AR TARGET SHEET

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DOCUMENT # DoE/RL 92-04

EDMC # 0026754

SECTION 2 OF 2

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5.0 HEALTH AND ENVIRONMENTAL CONCERNS

This preliminary qualitative evaluation of potential human health and environmental concerns is intended to provide input to the PUREX Plant Aggregate Area waste management unit recommendation process (Section 9.0). This process requires consideration of immediate and long-term impacts to human health and the environment. As discussed in Section 4.2, existing PUREX Plant Aggregate Area and waste management unit data are not adequate to support an evaluation of potential impacts on the environment. Although ecological impacts are an integral part of the complete assessment of aggregate area and waste management unit potential risks, they cannot be evaluated further at this time. Ecological risk assessment is included in the listing of data uses presented in Section 8.0 with the associated data needs identified as a data gap to be addressed in future investigations. The approach that has been taken to identify potential concerns related to individual waste management units and unplanned releases is as follows:

- Contaminants of potential concern are identified for each exposure pathway that is likely to occur within the PUREX Plant Aggregate Area. Selection of contaminants was discussed in Section 4.2. Contaminants of potential concern were selected from the list of candidate contaminants of potential concern presented in Table 4-32. This table includes contaminants that are likely to be present in the environment based on occurrence in the liquid process wastes that were discharged to soils, and also contaminants that have been detected in environmental samples within the aggregate area but have not been identified as components of PUREX Plant Aggregate Area waste streams.

- Exposure pathways potentially applicable to individual waste management units are identified based on the presence of the above contaminants of potential concern in wastes in the waste management units, consideration of known or suspected releases from those waste management units, and the physical and institutional controls affecting waste management unit access and use over the period of interest. The relationships between waste management units and exposure pathways are summarized in the conceptual model (Section 4.2).

- Estimates of relative hazard derived for the PUREX Plant Aggregate Area waste management units are identified using the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Hazard Ranking System (HRS), modified Hazard Ranking System (mHRS), surface radiation survey data, and by the Westinghouse Hanford Environmental Protection Group scoring. Other indicators of relative hazard, such as rate of release of contaminants, irreversible results of continuing residence of contaminants, etc., were not used because they generally require unit-specific data that are not available for most units.

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The human health concerns, and various hazard ranking scores listed above, are used to establish whether or not a waste management unit is considered a "high" priority. In the data evaluation process presented in Section 9.0, "high" priority sites are evaluated for the potential implementation of an interim remedial measure (IRM). "Low" priority sites are evaluated to determine what type of additional investigation is necessary to establish a final remedy. Further detail is presented in Section 9.0.

The data used for this evaluation are presented in the earlier sections of this report. The types of data that have been assessed include waste management units histories and physical descriptions (Section 2.0), descriptions of the physical environment of the study area (Section 3.0) and a summary of the available chemical and radiological data for each waste management unit (Section 4.0).

The quality and sufficiency of these data are assessed in Section 8.0. This information is also used to identify potentially applicable or relevant and appropriate requirements (ARARs) (Section 6.0).

5.1 CONCEPTUAL FRAMEWORK FOR RISK-BASED SCREENING

The range of potential human health and environmental exposure pathways at the PUREX Plant Aggregate Area was summarized in Section 4.2. In Section 4.2 the role of biota in transporting contaminants through the environment is also discussed, and biota are included as receptors in the conceptual model. However, the assessment of potential ecological risks associated with biota exposure to PUREX Plant Aggregate Area contaminants is currently constrained by the lack of data. This gap in the PUREX Plant Aggregate Area data is discussed in Section 8.2.3. As a result, the risk-based screening of waste management unit priorities discussed in this section is by necessity limited to potential human health risks.

The U.S. Environmental Protection Agency (EPA 1989a) considers a human exposure pathway to consist of four elements: (1) a source and mechanism for contaminant release, (2) a retention or transport medium (or media), (3) a point of potential human contact, and (4) an exposure route (e.g., ingestion) at the contact point. The probability of the existence of a particular pathway is dependent upon the physical and institutional controls affecting waste management unit access and use. In the absence of unit access controls and other land use restrictions, the identified potential exposure pathways could all occur. For example, it could be hypothesized that an individual could establish a residence within the boundaries of the PUREX Plant Aggregate Area, disrupt the soil surface and contact buried contamination, and drill a well and withdraw contaminated groundwater for drinking water and crop irrigation. However, within the five- to ten-year period of interest associated with identification and prioritization of remedial actions within the PUREX Plant Aggregate Area, unrestricted access and uncontrolled disruption of buried contaminants have a negligible probability of occurrence.

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The conceptual model presented in Section 4.2 was evaluated to identify an appropriate framework for screening waste management units and establishing their remediation priorities based on potential health hazards. Based on the five- to ten-year period of interest for waste unit prioritization, and the presence of site access controls during that period, a screening framework was developed encompassing the range of release mechanisms, affected media, and exposure routes associated with an onsite occupational receptor. The PUREX Plant Aggregate Area is currently an industrial area. While work activities are assumed to include occasional contact with surface soils, it is assumed that no contact with buried contaminants will take place without proper protective measures.

Workers may be exposed via the following routes at the PUREX Plant Aggregate Area:

- Ingestion of surface soils
- Inhalation of volatilized contaminants and resuspended particles
- Direct dermal contact with surface soils
- Direct exposure to radiation from surface soils and airborne resuspended particles.

Since evaluation of migration in the saturated zone is not within the scope of a source aggregate area management study (AAMS), ingestion of or contact with groundwater was not evaluated as exposure pathways. However, since migration of waste constituents within the saturated zone will be addressed in the 200 East Groundwater Aggregate Area Management Study Report (AAMSR), contaminants likely to migrate to the water table and waste management units that have a high potential to impact groundwater will be identified.

5.2 POTENTIAL EXPOSURE SCENARIOS AND HUMAN HEALTH CONCERNS

The routes by which a Hanford Site worker could potentially be exposed to contamination at the waste management units include ingestion, inhalation, direct contact with soils, and direct exposure to radiation. To evaluate the potential for exposure at individual waste management units, it is necessary to have data available for surface soils, air, and radiation levels. Although samples have been collected from each of these media, only the surface radiation survey data (contamination levels and dose rate) are specific to individual waste management units. Therefore, only pathways associated with the surface radiological contamination and external dose rates can be evaluated with confidence at this time. Potential exposures by other pathways were evaluated based on available knowledge regarding contaminants disposed to the waste management units and the integrity of engineered barriers.

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5.2.1 External Exposure

External dose rate surveys, which are performed on a waste management unit basis, were used as the measure of a unit's potential for impacting human health through direct external radiation exposure. The contaminants of potential concern for this pathway are the radionuclides that emit moderate to high energy penetrating gamma radiation. The measured dose rates at PUREX Plant Aggregate Area waste management units are presented in Table 5-1 from the available survey data.

For 42 of the 90 PUREX Plant Aggregate Area waste management units, no radiation survey data are available. For those units that do have radiation survey data of some type, 29 were reported as having no contamination detected.

Westinghouse Hanford manual WHC-CM-4-10, Section 7 (WHC 1992) was used as the basis for setting one of the criteria that are used to identify waste management units that can be considered high priority sites. The manual indicates that waste management units with radiation levels of 2 mrem/h be posted with "Radiation Area" signs and undergo access controls for the purposes of personnel protection. With the same objective in mind, the level of 2 mrem/h is recommended as one of the criteria for distinguishing "high priority" from "low priority" sites. The only PUREX Plant Aggregate Area waste management units that exceeded 2 mrem/h were 216-A-40 Trench, and Unplanned Release UN-200-E-100.

High levels of radiation were reportedly associated with some of the unplanned releases that are listed in Table 5-1. However, many of these releases occurred in the early years of the Hanford Site and more recent survey data are not available. Some of the releases were reportedly remediated by removing contaminated soil for disposal in burial grounds, paving or covering the area with soil, or flushing the soil with water. The effectiveness of the various remediation measures is not known, and confirmatory survey measurements are not available. Thus, with the exception of unplanned releases located within engineered waste management units, which are routinely surveyed, information on the current radiological status of remediated unplanned releases is deficient and is identified as a data gap in Section 8.0.

5.2.2 Ingestion of Soil or Inhalation of Fugitive Dust

Radionuclides and nonradioactive contaminants of concern for the soil ingestion and fugitive dust inhalation (see Section 4.2.2.2) pathways are those that are nonvolatile, persistent in surface soils, and have appreciable carcinogenic or toxic affects by ingestion or inhalation. However, little information is available to evaluate the levels of specific radionuclides or nonradioactive contaminants in surface soils. Available gross contamination survey data for the PUREX Plant Aggregate Area waste management units are provided in Table 5-1.

The Westinghouse Hanford Environmental Protection Group policies state that the presence of any smearable alpha constitutes a potential threat to human health and qualifies a waste management unit for a high remediation priority (Huckfeldt 1991b). Waste management units that exhibit elevated alpha readings in radiological surveys can be presumed to have surface contamination, since alpha radiation cannot penetrate solids.

Westinghouse Hanford manual *Radiation Protection* (WHC 1988b) was also used to set criteria for identifying waste management units that can be considered high remediation priority sites. The manual indicates that waste management units with a level of 100 ct/min (1,000 dis/min) above background beta/gamma and/or 20 dis/min alpha be posted with "Surface Contamination Area" signs and undergo access controls for purposes of personnel protection. With the same objective in mind, the levels of 100 ct/min above background beta/gamma and 20 dis/min alpha are recommended as two of the criteria for identifying high priority waste management units. For those beta/gamma survey readings that are in units of dis/min, a conversion was made to ct/min assuming a survey detector efficiency of 10%.

It should be noted that these radiation readings may indicate transient conditions (e.g., presence of contaminated vegetation) and that routine stabilization of surface contamination is carried out under the auspices of the Westinghouse Hanford Radiation Area Remedial Action (RARA) Program.

5.2.3 Inhalation of Volatiles

As summarized in Section 4.1, the distribution of volatile organics in soils is not well-defined in the PUREX Plant Aggregate Area. Although several semivolatile compounds, such as tributyl phosphate and paraffin hydrocarbons, have been disposed of in the cribs, no information is available on whether these compounds are still present in the near surface soil column for transport to the soil surface.

The primary volatile radionuclide of concern is tritium. Exposure to tritium (as tritiated water vapor) and the potential for tritium release via radiolytic production of hydrogen from aqueous radioactive wastes is of concern. The mode of disposal of this material can not be determined from available information.

5.2.4 Migration to Groundwater

Risks that could potentially occur due to migration of contaminants in groundwater to existing or potential receptors will be addressed in the 200 East Groundwater AAMSR and thus, will not be discussed in the PUREX Plant AAMSR. However, the potential for individual units to impact groundwater has been discussed in Section 4.1.

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5.3 ADDITIONAL SCREENING CRITERIA

In addition to determining human health concerns for a worker at each of the waste management units, previously developed site ranking criteria were investigated for the purpose of setting priorities for waste management units and unplanned releases. These criteria are the CERCLA HRS scores assigned during preliminary assessment/site inspection (PA/SI) activities performed for the Hanford Site (DOE/RL 1988), and the rankings assigned by the Westinghouse Hanford Environmental Protection Group to prioritize units needing remedial actions for radiological control (Huckfeldt 1991b).

Both of these ranking systems take into account some measure of hazard and environmental mobility and are thus appropriate to consider for waste management unit prioritization. The HRS ranking system evaluates sites based on their relative risk, taking into account the population at risk, the hazardous waste constituent toxicity and concentration at the facility, the potential for contamination of the environment, the potential risk of fire and explosion, and the potential for exposure associated with humans or animals that come into contact with the waste management unit inventory. The HRS is, thus, appropriate to consider for screening waste management units.

The PA/SI screening was performed using the EPA's HRS and the mHRS. The HRS (40 CFR 300) is a site ranking methodology that was designed to determine whether sites should be placed on the CERCLA National Priorities List (NPL) based on chemical contamination history. The EPA has established the criteria for placement on the NPL to be a score of 28.5 or greater. The HRS criteria used in PA/SI have been revised (December 14, 1990). The HRS scores are only used as available indicators of relative risk; therefore, the revision will not impact the evaluation process. The mHRS is a ranking system developed by the Pacific Northwest Laboratory (PNL) for the U.S. Department of Energy (DOE) that uses the basic methodology of the old (pre-December 1990) HRS; however, it more accurately predicts the impacts from radionuclides. The mHRS takes into account concentration, half-life, and other chemical-specific parameters that are not considered by the old HRS. The mHRS has not been accepted by EPA as a ranking system.

Many of the PUREX Plant Aggregate Area waste management units were ranked in the PA/SI using both the HRS and mHRS. For those waste management units that were not ranked in the PA/SI, unit type and discharge history were evaluated in comparison with ranked units for the purpose of setting priorities. If a waste management unit that has been ranked exhibits similar characteristics (e.g., construction, waste type, and volume), the value for the ranked unit was applied to the unit without an HRS or mHRS score. If no ranked waste management units exhibit similar characteristics, then the unit was not ranked; however, a high or low score was determined qualitatively through evaluation of unit configuration and contamination history.

Table 5-1 lists the HRS and mHRS rankings, as well as scores that were assigned for unranked waste management units, based on their similarity to ranked units in terms of type, construction, and quantity of waste disposed. If no similar waste management units were

available for comparison, the units were not ranked but were assigned a qualitative indicator of migration potential based on engineering judgement considering factors such as type of unit, waste characteristics, and volume of liquid received. Table 5-1 also lists the units scored by the Westinghouse Environmental Protection Group (Huckfeldt 1991b). A score of 7 or greater results in the assignment of a "high" priority to the unit. A value of 7 was chosen to represent the approximate midpoint of the scoring range.

For the HRS ranking, 11 units of the 90 PUREX Plant Aggregate Area waste management units were given a score of 28.5 or greater. For the mHRS ranking, 11 units were given a score of 28.5 or greater (all of which had HRS scores greater than 28.5). Six units received a qualitative "high" score and 40 units received a qualitative "low" score. Each of the units that received a qualitative "high" HRS and mHRS score (four cribs, one control structure, and one ditch) were given such a rating based on their discharge history of large quantities of hazardous materials, which could potentially have been transported to the groundwater. The units that received "low" scores (four cribs, one french drain, one reverse well, seven septic tanks and drain fields, two retention basins, and twenty-five unplanned releases) were given such a ranking because there is no known history of liquid hazardous material disposal that could affect groundwater beneath the PUREX Plant Aggregate Area.

Three of the 90 units were assigned Westinghouse Environmental Protection Group scores of 7 or greater, indicating the need for remedial action.

5.4 SUMMARY OF SCREENING RESULTS

The screening process was used to sort units as either high priority or low priority. Table 5-1 lists the PUREX Plant Aggregate Area waste management units that exceeded one or more of the screening criteria identified in the preceding Sections. In total, 25 units were identified as high priority.

Radiation survey results (dose rate and/or contamination) were available for 46 of the 90 waste management units and unplanned releases. Twenty-nine were reported as having no detectable results. Of the remaining 17 units, 15 had survey results that exceeded one or more of the criteria (2 mrem/h, 100 ct/min beta/gamma, and 20 dis/min alpha).

For the HRS scores, 11 waste management units were given scores of 28.5 or greater. For the mHRS, the same 11 units received a score of 28.5 or greater. Six units received qualitative "high" scores. Three of the 90 units were assigned Westinghouse Environmental Protection Group scores of 7 or greater, indicating the need for remedial action. Some of the sites were designated as high priority for 2 or more of the criteria, hence only 25 total units are designated high priority.

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Table 5-1. Hazard Ranking Scores for PUREX Plant Aggregate Area. (sheet 1 of 6)

Site Name	Site Type	HRS Rating[b]	mHRS Rating[b]	Radiation Surveys ct/min	dis/min	mrem/h	Environmental Protection Score[c]	Priority
Cribs and Drains								
216-A-1	Crib	1.03	0.71	NC	NC	NC	--	No
216-A-2	Crib	4.39	3.19	NC	NC	NC	--	No
216-A-3	Crib	Low	Low	NC	NC	NC	--	No
216-A-4	Crib	47.81	47.81	NC	NC	NC	--	Yes
216-A-5	Crib	60.40	50.42	NC	NC	NC	--	Yes
216-A-6	Crib	47.81	42.14	500[a]	NA	NA	--	Yes
216-A-7	Crib	57.88	42.79	3,000[a]	NA	NA	7	Yes
216-A-8	Crib	High	High	NC	NC	0.01	8	Yes
216-A-9	Crib	57.88	42.79	3,000[a]	NA	NA	--	Yes
216-A-10	Crib	High	High	NC	NC	NC	--	Yes
216-A-21	Crib	57.88	57.88	1,500[a]	NA	NA	--	Yes
216-A-24	Crib	57.88	48.67	NC	NC	NC	--	Yes
216-A-27	Crib	57.88	59.63	NC	NC	NC	--	Yes
216-A-30	Crib	High	High	NC	NC	0.01	--	Yes
216-A-31	Crib	1.03	1.42	NC	NC	NC	--	No
216-A-32	Crib	0.00	0.00	NC	NC	NC	--	No
216-A-36A	Crib	50.33	32.62	NC	NC	NC	--	Yes
216-A-36B	Crib	High	High	NC	NC	NC	--	Yes
216-A-37-1	Crib	Low	Low	NC	NC	NC	--	No
216-A-37-2	Crib	Low	Low	20[a]	500	NA	--	Yes

Table 5-1. Hazard Ranking Scores for PUREX Plant Aggregate Area. (sheet 2 of 6)

Site Name	Site Type	HRS Rating[b]	mHRS Rating[b]	Radiation Surveys ct/min	dis/min	mrem/h	Environmental Protection Score[c]	Priority
216-A-38-1	Crib	NU	NU	NC	NC	NC	--	No
216-A-41	Crib	1.03	0.71	NA	NA	NA	--	No
216-A-45	Crib	Low	Low	NC	NC	NC	--	No
216-A-11	French Drain	1.03	0.71	NC	NC	NC	--	No
216-A-12	French Drain	1.03	0.71	NC	NC	NC	--	No
216-A-13	French Drain	0.71	0.71	NC	NC	NC	--	No
216-A-14	French Drain	1.03	0.71	2,000[d]	56,000	NA	--	Yes
216-A-15	French Drain	1.03	0.55	NC	NC	NC	--	No
216-A-22	French Drain	1.96	1.31	NC	NC	NC	--	No
216-A-26	French Drain	Low	Low	NC	NC	NC	--	No
216-A-26A	French Drain	2.07	1.42	NC	NC	NC	--	No
216-A-28	French Drain	47.81	32.72	1,000[d]	2,300	NA	--	Yes
216-A-33	French Drain	0.00	0.00	NC	NC	NC	--	No
216-A-35	French Drain	1.03	0.71	NC	NC	NC	--	No
Reverse Wells								
299-E24-111	Injection Well	Low	Low	NA	NA	NA	NA	No
Ponds, Ditches and Trenches								
216-A-29	Ditch	High	High	NA	NA	NA	--	Yes
216-A-34	Ditch	1.09	0.76	NC	NC	NC	--	No
216-A-18	Trench	1.03	0.71	NC	NC	NC	--	No
216-A-19	Trench	2.18	1.63	NC	NC	NC	--	No

Table 5-1. Hazard Ranking Scores for PUREX Plant Aggregate Area. (sheet 3 of 6)

Site Name	Site Type	HRS Rating[b]	mHRS Rating[b]	Radiation Surveys ct/min	dis/min	mrem/h	Environmental Protection Score[d]	Priority
216-A-20	Trench	2.07	1.42	NC	NC	NC	--	No
216-A-40	Trench	32.71	32.71	--	--	4	11	Yes
Septic Tanks and Associated Drain Fields								
2607-EA	Septic Tank/Drain Field	Low	Low	NA	NA	NA	--	No
2607-EC	Septic Tank/Drain Field	Low	Low	NA	NA	NA	--	No
2607-ED	Septic Tank/Drain Field	Low	Low	NA	NA	NA	--	No
2607-EG	Septic Tank/Drain Field	Low	Low	NA	NA	NA	--	No
2607-EJ	Septic Tank/Drain Field	Low	Low	NA	NA	NA	--	No
2607-EL	Septic Tank/Drain Field	Low	Low	NA	NA	NA	--	No
2607-E6	Septic Tank/Drain Field	Low	Low	NA	NA	NA	--	No
Transfer Facilities, Diversion Boxes, and Pipelines								
216-A-524	Control Structure	High	High	10,000	NA	0.7	--	Yes
Basins								
207-A	Retention Basin	Low	Low	1,500	NA	NA	--	Yes
216-A-42	Retention Basin	Low	Low	20,000[d]	NA	NA	--	Yes

Table 5-1. Hazard Ranking Scores for PUREX Plant Aggregate Area. (sheet 4 of 6)

Site Name	Site Type	HRS Rating[b]	mHRS Rating[b]	Radiation Surveys ct/min	dis/min	mrem/h	Environmental Protection Score[c]	Priority
Burial Sites								
218-E-1	Burial Ground	0.70	0.50	5,000	--	--	--	Yes
218-E-8	Burial Ground	0.70	0.80	NA	NA	NA	--	No
218-E-12A	Burial Ground	0.70	0.80	2,000[a]	NA	NA	--	Yes
218-E-13	Burial Ground	0.00	0.00	NA	NA	NA	--	No
Unplanned Releases								
UN-200-E-10	Unplanned Release	Low	--	NA	NA	NA	--	No
UN-200-E-11	Unplanned Release	Low	--	NA	NA	NA	--	No
UN-200-E-12	Unplanned Release	1.00	--	NA	NA	NA	--	No
UN-200-E-13	Unplanned Release	Low	--	NA	NA	NA	--	No
UN-200-E-15	Unplanned Release	1.10	--	NA	NA	NA	--	No
UN-200-E-19	Unplanned Release	Low	--	NA	NA	NA	--	No
UN-200-E-20	Unplanned Release	Low	--	NA	NA	NA	--	No
UN-200-E-22	Unplanned Release	Low	--	NA	NA	NA	--	No
UN-200-E-25	Unplanned Release	1.10	--	NA	NA	NA	--	No
UN-200-E-26	Unplanned Release	Low	--	NA	NA	NA	--	No
UN-200-E-28	Unplanned Release	Low	--	NA	NA	NA	--	No
UN-200-E-31	Unplanned Release	1.03	--	NC	NC	NC	--	No
UN-200-E-33	Unplanned Release	Low	--	NA	NA	NA	--	No

Table 5-1. Hazard Ranking Scores for PUREX Plant Aggregate Area. (sheet 5 of 6)

Site Name	Site Type	HRS Rating[b]	mHRS Rating[b]	Radiation Surveys ct/min	dis/min	mrem/h	Environmental Protection Score[c]	Priority
UN-200-E-35	Unplanned Release	Low	--	NA	NA	NA	--	No
UN-200-E-39	Unplanned Release	1.00	--	NA	NA	NA	--	No
UN-200-E-40	Unplanned Release	1.00	--	NA	NA	NA	--	No
UN-200-E-42	Unplanned Release	Low	--	NA	NA	NA	--	No
UN-200-E-49	Unplanned Release	Low	--	NA	NA	NA	--	No
UN-200-E-56	Unplanned Release	Low	--	NA	NA	NA	--	No
UN-200-E-58	Unplanned Release	0.80	--	NA	NA	NA	--	No
UN-200-E-60	Unplanned Release	Low	--	NA	NA	NA	--	No
UN-200-E-62	Unplanned Release	Low	--	NA	NA	NA	--	No
UN-200-E-65	Unplanned Release	Low	--	NA	NA	NA	--	No
UN-200-E-67	Unplanned Release	Low	--	NA	NA	NA	--	No
UN-200-E-68	Unplanned Release	Low	--	NA	NA	NA	--	No
UN-200-E-72	Unplanned Release	Low	--	NA	NA	NA	--	No
UN-200-E-88	Unplanned Release	Low	--	6,000[a]	NA	NA	--	Yes
UN-200-E-94	Unplanned Release	1.00	--	NA	NA	NA	--	No
UN-200-E-96	Unplanned Release	Low	--	NA	NA	NA	--	No
UN-200-E-97	Unplanned Release	Low	--	NA	NA	NA	--	No
UN-200-E-100	Unplanned Release	Low	--	--	--	5	--	Yes
UN-200-E-114	Unplanned Release	Low	--	NA	NA	NA	--	No

Table 5-1. Hazard Ranking Scores for PUREX Plant Aggregate Area. (sheet 6 of 6)

				Radiation Surveys				
Site Name	Site Type	HRS Rating[b]	mHRS Rating[b]	ct/min	dis/min	mrem/h	Environmental Protection Score[c]	Priority
UN-200-E-117	Unplanned Release	1.00	--	NA	NA	NA	--	No
UN-200-E-142	Unplanned Release	Low	--	NA	NA	NA	--	No

NA = No data available.
NC = No contamination.
NU = Not used. Unit was never used.
-- = No information/data available.
[a] = Values derived from converting reported beta/gamma results from dis/min to ct/min.
[b] = A low (high) value was given to those units for which no similarity to other ranked units exist and a qualitative investigation indicates a low (high) score.
[c] = Relative to a maximum environmental protection score of 15.

6.0 POTENTIALLY APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

6.1 INTRODUCTION

The Superfund Amendments and Reauthorization Act (SARA) of 1986 amended the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) to require that all applicable or relevant and appropriate requirements (ARARs) be employed during implementation of a hazardous waste site cleanup. "Applicable" requirements are defined by the U.S. Environmental Protection Agency (EPA) in "CERCLA Compliance with Other Laws Manual" (OSWER Directive 9234.1-01, August 8, 1988) as:

> cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site.

A separate set of "relevant and appropriate" requirements that must be evaluated include:

> cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site.

"To-be-Considered Materials" (TBCs) are nonpromulgated advisories or guidance issued by federal or state governments that are not legally binding and do not have the status of potential ARARs. However, in many circumstances, TBCs will be considered along with potential ARARs and may be used in determining the necessary level of cleanup for protection of health or the environment.

The following sections identify potential ARARs to be used in developing and assessing various remedial action alternatives at the PUREX Plant Aggregate Area. Specific requirements pertaining to hazardous and radiological waste management, remediation of contaminated soils, surface water protection, and air quality will be discussed.

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The potential ARARs focus on federal or state statutes, regulations, criteria, and guidelines. The specific types of potential ARARs evaluated include the following:

- Contaminant-specific
- Location-specific
- Action-specific.

Potential contaminant-specific ARARs are usually health or risk-based numerical values or methodologies that, when applied to site-specific conditions, result in the establishment of numerical contaminant values that are generally recognized by the regulatory agencies as allowable to protect human health and the environment. In the case of the PUREX Plant Aggregate Area, potential contaminant-specific ARARs address chemical constituents and/or radionuclides. The potential contaminant-specific ARARs that were evaluated for the PUREX Plant Aggregate Area are discussed in Section 6.2.

Potential location-specific ARARs are restrictions placed on the concentration of hazardous substances, or the conduct of activities, solely because they occur in specific locations. The potential location-specific ARARs that were evaluated for the PUREX Plant Aggregate Area are discussed in Section 6.3.

Potential action-specific ARARs apply to particular remediation methods and technologies, and are evaluated during the detailed screening and evaluation of remediation alternatives. The potential action-specific ARARs that were evaluated for the PUREX Plant Aggregate Area are discussed in Section 6.4.

The TBC requirements are other federal and state criteria, advisories, and regulatory guidance that are not promulgated regulations, but are to be considered in evaluating alternatives. Potential TBCs include U.S. Department of Energy (DOE) Orders that carry out authority granted under the Atomic Energy Act. All DOE Orders are potentially applicable to operations at the PUREX Plant Aggregate Area. Specific TBC requirements are discussed in Section 6.5.

Potential contaminant- and location-specific ARARs will be refined during the aggregate area management study (AAMS) process. Potential action-specific ARARs are briefly discussed in this section, and will be further evaluated upon final selection of remedial alternatives. The points at which these ARARs must be achieved and the timing of the ARARs evaluations are discussed in Sections 6.6 and 6.7, respectively.

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6.2 CONTAMINANT-SPECIFIC REQUIREMENTS

A contaminant-specific requirement sets concentration limits in various environmental media for specific hazardous substances, pollutants, or contaminants. Based on available information, some of the currently known or suspected contaminants that may be present in the PUREX Plant Aggregate Area are outlined in Table 4-32. The currently identified potential federal and state contaminant-specific ARARs are summarized below.

6.2.1 Federal Requirements

Federal contaminant-specific requirements are specified in several statutes, codified in the U.S. Code (USC), and promulgated in the Code of Federal Regulations (CFR), as follows:

- **Clean Water Act (33 USC 1251).** Federal Water Quality Criteria (FWQC) (40 CFR 131) are developed under the authority of the Clean Water Act (CWA) (33 USC 1251) to serve as guidelines to the states for determining receiving water quality standards. Different FWQC are derived for protection of human health and protection of aquatic life. The human health FWQC are further subdivided according to how people are expected to use the water (e.g., drinking the water versus consuming fish caught from the water). The SARA 121(d)(2) states that remedial actions shall attain FWQC where they are relevant and appropriate, taking into account the designated or potential use of the water, the media affected, the purpose of the criteria, and current information. Many more substances have FWQC than maximum contaminant levels (MCLs) issued under the Safe Drinking Water Act (SDWA, see discussion below); consequently, EPA and other state agencies rely on these criteria more than MCLs, even though these criteria can only be considered relevant and appropriate and not applicable.

  The FWQC would not be considered at the PUREX Plant Aggregate Area, as no natural surface water bodies exist. The only existing man-made surface water bodies at PUREX Plant Aggregate Area are waste management units: the 207-A and the 216-A-42 retention basins.

- **Safe Drinking Water Act (42 USC 300(f)).** Under the authority of the Safe Drinking Water Act (42 USC 300(f)), MCLs (40 CFR 141) apply when the water may be used for drinking. Currently, EPA and the State of Washington apply MCLs as the standards for groundwater contaminants at CERCLA sites that could be used as drinking water sources. Groundwater contamination and application of MCLs as ARARs are addressed under a separate AAMS specific to groundwater.

- **Resource Conservation and Recovery Act (42 USC 6901, 40 CFR 260 to 271).** The Resource Conservation and Recovery Act (RCRA) addresses the generation and transportation of hazardous waste, and waste management activities at

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facilities that treat, store, or dispose of hazardous wastes. Subtitle C (Hazardous Waste Management) mandates the creation of a cradle-to-grave management and permitting system for hazardous wastes. The RCRA defines hazardous wastes (40 CFR 261) as "solid wastes" (even though the waste is often liquid in physical form) that may cause or significantly contribute to an increase in mortality or serious illness, or that poses a substantial hazard to human health or the environment when improperly managed. In Washington State, RCRA is implemented by EPA and the authorized state agency, the Washington State Department of Ecology (Ecology).

The CERCLA Sections 121(d) and 121(e) respectively require that CERCLA activities, including remedial actions, comply with substantive requirements and not administrative requirements such as permitting. Therefore, hazardous waste activities conducted onsite at the PUREX Plant Aggregate Area will comply with the substantive requirements of RCRA, and not permitting requirements of RCRA, which are deemed to be potential ARARs.

Two key potential contaminant-specific potential ARARs have been adopted under the federal hazardous waste regulations: the Toxicity Characteristic Leaching Procedure (TCLP) designation limits promulgated under 40 CFR Part 261; and the hazardous waste land disposal restrictions (LDRs) for constituent concentrations promulgated under 40 CFR Part 268.

The TCLP designation limits define when a waste is hazardous, and are used to determine when more stringent management standards apply than would be applied to typical solid wastes. Thus, the TCLP potential contaminant-specific potential ARARs can be used to determine when RCRA waste management standards may be required. The TCLP limits are presented in Table 6-1.

The LDRs are numerical limits derived by EPA by reviewing available technologies for treating hazardous wastes. Until a prohibited waste can meet the numerical limits, it can be prohibited from land disposal. Two sets of limits have been promulgated: limits for constituent concentrations in waste extract, which uses the TCLP test to obtain a leached sample of the waste; and limits for constituent concentrations in waste, which addresses the total contaminant concentration in the waste. Applicability to CERCLA actions is based on determinations of waste "placement/disposal" during a remediation action. According to OWSER Directive 9347.3-OSFS, EPA concludes that Congress did not intend in situ consolidation, remediations, or improvement of structural stability to constitute placement or disposal. The land disposal numerical limits can be used to determine if generated cleanup wastes can be redisposed of onsite without further treatment, or must be subject to certain treatment practices prior to land disposal. The LDR limits are presented in Table 6-1 (see Section 6.4.1 for further discussion on the applying limits.

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- **Clean Air Act (42 USC 7401).** The Clean Air Act (42 USC 7401) establishes National Primary and Secondary Ambient Air Quality Standards (NAAQS) (40 CFR Part 50), National Emission Standards for Hazardous Air Pollutants (NESHAP) (40 CFR Part 61), and New Source Performance Standards (NSPS) (40 CFR Part 60).

  In general, new and modified stationary sources of air emissions must undergo a preconstruction review to determine whether the construction or modification of any source, such as a CERCLA remedial program, will interfere with attainment or maintenance of NAAQS or fail to meet other new source review requirements including NESHAPs and NSPS. However, the process applies only to "major" sources of air emissions (defined as emissions of 250 tons per year). The PUREX Plant Aggregate Area would not constitute a major source.

  Section 112 of the Clean Air Act directs EPA to establish standards at the level that provides an ample margin of safety to protect the public health from hazardous air pollutants. The NESHAP standards for radionuclides are directly applicable to DOE facilities under Subpart H of Section 112 that establishes a 10 mrem/year facility-wide standard for exposure to an offsite receptor. Further, if the maximum individual dose during remediation exceeds 1% of the NESHAPs standard (0.1 mrem/yr), a report meeting the substantive requirements of an application for approval of construction must be prepared.

6.2.2 State of Washington Requirements

Potential state contaminant-specific requirements are specified in several statutes, codified in the Revised Code of Washington (RCW) and promulgated in the Washington Administrative Code (WAC).

- **Model Toxics Control Act (RCW 70.105D, Chapter 173-340 WAC).** The Model Toxics Control Act (MTCA) (RCW 70.105D) authorized Ecology to adopt cleanup standards for remedial actions at hazardous waste sites. These regulations are considered potential ARARs for soil, groundwater, and surface water cleanup actions. The processes for identifying, investigating, and cleaning up hazardous waste sites are defined and cleanup levels are set for groundwater, soil, surface water, and air in Chapter 173-340 WAC.

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Under the MTCA regulations, cleanup standards may be established by one of three methods.

- Method A may be used if a routine cleanup action, as defined in WAC 173-340-200, is being conducted at the site or relatively few hazardous substances are involved for which cleanup standards have been specified by Tables 1, 2, or 3 of WAC 173-340-720 through -745.

- Under Method B, a risk level of 10^{-6} is established and a risk calculation based on contaminants present is determined.

- Method C cleanup standards represent concentrations that are protective of human health and the environment for specified site uses. Method C cleanup standards may be established where it can be demonstrated that such standards comply with applicable state and federal laws, that all practical methods of treatment are used, that institutional controls are implemented, and that one of the following conditions exist: (1) Method A or B standards are below background concentrations; (2) Method A or Method B results in a significantly greater threat to human health or the environment; (3) Method A or Method B standards are below technically possible concentrations, or (4) the site is defined as an industrial site for purposes of soil remediation.

Table 1 of Method A addresses groundwater, so it is not considered to be an ARAR for the PUREX Plant Aggregate Area (groundwater will be addressed in the 200 East Groundwater Aggregate Area Management Study Report). Table 2 of Method A is intended for non-industrial site soil cleanups, and Table 3 is intended for industrial site soil cleanups. Method A industrial soil cleanup standards for preliminary contaminants of concern are provided as potential ARARs in Table 6-1.

- **State Hazardous Waste Management Act and Dangerous Waste Regulations (Chapter 173-303 WAC).** The State of Washington is a RCRA-authorized state for hazardous waste management, and has developed state-specific hazardous waste regulations under the authority of the State Hazardous Waste Management Act. Generally, state hazardous waste regulations (WAC 173-303) parallel the federal regulations. The state definition of a hazardous waste incorporates the EPA designation of hazardous waste that is based on the compound being specifically listed as hazardous, or on the waste exhibiting the properties of reactivity, ignitability, corrosivity, or toxicity as determined by the TCLP.

In addition, Washington State identifies other waste as hazardous. Three unique criteria are established: toxic dangerous waste; persistent dangerous waste; and

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carcinogenic dangerous waste. These additional designation criteria may be imposed by Ecology as potential ARARs, for purposes of determining acceptable cleanup standards and appropriate waste management standards.

- **Ambient Air Quality Standards and Emission Limits for Radionuclides (Chapter 173-480 WAC).** These Ecology ambient air quality standards specify maximum accumulated dose limits to members of the public. Other Air Quality Standards potentially applicable include carbon monoxide, ozone, nitrogen dioxide (WAC 173-475), and volatile organic compounds (VOCs) (WAC 173-490). Although these standards may be potential ARARs, these standards are less restrictive than DOE public dose limits per DOE Order 5400.5, Radiation Protection of the Public and the Environment.

- **Monitoring and Enforcement of Air Quality and Emission Standards for Radionuclides (Chapters 246-247 WAC).** These standards by the Washington State Department of Health (Health) adopt the Ecology standards for maximum accumulated dose limits to members of the public. These standards apply to DOE facilities as provided in WAC 246-247-010 (2).

- **Controls for New Sources of Toxic Air Pollutants (Chapter 173-460 WAC).** In accordance with regulations recently promulgated by Ecology in Chapter 173-460 WAC, any new emission source will be subject to Toxic Air Pollutant emission standards. The regulations establish acceptable source impact levels (ASILs) for hundreds of organic and inorganic compounds. Ecology's ASILs may constitute potential ARARs for cleanup activities that have a potential to affect air. The ASILs for preliminary contaminants of concern are provided in Table 6-1.

- **Water Quality Standards.** Washington State has promulgated various numerical standards related to surface water and groundwater contaminants. These are included principally in the following regulations:

  - **Public Water Supplies (Chapter 248-54 WAC).** This regulation establishes drinking water standards for public water supplies. The standards essentially parallel the federal drinking water standards (40 CFR Parts 141 and 143).

  - **Water Quality Standards for Groundwaters of the State of Washington (RCW 90.48, Chapter 173-200 WAC).** This regulation establishes contaminant standards for protecting existing and future beneficial uses of groundwater through the reduction or elimination of the discharge of contaminants to the state's groundwater.

- **Water Quality Standards for Surface Waters of the State of Washington (Chapter 173-201 WAC and Proposed Amendments to Chapters 173-203 and 173-201 WAC).** Ecology has adopted numerical ambient water quality criteria for six conventional pollutant parameters (defined at WAC 173-201-025): (1) fecal coliform bacteria; (2) dissolved oxygen; (3) total dissolved gas; (4) temperature; (5) pH; and (6) turbidity. In addition, toxic, radioactive, or deleterious material concentrations shall be below those of public health significance or which may cause acute or chronic toxic conditions to the aquatic environment or which may adversely affect any water use. Numerical criteria currently exist for a limited number of toxic substances (WAC 173-201-047). Ecology has initiated rulemaking to modify and incorporate additional numerical criteria for toxic chemicals, and to reclassify certain waters of the state to Class A or better.

  Under the state Water Quality Standards, the criteria and classifications do not apply inside an authorized dilution zone surrounding a wastewater discharge. In defining dilution zones, Ecology generally follows guidelines contained in "Criteria for Sewage Works Design." Although water quality standards can be exceeded inside the dilution zone, state regulations will not permit discharges that cause mortalities of fish or shellfish within the zone or that diminish aesthetic values.

These water quality standards do not constitute ARARs for purposes of establishing cleanup standards for the PUREX Plant Aggregate Area.

Groundwater will be addressed in the 200 East Groundwater AAMSR in which pertinent groundwater-related potential ARARs will be covered. No surface water bodies exist within the PUREX Plant Aggregate Area, so there will be no need to achieve ambient water quality standards during remediation activities.

The numerical water quality standards cited above may become potential ARARs if selected remedial actions could result in discharges to groundwater or surface water (e.g., if treated wastewaters are discharged to the soil column or the Columbia River). Determining appropriate standards for such discharges will depend on the type of remediation performed and will have to be established on a case-by-case basis as remedial actions are defined.

- **National Pollutant Discharge Elimination System and Water Quality Standards (RCW 90.48, WAC 173-220 and 40 CFR 122).** National Pollutant Discharge Elimination System (NPDES) regulations govern point source discharges into navigable waters. Limits on the concentrations of contaminants and volumetric flowrates that may be discharged are determined on a case-by-case

basis and permitted under this program. No point source discharges have been identified. The EPA implements this program in Washington State for federal facilities; however, assumption of the NPDES program by the state is likely within five years.

6.3 LOCATION-SPECIFIC REQUIREMENTS

Potential location-specific ARARs are restrictions placed on the concentration of hazardous substances or the conduct of activities solely because they are in specific locations. Some examples of special locations include floodplains, wetlands, historic places, and sensitive ecosystems or habitats.

Table 6-2 lists various location-specific standards and indicates which of these may be potential ARARs. Potential ARARs have been identified as follows:

- **Floodplains.** Requirements for protecting floodplains are not ARARs for activities conducted within the PUREX Plant Aggregate Area as the aggregate area is not located in flood plain boundaries (see Section 3.1). However, remedial actions selected for cleanup may require projects in or near floodplains (e.g., construction of a treatment facility outfall at the Columbia River). In such cases, location-specific floodplain requirements may be potential ARARs.

- **Wetlands, Shorelines, and Rivers and Streams.** Requirements related to wetlands, shorelines, and rivers and streams are not ARARs for activities conducted within the PUREX Plant Aggregate Area. However, remedial actions selected for cleanup may require projects on a shoreline or wetland, or discharges to wetlands (e.g., construction of a treatment facility outfall at the Columbia River). In such cases, location-specific shoreline and wetlands requirements may be potential ARARs.

- **Threatened and Endangered Species Habitats.** As discussed in Section 3.6, various threatened and endangered species inhabit portions of the Hanford Site and may occur in the PUREX Plant Aggregate Area (American peregrine falcon, bald eagle, white pelican, and sandhill crane). Therefore, critical habitat protection for these species would constitute a potential ARAR.

- **Wild and Scenic Rivers.** The Columbia River Hanford Reach is currently undergoing study pursuant to the federal Wild and Scenic Rivers Act. Pending results of this study, actions that may impact the Hanford Reach may be restricted. This requirement would not be an ARAR for remedial activities within the PUREX Plant Aggregate Area. However, Wild and Scenic Rivers Act requirements may be potential ARARs for actions taken as a result of PUREX Plant Aggregate Area cleanup efforts that could affect the Hanford Reach.

6.4 ACTION-SPECIFIC REQUIREMENTS

Potential action-specific ARARs are requirements that are triggered by specific remedial actions at the site. These remedial actions will not be fully defined until a remedial approach has been selected. However, the universe of potential action-specific ARARs defined by a preliminary screening of potential remedial action alternatives will help focus the selection process. Potential action-specific ARARs are outlined below. (Note that potential contaminant- and potential location-specific ARARs discussed above will also include provisions for potential action-specific ARARs to be applied once the remedial action is selected.)

6.4.1 Federal Requirements

- **Comprehensive Environmental Response, Compensation, and Liability Act (42 USC 9601).** The CERCLA and regulations adopted pursuant to CERCLA contained in the National Contingency Plan (40 CFR Part 300) include selection criteria for remedial actions. Under the criteria, excavation and offsite land disposal options are least favored when onsite treatment options are available. Emphasis is placed on alternatives that permanently treat or immobilize contamination. Selected alternatives must be protective of human health and the environment, which implies that federal and state ARARs be met. However, a remedy may be selected that does not meet all ARARs if the requirement is technically impractical, if its implementation would produce a greater risk to human health or the environment, if an equivalent level of protection can otherwise be provided, if state standards are inconsistently applied, or if the remedy is only part of a complete remedial action which attains ARARs.

  The CERCLA gives state cleanup standards essentially equal importance as federal standards in guiding cleanup measures in cases where state standards are more stringent. State standards pertain only if they are generally applicable, were passed through formal means, were adopted on the basis of hydrologic, geologic, or other pertinent considerations, and do not preclude the option of land disposal by a state-wide ban. Most importantly, CERCLA provides that cleanup of a site must ensure that public health and the environment are protected. Selected remedies should meet all ARARs, but issues such as cost-effectiveness must be weighed in the selection process.

- **Resource Conservation and Recovery Act (42 USC 6901, 40 CFR 260 to 271).** The RCRA (42 USC 6901), and regulations adopted pursuant to RCRA, describe numerous action-specific requirements that may be potential ARARs for cleanup activities. The primary regulations are promulgated under 40 CFR Parts 262

(standards for generators), 264, and 265 (standards for owners and operators of hazardous waste treatment, storage, or disposal facilities), and include such action-specific requirements as follows:

- Packaging, labeling, placarding, and manifesting of offsite waste shipments

- Inspecting waste management areas to ensure proper performance and safe conditions

- Preparation of plans and procedures to train personnel and respond to emergencies

- Management standards for containers, tanks, incinerators, and treatment units

- Design and performance standards for land disposal facilities

- Groundwater monitoring system design and performance.

Many of these requirements will depend on the particular remediation activity undertaken, and will have to be identified as remediation proceeds.

One key area of potential action-specific RCRA ARARs is the 40 CFR Part 268 LDRs. In addition to the contaminant-specific constituent concentration limits established in the LDRs (as previously discussed in Section 6.2), EPA has identified best demonstrated available treatment technologies (BDATs) for various waste streams. The EPA could require the use of BDATs prior to allowing land disposal of wastes generated during remediation. The EPA's imposition of the LDRs and BDAT requirements will depend on various factors.

Applicability to CERCLA actions is based on determinations of waste "placement/disposal" during a remediation action. According to OSWER Directive 9347.3-05FS, EPA concludes that Congress did not intend in situ consolidation, remediation, or improvement of structural stability to constitute placement or disposal. Placement or disposal would be considered to occur if:

- Wastes from different units are consolidated into one unit (other than a land disposal unit within an area of contamination)

- Waste is removed and treated outside a unit and redeposited into the same or another unit (other than a land disposal unit within an area of contamination)

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- Waste is picked up from a unit and treated within the area of contamination in an incinerator, surface impoundment, or tank and then redeposited into the unit (except for in situ treatment).

Consequently, the requirement to use BDAT would not apply under the LDR standards unless placement or disposal had occurred. However, remediation actions involving excavation and treatment could trigger the requirements to use BDAT for wastes subject to the LDR standards. In addition, the agencies could consider BDAT technologies to be relevant and appropriate when developing and evaluating potential remediation technologies.

Two additional components of the LDR program should be considered with regard to an excavate and treat remedial action. First, a national capacity variance was issued by EPA for contaminated soil and debris for a two-year period ending May 8, 1992 (54 FR 26640). Second, a series of variances and exemptions may be applied under an excavate and treat scenario. These include the following:

- A no-migration petition
- A case-by-case extension to an effective date
- A treatability variance
- Mixed waste provisions of a Federal Facilities Compliance Act.

The applicability and relevance of each of these options will vary based on the specific details of a PUREX Plant Aggregate Area excavate and treat option. An analysis of these variances can be developed once engineering data on the option becomes available.

The effect of the LDR program on mixed waste management is significant. Currently, limited technologies are available for effective treatment of these waste streams and no commercially available treatment facilities exist except for liquid scintillation counting fluids used for laboratory analysis and testing. The EPA recognized that inadequate capacity exists and issued a national capacity variance until May 8, 1992, to allow for the development of such treatment capacity.

Lack of treatment and disposal capacity also presents implications for storage of these materials. Under 40 CFR 268.50, mixed wastes subject to LDR may be stored for up to one year. Beyond one year, the owner/operator has the burden of proving such storage is for accumulating sufficient quantities for treatment. On August 29, 1991, EPA issued a mixed waste storage enforcement policy providing some relief from this provision for generators of small volumes of mixed wastes. However, the policy was limited to facilities generating less

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than 28 m^3 (1,000 ft^3) of land disposal-prohibited waste per year. Congress is considering amendments to RCRA postponing the storage prohibition for another five years; however, final action on these amendments has not occurred.

- **Clean Water Act (33 USC 1251).** Regulations adopted pursuant to the CWA (33 USC 1251) under the NPDES mandate use of best available treatment technologies (BAT) prior to discharging contaminants to surface waters. The NPDES requirements would not be ARARs for actions conducted only within the PUREX Plant Aggregate Area. However, NPDES requirements could constitute potential ARARs for cleanup actions which would result in discharge of treated wastewaters to the Columbia River, and associated treatment systems could be required to utilize BAT.

- **Department of Transportation Standards (49 CFR 171 to 177).** The Department of Transportation standards contained in 49 CFR 171 to 177 specify the requirements for packaging, labeling, and placarding for offsite transport of hazardous materials. These standards ensure that hazardous substances and wastes are safely transported using adequate means of transport and proper documentation.

6.4.2 State of Washington Requirements

- **Hazardous Waste Management (WAC 173-303).** As discussed in Section 6.2.2, there are various requirements addressing the management of hazardous wastes that may be potential action-specific ARARs. Pertinent Washington regulations appear in Chapter 173-303 WAC (under the authority of RCW 70.105) and generally parallel federal management standards. Determination of potential ARARs will be on a case-by-case basis as cleanup actions proceed.

- **Solid Waste Management (WAC 173-304).** Washington State regulations describe management standards for solid waste in Chapter 173-304 WAC (under the authority of RCW 70.95). Some of these management standards may be potential ARARs for disposal of cleanup wastes within the PUREX Plant Aggregate Area. Solid waste standards include such requirements as follows:

  - Inspecting waste management areas to ensure proper performance and safe conditions

  - Management standards for incinerators and treatment units

  - Design and performance standards for landfills

  - Groundwater monitoring system design and performance.

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Many of these requirements will depend on the particular remediation activity undertaken, and will have to be identified as remediation proceeds.

- **Water Quality Management.** Chapter 90.48 RCW, the Washington State Water Pollution Control Act (WPCA), requires use of all known, available, and reasonable treatment technologies (AKART) for treating contaminants prior to discharge to waters of the state. Implementing regulations appear principally at Chapters 173-216, 173-220, and 173-240 WAC.

  The WPCA requirements for groundwater could be potential ARARs for actions conducted within the PUREX Plant Aggregate Area if such actions would result in discharge of liquid contaminants to the soil column. In this event, Ecology would require use of AKART to treat the liquid discharges prior to soil disposal.

  The WPCA requirements for surface water would not be ARARs for actions conducted only within the PUREX Plant Aggregate Area. However, these requirements could potentially constitute ARARs for cleanup actions that would result in discharge of treated wastewaters to the Columbia River and associated treatment systems could be required to demonstrate they meet AKART.

- **Air Quality Management (RCW 70.94).** Under the authority of the Washington Clean Air Act (RCW 70.94) the Toxic Air Pollution regulations for new air emission sources, promulgated in Chapter 173-460 WAC, require use of best available control technology for air toxics (T-BACT). The Toxic Air Pollution regulations may be potential ARARs for cleanup actions at the PUREX Plant Aggregate Area that could result in emissions of toxic contaminants to the air. Ecology may require the use of T-BACT to treat such air emissions.

- **Water Well Construction (RCW 18.104).** This regulation establishes authority for Ecology to require the licensing of water well contractors and operators, and for the regulation of water well construction.

- **Nuclear Energy and Radiation (RCW 70.98).** Chapter 70.98 RCW establishes a program to establish procedures for assumption and performance of certain regulatory responsibilities with respect to byproduct, source, and special nuclear materials.

- **Pollution Disclosure Act (RCW 90.52).** Chapter 90.52 RCW describes the authority of the state to regulate reports for any commercial or industrial discharge, other than sanitary sewage, into waters of the state.

- **Water Resources Act (RCW 90.54).** Chapter 90.54 RCW gives the state authority to implement water related resources programs.

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- **Minimum Standards for Construction and Maintenance of Wells (Chapter 173-160 WAC).** Well construction regulations establish minimum standards for water well construction and require the preparation of construction reports.

- **Rules and Regulations Governing the Licensing of Well Contractors and Operators (Chapter 173-162 WAC).** Chapter 173-162 WAC establishes requirements for licensing well drillers.

- **State Waste Discharge Permit Program (Chapter 173-216 WAC).** Chapter 173-216 WAC establishes a permit system for discharges of wastewater to groundwater and surface water via municipal sewage system.

- **Underground Injection Control Program (Chapter 173-218 WAC).** Chapter 173-218 WAC pertains to the injection of wastes into aquifers that are used for drinking water.

- **Incinerators (Chapter 173-303-170 WAC).** If incinerators are used for a remedial technology this regulation would be applicable.

6.5 OTHER CRITERIA AND GUIDANCE TO BE CONSIDERED

In addition to the potential ARARs presented, other federal and state criteria, advisories, guidance, and similar materials are TBC in determining the appropriate degree of remediation for the PUREX Plant Aggregate Area. A myriad of resources may be potentially evaluated. The following represents an initial assessment of pertinent TBC provisions.

6.5.1 Health Advisories

The EPA Office of Drinking Water publishes advisories identifying contaminants for which health advisories have been issued.

6.5.2 International Commission of Radiation Protection/National Council on Radiation Protection

The International Commission of Radiation Protection and the National Council on Radiation Protection have a guidance standard of 100 mrem/yr whole body dose of gamma radiation. These organizations also issue recommendations on other areas of interest regarding radiation protection.

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6.5.3 Environmental Protection Agency Proposed Corrective Actions for Solid Waste Management Units

In the July 27, 1990, federal register (55 FR 30798), EPA published proposed regulations for performing corrective actions (cleanup activities) at solid waste management units associated with RCRA facilities. The proposed 40 CFR Part 264 Subpart S include requirements that would be TBCs for determining an appropriate level of cleanup at the PUREX Plant Aggregate Area. In particular, EPA included an appendix, "Appendix A - Examples of Concentrations Meeting Criteria for Action Levels," which presented recommended contaminant concentrations warranting corrective action. These contaminant-specific TBCs are included in Table 6-1 for the preliminary contaminants of concern.

6.5.4 Department of Energy Standards for Radiation Protection

A number of DOE Orders exist which could be TBCs. The DOE Orders that establish potential contaminant-specific or action-specific standards for the remediation of radioactive wastes and materials are discussed below.

- **DOE Order 5400.5 - DOE Standards for Radiation Protection of the Public and Environment.** The DOE Order 5400.5 establishes the requirements for DOE facilities to protect the environment and human health from radiation including soil and air contamination. The purpose of the Order is to establish standards and requirements for operations of the DOE and DOE contractors with respect to protection of members of the public and the environment against undue risk from radiation.

  The Order mandates that the exposure to members of the public from a radiation source as a consequence of routine activities shall not exceed 100 mrem/yr from all exposure sources due to routine DOE activities. In accordance with the Clean Air Act, exposures resulting from airborne emissions shall not exceed 10 mrem/yr to the maximally exposed individual at the facility boundary. The DOE Order 5400.5 provides Derived Concentration Guide (DCG) values for releases of radionuclides into the air or water. The DCG values are calculated so that, under conditions of continuous exposure, an individual would receive an effective dose equivalent of 100 mrem/yr. Because dispersion in air or water is not accounted for in the DCG, actual exposures of maximally exposed individuals in unrestricted areas are considerably below the 100 mrem/yr level.

  The DOE Order 5400.5 also provides for establishment of soil cleanup levels through a site-specific pathway analysis such as the allowable residual contamination level method. The calculation of allowable residual contamination level values for radionuclides is dependent on the physical characteristics of the site, the radiation dose limit determined to be acceptable, and the scenarios of human exposure judged to be possible and to result in the upper-bound exposure.

- **DOE Order 5820.2A - Radioactive Waste Management.** The DOE Order 5820.2A applies to all DOE contractors and subcontractors performing work that involves management of waste containing radioactivity. This Order requires that wastes be managed in a manner that assures protection of the health and safety of the public, operating personnel, and the environment. The DOE Order 5820.2A establishes requirements for management of high-level, transuranic, and low-level wastes as well as wastes containing naturally occurring or accelerator produced radioactive material, and for decommissioning of facilities. The requirements applicable to the PUREX Plant Aggregate Area remediation activities include those related to transuranic waste and low-level radioactive waste. These are summarized below.

  - **Management of Transuranic Waste.** Transuranic (TRU) waste resulting from the PUREX Plant Aggregate Area remedial action must be managed to protect the public and worker health and safety, and the environment, and performed in compliance with applicable radiation protection standards and environmental regulations. Practical and cost-effective methods must be used to reduce the volume and toxicity of TRU waste.

    The TRU waste must be certified in compliance with the Waste Isolation Pilot Plant (WIPP) Acceptance Criteria, placed in interim storage, if required, and sent to the WIPP. Any TRU waste that the DOE has determined, with the concurrence of the EPA Administrator, does not need the degree of isolation provided by a geologic repository or TRU waste that cannot be certified or otherwise approved for acceptance at the WIPP must be disposed of by alternative methods. Alternative disposal methods must be approved by DOE Headquarters and comply with NEPA requirements and EPA/state regulations.

  - **Management of Low-Level Radioactive Waste.** The requirements for management of low-level radioactive waste presented in DOE Order 5820.2A are relevant to the remedial alternative of removal and disposal of PUREX Plant Aggregate Area wastes. Performance objectives for this option shall ensure that external exposure to the radioactive material released into surface water, groundwater, soil, plants, and animals does not result in an effective dose greater than 25 mrem/yr to the public. Releases to the environment shall be at levels as low as reasonably achievable. An inadvertent intruder after the institutional control period of 100 years is not to exceed 100 mrem/yr for continuous exposure or 500 mrem for a single acute exposure. A performance assessment is to be prepared to demonstrate compliance with the above performance objectives.

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Other requirements under DOE Order 5820.2A which may affect remediation of the PUREX Plant Aggregate Area include waste volume minimization, waste characterization, waste acceptance criteria, waste treatment, and shipment. The low-level radioactive waste may be stored by appropriate methods prior to disposal to achieve the performance objectives discussed above. Disposal site selection, closure/post-closure, and monitoring requirements are also discussed in this Order.

6.6 POINT OF APPLICABILITY

A significant factor in the evaluation of remedial alternatives for the PUREX Plant Aggregate Area will be the determination of the point at which compliance with identified ARARs must be achieved (i.e., the point of a specific ARAR's applicability). These points of applicability are the boundaries at which the effectiveness of a particular remedial alternative will be assessed.

For most individual radioactive species transported by either water or air, Ecology and Health standards generally require compliance at the boundaries of the Hanford Site (e.g., Clean Air Act, Section 6.2.1). The assumed point of compliance for radioactive species is the point where a member of the public would have unrestricted access to live and conduct business, and, consequently, to be maximally exposed. Although Health is responsible for monitoring and enforcing the air standards promulgated by Ecology, and generally recognizes the site boundary as the point of applicability, Ecology has recently indicated that compliance may be required at the point of emission.

The point at which compliance with identified ARARs must be achieved will be a significant factor in evaluating appropriate remedial alternatives in the PUREX Plant Aggregate Area. Applicability of ARARs at the point of discharge, at the boundary of the disposal unit, at the boundary of the AAMS, at the boundary of the Hanford Site, and/or at the point of maximum exposure will need to be determined.

6.7 POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS EVALUATION

Evaluation of ARARs is an iterative process that will be conducted at multiple points throughout the remedial process:

- When the public health evaluation is conducted to assess risks at the PUREX Plant Aggregate Area, the contaminant-specific ARARs and advisories and location-specific ARARs will be identified more comprehensively and used to help determine the cleanup goals.

- During detailed analysis of alternatives, all the ARARs and advisories for each alternative will be examined to determine what is needed to comply with other laws and to be protective of public health and the environment.

Following completion of the investigation, the remedial alternative selected must be able to attain all ARARs unless one of the six statutory waivers provided in Section 121 (d)(4)(A) through (f) of CERCLA is invoked. Finally, during remedial design, the technical specifications of construction must ensure attainment of ARARs. The six reasons ARARs can be waived are as follows:

- The remedial action is an interim measure, where the final remedy will attain ARARs upon completion.

- Compliance will result in greater risk to human health and the environment than will other options.

- Compliance is technically impractical.

- An alternative remedial action will attain the equivalent performance of the ARAR.

- For state ARARs, the state has not consistently applied (or demonstrated the intention to consistently apply) the requirements in similar circumstances.

- For CERCLA-financed actions under Section 104, compliance with the ARAR will not provide a balance between the need for protecting public health, welfare, and the environment at the facility, and the need for fund money to respond to other sites (this waiver is not applicable at the Hanford Site).

Once investigations have been completed and final remedies have been selected, the ARARs that must be met will be formally identified in the Record of Decision (ROD). Compliance with those ARARs specified in the ROD will be achieved through the remedial action. The ARARs may need to be reevaluated if unanticipated circumstances are encountered during remediation which prevent the ability to satisfy the identified ARARs.

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Table 6-1. Potential Contaminant-Specific ARARs and TBCs for Preliminary Inorganic and Organic Contaminants of Concern.

	RCRA TCLP Designation Limits	RCRA Land Ban Limits Nonwastewater		MTCA Method A Cleanup Levels Industrial Soil	WCAA Toxic Air Pollutants ASIL	RCRA Corrective Action Levels (Proposed) (1)	
	in mg/L	CCWE in mg/L	CCW in mg/kg	in mg/kg	in $\mu g/m^3$	Air in $\mu g/m^3$	Soil in mg/kg
INORGANIC CHEMICALS							
Arsenic	5.0	5.0	—	200	.00023[b/]	0.00007	80
Barium	100	100	—	—	1.7*	0.4	4,000
Beryllium	-	-	-	-	.00042**	.0004	.02
Boron	—	—	—	—	***	—	—
Cadmium	1.0	1.0	—	10	.00056[a/b/]	0.0006	40
Chromium	5.0	5.0	—	500	.000083[b/]	0.00009	40
Copper	—	—	—	—	3.3[a/]	—	—
Cyanide (total)	—	—	590	—	16.7	—	2,000
Fluoride	—	—	—	—	8.3[a/]	—	—
Iron	-	-	-	-	2.7	-	-
Lead	5.0	5.0	—	1,000	0.2	—	—
Manganese	—	—	—	—	16.7	—	—
Mercury	0.2	0.20 (low-level)	—	1.0	0.3[a/]	—	20
Nickel	—	-	—	—	3.3[a/]	—	2,000
Nitrite	—	—	—	—	—	—	—
Silver	5.0	5.0	-	-	0.03	-	200
Vanadium	—	—	—	—	0.2[b/]	—	—
Zinc	—	—	—	—	0.03	—	—
ORGANIC CHEMICALS							
Acetone	—	0.5g	160	—	5,927.4[a/]	—	8,000
Chloroform	6.0	-	5.6	—	0.043[b/]	0.04	100
Hydrazine	-	-	-	-	-	0.0002	0.2
Methylene chloride	—	0.96	0.33	0.5	2.0	0.3	90
Toluene	—	0.33	28	40.6	1,248.8	7,000	20,000

ASIL = Acceptable Source Impact Level
CCWE = Constituent Concentration in Waste Extract
CCW = Constituent Concentration in Waste
MTCA = Washington State Model Toxics Control Act
RCRA = Federal Resource Conservation and Recovery Act
TCLP = Toxic Characteristic Leaching Procedure
WCAA = Washington State Clean Air Act

a/ Cadmium and compounds
b/ as V205

mg/L = milligrams per liter
mg/kg = milligrams per kilogram
$\mu g/m^3$ = micrograms per cubic meter

(1) RCRA Corrective Action Levels are only proposed at this time (40 CFR Part 264 Subpart S), so are not ARARs yet; they are "To Be Considered."

* Soluble compounds Ba
** Beryllium and compounds
*** Borontrifluoride - 10.0

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Table 6-2. Potential Location-Specific ARARs. (sheet 1 of 6)

Location	Requirement	Prerequisite	Citation
GEOLOGICAL:			
Within 154 m (500 ft) of a fault displaced in Holocene time.	New treatment, storage or disposal of hazardous waste prohibited.	Hazardous waste management near Holocene fault.	40 CFR 264.18; WAC 173-303-282
Holocene faults and subsidence areas.	New solid waste disposal facilities prohibited over faults with displacement in Holocene time, and in subsidence areas.	New solid waste management activities near Holocene fault.	WAC 173-304-130
Unstable slopes.	New solid waste disposal areas prohibited from hills with unstable slopes.	New solid waste disposal on an unstable slope.	WAC 173-304-130
100-year floodplains.	Solid and hazardous waste disposal facilities must be designed, built, operated, and maintained to prevent washout.	Solid or hazardous waste disposal in a 100-year floodplain.	40 CFR 264.18; WAC 173-303-282; WAC 173-304-460
	Avoid adverse effects, minimize potential harm, restore/preserve natural and beneficial values in floodplains.	Actions occurring in a floodplain.	40 CFR Part 6 Subpart A; 16 USC 661 et seq; 40 CFR 6.302
Salt dome and salt bed formations, underground mines, and caves.	Placement of non-containerized or bulk liquid hazardous wastes is prohibited.	Hazardous waste placement in salt dome, salt bed, mine, or cave.	40 CFR 264.18
SURFACE WATER:			
Wetlands.	New hazardous waste disposal facilities prohibited in wetlands.	Hazardous waste management within 154 m (500 ft) of wetland (one-quarter mile for land-based facilities).	WAC 173-303-282
	New solid waste disposal facilities prohibited within 61 m (200 ft) of surface water (stream, lake, pond, river, salt water body).	Solid waste disposal within 61 m (200 ft) of surface water.	WAC 173-304-130
	New solid waste disposal facilities prohibited in wetlands (swamps, marshes, bogs, estuaries, and similar areas).	Solid waste disposal in a wetland (swamp, marsh, bog, estuary, etc.).	WAC 173-304-130

Table 6-2. Potential Location-Specific ARARs. (sheet 2 of 6)

Location	Requirement	Prerequisite	Citation
	Discharge of dredged or fill materials into wetlands prohibited without a permit.	Discharges to wetlands and navigable waters.	40 CFR Part 230; 33 CFR Parts 303, and 320 to 330
	Minimize potential harm, avoid adverse effects, preserve and enhance wetlands.	Construction or management of property in wetlands.	40 CFR Part 6 Appendix A
Shorelines.	Actions prohibited within 61 m (200 ft) of shorelines of statewide significance unless permitted.	Actions near shorelines.	Chapter 90.58 RCW; Chapter 173-14 WAC.
Rivers and streams.	Avoid diversion, channeling or other actions that modify streams or rivers, or adversely affect fish or wildlife habitats and water resources.	Actions modifying a stream or river and affecting fish or wildlife.	40 CFR 6.302
Water code and water rights.	Specifies conditions for extracting surface water for non-domestic uses. In essence, the laws provide that water extraction must be consistent with beneficial uses of the resource and must not be wasteful.	Extracting surface water.	Chapter 90.03 RCW
GROUNDWATER:			
Water code and water rights.	Specifies conditions for extracting groundwater for non-domestic uses. In essence, the laws provide that water extraction must be consistent with beneficial uses of the resource and must not be wasteful.	Extracting groundwater.	Chapter 90.14 RCW
Sole source aquifer.	New solid and hazardous waste land disposal facilities prohibited over a sole source aquifer.	Disposal over a sole source aquifer.	WAC 173-303-282; WAC 173-304-130

Table 6-2. Potential Location-Specific ARARs. (sheet 3 of 6)

Location	Requirement	Prerequisite	Citation
Uppermost aquifer.	Bottom of lowest liner of new solid waste disposal facility must be at least 3 m (10 ft) above seasonal high water in uppermost aquifer (5 ft) if hydraulic gradient controls installed).	New solid waste disposal.	WAC 173-304-130
	Protects the upper aquifers and upper aquifer zones to avoid depletions, excessive water level declines, or reductions in water quality. State regulations for upper aquifer zones are applicable to remedial alternatives that involve treating groundwater or presenting risks of groundwater contamination.	Activities within an aquifer.	Chapter 173-154 WAC
	Requires that Ecology review and approve plans for waste water treatment facilities that discharge to groundwater.	New treatment facilities discharging to the groundwater.	Chapter 173-240 WAC
Aquifer Protection Areas.	Activities restricted within designated Aquifer Protection Areas.	Activities within an Aquifer Protection Area.	Chapter 36.36 RCW.
Groundwater Management Areas.	Activities restricted within Ground Water Management Areas.	Activities within a Groundwater Management Area.	Chapter 90.44 RCW; Chapter 173-100 WAC
DRINKING WATER SUPPLY:			
Drinking water supply well.	New solid waste disposal areas prohibited within 305 m (1,000) feet upgradient, or 90 days travel time, of drinking water supply well.	New solid waste disposal within 305 m (1,000 feet) of drinking water supply well.	WAC 173-304-130
Watershed.	New solid waste disposal areas prohibited within a watershed used by a public water supply system for municipal drinking water.	New solid waste disposal in a public watershed.	WAC 173-304-130

Table 6-2. Potential Location-Specific ARARs. (sheet 4 of 6)

Location	Requirement	Prerequisite	Citation
AIR:			
Attainment areas.	Defines emissions standards and design and operation of solid waste incinerator facilities.	Activities in an attainment area.	Chapter 173-434 WAC
	Defines when certification of operators is necessary at incinerators and landfills.	Activities in an attainment area.	Chapter 173-300 WAC
Non-attainment areas.	Restrictions on air emissions in areas designated as non-attainment areas under state and federal air quality programs.	Activities in a designated non-attainment area.	Chapter 70.94 RCW; Chapters 173-400 and 173-403 WAC.
SENSITIVE ENVIRONMENTS:			
Endangered/threatened species habitats.	New solid waste disposal prohibited from areas designated by US Fish and Wildlife Service as critical habitats for endangered/ threatened species.	New solid waste disposal in critical habitats.	WAC 173-304-130 16 U.S.C. 742 16 U.S.C. 2901 50 C.F.R. 17
	Actions within critical habitats must conserve endangered/threatened species.	Activities where endangered or threatened species exist.	50 CFR Parts 200 and 402.
Parks.	No new solid waste disposal areas within 305 m (1,000 feet) of state or national park.	New solid waste disposal near state/national park.	WAC 173-304-130
	Restrictions on activities in areas that are designated state parks, or recreation/ conservation areas.	Activities in state parks or recreation/conservation areas.	Chapter 43.51 RCW; Chapter 352.32 WAC
Wilderness areas.	Actions within designated wilderness areas must ensure area is preserved and not impaired.	Activities within designated wilderness areas.	16 USC 1131 et seq; 50 CFR 35.1 et seq
Wildlife refuge.	Restrictions on actions in areas that are part of the National Wildlife Refuge System.	Activities within designated wildlife refuges.	16 USC 668dd et seq; 50 CFR Part 27

Table 6-2. Potential Location-Specific ARARs. (sheet 5 of 6)

Location	Requirement	Prerequisite	Citation
Natural areas preserves.	Activities restricted in areas designated as having special habitat value (Natural Heritage Resources).	Activities within identified Natural Area Preserves.	Chapter 79.70 RCW; Chapter 332-650 WAC
Wild, scenic, or recreational rivers.	Avoid actions that would have adverse effects on designated wild, scenic, or recreational rivers.	Activities near wild, scenic, and recreational rivers.	16 USC 1271 et seq; 40 CFR 6.302; Chapter 79.72 RCW
Columbia River Gorge	Restrictions on activities that could affect resources in the Columbia River Gorge.	Activities within the Columbia River Gorge.	Chapter 43.97 RCW
UNIQUE LANDS AND PROPERTIES:			
Natural resource conservation areas.	Restrictions on activities within designated Conservation Areas.	Activities within designated Conservation Areas.	Chapter 79.71 RCW
Forest lands.	Activities restricted within state forest lands to minimize fire hazards and other adverse impacts.	Activities within state forest lands.	Chapter 76.04 RCW; Chapter 332-24 WAC
	Restrictions on activities in state and federal forest lands.	Activities within state and federal forest lands.	16 USC 1601; Chapter 76.09 RCW
Public lands.	Activities on public lands are restricted, regulated, or proscribed.	Activities on state-owned lands	Chapter 79.01 RCW
Scenic vistas.	Restrictions on activities that can occur in designated scenic areas.	Activities in designated scenic vista areas.	Chapter 47.42 RCW 16 U.S.C. 461
Historic areas.	Actions must be taken to preserve and recover significant artifacts, preserve historic and archaeologic properties and resources, and minimize harm to national landmarks.	Activities that could affect historic or archaeologic sites or artifacts.	16 UST 469, 470 et seq; 36 CFR Parts 65 and 800; Chapters 27.34, 27.53, and 27.58 RCW.

Table 6-2. Potential Location-Specific ARARs. (sheet 6 of 6)

Location	Requirement	Prerequisite	Citation
LAND USE:			
Neighboring properties.	No new solid waste disposal areas within 30.5 m (100 feet) of the facility's property line.	New solid waste disposal within 30.5 m (100 feet) of facility property line.	WAC 173-304-130
	No new solid waste disposal areas within 76 m (250 feet) of property line of residential zone properties.	New solid waste disposal within 76 m (250 feet) of property line of residential property.	WAC 173-304-130
Proximity to airports.	Disposal of garbage that could attract birds prohibited within 3,050 m (10,000 ft) (turbojet aircraft)/1,524 m (5,000 ft) (piston-type aircraft) of airport runways.	Garbage disposal near airport.	WAC 173-304-130

7.0 PRELIMINARY REMEDIAL ACTION TECHNOLOGIES

Previous sections identified contaminants of concern at the PUREX Plant Aggregate Area, potential routes of exposure, and potentially applicable or relevant and appropriate requirements (ARARs). Section 7.0 identifies preliminary remedial action objectives (RAOs) and develops preliminary remedial action alternatives consistent with reducing the potential hazards of this contamination and satisfying potential ARARs. The overall objective of this section is to identify viable and innovative remedial action alternatives for media of concern at the PUREX Plant Aggregate Area.

The process of identifying viable remedial action alternatives consists of several steps. In Section 7.1, RAOs are first identified. Next, in Section 7.2, general response actions are determined along with specific treatment, resource recovery, and containment technologies within the general response categories. Specific process options belonging to each technology type are identified, and these process options are subsequently screened based on their effectiveness, implementability, and cost (Section 7.3). The combining of process options into alternatives occurs in Section 7.4. Here the alternatives are described and diagrammed. Criteria are then identified in Section 7.5 for preliminary screening of alternatives that may be applicable to the waste management units and unplanned release sites identified in the PUREX Plant Aggregate Area. Figure 7-1 is a matrix summarizing the development of the remedial action alternatives starting with media-specific RAOs.

Because of uncertainty regarding the nature and extent of contamination at the PUREX Plant Aggregate Area waste management units, recommendations for remedial alternatives are general and cover a broad range of actions. Remedial action alternatives will be considered and more fully developed in future focused feasibility studies (FFS). The *Hanford Site Past-Practice Strategy* (DOE/RL 1992a) is used to focus the range of remedial action alternatives that will be evaluated in focused studies. In general, the *Hanford Site Past-Practice Strategy* remedial investigation (RI)/Feasibility Study (FS) and the Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI)/Corrective Measures Studies (CMS) are defined as the combination of interim remedial measures (IRMs), limited field investigations (LFIs) for final remedy selection where interim actions are not clearly justified, and focused or aggregate area feasibility/treatability studies for further evaluation of treatment alternatives. After completion of an IRM, data will be evaluated including concurrent characterization and monitoring data to determine if a final remedy can be selected.

A secondary purpose of the evaluation of preliminary remedial action alternatives is the identification of additional information needed to complete the evaluation. This information may include field data needs and treatability tests of selected technologies. Additional data will be developed for most waste management units or waste groups during future data gathering activities (e.g., LFIs, characterization supporting IRMs, or treatability studies). These data may be used to refine and supplement the RAOs and proposed alternatives

identified in this initial study. Data needs are defined in Section 8.0. Alternatives involving technologies that are not well-demonstrated under the conditions of interest are identified in Sections 7.3 and 7.5. These technologies may require bench-scale and pilot-scale treatability studies. The intent is to conduct treatability studies for promising technologies early in the RI/FS process. Conclusions regarding the feasibility of some individual technologies may change after new data become available.

The bias-for-action philosophy of addressing contamination at the Hanford Site requires an expedited process for implementing remedial actions. Implementation of general response actions may be accomplished using an observational approach in which the implementation is redirected as information is obtained. This observational approach is an iterative process of data acquisition and refinement of the conceptual model. Data needs are determined by the model, and data collected to fulfill these needs are used as additional input to the model. Use of the observational approach while conducting response actions in the 200 Areas will allow integrating these actions with longer range objectives of final remediation of similar areas and the entire 200 Areas. Site characterization and remediation data will be collected concurrently with the use of LFIs, IRMs, and treatability testing. The knowledge gained through these different activities will be applied to similar areas. The overall goal of this approach is convergence on an appropriate response action as early as possible while continuing to obtain valuable characterization information during remediation phases.

7.1 PRELIMINARY REMEDIAL ACTION OBJECTIVES

The RAOs are remediation goals for protection of human health and the environment that specify the contaminants and media of concern, exposure pathways, and allowable contaminant levels. The RAOs discussed in this section are considered to be preliminary and may change or be refined as new data are acquired and evaluated.

The fundamental objective of the corrective action process at the PUREX Plant Aggregate Area is to protect environmental resources and/or human receptors from the potential threats that may exist because of known or suspected contamination. Specific interim and final RAOs will depend in part on current and reasonable potential future land use in the PUREX Plant Aggregate Area and the 200 East Area. The RAOs also take into account the preference under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) for permanent isolation and permanent or significant reduction of volume, toxicity, or mobility of hazardous substances.

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To focus remedial actions with a bias for action through implementing IRMs, preliminary RAOs are identified for the 200 East Area and PUREX Plant Aggregate Area. The overall objective for the 200 East Area is as follows:

> Reduce the risk of harmful effects to the environment and human users of the area by isolating and permanently reducing the toxicity, mobility, or volume of contaminants from the source areas to meet ARARs or risk-based levels that will allow industrial use of the area (this is a potential final RAO, and an interim action objective based on current use of the 200 Areas).

The RAOs are further developed in Table 7-1 for media of concern and applicable exposure pathways (see Sections 4.1 and 4.2) for the PUREX Plant Aggregate Area. The media of concern for the PUREX Plant Aggregate Area include the following:

- Radionuclide-contaminated and chemically contaminated soils that could result in direct exposure or inhalation of vapors or particles
- Contaminated soils that are or could contribute to groundwater contamination
- Vadose zone vapors that could cause ambient air impacts or contribute to the lateral and vertical migration of contaminants in the soil and to the groundwater
- Biota that could mobilize radionuclides or chemical contaminants directly or could degrade the integrity of other controls, such as caps thereby mobilizing contaminants.

Waste materials currently stored in single-shell tanks that contribute or may contribute contaminants to environmental media will not be addressed by this aggregate area management study (AAMS) program but rather by the Single-Shell Tank Closure Program. In addition, groundwater as an exposure medium is not addressed in this source Aggregate Area Management Study Report (AAMSR), but is discussed in the 200-East Groundwater AAMSR.

7.2 PRELIMINARY GENERAL RESPONSE ACTIONS

General response actions represent broad classes of remedial measures that may be appropriate to achieve both interim and final RAOs at the PUREX Plant Aggregate Area, and are presented in Table 7-2. The following are the general response actions for the PUREX Plant Aggregate Area followed by a brief description:

- No action (applicable to specific facilities)
- Institutional controls

- Waste removal and treatment or disposal
- Waste containment
- In-situ waste treatment
- Combinations of the above actions.

These general response actions are intended to cover the range of options from no action to complete remediation. Included are options that satisfy the CERCLA preference for isolation and permanent or significant reduction in volume, mobility, and toxicity of hazardous substances. No action is included for evaluations as required by the National Environmental Policy Act (NEPA) and National Contingency Plan (NCP) [40 CFR 300.68 (f)(l)(v)] to provide a baseline for comparison with other response actions. The no action alternative may be appropriate for some facilities and sources of contamination if risk assessments determine acceptable natural resource or human health risks posed by those sources or facilities and no exceedances of contaminant-specific ARARs occur.

Institutional controls involve the use of physical barriers or access restrictions to reduce or eliminate public exposure to contamination. Many access and land use restrictions are currently in place at the Hanford Site and will remain in place during implementation of IRMs. Because the 200 Areas are already committed to waste management for the long term, institutional controls will also be important for final remedial measures alternatives.

Waste removal and treatment or disposal involves excavation of contamination sources for eventual treatment and/or disposal either on a small- or large-scale basis. One approach being considered for large-scale waste removal is macro-engineering, which is based on high volume excavation using conventional surface mining technologies. Waste removal on a macro-engineering scale would be used over large areas such as groups of waste management units, operable units, or operational areas as a final remedial action. Waste removal on a small scale would be conducted for individual waste management units on a selective basis. Small-scale waste removal could be conducted as either an interim or final remedial action.

The alternatives for disposal of the excavated waste would depend on the volume of soil and the nature of the contaminants:

- Soil that contained low levels of radionuclides but no hazardous chemical waste could be disposed of into existing disposal sites at Hanford, or it could be shipped to licensed offsite disposal sites.
- Soil that contained chemical contaminants but no radionuclides could be disposed of at existing offsite RCRA-approved landfills, or disposed of onsite in a Hanford RCRA-approved landfill.

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- Soil that was designated as "mixed waste" with both low-level radionuclides and hazardous chemical contaminants would have to be disposed of at Hanford.

- There are currently no facilities at the Hanford Site or offsite for permanent geologic disposal of transuranic (TRU) waste. If such soil was excavated, it would have to be temporarily stored at Hanford until a geologic repository disposal site was licensed and constructed or another disposal option is identified.

One potential problem with off-site radioactive waste disposal is the lack of an alternate disposal location that will decrease the potential human exposure over the long time required for many of the contaminants. Waste removal actions may not be needed, or only be required on a small scale, to protect human health or the environment for industrial uses of the 200 Areas.

Waste treatment involves the use of biological, thermal, physical, or chemical technologies. Typical treatment options include biological land farming, thermal processing, soil washing, and fixation/solidification/stabilization. As described in Section 7.3, some of the technologies that have been used as industrial sites may not be feasible at the Hanford Site. Some treatment technologies must be pilot tested before they could be implemented. Waste treatment could be conducted either as an interim or final action and may be appropriate in meeting RAOs for all potential future land uses.

Waste containment includes the use of capping technologies (i.e., capping and grouting) to minimize the driving force for downward or lateral migration of contaminants. Vertical barriers can also be used to minimize lateral migration and to prevent biota from penetrating into contaminated areas. Containment also provides a radiation exposure barrier and a barrier to direct exposure. In addition, these barriers provide long-term stability with relatively low maintenance requirements. Containment actions may be appropriate for either interim or final remedial actions.

In-situ waste treatment includes thermal, chemical, physical, and biological technology types, of which there are several specific process options including in-situ vitrification, in-situ grouting or stabilization, soil flushing, and in-situ biotreatment. The distinguishing feature of in-situ treatment technologies is the ability to attain RAOs without removing the wastes. The final waste form generally remains in place. This feature is advantageous when exposure during excavation would be significant or when excavation is technically impractical. In-situ treatment can be difficult because the process conditions may not be easily controlled.

In the next section, specific process options within these technology groups are evaluated.

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7.3 TECHNOLOGY SCREENING

In this section, potentially applicable technology types and process options are identified. These process options are then screened using effectiveness, implementability, and relative cost as criteria to eliminate those process options that would not be feasible at the site. The remaining applicable processes are then grouped into remedial alternatives in Section 7.4.

The effectiveness criteria focuses on: (1) the potential effectiveness of process options in handling the areas or volumes of media and meeting the RAOs; (2) the potential impacts to human health and the environment during the construction and implementation phase; and (3) how proven and reliable the process is with respect to the contaminants and conditions at the site. This criteria also concentrates on the ability of a process option to treat a contaminant type (organics, inorganics, metals, radionuclides, etc.) rather than a specific contaminant (nitrate, cyanide, chromium, plutonium, etc.).

The implementability criteria places greater emphasis on the institutional aspects of implementability, such as the ability to obtain necessary permits for offsite actions, the availability of treatment, storage, and disposal services, and the availability of necessary equipment and skilled workers to implement the technology. It also focuses on the process option's developmental status, whether it is an experimental or established technology.

The relative cost criterion is an estimate of the overall cost of a process, including capital and operating costs. At this stage in the process, the cost analysis is made on the basis of engineering judgement, and each process is evaluated as to whether the costs are high, medium, or low relative to other process options.

A process option is rated effective if it can handle the amount of area or media required, if it does not impact human health or the environment during the construction and implementation phases, and if it is a proven or reliable process with respect to the contaminants and conditions at the site. Also a process option is considered more effective if it treats a wide range of contaminants rather than a specific contaminant. An example of a very effective process option would be vitrification because it treats inorganics, metals, and radionuclides. On the other hand, chemical reduction may only treat chromium (VI), making it a less useful option.

An easily implemented process option is one that is an established technology, uses readily available equipment and skilled workers, uses treatment, storage, and disposal services that are readily available, and has few regulatory constraints. Preference is given to technologies that are easily implemented.

Preference is given to lower cost options, but cost is not an exclusionary criterion. A process option is not eliminated based on cost alone.

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Results of the screening process are shown in Table 7-3. Brief descriptions are given of the process options, followed by comments regarding the evaluation criteria. The last column of the table indicates whether the process option is rejected or carried forward for possible alternative formation. The table first lists technologies that address soil RAOs. Next, technologies pertaining to biota RAOs are presented. All the biota-specific technologies happen to be technologies that were listed for soil RAOs. Air RAOs are dealt with as soil remediation issues because the air contamination is a result of the contaminants in the soil: addressing and remediating the air pathways would be unnecessary and ineffective as long as there is soil contamination. If the soil is remediated, the source of the air contamination would be removed.

