Office of Independent Oversight and Performance Assurance
U. S. Department of Energy

Performance Analysis

Environmental Monitoring, Surveillance, and Control Programs Within the U. S. Department of Energy

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OVERSIGHT

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Abbreviations Used in This Report

ALARA	As Low As Reasonably Achievable
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
EH	DOE Office of Environment, Safety and Health
EH-1	Assistant Secretary for Environment, Safety and Health
EPA	Environmental Protection Agency
mrem	Millirem
NESHAPS	National Emission Standards for Hazardous Air Pollutants
pCi/g	picoCuries per gram
RCRA	Resource Conservation and Recovery Act

Executive Summary

Introduction

This report documents the results of a U.S. Department of Energy (DOE) Office of Independent Oversight and Performance Assurance (OA) analysis of DOE environmental monitoring, surveillance, and control activities. The analysis is based primarily on DOE Headquarters independent oversight evaluations of environmental monitoring and surveillance activities that were conducted at 14 different sites across the DOE complex during fiscal years 1999 through 2002.

OA conducted this analysis to identify and proactively communicate important performance information identified through past independent oversight activities. These results are being shared outside the bounds of a formal inspection to promote continuous improvement. It is OA's intention that the results of this analysis will be useful to line management efforts to evaluate and strengthen their environmental monitoring, surveillance, and control programs.

The DOE sites that were evaluated through independent oversight activities reflect a range of programmatic interests that include scientific research, national defense, and environmental management. These DOE sites support an array of ongoing activities, including facility operations, manufacturing, research and development, waste management, environmental restoration, decontamination and decommissioning, and reindustrialization.

Independent oversight evaluations were conducted to evaluate site performance in a number of environmental protection areas. These included groundwater monitoring and stewardship, monitoring of radiological air emissions, and environmental radiological monitoring and surveillance associated with contaminant migration and controls for liquid and sediment pathways. While the specific scope of each evaluation varied, all evaluations examined selected aspects of applicable Federal regulations and DOE directives. In particular, independent oversight evaluations examined the implementation of DOE Order 5400.1, *General Environmental Protection Program*, DOE Order 5400.5, *Radiation Protection of the Public and the Environment*, and/or alternative standards invoked in contracts between DOE and the site contractors.

Results

Independent oversight inspections identified several strengths common to most DOE environmental monitoring and surveillance programs:

- Extensive groundwater monitoring networks have been developed to support environmental restoration efforts. Groundwater plumes that are highly contaminated and present a significant threat have been identified, and many are undergoing remediation.

- The level of the radiological monitoring and surveillance was consistent with most DOE expectations and guidance, and was adequate to detect any major releases or migration of radionuclides.

- All sites evaluated have active National Emission Standards for Hazardous Air Pollutants (NESHAPS) programs that were effective in meeting dose-based radiological discharge limitations.

Notwithstanding these strengths, independent oversight evaluations determined a number of observations where weaknesses in implementing environmental monitoring, surveillance, and control programs were identified at DOE sites. In most cases, identified weaknesses involved small amounts of radioactive material and/or pathways that did not result in significant radiation exposures to workers or the public. While not necessarily evident at all the sites reviewed, these observations were identified at multiple sites and were sufficiently significant to warrant communication to DOE Headquarters and site managers for further evaluation. Observations included:

- Absence of proper data quality objectives in support of environmental radiological sampling and decision-making, and an over-reliance on gross alpha and beta analyses
- Ineffective monitoring of sediment migration pathways
- Weaknesses in the application of the as-low-as-reasonably-achievable (ALARA) principle to environmental releases
- Widely inconsistent implementation of radiological soil contamination posting and controls
- Weaknesses in ambient air monitoring and reporting for radionuclides
- Improper characterization and release of volumetrically contaminated materials from radiological control
- Discharge of liquid effluents without evaluating the applicability of DOE soil column prohibitions
- Incomplete analysis, control, and monitoring for potential releases of hazardous materials from operational facilities into the groundwater and soil column
- Weaknesses in trending and reporting mechanisms for anomalous groundwater conditions
- Incomplete monitoring and/or analysis of groundwater contamination occurring at lower concentrations.

OA's analysis of the weaknesses identified three contributing factors:

- **DOE expectations for environmental monitoring, surveillance, and control are not consistently understood, fully defined in all areas, or invoked in DOE contracts.** Many of the weaknesses identified in oversight reviews stemmed from insufficient understanding or clarity of DOE expectations (e.g., ambiguities in DOE requirements regarding the prohibition on liquid discharges to soil columns). In some cases, managers did not incorporate applicable groundwater protection and radiological monitoring and control requirements into management and operating contracts.
- **There is insufficient professional radiological expertise being applied to environmental radiological protection programs at some sites.** At some sites, personnel who were responsible for evaluating technical data, making decisions, and preparing and/or reviewing health physics-related reports had limited training and qualifications in health physics disciplines. This situation contributed to errors and omissions in the planning, implementation, evaluation, and reporting of a number of elements of site environmental programs.
- **Insufficient application of resources to environmental monitoring programs has impacted the ability to fully characterize environmental conditions in some areas.** Resource reductions and constraints at some sites have resulted in a significant reduction of DOE and contractor environmental support personnel, the number of monitoring stations, monitoring frequency, and analytical parameters. In addition, the capability of some DOE and contractor field organizations to manage and oversee environmental monitoring programs has been limited by loss of experienced personnel and sustained hiring limitations.

Conclusions and Opportunities for Improvement

Independent oversight evaluations determined that all sites had established environmental monitoring, surveillance, and control programs to implement regulatory requirements and DOE contractual obligations. Site environmental surveillance programs have been ongoing for many years, and an extensive baseline of information on contamination in environmental media has been developed. At all DOE sites evaluated, monitoring data demonstrates a decreasing trend in the levels of radiological discharges to the environment in air and water pathways.

However, some aspects of DOE policy are not clearly delineated and communicated to the field, and certain requirements are not effectively implemented

at DOE sites. Further improvements are warranted in a number of aspects of environmental monitoring and surveillance to ensure that expectations are clearly established, understood, and implemented.

In the spirit of promoting continuous improvement, some specific opportunities for improvement have been identified and are summarized in Table ES-1, and are further detailed in other sections of this report. It is OA's intention that these opportunities for improvement will be useful in the ongoing efforts by the DOE Office of Environment, Safety and Health to replace the outdated DOE environmental protection order with a new environmental management system-based order/ manual and to consolidate and re-issue guidance documents.

Table ES-1. Opportunities for Improvement

DOE LINE ORGANIZATIONS
1. Review groundwater protection programs to ensure appropriate monitoring and stewardship.
2. Evaluate environmental sampling and analysis methods and approaches to ensure that they are sufficient to demonstrate compliance with applicable limits and provide an adequate technical basis for the environmental monitoring program.
3. Ensure that the ALARA principle is systematically applied to environmental programs.
4. Evaluate the adequacy of application of resources to environmental monitoring and surveillance programs.
DOE OFFICE OF ENVIRONMENT, SAFETY AND HEALTH
1. Clarify DOE requirements and guidelines to ensure that a consistent set of expectations has been established for DOE field organizations to implement environmental monitoring, surveillance, and control programs. Specifically, clarify expectations and requirements in the areas of groundwater protection for operating facilities; investigation and monitoring of low-level groundwater plumes; policy and guidance for determining levels of regulatory concern for volumetrically-contaminated material; soil column requirements; and posting and control of areas with radiologically contaminated soils.
2. Re-evaluate the benefits of promulgating regulations that codify DOE internal directives for radiation protection of the public and the environment.

