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Groundwater/Vadose Zone Integration Project Summary Description

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EXECUTIVE SUMMARY

The Hanford Site Groundwater/Vadose Zone (GW/VZ) Integration Project (Integration Project) was established in 1997 to develop the technical capability and scientific information needed to perform site-wide assessments of the potential effects of Hanford Site soil and groundwater contaminants on people and ecological systems. More specifically, the risk assessment methodologies, computer models, and data developed by the project will help inform and influence key decisions by regulators and U.S. Department of Energy (DOE) on the selection of clean-up goals and technologies. Key decisions that will be supported by the project include single shell tank waste retrieval and closure, remediation of 200 Area waste sites, and final closure of the Hanford Site. In order to complete this mission, gaps in scientific understanding are being identified to initiate scientific research required to close those gaps.

The overall Integration Project mission will be accomplished over a long period of time, consistent with the schedule for implementing key remediation decisions. However, the project also provides vital near-term benefits to the Hanford Site by coordinating and focusing site characterization efforts, eliminating redundancies and overlaps, developing methods to evaluate risks and impacts on a broad scale, and putting key assessment information under site configuration control. The Integration Project is also influencing Hanford Site decisions and operations to better protect water resources, including the Columbia River.

The project is building on existing data and experience from the Hanford Site and DOE national laboratories. The project also benefits from the efforts of stakeholders, project participants, and the output of the *Columbia River Comprehensive Impact Assessment* (CRCIA). From this input, the Integration Project will assess contaminant fate and transport into and through the Columbia River system, risk measures beyond standard dose/comparison to standards, uncertainty analyses across the technical knowledge base, and an applied science program targeted at the key uncertainties.

The scope of the Integration Project crosscuts all of the major projects at the Hanford Site. To effectively execute the Integration Project, a site-wide contractor team was formed and co-located. Bechtel Hanford, Inc., which is the Hanford Site Environmental Restoration Contractor, was assigned the lead for the Integration Project team. Fluor Daniel Hanford, Inc., the prime contractor for the Project Hanford Management Contract team, and Battelle Memorial Institute, which operates the Pacific Northwest National Laboratory, are active members of the Integration Project team.

The Integration Project has adopted a mission that was framed through a series of meetings with regulators, Tribal Nations, stakeholders, and the State of Oregon. The mission focuses the project on developing a credible, technically-defensible assessment of the cumulative effects of Hanford Site wastes in order to provide risk information (public, environmental, and cultural/ socioeconomic) to inform and influence cleanup decisions. Incorporating the information that is supplied by the Integration Project into the cleanup decision process is a new, important, and fundamental evolution of DOE's management strategy for the Hanford Site.

The Integration Project is focused on five endeavors. Those endeavors reflect comments and recommendations from numerous customers:

- Integrate characterization and assessment work affecting long-term risk assessments (Integration).

- Assess the potential long-term effects of Hanford Site contaminants (System Assessment Capability).

- Enhance the role of science and technology as the basis for cleanup decisions (Science and Technology).

- 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).

INTEGRATION

The objective of the Integration endeavor is to coordinate and optimize vadose zone, groundwater, and Columbia River characterization data collection, and interpretation. Data must be available when needed, and the data must be maintained and used in a consistent and technically defensible manner. There are four areas of focus within the Integration endeavor.

Management of Key Project Interfaces. The Integration Project work scope cross-cuts Hanford Site projects that manage and clean up wastes that have the potential to contaminate water resources. The Integration Project is identifying key decisions within these projects that it can appropriately inform and influence with the risk information that will be provided out of the cumulative assessment.

Coordination of Characterization Work. The Integration Project is coordinating Hanford's vadose zone, groundwater, and Columbia River characterization work to ensure that data collection is being optimized across the Hanford Site. Data collection includes work relative to defining and predicting the inventory of existing and potential radiological and chemical releases to the environment, and the collection and interpretation of data from the vadose zone, groundwater, and Columbia River.

Standardizing Data Sets, Conceptual Models, and Assessment Methodologies. The Integration Project is initiating activities to standardize performance/risk assessment methodologies and conceptual models used at the Hanford Site. These activities provide configuration and quality control of data, and specify processes to maintain consistency.

A conceptual model is a description of the available level of scientific understanding. A conceptual model describes what is known, and where major uncertainties in understanding exist.

A conceptual model is often the first step in the design of environmental assessment work.

Focusing the Regulatory Path. Hanford's characterization and assessment activities are operating under multiple and sometimes overlapping requirements, including the *Hanford Federal Facility Agreement and Consent Order*, *Resource Conservation and Recovery Act* (RCRA), *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA), *Nation Environmental Policy Act* (NEPA), U.S. Nuclear Regulatory Commission (NRC), and DOE orders. The Integration Project is working with regulators (U.S. Environmental Protection Agency [EPA], Washington State Department of Ecology [Ecology]) and stakeholders to:

- Reach agreement with regulators, Tribal Nations, stakeholders, and DOE relative to Hanford's "end state" (the clean up end state is defined as the state of Hanford at completion of the cleanup mission in or around 2040).
- Document the regulatory drivers for key cleanup decisions.
- Identify opportunities for regulatory integration.
- Identify key cleanup decisions that require assessment of the cumulative impacts to the regional water resources.

SYSTEM ASSESSMENT CAPABILITY

The objective of the System Assessment Capability (SAC) endeavor is to provide the predictive tools to perform the assessments required to understand the human, environmental, cultural, and socio-economic health effects resulting from Hanford Site contaminants. The results of the SAC will provide the basis to inform and influence site-specific cleanup decisions about the cumulative, long-term regional impacts of the Hanford Site. It will also provide useful information for setting cleanup priorities, allocation of funding, and determining the need for additional data.

In the long term, the site-wide SAC will provide important information (including predictive models and qualitative assessment information) which will support Hanford Site closure decisions.

The SAC will be developed and improved through iterative cycles until the users are satisfied that it provides sufficiently complete and defensible assessments of the Hanford Site. These iterations will be approximately 18 months long. The first iteration is due in December 2000. It consists of two equally important facets: first is the establishment and maintenance of the SAC tools (including predictive models); and, second, is the performance of required and supporting assessments to address future impacts of remedial actions and waste disposal.

The SAC is developing the methods and information required to meet the needs, requirements, and interests of specific customers. Customers for this information include Hanford decision makers and others needing to understand and support these cleanup decisions, including the regulators, Tribal Nations, HAB, State of Oregon and others.

SCIENCE AND TECHNOLOGY

The main objective of the Science and Technology (S&T) endeavor is to provide new knowledge, data, tools, and the understanding needed to enable the Integration Project's' mission. S&T is focused on resolving key technical issues that help inform and influence decisions in partnership with the SAC and other Hanford Site projects. The scope of the S&T program is encompassed within five technical areas (technical elements): chemical and radioactive inventories, vadose zone, groundwater, river, and risk.

The implementation approach used by the S&T endeavor involves a "roadmapping" process. This process brings problem holders (e.g., DOE, Tribal Nations, regulators, stakeholders, and cleanup contractors) together with problem solvers (e.g., scientists and engineers from national laboratories and universities) to define problems and target solutions where S&T can be directly applied.

PUBLIC INVOLVEMENT

The objective of the public involvement is to provide effective and real time project participation, and involvement by all interested parties. Organizations and avenues for participating in the Integration Project currently include the following:

Tribal Governments. Technical discussions and ongoing involvement on an informal basis is conducted with tribal representatives. Consultations, including a more formal interface with Tribal Governments, are conducted in conjunction with DOE Richland Operations Office (RL) Office of External Affairs (OEA).

Hanford Advisory Board. Information is provided to the HAB Environmental Restoration (ER) Committee and Public Involvement Committee. The ER Committee determines when project information should be presented to the full HAB. The Integration Project provides the ER Committee with information during monthly meetings.

One-on-One Outreach Meetings. Individual discussions with interested parties are encouraged. This venue has been effective in gaining input and insight into many interests and values.

Media Relations. Regional communication of project specific information is made to general parties through the media. Press releases and interviews are used to engage the media.

Project Team Meetings. Project team meetings are held twice monthly, to encourage effective two way communication. Meetings are open to all interested parties, and minutes are provided. A project web site is also maintained with up-to-date information and documents (www.bhi-erc.com/vadose).

Working Groups. Focused working groups are used to address particular project areas. These groups are expected to be of limited duration, and to target technical or policy issues. These meetings are open to all interested parties.

TECHNICAL REVIEW

The objective of the Technical Review endeavor is to assure that the appropriate level of management and independent technical review is applied to all vadose zone, groundwater, and Columbia River work scope.

An Expert Panel has been established to provide broad oversight of the project. The Expert Panel focuses on problem resolution and technical reviews. Areas of greatest importance for the reviews include, but are not limited to, those that have (1) a high degree of technical uncertainty; (2) significant impacts on project outcomes; and (3) unresolved issues resulting from differences in technical interpretation. The panel meets approximately four times a year. The Expert Panel has the ability to establish sub-panels that are comprised of experts who are focused on specific technical topics.

The DOE is also pursuing independent technical review of the Integration Project through the National Academy of Sciences (NAS). In accordance with NAS standards, this review will be conducted by nationally recognized technical experts.

The Hanford Site projects utilize various technical and peer review methods to ensure quality and technically sound products. Relevant reviews will be coordinated with the Integration Project to ensure efficient use of resources and technical review results.

CHALLENGES

As with any project that sets out to challenge and change existing management and technical approaches, the Integration Project faces obstacles that must be recognized and managed as progress is made. The following list identifies the primary challenges to success that the Integration Project must address.

- Commitment is required by the DOE, the State of Washington, and federal regulators to develop an integrated regulatory framework to clean up and close the Hanford Site. *Can a consistent set of regulatory requirements be established to guide and integrate the assessment and cleanup at Hanford? Can agreement be reached on the end state of the cleanup mission for Hanford?*

- Effective S&T, and the development of a complicated set of tools to implement the SAC, is inherently difficult to manage on a critical path. *Can the Integration Project maintain its schedule with current levels of project participation and apparent funding constraints? Can the SAC stay on schedule to support critical cleanup decisions, such as a single shell tank retrieval methodology?*

- Regulator, public, and Tribal Nation participation and support is required for the Integration Project to be successful. The project has made progress in this area, but relationships are fragile. Trust and credibility must develop with time. *Can the Integration Project successfully manage the challenge of diverse interests and reach a consensus among various interested parties regarding the Integration Project direction, content, and decision-making processes? Can the Integration Project endure over time without a regulatory driver (i.e., Hanford Federal Facility Agreement and Consent Order [Tri-Party Agreement] milestone supported by DOE, Ecology, and EPA)?*

- This project represents a different management approach for the Hanford Site ("integration and coordination" versus "project line management"), and a departure from tradition for the DOE. At the same time, the Integration Project is required to operate within its existing project, contractor, and funding systems. *Can the Integration Project efficiently and effectively execute its mission over the longer term, within the context of current contract and management systems, which lack line authority for managing the subsurface and river project work scope?*

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ACRONYMS

CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act*
CRCIA	*Columbia River Comprehensive Impact Assessment*
D&D	Decontamination and Decommissioning
DNAPL	Dense Non-Aqueous Phase Liquids
DOE	U. S. Department of Energy
DQO	Data Quality Objective
DWP	*Detailed Work Plan*
Ecology	Washington State Department of Ecology
EM	Environmental Management
EMSP	Environmental Management Science Program
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration
ERC	Environmental Restoration Contractor
ERDF	Environmental Restoration Disposal Facility
ES&H	Environmental, Safety, and Health
FDH	Fluor Daniel Hanford, Inc.
GW/VZ	Groundwater and Vadose Zone
HAB	Hanford Advisory Board
ILAW	Immobilized Low Activity Waste
IPL	*Integrated Priority List*
LRP	*Long Range Plan*
MYWP	*Multi-Year Work Plan*
NAS	National Academy of Sciences
NEPA	*National Environmental Policy Act*
NRC	U.S. Nuclear Regulatory Commission
OEA	Office of External Affairs
PHMC	Project Hanford Management Contract
PI	Public Involvement
PMP	*Project Management Plan*
PNNL	Pacific Northwest National Laboratory
RCRA	*Resource Conservation and Recovery Act*
RL	Richland Operations Office
RPE	Retrieval Performance Evaluation
S&T	Science and Technology
SAC	System Assessment Capability
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
WSDOH	Washington State Department of Health

GLOSSARY

Consistency – Data, analysis methods, results, and conclusions that are logically connected and in agreement.

Credible – Work, results, and conclusions that are plausible, believable, and convincing in terms of quality and veracity. Credibility is determined by the individuals and groups that review and use the work, results, and conclusions, and not by the organizations that manage or develop the materials.

Impact Assessment – An evaluation of the consequences of contaminating locations or resources and/or exposing people or biota.

System Assessment Capability – Ability to convincingly predict, with results, conclusions, and uncertainty, the cumulative public, environmental, and cultural/socio-economic risks resulting from Hanford's contamination of groundwater and the Columbia River. The capability provides quantitative (e.g., model based) and qualitative (e.g., values and rule based) evaluations of the complete behavior of the system in response to the conditions, processes, and events that may affect it.

Technically Defensible – Positions, theses, or hypotheses that can be rigorously maintained and supported by arguments based on sound science and technology, as determined by independent technically qualified peer reviewers.

1.0 INTRODUCTION

The Hanford Site environmental legacy represents one of the U.S. Department of Energy's (DOE's) most complex technical, regulatory, and public policy challenges. Past Hanford Site operations resulted in radiological and chemical contamination of soils (referred to as the vadose zone), groundwater, and the Columbia River. Although cleanup progress is being made, individual cleanup project decisions and goals (end points) are not necessarily leading to a technically defensible and publicly acceptable end state for the overall Hanford Site.

Environmental field characterization and impact assessment work at the Hanford Site is sometimes fragmented between different projects. This work often must comply with different regulatory requirements, which can result in the inefficient use of technical and financial resources. Through interviews, comments, and recommendations from regulators, Tribal Nations, the Hanford Advisory Board (HAB), the State of Oregon, public interest groups, and the public, a well identified need has been defined to improve trust and credibility in the technical basis for decisions made at the Hanford Site, as well as in the site's decision-making process.

In late 1997, the DOE established the Hanford Site Groundwater/Vadose Zone (GW/VZ) Integration Project (Integration Project) to enhance DOE's commitment to ensure the protection of water resources, the Columbia River environment, river-dependent life, and users of Columbia River resources from contamination originating from Hanford Site operations.

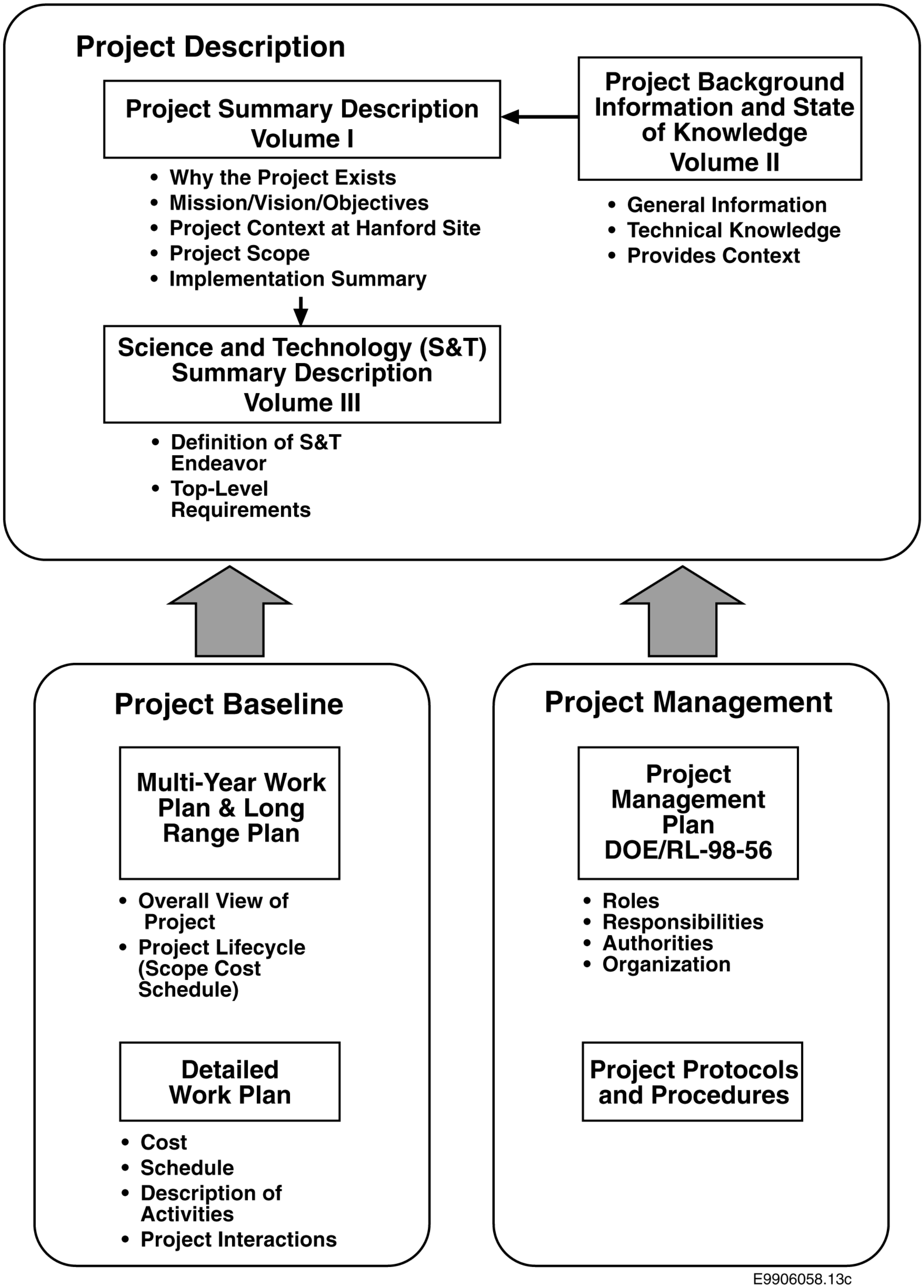
1.1 PURPOSE OF THE PROJECT SUMMARY DESCRIPTION

This *Project Summary Description* provides a high-level review of the reasons for establishing the Integration Project. It also identifies the mission that the project is tasked to accomplish; the work scope that must be performed to successfully accomplish the mission; and the organization and management approaches that will be used to implement the GW/VZ Integration Project work scope. The *Project Summary Description* is one of many documents and management tools that communicate the breadth and complexity of the Integration Project (see Figure 1-1).

The primary documents and management tools that provide an introduction to the Integration Project fall into three general groups: Project Description, Project Baseline, and Project Management Systems.

Three companion volumes make up the set of Project Description documents; these include the *Project Summary Description*, the *Background and State of Knowledge*, and the *Science and Technology (S&T) Summary Description* documents. These volumes are strategic in nature; therefore, their contents should be relatively fixed over time. This document, for example, will only be revised if DOE directs a change in the Integration Project mission or scope. The three Project Description volumes were developed out of materials that were contained in previous drafts of an Integration Project document called the *Project Specification*. Review comments on the December 1998 draft of the *Project Specification* indicated that the materials should be

Figure 1-1. Primary Project Documents and Management Tools.



broken out of one document into these separate documents, so that the technical information would be more focused and easier to read. These three volumes will be completed and released during calendar year 1999.

Project Baseline documents, which complement the Project Description documentation set, include detailed planning information for the Integration Project as a whole (for example, the *Multi-Year Work Plan* [MYWP] [DOE-RL 1998a], *Long Range Plan* [LRP], and *Detailed Work Plan* [DWP] [DOE-RL 1998b]). These documents and tools describe the dynamic planning process that supports implementation of Integration Project work scope. A high-level description of the processes that the project uses to develop and revise these documents and tools is provided in Section 3.2.

