5.1 Environmental and Ground-Water Surveillance at Hanford

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Environmental and ground-water surveillance of the Hanford Site and 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 *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance* (DOE 1991). The objectives, criteria, design, and description of the program are summarized below and provided in detail in the *Environmental Monitoring Plan* (DOE 1991c).

Ground-water surveillance is designed to meet the ground-water monitoring program objectives stated in DOE Order 5400.1 and described in DOE (1991). The objectives, rationale and design criteria for monitoring radiological and chemical contaminants in ground water are summarized in this section. Ground-water surveillance at Hanford is an integral part of the Hanford Site Ground-Water Protection Management Program (DOE 1994g) but is conducted independently of the operating contractor's programs. A brief description of the program is included below and provided in detail in the *Hanford Site Ground-Water Protection Management Plan* (DOE 1994g).

Environmental Surveillance

Environmental surveillance encompasses sampling and analyzing for potential radiological and nonradiological chemical (hereinafter referred to as chemical) contaminants on and off the Hanford Site. Emphasis is placed on surveillance of exposure pathways and chemical constituents that present the greatest potential risk to humans and the environment. 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 upon 1) examination of the types, location, and sources (contaminated soil, raw effluent, etc.) of contaminants occurring onsite; 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 that are the determining factor influencing the amount of exposure one 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, or travel through the atmosphere)
- physically or chemically transformed (e.g., deposition, precipitation, volatilization, photolysis, oxidation, reduction, hydrolysis; if radionuclide it may decay)
- biologically transformed (e.g., biodegradation)
- accumulated in the receiving media (e.g., an environmental sink, such as a chemical sorbed strongly in the soil column).

The Environmental surveillance program has always been focused on radionuclides and nonradiological water quality parameters. In the last few years, however, surveillance for hazardous chemicals has been initiated. In 1994, a detailed nonradiological chemical pathway and exposure analysis was completed. This type of analysis helps to ensure that the selection of nonradiological surveillance parameters such as environmental media, sampling location, and chemical constituents are chosen in a manner that is scientifically sound and

cost efficient. The chemical (nonradiological) pathway analysis is based upon source-term data reported in the literature through February 1994, and the use of the Multimedia Environmental Pollutant Assessment System (MEPAS) code, version 3.0 (Droppo et al. 1989, 1991). A report will be published in summer 1995 (Blanton et al, 1995)

Each year a radiological pathway analysis and exposure assessment is also performed. The radionuclide pathway analysis is based on 1994 source-term data and on the comprehensive pathway and dose assessment methodology included in the GENII computer code (Napier et al. 1988a, 1988b, 1988c) used for estimating the radiation doses to the public from Hanford operations. The pathway analysis is also based on the CRITR computer code (Baker and Soldat 1992) used to calculate doses to animals, and on hand calculations for those doses not addressed in the computer codes.

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 Quality, Safety, and Health Programs Division.

Objectives

Key surveillance objectives in 1994 included verifying compliance with DOE and EPA radiological dose standards for public protection, independently assessing the adequacy of facility pollution controls, assessing the environmental and public health impacts of Hanford operations, identifying and quantifying potential environmental quality problems, and providing information to DOE for environmental management of the Site, to the public, and to regulatory agencies.

Criteria

The criteria for environmental surveillance are derived from DOE Order 5400.1, guidance published for DOE sites (DOE 1991a), and the above-stated objectives. These criteria, pathway analyses to determine the radionuclides and media contributing to the dose to humans, and local needs and interests have been used in establishing the surveillance program. Experience gained from environmental surveillance activities and studies conducted at the Hanford Site for more than 45 years have provided valuable technical background for planning and data interpretation.

Surveillance Design

Environmental surveillance at Hanford is designed to meet the previously listed objectives, considering the environmental characteristics of the Site and the potential and actual releases from Site activities. The main focus is on determining environmental impacts and compliance with public health standards, as well as environmental standards or protection guides, rather than on detailed radiological and chemical characterization.

The primary pathways for movement of radioactive materials and chemicals from the Site to the public are the atmosphere, surface water, and ground water. Figure 5.1.1 illustrates these potential primary routes and the possible exposure pathways to humans.