1.0 Purpose and Evaluation Approach

The U.S. Department of Energy (DOE) Office of Independent Oversight and Performance Assurance (OA) performed an analysis of environmental monitoring and surveillance programs at DOE sites. The analysis was based on 14 independent oversight evaluations—published from October 1999 to July 2002—that included a review of environmental monitoring and surveillance programs. These oversight reports are listed in Appendix A.

OA conducted this analysis to identify and proactively communicate important performance information identified through past independent oversight activities. These results are being shared outside the bounds of a formal inspection to promote continuous improvement. It is OA's intention that the results of this analysis will be useful to line management efforts to evaluate and strengthen their environmental monitoring, surveillance, and control programs. The composition of the OA team that performed the analysis is listed in Appendix B.

Over the last several years, independent oversight evaluations have been conducted to evaluate the ability of DOE sites to appropriately characterize air and liquid process effluents and to identify the existence and impacts of contaminants in the environment. Independent oversight evaluations focused primarily on monitoring programs and controls for radionuclides because of the added technical complexity and the absence of external regulation of DOE sites in a number of related areas. This report presents information on the results of these evaluations. This report does not include an analysis of DOE site performance in managing non-radiological air and liquid effluents or other areas of environmental protection, such as the implementation of hazardous waste management requirements.

2.0 DOE Requirements and Programs

DOE manages a network of sites and facilities that perform scientific research and processing to support the national defense, energy research, environmental management, and other missions of DOE. These facilities use radionuclides and other hazardous materials in ongoing operations and/or have had significant quantities of these materials released into the environment through past practices. These operations and legacy conditions create potential pathways for the transport of radionuclides and hazardous chemicals to public and environmental receptors through release and transmission in the air, groundwater, surface water, and sediment/soil migration. DOE operations have significantly reduced their environmental impacts over the past several decades as a result of the establishment of Federal, state, and DOE regulations and requirements; increased public scrutiny and concern; pollution prevention and pollution control projects; and the termination of operations resulting from the reduction of national defense requirements.

DOE, the U.S. Environmental Protection Agency (EPA), and state agencies have established requirements related to the control and management of radionuclides and hazardous materials, including technical and management requirements for ensuring that adequate methods are established to monitor effluents and to determine environmental impacts, if any, from these releases. EPA promulgated regulations to implement the Clean Water Act, the Clean Air Act (CAA), the Safe Drinking Water Act, the Resource Conservation and Recovery Act (RCRA), the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), and others. Federal and state agencies enforce these regulations at DOE sites through review of plans,

establishment of permits, periodic inspections, and under some circumstances, independent sampling and analysis. Under the Atomic Energy Act of 1954, as amended, DOE is self-regulating in many aspects of its operations and sets internal standards through the promulgation of rules and the establishment of internal directives. Releases of radionuclides into the surface water, soil column, and groundwater are controlled by DOE through DOE Order 5400.5, *Radiation Protection of the Public and the Environment.* DOE Order 5400.1, *General Environmental Protection Program*, establishes additional environmental monitoring policy and requirements.

The following is a description of regulatory requirements and evaluation elements for the areas of groundwater monitoring and protection, environmental radiological monitoring and surveillance, and radiological air emissions. This information is presented as background information to support reader understanding of performance analysis results contained in Section 3.

Groundwater Monitoring and Protection

DOE sites are required to monitor groundwater quality to ensure that ongoing operational impacts are identified and that migration of contamination through groundwater flow is adequately understood in order to identify impacts to environmental receptors and the public. Groundwater monitoring preformed at sites across the DOE complex serves two purposes—stewardship and remediation. Groundwater monitoring performed for stewardship provides for early detection of leaks, which could originate from operating facilities and other activities, resulting in an adverse impact on the groundwater. These site monitoring and surveillance activities are implemented as part of internal DOE requirements for protection of the environment, as defined in DOE Order 5400.1. Groundwater monitoring performed as part of a remediation program provides information on the extent and concentration of legacy contamination, which can be used to evaluate restoration options and to determine the effectiveness of cleanup activities. Primarily, these restoration monitoring activities are conducted in response to regulatory requirements and cleanup agreements with Federal and state regulatory agencies. Typically, these two distinct monitoring and surveillance activities comprise the sitewide groundwater monitoring program at a DOE site.

Aerial View of a Radioactive Liquid Waste Treatment Facility at Los Alamos National Laboratory

DOE Order 5400.1 includes requirements for sites to develop plans and strategies to document the groundwater flow regime with respect to the quantity and quality of groundwater resources; conduct monitoring to determine and document the effects of operations; and provide data to permit the early detection of groundwater pollution or contamination. This Order acknowledges the flexibility needed by DOE line management in tailoring monitoring programs to site-specific needs and conditions.

Environmental restoration requirements for groundwater quality and protection are derived from site-specific Federal Facility Agreements. These are based on Federal and state regulatory mandates contained in RCRA, CERCLA, and state and local groundwater and aquifer protection laws, regulations, and requirements. In general, these requirements are drivers for groundwater monitoring associated with environmental restoration activities, waste management, and underground storage tanks.

In performing independent oversight evaluations, groundwater protection and monitoring programs were evaluated against the applicable provisions in DOE Order 5400.1 and accepted industry practices. In particular, independent oversight evaluations critiqued the adequacy of groundwater plume characterization, groundwater protection activities associated with operational facilities, and management processes for trending, tracking, and reporting groundwater monitoring information.

Environmental Radiological Monitoring and Surveillance

Effluent monitoring and environmental surveillance of radioactive materials are a continuing major part of the radiological protection programs at DOE sites. Under the Atomic Energy Act of 1954, as amended, DOE is obligated to regulate its own activities to provide radiation protection for both workers and the public. DOE conducts effluent monitoring and environmental surveillance programs to determine whether the public and the environment are adequately protected during DOE operations and whether operations are in compliance with DOE and other applicable Federal, state, and local radiation standards and requirements. It is DOE policy that site monitoring and surveillance programs be capable of detecting and quantifying unplanned releases and meet high standards of quality and credibility. DOE's objective is to properly and accurately measure radionuclides in effluents and ambient environmental media at all DOE sites and operations.

Radiological effluent monitoring and environmental surveillance programs may consist of liquid and air effluent monitoring, and environmental surveillance of air, liquids, sediments, soil, food products (terrestrial and aquatic), wildlife, and vegetation. Effluent monitoring is performed to quantify the amounts and levels of contaminants released into the environment in air and liquid process discharges. Environmental surveillance is designed to survey and quantify any effects that routine and non-routine site operations may have on the environment or receptors. These programs should be based on a radiological critical contaminant/critical pathway analysis that considered such factors as site operating history, release pathways, source terms, transport, exposure pathways, dose, and the resulting risk. The requirements applicable to environmental monitoring programs are delineated in DOE Order 5400.1, DOE Order 5400.5, and DOE/EH-0173T, *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance*. Environmental radiological monitoring and surveillance programs were evaluated against the applicable provisions of DOE requirements and accepted industry standards.

Radiological Air Emissions

The basic elements of an effective radiological air quality program include source identification, ambient and source air emissions characterization (including monitoring programs), air pollution control equipment operation and maintenance, and reporting and compliance management systems. The specific requirements applicable to DOE radiological air protection programs include DOE Orders 5400.1 and 5400.5, and the National Emission Standards for Hazardous Air Pollutants (NESHAPS) requirements portion of the CAA, as delineated in 40 CFR 61, Subparts A and H. Radiological air quality programs were evaluated against DOE order requirements and compliance with CAA requirements and associated regulations.