The conclusions column of Table 7-3 indicates that no action, monitoring, 3 institutional process options, and 16 other process options are retained for further development of alternatives. These options are carried forward into the development of preliminary alternatives.

7.4 PRELIMINARY REMEDIAL ACTION ALTERNATIVES

This section develops and describes several remedial alternatives considered applicable to disposal sites that contain hazardous chemicals, radionuclides, and volatile and semivolatile organic compounds (VOCs). These alternatives are not intended as recommended actions for any individual waste management units, but are intended only to provide potential options applicable to most units where multiple contaminants are present. Selection of actual remedial alternatives that should be applied to the individual units would be partly based on future expedited or interim actions and LFIs, as recommended in Section 9.0 of this report. Selection of proper alternatives would be conducted within the framework of the *Hanford Site Past-Practice Strategy* (DOE/RL 1992a) and the strategy outlined in Section 9.4. The selection process would also be based on a preference for isolation and permanent treatment.

The remedial alternatives are developed in Section 7.4.1. Then, in Section 7.4.2 through Section 7.4.7, the remedial action alternatives are described. Detailed evaluations and costs are not provided because site-specific conditions must be further investigated before meaningful evaluations could be conducted.

7.4.1 Development of Remedial Alternatives

Potentially feasible remedial technologies were described and evaluated in Section 7.3. Some of those technologies have been proven to be effective and constructible at industrial waste management units, while other technologies are in the developmental stages. The EPA guidance (EPA 1988b) on FSs for uncontrolled waste management units recommends that a

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limited number of candidate technologies be grouped into "Remedial Alternatives." For this study, technologies were combined to develop remedial alternatives and provide at least one alternative for each of the following general strategies:

- No action
- Institutional controls
- Removal, above-ground treatment, and disposal
- Containment
- In-situ treatment.

The alternatives are intended to treat all or a major component of the PUREX Plant Aggregate Area contaminated waste management units or unplanned releases. Consistent with the development of RAOs and technologies, alternatives were developed based on treating classes of compounds (radionuclides, heavy metals, inorganics, and organics) rather than specific contaminants. At a minimum, the alternative must be a complete package. For example, disposal of radionuclide-contaminated soil must be combined with excavation and backfilling of the excavated unit.

One important factor in the development of the preliminary remedial action alternatives is the fact that radionuclides, heavy metals, and some inorganic compounds cannot be destroyed. Rather, these compounds must be physically immobilized, contained, isolated, or chemically converted to less mobile forms to satisfy RAOs. Organic compounds can be destroyed, but may represent a smaller portion of the overall contamination at the PUREX Plant Aggregate Area. Both no action and institutional control options are required to be considered as part of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) RI/FS guidance. The purpose of including both of these alternatives is to provide decision makers with information on the entire range of available remedial actions.

For the containment alternative, an engineered multimedia cover, with or without vertical barriers (depending on the specifics of the remediation) was selected. Two alternatives were selected to represent the excavation and treatment strategy. One of these deals with disposal of TRU contaminated soils. Finally, three in-situ alternatives were identified. One deals with vapor extraction for VOCs, one with stabilization of soils and the other with vitrification of soils.

It is recognized that this does not represent an exhaustive list of all applicable alternatives. However, these do provide a reasonable range of remedial actions that are likely to be evaluated in future FSs. The remedial action alternatives are summarized as follows:

- No action
- Institutional controls
- Engineered multimedia cover with or without vertical barriers (containment); Feasible vertical barriers include slurry walls and grout curtains
- In-situ grouting or stabilization of soil (in-situ treatment)
- Excavation, above-ground treatment, and disposal of soil (removal, treatment and disposal); Feasible technologies for organic compounds include thermal processing and stabilization; Feasible technologies for radionuclides include soil washing, vitrification, and stabilization
- In-situ vitrification of soil (in-situ treatment)
- Excavation, treatment, and geologic disposal of soil with TRU radionuclides (removal, treatment, and disposal)
- In-situ soil vapor extraction of VOCs (in-situ treatment).

These alternatives, with the exception of no action and institutional controls, were developed because they satisfy a number of RAOs simultaneously and use technologies that are appropriate for a wide range of contaminant types. For example, constructing an engineered multimedia cover may effectively contain radionuclides, heavy metals, inorganic compounds, and organic compounds simultaneously. It satisfies the RAO of protecting human health and the environment from direct exposures from contaminated soil, bio-mobilization, and airborne contaminants. In-situ soil vapor extraction is more specific than the other alternatives, but it addresses a contaminant class (VOCs) that is not readily treated using the other options, such as in-situ stabilization. It is possible that some waste management units may require a combination of the identified alternatives to completely address all contaminants.

The use of contaminant-specific remedial technologies was avoided because there appear to be few, if any, waste management units where a single contaminant has been identified. It is possible to construct alternatives that include several contaminant-specific technologies, but the number of combinations of technologies would result in an unmanageable number of alternatives. Moreover, the possible presence of unidentified contaminants may render specific alternatives unusable. Alternatives may be refined as more

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contamination data are acquired. For now, the alternatives will be directed at remediating the major classes of compounds (radionuclides, heavy metals, inorganics, and organics).

In all alternatives except the no-action alternative, it is assumed that monitoring and institutional controls are required, although they may be temporary. These features are not explicitly mentioned, and details are purposely omitted until a more detailed evaluation may be performed in subsequent studies. Also, treatability studies may accompany many of the alternative during implementation.

In the next sections, the preliminary remedial action alternatives are described in more detail, with the exception of the no-action and institutional control options.

7.4.2 Alternative 1--Engineered Multimedia Cover with or without Vertical Barriers

Alternative 1 consists of an engineered multimedia cover. Vertical barriers such as grout curtains or slurry walls may be used in conjunction with the cover. Figure 7-2 shows a schematic diagram of an engineered multimedia cover with the vertical barriers. If the affected area includes either a naturally occurring or engineered depression, then imported backfill would be placed to control runoff and run-on water. The engineered cover itself may consist of fine-grained soil, gravel, sand, asphalt, top soil, and/or geo-synthetic liners. A liquid collection layer could also be included. The specific design of the cover and vertical barriers would be the subject of a focused feasibility study (FFS) which may be supported by treatability studies and performance testing. The barrier would be designed to minimize infiltration of surface water and to minimize biological intrusion (e.g., deep-rooting plants and burrowing animals). The covered area may be fenced, and warning signs may be posted.

Alternative 1 would provide a permanent cover over the affected area. The cover would accomplish the following: minimize the migration of precipitation into the affected soil; reduce the migration of windblown dust that originated from contaminated surface soils; reduce the potential for direct exposure to contamination and reduce the volatilization of VOCs and tritium to the atmosphere. If vertical barriers are included, they would limit the amount of lateral migration of contaminants.

This alternative would not reduce the volume or toxicity of the contaminants, and periodic inspections, maintenance, and monitoring would be required for an indefinite period.

7.4.3 Alternative 2--In-situ Grouting or Stabilization of Soil

Radioactive and hazardous soil would be grouted in this alternative using in-situ injection methods to significantly reduce the leachability of hazardous contaminants, radionuclides and/or VOCs from the affected soil. This technology has not been proven to

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be effective for VOCs, so it is not recommended as the sole remedial action for VOC affected areas. Grouting may also be used to fill voids, such as in cribs, thereby reducing subsidence. Another variation of this alternative would be to stabilize the soil using in-situ mixing of soil with stabilizing compounds such as pozzolanics or fly ash.

There are two common methods of in-situ grout injection that have been used at industrial sites. In the first method (shown on Figure 7-3), grout injection wells are installed at prescribed lateral spacing (based on pilot tests) and screened through the affected vertical zones. Specially formulated grout is then injected at high pressure, to provide overlapping zones of influence, and allowed to cure. This first method can theoretically be used to stabilize soil deep below the ground surface. In the second method, a patented large diameter auger/mixer is used to mechanically agitate and blend grout mixtures that are injected into the soil through ports in the auger. This method has commonly been used to grout large areas of soil down to a depth of about 4.6 m (15 ft).

Alternative 2 would provide a combination of immobilization and containment of heavy metal, radionuclide, and inorganic, and semivolatile organic contamination. Thus, this alternative would reduce migration of precipitation into the affected soil; reduce the migration of windblown dust that originated from contaminated surface soils; reduce the potential for direct exposure to contaminated soils; and reduce the volatilization of VOCs.

In-situ grouting has been demonstrated to be effective for stabilization of metals and semivolatile organic compounds at several CERCLA sites. However, this is considered to be a developing technology and has not yet been fully proven. Therefore, it is expected that treatability tests would be required. Because this alternative would not remove the contaminants from the soil, it is likely that institutional controls might also be required.

7.4.4 Alternative 3--Excavation, Soil Treatment, and Disposal

Under Alternative 3, radioactive and hazardous soil would be excavated using conventional techniques, with special precautions to minimize fugitive dust generation. Depending on the configuration of the area to be excavated, shoring might be required to comply with safety requirements and to reduce the quantity of excavated soil. The excavated soil would be treated above ground. Several treatment options could be selected from the physical, chemical, and thermal treatment process options screened in Section 7.3. For example, thermal desorption with off-gas treatment could be used if organic compounds are present; soil washing could be used to remove contaminated silts and sands or specific compounds; and stabilization could be used to immobilize radionuclides and heavy metals. The specific treatment method would depend on site-specific conditions. Treatability tests wold be performed to determine the specific soil treatment protocols methodology. The treated soil would be backfilled into the original excavation or landfilled. Soil treatment by-products may require additional processing or treatment. Figure 7-4 shows a schematic diagram of this alternative.

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Alternative 3 would be effective in treating a full range of contamination, depending on the type of treatment processes selected. Attainment of soil RAOs would depend on the depth to which the soil was excavated. If near surface soil was treated, airborne contamination, direct exposure to contaminated soil, and bio-mobilization of contamination would be minimized. Because of practical limits on deep excavation, deep contamination may not be removed and would be subject to migration into groundwater. Alternative 3 could be used in conjunction with Alternative 1 (multimedia cap) to reduce this possibility.

A combination of laboratory treatability tests and pilot-scale field tests might be required to develop the optimum methods for above-ground treatment of the excavated soil. The specification of the required treatability test would depend on the nature of the contaminants at each of the remediation sites.

7.4.5 Alternative 4--In-Situ Vitrification of Soil

In this alternative, the contaminated soil in a subject site would be immobilized by in-situ vitrification. Treatability tests would be performed initially to determine the unit-specific operating conditions. Figure 7-5 shows a schematic diagram of the alternative. Import fill would initially be placed over the affected area to reduce exposures to the remediation workers from surface contamination. High power electrodes would be used to vitrify the contaminated soil under the site to a depth below where contamination is present. A large fume hood would be constructed over the site before the start of the vitrification process to collect and treat emissions. After completion of the vitrification, the site would be built back to original grade with imported backfill. Fences and warning signs may be placed around the vitrified monolith to minimize disturbance and potential exposure.

In-situ vitrification would be effective in treating radionuclides, heavy metals, and inorganic contamination and may also destroy organic contaminants. This would reduce the potential for exposures by leaching to groundwater, windblown dust and direct dermal contact. However, this alternative would not reduce the mass or toxicity of the radionuclides present onsite. Also, in-situ vitrification may be limited to depths of less than about 30 m (100 ft), which may not be adequate to immobilize deep contamination.

If organic compounds are present in the affected area, they could migrate laterally and vertically during the vitrification process, as a result of the soil heating process. Therefore, this technology must include provisions for collecting and treating organic vapors. This could be done using a combination of soil venting wells and an above-ground capture hood.

It should be noted that the in-situ vitrification is a relatively new technology which is experiencing some "growing pains," and has not yet been used for a large-scale cleanup at an industrial site. Tests to date have not exceeded depths of 6 m (20 ft). Therefore, using this technology at the Hanford Site will likely require extensive pilot testing.

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7.4.6 Alternative 5--Excavation, Above-Ground Treatment, and Geologic Disposal of Soil with Transuranic Radionuclides

Some of the waste management units in the PUREX Plant Aggregate Area may contain isolated zones where the concentrations of TRU radionuclides exceed 100nCi/g. For Alternative 5, the soil from those isolated zones would be excavated, stabilized or treated, and shipped to an offsite geologic disposal site. Such a disposal facility has not yet been licensed, so interim storage of the stabilized soil may be required until the facility is constructed.

Figure 7-6 shows a schematic diagram of Alternative 5. Depending on the configuration of the affected area, shoring may be required during excavation to comply with worker safety regulations and to minimize the amount of excavated soil. Special excavation procedures would have to be used to minimize fugitive dust. The excavated soil would be sorted according to its TRU concentration. Soil with TRU radionuclides exceeding 100 nCi/g would be either vitrified or stabilized using an above-ground treatment plant, then stored until a geologic disposal facility was available.

Some of the excavated soil could contain TRU radionuclides at concentrations less than 100 nCi/g and could be treated using a combination of the technologies described in Section 7.3. After the non-TRU soil was treated to achieve appropriate cleanup standards, it could be backfilled into the original excavation. Alternatively, the non-TRU soil could be disposed of at an appropriate landfill. Imported fill material would be used to restore the unit to its original grade. If the residual unexcavated soil or the treated soil used for backfill contained contaminants at concentrations exceeding the RAOs, then a combination of an engineered cover and vertical barriers (Alternative 1) might have to be installed at the unit to prevent direct exposure or groundwater impacts.

This alternative would utilize many excavation and treatment technologies that have been only partly demonstrated at industrial sites. Extensive treatability testing would be required for the TRU-containing soil to develop optimum methods for treating or stabilizing the TRU radionuclides. Additional treatability studies might be required to support the above-ground treatment of the non-TRU soil.

For Alternative 5, soil containing TRU radionuclides at concentrations exceeding 100 nCi/g would be excavated, treated, and disposed. Thus, potential exposure to and migration of TRU-wastes would be minimized. Potential exposure to other contaminants would be determined by other remedial alternatives implemented. At sites containing TRU and non-TRU wastes, the use of Alternative 5 alone may not satisfy all RAOs.

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7.4.7 Alternative 6--In-situ Soil Vapor Extraction for Volatile Organic Compounds

Figure 7-7 shows a schematic diagram of a representative soil vapor extraction system. Soil vapor is vented from wells that are screened in permeable soil zones that contain high organic vapor concentrations. The vented air would be treated to remove water vapor, the organic vapor of concern, particulate radionuclides that might be entrained in the air stream, and volatile radionuclides. Figure 7-7 shows one common combination of offgas treatment technologies; other technologies can also be used depending on the nature of the vapors that are extracted. Water vapor must be removed (usually by condensation) to protect the vacuum pumps. If the condensed water contains organic contamination or radionuclides, then it would have to be treated and/or disposed of in an appropriate manner. Particulate radionuclides that were entrained in the air stream can be effectively removed using banks of conventional High Efficiency Particulate Air (HEPA) filters. The organic vapors would have to be treated to satisfy Best Available Control Technology (BACT) in accordance with air toxics regulations. If the disposal site is considered a RCRA facility, then the offgas treatment system must also satisfy RCRA emission control standards. Destruction efficiencies exceeding 98% have often been achieved using soil vapor extraction systems at industrial sites. The required destruction efficiency will be determined based on applicable ARARs.

A pilot-scale test would probably have to be performed to determine the required venting well spacing and the required vacuum pump design. Analysis of the vented gas during the pilot test would be done to assess what types of offgas emission controls would be required.

Some of the waste management units at the PUREX Plant Aggregate Area contain VOCs along with other non-volatile contaminants. Alternative 6 utilizes proven technologies to remove the volatilized vapors from the vadose zone soil. In-situ soil vapor extraction is a proven technology for removal of VOC from the vadose zone soils although some pilot-scale testing may be needed at specific units. Soil vapor extraction would reduce downward migration of the VOC vapors through the vadose zone, and thereby minimize potential cross-media migration into the groundwater. Soil vapor extraction would reduce upward migration of VOC through the soil column into the atmosphere, and thereby minimize inhalation exposures to the contaminants. In some cases the radionuclides were discharged to the waste management units with VOCs (e.g., MIBK). Removal of the VOC by implementing soil vapor extraction could reduce the mobility of the radionuclides, and thereby reduce the potential for downward migration of the radionuclides. Finally, soil vapor extraction would enhance partitioning of the VOC off of the soil and into the vented air stream, resulting in the permanent removal and destruction of the VOC. Alternative 6 may be used in conjunction with other alternatives if contaminants other than VOCs are present. However, because of the limited number of PUREX Plant Aggregate Area units that contain VOCs, the use of soil vapor extraction will not be extensive.

7.5 PRELIMINARY REMEDIAL ACTION ALTERNATIVES APPLICABLE TO WASTE MANAGEMENT UNITS AND UNPLANNED RELEASE SITES

The purpose of this section is to discuss which preliminary remedial action alternatives could be used to remediate each PUREX Plant Aggregate Area waste management unit or unplanned release site. The criteria used for deciding this are as follows:

- Installing an engineered multimedia cover with or without vertical barriers (Alternative 1) could be used on any site where contaminants may be leached or mobilized by surface water infiltration or if surface/near-surface contamination exists.

- In-situ grouting or stabilization (Alternative 2) could be used on any waste management unit or unplanned release site that contain heavy metals, radionuclides, and/or other inorganic compounds. In-situ grouting could also be effective in filling voids for subsidence control.

- Excavation and soil treatment (Alternative 3) could be used at most waste management units or unplanned release sites that contain radionuclides, heavy metals, other inorganics compounds, semi-volatile organic compounds, and VOCs.

- In-situ vitrification (Alternative 4) could be used at most waste management units or unplanned release sites, although vapor extraction may be needed when VOCs are present. Waste management units or unplanned release sites where in-situ vitrification may not be effective include reverse wells and other sites where the contamination is present in a very narrow geometry. In-situ vitrification is also not considered for surface spills.

- Excavation, treatment, and geologic disposal of TRU-containing soils (Alternative 5) could only be used on those waste management units and unplanned release sites that contain TRU radionuclides. Since a geologic repository is likely to accept only TRU radioactive soils, the non-TRU radioactive soils will not be remediated using this alternative.

- In-situ soil vapor extraction (Alternative 6) could be used on any waste management unit or unplanned release site that contains volatile organic compounds. Such sites are not common in the PUREX Plant Aggregate Area. Nonetheless, the 216-A-8 Crib, where butyl phosphate and/or paraffin hydrocarbons were disposed, is one site at which soil vapor extraction would be an effective remedy.

Using these criteria, Table 7-4 was created showing possible preliminary remedial action alternatives that could be used to remediate each of the waste management units and

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unplanned release sites. Each waste management unit or unplanned release may require just one alternative or a combination of many alternatives. Furthermore, similar units may be remediated simultaneously. Also, more specific waste treatment alternatives could be identified and evaluated as more information is obtained. Note that a single alternative may not be sufficient to remediate all contamination at a single waste management unit or unplanned release site. For example, soil vapor extraction could precede in-situ vitrification to remove organic contaminants. Also, different combinations of technologies are possible besides those presented in these preliminary alternatives. Table 7-4 excludes units that are covered by other programs. For example, single-shell tanks are excluded because they are addressed by the Single-Shell Tank Closure Program.

Each waste management unit or unplanned release site may require just one alternative or a combination of many alternatives. Furthermore, similar sites may be remediated simultaneously. Also, more specific waste treatment alternatives could be identified and evaluated as more information is obtained.

Technology development studies will be needed for the in-situ vitrification process; and treatability studies will be needed for the in-situ grouting or stabilization process and for soil treatment processes to make sure that they will effectively remediate the contaminants. Specifically, organic waste mobility may be a problem for in-situ vitrification; grouting agents and the resulting reduction of contaminant leachability will need to be determined before in-situ grouting can be performed; and appropriate treatment protocols and systems will need to be identified before soil washing can be used. Capping, soil vapor extraction, and disposal options are all proven processes but may require site-specific performance assessment (treatability) studies.

The FFs, will be required to evaluate alternative designs for all of the alternatives evaluated, as they relate to the specific waste management unit being remediated. A site-by-site economic evaluation is also required before making a decision. This evaluation will require site-specific information obtained in LFIs and FFSs.

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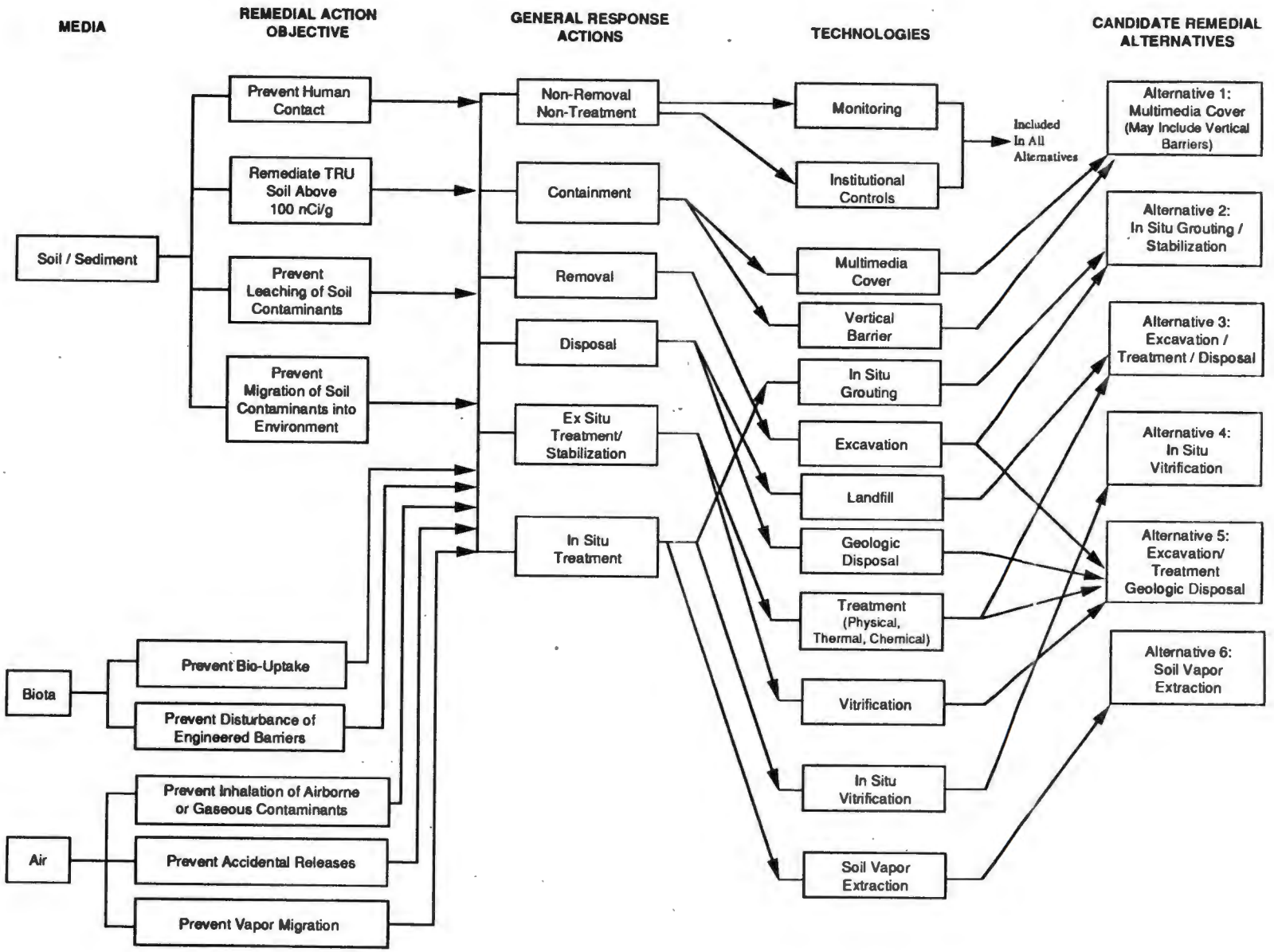

Figure 7-1. Development of Candidate Remedial Alternatives for the PUREX Plant Aggregate Area.

Figure 7-2. Alternative 1: Multimedia Cover with Vertical Barriers.

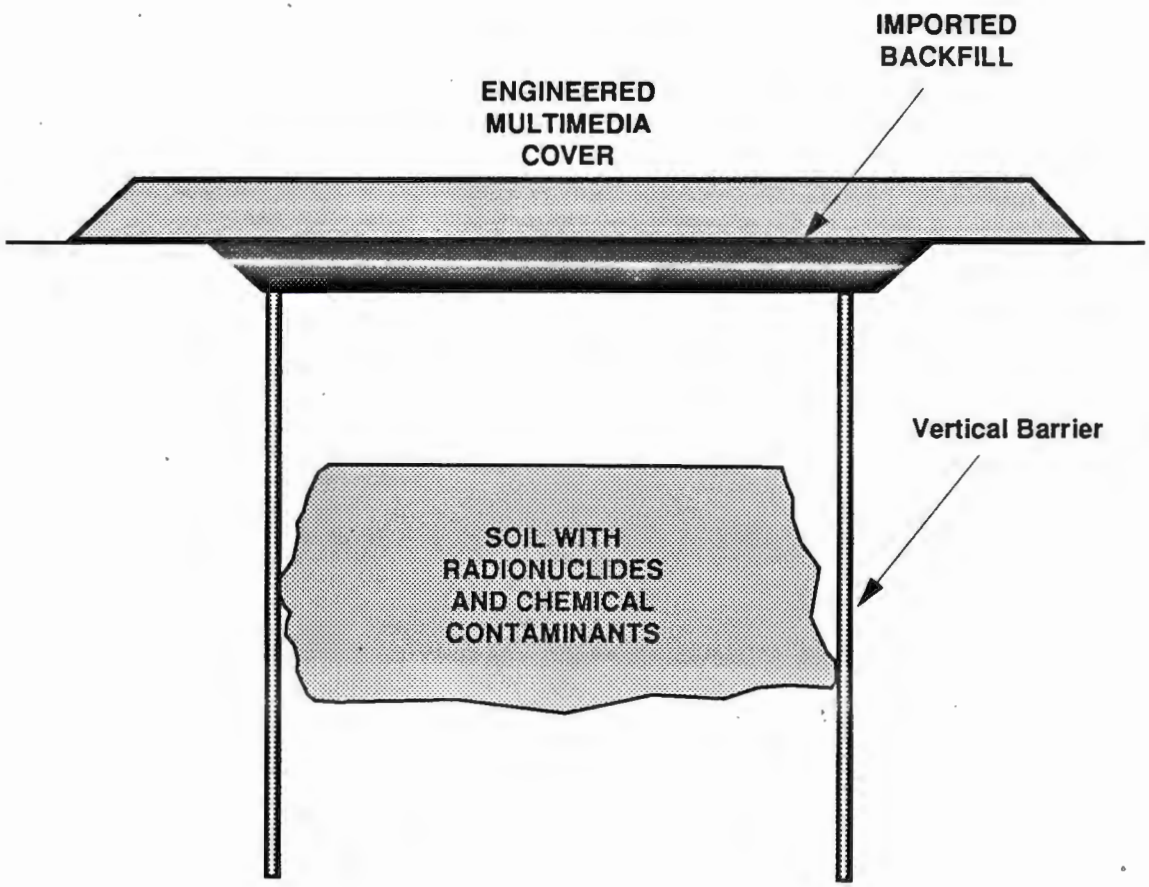

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Figure 7-3. Alternative 2: In Situ Grouting of Soil.

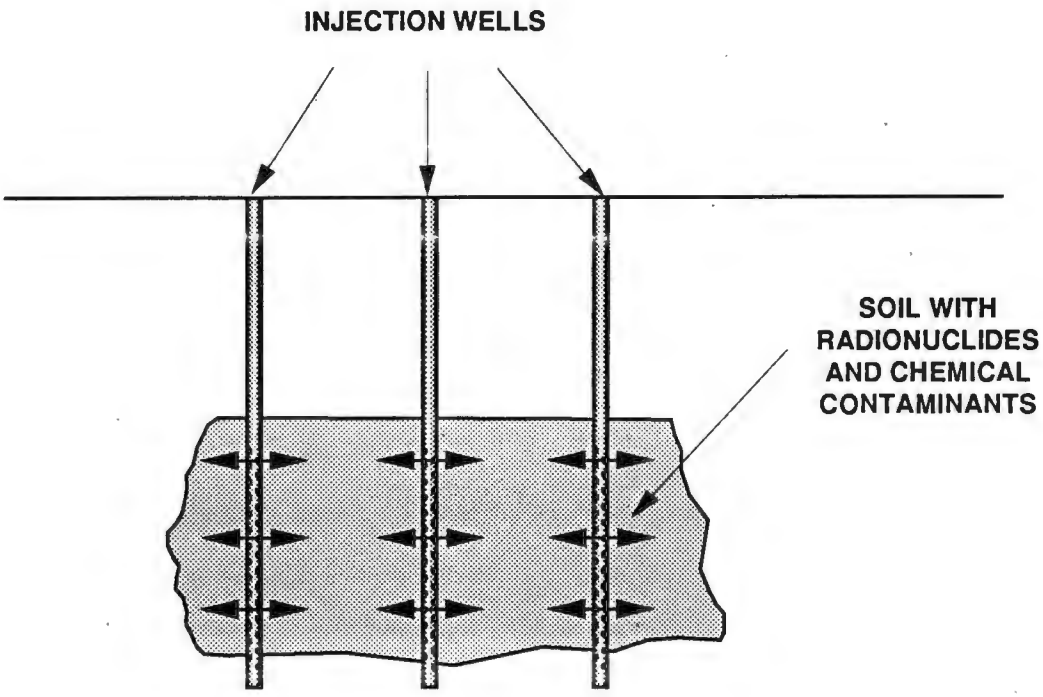

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Figure 7-4. Alternative 3: Excavation, Treament, and Disposal.

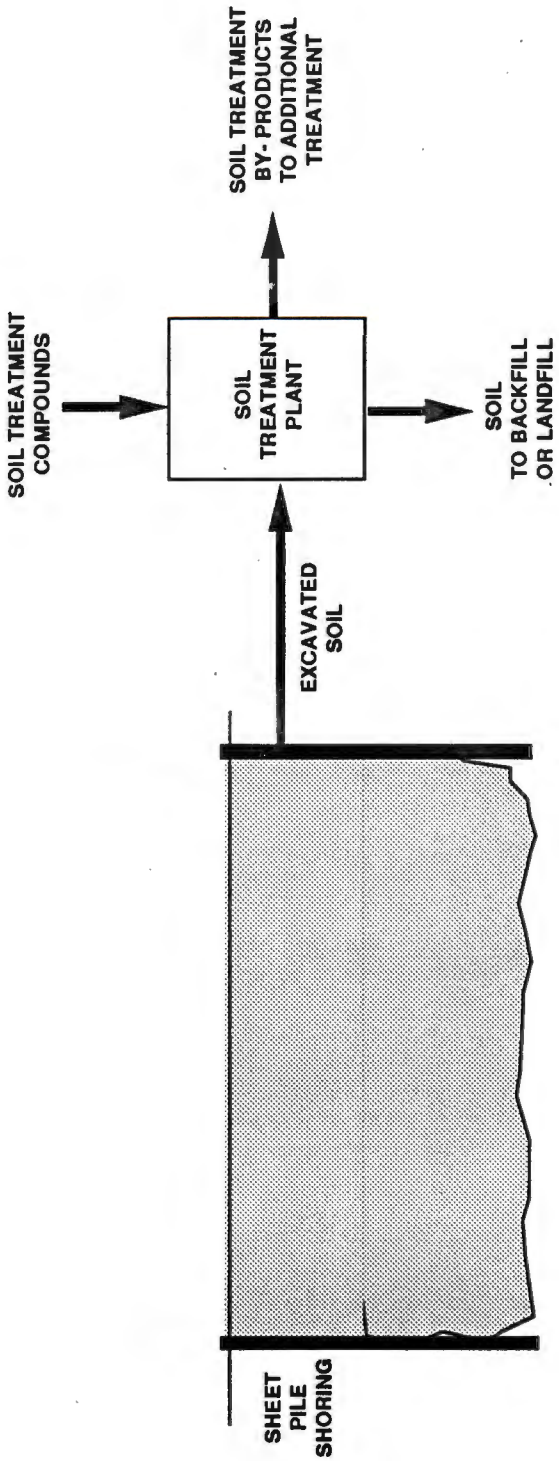

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Figure 7-5. Alternative 4: In Situ Vitrification of Soil.

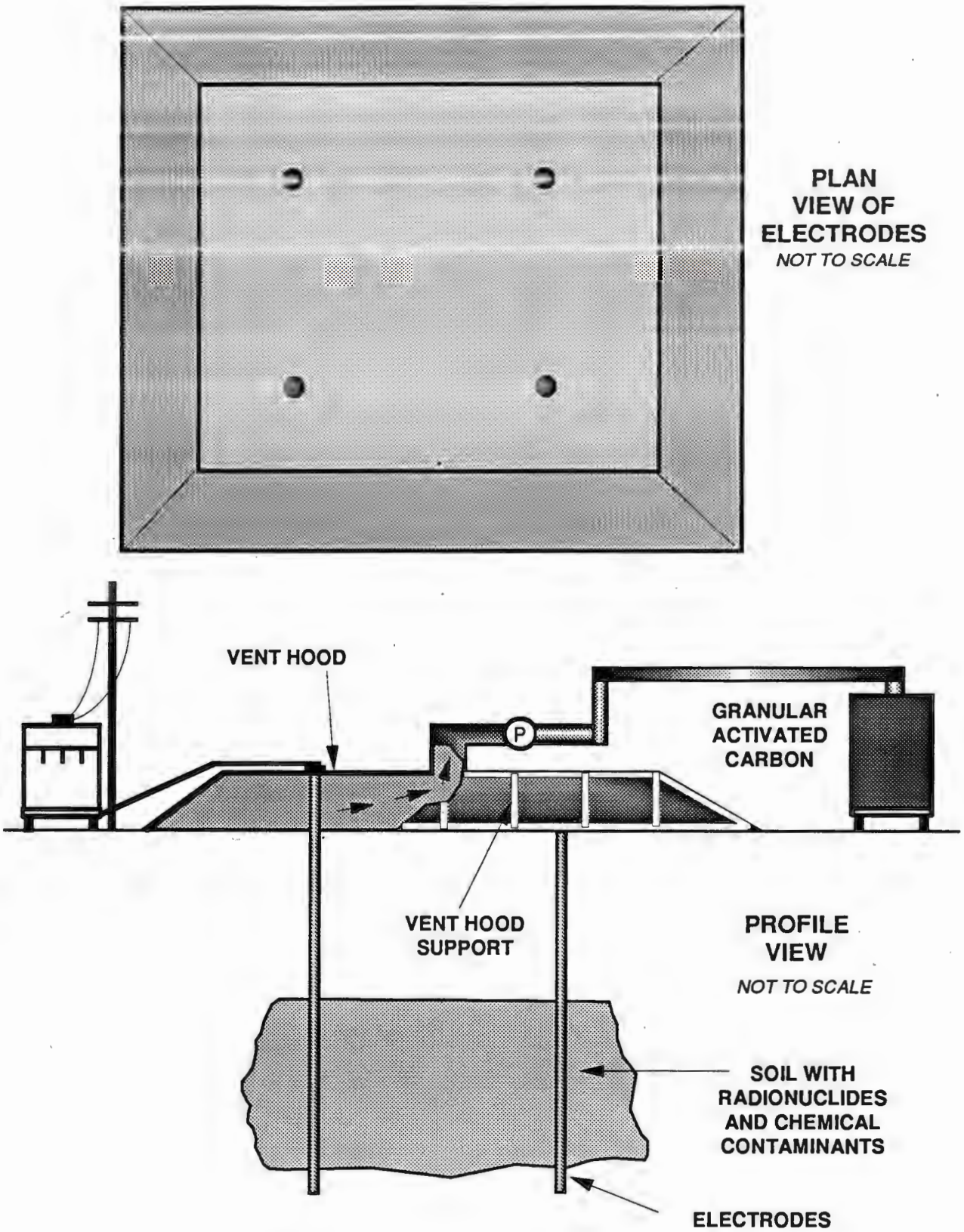

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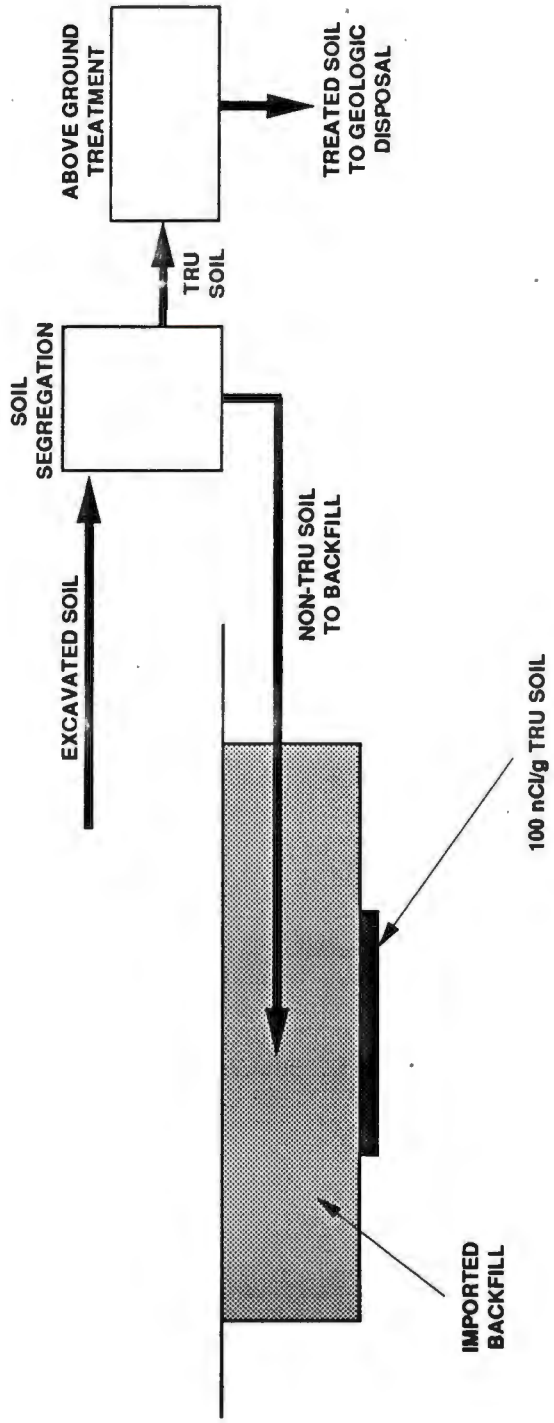
Figure 7-6. Alternative 5: Excavation, Vitrification, and Geologic Disposal of Soil with TRU Radionuclides.



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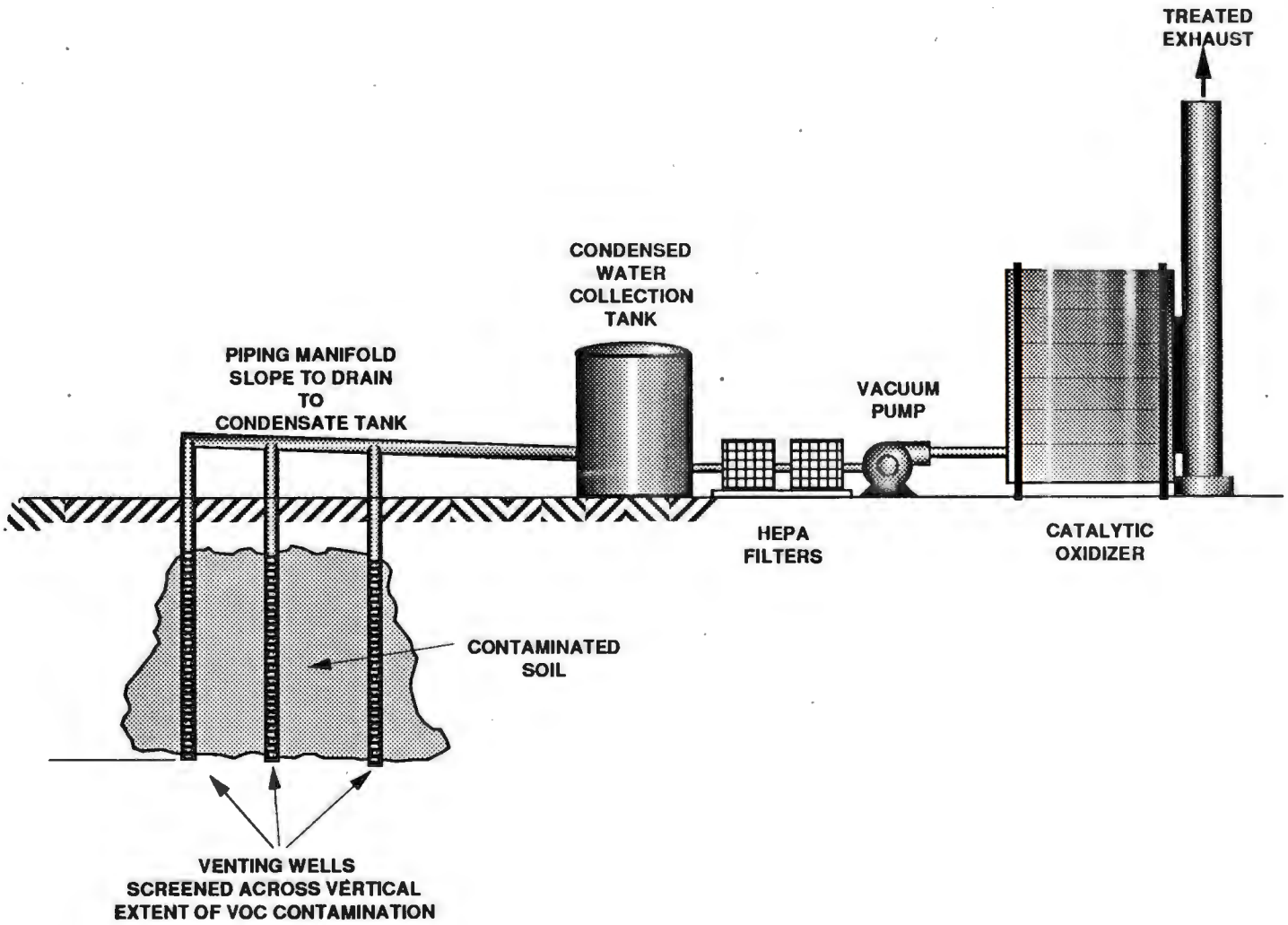

Figure 7-7. Alternative 6: Soil Vapor Extraction for Volatile Organic Compounds.

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Table 7-1. Preliminary Remedial Action Objectives and General Response Actions. (sheet 1 of 2)

Environmental Media	Remedial Action Objectives: Human Health	Remedial Action Objectives: Environmental Protection	General Response Actions
Soils/ Sediments	• Prevent ingestion, inhalation, or direct contact with solids containing radioactive and/or hazardous constituents present at concentrations above MTCA and DOE standards for industrial sites (or subsequent risk-based standards).	• Prevent migration of radionuclides and hazardous constituents that would result in groundwater, surface water, air, or biota contamination with constituents at concentrations exceeding ARARs. • Remediate soils containing TRU contamination above 100 nCi/g in accordance with 40 CFR 191 requirements. • Prevent leaching of contaminants from the soil into the groundwater that would cause groundwater concentrations to exceed MTCA and DOE standards at the compliance point location.	• No Action • Institutional Controls/ Monitoring • Containment • Excavation • Treatment • Disposal • In Situ Treatment
Biota	• Prevent bio uptake by plants. • Prevent disturbance of engineered barriers by biota.	• Prevent bio-uptake of radioactive contaminants.	• No Action • Institutional Controls/ Monitoring • Excavation • Disposal • Containment
Air[a/]	• Prevent inhalation of contaminated airborne particulates and/or volatile emissions exceeding MTCA and DOE limits from soils/sediments.	• Prevent adverse environmental impacts on local biota. • Prevent accidental release from collapse of containment structures.	

Table 7-1. Preliminary Remedial Action Objectives and General Response Actions. (sheet 2 of 2)

Environmental Media	Remedial Action Objectives: Human Health	Remedial Action Objectives: Environmental Protection	General Response Actions
Buried Containers	• Prevent leakage of liquids from buried containers that would cause groundwater concentrations to exceed MTCA standards at the compliance point location, or which could result in volatilization emissions of leaking chemicals to the atmosphere.	• Prevent wind erosion or soil cover material that would expose buried wastes. • Prevent wind erosion of contaminated soil that would lead to exposure exceeding MTCA or DCGs.	• No Action/Institutional Controls/Monitoring • Wind Barriers Installed • Capping • Drum Removal • Subsurface Barriers

Note: [a] No General Response Actions are required for the air because soil remediation will eliminate the air contamination source.

Table 7-2. Preliminary Remedial Action Technologies. (sheet 1 of 3)

Media	General Response Action	Technology Type	Process Option	Contaminants Treated
Soil	No Action	No Action	No Action	NA
	Institutional Controls	Land Use Restrictions	Deed Restrictions	NA
		Access Controls	Signs/Fences	NA
			Entry Control	NA
		Monitoring	Monitoring	NA
	Containment	Capping	Multimedia	I,M,R,O
		Vertical Barriers	Slurry Walls	I,M,R,O
			Grout Curtains	I,M,R,O
			Cryogenic Walls	I,M,R,O
		Dust & Vapor Suppression	Membranes/Sealants/Wind Breaks/Wetting Agents	I,M,R,O
	Excavation	Excavation	Standard Construction Equipment	I,M,R,O
	Treatment	Thermal Treatment	Vitrification	I,M,R,O
			Incineration	O
			Thermal Desorption	O
			Calcination	I,M,R,O
		Chemical Treatment	Chemical Reduction	M
			Hydrolysis	I,O
		Physical Treatment	Soil Washing	I,M,R,O
			Solvent Extraction	M,R,O
			Physical Separation	I,M,R,O
			Fixation/Solidification/ Stabilization	I,M,R,O
			Containerization	I,M,R,O

Table 7-2. Preliminary Remedial Action Technologies. (sheet 2 of 3)

Media	General Response Action	Technology Type	Process Option	Contaminants Treated
		Biological Treatment	Aerobic	O
			Anaerobic	O
	Disposal	On-Site Landfill	On-site Landfill	I,M,R,O
			Offsite RCRA Landfill	I,M,O
		Geologic Repository	Geologic Repository	T (I,M,O non-transuranic radionuclides if mixed with T)
	In Situ Treatment	Thermal Treatment	Vitrification	I,M,R,O
			Thermal Desorption	O
		Chemical Treatment	Reduction	M,O
		Physical Treatment	Soil Flushing	I,M,R,O
			Vapor Extraction	O
			Grouting	I,M,R
			Fixation/Solidification/ Stabilization	I,M,R,O
		Biological Treatment	Aerobic	O
			Anaerobic	O
Biota	No Action	No Action	No Action	NA
	Institutional Controls	Land Use Restrictions	Deed Restrictions	NA
		Access Controls	Signs/Fences	NA
			Entry Control	NA
		Monitoring	Monitoring	NA
	Excavation	Excavation	Standard Construction Equipment	I,M,R,O

Table 7-2. Preliminary Remedial Action Technologies. (sheet 3 of 3)

Media	General Response Action	Technology Type	Process Option	Contaminants Treated
	Disposal	Landfill Disposal	Landfill Disposal	I,M,R,O
	Containment	Capping	Multimedia	I,M,R,O

I = Other Inorganics contaminants applicability
M = Heavy Metals contaminants applicability
R = Radionuclide contaminants applicability
O = Organic contaminants applicability
NA = Not Applicable
T = TRU Radionuclides Applicability.

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Table 7-3. Screening of Process Options. (sheet 1 of 8)

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
SOIL TECHNOLOGIES:						
No Action	No Action	Do nothing to cleanup the contamination or reduce the exposure pathways.	Not effective in reducing the contamination or exposure pathways.	Easily implemented, but might not be acceptable to regulatory agencies, local governments, and the public.	Low	Retained as a "baseline" case.
Land Use Restrictions	Deed Restrictions	Identify contaminated areas and prohibit certain land uses such as farming.	Depends on continued implementation. Does not reduce contamination.	Administrative decision is easily implemented.	Low	Retained to be used in conjunction with other process options.
Access Controls	Signs/Fences	Install a fence and signs around areas of soil contamination.	Effective if the fence and signs are maintained.	Easily implemented. Restrictions on future land use.	Low	Retained to be used in conjunction with other process options.
	Entry Control	Install a guard/monitoring system to prevent people from becoming exposed.	Very effective in keeping people out of the contaminated areas.	Equipment and personnel easily implemented and readily available.	Low	Retained to be used in conjunction with other process options.
Monitoring	Monitoring	Analyze soil and soil gas samples for contaminants and scan with radiation detectors.	Does not reduce the contamination, but is very effective in tracking the contaminant levels.	Easily implemented. Standard technology.	Low	Retained to be used in conjunction with other process options.
Capping	Multimedia	Fine soils over synthetic membrane or other layers and covered with soil; applied over contaminated areas.	Effective on all types of contaminants, not likely to crack. Likely to hold up over time.	Easily implemented. Restrictions on future land use will be necessary.	Medium	Retained because of potential effectiveness and implementability.
Vertical Barriers	Slurry Walls	Trench around areas of contamination is filled with a soil (or cement) bentonite slurry.	Effective in blocking lateral movement of all types of soil contamination. May not be effective for deep contamination.	Commonly used practice and easily implemented with standard earth moving equipment. May not be possible for deep contamination.	Medium	Retained for shallow contamination.
	Grout Curtains	Pressure injection of grout in a regular pattern of drilled holes.	Effective in blocking lateral movement of all types of soil contamination.	Commonly used practice and easily implementable, but depends on soil type. May be difficult to ensure continuous wall.	Medium	Retained because of potential effectiveness and implementability.

Table 7-3. Screening of Process Options. (sheet 2 of 8)

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
	Cryogenic Walls	Circulate refrigerant in pipes surrounding the contaminated site to create a frozen curtain with the pore water.	Effective in blocking lateral movement of all types of soil contamination.	Specialized engineering design required. Requires ongoing freezing.	Medium	Rejected because it is difficult to implement.
Dust and Vapor Suppression	Membranes/ Sealants/ Wind Breaks/ Wetting Agents	Using membranes, sealants, wind breaks, or wetting agents on top of the contaminated soil to keep the contaminants from becoming airborne.	Effective in blocking the airborne pathways of all the soil contaminants, but may require regular upkeep.	Commonly used practice and very easy to implement, but land restrictions will be necessary.	Low	Rejected because of limited duration of integrity and protection.
Excavation	Standard Excavating Equipment	Moving soil around the site and loading soil onto process system equipment.	Effective in moving and transporting soil to vehicles for transportation, and for grading the surface.	Equipment and workers are readily available.	Low	Retained because of potential effectiveness and implementability.
Thermal Treatment	Above-ground Vitrification	Convert soil to glassy materials by application of electric current.	Effective in destroying organics and immobilizing the inorganics and radionuclides. Off-gas treatment for volatiles may be required.	Commercial units are available. Laboratory testing required to determine additives, operating conditions, and off gas treatment. Must pre-treat soil to reduce size of large materials.	High	Retained because of potential ability to immobilize radionuclides, inorganics and metals, and destroy organics.
	Incineration	Destroy organics by combustion in a fluidized bed, kiln, etc.	Effectively destroys the organic soil contaminants. Some heavy metals will volatilize. Radionuclides will not be treated.	Technology is well developed. Mobile units are currently available for relatively small soil quantities. Off-site treatment is available. Air emissions and wastewater generation should be addressed.	High	Rejected because of potential air emissions and wastewater generation.
	Thermal Desorption	Organic volatilization at 150 to 400°C (300 to 800°F) by heating contaminated soil followed by off gas treatment.	Effectively destroys the organic soil contaminants. Heavy metals less likely to volatilize than in high temperature treatments. Radionuclides will not be treated.	Successfully demonstrated on a pilot-scale level. Full-scale remediation yet to be demonstrated. Pilot testing essential.	Medium	Retained because of potential effectiveness and implementability.

Table 7-3. Screening of Process Options. (sheet 3 of 8)

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
	Calcination	High temperature decomposition of solids into separate solid and gaseous components without air contact.	Effective in the decomposition of inorganics such as hydroxides, carbonates, nitrates, sulfates, and sulfites. Removes organic components but does not combust them because of the absence of air. Radionuclides will not be treated.	Commercially available. Most often used for concentration and volume reduction of liquid or aqueous waste. Off-gas treatment is required.	High	Rejected because of limited effectiveness on non-liquid or aqueous wastes.
Chemical Treatment	Chemical Reduction	Treat soils with a reducing agent to convert contaminants to a more stable or less toxic form.	May be effective in treating heavy metal soil contaminants. Radioactivity will not be reduced.	Virtually untested on treating soils. Competing reactions may reduce efficiency.	Medium	Rejected because of limited applicability and implementation problems.
	Hydrolysis	Acid- or base-catalyst reaction in water to break down contaminants to less toxic components.	Very effective on compounds generally classified as reactive. Limited effectiveness on stable compounds. Radioactivity will not be reduced.	Common industrial process. Use for treatment of soils not well demonstrated.	Medium	Rejected because of limited effectiveness and unproven on soils.
	Chemical Dechlorination	Detoxify chlorinated organic chemicals by reaction with organic reagents.	Not commonly used on the chlorinated compounds that have been identified at T Plant.	Difficult to implement. Requires soil washing or solvent extraction before use.	High	Rejected because of limited effectiveness and difficult implementation.
	Chemical Dechlorination	Detoxify chlorinated organic chemicals byreaction with organic reagents.	Not commonly used on the chlorinated compounds that have been identified at Z Plant.	Difficult to implement. Requires soil washing or solvent extraction before use.	High	Rejected because of limited effectiveness and difficult implementation.

Table 7-3. Screening of Process Options. (sheet 4 of 8)

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
Physical Treatment	Soil Washing	Leaching of waste constituents from contaminated soil using a washing solution.	Effectiveness is contaminant specific. Effective with sandy soil may work with only low level radiation contaminated soil may not work with numus soil. Generally more effective on contaminants that partition to the fine soil fraction. Radioactivity will not be reduced.	Treatability tests are necessary. Well developed technology and commercially available.	Medium	Retained because of potential effectiveness and implementability.
	Solvent Extraction	Contacting a solvent with contaminated soils to preferentially dissolve the contaminants into the solvent.	The selected solvent is often just as hazardous as the contaminants presented in the waste. May lead to further contamination. Radioactivity will not be reduced.	Laboratory testing necessary to determine appropriate solvent and operating conditions. Not fully demonstrated for hazardous waste applications.	Medium	Rejected because the solvent may lead to further contamination.
	Physical Separation	Separating soil into size fractions.	Effective as a concentration process for all contaminants that partition to a specific soil size fraction.	Most often used as a pretreatment to be combined with another technology. Equipment is readily available.	Low	Retained because of potential effectiveness and implementability.
	Fixation/ Solidification/ Stabilization	Form low permeability solid matrix by mixing soil with cement, asphalt, or polymeric materials.	Effective in reducing inorganic and radionuclide soil contaminant mobility. Effectiveness for organic stabilization is highly dependent on the binding agent.	Stabilization has been implemented for site remediations. Treatability studies are needed. Volume of waste is increased.	Medium	Retained because of potential effectiveness and implementability.
	Containerization	Enclosing a volume of waste within an inert jacket or container.	Effective for difficult to stabilize, extremely hazardous, or reactive waste. Reduces the mobility of radionculides.	May be implemented for low concentration waste. Disposal or safe storage of containers required. Regulatory constraints may prevent disposal of containers of certain waste types.	Low	Retained because of potential effectiveness and implementability.

Table 7-3. Screening of Process Options. (sheet 5 of 8)

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
Biological Treatment	Aerobic (Landfarming)	Microbial degradation in an oxygen-rich environment.	Effectiveness is very contaminant- and concentration-specific. Treatment has been demonstrated on a variety of organic compounds. Not effective on inorganics or radionuclides.	Various options are commercially available to produce contaminant degradation. Treatability tests are required to determine site-specific conditions.	Medium	Rejected because of limited applicability and difficult implementation.
	Anaerobic	Microbial degradation in an oxygen deficient environment.	Effectiveness is very contaminant and concentration specific. Treatment has been demonstrated on a variety of organic compounds. Not effective on inorganics or radionuclides.	Various options are commercially available to produce contaminant degradation. Treatability tests are required to determine site-specific conditions.	Medium	Rejected because of limited applicability and difficult implementation.
Disposal	Landfill Disposal	Place contaminated soil in an existing onsite landfill.	Does not reduce the soil contamination but moves all of the contamination to a more secure place.	Easily implemented if sufficient storage is available in an on-site landfill area.	Medium	Retained because of potential effectiveness and implementability.
	Geologic Repository	Put the contaminated soil in a safe geologic repository.	Does not reduce the soil contamination, but is a very effective and long-term way of storing radionuclides. Probably unnecessary for nonradioactive waste.	Not easy to implement because of limited site availability, and permits for transporting radioactive wastes are hard to get.	High	Retained because of effectiveness on TRU wastes.
In Situ Thermal Treatment	Vitrification	Electrodes are inserted into the soil and a carbon/glass frit is placed between the electrodes to act as a starter path for initial melt to take place.	Effective in immobilizing radionuclides and most inorganics. Effectively destroys some organics through pyrolysis. Some volatilization of organics and inorganics may occur.	Potentially implementable. Implementability depends on site configuration, e.g., lateral and vertical extent of contamination. Treatability studies required.	High	Retained because of potential ability to immobilize radionuclides and destroy organics.

Table 7-3. Screening of Process Options. (sheet 6 of 8)

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
	Thermal Desorption	Soil is heated in situ by radio-frequency electrodes or other means of heating to temperatures in the 80 to 400°C (200 to 750°F) range thereby causing desorption of volatile and semi-volatile organics from the soil.	Effective for removal of volatile and semi-volatile organics from soil. Ineffective for most inorganics and radionuclides. Contaminants are transferred from soil to air.	Implementable for shallow organics contamination. Not implementable for radionuclides and inorganics. Emission treatment and treatability studies required.	Medium	Rejected because of limited applicability.
In Situ Chemical Treatment	Chemical Reduction	Reducing agent is added to the soil to change oxidation state of target contaminant.	Effective for certain inorganics, e.g., chromium. Ineffective for organics. Limited applicability.	Difficult to implement in situ because of distribution requirements for reducing agent.	Low	Rejected because of limited applicability and implementation problems.
In Situ Physical Treatment	Soil Flushing	Solutions are injected through injection system to flush and extract contaminants.	Potentially effective for all contaminants. Effectiveness depends on chemical additives and hydrology. Flushing solutions posing environmental threat likely to be needed. Difficult recovery of flushing solution.	Difficult to implement. Not implementable for complex solvents of contaminants. Flushing solution difficult to recover. Chemical additives likely to pose environmental threat.	Medium	Rejected because of implementation problem.
	Vapor Extraction	Vacuum is applied by use of wells inducing a pressure gradient that causes volatiles to flow through air spaces between soil particles to the extraction wells.	Effective for volatile organics. Ineffective for inorganics semivolatile organics and radionuclides. Emission treatment required.	Easily implementable for proper site conditions. Requires emission treatment for organics and capture system for radionuclides and volatilized metals.	Medium	Retained for potential application to volatile organics.
	Grouting	Involves drilling and injection of grout to form barrier or injection to fill voids.	Effective in limiting migration of leachate, but difficult to maintain barrier integrity. Potentially effective in filling voids.	Implementable as barrier and for filling voids. Implementability depends on site conditions.	Medium	Retained because of ability to limit contaminant migration and potential use for filling void spaces.

Table 7-3. Screening of Process Options. (sheet 7 of 8)

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
	Fixation/ Solidification/ Stabilization	Solidification agent is applied to soil by mixing in place.	Effective for inorganics and radionuclides. Potentially effective for organics. Effectiveness depends on site conditions and additives used.	Implementable. Treatability studies required to select proper additives. Thorough characterization of subsurface conditions and continuous monitoring required.	Medium	Retained because of potential effectiveness and implementability.
In Situ Biological Treatment	Aerobic	Microbial growth utilizing organic contaminants as substrate is enhanced by injection of or spraying with oxygen source and nutrients.	Effective for most organics at proper conditions. Ineffective for inorganics and radionuclides.	Difficult to implement. Treatability studies and thorough subsurface characterization required.	Low	Rejected because of limited applicability and difficult implementation.
	Anaerobic	Microbial growth utilizing organic contaminants as substrate is enhanced by addition of nutrients.	Effective for volatile and complex organics. Not effective for inorganics and radionuclides.	Difficult to implement. Anoxic ground conditions required. Treatability studies and thorough subsurface characterization necessary.	Low	Rejected because of limited applicability and difficult implementation.
BIOTA TECHNOLOGIES:						
No Action	No Action	Do nothing to clean-up the contamination or reduce the exposure pathways.	Not effective in reducing the contamination or exposure pathways.	Easily implemented, but might not be acceptable to regulatory agencies, local governments, and the public.	Low	Retained as a "baseline" case.
Land Use Restrictions	Deed Restrictions	Identify contaminated areas and prohibit certain land uses such as agriculture.	Effective if implementation is continued. Does not reduce contamination.	Administrative decision is easily implemented.	Low	Retained to be used in conjunction with other process options.
Access Controls	Signs/Fences	Install a fence and signs around areas of contamination to keep people out and the biota in.	Effective if fencing is maintained.	Easily implemented. Restrictions on future land use.	Low	Retained to be used in conjunction with other process options.
	Entry Control	Install a guard/monitoring system to eliminate people from coming in contact with the contamination.	Very effective in keeping people out of the contaminated areas.	Equipment and personnel are easily implemented and readily available.	Low	Retained to be used in conjunction with other process options.

Table 7-3. Screening of Process Options. (sheet 8 of 8)

Technology Type	Process Option	Description	Effectiveness	Implementability	Relative Cost	Conclusions
Monitoring	Monitoring	Take biota samples and test them for contaminants.	Does not reduce the contamination, but is very effective tracking the contaminant levels.	Easily implemented. Standard Technology.	Low	Retained to be used in conjunction with other process options.
Capping	Multimedia	Fine soils over synthetic membrane or other layers and covered with soil; applied over contaminated areas.	Effective in reducing the uptake of contaminants, not likely to crack. Likely to hold up over time.	Easily implemented. Restrictions on future land use will also be necessary.	Medium	Retained because of potential effectiveness and implementability.
Excavation	Standard Excavating Equipment	Remove affected biota and load it onto process system equipment.	Effective in moving and transporting biota to vehicles for transportation.	Equipment and workers are readily available.	Low	Retained because of potential effectiveness and implementability.
Disposal	Landfill Disposal	Place contaminated biota in an existing landfill.	Does not reduce the biota contamination but moves all of the contamination to a more secure place.	Easily implemented if sufficient storage is available in an offsite landfill area.	Medium	Retained because of potential effectiveness and implementability.

Table 7-4. Preliminary Remedial Action Alternatives Applicable to Waste Management Units and Unplanned Release Sites. (sheet 1 of 5)

Waste Management Unit or Unplanned Release	Alt 1. Multimedia Cover With or Without Vertical Barriers	Alt 2. In Situ Grouting or Stabilization	Alt 3. Excavation and Treatment	Alt 4. In Situ Vitrification	Alt 5. Excavation, Treatment, and Geologic Disp. of TRU Soil	Alt 6. In Situ Soil Vapor Extraction for VOCs
Cribs and Drains						
216-A-1 Crib	X	X	X	X	X	
216-A-2 Crib	X	X	X	X	X	X
216-A-3 Crib	X	X	X	X	X	
216-A-4 Crib	X	X	X	X	X	
216-A-5 Crib	X	X	X	X	X	
216-A-6 Crib	X	X	X	X	X	
216-A-7 Crib	X	X	X	X	X	
216-A-8 Crib	X	X	X	X	X	X
216-A-9 Crib	X	X	X	X	X	
216-A-10 Crib	X	X	X	X	X	
216-A-21 Crib	X	X	X	X	X	
216-A-24 Crib	X	X	X	X	X	X
216-A-27 Crib	X	X	X	X	X	
216-A-30 Crib	X	X	X	X	X	
216-A-31 Crib	X	X	X	X	X	
216-A-32 Crib	X	X	X	X	X	
216-A-36A Crib	X	X	X	X	X	
216-A-36B Crib	X	X	X	X	X	
216-A-37-1 Crib	X	X	X	X	X	
216-A-37-2 Crib	X	X	X	X	X	
216-A-38-1 Crib	X	X	X	X	X	
216-A-41 Crib	X	X	X	X	X	
216-A-45 Crib	X	X	X	X	X	

Table 7-4. Preliminary Remedial Action Alternatives Applicable to Waste Management Units and Unplanned Release Sites. (sheet 2 of 5)

Waste Management Unit or Unplanned Release	Alt 1. Multimedia Cover With or Without Vertical Barriers	Alt 2. In Situ Grouting or Stabilization	Alt 3. Excavation and Treatment	Alt 4. In Situ Vitrification	Alt 5. Excavation, Treatment, and Geologic Disp. of TRU Soil	Alt 6. In Situ Soil Vapor Extraction for VOCs
216-A-11 French Drain	X	X	X	X	X	
216-A-12 French Drain	X	X	X	X	X	
216-A-13 French Drain	X	X	X	X	X	
216-A-14 French Drain	X	X	X	X	X	
216-A-15 French Drain	X	X	X	X	X	
216-A-22 French Drain	X	X	X	X	X	
216-A-26 French Drain	X	X	X	X	X	
216-A-26A French Drain	X	X	X	X	X	
216-A-28 French Drain	X	X	X	X	X	
216-A-33 French Drain	X	X	X	X	X	
216-A-35 French Drain	X	X	X	X	X	
Reverse Wells						
299-E24-111 Injection Well	X	X				
Ponds, Ditches and Trenches						
216-A-29 Ditch	X	X	X	X	X	
216-A-34 Ditch	X	X	X	X	X	
216-A-18 Trench	X	X	X	X	X	
216-A-19 Trench	X	X	X	X	X	
216-A-20 Trench	X	X	X	X	X	
216-A-40 Trench	X	X	X	X	X	
Septic Tanks and Associated Drain Fields						
2607-EA Septic Tank/Drain Field	X	X	X			
2607-EC Septic Tank/Drain Field	X	X	X			
2607-ED Septic Tank/Drain Field	X	X	X			

Table 7-4. Preliminary Remedial Action Alternatives Applicable to Waste Management Units and Unplanned Release Sites. (sheet 3 of 5)

Waste Management Unit or Unplanned Release	Alt 1. Multimedia Cover With or Without Vertical Barriers	Alt 2. In Situ Grouting or Stabilization	Alt 3. Excavation and Treatment	Alt 4. In Situ Vitrification	Alt 5. Excavation, Treatment, and Geologic Disp. of TRU Soil	Alt 6. In Situ Soil Vapor Extraction for VOCs
2607-EG Septic Tank/Drain Field	X	X	X			
2607-EJ Septic Tank/Drain Field	X	X	X			
2607-EL Septic Tank/Drain Field	X	X	X			
2607-E6 Septic Tank/Drain Field	X	X	X			
Transfer Facilities, Diversion Boxes, and Pipelines						
216-A-524 Control Structure	X	X	X	X	X	X
Basins						
207-A Retention Basin	X	X	X		X	
216-A-42 Retention Basin	X	X	X		X	
Burial Sites						
218-E-1 Burial Ground	X	X	X			
218-E-8 Burial Ground	X	X	X			
218-E-12A Burial Ground	X	X	X			
218-E-13 Burial Ground	X	X	X			
Unplanned Releases						
UN-200-E-10 Unplanned Release	X	X	X			
UN-200-E-11 Unplanned Release	X	X	X			
UN-200-E-12 Unplanned Release	X	X	X			
UN-200-E-13 Unplanned Release	X	X	X			
UN-200-E-15 Unplanned Release	X	X	X			
UN-200-E-19 Unplanned Release	X	X	X			
UN-200-E-20 Unplanned Release	X	X	X			
UN-200-E-22 Unplanned Release	X	X	X			
UN-200-E-25 Unplanned Release	X	X	X			

Table 7-4. Preliminary Remedial Action Alternatives Applicable to Waste Management Units and Unplanned Release Sites. (sheet 4 of 5)

Waste Management Unit or Unplanned Release	Alt 1. Multimedia Cover With or Without Vertical Barriers	Alt 2. In Situ Grouting or Stabilization	Alt 3. Excavation and Treatment	Alt 4. In Situ Vitrification	Alt 5. Excavation, Treatment, and Geologic Disp. of TRU Soil	Alt 6. In Situ Soil Vapor Extraction for VOCs
UN-200-E-26 Unplanned Release	X	X	X			
UN-200-E-28 Unplanned Release	X	X	X			
UN-200-E-31 Unplanned Release	X	X	X			
UN-200-E-33 Unplanned Release	X	X	X			
UN-200-E-35 Unplanned Release	X	X	X			
UN-200-E-39 Unplanned Release	X	X	X			
UN-200-E-40 Unplanned Release		X	X			
UN-200-E-42 Unplanned Release	X	X	X			
UN-200-E-49 Unplanned Release	X	X	X			
UN-200-E-56 Unplanned Release	X	X	X			
UN-200-E-58 Unplanned Release			X			
UN-200-E-60 Unplanned Release			X			
UN-200-E-62 Unplanned Release	X	X	X			
UN-200-E-65 Unplanned Release	X	X	X			
UN-200-E-67 Unplanned Release		X	X			
UN-200-E-68 Unplanned Release	X	X	X			
UN-200-E-72 Unplanned Release	X	X	X			
UN-200-E-88 Unplanned Release		X	X			
UN-200-E-94 Unplanned Release	X	X	X			
UN-200-E-96 Unplanned Release	X	X	X			
UN-200-E-97 Unplanned Release	X	X	X			
UN-200-E-100 Unplanned Release	X	X	X			
UN-200-E-114 Unplanned Release	X	X	X			
UN-200-E-117 Unplanned Release	X	X	X	X		

Table 7-4. Preliminary Remedial Action Alternatives Applicable to Waste Management Units and Unplanned Release Sites. (sheet 5 of 5)

Waste Management Unit or Unplanned Release	Alt 1. Multimedia Cover With or Without Vertical Barriers	Alt 2. In Situ Grouting or Stabilization	Alt 3. Excavation and Treatment	Alt 4. In Situ Vitrification	Alt 5. Excavation, Treatment, and Geologic Disp. of TRU Soil	Alt 6. In Situ Soil Vapor Extraction for VOCs
UN-200-E-142 Unplanned Release	X		X			

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8.0 DATA QUALITY OBJECTIVES

As described in Section 1.2.2, this aggregate area management study (AAMS) process, as part of the *Hanford Site Past-Practice Strategy* (DOE/RL 1992a), is designed to focus the remedial investigation (RI)/feasibility study (FS) process toward comprehensive cleanup or closure of all contaminated areas at the earliest possible date and in the most effective manner. The fundamental principle of the *Hanford Site Past-Practice Strategy* is a "bias for action" that emphasizes the maximum use of existing data to expedite the RI/FS process as well as allow decisions about work that can be done at the site early in the process, such as expedited response actions (ERAs), interim remedial measures (IRMs), limited field investigations (LFIs), and focused feasibility studies (FFSs). The data have already been described in previous sections (2.0, 3.0, and 4.0). Remediation alternatives are described in Section 7.0. However, data, whether existing or newly acquired, can only be used for these purposes if it meets the requirements of data quality as defined by the data quality objective (DQO) process developed by the U.S. Environmental Protection Agency (EPA) for use at Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites (EPA 1987). This section implements the DQO process for this, the scoping phase in the PUREX Plant Aggregate Area.

In the guidance document for DQO development (EPA 1987), the process is described as involving three stages which have been used in the organization of the following sections:

- Stage 1--Identify decision types (Section 8.1)
- Stage 2--Identify data uses and needs (Section 8.2)
- Stage 3--Design a data collection program (Section 8.3).

8.1 DECISION TYPES (STAGE 1 OF THE DQO PROCESS)

Stage 1 of the DQO process is undertaken to identify:

- The decision makers (thus, data users) relying on the data to be developed (Section 8.1.1)
- The data available to make these decisions (Section 8.1.2)
- The quality of these available data (Section 8.1.3)
- The conceptual model into which these data must be incorporated (Section 8.1.4)
- The objectives and decisions that must evolve from the data (Section 8.1.5).

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These issues serve to define, from various sides, the types of decisions that will be made on the basis of the PUREX Plant AAMS.

8.1.1 Data Users

The data users for the PUREX Plant AAMS and subsequent investigations such as LFIs, RI/FSs, and Resource Conservation and Recovery Act (RCRA) Facility Investigations (RFI)/Corrective Measures Studies (CMSs) are the following:

- The decision makers for policies and strategies on remedial action at the Hanford Site. These are the signatories of the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1990) including the Washington State Department of Ecology (Ecology), EPA, and the U.S. Department of Energy (DOE).

  Nominally these responsibilities are assigned to the managers of these agencies (the Director of Ecology, the Administrator of EPA, and the Secretary of Energy for DOE), although the political process requires that more local policy-makers (such as the Regional Administrator of EPA and the head of the U.S. Department of Energy, Richland Operations Office (DOE RL) and, to a great extent, technical and policy-assessment staff of these agencies will have a major say in the decisions to be evolved through this process.

- Unit managers of Westinghouse Hanford and potentially other Hanford Site contractors who will be tasked with implementing remedial activities at the PUREX Plant Aggregate Area. Staff of these contractors will have to make the lower level (tactical) decisions about appropriate scheduling of activities and allocation of resources (funding, personnel, and equipment) to accomplish the recommendations of the AAMS.

- Concerned members of the wide community involved with the Hanford Site. These may include:

  - Other state (Washington, Oregon, and other states) and federal agencies
  - Affected Indian tribes
  - Special interest groups
  - The general public.

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These groups will be involved in the decision process through the implementation of the Community Relations Plan (Ecology et al. 1989), and will apply their concerns through the "primary" data users, the signatories of the Tri-Party Agreement.

The needs of these users will have a pivotal role in issues of data quality. Some of this influence is already imposed by the guidance of the Tri-Party Agreement.

8.1.2 Available Information

The *Hanford Site Past-Practice Strategy* specifies a "bias for action" which intends to make the maximal use of existing data on an initial basis for decisions about remediation. This emphasis can only be implemented if the existing data are adequate for the purpose.

Available data for the PUREX Plant Aggregate Area are presented in Sections 2.0, 3.0, and 4.0 and in topical reports prepared for this study. As described in Section 1.2.2, these data should address several issues:

- Issue 1: Facility and process descriptions and operational histories for waste sources (Sections 2.2, 2.3, and 2.4)
- Issue 2: Waste disposal records defining dates of disposal, waste types, and waste quantities (Section 2.3)
- Issue 3: Sampling events of waste effluents and affected media (Section 4.1)
- Issue 4: Site conditions including the site physiography, topography, geology, hydrology, meteorology, ecology, demography, and archaeology (Section 3.0)
- Issue 5: Environmental monitoring data for affected media including air, surface water, sediment, soil, groundwater and biota (Section 4.1, except that groundwater data is presented in the separate 200 East Groundwater Aggregate Area Management Study Report, AAMSR).

A major requirement for adequate characterization of many of these issues is identification of chemical and radiological constituents associated with the sites, with a view to determine the contaminants of concern there and the extent of their distribution in the soils beneath each of the waste management units in the PUREX Plant Aggregate Area. There was found to be a limited amount of data in this regard. The data reported for the various waste management units in the PUREX Plant Aggregate Area (see Section 4.1 and Tables 4-1, 4-2, and 4-3) have been found to describe:

- Inventory: generally estimated from chemical process data and emphasizing radionuclides (Issues 1 and 2). These data are especially limited regarding

reconstruction of early operations activities, and even the most recent data are based on very few sampling events, possibly non-representative of the long-term activity of the waste management units. In some cases (e.g., for the 2607-EL Septic Tank) even the location of the facility is not adequately understood.

- Surface radiological surveys: undifferentiated radiation levels, without identification of radionuclides present, presented in terms of extent of radiation and maximal levels (Issue 5). These historical data are extremely difficult to relate to the present-day distribution and nature of the radioactive contamination they purport to measure because of the lack of radionuclide identification and the likelihood that changes have occurred (at least to surface soils) since the time of these surveys.

- External radiation monitoring: similar to the surface radiological surveys but provide even less information because with a fixed-point thermoluminescent dosimeter (TLD) no spatial distribution is provided. In addition, data are also available for some TLDs placed at points not associated with specific waste management units. The TLD data also do not differentiate radionuclide species.

- Waste, soil, or sediment sampling: these include waste sampling in single-shell tanks (in the 241-A, 241-AX and 241-C Tank Farms), and sediment sampling in the 216-A-29 Ditch (Issue 5).

  There are also sets of data of soil sampling and analysis that were conducted for several years on a grid pattern that cannot be assigned to a particular waste management unit. These data would indicate impacts of historical operations at the Hanford Site, and in the vicinity of the grid points, but the impacts cannot be ascribed to a particular unit and so do not assist in decision making on a unit-by-unit basis but may be used to estimate background contamination levels.

- Biota sampling: only in the 216-A-24 Crib, and the 216-A-29 Ditch. These data could assist assessment of bio-uptake and transfer pathways from this unit (Issue 5).

  There are also analytical data for grid-point samples of vegetation which cannot be assigned to a specific waste management unit but may be useful to indicate background contamination levels in vegetation.

- Borehole geophysics: these data, for a number of units which discharged to the soil column (cribs, trenches, and ditches) and the single-shell tanks, were designed to detect the presence of radionuclides (by their gamma-ray radiation) in the subsurface and to indicate whether these materials are migrating vertically (Issue 5). A list of these surveys that have been conducted in the PUREX Plant

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Aggregate Area is included in the *PUREX Plant Geologic and Geophysics Data Package for the 200 Aggregate Area Management Study* prepared for this study (Chamness et al. 1992). Most of the earlier data are limited by the method's inability to identify specific radionuclides and, thus, to differentiate naturally occurring radioactive materials from possible releases. Variations in quality control further limit their comparability and possible use for estimation of concentrations.

Besides these historic data, additional borehole geophysical data will be available through the Radionuclide Logging System (RLS), being carried out at the time of this report and in support of the AAMS process. Like the previous (gross gamma) logging conducted at waste management units in the PUREX Plant Aggregate Area, the RLS depends on gamma rays and cannot detect some species of radionuclides. However, unlike the gross gamma surveys, the RLS is designed to identify individual radionuclide species through their characteristic gamma ray photon energy levels. It should thus be able to differentiate naturally-occurring radionuclides from those resulting from releases. It will also (like gross gamma logging) determine the vertical extent of the presence of the radionuclides. It will be conducted in about ten wells located in the PUREX Plant Aggregate Area and will be available with completion of the AAMS process.

Based on the above summary, the data are considered to be of varying quality. These data have not been validated, a process generally required for risk assessment or final Record of Decision (ROD) purposes. Most of the data are based on field methods, which are generally applicable only for screening purposes and can be used to focus future activities (e.g., sampling and analysis plans).

They are considered to be deficient in one or more of the following ways:

- Methods which have been used in the past are unable to differentiate the various radionuclides that may have been present at the time of the survey.

- The release locations have been changed (especially by remediation activities) since the time of the survey or sampling, and it is likely that contaminant distributions have changed.

- The survey or sampling has been done at a location different from the waste management unit or release, and so would not be representative of the concentrations in the zone of release. This deficiency applies to horizontal and vertical differences in location: the borehole geophysics data may be at the correct depths, but the distance of the borehole from the waste management unit can severely attenuate the gamma-radiation that is used to indicate contamination; surface sampling and surveys similarly cannot establish subsurface contaminant

concentrations or even disprove the possible presence of some radioactive constituents (particularly alpha-emitting transuranic elements).

- There has been virtually no measurement of non-radioactive hazardous constituents in the sampling and analysis of media in the PUREX Plant Aggregate Area.

As a result of these deficiencies, the data are not considered to be usable for input to a quantitative risk assessment or for comparison to ARARs. Further discussion of the data quality is provided in Section 8.1.3.

In addition to these data, there are also data regarding site conditions (Issue 4) that do not directly relate to the presence of environmental releases, but which will assist in the assessment of its potential migration if present. These data are generally summarized in the topical reports prepared for this AAMS. Those include the following:

- *PUREX Plant Geologic and Geophysics Data Package for the 200 Aggregate Area Management Study* (Chamness et al. 1992), contains tables of wells in which borehole geophysics have been conducted, the types and dates of the tests, and a reference to indicate the physical location of the logs. The package also includes a list of the data available from the drilling of each well located in the PUREX Plant Aggregate Area, such as the logs available (driller's or geologist's; indication of their physical location; grain size, carbonate, moisture, and chemical/radiological analyses; lists of depths, dates, elevation, and coordinates for all wells); and copies of the boring logs and well completion (as-built) summaries for a selection of wells in the PUREX Plant Aggregate Area.

- *Geologic Setting of the 200 East Area: An Update* (Lindsey et al. 1992) includes descriptions of regional stratigraphy, structural geology, and local (200 East Area) stratigraphy, with revised structure and isopach maps of the various unconsolidated strata found beneath the 200 East Area.

The data in these topical reports was obtained for the AAMS based on a review of driller's and geologist's logs for wells drilled in the PUREX Plant Aggregate Area. A selection of 15 of those logs was made which best represented the geologic structures below the aggregate area and is presented in Chamness et al. (1992). Lindsey et al. (1992) then used these wells (and others from other aggregate areas in the 200 East Area) to develop cross-sections, structure maps, and isopach maps, which were in turn adapted to the specific needs of this report and presented in Section 3.0. Only existing logs were used; no new wells were drilled as part of this study. The quality of the data varies among the logs according to the time they were drilled and the scope of the study they were supporting, but generally these data are sufficient for the general geological characterization of the site. Issues involving the potential of contaminant migration at specific sites, based on stratigraphic concerns, may not be fully addressed through any existing borings or wells

because appropriate borings may not be located in close proximity; these issues should be addressed during subsequent field investigations at locations where contaminant migration is considered likely.

Another class of data that was gathered in the general area of the 200 West Area, and is potentially appropriate to the PUREX Plant Aggregate Area, is the result of a set of studies which were performed for the Basalt Waste Isolation Project (BWIP) (DOE 1988b), in the attempt to site a high-level radioactive waste geologic repository in the basalt beneath and in the vicinity of the Hanford Site. The proposed Reference Repository Site included the 200 West Area and some distance beyond it, mainly to the west. For this siting project, a number of geologic techniques were used, and some of the data generated by the drilling program has been used for the stratigraphic interpretation presented in Section 3.4 (all the wells denoted with an alias "BH-.." were drilled for the BWIP) and a number of the figures used in this and other sections of Section 3.0. The program also included a number of geophysical studies, using the following techniques:

- Gravity
- Magnetics
- Seismic reflection
- Seismic refraction
- Magnetotellurics.

These data, as presented in Section 1.3.2.2.3 of DOE (1988b), were reviewed for their relevance to the present PUREX Plant (source area) AAMS. The limitations of these studies include the following aspects:

- Most of the studies covered a regional scale with lines or coverages that may have crossed the PUREX Plant Aggregate Area (or even the 200 East Area) only in passing. Some of the surveys (e.g., the grid of gravity stations) specifically avoided the 200 East Area ("due to restricted access").

- Many of the techniques are more sensitive to the basalt than to the suprabasalt sediments of specific interest in the AAMS program, and even less sensitive to the features which are closer to the surface, as is applicable to the source area AAMS. Basalt is by nature much denser than the unconsolidated sediments (and thus also has a characteristic seismic signature) and has more consistent magnetic properties. In addition, the analysis of the data emphasized the basalt features that were apparent in the data. All this is appropriate to a study of the basalt, but does not make the studies applicable to the current study.

- Even when features potentially caused by shallow sediments are identified, they are interpreted either very generally (e.g., "erosional features in the Hanford and (or) Ringold Formations") or as complications (e.g., "shallow sediment velocity variations causing stacking velocity correction errors"). There are very few features (and none in the PUREX Plant Aggregate Area) which are interpreted as descriptive of the structure of the suprabasalt sediments.

- Lastly, some of the anomalies which are interpreted in terms of a sedimentary stratigraphic cause (e.g., "erosion of Middle Ringold") do not bear up under the more detailed stratigraphic interpretation carried out under the topical reports for the AAMS (Lindsey et al. 1992; Chamness et al. 1992).

However, these data will be reviewed in more detail for the purposes of the 200 East Groundwater AAMSR, since deeper features (including in the basalt) are of more concern for that study.

Other data, presented in Sections 2.0, 3.0, and 4.0, are broader-scale rather than site-specific such as contaminant concentrations. These include topography, meteorology, surface hydrology, environmental resources, human resources, and contaminant characteristics. These data are generally of acceptable quality for the purposes of planning remedial actions in the PUREX Plant Aggregate Area.

8.1.3 Evaluation of Available Data

The EPA (1987) has specified indicators of data quality, the five "PARCC" parameters (precision, accuracy, representativeness, completeness, and comparability), which can be used to evaluate the existing data and to specify requirements for future data collection.

- Precision: the reproducibility of the data.

- Accuracy: the lack of a bias in the data.

  Much of the existing data are of limited precision and accuracy due to the analytical methods which have been used historically. The gross gamma borehole geophysical logging in particular is limited by methodological problems although reproducibility has been generally observed in the data. Conditions that have contributed to lack of precision and/or accuracy include: improvements in analytical instrumentation and methodology making older data incompatible; effects of background levels (particularly regarding radioactivity and inorganics); and lack of quality control on data acquisition.

  The limitations in precision and accuracy in existing data are mainly due to the progress of analytical methodologies and quality assurance (QA) procedures since

the time they were collected. The *Hanford Site Past-Practice Strategy* (DOE/RL 1992a) recommends that existing data be used to the maximum extent possible, at two levels: first to formulate the conceptual model, conduct a qualitative risk assessment, and prepare work plans, but also as an initial data set that can be the basis for a fully qualified data set through a process of review, evaluation, and confirmation.