Details on how the Integration Project is structured are captured in the complete set of Project Management documents. Project roles, responsibilities, and authorities are defined in the *Groundwater/Vadose Zone Integration Project Management Plan* (DOE-RL 1999). Management protocols and procedures also are part of this documentation set.

1.2 THE RATIONALE FOR ESTABLISHING AN INTEGRATION PROJECT

The Integration Project was established by DOE in late 1997. At that time, DOE Undersecretary Dr. Ernest Moniz directed that the Integration Project be the catalyst for fundamental change at the Hanford Site, with a mission to transform the status quo in order to resolve significant issues raised by stakeholders and regulators. These issues collectively resulted from questions about DOE's ability to carry out its mission to protect the Columbia River. Dr. Moniz further directed that the project be science-based, that it include strong participation from DOE's national laboratories, and that it incorporate a multi-level peer (technical) review process.

Many individual projects are actively managing waste and remediation projects in support of the Hanford Site cleanup mission. These projects include facility deactivation, building decontamination and decommissioning (D&D), waste site remediation, groundwater remediation, tank waste retrieval and processing, and solid waste management. These projects are all intended to complement one another.

Projects involved in vadose zone, groundwater, and Columbia River field characterization, as well as impact assessment and remediation work, are collectively referred to as projects of "core" importance to the Integration Project. These projects rely heavily on one another for support. In many instances they are fully dependent on one another, as one phase of work completes and another begins. However, with a cleanup mission as complex as that at the Hanford Site, the potential exists for fundamental gaps, overlaps, and inefficiencies to occur between these projects. Problems involving work and management fragmentation have been identified by numerous oversight and internal review panels, as well as by external organizations.

Current plans for the Hanford Site will result in the accumulation of significant quantities of radioactive and hazardous waste at the completion of the current cleanup mission. Federal and state regulators, the Tribal Nations, stakeholders, and the HAB have voiced their concerns over the current and potential threats that contaminants will pose to groundwater and the Columbia River. These groups, and others, have expressed the need for the DOE to assess the cumulative impacts of these wastes.

In summary, the key reasons for the establishing the Integration Project include the following:

- Past ways of organizing and managing technical work have resulted in an inefficient use of resources (e.g., key knowledge gaps and redundancies).

- The capability to determine the cumulative, long-term impacts of Hanford Site contamination does not currently exist.

- Current Hanford Site decisions for each cleanup action do not account for the composite, cumulative effect of other cleanup actions; therefore, these decisions may not lead to a defensible end state for the site as a whole.

- There is a lack of credibility and trust in the decision-making process, and in the technical basis for cleanup decisions.

A summary of the information that has either been solicited by or provided to the project by the Tribal Nations, advisory boards, public interest groups, and the regulatory community is contained in Appendix A.

1.3 MISSION AND VISION

The following mission and vision statements were framed and adopted by the Integration Project through a series meetings with regulators, Tribal Nations representatives, stakeholders, and the State of Oregon.

Mission

> *To ensure that Hanford Site decisions are defensible and possess an integrated perspective for the protection of water resources, the Columbia River environment, river-dependent life, and users of the Columbia River resources, the mission of the Groundwater/Vadose Zone Project is to develop and conduct defensible assessments of the Hanford Site's present and post-closure cumulative effects of radioactive and chemical materials that have accumulated throughout Hanford's history (and which continue to accumulate). To support this mission the Groundwater/Vadose Zone Integration Project will also define those actions necessary to establish consistency and maintain mutual compatibility among site-wide characterization and analysis tasks that bear on decisions, receptor impact, and regulatory compliance. The Groundwater/ Vadose Zone Integration Project will identify and oversee the science and technology initiatives pursued by the national laboratories, universities, and other public and private institutions (as necessary) to enable the assessment mission to be successfully completed.*

Vision

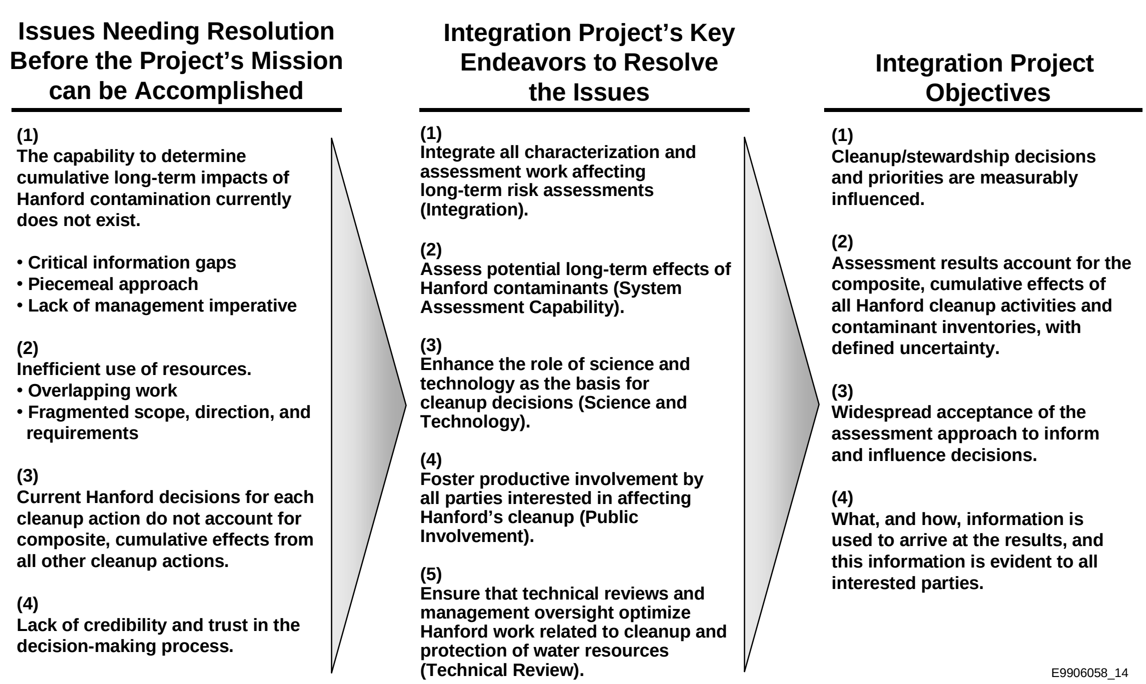
Completion of the mission has established broad trust and collaboration that resulted in credible decisions, based on defensible science, that effectively and efficiently protected water resources.

These mission and vision statements were developed in response to the issues outlined in Section 1.2. They embody a new approach to assessing the overall impacts of cleanup decisions at the Hanford Site. The Integration Project is using a Systems Engineering approach to translate the project's assigned mission into specific endeavors and objectives that focus the project on successfully completing its mission. The relationship of Integration Project issues, project endeavors, and project objectives is shown in Figure 1-2.

Four top-level issues are shown on the left side of Figure 1-2. Five key endeavors of the Integration Project, which correspond to these issues, are shown in the middle column of the figure. Details on the activities that the Integration Project is implementing within each endeavor are provided in Section 3.1. Top-level objectives for determining how successful the Integration Project is in accomplishing its mission are shown at the right side of Figure 1-2. Measures are being developed by which these criteria will be applied to assess the performance of the Integration Project in achieving its mission.

Systems Engineering is also being used to define and analyze the scope of work that the project must perform. The results of this analysis are described in Section 2.0.

Figure 1-2. Relationships of Unresolved Issues, Project Endeavors, and Project Objectives.



2.0 UNDERSTANDING THE PROJECT MISSION

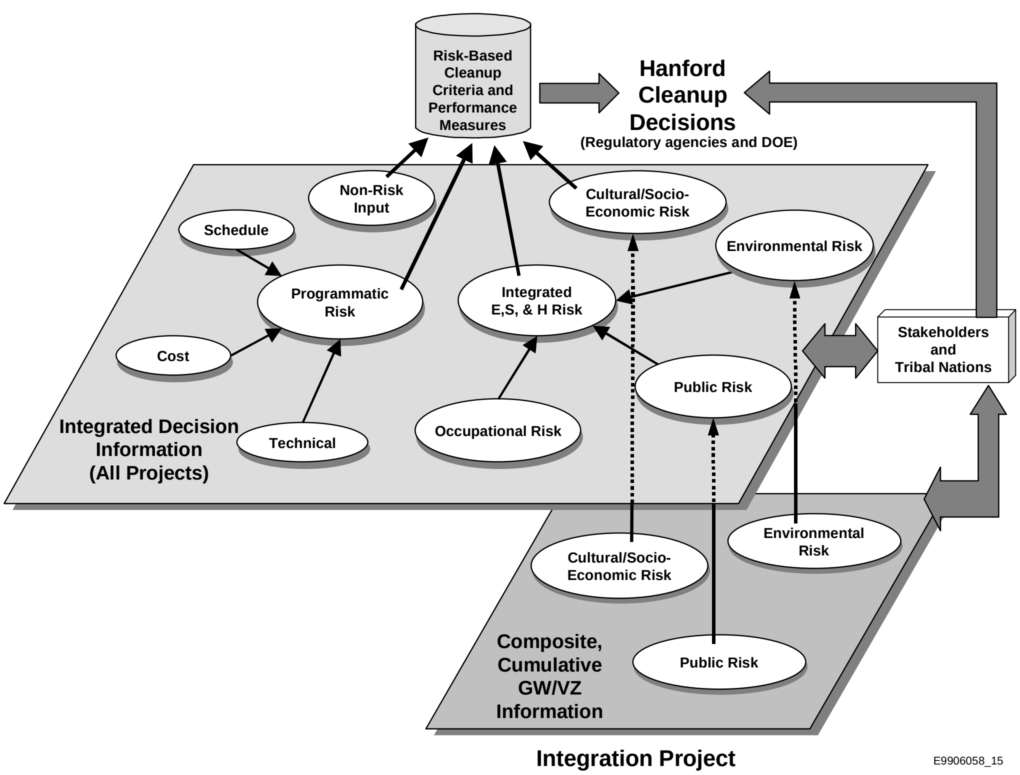
In partnership with interested and involved parties, the Integration Project is firmly committed to accomplishing its mission and vision (Section 1.3). Analysis of the Integration Project mission and vision has been performed in order to systematically translate both into a logical sequence of work activities that can be performed by the project team. This process will continue throughout the Integration Project's life in order to refine the understanding of the project's work scope, and to establish a logical sequence for performing the work that will best ensure project success.

The analysis performed on the project mission thus far has defined (a) the physical systems with which the project is concerned; (b) customers for the project's products; (c) the physical system and top-level project interfaces; (d) the project's top-level work activities, requirements, and the logical sequence for performing this work; and, (e) programmatic issues that will need to be managed in order to ensure project success. The results of this analysis are described in this section, and form the basis for project planning activities described in Section 3.0.

2.1 DECISION FRAMEWORK

The Integration Project's mission emphasizes the need to provide information that will ensure that Hanford Site decisions are defensible. Figure 2-1 has been developed to depict the Integration Project's role in informing and influencing Hanford Site decisions.

Figure 2-1. Decision Making Process.



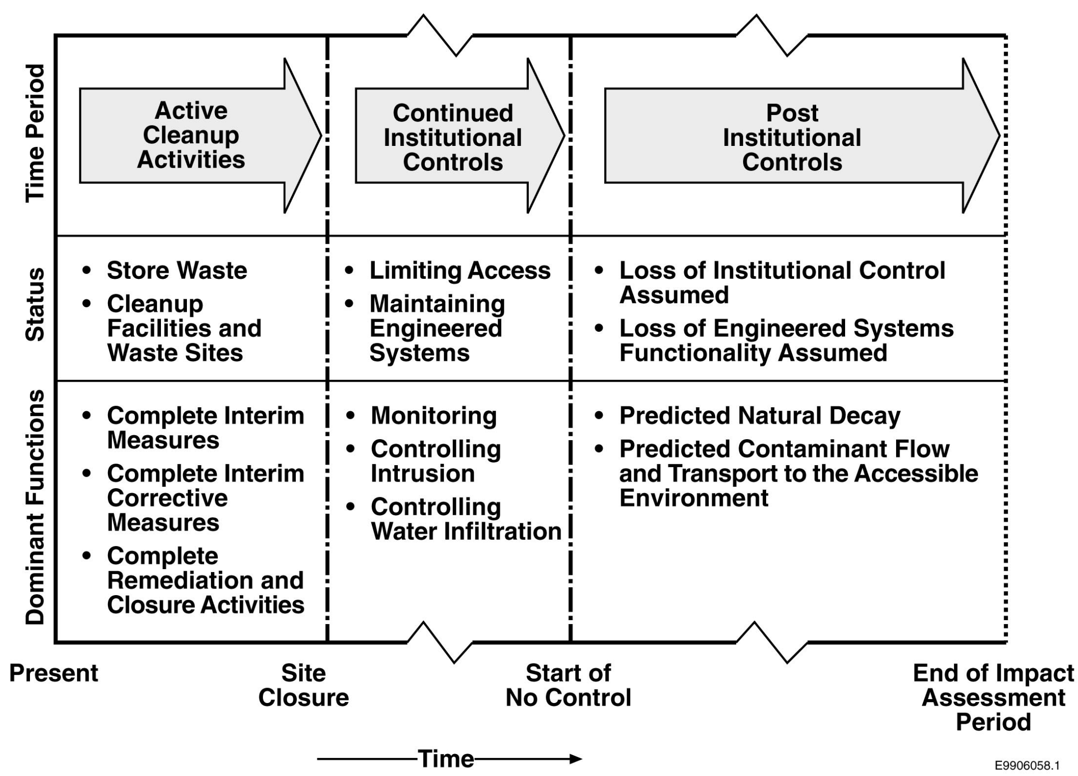
The Integration Project provides other Hanford Site projects with technically defensible assessments of the public health, environmental, and socio-economic risks associated with proposed cleanup alternatives. These assessments will be presented in terms of the cumulative impacts of all remediation and closure activities.

Figure 2-1 shows that the Integration Project provides part of the information required for informed decisions on Hanford Site cleanup. Decision criteria based on other information (such as worker risk, cost, schedule, operational, regulatory, and non-risk factors) must also be considered. These factors are evaluated by the project that is responsible for making appropriate decisions.

2.2 PHYSICAL SYSTEMS AND INTERFACES

Carrying out the Integration Project's mission requires a clear understanding of relevant physical and biological systems, and how they will interact over time periods longer than those associated with the current Hanford Site mission. This longer-term view of the Hanford Site life cycle is depicted in Figure 2-2. This figure is not comprehensive, but it does provide examples of the assumed status of controls that will be available and the functions, or activities, that will be performed during each major time period.

Figure 2-2. Hanford Life Cycle.



2.2.1 Surface Facility System

Hanford's Surface Facility System is comprised of engineered structures that either contain radioactive and hazardous chemical inventories, or affect the flux of water and/or contaminants to the subsurface in ways that adversely affect the subsurface system. The predicted flux of contaminants and water from each component of the surface system to the subsurface system is a key consideration in assessing risk to biological, cultural, and economic systems. Estimating this flux, and assessing the effectiveness of potential controls at the interfaces between engineered structures and the subsurface, is a key activity of the Integration Project.

Within the Surface Facility System, there are natural and human-induced factors and conditions that affect the amount of water entering and exiting that system. These factors include natural precipitation, evaporation, transpiration and runoff, human addition or redistribution of water within the administrative boundaries of Hanford through leaking water lines and holding basins, water-line purging, tank leaks, septic system operation, and treated effluent discharges and surface-management practices in contaminated areas (e.g., devegetation, graveling, paving, etc.). All of these conditions affect the amount of water available to carry contaminants downward through the vadose zone to the water table. These conditions are expected to change during the three time periods shown in Figure 2-2, but the magnitudes and effects of the changes are uncertain.

2.2.2 Subsurface System

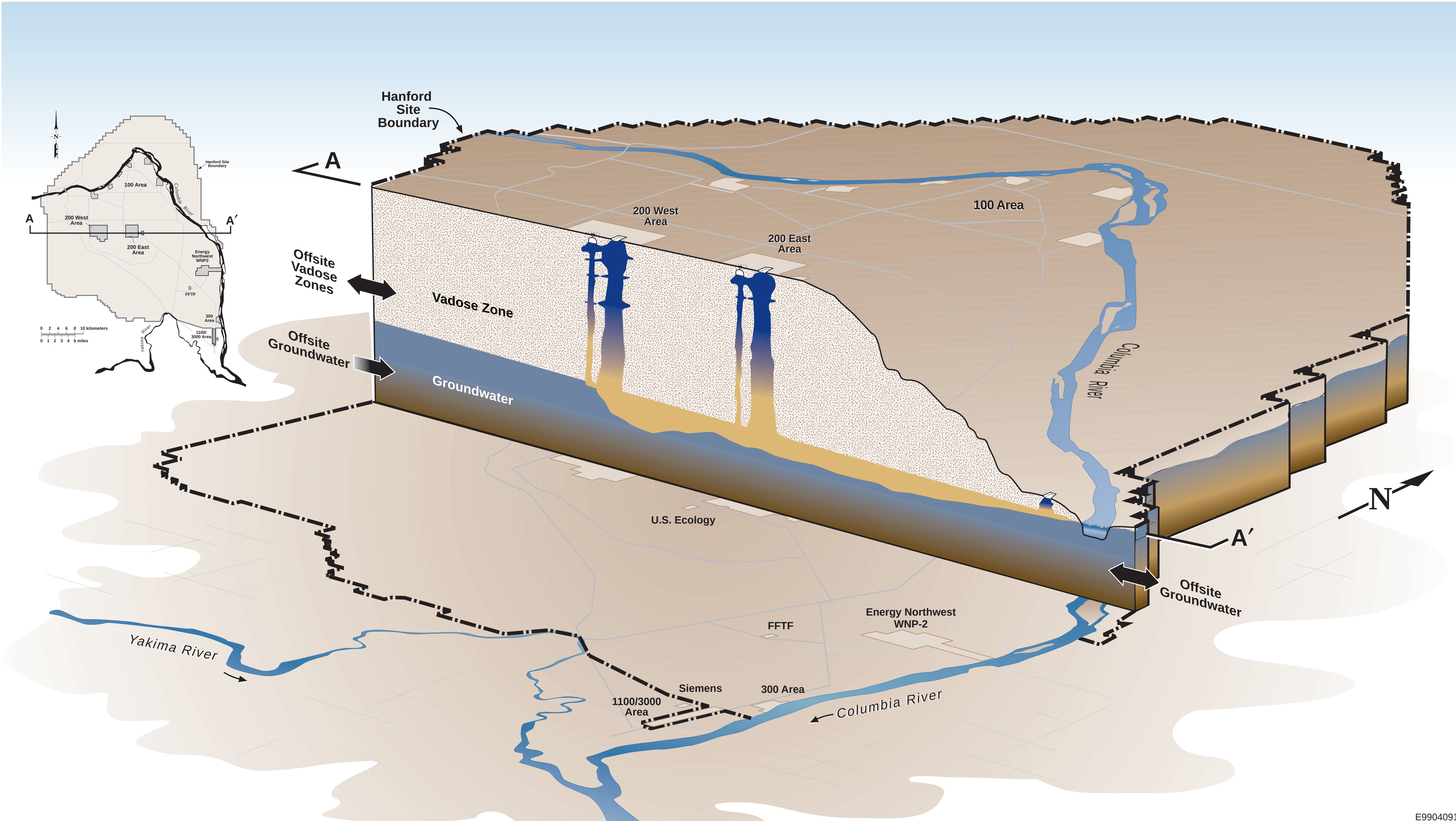
The Hanford Subsurface System consists of both natural and engineered subsystems. The natural subsystem includes the geologic strata and pore water of both the partially saturated (vadose) zone, and portions of the saturated zone (groundwater) within Hanford's administrative boundary. The engineered portion includes monitoring systems, in situ contaminant treatment systems, and contaminant immobilization systems. A cross-section of the Hanford Subsurface System is shown in Figure 2-3.

