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Page 1 of 1

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7. Abstract

This safety assessment is prepared to document the analysis of hazards leading to the conclusion that the activity does not present an unacceptable hazard to the facility worker, the onsite person 100 meters from the activity and the nearest resident. The activities described include well drilling, borehole drilling, and backhoe (or similar equipment) excavation of small contaminant inventory waste sites in the 100 Areas.

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1.0 INTRODUCTION AND SUMMARY

The U.S. Environmental Protection Agency (EPA) took action on October 4, 1989 to include the 100 Areas at the U.S. Department of Energy (DOE) Hanford Site on the National Priority List. The Westinghouse Hanford Company (Westinghouse Hanford) is preparing to perform characterization activities in the 100 Areas and nearby 600 Area locations for the DOE with agreement of the EPA and the Washington Department of Ecology. Descriptions of the types of characterization activities to be performed in the 100 Areas are provided in operable unit work plans (DOE-RL 1990a, 1991). The activities described include well drilling, borehole drilling, and backhoe (or similar equipment) excavation of small contaminant inventory waste sites in the 100 Areas.

This safety assessment documents the analysis of hazards, leading to the conclusion that the activity does not present an unacceptable hazard to the three receptor groups of concern: the facility worker, the onsite person located 330 ft (100 m) from the activity, or the offsite individual. This safety assessment satisfies the requirements of DOE 5481.1B, Safety Analysis and Review System, dated 9/23/86 (DOE 1986).

1.1 WORK DESCRIPTION

This assessment records the hazards and operational limitations to assure safe operation of the characterization activities associated with the 100 Area operable unit and isolated unit waste sites. The waste sites considered include cribs, trenches, basins, and french drains. Burial grounds containing solid radioactive material are not included in this assessment. Soil sampling in the vadose zone, well drilling into the water table, and the use of earth moving equipment (e.g., backhoes or similar equipment) are included. A description of the waste sites is provided by Westinghouse Hanford in *Preliminary Operable Units Designation Project* (WHC 1989).

1.2 ASSESSMENT SUMMARY

The hazardous material inventories reported in the 100 Area liquid waste sites are small. Typical sample concentrations taken in FY 1976 from cribs and trenches averaged from <3.6E-01 to 4.5E+05 pCi/g beta-gamma and 6.2E-02 to 1.9E+01 pCi/g alpha. The larger beta-gamma value consisted of approximately half ^{3}H and half ^{14}C. These values are expected to be representative (radionuclide decay not considered) of radioisotope levels encountered in the characterization activities described in Section 4. One exception is waste site 116-N-1 (1301-N Crib and Trench), where recent radiological surveys indicate a radionuclide inventory that is considerably higher than other 100 Area liquid waste sites. This waste site and solid radioactive waste burial grounds are not included in this assessment. A separate safety assessment will be required for characterization remediation activities planned for these work sites.

Considerable radionuclide inventory data for waste sites are given by Dorian and Richards (1978). Although very low, the radiological inventories are above the exempt quantity identified (WHC 1990, Attachment A). The amounts were evaluated to be well below the level that would present any significant adverse consequences to the three receptor groups of concern.

Analysis revealed maximum expected 8-h effective dose equivalents (EDE) of 8 mrem for the facility worker and <1 mrem for the onsite person 330 ft (100 m) from the activity. (The EDE represents the overall risk from irradiation of the body under uniform or nonuniform irradiation based on the dose equivalent to specific tissues. Nonuniform radiation, such as partial radiation exposure to an external radiation field, or internal exposure where the isotope concentrates to different degrees in various organics, weighting factors, which are based on the relative impact to the body as whole is used to calculate an EDE. The EDE is, therefore, a weighted sum of organ doses.) These EDE values are well below the low hazard classification values of 25 and 5.0 rem, respectively.

The public is assumed to be located on the south or west banks of the Columbia River, a distance greater than 330 ft (100 m) from the closest characterization activity other than ground water wells which will be drilled in uncontaminated surface areas. Therefore, the consequences to the three receptor groups would be well below regulatory requirements.

Some waste sites have hazardous material inventories consisting of a combination of low level radioactive and chemical material suspended in the subsurface soil. The current data of nonradioactive waste materials are not as extensive as that of radionuclides. There is no information regarding large concentrations of solid hazardous chemicals buried in the 100 Areas. Anecdotal information indicates there were probably small amounts of hazardous chemicals disposed of in nonradioactive solid waste burial trenches. Waste material disposed of in this era usually was either burned or crushed and compacted by heavy equipment, or both. These disposal methods significantly reduce the probability of encountering this type of material in nonradioactive solid burial grounds.

There are data regarding soil concentrations in or near several cribs, french drains, and other small waste sites that received liquid hazardous chemical materials (including volatile organics) before and during reactor operations. Data from ground water sampling disclosed that there are concentrations of nitrate (as NO_3) and chromium$^{(+6)}$ that exceed the drinking water standards. These contaminants are expected to be encountered during well drilling; however, any resulting airborne concentrations would be well below concentrations that would be hazardous to the well drillers.

The very low expected concentrations of these chemical waste materials would be a lower hazard than the radionuclide inventory to the facility worker and the onsite person 330 ft (100 m) from the activity. The nonradioactive inventory would be bounded by the consequences of a source term involving the radioactive inventory. The volume of contaminated soil exposed at ground level did not increase the hazard classification because of the very low inventories and resulting concentrations of hazardous waste material. The activities considered fall within the low hazard classification for the three receptor groups (WHC 1990). Hazard classification provides the basis for the level of DOE and Westinghouse Hanford review and approval of a hazard within a facility or encountered by an activity.

Work will stop in the remote event that radioactivity levels that exceed 200 mrad/hr (beta-gamma) or 3,000 dpm/100 cm^2 (total alpha) at contact are detected in the waste site's soil or material. Review and approval by independent safety is required before any work activities may proceed.

Activities included in this assessment have a very small potential for contacting solids because sampling will be done outside known radioactive solid waste disposal sites. Nonradioactive solid waste sites should not present a problem of containers of liquids for the previous reason. However, to assure the safety of the facility worker, all materials removed during well or borehole drilling and trenching must be monitored for volatile organic liquids (VOL) and vapors (VOV).

1.3 SUMMARY OF LIMITS AND PRUDENT CONTROLS

Controls will be applied to activities described to assure the safety of the facility worker and to minimize environmental impact. One operational safety limit (OSL) is provided to assure conformance with regulatory requirements and facility worker radiation exposure is as low as reasonably achievable (ALARA).

There are three prudent controls that have been adopted by line management and implemented by Westinghouse Hanford procedures. These controls are good safety and engineering practices that assure potential exposures at the various waste sites will be maintained ALARA.

The OSL is:

> Radiation exposure to facility workers must be minimized and personnel exposure limits must not be exceeded. The radioactive contamination levels in the soil are expected to be low. However, there is a small potential for pockets of material containing higher contamination levels. An OSL of 200 mrad/hr (total beta- gamma) or 3,000 dpm/100 cm^2 (total alpha) at contact is applied to any soil or material that is disturbed or raised to ground level during the activities described. The OSL requires work to stop if the limit values are exceeded. This will aid in assuring that personnel radiation exposure limits are not exceeded and unexpected radiation levels receive additional safety consideration and independent review.

Prudent controls adopted by Environmental Engineering management are:

1. Disturbed soil surfaces will be maintained damp or otherwise stabilized at all times to minimize dust generation and the possible spread of contaminants.

2. Health Physics coverage will be provided as needed during vadose drilling activities and trench and test pit sampling.

3. Material removed or exposed during drilling and trenching activities will be sampled for VOV and VOL. Action levels adequate to protect the facility worker from exposures (skin, respirable, fire, and explosion) will be established and implemented.

Occupational safety documentation will be required if not already provided, i.e., Hazardous Waste Operations Permit (HWOP), Job Safety Analysis (JSA), or Radiation Work Procedure (RWP).

1.4 HANFORD SITE DESCRIPTION

The Hanford Site is a 560-mi^2 (1,450-km^2) tract of land located in Benton, Franklin, Adams, and Grant counties in south-central of Washington. The 100 Areas are situated in the northern part of the Hanford Site, along the southern shoreline of the Columbia River, as shown in Figure 1. They are approximately 26 to 30 mi (41.8 to 48.3 km) north-northwest by northwest of the city of Richland (DOE 1987).