- Representativeness: the degree to which the appropriate environmental parameters or media have been sampled.

  This parameter highlights a shortcoming of most of the historical data. Some discussion of representativeness lmitations is presented in Section 8.1.2. Limitations include the observation only of gross gamma radiation rather than differentiating it by radionuclide (e.g., through spectral surveying methods as are being used by the RLS program), the analysis of samples only for radionuclides rather than for chemicals and radionuclides, and the failure to sample (especially in the subsurface) for the full potential extent of contaminant migration.

  The data are incomplete primarily because of the lack of subsurface sampling for extent of contamination. This is because no subsurface investigation has been initiated on the waste management units in the PUREX Plant Aggregate Area yet. The lack of these data is also caused by concerns to limit the potential exposure to radioactivity of workers who would have to drill in contaminated areas and the possible release or spread of contamination through these intrusive procedures. The result of this data gap is that none of the sites can be demonstrated to have contamination either above or below levels of regulatory concern, and a full quantitative risk assessment cannot be conducted.

  In addition, in many cases it has been necessary to use general data (i.e., from elsewhere in the 200 East Area or even from the vicinity of the 200 Areas) rather than data specific to a particular waste management unit. For most purposes of characterization for transport mechanisms, this procedure is acceptable given the screening level of the present study. For example, while it is appropriate to use a limited number of boring logs to characterize the stratigraphy in the aggregate area (Chamness et al. 1992, Lindsey et al. 1992), the later, waste management unit specific, field sampling plans will require detailed consideration of more of the logs of wells drilled in the immediate vicinity, whatever their quality, as a starting point to conceptually model the geology specifically beneath that unit.

- Completeness: the fraction of samples which are considered "valid."

  None of the data that have been previously gathered in the PUREX Plant Aggregate Area has been "validated" in the EPA Contract Laboratory Program (CLP) sense, although varying levels of quality control have been applied to the

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sampling and analysis procedures. The data are generally adequate for characterization purposes but may not be suitable for use in a formal risk assessment. The best indication of the validity of the data is the reproducibility of the results, at least as far as precision is concerned (accuracy requires proof of a lack of bias). This indicates that validity (completeness) is one of the less significant problems with the data.

- Comparability: the confidence that can be placed in the comparison to two data sets (e.g., separate samplings).

  With varying levels of quality control and varying procedures for sample acquisition and analysis, this parameter is also generally poorly met. Much of this is due to the more recent development of QA procedures.

While these limitations cannot in most cases be quantified (and some such as representativeness are specifically only qualitative), most of the data gathered in the PUREX Plant Aggregate Area can be cited as failing one or more of the PARCC parameters. As discussed in Section 8.1.2, the data are considered to be deficient in completeness, (the appropriate media, constituents, or locations were generally not sampled or analyzed). These data should, however, be used to the maximum extent in the development of work plans for site field investigations, prioritization of the various units, and to determine, to the extent possible, where contamination is or is not present.

In addition to these site-specific data, there are also a limited number of non site-specific sampling events that are being developed to determine background levels of naturally occurring constituents (Hoover and LeGore 1991). These data can be used to differentiate the effect of the environmental releases from naturally occurring background levels.

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8.1.4 Conceptual Model

The initial conceptual model of the waste management units in the PUREX Plant Aggregate Area is presented and described in Section 4.2 (Figure 4-3). The model is based on best estimates of where contaminants were discharged and their potential for migration from release points. The conceptual model is designed to be conservatively inclusive in the face of a lack of data. This means that a migration pathway was included if there is any possibility of contamination travelling on it, historically or at present. In most cases there may not be a significant flux of such contamination migration for many of the pathways shown on the figure.

The pathway from the cribs leading to adsorption of transuranic elements on vadose-zone soils is possibly the most significant. These and other pathways can be traced on the conceptual model. All are possible; only a few are likely because of the conservatism inherent in including all conceivable pathways. More importantly, even if a pathway carries

significant levels of a contaminant, it still may not have carried contamination to the ultimate receptors, human or ecological. This can only be assessed by sampling at the exposure point on this pathway, or sampling at some other point and extrapolating to the exposure point, to indicate the dosage to the receptors.

There are significant uncertainties in the contaminant levels in the contaminant migration pathways shown on the conceptual model, yet almost none of these pathways has been sampled to determine whether any contamination still exists in any of the locations implicated from the conceptual model, and if so which constituents, how much, and to what extent.

8.1.5 Aggregate Area Management Study Objectives and Decisions

The specific objectives of the PUREX Plant AAMS are listed in Section 1.3. They include the following:

- Assemble site data (as described in Section 8.1.2)
- Describe site conditions (see Section 3.0)
- Conduct limited new site characterization work (see separate topical reports)
- Develop a preliminary site conceptual model (see Section 8.1.4)
- Identify contaminants of concern and their distribution (Section 4.0)
- Identify potential ARARs (Section 6.0)
- Define preliminary remedial action objectives and screen potential remedial technologies to prepare preliminary remedial action alternatives (Section 7.0) and provide recommendations for FFS (Section 9.4.1) and treatability studies (Section 9.5)
- Define data needs, establish general DQOs, and set priorities
- Recommend ERA, IRM, LFI, or other actions (Section 9.0)
- Redefine and prioritize, as data allow, operable units, their boundaries, and work plan activities with emphasis on supporting early cleanup actions and records of decision (Sections 8.3 and 9.0)
- Integrate RCRA TSD closure activities with past-practice activities (Section 9.3.4).

The decisions that will have to be made on the basis of this AAMS can best be described according to the *Hanford Site Past-Practice Strategy* (DOE/RL 1992a) flow chart (Figure 1-2 in Section 1.0) that must be conducted on a site-by-site basis. Decisions are shown on the flow chart as diamond-shaped boxes, and include the following:

- Is an ERA justified?
- Is less than six months' response needed (is the ERA time critical)?
- Are data sufficient to formulate the conceptual model and perform a qualitative risk assessment?
- Is an IRM justified?
- Can the remedy be selected?
- Can additional required data be obtained by LFI?
- Are data (from field investigations) sufficient to perform risk assessment?
- Can an Operable Unit/Aggregate Area ROD be issued?

(The last two questions will only be asked after additional data are obtained through field investigations, and so are DQO issues only in assessing scoping for those investigations.)

Most of these decisions are actually a complicated mixture of many smaller questions, and will be addressed in Section 9.0 in a more detailed flowchart for assessing the need for remediation or investigation.

Similarly, the tasks that will need to be performed after the AAMS that drive the data needs for the study are found in the rectangular boxes on the flow chart. These include the following:

- ERA (if justified)
- Definition of the threshold contamination levels, and formulation of conceptual model, performance of qualitative risk assessment, and FS screening (IRM preliminaries)
- FFS for IRM selection
- Determination of minimum data requirements for IRM path

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- Negotiation of Scope of Work, relative priority, and incorporation into integrated schedule, performance of LFI

- Determination of minimum data needs for risk assessment and final remedy selection (preparation of RI/FS path).

These stages of the investigation must be considered in assessing data needs (Section 8.2.1).

8.2 DATA USES AND NEEDS (STAGE 2 OF THE DQO PROCESS)

Stage 2 of the DQO development process (EPA 1987) defines data uses and specifies the types of data needed to meet the project objectives. These data uses and needs are based on the Stage 1 results, but must be more specific. The elements of this stage of the DQO process include:

- Identifying data uses (Section 8.2.1)

- Identifying data types (Section 8.2.2.1)

- Identifying data quality needs (Section 8.2.2.2)

- Identifying data quantity needs (Section 8.2.2.3)

- Evaluating sampling/analysis options (Section 8.2.2.4)

- Reviewing data quality parameters (Section 8.2.2.5)

- Summarizing data gaps (Section 8.2.3).

Stage 2 is developed on the basis of the conceptual model and the project objectives. These following sections discuss these issues in greater detail.

8.2.1 Data Uses

For the purposes of the remediation in the PUREX Plant Aggregate Area, most data uses fall into one or more of four general categories:

- Site characterization

- Public health evaluation and human health and ecological risk assessments

- Evaluation of remedial action alternatives
- Worker health and safety.

Site characterization refers to a process that includes determination and evaluation of the physical and chemical properties of any wastes and contaminated media present at a site, and an evaluation of the nature and extent of contamination. This process normally involves the collection of basic geologic, hydrologic, and meteorologic data but more importantly for the PUREX Plant Aggregate Area waste management units, data on specific contaminants and sources that can be incorporated into the conceptual model to indicate the relative significance of the various pathways. Site characterization is not an end in itself, as stressed in the *Hanford Site Past-Practice Strategy* (DOE/RL 1992a), but rather the data must work toward the ultimate objectives of assessing the need for remediation (according to risk assessment methods, either qualitative or quantitative or compliance with ARARs) and providing appropriate means of remediation (through an FFS, FS, or CMS). The understanding of the site characterization, based on existing data, is presented in Sections 2.0, 3.0, and 4.0, and summarized in the conceptual model (Section 4.2).

Data required to conduct a public health evaluation, and human health and ecological risk assessments at the sites in the PUREX Plant Aggregate Area include the following: input parameters for various performance assessment models (e.g., the Multimedia Environmental Pollutant Assessment System); site characteristics; and contaminant data required to evaluate the threat to public and environmental health and welfare through exposure to the various media. These needs usually overlap with site characterization needs. An extensive discussion of risk assessment data uses and needs for both human health and ecological evaluations is presented in the *Risk Assessment Guidance for Superfund* Volumes 1 and 2 (EPA 1989a,c). The EPA Region 10 has also developed its preferred methodology for these risk assessment activities (EPA 1989a, 1991a). The ecological and human health risk assessments will follow the guidance outlined in the approved M-29-03 milestone document, *Hanford Site Baseline Risk Assessment Methodology*. The data requirements for an ecological risk assessment include (1) identification of critical species, (2) identification of habitat within and surrounding the Hanford Site, (3) feeding relationships among species of concern, and (4) contaminant concentrations in environmental media and species of interest. The main deficiency in the data available for waste management units in the PUREX Plant Aggregate Area is that a quantitative assessment of contaminant concentrations for purposes of risk assessment cannot be performed. The present understanding of site risks is presented in the selection of constituents of concern (Section 4.0). The data needs for quantitative risk assessments will be considered in developing site-specific sampling and analysis plans according to the *Hanford Site Past-Practice Strategy*.

Data collected to support evaluation of remedial action alternatives for ERAs, IRMs, FFSs, or the full RI/FS, include site screening of alternatives, feasibility-level design, and preliminary cost estimates. Once an alternative is selected for implementation, much of the data collected during site investigations (LFI or RI) can also be used for the final engineering

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design. Generally, collection of information during the investigations specifically for use in the final design is not cost effective because many issues must be decided about appropriate technologies before effective data gathering can be undertaken. It is preferable to gather such specific information during a separate predesign investigation or at the time of remediation (i.e., the "observational approach" of the *Hanford Site Past-Practice Strategy* [DOE/RL 1992a]). Based on the existing data, broad remedial action technologies and objectives have been identified in Section 7.0.

The worker health and safety category includes data collected to establish the required level of protection for workers during various investigation activities. These data are used to determine if there is concern for the personnel working in the vicinity of the aggregate area. The results of these assessments are also used in the development of the various safety documents required for field work (see Health and Safety Plan, Appendix B).

It should be noted that each of these data use categories (site characterization, risk assessment needs, remedial actions, and health and safety) will be required at each decision point on the *Hanford Site Past-Practice Strategy* (DOE/RL 1992a) flow chart, as discussed at the end of Section 8.1.5. To the extent possible, however, not all sites will be investigated to the same degree but only those with the highest priority. These results will then be extended to the other, analogous sites which have similar geology and disposal histories (see Section 9.2.3).

The existing data can presently be used for two main purposes:

- Development of site-specific sampling plans (site characterization use)
- Screening for health and safety (worker health and safety use).

Table 8-1 presents a summary of the availability of existing data for these two uses.

For the purposes of developing sampling plans, existing information is available for:

- The location of waste management units and unplanned releases: many of the units or releases have surface expressions, markers, or have been surveyed in the past. The unplanned releases in particular are lacking in this information, as well as for the 2607-EL Septic Tank and Drain Field. Many of the unplanned releases are located by coordinates only and can be found on various site maps by a number of different names.

- Possible contamination found at the waste management units: these data are derivable from the inventories for the units (mainly for the cribs and other disposal facilities) as well as from the limited sampling that has been done at specific sites, such as the 216-A-29 Ditch.

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- The likely depth of contaminants: this information is mainly obtained from the gross gamma borehole logging for many of the units.

Two types of information are available for the purposes of worker health and safety, and will be used for the development of health and safety documents:

- Levels of surface radiation: derived from the on-going periodic radiological surveys done under the Environmental Surveillance program (Schmidt et al. 1992). Table 8-1 shows where surveys have indicated no detectable levels of surface radiation and so no additional survey is required before surface activities can be conducted.

- Expected maximum contaminant levels: these data can be used mainly on the results of subsurface soil sampling. Extensive sampling of this type has generally not been conducted at the PUREX Plant Aggregate Area waste management units.

Table 8-1 also presents a first expression of the data needs for the individual waste management units in the PUREX Plant Aggregate Area, which must be addressed for remediation approaches to be developed.

8.2.2 Data Needs

The data needs for the PUREX Plant Aggregate Area are discussed in the following sections according to the categories of types of data (Section 8.2.2.1), quality (8.2.2.2), quantity (8.2.2.3), options for acquiring the data (8.2.2.4), and appropriate DQO (PARCC) parameters (8.2.2.5). These considerations are summarized for each category of waste management unit site in the PUREX Plant Aggregate Area (Section 8.2.3).

8.2.2.1 Data Types. Data use categories described in Section 8.2.1 define the general purpose of collecting additional data. Based on the intended uses, a concise statement regarding the data types needed can be developed. Data types specified at this stage should not be limited to chemical and radionuclide parameters, but should also include necessary physical parameters such as bulk density, moisture, and hydraulic conductivity. Precipitation recharge, chemical distribution coefficients, and organic complexation data appear adequate, but may require additional study based on the results of future evaluations. Since environmental media and source materials are interrelated, data types used to evaluate one media may also be useful to characterize another media.

Identifying data types by media indicates that there are overlapping data needs. Data objectives proposed for collection in the site investigations at sites in the PUREX Plant Aggregate Area are discussed in Section 8.3 to provide focus to investigatory methods that may be employed. The data type requirements for the preliminary remedial action alternatives developed in Section 7.4 are summarized in Table 8-2.

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8.2.2.2 Data Quality Needs. The various tasks and phases of a CERCLA investigation may require different levels of data quality. Important factors in defining data quality include selecting appropriate analytical levels and validation and identifying contaminant levels of concern as described below. The Westinghouse Hanford document, *A Proposed Data Quality Strategy for Hanford Site Characterization,* will be used to help define these levels (McCain and Johnson 1990). The DQOs will also be developed and defined on an operable unit basis in the work plans and, specifically, in the Quality Assurance Project Plans (QAPjPs) which will guide investigation activities.

Chemical and radionuclide laboratory analysis will be one of the most important data types, and is required at virtually all the waste management units in the PUREX Plant Aggregate Area. In general, increasing accuracy, precision, and lower detection limits are obtained with increasing cost and time. Therefore, the analytical level used to obtain data should be commensurate with the intended use. Table 8-3 defines five analytical levels associated with different types of characterization efforts. While the bulk of the analysis during LFIs/RIs will be screening level (DQO Level I or II), these data will require confirmation sampling and analysis to allow final remedial decisions through quantitative risk assessment methods. Individual DQO analytical PARCC parameters for Level III or IV analytical data associated with each contaminant anticipated in the PUREX Plant Aggregate Area (as developed in Section 5) are given in Table 8-4. These parameters will be used for the development of site-specific sampling and analysis plans and quality assurance plans for investigations and remediations in the aggregate area.

Before laboratory or even field data can be used in the selection of the final remedial action, they must first be validated. Exceptions are made for initial evaluations of the sites using existing data, which may not be appropriate for validation but will be used on a screening basis based on the *Hanford Site Past-Practice Strategy* (DOE/RL 1992a). Other screening data (e.g., estimates of contaminant concentration inferred from field analyses) may also be excepted. Validation involves determining the usability and quality of the data. Once data are validated, they can be used to successfully complete the remedial action selection process. Activities involved in the data validation process include the following:

- Verification of chain-of-custody and sample holding times
- Confirmation that laboratory data meet Quality Assurance/Quality Control (QA/QC) criteria
- Confirmation of the usability and quality of field data, which includes geological logs, hydrologic data, and geophysical surveys
- Proper documentation and management of data so that they are usable.

Validation may be performed by qualified Westinghouse Hanford personnel from the Office of Sample Management (OSM), other Westinghouse Hanford organizations, or a

qualified independent participant subcontractor. Data validation of laboratory analyses will be performed in accordance with *A Proposed Data Quality Strategy for Hanford Site Characterization* (McCain and Johnson 1990) and standards set forth by Westinghouse Hanford.

To accomplish the second point, all laboratory data must meet the requirements of the specific QA/QC parameters as set up in the QAPjP for the project before it can be considered usable. The QA/QC parameters address laboratory precision and accuracy, method blanks, instrument calibration, and holding times.

The usability of field data must be assessed by a trained and qualified person. The project geohydrologist/geophysicists will review the geologic logs, hydrologic data, geophysical surveys, and results of physical testing, on a daily basis, and senior technical reviews will be conducted periodically throughout the project.

Data management procedures are also necessary for the validation. Data management includes proper documentation of field activities, sample management and tracking, and document and inventory control. Specific consistent procedures are discussed in the Information Management Overview (Appendix D).

8.2.2.3 Data Quantity Needs. The number of samples that need to be collected during an investigation can be determined by using several approaches. In instances where data are lacking or are limited (such as for contamination in the vadose zone soils), a phased sampling approach will be appropriate. In the absence of any available data, an approach or rationale will need to be developed to justify the sampling locations and the numbers of samples selected. This will be accomplished and documented in the production of work plans and field sampling plans for each aggregate area, under the guidance and review of the Tri-Party Agreement participants. Specific locations and numbers of samples will be determined based on data collected during screening activities. For example, the number and location of beta/gamma spectrometer probe locations can be based on results of surface geophysical and radiation surveys. These may help locate some subsurface features, which may not be adequately documented. Details of any higher DQO level subsurface soil sampling scheme will depend on results of screening investigations such as geophysics surveys, surface radiation surveys, field chemical screening, and beta/gamma spectrometer probe surveys. In situations where and when available data are more complete, statistical techniques may be useful in determining the additional data required.

8.2.2.4 Sampling and Analysis Options. Data collection activities are structured to obtain the needed data in a cost-effective manner. Developing a sampling and analysis approach that ensures that appropriate data quality and quantity are obtained with the resources available may be accomplished by using field screening techniques and focusing the higher DQO level analyses on a limited set of samples at each site. The investigations on waste management units in the PUREX Plant Aggregate Area should take advantage of this approach for a comprehensive characterization of the site in a cost-effective manner.

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A combination of lower level (Levels I and II), higher level analytical data (Levels III and IV), and special analytical data (Level V) should be collected. This approach would provide the certainty necessary to determine contaminants present near the sources. Samples collected from the other media (i.e., subsurface soils, sediments) will be analyzed by *Test Methods for Evaluating Solid Wastes*, (EPA 1986), CLP (EPA 1991c, EPA 1991d), *Methods for Chemical Analysis of Water and Wastes* (EPA 1983), or *Prescribed Procedures for Measurement of Radioactivity in Drinking Water* (EPA 1980a).

8.2.2.5 Data Quality Parameters. The PARCC parameters are indicators of data quality. Ideally, the end use of the data collected should define the necessary PARCC parameters. Once the PARCC requirements have been identified, then appropriate analytical methods can be chosen to meet established goals and requirements. Definitions of the PARCC parameters are presented in Section 8.1.3.

In general the precision and accuracy objectives are governed by the capabilities of the available methodologies and in most cases these are more than adequate for the needs of the investigations. Chemical analyses can usually attain parts per billion detection range in soils and water, and this level is adequate to the needs of the risk assessment for most analytes. Radiological analyses reach similar levels. Table 8-4 shows detection levels, generally obtained from the method description such as the document *Test Methods for Evaluating Solid Wastes* (EPA 1986) or from experience with laboratory analysis. Some constituents (e.g., arsenic) would require analysis to much lower levels, but this is impossible because of the limitations of analytical methods and the effects of natural background levels. For example, EPA Method 200.62-C-CLP can analyze to detection levels of 500 mg/kg in soils, while the Model Toxics Control Act (MTCA) Method C industrial soils cleanup level is 50 μg/kg. In some cases, special analytical methods can be developed to obtain lower detection levels. In addition, risk assessment is conventionally computed only to a single digit of precision and uses conservative assumptions, which reduce the impact of measurements with lower accuracy.

For other measurements, such as physical parameters, the precision and accuracy capabilities of existing measurement technologies are sufficient for the evaluation methods used to produce characterization data, so the objectives are based on the limitations of the analysis methodologies.

Representativeness is maintained by fitting the sampling program to the governing aspects of the sources and transport processes of the site, as demonstrated in the site conceptual model (Section 4.2). Initial sampling should concentrate on sources, which are fairly well-understood, and on representative locations of anticipated transport mechanisms. If necessary, following activities can focus on aspects or locations that were not anticipated but were demonstrated by the more general results.

Completeness is generally attained by specifying redundancy on critical samples and maintaining quality control on their acquisition and analysis. As with representativeness, the initial sampling program may lead to modifications of which samples should be considered critical during subsequent sampling activities.

Comparability will be met through the use of Westinghouse Hanford standard procedures generally incorporated into the *Environmental Investigation and Site Characterization Manual* (WHC 1988b).

8.2.3 Data Gaps

Considering the data needs developed in Section 8.2.2, and the data available to meet these needs as presented in Section 8.1.2, it is apparent that a number of data gaps can be identified. These are summarized, on a waste management unit category basis, in Table 8-5, and should be the focus of LFIs on a waste management unit category basis, using the analogue sites approach. The contaminant concentration data are the highest priority because of the need to assess the need for remediation (through quantitative risk assesssment and evaluation of compliance with ARARs) and appropriate remedial actions for each site.

In addition to these data needs specifically addressing contamination problems at sites included for consideration in this aggregate area, there are general data needs which will be required for characterization of the possible transport pathways, as presented in the conceptual model, at locations away from the individual units. These general, nonsite-specific needs include characterization of the following:

- Geologic stratigraphy, particularly for possible perched water zones
- Transport through the vadose zone (mobilization through natural or artificial recharge or drainage)
- Air transport of contamination
- Ecological impacts and transport mechanisms (bio-uptake, bio-concentration, secondary receptors through predation)
- Potential releases from process effluent lines between facilities and to waste disposal sites.

All of these needs will have to be addressed in the data collection program (Section 8.3). In addition, data gaps that impact groundwater are also addressed in the 200 East Groundwater AAMSR.

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8.3 DATA COLLECTION PROGRAM (STAGE 3 OF THE DQO PROCESS)

The data collection program is Stage 3 of the process to develop DQOs. Conducting an investigation with a mixture of screening and higher-level data is a common method for optimizing the quantity and quality of the data collected. It would be very inefficient and overly expensive to specify beforehand all the types of samples and analyses that will yield the most complete and accurate understanding of the contamination and physical behavior of the site. Data adequate to achieve all the goals and objectives for remedial action decisions are obtained at a lower cost by using the information obtained in the field to focus the ongoing investigation and remediation process.

Initial sampling should collect new data believed most necessary to confirm and refine the conceptual model particularly at priority sites. Sampling may then be extended to further reduce uncertainty, to fill in remaining data gaps, to collect more detailed information for certain points where such information is required, or to conduct any needed treatability studies or otherwise support the data needs of the remedial action selection process. An alternative of extrapolating the data from a limited number of sites to other analogous ones will also be used. The need for subsequent investigation phases will be assessed throughout the investigation and remediation activities as data become available. Assessing completeness of the investigation data through a formal statistical procedure is not possible, given the complexity and uncertainty of the parameters required to describe the site and the time to make decisions. Rather, the use of engineering judgement is considered sufficient to the decision process.

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8.3.1 General Rationale

The general rationale for the investigation of sites in the PUREX Plant Aggregate Area is to collect needed data that are not available. Because of the size of the aggregate area, the complexity of past operations, and the number of unplanned releases and waste management units, a large amount of new information will be required such as the specific radionuclides and chemicals present, their spatial distribution and form, and the presence of special migration pathways.

The following work plan approach will be used for LFIs and RI/FS in the PUREX Plant Aggregate Area. The results are described in Sections 8.3.2 and 8.3.3 in general form.

- Existing data as described in Sections 2.0, 3.0, and 4.0 should be used to the maximum extent possible. Although existing data are not fully validated, the data are still useful in developing a preliminary conceptual model (Section 4.2) and in helping to focus and guide the planning of investigations, expedited actions, and interim measures.

- Additional data at validated and screening levels should be collected to obtain the maximum amount of useful information for the amount of time and resources invested in the investigation.

- Data should be collected to support the intended data uses identified in Section 8.2.1.

- Nonintrusive sampling (e.g., geophysical surveys, surface radiation surveys, soil gas, and spectral gamma probe surveys), and surficial and source sampling should be conducted early in any investigation effort to identify necessary interim response actions (i.e., additional ERAs or IRMs).

- Data collected from initial investigation activities should be used to confirm and refine the conceptual model (Section 4.2), refine the analyte constituents of concern, and provide information to conduct interim response actions or risk assessment activities.

- Additional investigation activities are proposed to support (if needed) quantitative baseline risk assessments for final cleanup actions and further refine the conceptual model.

- Field investigation techniques should be used to minimize the amount of hazardous or mixed waste generated. Any waste generated will be in accordance with EII 4.3, "Control of CERCLA and Other Past-Practice Investigation Derived Waste" (WHC 1988d).

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8.3.2 General Strategy

The overall objective of any field investigation (LFI, IRM, or RI) of the sites in the PUREX Plant Aggregate Area will be to gather additional information to support risk assessment and remedial action selection according to the *Hanford Site Past-Practice Strategy* (DOE/RL 1992a) flow chart discussed in Section 8.1.5. The general approach or strategy for obtaining this additional information is presented below.

- Analytical parameter selection should be based on verifying overall conditions and then narrowed to specific constituents of concern, in consideration with regulatory requirements and site conditions. Periodic analyses of the long list of parameters should be conducted to verify that the list of constituents of concern has not changed, either because new constituents are identified or some of those considered as a potential concern do not appear to be significant.

- Similarly, investigations should work from a screening level (DQO Levels I or II, e.g., surface radiation surveys) to successively more specific sampling and

analysis methodologies (e.g., beta/gamma spectral probes, then DQO Level III or IV soil sampling and analysis), without time consuming remobilizations.

- Dangerous and radioactive wastes may be generated during the field investigation. While efforts should be made to minimize these wastes, any waste generated will be handled in accordance with EII 4.3, "Control of CERCLA and Other Past-Practice Investigation Derived Waste" (WHC 1988d). The analyses of samples for constituents of concern analytes will allow wastes generated to be adequately designated.

8.3.3 Investigation Methodology

Initial field investigations (mainly LFIs, but also associated with IRMs at appropriate sites and possibly some RIs) may include some or all of the following integrated methodologies:

- Source Investigation (Section 8.3.3.1)
- Geological Investigation (Section 8.3.3.2)
- Surface Water Sediment Investigation (Section 8.3.3.3)
- Soil Investigation (Section 8.3.3.4)
- Air Investigation (Section 8.3.3.5)
- Ecological Investigation (Section 8.3.3.6)
- Geophysical Stratigraphic Survey (Section 8.3.3.7)
- Process Effluent Pipeline Integrity Assessment (Section 8.3.3.8)
- Geodetic Survey (Section 8.3.3.9)
- Cultural Resource Investigation (Section 8.3.3.10).

Each investigation methodology is briefly outlined in the following sections. Specific survey methods (such as electromagnetics or ground-penetrating radar) have not been recommended to allow flexibility in the development of field sampling plans which can be sensitive to very local conditions. A summary of the applicable methods for each waste management unit is presented in Table 8-6. In addition, some of the data needs must be addressed on an area-wide basis (e.g., stratigraphy interpretation). More detailed descriptions and specific methods and instrumentation will be included in site-specific work

plans, sampling and analysis plans, and field sampling plans for LFIs/IRMs at waste management units that require these investigations.

These investigations are presented in the approximate priority of their need, with the source investigation first because of its importance to the decisions about remedial action on a site-by-site basis. The other investigations are of lower priority, and will be conducted according to the need to determine whether contamination has been transported beyond the immediate vicinity of the waste management units. To some extent, this need will depend on the results of the source investigation.

8.3.3.1 Source Investigation. The purpose of source investigation activities in the PUREX Plant Aggregate Area is to characterize the known waste management units and unplanned releases that exist in the area and that may contribute to contamination of surface soil, vadose zone, surface water, sediment, air, and biota. The completeness of the characterization effort will be assessed according to the needs of risk assessment, ARARs compliance, and remedial action selection, which will also determine what levels of the various constituents of concern comprise "contamination."

Source sampling should be conducted at waste management units or unplanned release locations where the available data indicate that dangerous, mixed, or radioactive wastes may be present. Activities which are proposed to be performed during the source investigations include the following:

- Compile and evaluate additional existing data for the purpose of: verifying locations, specifications of engineered facilities, and pipelines, and waste stream characteristics; assessment of the construction and condition of boreholes/wells that exist in the operable unit and their suitability for use for investigation activities, QA/QC information, and raw data regarding radiological and hazardous substances monitoring; and integrating any additional environmental modeling data into the conceptual model. This has been done (on an aggregate area basis) in this report; the process will be extended to site-specific planning and on-going assessments of the investigation/remediation as it is carried out.

- Conduct surface radiological surveys of suspected or known source areas to verify locations and nature of surface and subsurface radiological contamination. Conditions at specific sources within a waste management unit should also be noted in order to plan sampling/remediation activities and worker health and safety.

- Conduct nonintrusive surface geophysical surveys at specific waste management units such as the 2607-EL Septic Tank and Drain Field (Section 2.3.6.6), and unplanned release locations to verify locations and physical characteristics of source locations. Data generated from these activities can be used in planning intrusive source sampling activities.

- Conduct beta/gamma spectrometer probe survey to screen for near-surface contamination and to confirm the absence or presence of some specific radionuclides, which may be of particular concern. Existing boreholes will be used to the maximum extent, but new boreholes may be needed at many locations (to be decided based on screening results). Logging will be done both by NaI detectors or μR meters for rapid screening as well as the RLS high purity germanium logging system. Westinghouse Hanford will develop an EII Procedure for the beta/gamma spectrometer probe survey. The beta/gamma spectrometer probe survey serves two purposes depending on the source conditions: to confirm absence of contamination in the near-surface soils, and to serve as a screening tool to choose locations and quantities of vadose zone soil borings. The RLS procedure could demonstrate "assay quality" data for radionuclide concentrations, but will probably continue to require supporting Level III or IV soil analysis data to allow a risk assessment before final remedial decisions. The need to conduct this survey will be based (at least in part) on the screening results of the surface survey and on information about site burial.

- Soil gas surveys should be conducted at waste management units such as cribs where volatile organic compounds are suspected, as a screening method to identify compounds such as solvents that may have been used in processes. The soil gas survey should not be considered conclusive that volatile organic compounds at lower concentrations may not be present. Data from the soil gas survey can be used to help locate surface and near-surface samples and vadose zone borings.

- Collect surface and near-surface samples of contaminated soils and/or waste materials at selected locations. Specific sampling sites will be chosen to assess particular facilities or releases. Additional sampling sites may be specified based on results from nonintrusive investigations.

8.3.3.2 Geologic Investigation. A geologic investigation should be performed to better characterize the vadose zone and the nature of unsaturated soils that make up this system. The geologic investigation will include the following tasks:

- Borings may be advanced into zones where an accurate interpolation of the subsurface stratigraphy is important to understanding migration pathways in the vadose zone.

- Geologic data collected during the ongoing vadose zone soil (Section 8.3.3.4) and other (deeper) investigations (e.g., geologic and geophysical logs from groundwater well installations for groundwater AAMS) will be compared, compiled, and evaluated.

8.3.3.3 Surface Water Sediment Investigation. A surface water sediment investigation should be conducted. The investigation will include:

- Radiation surveys along ditches and trenches for health and safety purposes and to locate areas of elevated radiation for selection of specific sediment sampling locations.

- Sampling of sediment in any ditches and trenches that still contain water. This will probably be limited to the 207-A Retention Basin. This sediment is likely to be windblown soil.

8.3.3.4 Soil Investigation. The purpose of soil investigations is to determine physical and chemical properties of the soil and to determine the nature, type, and extent of soil contamination associated with waste management units and unplanned releases to allow initiation of interim remedial actions and to assess the quantitative risk at other sites. Sampling will include:

- Samples of vadose zone soil will be collected and analyzed for constituents of concern when wells are drilled for other studies (i.e., groundwater investigations) in the vicinity of a waste management unit or unplanned release with reported liquid disposals or spills. Organic vapor (at sites with suspected volatiles) and radiation sampling should also be performed with samples selected by onsite screening.

- Data collected during this investigation will be evaluated to further understand the contribution of contaminants to the vadose zone from specific waste management units and/or unplanned releases and to better define the hydrology and water quality in the vadose zone system through moisture content profiles, tracking of specific contaminants, and soil hydraulic characteristics. However, the issue of contaminant transport through the vadose zone is more appropriate to studies conducted under the direction of the Groundwater AAMSRs.

8.3.3.5 Air Investigation. Air investigations (on an aggregate area scale) should consist of onsite particle sampling as part of the health and safety program. In addition, high-volume air samplers should be placed in appropriate locations on-site based on evaluation of existing meteorological data. The purpose of these samplers will be to determine if any migration of airborne contaminants occurs.

8.3.3.6 Ecological Investigation. Ecological investigation activities, on a site-wide scale, should include a literature search and data review, and a site walkthrough. Data collected during the soils characterization activities are expected to be sufficient to evaluate biota remediation technologies. These activities are intended to identify potential biota concerns which need to be addressed in the site investigation. Particular emphasis should be given to identifying potential exposure pathways to biota that migrate offsite or that introduce

contaminants into the food web. Data obtained in this survey will be used to both refine the conceptual model as well as to conduct the ecological risk assessment.

8.3.3.7 Geophysical Stratigraphic Survey. A geophysical survey of subsurface stratigraphy should be conducted across the aggregate area to help characterize the geology and hydrogeology of the vadose zone.

8.3.3.8 Process Effluent Pipeline Integrity Assessment. An assessment of process effluent pipeline integrity should be conducted early in site investigation activities to look for potential leaks and therefore possible areas of contamination. Initially, as part of this effort, drawings of the process lines and encasements within the aggregate area (Section 2.3.7) should be reviewed and their construction, installation, and operation evaluated. Specific lines will then be selected for integrity assessment with emphasis on lines serving the waste management units that have received large volumes of liquid (e.g., cribs). Investigation of operating high-level waste transfer lines will be deferred to their respective programs. Results of the integrity assessments will be evaluated and additional sampling activities may be recommended for subsequent studies.

8.3.3.9 Geodetic Survey. Geodetic surveys will be conducted after the installation and completion of each investigation activity. The survey will be used to locate the horizontal locations of surface and near-surface soil samples; corners of geophysics, soil gas, and beta/gamma probe surveys; and surface water and sediment sample locations. Horizontal and vertical locations of all vadose zone soil borings and perched zone wells will be surveyed. The geodetic survey should be conducted by a professional surveyor licensed in the state of Washington and should be referenced to both historic (e.g., Hanford coordinates) and current coordinate datums (e.g., North American Datum of 1983 - NAD-83), both vertical and horizontal.

8.3.3.10 Cultural Resource Investigation. A cultural resource investigation should be conducted for investigating locations outside the 200 East Area to verify the locations of known archaeological sites by reviewing existing data. The focus of the investigation will be to confirm that no archaeological resources are present at proposed drilling sites.

8.3.4 Data Evaluation and Decision Making

Data will be evaluated as soon as results (e.g., soil gas, radiation screening, drilling results) become available for use in restructuring and focusing the investigation activities. Data reports will be developed that summarize and interpret new data. This includes groundwater sampling and RLS borehole logging as part of the AAMS. Data will be used to refine the conceptual model, further assess potential contaminant-specific ARARs, develop the quantitative risk assessment, and assess remedial action alternatives.

The objectives of data evaluation are the following:

- To reduce and integrate data to ensure that data gaps are identified and that the goals and objectives of the PUREX Plant AAMS are met.
- To confirm that data are representative of the media sampled and that QA/QC criteria have been met.

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Table 8-1. Uses of Existing Data for PUREX Plant Aggregate Area Waste Management Units. (sheet 1 of 3)

Waste Management Unit	Development of Sampling Plans			Health and Safety	
	Location	Possible Contamination	Depth Contamination	Surface Radiation	Expected Maximum Level
Cribs and Drains					
216-A-1 Crib	*	*	--	*	*
216-A-2 Crib	*	*	--	*	--
216-A-3 Crib	*	*	--	*	--
216-A-4 Crib	*	*	--	*	--
216-A-5 Crib	*	*	--	*	--
216-A-6 Crib	*	*	--	*	*
216-A-7 Crib	*	*	--	*	*
216-A-8 Crib	*	*	--	*	--
216-A-9 Crib	*	*	--	*	*
216-A-10 Crib	*	*	--	*	--
216-A-21 Crib	*	*	--	*	*
216-A-24 Crib	*	*	--	*	--
216-A-27 Crib	*	*	--	*	--
216-A-30 Crib	*	*	--	*	--
216-A-31 Crib	*	*	--	*	--
216-A-32 Crib	*	--	--	*	--
216-A-36A Crib	*	*	--	*	--
216-A-36B Crib	*	*	--	*	--
216-A-37-1 Crib	*	*	--	*	--
216-A-37-2 Crib	*	--	--	*	--
216-A-38-1 Crib	*	*	--	*	--
216-A-41 Crib	*	--	--	--	--
216-A-45 Crib	*	*	--	*	--
216-A-11 French Drain	*	*	--	*	--
216-A-12 French Drain	*	*	--	*	--
216-A-13 French Drain	*	*	--	*	--
216-A-14 French Drain	*	*	--	*	--
216-A-15 French Drain	*	*	--	*	--
216-A-22 French Drain	*	*	--	*	--
216-A-26 French Drain	*	*	--	*	--
216-A-26A French Drain	*	*	--	*	--
216-A-28 French Drain	*	*	--	*	--
216-A-33 French Drain	*	--	--	*	--
216-A-35 French Drain	*	*	--	*	--

Table 8-1. Uses of Existing Data for PUREX Plant Aggregate Area Waste Management Units. (sheet 2 of 3)

Waste Management Unit	Development of Sampling Plans			Health and Safety	
	Location	Possible Contamination	Depth Contamination	Surface Radiation	Expected Maximum Level
Reverse Wells					
299-E24-111 Injection Well	*	*	--	*	--
Ponds, Ditches and Trenches					
216-A-29 Ditch	*	--	--	*	--
216-A-34 Ditch	*	--	--	*	--
216-A-18 Trench	*	--	--	*	--
216-A-19 Trench	*	--	--	*	--
216-A-20 Trench	*	--	--	*	--
216-A-40 Trench	*	--	--	*	--
Septic Tanks and Associated Drain Fields					
2607-EA Septic Tank/Drain Field	*	--	--	--	--
2607-EC Septic Tank/Drain Field	*	--	--	--	--
2607-ED Septic Tank/Drain Field	*	--	--	--	--
2607-EG Septic Tank/Drain Field	*	--	--	--	--
2607-EJ Septic Tank/Drain Field	*	--	--	--	--
2607-EL Septic Tank/Drain Field	--	--	--	--	--
2607-E6 Septic Tank/Drain Field	*	--	--	--	--
Transfer Facilities, Diversion Boxes, and Pipelines					
216-A-524 Control Structure	--	*	--	*	--
Basins					
207-A Retention Basin	*	--	--	*	*
216-A-42 Retention Basin	*	--	--	--	--
Burial Sites					
218-E-1 Burial Ground	*	*	--	*	--
218-E-8 Burial Ground	*	*	--	--	--
218-E-12A Burial Ground	*	*	--	*	--
218-E-13 Burial Ground	*	*	--	*	--
Unplanned Releases					
UN-200-E-10 Unplanned Release	*	--	--	--	--
UN-200-E-11 Unplanned Release	*	*	--	--	--
UN-200-E-12 Unplanned Release	*	*	--	--	--
UN-200-E-13 Unplanned Release	*	--	--	--	--
UN-200-E-15 Unplanned Release	*	--	--	--	--
UN-200-E-19 Unplanned Release	*	*	--	--	--

Table 8-1. Uses of Existing Data for PUREX Plant Aggregate Area Waste Management Units. (sheet 3 of 3)

	Development of Sampling Plans			Health and Safety	
Waste Management Unit	Location	Possible Contamination	Depth Contamination	Surface Radiation	Expected Maximum Level
UN-200-E-20 Unplanned Release	*	*	--	--	--
UN-200-E-22 Unplanned Release	*	*	--	--	--
UN-200-E-25 Unplanned Release	*	*	--	--	--
UN-200-E-26 Unplanned Release	*	*	--	--	--
UN-200-E-28 Unplanned Release	*	*	--	--	--
UN-200-E-31 Unplanned Release	*	*	--	--	--
UN-200-E-33 Unplanned Release	*	--	--	--	--
UN-200-E-35 Unplanned Release	*	--	--	--	--
UN-200-E-39 Unplanned Release	*	*	--	--	--
UN-200-E-40 Unplanned Release	*	*	--	--	--
UN-200-E-42 Unplanned Release	*	--	--	--	--
UN-200-E-49 Unplanned Release	*	--	--	--	--
UN-200-E-56 Unplanned Release	*	*	--	--	--
UN-200-E-58 Unplanned Release	*	--	--	--	--
UN-200-E-60 Unplanned Release	*	--	--	--	--
UN-200-E-62 Unplanned Release	*	--	--	--	--
UN-200-E-65 Unplanned Release	*	--	--	--	--
UN-200-E-67 Unplanned Release	*	--	--	--	--
UN-200-E-68 Unplanned Release	*	--	--	--	--
UN-200-E-72 Unplanned Release	*	--	--	--	--
UN-200-E-88 Unplanned Release	*	*	--	*	*
UN-200-E-94 Unplanned Release	*	--	--	--	--
UN-200-E-96 Unplanned Release	*	*	--	--	--
UN-200-E-97 Unplanned Release	*	--	--	--	--
UN-200-E-99 Unplanned Release	*	*	--	--	--
UN-200-E-100 Unplanned Release	*	*	--	--	--
UN-200-E-114 Unplanned Release	*	*	--	--	--
UN-200-E-117 Unplanned Release	*	*	--	--	--
UN-200-E-142 Unplanned Release	*	--	--	--	--

An asterisk (*) indicates potential use for available data.
A dashed line (--) indicates no data available.

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Table 8-2. Data Needs for Preliminary Remedial Action Alternatives for the PUREX Plant Aggregate Area. (sheet 1 of 2)

Alternative	Physical Attribute	Chemical/Radiochemical Attribute
1. Multimedia Cover (plus possible vertical barriers)	• areal extent • depth of contamination • structural integrity (collapse potential) • run-off/run-on potential • cover properties (permeability)	• surface radiation • biologic transport potential
2. In Situ Grouting/ Stabilization	• areal extent • depth • particle size • hydraulic properties (permeability/porosity) • stratigraphy • borehole spacing • grout/additive mix parameters	• solubility • reactivity • leachability from grout medium
3. Excavation, Soil Treatment, and Disposal	• areal extent[a/] • depth[a/] • particle size • silt-size (dust) content • excavation stability	• toxicity/radioactivity • levels of contaminants • solubility/reactivity • soil chemistry (relative affinity) • concentrations in PM-10 fraction • spent solvent treatment/disposal options
4. In Situ vitrification	• areal extent • depth • soil/waste conductivity • thermal properties • moisture contact • voids • air permeability	• volatility • reactivity • leachability/integrity • off-gas treatment waste disposal options
5. Excavation, Above Ground Treatment, and Geologic Disposal	• areal extent[a/] • depth[a/] • mineralogy of soil/waste • particle size • silt-size (dust) content • excavation stability • treatment parameters	• concentrations of TRU • toxicity/radioactivity • levels of contaminants • concentrations in PM-10 fraction • reactivity • leachability/integrity of final waste form

Table 8-2. Data Needs for Preliminary Remedial Action Alternatives for the PUREX Plant Aggregate Area. (sheet 2 of 2)

Alternative	Physical Attribute	Chemical/Radiochemical Attribute
6. In Situ Soil Vapor Extraction	• areal extent • depth • locations/depth of highest concentrations (vapors, adsorbed) • stratigraphy • soil permeability/porosity • voids	• volatility of constituents (Henry's Law Constant) • non-volatile organics • levels • volatile radionuclides (Radon) • treatability (catalytic oxidization)

✓ May be obtained during remediation using the observational approach recommended by the *Hanford Past-Practice Strategy* (DOE/RL 1992a)

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Table 8-3. Analytical Levels for the PUREX Plant Aggregate Area.

Level	Description
LEVEL I	Field screening. This level is characterized by the use of portable instruments which can provide real-time data to assist in the optimization of sampling point locations and for health and safety support. Data can be generated regarding the presence or absence of certain contaminants (especially volatiles) at sampling locations.
LEVEL II	Field analysis. This level is characterized by the use of portable analytical instruments which can be used onsite, or in mobile laboratories stationed near a site (close-support laboratories). Depending on the types of contaminants, sample matrix, and personnel skill, qualitative and quantitative data can be obtained.
LEVEL III	Laboratory analysis using methods other than the Contract Laboratory Program (CLP) Routine Analytical Services (RAS). This level is used primarily in support of engineering studies using standard EPA-approved procedures. Some procedures may be equivalent to CLP RAS without the CLP requirements for documentation.
LEVEL IV	Contract Laboratory Program (CLP) Routine Analytical Services (RAS). This level is characterized by rigorous QA/QC protocols and documentation and provides qualitative and quantitative analytical data. Some regions have obtained similar support via their own regional laboratories, university laboratories, or other commercial laboratories.
LEVEL V	Nonstandard methods. Analyses which may require method modification and/or development are considered Level V by CLP Special Analytical Services (SAS).

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Table 8-4. Data Quality Objective Parameters for Chemical/Radiochemical Analyses. (sheet 1 of 6)

	Soil/Sediment				Water			
	Analysis Method	Practical Quantitation Limit (pCi/g)[a] (mg/Kg)	Precision (RPD)	Accuracy (%)	Analysis Method	Practical Quantitation Limit (pCi/L)[a] (μg/L)	Precision (RPD)	Accuracy (%)
RADIONUCLIDES								
Gross Alpha	900.0 M	TBD	±30	±25	900.0	10	±25	±25
Gross Beta	900.0 M	TBD	±30	±25	900.0	5	±25	±25
Gamma Scan	D3699 M	TBD	±30	±25	D3649 M	TBD	±25	±25
Actinium-225	907.0 M	TBD	±30	±25	907.0	TBD	±25	±25
Actinium-227	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Americium-241	Am-01	TBD	±30	±25	Am-03	TBD	±25	±25
Americium-242	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Americium-242m	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Americium-243	Am-01	TBD	±30	±25	Am-03	TBD	±25	±25
Antinomy-126	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Antimony-126m	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Barium-137m	D3649 M	TBD	±30	±25	D3649 M	TBD	±25	±25
Bismuth-210	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Bismuth-211	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Bismuth-213	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Bismuth-214	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Carbon-14	C-01 M	TBD	±30	±25	TBD	TBD	±25	±25
Cesium-134	D3649 M	TBD	±30	±25	D3649 M	TBD	±25	±25

Table 8-4. Data Quality Objective Parameters for Chemical/Radiochemical Analyses. (sheet 2 of 6)

	Soil/Sediment				Water			
	Analysis Method	Practical Quantitation Limit (pCi/g)[a/] (mg/Kg)	Precision (RPD)	Accuracy (%)	Analysis Method	Practical Quantitation Limit (pCi/L)[a/] (μg/L)	Precision (RPD)	Accuracy (%)
RADIONUCLIDES (cont.)								
Cesium-135	901.0 M	TBD	±30	±25	901.0	TBD	±25	±25
Cesium-137	D3649 M	TBD	±30	±25	D3649 M	TBD	±25	±25
Cobalt-60	D3649 M	TBD	±30	±25	D3649 M	TBD	±25	±25
Curium-242	907.0 M	TBD	±30	±25	907.0	TBD	±25	±25
Curium-244	907.0 M	TBD	±30	±25	907.0	TBD	±25	±25
Curium-245	907.0 M	TBD	±30	±25	907.0	TBD	±25	±25
Europium-152	D3649 M	TBD	±30	±25	D3649 M	TBD	±25	±25
Europium-154	D3649 M	TBD	±30	±25	D3649 M	TBD	±25	±25
Europium-155	D3649 M	TBD	±30	±25	D3649 M	TBD	±25	±25
Francium-221	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Iodine-129	902.0 M	TBD	±30	±25	902.0	TBD	±25	±25
Lead-209	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Lead-210	Pb-01 M	TBD	±30	±25	Pb-01	TBD	±25	±25
Lead-211	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Lead-212	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Lead-214	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Neptunium-237	907.0 M	TBD	±30	±25	907.0	TBD	±25	±25
Neptunium-239	D3649 M	TBD	±30	±25	D3649 M	TBD	±25	±25
Nickel-59	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Nickel-63	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Niobium-93m	TBD	TBD	±30	±25	TBD	TBD	±25	±25

Table 8-4. Data Quality Objective Parameters for Chemical/Radiochemical Analyses. (sheet 3 of 6)

	Soil/Sediment				Water			
	Analysis Method	Practical Quantitation Limit (pCi/g)[a/] (mg/Kg)	Precision (RPD)	Accuracy (%)	Analysis Method	Practical Quantitation Limit (pCi/L)[a/] (µg/L)	Precision (RPD)	Accuracy (%)
RADIONUCLIDES (cont.)								
Plutonium	Pu-02	TBD	±30	±25	Pu-10	TBD	±25	±25
Plutonium-238	Pu-02	TBD	±30	±25	Pu-10	TBD	±25	±25
Plutonium-239/240	Pu-02	TBD	±30	±25	Pu-10	TBD	±25	±25
Plutonium-241	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Polonium-214	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Polonium-215	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Polonium-218	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Potassium-40	D3649 M	TBD	±30	±25	D3649 M	TBD	±25	±25
Protactinium-231	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Protactinium-234m	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Radium	Ra-04	TBD	±30	±25	Ra-05	TBD	±25	±25
Radium-225	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Radium-226	Ra-04	TBD	±30	±25	Ra-05	TBD	±25	±25
Ruthenium-106	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Samarium-151	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Selenium-79	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Sodium-22	D3649 M	TBD	±30	±25	D3649 M	TBD	±25	±25
Strontium-90	Sr-02	TBD	±30	±25	Sr-02	TBD	±25	±25
Technetium-99	Tc-01 M	TBD	±30	±25	Tc-01	TBD	±25	±25
Thallium-207	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Thorium-227	00-06	TBD	±30	±25	00-07	TBD	±25	±25

Table 8-4. Data Quality Objective Parameters for Chemical/Radiochemical Analyses. (sheet 4 of 6)

	Soil/Sediment				Water			
	Analysis Method	Practical Quantitation Limit (pCi/g)[a/] (mg/Kg)	Precision (RPD)	Accuracy (%)	Analysis Method	Practical Quantitation Limit (pCi/L)[a/] (μg/L)	Precision (RPD)	Accuracy (%)
RADIONUCLIDES (cont.)								
Thorium-229	00-06	TBD	±30	±25	00-07	TBD	±25	±25
Thorium-230	00-06	TBD	±30	±25	00-07	TBD	±25	±25
Thorium-231	TBD	TBD	±30	±25	TBD	TBD	±25	±25
Tritium	906.0 M	TBD	±30	±25	906.0	300	±25	±25
Uranium	U-04	TBD	±30	±25	U-04	TBD	±25	±25
Uranium-233	U	TBD	±30	±25	908.0	TBD	±25	±25
Uranium-234	U	TBD	±30	±25	908.0	TBD	±25	±25
Uranium-235	U	TBD	±30	±25	908.0	TBD	±25	±25
Uranium-238	U	TBD	±30	±25	908.0	TBD	±25	±25
Yttrium-90	Sr-02	TBD	±30	±25	Sr-02	TBD	±25	±25
Zirconium-93	TBD	TBD	±30	±25	TBD	TBD	±25	±25
INORGANICS								
Arsenic	7061	0.02	±25	±30	7061	10	±20	±25
Barium	6010	0.02	±25	±30	6010	20	±20	±25
Boron	6010	TBD	±25	±30	6010	TBD	±20	±25
Cadmium	6010	0.09	±25	±30	6010	1	±20	±25
Chromium	6010	0.07	±25	±30	6010	10	±20	±25
Copper	6010	0.06	±25	±30	220.2	10	±20	±25
Cyanide	9010	TBD	±25	±30	335.3	50	±20	±25
Fluoride	300 M	TBD	±25	±30	300	50	±20	±25
Iron	6010	20	±25	±30	6010	70	±20	±25

Table 8-4. Data Quality Objective Parameters for Chemical/Radiochemical Analyses. (sheet 5 of 6)

	Soil/Sediment				Water			
	Analysis Method	Practical Quantitation Limit (pCi/g)[a/] (mg/Kg)	Precision (RPD)	Accuracy (%)	Analysis Method	Practical Quantitation Limit (pCi/L)[a/] (µg/L)	Precision (RPD)	Accuracy (%)
INORGANICS (cont.)								
Lead	6010	0.45	±25	±30	6010	450	±20	±25
Manganese	6010	0.02	±25	±30	6010	20	±20	±25
Mercury	7471	0.02	±25	±30	245.2	2	±20	±25
Nickel	6010	1.5	±25	±30	6010	50	±20	±25
Nitrate	352.1	TBD	±25	±30	352.1	130	±20	±25
Nitrite	354.1	TBD	±25	±30	354.1	40	±20	±25
Selenium	6010	0.75	±25	±30	270.2	20	±20	±25
Silver	6010	2	±25	±30	272.2	10	±20	±25
Titanium	6010	TBD	±25	±30	6010	TBD	±20	±25
Vanadium	6010	0.08	±25	±30	286.2	40	±20	±25
Zinc	6010	0.02	±25	±30	6010	20	±20	±25
ORGANICS								
Acetone	8240	0.1	±25	±30	624	100	±20	±25
Carbon tetrachloride	8240	0.005	±25	±30	624	1	±20	±25
Chloroform	8240	0.005	±25	±30	624	5	±20	±25
Kerosene	8015-Mod	20	±35	±30	8015-Mod	500	±35	±25
Methylene chloride	8240	0.005	±25	±30	624	5	±20	±25
MIBK	8015	0.5	±25	±30	8015	5	±20	±25
1,1,1-Trichloroethane	8240	0.005	±25	±30	624	5	±20	±25

Table 8-4. Data Quality Objective Parameters for Chemical/Radiochemical Analyses. (sheet 6 of 6)

	Soil/Sediment				Water			
	Analysis Method	Practical Quantitation Limit (pCi/g)[a/] (mg/Kg)	Precision (RPD)	Accuracy (%)	Analysis Method	Practical Quantitation Limit (pCi/L)[a/] (μg/L)	Precision (RPD)	Accuracy (%)
ORGANICS (cont.)								
Toluene	8240	0.005	±25	±30	624	5	±20	±25
Tributyl phosphate	TBD	TBD	±25	±30	TBD	TBD	±30	±25

TBD = To Be Determined
M = method modified to include extraction from the solid medium, extraction method is matrix and laboratory-specific
RPD = Relative Percent Difference
Prescribed Procedures for Measurement of Radioactivity in Drinking Water (EPA 1980a)
Test Methods for Evaluation Solid Waste (SW 846) *Third Edition* (EPA 1986)
Methods for Chemical Analysis of Water and Waste (EPA 1983)
Radionuclide Method for the Determination of Uranium in Soil and Air (EPA 1980b)
EML Procedures Manual (DOE/EML 1990)
Eastern Environmental Radiation Facility RadioChemistry Procedures Manual (EPA 1984)
High-Resolution Gamma-Ray Spectrometry of Water (ASTM 1985)
Precision and accuracy are goals. Since these parameters are highly matrix dependent they could vary greatly from the goals listed.
a/ Practical Quantitation Limits for organics and inorganics are reported in units of mg/kg for soil and mg/L for water.

Table 8-5. Data Gaps by Site Category.

Site Category	Identified Data Gaps
Tanks and Vaults	• Contaminant concentrations in waste management units other than single-shell tanks • Distribution of contaminants in subsurface soils released in leaks • Constituents concentrations in related surface contamination
Cribs and Drains	• Contaminant concentrations in cribs • Contaminant concentrations in soils beneath cribs • Specific constituents (especially organic chemicals) • Distribution and vertical/lateral extent of contamination
Reverse Wells	• Contaminant concentrations in subsurface soils impacted by discharges • Specific constituents (especially organics) • Extent of contamination
Ditches and Trenches	• Distribution/extent of subsurface contamination • Buried contaminant concentrations in stabilized portions/units
Septic Tanks and Associated Drain Fields	• Actual discharge levels • Possible discharge and presence/level of non-sanitary wastes (e.g., laboratory drains)
Transfer Facilities, Diversion Boxes, and Pipelines	• Contamination constituents and concentrations • Direct radiation levels in facilities • Constituents/concentrations in related surface contamination • Integrity of transfer lines
Basins (207-A)	• Constituents and concentrations in sediments • Distribution/extent of subsurface contamination
Unplanned Releases	• Surface soil constituents and concentrations • Buried contamination constituents and concentrations

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Table 8-6. Applicable Characterization Methods at PUREX Plant Aggregate Area Waste Management Units. (sheet 1 of 5)

Waste Management Unit	Source Investigation Method							
	Surface Radiation Survey	Subsurface Spectral Geophysics	Surface Geophysics	Soil Gas Survey	Surface Soil Sampling	Surface Water Sediment Sampling	Subsurface Soil Sampling	Remarks
Cribs and Drains								
216-A-1 Crib	--	A	--	--	A	--	A	--
216-A-2 Crib	--	A	--	A	A	--	A	--
216-A-3 Crib	--	A	--	--	A	--	A	--
216-A-4 Crib	--	A	--	--	A	--	A	--
216-A-5 Crib	--	A	--	--	A	--	A	--
216-A-6 Crib	--	A	--	--	A	--	A	--
216-A-7 Crib	--	A	--	A	A	--	A	--
216-A-8 Crib	--	A	--	A	A	--	A	--
216-A-9 Crib	--	A	--	--	A	--	A	--
216-A-10 Crib	--	A	--	--	A	--	A	--
216-A-21 Crib	--	A	--	--	A	--	A	--
216-A-24 Crib	--	A	--	A	A	--	A	--
216-A-27 Crib	--	A	--	--	A	--	A	--
216-A-30 Crib	--	A	--	--	A	--	A	--
216-A-31 Crib	--	A	--	A	A	--	A	--
216-A-32 Crib	--	A	--	--	A	--	A	--
216-A-36A Crib	--	A	--	--	A	--	A	--
216-A-36B Crib	--	A	--	--	A	--	A	--
216-A-37-1 Crib	--	A	--	--	A	--	A	--
216-A-37-2 Crib	--	A	--	--	A	--	A	--
216-A-38-1 Crib	--	--	--	--	X	--	X	--

Table 8-6. Applicable Characterization Methods at PUREX Plant Aggregate Area Waste Management Units. (sheet 2 of 5)

Waste Management Unit	Source Investigation Method							
	Surface Radiation Survey	Subsurface Spectral Geophysics	Surface Geophysics	Soil Gas Survey	Surface Soil Sampling	Surface Water Sediment Sampling	Subsurface Soil Sampling	Remarks
216-A-41 Crib	A	A	--	--	A	--	A	--
216-A-45 Crib	--	A	--	--	A	--	A	--
216-A-11 French Drain	--	--	--	--	X	--	X	--
216-A-12 French Drain	--	--	--	--	X	--	X	--
216-A-13 French Drain	--	--	--	--	X	--	X	--
216-A-14 French Drain	--	A	--	--	A	--	A	--
216-A-15 French Drain	--	--	--	--	X	--	X	--
216-A-22 French Drain	--	--	--	--	X	--	X	--
216-A-26 French Drain	--	--	--	--	X	--	X	--
216-A-26A French Drain	--	--	--	--	X	--	X	--
216-A-28 French Drain	--	A	--	--	A	--	A	--
216-A-33 French Drain	--	--	--	--	X	--	X	--
216-A-35 French Drain	--	--	--	--	X	--	X	--
Reverse Wells								
299-E24-11 Injection Well	--	X	--	--	X	--	X	--
Ponds, Ditches and Trenches								
216-A-29 Ditch	--	--	--	--	X	--	X	--
216-A-34 Ditch	--	--	--	--	X	--	X	--
216-A-18 Trench	--	--	--	--	X	--	X	--
216-A-19 Trench	--	--	--	--	X	--	X	--
216-A-20 Trench	--	--	--	--	X	--	X	--
216-A-40 Trench	--	--	--	--	X	--	X	--

Table 8-6. Applicable Characterization Methods at PUREX Plant Aggregate Area Waste Management Units. (sheet 3 of 5)

Waste Management Unit	Source Investigation Method							
	Surface Radiation Survey	Subsurface Spectral Geophysics	Surface Geophysics	Soil Gas Survey	Surface Soil Sampling	Surface Water Sediment Sampling	Subsurface Soil Sampling	Remarks
Septic Tanks and Associated Drain Fields								
2607 EA Septic Tank/Drain Field	X	--	--	--	X	--	X	--
2607 EC Septic Tank/Drain Field	X	--	--	--	X	--	X	--
2607 ED Septic Tank/Drain Field	X	--	--	--	X	--	X	--
2607 EG Septic Tank/Drain Field	X	--	--	--	X	--	X	--
2607 EJ Septic Tank/Drain Field	X	--	--	--	X	--	X	--
2607 EL Septic Tank/Drain Field	X	--	X	--	X	--	X	--
2607 E6 Septic Tank/Drain Field	X	--	--	--	X	--	X	--
Transfer Facilities, Diversion Boxes, and Pipelines								
216-A-524 Control Structure	--	--	--	--	--	--	--	--
Basins								
207-A Retention Basin	--	--	--	--	--	X	--	--
216-A-42 Retention Basin	X	--	--	--	X	X	X	--
Burial Sites								
218-E-1 Burial Ground	X	--	--	--	X	--	X	--
218-E-8 Burial Ground	X	--	--	--	X	--	X	--
218-E-12A Burial Ground	X	--	--	--	X	--	X	--
218-E-13 Burial Ground	X	--	--	--	X	--	X	--

Table 8-6. Applicable Characterization Methods at PUREX Plant Aggregate Area Waste Management Units. (sheet 4 of 5)

Waste Management Unit	Source Investigation Method							
	Surface Radiation Survey	Subsurface Spectral Geophysics	Surface Geophysics	Soil Gas Survey	Surface Soil Sampling	Surface Water Sediment Sampling	Subsurface Soil Sampling	Remarks
Unplanned Releases								
UN-200-E-10 Unplanned Release	X	--	--	--	X	--	X	--
UN-200-E-11 Unplanned Release	X	--	--	--	X	--	X	--
UN-200-E-12 Unplanned Release	X	--	--	--	X	--	X	--
UN-200-E-13 Unplanned Release	X	--	--	--	X	--	X	--
UN-200-E-15 Unplanned Release	X	--	--	--	X	--	X	--
UN-200-E-19 Unplanned Release	X	--	--	--	X	--	X	--
UN-200-E-20 Unplanned Release	X	--	--	--	X	--	X	--
UN-200-E-22 Unplanned Release	X	--	--	--	X	--	X	--
UN-200-E-25 Unplanned Release	X	--	--	--	X	--	X	--
UN-200-E-26 Unplanned Release	X	--	--	--	X	--	X	--
UN-200-E-28 Unplanned Release	X	--	--	--	X	--	X	--
UN-200-E-31 Unplanned Release	X	--	--	--	X	--	X	--
UN-200-E-33 Unplanned Release	X	--	--	--	X	--	X	--
UN-200-E-35 Unplanned Release	X	--	--	--	X	--	X	--
UN-200-E-39 Unplanned Release	X	--	--	--	X	--	X	--
UN-200-E-40 Unplanned Release	X	--	--	--	X	--	X	--
UN-200-E-42 Unplanned Release	X	--	--	--	X	--	X	--
UN-200-E-49 Unplanned Release	X	--	--	--	X	--	X	--
UN-200-E-56 Unplanned Release	X	--	--	--	X	--	X	--
UN-200-E-58 Unplanned Release	X	--	--	--	X	--	X	--
UN-200-E-60 Unplanned Release	X	--	--	--	X	--	X	--

Table 8-6. Applicable Characterization Methods at PUREX Plant Aggregate Area Waste Management Units. (sheet 5 of 5)

Waste Management Unit	Source Investigation Method							
	Surface Radiation Survey	Subsurface Spectral Geophysics	Surface Geophysics	Soil Gas Survey	Surface Soil Sampling	Surface Water Sediment Sampling	Subsurface Soil Sampling	Remarks
UN-200-E-62 Unplanned Release	X	--	--	--	X	--	X	--
UN-200-E-65 Unplanned Release	X	--	--	--	X	--	X	--
UN-200-E-67 Unplanned Release	X	--	--	--	X	--	X	--
UN-200-E-68 Unplanned Release	X	--	--	--	X	--	X	--
UN-200-E-72 Unplanned Release	X	--	--	--	X	--	X	--
UN-200-E-88 Unplanned Release	X	--	--	--	X	--	X	--
UN-200-E-94 Unplanned Release	X	--	--	--	X	--	X	--
UN-200-E-96 Unplanned Release	X	--	--	--	X	--	X	--
UN-200-E-97 Unplanned Release	X	--	--	--	X	--	X	--
UN-200-E-99 Unplanned Release	X	--	--	--	X	--	X	--
UN-200-E-100 Unplanned Release	X	--	--	--	X	--	X	--
UN-200-E-114 Unplanned Release	X	--	--	--	X	--	X	--
UN-200-E-117 Unplanned Release	X	--	--	--	X	--	X	--
UN-200-E-142 Unplanned Release	X	--	--	--	X	--	X	--

X = Investigation at each individual site.
A = Investigation representative of several analogous sites.

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9.0 RECOMMENDATIONS

The purpose of the aggregate area management study (AAMS) is to compile and evaluate the existing body of knowledge to support the *Hanford Site Past-Practice Strategy* (DOE/RL 1992a) decision making process. A primary task in achieving this purpose is to assess each waste management unit and unplanned release within the aggregate area to determine the most expeditious path for remediation within the statutory requirements of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and Resource Conservation and Recovery Act (RCRA). The existing body of pertinent knowledge regarding PUREX Plant Aggregate Area waste management units and unplanned releases has been summarized and evaluated in the previous sections of this study. A data evaluation process has been established that uses the existing data to develop preliminary recommendations on the appropriate remediation path for each waste management unit. This data evaluation process is a refinement of the *Hanford Site Past-Practice Strategy* (Figure 1-2) and establishes criteria for selecting an appropriate *Hanford Site Past-Practice Strategy* path (expedited response action, ERA; interim remedial measures, IRM; limited field investigation, LFI; and final remedy selection) for individual waste management units and unplanned releases within the 200 Areas. A discussion of the criteria for path selection and the results of the data evaluation process are provided in Sections 9.1. and 9.2, respectively. Figure 9-1 provides a flowchart of the data evaluation process that will be discussed. Table 9-1 provides a summary of the results of the data evaluation assessment of each unit. Table 9-2 provides the decisional matrix patterns each unit followed.

This section presents recommended assessment paths for the waste management units and unplanned releases at the PUREX Plant Aggregate Area. These recommendations are only proposed at this time and are subject to adjustment and change. Factors that may affect development of final recommendations include, but are not limited to, comments and advice from the Washington State Department of Ecology (Ecology), U.S. Environmental Protection Agency (EPA), or U.S. Department of Energy (DOE); identification and development of new information; and modification of the criteria used in the assessment path decision making process. The data evaluation process depicted in Figure 9-1 and discussed in Section 9.1 was developed to facilitate only the technical data evaluation step shown on the *Hanford Site Past-Practice Strategy* (Box A, Figure 1-2). Procedural and administrative requirements for implementation of the recommendations provided in this AAMS will be performed in accordance with the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1990) and the *Hanford Site Past-Practice Strategy*. Changes in recommendations will be addressed, and more detail on recommended assessment paths for waste management units and unplanned releases will be included in workplans as they are developed for the actual investigation and remediation activities.

A majority of waste management units and unplanned releases do not have information regarding the nature and extent of contamination necessary for quantitative or qualitative risk assessment, especially with regard to hazardous constituents, and were recommended for additional investigation (e.g., LFI). Several units and releases assessed within the ERA path

were recommended for actions that fall within the scope of existing operational programs. Sites with elevated levels of surface radionuclide contamination are addressed by the Radiation Area Remedial Action (RARA) Program.

Waste management units and unplanned releases which are addressed entirely by other programs were not subjected to the data evaluation process. This includes units and unplanned releases that are within the scope of the Single-Shell Tank Closure Program, Decommissioning and RCRA Closure Program, and Waste Management Program. Table 9-3 provides a list of the units not included in the evaluation.

A majority of waste management units not addressed in the data evaluation fall within the scope of the Single-Shell Tank Closure Program. The activities associated with closure of the 200-PO-3 Operable Unit single-shell tanks have separate Tri-Party Agreement milestones and any recommendations for disposition of these units and associated unplanned releases will be developed as part of the ongoing program addressing the single-shell tanks. The units associated with the 200-PO-3 Operable Unit that were not evaluated include single-shell tanks and associated diversion boxes, vaults, catch tanks, and high-level waste transfer lines. The Waste Management Program will completely address the active double-shell tanks, and the active retention basins.

A discussion of the four decision-making paths shown on Figure 9-1: ERA, IRM, LFI, and final remedy selection, is provided in Section 9.1. Section 9.2 provides a discussion of the waste management units grouped under each of these paths. A discussion of regrouping and prioritization of the waste management units is provided in Section 9.3. Recommendations for redefining operable unit boundaries and prioritizing operable units for work plan development are also provided in Section 9.3. No additional aggregate area-based field characterization activities are recommended to be undertaken as a continuation of the AAMS. All recommendation for future characterization needs (see Section 8.0) will be more fully developed and implemented through work plans. Plan development and submittal will be accomplished in accordance with requirements of the *Hanford Site Past-Practice Strategy* and the Tri-Party Agreement and could include remedial investigation (RI)/feasibility study (RI/FS); RCRA facility investigation (RFI)/corrective measures study (CMS), or LFI work plans. Sections 9.4 and 9.5 provide recommendations for focused feasibility and treatability studies, respectively.

9.1 DECISION MAKING CRITERIA

The criteria used to assess the most expeditious remediation process path are based primarily on urgency for action and whether site data are adequate to proceed along a given path (Figure 9-1). All units and unplanned releases that are not completely addressed under other Hanford Site programs are assessed in the data evaluation process. All of the units and releases that are addressed in the data evaluation process are initially evaluated as candidates for an ERA. Sites where a release has occurred or is imminent are considered candidates for ERAs. Conditions that might trigger an ERA are the determination of an unacceptable health

or environmental risk or a short time frame available to mitigate the problem (DOE/RL 1992a). As a result, candidate ERA units were evaluated against a set of criteria to determine whether potential for exposure to unacceptable health or environmental risks exists. Units and unplanned releases that are recommended for ERAs will undergo a formal evaluation following the selection process outlined in WHC (1991b).

Waste management units and unplanned releases that are not recommended for consideration as an ERA continue through the data evaluation process. Sites continuing through the process that potentially pose a high risk (refer to Section 5.0), become candidates for consideration as an IRM. The criteria used to determine a potential for high risk, thereby indicating a high priority site, were the Hazard Ranking System (HRS) score used for nominating waste management units for CERCLA cleanup (40 CFR 300), the modified Hazard Ranking System (mHRS) scores, surface radiation survey data, and rankings by the Environmental Protection Program (Huckfeldt 1991b). Units and unplanned releases with HRS or mHRS scores greater than 28.5 (the CERCLA cleanup criterion) were designated as candidate sites for IRM consideration. Units and unplanned releases that did not have an HRS score were compared to similar sites to establish an estimated HRS score. Sites with surface contamination greater than 2 mrem/h exposure rate, 100 ct/min beta/gamma above background or alpha greater than 20 dis/min were also designated as candidate IRM sites. The radiation and surface contamination criteria are based on the Westinghouse Hanford Radiation Protection Manual (WHC-CM-4-10) posting requirements. In addition, surface contamination sites that had an Environmental Protection Program ranking of greater than 7 were also designated as candidate IRM sites. A value of 7 was chosen because it represents the approximate midpoint of the scoring range. The candidate IRM sites are listed in Table 5-1, which summarizes the high priority sites. The four risk indicators are based on limited data (refer to Section 8.0) and therefore may not adequately represent the actual risk posed by the site. Technical judgement, including assessment of similarities in site operational histories, was used to include sites not ranked as high priority in the list of sites under consideration for an IRM. Candidate IRM sites were then further evaluated to determine if an IRM is appropriate for the site. Candidate IRM sites that did not meet the IRM criteria were placed into the final remedy selection path. As future data become available the list of units recommended for consideration as IRM sites may be altered.

For certain units and unplanned releases, it was recognized that remedial actions could be undertaken under an existing operational or other Hanford Site program (e.g., Single-Shell Tank Closure, RARA, Waste Management, or Decommissioning and RCRA Closure Programs). As a result, recommendations were made that remedial actions be undertaken (partially or completely) outside the 200 AAMS past-practice program. Units or unplanned releases that could be addressed only in part by another program (e.g., surface contamination cleanup under the RARA Program) remained in the 200 AAMS data evaluation process for further consideration. If it cannot be demonstrated that these sites will be addressed under the operational program within a time frame compatible with the past practice program, they will be readdressed by the 200 AAMS process. Tracking of waste management units included in operational programs will be discussed in the work plans developed for each operable unit/aggregate area.

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Units and unplanned releases recommended for complete disposition under another program (e.g., single-shell tanks and associated structures under the Single-Shell Tank Closure Program) were not considered in the 200 AAMS data evaluation process. In addition potentially new sites that were identified during the AAMS were also not considered. It is recommended that a formal determination be made regarding the regulatory status of all new sites following established procedures before they are considered further under the 200 AAMS data evaluation process. Potentially new sites identified in the PUREX Plant Aggregate Area are described in Section 2.3.10.

Specific criteria used to develop initial recommendations for ERAs, LFIs, and IRMs for units and unplanned releases within the PUREX Plant Aggregate Area are provided in Sections 9.1.1 and 9.1.2. Units and unplanned releases not initially addressed under an ERA, LFI, or IRM will be evaluated under the final remedy selection path discussed in Section 9.1.3.

9.1.1 Expedited Response Action Path

Candidate ERA sites are evaluated to determine if they pose an unacceptable health or environmental risk and a short time-frame available to mitigate the problem exists. All units and unplanned releases other than those recommended for complete disposition under another Hanford program are assessed against the ERA criteria. The *Hanford Site Past-Practice Strategy* describes conditions that might trigger abatement of a candidate waste management unit or unplanned release under an ERA. Generally, these conditions would rely on a determination of, or suspected, existing or near future unacceptable health or environmental risk, and a short time-frame available to mitigate the problem. Conditions include, but are not limited to:

- Actual or potential exposure to nearby human populations, biota, or the food chain from hazardous substances and radioactive or mixed waste contaminants
- Actual or potential contamination of drinking water supplies or sensitive ecosystems
- Threats of release of hazardous substances and radioactive or mixed waste contaminants
- High levels of hazardous substances and radioactive or mixed waste contaminants in soils that pose or may pose a threat to human health or the environment, or have the potential for migration
- Weather conditions that may increase potential for release or migration of hazardous substances and radioactive or mixed waste contaminants

- The availability of other appropriate federal or state response mechanisms to respond to the release
- Time required to develop and implement a final remedy
- Further degradation of the medium which may occur if a response action is not expeditiously initiated
- Risks of fire or explosion or potential for exposure as a result of an accident or failure of a container or handling system
- Other situations or factors that may pose threats to human health or welfare or the environment.

These conditions were used as the initial screening criteria to identify candidate waste management units and unplanned releases for ERAs. Candidate waste management units and releases that did not meet these conditions were not assessed through the ERA evaluation path. Additional criteria for further, detailed screening of ERA candidates were developed based on the conditions outlined in the *Hanford Site Past-Practice Strategy*. Quantification of these criteria for further screening were developed. These screening criteria are depicted in Figure 9-1 and are described below.

The next decision point on Figure 9-1 used to assess each ERA candidate is whether a driving force to an exposure pathway exists or is likely to exist. Units or unplanned releases with contamination that is migrating or is likely to significantly migrate to a medium that can result in exposure and harm to humans required additional assessment under the ERA process. Units or unplanned releases where contamination could migrate and, therefore, potentially require significantly more extensive remedial action if left unabated were also assessed in the ERA path.

Waste management units and unplanned releases with a driving force were assessed to determine if unacceptable health or environmental risk and a short time-frame available to mitigate the problem exists from the release. The criteria used to determine unacceptable risks are based on the quantity and concentration of the release. If the release or imminent release is greater than 100 times the CERCLA reportable quantity for any constituent, the unit or unplanned release remains in consideration for an ERA. If the release or imminent release contains hazardous constituents at concentrations that are 100 times the most applicable standard, the unit or unplanned release continues to be considered for an ERA. Application of the criterion of 100 times applicable standards is for quantification of the strategy criterion that addresses "high levels of hazardous substances and radioactive or mixed waste contaminants... ." The factor of 100 is based on best engineering judgement of what constitutes a high level of contamination warranting expedited action. In some cases, engineering judgment was used to estimate the quantity and concentration of a postulated release. Standards applied include Model Toxics Control Act (MTCA) standards for

industrial sites and DOE and Westinghouse Hanford radiation criteria (refer to Section 6.0). The application of these standards does not signify they are recognized as ARARs.

The ERA screening criteria, in addition to those presented in the *Hanford Site Past-Practice Strategy*, were applied to provide a consistent quantitative basis for making recommendations in the AAMS. The decision to implement the recommendations developed in the AAMS will be made collectively between DOE, EPA and Ecology based only on the criteria established in the *Hanford Site Past-Practice Strategy*.

If a release is unacceptable with respect to health or environmental risk, a technology must be readily available to control the release for a unit or unplanned release to be considered for an ERA. An example that would require substantial technology development before implementation of cleanup would be a tritium release since no established treatment technology is available to separate low concentrations of tritium from water.

The next step in the ERA evaluation path involves determining whether implementation of the available technology would have adverse consequences that would offset the benefits of an ERA. Examples of adverse consequences include: (1) use of technologies that result in risks to cleanup personnel that are much greater than the risks of the release; (2) the ERA would foreclose future remedial actions; and (3) the ERA would prevent or greatly hinder future data collection activities. If adverse consequences are not expected, the site remains in consideration for an ERA.

The final criterion is to determine if the candidate ERA is within the scope of an operational program. Maintenance and operation of active waste management facilities are within the scope of activities administered by the Waste Management Program. Active facilities include certain transfer lines, diversion boxes, catch tanks, and the 207-A and the 216-A-42 Retention Basins. Generally, active waste management units will not be included in past-practice investigations unless operation is discontinued prior to initiation of the investigation. The Decommissioning and RCRA Closure Program is responsible for safe and cost-effective surveillance, maintenance, and decommissioning of surplus facilities and RCRA closures at the Hanford Site. The Decommissioning and RCRA Closure Program is also responsible for RARA activities that include surveillance, maintenance, decontamination, and/or stabilization of inactive burial grounds, cribs, ponds, trenches, and unplanned release sites.

If the proposed ERA will not address all the contamination present, the unit or unplanned release continues through the process to be evaluated under a second path. For example, surface contamination cleanup under the RARA Program may not address subsurface contamination and, therefore, additional investigation may be needed.

Final decisions regarding the conduct of ERAs in the aggregate area will be made among Ecology, EPA, and DOE based, at least in part, on the recommendations provided in this section, and results of the final selection process outlined in WHC (1991b).

9.1.2 Limited Field Investigation and Interim Remedial Measure Paths

High priority waste management units and unplanned release sites were evaluated to determine if sufficient need and information exists such that an IRM could be pursued. An IRM is desired for high priority units and unplanned releases where extensive characterization is not necessary to reach defensible cleanup decisions. Implementation of IRMs at waste management units and unplanned releases with minimal characterization is expected to rely on observational data acquired during remedial activities. Successful execution of this strategy is expected to reduce both time and cost for cleanup of units and unplanned releases without impacting the effectiveness of the implemented action.

The initial step in the IRM evaluation path is to categorize the units. The exposure pathways of interest are similar for each waste management unit in a category; therefore, it is effective to evaluate candidate units as a group. The groupings used in Section 2.3 (e.g., cribs; tanks and vaults; etc.) will continue to be used to group the units for IRM assessment. This grouping approach is especially effective in reducing characterization requirements. As done in the 100 Areas using the observational approach, the LFIs can be used to characterize a representative unit or units in detail to develop a remedial alternative for the group of units. Observational data obtained during implementation of the remedial alternative could be used to meet unit specific needs. Similarities of waste management units may make it possible to remediate them using the observational approach after first characterizing only a few units. It is expected, therefore, that a LFI would provide sufficient information to proceed with an IRM for groups of similar high priority waste management units.

Data adequacy is assessed in the next step. The existing data are evaluated to determine if: 1) existing data are sufficient to develop a conceptual model and qualitative risk assessment; 2) the IRM will work for this pathway; 3) implementing the IRM will have adverse impacts on the environment, future remediation activities or data collection efforts; 4) the benefits of implementing the IRM are greater than the costs. If data are not adequate an assessment was made to determine if an LFI might provide enough data to perform an IRM. If an LFI would not collect sufficient data to perform an IRM, the unit was addressed in the final remedy selection path.

The final step in the IRM evaluation process is to assess if the IRM will work without significant adverse consequences. This includes: will the IRM be successful? will it create significant adverse environmental impacts (e.g., environmental releases)? will the costs outweigh the benefits? will it preclude future cleanup or data collection efforts? and will the risks of the cleanup be greater than the risks of no action? Units where remediation is considered to be possible without adverse consequences outweighing benefits of the remediation are recommended for IRMs. Low priority unplanned releases at candidate IRM units will be included in the IRM evaluations of the candidate units.

Final decisions will be made among DOE, EPA, and Ecology regarding the conduct of IRMs in the PUREX Plant Aggregate Area based, at least in part, on the recommendations provided in this AAMSR, and the results of a supporting LFI.

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9.1.3 Final Remedy Selection Path

Sites recommended for initial consideration in the final remedy selection path are those not recommended for IRMs, LFIs, or ERAs and those considered to be low priority sites. It is recognized that all units and unplanned releases within the operable unit or aggregate area will eventually be addressed collectively under the final remedy path to support a final aggregate area or operable unit Record of Decision (ROD).

The initial step in the final remedy selection process path is to assess whether the combined data from the AAMS, and any completed ERAs, IRMs, and LFIs are adequate for performing a risk assessment (RA) and selecting a final remedy. Whereas the scope of an ERA, IRM, and LFI is limited to individual waste management units or groups of similar waste management units, the final remedy selection path will likely address an entire operable unit or aggregate area.

If the data are collectively sufficient, an operable unit or aggregate area RA will be performed. If sufficient data are not available, additional needs will be identified and collected.

9.2 PATH RECOMMENDATIONS

Initial recommendations for ERA, IRM, and LFI are discussed in Section 9.2.1 through 9.2.3, respectively. Waste management units and unplanned releases proposed for initial consideration under the final remedy selection path are discussed in Section 9.2.4. Table 9-1 provides a summary of the data evaluation process path assessment. A summary of the responses to the decision points on the flowchart that led to the recommendations is provided in Table 9-2. Following approval by Ecology, EPA, and DOE, these recommendations will be further developed and implemented in work plans.

9.2.1 Proposed Sites for Expedited Response Actions

Three waste management units meet all the criteria for an ERA prior to determining whether the proposed action was within the scope of an operational program. The three units are:

- 216-A-14 French Drain
- 216-A-28 French Drain
- 216-A-42 Retention Basin (Active).

However, each of the units is a surface contamination site and is recommended for disposition under the RARA program. A discussion of the recommendations for these waste

management units are included in this section. Since the anticipated response actions are not expected to fully remediate the ERA sites, all units will be included for further data evaluation.

9.2.1.1 Sites With Significant Surface Contamination. Each of the three units has levels of surface contamination that are high enough to be of immediate concern. Surface contamination is immediately accessible to humans (i.e., workers) and biota. The potential for transport by the wind or biota is also significant and so surface migration is also a problem. It is expected that the releases of radionuclides and potential radiation exposure levels at these units would be greater than 100 times reportable quantities and concentration standards. The corrective actions for these surface contamination units are addressed within the scope of the RARA Program.

Surface contamination control activities are recommended for evaluation and implementation under the RARA Program. Investigation as a part of the aggregate area RI is recommended following the RARA action to confirm waste management unit cleanup.

- The 216-A-14 French Drain has surface contamination of up to 56,000 dis/min (alpha).
- The 216-A-28 French Drain has surface contamination of up to 2,300 dis/min (alpha).
- The 216-A-42 Retention Basin has surface contamination of up to 200,000 dis/min (beta/gamma).

9.2.1.2 Non-ERA Sites. The primary reason most waste management units and unplanned releases were not recommended for ERAs was because of the lack of driving force to an exposure pathway. Inactive cribs, ponds, ditches, and trenches are no longer receiving waste and, therefore, no longer have artificial recharge as a driving force to move subsurface contaminants. Natural recharge from local precipitation was not considered a significant short-term driving force. Specifics for each waste management unit or unplanned release are provided in Table 9-2.