Emplacement and operational features of the engineered portion of the subsurface system are determined by requirements and needs for a) subsurface characterization; and/or b) groundwater remediation and protection. The engineered portions of the subsurface system include access and instrumentation for groundwater monitoring, and contaminant mitigation and remediation systems (e.g., subsurface barriers, ex situ and in situ soil, vapor and water treatment systems).

Because of Hanford's large size, the relative areas of influence of the engineered systems are expected to be small. Because of the long time frame of interest, engineered systems can only be assumed to be effective for a fraction of that time period.

Acceptable end-state requirements have not yet been established for either engineered or natural portions of the subsurface system. Points of compliance, and the requirements at those points of compliance, need to be established for the end of each time period depicted in Figure 2-2.

Figure 2-3. Cross-Section of the Hanford Subsurface System.



2.2.3 Offsite Physical System

The offsite physical system consists of the Columbia and Yakima rivers and their immediate environs, the vadose zone, and the uppermost aquifer adjacent to the Hanford Site's administrative boundaries. Both influxes and out-fluxes of water and contaminants may occur at the interface between the Hanford Subsurface System and the offsite physical system. Contaminants entering the Hanford Subsurface System from the offsite physical system may result from agricultural and mining activities in the watershed of the Columbia River.

The mission of the Integration Project encompasses assessments of the Hanford Site's impacts on the Columbia River, with reference to river conditions from Priest Rapids Dam to the mouth of the Columbia River.

2.2.4 Receptor Systems

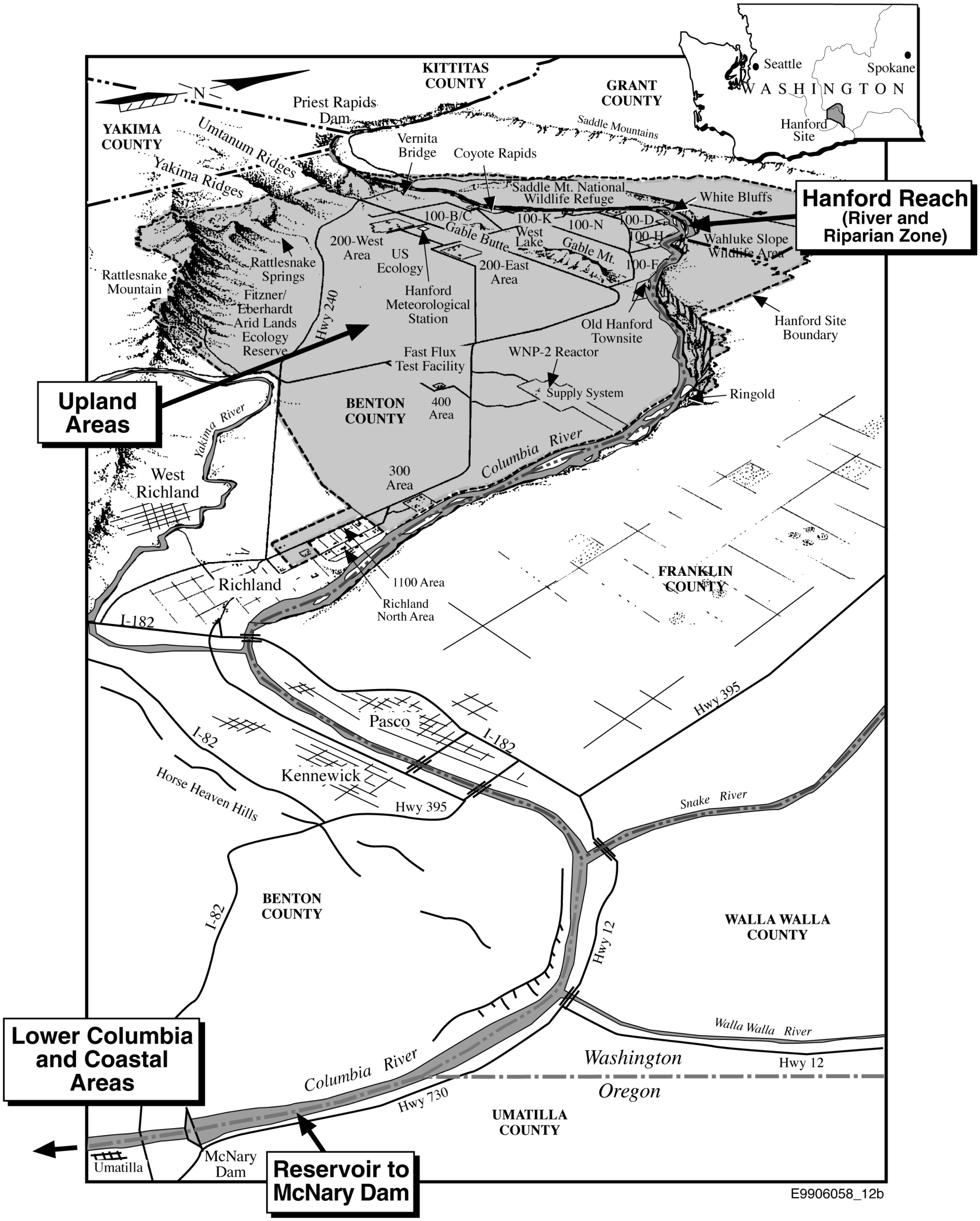
Hanford-related contamination will be assessed in a manner that is consistent with regulatory requirements and guidelines (e.g., human and ecological health), as well as considering impacts that complement applicable regulations (e.g., culture and economy). The primary tools that will be used to communicate the breadth of the cumulative impact assessment are dependency webs. Dependency webs are descriptions of relationships, or influence diagrams, composed of the resources, uses, functions, and services at selected locations where contamination and impacts are likely to occur. Figure 2-4 shows the four locations that are being considered in the impact assessment. The locations were chosen based on differences in river dynamics (free-flowing vs. pools) and habitat (fresh water vs. estuarine). The dependency web for each location will show the risks and impacts that will be evaluated.

2.3 CUSTOMERS

The Integration Project has numerous customers, and the project's relationships with these customers are complex. This section addresses some of the reasons for that complexity.

Decision-making authority for the Integration Project, and for Hanford's overall cleanup, is vested in regulatory agencies and the DOE. The U. S. Environmental Protection Agency (EPA), Washington State Department of Ecology (Ecology), Washington State Department of Health (WSDOH), and the U.S. Nuclear Regulatory Commission (NRC) have regulatory authority over varying aspects of Hanford Site activities. These agencies provide the Integration Project with compliance criteria and measures, as well as guidance on how applicable regulations will be implemented. Through the auspices of the DOE, the Integration Project provides regulatory agencies with information required to help determine compliance with the *Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement)*, the *Hanford Site-wide Resource Conservation and Recovery Act (RCRA) Permit*, and applicable regulations.

Figure 2-4. Potential Locations for Impact Assessments.



Collectively, Tribal Nations entities with treaty rights related to Hanford, the State of Oregon, and the general public also provide recommendations that influence the scope and focus of the Integration Project. In return, the Integration Project provides all interested parties with a common forum and venue for identifying and resolving issues.

Other customers of the Integration Project include oversight panels and review boards, advisory groups, and people who share special interests related to the impacts of Hanford Site contamination. These entities provide technical and management oversight, and value- or knowledge-based recommendations to the project. In return, the Integration Project provides these entities with the project information they request, and a forum through which issues are identified and resolved.

Other Hanford Site projects have both a customer role and a support role for the Integration Project. In support of the project, they provide estimates of the contaminants that have external impacts and/or will enter the groundwater from specific operable units or waste management areas. The data-gathering activities of these projects will be managed to both a) accommodate the needs of the Integration Project; and b) satisfy that project's own internal needs. The Integration Project will provide these projects with evaluation tools, cumulative impacts information, a common set of technical configuration and quality assurance/quality control requirements for vadose zone and groundwater information, identified data deficiencies, and priorities for deficiencies resolution. The relationships and interfaces between the Integration Project and other projects is described in more detail in Section 3.1.

2.4 REQUIREMENTS

Regulatory requirements that pertain to the Integration Project's mission derive from the *Tri-Party Agreement*, the *Hanford Site-wide RCRA Permit*, environmental statutes, and safety regulations. Federal and state regulations, along with DOE Executive Orders that are applicable to the Integration Project (or other Hanford Site projects), are listed in Appendix B.

The scope and focus of these requirements are highly diverse. Consequently, there is high potential for regulatory conflicts, overlaps, and gaps. The Integration Project has initiated discussions with DOE and regulatory agencies that are aimed at streamlining the regulatory framework within which the Integration Project and related projects function. The project is also establishing a formal means of identifying and statusing customer requirements.

2.5 INTERFACES

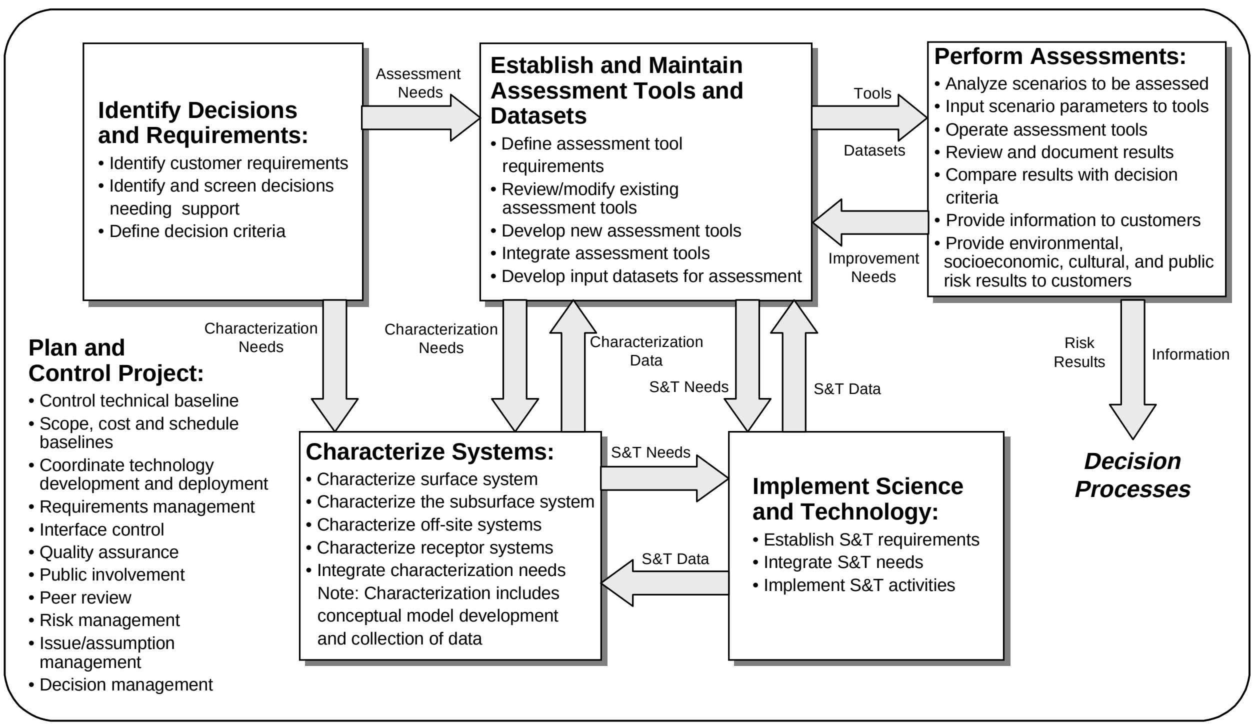
During identification of the project's work and requirements, physical and project interfaces (both internal and external to the Integration Project) were identified. Physical interfaces are of interest principally with respect to the flux of contaminants and water across these interfaces, and in terms of opportunities for controlling that flux. The Integration Project, in conjunction with its customers, will formulate the acceptable flux of contaminants that are estimated to cross physical system boundaries.

In contrast to physical system interfaces, project interfaces are concerned with information, requirements, work scope, and allocations of work, cost, and schedule. Key project interfaces are identified in Table 3-1. The Integration Project is in the process of establishing a formal project interface definition and control process.

2.6 WORK ACTIVITIES AND SEQUENCE

A key result of analyzing the mission is identifying what work must be performed, and the logical sequence for performing this work. Figure 2-5 shows the top-level logical relationships that have been established among these activities.

Figure 2-5. Integration Project Top Level Logic.



3.0 PROJECT SCOPE AND PLANNING

This section describes the connection between the top-level functions described in Section 2.6 and key project endeavors and activities. This section also describes the planning and integration processes that the project uses to identify and implement activities that benefit the Hanford Site and influence Integration Project decisions.

3.1 PROJECT WORK SCOPE

The directly-managed work scope of the Integration Project has been grouped into five endeavors. The relationship of these endeavors to functional needs is illustrated in Figure 3-1. The linkage to terminology used in the LRP is discussed in Section 3.2.

Figure 3-1. Relationships of Integration Project Functions, Endeavors, and Activities.

Top Level Logic Functions	Integration Project Key Endeavors	Long Range Plan Activities
• Characterize systems	• Integrate characterization (Integration)	• Characterization
• Establish and maintain assessment tools • Perform assessments	• Assess long-term effects (System Assessment Capability)	• System assessment capability
• Implement science and technology	• Enhance science and technology (Science and Technology)	• Science and technology
• Identify decisions and requirements • Plan and control project	• Foster public involvement (Public Involvement) • Ensure technical review (Technical Review)	• Project management

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3.1.1 Integration

The overall Integration objective is to coordinate and optimize vadose zone, groundwater, and Columbia River characterization data collection and interpretation. The basis for this endeavor is that data must be available when needed, and the data must be maintained and used in a consistent and technically defensible manner. There are four areas of focus within the Integration endeavor.

Management of Key Project Interfaces. For the Integration Project to be successful in achieving its mission, it must effectively manage its own directly-funded work scope, and manage interfaces with other site projects that are either directly or indirectly impacted by the results of the integration effort. The Hanford Site projects that interface with the Integration Project are listed in Table 3-1. Other organizations that operate on the Hanford Site, such as U.S. Ecology, will have wastes onsite that must be accounted for in the cumulative impact assessment. Interfaces will also be established with these organizations.

Table 3-1. Key Interfaces with the Integration Project.

Responsible Project	Activity
Office of River Protection	Immobilized Low Activity Waste
Office of River Protection	Tank Farms Vadose Zone Characterization
Waste Management	Solid Waste Management
Environmental Restoration	Groundwater Monitoring and Modeling
Environmental Restoration	Well Installation
Environmental Restoration	Vadose Zone Monitoring
Environmental Restoration	Groundwater Remedial Actions
Environmental Restoration	100/200/300 Area Remedial Actions and Assessments
Environmental Assurance Policy and Permits	Environmental Monitoring (Columbia River)

Coordination of Characterization Work. Hanford's vadose zone, groundwater, and Columbia River characterization work is being coordinated to ensure that data collection is being optimized across the Hanford Site. Date collection includes work relative to defining and predicting the inventory of existing and potential radiological and chemical releases to the environment, and the collection and interpretation of data from the vadose zone, groundwater and Columbia River. Coordinating and planning data quality objective (DQO) processes, which govern how data will be collected and used, is being applied to ongoing vadose zone, groundwater, and Columbia River characterization activities.

Standardizing Data Sets, Conceptual Models, and Assessment Methodologies. The Integration Project is responsible for standardizing the performance/risk assessment methodologies and conceptual models used at the Hanford Site. This activity provides configuration and quality control of data, and specifies processes to maintain consistency.

Focusing the Regulatory Path. Hanford's characterization and assessment activities are operating under multiple and sometimes overlapping regulatory requirements. These include RCRA, the *Comprehensive Environmental Response, Compensation, and Liability Act*

(CERCLA), the *National Environmental Policy Act* (NEPA), and requirements from the NRC. The Integration Project is working with the regulators (EPA, Ecology) and stakeholders to:

- Reach agreement with regulators, Tribal Nations, stakeholders, and DOE relative to Hanford's "end state" (the clean up end state is defined as the state of Hanford at completion of the cleanup mission in or around 2040).

- Document the regulatory drivers for key cleanup decisions.

- Identify opportunities for regulatory integration.

- Identify key cleanup decisions that require assessment of cumulative impacts to the regional water resources.

3.1.2 System Assessment Capability

The System Assessment Capability (SAC) is comprised of a set of quantitative (e.g., numerical models and data) and qualitative (e.g., rules on cultural values) tools and information that will be used to assess Hanford Site cumulative impacts on water resources, living systems, cultures, and regional socio-economics. A key element of the systems being assessed is the Columbia River. The results of this cumulative impact assessment will allow site-specific cleanup decisions and disposal authorizations to be made in the context of overall Hanford Site impacts on the region. The SAC will also provide useful information for making such site operational decisions as cleanup prioritization, funding allocation, and the need for additional data. In the long term, the SAC will provide important information to Hanford Site closure decisions.

The SAC will be improved through iterative cycles until the users are satisfied that it provides sufficiently complete and defensible impact assessments of the Hanford Site. Assessments completed through the SAC will address future impacts of waste remedial action and disposal in the near-river region of the 100 and 300 Areas, and in the Central Plateau region of the 200 Areas. The SAC will address a broad range of human health, ecological, cultural, and socio-economic risks and impacts. These impact assessments will seek to quantify and otherwise describe site-wide system impacts, and will provide estimates of water quality in the groundwater system and in the Columbia River adjacent to and downstream of the site.

The SAC is developing the tools and information required to perform these impact assessments, based on the needs and interests of a broad range of customers. Customers for SAC information and products include both organizations responsible for decisions at the Hanford Site, and others who need to understand the effects of these decisions and whose support for the decisions is necessary.

Based on the needs of these customers, the SAC has identified three high-level objectives:

- **Promote a common understanding** of environmental concerns and the cumulative effects of contaminants from the Hanford Site among all interested parties, including DOE, regulators, Hanford Site contractors, Tribal Nations, stakeholders, and the public.

- **Identify specific needs** for better protection of resources, and improved information for decisions, including S&T needs and information input from core projects.

To accomplish these objectives, the SAC will use established requirements for performing an assessment, using the *Columbia River Comprehensive Impact Assessment* (CRCIA), Part II, (DOE-RL 1998c) as a template. During the fall of 1998 the approach developed by the CRCIA group was translated into guidelines for the SAC, in collaboration with representatives of the CRCIA group. These guidelines are presented in Appendix C.

SAC Technical Elements. The development of the SAC is implemented through a number of technical elements. These include inventory, vadose zone, groundwater, Columbia River (including groundwater-river interface), and risk. Descriptions of these technical elements are provided in Appendix D. Two additional technical areas (release mechanisms and atmosphere) are being evaluated as to whether they should be identified as separate technical elements. Systems engineering principles are being used to establish the interfaces among the technical elements, and to ensure effective integration. Systems Engineering is also responsible for establishing and managing SAC requirements and interfaces with core projects and other non-SAC activities.

SAC Iterations. Current plans call for an iterative development and maturation of the SAC. The first iteration is intended as a proof-of-concept version of the capability. Subsequent iterations will point toward the development and application of a peer and regulator accepted decision-assisting tool.

Current plans for SAC iterations include the following:

First iteration (Revision 0) – The first iteration of SAC is intended as a proof-of-concept that will:

- Demonstrate the capability to:

  - Quantify and display uncertainty at this scale
  - Identify consistent models and metrics to accomplish objectives and guide improvements
  - Establish interfaces between the technical elements of SAC.

- Develop appropriate relationships with all participants in the process, including:

  - Interfaces with core projects
  - Relationships with regulators, Tribal Nations, and stakeholders.

To accomplish these objectives, the first iteration is being designed to:

- Examine radioactive and hazardous chemical contaminants that are expected to be the dominant contributors to risks and impacts.
- Determine the long-term migration and fate of contaminants in the Hanford Site operational areas (i.e., the 100, 200, and 300 Areas).
- Include a quantification of uncertainty.
- Include a broad suite of quantitative and qualitative metrics for human health, ecological, cultural, and socio-economic risks and impacts.