The significance of each pathway is determined from measurements and calculations that estimate the amount of radioactive material or chemical transported along each pathway and by comparing the concentrations or doses to environmental and public health protection standards or guides. Pathways are also evaluated based on prior studies and observations of radionuclide and chemical movement through the environment and food chains. Calculations based on effluent data show the expected concentrations off the Hanford Site to be low for all radionuclides and chemicals and generally below the level that can be detected by monitoring technology. To ensure that radiological and chemical analyses of samples are sufficiently sensitive, minimum detectable concentrations of key radionuclides and chemicals in air, water, and food are

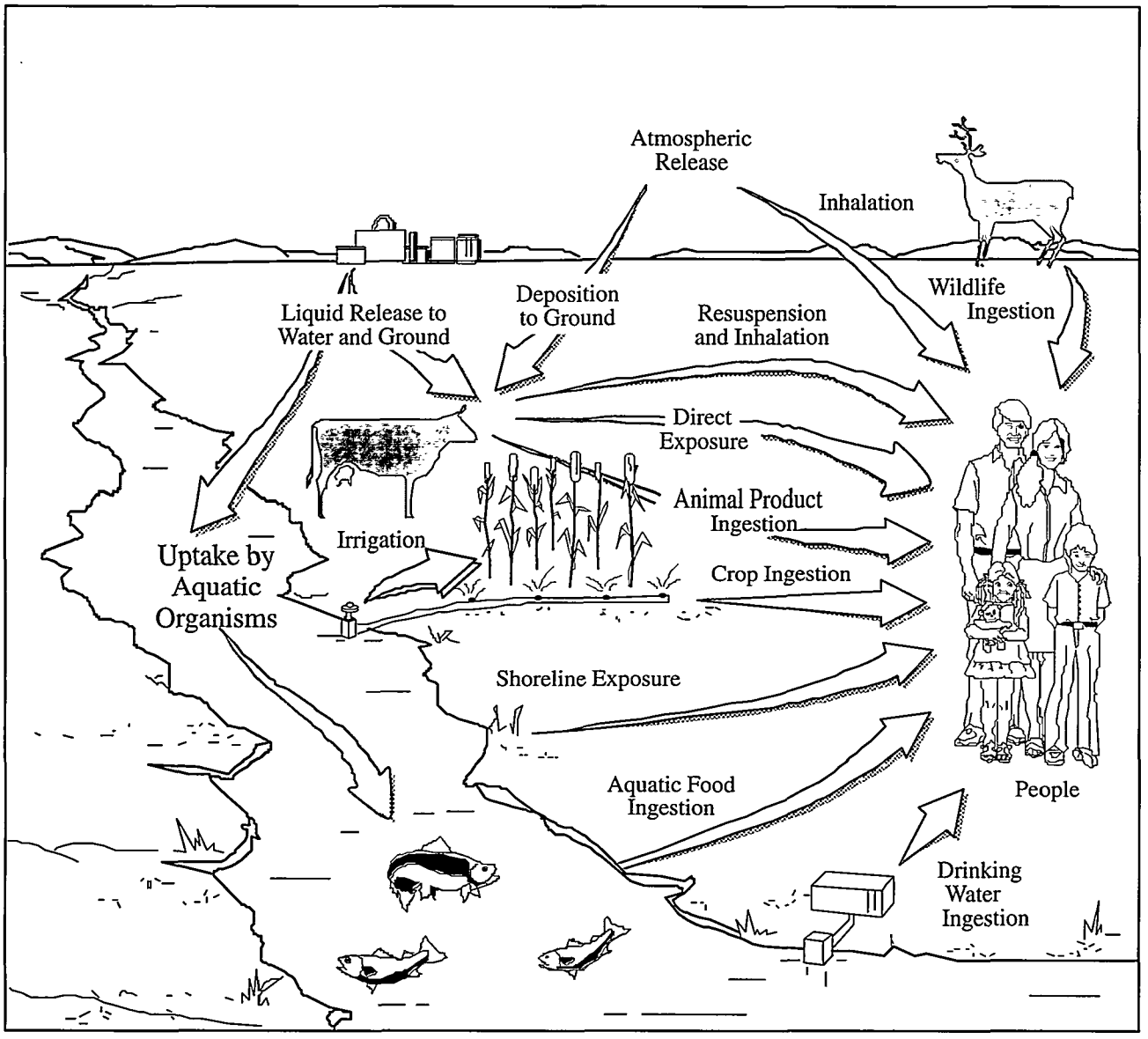

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Figure 5.1.1 Primary Exposure Pathways

established at levels well below the levels that correspond to the applicable health standards.

