4.0 Environmental Surveillance Information

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The following sections describe results of the Hanford Site surface environmental surveillance and drinking water surveillance projects for 2001 and include, where applicable, information on both radiological and non-radiological constituents. The objectives, criteria, design, and description of these projects are summarized below and provided in detail in the Hanford Site environmental monitoring plan (DOE/RL-91-50). Radiological doses associated with the surveillance results are discussed in Section 5.0. The quality assurance and quality control programs developed to assure the value of surveillance data are described in Section 9.0.

Many samples are collected and analyzed for the Hanford Site environmental surveillance project, and the resulting data are compiled in a large database. It is not practical nor desirable to list individual results in this report; therefore, only summary information is included, emphasizing those radionuclides or chemicals of Hanford Site origin that are important to the environment or human health and safety. Supplemental data for some sections can be found in Appendix B. More detailed results for specific surface environmental surveillance sampling locations are contained in *Hanford Site Environmental Surveillance Data Report for Calendar Year 2001* (PNNL-13910, APP. 1). The intent of these sections (Sections 4.1 through 4.7) is to provide current surveillance data, to compare 2001 data to past data and existing and accepted standards, and to present a general overview of Hanford Site surveillance activities.

In addition to Hanford Site environmental surveillance, environmental monitoring is conducted at or near facilities on the site. These near-facility monitoring efforts are discussed in Section 3.2.

4.0.1 Surface Environmental Surveillance

The Pacific Northwest National Laboratory's Surface Environmental Surveillance Project is a multimedia environmental monitoring effort to measure the concentration of radionuclides and chemicals in environmental media and assess the potential effects of these materials on the environment and the public. Samples of air, surface water, sediment, soil and natural vegetation, agricultural products, fish, and wildlife are collected routinely or periodically. Analyses include the measurement of radionuclides at very low environmental levels and non-radiological chemicals, including metals and anions. In addition, ambient external radiation is measured.

The project focuses on routine releases from U.S. Department of Energy (DOE) facilities on the Hanford Site; however, the project also responds 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 the DOE Richland Operations Office and the appropriate facility managers when they occur. Whereas effluent and near-facility environmental monitoring are conducted by the facility operating contractor or designated subcontractor, environmental surveillance is conducted under an independent program that reports directly to the DOE Richland Operations Office, Office of Site Services.

4.0.1.1 Surveillance Objectives

The general requirements and objectives for environmental surveillance are contained in DOE Orders 5400.1, "General Environmental Protection Program," and 5400.5, "Radiation Protection of the Public and the Environment." 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 DOE Orders and DOE/EH-0173T, *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance*, and include the following:

- determine compliance with applicable environmental quality standards, public exposure limits, and applicable laws and regulations; the requirements of DOE Orders; and the environmental commitments made in environmental impact statements, environmental assessments, safety analysis reports, or other official DOE documents. Additional objectives include conducting preoperational assessments, assessing radiological doses to the public and environment, assessing doses from other local sources, reporting alarm levels and potential doses exceeding reporting limits (DOE Order 5400.5, Chapter II, Section 7), and maintaining 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 conditions of environmental media
- determine effectiveness of 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 environmental quality problems.

DOE/EH-0173T stipulates 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 business community
- enhance public understanding of site environmental issues, primarily through public involvement and by providing public information
- provide environmental data and assessments to assist the DOE in environmental management of the site.

4.0.1.2 Surveillance Design

The DOE Orders require that the content of surveillance programs be determined on a site-specific basis by the DOE site offices. The surveillance programs must reflect facility characteristics; applicable regulations; hazard potential; quantities and concentrations of materials released; extent and use of affected air, land, and water; and specific local public interests and concerns. Environmental surveillance at the Hanford Site is designed to meet the listed objectives while considering the environmental characteristics of the site and potential and actual releases from site operations. Surveillance activities focus on the effect to the environment 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 and studies conducted at the Hanford Site for more than 50 years provide valuable technical background for planning the surveillance design and managing the site.