A majority of the unplanned release sites either will be addressed by the RARA Program to eliminate the airborne release pathway or had insufficient quantity and concentration of contamination to qualify as an ERA.

9.2.2 Proposed Sites for Interim Remedial Measures

Twenty-five of the 90 waste management units and unplanned releases addressed in the PUREX Plant Aggregate Area data evaluation process were identified as high priority units (refer to section 5.0) and were assessed as candidates for IRMs. Sixteen of the 25 units were designated as high priority units and unplanned releases because of high HRS and mHRS

scores. The remaining 9 units and unplanned releases were designated as high priority because of surface radiation measurements. The Environmental Protection rankings did not add to the high priority sites because they had been included on the list due to other criteria. In addition 8 low priority units were included as IRM candidates because of their similarities. Septic tanks and drain fields and the majority of the unplanned releases were two primary classes of units not considered in the IRM path.

All of the 33 candidate IRM waste management units or unplanned releases met the criteria for IRM designation with the exception of having adequate data. No direct sampling information exists for any of these 33 units. It was determined that an LFI could gather sufficient data for 25 of the 33 waste management units or unplanned releases; therefore, 25 units remain IRM candidates. The remaining 8 units and releases are recommended for direct inclusion in the final remedy selection path discussed in Section 9.2.4.1. A discussion of the LFIs is provided in 9.2.3.

9.2.3 Proposed Sites for Limited Field Investigation Activities

Twenty-five waste management units are recommended to undergo LFIs. The initial decision point in the IRM path is to assess whether data are adequate to conduct an IRM. For each of the twenty-five units, only screening level field data and inventory estimates are available. No data are available describing the nature and extent of contamination, so LFIs are required before IRMs may be implemented. The rationale for IRM and LFI will be more completely developed in work plans; however, the following addresses possible considerations during work plan development.

Possible LFI objectives would be to:

- Evaluate the potential for releases from the waste management unit to impact underlying groundwater quality.
- Determine if contamination exists in the soil beneath the waste management unit, and if so, assess the extent.
- Assess the nature and extent of contaminant migration from the waste management unit in support of focused feasibility studies.

Each waste management unit that is recommended for an LFI will be studied as part of an analogous group. The analogous site concept is presented in the *Hanford Site Past-Practice Strategy*.

This concept emphasizes that characterization activities can be reduced by identifying select sites (analogue sites) for characterization that are representative of group sites (analogous groups). This concept is particularly applicable to operable units which contain a number of waste management units that are similar in design, disposal history, and geology.

Appropriate confirmatory characterization, as necessary to support remedial action, can then be performed at the sites within each analogous group during remediation. Collection of confirmatory data can again be reduced during remediation activities by emphasizing in work plans the use of the observational approach discussed in the *Hanford Site Past-Practice Strategy*.

To facilitate the implementation of these strategies in work plans, individual LFIs are assembled into analogous groups for study. One analogous group has been identified in the PUREX Plant Aggregate Area: cribs and french drains. Specific waste management units are then identified that are considered to be representative of the analogous groups. Considerations used to select an analogue site for an analogous group include, but are not limited to, the following:

- Disposal history (including type and quantity of waste received)
- Physical and chemical setting.

Generally, the selection process favored as analogue sites those units or releases that received the most waste and were considered as conservative samples in terms of release mechanism, media of concern, exposure routes, and receptors.

9.2.3.1 Cribs and French Drains. Twenty-five waste management units have been assigned to this analogous group based on their design and type of waste received. These units include:

- 216-A-1 Crib
- 216-A-2 Crib
- 216-A-3 Crib
- 216-A-4 Crib
- 216-A-5 Crib
- 216-A-6 Crib
- 216-A-7 Crib
- 216-A-8 Crib
- 216-A-9 Crib
- 216-A-10 Crib

- 216-A-21 Crib
- 216-A-24 Crib
- 216-A-27 Crib
- 216-A-30 Crib
- 216-A-31 Crib
- 216-A-32 Crib
- 216-A-36A Crib
- 216-A-36B Crib
- 216-A-37-1 Crib
- 216-A-37-2 Crib
- 216-A-41 Crib
- 216-A-45 Crib
- 216-A-14 French Drain
- 216-A-28 French Drain
- 216-A-524 Control Structure.

The cribs and french drains have been grouped together because they have similar release points. The 216-A-524 Control Structure is included in this LFI grouping since it is ancillary equipment which will be remediated along with the 216-A-24 Crib. The 216-A-10 and the 216-A-36 B Cribs will be investigated under RCRA. Selection of these units as group analogs will allow for utilization of the data produced by the RCRA investigation in the CERCLA investigations. Any additional data requirements of the CERCLA investigation can be integrated into the RCRA investigation. This approach will maximize efficiencies and minimize costs, while securing data that is applicable to all the units in this analogous group.

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The physical and chemical settings for the releases from these waste management units are generally similar:

- Relatively large-scale liquid releases, up to 7,110,000,000 L (1,880,952,381 gal) occurred at these waste management units and wastewater probably reached the unconfined aquifer beneath the units (Table 4-15).

- The waste management units were completed at about the same depths and in the same stratigraphic horizons. The depth to groundwater is also similar for all of the units (49 to 61 m [162 to 199 ft]).

- The vadose zone stratigraphy is generally uniform beneath the aggregate area and would tend to favor the downward movement of fluid with little lateral spreading.

Three cribs are proposed for analog study due to the distinct nature of their associated PUREX waste streams. These cribs include:

- 216-A-8 Crib (241-A-431 Building Ventilation Condensate)

- 216-A-10 Crib (PUREX Process Condensate).

- 216-A-36B (PUREX Ammonia Distillate Condensate).

The french drains with surface contamination were addressed in the IRM path after first being assessed in the ERA path. The actions recommended for the units will not address the subsurface contaminations in the facilities; therefore, they were included for assessment under the remaining criteria.

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9.2.4 Proposed Sites for Final Remedy Selection

A number of unplanned releases, along with several diverse waste management units which are unique because of design, contaminants received, or operational history, have been proposed for the final remedy selection path. Section 9.2.4.2 discusses the sites proposed for direct inclusion in the final remedy selection risk assessment. Direct inclusion in the final remedy selection RI is recommended for 63 of the remaining 64 waste management units and unplanned releases due to the lack of information to perform RAs and select final remedies. These waste management units and unplanned releases are discussed in Section 9.2.4.1.

9.2.4.1 Proposed Sites for Remedial Investigation. A RI has been recommended for the PUREX Plant Aggregate Area which includes several groups of waste management units and unplanned releases. The first group contains french drains. The second group contains reverse wells. The third group contains the ditches and trenches. The fourth group contains the septic tanks and drain fields which require confirmatory sampling to show that the units do not contain hazardous or radioactive substances. The fifth group contains retention

basins. The sixth group contains burial sites which require confirmatory sampling to show no contamination exists. The seventh group contains unplanned releases which have unique contamination histories.

9.2.4.1.1 French Drains. Nine french drains have been grouped as a single class because of their similarity (see Tables 9-1 and 9-2). The french drains include the following:

- 216-A-11 French Drain
- 216-A-12 French Drain
- 216-A-13 French Drain
- 216-A-15 French Drain
- 216-A-22 French Drain
- 216-A-26 French Drain
- 216-A-26A French Drain
- 216-A-33 French Drain
- 216-A-35 French Drain.

All french drains are low priority units which were assessed in the final remedy selection path. Insufficient data exist at this unit to conduct a risk assessment. A RI is recommended that would include each of these units to provide nature and extent of contamination information to perform a risk assessment for final remedy selection.

9.2.4.1.2 Reverse Wells. Only one unit, the 299-E-34-11 Injection Well, appears in this group.

This unit is a low priority unit which was assessed in the final remedy selection path. Insufficient data exist at this site to conduct a risk assessment. A RI is recommended to provide nature and extent of contamination information to perform a risk assessment for final remedy selection.

9.2.4.1.3 Ditches and Trenches. Six units have been placed in this group due to their similarity. The group consists of two ditches and four trenches:

- 216-A-29 Ditch
- 216-A-34 Ditch

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- 216-A-18 Trench
- 216-A-19 Trench
- 216-A-20 Trench
- 216-A-40 Trench.

Two of the units, the 216-A-29 Ditch and 216-A-40 Trench, were rated as high priority and evaluated along the IRM path. Data were not adequate to perform an IRM and an LFI would not collect sufficient data, so these units were moved to the final remedy selection path. In each case insufficient data exists at these sites to provide nature and extent of contamination information to perform a risk assessment for final remedy selection.

The units were grouped and risk assessment possibilities were examined. No data exists to determine the nature and extent of contamination at these units. Therefore, inclusion in the aggregate area or operable unit RI was recommended to provide data adequate to perform a risk assessment and select a final remedy for the units.

9.2.4.1.4 Septic Tanks and Associated Drain Fields. Seven units have been placed in this group because of their similarity.

- 2607-EA Septic Tank and Drain Field
- 2607-EC Septic Tank and Drain Field
- 2607-ED Septic Tank and Drain Field
- 2607-EG Septic Tank and Drain Field
- 2607-EJ Septic Tank and Drain Field
- 2607-EL Septic Tank and Drain Field
- 2607-E6 Septic Tank and Drain Field.

There are no sampling or inventory data for any of the units and so an RA cannot be performed. Therefore, these units are recommended for inclusion in the aggregate area RI to conduct confirmatory sampling. The purpose of a limited sampling program is to confirm that no contamination exists in the septic tanks and drain fields. If no contamination were to be found, then no further action would likely be recommended.

9.2.4.1.5 Retention Basins. Two units, 207-A and 216-A-42, have been placed in this group. One retention basin (216-A-42) was recommended for action. The action implemented under the RARA rogram will mitigate surface radiation of concern. The action

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implemented under the RARA Program will mitigate the conditions that caused the unit to be high priority; therefore, the unit was directly included in the final remedy selection path. The 207-A Retention Basin was low priority and directly included into the final remedy selection. In both cases insufficient data exists to provide nature and extent of contamination information to perform a risk assessment for final remedy selection.

Investigations of the active 207-A Retention Basin and 216-A-42 Retention Basin will be included in the past-practices investigation if the units are deactivated prior to the investigation. Deactivation of the retention basins will remain with the ongoing program that is evaluating alternatives to replace the unit.

9.2.4.1.6 Burial Sites. Four burial sites have been placed in this group due to their similarity. This group includes:

- 218-E-1 Burial Ground
- 218-E-8 Burial Ground
- 218-E-12A Burial Ground
- 218-E-13 Burial Ground.

Two of the sites, 218-E-1 and 218-E-13, were rated as high priority due to surface contamination and evaluated along the IRM path. Data were not adequate to perform an IRM and an LFI would not collect sufficient data so the units were directly included in the final remedy selection path. The 218-E-8 Burial Ground and 218-E-13 Burial Ground were low priority and were directly included in the final remedy selection path. In each case, insufficient data exist in these sites to provide the nature and extent of contamination information to perform a risk assessment for final remedy selection; therefore, the burial sites are recommended in the aggregate area RI.

9.2.4.1.7 Unplanned Releases. Thirty-four unplanned release sites have been placed in this group. The candidate sites are listed in Table 9-1.

Two of the thirty-four unplanned releases, UN-200-E-88 and UN-200-E-100, were rated as high priority because of surface contamination and evaluated along the IRM path. Data were not adequate for an IRM and an LFI would not collect sufficient data, so these units were moved to the final remedy selection path. In all cases, insufficient data exists at these sites to provide nature and extent of contamination information to perform a risk assessment for final remedy selection; therefore, these sites are recommended for inclusion in the aggregate area RI.

9.2.4.2 Proposed Units for Risk Assessment. One candidate has sufficient information for inclusion in the RA under the final remedy selection path. The unit, 216-A-38-1 Crib, was reportedly never used. It is recommended that this unit be included in the final RA without additional investigation.

9.3 SOURCE OPERABLE UNIT REDEFINITION AND PRIORITIZATION

The investigation process can be made more efficient if units with similar histories and waste constituents are studied together. The data needs and remedial actions required for similar waste management units are generally the same. It is much easier to ensure a consistent level of effort and investigation methodology if like units are grouped together. Economies of scale also make the investigation process more cost effective if similar units are studied together.

9.3.1 Units Addressed By Other Aggregate Areas or Programs

The investigation of one unit should be transferred from the PUREX Plant Aggregate Area to the B Plant Aggregate Area for investigation. The 216-A-29 Ditch should be transferred to allow it to be investigated with the 216-B-3 Pond System along with units of similar regulatory and waste histories.

The investigation of several units should be transferred from the PUREX Plant Aggregate Area to other programs for investigation. The programs include the Waste Management Program, the Decommissioning and RCRA Closure Program, and the Single-Shell Tank Closure Program. Table 9-3 lists the waste management units and unplanned releases that are recommended for deferral to these programs.

The Waste Management Program is recommended to include four catch tanks and eleven diversion boxes. These units are located in operable units 200-PO-1 and 200-PO-3. The Decommissioning and RCRA Closure Program receives the waste management units upon decommissioning.

The Single-Shell Tank Closure Program is recommended to include all single-shell tanks (241-A, 241-AX, and 241-C Tank Farms) and ancillary equipment and unplanned releases in the three single-shell tank farms. The UPR-200-E-59 unplanned release in the 200-PO-1 Operable Unit and the four french drains, 216-A-16, 216-A-17, 216-A-23A and 216-A-23B in the 200-PO-5 Operable Unit are also recommended for deferral to these programs.

One potentially new site consisting of a fission products release to the environment has not been verified as an unplanned release. Action on this site is deferred until an actual release has been verified and the regulatory status of the site determined. The unplanned

release occurred within the 241-C Tank Farm area; therefore, it should be addressed by the Single-Shell Tank Closure Program. This unplanned release is discussed in detail in Section 2.3.10.

9.3.2 PUREX Plant Operable Unit Redefinition

Redefinition of the 200-PO-1 through 200-PO-6 Operable Units is suggested based on the data valuation in this report. General redefinition is recommended as follows:

- Investigation of groundwater should be removed from the scope and included in a 200 East Area Groundwater Operable Unit. Groundwater beneath the source operable units interacts with all surrounding operable units since it is not confined by the geographic boundaries. Contamination from nearby operable units can migrate beneath any PUREX Plant Operable Units. Similarly, the contamination originating from the operable units may migrate outside the boundaries of the operable units. These interactions with other operable units will necessitate the integration of groundwater response actions throughout the 200 East Area. This integration would likely be best handled in a combined groundwater operable unit, rather than in individual source operable units.

- High-level waste transfer facilities and encased pipelines should remain within the scope of the Waste Management Program and the Decommissioning and RCRA Closure Program. The facilities are also structures with no unplanned releases and can be dealt with more efficiently in these existing Hanford programs. The Tri-Party Agreement does not include these lines within the scope of the past-practices investigation. Effluent transfer lines associated with individual waste management units will be investigated with the respective units.

- Units included in other programs (e.g., RCRA, Waste Management Program, etc.) are listed in Table 9-3. All operable units had sites included in other programs. Operable unit 200-PO-6 had the least number of sites recommended for inclusion in other programs; only one site, operable unit 200-PO-3, had the greatest number of sites recommended for inclusion into other programs; over 50 sites.

Specific redefinition of the operable units are as follows:

- 200-PO-1 will have UPR-200-E-59 reassigned to 200-PO-3. This unplanned release is associated with the 216-A-40 Trench, but spread into the tank farm area and is, therefore, recommended for inclusion in the 200-PO-3 Operable Unit and subsequent jurisdiction of the Single-Shell Tank Closure Program.

- 200-PO-3 will have UN-200-E-68, UN-200-E-94, and UN-200-E-100 reassigned to 200-PO-1. These unplanned releases are outside the perimeter of the tank farm and are more appropriately addressed under the past-practices investigation.

- 216-A-29 Ditch will be moved from PUREX Plant Aggregate Area jurisdiction to B Plant Aggregate Area jurisdiction. This ditch has been a contributor to the B Pond System and is more appropriately addressed with the B Plant Aggregate Area units.

- Four french drains currently residing in the 200-PO-5 Operable Unit should be reassigned to the 200-PO-3 Operable Unit. These french drains currently reside within the 241-A Tank Farm boundary and are more adequately addressed as part of this operable unit. It is, therefore, recommended that the geographic boundaries of the units be redrawn in the area of the 216-A-16, 216-A-17, 216-A-23A, and 216-A-23B French Drains. The units are located in close proximity to one another and very near to a common border of the two operable units. Movement of a section of the common border to the east would satisfy the recommendation.

9.3.3 Investigation Prioritization

Very little if any data exist to rank the waste management units and unplanned releases within the PUREX Plant Aggregate Area on a risk-related basis. The HRS and surface contamination data which were used to sort the waste management units and unplanned releases into either high or low priority are indicators of potential risk but are not suitable to develop a risk-related ranking. The most useful data for indicating potential risk are probably the waste inventories and facility construction or operation information.

In the Tri-Party Agreement, the operable units were prioritized in the following order: (1) 200-PO-2, (2) 200-PO-5, (3) 200-PO-1 and 200-PO-4, and (4) 200-PO-6. Operable unit 200-PO-3 was not prioritized because it contained single-shell tanks. Based on estimated waste inventories in Table 2-2, the cribs and french drains received the largest quantities of contamination and should be investigated first. This approach would change the prioritization order of the Tri-Party Agreement to the 200-PO-4 Operable Unit being recommended for highest priority of investigation. The new order of prioritization would be (1) 200-PO-4, (2) 200-PO-2, (3) 200-PO-5, (4) 200-PO-1, and (5) 200-PO-6.

9.3.4 Resource Conservation and Recovery Act Facility Interface

A number of RCRA waste management units exist in the PUREX Plant Aggregate Area. They include:

- 216-A-29 Ditch
- 216-A-10 Crib
- 216-A-36B Crib
- 218-E-12B Burial Ground
- 241-A, 241-AX, and 241-C Single-Shell Tank Farm Systems
- 241-AN, 241-AP, 241-AW, 241-AY, and 241-AZ Double-Shell Tank Farm Systems
- 244-AR and 244-CR Vault
- 244-A Lift Station.
- Grout Treatment Facility

9.3.4.1 RCRA TSD Facilities. The following units are facilities under the control of the Waste Management Program:

- 241-AN, 241-AP, 241-AW, 241-AY, and 241-AZ Double-Shell Tank Farm Systems
- 244-AR and 244-CR Vault
- 244-A Lift Station
- 218-E-12B Burial Ground.
- Grout Treatment Facility

These units have current RCRA operating permits. Closure is not anticipated to occur for some time. Thus, there will be no need to interface with the past-practices program for these units at this time. In the event that any of these RCRA TSD facilities are closed while past-practices investigation or remediation activities are still occurring, it will be necessary at that time for the RCRA TSD closure activities to interface with the past-practices program.

9.3.4.2 216-A-10 and 216-A-36B Cribs. The 216-A-10 and 216-A-36B Cribs are inactive and also slated for closure.

The 216-A-10 and 216-A-36B Cribs have been recommended for consideration under the IRM path. To be successful, the LFIs/IRMs should be integrated with ongoing RCRA closure activities to ensure maximum efficiency, compatibility of remedial measures, and minimal duplication of efforts. Recommendations for such integration are discussed in detail below.

The 216-A-10 Pond and the 216-A-36B Cribs are scheduled to undergo closure, and are expected to be subject to post-closure care. A closure plan is scheduled for submission to Ecology and EPA by May 1996. It is recommended that TSD facility closure activities and the RFI/CMS investigation and remediation activities for past-practice units be integrated. To accomplish the integration, it is recommended that prior to submittal the closure plan will include the past-practice program requirements. The resulting document would be a combined closure plan and RFI/CMS work plan.

It is recommended that risk assessment and determination of clean closure be performed in a consistent manner for all the analogous group units. To accomplish this, the units would be evaluated in accordance with the risk assessment methodology being developed and agreed to between DOE, EPA, and Ecology under Tri-Party Agreement milestone M-29-03. The latest presentation of the risk assessment protocols appear in *The Hanford Site Baseline Risk Assessment Methodology*. It is expected that these risk assessment protocols will be at least as conservative as the guidelines established under the proposed 40 CFR Part 264 Subpart S EPA regulations published in the July 27, 1990 Federal Register. The Subpart S guidelines will provide the bases for closing RCRA units in a manner that will prevent future threats to human health and the environment. Use of the milestone M-29-03 methodology would both satisfy the past practices risk assessment procedures and allow evaluation of whether or not clean closure of RCRA TSD units had been accomplished.

9.3.4.3 RCRA Single-Shell Tanks. The RCRA regulated 241-A, 241-AX, and 241-C Tank Farms and associated facilities will be addressed under the Single-Shell Tank Closure Program and are administered under a separate Tri-Party Agreement 30-year schedule. Therefore, although there will be RCRA interfaces on these tanks, these interfaces are not addressed under this AAMS.

Investigations have been recommended for several non-RCRA burial ground units under this AAMS. Since partial closures and corrective actions of the RCRA burial grounds have not been established, the recommended investigations may precede or overlap with RCRA activities. It will be necessary to ensure that investigations at non-RCRA units are integrated with schedules and proposed actions for the RCRA burial grounds as they are incorporated into the final status permit.

In addition, there are a number of unplanned releases associated with RCRA TSD facilities within the PUREX Plant Aggregate Area that are recommended to be addressed during RCRA closure and/or permitting activities. Investigation and remediation of affected soils associated with these unplanned releases, if any, would results in a need to interface with the planned RCRA facility activities.

9.4 FEASIBILITY STUDY

Two types of the FS will be conducted to support remediation in the 200 Areas including focused and the final FS. The FFSs are studies in which a limited number of units or remedial alternatives are considered. Final FS will be prepared to provide the data necessary to support the preparation of final record of decision. Insufficient data exists to prepare either a focused or final FS for any units or group of units within the PUREX Plant Aggregate Area. Sufficient data are considered available to prepare a FFS on selected remedial alternatives.

9.4.1 Focused Feasibility Study

Both LFIs and IRMs are planned for the PUREX Plant Aggregate Area for individual waste management units or waste management unit groups. The IRMs will be implemented as they are approved, and the FFSs will be prepared to support their implementation. The FFSs applied in this manner are intended to examine a limited number of alternatives for a specific unit or groups of units. The FFSs supporting IRMs will be based on the technology screening process applied in Section 7.0, engineering judgement, and/or new characterization data such as that generated by an LFI.

Recommendations for the FFS in support of IRMs are not provided in this report because of limited data availability. In most cases, LFIs will be conducted at sites initially identified for IRMs. The information gathered is considered necessary prior to making a final determination whether an IRM is actually necessary or whether a remedy can be selected.

Rather than being driven by an IRM, the FFSs will also be prepared to evaluate select remedial alternatives. In this case, the FFSs focuses on technologies or alternatives that are considered to be viable based on their implementability, cost, and effectiveness and have broad application to a variety of units. The following recommendations are made for FFSs that focus on a particular technology or alternative:

- Capping
- Ex situ treatment of contaminated soils
- In situ stabilization.

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These recommendations reflect select technologies developed in Section 7.0 of this report.

The FFS is intended to provide a detailed analysis of select remedial alternatives. The results of the detailed analysis provide the basis for identifying preferred alternatives. The detailed analysis for alternatives consists of the following components:

- Further definition of each alternative, if appropriate, with respect to the volumes or areas of contaminated environmental media to be addressed, the technologies to be used, and any performance requirements associated with those technologies. Remedial investigations and treatability studies, if conducted, will also be used to further define applicable alternatives.

- An assessment and summary of each alternative against evaluation criteria specified in EPA's *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (EPA 1988b).

- A comparative analysis of the alternatives that will facilitate the selection of a remedial action.

9.4.2 Final Feasibility Study

To complete the remediation process for an aggregate area, a final or summary FS will be prepared. This study will address those sites not previously evaluated and will summarize the results of preceding evaluations. The overall study and evaluation process for an aggregate area will consist of a number of FFSs, field investigations, and interim RODs. All of this study information will be summarized in one final FS to provide the data necessary for the final ROD. The summary FS will likely be conducted on an aggregate area basis; however, future considerations may indicate that a larger scope is appropriate.

9.5 TREATABILITY STUDIES

A range of technologies which are likely to be considered for remediation of sites within the PUREX Plant Aggregate Area were discussed in Section 7.3. The range of technologies included:

- Engineered multimedia cover

- In situ grouting

- Excavation and soil treatment

- In situ vitrification

- Excavation, treatment, and disposal of transuranic (TRU) radionuclides

- In situ soil vapor extraction of volatile organic compounds (VOCs).

Treatability testing will be required to conduct a detailed analysis for most of the technologies. Relevant EPA guidance will be relied upon to conduct these future treatability studies. A summary of existing programs and treatability testing needs is as follows:

- Engineered multimedia cover--A number of cover design efforts have taken place in support of Hanford Site waste management, permitting, RARA and RCRA closure activities. Although performance testing is lacking, a number of conceptual cover designs have been developed for various types of waste management units. The feasibility/treatability process can be accelerated by utilizing existing cover design information. Long-term performance and maintenance objectives, and design criteria should be established for various categories of waste management units based on the degree of protection required. The adequacy of existing conceptual designs should be evaluated against these design criteria and modified appropriately. Hydrologic performance and constructibility data needs can then be assessed by pilot-scale testing of preliminary cover designs.

- In situ grouting--Field pilot tests would be required to assess the required injection well spacing and the optimum grout injection methods; bench-scale and pilot-scale tests would be required to demonstrate the effectiveness for stabilizing the contaminants.

- Excavation and soil treatment--Testing will likely be required for several components of an excavation and treatment system. It is anticipated that the waste management units would be excavated with conventional mining and construction equipment. However, some equipment modifications may be required to ensure worker protection. If available, remote excavation equipment could be utilized to protect workers at waste management units containing high exposure potential. Testing of measures to control fugitive dust during retrieval activities will be required.

  The testing required for the treatment process will depend on the type of treatment considered and the site-specific conditions. It is anticipated that most of the treatability information required could be obtained by a combination of literature research, laboratory screening, and bench-scale studies. However, pilot-scale testing may be required for certain treatment processes.

  Physical separation (i.e., soil washing) pilot-scale treatability testing within the 300-FF-I Operable Unit is being planned which will be applicable for the 200 Areas. The soils of the Hanford Site are well suited for treatment with a physical separations process. The soils are predominantly coarse sand and

gravel, with less than 10% silts and clay. It is expected that contaminants will be found largely adsorbed on the smaller soil particles and as coatings on larger particles. The physical soil washing process should provide removal of the precipitate coatings from the large particles and separation of large from small particles. This would result in a large volume reduction by separating and concentrating the contaminants.

The physical separations test in the 300-FF-1 Operable Unit will be conducted in three phases. In Phase I, soils will be characterized to assess physical, chemical, and radioactive properties. Phase II testing will establish baseline operations and capabilities of a system utilizing water as the washing solution. In Phase III, performance of the system will be optimized. Phase III may consist of two parts, processing with water only, and processing using selected nonhazardous and environmentally acceptable chemical extractants, if necessary to optimize the system. Laboratory bench tests may be performed to determine the primary and secondary chemical extractants to be considered for use in Phase III testing. However, it is anticipated that in the 300 Area, physical separation resulting in a large volume reduction of contaminated soil may be achieved with water only. Chemical extracts maybe required for soil washing to be successful in other areas of the Hanford Site (i.e., 200 and 100 Areas). This will depend to a large extent on the type of contaminant at the adsorption coefficient.

If the pilot-scale test is successful in the 300 Area, then the application of this process to the 200 Areas should be tested.

- In situ vitrification--In situ vitrification has been tested and field demonstrated on soil sites contaminated with radionuclides, heavy metals, and organic wastes. As a result of this testing and demonstration program, established capabilities and limitations of the in situ vitrification technology have been identified, along with technical issues that need to be resolved for successful implementation. The In Situ Vitrification Integrated Program was created by DOE's office of Technology Development to help resolve these issues and promote deployment of the technology in the field. The In Situ Vitrification Integrated Program is currently working to resolve the following key issues for implementation at contaminated soil sites:

  - Develop methods that accurately predict, measure, and achieve significantly greater melt depth and control of the melt shape. Presently, the in situ vitrification process has been demonstrated to a depth of 5 m (16 ft).

  - Improve the understanding of and verify VOC contaminant transport behavior.

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- Determine the potential for transient gas release events while vitrifying contaminated soils under varying conditions. Better define operating parameters and limits to ensure containment and treatment of offgases during processing.

- Resolve secondary waste generation and handling concerns as they relate to the volatilization of ^{137}Cs from highly concentrated soils.

Other DOE in situ vitrification related activities include evaluating the cost of in situ vitrification against other technologies (report to be released before fiscal year end) and a field demonstration at the Idaho National Engineering Laboratory (INEL) during fiscal year 1993. Additional field demonstrations will be required before all issues surrounding implementation of in situ vitrification to contaminated soil sites can be resolved.

There is a large uncertainty whether the In Situ Vitrification Integrated Program will obtain the funding required to resolve these issues. Without resolution of these issues in situ vitrification will have very limited application to remediation at the Hanford Site.

- Excavation, treatment and disposal of transuranic radionuclides--Development and testing of methods to characterize, retrieve, treat, and package waste from TRU contaminated waste management units will be required. The DOE Office of Technology Development has established the Buried Waste Integrated Demonstration (BWID) at INEL to resolve these issues. The BWID is focused on sites containing buried waste; however, it is expected that many of the original containers at INEL degraded significantly, resulting in contamination of the immediately surrounding soil. As a result, the BWID will also be resolving some of the issues surrounding retrieval and treatment of TRU contaminated soil.

  A major concern for retrieval of TRU contaminated materials will be control of fugitive dust. Testing of various types of foams and fixants, that will not interfere with treatment and disposal, will be required. In addition, development of foams and fixants for dust control will be important for non-TRU contaminated waste management units. The use of containment structures (e.g. buildings) to contain fugitive dust during remediation is very expensive and cumbersome (creating problems for both equipment and workers). A significant cost savings could be realized if foams and fixants are used in place of containment structures.

- In situ soil vapor extraction of volatile organic compounds--Development and testing of methods to characterize, retrieve, and treat waste from VOC contaminated soil will be required. The DOE has established the VOC-Arid Integration Demonstration to resolve these issues. The Z Plant Aggregate Area is currently the initial host site for the demonstration and is associated with an active ERA to remove carbon tetrachloride from the vadose zone using vapor

extraction. These activities are expected to resolve numerous design and treatability issues associated with in situ soil vapor extraction. However, additional treatability testing may be required to resolve site specific data needs.

As treatability testing of the various alternatives progresses, other parameters are likely to be identified which require further development.

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Figure 9-1. 200 Area Aggregate Area Management Study Data Evaluation Process.

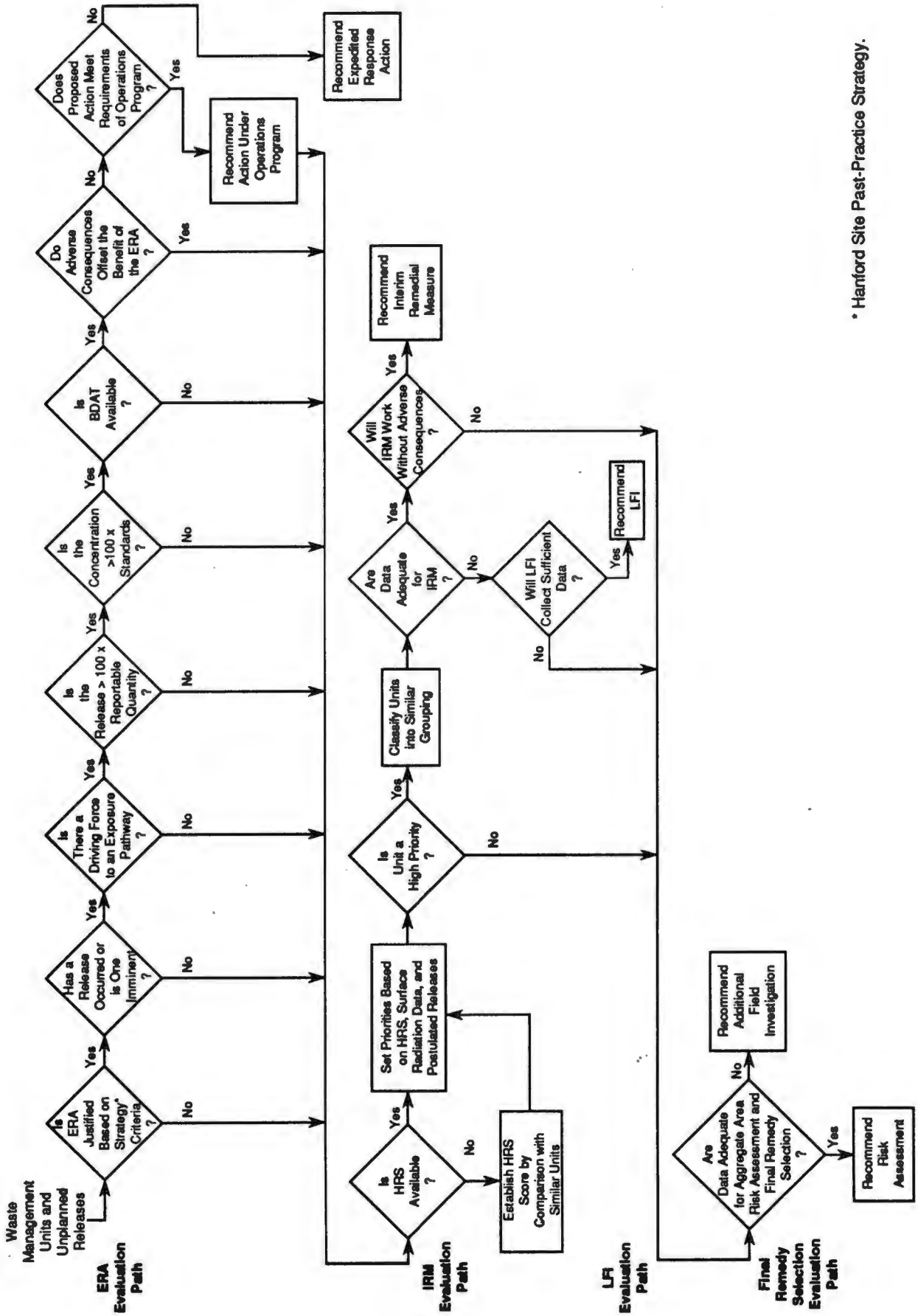

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Table 9-1. Summary of the Results of Data Evaluation Assessment for PUREX Plant Aggregate Area. (sheet 1 of 6)

Waste Management Unit	Operable Unit	ERA	IRM	LFI	RA	RI	OPS	Remarks
Cribs and Drains								
216-A-1 Crib	200-PO-5	--	X	X	--	--	--	--
216-A-2 Crib	200-PO-2	--	X	X	--	--	--	--
216-A-3 Crib	200-PO-1	--	X	X	--	--	--	--
216-A-4 Crib	200-PO-2	--	X	X	--	--	--	--
216-A-5 Crib	200-PO-2	--	X	X	--	--	--	--
216-A-6 Crib	200-PO-4	--	X	X	--	--	--	--
216-A-7 Crib	200-PO-5	--	X	X	--	--	--	--
216-A-8 Crib	200-PO-5	--	X	X	--	--	--	--
216-A-9 Crib	200-PO-1	--	X	X	--	--	--	--
216-A-10 Crib	200-PO-2	--	X	X	--	--	--	--
216-A-21 Crib	200-PO-2	--	X	X	--	--	--	--
216-A-24 Crib	200-PO-5	--	X	X	--	--	--	--
216-A-27 Crib	200-PO-2	--	X	X	--	--	--	--
216-A-30 Crib	200-PO-4	--	X	X	--	--	--	--
216-A-31 Crib	200-PO-2	--	X	X	--	--	--	--
216-A-32 Crib	200-PO-1	--	X	X	--	--	--	--
216-A-36A Crib	200-PO-2	--	X	X	--	--	--	--
216-A-36B Crib	200-PO-2	--	X	X	--	--	--	--
216-A-37-1 Crib	200-PO-4	--	X	X	--	--	--	--

Table 9-1. Summary of the Results of Data Evaluation Assessment for PUREX Plant Aggregate Area. (sheet 2 of 6)

Waste Management Unit	Operable Unit	ERA	IRM	LFI	RA	RI	OPS	Remarks
216-A-37-2 Crib	200-PO-4	--	X	X	--	--	--	--
216-A-38-1 Crib	200-PO-2	--	--	--	X	--	--	--
216-A-41 Crib	200-PO-1	--	X	X	--	--	--	--
216-A-45 Crib	200-PO-2	--	X	X	--	--	--	--
216-A-11 French Drain	200-PO-1	--	--	--	--	X	--	--
216-A-12 French Drain	200-PO-1	--	--	--	--	X	--	--
216-A-13 French Drain	200-PO-1	--	--	--	--	X	--	--
216-A-14 French Drain	200-PO-1	--	X	X	--	--	X	RARA - Surface Contamination
216-A-15 French Drain	200-PO-2	--	--	--	--	X	--	--
216-A-22 French Drain	200-PO-5	--	--	--	--	X	--	--
216-A-26 French Drain	200-PO-5	--	--	--	--	X	--	--
216-A-26A French Drain	200-PO-1	--	--	--	--	X	--	--
216-A-28 French Drain	200-PO-1	--	X	X	--	--	X	RARA - Surface Contamination
216-A-33 French Drain	200-PO-1	--	--	--	--	X	--	--
216-A-35 French Drain	200-PO-1	--	--	--	--	X	--	--
Reverse Wells								
299-E24-111 Injection Well	200-PO-2	--	--	--	--	X	--	--

Table 9-1. Summary of the Results of Data Evaluation Assessment for PUREX Plant Aggregate Area. (sheet 3 of 6)

Waste Management Unit	Operable Unit	ERA	IRM	LFI	RA	RI	OPS	Remarks
Ponds, Ditches, and Trenches								
216-A-29 Ditch	200-PO-5	--	--	--	--	X	--	Deferred to B Plant Aggregate Area
216-A-34 Ditch	200-PO-5	--	--	--	--	X	--	--
216-A-18 Trench	200-PO-5	--	--	--	--	X	--	--
216-A-19 Trench	200-PO-5	--	--	--	--	X	--	--
216-A-20 Trench	200-PO-5	--	--	--	--	X	--	--
216-A-40 Trench	200-PO-1	--	--	--	--	X	--	--
Septic Tanks and Associated Drain Fields								
2607-EA Septic Tank/Drain Field	200-PO-1	--	--	--	--	X	--	--
2607-EC Septic Tank/Drain Field	200-PO-5	--	--	--	--	X	--	--
2607-ED Septic Tank/Drain Field	200-PO-3	--	--	--	--	X	--	--
2607-EG Septic Tank/Drain Field	200-PO-3	--	--	--	--	X	--	--
2607-EJ Septic Tank/Drain Field	200-PO-3	--	--	--	--	X	--	--
2607-EL Septic Tank/Drain Field	200-PO-4	--	--	--	--	X	--	--
2607-E6 Septic Tank/Drain Field	200-PO-1	--	--	--	--	X	--	--
Transfer Facilities, Diversion Boxes, and Pipelines								
216-A-524 Control Structure	200-PO-5	--	X	X	--	--	--	--

Table 9-1. Summary of the Results of Data Evaluation Assessment for PUREX Plant Aggregate Area. (sheet 4 of 6)

Waste Management Unit	Operable Unit	ERA	IRM	LFI	RA	RI	OPS	Remarks
Basins								
207-A Retention Basin	200-PO-5	--	--	--	--	X	--	--
216-A-42 Retention Basin	200-PO-4	--	--	--	--	X	X	RARA - Surface Contamination
Burial Sites								
218-E-1 Burial Ground	200-PO-1	--	--	--	--	X	--	--
218-E-8 Burial Ground	200-PO-6	--	--	--	--	X	--	--
218-E-12A Burial Ground	200-PO-6	--	--	--	--	X	--	--
218-E-13 Burial Ground	200-PO-1	--	--	--	--	X	--	--
Unplanned Releases								
UN-200-E-10 Unplanned Release	200-PO-1	--	--	--	--	X	--	--
UN-200-E-11 Unplanned Release	200-PO-1	--	--	--	--	X	--	--
UN-200-E-12 Unplanned Release	200-PO-1	--	--	--	--	X	--	--
UN-200-E-13 Unplanned Release	200-PO-2	--	--	--	--	X	--	--
UN-200-E-15 Unplanned Release	200-PO-1	--	--	--	--	X	--	--
UN-200-E-19 Unplanned Release	200-PO-1	--	--	--	--	X	--	--
UN-200-E-20 Unplanned Release	200-PO-1	--	--	--	--	X	--	--
UN-200-E-22 Unplanned Release	200-PO-2	--	--	--	--	X	--	--
UN-200-E-25 Unplanned Release	200-PO-2	--	--	--	--	X	--	--

Table 9-1. Summary of the Results of Data Evaluation Assessment for PUREX Plant Aggregate Area. (sheet 5 of 6)

Waste Management Unit	Operable Unit	ERA	IRM	LFI	RA	RI	OPS	Remarks
UN-200-E-26 Unplanned Release	200-PO-2	--	--	--	--	X	--	--
UN-200-E-28 Unplanned Release	200-PO-1	--	--	--	--	X	--	--
UN-200-E-31 Unplanned Release	200-PO-1	--	--	--	--	X	--	--
UN-200-E-33 Unplanned Release	200-PO-1	--	--	--	--	X	--	--
UN-200-E-35 Unplanned Release	200-PO-1	--	--	--	--	X	--	--
UN-200-E-39 Unplanned Release	200-PO-2	--	--	--	--	X	--	--
UN-200-E-40 Unplanned Release	200-PO-2	--	--	--	--	X	--	--
UN-200-E-42 Unplanned Release	200-PO-1	--	--	--	--	X	--	--
UN-200-E-49 Unplanned Release	200-PO-1	--	--	--	--	X	--	--
UN-200-E-56 Unplanned Release	200-PO-5	--	--	--	--	X	--	--
UN-200-E-58 Unplanned Release	200-PO-1	--	--	--	--	X	--	--
UN-200-E-60 Unplanned Release	200-PO-1	--	--	--	--	X	--	--
UN-200-E-62 Unplanned Release	200-PO-6	--	--	--	--	X	--	--
UN-200-E-65 Unplanned Release	200-PO-1	--	--	--	--	X	--	--
UN-200-E-67 Unplanned Release	200-PO-5	--	--	--	--	X	--	--
UN-200-E-68 Unplanned Release	200-PO-3	--	--	--	--	X	--	--
UN-200-E-72 Unplanned Release	200-PO-3	--	--	--	--	X	--	--
UN-200-E-88 Unplanned Release	200-PO-1	--	--	--	--	X	--	--
UN-200-E-94 Unplanned Release	200-PO-3	--	--	--	--	X	--	--

Table 9-1. Summary of the Results of Data Evaluation Assessment for PUREX Plant Aggregate Area. (sheet 6 of 6)

Waste Management Unit	Operable Unit	ERA	IRM	LFI	RA	RI	OPS	Remarks
UN-200-E-96 Unplanned Release	200-PO-1	--	--	--	--	X	--	--
UN-200-E-97 Unplanned Release	200-PO-2	--	--	--	--	X	--	--
UN-200-E-99 Unplanned Release	200-PO-3	--	--	--	--	X	--	--
UN-200-E-100 Unplanned Release	200-PO-3	--	--	--	--	X	--	--
UN-200-E-114 Unplanned Release	200-PO-1	--	--	--	--	X	--	--
UN-200-E-117 Unplanned Release	200-PO-2	--	--	--	--	X	--	--
UN-200-E-142 Unplanned Release	200-PO-1	--	--	--	--	X	--	--

Table 9-2. PUREX Plant Aggregate Area Data Evaluation Decision Matrix. (sheet 1 of 5)

Waste Management Unit or Unplanned Release	ERA Evaluation Path								IRM Evaluation Path			LFI Path	Final Remedy
	Is an ERA Justified?	Release?	Path-way?	Quan-tity?	Concen-tration?	Treat-ment Avail-ability?	Adverse Conse-quences?	Oper-ational Programs?	High Priority?	Data Adequate?	No Adverse Conse-quences?	Collect Data?	Data Adequate?
Cribs and Drains													
216-A-1 Crib	Y	Y	N	Y	N	–	–	–	N[a]	N	–	Y	–
216-A-2 Crib	Y	Y	N	–	–	–	–	–	N[a]	N	–	Y	–
216-A-3 Crib	Y	Y	N	–	–	–	–	–	N[a]	N	–	Y	–
216-A-4 Crib	Y	Y	N	–	–	–	–	–	Y	N	–	Y	–
216-A-5 Crib	Y	Y	N	–	–	–	–	–	Y	N	–	Y	–
216-A-6 Crib	Y	Y	Y	Y	N	–	–	–	Y	N	–	Y	–
216-A-7 Crib	Y	Y	Y	Y	N	–	–	–	Y	N	–	Y	–
216-A-8 Crib	Y	Y	Y	Y	N	–	–	–	Y	N	–	Y	–
216-A-9 Crib	Y	Y	Y	Y	N	–	–	–	Y	N	–	Y	–
216-A-10 Crib	Y	Y	N	–	–	–	–	–	Y	–	–	–	N
216-A-21 Crib	Y	Y	Y	Y	N	–	–	–	Y	N	–	Y	–
216-A-24 Crib	Y	Y	N	–	–	–	–	–	Y	N	–	Y	–
216-A-27 Crib	Y	Y	N	–	–	–	–	–	Y	N	–	Y	–
216-A-30 Crib	Y	Y	N	–	–	–	–	–	Y	N	–	Y	–
216-A-31 Crib	Y	Y	N	–	–	–	–	–	N[a]	N	–	Y	–
216-A-32 Crib	Y	Y	N	–	–	–	–	–	N[a]	N	–	Y	–
216-A-36A Crib	Y	Y	N	–	–	–	–	–	Y	N	–	Y	–
216-A-36B Crib	Y	Y	N	–	–	–	–	–	Y	N	–	Y	–
216-A-37-1 Crib	Y	Y	N	–	–	–	–	–	N[a]	N	–	Y	–
216-A-37-2 Crib	Y	Y	Y	Y	N	–	–	–	Y	N	–	Y	–
216-A-38-1 Crib	N	–	–	–	–	–	–	–	N	–	–	–	Y
216-A-41 Crib	Y	Y	N	–	–	–	–	–	N[a]	N	–	Y	N
216-A-45 Crib	Y	Y	N	–	–	–	–	–	N[a]	N	–	Y	N

Table 9-2. PUREX Plant Aggregate Area Data Evaluation Decision Matrix. (sheet 2 of 5)

Waste Management Unit or Unplanned Release	ERA Evaluation Path								IRM Evaluation Path			LFI Path	Final Remedy
	Is an ERA Justified?	Release?	Path-way?	Quan-tity?	Concen-tration?	Treat-ment Avail-ability?	Adverse Conse-quences?	Oper-ational Programs?	High Priority?	Data Adequate?	No Adverse Conse-quences?	Collect Data?	Data Adequate?
216-A-11 French Drain	Y	Y	N	–	–	–	–	–	N	–	–	–	N
216-A-12 French Drain	Y	Y	N	–	–	–	–	–	N	–	–	–	N
216-A-13 French Drain	Y	Y	N	–	–	–	–	–	N	–	–	–	N
216-A-14 French Drain	Y	Y	Y	Y	Y	Y	N	Y	Y	N	–	Y	–
216-A-15 French Drain	Y	Y	N	–	–	–	–	–	N	–	–	–	N
216-A-22 French Drain	Y	Y	N	–	–	–	–	–	N	–	–	–	N
216-A-26 French Drain	Y	Y	N	–	–	–	–	–	N	–	–	–	N
216-A-26A French Drain	Y	Y	N	–	–	–	–	–	N	–	–	–	N
216-A-28 French Drain	Y	Y	Y	Y	Y	Y	N	Y	Y	N	–	Y	–
216-A-33 French Drain	Y	Y	N	–	–	–	–	–	N	–	–	–	N
216-A-35 French Drain	Y	Y	N	–	–	–	–	–	N	–	–	–	N
Reverse Wells													
299-E34-111 Injection Well	Y	Y	N	–	–	–	–	–	N	–	–	–	N
Ponds, Ditches, and Trenches													
216-A-29 Ditch	Y	Y	N	–	–	–	–	–	Y	N	–	N	N
216-A-34 Ditch	Y	Y	N	–	–	–	–	–	N	–	–	–	N
216-A-18 Trench	Y	Y	N	–	–	–	–	–	N	–	–	–	N
216-A-19 Trench	Y	Y	N	–	–	–	–	–	N	–	–	–	N

Table 9-2. PUREX Plant Aggregate Area Data Evaluation Decision Matrix. (sheet 3 of 5)

Waste Management Unit or Unplanned Release	ERA Evaluation Path								IRM Evaluation Path			LFI Path	Final Remedy
	Is an ERA Justified?	Release?	Path-way?	Quan-tity?	Concen-tration?	Treat-ment Avail-ability?	Adverse Conse-quences?	Oper-ational Programs?	High Priority?	Data Adequate?	No Adverse Conse-quences?	Collect Data?	Data Adequate?
216-A-20 Trench	Y	Y	N	–	–	–	–	–	N	–	–	–	N
216-A-40 Trench	Y	Y	Y	Y	N	–	–	–	Y	N	–	N	N
Septic Tanks and Associated Drain Fields													
2607-E6 Septic Tank	N	–	–	–	–	–	–	–	N	–	–	–	N
2607-EA Septic Tank	N	–	–	–	–	–	–	–	N	–	–	–	N
2607-EC Septic Tank	N	–	–	–	–	–	–	–	N	–	–	–	N
2607-ED Septic Tank	N	–	–	–	–	–	–	–	N	–	–	–	N
2607-EG Septic Tank	N	–	–	–	–	–	–	–	N	–	–	–	N
2607-EJ Septic Tank	N	–	–	–	–	–	–	–	N	–	–	–	N
2607-EL Septic Tank	N	–	–	–	–	–	–	–	N	–	–	–	N
Basins													
207-A Retention Basins	Y	Y	N	–	–	–	–	–	Y	N	–	N	N
216-A-42 Retention Basin	Y	Y	Y	Y	Y	Y	N	Y	Y	N	–	N	N
Burial Sites													
218-E-1 Burial Ground	Y	Y	Y	Y	N	–	–	–	Y	N	–	N	N
218-E-8 Burial Ground	Y	Y	N	–	–	–	–	–	N	–	–	–	N
218-E-12A Burial Ground	Y	Y	Y	Y	N	–	–	–	Y	N	–	N	N

Table 9-2. PUREX Plant Aggregate Area Data Evaluation Decision Matrix. (sheet 4 of 5)

Waste Management Unit or Unplanned Release	ERA Evaluation Path								IRM Evaluation Path			LFI Path	Final Remedy
	Is an ERA Justified?	Release?	Path-way?	Quan-tity?	Concen-tration?	Treat-ment Avail-ability?	Adverse Conse-quences?	Oper-ational Programs?	High Priority?	Data Adequate?	No Adverse Conse-quences?	Collect Data?	Data Adequate?
218-E-13 Burial Ground	Y	Y	N	–	–	–	–	–	N	–	–	–	N
Unplanned Releases													
UN-200-E-10	N	–	–	–	–	–	–	–	N	–	–	–	N
UN-200-E-11	N	–	–	–	–	–	–	–	N	–	–	–	N
UN-200-E-12	N	–	–	–	–	–	–	–	N	–	–	–	N
UN-200-E-13	N	–	–	–	–	–	–	–	N	–	–	–	N
UN-200-E-15	Y	Y	N	–	–	–	–	–	N	–	–	–	N
UN-200-E-19	N	–	–	–	–	–	–	–	N	–	–	–	N
UN-200-E-20	N	–	–	–	–	–	–	–	N	–	–	–	N
UN-200-E-22	N	–	–	–	–	–	–	–	N	–	–	–	N
UN-200-E-25	Y	Y	N	–	–	–	–	–	N	–	–	–	N
UN-200-E-26	N	–	–	–	–	–	–	–	N	–	–	–	N
UN-200-E-28	N	–	–	–	–	–	–	–	N	–	–	–	N
UN-200-E-31	N	–	–	–	–	–	–	–	N	–	–	–	N
UN-200-E-33	N	–	–	–	–	–	–	–	N	–	–	–	N
UN-200-E-35	N	–	–	–	–	–	–	–	N	–	–	–	N
UN-200-E-39	N	–	–	–	–	–	–	–	N	–	–	–	N
UN-200-E-40	N	–	–	–	–	–	–	–	N	–	–	–	N
UN-200-E-42	N	–	–	–	–	–	–	–	N	–	–	–	N
UN-200-E-49	N	–	–	–	–	–	–	–	N	–	–	–	N
UN-200-E-56	N	–	–	–	–	–	–	–	N	–	–	–	N
UN-200-E-58	N	–	–	–	–	–	–	–	N	–	–	–	N
UN-200-E-60	N	–	–	–	–	–	–	–	N	–	–	–	N

Table 9-2. PUREX Plant Aggregate Area Data Evaluation Decision Matrix. (sheet 5 of 5)

Waste Management Unit or Unplanned Release	ERA Evaluation Path								IRM Evaluation Path			LFI Path	Final Remedy
	Is an ERA Justified?	Release?	Path-way?	Quan-tity?	Concen-tration?	Treat-ment Avail-ability?	Adverse Conse-quences?	Oper-ational Programs?	High Priority?	Data Adequate?	No Adverse Conse-quences?	Collect Data?	Data Adequate?
UN-200-E-62	N	–	–	–	–	–	–	–	N	–	–	–	N
UN-200-E-65	N	–	–	–	–	–	–	–	N	–	–	–	N
UN-200-E-67	N	–	–	–	–	–	–	–	N	–	–	–	N
UN-200-E-68	N	–	–	–	–	–	–	–	N	–	–	–	N
UN-200-E-72	N	–	–	–	–	–	–	–	N	–	–	–	N
UN-200-E-88	Y	Y	Y	Y	N	–	–	–	Y	N	–	N	N
UN-200-E-94	N	–	–	–	–	–	–	–	N	–	–	–	N
UN-200-E-96	N	–	–	–	–	–	–	–	N	–	–	–	N
UN-200-E-97	N	–	–	–	–	–	–	–	N	–	–	–	N
UN-200-E-99	N	–	–	–	–	–	–	–	N	–	–	–	N
UN-200-E-100	N	–	–	–	–	–	–	–	Y	N	–	N	N
UN-200-E-114	N	–	–	–	–	–	–	–	N	–	–	–	N
UN-200-E-117	Y	Y	N	–	–	–	–	–	N	–	–	–	N
UN-200-E-142	N	–	–	–	–	–	–	–	N	–	–	–	N

(a) Site was low priority but assessed as IRM candidate because of similarities with other high priority units.
Dashes indicate decision point not reached on pathway. Evaluation branched to lower path.

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Table 9-3. Waste Management Units and Unplanned Releases Deferred to Other Programs. (sheet 1 of 3)

Site Name	Site Type	Program	Active/Inactive	Operable Units
Tanks and Vaults				
241-A-350	Catch Tank	WMP	Active	200-PO-3
241-A-417	Catch Tank	WMP	Active	200-PO-3
241-A-101	Single-Shell Tank	SSTCP	Inactive	200-PO-3
241-A-102	Single-Shell Tank	SSTCP	Inactive	200-PO-3
241-A-103	Single-Shell Tank	SSTCP	Inactive	200-PO-3
241-A-104	Single-Shell Tank	SSTCP	Inactive	200-PO-3
241-A-105	Single-Shell Tank	SSTCP	Inactive	200-PO-3
241-A-106	Single-Shell Tank	SSTCP	Inactive	200-PO-3
241-A-302A	Catch Tank	WMP	Active	200-PO-1
241-AX-101	Single-Shell Tank	SSTCP	Inactive	200-PO-3
241-AX-102	Single-Shell Tank	SSTCP	Inactive	200-PO-3
241-AX-103	Single-Shell Tank	SSTCP	Inactive	200-PO-3
241-AX-104	Single-Shell Tank	SSTCP	Inactive	200-PO-3
241-C-101	Single-Shell Tank	SSTCP	Inactive	200-PO-3
241-C-102	Single-Shell Tank	SSTCP	Inactive	200-PO-3
241-C-103	Single-Shell Tank	SSTCP	Inactive	200-PO-3
241-C-104	Single-Shell Tank	SSTCP	Inactive	200-PO-3
241-C-105	Single-Shell Tank	SSTCP	Inactive	200-PO-3
241-C-106	Single-Shell Tank	SSTCP	Inactive	200-PO-3
241-C-107	Single-Shell Tank	SSTCP	Inactive	200-PO-3
241-C-108	Single-Shell Tank	SSTCP	Inactive	200-PO-3
241-C-109	Single-Shell Tank	SSTCP	Inactive	200-PO-3
241-C-110	Single-Shell Tank	SSTCP	Inactive	200-PO-3
241-C-111	Single-Shell Tank	SSTCP	Inactive	200-PO-3
241-C-112	Single-Shell Tank	SSTCP	Inactive	200-PO-3
241-C-201	Single-Shell Tank	SSTCP	Inactive	200-PO-3
241-C-202	Single-Shell Tank	SSTCP	Inactive	200-PO-3
241-C-203	Single-Shell Tank	SSTCP	Inactive	200-PO-3
241-C-204	Single-Shell Tank	SSTCP	Inactive	200-PO-3
241-C-301C	Catch Tank	SSTCP	Inactive	200-PO-3
Cribs and Drains				
216-A-16	French Drain	SSTCP	Inactive	200-PO-5
216-A-17	French Drain	SSTCP	Inactive	200-PO-5

9 3 1 2 8 8 7 0 6 7 2

Table 9-3. Waste Management Units and Unplanned Releases Deferred to Other Programs. (sheet 2 of 3)

Site Name	Site Type	Program	Active/Inactive	Operable Units
216-A-23A	French Drain	SSTCP	Inactive	200-PO-5
216-A-23B	French Drain	SSTCP	Inactive	200-PO-5
216-A-39	Crib	SSTCP	Inactive	200-PO-3
216-C-8	French Drain	SSTCP	Inactive	200-PO-3
Diversion Boxes				
241-A-151	Diversion Box	WMP	Active	200-PO-1
241-A-152	Diversion Box	SSTCP	Inactive	200-PO-3
241-A-153	Diversion Box	SSTCP	Inactive	200-PO-3
241-A-A	Diversion Box	WMP	Active	200-PO-3
241-A-B	Diversion Box	WMP	Active	200-PO-3
241-AR-151	Diversion Box	WMP	Active	200-PO-3
241-AX-151	Diversion Box	WMP	Active	200-PO-3
241-AX-152DS	Diversion Box	WMP	Active	200-PO-3
241-AX-155	Diversion Box	WMP	Active	200-PO-3
241-AX-501	Valve Pit	WMP	Active	200-PO-3
241-AX-A	Diversion Box	WMP	Active	200-PO-3
241-AX-B	Diversion Box	WMP	Active	200-PO-3
241-C-151	Diversion Box	SSTCP	Inactive	200-PO-3
241-C-152	Diversion Box	SSTCP	Inactive	200-PO-3
241-C-153	Diversion Box	SSTCP	Inactive	200-PO-3
241-C-252	Diversion Box	SSTCP	Inactive	200-PO-3
241-CR-151	Diversion Box	SSTCP	Inactive	200-PO-3
241-CR-152	Diversion Box	SSTCP	Inactive	200-PO-3
241-CR-153	Diversion Box	SSTCP	Inactive	200-PO-3
241-ER-153	Diversion Box	DWMP	Active	200-PO-3
Unplanned Releases				
UN-200-E-16	Unplanned Release	SSTCP	--	200-PO-3
UN-200-E-18	Unplanned Release	SSTCP	--	200-PO-3
UN-200-E-27	Unplanned Release	SSTCP	--	200-PO-3
UN-200-E-48	Unplanned Release	SSTCP	--	200-PO-3
UN-200-E-81	Unplanned Release	SSTCP	--	200-PO-3
UN-200-E-82	Unplanned Release	SSTCP	--	200-PO-3
UN-200-E-107	Unplanned Release	SSTCP	--	200-PO-3
UN-200-E-118	Unplanned Release	SSTCP	--	200-PO-3

Table 9-3. Waste Management Units and Unplanned Releases Deferred to Other Programs. (sheet 3 of 3)

Site Name	Site Type	Program	Active/Inactive	Operable Units
UPR-200-E-59	Unplanned Release	SSTCP	--	200-PO-1
UPR-200-E-119	Unplanned Release	SSTCP	--	200-PO-3
UPR-200-E-125	Unplanned Release	SSTCP	--	200-PO-3
UPR-200-E-126	Unplanned Release	SSTCP	--	200-PO-3
UPR-200-E-136	Unplanned Release	SSTCP	--	200-PO-3
UPR-200-E-137	Unplanned Release	SSTCP	--	200-PO-3

WMP = Waste Management Program
SSTCP = Single-Shell Tank Closure Program

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10.0 REFERENCES

Baker, S.M., J.L. Devary, R.P. Elmore, R.F. Lorang, A.J. Rossi, and M.D. Freshley, 1988, *U1/U2 Uranium Plume Characterization, Remedial Action Review and Recommendation for Future Action,* WHC-EP-0133, Westinghouse Hanford Company, Richland, Washington.

Baker, V.R., B.N. Bjornstad, A.J. Busacca, K.R. Fecht, E.P. Kiver, U.L. Moody, J.G. Rigby, D.F. Stradling, and A.M. Tallman, 1991, "Quaternary Geology of the Columbia Plateau" in *Quaternary Nonglacial Geology; Conterminous U.S.*, Geological Society of America, The Geology of North America, v.k-2, Boulder, Colorado.

Bierschenk, W.H., 1959, *Techniques for Estimating the Specific Retention Properties of Hanford Soils*, HW-61644, General Electric, Hanford Atomic Products Operation, Richland, Washington.

Bixler, R.B., G.L. Hanson, and R.R. Jackson, 1981, *Safety Analysis Report 204-AR Waste Unloading Facility*, RHO-CD-757, Rockwell Hanford Operations, Richland, Washington.

Bjornstad, B.N., 1984, *Suprabasalt Stratigraphy Within and Adjacent to the Reference Repository Location*, SD-BWI-DP-039, Rockwell Hanford Operations, Richland, Washington.

Bjornstad, B.N., 1985, *Late-Cenzoic Stratigraphy and Tectonic Evolution within a Subsidiary Basin, South-Central Washington*, Geological Society of America, Abstracts with Programs, v. 17, no. 7, p. 524.

Bjornstad, B.N., K.R. Fecht, and A.M. Tallman, 1987, *Quaternary Stratigraphy of the Pasco Basin Area, South-central Washington,* RHO-BW-SA-563A, Rockwell Hanford Operations, Richland, Washington.

Bjornstad, B.N., 1990, *Geohydrology of the 218-W-5 Burial Ground, 200-West Area, Hanford Site*, PNL-7336, Pacific Northwest Laboratory, Richland, Washington, May 1990.

Black, R.F., 1980, *Clastic Dikes of the Pasco Basin, Southwestern Washington,* RHO-BWI-C-64, Rockwell Hanford Operations, Richland, Washington.

Brownell, L.E., J.G. Backer, R.E. Isaacson, and D.J. Brown, 1975, *Soil Moisture Transport in Arid Site Vadose Zones,* ARH-ST-123, Atlantic Richfield Hanford Company, Richland, Washington.

Buckmaster, M.A. and A. M. Kaczor, 1992, *Drilling and Sampling Highly Radioactive Contaminated Soil at the 200-BP-1 Operable Unit, Hanford Site, Richland, Washington*, WHC-SA-1460-FP, Westinghouse Hanford Company, Richland, Washington.

Buelt, J.L., W. Conbere, M.D. Freshley, R.J. Hicks, W.L. Kuhn, D.A. Lamar, R.J. Serne, and J.L. Smoot, 1988, *The Predicted Impacts to the Groundwater and Columbia River from Ammoniated Water Discharges to the 216-A-36B Crib,* 1988, PNL-6463, Pacific Northwest Laboratory, Richland, Washington.

Chamness, M.A., D.C. Lanigan, A.W. Pearson, R.E. Lewis, S.S. Teel, R.J. Brockman, 1992, *PUREX Plant Geologic and Geophysics Data Package for the 200 Aggregate Area Management Study,* WHC-SD-EN-DP-025, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Chatters, J. 1989, *Hanford Cultural Resources Management Plan*, PNL-6942, Pacific Northwest Laboratory, Richland, Washington.

Connelly, M.P., B.H. Ford, and J.V. Borghese, 1992, *Hydrogeologic Model for the 200 West Groundwater Aggregate Area*, WHC-SD-EN-TI-014, Rev. O, Westinghouse Hanford Company, Richland, Washington.

DeFord, D.H., 1991, *200-UP-2 Operable Unit Technical Baseline Report*, WHC-EP-0400, Prepared for the U.S. Department of Energy, Office of Environmental Restoration and Waste Management, Westinghouse Hanford Company, Richland, Washington.

Delaney, C.D., K.A. Lindsey, and S.P. Reidel, 1991, *Geology and Hydrology of the Hanford Site: A Standardized Text for Use in Westinghouse Hanford Company Documents and Reports*, WHC-SD-ER-TI-0003, Westinghouse Hanford Company, Richland, Washington.

DOE, 1986, *Hanford Inactive Site Survey (HISS) Database*, Phase I - Installation Assessment of Inactive Waste Disposal Sites.

DOE, 1988a, *Radioactive Waste Management*, DOE Order 5820.2A, U.S. Department of Energy, Office of Civilian Radioactive Waste Management, Washington, D.C.

DOE, 1988b, *Consultation Draft Site Characterization Plan,* DOE/RW-0164, Vols. 1-9, Office of Civilian Radioactive Waste Management, U.S. Department of Energy, Washington, D.C.

DOE, 1991, *Quality Assurance*, DOE Order 5700.6C, U.S. Department of Energy, Washington, D.C.

DOE/RL, 1987, *216-A-29 Ditch Preliminary Closure/Post-Closure Plan,* A-T041-008065, U.S. Department of Energy, Richland, Washington.

DOE/RL, 1988a, *Preliminary Site Assessment/Site Inspection Activities on Inactive Waste Sites at Hanford*, Draft, U.S. Department of Energy, Richland, Washington.

DOE/RL, 1988b, *Closure Plan 216-A-36B Crib*, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL, 1991a, *Hanford Site Waste Management Units Report,* DOE-RL,-88-30, U.S. Department of Energy, Richland Field Office, Richland, Washington.

DOE/RL, 1991b, *Annual Report for RCRA Groundwater Monitoring Projects at Hanford Site Facilities in 1990*, DOE-RL-91-03, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL, 1992a, *Hanford Site Past-Practice Strategy; Draft A* DOE/RL-91-40, U.S. Department of Energy, Richland, Washington.

DOE/RL, 1992b, *Hanford Site Baseline Risk Assessment Methodology*, DOE/RL-91-45, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Droppo, J.G., D.L. Strenge, J.W. Buck, B.L. Hoopes, R.D. Brockhaus, M.B. Walter, and G. Whelan, 1989, *Multimedia Environmental Pollutant Assessment System (MEPAS) Application Guidance*, PNL-7216, Pacific Northwest Laboratory, Richland, Washington.

Eberhardt, L.E., L.L. Cadwell, K.R. Price, and D.W. Carlile, 1989, *Trends in Radionuclide Concentrations for Selected Wildlife and Food Products Near the Hanford Site from 1971 through 1988,* PNL-6992, Pacific Northwest Laboratory, Richland, Washington.

Ecology, EPA, and DOE, 1989, *Community Relations Plan for the Hanford Federal Facility Agreement and Consent Order,* Olympia, Washington.

Ecology, EPA, and DOE, 1990, *Hanford Federal Facility Agreement and Consent Order* (First Amendment), 89-10 Rev. 1, Olympia, Washington.

Ecology, EPA, and DOE/RL, 1991, *Hanford Federal Facility Agreement and Consent Order Change Package,* Washington State Department of Ecology, Olympia, Washington, U.S. Environmental Protection Agency, Region X, Seattle, Washington, and U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Ecology, EPA, and DOE, 1992, *Hanford Federal Facility Agreement and Consent Order*, 1992 Annual Update (Amendment 3), Change Form M-17-91-05, Washington State Department of Ecology, Environmental Protection Agency, and Department of Energy.

Elder, R.E., A.W. Conklin, D.D. Brekke, G.W. Egert, and W.L. Osborne, 1986, *Rockwell Hanford Operations Environmental Surveillance Annual Report - Calendar Year 1985*, RHO-HS-SR-85-13P, Rockwell Hanford Operations, Richland, Washington.

Elder, R.E., G.W. Egert, A.R. Johnson, and W.L. Osborne, 1987, *Rockwell Hanford Operations Environmental Surveillance Annual Report - Calendar Year 1986*, RHO-HS-SR-86-13P, Rockwell Hanford Operations, Richland, Washington.

Elder, R.E., G.W. Egert, A.R. Johnson, and W.L. Osborne, 1988, *Westinghouse Hanford Company Environmental Surveillance Report - Calendar Year 1987*, WHC-EP-0145, Westinghouse Hanford Company, Richland, Washington.

Elder, R.E., S.M. McKinney, and W.L. Osborne, 1989, *Westinghouse Hanford Company Environmental Surveillance Annual Report - 200/600 Areas*, Calendar Year 1988, WHC-EP-0145-1, Westinghouse Hanford Company, Richland, Washington.

EPA, 1980, *Prescribed Procedures for Measurement of Radioactivity in Drinking Water*, In-House Report EPA-600/4-80-032, Environmental Monitoring and Support Lab, Cincinnati, Ohio.

EPA, 1983, *Methods for Chemical Analysis of Water and Wastes*, EPA-600/14-79-020, U.S. Environmental Protection Agency, EMSL, Cincinnati, Ohio.

EPA, 1986, *Test Methods for Evaluating Solid Wastes*, SW-846, Third Edition, U.S. Environmental Protection Agency/Office of Solid Waste and Emergency Response, Washington, D.C.

EPA, 1987, *Data Quality Objectives for Remedial Response Activities — Development Process*, EPA/540/G-87/003, OSWER Directive 9335.3-01, U.S. Environmental Protection Agency, Washington D.C.

EPA, 1988b, *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA*, Interim Final, EPA 540/G-89-004, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1989a, *Risk Assessment Guidance for Superfund, Vol. I: Human Health Evaluation Manual*, EPA/540/1-89/002, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C.

9 3 1 2 8 5 7 6 7 8

EPA, 1989c, *Risk Assessment Guidance for Superfund, Vol. 2: Human Health Evaluation Manual,* EPA/540/1-89/002, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1991a, *EPA Region 10 Supplemental Risk Assessment Guidance for Superfund,* U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1991b, *Integrated Risk Information System (IRIS),* Toxnet online database, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1991c, *USEPA Contract Laboratory Program Statement of Work for Organic Analysis: Multi-Media Multi-Concentration,* Sample Management Office, U.S. Environmental Protection Agency, Washington D.C.

EPA, 1991d, *USEPA Contract Laboratory Program Statement of Work for Inorganic Analysis: Multi-Media Multi-Concentration,* Sample Management Office, U.S. Environmental Protection Agency, Washington, D.C.

Fecht, K.R., G.V. Last, and K.R. Price, 1977, *Evaluation of Scintillation Probe Profiles from 200 Area Crib Monitoring Wells: Volumes I, II, and III,* ARH-ST-156, Atlantic Richfield Hanford Company, Richland, Washington.

Fecht, K.R., 1978, *Geology of the Gable Mountain - Gable Butte Area,* RHO-BWI-LD-5, Rockwell Hanford Operations, Richland, Washington.

Fecht, K.R., S.P. Reidel, and A.M. Tallman, 1987, "Paleodrainage of the Columbia River System on the Columbia Plateau of Washington State--a Summary," in *Selected Papers on the Geology of Washington,* Division of Geology and Earth Resources, Bulletin 77, p. 219-248, edited by J.E. Schuster.

GE, 1955, *PUREX Technical Manual,* HW-31000-DEL, General Electric Company, Richland, Washington.

Gee, G.W. and P.R. Heller, 1985, *Unsaturated Water Flow at the Hanford Site: A Review of Literature and Annotated Bibliography,* PNL-5428, Pacific Northwest Laboratory, Richland, Washington.

Gee, G.W., 1987, *Recharge at the Hanford Site: Status Report,* PNL-6403, Pacific Northwest Laboratory, Richland, Washington.

Goodwin, S.M., 1990, *Borehole Completion Data Package for the 216-U-12 Crib,* WHC-MR-0208, Westinghouse Hanford Company, Richland, Washington.

Graham, M.J., M.D. Hall, S.R. Strait, and W.R. Brown, 1981, *Hydrology of the Separations Area,* RHO-ST-42, Rockwell Hanford Operations, Richland, Washington.

Graham, M.J., G.V. Last, and K.R. Fecht, 1984, *An Assessment of Aquifer Intercommunication in the B Pond-Gable Mountain Pond Area of the Hanford Site,* RHO-RE-ST-12 P, Rockwell Hanford Operations, Richland, Washington.

Gustafson, F.W., 1991, *Site Selection Process for Expedited Response Actions at the Hanford Site*, WHC-MR-0290, Westinghouse Hanford Company, Richland, Washington.

Hamrick, D.G., 1988, *Tank Farms Facility Interim Stabilization Evaluation,* WHC-CM-5-7, Westinghouse Hanford Company, Richland, Washington.

Haney, W.A. and J.F. Honstead, 1958, *A History and Discussion of Specific Retention Disposal Radioactive Liquid Wastes in the 200 Areas,* HW-54599, General Electric, Hanford Atomic Products Operation, Richland, Washington.

Hanlon, B.M., 1992, *Tank Farm Surveillance and Waste Status Report for December 1991*, WHC-EP-0182-45, Westinghouse Hanford Company, Richland, Washington.

Hillel, D., 1971, *Soil and Water, Physical Principles and Process,* Academic Press, Inc., New York, New York.

Hoover, J.D. and T. LeGore, 1991, *Characterization and Use of Soil and Groundwater Background for the Hanford Site,* WHC-MR-0246, Westinghouse Hanford Company, Richland, Washington.

Huckfeldt, C.R., 1991a, *Quarterly Environmental Radiological Survey First Quarter 1991 - 100, 200, 300, and 600 Areas,* WHC-SP-0665-0, Westinghouse Hanford Company, Richland, Washington.

Huckfeldt, C.R., 1991b, *Quarterly Environmental Radiological Survey Summary Second Quarter 1991 - 100, 200, 300, and 600 Areas,* WHC-SP-0665-1, Westinghouse Hanford Company, Richland, Washington.

Hughes, M.C., R.K. Wahlen, and R.H. Winship, 1990, *Hanford Surplus Facilities Program Plan*, WHC-EP-0231-3, Westinghouse Hanford Company, Richland, Washington.

Jungfleisch, F.M., 1984, *Preliminary Estimation of the Waste Inventories in Hanford Tanks through 1980,* Rockwell Hanford Operations, Richland, Washington.

Kasper, R.B., 1981, *Field Study of Plutonium Transport in the Vadose Zone*, RHO-SA-224, Rockwell Hanford Operations, Richland, Washington.

Kasza, G.L., S.F. Harris, and M.J. Hartman, 1990, *Ground Water Maps of the Hanford Site*, WHC-EP-0394-1, Westinghouse Hanford Company.

Klem, M.J., 1990, *Inventory of Chemicals Used at Hanford Site Production Plants and Support Operations (1944-1980)*, WHC-EP-0172, Westinghouse Hanford Company, Richland, Washington.

Klepper, E.L., L.E. Rogers, J.D. Hedlund, and R.G. Schreckhise, 1979, *Radioactivity Associated with Biota and Soils of the 216-A-24 Crib*, PNL-1948, Pacific Northwest Laboratory, Richland, Washington.

Landeen, D.S., A.R. Johnson, and R.M. Mitchell, 1991, *Status of Birds at the Hanford Site in Southeastern Washington*, WHC-EP-0402, Westinghouse Hanford Company, Richland, Washington.

Last, G.V. and D.W. Duncan, 1980, *Radionuclide Distributions in Soils of the U-Pond Disposal System*, Rockwell Hanford Operations, Richland, Washington.

Last, G.V., B.N. Bjornstad, M.P. Bergeron, D.W. Wallace, D.R. Newcomer, J.A. Schramke, M.A. Chamness, C.S. Cline, S.P. Airhart, and J.S. Wilbur, 1989, *Hydrogeology of the 200 Areas Low-Level Burial Grounds - An Interim Report*, PNL-6820, Westinghouse Hanford Company.

Lindsey, K.A., and D.R. Gaylord, 1989, *Sedimentology and Stratigraphy of the Miocene-Pliocene Ringold Formation, Hanford Site, South-Central Washington*, WHC-SA-0740-FP, Westinghouse Hanford Company, Richland, Washington.

Lindsey, K.A., B.N. Bjornstad, and M.P. Connelly, 1991, *Geologic Setting of the 200 West Area: An Update*, WHC-SD-EN-TI-008, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Lindsey, K.A., B.N. Bjornstad, J. Lindberg, and K. Hoffman, 1992, *Geologic Setting of the 200 East Area: An Update*, WHC-SD-EN-TI-02, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Lundgren, L.L., 1970, *200 East and North Areas Radioactive Liquid Waste Disposal Sites*, ARH-1562, Atlantic Richfield Hanford Company, Richland, Washington.

Maxfield, H.L., 1979, *Handbook - 200 Area Waste Sites*, RHO-CD-673, Rockwell Hanford Operations, Richland, Washington.

McCain, R.G., and W.L. Johnson, 1990, *A Proposal Data Quality Strategy for Hanford Site Characterization*, WHC-SD-EN-AP-023, Westinghouse Hanford Company, Richland, Washington.

McCown, J.J. 1988, *Final Report on Single-Shell Tank Sample 241-C-106*, Pacific Northwest Laboratory, Richland, Washington.

Myers, C.W., S.M. Price, and J.A. Caggiano, M.P. Cochran, W.J. Czimer, N.J. Davidson, R.C. Edwards, K.R. Fecht, G.E. Holmes, M.G. Jones, J.R. Kunk, R.D. Landon, R.K. Ledgerwood, J.T. Lillie, P.E. Long, T.H. Mitchell, E.H. Price, S.P. Reidel, and A.M. Tallman, 1979, *Geological Studies of The Columbia Plateau: A Status Report,* RHO-BWI-ST-4, Rockwell Hanford Operations, Richland, Washington.

Newcomb, R.C., 1958, "Ringold Formation of the Pleistocene Age in the Type Locality, the White Bluffs, Washington," *American Journal of Science*, Vol. 33, No. 1, p. 328-340.

Newcomb, R.C., and S.G. Brown, 1961, *Evaluation of Bank Storage Along the Columbia River Between Richland and China Bar, Washington,* Water-supply Paper 1539-I, U.S. Geological Survey, Washington, D.C.

Pines, A.G., 1985, *244-AR Vault Safety Analysis Report*, SD-WM-SAR-018, Rev. 0, Rockwell Hanford Operations, Richland, Washington.

PSPL, 1982, *Skagit/Hanford Nuclear Project, Preliminary Safety Analysis Report*, Vol. 4, App. 20, Amendment 23, Puget Sound Power and Light Company, Bellevue, Washington.

Price, S.M., R.B. Kasper, M.K. Addition, R.M. Smith, and G.V. Last, 1979, *Distribution of Plutonium and Americium Beneath the 216-Z-1A Crib: A Status Report*, RHO-ST-17, Rockwell Hanford Operations, Richland, Washington.

Reidel, S.P., 1984, "The Saddle Mountains: the Evolution of an Anticline in The Yakima Fold Belt," *American Journal of Science,* Vol. 284, p. 942-978.

Reidel, S.P., and K.R. Fecht, 1981, "Wanapum and Saddle Mountains Basalt in the Cold Creek Syncline Area" in *Subsurface Geology of the Cold Creek Syncline*, RHO-BWI-ST-14, Rockwell Hanford Operations, Richland, Washington.

Reidel, S.P., K.R. Fecht, M.C. Hagood, and T.L. Tolan, 1989a, "The Geologic Evolution of the Central Columbia Plateau," in *Volcanism and Tectonism in the Columbia River Flood-Basalt Province*, Special Paper 239, edited by S.P. Reidel and P.R. Hooper, Geological Society of America, Boulder, Colorado, p. 247-264.

Reidel, S.P., T.L. Tolan, P.R. Hooper, M.H. Beeson, K.R. Fecht, R.D. Bentley, J.L. Anderson, 1989b, "The Grande Ronde Basalt, Columbia River Basalt Group: Stratigraphic Descriptions and Correlations in Washington, Oregon, and Idaho," in *Volcanism and Tectonism in the Columbia River Flood-Basalt Province*, Special Paper 239, edited by S.P. Reidel and P.R. Hooper, Geological Society of America, Boulder, Colorado, p. 21-53.

Reiman, R.T. and T.S. Dahlstrom, 1988, *An Aerial Radiological Survey of the Hanford Site and Surrounding Area, Richland, Washington*, EGG-10617-1062, Performed by EGG/EM for the U.S. Department of Energy under Contract DE AC08-88NV-10617.

Rice, D. G., 1980, *Cultural Resources Assessment of the Hanford Reach of the Columbia River State of Washington*, U.S. Army Corps of Engineers, Seattle District, Seattle, Washington.

Rockhold, M.L., M.J. Fayer, and G.W. Gee, 1988, *Characterization of Unsaturated Hydraulic Conductivity at the Hanford Site*, PNL-6488, Pacific Northwest Laboratory, Richland, Washington.

Rockhold, M.L., M.J. Fayer, G.W. Gee, and M.J. Kanyid, 1990, *Natural Groundwater Recharge and Water Balance at the Hanford Site*, PNL-7215, Pacific Northwest Laboratory, Richland, Washington.

Rogers, L.E. and W.H. Rickard, 1977, *Ecology of the 200 Area Plateau Waste Management Environs: A Status Report*, PNL-2253, Pacific Northwest Laboratory, Richland, Washington.

Routson, R.C., and V.G. Johnson, 1990, "Recharge Estimates for the Hanford Site 200 Areas Plateau," *Northwest Science*, Vol. 64, No. 3.

Schmidt J.W., C.R. Huckfeldt, A.R. Johnson, and S.M. McKinney, 1990, *Westinghouse Hanford Company Environmental Surveillance Report--200-600 Areas, Calendar Year 1989*, WHC-EP-0145-2, Westinghouse Hanford Company, Richland, Washington.

Schmidt J.W., C.R. Huckfeldt, A.R. Johnson, and S.M. McKinney, 1992, *Westinghouse Hanford Company Environmental Surveillance Report--200-600 Areas, Calendar Year 1990*, WHC-EP-0145-4, Westinghouse Hanford Company, Richland, Washington.

Serne, R.J. and M.I. Wood, 1990, *Hanford Waste-Form Release and Sediment Interaction, A Status Report with Rationale and Recommendations for Additional Studies*, PNL-7297, Pacific Northwest Laboratory.

Smith, A.E., 1973, *Nuclear Reactivity Evaluations of the 216-Z-9 Enclosed Trench*, ARH-2915, Atlantic Richfield Hanford Company, Richland, Washington.

Smith, G.A., B.N. Bjornstad, and K.R. Fecht, 1989, "Neogene Terrestrial Sedimentation on and Adjacent to the Columbia Plateau; Washington, Oregon, and Idaho," in *Volcanism and Tectonism in the Columbia River Flood-Basalt Province*, Special Paper 239, edited by S.P. Reidel and P.R. Hooper, Geological Society of America, Boulder, Colorado, p. 187-198.

9 3 1 2 8 6 7 0 6 8 3

Smoot, J.L., J.E. Szecsody, B. Sagar, G.W. Gee, and C.T. Kincaid, 1989, *Simulations of Infiltration of Meteoric Water and Contaminant Plume Movement in the Vadose Zone at Single-Shell Tank 241-T-106 at the Hanford Site*, WHC-EP-0332, Westinghouse Hanford Company, Richland, Washington.

Stenner, R.D., K.H. Cramer, K.A. Higley, S.J. Jette, D.A. Lamar, T.J. McLaughlin, D.R. Sherwood, and N.C. Van Houten, 1988, *Hazard Ranking System Evaluation of CERCLA Inactive Waste Sites at Hanford*, PNL-6456, Pacific Northwest Laboratory, Richland, Washington.

Stone, W.A., J.M. Thorp, O.P. Gifford, and D.J. Hoitink, 1983, *Climatological Summary for the Hanford Area*, PNL-4622, Pacific Northwest Laboratory, Richland, Washington.

Strenge, D.L. and S.R. Peterson, 1989, *Chemical Data Bases for the Multimedia Environmental Pollutant Assessment System (MEPAS): Version 1*, PNL-7145, Pacific Northwest Laboratory.

Swanson, L.C., D.C. Weekes, S.P. Luttrell, R.M. Mitchell, D.S. Landeen, A.R. Johnson, and R.C. Roos, 1988, *Grout Treatment Facility Environmental Baseline and Site Characterization Report*, WHC-EP-0150, Westinghouse Hanford Company, Richland, Washington.

Swanson, D.A., T.L. Wright, P.R. Hooper, and R.D. Bentley, 1979, *Revisions in Stratigraphic Nomenclature of the Columbia River Basalt Group*, Bulletin 1457-G, U.S. Geological Survey, Washington, D.C.

Tallman, A.M., K.R. Fecht, M.C. Marratt, and G.V. Last, 1979, *Geology of the Separations Areas, Hanford Site, South-central Washington*, RHO-ST-23, Rockwell Hanford Operations, Richland, Washington.

Tallman, A.M., J.T. Lillie, and K.R. Fecht, 1981, "Suprabasalt Sediments of the Cold Creek Syncline Area," in *Subsurface Geology of the Cold Creek Syncline*, RHO-BWI-ST-14, edited by C.W. Myers and S.M. Price, Rockwell Hanford Operations, Richland, Washington.