1.5 HISTORY OF 100 AREAS OPERATIONS

Between 1943 and 1963, nine water-cooled, graphite-moderated plutonium production reactors were built along the Columbia River upstream from the now abandoned town of Hanford. These reactors (100-B, 100-C, 100-D, 100-DR, 100-F, 100-H, 100-KE, 100-KW and 100-N) have been retired from service and are under evaluation for decommissioning.

The 100-B Reactor was constructed in 1943 and operated from 1944 through 1968. The 100-C Reactor was constructed near 100-B Reactor in 1951 and operated from 1952 through 1969. The 100-C Reactor shared some of the ancillary facilities constructed for the 100-B Reactor, such as the river pump house and reservoir, and the inert gas system.

The 100-D Reactor was constructed in 1943 and operated from 1944 through 1967. The 100-DR Reactor, near 100-D Reactor, was constructed between 1948 and 1950, and operated from 1950 through 1964. It shared many of the support facilities constructed for the 100-D Reactor.

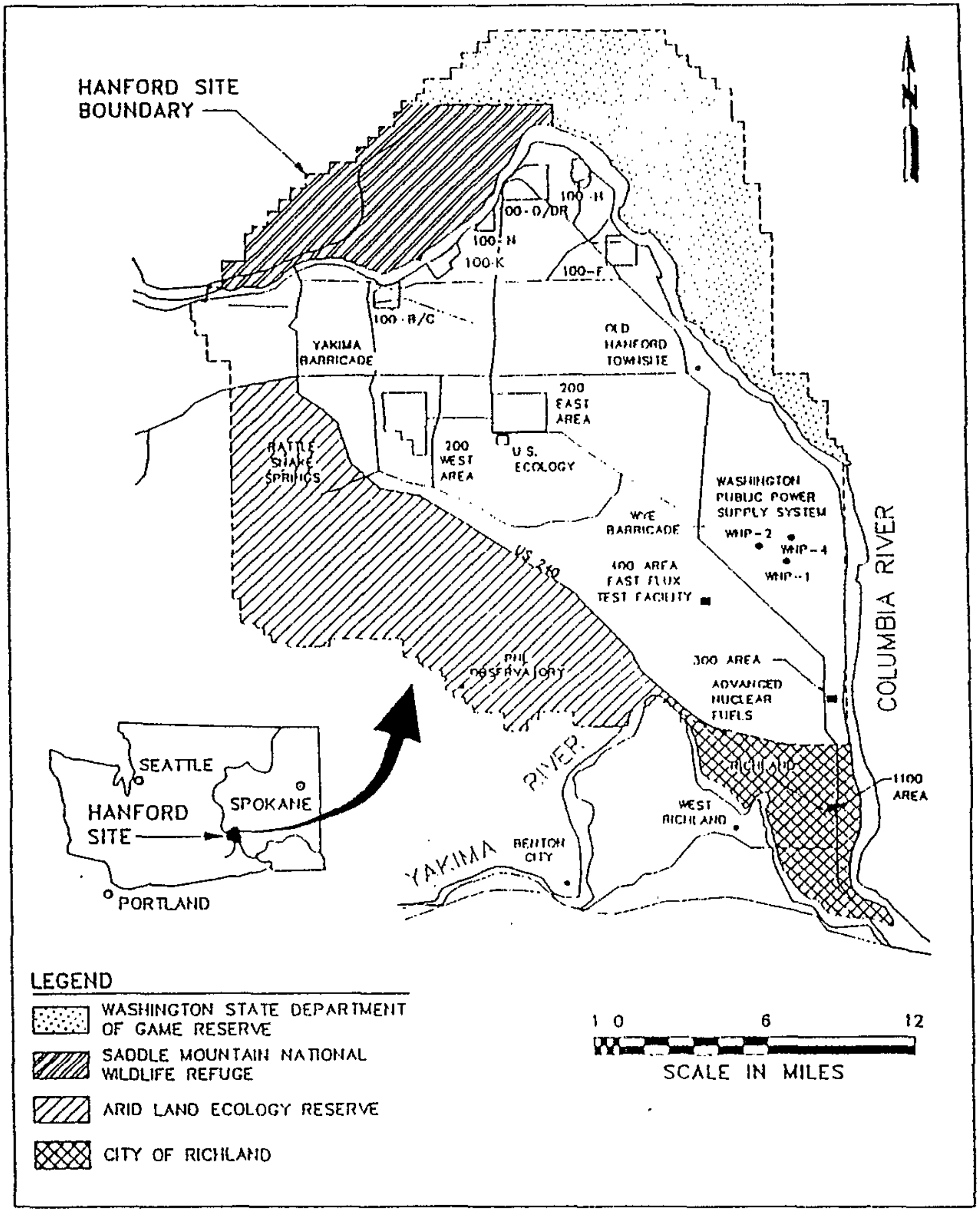
The 100-F Reactor was constructed between 1943 and 1945, and operated from 1945 through 1965; most of its facilities were retired in 1965. The 100-F Area also contained biology laboratories, operated from 1945 through 1976, for studying the effects of radiation on plants and animals.

The 100-H Reactor and support facilities were constructed between 1945 and 1948 and operated from 1949 through 1965; most of its facilities were retired shortly after shutdown.

The 100-KW and the 100-KE reactors and support facilities were constructed between 1952 and 1954. The 100-KW Reactor operated from 1955 through 1970, and the 100-KE Reactor operated from 1955 through 1971. The major support operations were duplicated, although a few ancillary structures were shared by the reactor facilities.

The 100-N Reactor was constructed in 1959 as a major production reactor and began operation in 1963. The reactor was designed as a dual purpose facility capable of producing special nuclear materials and steam. The steam production of the 100-N Reactor was sent to the Hanford Generating Plant for the production of electrical power. The reactor was placed in standown status in 1987, and in 1989 was placed in cold standby status. On August 14, 1991, the Secretary of Energy announced the permanent closure of the 100-N Reactor.

Figure 1. Hanford Site.



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A plan for decontamination and deactivation of the reactors and associated facilities was implemented after reactor operations ceased to minimize the potential spread of radioactive isotopes. Deactivation consisted of removing equipment, electrical hardware, piping, and other items from the buildings and flushing or wiping pipes and equipment with decontamination agents.

Each of the reactor areas have been divided into two to five operable units. There are five 100 Area waste sites not located in reactor areas; these sites are called isolated units. Site locations and descriptions for waste units are provided by Westinghouse Hanford (1989).

2.0 PHYSICAL SETTING

2.1 TOPOGRAPHY AND PHYSIOGRAPHY

The Hanford Site is situated within the Pasco Basin of south-central Washington State. The Pasco Basin is one of several topographic depressions located within the Columbia Plateau Physiographic Province, the broad basin located between the Cascade Range and the northern Rocky Mountains. The Pasco Basin is bounded on the north by the Saddle Mountains; on the west by the Umtanum Ridge, Yakima Ridge and the Rattlesnake Hills; on the south by Rattlesnake Mountain and Rattlesnake Hills; and on the east by the Palouse Slope.