3.0 Performance Analysis

This performance analysis is based on an examination of past independent oversight evaluations of environmental monitoring and surveillance programs and practices that were conducted at 14 different sites across the DOE complex during fiscal years 1999 through 2002. The performance analysis is presented in four areas: (1) groundwater monitoring and protection, (2) environmental radiological program management, (3) environmental radiological monitoring and surveillance, and (4) radiological air emissions. In each area, OA provides an analysis of DOE's overall performance, based on the results of previous independent oversight reviews, and presents DOE-wide observations, which identify areas where DOE line managers and policy organizations should consider improvements to policy, guidance, program management, or program implementation.

3.1 Groundwater Monitoring and Protection

In general, independent oversight evaluations determined that DOE sites have established strong groundwater monitoring programs to support environmental cleanup requirements. In most cases, extensive monitoring networks, supported by highly qualified personnel, have been developed to analyze subsurface legacy contamination. Groundwater plumes that are highly contaminated and present a significant threat have been identified and bounded. For all sites evaluated, corrective actions and engineering controls have been or are being put into place to address the most significant problems. With few exceptions, sites were appropriately sampling groundwater wells, analyzing samples for the appropriate set of potential contaminants, and reporting monitoring results consistent with established cleanup agreements.

Observations in the groundwater protection area were made with respect to DOE site efforts to develop groundwater monitoring and protection programs to promote stewardship of groundwater resources, trending and reporting mechanisms for anomalous monitoring results, and monitoring of groundwater plumes containing low concentrations of contaminants.

Observations

1. Weaknesses were identified in site groundwater stewardship programs. Many DOE sites have not fully analyzed, controlled, and monitored for potential releases of hazardous materials from operational facilities into the groundwater and soil column.

DOE expectations for groundwater stewardship are included in DOE Order 5400.1. Chapter III.4.a establishes expectations for DOE sites to develop groundwater protection management programs to guide the characterization, protection, and remediation of groundwater resources. Chapter IV.9.b requires that "Groundwater that is or could be affected by DOE activities shall be monitored to determine and document the effects of operations on groundwater quality." Additionally, it specifies the development of a groundwater monitoring plan and the performance of groundwater monitoring to provide data to permit the early detection of groundwater pollution or contamination.

DOE operates numerous facilities in the execution of its defense, energy research, and environmental management missions. Many of these facilities use or process hazardous chemicals and radionuclides and create waste streams and byproducts that must be recovered, treated, and disposed. A significant number of DOE facilities that have operated since the Manhattan Project have contributed to groundwater contamination through leaks in sumps, process vessels, waste piping systems, and underground storage tanks. Many of these facilities have been shut down and placed under the stewardship of the Environmental Restoration Program. Although some new facilities have been constructed, many facilities that were built decades ago continue to operate with aging

equipment, which can be susceptible to leaks and degraded reliability.

Protection of groundwater resources around operational facilities can be achieved by implementing a systematic approach to groundwater protection that is consistent with the core functions of the DOE integrated safety management process, which would include:

- Identifying the scope of all operations that have the potential to impact groundwater quality
- Conducting environmental pathway analyses to identify process equipment vulnerable to releases, and evaluating the potential impacts to groundwater quality
- Establishing equipment surveillance and maintenance programs to ensure the reliability of vulnerable systems, and where appropriate, establishing groundwater surveillance monitoring networks in the vicinity of identified pathways to provide for the early detection of any releases
- Performing groundwater surveillance monitoring and equipment surveillance and maintenance as established in internal procedures and plans
- Evaluating and improving operational performance through an analysis of surveillance and monitoring data and periodic re-evaluations of planning assumptions, hazard analyses, and established controls.

Oversight evaluations determined that groundwater protection management programs at many DOE sites have not been sufficient to provide a systematic approach to protect groundwater resources. At some sites, releases from operational facilities were not prevented or identified and mitigated in a timely manner. Problems identified through oversight reviews and event investigations included:

- Incomplete identification of threats to groundwater, including the existence of active and legacy tanks with chemical and/or radiological contents. At two sites, large forty-year-old, single-walled concrete process tanks, used in radiological process water storage and wastewater treatment operations, were not identified as a potential threat to groundwater quality.
- An incomplete understanding of the hydrogeology in the vicinity of facilities, resulting in a monitoring strategy that was not able to detect releases consistent with management expectations.
- An incomplete analysis of the potential pathways for release of hazardous materials from process vessels, storage tanks, and piping systems to the environment, resulting in the existence of unidentified equipment vulnerabilities and release pathways. Some sites have good inventories of tanks, sumps, and process lines; however, their existence is sometimes not known by facility or environmental managers who are responsible for groundwater protection.
- Configuration of facility piping systems, sumps, and tanks not understood or not consistent with as-built drawings, resulting in inappropriate well placement and inappropriate reliance on surveillance monitoring of building foundation drains.
- Surveillance and maintenance of process equipment not adequate to detect deteriorating equipment, creating unmonitored pathways to the environment.
- Inadequate surveillance monitoring in the vicinity of operational facilities and hazardous material storage and conveyance systems, resulting in undetected or partially analyzed impacts on groundwater quality.
- Systematic elimination of monitoring wells near operational facilities because baseline information about water quality was developed. These decisions were made without the benefit of an analysis of potential release pathways and resulting potential threats to the groundwater resources.

Liquid Sampling at an Outfall

Inconsistent understanding of DOE expectations contributes to weaknesses in groundwater protection measures for operational facilities. Some DOE field offices have not incorporated groundwater stewardship requirements in contracts even though facilities and activities pose potential threats to groundwater resources. Additionally, although DOE Order 5400.1 contains specific requirements for monitoring, facility pathway analysis, and groundwater protection planning, DOE sites have various interpretations about the level of effort and diligence required for operational facility monitoring. In some cases, line managers did not understand the need to establish controls until confronted with an actual site release. Independent oversight reviews found that several sites have responded appropriately in reaction to identified groundwater contamination events. DOE organizations may want to evaluate efforts that were undertaken at the Brookhaven National Laboratory and the Oak Ridge National Laboratory to systematically identify groundwater contamination vulnerabilities associated with current operations.

DOE has not established strategies or requirements for the surveillance, maintenance, or phaseout of single-walled tank and piping systems used for some radiological services. While many single-walled tanks and piping systems (i.e., systems used in routine radiological processes or for low-level waste applications) have been abandoned or replaced with modern double-walled equipment that has leak detection capabilities, single-walled equipment still remains in service at some DOE sites, presenting vulnerabilities to groundwater resources. This situation is not consistent with the stringent regulatory standards that have been promulgated by EPA and state agencies for the storage of petroleum products. This observation does not apply to high-level waste tanks, where significant efforts have been made to develop remediation and closure strategies.

The DOE Headquarters Office of Environment, Safety and Health (EH) should work with line management in clarifying DOE expectations regarding groundwater protection measures associated with operating facilities, including use of single-walled tank and piping systems for radiological services. DOE line managers should review their groundwater protection management programs to ensure that all operational activities potentially impacting groundwater quality have been identified; contaminant release pathways and potential impacts have been analyzed; and necessary monitoring and equipment surveillance controls have been established and implemented.

2. Independent oversight reviews identified a number of cases where line management has not exercised sufficient diligence in the trending and tracking of groundwater monitoring data to ensure that changes in groundwater contamination conditions are fully identified and reported.