The Hanford Site environmental surveillance project historically focused on radionuclides in various media and non-radiological water quality parameters. In recent years, surveillance for non-radiological constituents, including hazardous chemicals, has been expanded. A detailed chemical pathway and exposure analysis for the Hanford Site was completed in 1995 (PNL-10714). 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 2001 pathway analysis was based on 2001 source-term data and on the comprehensive pathway and dose assessment methods included in the Generation II (GENII) computer code (PNL-6584) used to estimate radiation doses to the public from Hanford Site operations. The Biota Dose Calculator, a spreadsheet program, was used to calculate doses to animals. 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., skin contact, lungs, gut). An exposure pathway is identified based on (1) examination

of the types, location, and sources (contaminated soil, raw effluent) of contaminants; (2) principal release mechanisms; (3) probable environmental fate and transport (including persistence, partitioning, and intermediate transfer) of contaminants of interest; and, most important, (4) 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 off the site by 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 routes and exposure pathways to humans.

The significance of each pathway was determined from measurements and calculations that estimated the

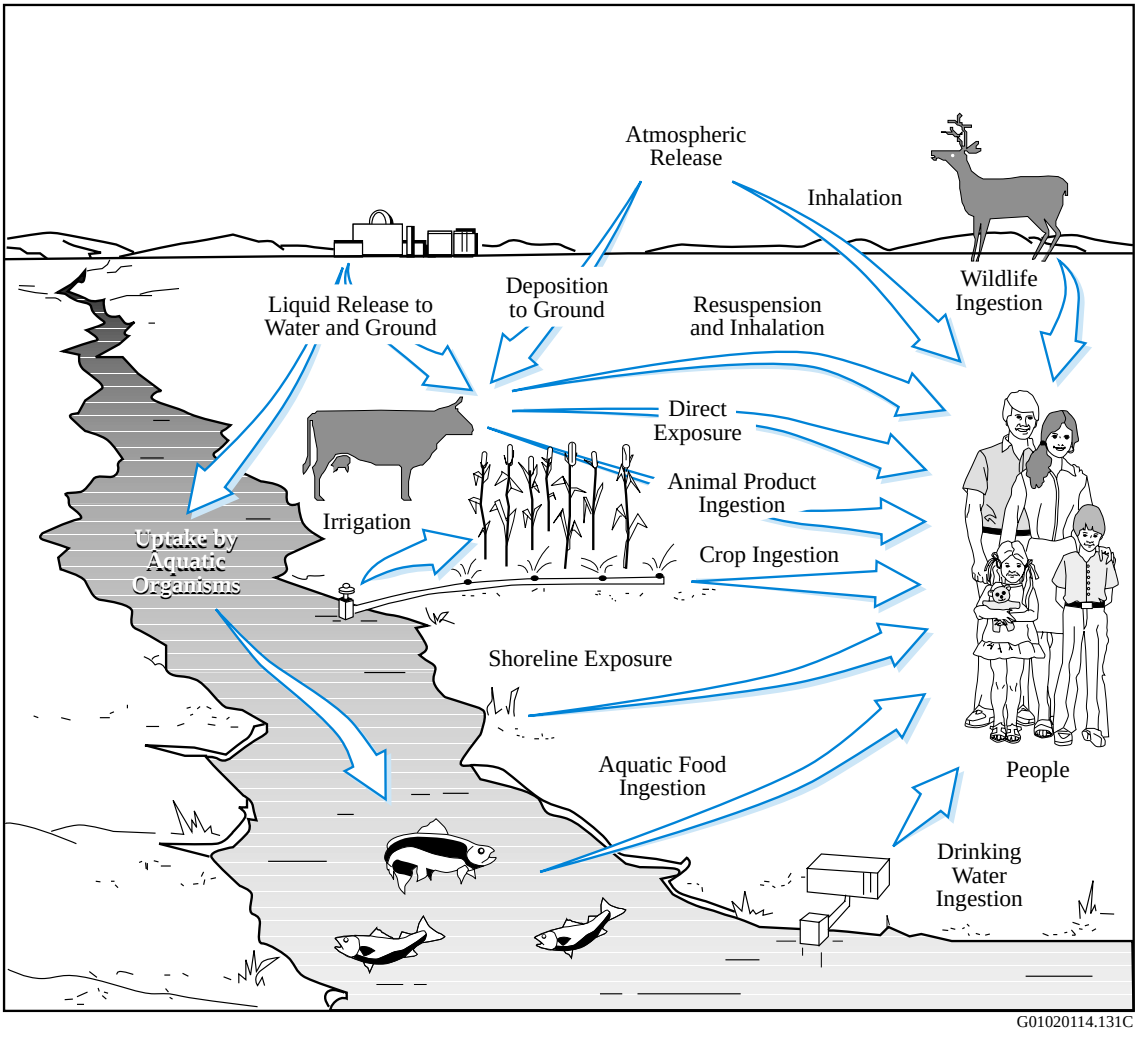

Figure 4.0.1. Primary Exposure Pathways

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 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, for all Hanford-produced radionuclides and chemicals, to be frequently below the levels that could be detected by monitoring technology. To assure 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 radionuclide 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, along State Highway 240, which runs through the site from Richland to the Yakima Barricade, and along the Columbia River (see Figure 1.0.1). The third surveillance zone consisted of locations in communities within an 80-kilometer (50-mile) 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 Site 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 2001. A summary of the number and types of samples collected during 2001, and the number of analytical results obtained from those samples is provided in Table 4.0.2. Except for special studies, soil and vegetation samples are only collected every 3 to 5 years. Soil and vegetation samples were collected in 2001.

Background concentrations were measured at distant locations and compared with concentrations measured on the site and at perimeter and community locations. Background locations were essentially unaffected by Hanford Site operations (i.e., these locations could be used to

Table 4.0.1. Routine Environmental Surveillance Sample Types and Measurement Locations, 2001

		Sample Locations						
						Columbia River		