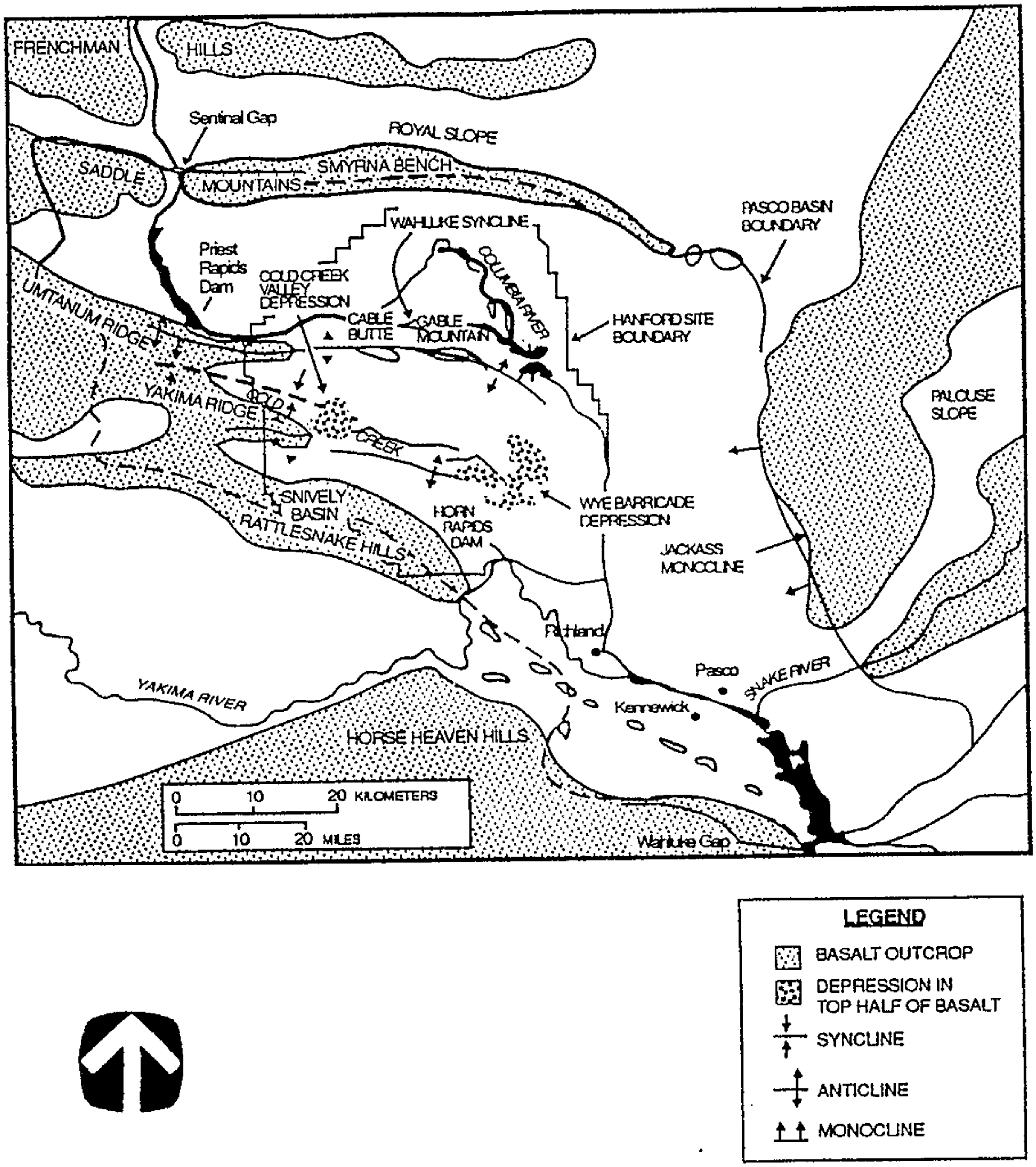
Typical physiography of the Hanford Site is low-relief plains of the Central Plains Physiographic Region and anticlinal ridges of the Yakima Folds Physiography Region.

The 100 Areas are situated in the northern part of the Hanford Site and are bounded to the north by the Columbia River. Elevations in this area range between 390 ft (119 m) and 470 ft (143 m) above mean sea level. Surface elevations gradually increase away from the Columbia River toward Gable Mountain, which lies to the south.

2.2 GEOLOGY

The Hanford Site lies in the Pasco Basin near the eastern limit of the Yakima Fold Belt, Figure 2. The Pasco Basin is a structural depression bounded by anticlinal ridges on the north, west, and south, and the monocline on the east. The Pasco Basin is divided by the east-west trending Gable Mountain anticline, with the Wahluke syncline lying to the north and the Cold Creek syncline to the south. The 100 Areas lie within the Wahluke syncline and are underlain by Miocene basalts of the Columbia River Basalt Group and by late Miocene to Pleistocene Epoch suprabasalt sediments. The basalts and sediments thicken progressively toward the center of the Pasco Basin, reaching their maximum thickness in the Cold Creek syncline (Delaney et al. 1991).

Figure 2. Geologic Structure Map of the Pasco Basin and Hanford Site.



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2.3 HYDROLOGY

The Hanford Site lies near the center of the Pasco Basin, a subbasin of the Columbia Basin. Ground water at the Hanford Site occurs under confined and unconfined conditions. The unconfined aquifer is contained primarily within sedimentary deposits of the Ringold Formation. The ground water depth beneath most of the Hanford Site is generally 200 to 300 ft (61 to 91 m). However, north and east of Gable Butte in the 100 Areas, the water table is shallower and lies within the Hanford formation at depths of <200 ft (61 m) (Liikala et al. 1988). Figure 3 graphically displays the water table levels in the 100 Areas. The base of the unconfined aquifer is defined by the clay zones of the lower Ringold Formation or by the top of Columbia River Basalts where the lower Ringold Formation is absent.

The largest historical floods on the Columbia River occurred in June 1894 and June 1948, inundating parts of several of the 100 Areas. Maximum flows during these floods were approximately 740,000 and 690,000 ft^3/s (21,000 and 19,500 m^3/s), respectively (McGavock et al. 1987). Several flood-control, water-storage, and electric power-generation dams upstream of the Hanford Site constructed since 1948 have significantly reduced the likelihood of floods of this magnitude (DOE 1987).

The dam-regulated probable maximum flood, a theoretical maximum flood resulting from the most severe combination of meteorologic and hydrologic conditions reasonably possible in the region, was calculated to produce a peak flow of approximately 1.4 million ft^3/s (40,000 m^3/s). The floodplain associated with the probable maximum flood is illustrated in Figure 4 and would inundate all or several of the 100 Area operable units. A flood scenario based on a 50% breach at the outfall of Grand Coulee Dam is calculated to have a flow of 21 million ft^3/s (600,000 m^3/s), inundating all of the 100 Areas and the city of Richland (DOE 1987).

2.4 METEOROLOGY

The Hanford Site has dry, mild weather. The Cascade Mountains to the west form a rain shadow and serve as a source of cold air drainage which affects the wind regime. Frequent strong temperature inversions occurring at night and breaking during the day result in unstable and turbulent winds.

Precipitation - The average annual precipitation at the Hanford Site is 6.3 in. (16 cm), with nearly half occurring in November through February and only about 15% in summer. About 45% of winter precipitation is snow. The highest snowfall on record is 24 in. (61 cm); the second highest is less than half that amount; and the lowest is 0.3 in. (0.8 cm). Days having more than 0.5 in. (1.3 cm) of precipitation occur <1% of the year. Rainfall intensities of 0.5 in/h (1.3 cm/h) persisting for 1 h are expected once in 10 yr, and 1.0 in/h (2.5 cm/h) for 1 h only once every 500 yr.

Evapotranspiration - The mean annual evapotranspiration for the Hanford Site has been estimated to be about 29 in. (74 cm). The actual annual evapotranspiration rate under normal conditions for a 6-in. (15-cm) assumed available water capacity is estimated at be about 7 in. (18 cm) (USWB/DOA 1962).

