4.0 Environmental Surveillance Information

Environmental surveillance of the Hanford Site and the surrounding region is conducted to demonstrate compliance with environmental regulations, confirm adherence to DOE environmental protection policies, support DOE environmental management decisions, and provide information to the public. Surveillance is conducted as an independent program under DOE Orders 5400.1, "General Environmental Protection Program," and 5400.5, "Radiation Protection of the Public and Environment," and the guidance in DOE/EH-0173T, *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance* (DOE 1991). The environmental surveillance program consists of the Surface Environmental Surveillance Project and the Ground-Water Surveillance Project at Hanford. The objectives, criteria, design, and description of the program are summarized below and provided in detail in the *Environmental Monitoring Plan* (DOE 1994a, Rev. 1).

Sections 4.1 through 4.8 of this report describe results of the Hanford Site surface environmental surveillance programs for 1995 and include, where applicable, information on both radiological and nonradiological constituents. Radiological doses associated with the surveillance results are discussed in Section 5.0, "Potential Radiation Doses from 1995 Hanford Operations," and the quality assurance and quality control programs developed for ensuring the value of surveillance data are described in Section 7.0, "Quality Assurance." The ground-water surveillance activities discussed in the following sections were conducted by Pacific Northwest National Laboratory independent of ground-water programs managed and conducted by other contractors on the Site.

Many samples are collected and analyzed for the Hanford Site monitoring and surveillance programs, and data obtained from the analytical laboratories are compiled in large databases. It is not practical or desirable to list individual results in this report; therefore, only summary information emphasizing those radionuclides or chemicals of Hanford origin that are important to environmental or human health concerns are included. Supplemental data for some sections can be found in Appendix A.

More detailed results for specific surface environmental surveillance sampling locations are contained in a companion volume, *1995 Surface Environmental Surveillance Data* (Bisping 1996). Additional information on Hanford Site ground-water monitoring can be found in the annual Hanford Site ground-water monitoring report (Dresel et al. 1996). The intent of the summaries (Sections 4.1 through 4.8) is to provide current surveillance data, compare 1995 data to past data and existing and accepted standards so that concentrations can be viewed in perspective, and to present a general overview of Hanford Site surveillance activities.

Surface Environmental Surveillance

The Surface Environmental Surveillance Project is a multi-media environmental monitoring program conducted to measure the concentration of radionuclides and chemical contaminants in the environment and assess the integrated effects of these contaminants on the environment and the public. The monitoring program includes sampling air, surface water, sediments, soil, natural vegetation, agricultural products, fish, and wildlife. Analytical capabilities include the measurement of radionuclides at very low environmental concentrations as well as an extensive list of nonradiological chemicals including metals, anions, thioureas, volatile organic compounds, semivolatile organic compounds, pesticides, and polychlorinated biphenyls. In addition, the program includes the capability to measure ambient external radiation levels in the environment.

Activities inherent in the operation of the Surface Environmental Surveillance Project include environmental surveillance program design and implementation, sample collection, sample analysis, database management, data review and evaluation, exposure assessment, and reporting. Other elements of the project include project management, quality assurance/control, training, and records management.

Results of the sampling program are used to assess the fate, transport, and exposure of radionuclides and hazardous chemicals (non-radiological chemicals) to the public and determine compliance with applicable environmental quality standards, as well as assess the impacts of these contaminants on the environment. This includes the use of environmental data and mathematical models for the calculation of potential radiation doses to humans and aquatic biota, and the carcinogenic and non-carcinogenic risks to humans. Environmental surveillance data are also useful in dose reconstruction efforts, site characterizations performed in conjunction with ongoing Site environmental restoration activities, and in contaminant transport model verification and validation.

The environmental surveillance program focuses on routine releases from DOE facilities on the Hanford Site; however, the program is also responsive to unplanned releases and releases from non-DOE operations on and near the Site. Surveillance results are provided annually through this report series. In addition, unusual results or trends are reported to DOE and the appropriate facility managers when they occur. Whereas effluent and near-facility environmental monitoring are conducted by the facility operating contractor, environmental surveillance is conducted under an independent program that reports directly to the DOE Environmental Assurance, Permits and Policy Division.

