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.

Sections 4.1 through 4.8 describe results of the Hanford Site surface and groundwater environmental surveillance programs for 1996 and include, where applicable, information on both radiological and nonradiological constituents. The objectives, criteria, design, and description of these programs are summarized below and provided in detail in the environmental monitoring plan (DOE 1994a). Radiological doses associated with the surveillance results are discussed in Section 5.0, "Potential Radiation Doses from 1996 Hanford Operations." The quality assurance and quality control programs developed for ensuring the value of surveillance data are described in Section 7.0, "Quality Assurance."

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 *Hanford Site Environmental Data for Calendar Year 1996* (Bisping 1997). Additional information on Hanford Site groundwater monitoring can be found in the annual Hanford Site groundwater monitoring report (Hartman and Dresel 1997). The intent of the summaries (Sections 4.1 through 4.8) is to provide current surveillance data, to compare 1996 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 multimedia environmental monitoring effort to measure the concentration of radionuclides and chemicals in environmental media and assess the integrated effects of these materials on the environment and the public. The project collects samples of air, surface water, sediments, soil and natural vegetation (approximately every 5 years), agricultural products, fish, and wildlife. Analytical capabilities include the measurement of radionuclides at very low environmental concentrations and nonradiological chemicals, including metals, anions, thioureas, volatile organic compounds, semivolatile organic compounds, pesticides, and polychlorinated biphenyls. In addition, the project includes the capability to measure ambient external radiation.

Activities inherent in the operation of the Surface Environmental Surveillance Project include 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.

The project focuses on routine releases from DOE facilities on the Hanford Site; however, the project 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 Richland Operations Office 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 DOE Orders and DOE (1991) 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 DOE 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)
  - 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 conditions 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 environmental quality problems.

DOE (1991) 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 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 DOE 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; hazard 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 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 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 50 years provide valuable technical background for planning the surveillance design.

The Hanford Site environmental surveillance program historically has focused on radionuclides in various media 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 1996 pathway analysis was based on 1996 source-term data and on the comprehensive pathway and dose assessment methodology included in the Generation II (GENII) computer code (Napier et al. 1988) 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 manual 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) 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 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 routes and 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 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 to be 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 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 Vernita Bridge, and along the Columbia River. 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