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

The first zone extends 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) will generally be the highest, and therefore most easily detected, in this zone. The second surveillance zone consists of a series of perimeter sampling stations positioned near or just inside the Site boundary. Exposures at these locations are typically the maximum that any member of the public could receive. The third surveillance zone consists of nearby and distant community locations within an 80-km (50-mi) radius of the Site. Surveillance is conducted in communities to provide measurements at locations where a large number of people may

potentially be exposed to Hanford releases and to provide assurance to the communities that contaminant levels are well below standards established to protect public health.

Background concentrations are measured at distant locations and compared with concentrations measured onsite and at perimeter and community locations. Background locations are locations that are essentially unaffected by Hanford operations, i.e., locations that can be used to measure ambient environmental levels of chemicals and radionuclides. Comparing background concentrations to concentrations measured on or near the Site provides an indication of 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 have generally been too small to be measured directly once dispersed in the offsite environment. For the measurable radionuclides, it is often not possible to distinguish levels resulting from worldwide fallout and natural sources from those associated from Hanford releases. Therefore, offsite doses in 1994 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 (for example, from contaminated soils) were estimated from measured airborne concentrations at Site perimeter locations.
- Doses from fugitive liquid releases (for example, ground water seeping into the Columbia River) were estimated based on differences in measured concentrations upstream and downstream from the Hanford Site.

Program Description

In the first surveillance zone, between the operational areas and the Site perimeter, air monitoring stations were located near operational areas (see Figure 5.2.1) because air transport is a potential key pathway for movement of radioactive materials off the Site. Surface-water ponds, potentially accessible to wildlife, and drinking water sources were also sampled (see Figure 5.3.1). Ground water was sampled from wells located near operating areas and along potential transport pathways (see Figures 5.8.8-5.8.10). In addition to air and water surveillance, samples of soil, native vegetation, and wildlife were collected (see Figures 5.5.1 and 5.6.1). Direct radiation dose rates were also measured (Figures 5.7.1-5.7.3).

In the second or perimeter zone, air monitoring stations, radiation measurement locations, and groundwater surveillance wells were located near or just inside the Site boundary. Agriculture is an important industry near the Site; therefore, milk, crops, soil, and native vegetation are monitored (see Figures 5.4.1 and 5.6.1) to detect any influence from Hanford on locally produced food and farm products. The Columbia River is included in the second zone. River water is monitored upstream from the Site at Priest Rapids Dam and downstream at Richland, Washington, where it is used for public drinking water. Water pumped from the Columbia River for irrigation is also monitored.

Surveillance in the third zone, consisting of nearby and distant communities, includes air, soil, water supplies, vegetation, and food products sampling, and direct radiation dose rate measurements. Table 5.1.2 summarizes the geographic distribution of measurement locations.

Table 5.1.2 Environmental Surveillance Sample Types and Measurement Locations, 1994

		Sample Locations							
							Columbia River		
	Total Number	Onsite[a]	Site Perimeter[b]	Nearby Locations[c]	Distant Locations[c]	COES Stations[c,d]	Upstream[c]	Hanford Reach[b]	Downstream[c]
Air	39	20	10	4	2	3			
Ground water[e]	528	528[f]							
Springs	7							7	
Columbia River	7						2	4	1
Irrigation water	1		1						
Drinking water	13	8[g]	5[h]						
Columbia River sediments	9						1	6	2
Ponds	3	3							
Foodstuffs	11		7	1	3				
Wildlife	14[i]	5			4			5	
Soil	20	15	4		1				
Vegetation	9	4	4		1				
TLDs[j]	69	26	33[k]	5	2	3			
Shoreline surveys	16		16						

(a) Surveillance Zone 1.
(b) Surveillance Zone 2.
(c) Surveillance Zone 3.
(d) COES = community-operated environmental surveillance.
(e) Approximately 806 wells were sampled for all ground-water monitoring programs onsite.
(f) Some onsite wells along the Columbia River are referred to as perimeter locations in the text.
(g) Data are reported by Hanford Environmental Health Foundation (e.g., HEHF 1994).
(h) Includes four offsite water supplies.
(i) Does not include roadkill deer.
(j) TLDs = thermoluminescent dosimeters.
(k) Includes locations along the Columbia River.