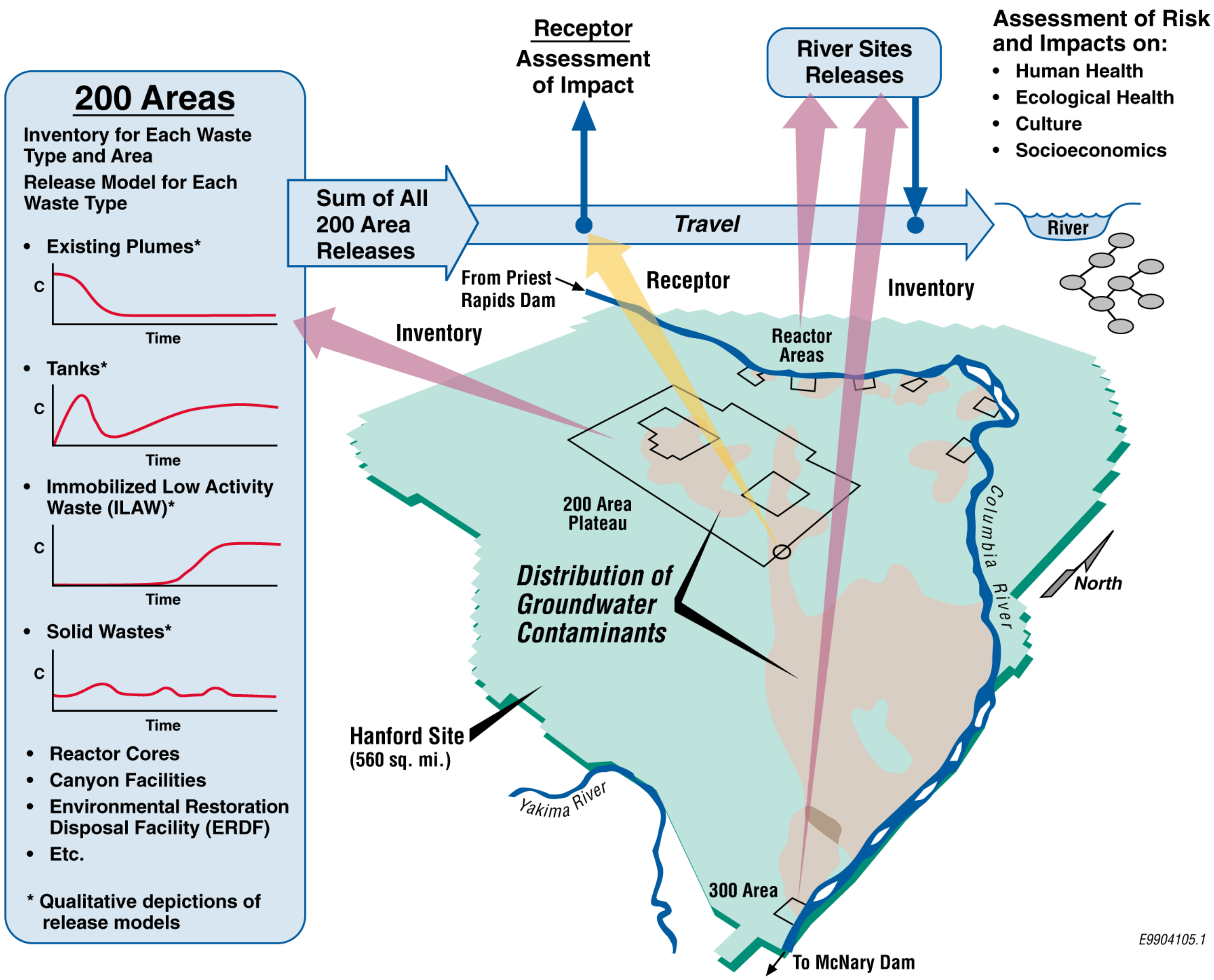
The design of the first iteration will also distinguish the risks and impacts of the various waste types within each operational area, and the sources located in the different areas (e.g., 200 Area plateau sources, versus near-river sources in the 100 and 300 Areas). The results of this first iteration, while expected to have a high level of uncertainty, will provide a "first cut" indication of cumulative risks and impacts that participants and interested parties can begin to use to determine the acceptability of post-closure Hanford scenarios. The approach proposed for the first (Rev. 0) iteration of the SAC is depicted in Figure 3-2.

The SAC will be designed so that a broad range of scenarios can be assessed. The configuration of waste sites to be evaluated in the first run of the assessment has not been determined. These will probably be an assessment of the *Hanford Site Disposition Baseline*, as described by CRCIA, or of a "no action alternative" using the current site conditions. CRCIA called for the analysis of the set of Hanford Site-wide cleanup/disposal decisions that make up the approved Hanford Site post-cleanup end state. In the absence of an officially recognized end-state plan, CRCIA called for the analysts to develop the most credible surrogate end state information available. The project currently views the end states included in the site planning baseline as the most credible information available, which could be used as a baseline for evaluation of remediation alternatives.

Second iteration (Revision 1) **–** The second iteration of the SAC will be affected by what is learned in the first iteration, by the needs of specific decisions that are on a schedule to use second iteration results, by new information gathered by core projects, and by S&T developments. In particular, the decisions in the 2002-2004 timeframe identified in the long-range plan will be key decision drivers. Expected enhancements in the second iteration will include:

- Additional preclosure scenarios
- Preliminary assessments supporting specific decisions

Figure 3-2. SAC (Rev. 0) Conceptual Model.



- Enhancements to SAC technical elements and information as a result of S&T investments.
- Upgrades in handling of uncertainty
- Possible additions in temporal and/or spatial scope
- Possible enhancements in temporal and/or spatial resolution (e.g., spatial resolution of inventory).

S&T investments, and work done by core projects, are expected to improve available knowledge of inventory, and to improve vadose zone and Columbia River conceptual models. Improvements in inventory will be principally related to an improved understanding of how waste was distributed to soil sites. Results of work performed at the vadose zone test facility, and through vadose zone characterization efforts in and near the tank farms, will improve the current understanding of contaminant distribution and movement in the vadose zone. S&T investments will also result in an improved regional conceptual model of the Columbia River. Project investments are expected to result in better representation of uncertainty in the site-wide groundwater transport model.

Third iteration (Revision 2) – The third iteration of the SAC will be altered by what is learned in the first two iterations, by S&T developments, and as a result of the assessment integration efforts initiated in 1999. Some of the S&T results expected to be available for this iteration include the following:

- A fully reconciled inventory, with validation from field study data.
- An improved release model for canyons and similar facilities.
- Results from the vadose zone test facility.
- Bio-geological transport models in groundwater.
- Improved models of groundwater-river interfaces.
- Biological uptake models for the river.
- A more complex hydrological model, with reconcentrations of contaminants at specific locations.

The set of standard requirements for assessments performed at the Hanford Site will allow the results of waste site-specific assessments to be incorporated directly in the site-wide assessments performed in support of the SAC. Examples include the immobilized low activity waste (ILAW) performance assessment, tank-specific assessments (such as the Retrieval Performance Evaluation [RPE]) performed on the AX Tank Farm, and the performance assessments performed on 200 East and 200 West Area burial grounds.

The SAC will be developed to support specifically-identified decisions. In particular, it will provide specific site-wide and regional impact information to SST remedial action, retrieval, and closure decisions; ILAW storage and closure (cumulative assessment complementing the ILAW performance assessment); and 200 Area remedial action decisions. The SAC will also provide the cumulative risks and impacts assessments needed to meet draft DOE Order 435.1, and which Tribal Nations and stakeholders will accept as reasonable (with limitations clearly identified and understood).

Subsequent iterations – Subsequent iterations of the SAC will continue to focus on upgrades needed to achieve regulatory and quality cumulative risks and impacts information for all relevant decisions. The SAC will also be upgraded to respond to Tribal Nations, stakeholder, and public concerns; to incorporate new S&T; and ultimately to be a primary support capability for Hanford Site closure decisions.

3.1.3 Science and Technology

The objective of the S&T endeavor is to provide the understanding, knowledge, data, tools, and methodologies that come out of an applied research approach that is not available to individual projects. The information developed by the S&T effort will be provided to projects (and to the SAC) to help inform and influence remediation and closure decisions at the Hanford Site (see Section 2.1). The scope of the S&T program encompasses the inventory, vadose zone, groundwater, and Columbia River technical elements that are needed to describe the controlling features and processes in each of these environmental settings. Physical, chemical, and biological features, events, and processes are all considered. The scope also includes the risk and monitoring technical elements that are needed to ensure that methodologies and capabilities in these areas are available.

The focus of the inventory technical element is on the development of data and tools to describe the quantity, location, timing of release, mechanism of release, and composition of releases to soil sites. The uncertainty factor associated with these data is also an important area of emphasis.

The vadose zone technical element scope focuses on determining the processes that control the flux of contaminants through the vadose zone to the groundwater under varying geologic, hydrologic, and chemical conditions. This scope includes (1) improvement to the conceptual and numerical models that describe the location of contaminants today; and (2) providing the basis for forecasting future movement of contaminants on both site-specific and site-wide scales. Collection of field data from both contaminated and uncontaminated sites to test hypotheses about contaminant movement, along with improved multiphase and multiple reaction contaminant transport modeling that is supported by laboratory investigations, are included in the scope of this S&T activity.

The groundwater technical element scope focuses on gaps in knowledge about the 3-dimensional (3D) plume at the interface between the vadose zone and groundwater, across the region, and at the interface between the groundwater and Columbia River. This effort will improve the ability to assess site-wide contaminant inventory and movement. This scope also includes characterization, 3D modeling, and parameter estimation across a hierarchy of spatial scales for both site-specific and site-wide assessments. Finally, the groundwater scope includes generating data to describe transport phenomena associated with dense nonaqueous phase liquids (DNAPLS).

The Columbia River technical element focuses on the conceptual and numerical models of the river that are needed to support meaningful site-wide assessments. Of particular importance is the understanding, data, and tools needed to assess biological fate and transport, as well as subsequent impacts to ecological systems.

The focus of the risk technical element is in development of system-wide methodologies for land management, with particular emphasis on human, environmental, cultural, and socio-economic health. The monitoring technical element includes those technology improvements needed to monitor physical, biological, and chemical characteristics that are important for ensuring human, environmental, cultural, and socio-economic health.

The main approach for implementation of the S&T Program for the Integration Project involves use of the roadmapping process. This process brings the problem holders (e.g., DOE, Tribal Nations, regulators, stakeholders, and remediation contractors) together with problem solvers (e.g., scientists and engineers from national laboratories and universities) to define problems and approaches to solve those problems. The results of these interactions are documented in the *S&T Roadmap*, which is presented in detail in Volume III of the Integration Project's document hierarchy (in Figure 1-1).

3.1.4 Technical Review

Technical review activities, which include the expert panel, associated sub-panels, the National Academy of Sciences (NAS), and project specific reviews, are an integral part of the Integration Project.

A technical expert panel has been established to address specific technical issues. The panel focuses on problem resolution and technical reviews. The purpose of the external panel is to provide DOE with technical observations and recommendations regarding the planning, execution, and interpretation of results from the Integration Project. In this way, the panel functions in a review or consulting mode, depending upon the specific need being addressed, and the panel will thereby ensure appropriate technical reviews of project activities and deliverables. Areas of greatest importance for the reviews include, but are not limited to, those that have (1) a high degree of technical uncertainty; (2) significant impacts on project outcomes; and (3) unresolved issues resulting from differences in technical interpretation. The panel reports to DOE Richland Operations Office (RL). The expert panel operates through written procedures that address requirements, protocols, the timeliness of producing panel reports, and a formal recommendation and comment resolution tracking and response process. The expert panel has the ability to establish sub-panels that are comprised of experts who are focused on a specific technical topic, according to project needs. The panel meets on a regular basis (approximately four times a year).

Another process for independent review that is being pursued by the DOE is through the NAS. The DOE has requested that independent, external peer reviews be conducted by the NAS on a periodic basis. These reviews will be coordinated with the expert panel, and conducted to avoid conflicts of interest or any bias potentially associated with conclusions and recommendations. In accordance with NAS standards, this review will consist of highly qualified technical experts.

The Hanford Site projects utilize various forms of internal technical and peer review to ensure quality and technically sound products. Those reviews associated with groundwater and vadose zones activities will be coordinated with the Integration Project to ensure efficient use of resources (and results) that address the needs of the overall Hanford Site.

3.1.5 Public Involvement

The Public Involvement (PI) effort enables effective and real-time project participation, as well as involvement by all interested audiences. There are various ways of communicating with and participating in the progress of the Integration Project. Effective dialogue between the

Integration Project team and interested audiences will communicate issues, values, and concerns that affect decision-making processes. These methods include the following:

Tribal Governments. Direct discussions and involvement on an informal basis will be offered and conducted upon request, and/or based on project needs. Consultations, including a more formal interface with Tribal Governments, will be conducted in conjunction with the RL Office of External Affairs (OEA).

Hanford Advisory Board. Information will be provided to the HAB's Environmental Restoration (ER) Committee and PI Committee. The ER Committee will determine when project information should be presented to the full board, and if draft advice should be presented to the full board. The Integration Project Team will provide the ER Committee with current status information at their monthly meetings. Updated status information will be provided to the PI Committee at the *Tri-Party Agreement* Quarterly PI planning meetings.

One-on-Ones. These are individual discussions held with interested audiences.

Media Relations. Regional communication of specific information will be made to general audiences through the media. The use of press releases, media availability, interviews, and other communication methods and mechanisms will be employed to meet communication and project goals.

Project Team Meetings. Project team meetings will be held routinely to facilitate a detailed dialogue. Meetings will be held at regular intervals, and will be open to all interested audiences. Meeting notes will be distributed to the mailing list.

Focused Topic Working Groups. Focused working groups may be established to address particular topic areas. The groups are expected to be of limited duration, but may be extended depending on the breadth of issues to be addressed. Meetings are open to all interested parties. Four working groups have been established in FY99 to address issues on policy, the development of the LRP, the development of the SAC, and the regulatory path for Hanford Site projects.

3.2 PROJECT PLANNING

The Integration Project has the responsibility to inform and influence Hanford Site decisions affecting protection of water resources. In order to implement this responsibility, the Integration Project must start by critically reviewing, during fiscal year and lifecycle planning, the project activities that support the decision processes. Additionally, the Integration Project will drive integrated planning of individual activities through the DQO process, including development of interface control documentation between the Integration Project and Hanford Site projects, and continual coordination and interface of the projects and national laboratories for S&T needs.

The mission, vision, and objectives of the Integration Project will be achieved through the development and implementation of the overall Project Baseline. The Project Baseline includes the five volumes described in Section 1.5, and the details of scope, schedule, and budget for all of the core projects (as well as the LRP). The LRP is a graphical representation of the key elements and inter-relationships between the core project activities, in the context of Hanford Site milestones and decision points. The primary purpose of the LRP is to provide a tool to communicate the overall scope, schedule, and summary level interfaces. The LRP structure is aligned with the five key endeavors shown in Figure 3-1.

The Integration Project planning utilizes the Environmental Restoration Contractor (ERC) detail work planning (three year detail) and multiyear work planning (lifecycle) processes. For those projects under the Project Hanford Management Contract (PHMC), multi-year work plan information is utilized.

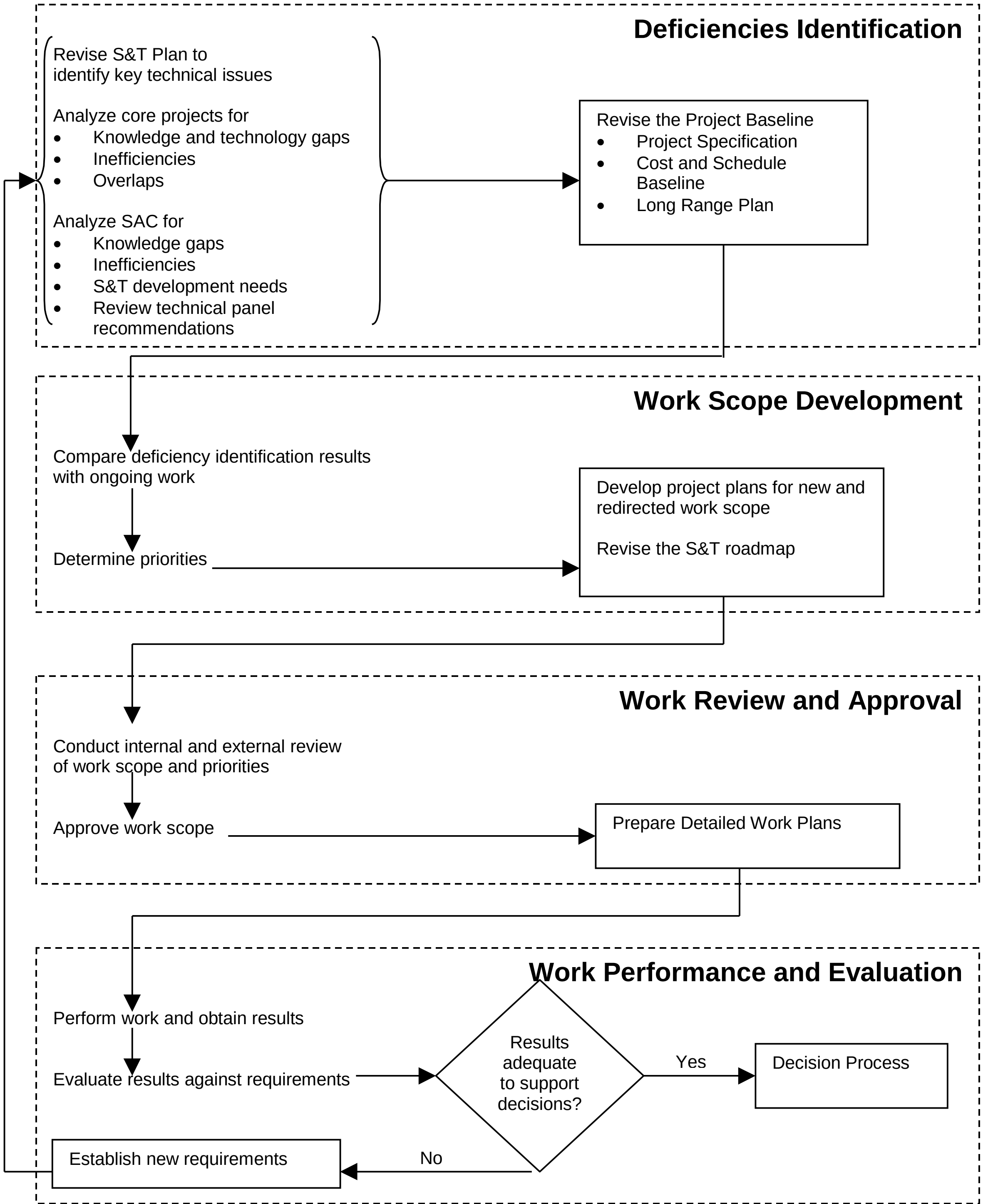
Planning is performed annually by the Integration Project, following a four-step process. The four steps are Deficiencies Identification, Work Scope Development, Work Scope Review and Approval, and Work Performance and Evaluation. The cycle is shown in Figure 3-3.

Deficiencies identification is designed to systematically review and evaluate the work scope, technical capabilities, and the technical knowledge base. There are four primary sources of input to the deficiencies requirements. These are provided from the core projects, from key technical issues generated out of the *S&T Plan*, SAC requirements, and technical review comments. The current S&T plan is presented in Volume III. The work identifies knowledge, data, and capability gaps, as well as inefficiencies or overlaps in work scope. Once the deficiencies have been identified, they are sorted into one of four categories: site integration issues, core project work, SAC requirements, or S&T needs. The results are incorporated in the overall Project Baseline, and are utilized in fiscal year planning.