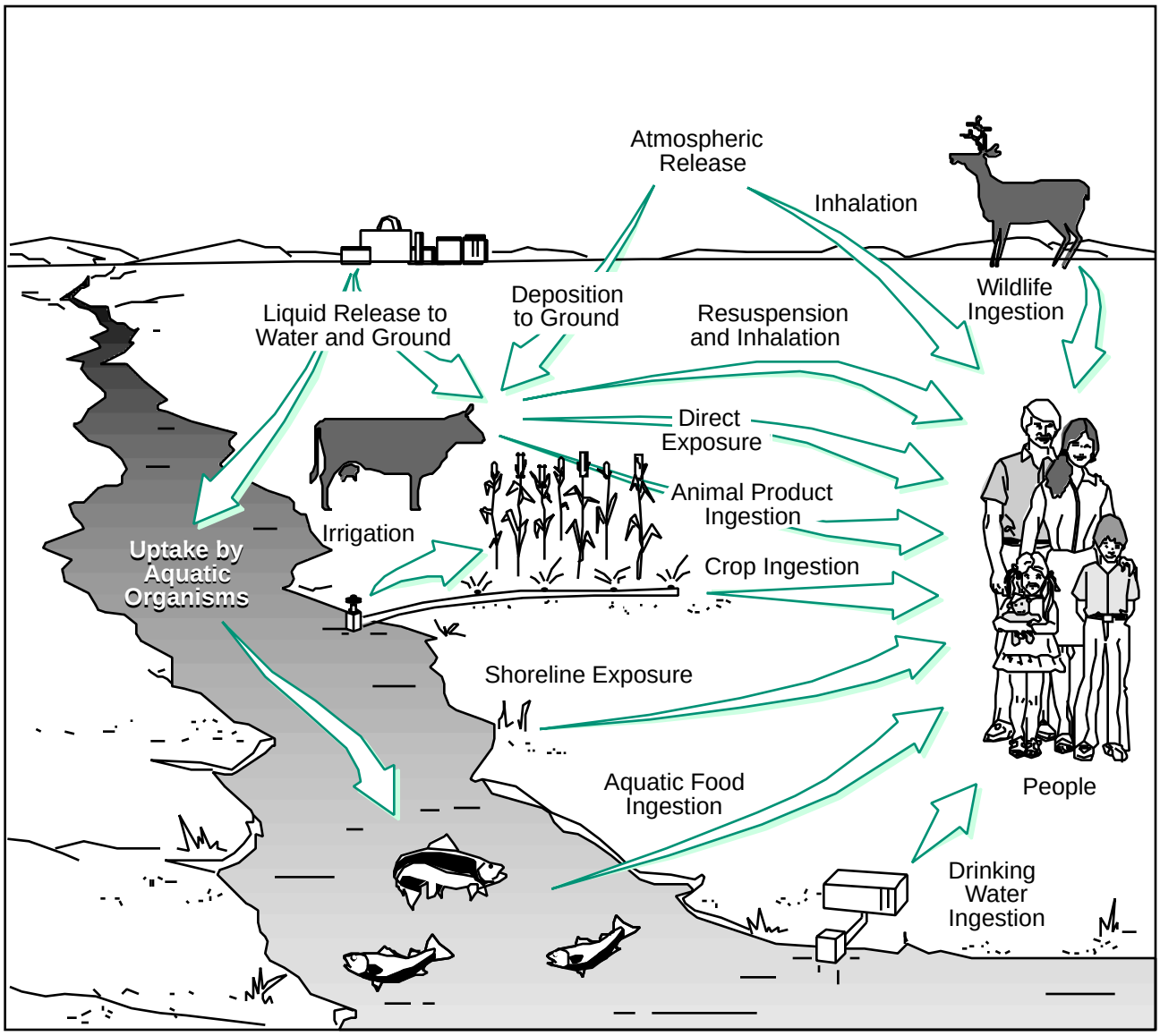

Figure 4.0.1. Primary Exposure Pathways

established to protect public health. Table 4.0.1 summarizes the sample types and measurement locations in all three zones for 1996.

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, radiological dose assessments should be based on direct measurements of 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

Table 4.0.1. Environmental Surveillance Sample Types and Measurement Locations, 1996

		Sample Locations						
						Columbia River		
Type	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]			
Groundwater[f]	499	499[g]						
Springs water	6						6	
Springs sediment	4						4	
Columbia River	7					2	4	1
Irrigation water	1		1					
Drinking water	7	7						
Columbia River sediments	6					1	3	2
Ponds	3	3						
Foodstuffs	4			3	1			
Wildlife	8	3			1	1[h]	3	
Soil	0							
Vegetation	0							
TLDs[i]	66	24	32[j]	8[d]	2[e]			
Shoreline surveys	16		16					

(a) Surveillance zone 1.
(b) Surveillance zone 2.
(c) Surveillance zone 3.
(d) Includes eight community-operated environmental surveillance stations.
(e) Includes one community-operated environmental surveillance station.
(f) Approximately 800 wells were sampled for all groundwater monitoring programs onsite.
(g) Some onsite wells along the Columbia River are referred to as perimeter locations in the text.
(h) Sample furnished by the Washington State Department of Health.
(i) TLDs = thermoluminescent dosimeters.
(j) Includes locations along the Columbia River.

levels resulting from worldwide fallout and natural sources from those associated with Hanford releases. Therefore, offsite doses in 1996 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 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 1996 Surface Environmental Surveillance Project activities are presented in Sections 4.1 through 4.7 and 5.0 and 7.0.

Groundwater Surveillance

During 1996, groundwater surveillance and monitoring activities at Hanford were restructured into the Groundwater Monitoring Project. This project incorporates sitewide groundwater monitoring mandated by DOE Orders and previously performed under the Groundwater Surveillance Project with near-field groundwater monitoring conducted to ensure that operations in and around specific waste disposal facilities are in compliance with applicable regulations. The objectives of integrating these activities were to improve efficiency of monitoring activities and increase the consistency of interpretations of the groundwater flow system and contaminant distributions.

