APPLICATION OF SCIENCE AND TECHNOLOGY TO AID IN CLEANUP DECISIONS

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ABSTRACT

The U.S. Department of Energy (DOE) established the Groundwater/Vadose Zone Integration Project (Integration Project) in late 1997 to provide an innovative, new approach at DOE's Hanford Site for protecting the Columbia River. The Integration Project brings together all activities that impact Hanford's subsurface, and ultimately, the Columbia River. The Integration Project is assembling a capability to perform a site-wide assessment of the impacts of existing and future contamination. This capability requires data and information for the inventory, vadose zone, groundwater, river, risk, monitoring, and remedial options technical areas. A credible and defensible understanding of these areas is required to adequately predict the movement of contaminants in the subsurface and surface environments, and to subsequently design and monitor remedial options.

A significant focus of the Integration Project is to design and apply specific science and technology (S&T) to fill in gaps that exist in the understanding, knowledge, data, tools, and methodologies for informing and influencing remediation and closure decisions at the Hanford Site. The Integration Project S&T uses a roadmap as a tool for implementing a program to address scope in the inventory, vadose zone, groundwater, Columbia River and risk technical elements, which are needed to describe the controlling features and processes in each of these environmental settings. Physical, chemical, and biological features, events, and processes are being evaluated. These descriptions of groundwater, vadose zone, Columbia River, and risk phenomenology will provide input to the technical and scientific basis required for Hanford cleanup decisions.

INTRODUCTION

The Hanford Site in southcentral Washington State is approximately 1517 km^2 (586 mi^2) of semiarid shrub and grasslands located just north of the confluence of the Snake and Yakima rivers with the Columbia River (Figure 1). This land, with restricted public access, provides a buffer for the smaller areas historically used for production of nuclear materials, waste storage, and waste disposal. The Hanford Site was acquired by the federal government in 1943 and, until 1989, was dedicated primarily to production of plutonium for national defense and the management of resulting wastes. With the shutdown of the production facilities in the 1970s and 1980s, the U.S. Department of Energy (DOE) ended production of nuclear materials for weapons at the Hanford Site. The current mission for the site consists of environmental management including decontamination and decommissioning of facilities, facility stabilization, environmental restoration, waste management, and research and technology development.

