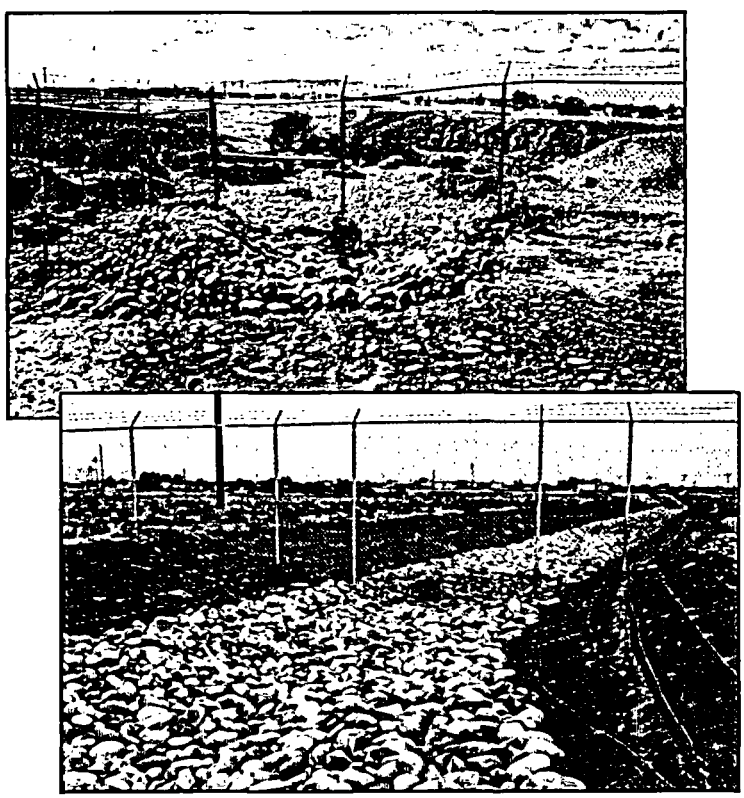
Shiprock, New Mexico

Cleanup of the former Shiprock uranium ore-processing site was completed in November 1986 by consolidating and stabilizing mill tailings in an on-site engineered disposal cell. NRC licensed the Shiprock Disposal Site in 1996. The Navajo Nation retains title to the land. Annual maintenance activities include controlling deep-rooted weeds and tamarisk, a noxious shrub, through cutting and application of herbicides. The outflow channel for runoff from the cell was redesigned and constructed in 2003 to repair damages caused by runoff from severe storm events in 2001 and 2002 (see sidebar). A section of the security fence and a boundary monument that were damaged or washed out by the storm runoff were replaced.

Erosion Repair at Shiprock, New Mexico

Runoff from the disposal cell at Shiprock, New Mexico, eroded the outflow channel and damaged property adjacent to the site during a severe rainstorm in 2001. Temporary repairs were made while the channel was being evaluated and redesigned. Another severe storm in 2002 washed out the temporary repairs and caused additional harm, including damage to the security fence and displacement of a concrete-encased boundary monument.

The outflow channel was redesigned to divert and confine flow to an engineered channel down the edge of a terrace to a natural drainage channel (Bob Lee Wash) that runs along the west side of the disposal site. The new channel, repositioned about 200 feet north of the original channel, is armored with rock-filled gabions (wire-mesh enclosures) and ends at a gabion-lined energy dissipation basin at the confluence with Bob Lee Wash. Other repairs included rebuilding a portion of the security fence and installing a new boundary monument. Reconstruction work was completed in early 2003. Although no severe storms occurred at the site during 2003, the new channel successfully diverted runoff during 2003 rainfall events.



Storm damage to an outflow channel at the Shiprock, New Mexico, Disposal Site (top photograph) resulted in redesigning and repositioning the channel (bottom photograph).

Monitoring of the aquifer beneath the cell is not required by the long-term surveillance plan because of its low yield and naturally poor water quality. However, the terrace and San Juan River floodplain alluvial aquifers were contaminated by former uranium ore-processing operations. In 2003, DOE began removing ground water from the terrace aquifer to lower the water level and reduce seepage into a nearby drainage and from the floodplain aquifer to reduce the contaminant mass at that location.

Slick Rock, Colorado

Tailings from two former uranium ore-processing sites adjacent to the Dolores River near Slick Rock, Colorado, were relocated to the Slick Rock Disposal Site in 1996. The site was accepted under the NRC general license in 1998. The cell contains tailings, contaminated debris, and soil from the demolished mill structures and vicinity properties. The riprap-armored cell is sited on a small mesa on unsaturated sedimentary rock. Ground water monitoring is not required at the disposal site. In 2002, DOE decommissioned two standpipes that had been used to monitor water levels in the cell because water levels were continuously below the datum specified in the long-term surveillance plan. Radon was monitored at the site during 2003 to verify that removal of the standpipes did not affect the performance of the radon barrier; results indicate that radon was not released and the cell continues to perform as designed.

Contaminated ground water remains in the alluvial aquifer at the former processing sites. Ground water at both sites will be remediated through natural flushing, and DOE will continue to monitor ground water quality until it conforms to EPA standards stipulated in 40 CFR 192, Subpart B.

Spook, Wyoming

The Spook Disposal Site formerly consisted of a small open-pit uranium mine, ore piles, mine adits, ore-processing structures, and associated tailings. DOE placed all contaminated material in the pit on a low-permeability soil layer and constructed an engineered cover over the waste. Under the Surface Mining Control and Reclamation Act, stockpiled overburden was compacted to 60 feet thick over the encapsulated material. The surface was graded to provide drainage away from the site and to match surrounding topography. Because of the successful site grading and revegetation efforts, only the site markers and perimeter signs distinguish the site from the surrounding land. The site was accepted under the NRC general license in 1993. Ground water monitoring is not required because the existing ground water contains widespread and naturally occurring dissolved uranium and is classified as limited use.

Tuba City, Arizona

DOE encapsulated mill tailings in place over the existing tailings pile at this site in 1990. The disposal site was accepted under the NRC general license in 1996. The Navajo Nation retains title to the land. Accumulation of blowing sand and associated minor volunteer vegetation growth on the rock cover continue to be studied to assess if the plants are affecting the water-barrier properties of the cover system. Until the study is completed, maintenance activities include cutting deep-rooted plants and treating them with herbicide.