Insufficient attention to groundwater monitoring data, particularly in the stewardship programs required by DOE orders, has contributed to shortcomings in the trending, interpreting, and reporting of results at several DOE sites. In a few cases, failure to report new discoveries or increases in groundwater contamination levels in a timely manner has contributed to stakeholder concern. Identified problems included:

- The failure to trend monitoring data from groundwater wells and building foundation drains contributed to the delayed discovery of a process waste pipe failure and a release to the environment.

- The performance of trending and interpretation of groundwater monitoring data on an annual basis rather than on a continuous basis resulted in delays in identifying an anomaly from identified baseline water quality conditions.

- The utilization of multiple databases for groundwater monitoring analytical results increased the difficulty at several sites in analyzing groundwater contamination information.

- A lack of formalized processes for systematically trending, documenting, and interpreting groundwater monitoring results limits the utility of the monitoring for identifying changing environmental conditions. The lack of such processes was particularly noticeable in monitoring of wells near operational facilities and the programs for monitoring sitewide and background contamination levels.

- The absence of formalized reporting procedures and criteria for monitoring results, including specifications for identifying unanticipated results, created the potential for delays in notifying responsible managers and stakeholders, and delays in response actions. In one case, site analytical data was only captured in a database, and was not reported to responsible facility managers or environmental coordinators.

Trending and reporting of groundwater contamination information associated with environmental restoration program activities were generally effectively performed. The rigorous reporting requirements from site regulators and the high levels of technical resources and competencies within DOE sites dedicated to cleanup activities contribute to the effective performance in this area.

Line managers should review their practices for trending, interpreting, and reporting groundwater monitoring data to ensure that analytical data is fully utilized for identifying changing environmental conditions. Line managers should ensure that procedural controls consistent with management expectations have been established for trending and for reporting anomalous conditions.

3. In some cases, groundwater plumes containing lower concentrations of contaminants have not been monitored through direct measurement to determine the full nature and extent of the contamination.

The presence of groundwater contamination, even in low concentrations (i.e., in the range of drinking-water standards or below), can cause significant public relations repercussions because of a high level of interest and concern by residents living near most DOE sites. This is particularly true when contamination is present in the vicinity of site property boundaries, above aquifers used for drinking water and irrigation sources, or where plumes discharge into surface water bodies. While these conditions may not present significant public or environmental risks, DOE line management needs to have sufficient information to support definitive technical conclusions and to provide assurance to stakeholders. At some DOE sites, much work remains to complete the investigation of groundwater contamination occurring at relatively low concentrations. Problems identified through oversight reviews included:

- At several sites, contaminated source areas have resulted in plumes of low concentrations extending significant distances. The furthest reaches of the plumes were not monitored. Plume pathways and discharges of contamination to surface water were not understood, leading to uncertainties in the fate and transport of contaminants in the environment.

- At one site, large plumes of contamination have been characterized in the upper water table aquifer. Due to the site's hydrogeology, migration of contaminants downward through less permeable materials has been expected for several years. Moreover, the regional drinking-water aquifer underlies the site. Monitoring in the lower water table aquifer has been sparse and inadequate for demonstrating the protection of drinking-water supplies.

- Low-concentration volatile organic compound and tritium plumes at several sites were identified, but were not fully defined through hydrological investigations and monitoring. No additional characterization of these areas was planned. In these cases, line management assumed that contaminants would naturally attenuate within the environment; however, they did not have the necessary level of monitoring to systematically evaluate the performance of natural attenuation over time.

- Monitoring was not always performed to define the presence or extent of offsite groundwater contamination occurring at low concentrations. At one site, monitoring was not in place down gradient of a groundwater containment slurry wall to validate the effectiveness of the wall in preventing offsite migration. At another site, low levels of tritium contamination (below drinking-water standards) were found in wells installed at a site property boundary adjacent to a site landfill. Offsite migration of the plume is clear; however, wells have not been installed in offsite areas where tritium migration is highly likely. At another site, monitoring was not adequate to determine that an offsite plume had migrated to the point where it discharged to a river.

- In several cases, published groundwater contamination maps did not always accurately portray the presence or extent of known or suspected offsite contamination.

Overall, line management has appropriately prioritized resources and is appropriately managing investigations and remedial activities to address DOE's vast groundwater contamination challenges. However, there are clear liabilities associated with the existence of low-level contamination plumes. In some cases, stakeholders have expressed significant concerns about the discovery of unanticipated occurrences of

groundwater contamination from DOE sites occurring at both onsite and offsite locations. DOE has also experienced significant negative media coverage in some cases, which distracts management and detracts from the credibility of DOE's environmental programs.

DOE line managers should review their site-specific groundwater monitoring programs to verify the adequacy of their programs for monitoring and reporting groundwater contamination occurring at low concentrations. Line management should ensure that sufficient investigations have been performed, or included in site project plans, to confidently determine the extent of all known groundwater contamination.

EH should consider enhancements in DOE directives and guidance to better articulate the level of diligence required to investigate and monitor low-level groundwater plumes on DOE sites.

3.2 Environmental Radiological Program Management

All evaluated DOE sites and contractors have established programs and assigned personnel to implement environmental radiological protection responsibilities. However, independent oversight reviews identified a number of specific programmatic areas where implementation weaknesses existed, inconsistent approaches were implemented across DOE, and DOE expectations are unclear. Observations were made in the application of health physics expertise to environmental programs, application of ALARA principles to environmental concerns, release of materials from radiological controls that may be volumetrically contaminated, and requirements and practices for managing radioactively contaminated soils and soil columns.

Observations

1. **The application of qualified health physics resources to environmental programs at some sites has not been sufficient to ensure that DOE radiological requirements and objectives are met.**

Radiological requirements and standards are generally technical in nature, often requiring professional interpretation. DOE integrated safety management guiding principles require that all individuals possess a level of competence commensurate with their responsibilities. As such, individuals responsible for directing, managing, implementing, or overseeing these programs must possess analytical skills and an educational foundation that includes a background in health physics or radiation protection.

At some sites, personnel who were responsible for evaluating technical data, making decisions, and preparing and/or reviewing health physics-related reports had limited training and qualifications in health physics disciplines. Consequently, errors and omissions occurred in the planning, implementation, evaluation, and reporting of a number of elements of site environmental programs, including:

- Several sites published reports containing inaccurate technical information, such as incorrect derived concentration guides for comparison of sampling data.
- One site failed to consider available isotopic information, leading to erroneous calculations that underestimated radiological risk.
- At several sites, environmental restoration activities in support of CERCLA or RCRA actions were not performed consistent with DOE and health physics industry requirements and guidance.
- Several sites failed to properly post areas of environmental radiological contamination, and most sites did not have specific posting criteria consistent with DOE expectations and guidance.
- Several sites failed to investigate unusually high sampling results or to set thresholds for initiating actions in response to high sampling results.
- Several sites failed to include appropriate data quality objectives in support of environmental sampling activities, rendering the data collected of limited value.

Environmental radiological analyses and decision-making were generally of higher quality, and errors in reports and evaluations were less frequent, at sites where responsibility for environmental radiation protection was more closely tied with the site health physics organization. This trend may be partially attributed to the greater ability of personnel with environmental responsibilities to consult with qualified

health physics resources and obtain peer review of health physics-related technical work.

Skill shortfalls identified during inspections indicate that more emphasis is needed to ensure appropriate professional competence in environmental radiological disciplines at both the DOE and contractor levels. Sites should take measures to ensure that adequate and qualified health physics resources are available to implement environmental radiological programs, and that clear accountability mechanisms are established for the technical quality of these programs.

2. Many sites did not have mature programs and the institutional documents necessary to effect full and effective environmental ALARA implementation, consistent with DOE Order 5400.5.