Identified gaps, inefficiencies, and overlaps are compared to ongoing work activities that may provide data to resolve deficiencies. If ongoing work is unlikely to provide the information that is needed, new work scope is identified (or existing work is redirected). The determination of work priorities is focused on assuring that appropriate and essential work scope is completed on time, and that work activities constitute an appropriate expenditure of public funds. To establish a baseline for these activities, the scope is to be added to the Hanford Site *Integrated Project List* (IPL) and then evaluated and ranked with all of the other items that fall within the Hanford Site scope. This IPL process uses the overall Hanford Site priorities (minimum safe operations, essential services, mitigate urgent risk, and compliance) to establish a list of the scope items that can be accomplished within the funding constraints for a particular fiscal year. Detailed project plans are subsequently developed.

Detailed planning for the S&T scope is contained in the S&T roadmap, which is presented in Volume III. The Environmental Management (EM)-50 funding cycle generally aligns with the overall EM funding cycle, but includes an evaluation of needs and proposals prior to initiation of the cycle. The Environmental Management Science Program (EMSP) cycle occurs during the fiscal year for which funding has been authorized. The cycle includes submittal of proposals and science and relevancy reviews. Funding is awarded and authorized work is initiated in the second half of the fiscal year.

Figure 3-3. Annual Planning Cycle.



Final work review and approval involves internal and external review of the proposed work scope and assigned priorities. This process is open to public comment. Tribal Nations entities and stakeholders are encouraged to provide comments for consideration in the final approval process, before the work scope is incorporated into the DWP.

Once work has been performed, it is evaluated against the initial requirements. If the results are adequate to support a decision process (e.g., supporting the SAC or directly supporting a technical issue in a regulatory decision), the results are provided to that process. If the results are not adequate, then new requirements are established and provided back to the Integration Project for re-evaluation.

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APPENDIX A

SUMMARY INFORMATION AND RECOMMENDATIONS ON THE NEED FOR AN INTEGRATION PROJECT

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APPENDIX A

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SUMMARY INFORMATION AND RECOMMENDATIONS ON THE NEED FOR AN INTEGRATION PROJECT

At the time that the Groundwater/Vadose Zone (GW/VZ) Integration Project was established in late 1997 there were a number of issues, concerns, and recommendations that had been identified regarding the management and conduct of site activities involved in the protection of water resources. This appendix summarizes this body of information.

A.1 RECOMMENDATIONS FROM REGULATORS, TRIBAL NATIONS AND THE PUBLIC

The following provides a summary of the information that has either been solicited by or provided to the project by the Tribal Nations, advisory boards, public interest groups, and the regulatory community regarding the need to integrate activities for the protection of water resources at the Hanford Site.

Recent Interviews with Stakeholders**:** As part of the early planning associated with the Integration Project, a number of groups and individuals that have shown a strong interest in the project were interviewed. Values and expectations expressed in these interviews included the following:

- Protect the Columbia River from further contamination, to the maximum extent possible.
- Integrate activities to ensure a holistic approach to Hanford Site cleanup.
- Address all known sources of contamination.
- Minimize further contamination of the GW/VZ.
- Develop models for vadose zone contamination and contaminant transport mechanisms judged by consensus of stakeholders to be adequate.
- Conduct independent expert and independent technical peer reviews.

Regulatory Agencies**:** Values expressed by regulatory agencies are documented in records of decision (RODs) associated with remedial actions, and in permits for TSD facilities. Remedial actions must be designed such that their implementation does not result in a new threat to human health and the environment. An underlying value common to all regulatory agencies is that cleanup decisions, remedial actions, and operating facilities must comply with federal/state law and implementing regulations. For example, CERCLA requires that groundwater remedial actions currently in progress at several reactor areas along the Columbia River protect human health and the environment. More specific values are expressed in the objectives for proposed remedial actions. Likewise, under RCRA regulations to protect the environment, the monitoring associated with a permitted facility must be capable of detecting new contamination or assessing known contamination.

RODs also contain a "Responsiveness Summary" appendix. This summary contains public comment and agency responses to issues raised during the public review and comment period for proposed actions. The value of protecting the Columbia River from degradation as the result of contaminants from the Hanford Site is prominent in these comments.

Advisory Boards**:** The Hanford Advisory Board (HAB) is composed of representatives from state agencies, Tribal Nations, public interest groups, local governments, economic development organizations, employees at the Hanford Site, and the public at large. Specific values and principles expressed by the HAB include the following:

- Protect the Columbia River ecosystem.
- Deal realistically and forcefully with groundwater contamination.
- Use a systems design approach that keeps endpoints in mind as interim decisions are made.
- Recognize the importance of cultural and ecological diversity, and recreational opportunities; enhance these opportunities as a result of cleanup and waste management decisions.
- Consider these concerns while promoting the most effective and efficient actions that will protect the environment, public health, and safety -- now, and for future generations.

Tribal Nations**:** Several Tribal Nations and the Wanapum people have provided RL with comments on Hanford Site activities. The Tribal Nations include the Confederated Tribes and Bands of the Yakama Indian Nation (YIN), the Confederated Tribes of the Umatilla Indian Reservation (CTUIR), and the Nez Perce Tribe (NPT). A value common to all the Tribal Nations is the protection of the Columbia River's natural resources, which are used by tribal members for sustenance and in their traditional culture. Of special value is protection of the salmon fishery. For those tribes that used the Pasco Basin in earlier times, protection of cultural resources along the riverbanks is highly important. An underlying value for each Tribal Nation is the opportunity to participate in the selection of remediation alternatives and the design stages of environmental restoration projects.

Recent correspondence from the YIN emphasizes that new programs, like the Integration Project, should be developed by using the experience gained through such previous programs as the *Columbia River Comprehensive Impact Assessment* (CRCIA). A central value of the CRCIA is that assessment of impacts on the Columbia River that are related to Hanford Site contamination will be conducted in a holistic manner. The CRCIA assessment plan emphasized a broad, overarching analysis that spans Hanford Site contaminant sources, contaminant pathways to the river, sensitive receptors, and receptor impacts. The analysis must consider (1) a time scale that extends well into the future; and (2) impacts to natural and cultural resources.

The CTUIR provided a comprehensive statement of their values in a 1993 letter that commented on the initial plans for a comprehensive river impact evaluation:

"From salmon and sturgeon to tule reeds and eagle feathers, the ecosystem provides the very fabric of tribal culture. Any impact evaluation that considers the Columbia River environment should assist the CTUIR in understanding and evaluating the magnitude and future consequences of adverse impacts on natural resources."

The statement adds that *"cleanup of contamination is conducted in a manner that optimizes sustained net flow of tribal benefit through the conservation, management, and utilization of fish, wildlife, plant, and cultural resources, while protecting the integrity, sustainability, and diversity of the natural ecosystem."*

Correspondence from the NPT reinforces values expressed by other tribes concerning protection of Columbia River resources from degradation caused by Hanford Site contaminants. The NPT emphasizes that *"Tribal consultation, on future Hanford Site land use (which) directly impacts our most important resource, the Columbia River, is of utmost concern to the Nez Perce People."*

Public Interest Groups: Several public interest groups (e.g., Heart of American, Government Accountability Project, Columbia River Alliance) actively provide input to Hanford Site activities. A common value expressed by these groups involves the responsible use of public funds to address contamination and waste management issues at the Hanford Site. Some public interest groups actively supported scientific investigations to better define contamination characteristics along the Hanford Site shoreline, in order to provide a technical basis for cleanup decisions. An important value to many public interest groups is that the public should be an active participant in Hanford Site decisions, particularly the public living along the river downstream of the Hanford Site.

At this time, the *Tri-Party Agreement* agencies, as well as the State of Oregon, the Tribal Nations, and Hanford Site stakeholders, must re-examine strategic approaches to management of the investigation and cleanup of the Hanford Site. Vadose zone issues are not currently being addressed to the satisfaction of Pacific Northwest stakeholders. For example, existing plans and approaches for the investigation of soil contaminants from tank leaks, and 120,000,000 gallons of direct discharges to soil and groundwater from the tanks, are not aligned and will not provide sufficient data for responsible decision-making in a timely manner and at a reasonable cost.

Additional common needs are as follows:

- Prior to the initiation of retrieval from single-shell tanks, leak loss limits must be established with consideration of cumulative risk terms. Characterization of previous tank leaks, specific retention trenches, cascading cribs, and other soil disposal of significant hazardous and radionuclide inventories is required to assess cumulative impacts. This holds for existing contamination, and for the end-state where tank retrieval losses and tank heel inventory will be added to the existing contaminant loading. An understanding of vadose zone transport parameters and waste interactions with the soil is also required. Mechanisms resulting in chemically enhanced transport and the effects of geologic features (such as clastic dikes) are no less important.

- Pumping the remaining approximately 5,000,000 gallons of liquids from the single-shell tanks is necessary to stop additional contaminants from increasing the contaminant loading of the soil column.

- Near-term actions (interim actions, expedited response actions [ERAs], or corrective actions) for the control of infiltration on the surface of tank farms, and other highly contaminated sites, is necessary to reduce the mobility of contaminants.

- Immediate and visible progress of waste site characterization, and interim actions to control waste leaks and transport, are needed to demonstrate the effectiveness of the *Tri-Party Agreement*.

- Such activities must also be carried out with ample opportunities for early and meaningful stakeholder participation.

To meet these common needs and to address the characterization of waste sites (including soils contaminated by tank leaks), an integrated approach is necessary. The approach must be efficient and effective, technically sound, and compliant with applicable regulations. Near-term visible progress and proactive stakeholder participation are required for public acceptance.

Lessons learned from the past nine years of contaminated site characterization and cleanup must be applied to improve future results. Based on these lessons, detailed characterization plans should not be fully developed, nor should complex numerical models be developed and utilized for waste sites where insufficient or conflicting information makes the formulation of useful or credible conceptual models problematic. Rather, working hypotheses should be revised, base on new information, and only then should a detailed characterization work plan be developed and implemented. Otherwise, detailed plans will likely be developed that have to repeatedly be redone after initial results from new characterization work become available. In conjunction with completion of the initial scoping investigations, potential interim remedial measures (IRMs) should expeditiously be evaluated for their potential to mitigate worsening of the contamination. Equally import is the recognition that some sites do not need detailed characterization if they can be quickly and cost-effectively removed.

Several activities need to be brought together and managed as a coordinated effort consistent with the *Tri-Party Agreement*, including the following:

- ORP vadose zone characterization plans
- ORP Modeling
- The Environmental Restoration *200 Area Strategy*
- RCRA groundwater field characterization
- Groundwater Monitoring

- Groundwater Modeling
- Groundwater Remediation
- The GW/VZ/Columbia River Project
- Participation of the national laboratories
- Expert Panels
- Peer Review
- Regulator, stakeholder, and Tribal Nations participation.

A.2 EXTERNAL OVERSIGHT ASSOCIATED WITH TANK FARMS

Much of the external oversight of the Hanford Site during the past 10 years has involved issues associated with tank farms. During the early planning stages for the Integration Project, a review of documents and correspondence was made to summarize major issues and recommendations concerning contamination in the vadose zone and groundwater beneath the tank farms, as viewed by outside organizations. The review included comments from the following organizations and stakeholders:

- National Academy of Sciences (NAS)
- General Accounting Office
- Expert Panels (chartered by DOE, Congress, etc.)
- Defense Nuclear Facilities Safety Board
- HAB
- State and local regulatory agencies
- Tribal Nations (YIN, CTUIR, and NPT)
- Special Interest Groups (Hanford Environmental Action League [HEAL], Columbia River United [CRU], etc.).

Although numerous issues and recommendations were discovered that relate to the tank farms in general, a relatively small subset is directed at the vadose zone and groundwater. The following is a synopsis of these recurring issues:

- Significant uncertainties exist regarding the composition, concentration, and distribution of tank leakage in the soil column beneath the tank farms, and this limits the credibility of tank remediation decisions and environmental risk assessments.

- Organizational complexities and vested interests are barriers to solving difficult engineering and scientific problems associated with the tank farms. However, solving the engineering and scientific problems is not an insurmountable problem.

- The scope, schedule, and budget constraints imposed by the *Tri-Party Agreement* are frequently viewed as unrealistic, with an inadequate technical basis. Rigid adherence to these constraints is a hindrance to progress in solving tank farm technical problems.
- The DOE is not providing effective management of tank farm cleanup activities.

External reviewers frequently offered recommendations on how to address the issues that were identified. A synopsis of many of the recommendations is as follows:

- Uncertainties in available information can be reduced through (1) improved monitoring of conditions outside the tanks; (2) improved characterization of vadose zone stratigraphy (e.g., lithology and structures in sediments); and (3) improved understanding of how contamination moves in the vadose zone sediments.

- The tank farm project could benefit from new approaches and ideas for solving its variety of technical problems, including environmental contamination. Solutions might include (1) a revised project organizational structure; (2) more frequent independent peer reviews; (3) open competition for performance of key tasks; and (4) better communication with the public.

- A phased approach to final disposition of the tank farms is recommended, proceeding from accurate characterization of the wastes inside and outside the tanks, so as to understand how leaked contamination moves through the vadose zone, and to describe risks posed by the contamination that reaches the water table and is distributed through groundwater movement. Engineering solutions to tank waste removal and/or stabilization should proceed based in part on results from characterization activities.

A.3 RECOMMENDATIONS FROM THE CRCIA TEAM

The stated purpose of the CRCIA team was to assess the effects of Hanford-derived materials and contaminants on the Columbia River environment, river-dependent life, and users of river resources for as long as these contaminants are hazardous.

The CRCIA team prepared an extensive list of requirements for inclusion in any Hanford Site impact assessment activity. These requirements reflect a much broader view of the Hanford Site's impact on the Columbia River than was previously available. Recommendations offered by the CRCIA team are outlined below:

- Decisions affecting waste isolation must consider and encompass (1) cumulative site-wide effects on the region; (2) uncertainty in the estimated effects; and (3) needed safety margins for the endstate envisioned for the Hanford Site.

- Hanford Site endstates must be defined to (1) understand source of effects; and (2) provide descriptions for review by potentially affected people.

- Key decisions should be evaluated for Columbia River and regional impacts, including (1) shipment of offsite wastes to the Hanford Site; (2) the planned endstate for the Hanford Site; (3) tank waste retrieval and storage; (4) the planned endstate for the burial grounds; and (5) containment performance of liners and subsurface barriers.

- Independent direction of the assessment's performing contractor is essential to acceptable results. It is common practice for the evaluator to be independent of the agent performing the work. The concept is consistent with DOE Headquarters' (HQ) independent project review process.

The CRCIA requirements with the exception of certain approval and management authorities have been adopted as a starting point for the impact assessment capability that the Integration Project is developing. The general requirements and guidelines for the assessment capability, as adopted from the CRCIA, are described in Volume II.

APPENDIX B

PERTINENT FEDERAL AND STATE LAWS AND REGULATIONS

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APPENDIX B

PERTINENT FEDERAL AND STATE LAWS AND REGULATIONS

Table B-1. Federal Laws, Regulations, and DOE Orders.

Citation	Requirement	Application
Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 USC 9602-9604, as amended		
National Oil and Hazardous Substances Pollution Contingency Plan, Subpart E, 40 CFR 300.400	Establishes the process to be followed upon discovery of a release of a hazardous substance, including notification, site evaluation, and remedial response. Establishes CERCLA remediation criteria consisting of a risk range of 10^{-4} to 10^{-6} for carcinogens and a hazard index of less than 1 for noncarcinogens.	CERCLA hazardous substances have been released to the vadose zone and groundwater and, as a result, the 100, 200, and 300 Areas are identified on the National Priorities List for action under CERCLA.
Designation, Reportable Quantities, and Notification, 40 CFR 302	Defines the comprehensive list of hazardous substances regulated under CERCLA. Imposes reporting requirements in the event of a release in excess or reportable quantities.	CERCLA hazardous substances are present in the vadose zone and groundwater.
Safe Drinking Water Act of 1974, 42 USC 300, et seq.		
National Primary Drinking Water Standards, 40 CFR 141	Establishes maximum contaminant levels (MCLs) and maximum contaminant level goals (MCLGs) that are drinking water criteria designed to protect human health from the potential adverse effects of contaminants in drinking water.	Groundwater at the Hanford Site is not a current drinking water source, but it is considered a potential future source of drinking water using EPA's groundwater classification strategy. In addition, Hanford groundwater is hydraulically connected to groundwater that is used for drinking water and to the Columbia River. MCLs and MCLGs should be considered in establishing cleanup levels that are protective of groundwater, points of compliance, and institutional controls.
National Secondary Drinking Water Standards, 40 CFR 143	Establishes secondary drinking water standards for use in establishing cleanup levels.	Federal secondary standards are not enforceable standards and are not typically applicable or relevant and appropriate requirements; however, the State of Washington Model Toxics Control Act requires that these standards be considered in establishing cleanup levels protective of groundwater.
Clean Water Act of 1977, 33 USC 1251, as amended		
Water Quality Standards, 40 CFR 131	Establishes the requirements and procedures for states to develop and adopt water quality standards based on federal water quality criteria that are at least as stringent as the federal standards. Provides EPA authority to review and approve state standards. Washington State has received EPA approval and has adopted more stringent standards under WAC 173-201A.	Not applicable (the requirement to develop standards applies to the states, not individual facilities) but relevant in establishing the basis for state regulation.

Table B-1. Federal Laws, Regulations, and DOE Orders.

Citation	Requirement	Application
Atomic Energy Act of 1954, as amended, 42 USC 2011, et seq.		
Department of Energy Occupational Radiation Protection, 40 CFR 835	These requirements set occupational dose limits for adults. Total effective dose equivalent is equal to 5 rem/yr	These standards are applicable when performing any assessment or response actions.
DOE Order 5400.5, Radiation Protection of the Public and the Environment, and 10 CFR 834 (Proposed)	This DOE order sets radiation standards for protection of the public in the vicinity of DOE facilities. The order set limits for the annual effective dose equivalent of 100 mrem, but allows temporary limits of 500 mrem if avoiding the higher exposures is impractical. The standard sets annual dose limits for any organ at 5 mrem. The order sets an annual dose equivalent from drinking water supplies operated by DOE at 4 mrem, and states that liquid effluent from DOE activities will not cause public drinking water systems to exceed EPA MCLs. The proposed rule, Radiation Protection of the Public and the Environment (10 CFR 834), in the March 23, 1993 Federal Register (58 FR 16268), promulgates the standards presently found in DOE Order 5400.5. The proposed rule identifies DCGs not as "acceptable" discharge limits, but to be used as reference values for estimating potential dose and determining compliance with the requirements of the proposed rule. Where residual radioactive materials remain, the proposed rule states that various disposal modes should address impacts beyond the 1,000-year time period identified in the existing DOE Order.	Both the DOE order and the proposed rule are relevant in assessing risks associated with existing contamination and identifying appropriate response actions.
DOE Order 5820.5, Radioactive Waste Management	These guidelines set performance objectives to limit the annual effective dose equivalent beyond the facility boundary to 25 mrem. Selected disposal methods must be sufficient to limit the annual effective dose equivalent to 100 mrem for continuous exposure, or 500 mrem for acute exposures when active institutional controls are removed.	The order is applicable to any radioactive waste that is present in Hanford Site waste management units, or for waste that might be generated during assessment or response actions.
Nuclear Regulatory Standards for Protection Against Radiation, 10 CFR 20	The regulation establishes standards for protection of the public against radiation arising from the use of regulated materials. Remedial alternatives need to limit external and internal exposure from releases to levels that do not exceed 100 mrem/yr total effective dose equivalent, or 2 mrem/hr from external exposure in unrestricted areas. These requirements also establish criteria for closing NRC-licensed sites, including a standard of 25 mrem/yr from all sources, and reducing residual radioactivity to levels that are as low as reasonably achievable (ALARA).	The regulation is not strictly applicable at the Hanford Site because it applies to NRC-licensed facilities. However, it is relevant and appropriate because it establishes standards for protection of the public against radiation.
EPA Memorandum, Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination," OSWER No. 9200.4-18	This memorandum provides guidance on cleanup levels at CERCLA sites. EPA has determined in this directive that dose limits established by the NRC in 10 CFR 20 (25 mrem/yr and ALARA) are generally not protective at CERCLA sites, and instead states that a cleanup level of 15 mrem/yr is protective of human health and the environment. EPA dose limits are to generally achieve risk levels in the 10^{-4} to 10^{-6} risk range.	The standard established in this memorandum is considered protective by EPA in lieu of the NRC standards and is relevant in establishing cleanup levels.