Surveillance is conducted using established quality assurance plans (see Section 7.0, "Quality Assurance") and written procedures (PNL 1992a, 1993). Sample scheduling, accountability, data storage, and data screening were managed and controlled by computerized systems. Laboratory analyses of samples for radioactivity and chemicals were conducted principally by International Technology Corporation and PNL, both in Richland, Washington. Selected river water quality and chemistry analyses, and temperature and flow measurements were performed by the U.S. Geological Survey, Denver, Colorado.

Ground-Water Surveillance

Ground-water surveillance at the Hanford Site is conducted to assess radiological and hazardous chemical impacts of Hanford activities on ground water, to provide an integrated assessment of

ground-water quality on the Hanford Site, and to evaluate potential offsite impacts. In addition to the sitewide monitoring activities performed for environmental surveillance, near-field ground-water monitoring evaluates the effects of operations in and around specific waste-disposal facilities for compliance with DOE Orders (Johnson 1993) and compliance with 40 CFR 265 and WAC 173-303 and -304 (DOE 1995a and c). The results from these operational and compliance monitoring programs contribute information useful in determining the total impact of Hanford Site operations on ground water and are used in meeting DOE's environmental surveillance responsibilities.

Objectives

Ground-water surveillance objectives include 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.

Criteria

The Ground-water Surveillance Project is designed to monitor the effects of DOE activities at the Hanford Site on ground water 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, or predecessor projects, have monitored ground water at Hanford for more than 45 years. Hydrogeologic characterization and ground-water modeling are conducted to adequately design the monitoring network and to evaluate potential impacts of Hanford Site ground-water contamination on water users offsite and onsite.

Design

The selection of radionuclides and chemicals for analysis at particular wells is based on waste materials previously disposed of at Hanford (Stenner et al. 1988), ongoing waste disposal activities (Diediker and Rokkan 1993), and chemical contaminants observed in the past in neighboring wells (Dresel et al. 1994). The information contained in these documents is used to identify radionuclide and chemical sources and to develop a monitoring network that includes a study of chemicals and radionuclides important in terms of dose to humans and understanding of contaminant distributions and movement. Monitoring wells to be sampled and their sampling frequency are identified each year in the *Environmental Surveillance Master Sampling Schedule* (Bisping 1994). Ground-water surveillance is conducted using established quality assurance plans (see Section 7.0) and written procedures (PNL 1992). Computerized database 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.

Ground-water samples are collected from wells completed in the unconfined and upper-confined aquifers. The unconfined aquifer is monitored extensively because it has been contaminated from Hanford operations (Dresel et al. 1994) and provides a pathway for contaminants to reach points of human exposure (e.g., water supply wells, Columbia River). The upper-confined aquifer is monitored, although less extensively than the unconfined aquifer, because it also provides a potential pathway for contaminants to migrate off the Hanford Site. Wells are also used for detecting the presence of potential contaminants at the request of DOH.

Contaminant source areas are monitored to characterize and define trends in the chemical condition of the ground water and to identify and quantify existing, emerging or potential ground water quality problems. Source areas include regions with active waste disposal facilities or with facilities that have generated or received waste in the past. These include the 100, 200 and 300 Areas on the Site as well as the central landfill. Ground-water monitoring in these areas is performed primarily by the RCRA compliance or operational monitoring programs conducted by the Site operating contractor. Additional sampling is conducted by the Environmental Restoration Contractor-Team as part of CERCLA activities on the Hanford Site. The

Ground-Water Surveillance Project will supplement these monitoring activities if it is required to meet the needs of the DOE.

Wells located within known contaminant plumes continue to be monitored to characterize and define trends in the concentrations of the associated radiological or chemical constituents. These wells are also monitored to quantify existing ground water quality problems and to provide a baseline of environmental conditions against which future changes can be assessed.

Water supplies on and near the Site potentially provide the most direct route for human exposure to contaminants in ground water. Three water supplies exist onsite. One is for staff and visitors at the FFTF, one is at the Yakima Barricade guard house, and one is at the Hanford Patrol shooting range. Water supply wells for the City of Richland are adjacent to Hanford's southern boundary. Wells near these water systems are monitored to identify any potential water quality problems long before regulatory limits are reached.

Wells are monitored to assess the quality of ground water at the Site perimeter. Wells in a region about 2-km-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 before Hanford operations 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 operations 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.