The basic principle guiding the radiological protection industry is that any exposure to radiation, including background exposures, poses some level of risk, even if it is too low to adequately quantify. Thus, while the regulatory framework specifies the familiar concept of exposure and release limits, it also requires that exposures and releases be maintained ALARA below these limits, in keeping with the fundamental premise that any exposure possesses some incremental risk. DOE Order 5400.5 requires the ALARA process to be formally implemented at all DOE facilities that cause public dose and/or release radioactive materials. The magnitude of the dose is not specified, and DOE guidance indicates that the ALARA process must be applied no matter how small the dose. The ALARA process must also be applied to liquid discharges that may result in the need for future remediation or further the spread of legacy radiological contamination within the environment.

At many sites, the environmental ALARA program is not sufficiently formalized, and personnel responsibility for environmental ALARA has not been sufficiently defined. As a result, some activities have not received adequate and/or documented ALARA reviews that include justification and consideration of alternatives that might further reduce doses and potential environmental radiological impacts. The following are some examples of weaknesses in environmental ALARA decision-making and implementation that were noted during the oversight evaluations:

- Most sites, while having a formal occupational ALARA program, did not have a similarly developed environmental ALARA program.

- At one site, radioactivity in the form of depleted uranium was being intentionally added to waste prior to incineration to meet nuclear criticality safety requirements, without a formal or documented ALARA review that justified this activity and provided assurance that all possible alternative options were explored.

- Many sites did not adequately incorporate the ALARA process in the review and analysis of environmental discharges and monitoring data. For example, at one site, derived concentration guidelines were incorrectly applied as de facto liquid radiological discharge limits. As such, further reductions in radiological concentrations, although possible, were not considered. At several sites, radiological effluent concentrations were biased low because of the placement of sampling points at locations significantly impacted by dilution with process streams; thus, the potential for further reducing radioactivity in the contributing process liquid streams was not adequately considered.

- At several sites, areas of legacy environmental contamination were not being managed in a manner that would minimize continued and further environmental atmospheric releases from fugitive emission, or minimize the spread of contamination from liquid runoff.

The full integration of the ALARA principle into DOE environmental programs has lagged behind its application to occupational health and safety programs. Sites should take actions to ensure that the appropriate mechanisms, procedural requirements, and training and performance criteria are developed and implemented as needed to foster the full integration of the ALARA process into environmental programs, consistent with DOE Order 5400.5 and associated guidance.

3. The absence of clear radiological soil posting standards and requirements has resulted in inconsistent hazard analyses and control across DOE sites that have soil and sediment contamination.

Title 10 CFR 835 specifies legal requirements for posting of areas that contain surface radioactive contamination, but it does not include requirements for posting areas of contamination where the radioactivity is volumetrically distributed, such as in the case of

outdoor soils or sediments. Many DOE sites have outdoor areas of soil and sediment contamination both within and outside site boundaries. The DOE Radiological Control Standard (DOE-STD-1098-99) calls for the establishment of posted soil contamination areas for any area that contains soil that is not releasable in accordance with DOE Order 5400.5. However, DOE Order 5400.5 release criteria provisions are not specific (i.e., concentration limits are not specified), thereby requiring case-by-case approval of volumetric contamination or "release" limits by EH. A number of problems with this approach were identified by oversight evaluations, including:

- The term "releasable" is subjective because there are a number of different scenarios that could be postulated for radiological release (i.e., unrestricted, restricted, commercial, and residential). Therefore, a broad range of releasable values (and resulting risks) for the same radionuclide can be postulated and derived.

- Most sites were found to have no specific soil or volumetric posting criteria.

- One site had specific criteria that would require posting of soil contamination only when the dose consequence might exceed the DOE public dose limit of 100 millirem (mrem). In this case, the use of 100 mrem as a threshold in the derivation was inconsistent with DOE's single pathway dose constraint of 30 mrem (i.e., residual soil is a single pathway, and other pathways might contribute dose to an individual who may then exceed the DOE 100-mrem limit). The 30-mrem constraint is specified only in a DOE guidance document.

- Such interpretive variations can allow for significant levels of contamination to exist in unposted areas, and the resulting levels of contamination could pose risks that are greater than those derived from 10 CFR 835 surface contamination posting levels.

- Areas of unposted and inconsistently posted radiological contamination were noted at several sites.

EH should take steps to revisit standards and guidance and modify the requirements in a manner that is commensurate with the hazard and the level of risk associated with surface contamination posting and release requirements noted in 10 CFR 835 and DOE Order 5400.5

4. Some sites have not properly followed the requirements of DOE Order 5400.5 and supporting guidance for offsite releases of materials that may be volumetrically contaminated with residual radioactive materials.

The requirements for release of property from DOE's radiological control are published in DOE Order 5400.5, Chapter II. While numerical standards and methods have been defined for materials and equipment that may have surface contamination, no guidance is currently available for release of materials that may have been contaminated throughout its volume, such as activated material or smelted contaminated metals (e.g., radioactivity per unit volume or per unit mass). In accordance with DOE Order 5400.5, such materials may only be released if criteria and survey techniques are approved by the Assistant Secretary for

Air Stack

Environment, Safety and Health (EH-1). Further clarification of this requirement was published in a 1995 EH memorandum. Independent oversight reviews have found several cases where potentially volumetrically contaminated materials were being released to the general public or sanitary landfills without analytical results that adequately demonstrated the material did not contain site-derived concentrations of radioactive material above background or evidence of appropriate authorization from EH-1.

- At one site, sludge generated at a liquid radioactive waste treatment facility was being released to a sanitary landfill without a requirement for sampling or evidence of EH-1 approval of sampling methods and limits that were used periodically.

- One site was releasing potentially contaminated scintillation "cocktail" to a commercial hazardous waste disposal company without consideration of DOE Order 5400.5 requirements.

- One site released equipment containing potentially contaminated liquid to a private company without full characterization or the required authorizations from EH-1.

Some of the sites were unfamiliar with the 1995 clarification of requirements for release of volumetrically contaminated materials. EH should formalize guidance clarifying DOE Order 5400.5 requirements to ensure that personnel responsible for implementation of requirements are aware of DOE expectations. Additionally, there is no acceptable industry-wide "below regulatory concern" policy for volumetrically contaminated material; thus, EH should publish guidance outlining examples of the types of materials that need to be evaluated and specifying appropriate analytical methods and data quality objectives for demonstrating that potentially volumetrically contaminated materials are indistinguishable from background and can therefore be released. Ultimately, publication of specific volumetric release limits for volumetrically contaminated material following industry accepted guidance, such as the American National Standards Institute Health Physics Society standards for clearance (or another consistent approach), would eliminate confusion and subjectivity associated with current DOE requirements.

5. DOE Order 5400.5 requirements for management of soil columns and inactive release areas were not always properly followed or considered in discharge strategies.

DOE Order 5400.5 defines a soil column as an in situ volume of soil through which liquid wastes percolate down from ponds, cribs, seepage basins, or trenches. The use of soil columns to retain, by sorption or ion exchange, suspended or dissolved radionuclides from liquid waste streams was prohibited when DOE Order 5400.5 was issued in 1990. The practice was used extensively at some sites prior to 1990, resulting in significant radiological contamination in certain areas around these sites. In an effort to prevent the further spread of radionuclides in the environment, DOE Order 5400.5 placed a prohibition on the use of soil columns as a treatment practice and prohibits further discharge of any liquids, including uncontaminated liquids, to previously contaminated release areas.