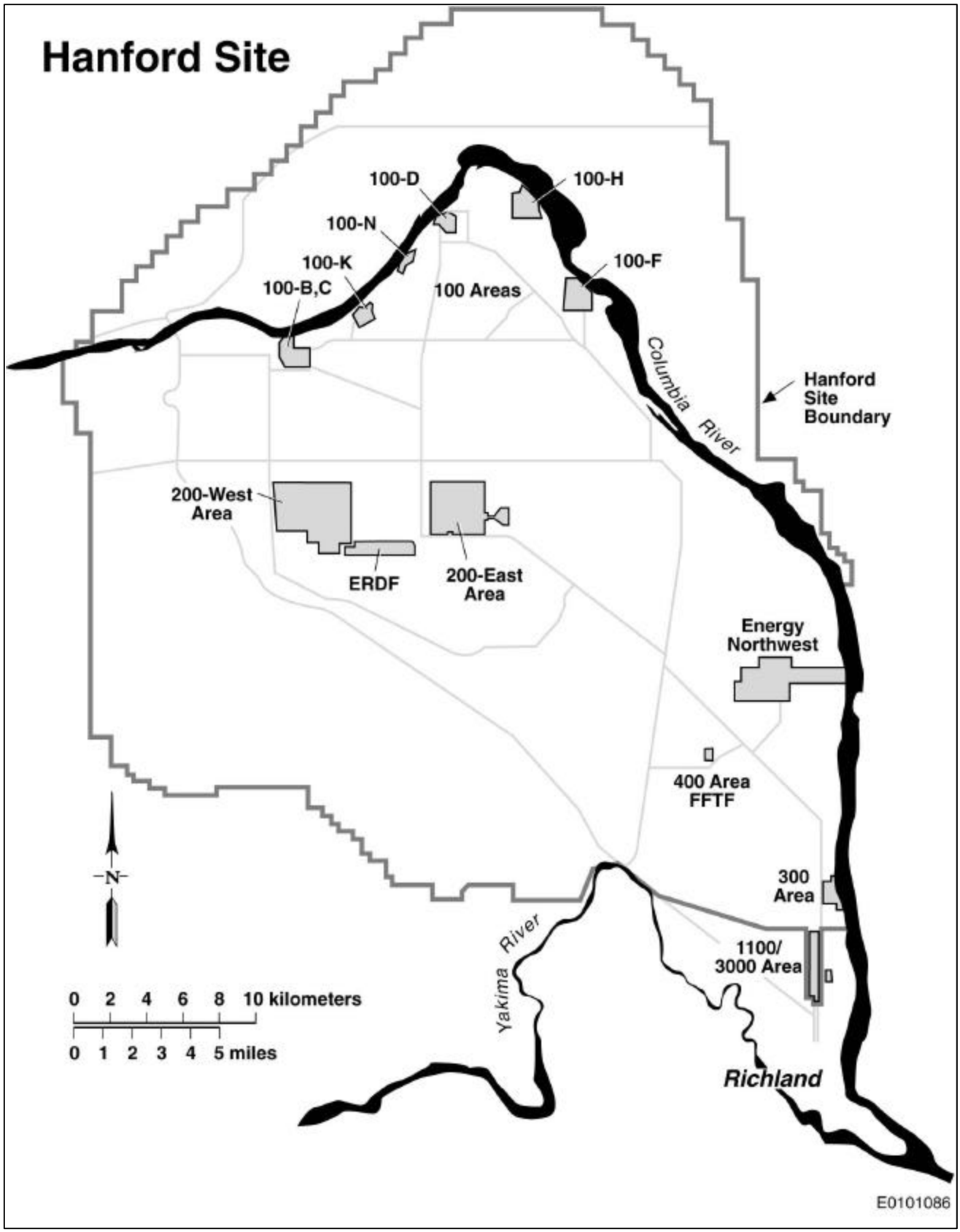

Fig. 1. The Hanford Site

The Groundwater/Vadose Zone Integration Project (Integration Project) was established by DOE to provide assurance that cleanup actions and decisions at Hanford are protective of the Columbia River. The Integration Project is the single entity for integrated management of vadose zone, groundwater, and Columbia River-related activities at the Hanford Site. This integrated management involves five activities (1):

- Integrate environmental characterization and monitoring affecting long-term risk assessments (Integration)
- Assess the potential long-term effects of Hanford Site contaminants (System Assessment Capability [SAC])
- Enhance the role of science and technology in cleanup decisions (S&T)
- Ensure productive involvement by parties interested in affecting Hanford's cleanup (Public Involvement)
- Ensure independent technical reviews and management oversight of the Integration Project (Technical Review).

At Hanford, as with most complex sites, multiple projects and organizations responsible for various aspects of the environmental restoration mission. Projects whose primary scope involves environmental characterization and monitoring, or risk and performance assessments participate in the Integration Project. Teaming of these projects has created a coordinated and cohesive approach to the environmental restoration scope of work. The Integration Project also added elements that were either lacking or under emphasized (e.g. S&T). As a result, S&T is directly included in the approach to the Site mission.

The objective of S&T associated with the Integration Project is to provide new knowledge, data, tools, and the understanding needed to enable the project's mission. The S&T is focused on resolving key technical issues that help inform and influence decisions on remediation and closure of tank farms, characterization and remediation of contaminated soil sites, and plans for final end states and Site closure. This input occurs either directly through the Integration Project or another Hanford Site Project, or through the SAC, which will be applied in site-wide assessments of the Hanford Site, starting with a proof of principal Rev. 0 application in 2001.

S&T ROADMAP AND LINKAGES

The S&T efforts are organized along technical elements. The inventory, vadose zone, groundwater, and Columbia River technical elements provide the technical information and data to characterize various features and processes essential to development of conceptual and numerical models. The risk assessment technical element identifies the methods and capabilities required for performing site-wide system assessments. Other elements that will be added to the project include remediation to identify potential improvements to the Hanford Site's remediation strategy, and the monitoring element, which will provide improvements to the strategies and technologies used for environmental monitoring.

The Integration Project S&T constructed the first project-level roadmap for a major DOE site-wide project (2 and 3). This project-level roadmap is used to plan and document implementation

of work scope to address scientific and technical challenges faced by the Hanford Site in assessing and cleaning up soil and groundwater contamination.

Roadmapping is a process in which problem holders come together with problem solvers to define problems and establish a path to solution. A roadmap, which is a dynamic and evolving document, briefly describes objective, scope and outcomes for S&T activities and provides estimates of schedule, budget, and priorities for the activities.