Former milling operations contaminated ground water at this site; DOE began active ground water remediation at the site in 2000. The long-term surveillance plan specifies ground water sampling at seven monitor wells to assess cell performance.

Locations of UMTRCA Title II Sites

UMTRCA Title II Disposal Sites

Uranium processing sites addressed by Title II of UMTRCA were active when the act was passed in 1978. These sites were commercially owned and are regulated under NRC license. For license termination, the owner must conduct an NRC-approved reclamation of any on-site radioactive waste remaining from former uranium ore-processing operations. The site owner also must ensure full funding for inspections and, if necessary, ongoing maintenance. DOE then accepts title to these sites for custody and care. DOE administers the sites under the provisions of the general NRC license granted under 10 CFR 40.28, "General License for Custody and Long-Term Care of Uranium or Thorium Byproduct Materials Disposal Sites."

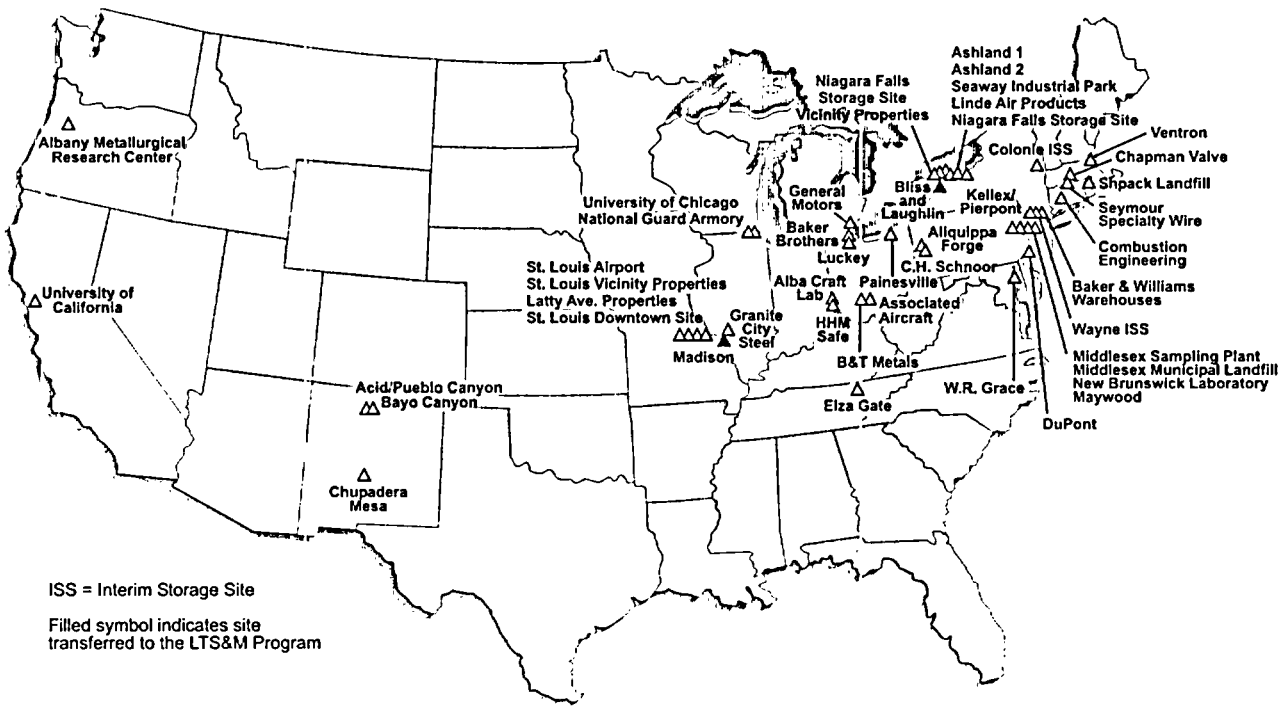
DOE managed three UMTRCA Title II sites in 2003; this number is expected to increase to 21 sites by 2007 as ongoing site reclamations are completed. Ultimately, as many as 27 UMTRCA Title II sites may be managed by DOE.

Three sites were expected to be transferred to DOE in 2003, but circumstances have delayed the transfers. NRC approved the completion of surface reclamation at the Shirley Basin (South) and Bear Creek sites in Wyoming and at the L-Bar site in New Mexico and granted alternate concentration limits as the ground water compliance strategy for each site. Nearly all the site management issues have been resolved between DOE, NRC, state regulatory agencies, and the licensees to complete the final site transfers to DOE. Transfer of these sites to DOE should occur in 2004.

A summary of the status of each UMTRCA Title II site managed by DOE is presented in this report. Annual inspection reports and fact sheets for these sites are available on the Internet at **http://www.gjo.doe.gov/LM** or from the DOE office in Grand Junction.

Bluewater, New Mexico

ARCO Coal Company stabilized mill tailings piles in place and completed engineered covers in 1995. NRC accepted the site under the general license in 1997. The radon barrier covering the wastes is protected by riprap. The Bluewater Disposal Site incorporates other stabilized disposal areas, including a



Locations of FUSRAP Sites

small riprap-armored disposal cell containing polychlorinated biphenyl-contaminated by-product material that was permitted by EPA and is in compliance with the Toxic Substances Control Act. Several years of active ground water treatment did not succeed in lowering ground water contaminant levels to background concentrations. Subsequently, NRC granted alternate concentration limits for the site. Ground water monitoring is conducted at the Bluewater site to verify continued compliance with the approved limits.

Edgemont, South Dakota

The Tennessee Valley Authority relocated tailings from the former millsite at Edgemont to an engineered disposal cell in 1989. Material from Edgemont vicinity properties was co-located in the disposal cell with material from the millsite. NRC concurred with placing this disposal site under the general license for long-term custody in 1996. Ground water monitoring is not required for this site because the uppermost confined aquifer lies below an impermeable bedrock layer. The top of the cell has a grass cover and is managed by controlled livestock grazing to promote the long-term health of the turf.