A common problem noted at DOE sites was insufficient consideration of DOE Order 5400.5 soil column requirements relative to current practices for discharging radiological, nonradiological, and/or potentially contaminated liquids to previously contaminated land areas. Liquid discharges have been occurring at several sites without formal evaluation against DOE Order 5400.5 soil column and ALARA requirements, which are intended to prevent the continued spread and migration of previously deposited radionuclides in the environment. The hazards posed by ongoing discharges were not evaluated against the DOE Order 5400.5 soil column and ALARA requirements or integrated into sitewide liquid discharge goals, objectives, and long-term strategies.

Several sites did not consider the DOE prohibition on new soil columns when ponds or settling basins that could have contained radiological contamination were used or where new basins were constructed. In these cases, documentation to demonstrate that these areas were not or would not be receiving contaminated liquids and thus become soil columns was not available.

There is some ambiguity in the soil column provisions contained within DOE Order 5400.5. For example, the soil column definition does not explicitly define soil columns as engineered features designed specifically for the treatment of liquid wastes. At some sites, contaminated soil columns (as defined in DOE Order 5400.5) in the form of trenches and gullies have

been created naturally where there is a lack of surface water flow with a similar end result as an engineered system. While the intent of DOE Order 5400.5 is to minimize contamination in the environment to eliminate the need for future remediation, application and understanding of the requirements have varied. EH should revisit the soil column requirements, including definitions and sections on liquid releases to previously contaminated areas, to provide additional clarity and to eliminate subjective interpretations from line organizations responsible for implementation.

3.3 Environmental Radiological Monitoring and Surveillance

All sites performed some form of environmental radiological monitoring and surveillance. The level of the monitoring and surveillance was generally consistent with DOE expectations and guidance. With few exceptions, site environmental monitoring programs were found to be capable of detecting major releases or migration of radionuclides. However, areas for improvement and refinement were noted in a number of aspects. Observations were identified with respect to radiological characterization of liquid effluents, reliance on gross indicator parameters, data quality objectives for environmental sampling, and sediment monitoring.

Observations

1. At most sites, settleable solids were not being analyzed, and compliance was not being documented.

As discussed in DOE/EH-0173T, water sampling is generally not an effective indicator of low levels of waterborne radionuclides. For this reason, sediment sampling and assessment of radioactivity content of settleable solids in liquid discharges is required to ensure that long-term accumulation of radioactivity in sediments is properly controlled. DOE Order 5400.5, Chapter II.3, limits the amount of radioactivity that can be present in settleable solids in liquid discharges to surface waters to five picoCuries per gram (pCi/g) alpha and 50 pCi/g beta-gamma. This limit is established to prevent buildup of radioactivity in sediment. Although it is not likely that any sites are exceeding the limit, numerous problems with understanding and demonstrating compliance with DOE order requirements were evident. Examples included:

- None of the sites visited were conducting the required analysis of settleable solids to demonstrate compliance with the DOE Order 5400.5 limit.
- Many sites believed that there were insufficient quantities of settleable solids in the effluent to accurately measure, and used this informal and undocumented belief as a basis for the lack of monitoring.
- Some sites incorrectly used information in a 1995 EH memorandum (intended to clarify the method of demonstrating compliance) to justify an exemption from the settleable solids requirements.

The instances of insufficient demonstration of compliance with this provision of DOE Order 5400.5 may be partially attributed to unclear and/or fragmented guidance for DOE's expectations. In addition, most sites believe that the level of settleable solids in liquid discharges is so small that it is insignificant, and not worth the expense of monitoring in accordance with the published DOE methodology. However, indirect methods of demonstrating compliance have been authorized by EH and documented in specific memoranda. Sites should ensure that they perform sufficient analyses and have a sound technical basis to document compliance with this requirement.

2. Sediment sampling locations and rigor were not always sufficient to detect contamination and evaluate trends.

The sampling of sediments from streams or ponds can provide an indication of the accumulation of undissolved radionuclides in the aquatic environment. The accumulation of radioactive materials in sediment can lead to exposure of humans through ingestion of aquatic species, through sediment resuspension into drinking-water supplies, or as an external radiation source for people who are fishing, wading, or sunbathing. Because of the accumulation of contaminants, sediment sampling is a more sensitive indicator of waterborne radionuclides than water sampling or, for some aquatic species, aquatic biota sampling. At a number of sites, the sediment sampling program did not adequately characterize environmental

impacts posed by liquid discharges and runoff from contaminated areas. For example:

- Sediment sampling locations were often not close enough to source areas to detect radionuclide migration in a timely manner.

- Incomplete characterization of known impacted areas affected the quality and consistency of public dose estimates.

- Some radionuclides potentially present at sites were not being analyzed.

Sites should review sediment sampling programs to ensure that sampling locations are sufficient in number and placement and that analytical methods are sufficiently sensitive to distinguish any site-derived radionuclides, and to evaluate both short- and long-term accumulation of contaminants and/or migration of radioactivity from source areas.

3. A number of sites relied too heavily on gross alpha and beta analyses and did not routinely establish proper data quality objectives in support of environmental radiological sampling and decision-making.

Natural background radiation includes both alpha and beta particles, which are emitted from most environmental media. Some DOE site-derived radionuclides are not present naturally and their presence cannot be effectively identified with gross alpha and beta techniques because of insufficient analytical sensitivity and interference from naturally occurring radioisotopes. Some of the possible DOE radionuclides, such as plutonium and neptunium, have a much higher radiotoxicity than the naturally occurring radioisotopes, making it imperative that they be correctly identified and quantified if they are present in environmental media. Specific radiochemical analysis is often required. For all radionuclides, trending and early detection of possible impacts, including the ability to distinguish the site-derived component from natural background, are key objectives of environmental monitoring and surveillance programs and are required to make effective radiation protection and waste management decisions. The following types of problems were identified by oversight evaluations at many sites and are the result of relying too much on the use of gross radiation measurements without corresponding isotopic analysis and data quality objectives:

- Failure to establish appropriate volumetric contamination limits for possible low-level radioactive waste

- Inability to distinguish site-derived radionuclides from natural background

- Lack of proper requests to provide appropriate minimum sensitivity for requested radiological analyses, resulting in minimum detectable activity much higher than that needed

- Use of gross alpha, beta, or total uranium results, with no guidance on levels of concern or specific actions to be taken

- Use of total uranium results to calculate isotopic uranium values without knowledge of specific enrichment levels

- Analytical results with error ranges higher than the stated results.

While the use of gross alpha and beta measurements is an acceptable and valuable tool in evaluating trends and qualitatively determining sample activities, sites should ensure that specific isotopic analyses at a predetermined sensitivity are performed regularly to complement the gross measurements and to provide a technical basis for decision-making. In some cases, gross alpha and beta measurements can be used as surrogates for a specific isotopic analysis, provided an appropriate evaluation has been conducted and documented to support the basis. In addition, the establishment of appropriate data quality objectives, including minimum required laboratory sensitivities and related parameters, should be established before performing any analytical work.

3.4 Radiological Air Emissions

All sites were found to have an active NESHAPS program that was effective in meeting applicable dose-based Federal air regulations for radionuclides. However, weaknesses were noted in certain elements of the air quality programs that form the basis for

compliance with requirements and affect the accuracy and validity of the program's technical bases. For example, one site did not possess appropriate documentation supporting the potential to emit calculations, which determines the status of the stack under 40 CFR 61, Subpart H. Other areas where improvements were needed included stack sample line design and placement, and ambient air monitoring. At several sites, although sampling systems comply with basic requirements, the sites could not demonstrate that sampling was actually representative of the contaminant flow through the stack because of such various conditions as saturated stack environments or the presence of multiple 90-degree bends in stack sample lines.