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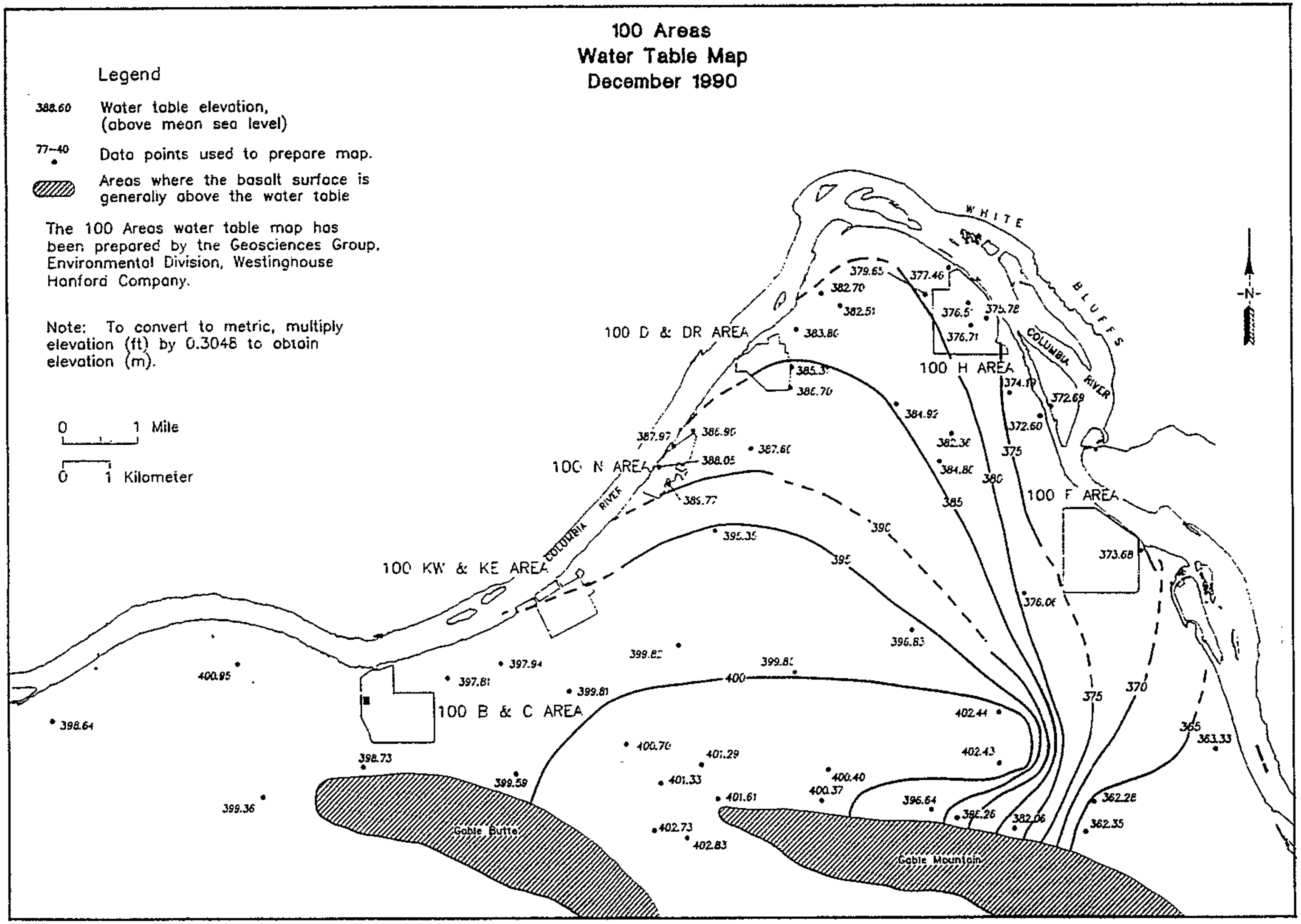
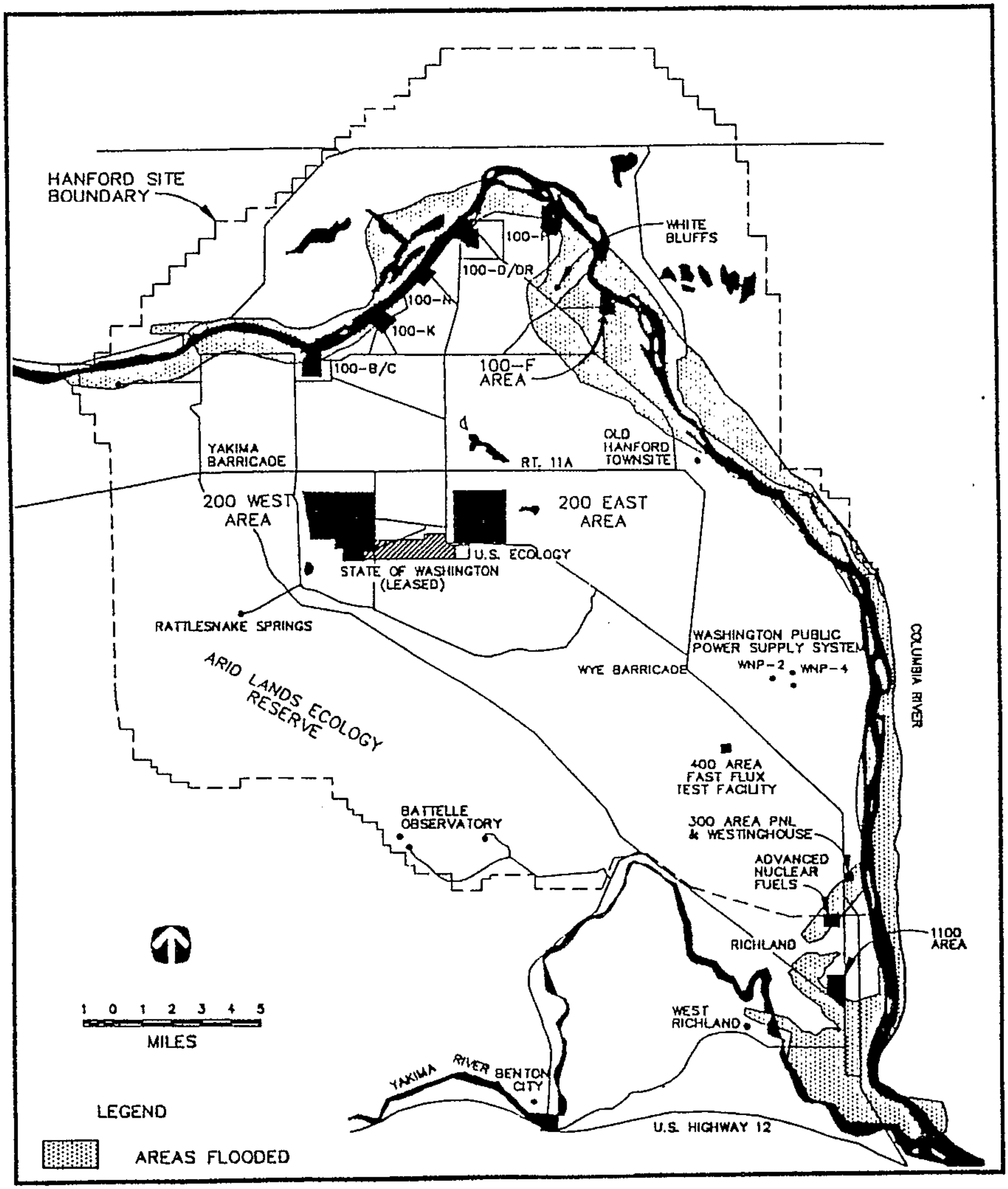


Figure 3. Hanford Site 100 Areas Water Table, December 1990.

Figure 4. Flooded Area for the Probable Maximum Flood.



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Temperature - Average monthly temperature at the Hanford Site have ranged from 21°F (-6°C) to 44°F (7°C) in winter, and 63°F (17°C) to 82°F (28°C) in summer. Average minimum and maximum temperatures in January are 21°F and 37°F (-6°C and 3°C); in July, they are 61°F and 90°F (16°C and 32°C).

Wind - The prevailing regional winds throughout the year are from the northwest and are more prominent during the winter and summer. Secondary wind directions are southwesterly; the frequency of these winds increases in the spring and fall. Winds blowing from other directions display minimal seasonal variations. Wind roses for various parts of the Hanford Site, including the 100 Areas, are shown in Figures 5 and 6.

2.5 LAND USE

Access to the entire Hanford Site is administratively controlled and is expected to remain this way in the foreseeable future to ensure public health and safety and for national security (DOE 1987). The Hanford Site is currently zoned as an unclassified-use district by Benton County. The Hanford Site may be used for nuclear-related activities under the county's comprehensive land-use plan.

2.6 DEMOGRAPHY

No one resides on the Hanford Site. The nearest resident to the 100 Area waste sites is located 5 mi (8.1 km) from the 100-F Area. There are boaters on the Columbia River throughout the year who may access the west and south banks of the river. The closest location to the riverbank where characterization activities (ground water wells) could result in a measurable hazardous exposure is >165 ft (50 m). The nearest public road is State Highway 24, located 0.88 mi (1.4 km) from the closest 100 Area.

3.0 PURPOSE AND SCOPE

The purpose of the characterization activities described and analyzed here are to confirm or further define the contaminants present in the soils beneath selected waste sites in the 100 Areas.

The scope is limited to the activities described in Section 4 occurring in the 100 Areas operable units and isolated units that fall into the low hazard or general use classification for the three receptor groups.

Activities that present a hazard greater than the low hazard classification are not included in this assessment. Those activities will require additional safety assessment documentation specific to their respective hazardous inventories and locations. Waste site 116-N-1 (1301-N Crib and Trench) and burial grounds containing solid radioactive material are not included in this assessment.

Figure 5. Hanford Telemetry Network Wind Roses, 1988.