Table B-1. Federal Laws, Regulations, and DOE Orders.

Citation	Requirement	Application
Licensing Requirements for the Land Disposal of Radioactive Waste, 10 CFR 61	Requires that disposal systems be designed to limit the annual dose equivalent beyond the facility boundary below 25 mrem to the whole body, 75 mrem to the thyroid, or 25 mrem to any other organ. The systems must be relevant and appropriate to remedial actions that include land disposal or release radioactive effluent. Inadvertent intruder requirements for land disposal units are also contained in this regulation	The regulation is not strictly applicable because it applies to land disposal of radioactive wastes containing byproduct, source, and special nuclear material received from other persons. However, it is relevant and appropriate if radioactive waste will be left in place following remediation. Requirements to protect inadvertent intruders may also be relevant and appropriate in assessing risks and determining appropriate response actions.
Packaging and Transportation of Radioactive Material, 10 CFR 71	These requirements apply to the packaging, preparation for shipment, and transportation of licensed radioactive material.	The regulation is not strictly applicable because the Hanford Site is not NRC-licensed. However, radioactive waste might be generated during assessment or response actions, and subparts of this regulation are relevant and appropriate for packaging, testing, and preparation of packages containing radioactive material.
Environmental Radiation Protection Standards for Nuclear Power Operations, 40 CFR 190	Specifies the levels below which normal operations of the uranium fuel cycle are determined to be environmentally acceptable. The standard sets dose equivalents from the facility that are not to exceed 25 mrem/yr to whole body, 75 mrem/yr to thyroid, or 25 mrem/yr to any other organ.	These standards are not strictly applicable at the Hanford Site, because the standard excludes operations at disposal sites and uses a definition of the uranium fuel cycle that focuses on those processes that result in generation of electrical power. However, the standards are relevant and appropriate in the assessment because they address acceptable dose to the public.
Environmental Radiation Protection Standards for the Management and Disposal of Spent Nuclear Fuel, High-Level, and Transuranic Radioactive Wastes, 40 CFR 191	Establishes standards for management and disposal of spent nuclear fuel, high-level waste, and transuranic wastes at facilities operated by the DOE. The standard addresses all disposal methods. Subpart A applies to facilities regulated by the NRC, and sets maximum committed effective dose of 15 mrem/yr for any member of the public. Environmental standards set in Subpart B address protection of individual members of the public and groundwater at disposal facilities. Appendix A provides numeric standards for potential future releases.	The requirements are applicable because high-level wastes and transuranic wastes are present at the Hanford Site, and must be addressed during closure of waste units and/or remediation of environmental media.
Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings, 40 CFR 192	Standards for cleanup are set under this program, including groundwater protection requirements for radium-226, radium-228, and gross alpha particle activity, which are set at levels established under state and federal water quality criteria programs.	The standard is not strictly applicable because the Hanford Site is not a uranium or thorium milling site. However, standards for cleanup set under this program are relevant and appropriate to assessment and response actions conducted at the Hanford Site.
Resource Conservation and Recovery Act, 42 USC 6901, et seq.		
Criteria for Classification of Solid Waste Disposal Facilities and Practices, 40 CFR 257	Criteria specified under this standard are used to determine which solid waste disposal facilities and practices pose a reasonable possibility of adverse risk to human health and the environment.	Although Hanford has solid waste disposal facilities, most of the provisions of this chapter have been delegated to the state. (See Table B-2, Hazardous Waste Management Act.)

Table B-1. Federal Laws, Regulations, and DOE Orders.

Citation	Requirement	Application
Identification and Listing of Wastes, 40 CFR 261	This part establishes the framework for determining whether a waste is hazardous, including testing methods, criteria for characteristic waste, and definitions of listed wastes.	Although hazardous waste is present at the Hanford Site, and might be generated during assessment and response actions, most of the provisions relative to designation have been delegated to the state.
Generator Standards, 40 CFR 262, Standards Applicable to Transporters of Hazardous Waste, 40 CFR 263, Standards for Owners and Operators of TSD Units, 40 CFR 264 and 265	Establishes specific requirements for facilities that generate, transport, store, treat, and/or dispose of hazardous waste. Requirements cover such items as permitting, waste unit design and operation, training, and emergency preparedness planning.	Although hazardous waste is present at the Hanford Site and might be generated during assessment and response actions, most of the provisions relative to waste generation and management have been delegated to the state.
Groundwater Protection Standards, 40 CFR 264.92	Three remediation levels of groundwater protection established by this section are background, MCLs, and ACLs. MCLs are set at the same levels as SDWA MCLs. Where no SDWA MCL has been set, health-based ACLs may be established that are protective of human health and environment.	Groundwater restoration goals established by this section are relevant and appropriate in establishing soil cleanup levels that are protective of groundwater.
Corrective Action for Solid Waste Management Units, 40 CFR 264, Subpart S (proposed)	Identifies a process for implementing corrective action under RCRA, and establishes chemical-specific soil cleanup levels that are protective based on direct exposure.	Releases from solid waste management units will be considered in the assessment and in identifying response actions. Soil remediation goals established by this section may be pertinent to the establishment of soil cleanup levels. Because this is a proposed rule, it is not strictly applicable at this time.
Land Disposal Restrictions, 40 CFR 268	These requirements prohibit the placement of restricted RCRA hazardous wastes in land-based units until treated to standards considered protective for disposal. Specific treatment standards are included in the requirements.	These requirements are applicable if restricted waste is generated during assessment or response actions.
Toxic Substances Control Act (TSCA), 15 USC 2601 et seq.		
Regulation of PCBs, 40 CFR 761	These requirements identify standards applicable to the handling and disposal of PCBs above 50 ppm. Spills that occurred before May 4, 1987, are to be decontaminated to requirements established at the discretion of the EPA.	PCBs are known to have been used at the Hanford Site and might be present in waste units and/or might have been released to the environment. TSCA requirements for remediation, treatment, and disposal of PCBs are applicable in developing response actions if the PCBs are present at regulated levels.
Guidance on Remedial Actions for Superfund Sites with PCB Contamination, U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response	This document provides guidance for evaluating and selecting a remedy for sites contaminated with PCBs. The guidance presents a range of preliminary remediation goals for the cleanup of PCB-contaminated sites that are protective of human health and intended to meet the goals of the NCP and TSCA. EPA guidance notes that in selecting a response action under CERCLA, cleanup levels and disposal methods should be selected based on the form and concentration found at the site.	PCBs might be present at CERCLA waste sites at the Hanford Site.
Clean Air Act of 1977, as amended 42 USC 7401, et seq.		
National Ambient Air Quality Standards, 40 CFR 50	Requirements of these regulations are applicable to airborne releases of criteria pollutants specified under the statute. Specific release limits for particulates are set at 50 $\mu g/m^3$ annually or 150 $\mu g/m^3$ per 24-hour period.	Applicable to airborne releases of criteria pollutants that might be generated during assessment or response actions.

Table B-1. Federal Laws, Regulations, and DOE Orders.

Citation	Requirement	Application
Ambient Air Quality Monitoring, 40 CFR 58	This regulation presents the criteria and requirements for ambient air quality monitoring and reporting for local air pollution control agencies and operators of new sources of air pollutants.	Applicable to assessment or response actions that meet the regulatory definition of a new source. Also, these requirements may be considered relevant and appropriate to response actions that have the potential to emit air contaminants, even if they are not a new source.
Standards of Performance for New Stationary Sources, 40 CFR 60	These requirements provide standards for new stationary sources or modifications of existing sources.	Applicable if assessment or response actions include stationary sources.
National Emission Standard for Hazardous Air Pollutants (NESHAP), 40 CFR 61	40 CFR 61 provides general requirements and listings for actions that will generate regulated emissions at a regulated facility.	These requirements are applicable to assessment or response actions that release air emissions into unrestricted areas.
Subpart H, National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities, 40 CFR 61	Subpart H sets emissions limits to ambient air from the entire facility, not to exceed an amount that would cause any member of the public to receive an effective dose equivalent of 10 mrem/yr. The definition of “facility” for the Hanford Site includes all buildings, structures, and operations collectively as one contiguous site. Radionuclide emission from stacks shall be monitored and effective dose equivalent values to members of the public calculated.	These requirements are applicable to assessment and response actions that have the potential to release air emissions to unrestricted areas.
National Emission Standards for Asbestos, Standard for Demolition and Renovation, 40 CFR 61.145 – 150	This section specifies that facilities are to be inspected for the presence of asbestos prior to demolition. The standard defines regulated asbestos-containing materials and establishes removal requirements based on the quantity present and handling requirements. These requirements also specify handling and disposal requirements for regulated sources having the potential to emit asbestos. Specifically, no visible emissions are allowed during handling, packaging, and transport of asbestos-containing materials.	These requirements are applicable if response actions require demolition of buildings or structures containing regulated asbestos-containing materials.
Hazardous Materials Transportation Act, 49 USC 1801, et seq.		
Hazardous Materials Regulation, 49 CFR 171	These requirements state that no person may offer to accept hazardous material for transportation in commerce unless the material is properly classed, described, packaged, marked, labeled, and in condition for shipment.	These requirements are applicable to hazardous material generated during assessment or response actions, which is sent offsite for disposal.
Hazardous Materials Tables, Hazardous Materials Communications Requirements, and Emergency Response Information Requirements, 49 CFR 172	Tables are used to identify requirements for labeling, packaging, and transportation based on categories of waste types. Small quantities of radioactive wastes are not subject to the requirements of the standard if activity levels are below limits established in paragraph 173.421, 173.422, or 173.424. Specific performance requirements are established for packages used for shipping and transport of hazardous materials.	These requirements are applicable if hazardous materials are transported offsite during assessment or response actions. In the event of a discharge of hazardous waste during transportation from the treatment facility to the disposal facility, this section is applicable.

Table B-1. Federal Laws, Regulations, and DOE Orders.

Citation	Requirement	Application
Executive Order 12856, Federal Compliance with Right- to-Know Laws and Pollution Prevention Requirements	Requires that federal agencies will comply with Emergency Planning and Community Right-To-Know Act of 1986 (EPCRA) and the Pollution Prevention Act of 1990 (PPA) to the extent that private entities would. The EO incorporates, by reference, all implementing regulations of EPCRA and the PPA. EPCRA requires tracking and reporting information on the storage, use, and release of extremely hazardous substances, hazardous substances, listed chemicals, and toxic chemicals to inform the public about the presence of such hazards in their community and to provide emergency planners and emergency response organizations with information needed to provide appropriate response to potential emergencies at the facilities. The PPA requires entities to implement practices that reduce or eliminate the creation of pollutants through increased efficiency in the use of raw materials, energy, water, or other resources; or protection of natural resources by conservation.	Applicable to federal agencies that either own or operate a "facility" as that term is defined in section 329(4) of EPCRA if such facility meets the threshold requirements set forth in EPCRA. Hanford meets the definition and threshold requirements.
DOE 1998, Draft Hanford Remedial Action Environmental Impact Statement, DOE/RL-98-X	The draft Hanford Remedial Action EIS will define land use decisions for the Hanford Site.	Land use and associated exposure scenarios are important in assessing risk and determining appropriate response actions.
National Historic Preservation Act of 1966, 16 USC 470	Requires that historically significant properties be protected. The act requires that agencies undertaking projects must evaluate impacts to properties listed on or eligible for inclusion in the National Register of Historic Places. An eligibility determination provides a site with the same level of protection as a site listed on the National Register of Historic Places. The regulations implementing the act require that the lead agency for a project identify, evaluate, and determine the effects of the project on any cultural resource sites that may be within the area impacted by the project. The implementing regulations require that negative impacts be resolved.	This law is applicable to assessment or response actions that could impact any of the various buildings/structures at the Hanford Site that are eligible for the National Register.
Archeological and Historic Preservation Act, 16 USC 469a	Requires that actions conducted at the site must not cause the loss of any archeological and historic data. This act mandates preservation of the data and does not require protection of the actual facility. Where a site is determined to be eligible for the National Register and mitigation is unavailable, artifacts and data will be recovered and preserved prior to commencement of the action.	Archeological and historic sites have been identified at the Hanford Site, and therefore these requirements are applicable to activities that might disturb these sites.
Endangered Species Act of 1973, 16 USC 1531, et seq.	This act prohibits federal agencies from jeopardizing threatened or endangered species or adversely modifying habitats essential to their survival. If waste site remediation is within sensitive habitat or buffer zones surrounding threatened or endangered species, mitigation measures must be taken to protect these resources.	The Endangered Species Act of 1973 would be considered applicable if threatened or endangered species are identified in areas covered by the assessment. Their presence could dictate the approach to assessment or response actions that may be necessary.

Table B-1. Federal Laws, Regulations, and DOE Orders.

Citation	Requirement	Application

ACL	=	alternate concentration level
ALARA	=	as low as reasonably achievable
CAMU	=	corrective action management unit
CERCLA	=	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	=	Code of Federal Regulations
DCG	=	derived concentration guide
DOE	=	U.S. Department of Energy
EPA	=	U.S. Environmental Protection Agency
HCRL	=	Hanford Cultural Resources Laboratory
MCL	=	maximum contaminant level
MCLG	=	maximum contaminant level goal
NESHAP	=	National Emission Standards for Hazardous Air Pollutants
NCP	=	National Oil and Hazardous Substance Contingency Plan
NEPA	=	National Environmental Policy Act
NPDES	=	National Pollutant Discharge Elimination System
NRC	=	U.S. Nuclear Regulatory Commission
PCB	=	polychlorinated biphenyls
RCRA	=	*Resource Conservation and Recovery Act*
SDWA	=	Safe Drinking Water Act
TBC	=	to be considered
TSCA	=	Toxic Substance Control Act.

Table B-2. State of Washington Laws and Regulations.

ARAR Citation	Requirement	Application
Hazardous Waste Clean Up/Model Toxics Control Act, Ch. 70.105D RCW		
Model Toxics Control Act, WAC 173-340-700	Establishes a process and requirements for cleanup of contaminated sites in the state. MTCA regulations have been authorized for use in implementing RCRA corrective action in the state. Specifies that all cleanup actions be protective of human health; comply with all applicable state and federal regulations; and provide for compliance monitoring. Identifies the methods used to develop cleanup standards and their use in selection of a cleanup action. Specifies cleanup goals, which implement the strictest federal or state cleanup criteria. In addition to meeting requirements of other regulations, MTCA uses three basic methods for establishing cleanup levels. These methods may be used to identify cleanup standards for groundwater, surface water, soils, and protection of air quality. Cleanup levels for soils may be calculated using Method A – routine; Method B - standard method; and Method C – conditional standards. MCLs, MCLGs, and secondary drinking water standards are identified in the regulation as groundwater cleanup criteria.	Requirements of MTCA are applicable to RCRA corrective action sites at the Hanford Site and relevant and appropriate for other Hanford waste sites (e.g., CERCLA sites). State requirements that are not authorized through a federal program, such as MTCA, are not directly applicable to federal facilities.
Hazardous Waste Management Act, 70.105 RCW		
Dangerous Waste Regulations, WAC 173-303	Establishes the design, operation, and monitoring requirements for managing dangerous waste.	Dangerous waste is present in Hanford Site waste units and might be generated during assessment or response actions. Sections of this chapter are applicable to dangerous waste management activities and may be relevant and appropriate in certain situations even when they are not applicable. Key sections are discussed below.
Designation of Waste, WAC 173-303-070 through 110	Establishes the methods and procedures to determine if solid waste requires management as dangerous waste.	The requirements of this section are applicable because dangerous waste might be generated.
Land Disposal Restrictions, WAC 173-303-140	Identifies dangerous wastes that are restricted from land disposal and describes requirements for state-only restricted wastes; defines the circumstances under which a prohibited waste may be disposed.	Applicable to the disposal of restricted wastes.
Spills and Discharges into the Environment, WAC 173-303-145	Sets forth the requirements that apply when any dangerous waste or hazardous substance is intentionally or accidentally spilled or discharged into the environment such that human health and the environment are threatened, regardless of the quantity of dangerous waste or hazardous substance.	Applicable should dangerous waste or hazardous substances be spilled or discharged into the environment.
Requirements for Generators of Dangerous Waste, WAC 173-303-170 through 230	Requirements defined under this section include specific levels of training and emergency preparedness.	Applicable to actions performed at the site if dangerous waste is generated.

Table B-2. State of Washington Laws and Regulations.

ARAR Citation	Requirement	Application
General Requirements for Dangerous Waste Management Facilities, WAC 173-303-280 through 395	General requirements include siting standards, training, emergency preparedness, security, inspections, contingency planning, waste analysis, and management of containers.	Applicable to actions that include treatment, storage, or disposal of designated dangerous waste.
Treatment, Storage, and Disposal Facility Requirements, WAC 173-303-600 through 695	Specifies closure and post-closure standards (which require compliance with MTCA cleanup levels), groundwater monitoring requirements, corrective action management unit/temporary unit requirements, air emission standards for process vents and equipment leaks, and specific unit requirements for containers, tanks, surface impoundments, land treatment units, waste piles, landfills, incinerators, drip pads, miscellaneous units, and containment buildings.	Applicable because permitted TSD units are present and/or assessment or remediation wastes may be managed in units that are TSDs.
Releases from regulated units, WAC 173-303-645	Establishes groundwater protection standards for releases to groundwater from dangerous waste management units.	The standard is applicable because TSD units are present.
Solid Waste Management, Recovery and Recycling Act, Ch. 70.95 RCW		
Minimum Functional Standards for Solid Waste Handling, WAC 173-304	These standards establish requirements to be met for the management of solid waste. Solid waste controlled by this Act includes garbage, industrial waste, construction waste, and ashes. Requirements for containerized storage, collection, transportation, treatment, and disposal of solid waste are included. These standards set groundwater MCLs at the same levels as the state drinking water standards.	These regulations are applicable when solid waste is generated during assessment or response actions, and may be relevant and appropriate to existing solid waste facilities at the Hanford Site.
Water Pollution Control/Water Resource Act of 1971, Ch. 90.48 RCW/Ch.90.54 RCW		
Surface Water Quality Standards, WAC 173-201A	These standards set water quality standards at levels protective of aquatic life.	Groundwater from the Hanford Site discharges to the Columbia River; therefore, surface water quality criteria established under this chapter are applicable in assessing risk and response actions.
Protection of Upper Aquifer Zones, WAC 173-154	This regulation directs Ecology to provide for protection of upper aquifers and upper aquifer zones to avoid depletions, excessive water level declines, or reductions in water quality.	This regulation is not applicable because it establishes the policy and program for Ecology. However, the regulation is relevant and appropriate because protection of the aquifer from adverse impacts caused by waste management units is a primary goal.
State Waste Discharge Program, WAC 173-216	The regulation establishes requirements for industrial and commercial operations that discharge to the groundwater, surface waters, or municipal sewerage systems. Specific discharges prohibited under the program are identified. The intent of the regulation is to maintain the highest possible standards, and the law requires the use of all known available and reasonable methods to prevent and control the discharge of wastes into the waters of the state.	Requirements of this program are applicable to assessment or response actions that include discharges to the ground.

Table B-2. State of Washington Laws and Regulations.