Tolan, T.L. and S.P. Reidel, 1989, "Structure Map of a Portion of the Columbia River Flood-Basalt Province," in *Volcanism and Tectonism in the Columbia River Flood-Basalt Province*, Special Paper 239, edited by S.P. Reidel and P.R. Hooper, Geological Society of America, Boulder, Colorado, plate 1.

Tolan, T.L., S.P. Reidel, M.H. Beeson, J.L. Anderson, K.R. Fecht, and D.A. Swanson, 1989, "Revisions to the Extent and Volume of the Columbia River Basalt Group" in *Volcanism and Tectonism in the Columbia River Flood-Basalt Province,* Special Paper 239, edited by S.P. Reidel and P.R. Hooper, Geological Society of America, Boulder, Colorado, p. 1-20.

Van Genuchten, M.P., F.J. Lij, and S.R. Yates, 1991, "The RETC Code for Quantifying the Hydraulic Functions of Unsaturated Soils," Robt. S. Kerr Environmental Research Laboratory, Office of Research and Development, United States Environmental Protection Agency, Ada, Oklahoma.

Walker, C.M., 1977, *History and Status of Tanks 241-C-105 and 241-C-106*, ARH-CD-948, Atlantic Richfield, Hanford Company, Richland, Washington.

Washington State Department of Resources, 1990, *Endangered, Threatened, and Sensitive Vascular Plant Species of Washington,* Natural Heritage Program, Department of Natural Resources, Olympia, Washington.

Washington State Department of Wildlife, 1991, *Species of Concern in Washington,* Department of Wildlife, Olympia, Washington.

Welty, R.K., 1989, *Waste Storage Tank Status and Leak Detection Criteria,* WHC-SD-WM-TI-357, Westinghouse Hanford Company, Richland, Washington.

WHC, 1988a, *Quality Assurance Manual,* WHC-CM-4-2, Westinghouse Hanford Company, Richland, Washington.

WHC, 1988b, *Properties and Environmental Impact of Ammonia Scrubber Discharge Waste to the 216-A-36B Crib*, WHC-EP-0100, Westinghouse Hanford Company, Richland, Washington.

WHC, 1988c, *Radiation Protection*, WHC-CM-4-10 Westinghouse Hanford Company, Richland, Washington.

WHC, 1988d, *Environmental Investigation and Site Characterization Manual*, Westinghouse Hanford Company, Richland, Washington.

WHC, 1990a, *Environmental Engineering, Technology, and Permitting Function Quality Assurance Program Plan,* WHC-EP-0383, Westinghouse Hanford Company, Richland, Washington.

WHC, 1990b, *244-AR Vault Cooling Water Stream-Specific Report*, WHC-EP-0342, Addendum 25, Westinghouse Hanford Company, Richland, Washington.

9 3 1 2 8 6 7 0 6 8 5

WHC, 1990c, *PUREX Plant Steam Condensate Stream-Specific Report*, WHC-EP-0342, Addendum 5, Westinghouse Hanford Company, Richland, Washington.

WHC, 1990d, *PUREX Plant Cooling Water Stream-Specific Report*, PUREX/UO_2 Operations, WHC-EP-0342, Addendum 20, Westinghouse Hanford Company, Richland, Washington.

WHC, 1990e, *PUREX Plant Chemical Sewer Stream-Specific Report*, PUREX/UO_3 Operations, WHC-EP-0342, Addendum 2, Westinghouse Hanford Company, Richland, Washington.

WHC, 1990f, *PUREX Plant Process Condensate Stream-Specific Report*, WHC-EP-0342, Addendum 12, Westinghouse Hanford Company, Richland, Washington.

WHC, 1990g, *N Reactor Effluent Stream-Specific Report*, N Reactor Environmental Safety, WHC-EP-0342, Addendum 3, Westinghouse Hanford Company, Richland, Washington.

WHC, 1990h, *242-A Evaporator Steam Condensate Stream-Specific Report,* Tank Farms Environmental Engineering, WHC-EP-0342, Addendum 26, Westinghouse Hanford Company, Richland, Washington.

WHC, 1990i, *242-A Evaporator Cooling Water Stream-Specific Report,* Tank Farms Environmental Engineering, WHC-EP-0342, Addendum 21, Westinghouse Hanford Company, Richland Washington.

WHC, 1990j, *242-A Evaporator Process Condensate Stream-Specific Report,* Tank Farms Environmental Engineering, WHC-EP-0342, Addendum 15, Westinghouse Hanford Company, Richland Washington.

WHC, 1991a, *Waste Information Data System,* (WIDS), Westinghouse Hanford Company, Richland, Washington.

WHC, 1991b, *Prioritizing Sites for Expedited Response Actions at the Hanford Site,* WHC-MR-0244, Westinghouse Hanford Company, Richland, Washington.

Winship, R.A. and M.C. Hughes, 1991, *Hanford Site Surface Soil Radioactive Contamination Control Plan for Fiscal Year 1992*, WHC-EP-0489, Westinghouse Hanford Company, Richland, Washington.

Woodruff, R.K., R.W. Hanf, M.G. Hefty, and R.E. Lundgren, 1991, *Hanford Site Environmental Report for Calendar Year 1990,* PNL-7930, Pacific Northwest Laboratory, Richland, Washington.

Zimmerman, D.A., A.E. Reisenauer, G.D. Black, M.A. Young, 1986, *Hanford Site Water Table Changes 1950 through 1980, Data Observations and Evaluation,* PNL-5506, Pacific Northwest Laboratory, Richland, Washington.

9 3 1 2 8 6 7 9 6 8 7

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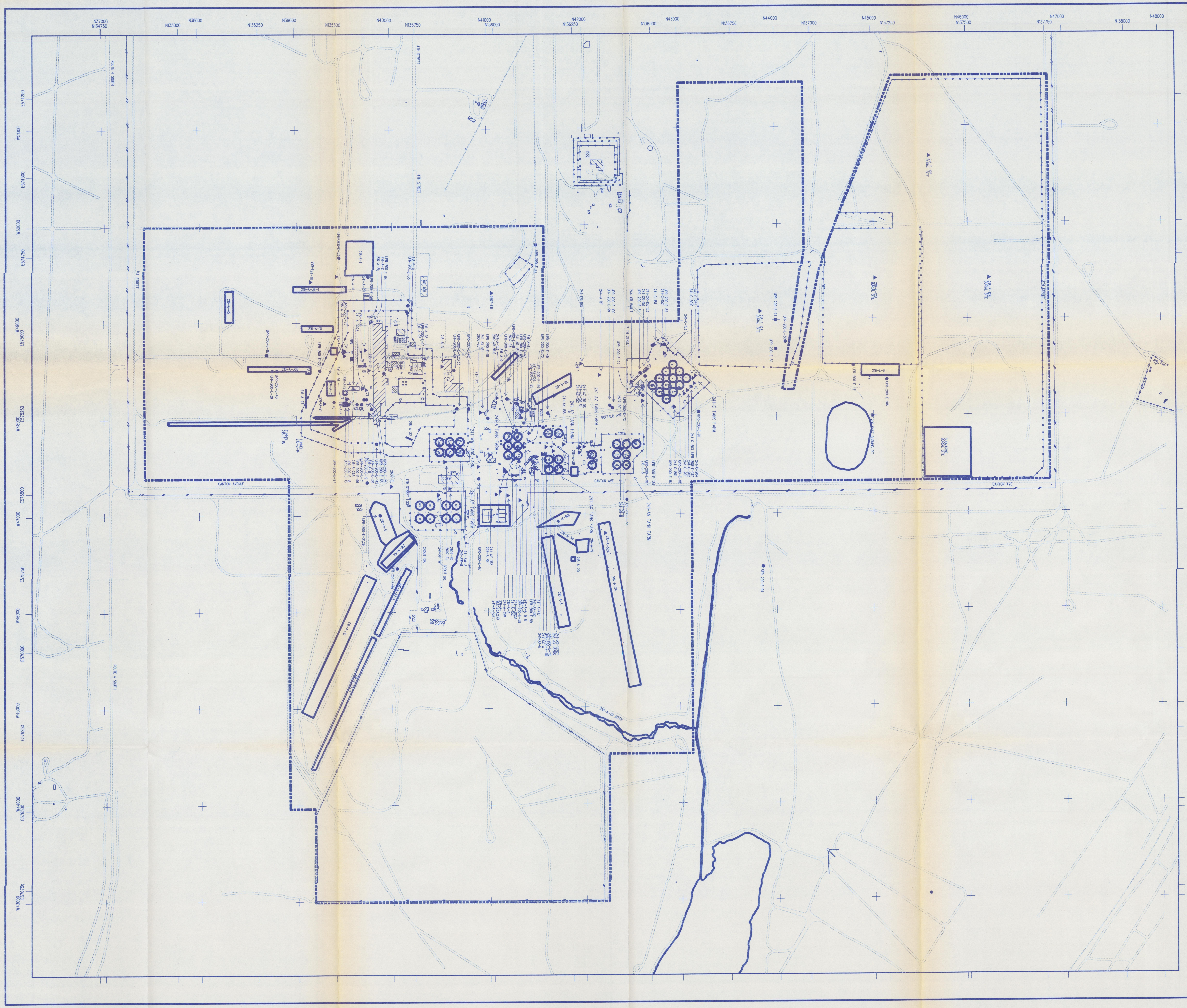

Westinghouse Hanford Company
Aggregate Area Management Studies

PURIX AGGREGATE AREA

PLATE 1 - Facilities, Sites, & Unplanned Releases

LEGEND

- Aggregate Area Boundary
- Security Systems/Fences
- Perimeter Boundary
- Buildings
- Waste Management Units
- Unplanned Releases
- Other Waste Mgmt Units

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Scale in Meters
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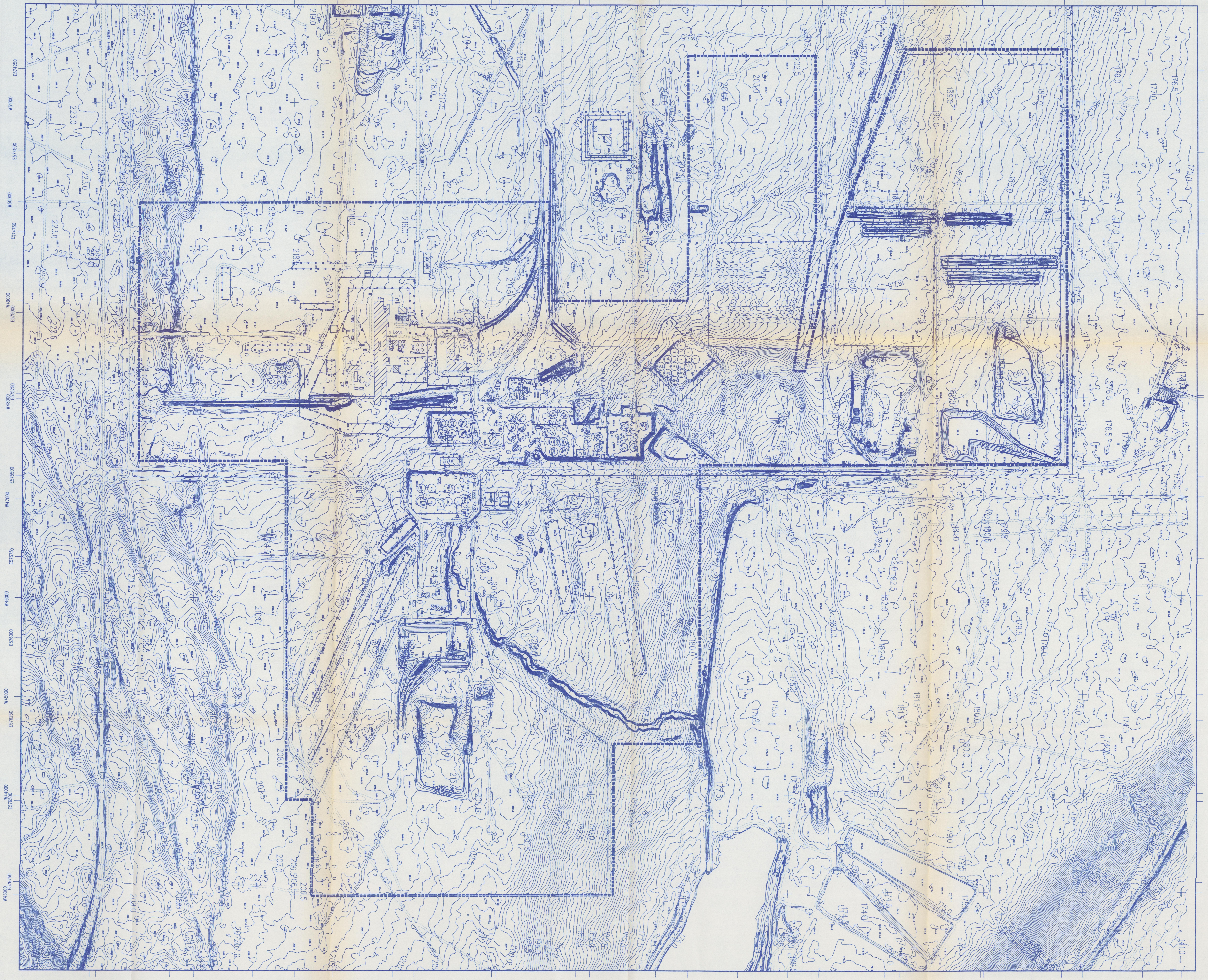

Westinghouse Hanford Company
Aggregate Area Management Studies

PURAEX AGGREGATE AREA
PLATE 2 - Topography

LEGEND

- Aggregate Area Boundary
- Security Systems/Fences
- Perimeter Boundary
- Buildings

Contour Interval .5 Meter

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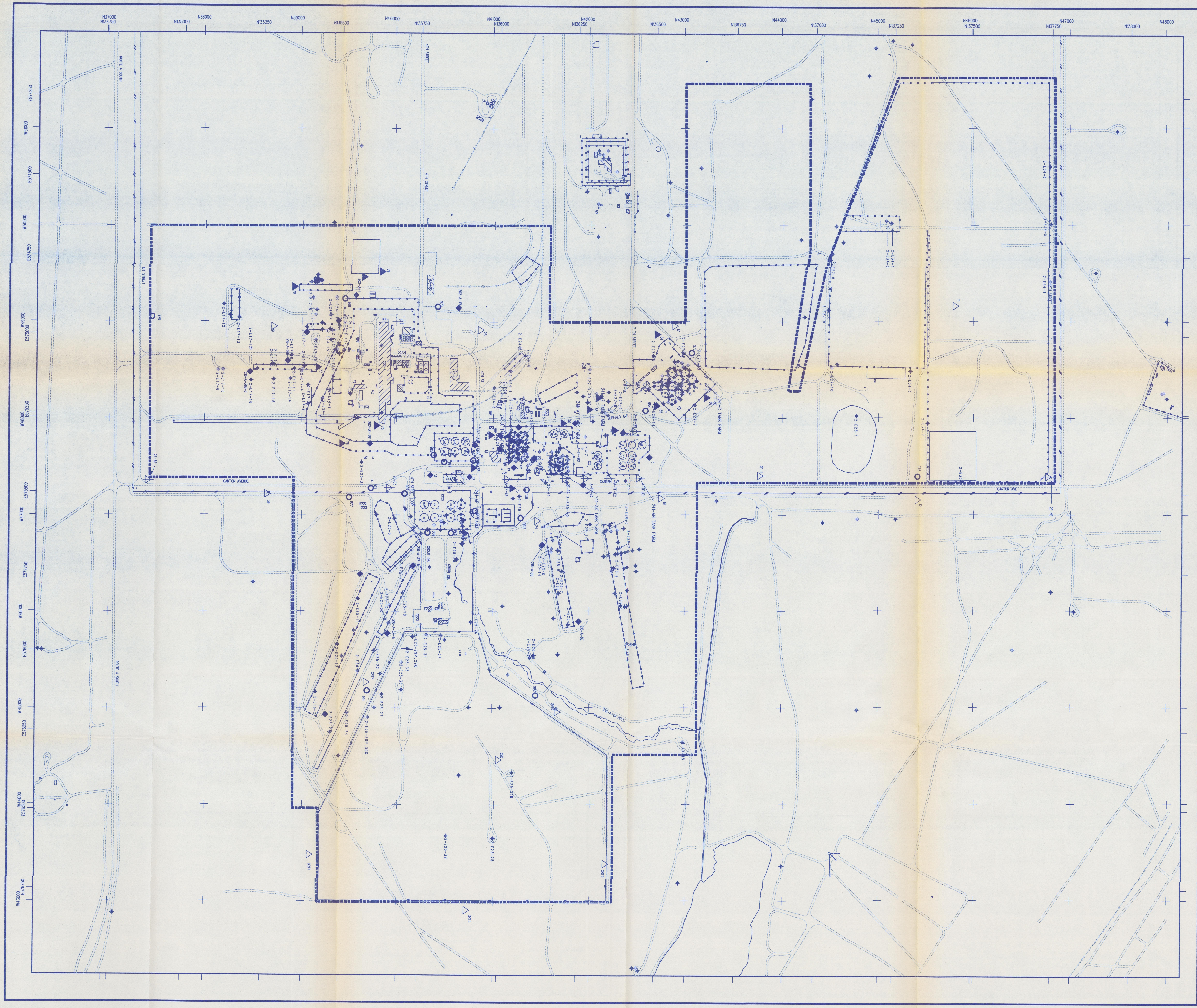

Westinghouse Hanford Company
Aggregate Area Management Studies

PUREX AGGREGATE AREA
PLATE 3 - Monitoring Wells & Sampling Locations

LEGEND

- Aggregate Area Boundary
- Security Systems/Fences
- Perimeter Boundary
- Buildings
- Monitor Wells

SAMPLING LOCATIONS (Approximate)

Soil Sampling Locations

- △ Former Locations (to 1989) --including TLDs
- ▲ New Sampling Locations (1990 and following)
- Fenceline Sampling Locations
- ◆ TLD Sampling Locations
- O Air Sampling Locations

Scale in Feet: 0, 1000, 2000

Scale in Meters: 0, 100, 500

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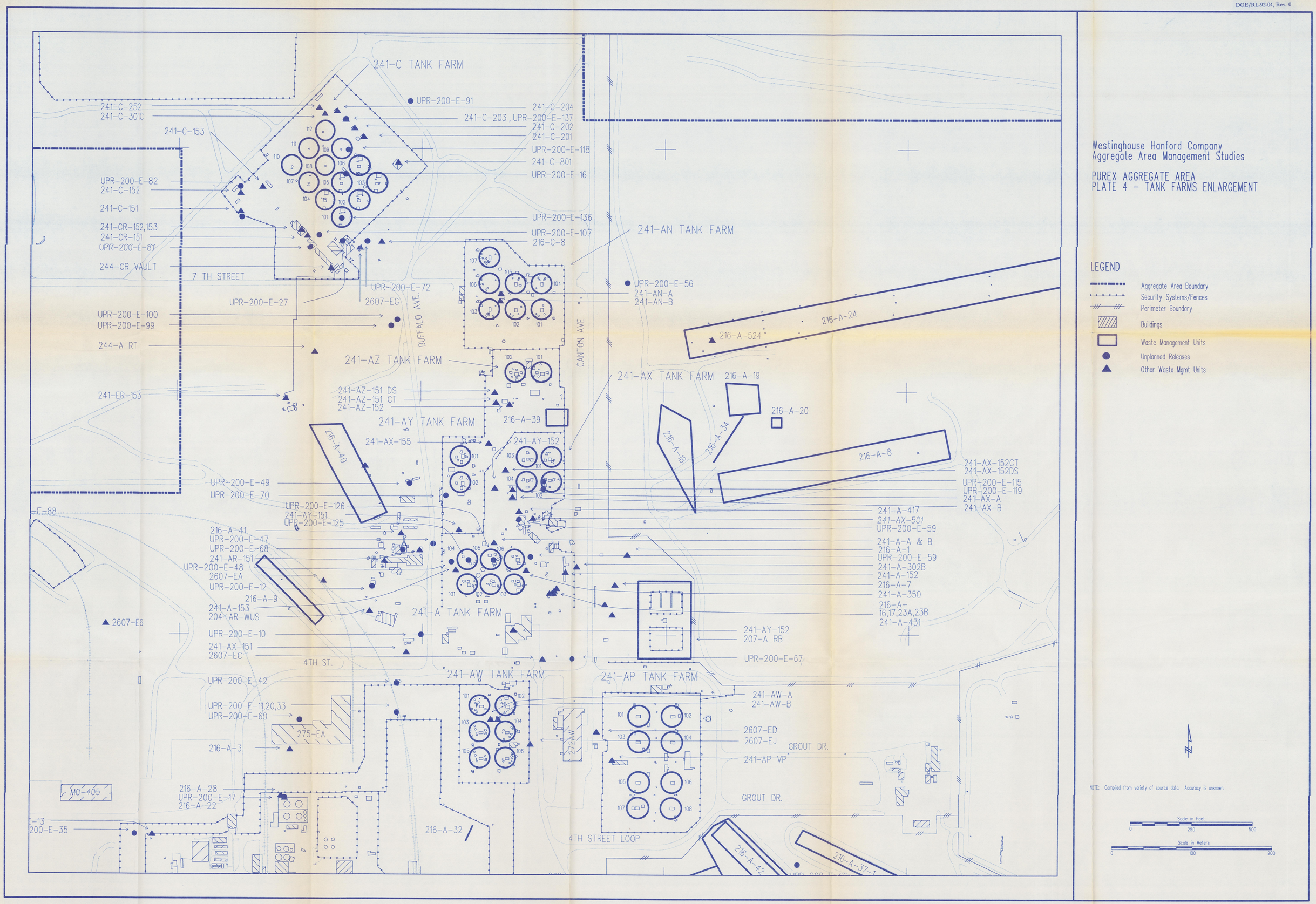
Westinghouse Hanford Company
Aggregate Area Management Studies
PUREX AGGREGATE AREA
PLATE 4 - TANK FARMS ENLARGEMENT
LEGEND
Aggregate Area Boundary
Security Systems/Fences
Perimeter Boundary
Buildings
Waste Management Units
Unplanned Releases
Other Waste Mgmt Units
241-C TANK FARM
241-AN TANK FARM
241-AZ TANK FARM
241-AY TANK FARM
241-AX TANK FARM
241-A TANK FARM
241-AW TANK FARM
241-AP TANK FARM
7 TH STREET
BUFFALO AVE.
CANTON AVE
4TH ST.
4TH STREET LOOP
GROUT DR.
GROUT DR.
275-EA
272AW
MO-405
216-A-24
216-A-524
216-A-19
216-A-20
216-A-18
216-A-34
216-A-8
216-A-39
216-A-40
216-A-32
216-A-42
216-A-37-1
241-C-252
241-C-301C
241-C-153
UPR-200-E-91
241-C-204
241-C-203, UPR-200-E-137
241-C-202
241-C-201
UPR-200-E-118
241-C-801
UPR-200-E-16
UPR-200-E-82
241-C-152
241-C-151
241-CR-152,153
241-CR-151
UPR-200-E-81
244-CR VAULT
UPR-200-E-136
UPR-200-E-107
216-C-8
UPR-200-E-56
241-AN-A
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2607-EG
UPR-200-E-27
UPR-200-E-100
UPR-200-E-99
244-A RT
241-ER-153
241-AZ-151 DS
241-AZ-151 CT
241-AZ-152
241-AX-155
241-AY-152
UPR-200-E-49
UPR-200-E-70
UPR-200-E-126
241-AY-151
UPR-200-E-125
216-A-41
UPR-200-E-47
UPR-200-E-68
241-AR-151
UPR-200-E-48
2607-EA
UPR-200-E-12
216-A-9
241-A-153
204-AR-WUS
2607-E6
UPR-200-E-10
241-AX-151
2607-EC
UPR-200-E-42
UPR-200-E-11,20,33
UPR-200-E-60
216-A-3
216-A-28
UPR-200-E-17
216-A-22
200-E-35
241-AX-152CT
241-AX-152DS
UPR-200-E-115
UPR-200-E-119
241-AX-A
241-AX-B
241-A-417
241-AX-501
UPR-200-E-59
241-A-A & B
216-A-1
UPR-200-E-59
241-A-302B
241-A-152
216-A-7
241-A-350
216-A-16,17,23A,23B
241-A-431
241-AY-152
207-A RB
UPR-200-E-67
241-AW-A
241-AW-B
2607-ED
2607-EJ
241-AP VP
NOTE: Compiled from variety of source data. Accuracy is unknown.
Scale in Feet
0 250 500
Scale in Meters
0 100 200

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APPENDIX A

SUPPLEMENTAL DATA

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APPENDIX A.1

GEOPHYSICAL DATA

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A-1.1 INTRODUCTION

Geophysical well logging has been conducted in monitoring wells located within the 200 East and West Areas since 1954 and in the PUREX Plant Aggregate Area since at least as early as 1958. Such logging can be used to map lithologic boundaries (Additon 1978; Last et al. 1989; Brodeur and Koizumi 1989), soil moisture content (Lane 1990) and to evaluate the location and extent of radionuclides in the subsurface due to waste disposal activities (Fecht et al. 1977; Additon 1978; Brodeur 1988; Lane 1990). The geophysical borehole logging techniques that have been used include density, neutron, temperature, and gross gamma radiation logging. The most successful of these for mapping lithologic boundaries and monitoring radionuclides in the subsurface has been the gross gamma logging. The other techniques have been less successful because either they are not suitable for use in cased holes or they do not measure radiation (Lane 1990).

Previous studies based on the gross gamma logs collected from wells monitoring various waste management units in the 200 East and West Areas were conducted in 1964, 1969, 1977, 1978, 1986, and 1988. The tank farms located in the 200 East and West Areas were not considered in these reports. Additon et al. (1978) reports that the 1964 study by Raymond and McGhan discusses the disposition of radionuclides beneath most of the waste management units active between 1945 and 1963. The 1969 study (Tillson and McGhan 1969) is reported by Additon et al. (1978) to be a discussion of the waste management units where significant changes in the gamma logs were observed after 1963. The report by Fecht et al. (1977) is a qualitative study of the distribution, redistribution, and decay of radionuclides beneath approximately 100 waste management units in the 200 East and West Areas. Fecht et al. (1977) included a summary of the waste disposal history of each facility evaluated and based their conclusions on approximately 300 selected gross gamma logs collected between 1954 and 1976. Plots of the logs used were provided with the report. Additon et al. (1978) provided a complete summary of the logging systems used and a discussion of the limitations of using gross gamma logs to evaluate the distribution and composition of radionuclides in the subsurface. The methodologies used to qualitatively evaluate the gross gamma logs collected from wells monitoring the waste disposal facilities in the 200 East and West Areas were also summarized. Plots of the gross gamma logs collected from 154 monitoring wells outside the tank farms in the 200 East Area was included in the report by Additon et al. (1978). Chamness (1986) and Brodeur (1988) reviewed gross gamma logs available from selected wells in the 200 Areas and qualitatively summarized any changes in the logs between 1976 and the dates of their reports.

Thirty-one active and inactive waste management units in the PUREX Plant Aggregate Area, which are monitored by wells in which gross gamma logs are collected, were evaluated in this study. These waste management units were grouped into eight geographically related areas and been qualitatively evaluated in terms of the location and extent of radionuclides in the subsurface, any evidence of vertical or lateral migration, and the potential for radionuclides reaching the ground water (Figure A1-1). The results of the evaluations for these waste management units are summarized in Table A1-1. Additionally,

logs from the three inactive single-shell tank farms in the PUREX Plant Aggregate Area were reviewed and the approximate extent, location and source of radionuclides in the subsurface summarized. The results of the tank farm evaluations are summarized in Table A1-1.

A-1.2 GROSS GAMMA LOGGING

Borehole gross gamma radiation measurements are used to determine the level of gamma activity with depth in the vicinity of the well bore. These measurements do not differentiate between the mechanisms through which gamma radiation is produced or the energy of the gamma radiation photons detected. The response of the gamma radiation detector to different energy levels is generally unknown, except perhaps for the lowest energy photon detectable (Arthur 1990). Gross gamma logs cannot be used to determine the isotopic composition of the subsurface since this is determined through the analysis of the energy spectra of the gamma radiation detected. The capability to measure the spectra of gamma radiation detected in the subsurface and assay the types and amounts of isotopes present is currently being developed, but has not yet reached the stage of practical application (Lane 1990; Price et al. 1990).

The bulk of the gamma logs available for the PUREX Plant Aggregate Area were collected with scintillation probes by Pacific Northwest Laboratories (PNL) or by the Tank Farm Surveillance Analysis and Support group (TFSA&S). Scintillation probes detect the flash of light produced by the interaction between a gamma photon and a crystal of thallium-activated sodium iodide (NaI(Tl)) with a photomultiplier tube. The resulting pulse of electricity is amplified, routed through a signal generator and sent through the logging cable to the surface. The pulses are separated from the electrical signal with a discriminator, amplified, counted by a rate meter and output to a pen plotter, which is driven at a rate determined by the logging speed (Fecht et al. 1977; Additon et al. 1978; Brodeur and Koizumi 1989; Arthur 1990).

The accuracy and precision of gamma activity measurements in the subsurface is determined by details of the logging system instrumentation, the field data acquisition methodology, the surrounding media, and the radionuclides present. The relationship between the gamma activity detected by a scintillation probe and the actual activity, the distance gamma radiation may travel through geologic materials before being completely attenuated and the vertical resolution of changes in activity by the logging systems used will be discussed below.

The time required for the logging system to process a detected gamma photon, or "dead time", is an important limitation in the measurement gamma activity (Brodeur and Koizumi 1989; Arthur 1990). During this short span of time, no other photons will be processed by the instrument. The "dead time" computed for the PNL system currently in use

is 17.8 microseconds (Arthur 1990). Based upon this value, the maximum count rate this logging system is capable of is about 56,000 counts per second (ct/sec). If the activity is above that level, the system will become "paralyzed" and read 0 ct/sec until it resets itself. The maximum count rate of the TFSA&S system currently in use is about 100,000 ct/sec with Probe No. 4 (Strong 1980). This suggests that the "dead time" of their logging system is about 10 microseconds. There is no evidence that TFSA&S's system will become paralyzed if this activity level is exceeded.

The actual gamma activity on an interval may be computed by multiplying the "dead time" corrected activity by a factor consistent with the amount of attenuation due to well construction. The amount of attenuation of the gamma radiation experiences in penetrating well casing is significant. A single string of casing reduces the count rate measured by the scintillation probe by about 25%, groundwater in an uncased hole reduces the observed count rate by 11%, and groundwater in a cased hole reduces the observed count rate by about 33% (Brodeur and Koizumi 1989; Arthur 1990).

The relationship between the gamma activity observed with a scintillation probe and the actual activity is linear over much of the system's range. However, above some threshold activity level, the relationship between the observed and actual activity becomes non-linear. At this point the tool is said to be saturated. The gross gamma logging system currently in use by PNL becomes saturated around 14,500 ct/sec (Brodeur and Koizumi 1989; Arthur 1990), and that currently in use by TFSA&S with Probe No. 4 becomes saturated around 70,000 ct/sec (Strong 1980).

Where the relationship between the observed and actual gamma activity is linear, and complete details of well construction are available, the activity may be converted to standard units related to decay rates or to concentrations of specific radionuclides (thorium or uranium for example). Such conversions allow the direct comparison of data collected by different logging systems and quantitative analyses of the concentrations of gamma emitters with depth. To achieve this, it is necessary to calibrate the scintillation probes used with a model bore hole containing intervals with known activities (Strong 1980; Brodeur and Koizumi 1989; Arthur 1990). The rigorous procedures and facilities necessary for calibrating scintillation probes have not yet been completed.

A scintillation probe is calibrated by periodically adjusting the components of the system to meet established specifications and by logging a test well with intervals of known activity under standard conditions. The probe's calibration is then verified in the field before and after each logging run using portable equipment and procedures, which are correlated with those of the calibration procedure. Standard conditions are established by constructing the test bore hole in a known geologic environment with background radiation levels similar to those found in the area where the probe is used. The test well should be constructed in a similar fashion to the wells to be logged by the probe (Brodeur and Koizumi 1989).

The average distance through which gamma radiation penetrates geologic and well construction materials and is still detected by the scintillation probe is known as the radius of

investigation. This distance is determined by the density of the media surrounding the bore hole, the well construction materials, and the energy and intensity of the gamma radiation. The average radius of investigation for gross gamma radiation measurements in an open hole is about 0.3 m (1 ft) from the wall of the bore hole in sedimentary rocks (Schlumberger 1972). The radius of investigation is larger on intervals where there are high concentrations of radionuclides since higher intensities of gamma radiation will penetrate a greater thickness of a given material. The radius of investigation is decreased by well casing, grout, and groundwater since they increase the effective density of sediments. Another factor in determining the radius of investigation is the tool response to low energy (frequency) gamma photons. The scintillation probe currently used by PNL has a low energy cutoff of between 46.5 and 59.5 keV (Arthur 1990). Gamma radiation with energies below this value will not be detected by that probe. The low energy cutoff for the probes used by TFSA&S is unknown.

The vertical resolution and apparent location of a change in the gamma activity measured by a scintillation probe depends upon details of how the probe signal is processed by the rate meter and the logging speed. The rate meter used in PNL's logging system differs from that used by TFSA&S. The rate meter used by PNL smooths its output using an electronic circuit (an RC circuit). The amount of smoothing is determined by the time constant of the circuit used. This removes statistical variations in the signal detected by the scintillation probe and improves the reproducibility and sensitivity of the data. However, a "lag" is introduced between the depth at which a change in the gamma activity is first encountered by the scintillation probe and the depth at which it is plotted. The size of this "depth lag" is the distance traveled before half of the amplitude of the change in activity is recorded. One time constant is required to reach 63% of the amplitude of any change in activity. So, the "depth lag" is approximately the product of the logging speed and the time constant used (Schlumberger 1972). Before 1989, the logging speed used by PNL was 4.5 m (15 ft) per minute (0.07 m, 0.25 ft per second) and the time constant used was 3 seconds. This results in a depth lag of 0.2 m (0.75 ft). The thinnest interval of elevated activity which can be resolved is also 0.2 m (0.75 ft) on these older profiles. In 1989, the logging speed was reduced to 1.5 m/min (5 ft/min) 2.5 cm/sec (1 in./sec) and the time constant to 1 second. The expected vertical resolution and "depth lag" of these logs is 2.5 cm (1 in.). The rate meter used by TFSA&S sums the pulses over the period of time required for the probe to ascend through 0.3 m (1 ft) and averages the reading over time. This process does not remove the statistical variations from the data so the data are less reproducible. Since no time constant is used, no "lag" between the depth a change in gamma activity is encountered and the depth where it is plotted is introduced. However, the vertical resolution of changes in activity on these logs is 0.3 m (1 ft), the distance over which the activity is averaged.

A-1.3 TECHNICAL APPROACH

Scintillation probe profiles collected periodically from monitoring wells within the PUREX Plant Aggregate Area have been used to qualitatively to assess the location and extent of radionuclides in the subsurface, any evidence of vertical or lateral migration, and the potential for radionuclides from waste disposal activities reaching the groundwater. The approach used here is similar to that of Fecht et al. (1977). Scintillation probe profiles collected from wells monitoring a facility or group of facilities were compiled and analyzed in an attempt to gain an understanding of the subsurface distribution of gamma emitters from waste disposal activities. Each analysis is accompanied by a summary of the types and sources of wastes handled, the service dates and the volume of wastes disposed of or stored at a given facility. The conclusions reached in these evaluations should not be considered the final word since they are based on a limited data set, which can only be used for qualitative purposes.

The approach used here differs from that of Fecht et al. (1977) and other previous evaluations in the manner in which the data were compiled and analyzed. The thirty-one waste management units evaluated were grouped into eight geographic areas and evaluated as a whole (Figure A1-1). The three tank farms for which summary evaluations were made were accounted for three additional areas. Geological methods of analysis incorporating cross sections and mapping of subsurface attributes such as the thickness of zones of elevated gamma radiation and relevant lithologic horizons were used extensively. The advantages of this approach are the clearer representation of potential subsurface conditions around the waste disposal facilities, and identification of data deficiencies.

Fecht et al. (1977) attempted to "normalize" the scintillation probe profiles used in their evaluations to a level consistent with the profiles collected in 1976. This normalization scheme involved scaling the profiles from each vintage using an average "peak to background" ratio and bulk shifting the corrected curves to correspond to the 1976 profiles. Since there are distinct differences between the response characteristics of each logging system and their modifications (in the saturation levels, low energy cutoff, etc), there are doubts to the validity of such an exercise. The logs used in the evaluations presented here have not been normalized.

No attempt has been made to quantitatively compare the activity levels detected by different vintages of scintillation probes in the evaluations presented here. If gross changes in the profiles are evident, they have been noted in a qualitative sense.
The criteria used to identify radionuclide decay are the significant, consistent decline of activity levels and the "narrowing" of the features representing elevated radiation on the logs over time. However, such changes may also be indicative of lateral migration of radionuclides away from a particular well. Identification of lateral migration is generally uncertain. The most reliable criteria for identifying lateral migration of radionuclides is the notable increase of activity on an interval in a well that is downgradient (of a stratigraphic or hydrologic boundary) from other wells with elevated activity on a similar interval. It is very

important to consider the spacial and temporal context of the scintillation probe data in determining if lateral migration has occurred, even on a qualitative level.

Although the activity measured by the scintillation probes cannot be quantified to known standards, the activity in the subsurface may be reliably located. The location of features in the scintillation probe profiles such as the top and bottom of intervals of elevated gamma radiation are generally found at the same depth on successive logs. Care must be taken in comparing the logs collected by TFSA&S and PNL. Depth discrepancies of up to 5 feet have been noted between these logs. This error is due in part to the "depth lag" of the PNL logging system. This "depth lag" will place equivalent features on PNL logs (collected before 1989) 0.75 feet shallower than those on TFSA&S logs. Also, differences in the responses of the PNL and TFSA&S systems may account for some of this discrepancy.

Three criteria were used to establish downward migration of radionuclides in the vicinity of a well. The most important of these was an unambiguous downward displacement of the top and bottom of a region of elevated radiation with time. Downward migration of other correlatable features on an interval of elevated activity may be used in support of this evidence. Secondly, the total amount of downward migration should exceed the vertical resolution of the logging system used (0.22 m, 0.75 ft, for the PNL pre-1989 logs and 0.3 m, 1 ft, for TFSA&S logs). Finally, any change in the point from which depths are measured during logging should be identified and accounted for, this can be inferred from stationary subsurface features, such as lithologic boundaries and bottoms of casing strings.

All of the available well data were reviewed for each area evaluated, and selected logs were used to construct cross sections representative of subsurface conditions. These cross sections were correlated with stratigraphic information from nearby wells, regional cross sections and regional mapping. Boundaries of zones of elevated gamma radiation were also marked. Any mappable attributes that could be used to represent the location and extent of the region of elevated gamma radiation were compiled into maps. The evaluation of the scintillation probe profiles referenced these graphical representations to describe the location and extent of any zones of elevated gamma radiation, and the behavior of this zone over time, particularly in regards to vertical or lateral migration. Any evidence of gamma emitters reaching the groundwater was also noted.

To represent the logs used in the cross sections in a clear, yet compact format and to facilitate comparisons between different vintages of data, it was necessary to digitize the original logs and to redisplay them on a semi-logarithmic scale. Depth in feet from the top of casing was represented on the linear scale, and activity in ct/sec on the logarithmic scale. The logs used in these evaluations which were collected before 1976, and some of the 1976 vintage logs had been previously digitized by PNL, who provided text files of the information. Unfortunately, it was not realized until late in the evaluations that the 1970 vintage and earlier logs had been plotted on a scale of counts per minute (ct/min). The reader should be aware that these logs are not plotted in ct/sec, but in ct/min. The apparent wide difference between these earlier logs and those collected in 1976 and later is due to an

error in scaling. Logs plotted on a scale of ct/min were denoted on the legend for each plot of scintillation probe profiles. The cross sections are not scaled horizontally.

Features that were mapped in the evaluations for the PUREX Plant Aggregate Area include the thickness of the interval of elevated gamma radiation, the top of the elevated gamma radiation and the top of any correlatable lithologic horizon, which is useful in explaining the distribution of radionuclides in the subsurface. The most commonly used map was the thickness of the interval of elevated gamma radiation. Although such maps do not give any indication of gamma activity, they do provide a reasonable representation of the potential extent of gamma emitters. Use of activity data was avoided since the data are not suitable to be used in such a quantitative fashion.

A-1.4 EVALUATION OF WASTE MANAGEMENT UNIT AREAS

A-1.4.1 216-A-1 AND 216-A-7 CRIBS

Evaluation of Scintillation Probe Profiles:

Well E25-2 monitors the 216-A-1 Crib and Well E25-54 monitors the 216-A-7 Crib. Previous evaluations using the scintillation probe profiles have been done by Fecht et al. (1976) (for 216-A-1 Crib) and by Chamness (1986) (for 216-A-7 Crib). In both cases the authors concluded the level of gamma activity in the subsurface is declining. Fecht et al. also concluded that there was no measurable migration of radionuclides under the 216-A-1 Crib and that the contamination had not reached the groundwater. The following analysis is consistent with these conclusions.

Scintillation probe profiles for the 2 wells that monitor cribs 216-A-1 and 216-A-7 were compiled and roughly correlated with the stratigraphy of Well E24-5, located about 460 m (1,500 ft) to the east, and Well E26-6, located about 330 m (1,100 ft) to the north (Lindsey et al. 1990) (Figure A1-2). The data are inadequate to construct a map of the contaminant thickness and extent.

Elevated gamma radiation levels are found at two intervals in the subsurface. The upper interval is found beneath the 216-A-7 Crib from the surface to a depth of about 5 m (15 ft). The lower interval is found beneath both cribs at a depth of about 13 m (27 ft), and is about 5 m (15 ft) thick. The top of the lower interval of contamination is located at a depth consistent with that of the top of the fine-sandy facies of the Hanford formation. The upper interval of contamination appears to coincide with an erosional surface found in the stratigraphic column of Well E26-6 (Figure A1-2).

There is no evidence of vertical or lateral migration of contaminants. However, since the top of the fine-sandy facies of the Hanford formation dips (Lindsey et al. 1990), it is

unlikely that any lateral migration would be detected. Radiation levels have declined to near background levels beneath the 216-A-1 Crib, but remain significant beneath the 216-A-7 Crib.

A-1.4.2 216-A-2, -4, -21, -26, -27, -31, -36A, AND -36B CRIBS

Evaluation of Scintillation Probe Profiles:

The 216-A-2, -4, -21, -27, -31, -36A, and -36B Cribs are located in the 200-PO-2 Operable Unit and the 216-A-26 and -26A French Drains in the 200-PO-1 Operable Unit. The 216-A-2 and 216-A-4 Cribs are monitored by Wells E24-53 and -54, respectively. Since the 216-A-26 and 216-A-26A French Drains are located between these cribs, they too are monitored by these wells. The 216-A-21 Crib is monitored by Well E24-12. The-216-A-27 Crib is monitored by the E17-2 and -3 wells. Well E24-9 monitors the 216-A-31 Crib. The 216-A-36A Crib is monitored by Wells E17-4 (01-36-01), -9, and -10. The 216-A-36B Crib is monitored by Wells E17-5, -6, -7 (01-36-07), -11 (01-36-11), and -51 (01-36-06) (Fecht et al. 1977; Welty and Vermeulen 1989).

All of the monitoring wells in the area of the 216-A-2, -4, -21, -26, -27, -31, and -36 Cribs have been logged by PNL. Currently, Wells E17-4 (01-36-01), -7 (01-36-07), -11 (01-36-11), and -51 (01-36-06) are also logged on a semi-annual basis by TFSA&S (Welty and Vermeulen 1989). Details of the monitoring wells and the logs used in this evaluation are given in Table A1-3.

Scintillation probe profiles from the wells monitoring the 216-A-2, -4, -21, -26, -27, -31, and -36 Cribs have been evaluated in the past by Fecht et al. (1977), Chamness (1986) and Brodeur (1988).

Fecht et al. (1977) evaluated gross gamma logs from well monitoring the 216-A-2, -4, -21, -27, -31, -36A, and -36B Cribs and concluded that there was no evidence of significant vertical migration of gamma emitters beneath these waste management units after waste disposal activities ceased and that radionuclides from these units had not reached the water table. Fecht et al. (1977) concluded that radionuclides disposed of in the 216-A-36B Crib had not reached the southern end of the crib. This conclusion was based on the scintillation probe profiles collected from Well E17-6, which according to the Westinghouse Hanford GIS listing of well statistics and Welty and Vermeullen (1989), is located approximately 90 m (300 ft) south of the location used by Fecht et al. (1977). Some lateral migration of radionuclides was also noted under the 216-A-36B Crib.

Chamness (1986) noted that radiation levels beneath the 216-A-27 and 216-A-36A cribs was declining slowly based on logs collected in 1986.

9 3 1 2 8 6 7 0 7 0 4

Brodeur (1988) evaluated cribs 216-A-2, -4, -27, -31, -36A, and -36B. Brodeur (1988) noted significant levels of activity beneath cribs 216-A-2, -4, -27, -36A, and -36B, and that radionuclides probably had reached the groundwater between cribs 216-A-36A and 216-A-27. Brodeur (1988) used a log from Well E24-65 in the evaluation of 216-A-2 Crib. According to the Westinghouse Hanford GIS listing of well statistics, this well is located within the 241-A Tank Farm, a considerable distance northwest of the 216-A-2 Crib.

This evaluation concurs with Brodeur (1988) in regards to gamma emitters reaching the water table between the 216-A-27 and 216-A-36A Cribs. Fecht et al. (1977) had concluded that gamma emitters had not reached the water table in this area. This evaluation does not concur with Fecht et al. (1977) in regards to the distribution of radionuclides in the 216-A-36B Crib. The conclusions of the current evaluation on this point is based on profiles from a recently emplaced well (E17-51) located near the southern end of the 216-A-36B Crib and the coordinates for Well E17-6 from the Westinghouse Hanford GIS listing of well statistics.

Scintillation probe profiles from Wells E17-2, -3, -4, -5, -9, -10, -11, -51, E24-9, -12, -53, and -54 were compiled into four cross sections and correlated with the stratigraphy found in Well E17-4, and -12 (located about 265 m or 875 ft to the southeast), and with the regional mapping of Lindsey et al. (1992) (Figures A1-3 and A1-4). Although Wells E17-6 and -7 were not included in these cross sections, they were correlated with the stratigraphy from Wells E17-4 and -12 and used in this evaluation (Figure A1-5). The Hanford upper gravel, the Hanford sand, and the Ringold Formation are found in this area. The Hanford lower gravel may also be present on the edge of the area, in Well E17-10. The boundaries between these units are expressed as subtle features on the gamma logs from Wells E17-10, E24-9, and -12, which represent background conditions for the most part. Internal changes in facies within these units are not expressed on these background profiles.

Significant levels of gamma activity within the Hanford sand has been detected in the vicinity of the two wells monitoring the 216-A-2 and 216-A-4 Cribs and the 216-A-26 and 216-A-26A French Drains. The top of the zone of elevated radiation corresponds to the top of the Hanford sand and the base of the cribs (Figure A1-3). However, since the wells do not fully penetrate the zone of elevated radiation, the distribution of gamma emitters in that area cannot be further characterized.

The well data are adequate to characterize the distribution of radionuclides beneath cribs A-27, -36A, and -36B. The top of the elevated radiation in the immediate vicinity of these cribs corresponds to the top of the Hanford sand and the base of the cribs (6.1 to 7.6 m or 20 to 25 ft below grade) and becomes considerably deeper (16.2 to 40.5 m or 53 to 133 ft below grade) outside the confines of these cribs (Figures A1-3 and A1-4). Over most of the area, the base of the elevated activity roughly corresponds to the top of a silty interval within the Hanford sand. Elevated levels of radiation in the Ringold Formation, above the water table, are found under crib 216-A-36A and the northern and eastern ends of cribs 216-A-36B and 216-A-27, respectively. The thickness and possible extent of the elevated gamma

radiation within the Hanford sand and the possible extent of elevated gamma radiation within the Ringold Formation are shown in Figure A-1.6. The approximate thickness of the elevated gamma radiation in the Hanford sand is currently 31.4 m (103 ft) near the southern end of crib 216-A-36A. In 1976, it was nearly 67 m (220 ft) thick, and the base of the interval of elevated radiation was within 4.6 m (15 ft) of the top of the Ringold Formation. This suggests that the 216-A-36A Crib was a source of gamma emitters to the groundwater before 1976. The thickness of the region of probable anthropogenic radionuclides within the Hanford sand also increases under the southern end of the 216-A-36B Crib and the 216-A-27 Crib. However, no gamma emitters are detected within the Ringold Formation in these areas.

There is evidence that the distribution of radionuclides below cribs 216-A-27, -36A, and -36B was controlled by lithologic facies changes within the Hanford sand. The scintillation probe profiles from the wells monitoring cribs 216-A-27, -36A, and -36B indicate that gamma emitters are confined to two distinct horizons within the Hanford sand beneath crib 216-A-36B and the western end of crib 216-A-27 (Figures A1-3, A1-4, and A1-5). This is manifested by two well developed peaks separated by a thin interval 2.1 to 4.6 m thick or 7 to 15 ft of near background readings found at a depth of 19.8 to 21.3 meters or 65 to 70 feet. In the past, gamma levels were much higher within this thin interval, but the character of the logs has remained consistent. This "notch" can be explained by postulating a thin, discontinuous lense of coarse grained material within the Hanford sand. Such a lense could act as a "leaky" barrier to the movement of wastes in the subsurface (Additon et al. 1978). Vertical movement would be inhibited because capillary attraction would prevent movement from less permeable to more permeable sediments. The scintillation profiles from Wells E17-2, -5, -7, -9, -11, and -51 (Figures A1-3, A1-4, and A1-5) indicate that this postulated lense is a synform whose axis is located between Wells E17-5 and -51 and plunges toward the northwest. This is consistent with deposition at the bottom of a river channel in an alluvial environment and the regional mapping of Lindsey et al. (1992). The profiles from Wells E17-3 and E17-4 do not have this "notched" character and the depth to the top of the elevated gamma activity is considerably deeper (Figures A1-3 and A1-4). This suggests that the postulated lense is absent in that area so radionuclides could penetrate to a greater depth. The edge of this postulated lense corresponds to increased gamma radiation levels in the Ringold Formation (Figure A1-3 and A1-4).

The wells monitoring cribs 216-A-21 and 216-A-31 do not appear to be optimally placed. The regional mapping of Lindsey et al. (1992) and the distribution of radionuclides beneath cribs 216-A-27, -36A, and -36B (Figure A1-6) suggest that potential contaminants may be found northwest of these cribs.

There is no evidence of lateral or vertical migration of radionuclides after their emplacement beneath cribs 216-A-2, -4, -27, -36A, and -36B. The only changes in the scintillation probe profiles from the wells monitoring these structures over time has been a thinning of the peaks due to radionuclide decay.

Scintillation profiles from all the wells reaching the water table indicate that although elevated gamma radiation was detected in the groundwater under cribs 216-A-21, -27, -31, -36A, and -36B prior to the 1976 logging campaign (Fecht et al. 1977), levels are currently at or near background levels.

A-1.4.3 216-A-5, -10, -15, AND -38-1 CRIBS

Evaluation of Scintillation Probe Profiles:

The 216-A-5, -10, and -38 Cribs and the 216-A-15 French Drain are all located within the 200-PO-2 Operable Unit, south of building 202-A. The 216-A-5 Crib is monitored by Wells E24-1, -10, -56, -57, and -58. The 216-A-10 Crib is monitored by Wells E17-1, E24-2, -15 (01-10-02), -59 (01-10-03), -60 (01-10-09), and -160 (01-10-01). No wells are positioned to monitor the 216-A-15 French Drain. The 216-A-38 Crib is monitored by Wells E17-8 and E24-11. Except for Well E24-15, each of these monitoring wells have been logged by PNL. Wells E24-59, -60, and -160 are also logged by TFSA&S on a semi-annual basis. Well E24-15 was monitored by TFSA&S before it was taken out of service. Details of the monitoring wells and scintillation probe profiles used in this evaluation are given in Table A1-4.

The 216-A-5, -10, and -38 Cribs were evaluated by Fecht et al. (1977), and the 216-A-5 and 216-A-38 Cribs were also evaluated by Brodeur (1988). No previous evaluations are available for the 216-A-15 French Drain. Fecht et al. (1977) and Brodeur (1988) both noted significant levels of gamma radiation in the vadose zone and in the groundwater beneath the 216-A-5 Crib. Both studies conclude that radionuclides from the 216-A-5 Crib may have reached the groundwater. Fecht et al. (1977) similarly concluded that radionuclides from the 216-A-10 Crib may also have reached the groundwater. Elevated gamma activity under the 216-A-38 Crib at a depth of about 30.5 m (100 ft) was observed by Fecht et al. (1977). Since that crib had never been used, this activity was attributed to lateral migration of radionuclides from the 216-A-10 Crib. Brodeur (1988) noted that elevated gamma radiation is evident only in the groundwater beneath the 216-A-38 Crib. The results of this evaluation do not differ significantly from those of Fecht et al. (1977) and Brodeur (1988).

Except for Wells E24-2 and -11, the wells monitoring the 216-A-5, -10, and -38-1 Cribs were compiled into three cross sections and correlated with the stratigraphy from Wells E17-4, located about 160 m (535 ft) to the northwest; E17-12, located about 350 m (1,150 ft) south-southwest; and E24-5, located about 600 m (1,960 ft) north-northwest (Lindsey et al. 1992) (Figure A1-7). This correlation should be considered fair since the changes in lithology have very subtle expression on the gamma logs and the regional mapping by Lindsey et al. (1992) is not detailed on the scale used in this evaluation.

Significant levels of gamma radiation are found under the 216-A-5 and 216-A-10 Cribs. The top of the interval of containing probable anthropogenic radionuclides

is found between 9.1 to 11.9 m (30 to 39 ft) below the surface, and the bottom of this interval at a depth of about 53.4 m (175 ft). The top of the elevated gamma radiation is correlated with the top of the Hanford sand in Well E24-10, adjacent to the 216-A-5 Crib (Figure A1-7). Elsewhere, the top of the elevated activity does not correspond to a particular lithologic unit (Figure A1-7). The base of the elevated radiation appears to be controlled by the top of a silty interval found within the Hanford sand (Lindsey et al. 1992). The "sawtoothed" character of the scintillation probe profiles from wells that penetrate the interval of elevated activity suggest that this silty interval inhibited but did not stop the downward migration of gamma emitters (Figure A1-7).

In the evaluations of the 216-A-5 and 216-A-10 Cribs by Fecht et al. (1977) and Brodeur (1988), secondary peaks were noted in the scintillation probe profiles from wells in the area. Fecht et al. (1977) attributed these secondary peaks to the relatively high retention of gamma emitting radionuclides in fine grained sediments versus that of coarse grained sediments. The well data are inadequate to further characterize these postulated lenses of fine grained material.

The current gross thickness and probable extent of the interval of elevated gamma radiation was mapped (Figure A1-8). This map suggests that the gamma emitters from the 216-A-10 Crib merged with those from the 216-A-5 Crib to the west. This is consistent with the dip of the top of the Hanford sand in this area (Lindsey et al. 1992). There is no explicit evidence of the presence of gamma emitters from the 216-A-15 French Drain. However, the "spreading" of the contours near Well E24-57 and the 13.4 m (44 ft) disposal depth for the 216-A-15 French Drain suggests that there may be some influence on the shape of the region of elevated gamma activity due to radionuclides from the 216-A-15 French Drain.

The extent of the elevated gamma radiation in the subsurface toward the east may have been influenced by the lateral migration of radionuclides from the 216-A-10 Crib when it was active. Fecht et al. (1977) proposed that elevated gamma radiation observed at a depth of about 21.3 m (70 ft) in Well E17-8 was due to gamma emitters migrating laterally from the 216-A-10 Crib. However, to reach the 216-A-38 Crib from the 216-A-10 Crib, gamma emitters would have had to travel up the regional dip of the top of the Hanford sand (Lindsey et al. 1992). The available scintillation profiles from Well E17-8 indicate that gamma activity on this interval had declined to near background levels by 1976. Brodeur (1988) observed no subsequent changes in the profiles for Well E17-8 on this interval. Based on the available data, only small quantities, if any, of radionuclides from the 216-A-10 Crib reached the 216-A-38 Crib area.

Currently, the gamma radiation levels measured by scintillation probes in the groundwater beneath the 216-A-5, -10, -15, and -38 Crib areas are at or near background levels. However, the scintillation probe profiles from Wells E24-10 and E17-1, which monitor the 216-A-5 and 216-A-10 Cribs, respectively, suggest that gamma emitters did reach the groundwater between 1958 and 1979 (Figure A1-7).

There is no evidence that gamma emitters placed in the 216-A-5 and 216-A-10 Cribs are currently migrating laterally or vertically in the subsurface. The location of features on the scintillation probe profiles from the wells monitoring the cribs have remained constant over time (Figure A1-7). The consistent reduction in the amplitude of features on the profiles over time indicates that radionuclide decay is occurring.

A-1.4.4 216-A-6 CRIB

Evaluation of Scintillation Probe Profiles:

Wells E25-3 and -53 monitor the 216-A-6 Crib. Details of these wells and the scintillation probe profiles used in this evaluation are given in Table A-1.5.

The scintillation probe profiles for Wells E25-3 and -53 have been evaluated by Fecht et al. (1977), Chamness (1986) and Brodeur (1988). Fecht et al. (1977) observed elevated levels of gamma radiation at the surface and between 6.1 to 12.2 m (20 to 40 ft) below the surface. Chamness (1986) noted that the 1986 profile for Well E25-53 did not differ from previous logs. Brodeur (1988) found no change in the character of the 1987 profiles from earlier profiles for both Wells E25-3 and -53. Brodeur (1988) also observed elevated activity at a depth of 10.7 m (35 ft). This evaluation is consistent with these previous reports.

A cross section was constructed from the compiled scintillation probe profiles from Wells E25-3 and 53 (Figure A1-9). The profiles were roughly correlated with the stratigraphy from Wells E24-5 and E17-4 (Lindsey et al. 1992), located approximately 670 m (2,200 ft) northeast and southeast of the 216-A-6 Crib, respectively.

Elevated gamma radiation was detected at a depth between 6.1 to 12.2 m (20 to 40 ft) in Well E25-3. Slightly elevated radiation levels are also detected in Well E25-53 between 6.1 to 12.2 m (20 to 40 ft). The top of the elevated activity is correlated with the top of the Hanford sand in this area (Lindsey et al. 1992). The distribution of the elevated gamma radiation levels is consistent with the northwesterly regional dip of the top of the Hanford sand (Lindsey et al. 1992).

There is no evidence of vertical migration of radionuclides from the 216-A-6 Crib. The data are inadequate to assess the lateral extent of contaminants in the subsurface down dip from the 216-A-6 Crib.

A-1.4.5 216-A-8, -18, -19, -20, -24, -29, and 524 WMUs

Evaluation of Scintillation Probe Profiles:

The 216-A-8 and 216-A-24 Cribs, 216-A-18, -19, and -20 Trenches, 216-A-29 and 216-A-34 Ditches, and the 216-A-524 Control Structure are all located within the 200-PO-5 Operable Unit, east of the 241-A and 241-AX Tank Farms. The 216-A-8 Crib is monitored by Wells E25-4 (01-08-08), -5 (01-08-09), -6 (01-08-07), -7 (01-08-10), -8 (01-08-03), -9, -14, and -169. Well 299-E25-169 is reported to be near the 216-A-8 Crib, but the correct coordinates for the well were unavailable at the time of writing. The 216-A-18, -19 and -20 Trenches and the 216-A-34 Ditch are monitored by Well 299-E25-10. The 216-A-18, -19, and -20 Trenches and the 216-A-34 Ditch are monitored by Well E25-10. The 216-A-24 Crib is monitored by Wells E26-2, -3, -4, -5, -7, -53, and -54. The 216-A-524 Control Structure is located at the west end of the 216-A-24 Crib. The closest monitoring well to the control structure is Well 299-E26-5. This well monitors the 216-A-24 Crib. The 216-A-29 Ditch is monitored by Well E25-28. All of these monitoring wells have been logged by PNL. Wells E25-4 (01-08-08), -5 (01-08-09), -6 (01-08-07), -7 (01-08-10), and -8 (01-08-03) are currently logged by TFSA&S on a semi-annual basis (Welty and Vermeulan 1989). Details of the monitoring wells are given in Table A1-6.

The 216-A-8 Crib has been evaluated by Fecht et al. (1977). They concluded that no measurable migration of radionuclides has occurred beneath this crib and that breakthrough to the groundwater has not occurred. The conclusions of this evaluation differ from those of Fecht et al. (1977) on both points.

The 216-A-24 Crib has been evaluated by Fecht et al. (1977), Chamness (1986) and Brodeur (1988). Fecht et al. (1977) concluded that measurable downward migration of contaminants occurred beneath the 216-A-24 Crib during waste disposal activities. They also concluded that gamma emitters have reached the water table under the western end of the 216-A-24 Crib. Chamness (1986) reported that by 1986, activity in the vadose zone had decayed to background levels. Brodeur (1988) also reported background levels in the vadose zone. The activity detected between 61 to 73.2 m (200 to 240 ft) in depth reported by Brodeur (1988) is probably due to changes in lithology at that depth. The conclusions of this evaluation for the 216-A-24 Crib are consistent with the previous studies.

Scintillation probe profiles from wells monitoring the 216-A-18, -19, and -20 Trenches, the 216-A-29 and 216-A-34 Ditches have not been previously evaluated.

Except for Wells E25-6, -28, -169, and E26-54, the wells monitoring the 216-A-8 and 216-A-24 Cribs, the 216-A-18, -19, and -20 Trenches, and the 216-A-29 and 216-A-34 Ditches were compiled into three cross sections and correlated with the lithologic column for Well E26-6 (Lindsey et al. 1992) and the regional mapping of Lindsey et al. (1992) (Figures A1-10 and A1-11). There is a discrepancy between the location of Well E25-6 given by the GIS coordinates used to construct the basemap and that used on the TFSA&S map (Welty and Vermeulen 1989). The elevation for the top of casing of 207 m

(680 ft) given by the GIS listing for Well E25-14 is probably incorrect. The top of casing of 2 nearby Wells (E25-4 and 5) are both less than 200 m (660 ft). On cross section B-B' (Figure A1-10), the scintillation probe profile for well E25-14 was positioned to reflect a more consistent top of casing. Although the expression of the lithologic changes is subtle on the scintillation profiles in this area, the correlation may be considered good since well E26-6 is located adjacent to the area (about 175 m or 600 ft west of the 216-A-24 Crib). Well 299-E25-169 was not included in any of the cross sections since the correct coordinates for that well were not available. The coordinates for 299-E25-169 given by the GIS listing place it in the vicinity of the 216-A-29 Ditch. Apparently the actual location of the well is near the western end of the 216-A-8 Crib. The correct coordinates for this well were not available at the time of writing.

Significant levels of gamma radiation are currently found beneath the 216-A-8 and 216-A-24 Cribs and the 216-A-29 Ditch. The thickness and estimated extent of these regions of elevated gamma radiation are shown in Figure A1-12. Except in Wells E25-14 (monitoring the 216-A-8 Crib) and E26-7 (monitoring the 216-A-24 Crib), the region of elevated gamma radiation is confined to the lower of 2 upward-fining sequences, which comprise the Hanford upper gravel in this area (Lindsey et al. 1992). The top of this lower sequence is 3 to 8.2 m (10 to 27 ft) below the surface and the bottom at 15.2 to 21.3 m (50 to 70 ft) below the surface (Figures A1-10 and A1-11). The highest levels of gamma radiation are currently detected at the top of this lower sequence and, except in Wells E25-14 and E26-7, decline to background levels at its base. In the vicinity of Wells E25-14 and E26-7, elevated radiation levels are detected well into the Hanford sand.

The existing data from wells monitoring the 216-A-8 Crib are inadequate to fully define the lateral extent and potential for lateral migration of radionuclides in the subsurface. The map representing the thickness and extent of radionuclides in the subsurface is poorly constrained north and northeast of the 216-A-8 Crib due to lack of well control (Figure A1-12). No wells have been placed north of the 216-A-8 Crib, near potential contributors (the 216-A-18, -19, -20, and -34 waste management units) to the elevated activity detected, and no wells have been placed northeast of the 216-A-8 Crib, down the regional dip of the top of the Hanford sand.

The increased thickness of the interval of elevated gamma activity under the 216-A-8 Crib in the vicinity of Well E25-14 (Figure A1-12) suggests that the radionuclides placed in the crib have moved southward. This is not consistent with the northeasterly regional dip of the top of the Hanford sand (Lindsey et al. 1992). Although the cross sections in Figures A1-10 and A1-11 are consistent with the regional mapping of Lindsey et al. (1992), the correlations used are open to interpretation. It is possible that locally, the top of the Hanford sand dips toward the south. An alternative interpretation is that Well E25-14 was not properly constructed and serves as a conduit for the downward migration of contaminants. This would explain the inconsistent location of the thickest interval of elevated radiation relative to the 216-A-8 Crib and the regional dip of the Hanford

sand. Also, the inconsistent character of the profiles from Well E25-14 relative to those from the surrounding wells could be explained by the difference in the pathways into the subsurface followed by the gamma emitters (Figure A1-10).

There is evidence of measurable downward migration of contaminants under the 216-A-8 Crib. Peaks and troughs in the profiles for Wells E25-4, -5, -7, and -14 show a downward displacement of about 1 m (3 ft) over 5 years (Figure A1-10) within the Hanford upper gravel. The development of a secondary peak at a depth of 50 to 55 m (165 to 180 ft) on the 1982 scintillation probe profile for Well E25-14 (Figure A1-10) is additional evidence of vertical migration of gamma emitters. Increasing radiation levels detected near the bottom of the 1987 profile (at a depth of 44 m or 145 ft) suggest that the peak is broadening. Currently, all of the wells monitored by TFSA&S are only logged to a depth of 45.7 m (150 ft), which is inadequate to detect this secondary peak.

Currently, there is no evidence that gamma emitters reach the water table under the 216-A-8 Crib. However, logs collected in 1958 from the wells monitoring this crib show levels of activity 2 or 3 orders of magnitude above background levels for logs of this vintage within the Ringold Formation and approaching the water table (Figure A1-10).

The lateral extent of elevated gamma radiation beneath the 216-A-24 Crib is adequately constrained by surrounding wells (Figure A1-12). Fecht et al. (1977) noted that there was measurable downward migration of contaminants under the western end of this crib when it was active. There is no evidence of downward migration of gamma emitters on more recent profiles (Figures A1-10 and A1-11). The extreme thickness of the interval of elevated gamma activity in Well E26-7 relative to that of detected other, nearby wells suggests that the well bore itself may be a conduit for downward migration of radionuclides (Figure A1-12). The increase in activity from 1968 levels measured in Well E26-7 in 1976 while all of the other wells monitoring the 216-A-24 Crib had lower levels of activity is further evidence that Well E26-7 may be improperly constructed (Figure A1-13).

Currently there is no evidence that gamma emitters reach the water table under the 216-A-24 Crib. However, levels of activity well above background levels were detected within the Ringold Formation in 1958 (Figures A1-10, A1-11 and A1-13). The proximity of elevated radiation levels to the water table suggests that radionuclides may have reached the groundwater under this crib.

There is no evidence of gamma emitters from the 216-A-29 Ditch in the subsurface. Only background levels of gamma radiation have been detected in Wells 299-E25-28 and 699-43-45.

A-1.4.6 216-A-9 CRIB AND 216-A-40 TRENCH

Evaluation of Scintillation Probe Profiles:

Both the 216-A-9 Crib and the 216-A-40 Trench are located within the 200-PO-1 Operable Unit, west of the 241-A and 241-AX Tank Farms. The 216-A-9 Crib is monitored by Wells E24-3, -4, -5, and -63. The 216-A-40 Trench is monitored by the E27-3 well, located about 45.7 m (150 ft) off the northern end of the trench. Details of the monitoring wells and scintillation probe profiles used in this evaluation are given in Table A-1.7.

The 216-A-9 Crib has been evaluated in the past by Fecht et al. (1977) and Chamness (1986). No previous evaluations are available for the 216-A-40 Trench. Fecht et al. (1977) reported that the region of elevated gamma radiation under the 216-A-9 Crib detected in 1963 had declined to near background levels by 1976. Chamness (1986) found no further change in the conditions under the 216-A-9 Crib in the profile from well E24-63 collected in 1986. The conclusions of the current evaluation does not differ from those of the previous studies.

The scintillation probe profiles from the wells monitoring the 216-A-9 Crib were compiled into a cross section and correlated with the stratigraphic column available from Well E24-5 (Lindsey et al. 1992) (Figure A1-14). The well monitoring the 216-A-40 Trench was also correlated with the stratigraphic column for Well E24-5 (located about 230 m or 750 ft to the south-southwest) (Figure A1-14). Although Well E24-5 is within the area evaluated, the lithographic correlations are only fair because the changes in lithology have very subtle or no expression on the scintillation profiles, and the regional mapping of Lindsey et al. (1992) is not detailed on the scale used in this evaluation.

Currently, there is no evidence of elevated gamma radiation beneath the 216-A-9 Crib and the 216-A-40 Trench. Based upon the regional dip of the top of the Hanford sand (Lindsey et al. 1992), which probably controls the lateral distribution of radionuclides from the waste management units, the wells near the 216-A-9 Crib are well placed to detect the presence of gamma emitters in the subsurface. Although the well monitoring the 216-A-40 Trench is also down dip, it may be too far from the trench (45.7 m or 150 ft off the northern end of the trench) to detect any gamma emitters from the trench.

A-1.4.7 216-A-30, -37-1, -37-2, AND -42 CRIBS

Evaluation of Scintillation Probe Profiles:

The 216-A-30, -37-1, and -37-2 Cribs and the 216-A-42 Retention Basin are located within the 200-PO-4 Operable Unit. Each of these 4 units are active. The 216-A-30 Crib is monitored by Wells E16-2, E25-11, -12 (01-30-06), -190 (01-30-11), -191 (01-30-23) and -193 (01-30-03) (Fecht et al. 1977; Welty and Vermeulen 1989). The 216-A-37-1 Crib is

monitored by Wells E25-17, -18 (01-37-11), -19 (01-37-05), and -20 (Welty and Vermeulen 1989). Well E25-17 is also in a location suitable to monitor the 216-A-42 Retention Basin. The 216-A-37-2 Crib is monitored by Wells E25-21, -22 (01-37-22), -23 (01-37-17), and -24 (Welty and Vermeulen 1989). The location of the 216-A-37-2 Crib does not agree with that shown by Welty and Vermeulen (1989).

Scintillation probe profiles have been collected for most of these wells by PNL or Westinghouse's TFSA&S. Wells E25-12, -17, -18, -190, -191, and -193 are currently logged by TFSA&S on a semi-annual basis (Welty and Vermeulen 1989). Well E25-19 has been taken out of service (Welty and Vermeulen 1989). The PNL has logged Wells E16-2, E25-17, -18, -19, and -20. Wells E25-37 and -38, which are northwest of the 216-A-30, -37 and -42 Crib area, have also been logged by PNL. There are no profiles available for the wells monitoring the 216-A-37-2 Crib (Wells E25-21, -22, -23, and -24). Details of the monitoring wells and the logs used in this evaluation are given in Table A1-8.

The only available previous evaluation of scintillation probe profiles from the monitoring wells in the 216-A-30, -37, and -42 area is that of Fecht et al. (1977) for the 216-A-30 Crib. They found that the low levels detected in 1963 had declined to near background levels. They found no evidence of radionuclide migration beneath the 216-A-30 Crib and concluded that breakthrough to the groundwater had not occurred. The present evaluation does not address the issue of the 1963 contamination since levels had reached background by 1976 and there is no evidence of migration of radionuclides.

Scintillation probe profiles from Wells E16-2, E25-12, -17, -18, -19, -190, -191, and -193 were compiled into two cross sections (Figure A-15). These cross sections were roughly correlated with the stratigraphy from Wells E17-12 and E26-6 (Lindsey et al. 1990), located 1,130 m (3,720 ft) east and 820 m (2,700 ft) north, respectively, and with the regional mapping of Lindsey et al. (1990). This correlation must be considered poor since the wells are very far from the area evaluated, the mapping of Lindsey et al. (1990) is not detailed on the scale used and the lithologic boundaries do not have a clear signature on the gamma logs in this area.

Low to moderate levels of gamma radiation is detected under the 216-A-30 Crib (Figure A1-12). The potential extent and thickness of the region of elevated gamma radiation is shown in Figure A1-16. The top of this plume corresponds to the base of the 216-A-30 Crib, within the Hanford Upper Gravel and the base of the plume is at or near the top of the Hanford Sand (Figure A1-12). The northwesterly location of this plume relative to the 216-A-30 Crib implies that the lateral migration of radionuclides during emplacement is controlled by the regional dip of the top of the Hanford Sand (Lindsey et al. 1990).

There is evidence that the region of elevated gamma radiation under the 216-A-30 Crib is currently migrating in a vertical direction. The peaks on the scintillation profiles from wells E25-190, -191, and -193 have broadened and moved downward 0.3 to 1.5 m (1 to 5 ft) in the 8 years between 1982 and 1990 (Figure A1-12).

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Background levels of gamma radiation were detected in the vicinity of the wells monitoring the 216-A-37-1 Crib and 216-A-42 Retention Basin. The wells monitoring these structures are well placed to detect any laterally migrating radionuclides (assuming the 216-A-42 Retention Basin is properly located) given the northwesterly dip of the top of the Hanford Sand in this area and the behavior of the contaminant plume from the 216-A-30 Crib.

Since there are no scintillation probe profiles available for the wells monitoring the 216-A-37-2 Crib, no evaluation could be done of this active unit.

A-1.4.8 216-A-45 CRIB

Evaluation of Scintillation Probe Profiles:

The 216-A-45 Waste Management Unit is an active crib monitored by Wells E25-12, -13, -53 (01-45-04) and -54 (01-45-10). Wells E25-53 and 54 are logged by TFSA&S on a semi-annual basis (Welty 1988). Wells E25-12 and -13 were last monitored by PNL in 1986, prior to the commencement of waste disposal activities. Details of the monitoring wells and scintillation probe profiles used in this evaluation are given in Table A1-9.

Scintillation probe profiles from the wells monitoring the 216-A-45 Crib have not been previously evaluated.

Scintillation probe profiles from Wells E25-53 and E25-54 were compiled into a cross section and roughly correlated with a stratigraphic column for Well E25-12 (Lindsey et al. 1992) (Figure A1-17). Since the scintillation probe profile for E25-12 was collected before wastes were placed in the 216-A-45 Crib, it represents background conditions in the subsurface. Subtle changes in the profile for Well E25-12 correspond to the top of the Hanford sand, the top of the Hanford lower gravel and the top of the Ringold Formation (Figure A1-17). Internal facies changes of these lithologic units are not expressed on the gamma logs.

Elevated gamma radiation (2 to 3 times background levels) is evident in Wells E25-53 and E25-54 from a depth of about 12.2 m (40 ft) to the bottom of the wells (Figure A1-17). The top of the elevated radiation corresponds to the base of the crib and to the top of the Hanford sand. A secondary peak appears to be developing at a depth of about 32 m (105 ft) in Well E25-53. This can be correlated with the top of a silty interval within the Hanford sand.

The vertical extent of elevated gamma radiation beneath cannot be determined from these data since Wells E25-53 and E25-54 do not penetrate the region of elevated activity and no current scintillation probe profiles are available for Wells E25-12 and E25-13. However,

assuming that background conditions existed in the subsurface before waste disposal activities commenced, the current interval of elevated radiation detected in wells E25-53 and E25-54 is good evidence of vertical migration of radionuclides.

Although the lateral extent of contaminants in the 216-A-45 Crib area cannot be determined from these data, the potential for lateral migration can be assessed. Such migration is likely to be controlled by the dip direction of the top of the Hanford sand and the silty interval within the Hanford sand. The top of the Hanford sand is dipping to the northeast according to the regional mapping of Lindsey et al. (1992). Since the top of the Hanford Sand is an erosional surface, the dip direction of the silty interval within the Hanford sand cannot be determined from the mapped data.

A-1.4.9 241-A TANK FARM AREA

Evaluation of Scintillation Probe Profiles

The 241-A Tank Farm is located within the 200-PO-3 Operable Unit, northeast of the PUREX Chemical Separations Facility. Each of the 6 single-shell tanks in the 241-A Tank Farm has a capacity of 1,000,000 gal. All of these tanks were removed from service by 1980, and have been initially stabilized. Each tank has a status of interim isolated or partially interim isolated. Tanks 241-A-104 and 241-A-105 have been categorized as confirmed leakers (Welty 1988) (assumed leakers in Hanlon 1991) and tank 241-A-103 as an assumed leaker (Hanlon 1991; Welty 1988). Vapors from these tanks are processed along with those from the 241-AZ Tank Farm in the 241-AX facilities and routed to the 241-A or 241-AX Tank Farm tanks or are disposed of in the 216-A-24 Crib.

There are 7 outlying monitoring wells around the 241-A Tank Farm, 3 of which reach the water table. Tank 241-A-101 is monitored by 11 drywells, and by one well that reaches the water table (E25-1, 10-01-05). Tanks 241-A-102, -103, -104, -105, and -106 are monitored by 7 drywells each. The wells that are used to monitor the subsurface gamma activity in the 241-A Tank Farm are periodically logged by TFSA&S. Only 1 well, E24-65, is not logged by TFSA&S. This well was logged once by PNL in 1987. Details of each monitoring well within the 241-A Tank Farm are given in Table A-1.10.

The wells used in this evaluation were selected based upon their historic activity as reported by Welty (1988). Logs from wells in which activity above 50 ct/sec was reported (Welty 1988) and logs from neighboring wells were used. It appears that elevated near surface activity was not always reported. It is possible that many wells where potential surface contamination was recorded may have been left out by the screening process used, so the extent of the near-surface region of elevated gamma radiation may not be adequately characterized in this evaluation.

Scintillation probe profiles from selected monitoring wells within the 241-A Tank Farm were compiled into five cross sections and correlated with the lithologic cross sections

of Price and Fecht (1976) (Figures A1-18, A1-19, and A1-20). The correlation between features on the scintillation probe profiles and the lithologic sections of Price and Fecht (1976) were good.

The stratigraphy of the 241-A Tank Farm area can be divided into 3 units. The shallowest of these is the poorly sorted backfill composed of native material, which was used to fill the excavation where the tanks were placed (Price and Fecht 1976). The fill extends from the local surface grade to the base of the tanks, at a depth of about 16.8 m (55 ft). The fill material is composed of poorly sorted, slightly silty, pebbly, very coarse to coarse sand (Price and Fecht 1976). Beneath the backfill, a pebbly facies of the Hanford sand is found that reaches depths of 29 to 38.1 m (95 to 125 ft) below the surface. This pebbly facies is composed of interfingering lenses of pebbly material with varying amounts of silt and grain distributions of sand. Occasionally, well sorted lenses of sandy material, with no pebbles, are found (Price and Fecht 1976). Beneath the pebbly facies, a relatively homogenous sandy facies of the Hanford sand is found. This sandy facies grades laterally from slightly silty, coarse to medium sands and coarse to medium sands into slightly pebbly, very coarse to coarse sands and slightly silty coarse to medium sands in the southeastern part of the farm, under tank A-101 (Price and Fecht 1976). On the lithologic sections of Price and Fecht (1976), a "high" trending to the north is evident in the top of the sandy facies beneath tanks 241-A-102 and 241-A-103.

Significant levels of gamma radiation are detected at or near the ground surface, within the backfill and within the pebbly facies of the Hanford sand in several areas of the 241-A Tank Farm. The relationships between the depths and lateral extent of each occurrence of gamma emitters is complex. It appears that the near surface occurrences of elevated gamma radiation merge laterally over much of the area into two or three large areas (Figure A1-21). There may be several different sources of gamma emitters within these areas. At greater depths, there appears to be two areas where elevated gamma radiation is detected in the backfill, and three within the pebbly facies (Figure A1-22). These areas overlap to a certain extent and may merge in some places.

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A-1.4.10 241-AX TANK FARM AREA

Evaluation of Scintillation Probe Profiles

The 241-AX Tank Farm is located within the 200-PO-3 Operable Unit, northeast of the PUREX Chemical Separation Facility. Each of the 4 single-shell tanks in the 241-AX Tank Farm has a capacity of 1,000,000 gal. These tanks have been removed from service and the ventilation system isolated from other tank farms. The 241-101-AX Single-Shell Tank is monitored by 8 drywells, the 241-102-AX Single-Shell Tank by 11 drywells, the 241-103-AX Single-Shell Tank by 6 drywells, and the 241-104-AX Single-Shell Tank by 7 drywells. These wells are periodically logged by TFSA&S. Details of the wells monitoring the 241-AX Tank Farm tanks are given in Table A1-11.

Several of the wells monitoring the 241-AX Tank Farm tanks were compiled into four cross sections and correlated with the lithologic cross sections in Price (1976) (Figures A-1.23, 24, and 25). Subtle changes in the logs often correspond to changes in the grain size distribution of the sediments. There is a discrepancy between the location for Well E25-121 (11-04-07) on the as-built drawing (Welty 1988) and that of Price (1976), so that well was not used in any of the cross sections. The top of casing for each well in the 241-AX Tank Farm was scaled from the cross sections of Price (1976).

The stratigraphy of the 241-AX Tank Farm area can be divided into 3 units. The shallowest of this is the poorly sorted fill which envelops the tanks and consists of slightly pebbly, slightly silty coarse to fine sand (Price, 1976). At the base of the fill and the tanks, a pebbly facies of the Hanford sand is present. This pebbly facies is made up of discontinuous lenses of pebbly material with varying amounts of silt and grain distributions of sand. The top of the pebbly facies is at an elevation of about 190 m (625 ft) and its base dips in a westerly direction from an elevation of about 182 m (600 ft) to about 175 m (575 ft) (Price 1976). A relatively homogeneous sandy facies of the Hanford sand is found. This sandy facies consists of slightly silty, very coarse to medium sand with occasional lenses of relatively sandy or silty material (Price 1976).

Presently, there are eight areas of potential contamination by anthropogenic radionuclides within the 241-AX Tank Farm (Figure A1-26). In two of these areas, elevated gamma activity can be correlated between three or four adjacent wells. The remaining occurrences of elevated gamma radiation are isolated areas near single wells. In all of these areas, the gamma emitters detected are confined to the fill material. Activity is mainly found at or near the surface and declines to background levels with increasing depth. There is no evidence of elevated gamma radiation within the Hanford sand.

A-1.4.11 241-C Tank Farm

Evaluation of Scintillation Probe Profiles

The 241-C tank farm is located with in the 200-PO-3 operable unit, north of the PUREX Chemical Separation Facility. Twelve of the sixteen single shell tanks in the 241-C tank farm have a capacity of 533,000 gal., and the remaining four tanks have a capacity of 55,000 gal. These tanks have all been removed from service and have been partially or interim isolated. Tanks C-101, C-110 and C-112 are monitored by 4 drywells, tanks C-103 and C-111 by 5 drywells, tanks C-104 and C-107 by 7 drywells, tank C-105 by 9 drywells, tank C-106 by 6 dry wells and tank C-108 by 3 dry wells. No drywells are constructed to monitor tanks C-102, C-201, C-202, C-203 and C-204. However, the 11 drywells on the perimeter of the 241-C tank farm or wells which monitor neighboring tanks provide a degree of monitoring capability for these tanks. These wells are logged on a periodic basis by TFSA&S. Details of the wells monitoring the C-farm tanks and the scintillation probe profiles used in this evaluation are given in Table A1-12.

Scintillation probe profiles from several of the drywells in the C-farm were compiled into 5 cross sections and correlated with the lithologic cross sections of Price & Fecht (1976c) (Figures A1-27, A1-28, A1-29, A1-30 and A1-31). Although the response of the gamma logs to changes in lithology is often subtle, the correlation between the lithology and the gamma logs can be considered good due to the detail of the available lithologic information and the uniform response between the different vintages of logs used.

The stratigraphy of the C-farm area can be divided into three units. The shallowest of these is the poorly sorted fill which envelops the tanks and consists of gravelly, very coarse to medium sand and occasional silt (Price & Fecht, 1976). The base of the fill, and the tanks, is at an elevation of about 610 feet. Beneath the backfilled excavation for the tank farm, a pebbly facies of the Hanford sand is present. This pebbly facies consists of discontinuous lenses of pebbly material with varying grain size distributions. In the southern portion of the C-farm, there is a lens of slightly silty coarse sand which does not contain pebbles between deeper pebbly material and the backfill. The base of the pebbly facies sediments dip toward the south from an elevation of about 600 feet to about 560 feet across the tank farm. Beneath the pebbly facies of the Hanford sand, a relatively homogeneous sandy facies is found. This sandy facies is generally composed slightly silty, coarse to very coarse sand. Over much of the area, there is discontinuous lens, up to 30 feet thick, of slightly silty coarse to medium sands at the top of the sandy facies sediments. Also, at greater depths within the sandy facies, a lens of slightly pebbly material is present in the northern part of the tank farm (Price & Fecht, 1976).

Elevated gamma radiation is found within several regions in the fill, the pebbly facies and the sandy facies. There are three areas where elevated activity is detected at or near the surface (Figure A1-32). The sources of this near surface activity can be attributed to known surface contamination or to radionuclides contained within piping at or near the surface. There is clear evidence of downward migration of gamma emitters in all three of these areas. There are eight areas where elevated radiation is found within the backfill and the pebbly facies (Figure A1-33). Of these, two can be attributed to leaking tanks, five are related to near surface releases and one is of unknown origin (adjacent to tank C-109). The is evidence of downward migration of gamma emitters in seven of the eight occurrences of elevated activity within the fill and the pebbly facies. There are two occurrences of elevated radiation within the sandy facies. The levels of activity of these occurrences is very low and may not be statistically significant on some of the profiles where it is identified (Figures A1-29, A1-30 and A1-31). The source of one of these occurrences can be attributed to a leaking tank, the source of the other is unknown. There is no evidence of downward migration of radionuclides for either of these occurrences of elevated gamma radiation in the sandy facies.