The Integration Project S&T roadmap was developed through a series of meetings conducted during FY 1998. In these meetings, representatives from DOE National Laboratories who are scientific experts in subsurface assessment and remediation, met with the DOE, site remediation contractors, regulators, Tribal Nations, and local stakeholders. Many of these scientists had developed assessment capabilities for other DOE programs, such as Yucca Mountain. This diverse set of experience and capabilities was used to identify the scientific and technical challenges facing the Hanford Site, and describe those challenges in the S&T plan. The S&T activities and outcomes to address these challenges were defined in Rev. 0 of the roadmap during FY 1999.

The S&T roadmap describes the products on a schedule documenting linkages to Hanford Site projects receiving S&T input (Figure 2). The S&T roadmap for the vadose zone technical element is illustrated in Figure 3. In both Figure 2 and 3, "up" triangles depict a S&T product that provides input to a Hanford Site Project, "down" triangles show a S&T product that feeds into the SAC, and a circle denotes a S&T product to another science activity within the Integration Project. The roadmap (3) documents S&T activities within each technical element (inventory, vadose zone, groundwater, Columbia River, and risk assessment), a brief definition of each product, project linkages and interactions, identification of the customer for the S&T product, and both startup and delivery dates. The document also includes a summary of budgets estimated for planning and executing the S&T activities.