ARAR Citation	Requirement	Application
Department of Health Standards for Public Water Supplies, WAC 246-290	The rule established under WAC 246-290 defines the regulatory requirements necessary to protect consumers using public drinking water supplies. The rules are intended to conform with the federal SDWA, as amended. WAC 246-290-310 establishes MCLs that define the water quality requirements for public water supplies. WAC 246-290-310 establishes both primary and secondary MCLs and identifies that enforcement of the primary standards is the Department of Health's first priority.	The requirements of WAC 246-290-310 are relevant and appropriate because the groundwater at the Hanford Site is classified as a potential future source of drinking water , based on the State classification strategy.
State Radiation Protection Requirements, Ch. 70.98 RCW		
Radiation Protection Standards, WAC 246-221	Establishes annual average concentration limits for radionuclides in gaseous and liquid effluents released to unrestricted areas from licensed nuclear facilities. Occupational dose to adults and minors are set in these requirements. Dose limits that individual members of the public may receive in unrestricted areas from external sources are also set. The standard identifies the methods required to demonstrate compliance and provides derived air concentration and annual limit on uptake values that may be used to determine an individual's occupational dose. The standard specifies requirements for monitoring personnel exposure for both external and internal exposure.	This regulation is not strictly applicable because the Hanford Site does not have licensed nuclear facilities; however, it might be relevant and appropriate because it establishes standards for acceptable levels of exposure to radiation.
Radioactive Waste-Licensing Land Disposal, WAC 246-250	Establishes the procedures, criteria, and conditions for licensing of low-level radioactive waste land disposal facilities. This section presents specific levels of radiation protection and technical requirements for land disposal of radioactive waste.	This regulation is not strictly applicable because the Hanford Site does not have licensed disposal facilities; however, it might be relevant and appropriate to the assessment if response actions allow radioactive waste to remain on site.
Washington Clean Air Act, Ch. 70.94 RCW and Ch. 43.21A RCW		
General Regulations for Air Pollution, WAC 173-400	The regulation requires that all sources of air contaminants meet emission standards for visible, particulate, fugitive, odors, and hazardous air emissions. This section requires that all emission units use reasonably available control technology, which may be determined for some source categories to be more stringent than the emission limitations listed in this chapter. The regulation requires that source testing and monitoring be performed. A new source would include any process or source that may increase emissions or ambient air concentration of any contaminant for which federal or state ambient or emission standards have been established.	Requirements of this standard are applicable to assessment and response actions that could result in the emission of hazardous air pollutants.

Table B-2. State of Washington Laws and Regulations.

ARAR Citation	Requirement	Application
Controls for New Sources of Air Pollution, WAC 173-460	This standard requires that new sources of air emissions provide emission estimates for toxic air contaminants listed in the regulation. The standard requires that emissions be quantified and used in risk modeling to evaluate ambient impacts and to establish acceptable source impact levels. The standard establishes three major requirements for new sources of air pollutants: use of best available control technology; quantification of toxic emissions; and demonstration that human health is protected.	The standard is applicable to assessment and response actions where contaminants identified as toxic air pollutants are present and air emissions might be generated.
Ambient Air Quality Standards for Particulate Matter, WAC 173-470	These requirements set maximum acceptable levels for particulate matter in the ambient air and the 24-hour ambient air concentration standard for particles less than 10 µm in diameter (PM_{10}). The section defines standards for particle fallout in industrial, commercial, and residential areas. Alternate levels are set for areas where natural dust levels are high.	These requirements are applicable to assessment and response actions (e.g., drilling) that might emit particulate matter to the air.
Ambient Air Quality Standards and Emission Limits for Radionuclides, WAC 173-480	These requirements establish that the most stringent federal or state ambient air quality standard for radionuclides are enforced. The requirements define the maximum allowable level for radionuclides in the ambient air, which shall not cause a maximum accumulated dose equivalent of 25 mrem/yr to the whole body or 75 mrem/yr to any critical organ. However, ambient air standards under 40 CFR 61 Subparts H and I are not to exceed amounts that result in an effective dose equivalent of 10 mrem/yr to any member of the public. Emission standards for new and modified emission units shall utilize best available radionuclide control technology.	Requirements of this standard are applicable to assessment and response actions that might emit radionuclides to the air.
Emission Standards and Controls for Sources Emitting Volatile Organic Compounds (VOC), WAC 173-490	This chapter establishes technically feasible and attainable standards for sources emitting volatile organic compounds.	This regulation is applicable if assessment or response actions will result in airborne emissions of volatile organic compound.
Radiation Protection - Air Emissions, WAC 246-247	This regulation promulgates air-emission limits for airborne radionuclide emissions as defined in WAC 173-480 and 40 CFR 61, Subparts H and I. The ambient air standards under WAC 173-480 require that the most stringent standard be enforced. Ambient air standards under 40 CFR 61, Subparts H and I, are not to exceed amounts that result in an effective dose equivalent of 10 mrem/yr to any member of the public. The ambient standard in WAC 173-480 specifies that emission of radionuclides to the air must not cause a dose equivalent of 25 mrem/yr to the whole body or 75 mrem/yr to any critical organ.	This regulation is applicable to any assessment or response actions that would result in airborne emissions of radionuclides.

Table B-2. State of Washington Laws and Regulations.

ARAR Citation	Requirement	Application
Radiation Protection at Uranium and Thorium Milling Operations, WAC 246-252	Radium-226 concentrations are required to be less than 5 pCi/g, averaged over the upper 15 cm, and not more than 15 pCi/g averaged over any 15-cm interval deeper than 15 cm from the surface. Groundwater protection standards established for gross alpha excluding radon and uranium are set at 15 pCi/L, and for combined radium-226 and radium-228 not to exceed 5 pCi/L.	This regulation is not strictly applicable because the Hanford Site does not have uranium or thorium milling operations; however, it is relevant and appropriate because it contains specific soil cleanup limits for radium-226 and radium-228 and groundwater protection limits.
Department of Game Procedures, WAC 232-012	This standard defines the requirements that the Department of Game must take to protect endangered or threatened wildlife.	These requirements may be applicable if endangered or threatened wildlife are identified in areas affected by assessment or response actions. The requirements of this chapter should be evaluated on an activity-specific basis.
National Area Preserves, RCW 79.70		
Washington Natural Heritage Program	The Washington State Natural Heritage Program is authorized under RCW 79.70, Natural Area Preserves, and serves as an advisory council to the Washington State Department of Natural Resources, Fish and Wildlife, the Parks and Recreation Commission, and other state agencies managing state-owned land or natural resources. The list of state endangered, threatened, and sensitive plants developed by the program, along with program-recommended levels of protection, are to be used to assist resource managers in determining which species of concern occur in their areas and recommend protection. The designations provided to plants by the Washington State Natural Heritage program are advisory and do not specify a regulatory level of protection.	The requirements of the Natural Heritage Program provide guidance that could affect assessment or response actions in areas where threatened or endangered plant species have been identified.
Water Well Construction, Ch. 18.104 RCW		
Minimum Standards for Construction and Maintenance of Water Wells, WAC 173-160	These requirements establish minimum standards for design, construction, capping, and sealing of all wells. The requirements set additional requirements, including disinfection of equipment, decommissioning of wells, and quality of drilling water.	These requirements are applicable because assessment or response actions could include construction of wells for groundwater extraction, monitoring, injection of treated groundwater, or resource protection, or geotechnical borings.
Rules and Regulations Governing the Licensing of Well Contractors and Operators, WAC 173-162	This regulation establishes training standards for well contractors and operators.	This regulation is relevant and appropriate because assessment or response actions could involve groundwater well installation or construction of geotechnical borings.
State Environmental Policy Act, Chapter 43.21C RCW		
SEPA Rules, WAC 197-11	These requirements establish compliance with the State Environmental Policy Act.	These requirements are applicable.

Table B-2. State of Washington Laws and Regulations.

ARAR Citation	Requirement	Application
Water Quality Standards for Ground Waters of the State of Washington; WAC 173-200	Establishes groundwater quality standards to provide for protection of the environment and human health, as well as an antidegradation policy to protect existing and future beneficial uses of ground water.	WAC 173-200 standards do not apply to cleanup actions undertaken pursuant to the Model Toxics Control Act (MTCA) or the Comprehensive Environmental Response, Compensation, and Liability Act. Instead, MTCA establishes groundwater cleanup standards at such sites.
Sediment Management Standards; WAC 173-204-340, WAC 173-204 Part V	WAC 173-204-340 establishes freshwater sediment quality standards. Part V of WAC 173-204 establishes the process for establishing sediment cleanup standards and managing contaminated sediments.	WAC 173-204-340 is currently reserved and freshwater sediment standards are established on a case-by-case basis. Part V identifies specific sediment cleanup standards only for Puget Sound; cleanup standards for all other sites are established on a case-by-case basis.

CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
CFR = Code of Federal Regulations
Ecology = Washington Department of Ecology
MCL = maximum contaminant level
MCLG = maximum contaminant level goal
MTCA = Model Toxics Control Act
NPDES = National Pollutant Discharge Elimination System
RCRA = Resource Conservation and Recovery Act
RCW = Revised Code of Washington
SEPA = State Environmental Policy Act
SDWA = Safe Drinking Water Act
TBC = to be considered
TSD = treatment, storage, and disposal
VOC = Volatile Organic Compounds
WAC = Washington Administrative Code.

APPENDIX C

REQUIREMENTS AND GUIDELINES FOR THE DEVELOPMENT AND CONDUCT OF A HANFORD SITE CUMULATIVE IMPACTS ASSESSMENT

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APPENDIX C

REQUIREMENTS AND GUIDELINES FOR THE DEVELOPMENT AND CONDUCT OF A HANFORD SITE CUMULATIVE IMPACTS ASSESSMENT

This Appendix presents requirements and guidelines for the development and conduct of a Hanford Site cumulative impacts assessment and were developed collaboration with representatives of the CRCIA group. The Integration Project intends to use this information as a basis for guidelines for developing the System Assessment Capability (SAC). Every attempt has been made to provide clear, concise statements of principles, general requirements, and specific detail requirements that will be evaluated and incorporated into the SAC as it matures and evolves. The scope of these requirements and guidelines is extensive, and affects many areas of the assessment. If principles and guidelines conflict, the first four principles (dominance, uncertainty, fidelity, and use of expert judgment) override all others. The *Columbia River Comprehensive Impact Assessment: Phase II* provides the original source material for this section.

The purpose of this section is to demonstrate the level of coordination and integration of the requirements of the CRCIA work into the Integration Project.

C.1 INTEGRATION PROJECT MISSION

To ensure that Hanford Site decisions are defensible and possess an integrated perspective for the protection of water resources, the Columbia River environment, river-dependent life, and users of Columbia River resources, the mission of the Integration Project is to assess the Hanford Site's present and post-closure cumulative effects in terms of the radioactive and chemical materials that have accumulated throughout Hanford's history and which continue to be received. To support this mission the Integration Project will also define those actions necessary to bring into consistency -- and maintain mutual compatibility among -- site-wide characterization and analysis tasks that bear on decisions affecting cleanup operations, planned and achieved waste disposal isolation performance, receptor impact, and regulatory compliance. The Integration Project will identify and oversee the science and technology (S&T) initiatives as necessary to enable the mission to be successfully completed.

C.2 INTEGRATION PROJECT APPROACH

Among other tasks, the Integration Project will develop the capability to estimate, and assess, impacts of the Hanford Site's waste management, remediation, and disposal activities. For Integration Project planning purposes, Hanford's cleanup decisions can be divided into three time frames: near-term, intermediate, and long-term. Near-term decisions are those that must be made as quickly as possible to stabilize contaminants and materials that are escaping containment and/or pose a threat to safety that is so imminent that decisions must be made with the available information. Impacts across long-term time frames are generally associated with end state decisions (or decisions limiting end state options), where the implications of the solutions chosen now may not be experienced for decades (or centuries). The Integration Project will evaluate the expected environmental, human health, cultural, and economic impacts resulting from Hanford Site cleanup decisions over many decades. Assessments of this long term time frame necessitate development of a SAC that will be utilized iteratively throughout the period of cleanup operations to estimate the effects of various cleanup options, postulated environmental scenarios, and probable demographic changes. The analyses will consider a time horizon of sufficient duration to estimate major effects, so as not to inadvertently truncate important long-term effects of credible situations. The intermediate time frame is that time frame between the short term and long term where sufficient time exists to properly identify problems, frame a systematic approach, and collect information to implement a selected approach. Much of the Integration Project's planning related to the development of a system evaluation capability falls into the intermediate time frame.

The Integration Project is driven both by the practical need to minimize adverse impact to chosen lifestyles in the region, and the need to make remediation and mitigation decisions that are compliant with various federal and state statutes, laws, and regulations. It is of the utmost importance to the Integration Project that the support for these decisions has a fundamentally sound technical basis. It is also fundamentally important that cultural values of affected peoples and Tribal Nations be incorporated into the evaluation processes and techniques developed by the Integration Project. Therefore, the Integration Project will endeavor to provide the necessary leadership and resources to ensure that decisions are both technically and publicly credible.

The Integration Project considers the effective management of uncertainty to be essential to a prudent allocation of resources and rapid movement toward credible, technically sound decision making. The Integration Project is committed to conduct a systematic evaluation of the factors affecting the level of uncertainty of impact estimates. Primary sources of uncertainty will be identified and ranked in terms of their relative importance. It is expected that this analysis would be qualitative at first, and would become more quantitative as the Integration Project progresses and the SAC matures. The results of this evaluation will refine the approach and guide the allocation of resources. Sources of uncertainty will also be identified within each technical element.

The approach to the development of the SAC can significantly affect the identification of issues and the conclusions. The Integration Project will conduct a systematic assessment of the requirements of each technical element, and will adopt a controlled approach to identifying dominant factors in order to discard smaller contributors. Criteria will be developed (as appropriate) to support these evaluations.

The Integration Project recognizes that many requirements and guidelines will be difficult to meet. Some may require research and development. The details of the incorporation of each requirement into the Integration Project are also not developed at this time. Certainly, some requirements will not be met in early versions of the SAC.

C.3 PRINCIPLES

The following principles are applicable to all phases of the development of the SAC:

- **Dominance.** This is the principle that, in virtually all things, a relatively small number of factors dominate the outcome. This assessment must not leave out any factors that dominate the results. Yet, the magnitude of work and cost of the analysis must be responsibly managed. Sensitivity analyses, parametric analyses, and related methods will be used to identify and rank the factors that dominate the outcome. These factors may be physical attributes of the Hanford Site, or effectiveness of waste disposal, or they may be technical characteristics and challenges within the study itself. Assumptions framed through expert judgment (in lieu of repeatable analyses) will not be used to identify dominant factors or discard smaller contributors. The resulting understanding of relative importance will be used to focus technical emphasis, management oversight, and assessment planning, as well as Hanford Site budget estimates and funding allocations.

- **Uncertainty.** System and technical element level uncertainty must be managed to support efficiently reaching Integration Project goals. The uncertainty inherent in results will be qualitatively and quantitatively determined, and used in the technical definition of the assessment as well as in the study's management and allocation of resources. The level of uncertainty that can be tolerated in the study results as a basis for cleanup decisions will be a guiding requirement. Ideally, uncertainty will be equalized across the various study tasks. Uncertainty will be used to determine the usefulness of spending additional effort to reduce uncertainty. Technical attention will be focused accordingly. It should also be recognized that uncertainty and the dominance principle are coupled. The quantification of uncertainty is a useful method and its use is supported by the Integration Project.

- **Fidelity of Assessment Results.** The level of detail of this assessment must enable detection of an impact and resultant effect that is (or will be) significant to the receptors affected by the cleanup and waste disposal decisions made at Hanford. In this context, fidelity includes the concepts of accuracy, resolution of information in both time and location, and statistical significance. Perhaps the primary consideration is that results should have enough fidelity to distinguish among cleanup and disposal alternatives in the Hanford Site decision-making process. The analysts must be careful not to dismiss an effect that may be important from a cultural perspective simply because popular analytical approaches may discard such effects.

- **Use of Expert Judgment.** Experienced and knowledgeable analysts are expected to exercise their skills and judgment with the highest professionalism in planning and conducting this assessment. Substituting expert judgment for analytical quantification should, however, be avoided unless a convincing rationale is presented to the contrary. Clearly, time, available resources, and significance of the matter at hand must guide the analysts. The bases in making such choices are credibility and reproducibility. The Integration Project's credibility and acceptance may be irreparably damaged if it appears that expert judgment was used to precipitate a predetermined favored result. Pivotal activities in the assessment must be reproducible by qualified professionals. The assessment must not be vulnerable to dispute because results cannot be independently reproduced.

- **Development and Use of Assumptions.** Arbitrary assumptions will be avoided in this Integration Project. The Integration Project's credibility and acceptance may be irreparably damaged if it appears that assumptions were deliberately imbedded in models (or other work) so as to precipitate a predetermined favored result. Assumptions will be documented and evaluated as part of the natural progression of the study. Assumptions made in the approach and in the technical elements must be traceable, documented, and made available to interested parties upon request.

- **Integration of Tasks within the Assessment.** As the assessment is subdivided into work tasks, care will be taken to ensure consistency and compatibility in the application of requirements, use of data, seamlessness of modeling, management of uncertainty, and treatment of related factors bearing on overall quality.

- **Integration with Other Site Efforts.** Two areas require continuous management. First, the assessment must remain integrated with cleanup and waste disposal decisions, including related environmental impact statements, records of decision, conceptual design contract awards, planning bases for budget submittals, strategic planning, and Hanford Site project requirements documents. Second, integration must be achieved and maintained with other related analytical efforts, especially other studies involving the Columbia River. Relevant analyses performed by other organizations will be used to the maximum extent to which they are valid for the purpose and objectives of this assessment. Those performing other analyses should be asked to consider adopting this Integration Project's requirements in order to enhance usability.

- **Use of Other Study Results.** Care must be taken to avoid jeopardizing acceptance of results by including data that do not meet the requirements defined herein. This assessment will, however, use the Hanford Site disposition baseline for defining disposal methods and, if available, estimates of containment performance. Composite source term information compiled elsewhere may be used if it meets Integration Project requirements.

- **Science and Technology Development and Support of Analysis Methods.** Several of the important objectives of this assessment lie beyond conventional analytical practices. For example, in projecting mutagenic and cultural effects, existing methods will need to be modified and new techniques developed. Design and planning of the assessment must include definition of S&T needs in order to ensure that the proper analytical tools and technical information will be available (when needed), and that the resources of the Department of Energy (DOE) can be used for their development.

C.4 GENERAL REQUIREMENTS

- **Columbia River Area to be Assessed.** Bearing in mind the overarching principle of excluding from the assessment progressively less important factors and effects, the geographic section of the Columbia River to be assessed begins at the Priest Rapids Dam and proceeds progressively downstream as far as significant impacts are indicated to the river's mouth. Initially, the Integration Project will concentrate on the area between Priest Rapids and McNary dams. The final assessment will incorporate a geographic area that is defined by the extent of actual and potential impacts. The river area includes the riparian zone and both drinking water and irrigation water drawn from the river. It also includes the aquatic and upland terrestrial life that depends on the river for biological, social, or economic reasons. The water ingested from the Hanford Reach area includes undiluted, or only somewhat diluted, groundwater found in seeps and springs in the riparian zone, as well as groundwater upwelling in the river bottom where aquatic habitat is found.

- **Terrestrial Area to be Assessed.** In addition to the land area influenced by the Columbia River (as described above), the Integration Project should assess Hanford's effects throughout the Pasco Basin. (At this time, this terrestrial assessment is not included in the Integration Project workscope). Generally, the Pasco Basin is bounded on the North by the Saddle Mountains, on the West through South by the Umtanum, Yakima, and Rattlesnake Ridges, and on the East by geologic features more or less following highway 395.