A-1.5 REFERENCES

Additon, M.K., K.R. Fecht, T.L. Jones and G.V. Last, 1978, *Scintillation Probe Profiles 200 East Area Crib Monitoring Wells*, RHO-LD-28, Rockwell Hanford Operations, Richland, Washington.

9 3 1 2 8 6 7 0 7 1 9

Arthur, R.J., 1990, 1990 *Yearly Calibration of Pacific Northwest Laboratory's Gross Gamma Borehole Geophysical Logging System,* PNL-7460, Pacific Northwest Laboratory, Richland, Washington.

Brodeur, J.R., 1988, *Fiscal Year 1987 Inactive Crib Monitoring Report*, 80230-88-004, Westinghouse Hanford Company, Richland, Washington.

Brodeur, J.R. and C.J. Koizumi, 1989, *Base Calibration of Pacific Northwest Laboratory's Gross Gamma Borehole Geophysical Logging System,* WHC-EP-0246, Westinghouse Hanford Company, Richland, Washington.

Chamness, M.A., 1986, *Fisical Year 1986 Scintillation Logging Status,* 65633-86-107, Rockwell Hanford Operations, Richland, Washington.

Fecht, K.R., G.V. Last and K.R. Price, 1977, *Evaluation of Scintillation Probe Profiles from 200 Area Crib Monitoring Wells,* ARH-ST-156, Atlantic Richfield Hanford Company, Richland, Washington.

Hanlon, B.M., 1991, *Tank Farm Surveillance and Waste Status Report for July 1991*, WHC-EP-0182-40, Westinghouse Hanford Company, Richland, Washington.

Lane, K.A., 1990, *Requirements Analysis for Surveillance of Single Shell Tank Farm Vadose Zone*, WHC-SD-WM-RD-006, Westinghouse Hanford Company, Richland Washington.

Last, G.V., B.N. Bjornstad, M.P. Bergeron, D.W. Wallace, D.R. Newcomer, J.A. Schramke, M.A. Chamness, C.S. Cline, S.P. Airhart and J.S. Wilbur, 1989, *Hydrogeology of the 200 Areas Low-Level Burial Grounds - An Interim Report*, PNL-6820, Westinghouse Hanford Company, Richland, Washington.

Lindsey, K.A., B.N. Bjornstad, J. Lindberg and K. Hoffman, 1992, *Geologic Setting of the 200 East Area: An Update,* WHC-SD-EN-TI-02, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Price, W.H. and K.R. Fecht, 1976a, *Geology of the 241-A Tank Farm,* ARH-LD-127, Atlantic Richfield Hanford Company, Richland, Washington.

Price, W.H. and K.R.Fecht, 1976b, *Geology of the 241-AX Tank Farm*, ARH-LD-128, Atlantic Richfield Hanford Company, Richland, Washington.

Price, W.H. and K.R.Fecht, 1976c, *Geology of the 241-C Tank Farm*, ARH-LD-132, Atlantic Richfield Hanford Company, Richland, Washington.

Raymond, J.R. and V.L. McGhan, 1964, *Scintillation Probe Results - 200 Area Waste Disposal Site Monitoring Wells*, HW-84577, General Electric Company, Richland, Washington.

Strong, F.S., 1980, *Gamma Calibration Curves - Dry Well Van Probes, Drawing No. H-2-72449*, Rockwell Hanford Operations, Richland, Washington.

Tillson, D.D. and V.L. McGhan, 1969, *Changes in Scintillation Probe Findings - 1964 to 1968, 200 Area Waste Disposal Site Monitoring Wells*, BNWL-CC-2255, Battelle Pacific Northwest Laboratories, Richland, Washington.

Welty, R.K. and N.J. Vermeulen, 1989, *Waste Storage Tank Status and Leak Detection Criteria,* WHC-SD-WM-TI-357, Westinghouse Hanford Company, Richland, Washington.

Welty, R.K., 1988, *Waste Storage Tank Status and Leak Detection Criteria*, SD-WM-TI-356, Westinghouse Hanford Company, Richland, Washington.

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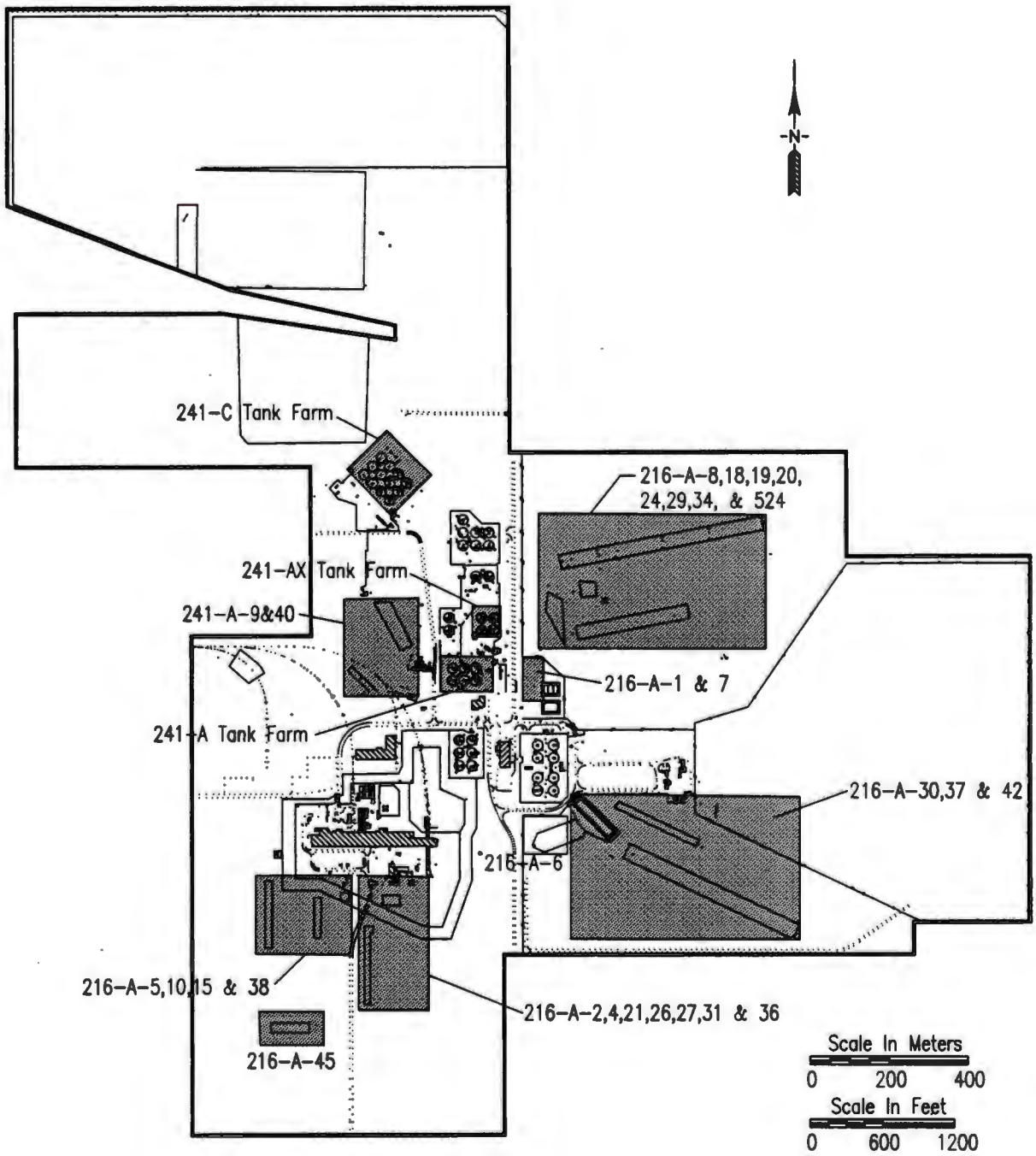
Figure A1-1. PUREX Plant Aggregate Area:
Waste Management Unit Areas Evaluated.



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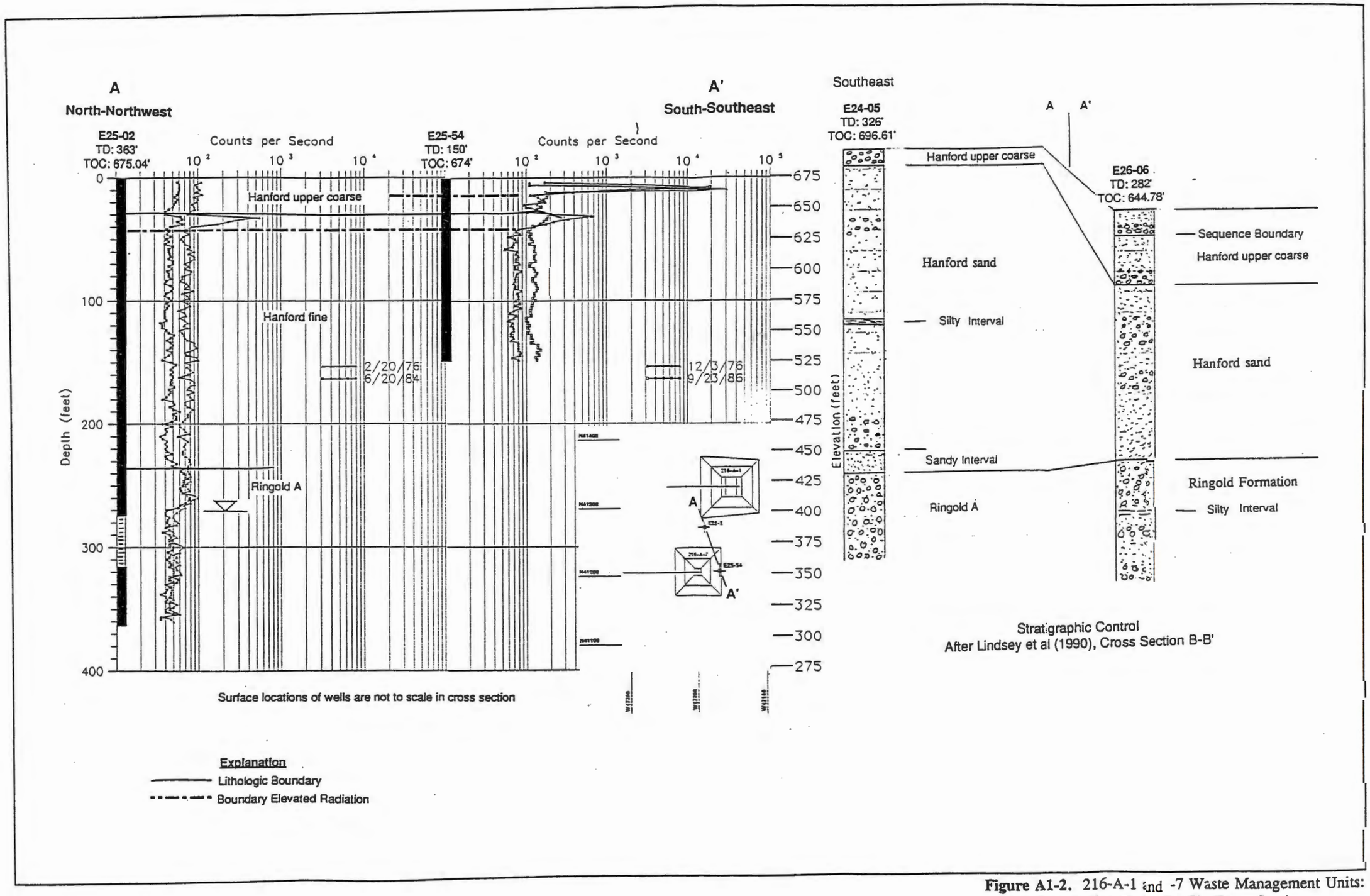

Figure A1-2. 216-A-1 and -7 Waste Management Units: Scintillation Probe Profile Cross Section.

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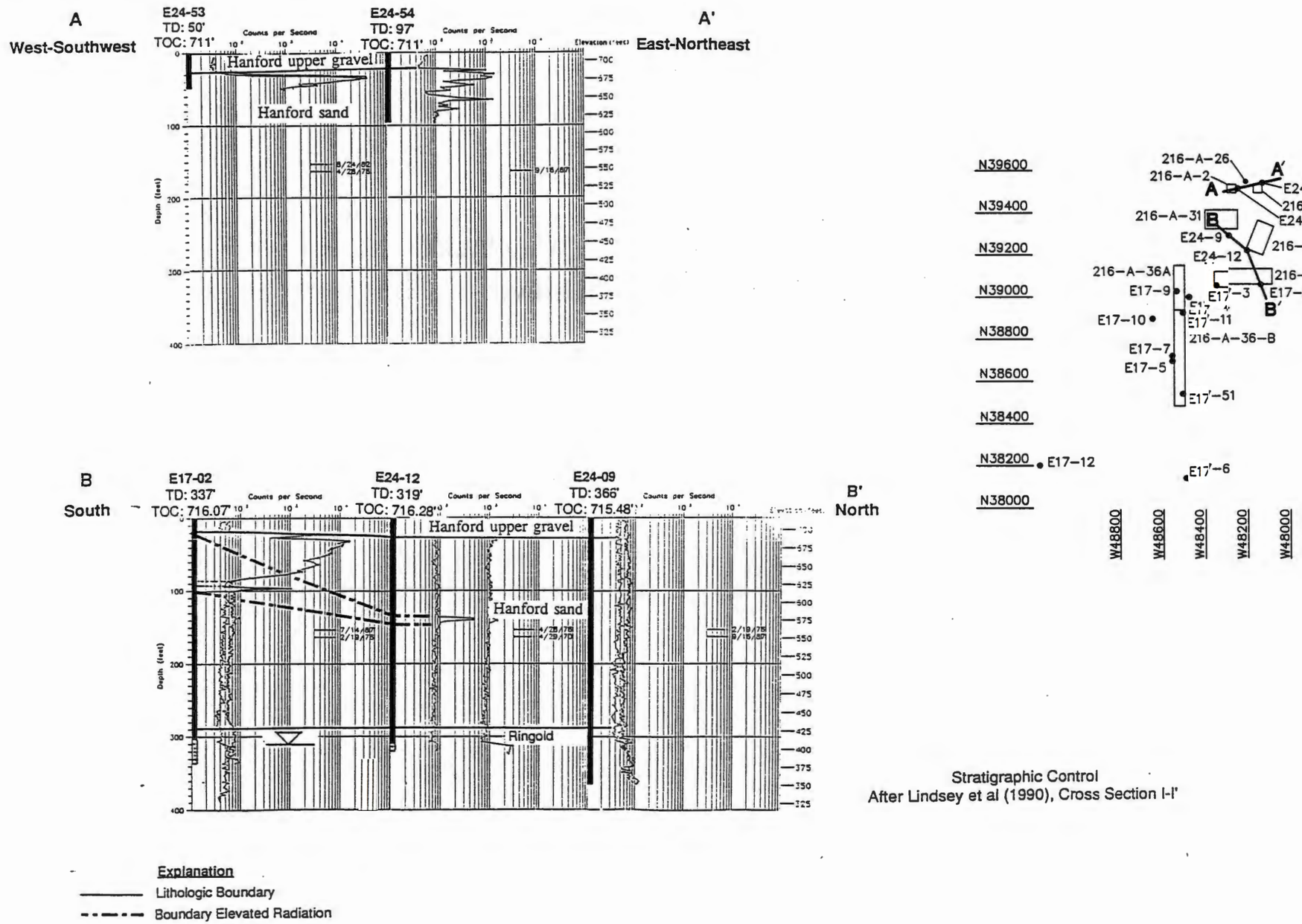

Figure A1-3. 216-2, -4, -21, -26, -27, -31, and -36 Waste Management Units: Scintillation Probe Profile Cross Sections A-A' and B-B'.

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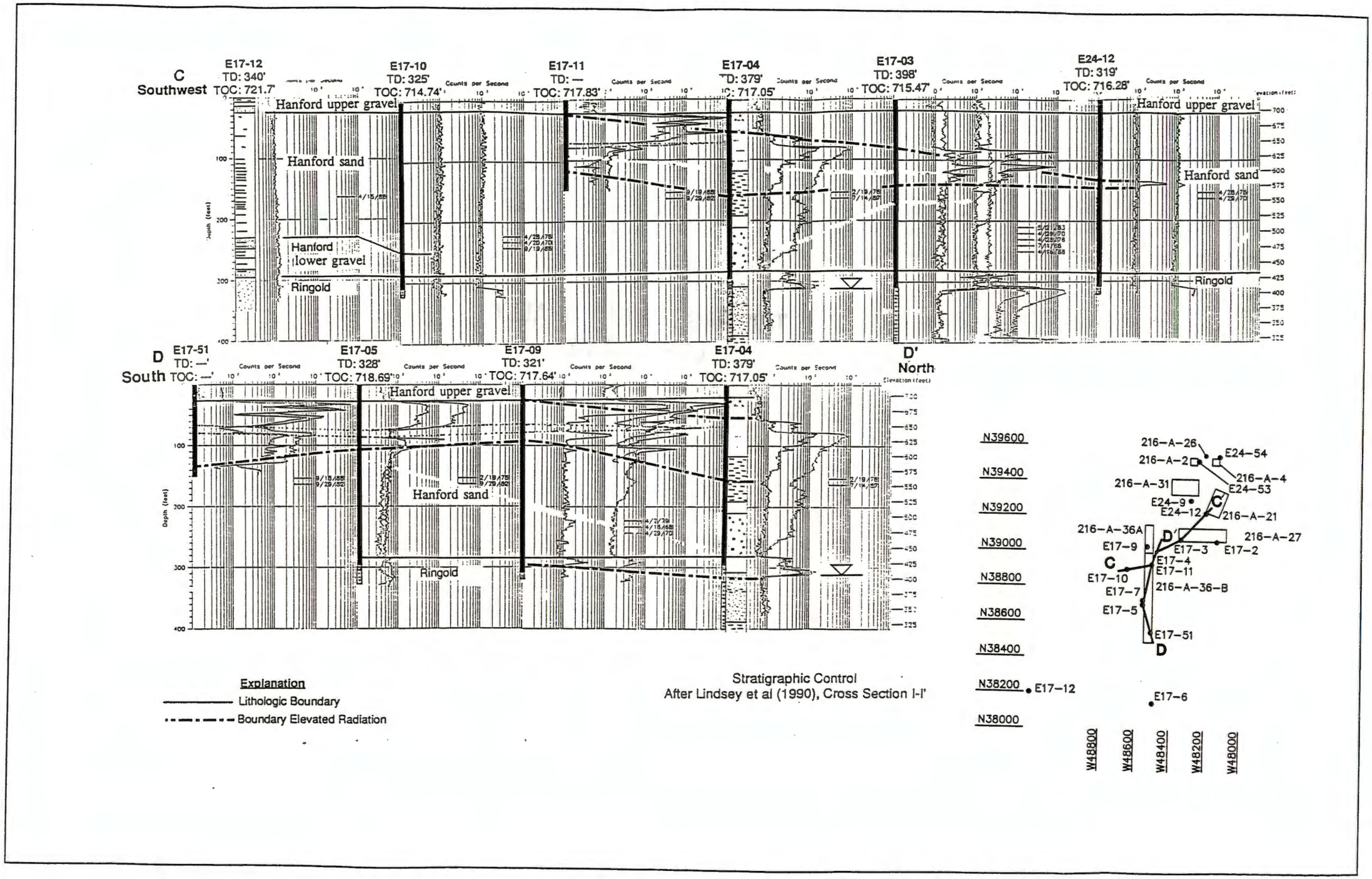

Figure A1-4. 216-2, -4, -21, -26, -27, -31, and -36 Waste Management Units: Scintillation Probe Profile Cross Sections C-C' and D-D'.

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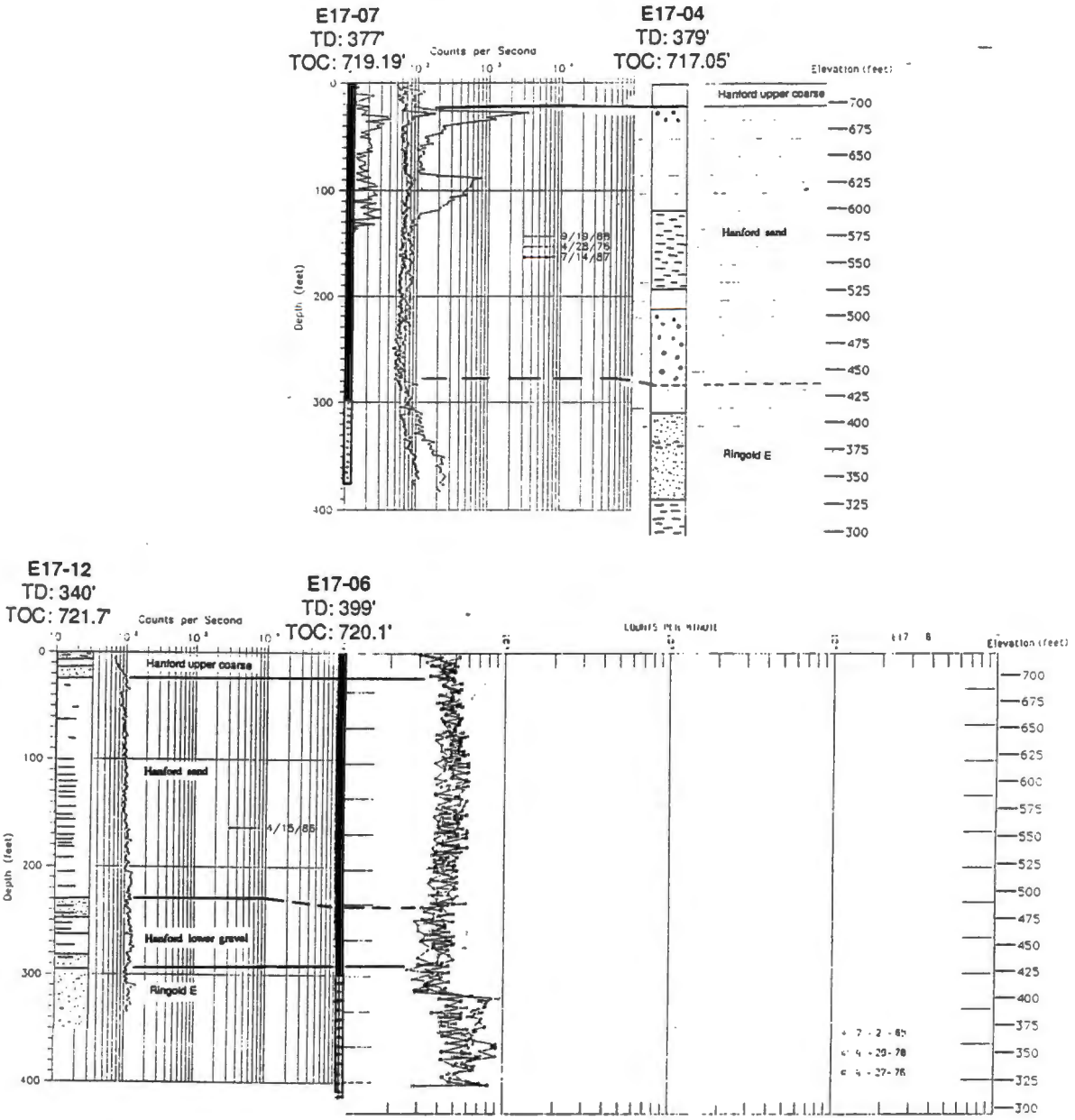
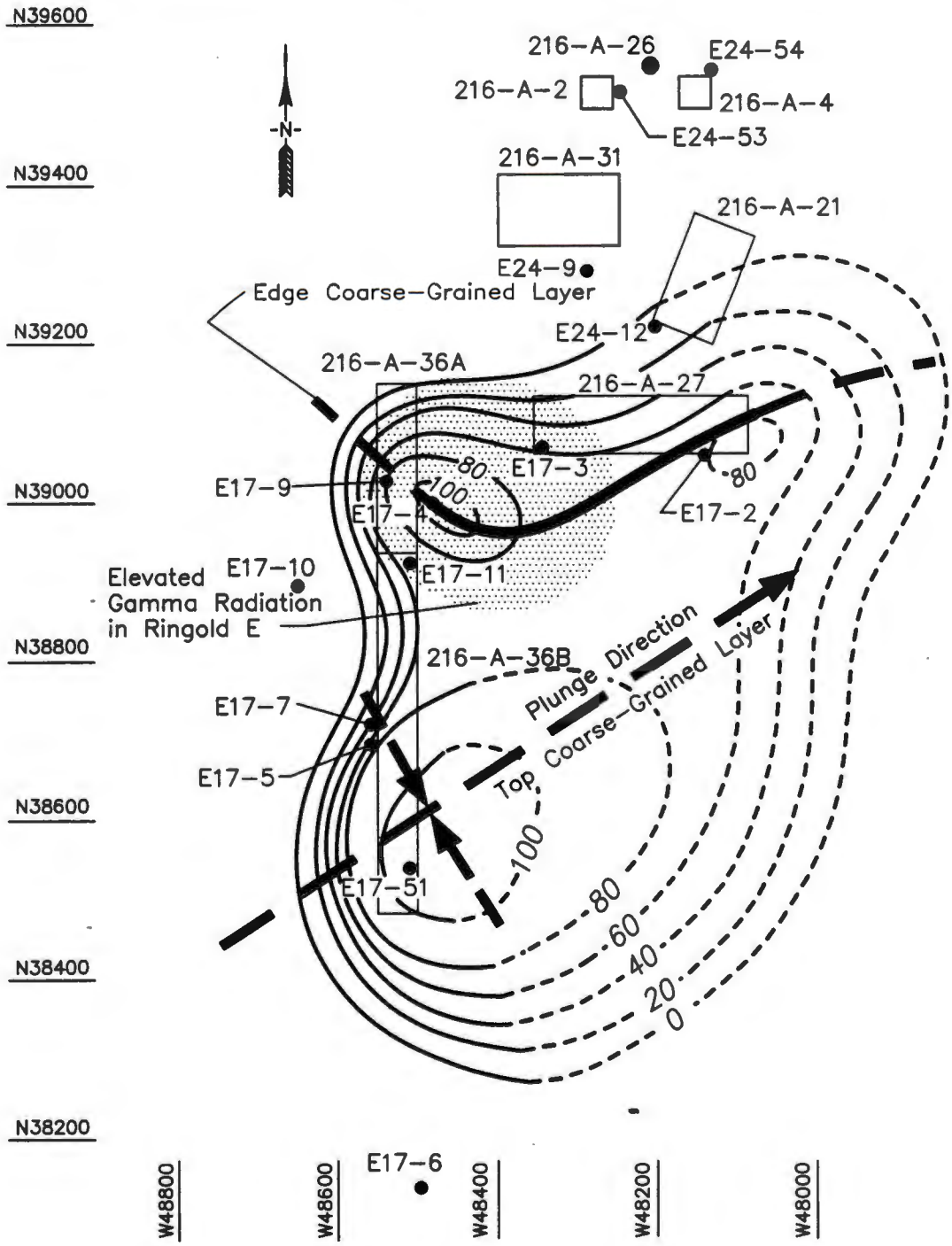
Figure A1-5. 216-A-2, -4, -21, -26, -27, -31, and -36 Waste Management Units: Additional Scintillation Probe Profiles.



Stratigraphic Control
After Lindsey et al (1990), Cross Section I-I'

Figure A1-6. 216-A-2, -4, -21, -26, -27, -31, and -36 Waste Management Units: Hanford Sand Elevated Gamma Radiation Isopach Map.



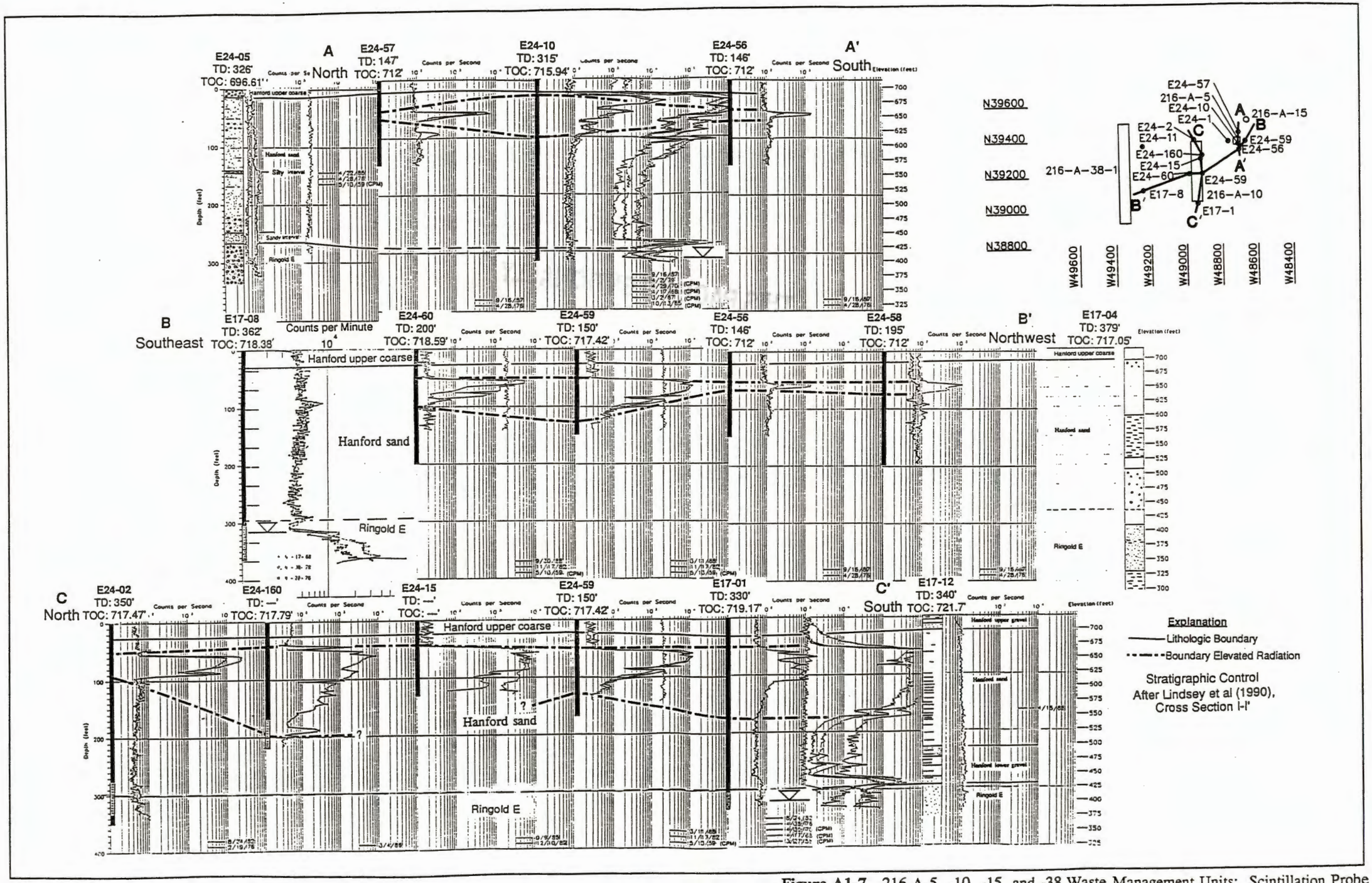


Figure A1-7. 216-A-5, -10, -15, and -38 Waste Management Units: Scintillation Probe Profile Cross Sections A-A', B-B', and C-C'.

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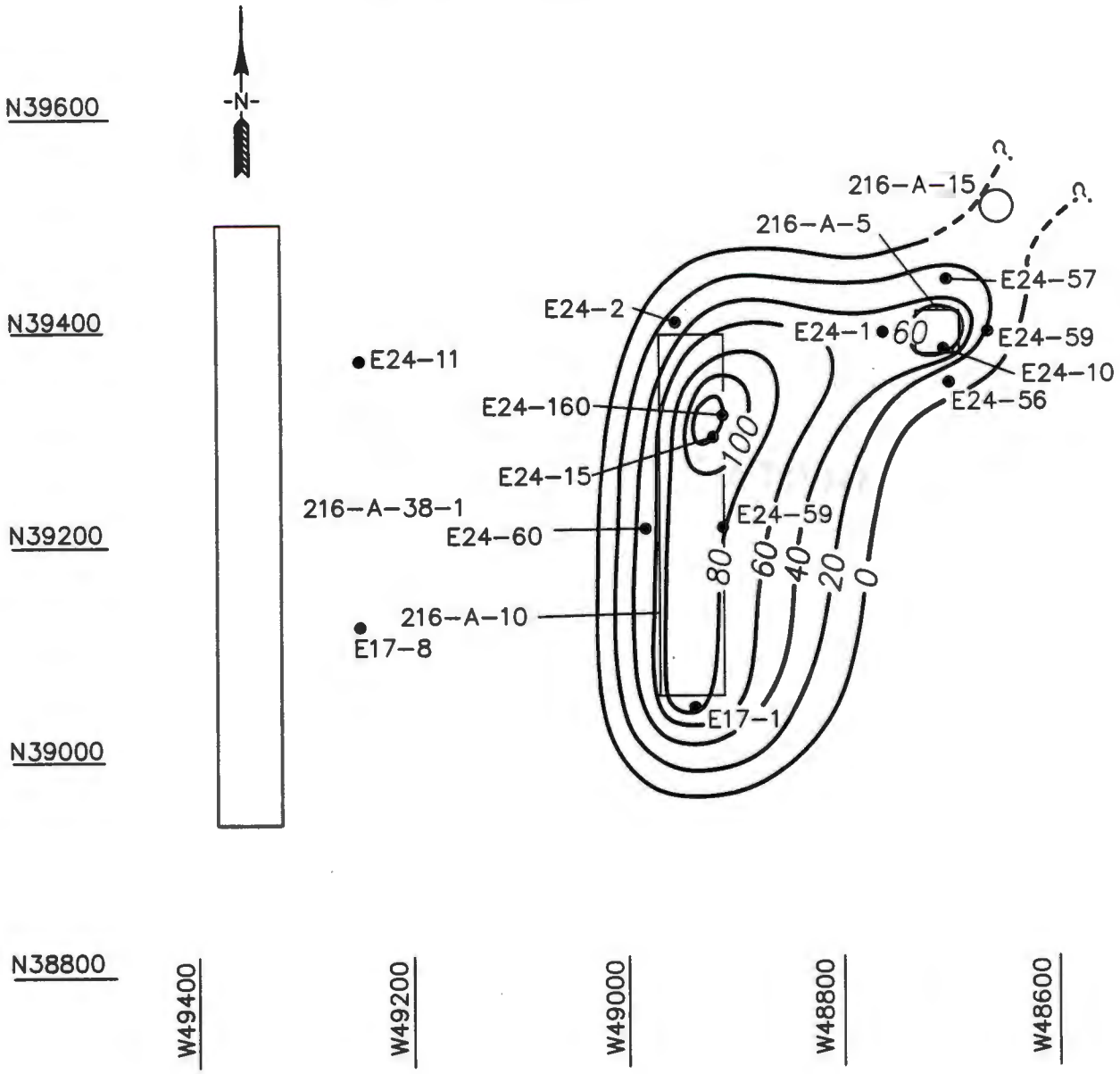
Figure A1-8. 216-A-5, -10, -15, and -38 Waste Management Units: Elevated Gamma Radiation Isopach Map.



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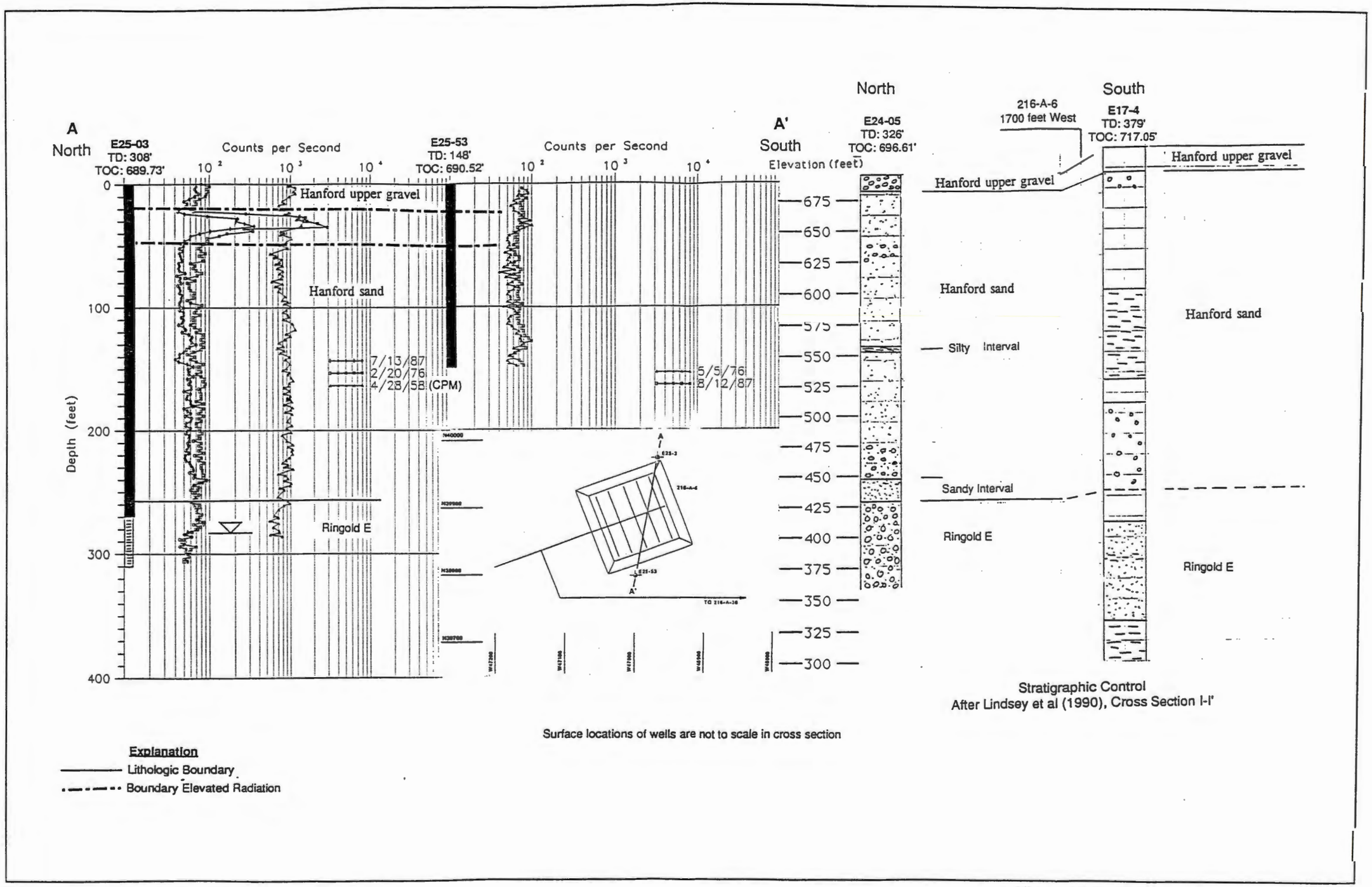

Figure A1-9. 216-A-6 Waste Management Unit: Scintillation Probe Profile Cross Section A-A'.

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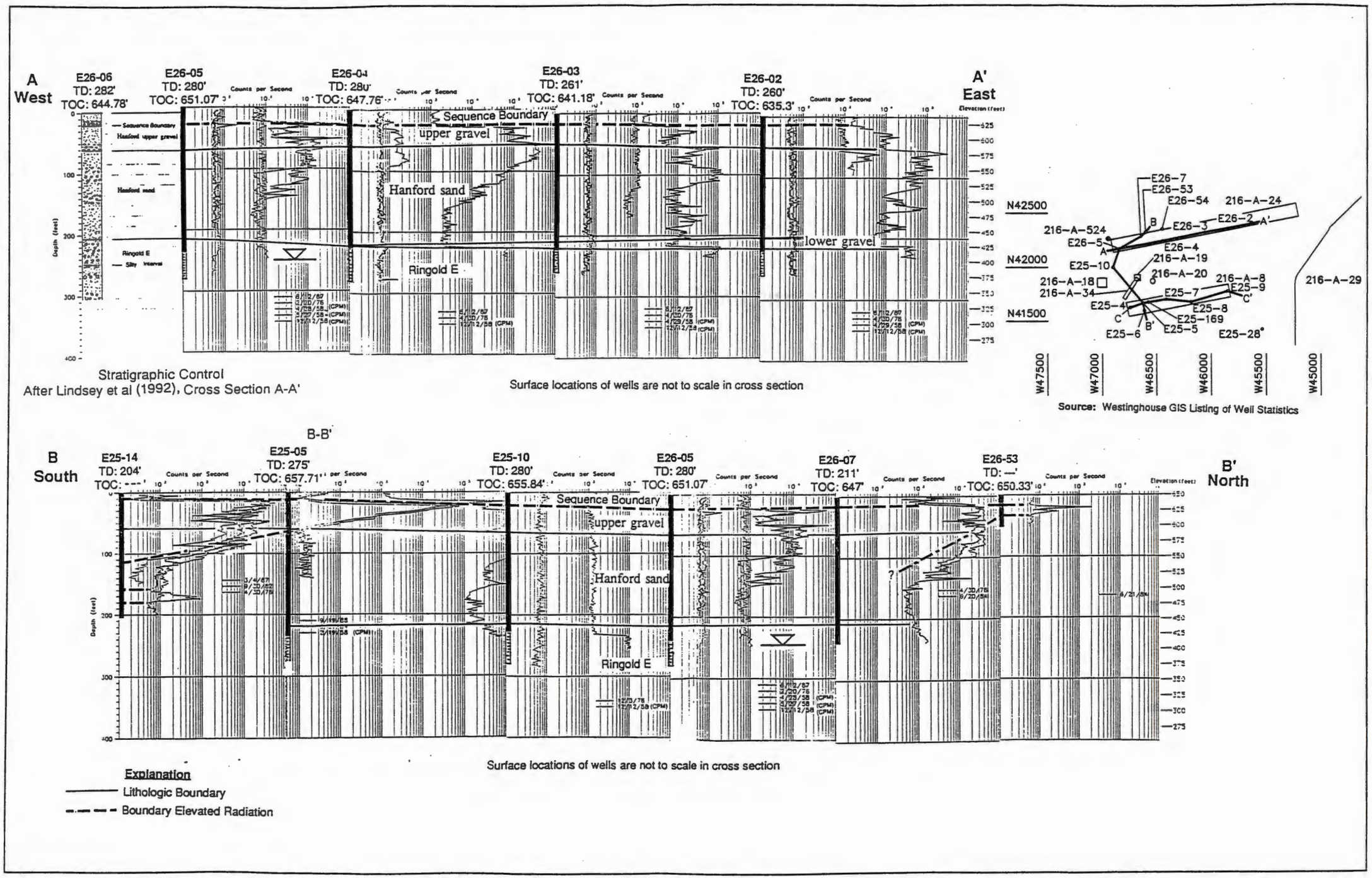

Figure A1-10. 216-A-8, -18, -19, -20, -24, -29, -34, and -524 Waste Management Units: Scintillation Probe Profile Cross Sections A-A' and B-B'.

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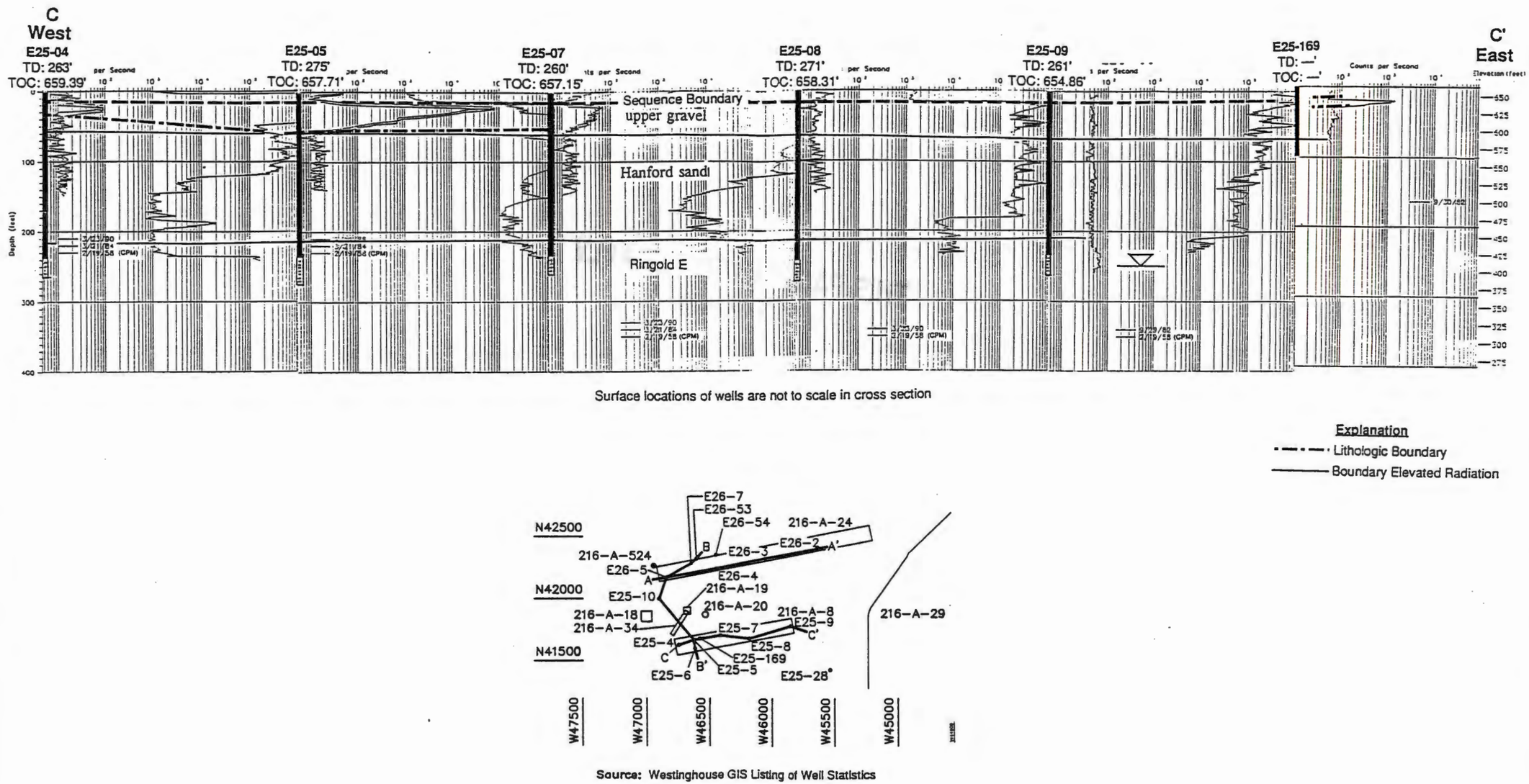

Figure A1-11. 216-A-8, -18, -19, -20, -24, -29, -34, and -524 Waste Management Units: Scintillation Probe Profile Cross Section C-C'.

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Figure A1-12. 216-A-8, -18, -19, -20, -24, -29, -34, and -524 Waste Management Units: Elevated Gamma Radiation Isopach Map.

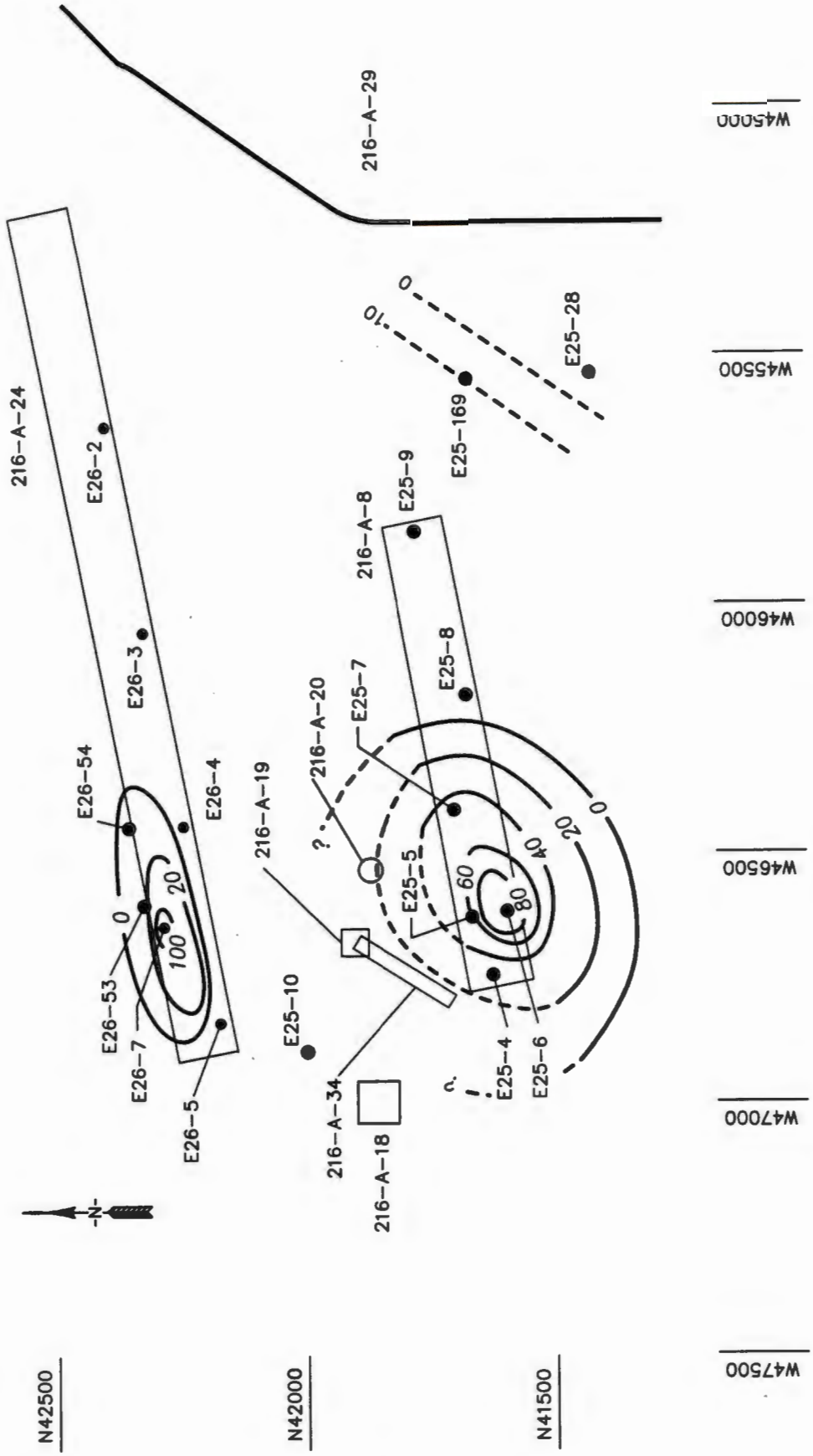

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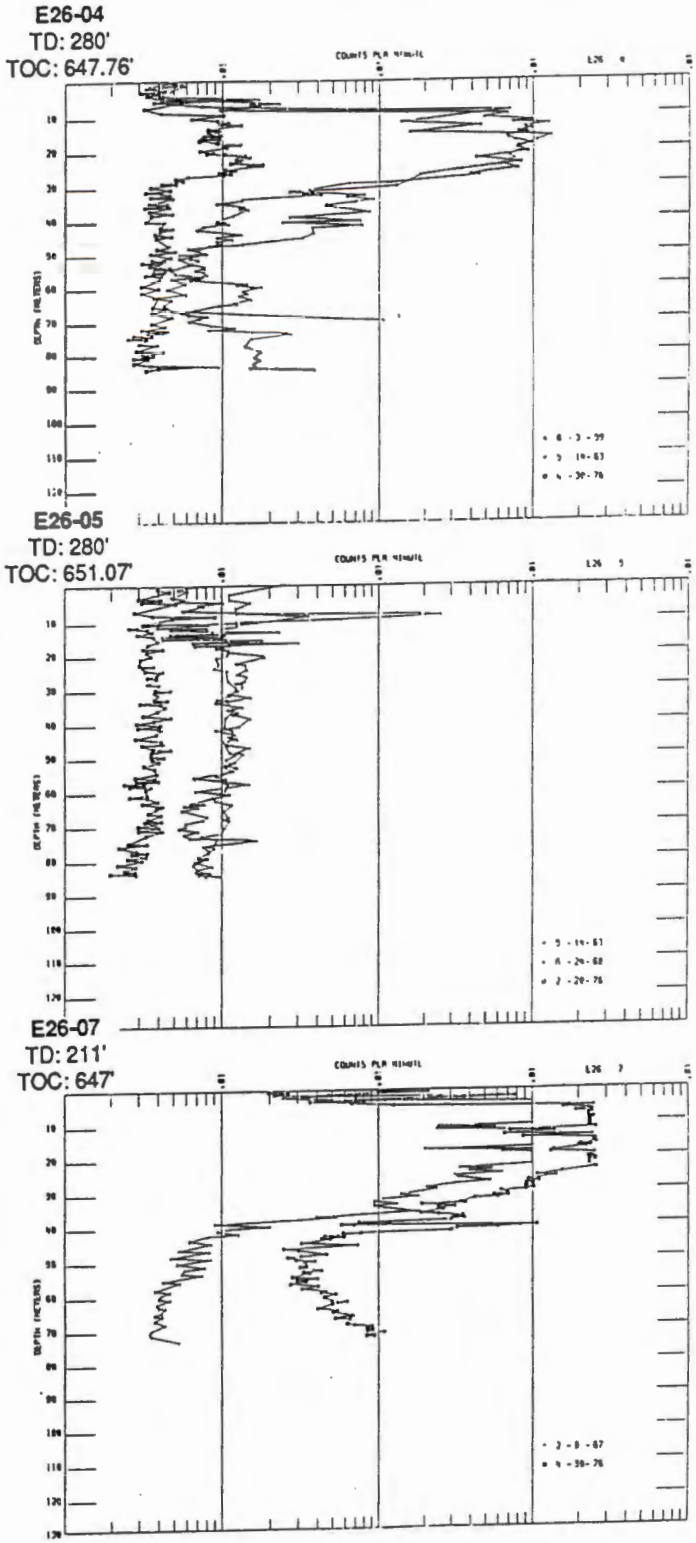
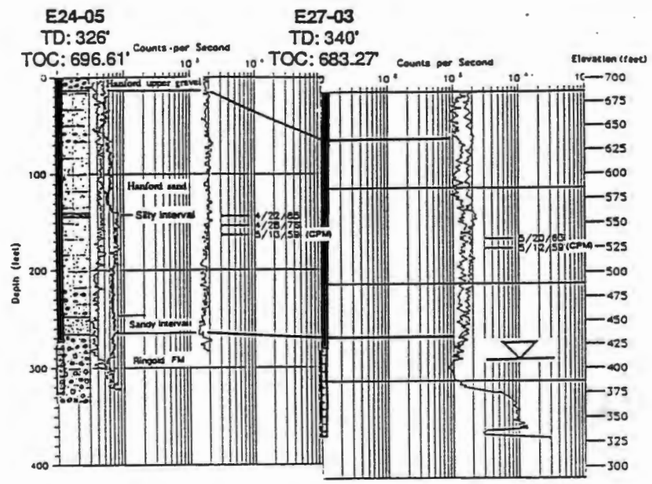
Figure A1-13. 216-A-24 Waste Management Unit: Change in Gamma Radiation Levels, 1968-1976.



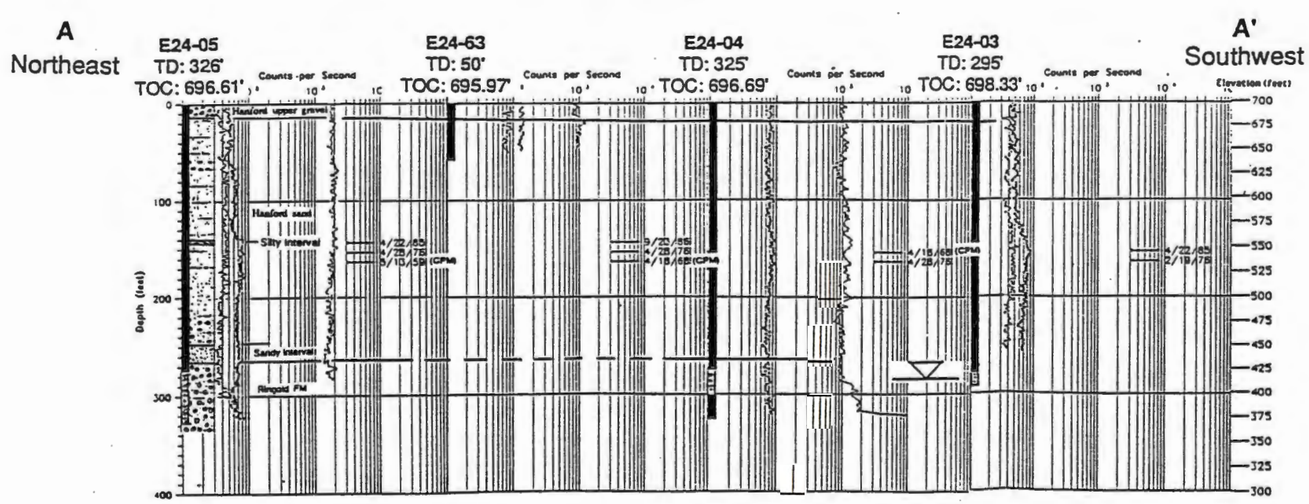
Both wells E26-4 and 5 show a decline in gamma radiation levels to background on the scintillation probe profiles collected between 1968 and 1976.

In well E26-7 there is an increase in the levels of gamma radiation from 1967 to 1976, after the waste disposal activities in the A-24 crib ceased. This is evidence of downward migration of radionuclides, possibly in the well bore. The water table is found at a depth of about 230 to 240 feet (70 to 73 meters)

9 3 1 2 8 ' 7 0 7 3 4



Surface locations of wells are not to scale in cross section

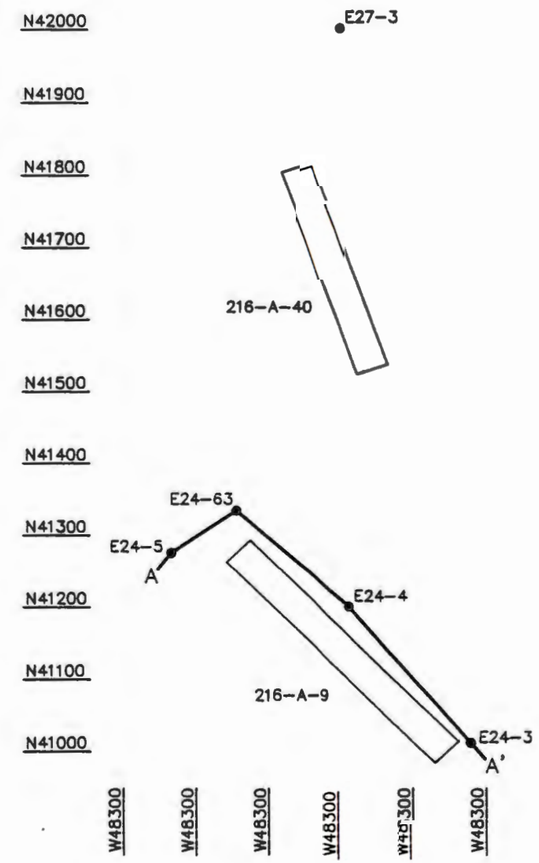


Surface locations of wells are not to scale in cross section

Explanation

Lithologic Boundary

Boundary Elevated Radiation



Stratigraphic Control
After Lindsey et al. (1992), Cross Sections
B-B' and I-I'

Figure A1-14. 216-A-9 and -40 Waste Management Units: Scintillation Probe Profile Cross Section A-A'.

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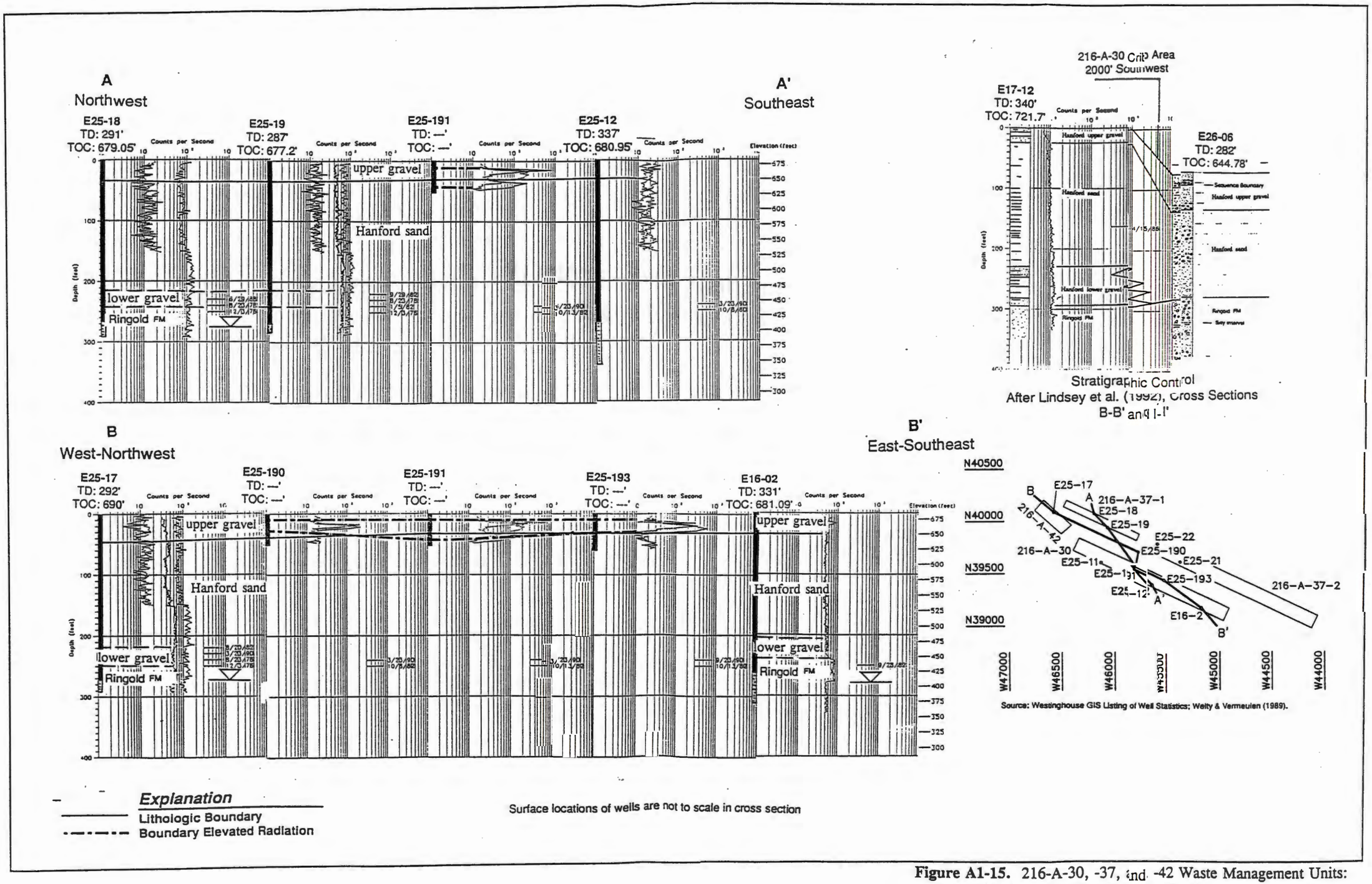

Figure A1-15. 216-A-30, -37, and -42 Waste Management Units: Scintillation Probe Profile Cross Section A-A' and B-B'.

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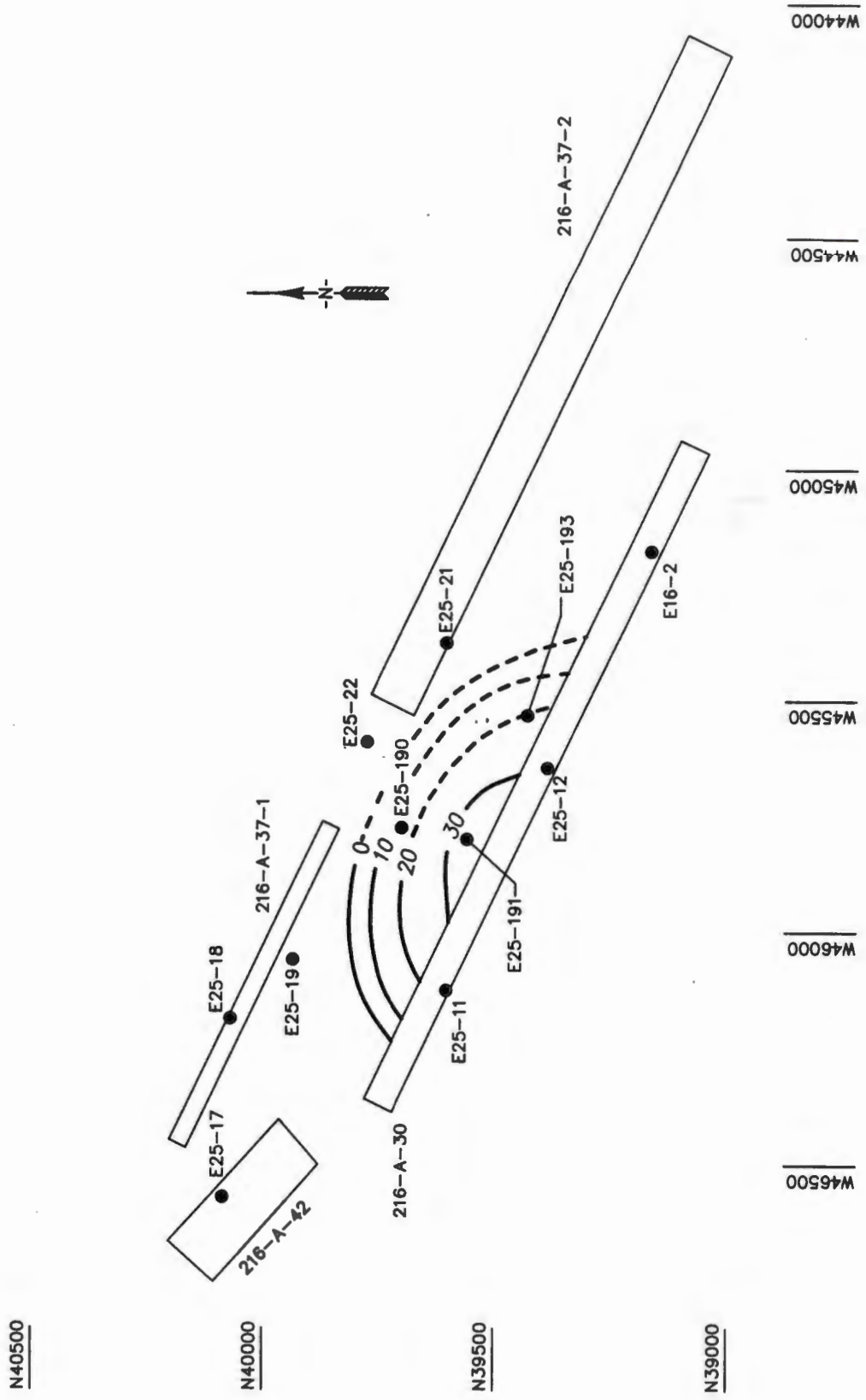
Figure A1-16. 216-A-30, -37, and -42 Waste Management Units: Elevated Gamma Radiation Isopach Map.



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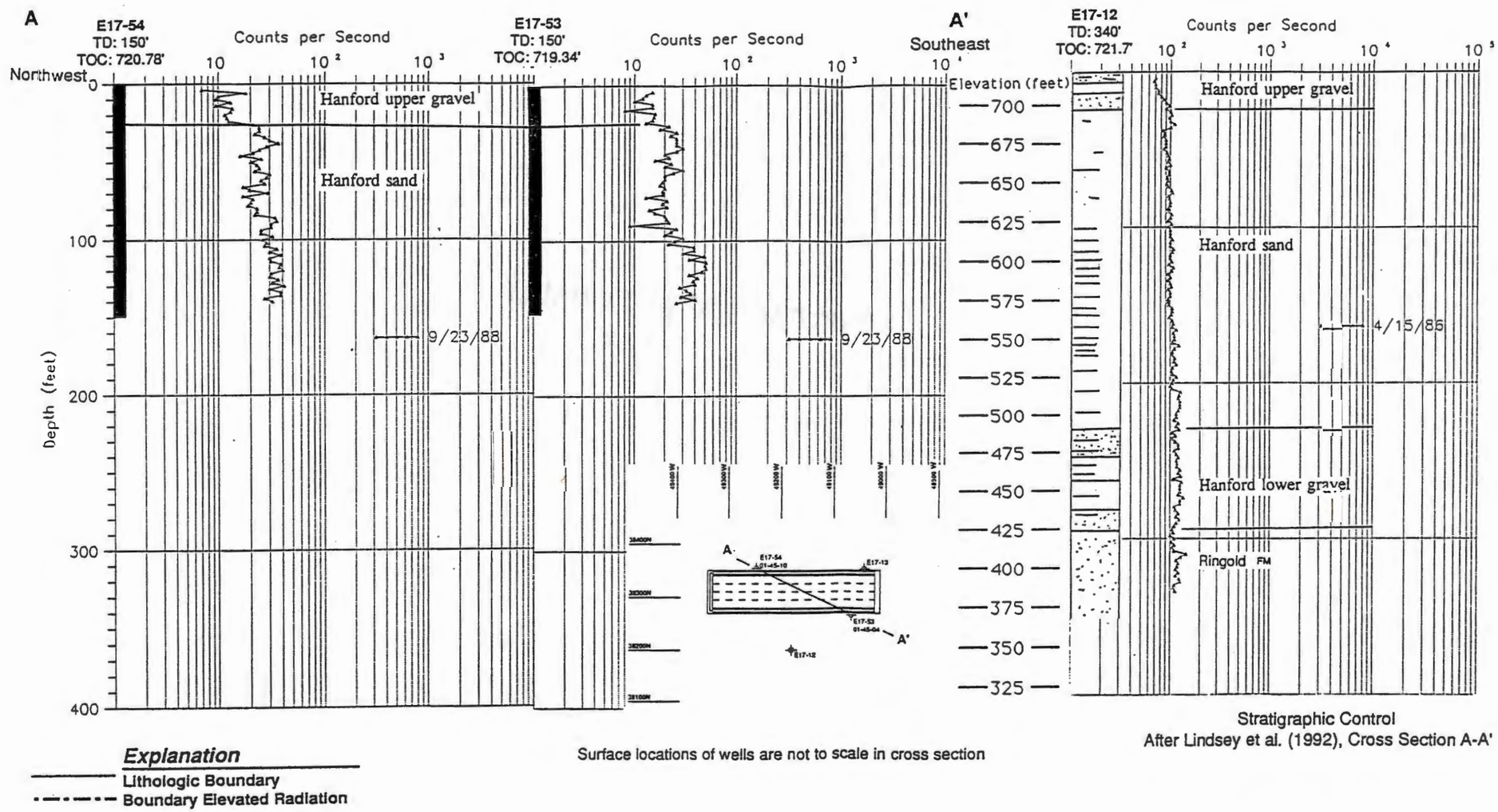

Figure A1-17. 216-A-45 Waste Management Unit: Scintillation Probe Profile Cross Section.

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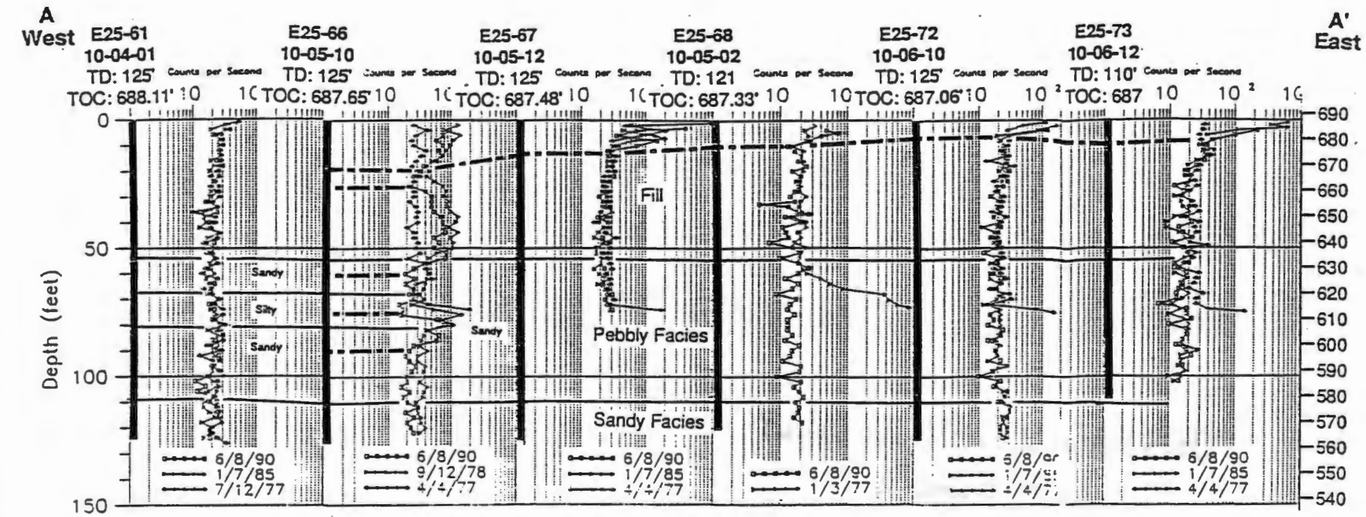
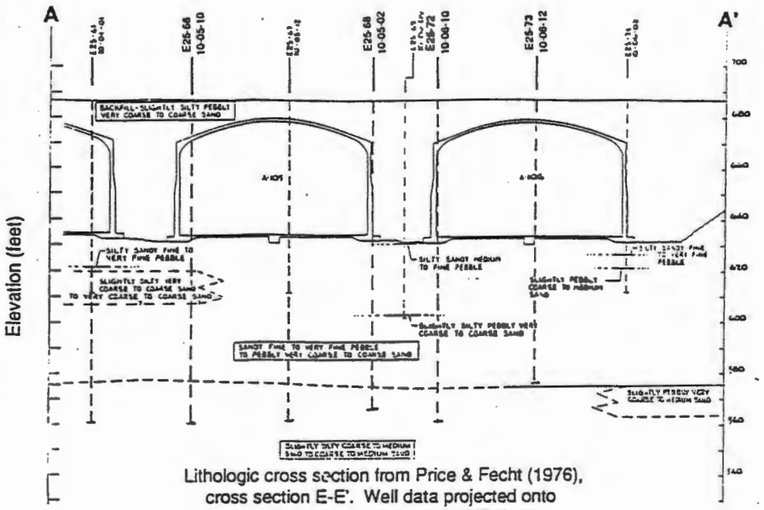
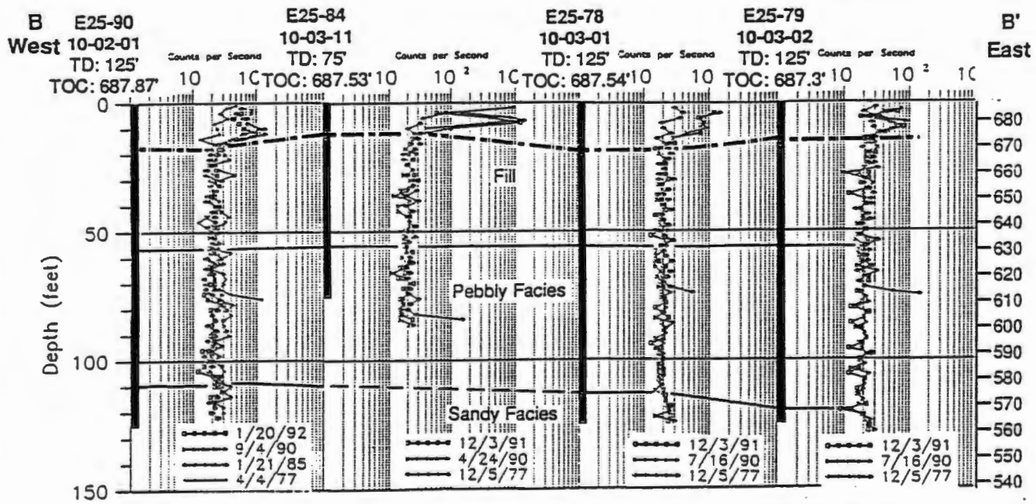


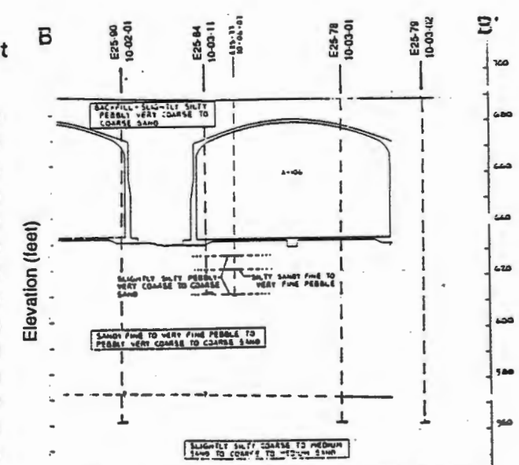
Surface locations of wells are not to scale in cross section



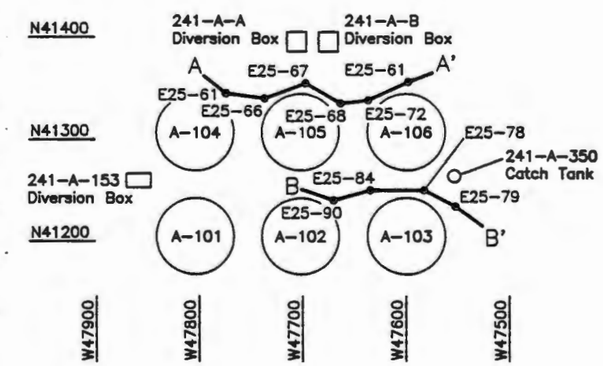
Lithologic cross section from Price & Fecht (1976), cross section E-E'. Well data projected onto east-west line of section at 41357 North.



Surface locations of wells are not to scale in cross section



Lithologic cross section from Price & Fecht (1976), cross section F-F'. Well data projected onto east-west line of section at 41255 North.



Explanation

Lithologic Boundary

Boundary Elevated Radiation

Figure A1-18. 241-A Tank Farm: Scintillation Probe Profile Cross Sections A-A' and B-B'.

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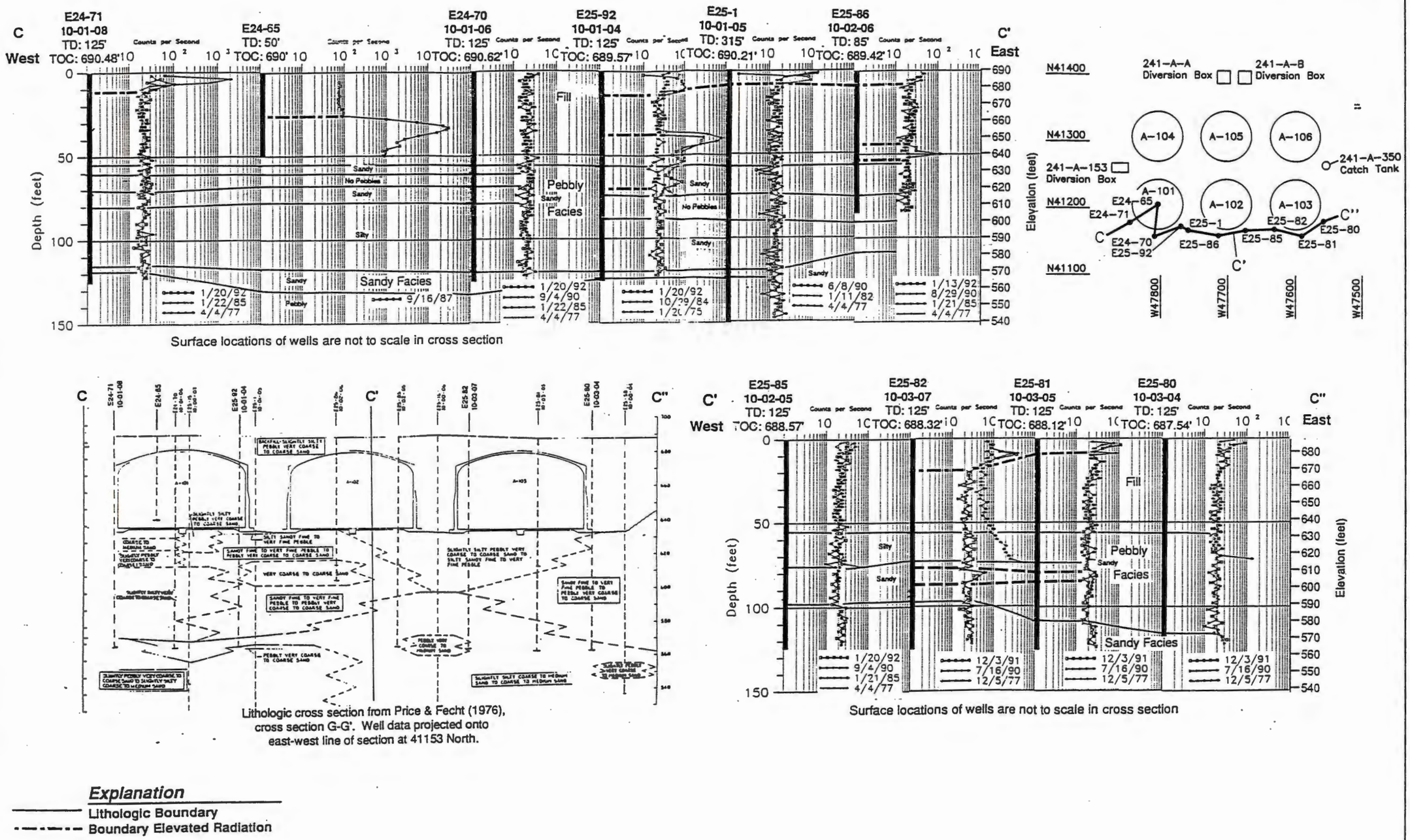

Figure A1-19. 241-A Tank Farm: Scintillation Probe Profile Cross Section C-C' and C-C''.

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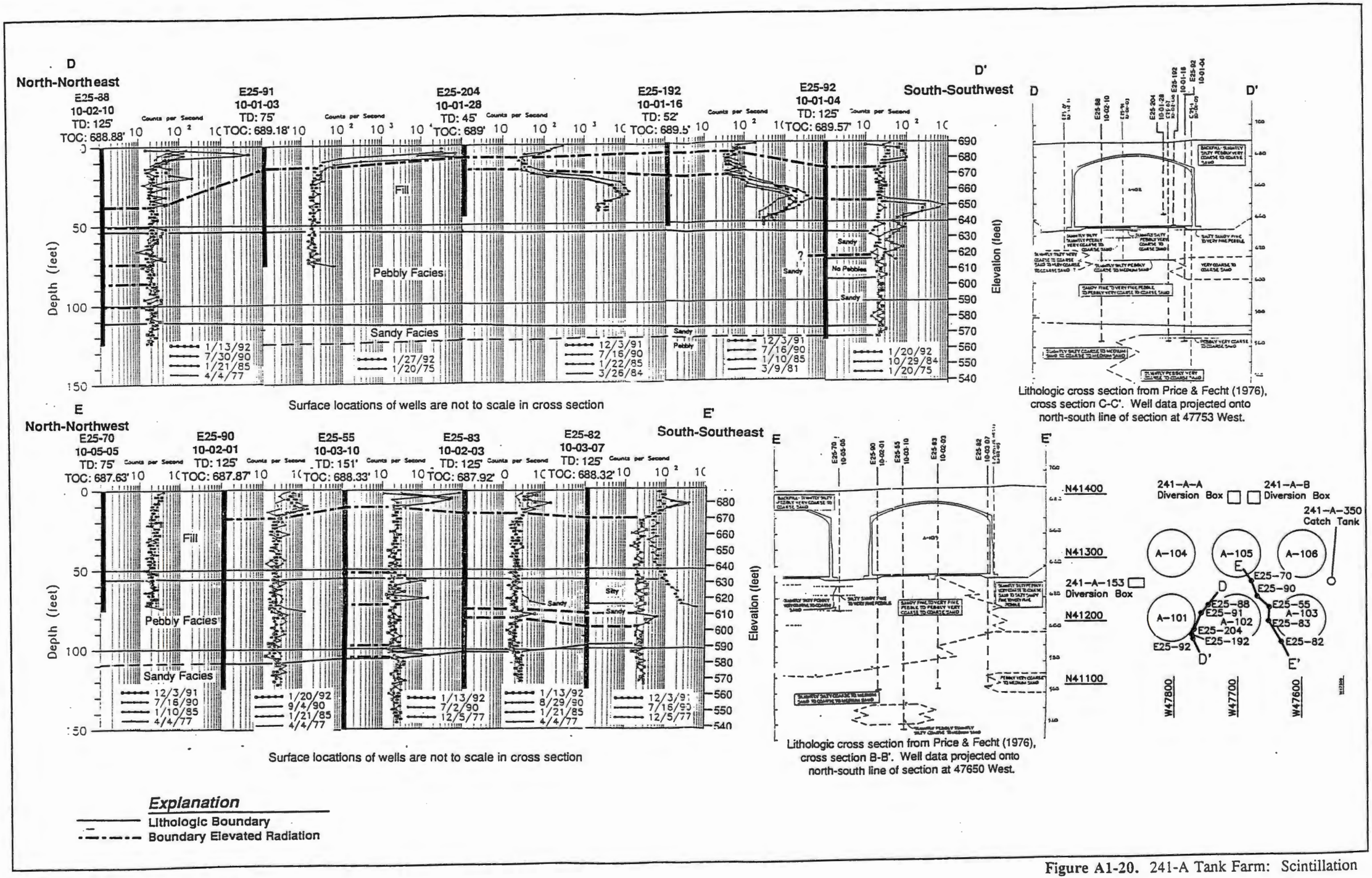

Figure A1-20. 241-A Tank Farm: Scintillation Probe Profile Cross Sections D-D' and E-E'.