Sherwood, Washington

The Sherwood Disposal Site is situated on the Spokane Indian Reservation. Western Nuclear, Inc., completed encapsulating the tailings and contaminated materials from mining and milling operations in an engineered disposal cell in 1996; NRC included the site under general license in 2001. Native plant species were established on the soil cover of the disposal cell. The encapsulated waste remains saturated by design to prevent metals in the waste from chemically altering to forms that might leach into the underlying bedrock. Ground water sampling and analyses are conducted in accordance with the site-specific long-term surveillance plan; 2003 sampling results show that all measured parameters are within acceptable ranges. The cell embankment has been classified as a dam, requiring safety inspections to ensure compliance with the Federal Dam Safety Act. A small percentage of the riprap on portions of the dam face has crumbled and several plots were established in 2003, at the request of NRC, to monitor rock durability annually. During 2003, DOE released six different insect species to control noxious weeds that have infested the site (see sidebar on page 7).

FUSRAP Sites

DOE established the Formerly Utilized Sites Remedial Action Program (FUSRAP) in 1974 to remediate sites where radioactive contamination remained from Manhattan Project and early U.S. Atomic Energy Commission (AEC) operations. DOE assessed more than 500 candidate facilities and determined that 46 sites required remediation. DOE remediated 25 sites by 1998; thereafter, the U.S. Congress directed the U.S. Army Corps of Engineers to remediate the remaining 21 designated FUSRAP sites. Remediation of FUSRAP sites follows CERCLA protocols.

The initial 25 sites remediated by DOE were released for unrestricted use and will be assigned to the DOE office in Grand Junction for records management and stakeholder support. DOE personnel currently are coordinating transfer of records for those sites to program archives. DOE transferred some of the records to the U.S. Army Corps of Engineers in 1998 and will obtain access to those records that are now in a Federal Records Center.

In 1999, DOE negotiated a Memorandum of Understanding with the U.S. Army Corps of Engineers to transfer responsibility for FUSRAP sites to DOE for long-term care 2 years after remedial action has been completed. Two remediated sites were transferred to DOE in 2002. Those sites, located at Madison, Illinois, and at Buffalo (Bliss and Laughlin facility), New York, were released for unrestricted use. DOE responsibilities for these sites consist of managing records and responding to requests for information. In 2003, DOE began posting records for these sites on the Internet.

Site transition activities in 2003 focused on acquiring and managing records, finalizing agreements and protocols, and tracking issues and schedules for individual sites. LTS&M Program personnel participated in a stakeholders' meeting for FUSRAP sites in the St. Louis, Missouri, area and answered questions about providing for the long-term surveillance and maintenance needs of remediated sites.

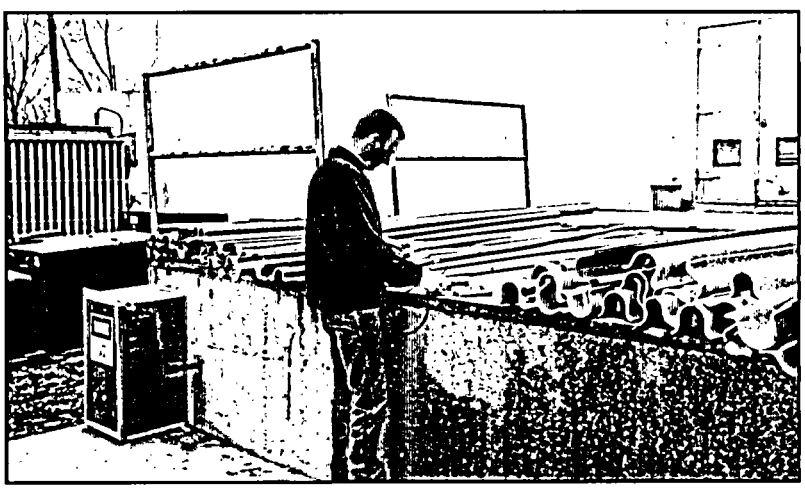
D&D Sites

The LTS&M Program managed five DOE Defense Decontamination and Decommissioning (D&D) Program sites in 2003: Piqua, Ohio, Hallam, Nebraska, Site A/Plot M located near Chicago, Illinois, Grand Junction, Colorado, and Rincón, Puerto Rico. The first three sites were transferred from the custody of the DOE Chicago Operations Office in 1998. The Grand Junction Site was transferred to the LTS&M Program in 2001.

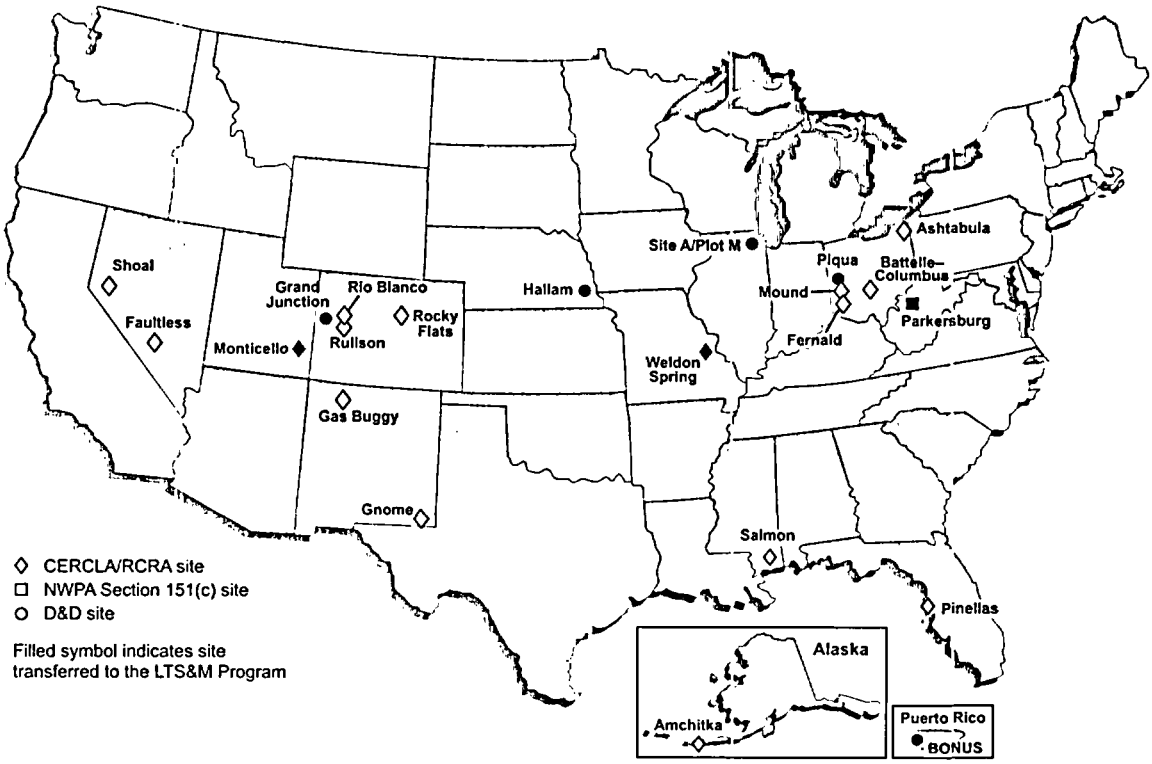
DOE began transition activities for the decommissioned Boiling Nuclear Superheater (BONUS) research reactor in Rincón, Puerto Rico, in 2002. DOE manages this facility as a fifth D&D site because AEC constructed and entombed the reactor under a program similar to the one used for the reactors at Piqua and Hallam.