Type	Total Number	Onsite[a]	Site Perimeter[b]	Nearby[c]	Distant[c]	Upstream[c]	Hanford Reach[b]	Downstream[c]
Air	45	24	11	8[d]	2[d]			
Spring water	8						8	
Spring sediment	5						5	
Columbia River	7					2	4	1
Irrigation water	2		2					
Drinking water	4	4						
River sediment	6					1	3	2
Ponds	2	2						
Foodstuffs	7			5	2			
Wildlife	6	3			1		1	1
External dose	76	29	38	7	2			
External shoreline radiation	14		14					
Exposure rate	4			3	1			
Soil	39	24	8	2	5			
Vegetation	14	8	4		2			

(a) Surveillance Zone 1.
(b) Surveillance Zone 2.
(c) Surveillance Zone 3.
(d) Includes community-operated environmental surveillance stations.

Table 4.0.2. Samples Collected for the Surface Environmental Surveillance Project and Analytical Results Obtained, 2001

Media	Number of Samples Collected	Number of Analytical Results Obtained
Air	1,605	4,161
Biota	428	3,932
Soil and sediment	109	1,281
Surface water	635	6,345
Drinking water	16	64
External radiation	290	290
Totals	3,083	16,073

measure ambient environmental levels of chemicals and radionuclides). Comparing concentrations at these background locations to concentrations measured on or near the site indicated the impact, if any, of Hanford Site operations.

To the extent possible, radiological dose assessments should be based on direct measurements of dose rates and radionuclide activities in environmental media. However, the amounts of most radioactive materials released from Hanford Site 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 Site releases. Therefore, offsite doses in 2001 were estimated using the following methods:

- Doses from monitored air emissions and liquid effluents released to the Columbia River 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 unmonitored, resuspended, contaminated soils) were estimated from measured airborne concentrations at site perimeter locations.
- Doses from fugitive liquid releases (e.g., unmonitored groundwater seeping into the Columbia River) were estimated by evaluating differences in measured concentrations in Columbia River water 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 (e.g., PNNL-13418 for 2001).

4.0.2 Special Studies in 2001

In August and September 2001, the Surface Environmental Surveillance Project and the Washington State Department of Health conducted a contaminant characterization and biological and human dose/risk assessment study of the Columbia River shoreline of the 300 Area. This work was also supported by Washington State Department of Ecology and U.S. Environmental Protection Agency (EPA) staff. Numerous samples of river water, shoreline springs water, river bottom porewater (within the gravels on the river bottom), riparian and aquatic plants, terrestrial biota, and aquatic organisms were collected and analyzed for radiological and chemical contaminants. Samples were collected near three known shoreline springs in the 300 Area and from two reference sites – one upstream near the Vernita Bridge and the other downstream of the study area. The study results and assessment are summarized in a technical report issued in 2002 (PNNL-13692).