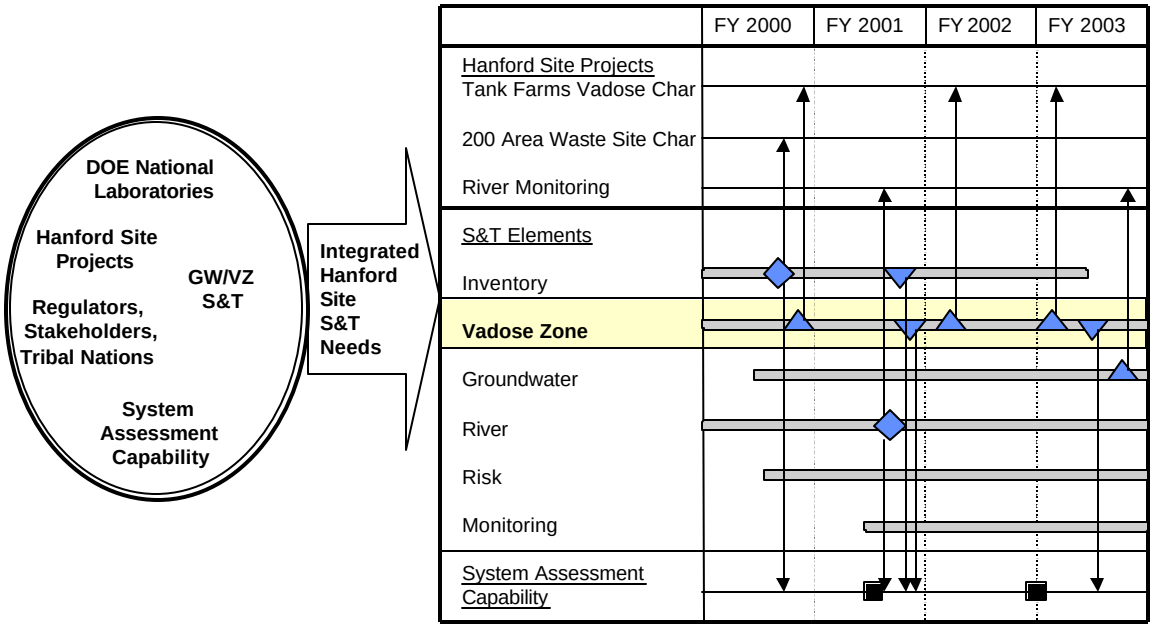

Fig. 2. Science and Technology Roadmap

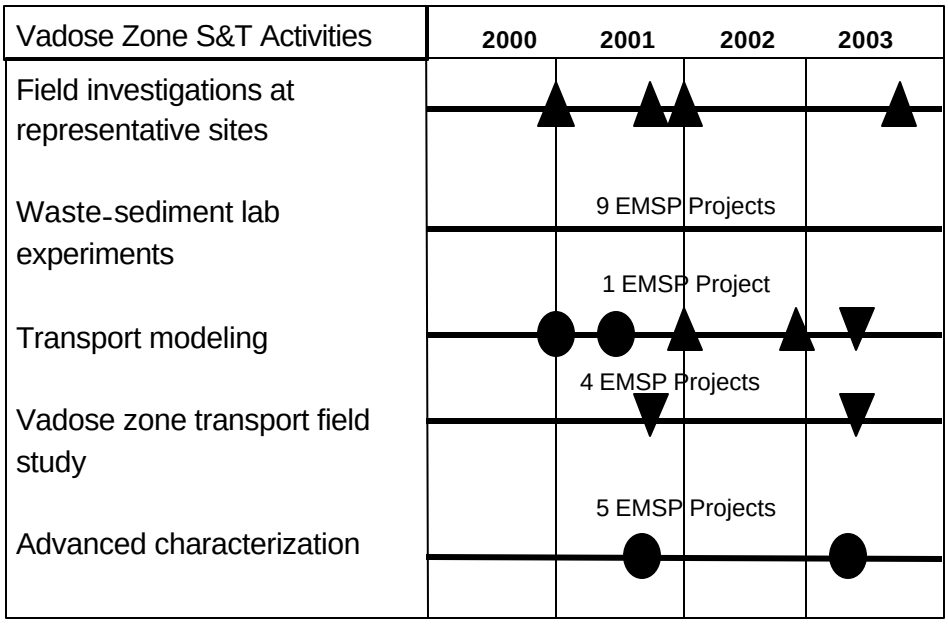

Fig. 3. S&T Roadmap for the Vadose Zone Technical Element

The S&T roadmap for the Integration Project identified the following broad needs for each of the technical elements:

- An approach is needed to provide a mass-balanced-based inventory of contaminants in soil sites that can be used in applications of the SAC and by individual projects
- Improved conceptual and numerical models describing the current location of contaminants and used to forecast future movement of contaminants at both site-specific and site-wide scales are needed. Current conceptual models have not been sufficient to forecast the fate and transport of contaminants under the varied conditions at the Hanford Site
- Advanced characterization and monitoring tools are needed to improve detection and monitoring of contaminants in the vadose zone
- Three-dimensional distributions of contaminants at the interfaces of the groundwater at the vadose zone and the Columbia River are not well characterized and the behavior of contaminants at these interfaces is not known
- An enhanced conceptual models of the Columbia River is needed that accounts for multiple contaminant sources, fate and transport of contaminants in the river environment, and the potential impacts of those contaminants
- Data and models are needed to reduce uncertainty in ecological and human health risk assessments at the Hanford Site, as well as develop methods for predicting economic and socio-cultural impacts from Hanford-derived contaminants.

IMPLEMENTATION

The Integration Project S&T roadmap is used to guide decisions regarding investments for S&T. Specifically, the Integration Project uses the S&T roadmap as input to developing detailed work plans each fiscal year. Rev. 0 of the roadmap provided the basis for defining the FY 2000 scope of work for the Integration Project S&T and was used to influence a call for proposals by the DOE Environmental Management Science Program (EMSP). The activities and budgets for FY 2000 were prioritized by Integration Project staff, other Hanford contractors, and representatives of DOE Richland Operations based on their value for addressing uncertainties inherent in Hanford's ability to perform defensible assessments of the cumulative effects of wastes that will remain at the Site.

EMSP is administered through the DOE Office of Science and Technology and invests in basic and applied science. During FY 1999, the EMSP awarded 31 new grants (worth $25M in work scope over three years) directed at the vadose zone problem at Hanford. The principal investigators participating in these projects are from across the DOE complex, universities, and private industry. During November 1999, the Integration Project S&T held an orientation workshop for the successful EMSP investigators to link their efforts with research efforts at the Hanford Site. The Integration Project continues to interact with the EMSP principal investigators to incorporate their research results into scientific investigations supporting the Hanford Site. A second EMSP principal investigator workshop was held in November 2000, with participants from EMSP projects, Integration Project staff, and contractors for other Hanford projects.

Many of the EMSP projects funded in FY 1999 have objectives and scope that are closely aligned with work scope being performed on projects at the Hanford Site. Beyond the two EMSP principal investigator workshops, the Integration Project has provided guidance and information to enhance the relevancy of planned EMSP research and to solicit EMSP investigator involvement of key scientific issues that fall within the scope of their project. In addition, the Integration Project has provided Hanford Site materials (e.g. sediment and water samples) for performing EMSP experiments, and involving EMSP investigators in Integration Project scientific research, specifically the vadose zone transport field experiments that are being performed.