Piqua, Ohio, and Hallam, Nebraska

The Piqua and Hallam sites are former nuclear reactor facilities that were built for the AEC Power Demonstration Program during the mid-1960s. In both cases, the reactors were operated in cooperation with, and on the property of, local electric utilities. Both reactors were decommissioned in the late 1960s; after removal of fuel assemblies and removable contamination, the reactor vessels



Radiological measurements are collected annually at the Piqua, Ohio, Site.



Locations of Other Sites

were sealed with concrete and steel. Annual inspections and monitoring are conducted to verify encapsulation integrity.

Site A/Plot M, Illinois

The Site A/Plot M area is the former location of Argonne National Laboratory and its predecessor, the University of Chicago Metallurgical Laboratory. Site A contains buried contaminated building debris and the biological shield for Enrico Fermi's CP–2 and CP–3 reactors. Plot M contains buried radioactive waste that was generated from the mid-1940s to 1949. Site A/Plot M was decommissioned in 1956. DOE is responsible for surface maintenance and environmental monitoring of this area and informing stakeholders of site conditions.

Grand Junction, Colorado

The Grand Junction Site, a site formerly owned and operated by DOE, was established by the Manhattan Project to purchase uranium ore concentrates. AEC conducted pilot uranium ore-milling studies at the site between 1953 and 1958. Contaminated soils from the pilot milling operations were removed except for deposits under portions of two buildings; this contamination will be remediated when DOE vacates and demolishes the buildings. All the other buildings that were contaminated during site milling operations were decontaminated or demolished. Contaminated water remains in the underlying alluvial aquifer, two ponds, and wetlands on the site and is being remediated through natural flushing of the aquifer. Ground water and surface water quality is expected to meet standards by 2080. The Grand Junction Site was transferred to the LTS&M Program in 2001. Institutional controls and water-quality monitoring will be necessary until all remediation is completed.

BONUS, Puerto Rico

The BONUS research reactor operated from 1962 until 1967. Decommissioning was completed by 1970. The reactor was defueled and the radioactive pressure vessel and internal components were entombed in place. DOE is responsible for the radioactive material at the site; the Puerto Rico Electric Power Authority owns the land and improvements.

Long-term management requirements include inspections, radiological monitoring, records management, and stakeholder services. Site transition activities commenced in 2002, including a review of the 2002 radiological survey report for the decommissioned reactor and acquisition of site records. The transition will be finalized when several small remediation activities are completed (see sidebar).

CERCLA/RCRA Sites

DOE has long-term management responsibilities for remediated sites with one or more components that were placed on the National Priorities List by EPA. Federal milling, processing, and/or weapons manufacturing operations radiologically contaminated the sites. Site remediation is conducted in accordance with Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and Resource Conservation and Recovery Act (RCRA) regulations. DOE is required by statute to conduct 5-year remedy performance reviews at these sites because remaining contamination prevents their release for unrestricted use.

In 2001, the LTS&M Program assumed responsibility for the Monticello, Utah, Sites. Transfer of the Weldon Spring, Missouri, Site occurred in 2002. Fourteen more sites are projected to be transferred to the Office of Legacy Management by the end of 2007, including the former weapons production sites at Mound and Fernald in Ohio and at Rocky Flats in Colorado.

Monticello, Utah

EPA listed the Monticello Radioactively Contaminated Properties Site (also known as the Monticello Vicinity Properties Site) and the Monticello, Utah, Mill Tailings Site on the National Priorities List in 1986 and 1989, respectively. The former uranium and vanadium ore-processing millsite and more than 400 peripheral and vicinity properties were remediated, and the material was placed in a disposal cell on DOE-owned property south of the former millsite. Construction of the disposal cell was completed in 2000.

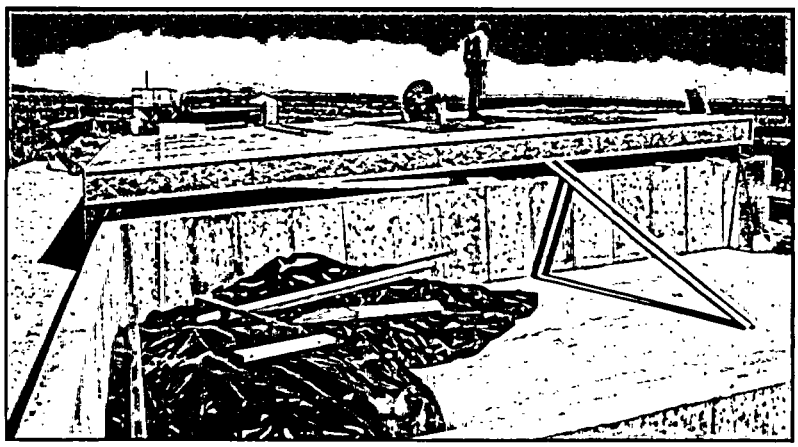
Transition Activities for BONUS Reactor

The Boiling Nuclear Superheater (BONUS) reactor, near Rincón, Puerto Rico, was decommissioned in 1970 by entombing the defueled reactor and internal components in place. Most support systems, such as control room instrumentation and fuel handling systems, remain intact. Because of the unique design of the reactor, the Puerto Rico Electric Power Authority, which owns the property and improvements, decided to preserve the structure and open it to the public as a museum.