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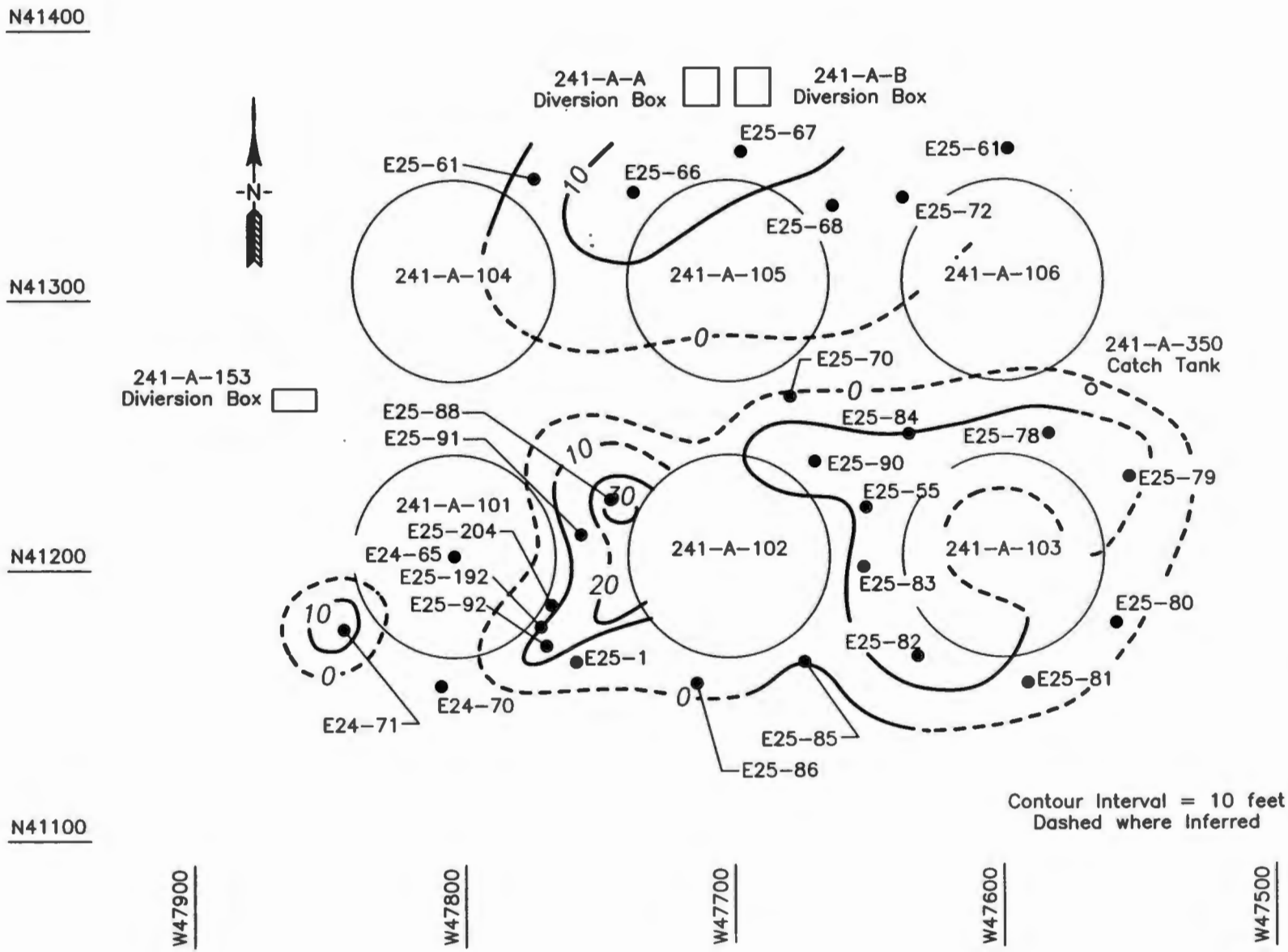

Figure A1-21. 241-A Tank Farm: Near Surface Elevated Gamma Radiation Isopach Map.

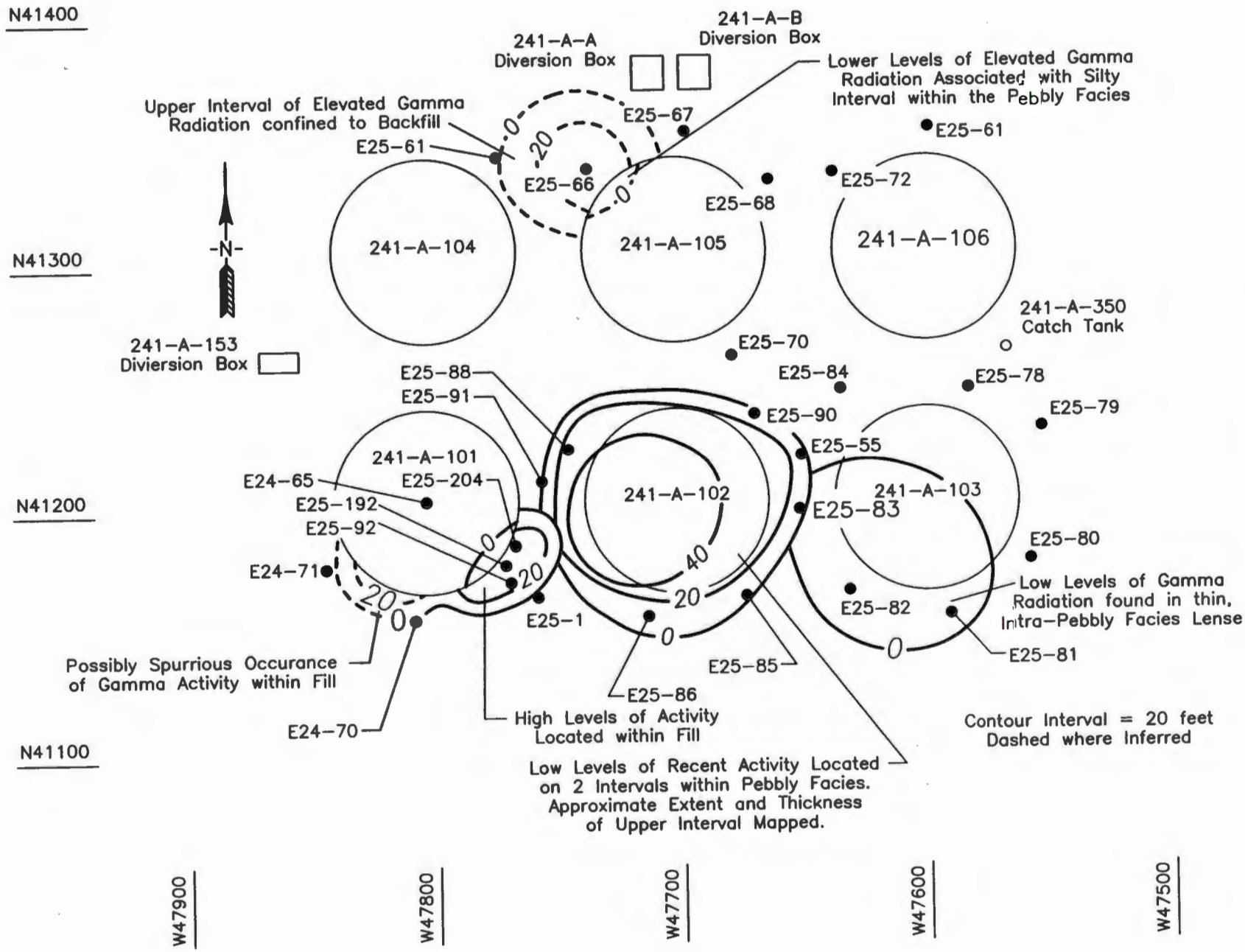

Figure A1-22. 241-A Tank Farm: Intra-Backfill Elevated Gamma Radiation Isopach Map.

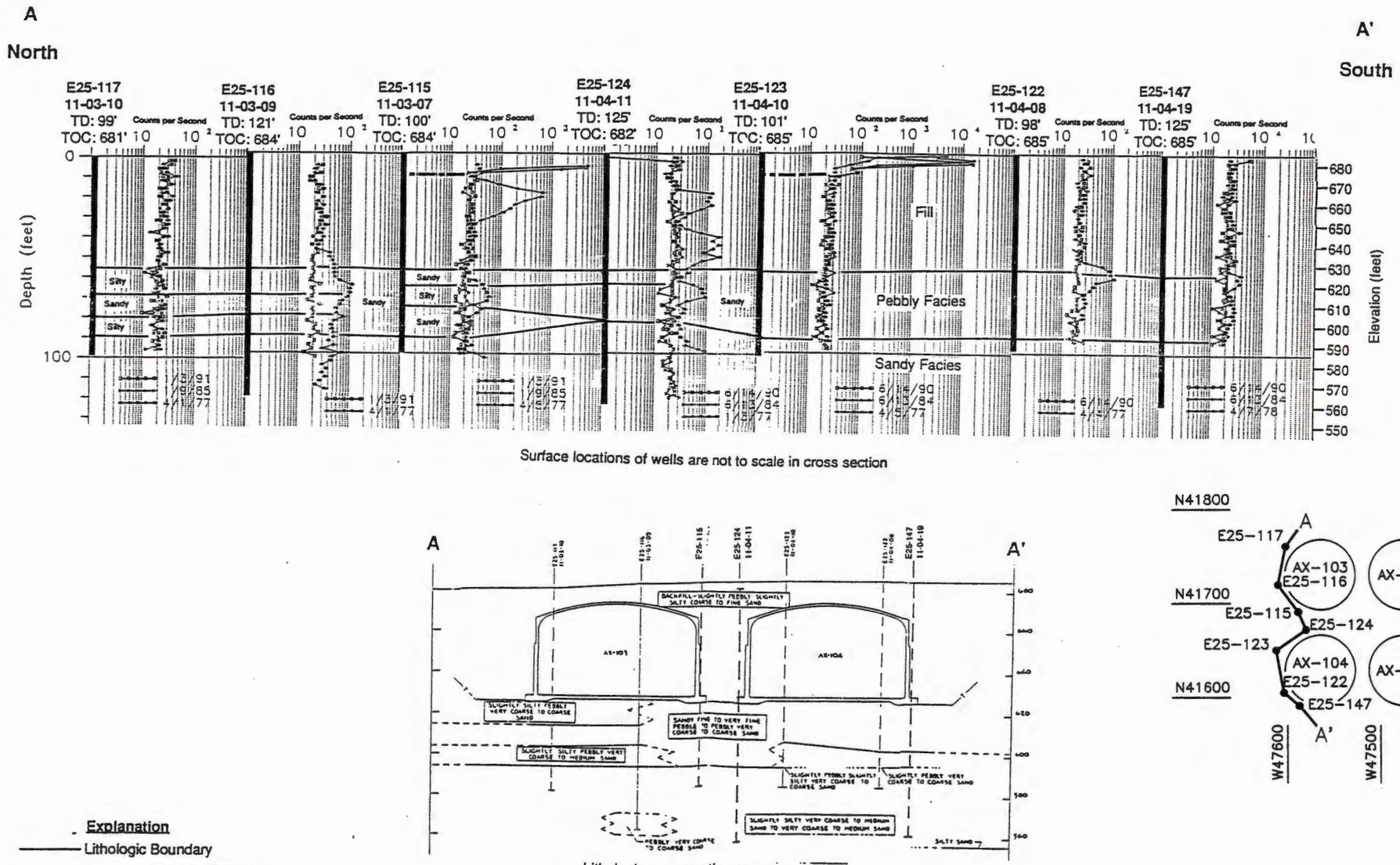

Figure A1-23. 241-AX Tank Farm: Scintillation Probe Profile Cross Section A-A'.

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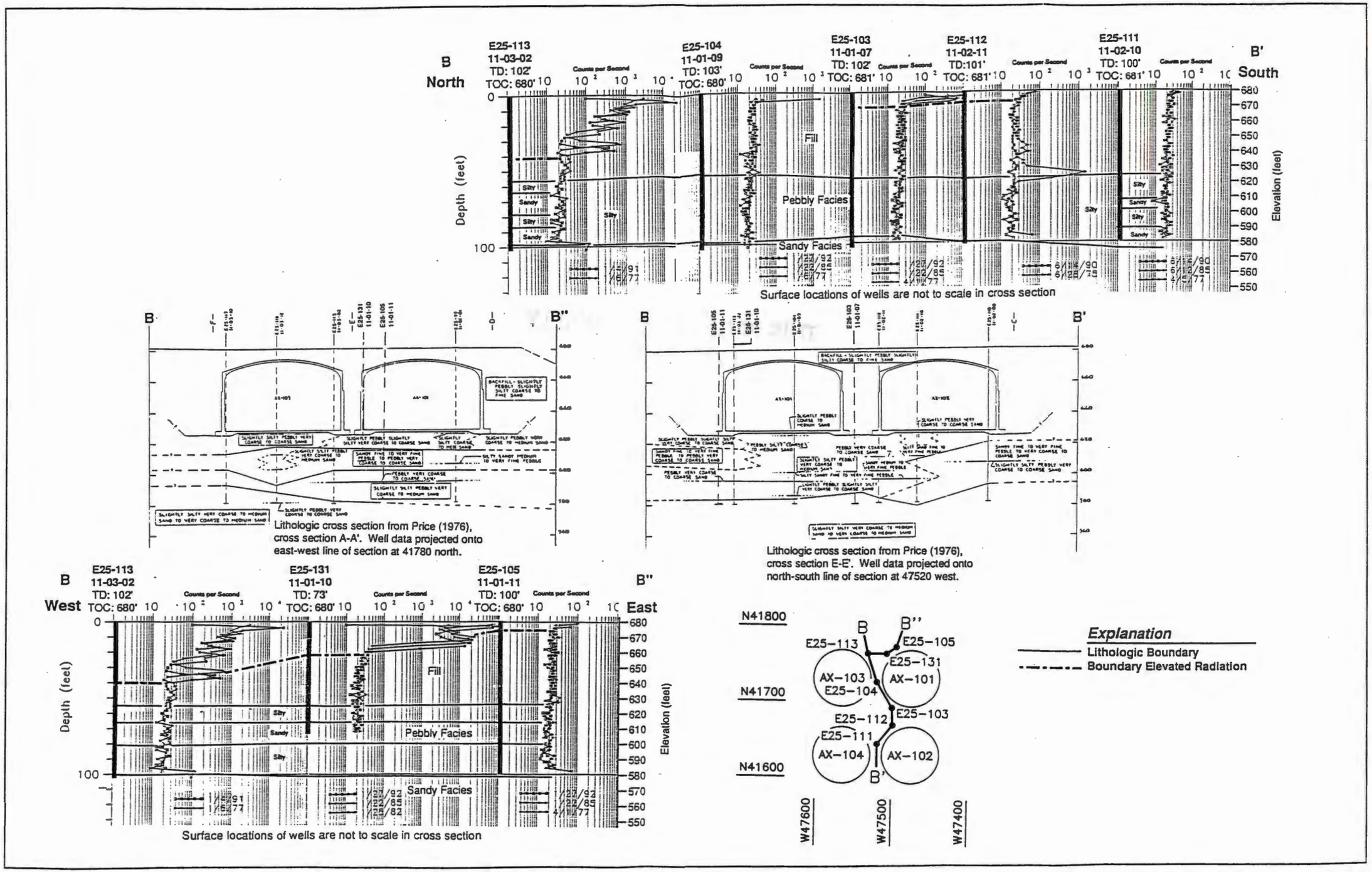

Figure A1-24. 241-AX Tank Farm: Scintillation Probe Profile Cross Sections B-B' and B-B''.

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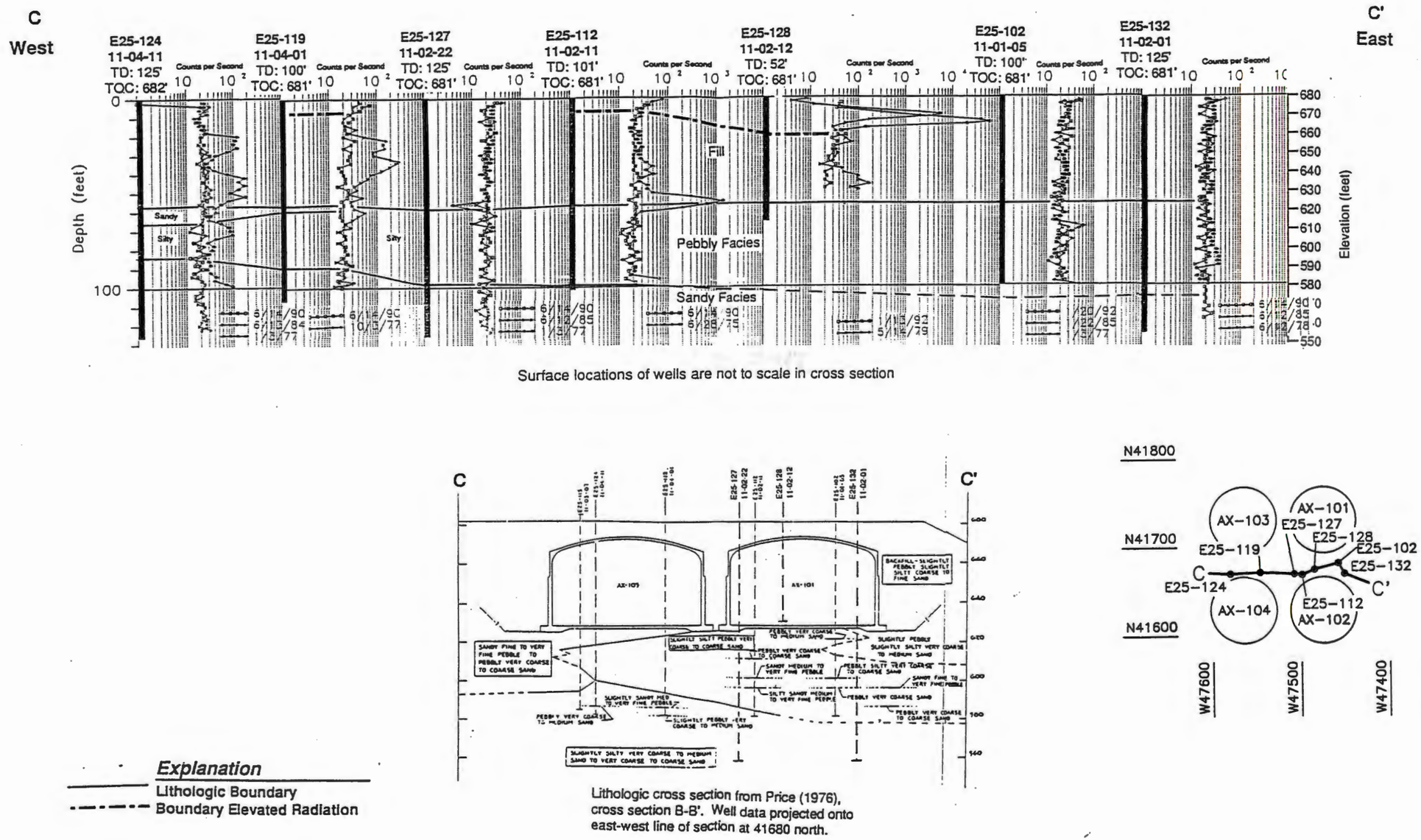

Figure A1-25. 241-AX Tank Farm: Scintillation Probe Profile Cross Section C-C'.

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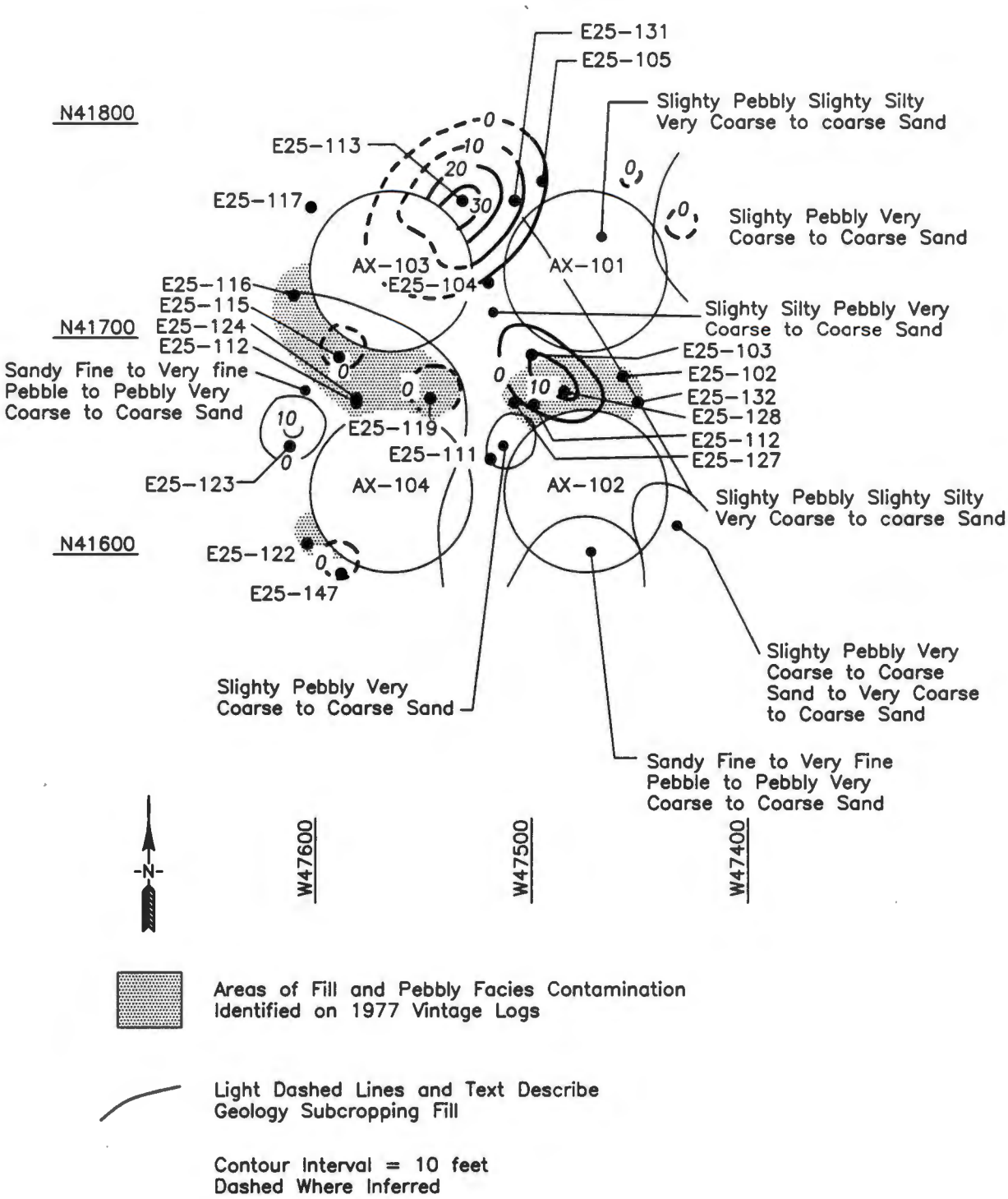
Figure A1-26. 241-AX Tank Farm: Elevated Gamma Radiation Isopach Map.



9 3 1 2 8 ' 7 0 7 4 7

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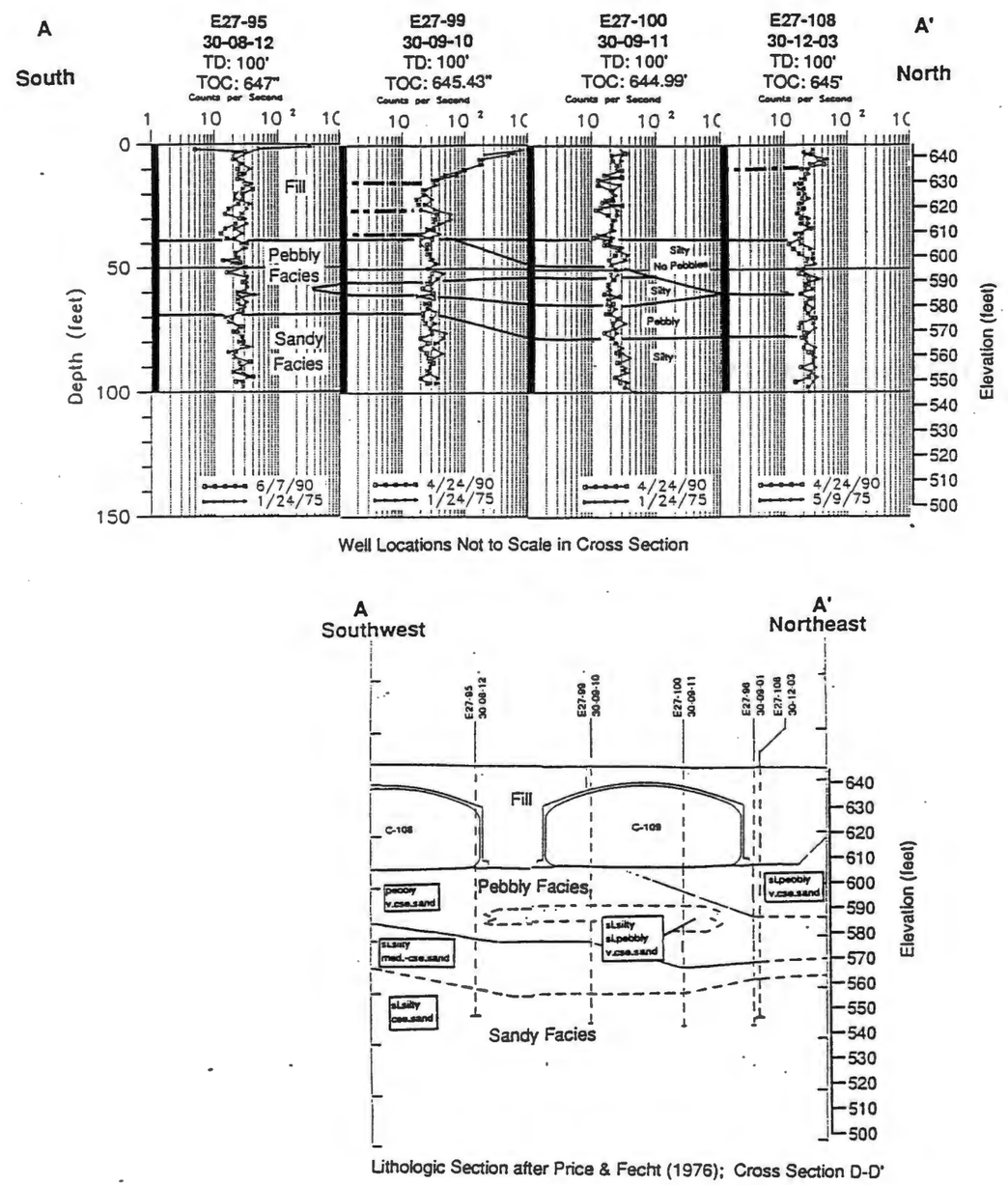

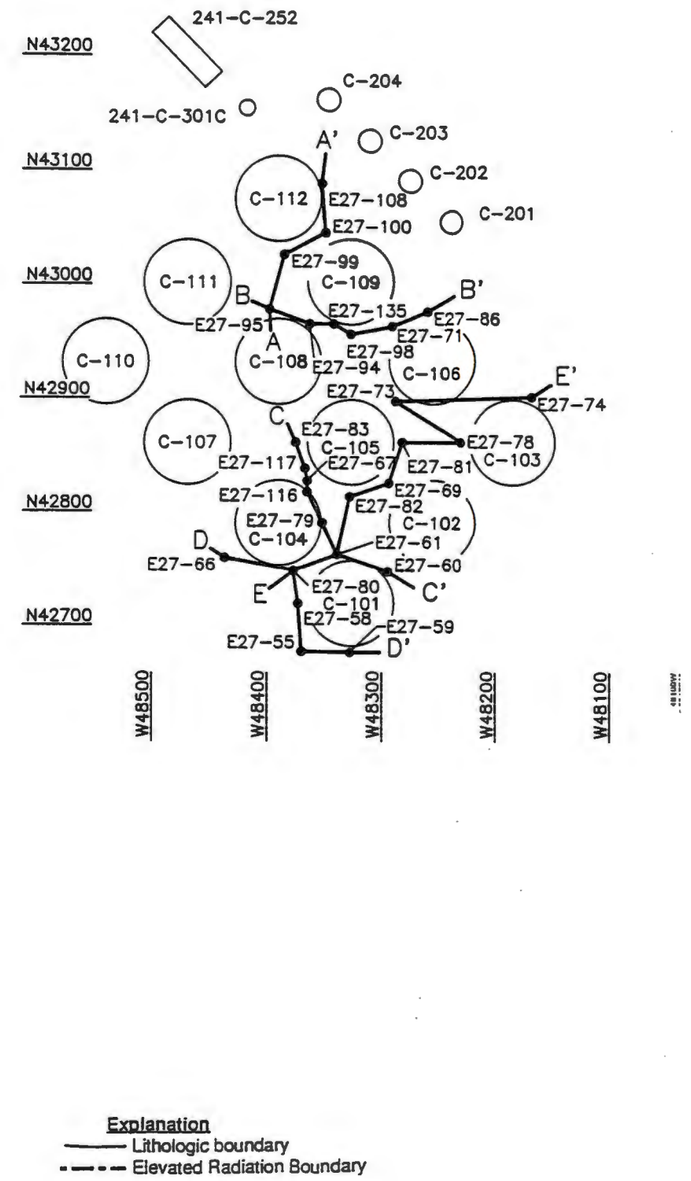

Figure A1-27. 241-C Tank Farm: Scintillation Probe Profile Cross Section A-A'.

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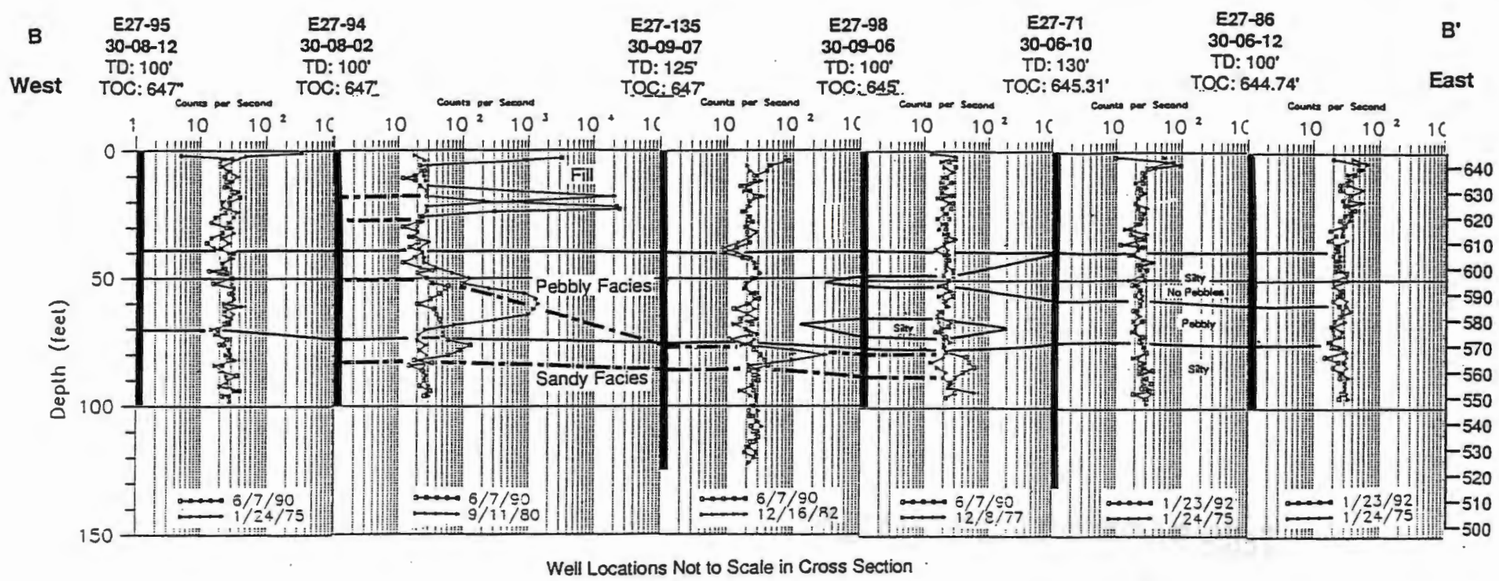
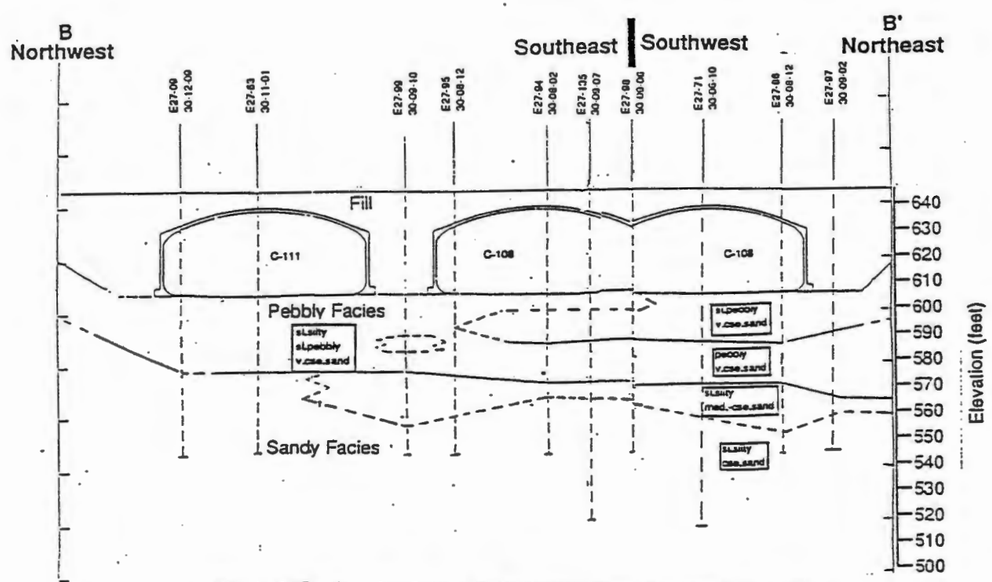
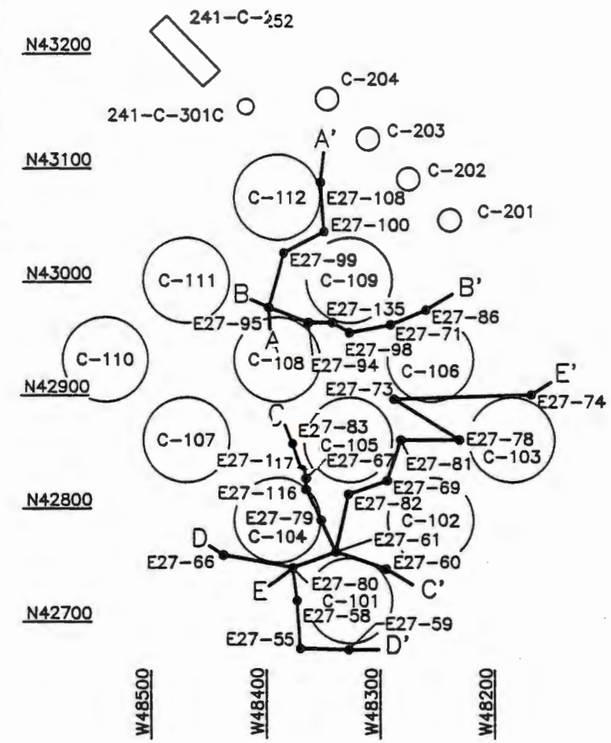




Lithologic Section after Price & Fecht (1976); Cross Sections C-C' and H-H'



Source: Welty (1988)

Explanation
Lithologic boundary
Elevated Radiation Boundary

Figure A1-28. 241-C Tank Farm: Scintillation Probe Profile Cross Sections B-B'.

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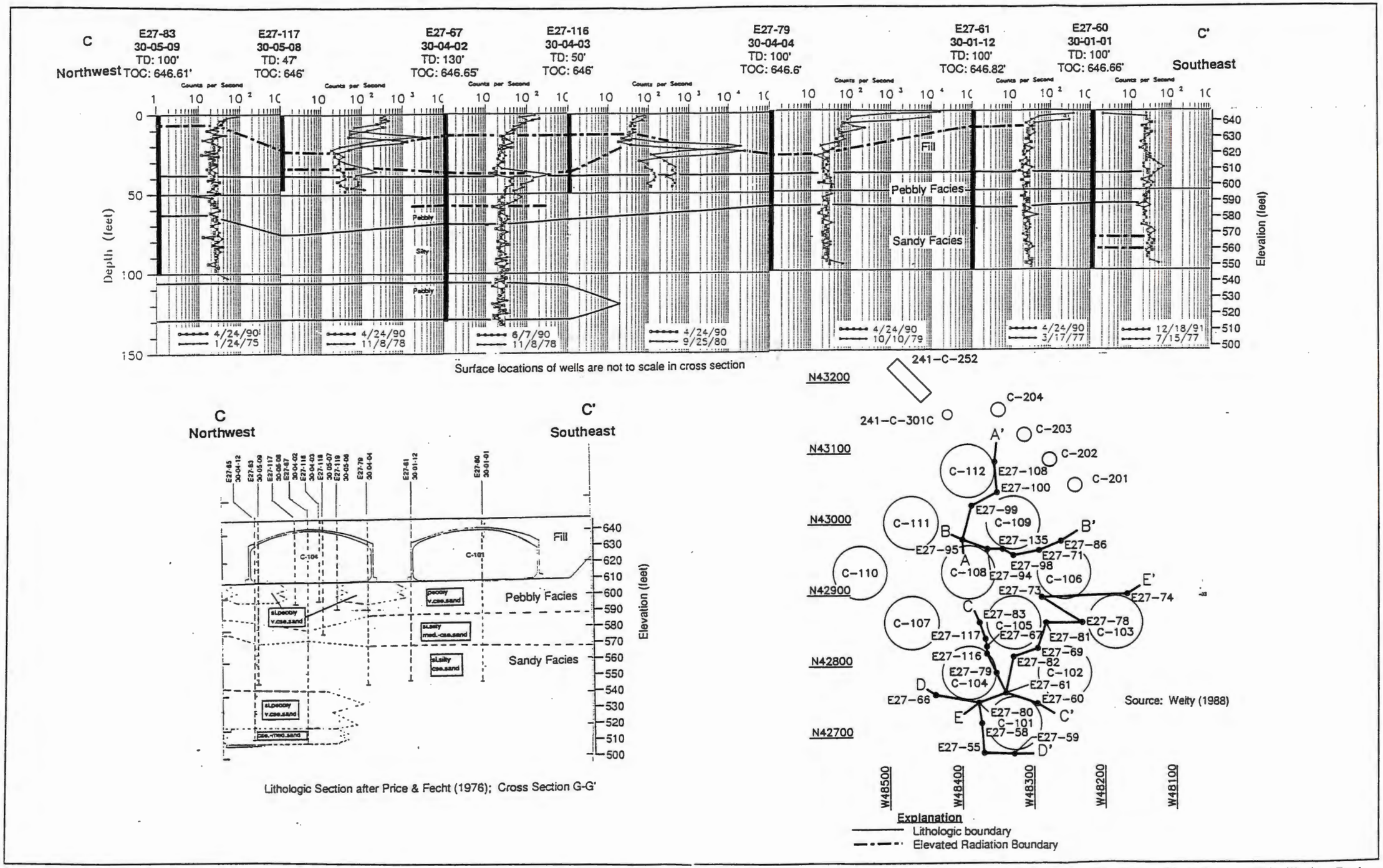

Figure A1-29. 241-C Tank Farm: Scintillation Probe Profile Cross Section C-C'.

9 3 1 2 8 7 0 7 5 0

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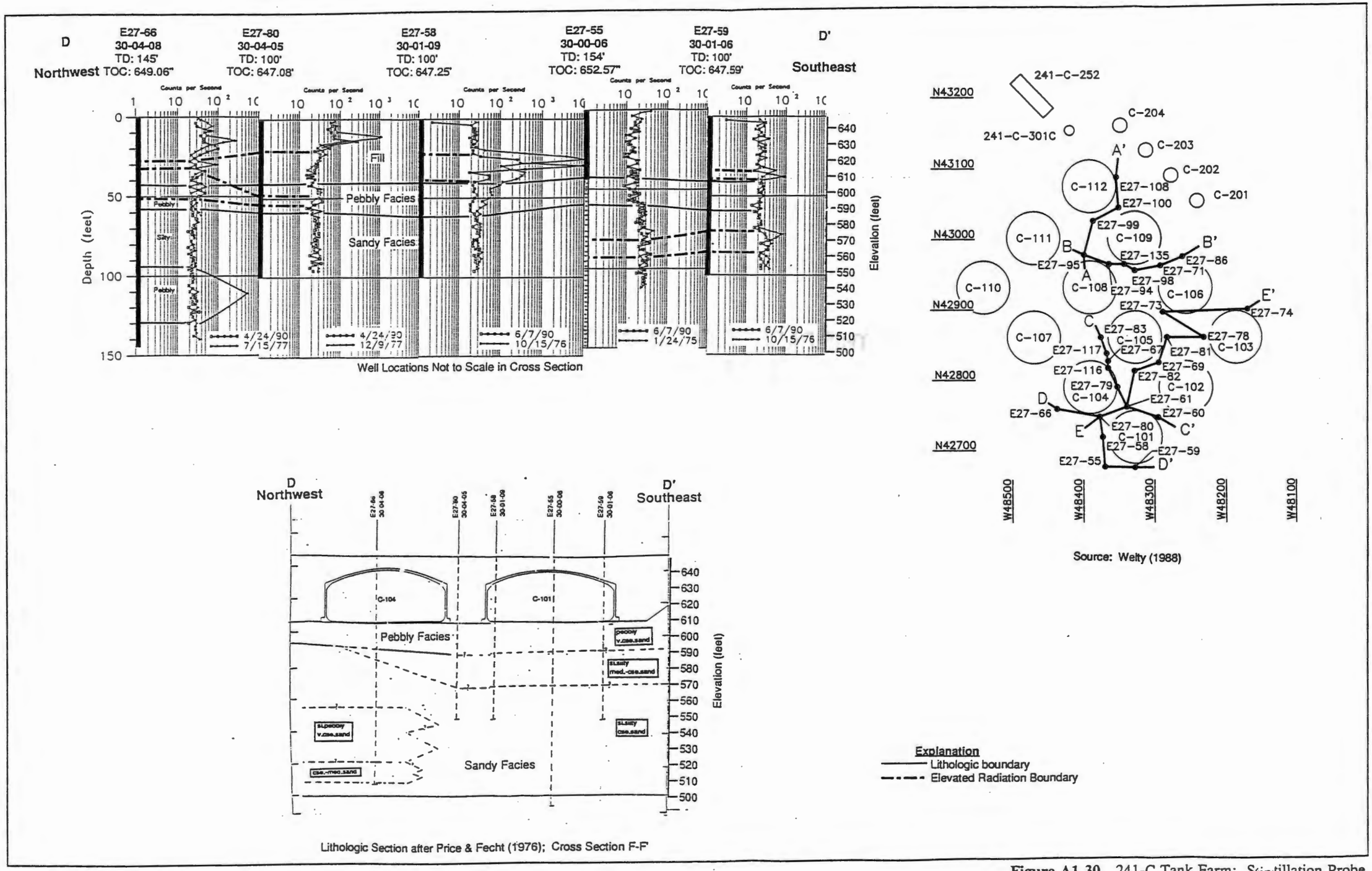

Figure A1-30. 241-C Tank Farm: Scintillation Probe Profile Cross Sections D-D'.

9 3 1 2 8 ' 7 0 7 5 1

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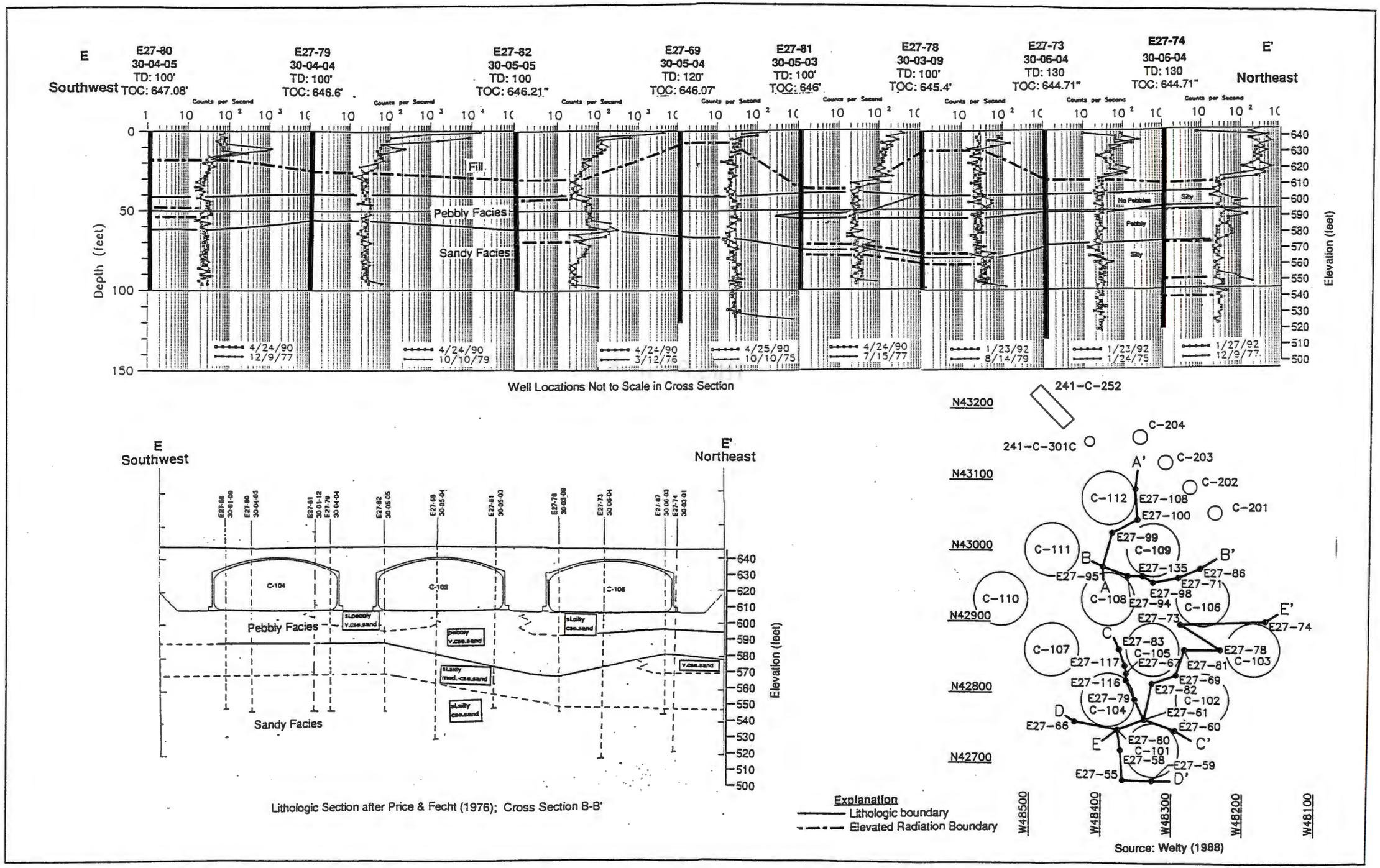

Figure A1-31. 241-C Tank Farm: Scintillation Probe Profile Cross Section E-E'.

9 3 1 2 8 ' 7 0 7 5 2

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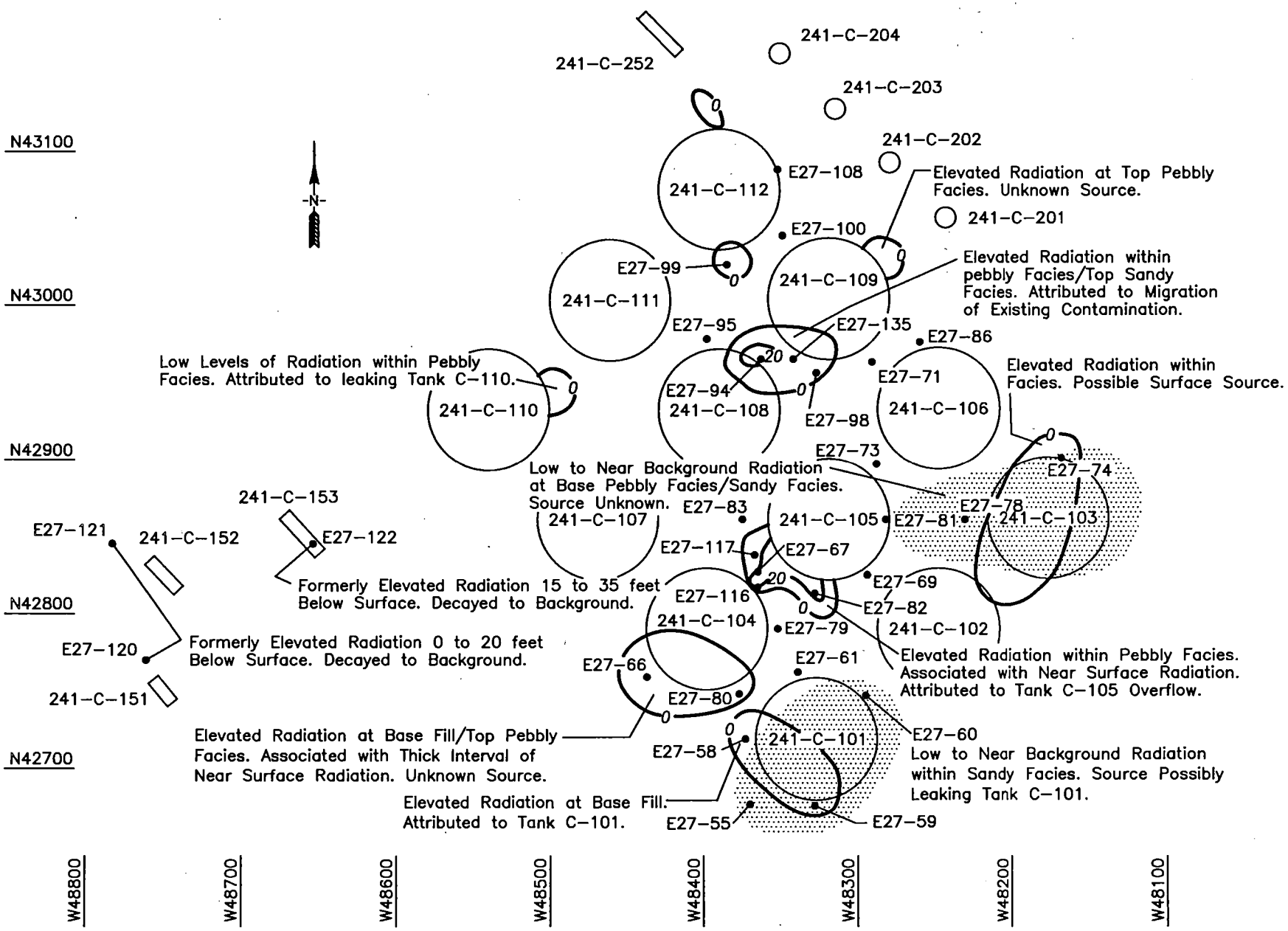

Figure A1-32. 241-C Tank Farm: Near Surface Elevated Gamma Radiation Isopach Map.

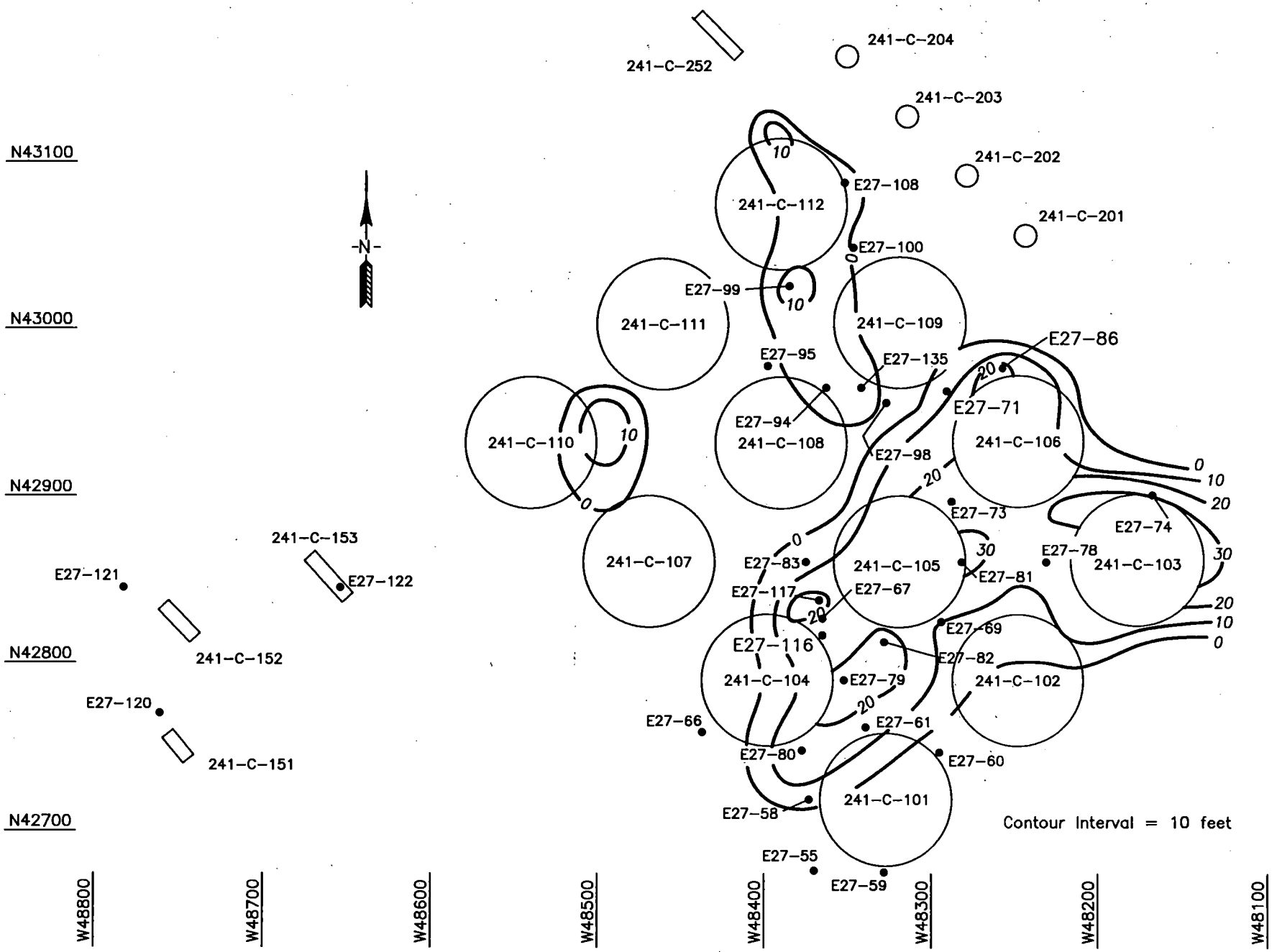

Figure A1-33. 241-C Tank Farm: Elevated Gamma Radiation within Fill and Pebbly Facies Isopach Map.

Table A1-1. Summary of Waste Management Unit Evaluation Results.

WMU	Description	Radiation Detected	Depth Interval (ft)	Evidence of Migration	Detected in Groundwater
216-A-1	Crib	Yes	27-42	No	No
216-A-7	Crib	Yes	0-15 27-42	No No	No
216-A-2	Crib	Yes	25-??	No	No
216-A-4	Crib	Yes	25-??	No	No
216-A-21	Crib	Unknown	---	---	---
216-A-26	French Drain*	Yes	25-??	No	No
216-A-26A	French Drain	Yes	25-??	No	No
216-A-27	Crib	Yes	20-140 280-320	No No	No
216-A-31	Crib	Unknown	---	---	---
216-A-36A	Crib	Yes	20-160 280-320	No	No
216-A-36B	Crib	Yes	20-135+	No	No
216-A-5	Crib	Yes	25-50	No	No
216-A-10	Crib	Yes	50-200	No	No
216-A-15	French Drain	Unknown	---	---	No
216-A-38	Crib	No	---	---	---
216-A-6	Crib	Yes	20-40	No	No
216-A-8	Crib*	Yes	0-120 145-180+	Yes	Unknown
216-A-18	Trench	No	---	---	---
216-A-19	Trench	No	---	---	---
216-A-20	Trench	No	---	---	---
216-A-24	Crib	Yes	0-123+	No	Unknown
216-A-29	Ditch*	Yes	18-31	Unknown	No
216-A-34	Ditch	No	---	---	---
216-A-524	Control Structure	No	---	---	---
216-A-9	Crib	No	---	---	---
216-A-40	Trench	No	---	---	---
216-A-30	Crib*	Yes	8-42	Yes	No
216-A-37-1	Crib*	No	---	---	---
216-A-37-2	Crib*	Unknown	---	---	---
216-A-42	Retention Basin*	No	---	---	---
216-A-45	Crib*	Yes	40-150+	Yes	Unknown
241-A-101 to 106	Tank Farm	Yes	0-100	Yes	No
241-AX-101 to 104	Tank Farm	Yes	0-39	Yes	No
241-C-101 to 112	Tank Farm	Yes			

* Unit is Currently Active.

Table A1-2. Details of Wells and Logs Used in Evaluation of 216-A-1 and -7 Waste Management Units.

Well #	Northing	Westing	TOC	TD	Perforations	Logs Used	
E25-2	41270	47190	675.04	363	276-316	6/20/84	*
						2/20/76	*
						4/25/68	
						5/14/63	
						5/14/59	
E25-54	41205	47169	674	150	---	9/23/86	*
						12/3/76	*

* Digitized Logs

Source: Westinghouse GIS Listing of Well Statistics.

9 3 1 2 8 ' 7 0 7 5 6

Table A1-3. Details of Wells and Logs Used in Evaluation of 216-A-2, -4, -21, -26, -27, -31, and -36 Waste Management Units.

Well #	Northing	Westing	TOC	TD	Perforations	Logs Used	
E17-2	39063	48141	716.07	337	303-398	7/14/87	*
						2/19/76	*
						4/29/70	
						5/21/63	
E17-3	39066	48340	715.47	398	310-400	7/1/86	*
						4/28/76	*
						4/29/70	*
						4/16/68	*
						5/21/63	*
E17-4	38999	48480	717.05	379	298-398	7/14/87	*
						2/19/76	*
						4/29/70	
						4/16/68	
E17-5	38699	48560	718.69	328	298-335	9/29/82	*
						2/19/76	*
						4/28/70	
						4/16/68	
						10/18/65	
E17-6	38140	48499	720.1	499	300-460	4/27/76	
						4/29/70	
						7/2/65	
E17-7	38711	48599	719.19	377	300-385	9/19/88	*
						7/14/87	*
						4/28/76	*
						4/29/70	
						7/2/65	
E17-9	39027	48538	717.64	321	310-320	4/2/79	*
						4/28/76	
						4/29/70	*
						4/18/68	*
E17-10	38896	48650	714.74	325	310-320	9/19/86	*
						4/28/76	*
						4/29/70	*
E17-11	38924	48509	717.83	150	---	9/19/88	*
						9/29/82	*
E17-51	38540	48510	---	150	---	9/18/88	*
						9/29/82	*
E24-9	39295	48292	715.48	366	---	9/16/87	*
						2/19/76	*
						4/29/70	
						5/21/63	
E24-12	39219	48203	716.28	319	310-320	4/28/76	*
						4/29/70	*
E24-53	39515	48245	711	50	---	8/24/82	*
						4/28/76	*
						5/21/63	
E24-54	39542	48130	711	97	---	9/16/87	*
						5/21/63	

* Digitized Logs

Sources: Westinghouse GIS Listing of Well Statistics, Welty & Vermeulen (1989)

Table A1-4. Details of Wells and Logs Used in Evaluation of 216-A-5, -10, -15, and -38 Waste Management Units.

Well #	Northing	Westing	TOC	TD	Perforations	Logs Used	
E17-1	39053	48942	719.17	330	303-333	8/24/82	*
						4/28/76	*
						4/30/70	*
						4/17/63	*
						5/21/63	
						5/13/59	
						3/27/58	*
E17-8	39123	49247	718.38	362	303-362	4/28/76	
						4/30/70	
						4/17/68	
E24-1	39396	48761	716.22	338	300-341	9/16/87	*
						2/19/76	*
						4/29/70	
						5/21/63	
						5/13/59	
						3/27/58	*
E24-2	39404	48953	717.47	350	277-331	8/24/82	*
						2/19/76	*
						4/30/70	
						4/17/68	
						5/21/63	
						5/13/59	
E24-10	39379	48710	715.94	315	---	9/16/87	*
						4/2/79	*
						4/29/70	*
						4/17/68	*
						3/2/67	*
						10/13/65	*
E24-11	39371	49252	718.39	336	308-362	7/14/87	*
						2/19/76	*
						4/30/70	
						4/17/68	
E24-15	39300	48920	---	---	---	9/9/85	*
						12/10/82	*
E24-56	39350	48704	712	146	---	9/16/87	*
						4/28/76	*
						5/21/63	
						5/23/59	
E24-57	39447	48704	712	147	---	9/16/87	*
						4/28/76	*
						5/21/63	
						5/13/59	
E24-58	39397	48666	712	195	---	9/16/87	*
						4/28/76	*
						5/21/63	
						5/13/59	
E24-59	39215	48913	717.42	150	---	3/11/88	*
						11/17/82	*
						4/28/76	
						4/17/68	
						5/21/63	
						5/13/59	*
E24-60	39216	48984	718.59	200	---	9/30/88	*
						11/17/82	*
						4/28/76	
						4/17/68	
						5/21/63	
						5/13/59	*
E24-160	39320	48910	717.79	---	170-218	3/4/86	*

* Digitized Logs

Sources: Westinghouse GIS Listing of Well Statistics, Welty & Vermeulen (1989).

Table A1-5. Details of Wells and Logs Used in Evaluation of 216-A-6 Waste Management Unit.

Well #	Northing	Westing	TOC	TD	Perforations	Logs Used	
E25-3	39980	46960	689.73	308	270-312	7/13/87	*
						2/20/76	*
						4/25/68	
						5/13/63	
						5/14/59	
						4/28/58	*
E25-53	39795	47000	690.52	148	---	8/12/87	*
						5/5/76	*

* Digitized Logs

Source: Westinghouse GIS Listing of Well Statistics.

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Table A1-6. Details of Wells and Logs Used in Evaluation of 216-A-8, -18, -19, -20, -24, -29, -34, and -524 Waste Management Units.

Well#	Northing	Westing	TOC	TD	Perforations	Logs Used	
E25-4	41615	46739	659.39	263	239-281	3/23/90	•
01-08-08						3/21/84	•
						2/20/76	
						5/14/63	
						6/1/59	
						2/19/58	•
E25-5	41667	46632	657.71	275	235-291	8/19/88	•
01-08-09						3/21/84	•
						4/30/76	
						5/14/63	
						6/1/59	
						2/19/58	
E25-6	41598*	46619*	658.31	274	234-288	3/23/90	•
01-08-07						9/30/82	•
						4/30/76	•
						4/25/68	
						5/14/63	
						6/3/59	
						2/19/58	•
E25-7	41709	46416	657.15	260	235-290	3/23/90	•
01-08-10						3/21/84	•
						4/30/76	
						4/25/68	
						5/14/63	
						6/1/59	
						2/19/58	•
E25-8	41682	46187	658.31	271	244-284	3/23/90	•
01-08-03						4/30/76	
						5/14/63	
						6/1/59	
						2/19/58	•
						12/3/76	•
E25-9	41779	45860	654.86	261	233-288	9/29/82	•
						2/20/76	
						4/25/68	
						5/14/63	
						6/1/59	
						2/19/58	•
E25-10	42000	46900	655.84	280	226-291	12/3/76	•
						12/12/58	•
E25-14	41600	46650	680*	204	---	3/4/87	•
						9/30/82	•
						4/30/76	•
						2/9/67	
E25-28	41424	45541	662.44	335	---	4/15/88	•
E25-169	41675	45550	---	---	---	9/30/82	•

*Digitized Logs
•Discrepency between GIS listing and Welty & Vermeulen (1989)
*TOC inconsistent with nearby wells.
Sources: Westinghouse GIS Listing of Well Statistics and Welty & Vermeulen (1989).

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Table A1-6. Details of Wells and Logs Used in Evaluation of 216-A-8, -18, -19, -20, -24, -29, -34, and -524 Waste Management Units.

Well#	Northing	Easting	TOC	TD	Perforations	Logs Used	
E26-2	42400	45664	635.3	260	220-265	8/12/87	*
						4/30/76	*
						5/14/63	
						6/3/59	
						12/12/58	*
						4/29/58	*
E26-3	42324	46-57	641.18	261	222-272	8/12/87	*
						4/30/76	*
						5/14/63	
						6/3/59	
						12/12/58	*
						4/29/58	*
E26-4	42245	46449	647.76	280	225-281	8/12/87	*
						4/30/76	*
						5/14/63	
						6/3/59	
						12/12/58	*
E26-5	42172	46842	651.07	280	237-290	8/12/87	*
						2/20/76	*
						6/24/68	
						5/14/63	
						6/3/59	
						12/12/58	*
						5/27/58	*
						4/28/58	*
E26-7	42285	46650	647	211	---	6/20/84	*
						4/30/76	*
						2/9/67	
E26-53	42325	46605	650.33	---	---	8/21/84	*
E26-54	42355	46449	---	---	---	6/21/84	*

*Digitized Logs
Sources: Westinghouse GIS Listing of Well Statistics and Welty & Vermeulen (1989).

Table A1-7. Details of Wells and Logs Used in Evaluation of 216-A-9 and -40 Waste Management Units.

Well#	Northing	Westing	TOC	TD	Perforations	Logs Used	
E24-3	41011	48310	698.33	295	277-331	4/22/85	*
						2/19/76	*
						4/17/68	
						5/20/63	
						5/12/59	
E24-4	41182	48483	696.69	325	272-298	4/28/76	*
						4/18/68	*
						5/20/63	
						5/12/59	
E24-5	41275	48727	696.61	326	274-327	4/22/85	*
						4/28/76	*
						5/13/59	*
E24-63	41335	48644	695.97	50	---	9/23/86	*
						4/28/76	*
						4/18/68	*
E27-3	42000	48500	683.27	340	265-348	5/20/63	*
						5/12/59	*

*Digitized Logs

Sources: Westinghouse GIS Listing of Well Statistics, Fecht et al. (1977) and Welty & Vermeulen (1989

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Table A1-8. Details of Wells and Logs Used in Evaluation of 216-A-30, -37, and -42 Waste Management Units.

Well#	Northing	Westing	TOC	TD	Perforations	Logs Used
E16-2	39151	45162	681.09	331	265-336	9/28/82 *
						4/29/76
						4/25/68
						5/13/63
E25-11	39611	46126	681.28	309	265-338	10/8/80 *
						2/26/63
						5/13/63
E25-12	39388	45655	680.95	337	265-338	3/23/90 *
						10/8/80 *
						4/29/76
						5/13/63
E25-17	40086	46570	690	292	273-295	3/23/90 *
						8/20/82 *
						8/23/78 *
						12/3/76 *
E25-18	40070	46187	679.05	291	269-294	6/29/88 *
						8/23/78 *
						12/3/76 *
E25-19	39935	46060	677.2	287	270-295	9/29/82 *
						1/5/82 *
						8/23/78 *
						12/3/76 *
E25-20	39925	45875	676.3	294	268-293	9/29/82 *
						1/5/82 *
						8/23/78 *
						12/3/76 *
E25-21	39609	45377	677.27	295	270-293	N/A
E25-22	39776	45589	674.02	295	---	N/A
E25-23	39308	44746	680.13	295	273-304	N/A
E25-24	39484	44949	679.55	293	270-290	N/A
E25-37	40462	45749	673.29	280	260-280	6/28/89 *
E25-38	40056	45469	673.52	280	260-280	7/5/89 *
E25-190	39700	46075"	---	50	---	3/23/90 *
						10/8/82 *
E25-191	39560	45800	---	50	---	3/23/90 *
						10/13/82 *
E25-193	39430	45532	---	60	---	9/23/90 *
						10/13/82 *

*Digitized Logs
"Coordinate changed to correspond to Welty & Vermeulen (1989).
N/A Not Available
Sources: Westinghouse GIS Listing of Well Statistics; Welty & Vermeulen (1989).

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Table A1-9. Details of Wells and Logs Used in Evaluation of 216-A-45 Waste Management Unit.

Well#	Northing	Westing	TOC	TD	Perforations	Logs Used	
E17-12	38200	47180	721.7	340	---	4/15/86	*
E17-13	38353	49040	719.25	---	---	8/11/86	*
E17-53	38266	49065	719.34	150	---	9/23/88	*
01-45-04							
E17-54	38354	49246	720.78	150	---	9/23/88	*
01-45-10							

*Digitized Logs
Source: Westinghouse GIS Listing of Well Statistics.

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Table A1-10. Details of Wells and Logs Used in 241-A Tank Farm Evaluation.

Well #	Northing	Westing	TOC	TD	Logging Freq (/yr)	Logs Used
E25-57	41379	47565	687.47	150	1	Not Used
10-00-01						
E25-51	41357	47505	---	---	0	Not Used
10-00-02						
E25-58	41160	47540	688.02	151	1	Not Used
10-00-04						
E25-15	41125	47651	689.67	340	1	6/8/90
10-00-06						6/13/85
						4/5/77
E24-14	41125	47799	690.8	340	1	Not Used
10-00-07						
E24-13	41187	47875	691.05	308*	1	Not Used
10-00-08						
E24-64	41155	47819	685	80	0	Not Used
E25-97	41247	47781	689.09	125	52	Not Used
10-01-01						
E25-91	41213	47757	689.18	75	52	1/27/92
10-01-03						1/20/75
E25-92	41172	47770	689.57	125	52	1/20/92
10-01-04						10/29/84
						1/20/75
E25-1	41166	47759	690.21	315*	1	6/8/90
10-01-05						1/11/82
						4/4/77
E24-70	41157	47809	690.62	125	26	1/20/92
10-01-06						9/4/90
						1/22/85
						4/4/77
E24-71	41178	47845	690.48	125	26	1/20/92
10-01-08						1/22/85
						4/4/77
E24-75	41200	47853	691[2]	75	26	Not Used
10-01-09						
E24-72	41224	47850	689.89	125	26	Not Used
10-01-10						
E24-73	41250	47822	689.83	125	26	Not Used
10-01-11						
E25-192	41179	47772	689.5[2]	52	4	12/3/91
10-01-16						7/16/90
						1/10/85
						3/9/81
E25-204	41187	47768	689[2]	45	4	12/3/91
10-01-28						7/16/90
						1/22/85
						3/26/84
E24-65[e]	41170	47819	690	50	0	9/16/87

Sources: Welty & Vermeulen (1989); Price & Fecht (1976); Jacques (1972); Westinghouse GIS listing.
*TD from Westinghouse GIS listing used, differs from Welty & Vermeullen (1989).
[e]Logged by PNL.
[f]Coordinate used from Westinghouse GIS listing differs from Jacques (1972).
[2]Scaled from Price & Fecht (1976).

Table A1-10. Details of Wells and Logs Used in 241-A Tank Farm Evaluation.

Well #	Northing	Westing	TOC	TD	Logging Freq (/yr)	Logs Used
E25-90 10-02-01	41240	47670	687.87	125	26	1/20/92 9/4/90 1/21/85 4/4/77
E25-83 10-02-03	41201	47652	687.92	125	12	1/13/92 8/29/90 1/21/85 4/4/77
E25-85 10-02-05	41166	47675	688.57	125	26	1/20/92 9/4/90 1/20/85 4/4/77
E25-86 10-02-06	41158	47714	689.42	85[a]	12	1/13/92 8/29/90 1/21/85 4/4/77
E25-87 10-02-08	41184	47746	689.42	125	12	1/13/92 1/21/85 4/4/77
E25-88 10-02-10	41226	47746	688.88	125	12	1/13/92 7/30/90 4/4/77
E25-89 10-02-11	41250	47720	688.9	125	12	Not Used
E25-78 10-03-01	41250	47583	687.54	125	4	12/3/91 7/16/90 12/5/77
E25-79 10-03-02	41234	47553	687.3	125	4	12/3/91 7/16/90 12/5/77
E25-80 10-03-04	41180	47558	687.54	125	4	12/3/91 7/16/90 12/5/77
E25-81 10-03-05	41158	47591	688.12	125	4	12/3/91 7/16/90 12/5/77
E25-82 10-03-07	41168	47632	688.32	125	4	12/3/91 7/16/90 12/5/77
E25-55 10-03-10	41223	47651[c]	688.33	151	12	1/13/92 7/2/90 12/5/77
E25-84 10-03-11	41250	47635	687.53	75[a]	4	12/3/91 4/24/90 12/5/77

Sources: Welty & Vermeulen (1989); Price & Fecht (1976); Jacques (1972); Westinghouse GIS listing.
[a]TD from Westinghouse GIS listing used, differs from Welty & Vermeulen (1989).
[b]Logged by PNL.
[c]Coordinate used from Westinghouse GIS listing differs from Jacques (1972).

Table A1-10. Details of Wells and Logs Used in 241-A Tank Farm Evaluation.

Well #	Northing	Westing	TOC	TD	Logging Freq (/yr)	Logs Used
E25-61 10-04-01	41345	47774	688.11	125	1	6/8/90 1/7/85 7/12/77
E25-56 10-04-04	41283	47753	682.62	151	1	Not Used
E25-63 10-04-05	41275	47768	688.43	130[a]	1	Not Used
E24-66 10-04-07	41262	47819	689.36	125[a]	1	Not Used
E24-67 10-04-08	41287	47849	689.35	125	1	Not Used
E24-68 10-04-10	41328	47848	689.09	125[a]	1	Not Used
E24-69 10-04-12	41355	47815	688.32	125[a]	1	Not Used
E25-68 10-05-02	41335	47663	687.33	121[a]	1	6/8/90 1/3/77
E25-70 10-05-05	41264	47679	687.63	75	4	12/3/91 7/16/90 1/10/85 4/4/77
E25-71 10-05-07	41263	47721	688.48	74	1	Not Used
E25-98 10-05-08	41274	47749	688.64	56	1	Not Used
E25-62 10-05-09	41304	47753	688.21	125[a]	1	6/8/90 1/7/85 4/4/77
E25-66 10-05-10	41340[c]	46637	687.65	125	1	6/8/90 9/12/78 4/4/77
E25-67 10-05-12	41355	47697	687.48	125[a]	1	6/8/90 1/7/85 4/4/77
E25-74 10-06-02	41337	47562	687.27	125	1	Not Used
E25-75 10-06-04	41296	47552	688.9	125	1	Not Used
E25-76 10-06-05	41264	47577[c]	687.15	75	1	Not Used
E25-77 10-06-07	41264	47623[c]	687.25	125	1	Not Used
E25-69 10-06-09	41304	47651	687	125	1	6/8/90 1/8/85 4/4/77
E25-72 10-06-10	41338	47637	687.06	125	1	6/8/90 1/7/85 4/4/77
E25-73 10-06-12	41356	47598	687	110[a]	1	6/8/90 1/7/85 4/4/77

Sources: Welty & Vermeulen (1989); Price & Fecht (1976); Jacques (1972); Westinghouse GIS listing.
[a]TD from Westinghouse GIS listing used, differs from Welty & Vermeulen (1989).
[b]Logged by PNL.
[c]Coordinate used from Westinghouse GIS listing differs from Jacques (1972).

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Table A1-11. Details of Wells and Logs Used in 241-AX Tank Farm Evaluation.

Well #	Northing	Westing	TOC	TD	Logging Freq (/yr)	Logs Used
E25-99 11-01-01	41776	47453	681	100	12	1/20/92 1/22/85 4/1/78
E25-100 11-01-02	41753	47429	680	100	12	1/20/92 1/22/85 4/1/77
E25-101 11-01-04	41710	47429	681	100	12	1/20/92 1/22/85 4/1/77
E25-102 11-01-05	41682	47458	681	100	12	1/20/92 1/22/85 1/3/77
E25-105 11-01-07	41692	47500	681	102	18	1/27/92 1/22/85 4/1/77
E25-104 11-01-09	41726	47520	680	103	18	1/27/92 1/22/85 1/6/77
E25-131 11-01-10	41763*	47511*	680	73	18	1/27/92 1/22/85 1/25/82
E25-105 11-01-11	41773	47495	680	100	18	1/27/92 1/22/85 6/12/78
E25-132 11-02-01	41668*	47449*	681	125	1	6/14/90 6/12/85 6/12/78
E25-106 11-02-02	41648	47429	682	100	1	Not Used
E25-133 11-02-03	41629*	41728*	682	75	1	Not Used
E25-107 11-02-04	41600	47428	680	100	1	Not Used
E25-108 11-02-05	41585	47455	682	104	1	Not Used
E25-109 11-02-07	41585*	47496*	682	99	1	Not Used
E25-110 11-02-08	41595	47520	682	N/A	0	Not Used
E25-111 11-02-10	41644	47519	681	100	1	6/14/90 6/12/85 4/5/77
E25-112 11-02-11	41669	47499	684	101	1	6/14/90 6/28/75
E25-128 11-02-12	41675	47485	681	52	12	1/13/92 5/14/79
E25-127 11-02-22	41670	47508	681	125	1	6/14/90 6/12/85 1/3/77

* Scaled from Drawing H-2-36935, Rev.4 (Tabasinski, 1978).
Sources: Welty & Vermeulen (1989); Tabasinski (1978).

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Table A1-11. Details of Wells and Logs Used in 241-AX Tank Farm Evaluation.

Well #	Northing	Westing	TOC	TD	Logging Freq (/yr)	Logs Used
E25-113	41764	47532	680	102	4	1/4/91
11-03-02						1/6/77
E25-114	41691	47540	682	100	4	1/3/91
11-03-05						1/9/85
						1/6/77
E25-115	41691	47589	684	100	4	1/3/91
11-03-07						1/9/85
						4/5/77
E25-116	41720	47610	684	121	4	1/3/91
11-03-09						4/1/77
E25-117	41761	47602	681	99	4	1/3/91
11-03-10						1/9/85
						4/1/77
E25-118	41776	47569	681	100	4	Not Used
11-03-12						
E25-119	41672	47547	681	100	1	6/14/90
11-04-01						10/3/77
E25-120	41583	47544	682	100	1	Not Used
11-04-05						
E25-121	41585	47686	682	95	1	6/13/90
11-04-07						6/15/84
						10/5/77
E25-122	41605	47604	685	98	1	6/14/90
11-04-08						4/4/77
E25-123	41650	47612	685	101	1	6/14/90
11-04-10						6/13/84
						4/5/77
E25-124	41672	47581	682	125	1	6/14/90
11-04-11						6/13/84
						1/3/77
E25-147	41591	47588	685	125	1	6/14/90
11-04-19						6/13/84
						4/7/78

* Scaled from Drawing H-2-36935, Rev.4 (Tabasinski, 1978).
Sources: Welty & Vermeulen (1989); Tabasinski (1978).

Table A1-12. Details of Wells and Logs Used in 241-C Tank Farm Evaluation.

Well #	Northing	Westing	TOC	TD	Logging Freq. (/yr)	Logs Used
E27-56 30-00-01	42954	48191	639.17	145*	4	Not Used
E27-54 30-00-03	42771	48149	651.57	155*	4	Not Used
E27-55 30-00-06	42677	48370	652.57	154*	1	6/7/90 1/24/75
E27-57 30-00-09	42889	48583	653.46	150*	4	4/24/90 1/24/75
E27-53 30-00-10	43029	48549	649.17	150*	1	Not Used
E27-121 30-00-11	42840	48780	---	60	1	6/7/90 12/9/77
E27-52 30-00-12	43096	48322	645.96	150*	1	Not Used
E27-123 30-00-13	43150	48500	---	60	1	Not Used
E27-120 30-00-22	42770	48760	---	60	1	6/14/90 12/9/77
E27-122 30-00-24	42840	48650	---	60	1	6/7/90 12/9/77
E27-60 30-01-01	42747	48295	646.66	100	12	12/18/91 7/15/77
E27-59 30-01-06	42676	48328	647.59	100	1	6/7/90 10/15/76
E27-58 30-01-09	42719	48373	647.25	100	1	6/7/90 10/15/76
E27-61 30-01-12	42762	48339	646.82	100	4	4/24/90 3/17/77
E27-74 30-03-01	42901	48168	645	125	26	1/27/92 12/9/77
E27-75 30-03-03	42861	48140	645	100	17	1/23/92 5/7/79
E27-76 30-03-05	42820	48165	645	100	17	1/23/92 1/24/75
E27-77 30-03-07	42825	48215	645.64	100	12	1/16/92 1/24/75
E27-78 30-03-09	42861	48231	---	100	17	1/23/92 8/14/79

* Log collected with Probe #2 (shielded probe) not with Probe #4 (unshielded).

o Bottom 100 feet of well is perforated.

Sources: Westinghouse GIS Listing of Well Statistics;
Welty & Vermeulen (1989); Welty (1988).

Table A1-12. Details of Wells and Logs Used in 241-C Tank Farm Evaluation.

Well #	Northing	Westing	TOC	TD	Logging Freq. (/yr)	Logs Used
E27-115 30-04-01	42829	48378	646	50	4	4/24/90 1/24/75
E27-67 30-04-02	42827	48365	646.65	130	1	6/7/90 11/8/78
E27-116 30-04-03	42817	48365	646	50	4	4/24/90 9/25/80
E27-79 30-04-04	42790	48352	646.6	100	4	4/24/90 10/10/79
E27-80 30-04-05	42748	48377	647.08	100	4	4/24/90 12/9/77
E27-66 30-04-08	42759	48437	649.06	145	4	4/24/90 7/15/77
E27-65 30-04-12	42835	48405	647.21	135	4	4/24/90 1/24/75
E27-70 30-05-02	42893	48290	645.7	126	4	4/24/90 10/6/78
E27-81 30-05-03	42861	48282	646	100	4	4/24/90 7/15/77
E27-69 30-05-04	42825	48294	646.07	120	4	4/25/90 10/10/75
E27-82 30-05-05	42813	48328	646.21	100	4	4/24/90 3/12/76
E27-119 30-05-06	42814	48353	646	55	4	4/24/90 9/15/78
E27-118 30-05-07	42826	48353	646	66	4	4/24/90 * 11/2/76 * 2/14/75
E27-117 30-05-08	42838	48367	646	47	4	4/24/90 11/8/78
E27-83 30-05-09	42861	48375	646.61	100	4	4/24/90 1/24/75
E27-68 30-05-10	42893	48366	646.23	135	4	4/24/90 3/10/82
E27-72 30-06-02	42967	48244	645.33	125	17	1/23/92 1/24/75
E27-84 30-06-03	42933	48209	644.8	100	17	1/23/92 7/15/77
E27-73 30-06-04	42897	48288	644.71	130	17	1/23/92 1/24/75
E27-85 30-06-09	42932	48302	645.44	100	17	1/23/92 1/24/75
E27-71 30-06-10	42963	48291	645.31	130	17	1/23/92 1/24/75
E27-86 30-06-12	42976	48260	644.74	100	26	1/23/92 1/24/75

* Log collected with Probe #2 (shielded probe) not with Probe #4 (unshielded).

o Bottom 100 feet of well is perforated.

Sources: Westinghouse GIS Listing of Well Statistics;
Welty & Vermeulen (1989); Welty (1988).

Table A1-12. Details of Wells and Logs Used in 241-C Tank Farm Evaluation.

Well #	Northing	Westing	TOC	TD	Logging Freq. (/yr)	Logs Used
E27-87 30-07-01	42911	48448	646	100	4	Not Used
E27-88 30-07-02	42883	48419	646	100	4	Not Used
E27-89 30-07-05	42823	48447	646	100	4	Not Used
E27-90 30-07-07	42815	48485	646	99	4	Not Used
E27-91 30-07-08	42842	48512	646	99	4	Not Used
E27-92 30-07-10	42879	48515	646	100	4	Not Used
E27-93 30-07-11	42898	48489	646.59	100	4	4/25/90 1/24/75
E27-94 30-08-02	42965	48363	647	100	1	6/7/90 9/11/80
E27-51 30-08-03	42932	48345	646.96	150*	1	Not Used
E27-95 30-08-12	42978	48398	647	100	1	6/7/90 1/24/75
E27-96 30-09-01	43047	48313	644.85	100	1	6/7/90 1/24/75
E27-97 30-09-02	43023	48284	645.17	100	1	6/7/90 6/7/79
E27-98 30-09-06	42956	48327	645	100	1	6/7/90 12/8/77
E27-135 30-09-07	42965	48342	---	125	1	6/7/90 12/16/82
E27-99 30-09-10	43026	48385	645.43	100	4	4/24/90 1/24/75
E27-100 30-09-11	43045	48349	644.99	100	4	4/24/90 1/24/75
E27-101 30-10-01	42979	48528	646	100	4	4/25/90 1/24/75
E27-102 30-10-02	42945	48494	646.52	100	4	4/24/90 1/24/75
E27-103 30-10-09	42926	48585	646	100	4	4/14/90 7/15/77
E27-104 30-10-11	42967	48570	646	100	4	4/25/90 9/11/79

* Log collected with Probe #2 (shielded probe) not with Probe #4 (unshielded).

o Bottom 100 feet of well is perforated.