Surveillance Objectives

The general requirements and objectives for environmental surveillance are contained in DOE Orders 5400.1 and 5400.5. The broad objectives (DOE Order 5400.1) are to demonstrate compliance with legal and regulatory requirements, to confirm adherence to DOE environmental protection policies, and to support environmental management decisions.

These requirements are embodied in the surveillance objectives stated in the Orders and DOE/EH-0173T and include the following:

- determine compliance with applicable environmental quality standards and public exposure limits and applicable laws and regulations; the requirements of DOE Orders 5400.1 and 5400.5; and the environmental commitments made in environmental impact statements, environmental assessments, safety analysis reports, or other official DOE documents.

  Additional objectives that derive from the Orders and this primary objective include the following:

  - conduct preoperational assessments
  - assess radiological doses to the public and aquatic biota from Site operations
  - assess doses from other local sources
  - report alarm levels and potential doses exceeding reporting limits (DOE Order 5400.5, Chapter II, Section 7)
  - prepare an annual Site environmental report
  - maintain an environmental monitoring plan

- determine background levels and Site contributions of contaminants in the environment
- determine long-term accumulation of Site-related contaminants in the environment and predict trends; characterize and define trends in the physical, chemical, and biological condition of environmental media
- determine effectiveness of effluent treatment and controls in reducing effluents and emissions
- determine validity and effectiveness of models to predict the concentrations of pollutants in the environment
- detect and quantify unplanned releases
- identify and quantify new or existing environmental quality problems.

DOE/EH-0173T indicates that subsidiary objectives for surveillance should be considered. Subsidiary objectives applicable to the Site include the following:

- obtain data and maintain the capability to assess the consequence of accidents
- provide public assurance; address issues of concern to the public, stakeholders, regulators, and the business community.

- enhance public understanding of Site environmental impacts, primarily through public involvement and by providing public information

- provide environmental data and assessments to assist the DOE Richland Operations Office in environmental management of the site.

Surveillance Design

The Orders require that the content of surveillance programs be determined on a site-specific basis by the DOE Richland Operations Office. The surveillance programs must reflect facility characteristics; applicable regulations; hazardous potential; quantities and concentrations of materials released; extent and use of affected air, land, and water; and specific local public interest and concern. Environmental surveillance at Hanford was designed to meet the previously listed objectives while considering the environmental characteristics of the Site and potential and actual releases from Site operations. Surveillance activities focused on determining environmental impacts and compliance with public health and environmental standards or protection guides, rather than on providing detailed radiological and chemical characterization. Experience gained from environmental surveillance activities and studies conducted at the Hanford Site for more than 45 years provided valuable technical background for planning the surveillance design.

The Hanford Site environmental surveillance program historically has focused on radionuclides and nonradiological water quality parameters. In recent years, surveillance for nonradiological constituents, including hazardous chemicals, has been expanded significantly. A detailed chemical pathway and exposure analysis for the Hanford Site was completed in 1994 (Blanton et al. 1995a). The analysis helped guide the selection of chemical surveillance media, sampling locations, and chemical constituents.

Each year, a radiological pathway analysis and exposure assessment is performed. The 1995 pathway analysis was based on 1995 source-term data and on the comprehensive pathway and dose assessment methodology included in the Generation II (GENII) computer code (Napier et al. 1988a, 1988b, 1988c) used for estimating radiation doses to the public from Hanford operations. The CRITR computer code (Baker and Soldat 1992) was used to calculate doses to animals, and hand calculations were used to compute the doses not addressed in the computer codes. The results of the pathway analysis and exposure assessment serve as a basis for future years' surveillance program design.