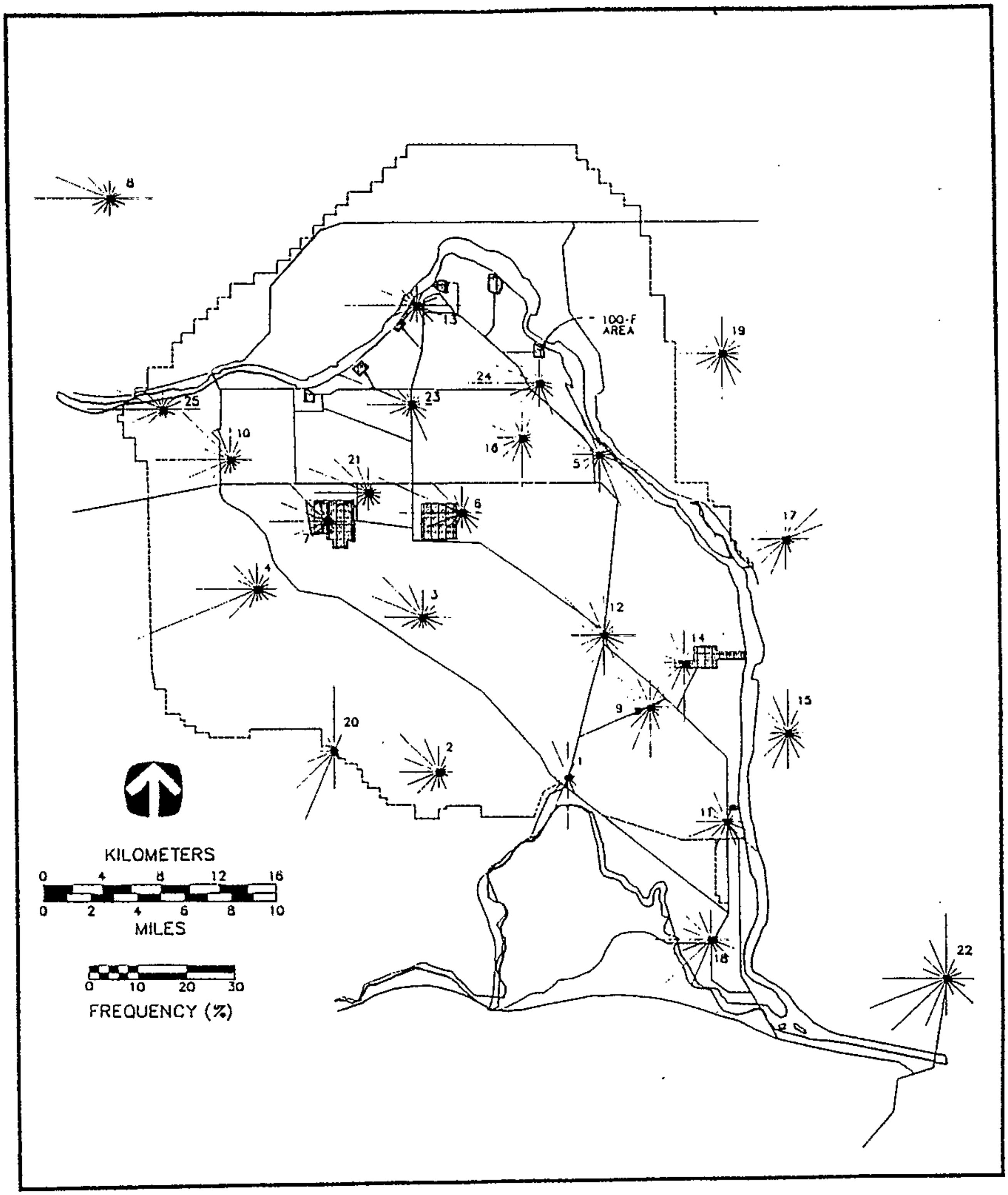

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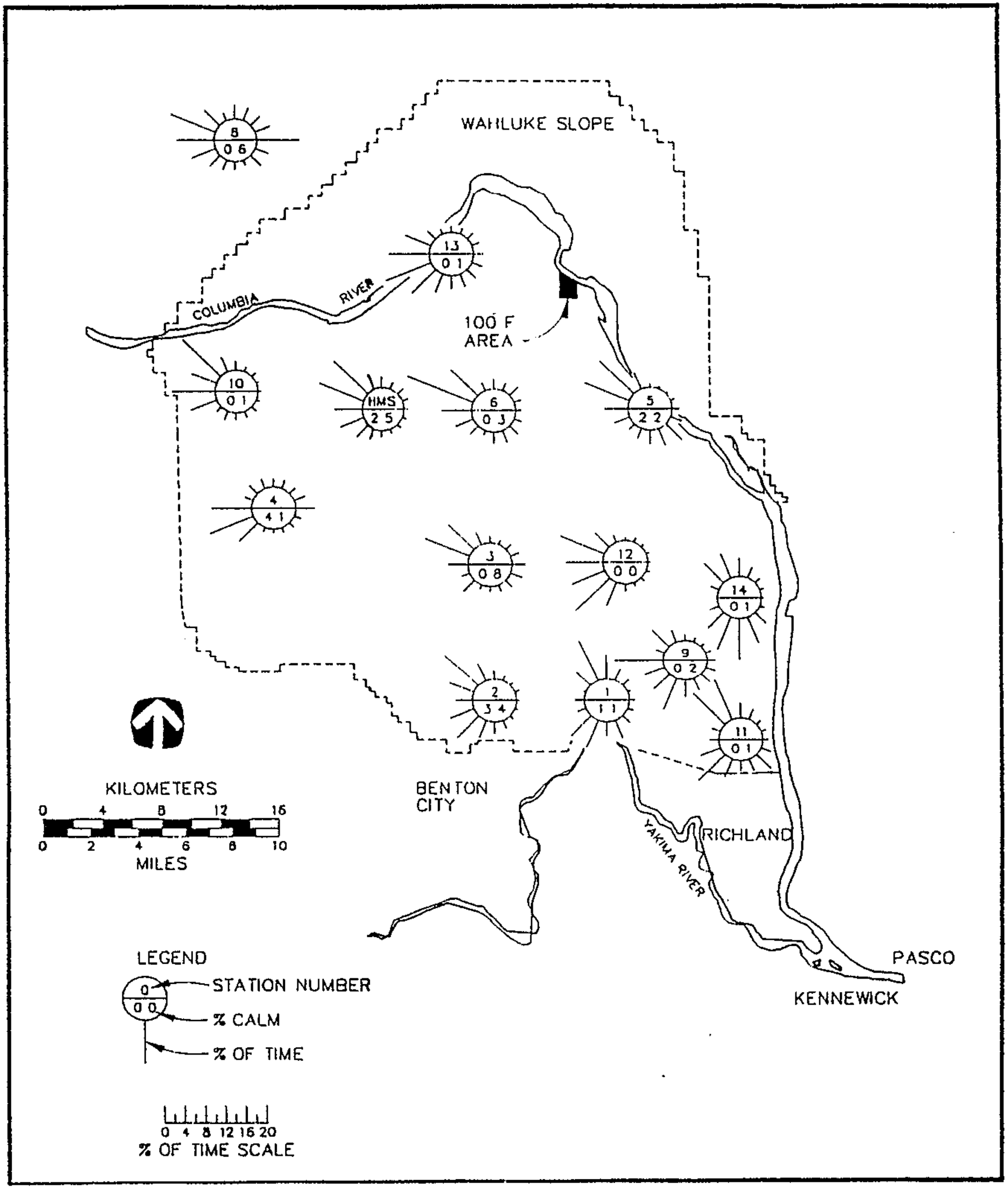
Figure 6. Hanford Telemetry Network Wind Roses, 1979-1982.



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4.0 WORK DESCRIPTION

Characterization activities are planned for selected waste sites in the 100 Area operable units and isolated units. These activities do not include known radioactive solid disposal sites and liquid waste site 116-N-1. This assessment is based on the sampling and drilling methods described in this section. Additional details regarding these methods and associated personnel safety requirements can be found in *Environmental Investigations and Site Characterization Manual* (WHC 1988a).

4.1 PROCESS EFFLUENT AND DISCHARGE PIPELINES INTEGRITY ASSESSMENTS

The purpose of this activity is to determine the location and severity of suspected pipeline leaks so the soils beneath suspected leaks can be sampled. The entire interior circumference of the process effluent and discharge pipelines will be inspected using the remote camera system. The visual image of the pipe interior will be monitored during the inspection and recorded on videotape. The remote camera system will also have combustible gas and radiation detection devices.

The duration of this activity will range from 2 to 4 wk per waste site depending on the configuration and length of the pipelines. This activity may occur at any time during the year.