- **Time Period of Potential Impact.** Hanford's impact on the region began with the federal government's acquisition of Hanford lands in 1943. The focus continues through the period during which the radioactive and chemical materials remain intrinsically harmful, including radioactive decay products and chemical reaction products. The generally recognized current regulatory horizon (about 30-50 years) is inconsistent with the long-term persistence of Hanford's wastes and materials. The assessment must be guided by the material's period of intrinsic hazard, rather than the regulatory period. However, to ensure that the results are also useful in regulatory matters, points of time important in regulatory considerations will be identifiable in assessment results.

- It is beyond the scope of this Integration Project to estimate past injury or damages. Nevertheless, to the extent that past Hanford Site events have resulted in present day cumulative effects, or conditions that bear on future impacts, the past events must be understood and taken into account in this assessment.

- **Radioactive and Chemical Materials.** Calculations involving radioactive and hazardous materials data will include radioactive decay products and chemical compounds/properties estimated to occur with time and after reaction with other chemicals, soils, and river chemistry.

- **Impact Comparison Baseline.** "Impact," as used throughout this assessment, means (and will be compared with) conditions that would exist if no Hanford Site contamination had ever occurred. Generally, this pre-Hanford state will be equated with today's conditions extending northward from Hanford to appropriate areas upstream (such as the area in the vicinity of the Priest Rapids Dam). It is recognized that Hanford contaminants are not entering a pristine ecosystem. Hanford's impact is the fractional contribution of total impacts resulting from Hanford contaminants entering into the existing system. Total impacts shall include the combined effects of Hanford contaminants and those originating elsewhere.

- **Assessment Metrics and Criteria.** Contaminant concentrations, doses, and impacts prescribed in regulations can be used in the assessment for general information and guidance. However, caution must be exercised to ensure that effects of interest are adequately considered in this assessment, even though they may be not adequately treated in current regulations. Additionally, other impacts of interest are typically not addressed in regulations; for example, mutagenic effects, teratogenic effects, and cultural effects. Levels of contaminants elevated above those generally found in areas outside of Hanford's influence will not be ignored because they lie below regulatory levels or because of a void in research linking such contaminant levels to adverse effects. This requirement is especially important where two or more source terms potentially interact but are typically ignored in individual project's analyses. Consequently, individual project's point of compliance criteria ten meters down gradient, for example, may have little relevance in a cumulative assessment of multiple source terms. Criteria used by assessment analysts must include consideration of existing reference levels of the contaminants, the presence of multiple contaminants and multiple exposure pathways, general environmental cleanup experience, the body of regulatory experience, and historical environmental events (such as Chernobyl). Other considerations include health physics accepted practice; international standards, such as those of the International Commission on Radiological Protection; cause and effect correlations from the medical community; and new developments in ecology, toxicology, and risk assessment. In addition to the need for criteria for elevated contaminant levels, criteria also may also need to be developed for the aggregate tolerable contaminant load in groundwater and total plume size, both based on the presence of multiple contaminants. Development of criteria to assess some of these effects may require a S&T effort. However, by virtue of the research time required, these may necessitate planning for a inclusion in the assessment at a later time.

- **Required Results.** A primary result is the actual or projected dose level, and its expected consequence, from Hanford-derived contaminants for each receptor and each dominant contaminant as it varies in spatial distribution throughout the time period of interest. A "receptor" in this assessment may be a human or a human population group, a cultural lifestyle, biota or ecological system, or a regional business economy. Estimates must be made for individual dominant contaminants, as well as multiple contaminants that, when assessed in combinations occurring at the same time, result in elevated toxicity levels. Analysts might expect to find suspiciously high levels of some contaminants for which biological effects are not well established. Any such findings must be retained and reported. Concern about specific impacts has been expressed by stakeholders and must be evaluated to determine the potential for their existence and their severity.

- **Assessment Control.** The aggregate of the requirements makes it indispensable to focus relentless attention on the control of the conduct of the assessment. Sensibly applying and maintaining the delicate balance among the principles of dominance, management of uncertainty, and fidelity require thoughtful conceptualization and planning of the assessment, as well as continual reassessment and rebalancing of the on-going effort.

- **Assessment Frequency.** As discussed in the Mission Statement and Project Approach sections above, this project will provide a technically defensible and publicly credible, integrated basis for Hanford cleanup decisions related to cleanup operations, the present site baseline, and changes thereto. Accordingly, the Integration Project will develop and maintain a SAC for use in evaluating the effectiveness of planned and actual site end states, proposed changes, and alternative technologies. It will be important to improve previous assessments by iterating the estimating process as (1) analysis methods mature; (2) field data become more complete; or (3) new environmental/demographic information suggests new scenarios (or new paths) to decrease previous uncertainties.

- **Required Continuation of Columbia River Monitoring.** Much of the basis for detecting trends in changes to the river, which are very important to realistic assessment results, comes from monitoring current groundwater and river conditions. The monitoring program must be continued and periodically refocused to the findings and needs of this assessment.

APPENDIX D

TECHNICAL ELEMENT DESCRIPTIONS

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TECHNICAL ELEMENT DESCRIPTIONS

The Integration Project divides its work into areas of work scope that are divided along technical boundaries. Those technical areas are referred to as technical elements of the project. The relationships within and between elements are coordinated through the system assessment.

D.1 SYSTEM ASSESSMENT

The system assessment technical element quantifies the cumulative environmental consequences of past, present, and future Hanford Site activities on the vadose zone, groundwater, and the Columbia River. Assessment capabilities evaluate the affects of residual contamination from past activities, as well as potential future contamination. The scope of the system assessment technical element is to design, develop, and apply methods that meet the objectives of the Integration Project. This technical element also provides a vehicle to integrate activities and information generated by the other technical elements, so that coherent and consistent information is available for making major cleanup decisions. The iterative aspect of (1) defining requirements and objectives; (2) obtaining required information and data; (3) interpreting and using the new information; and (4) evaluating the new information in terms of the original requirements is part of this technical element.

The system assessment technical element coordinates and integrates the scope and results of assessments made for specific projects. This allows the project to develop assessments at a higher resolution than that needed for overall system assessment. This integration ensures that the system analysis is reasonably complete and adequate, and that it is internally consistent.

The system assessment scope is oriented toward site-wide and broader scales that consider the significant components of the natural system and waste management issues when evaluating environmental and human health consequences. As a result, system assessments tend to be directed at the longer-term consequences of contaminants in the environment. However, because of the need to evaluate mitigation and remediation alternatives, and impacts from past discharges to the environment, system assessment capabilities must also include near-term durations.

To ensure the coordination and overall consistency of analyses contributing to the system assessment, the system assessment technical element establishes common requirements for shared databases and consensus interpretations of the environmental setting. This technical element is responsible for data-sharing structures. The data-sharing structure recognizes the multiple temporal and spatial scales of observations and required assessments, and ensures that consistent methods are employed for scales ranging from an individual pore or mineral-grain surface to the regional aquifer and the Columbia River.

Once system requirements and standards are agreed upon, they are imposed for all technical elements and scales of analysis. This process ensures completeness and consistency for analyses conducted for other technical elements (e.g., the vadose zone and the groundwater technical elements). In turn, this ensures the applicability of results on a system-assessment scale.

The system assessment technical element is responsible for reconciling technical differences at interfaces between technical elements. For example, the vadose zone technical element provides estimates of past and future releases of contaminants from the vadose zone to the uppermost aquifer. Similarly, the groundwater technical element provides estimates of current and future contaminants within the uppermost aquifer. If the estimate of past releases of vadose zone contaminants to the aquifer fails to agree with the estimate of contaminants in the aquifer, then the system assessment technical element, which uses results of both the vadose zone technical element and the groundwater technical element, must resolve the difference.

D.2 INVENTORY

Inventory is the total quantity of radiological and chemical constituents used and created at the Hanford Site, and their distribution in facilities, waste disposal sites, the vadose zone, groundwater, and Columbia River ecosystem. Development of an integrated, holistic inventory for the Hanford Site and understanding release mechanisms and rates is the prime technical responsibility of the inventory technical element. Other technical elements will provide information to aid the development. Information needs associated with inventory include (1) locations, amounts, and concentrations; (2) characteristics of the radionuclide or chemical compound; (3) mobilization and release mechanisms and rates; and (4) the change in inventory because of natural processes (e.g., decay), remediation activities, and Hanford Site operations.

In addition to inventory estimates, mechanisms must be identified that result in release of the inventory from facilities into the vadose zone, unconfined aquifer, or the Columbia River. Because the long-term configuration of the waste inventory depends on future remediation and land-use decisions, a baseline estimate of end-state inventory distributions must be defined.

To date, inventory estimates for radionuclides and hazardous chemicals have been developed within specific projects. These estimates tend to be conservatively high. No comprehensive analysis has been performed that compares and reconciles the estimates for each facility with estimates of the total Hanford Site inventory. A comprehensive integrated analysis will help ensure that estimates for key contaminants are sufficiently accurate, and credible, to support a site-wide assessment of environmental impacts and risks.

D.3 VADOSE ZONE

The purpose of the vadose zone technical element is to develop technical understanding, models, and supporting databases that sufficiently describe moisture flow and contaminant transport through the Hanford Site vadose zone. The scope of this technical element encompasses the unsaturated zone beneath the Hanford Site. The geographic focus is on areas that (1) underly liquid waste disposal sites; (2) have the potential for leaks or leaching; and (3) have experienced past leaks and spills. Also included are selected areas away from the focus areas, such as areas representative of background conditions, and areas that have the potential to become contaminated in the future. Numerical modeling may be made to support the characterization by simulating flow and contaminant transport processes believed to occur within the vadose zone. Specific topics include (1) subsurface contamination (i.e., characteristics of past disposal and leakage); (2) surface hydrologic features and processes (e.g., winter rain and snowmelt, water line leaks, infiltration, deep drainage, and evaporation rates); and (3) subsurface geologic and hydraulic features and processes (e.g., stratigraphy, structures, physical properties, geochemistry, and microbiology of the sediments above the water table). Information is needed to better understand the vertical and/or horizontal movement of contaminants to the water table.

Sufficient information will be collected to provide (1) a depiction, at appropriate temporal and spatial scales, of contaminant distributions beneath waste, spill, and disposal sites; (2) early warning of potential surface or groundwater contamination problems so that corrective actions can be taken; and (3) credible numerical simulations that acceptably depict the movement and fate of contaminants in the vadose zone.

D.4 GROUNDWATER

This technical element provides the information, analytic capabilities, and understanding required for technically-sound assessments of Hanford Site impacts to groundwater resources and the Columbia River. The technical scope of the groundwater technical element complements that of the vadose zone element by extending the characterization work into the saturated sediments under the Hanford Site. The saturated zone includes the capillary fringe, the unconfined aquifer, aquitards, and uppermost confined aquifers. Major topics include (1) the distribution of contamination within the saturated sediments; (2) the hydrology, geology, geochemistry, and microbiology of the saturated zone; (3) groundwater flow and transport of contamination; and (4) numerical models that depict the movement of water and contaminants. Data management, presentation, evaluation, interpretation, and reporting are essential components of the technical element.

Numerical models that represent groundwater movement beneath the Hanford Site require boundaries that may be far removed from the areas of greatest interest, which are the pathways between the contaminant source and the Columbia River. Finer-scale modeling is required to describe and predict flow for specific contaminant plumes, and for interaction by groundwater discharges to the Columbia River.

Information needs include an accurate understanding of current conditions, and the ability to assess potential future conditions for near- and long-term scenarios. Assessment of groundwater impacts must permit differentiating contamination attributable to the Hanford Site from other sources, such as fallout from nuclear weapons testing and other human activities.

D.5 COLUMBIA RIVER

The Columbia River technical element scope includes the capability to provide information necessary to accurately and credibly assess risk and impacts posed by Hanford Site contaminants to aquatic, terrestrial, and human receptors in the river environment. Key information needs include identifying (1) locations where contaminants enter a pathway to receptors; (2) various habitats in the river environment; (3) contaminant-sensitive receptors; and (4) exposure pathways to habitats and receptors.

Technical scope associated with the Columbia River ecosystem extends from reference locations upstream of the Hanford Site to downstream locations appropriate for specific aspects of the system assessment. Environments of interest include the riparian zone, near-river groundwater, the hyporheic zone, and the Columbia River water column. Within each environment, a wide variety of information is needed to define physical, chemical, and biological characteristics.

The scope of this technical element starts with direct discharges and with the zone in which groundwater from the Hanford Site meets the Columbia River. Key topics in this zone include mixing, geochemical conditions, preferential pathways, and biological activity. Credible conceptual and numerical models for processes occurring in this zone are crucial to (1) identifying impacts to the river's ecosystem; and (2) quantifying risks to aquatic and human receptors. This zone encompasses near-river groundwater and infiltrated river water (bank storage), and the hyporheos (sediment pore water and biota immediately beneath the free-flowing stream).

Once in the Columbia River, Hanford Site groundwater and any entrained contamination co-mingle with river water and disperse to a wide array of potential receptors. The scope of this technical element relates to information needs associated with the fate and transport of contamination within this river environment. These include the contaminant characteristics (type, nature, concentration, decay/attenuation qualities), physical movement in the dynamic flow of the river, and bioavailability. Interaction with the suspended load of the river, and with biological systems, is key to anticipating the fate of contaminants. Erosion and deposition patterns for the river are major topics for understanding where potential contaminant sinks are located, and where sensitive species and humans are at greatest potential threat of exposure. Understanding how the channel morphology and its distribution of sediments evolve (with time) is key to anticipating future conditions.

An understanding of contaminant bioavailability is crucial for assessing potential impacts and risk. Contaminant-transfer coefficients and bioaccumulation rates are also needed for contaminant/species combinations of interest. The capability to differentiate Hanford-derived contamination from other sources is a part of this effort, as is analysis of the potential cultural consequences that may result from impacts to the natural resources of the river environment. The assessment of risk considers near-term conditions, as well as conditions extending far into the future.

D.6 RISK

The purpose of the risk technical element is to assess the cumulative health and environmental effects of Hanford Site contaminants on the ecology, human health, culture and economy of the affected area. The risk technical element receives information from the other technical elements to address questions relating to the potential risks and impacts. Consequently, the questions that must be addressed in the system assessment are identified by the risk technical element.

The Integration Project has agreed to conduct the study using the Columbia River Comprehensive Impact Assessment (CRCIA) Part II requirements as a template (DOE/RL 96-16). The scope of the assessment based on the requirements is broader than what is traditionally performed. In order to address the breadth of concerns, dependency webs have been proposed as a communication tool for addressing the breadth of the assessment.

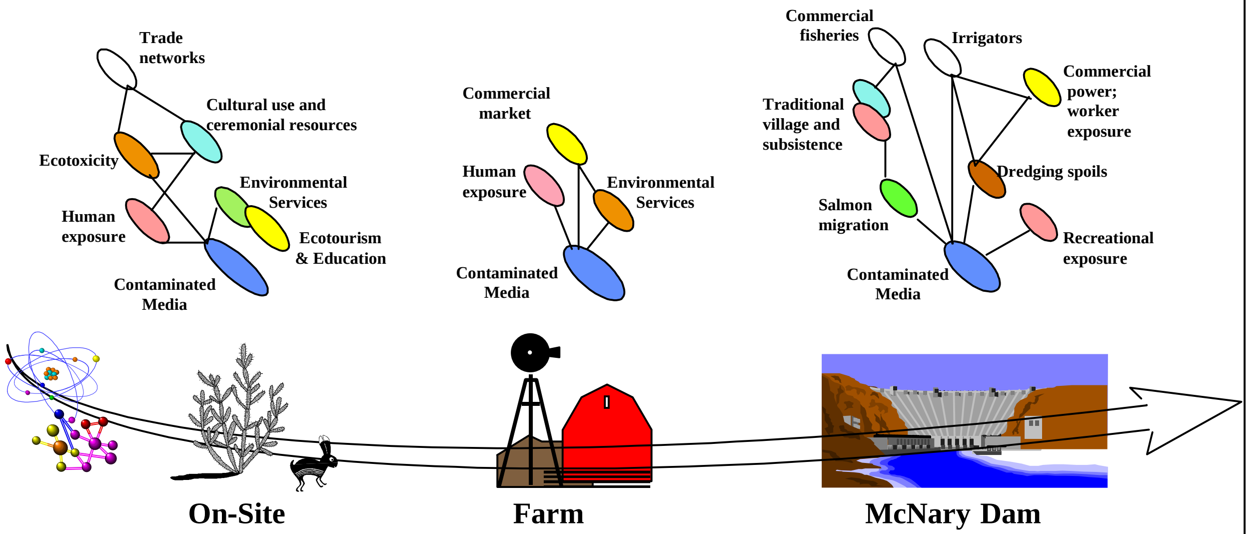
Dependency webs are relational descriptions or influence diagrams composed of the resources (air, water, geologic material, and living things) described above and their *uses, functions, goods,* and *services* at selected locations where contamination and impacts are likely to occur. The dependency webs are intended to describe what is potentially "at risk" along the contaminant migration path, and what is at stake if those locations become contaminated. The dependency webs will include conventional human and ecological food chains, as well as other human and environmental functions and services co-located with the affected site or resource. Some of those uses, goods, or services could provide a pathway to human exposure, while others lead to ecotoxicity, adverse cultural impacts, and so on. These elements are then organized into a web based on a particular location. The dependency webs, utilizing a wide range of input, identify the potential impacts associated with contamination reaching receptors at these locations.

An example of how stakeholder concerns change for different habitats and locations is captured in the dependency webs that are illustrated in Figure D-1. On the Hanford Site itself, concerns focus on ecological toxicity and cultural and educational uses of natural resources. Once offsite, concerns shift to include effects on salmon migration, agriculture, power generation, and transportation. Based on differences in habitat and river dynamics, four locations have been chosen for development of dependency webs. These include:

- Hanford Site upland area
- Hanford Reach of the Columbia River (including the adjacent riparian zone)
- Reservoirs of the Columbia River behind McNary, John Dam, The Dalles, and Bonneville Dams
- Lower Columbia River and coastal areas.

Figure D-1. Dependency Webs for Different Locations.

As contamination moves through different areas, different resources are affected, different impacts occur, and different people will be concerned. In order to answer the questions people are asking, accuracy is more important than complexity, and innovative methods need to supplement conventional modeling tools.



Once the potential impacts to receptors have been defined, exposures, risks, and impacts can be estimated either qualitatively or quantitatively to humans, the environment, specific cultures and quality of life, and selected economies from radioactive and chemical contaminants at those locations. These impacts may be assessed for current contaminant distributions, as defined by monitoring data and information on historical operations, and for potential future conditions.

Human health risk involves generally accepted exposure pathways and scenarios originally developed and documented by the EPA. Recently, there has been increased interest (e.g., CRCIA and the *Hanford Remedial Action Environmental Impact Statement* [HRA-EIS]) in the assessment of “lifestyle” scenarios that may involve non-standard uses of resources and exposure patterns associated with specific groups, such as Native Americans (and others) whose lifestyles are closely tied to the Columbia River.

Ecological risk assessment is not as easily outlined as human health risk assessment, because of the larger number of potential receptors and pathways, which often result in the need for a very location specific analysis. Of particular interest for assessing ecological risk are locations where sensitive habitats have been contaminated, and where the potential uptake of contaminants is most likely. A critical location is one where receptors are likely to be exposed to contaminants, including through the food chain. The pathways or mechanisms by which receptors of interest are potentially exposed to contaminants are characterized as an integral part of a risk assessment.

The process of estimating risks to cultures and economies uses the same contaminant location, duration, and concentration information used in the human and ecological risk assessment. Several models are being developed to address cultural impacts for tribal cultures and communities. These methods are sufficiently well developed, with published proof-of-principle reports, that they can be used by the Integration Project. It is essential, however, that Tribal Nation technical staff be involved in the evaluation of risks to tribes, their cultures, their economies, and the determination of potentially disproportionate impacts to tribal communities. A standard economic impact analysis will be appropriate for non-tribal economies.

The last step in the risk and impact analyses is to assess cumulative risks and impacts for specific locations and populations. These risks or impacts will be placed into perspective with the other, non-Hanford impacts to the environment.

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