One observation was made with respect to ambient air monitoring systems.

Observation

1. Ambient air monitoring programs are not always considering minimum dose sensitivity, release conditions, and particle size.

Data collected from ambient air monitoring programs is generally used as a supplemental method to demonstrate and validate the low levels of emissions modeled by calculation under NESHAPS. This data is often reported in site environmental reports and NESHAPS reports as evidence of low emissions. As such, technical accuracy and rigor are important to establish and maintain credibility. There are limitations associated with these systems that have not always been appropriately considered or defined as part of reporting processes. For example:

- Only one site evaluated had documentation of the minimum dose the samplers would be able to capture at the minimum detectable activity. The low-volume samplers used at many sites further hinder the minimum sensitivity of the samplers. Contrary to statements made in annual NESHAPS reports, most sites have not established or documented that the limit of detection matches the purpose of the sampler, such as providing evidence (beyond calculations) that the 40 CFR 61, Subpart H, 10-mrem limit has been met, or that a dose of 10 mrem or less, above background, can be detected.

- Siting of air samplers was problematic at several sites. Studies were either not performed or did not take into account the type of release the samplers were designed to measure.

DOE line managers should evaluate ambient air monitoring systems for radionuclides to ensure adequate selection and citing of samples. Evaluate and include in applicable environmental reports the minimum dose sensitivity of the ambient air monitoring system.

4.0 Conclusions

Independent oversight evaluations determined that all sites had established environmental monitoring, surveillance, and control programs to implement regulatory requirements and DOE contractual obligations. The level of resources and program formality was generally consistent with the hazards posed by operational activities and legacy contamination. Site environmental surveillance programs have been ongoing for many years, and an extensive baseline of information on contamination in environmental media has been developed. At all DOE sites evaluated, monitoring data demonstrates a decreasing trend in the levels of radiological discharges to the environment in air and water pathways. This can be directly linked to the reduction in operational activities, regulatory permitting and inspection programs, and implementation of pollution prevention and pollution control projects.

Oversight inspections identified a number of common strengths within DOE environmental monitoring, surveillance, and control programs.

- Extensive groundwater monitoring networks have been developed to support environmental restoration efforts. Groundwater plumes that are highly contaminated and present a significant threat have been identified, and many are undergoing remediation.

- The level of the radiological monitoring and surveillance was consistent with most DOE expectations and guidance, and was adequate to detect any major releases or migration of radionuclides.

- All sites evaluated have active NESHAPS programs that were effective in meeting dose-based radiological discharge limitations.

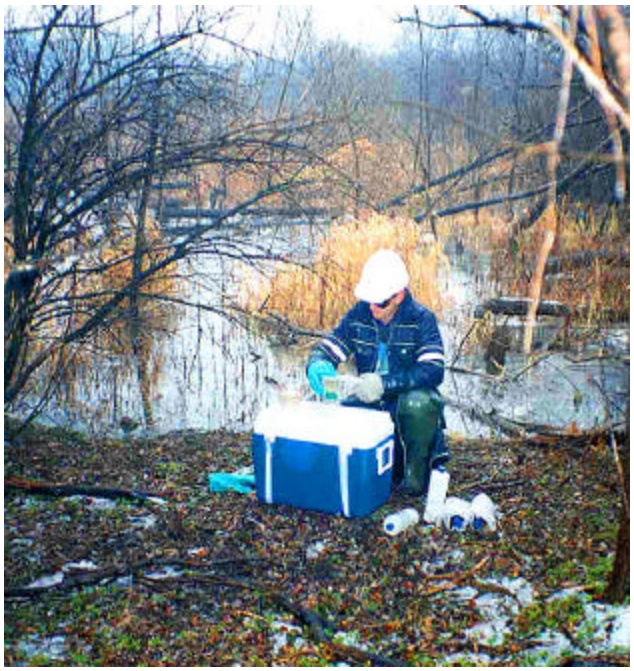
Independent oversight evaluations also noted a number of weaknesses in the implementation of environmental monitoring, surveillance, and control programs as discussed in detail in the observations in Section 3. In most cases, these weaknesses involve small amounts of radioactive material and/or pathways that do not result in significant radiation exposures to workers or the public. Further, for the most part, DOE sites have adequately identified the higher hazard conditions and are taking appropriate corrective and remedial actions. However, the weaknesses identified in Section 3 indicate a need for further analysis and attention to ensure that improvements are made in DOE environmental monitoring and surveillance expectations and program implementation.

Three factors appeared to contribute to most of the observations contained in this report:

1. **DOE expectations for environmental monitoring, surveillance, and control are not consistently understood, fully defined in all areas, or invoked in DOE contracts.**

Many of the weaknesses identified in oversight reviews stemmed from insufficient understanding or clarity of DOE expectations. Site personnel were either unaware of DOE expectations or did not accurately interpret the specific expectations contained in DOE Orders 5400.1 and 5400.5 and guidance documents. This factor was observed consistently in the areas of groundwater stewardship; application of ALARA principles to environmental releases; demonstrating compliance with DOE limits on settleable solids in liquid effluents; and releasing volumetrically contaminated materials from radiological controls. In several areas, oversight evaluations determined that DOE had not established clear expectations. DOE occupational radiation protection regulations (10 CFR 835), Order 5400.5, and standards do not establish clear expectations for posting and control of radioactively contaminated soils, resulting in inconsistent and in some cases non-conservative control practices. Additionally, ambiguities regarding the prohibition on liquid discharges to soil columns were found in DOE requirements.

Problems in the implementation of DOE expectations for environmental monitoring and controls can also be linked to the age of DOE orders and guidance, and deficiencies in the implementation of the Work Smart Standards.



Sampling Wetlands

DOE Orders 5400.1 and 5400.5 have not been updated in nearly a decade and contain outdated information. Additionally, supplemental guidance has been issued over the years by EH and through various memoranda. However, oversight reviews determined that responsible site personnel did not consistently have knowledge concerning the existence and content of these memoranda.

DOE managers at some sites have utilized the Work Smart Standards process to tailor DOE environmental monitoring, surveillance, and control requirements applicable to the scope of work to be performed by management and operating contractors. In most cases, a diligent effort was undertaken to establish a set of requirements appropriate to the work and hazards. In several cases, implementation of the Work Smart Standards process was not consistent with its intent. In these cases, managers did not incorporate DOE groundwater protection and radiological monitoring and control requirements, or alternate standards, into management and operating contracts, even though there were substantial operational activities and legacy conditions that necessitated reliable controls and defensible environmental measurements.

2. There is insufficient professional radiological expertise being applied to environmental radiological protection programs at some sites.

Oversight evaluations determined that some sites did not have or apply necessary health physics expertise to effectively manage environmental radiological protection responsibilities. At some sites, personnel who were responsible for evaluating technical data, making decisions, and preparing and/or reviewing health physics-related reports had limited training and qualifications in health physics disciplines. This resulted in errors and omissions in the planning, implementation, evaluation, and reporting of a number of elements of site environmental programs. Generally, better performance was noted at those sites where responsibility for environmental radiological protection was most integrated with the sitewide health physics program.

3. Insufficient application of resources to environmental monitoring programs has impacted the ability to characterize environmental conditions in some areas.