Collection and analysis of groundwater samples to determine the distributions of radiological and chemical constituents were major parts of the groundwater monitoring effort. In addition, hydrogeologic characterization and modeling of the groundwater flow system were used to assess the monitoring network and to evaluate potential impacts of Hanford Site groundwater contamination. Other activities are data management, interpretation, and reporting. Additional details concerning the Groundwater Monitoring Project are available in Hartman and Dresel (1997).

Surveillance Objectives

Groundwater surveillance was conducted to assess the impacts on groundwater of radiological and hazardous chemicals from the Hanford Site, to provide an integrated assessment of the quality of Hanford Site groundwater, and to evaluate potential offsite impacts from the groundwater pathway. Groundwater monitoring was also performed to verify compliance with applicable environmental laws and regulations and to fulfill commitments. Additional objectives were to characterize physical and chemical trends in the groundwater flow system; establish groundwater quality baselines; provide a continuing, independent assessment of groundwater remediation; and identify new or existing groundwater problems.

Sitewide groundwater monitoring activities previously carried out under the Groundwater Surveillance Project were designed to meet the groundwater monitoring program objectives stated in DOE Order 5400.1 and described above. The impacts of Hanford operations on groundwater have been monitored for more than 50 years under this project and it predecessors. Near-field monitoring of groundwater around specific waste facilities was performed to meet the requirements of 40 CFR 265 and WAC 173-303 and 173-304 as well as applicable DOE Orders (e.g., 5400.1, 5400.5). Groundwater monitoring was also performed in conjunction with cleanup investigations under the Comprehensive Environmental Response, Compensation, and Liability Act.

Surveillance Design

Specific chemicals and radionuclides analyzed at each monitoring well were selected based on past waste disposal activities (Stenner et al. 1988, Diediker and Rokkan 1993) and on previous analysis results. Information on the location of potential contaminant sources and groundwater flow directions was also considered. Selections also involved determining those chemicals and radionuclides important in assessing health risk and for understanding contaminant distribution and movement. Sampling locations and frequencies for 1996 were identified in Bisping (1996).

Groundwater surveillance was conducted using established quality assurance plans (see Section 7.0, “Quality Assurance”) and written procedures (Pacific Northwest Laboratory 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 groundwater results.

Groundwater 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, though less extensively than the unconfined aquifer, because it also provides a potential pathway for contaminants to migrate off the Hanford Site. Also, 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 groundwater and to identify and quantify existing, emerging, or potential problems in groundwater quality. Source areas included active waste disposal facilities or facilities that had generated or received wastes in the past. Most of these facilities are located within the 100, 200, and 300 Areas.

However, some sources, such as the Solid Waste Landfill, are located outside the operational areas.

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 groundwater 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 Hanford Site continues. This will provide a continuing assessment of the effect of remediation efforts on groundwater.

Water supplies on and near the Hanford Site potentially provide the most direct route for human exposure to contaminants in groundwater. In 1996, three water supplies provided groundwater for human consumption on the Hanford Site. One well supplied water at the Fast Flux Test Facility, one supplied personnel at the Yakima Barricade guardhouse, and one was located at the Hanford Patrol shooting range (see Section 4.3, "Hanford Site Drinking Water Surveillance"). Water supply wells used by 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 groundwater at locations near the site boundary. Data gathered from wells in a region approximately 2 km (1.2 mi) wide along the boundary helped address objectives of the Groundwater Monitoring Project. These include identifying and quantifying existing, emerging, or potential groundwater quality problems and assessing the potential for contaminants to migrate off the Hanford Site through the groundwater pathway.

To determine the impact of Hanford operations on the environment, 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 groundwater that existed before Hanford operations began are not available. Therefore, concentrations of naturally occurring chemical and radiological constituents in groundwater sampled from wells located in areas unaffected by Hanford operations, including upgradient locations, provide the best estimate of pre-Hanford groundwater 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.