Exposure is defined as the interaction of an organism with a physical or chemical agent of interest. Thus, exposure can be quantified as the amount of chemical or physical agent available for absorption at the organism's exchange boundaries (i.e., dermal contact, lungs, gut, etc.). An exposure pathway is identified based on 1) examination of the types, location, and sources (contaminated soil, raw effluent, etc.) of contaminants; 2) the principal release mechanisms; 3) the probable environmental fate and transport (including persistence, partitioning, and intermediate transfer) of contaminants of interest; and, most importantly, 4) the location and activities of the potentially exposed populations. Mechanisms that influence the fate and transport of a chemical through the environment and influence the amount of exposure a person might receive at various receptor locations are listed below.

Once a radionuclide or chemical is released into the environment it may be:

- transported (e.g., migrate downstream in solution or on suspended sediment, travel through the atmosphere, or be carried offsite in contaminated wildlife)

- physically or chemically transformed (e.g., deposition, precipitation, volatilization, photolysis, oxidation, reduction, hydrolysis or radionuclide decay)

- biologically transformed (e.g., biodegradation)

- accumulated in the receiving media (e.g., sorbed strongly in the soil column, stored in organism tissues).

The primary pathways for movement of radioactive materials and chemicals from the Site to the public are the atmosphere and surface water. Figure 4.0.1 illustrates these potential primary routes and the possible exposure pathways to humans.

The significance of each pathway was determined from measurements and calculations that estimated the amount of radioactive material or chemical transported along each pathway and by comparing the concentrations or potential doses to environmental and public health protection standards or guides. Pathways were also evaluated