An Environmental Assessment concluded that there was no risk of exposure to museum visitors once minor surface contamination is fixed in place. The remainder of the plant has been decontaminated, and remediation of the site is planned for completion in 2004. The Puerto Rico Electric Power Authority and DOE are negotiating a Memorandum of Understanding that defines roles and responsibilities for long-term management of the site. DOE responsibilities are expected to include annual review of radiological survey monitoring results, periodic inspection of the entombment structure, records management, and stakeholder interaction.

In February 2003, a representative of the DOE office in Grand Junction, Colorado, traveled to Puerto Rico to identify and copy records that would be useful for long-term surveillance and maintenance activities. More than 800 cubic feet of records, documenting reactor design, construction, operations, and decommissioning, were stored at the site. Selected records were shipped to Grand Junction.

The U.S. Department of Energy has initiated transition activities for the decommissioned Boiling Nuclear Superheater (BONUS) research reactor in Puerto Rico.



A removable roof was constructed for a facility near the Monticello, Utah, Disposal Site that is used for temporary storage of mill tailings excavated from supplemental standards areas.

Supplemental standards were applied to limited occurrences of radioactive material that were left in place in the Monticello area because the material posed no risks and remediation would be technically unfeasible, unjustifiably expensive, or harmful to the environment. The supplemental standards areas include subgrade portions of streets and buried utilities.

Annual inspections of the Monticello Sites and supplemental standards areas, which DOE will conduct in perpetuity, were initiated in 2001. Inspections are conducted in accordance with long-term surveillance and maintenance operating procedures that incorporate EPA's comprehensive 5-year review guidance under CERCLA. The second post-closure 5-year review report will be prepared following the 2006 annual site inspections.

Personnel assigned to the Monticello Sites monitor and maintain disposal cell systems and arrange for disposal of mill tailings encountered during construction activities in supplemental standards areas. Activities in 2003 included repair of erosion features; control of undesirable plants; radiological monitoring of excavations of Monticello city streets and utilities; shipment of contaminated soil and debris to the Grand Junction, Colorado, Disposal Site; and construction of a removable roof for a temporary storage facility located near the repository.

Weldon Spring, Missouri

The Federal Government operated the Weldon Spring Uranium Feed Materials Plant (referred to as the chemical plant) between 1955 and 1966 on a site previously used by the U.S. Army to manufacture explosives. Operations consisted of purifying uranium oxide and other concentrates into uranium metal or into feedstock for enrichment operations at other locations. Both the U.S. Army and DOE disposed of waste materials in a nearby quarry.

The chemical plant and quarry sites were added to the National Priorities List in 1987 and 1989, respectively. Remedies were selected and remediation has been completed at three of four designated operable units. Approximately 1.48 million cubic yards of contaminated soil and debris was encapsulated in a disposal cell at the former chemical plant site. Selection of the remedy for the Ground Water Operable Unit, involving remediation of contaminated ground water associated with the chemical plant site, is expected in 2004. Institutional controls for managing areas with contamination left in place and to complete CERCLA closeout documentation are expected to be implemented in 2004.

The Weldon Spring Site was transferred to the LTS&M Program in 2002. Long-term surveillance and maintenance requirements include conducting annual site inspections; performing CERCLA 5-year reviews; maintaining the cell leachate collection system; monitoring ground water, surface water, and institutional controls; and continuing stakeholder services. During 2002 and 2003, approximately 150 acres of DOE property at the former chemical plant area adjacent to the disposal cell were seeded to develop a prairie grassland. DOE conducted fertilizing, mowing, and noxious-weed control activities during 2003 to establish and maintain the prairie (see sidebar on page 27). Erosion control activities were performed at several reclaimed areas. The first annual site inspection was conducted in 2003 in accordance with a draft long-term surveillance and maintenance plan.

NWPA Section 151(c) Site

Certain sites with low-level radioactive contamination remediated by the owner under the NRC Site Decommissioning

Management Program can be transferred to the Federal Government under Section 151 of the Nuclear Waste Policy Act (NWPA). Section 151(c) of NWPA requires that if low-level radioactive waste is the result of a licensed activity to recover zirconium, hafnium, and rare earth metals, DOE shall assume title and custody of the site if requested by the site owner.

NRC will terminate the site license only after concurring with the implemented remedial action, determining that the owner has obtained approval of DOE to accept responsibility for the site, and ensuring future funding for long-term surveillance and maintenance. Only one NWPA Section 151(c) site, located at Parkersburg, West Virginia, has been transferred to DOE.

Parkersburg, West Virginia

Radioactive zirconium ore was processed at this site under contract to AEC from 1957 to 1968, resulting in waste accumulation and soil contamination. Remediation of the site and construction of the NRC-approved disposal cell were completed in 1983. American Metals Climax, the site owner and NRC licensee, transferred the site to DOE in 1994.

The grass-covered disposal cell covers an area of approximately 12 acres. Custodial maintenance for the Parkersburg Disposal Site includes mowing to discourage the establishment of shrubs or trees that may degrade the cover. Regional drought stressed the turf on the cell cover, allowing encroachment of noxious and invasive weeds. DOE initiated a vegetation control program at the site to eradicate undesirable plants and restore the turf to good health (see sidebar on page 7).

Site ground water quality, which is monitored by DOE at 5-year intervals and was sampled in 2003, complies with the Federal Safe Drinking Water Act and State of West Virginia ground water standards.

Prairie Returns to Weldon Spring

A prairie is being reestablished in Missouri where early settlers, then explosives production workers, and then uranium ore processors once worked. Native plants, such as Prairie Blazing Star and Little Blue Stem, will once again cover an area of 150 acres surrounding the completed disposal cell at the Weldon Spring Site that is located about 30 miles west of St. Louis.

Settlers homesteaded the land surrounding the Weldon Spring Site in the early 1800s, including a group led by Francis Howell. Native prairie grasses and wildflowers dominated an area that became known as the Howell Prairie. But farming and the development of small towns in the area eventually caused the prairie to disappear.

DOE is committed to restoring the site to a native prairie ecosystem. Because less than 1 percent of the 15 million acres of prairie that once covered Missouri remains today, restoration of the Howell Prairie reflects DOE's long-term commitment to identify, protect, and conserve environmentally significant parcels of land in partnership with federal and state agencies. An established prairie will help prevent erosion for the long term and offers an ideal solution for revegetation of the 150 acres surrounding the disposal cell.