4.2 PROCESS EFFLUENT AND DISCHARGE PIPELINES SLUDGE SAMPLING

Sampling may be conducted if sludge deposits are identified during the pipeline integrity assessments described in Section 4.1 using the methods described in Section 4.3. Composite sludge samples will be obtained from each pipeline where sludge is present. Locations for sampling will be selected where there is sludge in sufficient quantity to sample effectively. The number of samples for each composite will depend on the volume of material available for sampling.

The duration of this activity will range from 2 to 4 wk if integrated with the remote camera inspection, or several days at each pipeline if done as a separate task. The sludge sampling may occur at any time during the year.

4.3 SOIL AND SEDIMENT SAMPLING

Surface soil/sludge sampling methods that may be used include the sampling thief, sampling trier, hand augers, sampler, scoop/spade/shovel, hand corer, and the soil/sediment punch. Soil/borehole sampling methods will include dual-wall core-barrel sampling, split-spoon sampling, shelby tube sampling, and drive tube sampling. A description of each of these methods can be found in environmental investigations instruction (EII) 5.2 (WHC 1988a).

The duration of this activity will be approximately 1 d per activity location and may occur at any time during the year.

4.4 WIPE SAMPLES

The wipe sample method will be used to sample for removable radiological and toxicological contaminants. The terms "wipe sample," "swipe sample," and "smear sample" have all been used synonymously. Wipe sample is used in this section. Locations where wipe samples will be taken include pipe, concrete, and metal surfaces. The duration of this activity will be approximately 1 d per activity location and may occur at any time during the year.

4.5 TANK SAMPLING

This activity will be accomplished to determine the contents of a tank or drum, e.g., chemical and fuel tanks and septic tanks. Sampling devices will include coli/wasa, open-tube, dip sampler, manual pump, weighted bottle, grain sampler, sampling trier, trowel/scoop/spoon, hand auger, hand corer, and split-spoon. A description of these methods is given in EII 5.13 (WHC 1988a). The duration of this activity will be approximately 1 d per activity location and may occur at any time during the year.

4.6 TRENCHES AND TEST PIT SAMPLING

Trenches and test pits are open shallow excavations, typically longitudinal (if a trench) or rectangular (if a pit) to determine the shallow subsurface conditions for engineering, geological, and soil chemistry exploration and/or sampling purposes. These pits are excavated manually or by machine, such as a backhoe. Samples are taken typically from materials in the equipment bucket. Personnel are not normally required to enter the excavation to obtain a sample.

Test pits normally have a minimum cross section that are 4 to 10 ft (1.2 to 3.0 m) square; test trenches are usually a minimum of 3 to 6 ft (0.91 to 1.8 m) wide and may be extended for any length required to reveal conditions along a specific line.

Depths of the trenches and test pits are expected to vary, depending on the waste unit being characterized. The maximum depth is not expected to exceed 30 ft (9.1 m). Trenches and test pits are considered to be 30 ft (9.1 m) deep for purposes of this assessment. A cross-section of the liquid waste sites where this method of sampling will be used typically consisted of about 14 to 16 ft (4.3 to 4.9 m) of waste material with 4 to 6 ft (1.2 to 1.8 m) of noncontaminated fill material. Duration of this activity is dependent on the size of waste unit and the type of equipment being used and may occur at any time during the year.

4.7 DRILLING ACTIVITIES

Vadose boreholes and ground water monitoring wells will be drilled using similar techniques. It is expected that there will be more than one technique used in drilling the boreholes and wells. Cable-tool drilling is to be the predominate method used in the 100 Areas. The diamond core method will be used when drilling through structural materials, such as concrete. Descriptions of these drilling methods are provided in EII 5.2 and 6.7 (WHC 1988a).

All boreholes and wells will be drilled and samples obtained when required. Field analyses will be performed in accordance with the procedures and equipment specified in approved Westinghouse Hanford, participant contractor, or subcontractor procedures (WHC 1988a). Where surface contamination is present, a protective covering will be provided at each drilling location to minimize contact between the underlying soil and the drilling rig, equipment and crew.

The vadose boreholes will range from 5 to 80 ft (1.5 to 24 m) in depth and will be 8 in. (20 cm) or smaller in diameter. Some boreholes may be extended to, or into, the unconfined aquifer. Sampling through the vadose zone is planned on 5-ft (1.5-m) intervals from the surface to total depth. All samples will be screened for radioactivity and volatile organics. When field screening indicates that samples are "clean", one additional sample will be taken and drilling will terminate at this point. When field screening indicates contamination extends to the unconfined aquifer, drilling will go below the water table to permit collection of at least one sample of the aquifer matrix. The duration of this activity is expected to be approximately 2 wk per borehole and may occur at any time during the year.

The ground water monitoring wells will range from 40 to 200 ft (12 to 61 m) deep and will be 8 in. (20 cm) or smaller in diameter. The duration of this activity is expected to be three weeks per boring.

Once constructed, the wells will be developed and pumped, resulting in the accumulation of ground water to the surface. Purge water is collected or contained, stored, treated and/or disposed according to requirements and agreements established in and through DOE instructions (DOE-RL 1990b). Ground water samples are collected and analyzed for constituents of concern.

5.0 HAZARDS

5.1 BASES FOR HAZARDS CONSIDERED

Intrinsic hazards inventories and initiating events that could create a credible source term release were considered. A basis for these conclusions follows in this section. Criticality, flood, lightning, heavy rain, and range fire events were considered. These events were determined to be either incredible or would not result in any consequence change to the receptor groups. Hazards inventories and initiating events were enveloped into broader categories as much as possible.

5.2 HAZARDS INVENTORY

The hazards inventory in the retired 100 Area waste sites consists of a combination of waste radioactive and chemical material. The large majority of this material was disposed of during the period the production reactors (100-B, 100-C, 100-D, 100-DR, 100-F, 100-H, 100-KE, and 100-KW) were operating (1943-71) (AEC 1973, Dorian and Richards 1978). This extended time period of 20 to 48 yr has permitted a significant reduction in the radionuclide inventory due to decay. Inventories of waste chemicals disposed to the cribs,

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trenches, etc. have diminished. The 100-N Reactor waste material has not had as long a period to decay and disperse.

Sampling of the retired 100 Area radioactive liquid waste disposal sites for radionuclides was completed in FY 1976 (Dorian and Richards 1978). Principle isotopes identified included ^{152}Eu, ^{154}Eu, ^{155}Eu, ^{60}Co, ^{137}Cs, ^{90}Sr, and ^{63}Ni. The concentration values given in the reference have experienced radioactive decay over the 14 yr since the samples were analyzed. Values reported in the reference were used conservatively for purposes of this assessment.

Based on historical information, the nonradioactive hazardous liquid wastes that are believed to have leaked or were disposed of in the 100 Areas included sodium dichromate, sodium oxalate, sodium sulfamate, sulfuric acid, bauxite, lubricating oil, gasoline, and oil contaminated with polychlorinated biphenyls. Very low concentrations of these waste materials have been recently detected in the soil and ground water in the 100 Areas. Analyses of samples of ground water over the years indicate a continuing reduction of concentrations of these waste materials. However, there is a possibility that pockets of concentrated contaminants may be encountered.

6.0 HAZARD ASSESSMENT

6.1 INTRODUCTION

There are several waste sites in the 100 Areas. This assessment considers the waste sites together, rather than individually assessing each site. Different energy sources were considered that could cause a hazard inventory to become a source term exposure to the three receptor groups. Wind is the energy source that could cause a hazardous material inventory to result in a source term.

The waste sites were analyzed to determine individual isotope concentrations, total radioactive inventory, and various chemical contaminants. The 116-C-2c Sand Filter was found to have the highest dose rates and radionuclide concentrations (other than in waste site 116-N-1 and radioactive solid waste burial grounds) that could be used to create a bounding source term. Waste site 116-C-2c inventory was used in developing the source term for the characterization activities in Section 4. Slightly higher concentrations were found at other locations, but the smaller total volume at these sites would result in a smaller source term.

Nonradioactive liquid contaminants in the soil and ground water are in very low concentrations, are combined with radioactive isotopes and are not expected to result in a source term potential. The radiological contaminant concentrations, while also low, represent a potentially greater hazard than the nonradioactive contaminants. The concentrations are used to bound the hazard of the nonradioactive materials in this assessment. The analysis disclosed that the resulting source terms were very low.

Accident events leading to the generation of the source term are not necessary or identified in this assessment. A source term is assumed to have been created.