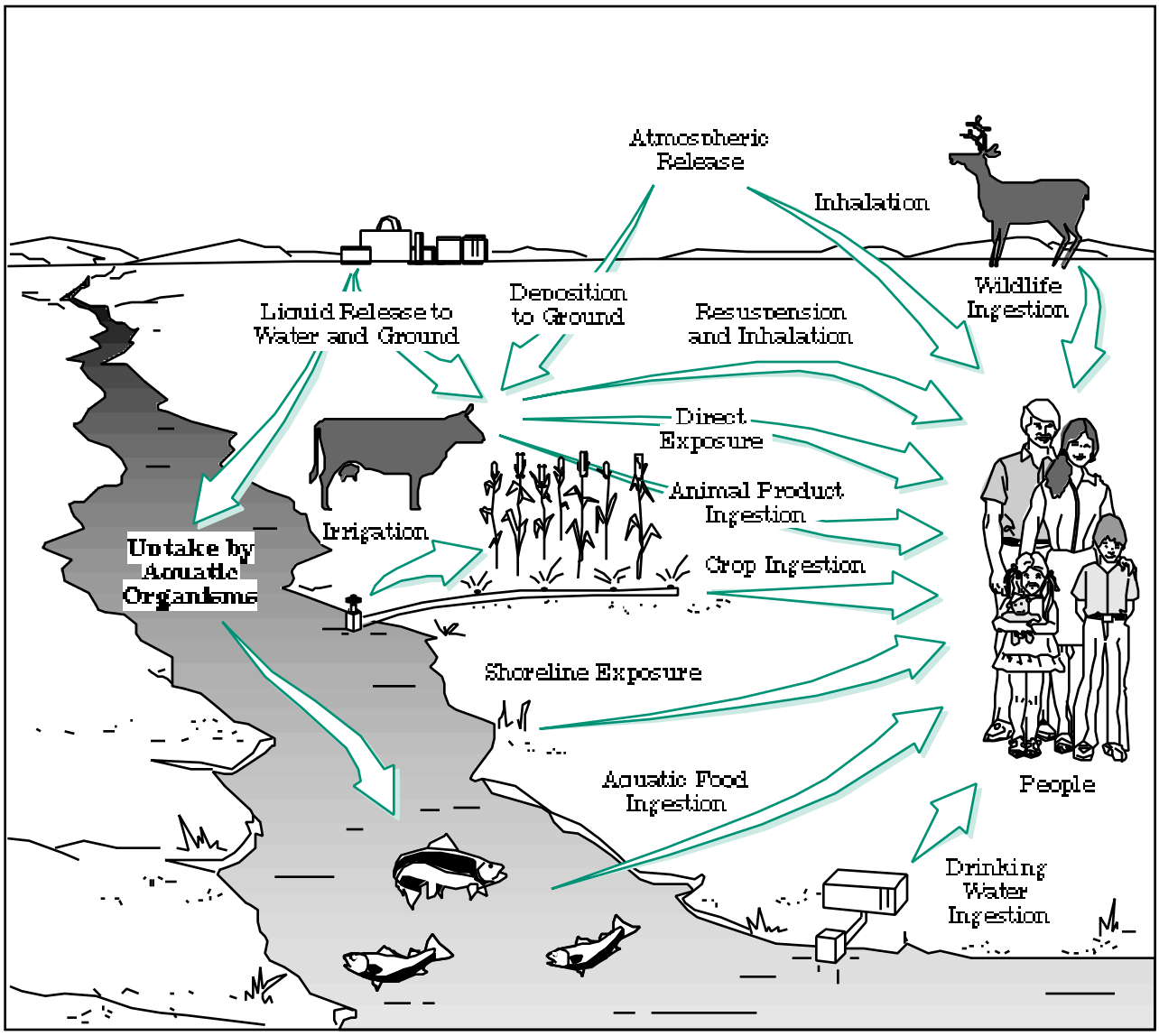

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Figure 4.0.1. Primary Exposure Pathways

based on prior studies and observations of radionuclide and chemical movement through the environment and food chains. Calculations based on effluent data showed the expected concentrations off the Hanford Site to be low for all Hanford-produced radionuclides and chemicals, and frequently below the level that could be detected by monitoring technology. To ensure that radiological and chemical analyses of samples were sufficiently sensitive, minimum detectable concentrations of key radionuclides and chemicals were established at levels well below applicable health standards.

Environmental and food-chain pathways were monitored near facilities releasing effluents and at potential offsite receptor locations. The surveillance design at Hanford used a stratified sampling approach to monitor these pathways. Samples were collected, and radiation and chemical concentrations were measured in three general surveillance zones that extended from onsite operational areas to the offsite environs.

The first surveillance zone extended from near the operational areas to the Site perimeter. The environmental

concentrations of releases from facilities and fugitive sources (those released from other than monitored sources, such as contaminated soils) generally would be the highest and therefore most easily detected in this zone. The second surveillance zone consisted of a series of perimeter sampling stations positioned near or just inside the Site boundary and along State Highway 240, which runs through the Site from Richland to the Vernita Bridge. Exposures at these locations were typically the maximum that any member of the public could receive. The third surveillance zone consisted of nearby and distant community locations within an 80-km (50-mi) radius of the Site. Surveillance was conducted in communities to obtain measurements at locations where a large number of people potentially could be exposed to Hanford releases and to document that contaminant levels were well below standards established to protect public health. Table 4.0.1 summarizes the sample types and measurement locations in all three zones for 1995.

Background concentrations were measured at distant locations and compared with concentrations measured onsite and at perimeter and community locations. Background locations were essentially unaffected by Hanford operations, i.e., these locations could be used to measure ambient environmental levels of chemicals and radionuclides. Comparing background concentrations to concentrations measured on or near the Site indicated the impact of Hanford operations.

To the extent possible, radiation dose assessments should be based on direct measurements of radiation dose rates and radionuclide concentrations in environmental media. However, the amounts of most radioactive materials released from Hanford operations in recent years generally have been too small to be measured directly once dispersed in the offsite environment. For the measurable radionuclides, often it was not possible to distinguish levels resulting from worldwide fallout and natural sources from those associated with Hanford releases. Therefore, offsite doses in 1995 were estimated using the following methods:

- Doses from controlled effluents were estimated by applying environmental transport and dose calculation models to measured effluent monitoring data and selected environmental measurements

- Doses from fugitive air emissions (e.g., from resuspended contaminated soils) were estimated from measured airborne concentrations at Site perimeter locations

- Doses from fugitive liquid releases (e.g., ground water seeping into the Columbia River) were estimated by evaluating differences in measured concentrations upstream and downstream from the Hanford Site.