DOE formed an advisory group—the Howell Prairie Council—of interested individuals to discuss issues and ideas associated with the Howell Prairie. Council participants include representatives of the Missouri Department of Conservation, the Missouri Botanical Garden, the Missouri Prairie Foundation, and other local citizen organizations and prairie advocates.

The first seeding of Howell Prairie took place in spring 2002, followed by two additional seedings. Currently, more than 80 species of prairie grasses and wildflowers have been planted. Also planned for development at the site is a 5-acre garden of plants that are native to the state of Missouri to complement the adjacent prairie. The garden will feature walking paths and educational signs to enhance visitors' appreciation of native plants and to help them identify particular species in the larger prairie area.

Research Initiatives

LTS&M Program scientists and engineers continued to participate in research initiatives to study disposal techniques, impoundment designs, and disposal cell cover-performance evaluation methods. The disposal sites managed by DOE provide case studies of the performance of existing designs. Evolving design guidance will incorporate the results of investigations into future contaminant-isolation systems constructed by DOE and other government and private entities.

Issues of immediate interest are also being investigated, including the effect of vegetation on disposal cell cover performance, water movement within disposal cells, slope stability and erosion control, and effects of potential long-term environmental changes. Research into naturally occurring processes that will influence the performance of containment and closure systems must continue for many years before conclusive results are evident. Significant results have already been reached in some areas of research, as indicated by the publications and presentations described in the "Program Accomplishments" section (see page 8).

Investigators from many agencies and institutions are working together on site management research. In 2003, LTS&M Program researchers teamed with colleagues from the EPA Region 8 Federal Facilities Program, EPA National Risk Management Laboratory, DOE Science and Technology Program, DOE Sandia National Laboratories, DOE Pacific Northwest National Laboratory, DOE Savannah River Technology Center, Desert Research Institute, and University of Arizona on studies of the design and long-term performance of engineered covers and applications of phytotechnologies (using plants to remediate ground water). Highlights of some of the studies follow.

Analogs of the Long-Term Performance of Engineered Covers

Engineered cover systems are needed that will limit risks to human health and the environment from encapsulated contaminants for hundreds to thousands of years. This task is an unprecedented engineering challenge. To compound the issue, many current design approaches do not take into consideration the influences that the inevitable long-term changes in the environmental settings may have on the covers and the encapsulated materials.

In 2003, the LTS&M Program concluded collaboration with the DOE Science and Technology Program, Desert Research Institute, and Washington State University on a demonstration of methods derived from the natural sciences for incorporating projected environmental change in the engineering design process. The demonstration involved the characterization of natural analogs (locations with natural soils similar to the cover materials) that represent likely long-term changes in the climate, soil hydrology, and ecology of engineered covers.

Lysimeter Studies of Evapotranspiration Cover Designs

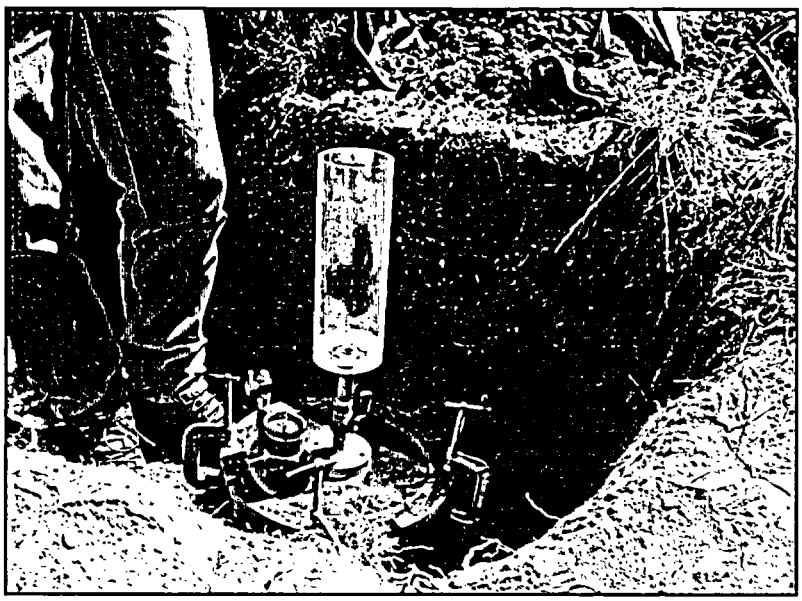
The LTS&M Program continued to collaborate with EPA Region 8 at the Monticello, Utah, Lysimeter Test Facility on studies of alternative engineered cover designs. The alternative designs depart from conventional UMTRCA and RCRA designs. Two studies using small weighing lysimeters and large drainage lysimeters are ongoing.

The small weighing lysimeters consist of 30-centimeter-diameter tubes filled with different cover design materials. The study compares designs consisting of different soil types and layer thicknesses overlying capillary barriers. In 2003, a study was initiated to determine the water storage capacity of each design and to evaluate the probability that water storage will exceed the capacity, causing drainage from the various design components.

Two large drainage lysimeters consisting of steel caissons lined with high-density polyethylene were installed in 2000 to evaluate the hydrological and ecological performances of the cover constructed on the disposal cell at Monticello, Utah. Results to date indicate that seemingly subtle differences in soil types, sources, and compaction can produce significant differences in performance. Success in establishing a diverse, seeded community of predominantly native perennial species on the lysimeters during the recent 3-year drought highlights the importance of a sound understanding of the local ecology and of implementing methods of disturbed-land revegetation.

Grand Junction, Colorado, Cover Permeability

The effects of woody plant establishment on the permeability and water content of the cell cover at the Grand Junction Disposal Site were evaluated. The roots of four-wing saltbush, a native shrub, are growing through the compacted soil layer in the cover. After examining root growth patterns and soil structure in the compacted soil layer, it is suspected that roots follow flow paths of construction-related soil moisture and paths of least resistance. The water content of the compacted soil layer approaches saturation in the spring where plants have not established, but the soil layer was drier beneath the few scattered saltbush. As with other arid sites, evapotranspiration from plants establishing on rock covers may help prevent saturation from occurring and, therefore, limit the amount of water passing into the underlying tailings.



Results of air-entry permeameter tests conducted at the Lakeview, Oregon, Disposal Site were used to evaluate the permeability of the disposal cell cover.