6.2 ASSESSMENT

This assessment is presented in two parts. The first part considers the inventory in the soil removed during the drilling of a borehole or groundwater well. The contaminant concentrations at the borehole site and 330 ft (100 m) downwind are presented. The resulting hazard to the facility worker is very low and to the onsite person 330 ft (100 m) from the activity and the nearest resident, insignificant. The second part recognizes the very low hazard presented from the ground water well or borehole inventory and then considers a spoil pile of unspecified volume or dimension and the resultant effect to the three receptor groups.

The hazard inventory in the first part results from the drilling of a borehole or well into soil contaminated with the composite concentration of radionuclides described in Section 5.2. The inventory is expected to be the maximum brought to the surface in the sand and soil from the top 30 ft (9.1 m) of each borehole. Based on data from previous sampling (Dorian and Richards 1978), hazards inventories >30 ft (9.1 m) below the surface are expected to be insignificant and therefore are not included. The borehole is assumed to be a maximum of 8 in. (20 cm) in diameter. The assumed radionuclide inventory and resulting concentrations for one borehole are shown in Table 1. Table 2 contains the calculated personnel radiation exposure that results from the source term derived from the radionuclide inventory. The derived air concentration (DAC) fraction and the 8-h EDE the facility worker receives at the drilling equipment is very low (WHC 1988b). The consequence of this source term to people 330 ft (100 m) and beyond the activity would be insignificant. Table 3 is a comparison of the EDE values for the facility worker and onsite personnel located at 330 ft (100 m) and the ceiling of the low hazard classification for these two receptor groups.

The second part considers a spoil pile of undefined shape, and unlimited volume and surface area resulting from trenching in a waste site. The source term is based on the maximum amount of dust that can be suspended in air. This conservative source term is used because the large size of the spoil pile cannot be considered a point source. The hazardous material inventory basis is the same as for the borehole described in the first part. The 8-mrem EDE and the DAC fractions of 1.9E-01 alpha and 2.1E-01 beta-gamma are considered the same for the three receptor groups. These values are the same as those for the facility worker in the first part. They are based on moderate dust loading in the air combined with the amount of air a human would breathe in an 8-h period (Mishima 1964).

Table 1. Radionuclide Inventory and Resulting Concentration.

Substance	Inventory (in µCi)	Soil (in pCi/g)	Concentration Facility Worker (µCi/cm^3)	Onsite Personnel (µCi/cm^3)
Alpha	1.9E+01	3.8E+01	3.8E-13	8.00E-15
Beta-Gamma	2.1E+04	4.2E+04	4.2E-10	8.83E-12

Table 2. Facility Worker and Onsite Personnel Radiation Exposure Resulting From the Radionuclide Inventory.

Substance	DAC Limit ($\mu Ci/cm^3$)	DAC Fraction		8-h Estimated Dose Equivalent (rem)	
		Facility Worker	Onsite Personnel	Facility Worker	Onsite Personnel
Alpha	2E-12 (^{239}Pu)	1.9E-01	4.0E-03	3.8E-03	8.0E-05
Beta-Gamma	2E-09 (^{90}Sr)	2.1E-01	4.4E-03	4.2E-03	8.8E-05
EDE Total				8.0E-03 8 mrem	1.7E-04 <1 mrem

Supporting calculations for Tables 1 and 2 are found in Appendix A.

Table 3. Comparison of EDE Values With Low Hazard Ceiling.

	Facility Worker	Onsite Personnel
EDE	8 mrem	<1 mrem
Low Hazard Ceiling	<25 rem	<5 rem

The concern of encountering hazardous concentrations of organic vapors and hazardous chemical materials during drilling operations was assessed. Review of the data regarding materials disposed of in waste sites and the ground water sampling program disclosed that there may be small amounts of toxic or organic materials. Based on the sampling results, concentrations that represent a hazard are not expected. Characterization activities are not planned in areas where liquid material may be encountered. This will significantly reduce the probability of contact with concentrated VOL that could present a potential explosion. However, to assure the safety of facility workers, management has implemented requirements that require material exposed or removed during drilling and trenching operations be sampled for VOL.

The remaining sampling activities, process effluent and discharge pipelines sludge sampling, soil and sediment sampling, wipe samples, and tank sampling (described in Section 4) were reviewed. The sample size and material, hazard material content, the amount of material disturbed to obtain the sample, and the potential for the activity to create a significant source term were considered in determining the hazard to the three receptor groups. The analysis disclosed that the resulting hazard would be low and within the bounds of the assessment for the ground water well and borehole and the unlimited spoil pile. These activities are not specifically reported because of this.

Some of the ground water wells will be drilled 165 to 195 ft (50 to 60 m) from the Columbia River. This drilling is not expected to produce a hazardous inventory significant to this assessment because the drilling will be done in locations where there is no surface contamination. Previous sampling data indicates contamination, if any, would not be expected within 20 to 30 ft (6.1 to 9.1 m) of the surface at locations 165 to 195 ft (50 to 60 m) from the river bank (Dorian and Richards 1978). Concentrations below this depth are expected to be low. Materials that result from these drilling operations are not expected to exceed the bounds of the assessment.

The conservative inventory and radiological concentrations result in very low exposures to the three receptor groups. Any hazardous chemical exposure to the three receptor groups is expected to be insignificant and well below regulatory limits.

Personal protective equipment requirements for the facility worker (i.e., clothing, respirators, and head and foot protection) are identified in the HWOP, JSA and RWP.

Controls to reduce amounts of hazardous materials that could become source terms will apply equally to both radioactive and hazardous chemical material.

The HWOP requires contaminated spoil material to be promptly containerized to prevent it from becoming airborne. This requirement will further reduce the probability of a hazardous source term occurring.

There is a potential for environmental spread of contamination during drilling activities. When drilling through the unsaturated (dry) zone, water may be added to the hole that could lead to the movement of contamination to the water table. The spreading of contaminants is limited by the telescoping casing method used, the short drilling depth limited by drilling capacity, drilling procedures, and administrative controls. Vadose zone drilling will extend into the unconfined aquifer where contamination is present in the soil immediately above the aquifer. The water level in the unconfined aquifer in the 100 Areas has experienced changes in elevation because of elevation fluctuation in the Columbia River. Because of reactor shutdowns and the reduction of waste water generation, the unconfined aquifer level has dropped several feet. The potential for the drilling operation to add contaminants to the unconfined aquifer is very small because of the general lower elevation of water tables in the 100 Areas, and because the contaminated soil would be in contact with the aquifer where drilling would occur. The use of the telescope casing method will limit the introduction of contaminants from higher elevations.

Boreholes will be abandoned following sampling in a manner that will prevent contamination of the ground water resource. This will be done in accordance with EII 6.5 (WHC 1988a).

6.3 NATURAL ENERGY SOURCES

Energy sources that naturally occur were considered in this assessment. When events such as floods, lightning, earthquakes, and tornadoes occur, they do not adversely affect the conclusions drawn because the resultant exposures to the three receptor groups assume maximum potential release of the hazardous inventory. Range fires also were considered, but they did not alter the previous conclusions. Criticality was considered incredible because of the small amount of fissionable material available.

7.0 SUMMARY AND CONCLUSIONS

The radiological and toxicological dose consequences were found to be within the criteria for low hazard activities (WHC 1990). The bases for the radiological calculations leading to the low hazard determination were conservatively taken from the results of sampling in 100 Area waste sites 14 yr ago (Dorian and Richards 1978). The radionuclide inventory in waste site 116-C-2c was chosen because it produced the highest source term to the facility worker. Waste site 116-N-1 was not considered or included in this assessment because the radionuclide inventory is much higher. The DAC fraction and EDE were calculated using waste site 116-C-2c inventory. Credit was not taken for radioactive decay since 1977. The resulting DAC fraction and EDE exposures for the facility worker also were used as the exposures for the onsite person 330 ft (100 m) from the activity and the offsite person. This conservative approach to determining hazards resulted in the conclusion that there was no bound on the size, shape, or surface area of the hazard inventory. The size of the hazard inventory (a spoil pile resulting from the excavation of a waste site) did not increase the exposure to the three receptor groups. The source term is based on moderate dust loading conditions (Mishima 1964). Nonradioactive liquid waste materials were considered but not specifically calculated because of their low concentrations. Nonradioactive waste concentrations are expected to be very low because of the nature of the liquid waste disposal sites and the long period they have been inactive. The concentrations are not expected to result in hazardous exposures to the three receptor groups and anticipated concentrations would be well below regulatory requirement limits. The determination based on the unlimited size and shape of the hazard inventory is also the bounding inventory and source term for the other activities considered in Section 4.