The surveillance design is reviewed annually based on the above considerations as well as an awareness of planned waste management and environmental restoration activities. The final sampling design and schedule are documented annually in the *Environmental Surveillance Master Sampling Schedule* (Bisping 1996). Results of the 1995 Surface Environmental Surveillance Project activities are presented in Sections 4.1 through 4.7 and Chapters 5.0 and 7.0.

Ground-Water Surveillance

Ground-water surveillance at the Hanford Site was conducted to assess the impacts of radiological and hazardous chemicals from Hanford on ground water, to provide an integrated assessment of quality of Hanford Site ground water, and to evaluate potential offsite impacts from the ground-water pathway. Additionally, near-field groundwater monitoring was conducted by Westinghouse Hanford Company to ensure that operations in and around specific waste-disposal facilities were in compliance with DOE Orders (Johnson 1993) and with 40 CFR 265 and WAC 173-303 and -304 (DOE 1996). The results from both the surveillance and compliance ground-water monitoring programs, along with data from Comprehensive Environmental Response, Compensation, and Liability Act investigations, were useful in determining the total impact of Hanford Site operations on ground water.

Surveillance Objectives

Ground-water surveillance objectives included verifying compliance with applicable environmental laws and regulations; verifying compliance with environmental commitments made in environmental impact statements, environmental assessments, safety analysis reports, or other official DOE documents; characterizing and defining trends in the physical, chemical, and biological condition of environmental media; establishing environmental quality baselines; providing a continuing assessment of pollution abatement programs; and identifying and quantifying new or existing environmental quality problems.

Table 4.0.1. Environmental Surveillance Sample Types and Measurement Locations, 1995

		Sample Locations						
						Columbia River		
	Total Number	Onsite[a]	Site Perimeter[b]	Nearby Locations[c]	Distant Locations[c]	Upstream[c]	Hanford Reach[b]	Downstream[c]
Air	40	20	9	8[d]	3[e]			
Ground water[f]	499	499[g]						
Springs water	7						7	
Springs sediment	4						4	
Columbia River	7					2	4	1
Irrigation water	1		1					
Drinking water	12	7	5					
Columbia River sediments	6					1	3	2
Ponds	3	3						
Foodstuffs	11		7	1	3			
Wildlife	15	5	1		4	2	3	
Soil	0							
Vegetation	0							
TLDs[h]	69	25	33[i]	8[d]	3[e]			
Shoreline surveys	16		16					

(a) Surveillance Zone 1.
(b) Surveillance Zone 2.
(c) Surveillance Zone 3.
(d) Includes seven community-operated environmental surveillance stations.
(e) Includes one community-operated environmental surveillance station.
(f) Approximately 800 wells were sampled for all ground-water monitoring programs onsite.
(g) Some onsite wells along the Columbia River are referred to as perimeter locations in the text.
(h) TLDs = thermoluminescent dosimeters.
(i) Includes locations along the Columbia River.

Surveillance Criteria

The Ground-Water Surveillance Project was designed to monitor the effects of DOE activities on ground water beneath the Hanford Site in order to meet the ground-water monitoring program objectives stated in DOE Order 5400.1 and the specific project objectives stated above. The Ground-Water Surveillance Project, and predecessor projects, have monitored ground water at Hanford for more than 45 years. Hydrogeologic characterization and ground-water modeling were used to assess the monitoring network and to evaluate potential impacts of Hanford Site ground-water contamination on water users.

Surveillance Design

Specific chemicals and radionuclides in each monitoring well were selected for analysis based on past waste disposal activities (Stenner et al. 1988), ongoing waste disposal activities (Diediker and Rokkan 1993), and previous analyses from neighboring wells (Dresel et al. 1995). Selections also involved identifying contaminant sources and determining which chemicals and radionuclides were important to human dose and for understanding contaminant distribution and movement. Sampling locations and frequencies for 1995 were identified in the *Environmental Surveillance Master Sampling Schedule* (Bisping 1995a).