Lakeview, Oregon, Cover Performance Modeling

Observations during routine inspections of woody plant encroachment on the soil-covered top slope of the cell at the Lakeview Disposal Site led to an evaluation of cover performance. Measurements with air-entry permeameters have shown that the permeability of the cover where woody plants have established exceeds the design specification and is highly variable. Further evaluations revealed that water moves through small fractures in the compacted soil layer in the cover that are artifacts of the natural structure of the borrow soils. However, the results of a vegetation analog study suggest that an increase in plant abundance on the cover and associated increases in evapotranspiration over time could help offset infiltration. In 2003, LTS&M Program scientists began collaboration with Sandia National Laboratories personnel to model the hydrologic performance of the disposal cell and associated changes in risk for a range of existing and possible future conditions at the site.

Soil samples were collected at the former Monument Valley, Arizona, processing site to measure ammonia and nitrate concentrations in a phytoremediation test plot.

Monticello, Utah, Cover Performance Monitoring

In 2003, LTS&M Program scientists and engineers continued participation in the Alternative Cover Assessment Program funded by the EPA National Risk Management Research Laboratory. The goal of this program is to develop new guidance for cheaper, more effective covers for municipal and hazardous waste landfills in arid and semiarid western states that currently are regulated under RCRA Subtitle C or D. Researchers use field studies and modeling to acquire data needed to evaluate alternative covers.

In 2000, a team of scientists and engineers from the EPA National Risk Management Research Laboratory, Pacific Northwest National Laboratory, Desert Research Institute, and the LTS&M Program installed instrumentation and telemetric devices to begin a 5-year monitoring study of the performance of a portion of the cell cover at Monticello, Utah, creating one of the largest water-balance lysimeters in the world.

LTS&M Program and Desert Research Institute scientists continue to monitor the water balance and plant ecology of the lysimeter. The measured water flux rate from the capillary barrier has been several orders of magnitude below the EPA standard since monitoring began in 2000. Despite 3 years of drought at Monticello, a diverse plant community has established on the cover. A sustainable plant community is a key component of the cover design.

Monument Valley, Arizona, Desert Phytoremediation

LTS&M Program scientists have been collaborating with University of Arizona personnel since 1999 on studies using plants to remediate nitrate-contaminated soil and ground water at the former Monument Valley Processing Site located on Navajo Nation land. Field and greenhouse experiments conducted since 1999 evaluated two phytoremediation options for the ground water nitrate plume: passive phytoremediation and land farming. The first phase of the project was completed in 2003.

A field study using small ungrazed enclosures determined that two native deep-rooted shrubs, black greasewood and four-wing saltbush, were rooted in and extracting water and nitrate from the alluvial aquifer. Results indicate that passive phytoremediation, where roots of the shrubs contact the ground water, can remediate the nitrate plume without extraction wells because the plants extract the contaminated ground water and use the nitrate as a nutrient.

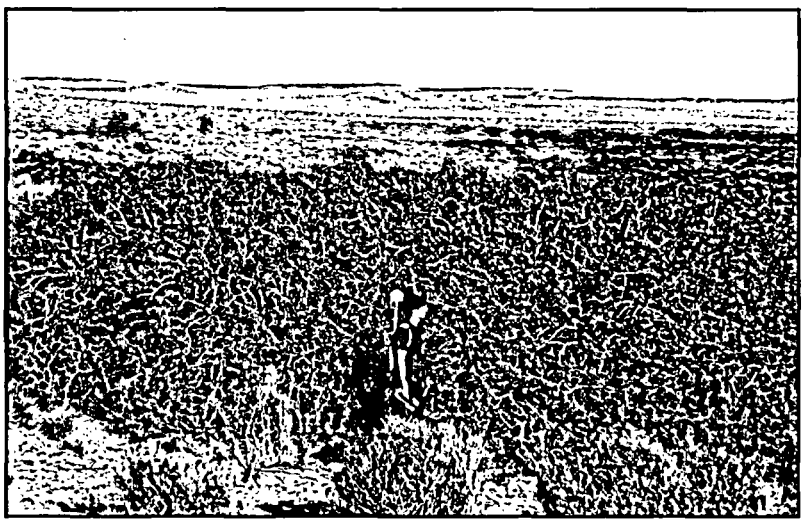
Results of a soil phytoremediation study indicate that an irrigated planting of four-wing saltbush is extracting ammonium and nitrate from the plume source and preventing recharge and leaching of nitrogen into the alluvial aquifer. Larger amounts of nitrate were removed from the soil than could be attributed to plant uptake alone. Because no downward flux of water was detected, microbial activity is suspected to be primarily responsible for the transformation of nitrate in the soil. Analyses of soil samples collected in 2003 suggest that irrigation may be responsible for an increase in microbial activity.

University of Arizona personnel conducted a greenhouse study to test the concept of planting a phytoremediation farm to clean up the nitrate plume. The remedy would involve pumping plume water from wells drilled into the aquifer and using the plume water to irrigate and fertilize crops. In the greenhouse study, most plants accumulated nitrate or hydrocyanic acid at levels above the highest amount considered safe for cattle feed. Considering these results, researchers recommended not growing forage crops with plume water. An alternative would be to use plume water to irrigate plants that can be grown for seed. This seed could then be used in mine land reclamation and rangeland improvement on Navajo Nation land.

Tuba City, Arizona, Infiltration Control Study

A water-balance model for the Tuba City Disposal Site indicated that enhanced recharge occurring along the southern toe slope of the disposal cell could be contributing to increased flow and contaminant transport in the ground water beneath the cell. The disposal cell cover consists of a compacted soil layer that is overlain by a gravel drainage layer and a basalt riprap cap. Evaluation of the design and neutron hydroprobe monitoring of soil water indicate that precipitation rapidly infiltrates the basalt riprap, flows laterally in the underlying gravel drainage layer to the southern toe slope, and then recharges the aquifer.

A study was initiated in 2000, in collaboration with University of Arizona personnel, to determine if planting deep-rooted native species with relatively high evapotranspiration rates could control recharge along the toe of the disposal cell. Nine pairs of test plots were established; each pair consists of one plot of transplanted four-wing saltbush and one plot with no vegetation. Neutron hydroprobe ports were installed in the center of each plot. Evaluation of the survival and growth of transplants was completed in 2003; a report on investigation results will be finalized in 2004.