Oversight reviews have found that many sites have significantly reduced the resources allocated to environmental monitoring. Resource constraints at some sites have resulted in a significant reduction of DOE and contractor environmental support personnel, the number of monitoring stations, monitoring frequency, and analytical parameters. While some of the observed reductions were justified based upon the development of comprehensive baseline information, resource reductions have directly impacted some sites' ability to fully characterize DOE contaminants in the environment. Resource reductions were observed to have contributed to an inappropriate reduction of groundwater surveillance wells near operational facilities; over-reliance of gross alpha and beta analytical measurements; insufficient characterization of sediment migration pathways; and failure to periodically monitor contaminants in some environmental media, including biota and foodstuffs, to confirm baseline information.

The capability of many DOE field organizations to manage and oversee environmental monitoring programs has been limited by loss of experienced personnel and sustained hiring limitations. In addition to the above-mentioned concerns on environmental radiological expertise, management contractors have also experienced staffing constraints for environmental monitoring positions. In particular, the loss of experienced hydrogeologists has also hindered groundwater protection and remediation programs at some sites.

5.0 Opportunities for Improvement

In the spirit of promoting continuous improvement, some specific opportunities for improvement have been identified. These potential enhancements are not intended to be prescriptive. Rather, they are intended to be reviewed and evaluated by the responsible DOE and contractor line management and prioritized and modified as appropriate, in accordance with site-specific and DOE-wide programmatic objectives. Also, it is OA's intention that these opportunities for improvement will be useful in the ongoing efforts by EH to replace the outdated DOE environmental protection order with a new environmental management system-based order/manual and to consolidate and re-issue guidance documents.

DOE Line Organizations

DOE sites should compare their operational practices against the twelve specific observations in this report to determine their applicability, and should take corrective actions to address specific problems and causal factors as appropriate. Specific actions to consider are summarized below.

1. **Review groundwater protection programs to ensure appropriate monitoring and stewardship.**

- Review groundwater protection management programs to ensure that all operational activities potentially impacting groundwater quality have been identified; contaminant release pathways and potential impacts have been analyzed; and necessary monitoring and equipment surveillance controls have been established and implemented.

- Evaluate efforts that were undertaken at other DOE sites (e.g., Brookhaven National Laboratory and the Oak Ridge National Laboratory) to systematically identify groundwater contamination vulnerabilities associated with current operations. Incorporate lessons learned and best practices as applicable.

- Review practices for trending, interpreting, and reporting groundwater monitoring data to ensure that analytical data is fully utilized for identifying changing environmental conditions. Ensure that procedural controls consistent with management expectations have been established for trending and for reporting anomalous conditions.

- Review site-specific groundwater monitoring programs to verify the adequacy of their programs for monitoring and reporting groundwater contamination occurring at low concentrations. Ensure that sufficient investigations have been performed, or included in site project plans, to confidently determine the extent of all known groundwater contamination.

2. **Evaluate environmental sampling and analysis methods and approaches to ensure that they are sufficient to demonstrate compliance with applicable limits and provide an adequate technical basis for the environmental monitoring program.**

- Ensure sufficient analyses are performed to provide a sound technical basis to document compliance with DOE settable solids discharge limitations.

- Ensure that specific isotopic analyses at a predetermined sensitivity are performed regularly to complement the gross measurements and to provide an appropriate technical basis for decision-making.

- Review sediment sampling programs to ensure that sampling locations are sufficient in number and placement and that analytical methods are sufficiently sensitive to distinguish any site-derived radionuclides and to evaluate both short- and long-term accumulation of contaminants and/or migration of radioactivity from source areas.

- Evaluate ambient air monitoring systems for radionuclides to ensure adequate selection and citing of samples. Evaluate and include in applicable environmental reports the minimum dose sensitivity of the ambient air monitoring system.

3. Ensure that the ALARA principle is systematically applied to environmental programs.

- Establish appropriate mechanisms, procedural requirements, and training and performance criteria to foster the full integration of the ALARA process into environmental programs, consistent with DOE Order 5400.5 and associated guidance.

- Ensure that organizational/individual responsibility for environmental ALARA is assigned.

- Ensure that ALARA reviews are documented and are sufficient to identify alternatives that might further reduce doses and potential environmental radiological impacts.

4. Evaluate the adequacy of application of resources to environmental monitoring and surveillance programs.

- Evaluate staffing allocations and hiring practices to ensure that adequate and qualified health physics resources are available to implement environmental radiological programs.

- Ensure that clear accountability mechanisms are established for the technical quality of environmental radiological programs.

- Evaluate resources allocated to environmental monitoring, with a particular focus on adequacy of monitoring stations, monitoring frequency, analytical parameters, groundwater surveillance wells near operational facilities, characterization of sediment migration pathways, and periodic monitoring of pathways, including contaminants in biota and foodstuffs.

Office of Environment, Safety and Health

EH is currently in the process of replacing DOE Order 5400.1 with a new environmental management system order (Draft DOE Order 450.1)/implementation manual and consolidating and re-issuing guidance documents. As part of this effort, and in coordination with the DOE program and field organizations, EH should evaluate the observations and causal factors identified in this report and factor them into the ongoing efforts to update applicable environmental orders, standards, and guidance. Specific actions to consider are summarized below.

1. Clarify DOE requirements and guidelines to ensure that a consistent set of expectations has been established for DOE field organizations to implement environmental monitoring, surveillance, and control programs.

- Establish clear requirements for posting and control of areas with radiologically contaminated soils.

- Clarify radiological control requirements for the discharge of liquid effluents to soil columns.

- Clarify DOE expectations regarding groundwater protection measures associated with operating facilities, including the use of single-walled tank and piping systems for radiological services.

- Provide guidance on the minimum level of investigation, monitoring, and reporting of low-level groundwater plumes.

- Review requirements and guidance for the release of materials from radioactive controls that are volumetrically-contaminated.

2. Re-evaluate the benefits of promulgating regulations that codify DOE internal directives for radiation protection of the public and the environment.

- Evaluate DOE Order 5400.5 to ensure that its requirements provide sufficient standards for implementing DOE's authorities and responsibilities under the Atomic Energy Act of 1954, as amended.

- Evaluate the benefits of regulations that encompass the requirements for protecting the public and environments from exposure to radiation.

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APPENDIX A
RELATED INDEPENDENT OVERSIGHT EVALUATION REPORTS

REPORT TITLE	REPORT DATE
Independent Investigation of the Paducah Gaseous Diffusion Plant Phase I	October 1999
Independent Investigation of the Portsmouth Gaseous Diffusion Plant	May 2000
Pantex Ground Water Monitoring and Reporting Program Review - Report to the Secretary of Energy	May 2000
Inspection Report on the Gamma Irradiation Facility Pool Leak	September 2000
Independent Investigation of the East Tennessee Technology Park	October 2000
Focused Safety Management Evaluation of the Idaho National Engineering and Environmental Laboratory	January 2001
Independent Review of the High Flux Isotope Reactor Tritium Leak	February 2001
Independent Inspection of the Savannah River Site Environmental Monitoring and Surveillance Programs	April 2001
Inspection of the Argonne National Laboratory - East Environmental Monitoring and Surveillance Programs	August 2001
Inspection of the Lawrence Berkeley National Laboratory Environmental Monitoring and Surveillance Programs	August 2001
Focused Review of Environment, Safety and Health and Emergency Management at the Kansas City Plant	December 2001
Inspection of Environment, Safety, and Health Management at the Hanford Site	March 2002
Inspection of Environment, Safety, and Health Management at the Los Alamos National Laboratory, Volume I	April 2002
Inspection of Environment, Safety, and Health Management at the Lawrence Livermore National Laboratory, Volume I	July 2002

APPENDIX B
TEAM COMPOSITION

Project Team

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