During FY 2000, the S&T roadmap was revised (Rev. 1) to include the risk technical element and incorporate the FY 1999 EMSP awards. The activities and outcomes were revised to match changes in Hanford Site project strategies and schedules. The FY 2001 work scope includes the following activities:

- Develop probabilistic model to estimate mass-balanced soil waste inventories for the SAC
- Complete scientific studies of samples from beneath several of the high-level waste tank farms that are suspected of having contaminated groundwater, complete modeling studies of these tank farms, and provide direct input to field characterization reports
- Perform vadose zone transport field experiment with high salt tracer and analyze the results, including evaluation of advanced characterization technologies suitable for the Hanford vadose zone
- Complete analyses of groundwater/river interactions at key locations along the Columbia River to develop dilution models for the SAC
- Initiate laboratory studies of biological uptake and elimination in aquatic organisms exposed to key Hanford contaminants in the Columbia River.

For the Integration Project S&T activity to have an impact, it must deliver correct scientific and technical information in a timely manner that allows the information to be used by other Integration Project tasks and other Hanford Site projects. The outcomes were defined based on S&T needs identified in the process of developing the roadmap and through ongoing discussions between scientists and Hanford Site projects. Linkages of S&T activities to other tasks of the Integration Project occur through ongoing and frequent interactions of scientists with Integration Project staff.

The Integration Project is conducted in an open forum with emphasis on public involvement. Opportunities for public involvement with S&T include meetings and technical discussions with regulators, Tribal Nations, advisory boards, one-on-one meetings, and open project meetings.

Peer review occurs through interactions with the Integration Project Expert Panel (IPEP). The IPEP was established in 1998 to provide independent management and technical review of the Integration Project work scope. In addition to the IPEP, DOE Headquarters requested review of the S&T activities and their relevance to Hanford Site decisions by a 14-member National Academy of Sciences committee, which initiated their review during FY 2000. This committee will complete their 18-month review in Spring, 2001.

ROADMAP ACCOMPLISHMENTS

The Integration Project S&T roadmap has proven to be an effective planning and management tool. Through implementation of the roadmap, the Integration Project has accomplished the following:

- Identification and prioritization of critical gaps and the scientific studies and technology development efforts needed to fill those gaps
- Application of EMSP projects to Hanford subsurface problems. EMSP principal investigators are directly linked with investigations of tank farms that may have impacted groundwater, vadose zone transport field studies, and evaluation of advanced characterization technologies
- The DOE National Laboratory System, university researchers, and private industry are engaged in helping to address the Hanford Site's most critical issues
- The scientists and technology providers are linked with the problems, resulting in S&T activities that are outcome-driven and directly support remediation projects.

The benefits of defining and implementing the S&T roadmap for the Integration Project include:

- Systematic identification of gaps in scientific knowledge and technologies needed for assessment of the subsurface and Columbia River
- Understanding the timing of science and technology needed to fill critical gaps and justification of S&T investments
- Improved collaboration of scientists and the Integration Project team, including contributions from DOE national laboratories, universities, and private industry outside of the Hanford Site. Scientists better understand how to focus studies to produce results (scientific knowledge or new technology) that will be used by projects
- Improved collaboration with similar projects at other DOE sites.

Implementation of the Integration Project S&T roadmap faced some challenges. The premise of a roadmap is that it represents a process where problem holders come together with problem solvers to define a path forward to solution. The first challenge was that the project faced some difficulty translating activities defined in the roadmap to specific work scope and in gaining acceptance by all of the problem holders (e.g. DOE, remediation contractors, Tribal Nations, regulators, and stakeholders). In some cases, the process had to be worked to a point where results could be used to demonstrate the value of the S&T contributions to the Hanford Site mission. The second challenge was that more work scope was identified than funding, so the Integration Project had to prioritize S&T investments. Prioritization of existing multi-year S&T tasks versus initiating new work scopes is an ongoing challenge for the project.

CONCLUSIONS

The Integration Project S&T represents a strategic investment by DOE to integrate engineering, technology development, and science to solve complex environmental cleanup problems that exist at the Hanford Site. Successful implementation of the Integration Project S&T roadmap has depended on:

- Definition and management of S&T as part of Hanford's Integration project
- Delivery of value added products that are incorporated in Integration Project and Hanford Site project outcomes
- Recognition of for technical and scientific excellence in all products, verified through appropriate technical reviews
- Effective two-way communication with diverse project participants.

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