A scientist uses global positioning system equipment to map the location of a large stand of New Mexico olive, a candidate species for passive phytoremediation at the Tuba City, Arizona, Disposal Site.

LTS&M Program Disposal Site Characteristics[a]

Disposal Site	Site Area (acres)	Cell Area (acres)	Cell Volume (1,000 cubic yards)	Total Activity of Radium-226 (curies)
Uranium Mill Tailings Radiation Control Act Title I				
Ambrosia Lake, New Mexico	290	91	5,162	1,850
Burrell, Pennsylvania	72	4	73	4
Canonsburg, Pennsylvania	34	6	192	100
Durango, Colorado	120	60	2,533	1,400
Falls City, Texas	231	127	6,019	1,277
Grand Junction, Colorado[b]	360	60	4,034	Undetermined
Green River, Utah	26	6	382	30
Gunnison, Colorado	115	29	796	175
Lakeview, Oregon	40	16	944	42
Lowman, Idaho	18	8	126	12
Maybell, Colorado	250	66	4,100	455
Mexican Hat, Utah	119	68	3,483	1,800
Naturita, Colorado	27	10	399	79
Rifle, Colorado	205	71	3,757	2,738
Salt Lake City, Utah	100	54	2,710	1,550
Shiprock, New Mexico	105	77	2,800	746
Slick Rock, Colorado	62	12	857	175
Spook, Wyoming	14	5	315	125
Tuba City, Arizona	145	50	1,631	940
Uranium Mill Tailings Radiation Control Act Title II				
Bluewater, New Mexico	3,300	320	18,000	12,330
Edgemont, South Dakota	360	100	3,000	527
Sherwood, Washington	380	100	2,150	470
Comprehensive Environmental Response, Compensation, and Liability Act/ Resource Conservation and Recovery Act				
Monticello, Utah	119	86	2,600	2,780
Weldon Spring, Missouri	217	41	1,480	6,570
Nuclear Waste Policy Act Section 151(c)				
Parkersburg, West Virginia[c]	15	12	Less than 20	Unknown

[a]Sites managed in 2003 that do not have disposal cells are Bliss and Laughlin, New York; BONUS, Puerto Rico; Grand Junction Site, Colorado; Hallam, Nebraska; Madison, Illinois; Monument Valley, Arizona; Piqua, Ohio; Riverton, Wyoming; and Site A/Plot M, Illinois.

[b]A portion of the cell at Grand Junction, Colorado, continues to receive radioactive material.

[c]The precise quantity of radioactive material in the cell at Parkersburg, West Virginia, is unknown; therefore, the total activity is unknown.

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Resources

Consortium for Risk Evaluation with Stakeholder Participation: This organization is working to foster a broader and deeper understanding of risk-related issues that concern waste cleanup. This initiative involves multiple areas of investigation. **http://www.cresp.org**

Energy Communities Alliance: The role of local governments in long-term management of DOE sites is addressed in this website. **http://www.energyca.org**

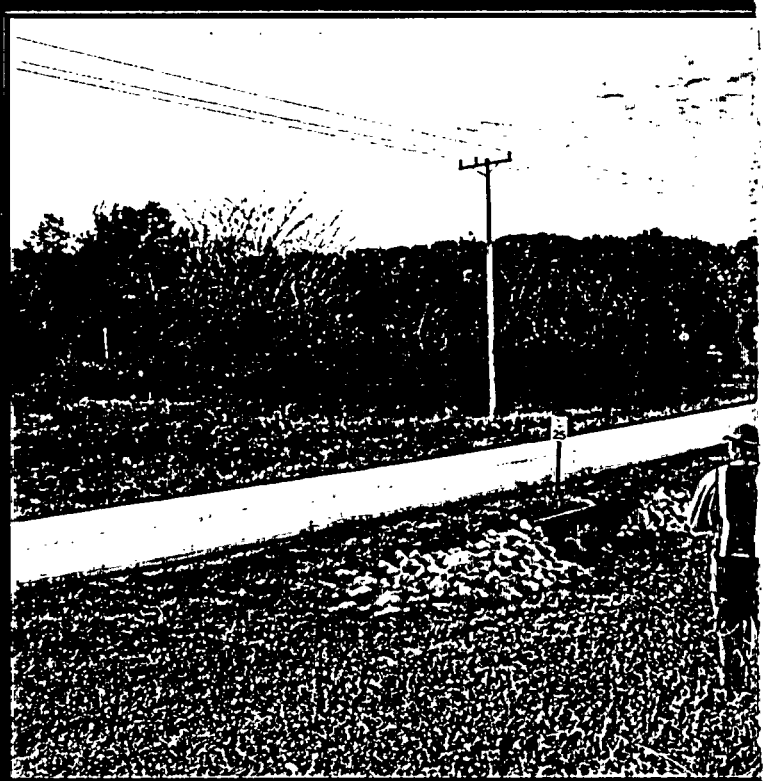
Formerly Utilized Sites Remedial Action Program (FUSRAP): This website includes the FUSRAP sites assigned to the U.S. Army Corps of Engineers for remedial action. These sites will be transferred to the Office of Legacy Management after completion of remedial action. **http://hq.environmental.usace.army.mil/programs/fusrap/fusrap.html**

Land Use Controls: Current information on land use controls, also known as institutional controls, for federal facilities and Superfund sites is provided at this website. **http://www.lucs.org**

Legacy Management at Grand Junction Website: This website contains fact sheets, long-term surveillance plans, and compliance reports for DOE Office of Legacy Management sites; links to related websites and applicable or relevant and appropriate regulations; and other related information. **http://www.gjo.doe.gov/LM**

National Governors' Association: This website contains information about long-term management activities being implemented across the DOE nuclear weapons complex and contains links to other DOE sites. **http://www.nga.org/nga/**

State and Tribal Governments Working Group: This stakeholder organization, sponsored by DOE, has been active since 1989 in promoting sound long-term management practices for DOE sites after remediation is complete. **http://www.em.doe.gov/stgwg/**

U.S. Department of Energy (DOE) Office of Environmental Management: This website provides descriptions of many of the DOE remedial action programs and has information on individual sites. **http://www.em.doe.gov/**

U.S. Environmental Protection Agency (EPA) Alternative Cover Assessment Program Activities Summary: Summaries of the work of the Alternative Cover Assessment Program are available at this website. **http://www.rtdf.org/public/phyto/minutes/altcov/default.htm**