Ground-water surveillance was conducted using established quality assurance plans (see Section 7.0, "Quality Assurance") and written procedures (PNL 1992). Computerized data management systems are used to schedule sampling activities; generate sample labels and chain-of-custody forms; track sample status; and load, store, report, and evaluate data. The Hanford

Environmental Information System is the central consolidated database for storing and managing the ground-water results.

Ground-water samples were collected from both the unconfined and upper-confined aquifers. The unconfined aquifer was monitored extensively because it contains contaminants from Hanford operations (Dresel et al. 1994) and provides a potential pathway for contaminants to reach points of human exposure (e.g., water supply wells, Columbia River). The upper-confined aquifer was monitored, less extensively than the unconfined aquifer, because it also provides a potential pathway for contaminants to migrate off the Hanford Site. Some sampling was conducted at the request of the Washington State Department of Health.

Contaminant source areas were monitored to characterize and define trends in the condition of the ground water and to identify and quantify existing, emerging, or potential problems in ground water quality. Source areas included regions with active waste disposal facilities or with facilities that had generated or received wastes in the past. These included facilities within the 100, 200, and 300 Areas and the central landfill. Ground-water monitoring in these areas was performed primarily by the Resource Conservation Recovery Act compliance or operational monitoring programs conducted by the operating contractor. Additional sampling was conducted by the Environmental Restoration Contractor-Team as part of the Comprehensive Environmental Response, Compensation, and Liability Act activities on the Hanford Site. When necessary, the Ground-Water Surveillance Project supplemented these monitoring activities to meet the needs of DOE. Separate reports discuss the specific results and evaluations from these monitoring efforts (DOE 1996).

Wells located within known contaminant plumes were monitored to characterize and define trends in the concentrations of the associated radiological or chemical constituents. These wells were also monitored to quantify existing ground water quality problems and to provide a baseline of environmental conditions against which future changes can be assessed. These wells will continue to be monitored as releases of waste to disposal facilities are halted and cleanup of the Site begins. This will provide a continuing assessment of the effect of Hanford's remediation programs on ground water.

Water supplies on and near the Site potentially provide the most direct route for human exposure to contaminants in ground water. In 1995, three water supplies provided Hanford Site ground water for human consumption onsite. One supplied the staff at the Fast Flux Test Facility, one supplied personnel at the Yakima Barricade guard house, and one was located at the Hanford Patrol shooting range (see Section 4.3, "Hanford Site Drinking Water Surveillance"). Water supply wells for the City of Richland are near Hanford's southern boundary. Monitoring wells near these water systems were routinely sampled to ensure that any potential water quality problems would be identified long before regulatory limits were reached.

Wells along the Hanford Site perimeter were monitored to assess the quality of ground water at locations near the Site boundary, where access to the water is restricted by DOE. Wells in a region about 2 km wide (1.2 mi wide) along the boundary of the Site have been identified for monitoring. Data gathered from wells in this region help address a number of the objectives of the program including the identification and quantification of existing, emerging or potential ground water quality problems, and the assessment of the potential for contaminants to migrate off the Hanford Site through the ground-water pathway.

To determine the impact of Hanford operations on the environment, the background conditions, or the quality of water on the Hanford Site unaffected by operations, must be known. Data on the concentration of contaminants of concern in ground water that existed before Hanford operations began are not available; therefore, concentrations of naturally occurring chemical and radiological constituents in ground water sampled from wells located in areas unaffected by Hanford operations, including upgradient locations, provide the best estimate of pre-Hanford ground-water quality.

Samples are collected at various frequencies depending on the historical trends of constituent data, regulatory or compliance requirements, and characterization requirements. Sampling frequencies range from monthly to annually; some constituents are monitored less frequently than annually in some wells.