Normal job site worker safety requirements contained in the HWOP, JSA, and RWP would provide adequate respiratory and skin protection for the facility workers.

8.0 LIMITS AND PRUDENT CONTROLS

There is one OSL applied to the described activities to assure the safety of the facility worker and to minimize environmental impact. Three prudent controls have been adopted by management to enhance the safety of the described activities.

8.1 OPERATIONAL SAFETY LIMIT

This OSL applies to the maximum allowable radiation dose rate at the work site.

Operational Safety Limit 1

1.0 **Title** - Radiological dose rate limit.

1.1 **Applicability** - This limit applies to soil or material disturbed or raised to ground level during all low level characterization activities at waste sites in the 100 Area operable units and isolated units.

1.2 **Objective** - To alert the facility worker that unexpected high radiation dose rates have been encountered.

1.3 **Requirements** - a. Stop all work when activity levels are encountered that exceed 200 mrad/hr (beta/gamma, CP open window, uncorrected) or 3,000 dpm/100 cm^2 (total alpha) at contact.

b. Remove affected personnel to a low dose rate area.

c. Alert the Health Physics supervisor and the Field Team Leader of the unexpected condition as soon as possible.

1.4 **Surveillance** - Project documents will specifically require that: (1) work activity stops when radiation levels exceeding 200 mrad/hr (total beta-gamma, CP open window, uncorrected) or 3,000 dpm/100 cm^2 (total alpha) at contact are encountered, (2) that people be removed from that exposure to a low dose rate area, and (3) the area Health Physics supervisor be alerted as soon as possible.

1.5 **Recovery** - In the event that the dose rates in Section 1.3 of this OSL are encountered, all operations at the site where the high dose occurred will cease. The condition must be reviewed with Independent Safety and a recovery plan developed. Environmental Engineering will review the recovery plan with Independent Safety and obtain their approval of the plan.

1.6 **Audit Point** - Program work documents and Environmental Engineering site surveillances. An audible log shall be maintained at the site documenting surveillance readings.

1.7 **Basis** - The hazardous materials inventory identified in this assessment is the recorded inventory. Extensive sampling has been accomplished in the 100 Areas; however, it is impossible to sample the entire contents of each waste site. Although unlikely, it is possible waste materials could contain higher radiation levels than previously encountered in the sampling programs. The 200 mrad/hr (total beta-gamma) and 3,000 dpm/100 cm^2 (total alpha) values were chosen as these combined activity levels would result in one DAC exposure to the facility worker. The DAC limit bases are ^{90}Sr (beta/gamma) and ^{239}Pu (alpha). The occupational safety procedures implemented through the HWOP, JSA and RWP minimize the potential consequences to the facility worker. This OSL will assure that radiological consequences are controlled within the bounds of the safety assessment.

8.2 PRUDENT CONTROLS

Prudent controls adopted by Environmental Engineering management that will be included in work documents are:

1. Disturbed soil surfaces will be maintained damp or otherwise stabilized at all times to minimize dust generation and the possible spread of contaminants.

2. Health Physics coverage will be provided as needed during vadose drilling activities and trench and test pit sampling.

3. Material removed or exposed during drilling and trenching activities will be sampled for VOV and VOL. Action levels adequate to protect the facility worker from exposures (skin, respirable, fire and explosion) will be established and implemented.

Occupational safety documentation will be required if not already provided (i.e., HWOP, JSA, or RWP).

A readiness review will be held prior to start of work to assure the controls identified in Section 8 and the occupational safety documents have been prepared and are adequate.

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ATTACHMENT A

100 AREA LOW HAZARD

CHARACTERIZATION ACTIVITIES

SAFETY ASSESSMENT

SUPPORTING CALCULATIONS

SUPPORTING CALCULATIONS FOR TABLES 1 AND 2

Inventory Basis

The volume and mass of contaminated soil brought to the surface at each drilling location:

$$30 \text{ ft} \times (8/12)^2 \times \pi/4 = 10.5 \text{ ft}^3 = 297000 \text{ cm}^3$$

The soil density is assumed to be 1.7 g/cm^3.
Mass of soil = 1.7 g/cm^3 x 297000 cm^3 = 504900 grams

Radionuclide concentration is assumed to be the average concentration found in the 116-C-2c sand filter (Dorian and Richards 1978):

Alpha = 3.8E-5 µCi/g
Beta-Gamma = 4.2E-2 µCi/g

Inventory

Mass of soil extracted from borehole (in grams) x contaminant concentration in soil (µCi/g) = Inventory brought to surface.

Alpha: 3.8E-5 µCi/g x 504900 g = 19.2 µCi
Beta-Gamma: 4.2E-2 µCi/g x 504900 g = 21200 µCi

Drill Site Concentrations and Effective Dose Equivalents

Contaminant concentration (µCi/g) x assumed dust loading conditions (g/m^3) x $m^3/10^6cm^3$ = Drill site air concentration (in $µCi/cm^3$)

Assumed moderate dust loading conditions: 10 mg/m^3. (Mishima 1964).

Alpha: 3.8E-5 µCi/g x 0.01 g/m^3 x $m^3/10^6cm^3$ = 3.8E-13 $µCi/cm^3$
Beta-Gamma: 4.2E-2 µCi/g x .01 g/m^3 x $m^3/10^6cm^3$ = 4.2E-10 $µCi/m^3$

<u>Effective Dose Equivalent (EDE)</u> (WHC 1988b)

Breathing 1 Derived Air Concentration (DAC) for 8 hours will give a person an EDE of 0.02 rem.

<u>Derived Air Concentration (DAC)</u> (WHC 1988b)

Assume Alpha = ^{238}Pu: 2.0E-12 $µCi/cm^3$
Assume Beta-Gamma = ^{90}Sr: 2.0E-9 $µCi/cm^3$
Formula: Air concentration (in $µCi/cm^3$) ÷ DAC (in $µCi/cm^3$) x 0.02 rem = Effective Dose Equivalent (in rem)

<u>Ratio of Air Concentration to DAC</u>

Alpha: 3.8E-13 ÷ 2.0E-12 = 1.9E-1
Beta-Gamma: 4.2E-10 ÷ 2.0E-9 = 2.1E-1

Resulting EDE for Facility Worker at Drill Site:

Alpha:	1.9E-1 x 0.02	=	3.8E-3 rem
Beta-Gamma:	2.1E-1 x 0.02	=	4.2E-3 rem
Total eight hour exposure		=	8.0E-3 rem
			8.0 mrem

100 Meter Concentrations and Effective Dose Equivalents

Formula: Inventory (in µCi) x source reduction factor (0.001) ÷ release time of 8 hours (in sec) x atmospheric dispersion factor (X/Q = 1.2E-2 s/m^3) x $m^3/10^6 cm^3$ = air concentration at 100 meters (in µCi/cm^3)

Quantity Released

Alpha: 19.2 µCi x .001 = 1.92E-2 µCi
Beta-Gamma: 21200 µCi x .001 = 2.12E+1 µCi

Release Rate (8 hours)

8 hours = 28800 seconds
Alpha: 1.9E-2 µCi ÷ 28800 sec = 6.67E-7 µCi/s
Beta-Gamma: 2.12E+1 µCi ÷ 28800 sec = 7.36E-4 µCi/s

Air Concentrations at 100 Meters

Atmospheric dispersion factor = 1.2E-2 s/m^3
Alpha: 6.67E-7 µCi/s x 1.2E-2 s/m^3 x $m^3/10^6 cm^3$ = 8.00E-15 µCi/cm^3
Beta-Gamma: 7.36E-4 µCi/s x 1.2E-2 s/cm^3 x $m^3/10^6 cm^3$ = 8.83E-12 µCi/cm^3

Ratio of Air Concentration to DAC

Alpha: 8.00E-15 ÷ 2.0E-12 = 4.0E-3
Beta-Gamma: 8.83E-12 ÷ 2.0E-9 = 4.42E-3

Resulting Effective Dose Equivalent

Alpha:	4.0E-3 x 0.02 rem	=	8.00E-5 rem
Beta-Gamma:	4.42E-3 x 0.02 rem	=	8.84E-5 rem
Total eight hour exposure		=	1.68E-4 rem
			< 1 mrem

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Reviewed by Curtis Ken Kirk August 21, 1991
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100 Area Low Hazard Characterization Activities Safety Assessment

EDT No.: 129406 ECN No.:

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