Sources: Westinghouse GIS Listing of Well Statistics;
Welty & Vermeulen (1989); Welty (1988).

Table A1-12. Details of Wells and Logs Used in 241-C Tank Farm Evaluation.

Well #	Northing	Westing	TOC	TD	Logging Freq. (/yr)	Logs Used
E27-63 30-11-01	43036	48441	645.77	100	4	4/24/90 1/31/75
E27-105 30-11-05	42964	48438	646	100	1	Not Used
E27-64 30-11-06	42957	48469	646.49	100	1	6/7/90 1/24/75
E27-62 30-11-09	43002	48514	646.37	100	1	Not Used
E27-106 30-11-11	43043	48495	646	100	1	Not Used
E27-107 30-12-01	43120	48380	645	100	4	4/24/90 9/11/79
E27-108 30-12-03	43088	48352	645	100	4	4/24/90 5/9/75
E27-109 30-12-09	43074	48446	645	100	4	4/24/90 10/9/79
E27-125 30-12-13	43116	48387	---	116	4	4/24/90 5/9/79

* Log collected with Probe #2 (shielded probe) not with Probe #4 (unshielded).

o Bottom 100 feet of well is perforated.

Sources: Westinghouse GIS Listing of Well Statistics;
Welty & Vermeulen (1989); Welty (1988).

APPENDIX A.2

SAMPLE DATA

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Table A-2.1. Results of Grid Soil Sampling (pCi/g)
Location 2E11

	1985		1986		1987		1988		1989		
Radionuclide	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Average Result
Ce-141	–	–	–	–	–	–	–	–	–	–	–
Ce-144	–	–	2.10E-01	1.90E-01	–	–	< 6.00E-02	1.30E-01	–	–	1.35E-01
Co-58	*	–	–	–	–	–	< -5.00E-03	1.70E-02	–	–	5.00E-03
Co-60	*	–	2.00E-02	2.00E-02	–	–	< 7.70E-03	1.70E-02	–	–	1.39E-02
Cs-134	*	–	8.00E-02	3.00E-02	–	–	< -2.40E-04	1.90E-02	–	–	3.99E-02
Cs-137	1.30E+01	8.33E-01	1.40E+01	1.42E+00	–	–	8.60E+00	8.70E-01	–	–	1.19E+01
Eu-152	1.82E-01	1.65E-01	2.30E-01	9.00E-02	–	–	1.20E-01	9.90E-02	–	–	1.77E-01
Eu-154	*	–	–	–	–	–	< -5.50E-02	5.40E-02	–	–	5.50E-02
Eu-155	*	–	–	–	–	–	< 1.80E-02	7.10E-02	–	–	1.80E-02
I-129	–	–	–	–	–	–	–	–	–	–	–
K-40	–	–	–	–	–	–	–	–	–	–	–
Mn-54	*	–	–	–	–	–	2.60E-02	1.60E-02	–	–	2.60E-02
Nb-95	*	–	–	–	–	–	–	–	–	–	–
Pb-212	–	–	–	–	–	–	–	–	–	–	–
Pb-214	–	–	–	–	–	–	7.90E-01	1.10E-01	–	–	7.90E-01
Pu-238	2.60E-03	8.00E-04	1.00E-03	5.00E-04	–	–	8.60E-04	6.50E-04	–	–	1.49E-03
Pu-239	7.30E-02	8.00E-03	7.30E-02	8.00E-03	–	–	4.20E-02	6.20E-03	–	–	6.27E-02
Ru-106	*	–	–	–	–	–	< 3.50E-02	1.80E-01	–	–	3.50E-02
Sr-90	2.18E+00	3.98E-01	8.90E-01	1.70E-01	–	–	2.70E+00	5.10E-01	–	–	1.92E+00
Tc-99	–	–	–	–	–	–	–	–	–	–	–
U (total)	3.85E-01	1.26E-01	3.70E-01	1.20E-01	–	–	1.80E-01	6.40E-02	–	–	3.12E-01
Zn-65	*	–	–	–	–	–	< -1.60E-02	4.20E-02	–	–	1.60E-02
Zr-95	*	–	–	–	–	–	< 1.40E-02	3.30E-02	–	–	1.40E-02

Table A-2.1. Results of Grid Soil Sampling (pCi/g)
Location 2E12

	1985		1986		1987		1988		1989		
Radionuclide	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Average Result
Ce-141	–	–	–	–	< -4.40E-03	3.50E-02	–	–	1.02E-01	1.51E-01	4.88E-02
Ce-144	–	–	3.00E-01	2.60E-01	< -7.00E-03	9.70E-02	< -1.10E-02	1.10E-01	1.45E-01	2.29E-01	1.07E-01
Co-58	*	–	–	–	< -6.40E-03	1.80E-02	< -4.80E-03	1.60E-02	8.28E-03	2.27E-02	6.49E-03
Co-60	*	–	–	–	< -2.60E-03	2.00E-02	< 7.40E-04	1.60E-02	1.69E-02	2.29E-02	5.01E-03
Cs-134	6.60E-02	3.40E-02	8.00E-02	3.00E-02	4.50E-02	2.00E-02	< -8.50E-03	1.80E-02	2.73E-02	3.30E-02	4.20E-02
Cs-137	1.21E+01	7.84E-01	2.55E+01	2.56E+00	1.50E-01	3.00E-02	6.80E+00	6.90E-01	2.35E+01	2.36E+00	1.36E+01
Eu-152	*	–	–	–	1.10E-01	8.80E-02	< 6.80E-02	7.10E-02	1.75E-02	1.03E-01	6.52E-02
Eu-154	*	–	–	–	< 4.60E-02	5.00E-02	< -1.80E-02	5.20E-02	2.54E-02	7.07E-02	1.78E-02
Eu-155	*	–	1.90E-01	1.50E-01	7.00E-02	5.40E-02	7.30E-02	6.20E-02	4.85E-02	1.02E-01	9.54E-02
I-129	–	–	–	–	–	–	–	–	2.37E-02	2.79E-01	2.37E-02
K-40	–	–	–	–	–	–	–	–	1.19E+01	1.46E+00	1.19E+01
Mn-54	*	–	3.00E-02	2.00E-02	2.20E-02	1.50E-02	2.10E-02	1.50E-02	1.24E-02	2.47E-02	2.14E-02
Nb-95	*	–	–	–	–	–	–	–	1.21E-01	6.42E-02	1.21E-01
Pb-212	–	–	–	–	–	–	–	–	7.85E-01	1.07E-01	7.85E-01
Pb-214	–	–	–	–	–	–	7.40E-01	1.10E-01	6.42E-01	1.30E-01	6.91E-01
Pu-238	9.00E-04	5.00E-04	1.00E-03	5.00E-04	4.50E-04	2.50E-04	< 4.40E-04	5.70E-04	4.18E-03	7.82E-04	1.39E-03
Pu-239	2.80E-02	4.00E-03	4.20E-02	5.00E-03	7.40E-03	1.20E-03	1.60E-02	3.70E-03	1.05E-01	1.10E-02	3.97E-02
Ru-106	*	–	–	–	< 2.10E-02	1.30E-01	< -2.20E-01	1.80E-01	1.98E-01	3.22E-01	1.46E-01
Sr-90	1.36E+00	2.48E-01	2.10E+00	3.80E-01	4.10E-01	1.00E-01	6.50E-01	1.30E-01	1.67E+00	3.20E-01	1.24E+00
Tc-99	–	–	–	–	–	–	–	–	3.41E-01	1.07E+00	3.41E-01
U (total)	2.79E-01	9.50E-02	2.20E-01	8.00E-02	1.30E-01	4.30E-02	2.10E-01	7.00E-02	1.92E-01	6.32E-02	2.06E-01
Zn-65	*	–	–	–	< -3.20E-02	4.70E-02	< -1.20E-01	4.80E-02	2.27E-02	5.80E-02	5.82E-02
Zr-95	9.80E-02	6.10E-02	8.00E-02	6.00E-02	5.00E-02	2.90E-02	< 1.30E-02	2.90E-02	3.52E-02	6.06E-02	5.52E-02

Table A-2.1. Results of Grid Soil Sampling (pCi/g)
Location 2E17

	1985		1986		1987		1988		1989		
Radionuclide	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Average Result
Ce-141	--	--	--	--	4.10E-02	3.80E-02	--	--	6.65E-02	9.90E-02	5.38E-02
Ce-144	--	--	--	--	< -8.40E-02	1.30E-01	< 5.60E-02	1.50E-01	6.51E-02	1.27E-01	1.24E-02
Co-58	*	--	5.00E-02	3.00E-02	2.30E-02	1.40E-02	< 6.00E-04	1.80E-02	8.00E-03	2.67E-02	2.04E-02
Co-60	*	--	--	--	< -1.20E-02	1.90E-02	< -3.00E-03	2.00E-02	7.69E-03	1.89E-02	7.56E-03
Cs-134	*	--	5.00E-02	4.00E-02	3.70E-02	2.10E-02	< -1.80E-03	2.10E-02	4.23E-02	2.16E-02	3.19E-02
Cs-137	3.37E+00	2.51E-01	2.19E+00	2.50E-01	5.70E+00	5.90E-01	6.40E+00	6.50E-01	4.07E+00	4.19E-01	4.35E+00
Eu-152	*	--	--	--	< -5.50E-02	9.80E-02	8.40E-02	8.30E-02	1.19E-01	8.41E-02	4.93E-02
Eu-154	2.16E-01	1.03E-01	--	--	< 4.40E-02	5.40E-02	< -3.30E-02	6.10E-02	3.35E-02	5.68E-02	6.51E-02
Eu-155	*	--	--	--	< -2.80E-02	7.50E-02	< 2.30E-02	8.10E-02	4.67E-02	7.11E-02	1.39E-02
I-129	--	--	--	--	--	--	--	--	3.55E-02	2.63E-01	3.55E-02
K-40	--	--	--	--	--	--	--	--	1.50E+01	1.69E+00	1.50E+01
Mn-54	*	--	--	--	< 1.90E-03	1.90E-02	< 1.40E-02	1.70E-02	5.78E-04	2.07E-02	5.49E-03
Nb-95	*	--	--	--	--	--	--	--	7.69E-02	6.96E-02	7.69E-02
Pb-212	--	--	--	--	--	--	--	--	7.90E-01	9.26E-02	7.90E-01
Pb-214	--	--	--	--	--	--	5.40E-01	9.10E-02	6.17E-01	8.87E-02	5.79E-01
Pu-238	*	--	--	--	4.60E-04	3.90E-04	1.30E-03	5.60E-04	4.81E-04	2.60E-04	7.47E-04
Pu-239	2.00E-02	5.00E-03	7.00E-03	2.00E-03	1.70E-02	2.80E-03	3.20E-02	4.30E-03	4.09E-02	4.70E-03	2.34E-02
Ru-106	*	--	--	--	2.60E-01	1.70E-01	< -2.60E-02	2.00E-01	2.05E-01	1.94E-01	1.46E-01
Sr-90	2.71E+00	4.89E-01	3.04E+00	5.60E-01	5.20E+00	1.30E+00	3.40E+00	6.20E-01	3.10E+00	6.17E-01	3.49E+00
Tc-99	--	--	--	--	--	--	--	--	2.35E-01	1.06E+00	2.35E-01
U (total)	2.57E-01	8.90E-02	2.20E-01	7.00E-02	1.60E-01	5.20E-02	2.20E-01	7.20E-02	2.88E-01	9.07E-02	2.29E-01
Zn-65	*	--	--	--	< -9.60E-02	5.40E-02	< -3.00E-02	4.70E-02	8.76E-02	5.61E-02	7.12E-02
Zr-95	1.05E-01	6.60E-02	--	--	< 1.10E-02	3.60E-02	< 1.90E-02	3.20E-02	2.90E-02	5.98E-02	4.10E-02

Table A-2.1. Results of Grid Soil Sampling (pCi/g)
Location 2E18

	1985		1986		1987		1988		1989		
Radionuclide	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Average Result
Ce-141	–	–	–	–	< -2.40E-02	3.90E-02	–	–	1.35E-03	9.21E-02	1.27E-02
Ce-144	–	–	–	–	< -2.60E-02	1.10E-01	< 1.40E-02	1.10E-01	-2.71E-02	1.25E-01	2.24E-02
Co-58	*	–	–	–	< 1.40E-03	1.60E-02	< -2.20E-02	1.70E-02	8.06E-03	2.50E-02	1.05E-02
Co-60	*	–	–	–	< 1.00E-02	1.40E-02	< -9.50E-03	1.70E-02	7.46E-03	1.55E-02	2.65E-03
Cs-134	4.30E-02	2.90E-02	9.00E-02	3.00E-02	3.20E-02	1.90E-02	< -3.80E-02	1.90E-02	5.57E-03	1.72E-02	2.65E-02
Cs-137	5.15E+00	3.49E-01	1.03E+01	1.05E+00	4.60E+00	4.70E-01	3.20E+00	3.30E-01	7.96E+00	8.06E-01	6.24E+00
Eu-152	1.77E-01	1.08E-01	1.30E-01	1.00E-01	7.60E-02	6.60E-02	< 3.50E-02	7.80E-02	1.79E-02	8.11E-02	8.72E-02
Eu-154	*	–	–	–	7.10E-02	4.20E-02	< 7.50E-03	5.60E-02	3.95E-03	4.98E-02	2.75E-02
Eu-155	*	–	–	–	< 3.90E-03	6.10E-02	< 5.10E-02	7.20E-02	5.98E-02	6.07E-02	3.82E-02
I-129	–	–	–	–	–	–	–	–	1.85E-01	4.53E-01	1.85E-01
K-40	–	–	–	–	–	–	–	–	1.51E+01	1.67E+00	1.51E+01
Mn-54	*	–	–	–	3.10E-02	1.50E-02	< 1.10E-02	1.60E-02	1.06E-02	1.74E-02	1.75E-02
Nb-95	*	–	–	–	–	–	–	–	3.44E-02	6.23E-02	3.44E-02
Pb-212	–	–	–	–	–	–	–	–	7.48E-01	8.78E-02	7.48E-01
Pb-214	–	–	–	–	–	–	6.30E-01	8.80E-02	7.48E-01	1.02E-01	6.89E-01
Pu-238	6.00E-04	4.00E-04	4.00E-04	3.00E-04	< 2.10E-05	1.10E-04	< 7.30E-05	1.00E-04	2.23E-04	1.62E-04	2.63E-04
Pu-239	1.10E-02	2.00E-03	1.10E-02	2.00E-03	6.80E-03	1.20E-03	6.20E-03	1.10E-03	1.49E-02	1.95E-03	9.98E-03
Ru-106	*	–	–	–	< -4.60E-02	1.60E-01	< 5.50E-02	1.60E-01	-8.82E-02	1.79E-01	6.31E-02
Sr-90	1.18E+00	2.17E-01	1.29E+00	2.40E-01	1.20E+00	3.00E-01	5.60E-01	1.10E-01	2.40E+00	4.75E-01	1.33E+00
Tc-99	–	–	–	–	–	–	–	–	6.86E-01	1.10E+00	6.86E-01
U (total)	4.30E-01	1.38E-01	3.80E-01	1.20E-01	2.60E-01	7.70E-02	2.10E-01	7.00E-02	4.08E-01	1.23E-01	3.38E-01
Zn-65	*	–	8.00E-02	5.00E-02	< 3.20E-02	3.60E-02	< -9.80E-02	5.00E-02	-7.07E-02	4.70E-02	6.69E-02
Zr-95	*	–	–	–	< -4.80E-04	3.10E-02	3.50E-02	2.90E-02	2.48E-02	4.96E-02	1.98E-02

Table A-2.1. Results of Grid Soil Sampling (pCi/g)
Location 2E23

	1985		1986		1987		1988		1989		
Radionuclide	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Average Result
Ce-141	–	–	–	–	< 2.00E-02	5.10E-02	–	–	–	–	2.00E-02
Ce-144	–	–	–	–	< -1.10E-01	1.80E-01	1.80E-01	1.40E-01	–	–	3.50E-02
Co-58	*	–	–	–	< -2.70E-03	1.90E-02	< -2.20E-02	1.80E-02	–	–	1.24E-02
Co-60	*	–	3.00E-02	2.00E-02	2.90E-02	2.00E-02	< 1.40E-02	2.10E-02	–	–	2.43E-02
Cs-134	*	–	6.00E-02	4.00E-02	< 1.70E-02	2.60E-02	< -7.90E-02	2.90E-02	–	–	4.20E-02
Cs-137	9.29E+00	6.08E-01	9.98E+00	1.02E+00	1.10E+01	1.10E+00	9.60E+00	9.80E-01	–	–	9.97E+00
Eu-152	1.25E-01	1.16E-01	2.30E-01	1.00E-01	< 6.90E-02	8.60E-02	1.60E-01	9.60E-02	–	–	1.46E-01
Eu-154	*	–	–	–	< 4.80E-02	6.80E-02	< 3.00E-02	6.80E-02	–	–	3.90E-02
Eu-155	*	–	1.90E-01	1.60E-01	1.50E-01	1.00E-01	< 3.10E-02	8.20E-02	–	–	1.24E-01
I-129	–	–	–	–	–	–	–	–	–	–	–
K-40	–	–	–	–	–	–	–	–	–	–	–
Mn-54	2.10E-02	2.00E-02	–	–	< 1.70E-03	2.10E-02	< 1.40E-02	2.10E-02	–	–	1.22E-02
Nb-95	*	–	–	–	–	–	–	–	–	–	–
Pb-212	–	–	–	–	–	–	–	–	–	–	–
Pb-214	–	–	–	–	–	–	6.80E-01	1.10E-01	–	–	6.80E-01
Pu-238	5.30E-03	1.20E-03	4.00E-03	1.40E-03	1.50E-01	1.50E-02	5.00E-03	1.40E-03	–	–	4.11E-02
Pu-239	1.84E-01	1.80E-02	1.20E-01	1.60E-02	3.90E-02	4.70E-03	1.60E-01	1.90E-02	–	–	1.26E-01
Ru-106	*	–	–	–	< 1.40E-01	2.40E-01	< 1.10E-02	2.40E-01	–	–	7.55E-02
Sr-90	2.34E+00	4.25E-01	4.47E+00	8.50E-01	1.60E+00	3.90E-01	1.10E-01	2.50E-02	–	–	2.20E+00
Tc-99	–	–	–	–	–	–	–	–	–	–	–
U (total)	3.00E-01	1.10E-01	5.30E-01	1.70E-01	2.90E-01	8.70E-02	2.70E-01	8.80E-02	–	–	3.48E-01
Zn-65	*	–	1.10E-01	5.00E-02	< -6.10E-02	5.70E-02	< -1.10E-01	5.80E-02	–	–	9.37E-02
Zr-95	*	–	9.00E-02	6.00E-02	< 3.20E-02	3.70E-02	< 1.20E-02	3.60E-02	–	–	4.47E-02

Table A-2.1. Results of Grid Soil Sampling (pCi/g)
Location 2E24

	1985		1986		1987		1988		1989		
Radionuclide	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Average Result
Ce-141	–	–	–	–	< 2.20E-02	3.60E-02	–	–	2.97E-02	1.17E-01	2.59E-02
Ce-144	–	–	–	–	< -5.00E-02	1.20E-01	< 7.60E-02	1.50E-01	-1.94E-02	1.44E-01	2.20E-03
Co-58	*	–	–	–	< -8.10E-03	1.60E-02	< -4.60E-03	1.80E-02	2.87E-03	2.43E-02	1.19E-03
Co-60	*	–	–	–	< 9.00E-03	1.10E-02	< 8.60E-03	1.70E-02	3.09E-03	1.71E-02	6.90E-03
Cs-134	1.18E-01	3.60E-02	5.00E-02	4.00E-02	3.50E-02	1.90E-02	< -1.20E-02	2.00E-02	6.50E-03	1.52E-02	3.95E-02
Cs-137	4.94E+00	3.48E-01	8.95+00	9.20E-01	6.80E+00	6.90E-01	5.80E+00	5.90E-01	9.68E-01	1.12E-01	5.49E+00
Eu-152	2.31E-01	1.48E-01	1.60E-01	1.20E-01	1.00E-01	6.50E-02	< 6.40E-02	1.00E-01	6.49E-02	8.95E-02	1.24E-01
Eu-154	*	–	–	–	< -3.90E-02	5.20E-02	< 2.50E-02	5.60E-02	-3.89E-03	4.50E-02	2.26E-02
Eu-155	*	–	–	–	< -1.30E-02	6.90E-02	< 3.50E-02	8.00E-02	2.35E-02	8.05E-02	1.52E-02
I-129	–	–	–	–	< -3.20E-01	3.70E-01	–	–	1.74E-01	2.59E-01	2.47E-01
K-40	–	–	–	–	–	–	–	–	1.37E+01	1.60E+00	1.37E+01
Mn-54	*	–	–	–	< -3.80E-03	1.40E-02	< 1.30E-02	1.90E-02	-1.31E-02	1.83E-02	9.97E-02
Nb-95	*	–	–	–	–	–	–	–	-1.07E-01	6.58E-02	1.07E-01
Pb-212	–	–	–	–	–	–	–	–	8.55E-01	1.00E-01	8.55E-01
Pb-214	–	–	–	–	–	–	6.60E-01	9.90E-02	6.84E-01	9.64E-02	6.72E-01
Pu-238	5.00E-04	3.00E-04	1.10E-03	5.00E-04	4.10E-04	3.30E-04	6.20E-04	4.40E-04	7.92E-04	2.89E-04	6.84E-04
Pu-239	2.60E-02	3.00E-03	4.00E-02	5.00E-03	2.50E-02	3.20E-03	2.70E-02	4.00E-03	3.35E-02	3.75E-03	3.03E-02
Ru-106	*	–	–	–	< 1.50E-01	1.60E-01	< -1.00E-02	2.10E-01	-8.61E-02	1.68E-01	1.80E-02
Sr-90	1.28E+00	2.38E-01	1.27E+00	2.30E-01	1.20E+00	3.00E-01	< 1.80E-03	5.70E-03	2.19E-01	4.37E-02	7.94E-01
Tc-99	–	–	–	–	< 7.60E-03	7.70E-01	–	–	3.25E-01	1.07E+00	1.66E-01
U (total)	3.42E-01	1.13E-01	4.60E-01	1.50E-01	2.10E-01	6.40E-02	3.20E-01	1.00E-01	3.27E-01	1.02E-01	3.32E-01
Zn-65	*	–	–	–	< -2.20E-02	4.00E-02	< -3.50E-02	4.60E-02	-1.72E-02	4.08E-02	2.47E-02
Zr-95	*	–	–	–	4.10E-02	2.70E-02	< -1.80E-03	3.50E-02	2.01E-02	5.19E-02	1.98E-02

Table A-2.1. Results of Grid Soil Sampling (pCi/g)
Location 2E29

	1985		1986		1987		1988		1989		
Radionuclide	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Average Result
Ce-141	–	–	–	–	–	–	–	–	3.03E-02	7.97E-02	3.03E-02
Ce-144	–	–	–	–	–	–	< -1.60E-01	1.50E-01	-4.50E-02	1.02E-01	1.03E-01
Co-58	4.50E-02	4.10E-02	–	–	–	–	2.70E-02	2.20E-02	1.53E-02	2.65E-02	2.91E-02
Co-60	*	–	–	–	–	–	< 9.00E-03	1.80E-02	5.42E-03	1.70E-02	7.21E-03
Cs-134	6.60E-02	4.20E-02	8.00E-02	3.00E-02	–	–	< 3.00E-03	2.20E-02	-7.63E-03	1.69E-02	3.53E-02
Cs-137	2.98E+00	2.31E-01	2.37E+00	2.50E-01	–	–	3.20E+00	3.40E-01	1.93E+00	2.07E-01	2.62E+00
Eu-152	*	–	1.50E-01	8.00E-02	–	–	< -2.20E-03	1.20E-01	5.63E-02	6.98E-02	6.80E-02
Eu-154	*	–	–	–	–	–	< 9.50E-03	7.30E-02	3.97E-03	5.14E-02	6.74E-03
Eu-155	*	–	–	–	–	–	< 2.80E-02	8.30E-02	1.43E-02	5.52E-02	2.12E-02
I-129	–	–	–	–	–	–	–	–	1.74E-01	3.09E-01	1.74E-01
K-40	–	–	–	–	–	–	–	–	1.54E+01	1.74E+00	1.54E+01
Mn-54	*	–	–	–	–	–	< 4.50E-04	2.10E-02	-1.01E-02	1.96E-02	5.28E-03
Nb-95	1.23E-01	6.20E-02	–	–	–	–	–	–	-3.27E-02	7.08E-02	4.52E-02
Pb-212	–	–	–	–	–	–	–	–	8.75E-01	1.01E-01	8.75E-01
Pb-214	–	–	–	–	–	–	7.60E-01	1.10E-01	6.67E-01	9.09E-02	7.14E-01
Pu-238	2.40E-03	7.00E-04	1.80E-03	1.00E-03	–	–	1.90E-03	5.60E-04	1.24E-03	3.70E-04	1.84E-03
Pu-239	7.70E-02	8.00E-03	4.60E-02	7.00E-03	–	–	6.80E-02	7.80E-03	5.06E-02	5.48E-03	6.04E-02
Ru-106	*	–	4.00E-01	2.20E-01	–	–	< 1.40E-01	2.20E-01	1.30E-01	1.79E-01	2.23E-01
Sr-90	1.19E+00	3.51E-01	4.20E-01	8.00E-02	–	–	4.80E-01	8.80E-02	3.32E-01	6.28E-02	7.86E-01
Tc-99	–	–	–	–	–	–	–	–	2.24E-01	1.06E+00	2.24E-01
U (total)	3.99E-01	1.29E-01	5.90E-01	2.00E-01	–	–	3.20E-01	1.00E-01	4.82E-01	1.42E-01	4.48E-01
Zn-65	*	–	–	–	–	–	< -1.60E-02	5.80E-02	-1.87E-02	4.41E-02	1.74E-02
Zr-95	9.60E-02	7.90E-02	–	–	–	–	< -1.00E-02	4.50E-02	-2.22E-02	5.98E-02	2.13E-02

Table A-2.1. Results of Grid Soil Sampling (pCi/g)
Location 2E30

	1985		1986		1987		1988		1989		
Radionuclide	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Average Result
Ce-141	--	--	--	--	< -1.90E-02	2.80E-02	--	--	-4.98E-02	7.60E-02	3.44E-02
Ce-144	--	--	--	--	< 2.40E-02	9.60E-02	< 8.30E-03	1.20E-01	-4.86E-02	9.92E-02	2.70E-02
Co-58	*	--	--	--	< -7.30E-03	1.50E-02	< -5.10E-03	1.80E-02	3.24E-04	2.47E-02	4.24E-03
Co-60	*	--	--	--	< 5.00E-03	1.70E-02	< 3.00E-03	2.00E-02	-1.84E-03	1.45E-02	2.05E-03
Cs-134	*	--	--	--	4.70E-02	1.80E-02	< 1.40E-02	1.60E-02	-7.36E-02	1.93E-02	4.49E-02
Cs-137	2.33E-01	4.20E-02	--	--	2.20E-01	3.30E-02	3.20E-01	4.60E-02	3.41E-01	4.66E-02	2.79E-01
Eu-152	*	--	--	--	< 5.70E-02	6.20E-02	< 2.10E-02	9.90E-02	9.74E-02	7.13E-02	5.85E-02
Eu-154	*	--	--	--	< 4.30E-02	4.90E-02	< 3.10E-02	4.80E-02	-4.69E-02	5.44E-02	9.03E-03
Eu-155	*	--	--	--	< 3.80E-02	5.50E-02	< 2.80E-02	7.50E-02	7.85E-02	5.03E-02	4.82E-02
I-129	--	--	--	--	--	--	--	--	6.30E-02	4.65E-01	6.30E-02
K-40	--	--	--	--	--	--	--	--	1.35E+01	1.51E+00	1.35E+01
Mn-54	3.10E-02	2.30E-02	--	--	< -1.30E-02	1.80E-02	< 2.30E-03	1.80E-02	-4.48E-03	1.70E-02	3.96E-03
Nb-95	*	--	--	--	--	--	--	--	-1.14E-02	6.82E-02	1.14E-02
Pb-212	--	--	--	--	--	--	--	--	7.04E-01	8.07E-02	7.04E-01
Pb-214	--	--	--	--	--	--	6.50E-01	8.90E-02	6.02E-01	7.97E-02	6.26E-01
Pu-238	7.00E-04	4.00E-04	--	--	5.90E-04	2.70E-04	5.40E-04	2.40E-04	2.68E-03	5.62E-04	1.13E-03
Pu-239	1.90E-02	3.00E-03	--	--	1.70E-02	2.10E-03	1.80E-02	2.30E-03	3.53E-02	3.89E-03	2.23E-02
Ru-106	*	--	--	--	5.00E-01	1.70E-01	3.20E-01	1.70E-01	3.28E-01	1.52E-01	3.83E-01
Sr-90	6.48E-01	1.23E-01	--	--	2.00E-01	5.00E-02	4.20E-01	7.70E-02	2.03E-01	4.31E-02	3.68E-01
Tc-99	--	--	--	--	--	--	--	--	1.66E-01	1.05E+00	1.66E-01
U (total)	4.50E-01	1.45E-01	--	--	5.10E-02	2.30E-02	1.70E-01	5.90E-02	5.56E-01	1.62E-01	3.07E-01
Zn-65	*	--	--	--	< 6.20E-03	3.30E-02	4.30E-02	4.00E-02	-9.23E-02	5.26E-02	1.44E-02
Zr-95	*	--	--	--	< 3.50E-03	3.10E-02	< 2.00E-02	3.30E-02	3.36E-02	5.22E-02	1.90E-02

Table A-2.1. Results of Grid Soil Sampling (pCi/g)
Location 2ED

	1985		1986		1987		1988		1989		
Radionuclide	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Average Result
Ce-141	--	--	--	--	3.80E-02	3.30E-02	--	--	-2.74E-02	8.64E-02	5.30E-03
Ce-144	--	--	--	--	< -1.50E-02	1.10E-01	< 3.70E-02	9.70E-02	-5.57E-02	1.06E-01	3.59E-02
Co-58	*	--	--	--	< 8.70E-03	1.70E-02	< -1.00E-02	1.40E-02	2.44E-02	2.57E-02	7.70E-03
Co-60	*	--	--	--	2.50E-02	1.50E-02	< -7.10E-03	1.70E-02	-8.91E-03	1.56E-02	3.00E-03
Cs-134	7.30E-02	2.20E-02	6.00E-02	3.00E-02	4.30E-02	2.20E-02	< -5.60E-03	1.50E-02	1.29E-03	1.40E-02	3.43E-02
Cs-137	8.15E+00	5.10E-01	2.33E+00	2.50E-01	2.80E+00	2.90E-01	3.40E+00	3.50E-01	2.42E+00	2.53E-01	3.82E+00
Eu-152	*	--	1.10E-01	8.00E-02	< 5.50E-02	7.80E-02	1.30E-01	8.50E-02	1.29E-01	7.95E-02	1.06E-01
Eu-154	*	--	--	--	8.40E-02	4.70E-02	< -2.50E-02	5.50E-02	3.94E-02	5.77E-02	3.28E-02
Eu-155	*	--	9.00E-02	7.00E-02	< 6.00E-02	6.20E-02	< 4.60E-02	5.30E-02	6.19E-02	5.08E-02	6.45E-02
I-129	--	--	--	--	5.60E-01	3.20E-01	--	--	-2.52E-01	5.34E-01	1.54E-01
K-40	--	--	--	--	--	--	--	--	1.63E+01	1.79E+00	1.63E+01
Mn-54	*	--	--	--	1.80E-02	1.50E-02	2.40E-02	1.70E-02	-1.50E-02	1.83E-02	9.00E-03
Nb-95	*	--	--	--	--	--	--	--	-6.84E-02	7.10E-02	6.84E-02
Pb-212	--	--	--	--	--	--	--	--	7.70E-01	8.71E-02	7.70E-01
Pb-214	--	--	--	--	--	--	6.90E-01	9.00E-02	6.76E-01	8.82E-02	6.83E-01
Pu-238	2.50E-03	7.00E-04	5.00E-04	3.00E-04	6.50E-04	2.90E-04	9.00E-04	3.10E-04	1.60E-04	1.35E-04	9.42E-04
Pu-239	7.10E-02	7.00E-03	3.10E-02	4.00E-03	4.50E-02	5.10E-03	3.90E-02	4.30E-03	1.80E-02	2.24E-03	4.08E-02
Ru-106	*	--	--	--	< 2.70E-02	1.50E-01	< 6.40E-02	1.50E-01	7.01E-02	1.48E-01	5.37E-02
Sr-90	1.83E+00	3.40E-01	7.20E-01	1.40E-01	7.00E-01	1.70E-01	8.00E-01	1.50E-01	4.51E-01	9.42E-02	9.00E-01
Tc-99	--	--	--	--	< 2.20E-02	9.80E-01	--	--	2.30E-01	1.03E+00	1.26E-01
U (total)	5.16E-01	1.63E-01	9.50E-01	3.10E-01	3.40E-01	9.80E-02	3.20E-01	1.00E-01	3.56E-01	1.09E-01	4.96E-01
Zn-65	*	--	--	--	4.60E-02	3.80E-02	< -1.60E-01	5.30E-02	-8.64E-02	4.89E-02	9.75E-02
Zr-95	*	--	--	--	< 2.20E-02	3.40E-02	< -1.60E-02	2.80E-02	3.73E-02	5.25E-02	1.44E-02

Table A-2.1. Results of Grid Soil Sampling (pCi/g)
Location 2EDB

	1985		1986		1987		1988		1989		
Radionuclide	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Average Result
Ce-141	--	--	--	--	< 1.90E-02	3.10E-02	--	--	--	--	1.90E-02
Ce-144	--	--	--	--	< 9.20E-03	1.10E-01	--	--	--	--	9.20E-03
Co-58	--	--	--	--	< 7.60E-03	1.30E-02	--	--	--	--	7.60E-03
Co-60	--	--	--	--	< 8.40E-03	1.60E-02	--	--	--	--	8.40E-03
Cs-134	--	--	--	--	6.60E-02	2.10E-02	--	--	--	--	6.60E-02
Cs-137	--	--	--	--	2.80E+00	2.90E-01	--	--	--	--	2.80E+00
Eu-152	--	--	--	--	1.50E-01	6.80E-02	--	--	--	--	1.50E-01
Eu-154	--	--	--	--	< -3.90E-02	6.10E-02	--	--	--	--	3.90E-02
Eu-155	--	--	--	--	5.80E-02	5.50E-02	--	--	--	--	5.80E-02
I-129	--	--	--	--	< 1.00E-01	3.40E-01	--	--	--	--	1.00E-01
K-40	--	--	--	--	--	--	--	--	--	--	--
Mn-54	--	--	--	--	1.70E-02	1.60E-02	--	--	--	--	1.70E-02
Nb-95	--	--	--	--	--	--	--	--	--	--	--
Pb-212	--	--	--	--	--	--	--	--	--	--	--
Pb-214	--	--	--	--	--	--	--	--	--	--	--
Pu-238	--	--	--	--	5.00E-04	2.40E-04	--	--	--	--	5.00E-04
Pu-239	--	--	--	--	4.00E-02	4.40E-03	--	--	--	--	4.00E-02
Ru-106	--	--	--	--	< 1.00E-01	1.30E-01	--	--	--	--	1.00E-01
Sr-90	--	--	--	--	6.60E-01	1.60E-01	--	--	--	--	6.60E-01
Tc-99	--	--	--	--	< 5.20E-01	1.10E+00	--	--	--	--	5.20E-01
U (total)	--	--	--	--	3.70E-01	1.10E-01	--	--	--	--	3.70E-01
Zn-65	--	--	--	--	< 4.00E-03	3.60E-02	--	--	--	--	4.00E-03
Zr-95	--	--	--	--	< -2.00E-03	3.20E-02	--	--	--	--	2.00E-03

Table A-2.1. Results of Grid Soil Sampling (pCi/g)
Location GRT1

	1985		1986		1987		1988		1989		
Radionuclide	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Average Result
Ce-141	–	–	–	–	< -1.50E-02	3.50E-02	–	–	-3.37E-02	8.04E-02	2.44E-02
Ce-144	–	–	–	–	< -9.30E-02	1.20E-01	< -1.40E-02	7.40E-02	-1.60E-02	1.03E-01	4.10E-02
Co-58	–	–	–	–	< -1.40E-02	1.80E-02	< 1.00E-02	1.10E-02	1.74E-02	2.47E-02	4.47E-03
Co-60	–	–	–	–	< -2.30E-02	2.00E-02	< -3.20E-03	1.30E-02	-1.09E-02	1.57E-02	1.24E-02
Cs-134	–	–	–	–	3.90E-02	2.20E-02	< -4.40E-03	1.10E-02	-4.60E-04	1.47E-02	1.14E-02
Cs-137	–	–	–	–	1.80E+00	1.90E-01	7.10E-01	7.90E-02	1.98E+00	2.09E-01	1.50E+00
Eu-152	–	–	–	–	1.30E-01	8.10E-02	< 5.80E-02	6.30E-02	1.35E-01	8.53E-02	1.08E-01
Eu-154	–	–	–	–	< -4.60E-02	6.00E-02	< -9.90E-04	4.20E-02	-1.70E-02	5.03E-02	2.13E-02
Eu-155	–	–	–	–	< 4.00E-02	5.90E-02	5.10E-02	4.20E-02	4.48E-02	5.03E-02	4.53E-02
I-129	–	–	–	–	< -1.40E-01	3.40E-01	3.30E-01	2.80E-01	-1.75E-01	5.51E-01	5.00E-03
K-40	–	–	–	–	–	–	–	–	1.45E+01	1.62E+00	1.45E+01
Mn-54	–	–	–	–	3.90E-02	1.60E-02	< 4.20E-03	1.30E-02	2.05E-02	1.82E-02	2.12E-02
Nb-95	–	–	–	–	–	–	–	–	-5.28E-02	7.16E-02	5.28E-02
Pb-212	–	–	–	–	–	–	–	–	7.63E-01	8.72E-02	7.63E-01
Pb-214	–	–	–	–	–	–	5.80E-01	7.30E-02	5.97E-01	8.27E-02	5.89E-01
Pu-238	–	–	–	–	3.90E-04	2.50E-04	< 1.40E-04	2.20E-04	5.34E-04	2.31E-04	3.55E-04
Pu-239	–	–	–	–	1.70E-02	2.20E-03	7.30E-03	1.80E-03	2.00E-02	2.38E-03	1.48E-02
Ru-106	–	–	–	–	< -1.80E-01	1.70E-01	< -4.00E-02	1.00E-01	-1.26E-02	1.48E-01	7.75E-02
Sr-90	–	–	–	–	4.40E-01	1.10E-01	3.00E-01	5.80E-02	3.65E-01	7.02E-02	3.68E-01
Tc-99	–	–	–	–	< 5.20E-01	8.60E-01	–	–	4.92E-02	1.16E+00	2.85E-01
U (total)	–	–	–	–	2.20E-01	6.90E-02	–	–	4.42E-01	1.33E-01	3.31E-01
Zn-65	–	–	–	–	4.80E-02	3.90E-02	< -1.70E-02	2.80E-02	-5.70E-02	4.55E-02	4.07E-02
Zr-95	–	–	–	–	4.10E-02	3.70E-02	< -8.70E-03	2.20E-02	2.57E-02	5.11E-02	1.93E-02

Table A-2.1. Results of Grid Soil Sampling (pCi/g)
Location GRT2

	1985		1986		1987		1988		1989		
Radionuclide	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Average Result
Ce-141	--	--	--	--	< -1.50E-02	4.40E-02	--	--	2.47E-02	9.40E-02	4.85E-03
Ce-144	--	--	--	--	< -2.50E-02	1.40E-01	< -1.50E-02	9.90E-02	2.08E-03	1.12E-01	1.40E-02
Co-58	--	--	--	--	< -7.10E-03	1.80E-02	< -1.10E-03	1.40E-02	1.84E-02	2.58E-02	3.40E-03
Co-60	--	--	--	--	1.80E-02	1.70E-02	< -7.40E-03	1.50E-02	-1.43E-02	1.87E-02	1.32E-02
Cs-134	--	--	--	--	3.20E-02	2.40E-02	< 3.40E-03	1.40E-02	-5.30E-02	2.07E-02	2.95E-02
Cs-137	--	--	--	--	2.30E+00	2.40E-01	2.30E+00	2.40E-01	1.19E+00	1.31E-01	1.93E+00
Eu-152	--	--	--	--	9.20E-02	8.60E-02	< 7.60E-02	7.60E-02	-2.45E-02	8.30E-02	4.78E-02
Eu-154	--	--	--	--	< 2.30E-02	5.70E-02	< -3.00E-02	5.30E-02	4.84E-02	6.34E-02	1.38E-02
Eu-155	--	--	--	--	< -6.70E-03	8.40E-02	7.30E-02	5.80E-02	3.09E-02	5.60E-02	3.24E-02
I-129	--	--	--	--	< 1.80E-01	3.30E-01	< 1.60E-02	3.40E-01	9.59E-02	4.68E-01	9.73E-02
K-40	--	--	--	--	--	--	--	--	1.42E+01	1.60E+00	1.42E+01
Mn-54	--	--	--	--	< 1.10E-02	1.70E-02	< -2.20E-03	1.60E-02	-3.87E-03	1.78E-02	1.64E-03
Nb-95	--	--	--	--	--	--	--	--	-8.71E-02	7.34E-02	8.71E-02
Pb-212	--	--	--	--	--	--	--	--	8.43E-01	9.71E-02	8.43E-01
Pb-214	--	--	--	--	--	--	6.40E-01	8.40E-02	6.04E-01	8.36E-02	6.22E-01
Pu-238	--	--	--	--	7.70E-04	2.90E-04	< -1.60E-05	4.30E-04	7.33E-04	2.93E-04	4.96E-04
Pu-239	--	--	--	--	7.10E-02	7.50E-03	1.10E-02	3.10E-03	9.48E-03	1.39E-03	3.05E-02
Ru-106	--	--	--	--	< 1.20E-01	1.60E-01	< 9.40E-02	1.30E-01	5.72E-02	1.69E-01	9.04E-02
Sr-90	--	--	--	--	3.90E-01	1.00E-01	4.80E-01	9.40E-02	1.83E-01	3.52E-02	3.51E-01
Tc-99	--	--	--	--	< 5.30E-01	1.10E+00	--	--	2.47E-01	1.17E+00	3.89E-01
U (total)	--	--	--	--	3.20E-01	9.40E-02	--	--	4.51E-01	1.34E-01	3.86E-01
Zn-65	--	--	--	--	8.20E-02	3.90E-02	< -1.80E-02	4.10E-02	-1.60E-01	6.10E-02	8.67E-02
Zr-95	--	--	--	--	< -3.10E-02	4.10E-02	3.00E-02	2.80E-02	4.95E-02	6.43E-02	1.62E-02

Table A-2.1. Results of Grid Soil Sampling (pCi/g)
Location GRT4

	1985		1986		1987		1988		1989		
Radionuclide	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Average Result
Ce-141	--	--	--	--	< -3.40E-02	4.40E-02	--	--	2.24E-02	7.90E-02	2.82E-02
Ce-144	--	--	--	--	< -2.30E-02	1.30E-01	< -4.00E-03	8.50E-02	2.49E-02	9.69E-02	1.73E-02
Co-58	--	--	--	--	< -3.10E-03	1.80E-02	< 9.30E-03	1.40E-02	1.10E-02	2.53E-02	5.73E-03
Co-60	--	--	--	--	< -2.30E-02	2.00E-02	< -4.30E-03	1.40E-02	-2.82E-02	1.82E-02	1.85E-02
Cs-134	--	--	--	--	6.50E-02	2.40E-02	< -7.30E-03	1.40E-02	-8.10E-02	1.97E-02	5.11E-02
Cs-137	--	--	--	--	1.30E+00	1.40E-01	1.20E+00	1.30E-01	5.26E-01	6.43E-02	1.01E+00
Eu-152	--	--	--	--	1.10E-01	7.40E-02	1.20E-01	7.50E-02	8.71E-02	7.78E-02	1.06E-01
Eu-154	--	--	--	--	< -1.50E-02	6.30E-02	< -1.80E-02	4.40E-02	1.16E-02	5.12E-02	1.49E-02
Eu-155	--	--	--	--	< 7.50E-02	7.60E-02	6.70E-02	4.70E-02	3.24E-02	4.93E-02	5.81E-02
I-129	--	--	--	--	< -1.10E+00	6.50E-01	< -5.70E-01	5.70E-01	-9.87E-02	4.90E-01	5.90E-01
K-40	--	--	--	--	--	--	--	--	1.51E+01	1.67E+00	1.51E+01
Mn-54	--	--	--	--	2.30E-02	1.70E-02	< 1.30E-02	1.50E-02	-6.94E-03	1.84E-02	9.69E-03
Nb-95	--	--	--	--	--	--	--	--	-2.89E-02	6.53E-02	2.89E-02
Pb-212	--	--	--	--	--	--	--	--	7.91E-01	8.86E-02	7.91E-01
Pb-214	--	--	--	--	--	--	6.90E-01	8.80E-02	5.98E-01	7.77E-02	6.44E-01
Pu-238	--	--	--	--	3.40E-04	1.90E-04	< 3.30E-04	3.30E-04	6.64E-04	3.05E-04	4.45E-04
Pu-239	--	--	--	--	1.60E-02	1.90E-03	2.00E-02	3.20E-03	7.35E-03	1.24E-03	1.45E-02
Ru-106	--	--	--	--	< -2.70E-03	1.80E-01	< 5.30E-02	1.20E-01	5.74E-02	1.40E-01	3.59E-02
Sr-90	--	--	--	--	3.40E-01	8.50E-02	3.80E-01	7.20E-02	1.80E-01	3.53E-02	3.00E-01
Tc-99	--	--	--	--	< 2.40E-01	8.50E-01	--	--	4.23E-01	1.04E+00	3.32E-01
U (total)	--	--	--	--	3.10E-01	9.10E-02	--	--	3.24E-01	9.97E-02	3.17E-01
Zn-65	--	--	--	--	< 1.80E-03	4.00E-02	< -6.60E-02	4.10E-02	-9.95E-02	4.99E-02	5.58E-02
Zr-95	--	--	--	--	< 1.80E-02	3.20E-02	< -1.60E-02	2.80E-02	2.23E-02	5.46E-02	8.10E-03

Table A-2.1. Results of Grid Soil Sampling (pCi/g)
Location GRT5

	1985		1986		1987		1988		1989		
Radionuclide	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Average Result
Ce-141	--	--	--	--	< 7.20E-03	3.10E-02	--	--	-2.47E-02	8.02E-02	1.60E-02
Ce-144	--	--	--	--	< -6.00E-02	1.00E-01	< -1.70E-02	7.70E-02	-1.36E-03	9.95E-02	2.61E-02
Co-58	--	--	--	--	< 9.20E-04	1.70E-02	< -7.10E-03	1.20E-02	-2.34E-02	2.93E-02	1.05E-02
Co-60	--	--	--	--	< 1.20E-03	1.70E-02	< -9.30E-03	1.20E-02	1.24E-02	1.64E-02	1.43E-03
Cs-134	--	--	--	--	6.30E-02	2.00E-02	< 8.10E-04	1.20E-02	9.82E-03	1.54E-02	2.45E-02
Cs-137	--	--	--	--	1.20E+00	1.30E-01	1.30E+00	1.30E-01	2.33E+00	2.44E-01	1.61E+00
Eu-152	--	--	--	--	9.30E-02	7.20E-02	< 4.60E-02	6.40E-02	4.24E-02	7.41E-02	6.05E-02
Eu-154	--	--	--	--	< 2.10E-02	5.90E-02	< 5.90E-03	4.10E-02	-4.09E-02	5.44E-02	2.26E-02
Eu-155	--	--	--	--	< 2.40E-02	5.60E-02	< 4.10E-02	4.30E-02	2.35E-02	5.31E-02	2.95E-02
I-129	--	--	--	--	3.60E-01	3.00E-01	< -2.60E-01	5.10E-01	-3.37E-01	5.73E-01	3.19E-01
K-40	--	--	--	--	--	--	--	--	1.48E+01	1.65E+00	1.48E+01
Mn-54	--	--	--	--	< 1.30E-02	1.50E-02	< 1.30E-03	1.40E-02	5.56E-03	1.93E-02	6.62E-03
Nb-95	--	--	--	--	--	--	--	--	-1.49E-01	7.13E-02	1.49E-01
Pb-212	--	--	--	--	--	--	--	--	7.97E-01	9.25E-02	7.97E-01
Pb-214	--	--	--	--	--	--	6.90E-01	8.50E-02	6.51E-01	8.70E-02	6.71E-01
Pu-238	--	--	--	--	2.60E-04	1.80E-04	3.90E-04	2.60E-04	3.60E-04	1.92E-04	3.37E-04
Pu-239	--	--	--	--	6.90E-03	1.00E-03	1.30E-02	2.10E-03	1.84E-02	2.23E-03	1.28E-02
Ru-106	--	--	--	--	< -2.00E-01	1.50E-01	< 5.20E-02	1.10E-01	-7.51E-03	1.67E-01	8.65E-02
Sr-90	--	--	--	--	2.20E-01	5.50E-02	3.30E-01	6.50E-02	9.76E-01	1.91E-01	5.09E-01
Tc-99	--	--	--	--	< 2.70E-01	8.50E-01	--	--	5.62E-01	1.05E+00	4.16E-01
U (total)	--	--	--	--	3.50E-01	1.00E-01	--	--	4.13E-01	1.25E-01	3.82E-01
Zn-65	--	--	--	--	< 8.40E-03	4.10E-02	< -8.20E-02	3.80E-02	-9.42E-03	5.14E-02	3.33E-02
Zr-95	--	--	--	--	< 2.10E-03	3.30E-02	< 1.50E-02	2.30E-02	0.00E+00	5.76E-02	5.70E-03

Table A-2.1. Results of Grid Soil Sampling (pCi/g)
Location GRT6

	1985		1986		1987		1988		1989		
Radionuclide	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Average Result
Ce-141	–	–	–	–	< -3.60E-03	3.90E-02	–	–	-5.63E-02	8.22E-02	3.00E-02
Ce-144	–	–	–	–	< -2.90E-02	1.30E-01	< 2.50E-03	9.30E-02	-5.48E-02	1.10E-01	2.88E-02
Co-58	–	–	–	–	> 8.80E-03	1.80E-02	< -4.00E-03	1.50E-02	-2.92E-02	3.34E-02	1.40E-02
Co-60	–	–	–	–	< -2.50E-03	2.10E-02	< 6.30E-03	1.40E-02	1.20E-02	1.97E-02	5.27E-03
Cs-134	–	–	–	–	3.80E-02	2.30E-02	< -4.50E-03	1.30E-02	2.19E-03	1.78E-02	1.19E-02
Cs-137	–	–	–	–	2.30E+00	2.50E-01	1.20E+00	1.30E-01	1.70E+00	1.83E-01	1.73E+00
Eu-152	–	–	–	–	< 4.60E-02	8.30E-02	< 6.90E-02	7.10E-02	5.60E-02	7.58E-02	5.70E-02
Eu-154	–	–	–	–	< 4.40E-02	5.70E-02	< 1.40E-02	4.70E-02	-9.17E-03	6.06E-02	1.63E-02
Eu-155	–	–	–	–	< 5.60E-02	7.30E-02	5.90E-02	5.30E-02	2.62E-02	5.80E-02	4.71E-02
I-129	–	–	–	–	3.90E-01	2.90E-01	4.60E-01	2.70E-01	1.11E-01	3.24E-01	3.20E-01
K-40	–	–	–	–	–	–	–	–	1.50E+01	1.71E+00	1.50E+01
Mn-54	–	–	–	–	< -7.10E-03	2.00E-02	< 6.00E-04	1.50E-02	9.42E-03	2.28E-02	9.73E-04
Nb-95	–	–	–	–	–	–	–	–	-1.38E-01	7.12E-02	1.38E-01
Pb-212	–	–	–	–	–	–	–	–	8.28E-01	9.69E-02	8.28E-01
Pb-214	–	–	–	–	–	–	5.80E-01	7.80E-02	6.68E-01	9.50E-02	6.24E-01
Pu-238	–	–	–	–	8.50E-04	3.50E-04	< -1.60E-05	1.70E-04	1.58E-04	1.44E-04	3.31E-04
Pu-239	–	–	–	–	1.60E-02	2.20E-03	5.90E-03	1.40E-03	1.02E-02	1.50E-03	1.07E-02
Ru-106	–	–	–	–	< -1.30E-02	1.50E-01	< 3.60E-02	1.20E-01	-3.91E-02	1.70E-01	2.94E-02
Sr-90	–	–	–	–	4.10E-01	1.00E-01	2.10E-01	4.10E-02	2.39E-01	4.64E-02	2.86E-01
Tc-99	–	–	–	–	< 2.50E-01	8.50E-01	–	–	3.59E-01	1.04E+00	3.05E-01
U (total)	–	–	–	–	3.50E-01	1.00E-01	–	–	4.47E-01	1.34E-01	3.99E-01
Zn-65	–	–	–	–	< 2.30E-02	4.20E-02	< -1.30E-02	3.60E-02	-2.36E-02	5.45E-02	1.99E-02
Zr-95	–	–	–	–	< 3.20E-02	3.70E-02	< 2.30E-02	2.70E-02	7.18E-02	6.10E-02	4.23E-02

NOTE: Negative values indicate concentrations at or near background levels of radioactivity.
Shaded Areas indicate a positive detection, the result is larger than the error.
Dashes indicate no data are available.
An asterisk (*) indicates that radionuclide concentration is less than detectable. The detection limits are as follows: Mn-54 = 2.0E-02, Co-58 = 2.0E-02, Co-60 = 2.0E-02, Zn-65 = 4.0E-02, Sr-90 = 5.0E-03, nb-95 = 3.0 E-02, Zr-95 = 3.0E-02, Ru-106 = 1.7E-01, Cs-134 = 2.0E-02, Cs-137 = 2.0E-02, Eu-152 = 1.1E-01, Eu-154 = 5.0E-02, Eu-155 = 5.0E-02, Pu-238 = 6.0E-04, Pu-239 = 6.0E-04, and U total = 1.0E-02.
Source: Schmidt et al. 1990; Elder et al. 1986, 1987, 1988, 1989

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Table A-2.2 Results of Fenceline Soil Sampling (pCi/g)
Location 2E-1

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Ce-141	--	--	--	--	<9.10E-03	2.80E-02	<1.20E-02	2.60E-02	-2.40E-02	8.26E-02	-9.67E-04
Ce-144	--	--	--	--	<2.90E-02	9.30E-02	--	--	-4.48E-04	1.06E-01	1.43E-02
Co-58	*	--	--	--	<3.40E-03	1.50E-02	--	--	0.00E+00	2.37E-02	1.70E-03
C0-60	6.10E-02	3.10E-02	--	--	<1.30E-02	1.60E-02	--	--	7.06E-04	1.45E-02	2.49E-02
Cs-134	7.00E-02	3.50E-02	3.00E-02	2.90E-02	<1.00E-02	2.00E-02	<7.30E-03	1.20E-02	-5.15E-02	1.94E-02	1.32E-02
Cs-137	3.59E+00	2.91E-01	1.31E+00	1.52E-01	1.10E+00	1.20E-01	1.50E+00	1.60E-01	4.85+00	4.94E-01	2.47E+00
Eu-152	*	--	2.35E-01	8.90E-02	1.30E-01	6.60E-02	7.60E-02	6.40E-02	4.16E-02	6.84E-02	1.21E-01
Eu-154	*	--	--	--	1.20E-01	4.50E-02	<1.10E-02	4.90E-02	-1.74E-02	4.67E-02	3.79E-02
Eu-155	*	--	--	--	<-3.70E-02	5.70E-02	<3.00E-02	5.20E-02	2.32E-02	5.69E-02	5.40E-03
I-129	--	--	--	--	--	--	--	--	--	--	--
K-40	--	--	--	--	--	--	--	--	1.32E+01	1.46E+00	1.32E+01
Mn-54	*	--	--	--	<5.80E-03	1.60E-02	<1.90E-03	1.50E-02	1.16E-02	1.64E-02	6.43E-03
Nb-95	*	--	--	--	--	--	--	--	2.00E-03	5.15E-02	2.00E-03
Pb-212	--	--	--	--	--	--	--	--	6.29E-01	7.46E-02	6.29E-01
Pb-214	--	--	--	--	--	--	--	--	4.60E-01	7.01E-02	4.60E-01
Pu-238	2.00E-04	2.00E-04	--	--	<4.40E-05	1.20E-04	<-1.60E-05	9.20E-05	--	--	7.60E-05
Pu-239	2.80E-02	3.00E-03	2.00E-03	1.00E-03	1.10E-03	4.00E-04	1.60E-03	4.80E-04	--	--	8.18E-03
Ru-106	*	--	--	--	<1.20E-01	1.30E-01	<2.20E-02	1.20E-01	4.33E-02	1.60E-01	6.18E-02
Sr-90	1.12E+00	2.50E-01	4.42E-01	8.60	3.50E-01	8.70E-02	5.20E-01	9.80E-02	--	--	6.08E-02
Tc-99	--	--	--	--	--	--	--	--	--	--	--
U (total)	2.50E-01	8.70E-02	3.60E-01	1.18E-01	3.20E-01	1.50E-01	1.30E-01	4.80E-02	--	--	2.65E-01
Zn-65	*	--	--	--	<-5.50E-02	4.20E-02	--	--	-1.13E-01	4.97E-02	-8.40E-02
Zr-95	*	--	--	--	<-7.90E-03	3.00E-02	<-8.70E-03	2.60E-02	-3.56E-03	4.43E-02	-6.72E-03

Table A-2.2 Results of Fenceline Soil Sampling (pCi/g)
Location 2E-2

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989		Average Result
Ce-141	–	–	–	–	<-3.10E-02	5.90E-02	<2.20E-03	3.70E-03	5.23E-02	8.72E-02	7.83E-03
Ce-144	–	–	–	–	<8.20E-02	2.00E-01	–	–	-4.45E-02	1.17E-01	1.88E-02
Co-58	*	–	–	–	<3.10E-04	1.70E-02	–	–	-1.22E-02	2.17E-02	-5.95E-03
C0-60	*	–	–	–	<-7.60E-03	1.60E-02	–	–	-1.20E-03	1.58E-02	-4.40E-03
Cs-134	*	–	–	–	7.50E-02	2.10E-02	<1.80E-02	1.90E-02	-4.95E-03	1.76E-02	2.94E-02
Cs-137	2.10E+01	1.35E+00	2.12E+01	2.15E+00	2.50E+01	2.50E+00	1.50E+01	1.50E+00	7.66E+00	7.76E-01	1.80E+01
Eu-152	*	–	1.67E-01	1.06E-01	<5.60E-02	7.40E-02	8.50E-02	8.10E-02	6.20E-02	6.74E-02	9.25E-02
Eu-154	*	–	–	–	<5.00E-02	5.30E-02	<-6.50E-04	4.80E-02	6.12E-02	4.40E-02	3.69E-02
Eu-155	*	–	–	–	<8.70E-02	1.20E-01	<5.40E-02	7.50E-02	3.61E-03	5.73E-02	4.82E-02
I-129	–	–	–	–	–	–	–	–	–	–	–
K-40	–	–	–	–	–	–	–	–	1.36E+01	152E+00	1.36E+01
Mn-54	*	–	–	–	<8.40E-03	1.60E-02	<7.70E-03	1.40E-02	1.56E-02	1.61E-02	1.06E-02
Nb-95	*	–	–	–	–	–	–	–	-1.64E-02	4.46E-02	-1.64E-02
Pb-212	–	–	–	–	–	–	–	–	6.13E-01	7.50E-02	6.13E-01
Pb-214	–	–	–	–	–	–	–	–	4.69E-01	7.60E-02	4.69E-01
Pu-238	5.00E-04	3.00E-04	–	–	<2.70E-04	4.00E-04	<-3.20E-05	3.30E-04	–	–	2.46E-04
Pu-239	8.00E-03	2.00E-03	7.00E-03	2.00E-03	7.30E-03	1.70E-03	4.30E-03	1.50E-03	–	–	6.65E-03
Ru-106	*	–	1.88E-01	4.45E-01	<2.30E-01	2.50E-01	<1.20E-01	2.00E-01	3.73E-02	1.71E-01	2.16E-01
Sr-90	2.67E+00	4.95E-01	2.35E+00	4.28E-01	2.60E+00	6.60E-01	2.10E+00	3.90E-01	–	–	2.43E+00
Tc-99	–	–	–	–	–	–	–	–	–	–	–
U (total)	3.08E-01	1.03E-01	2.87E-01	9.50E-02	3.90E-01	1.80E-01	3.30E-01	1.00E-01	–	–	3.29E-01
Zn-65	*	–	1.09E-01	6.20E-02	<1.60E-02	4.00E-02	–	–	-3.69E-02	4.26E-02	2.94E-02
Zr-95	*	–	–	–	<-2.40E-02	3.20E-02	<6.80E-03	2.50E-02	-2.52E-02	4.19E-02	-1.41E-02

Table A-2.2 Results of Fenceline Soil Sampling (pCi/g)
Location 2E-3

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Ce-141	–	–	–	–	<-8.70E-03	2.90E-02	<7.50E-03	2.60E-02	-1.94E-02	6.85E-02	-6.87E-03
Ce-144	–	–	–	–	<-9.30E-02	9.80E-02	–	–	-7.68E-02	8.80E-02	-8.49E-02
Co-58	*	–	–	–	<7.80E-03	1.60E-02	–	–	-8.49E-03	2.53E-02	-3.45E-04
C0-60	*	–	–	–	<6.40E-03	1.60E-02	–	–	5.46E-03	1.51E-02	5.93E-03
Cs-134	9.60E-02	6.40E-02	–	–	4.90E-02	2.40E-02	2.50E-02	1.40E-02	-4.99E-03	1.39E-02	4.13E-02
Cs-137	6.00E-01	1.17E-01	2.23E-01	4.60E-02	4.90E-01	6.40E-02	7.80E-01	8.90E-02	2.90E-01	3.94E-02	4.77E-01
Eu-152	*	–	1.41E-01	9.40E-02	1.00E-01	6.10E-02	7.20E-02	5.70E-02	1.28E-01	7.51E-02	1.10E-01
Eu-154	*	–	–	–	<7.40E-03	5.20E-02	<1.80E-02	4.40E-02	-3.33E-04	5.06E-02	8.36E-03
Eu-155	*	–	–	–	<-4.00E-03	5.90E-02	5.50E-02	5.30E-02	5.17E-02	4.59E-02	3.42E-03
I-129	–	–	–	–	–	–	–	–	–	–	–
K-40	–	–	–	–	–	–	–	–	1.43+01	1.58E+00	1.43E+01
Mn-54	*	–	–	–	2.30E-02	1.70E-02	<9.30E-03	1.50E-02	5.33E-03	1.66E-02	1.25E-02
Nb-95	*	–	–	–	–	–	–	–	-4.15E-02	5.45E-02	-4.15E-02
Pb-212	–	–	–	–	–	–	–	–	6.61E-01	7.65E-02	6.61E-01
Pb-214	–	–	–	–	–	–	–	–	5.28E-01	7.05E-02	5.28E-01
Pu-238	4.00E-04	3.00E-04	4.00E-04	3.00E-04	3.90E-04	2.40E-04	3.50E-04	1.90E-04	–	–	3.85E-04
Pu-239	4.20E-02	5.00E-03	1.00E-02	2.00E-03	1.00E-02	1.60E-03	1.30E-02	1.70E-03	–	–	1.88E-02
Ru-106	9.89E-01	6.89E-01	2.22E-01	2.19E-01	4.40E-01	1.80E-01	2.30E-01	1.40E-01	2.11E-02	1.48E-01	3.80E-01
Sr-90	1.00E+00	1.87E-01	3.06E-01	6.20E-02	5.70E-01	1.40E-01	2.50E-01	4.80E-02	–	–	5.32E-01
Tc-99	–	–	–	–	–	–	–	–	–	–	–
U (total)	2.67E-01	9.20E-02	3.97E-01	1.29E-01	2.40E-01	1.20E-01	3.20E-01	1.00E-01	–	–	3.06E-01
Zn-65	*	–	–	–	<3.30E-02	3.60E-02	–	–	-1.60E-02	–	8.50E-03
Zr-95	*	–	–	–	<2.60E-02	3.10E-02	<-1.60E-02	2.80E-02	2.03E-02	4.83E-02	1.01E-02

Table A-2.2 Results of Fenceline Soil Sampling (pCi/g)
Location 2E-4

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Ce-141	–	–	–	–	–	–	–	–	–	–	–
Ce-144	–	–	–	–	–	–	–	–	–	–	–
Co-58	*	–	–	–	–	–	–	–	–	–	–
C0-60	*	–	–	–	–	–	–	–	–	–	–
Cs-134	8.60E+01	–	–	–	–	–	–	–	–	–	8.60E+01
Cs-137	*	–	–	–	–	–	–	–	–	–	–
Eu-152	*	–	–	–	–	–	–	–	–	–	–
Eu-154	–	–	–	–	–	–	–	–	–	–	–
Eu-155	–	–	–	–	–	–	–	–	–	–	–
I-129	–	–	–	–	–	–	–	–	–	–	–
K-40	–	–	–	–	–	–	–	–	–	–	–
Mn-54	*	–	–	–	–	–	–	–	–	–	–
Nb-95	*	–	–	–	–	–	–	–	–	–	–
Pb-212	–	–	–	–	–	–	–	–	–	–	–
Pb-214	–	–	–	–	–	–	–	–	–	–	–
Pu-238	*	–	–	–	–	–	–	–	–	–	–
Pu-239	2.30E+02	–	–	–	–	–	–	–	–	–	2.30E+02
Ru-106	*	–	–	–	–	–	–	–	–	–	–
Sr-90	7.80E+00	–	–	–	–	–	–	–	–	–	7.80E+00
Tc-99	–	–	–	–	–	–	–	–	–	–	–
U (total)	*	–	–	–	–	–	–	–	–	–	–
Zn-65	*	–	–	–	–	–	–	–	–	–	–
Zr-95	*	–	–	–	–	–	–	–	–	–	–

Table A-2.2 Results of Fenceline Soil Sampling (pCi/g)
Location 2E-NE

	1985		1986		1987		1988		1989		
Radionuclide	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Average Result
Ce-141	–	–	–	–	<1.80E-02	2.80E-02	<-2.00E-03	3.10E-02	-3.88E-102	7.66E-02	-7.60E-03
Ce-144	–	–	–	–	<-6.40E-02	1.00E-01	–	–	1.67E-02	1.10E-01	-2.37E-02
Co-58	*	–	–	–	<-1.00E-02	1.80E-02	–	–	-9.15E-03	2.69E-02	-9.58E-03
C0-60	*	–	–	–	<1.20E-02	1.50E-02	–	–	8.39E-03	1.60E-02	1.02E-02
Cs-134	9.40E-02	5.60E-02	9.80E-02	3.40E-02	3.20E-02	2.00E-02	<-3.00-03	2.10E-02	-2.16E-03	1.55E-02	4.38E-02
Cs-137	5.10E-01	1.83E-01	1.54E+00	1.75E-01	1.10E+00	1.20E-01	1.70E+00	1.90E-01	1.08+00	1.20E-01	1.19E+00
Eu-152	*	–	–	–	<-2.00E-03	8.10E-02	<8.00E-02	9.60E-02	1.71E-02	8.30E-02	3.17E-02
Eu-154	*	–	–	–	<3.90E-02	4.40E-02	<1.80E-02	6.60E-02	1.21E-03	5.78E-02	1.94E-02
Eu-155	*	–	–	–	<4.40E-02	5.30E-02	<6.80E-02	7.30E-02	2.00E-02	4.83E-02	4.30E-02
I-129	–	–	–	–	–	–	–	–	–	–	–
K-40	–	–	–	–	–	–	–	–	1.38E+01	1.57E+00	1.38E+01
Mn-54	6.70E-02	4.90E-02	2.90E-02	2.40E-02	<-1.10E-02	1.80E-02	<1.60E-02	1.90E-02	1.72E-02	1.93E-02	2.36E-02
Nb-95	*	–	–	–	–	–	–	–	-4.63E-02	6.43E-02	-4.63E-02
Pb-212	–	–	–	–	–	–	–	–	7.27E-01	8.47E-02	7.27E-01
Pb-214	–	–	–	–	–	–	–	–	6.00E-01	8.36E-02	6.00E-01
Pu-238	6.00E-04	4.00E-04	–	–	<1.60E-04	1.80E-04	<2.20E-04	2.40E-04	–	–	3.27E-04
Pu-239	5.00E-03	1.00E-03	5.00E-03	1.00E-03	5.10E-03	1.00E-03	6.50E-03	1.50E-03	–	–	5.40E-03
Ru-106	*	–	–	–	<3.10E-02	1.40E-01	<-2.70E-02	2.00E-01	-2.53E-02	1.53E-01	-6.50E-03
Sr-90	1.88E+00	3.44E-01	1.46E+00	2.71E-01	1.00E+00	2.50E-01	2.20E+00	4.20E-01	–	–	1.64E+00
Tc-99	–	–	–	–	–	–	–	–	–	–	–
U (total)	2.14E-01	7.60E-02	3.54E+00	1.17E-01	1.20E-01	6.20E-02	2.30E-01	7.40E-02	–	–	2.30E-01
Zn-65	*	–	6.50E-02	4.80E-02	<-1.50E-03	3.60E-02	–	–	-2.40E-02	4.95E-02	1.43E-02
Zr-95	1.28E-01	1.03E-01	7.60E-02	7.40E-02	<-2.50E-02	2.70E-02	<2.40E-03	4.10E-02	6.48E-03	5.31E-02	3.76E-02

Table A-2.2 Results of Fenceline Soil Sampling (pCi/g)
Location 2E-SE

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Ce-141	--	--	--	--	<-2.20E-02	1.80E-02	<9.30E-03	2.30E-02	1.01E-02	8.18E-02	-8.67E-04
Ce-144	--	--	--	--	<5.90E-02	6.10E-02	--	--	-8.94E-03	1.06E-01	2.50E-02
Co-58	*	--	--	--	<-6.90E-03	9.60E-03	--	--	5.69E-03	2.48E-02	-6.05E-04
C0-60	3.60E-02	2.40E-02	--	--	1.30E-02	9.70E-03	--	--	-1.79E-03	1.90E-02	1.57E-02
Cs-134	5.40E-02	4.40E-02	7.80E-02	3.40E-02	4.70E-02	1.40E-02	<-6.70E-02	1.80E-02	1.11E-03	1.46E-02	2.26E-02
Cs-137	6.30E-02	5.20W-02	1.66E-01	4.30E-02	1.20E-01	2.00E-02	1.00E-01	2.40E-02	1.34E+00	1.46E-01	3.58E-01
Eu-152	*	--	1.03E-01	9.20E-02	<4.10E-02	4.70E-02	<3.70E-02	8.10E-02	1.50E-01	7.30E-02	8.28E-02
Eu-154	*	--	--	--	<5.60E-03	3.70E-02	<-1.80E-02	5.50E-02	3.77E-02	5.39E-02	8.43E-02
Eu-155	*	--	--	--	<2.40E-02	3.30E-02	<3.60E-02	5.10E-02	6.49E-02	5.46E-02	4.16E-02
I-129	--	--	--	--	--	--	--	--	--	--	--
K-40	--	--	--	--	--	--	--	--	1.51E+01	1.68E+00	1.51E+01
Mn-54	*	--	--	--	<-9.10E-04	9.90E-03	<1.20E-02	1.50E-02	3.85E-03	1.70E-02	4.98E-03
Nb-95	*	--	--	--	--	--	--	--	-5.54E-02	6.50E-02	-5.54E-02
Pb-212	--	--	--	--	--	--	--	--	7.48E-01	8.57E-02	7.48E-01
Pb-214	--	--	--	--	--	--	--	--	6.14E-01	8.48E-02	6.14E-01
Pu-238	4.00E-04	3.00W-04	3.00E-04	3.00E-04	<-3.10E-06	8.50E-05	<1.80E-04	1.90E-04	--	--	2.19E-04
Pu-239	2.00E-03	1.00W-04	1.00E-03	1.00E-03	1.50E-03	4.20E-04	1.90E-03	5.50E-04	--	--	1.60E-04
Ru-106	*	--	2.60E-01	2.07E-01	<-3.20E-02	7.90E-02	<-2.30E-02	1.30E-01	6.05E-02	1.49E-01	6.64E-02
Sr-90	1.56+00	2.90E-01	4.83E-01	9.50E-02	3.50E-01	9.00E-02	3.80E-01	7.40E-02	--	--	6.93E-01
Tc-99	--	--	--	--	--	--	--	--	--	--	--
U (total)	3.62E-01	1.19E-01	3.14E-01	1.04E-01	2.40E-01	1.20E-01	2.90E-01	9.30E-02	--	--	3.02E-01
Zn-65	*	--	--	--	<-2.50E-02	2.90E-02	--	--	-7.47E-02	4.79E-02	-4.99E-02
Zr-95	*	--	--	--	<1.00E-02	2.00E-02	<1.20E-02	2.80E-02	2.49E-02	5.22E-02	1.56E-02

Table A-2.2 Results of Fenceline Soil Sampling (pCi/g)
Location A-TF-E1

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Ce-141	--	--	--	--	<-1.60E-02	3.20E-02	<-1.10E-03	2.50E-02	-5.66E-02	9.96E-02	-2.46E-02
Ce-144	--	--	--	--	<-2.00E-02	1.10E-01	--	--	-6.39E-02	1.17E-01	-4.20E-02
Co-58	*	--	--	--	<-2.60E-03	1.70E-02	--	--	3.04E-02	2.79E-02	1.39E-02
C0-60	*	--	--	--	<-1.20E-02	1.60E-02	--	--	1.10E-02	1.92E-02	-5.00E-04
Cs-134	*	--	4.10E-02	2.90E-02	3.70E-02	2.50E-02	<-2.00E-03	1.40E-02	4.29E-03	1.88E-02	2.01E-02
Cs-137	9.60E-01	1.35E-01	2.44E+00	2.70E-01	2.10E+00	2.20E-01	3.70E+00	3.80E-01	2.79E+00	2.94E-01	2.40E+00
Eu-152	*	--	2.30E-01	1.17E-01	8.40E-02	8.20E-02	8.30E-02	6.90E-02	2.55E-02	9.47E-01	1.06E-01
Eu-154	*	--	--	--	<4.00E-02	4.80E-02	<-3.20E-02	4.60E-02	3.32E-02	5.92E-02	1.37E-02
Eu-155	*	--	--	--	<5.30E-02	6.30E-02	8.20E-02	5.50E-02	1.84E-02	5.98E-02	5.11E-02
I-129	--	--	--	--	--	--	--	--	--	--	--
K-40	--	--	--	--	--	--	--	--	1.21E+01	1.43E+00	1.21E+01
Mn-54	*	--	--	--	<3.70E-03	1.60E-02	<4.80E-04	1.30E-02	5.05E-03	1.84E-02	3.08E-03
Nb-95	*	--	--	--	--	--	--	--	-4.77E-02	7.27E-02	-4.77E-02
Pb-212	--	--	--	--	--	--	--	--	4.82E-02	6.83E-02	4.82E-01
Pb-214	--	--	--	--	--	--	--	--	5.01E-01	8.14E-02	5.01E-01
Pu-238	*	--	1.40E-03	7.00E-04	<-1.00E-05	7.70E-05	<7.50E-05	1.10E-04	--	--	4.88E-04
Pu-239	2.00E-03	1.00E-03	3.00E-03	1.00E-03	<6.10E-05	9.10E-05	3.10E-03	6.20E-04	--	--	2.04E-03
Ru-106	*	--	--	--	<1.30E-01	1.60E-01	<-1.70E-02	1.20E-01	1.49E-01	1.91E-01	8.73E-02
Sr-90	3.63E-01	7.10E-02	3.98E-01	7.90E-02	4.80E-01	1.20E-01	4.70E-01	9.10E-02	--	--	4.28E-01
Tc-99	--	--	--	--	--	--	--	--	--	--	--
U (total)	2.57E-01	8.90E-02	2.10E-01	8.70E-02	2.80E-01	1.30E-01	1.40E-01	5.00E-02	--	--	2.22E-01
Zn-65	--	--	--	--	<-5.70E-02	4.80E-02	--	--	-4.80E-02	5.29E-02	-5.25E-02
Zr-95	--	--	--	--	<3.00E-02	3.00E-02	<-6.10E-03	2.60E-02	-9.53E-03	6.06E-02	4.79E-03

Table A-2.2 Results of Fenceline Soil Sampling (pCi/g)
Location A-TF-E2

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Ce-141	–	–	–	–	<7.30E-03	3.70E-02	<8.40E-04	3.00E-02	4.05E-02	9.52E-02	1.62E-02
Ce-144	–	–	–	–	<4.50E-03	1.30E-01	–	–	-4.02E-02	1.24E-01	-1.79E-02
Co-58	*	–	4.70E-02	2.50E-02	<2.80E-04	1.50E-02	–	–	1.88E-02	2.76E-02	2.20E-02
C0-60	*	–	–	–	1.80E-02	1.20E-02	–	–	-5.44E-03	1.75E-02	6.28E-03
Cs-134	*	–	4.20E-02	2.40E-02	8.00E-02	2.20E-02	2.50E-02	1.60E-02	3.42E-03	1.88E-02	3.76E-02
Cs-137	4.57E+00	3.52E-02	1.26E+01	1.28E+00	1.10E+01	1.10E+00	4.20E+00	4.40E-01	4.08+00	4.18E-01	7.29E+00
Eu-152	*	–	–	–	1.00E-01	6.30E-02	1.10E-01	6.70E-02	7.50E-02	7.45E-02	9.50E-02
Eu-154	*	–	–	–	5.10E-02	4.50E-02	<-5.20E-02	5.40E-02	-5.44E-02	5.44E-02	-1.85E-02
Eu-155	*	–	–	–	7.30E-02	6.40E-02	<3.90E-02	6.00E-02	5.23E-02	5.41E-02	5.48E-02
I-129	–	–	–	–	–	–	–	–	–	–	–
K-40	–	–	–	–	–	–	–	–	1.39E+01	1.55E+00	1.39E+01
Mn-54	6.40E-02	3.50E-02	2.20E-02	1.90E-02	<-1.50E-03	1.60E-02	<1.20E-03	1.60E-02	1.58E-02	1.90E-02	2.03E-02
Nb-95	1.11E-01	7.40E-02	–	–	–	–	–	–	-5.21E-02	6.66E-02	2.95E-02
Pb-212	–	–	–	–	–	–	–	–	6.68E-01	7.96E-02	6.68E-01
Pb-214	–	–	–	–	–	–	–	–	5.27E-01	7.55E-02	5.27E-01
Pu-238	*	–	5.00E-04	5.00E-04	9.00E-04	4.30E-04	<1.10E-04	1.90E-04	–	–	5.03E-04
Pu-239	1.00E-03	1.00E-03	4.00E-03	1.00E-03	7.60E-03	1.40E-03	3.70E-03	1.10E-03	–	–	4.08E-03
Ru-106	*	–	–	–	<-5.20E-02	1.70E-01	1.70E-01	1.50E-01	1.31E-01	1.89E-01	8.30E-02
Sr-90	1.17E+00	2.16E-01	2.41E+00	4.44E-01	4.30E+00	1.10E+00	7.20E-01	1.40E-01	–	–	2.15E+00
Tc-99	–	–	–	–	–	–	–	–	–	–	–
U (total)	2.66E-01	9.20E-02	5.52E-01	1.83E-01	3.10E-01	1.40E-01	3.20E-01	9.90E-02	–	–	3.62E-01
Zn-65	*	–	–	–	<-3.10E-02	4.00E-02	–	–	-3.27E-03	4.57E-02	-1.71E-02
Zr-95	1.43E-01	1.02E-01	–	–	<1.00E-02	2.80E-02	<1.00E-03	2.80E-02	9.31E-04	5.67E-02	3.87E-02

Table A-2.2 Results of Fenceline Soil Sampling (pCi/g)
Location 2E-1

	1985		1986		1987		1988		1989		
Radionuclide	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Average Result
Ce-141	–	–	–	–	<2.70E-03	3.80E-02	<2.60E+00	7.30E+00	-8.41E-02	1.11E-01	8.40E-01
Ce-144	–	–	–	–	<2.50E-02	1.30E-01	–	–	-8.47E-02	1.48E-01	-2.99E-02
Co-58	*	–	–	–	<-2.90E-03	1.30E-02	–	–	5.98E-03	2.61E-02	1.54E-03
C0-60	4.50E-02	2.60E-02	–	–	<7.00E-03	1.50E-02	–	–	-2.49E-02	1.89E-02	9.03E-03
Cs-134	5.50E-02	3.70E-02	1.19E-01	3.40E-02	8.50E-02	2.40E-02	<9.10E-03	2.20E-02	1.36E-02	2.20E-02	5.63E-02
Cs-137	5.36E+00	3.97E-01	1.51E+01	1.52E+00	1.10E+01	1.10E+01	1.30E+01	1.30E+00	7.09E+00	7.22E-01	1.03E+01
Eu-152	*	–	8.50E-02	6.90E-02	<4.60E-02	6.10E-02	<6.00E-02	7.70E-02	6.16E-02	7.50E-02	6.32E-02
Eu-154	*	–	–	–	7.10E-02	4.80E-02	<-2.10E-02	5.40E-02	4.52E-02	4.69E-02	3.17E-02
Eu-155	*	–	–	–	<1.20E-02	7.10E-02	<6.80E-02	8.30E-02	2.79E-02	8.32E-02	3.60E-02
I-129	–	–	–	–	–	–	–	–	–	–	–
K-40	–	–	–	–	–	–	–	–	1.51E+01	1.72E+00	1.51E+01
Mn-54	*	–	2.50E-02	1.60E-02	<9.00E-03	1.30E-02	<2.10E-02	2.70E-02	3.65E-02	2.84E-02	2.29E-02
Nb-95	*	–	–	–	–	–	–	–	-8.16E-02	6.65E-02	-8.16E-02
Pb-212	–	–	–	–	–	–	–	–	7.07E-01	9.03E-02	7.07E-01
Pb-214	–	–	–	–	–	–	–	–	5.00E-01	8.93E-02	5.00E-01
Pu-238	*	–	4.00E-04	4.00E-04	<-5.90E-05	1.30E-04	2.90E-04	1.60E-04	–	–	2.10E-04
Pu-239	3.00E-03	1.00E-03	3.00E-03	1.00E-03	1.40E-03	5.40E-04	4.30E-03	7.30E-04	–	–	2.93E-03
Ru-106	*	–	6.96E-01	3.30E-01	<1.40E-01	1.90E-01	<6.30E-02	2.90E-01	7.74E-02	2.40E-01	2.44E-01
Sr-90	8.32E-01	1.55E-01	5.25E+00	9.60E-01	1.60E+00	3.90E-01	2.10E+00	3.90E-01	–	–	2.45E+00
Tc-99	–	–	–	–	–	–	–	–	–	–	–
U (total)	3.25E-01	1.09E-01	2.34E-01	7.80E-02	1.70E-01	1.00E-01	2.90E-01	9.00E-02	–	–	2.55E-01
Zn-65	8.20E-02	4.80E-02	–	–	<-3.20E-02	4.00E-02	–	–	1.37E-02	4.50E-02	2.12E-02
Zr-95	*	–	–	–	<-2.10E-02	2.70E-02	<-1.70E-01	4.10E-01	-2.28E-02	5.91E-02	-7.13E-02

Table A-2.2 Results of Fenceline Soil Sampling (pCi/g)
Location A-TF-E4

	1985		1986		1987		1988		1989		
Radionuclide	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Average Result
Ce-141--	--	--	--	--	<-5.30E-02	7.00E-02	<-4.30E-03	3.70E-02	5.17E-02	8.31E-02	-1.87E-03
Ce-144	--	--	--	--	<-8.60E-03	2.30E-01	--	--	-7.31E-03	1.07E-01	-7.96E-03
Co-58	--	--	4.60E-02	3.00E-02	<8.90E-03	1.40E-02	--	--	-5.50E-03	2.27E-02	1.65E-02
C0-60	--	--	--	--	<-9.20E-03	2.00E-02	--	--	-2.66E-03	1.36E-02	-5.93E-03
Cs-134	--	--	9.04E+01	9.06E+00	3.60E-02	2.10E-02	<-5.90E-02	2.50E-02	-8.95E-03	1.43E-02	-1.07E-02
Cs-137	--	--	--	--	4.20E+01	4.20E+00	1.00E+01	1.00E+00	4.37E+00	4.46E-01	3.67E+01
Eu-152	--	--	9.00E-02	4.90E-02	1.20E-01	6.30E-02	9.90E-02	8.00E-02	-6.92E-03	6.99E-02	7.07E-02
Eu-154	--	--	2.34E-01	1.86E-01	<2.00E-02	5.40E-02	<-8.70E-03	6.00E-02	1.15E-02	5.07E-02	2.82E-02
Eu-155	--	--	--	--	<6.10E-02	1.30E-01	<5.80E-04	8.00E-02	3.73E-02	5.26E-02	8.32E-02
I-129	--	--	--	--	--	--	--	--	--	--	--
K-40	--	--	--	--	--	--	--	--	1.29E+01	1.43E+00	1.29E+01
Mn-54	--	--	--	--	<1.10E-02	1.50E-02	<1.40E-02	1.50E-02	3.33E-03	1.53E-02	9.44E-03
Nb-95	--	--	--	--	--	--	--	--	-2.98E-02	5.57E-02	-2.98E-02
Pb-212	--	--	--	--	--	--	--	--	6.06E-01	7.17E-02	6.06E-01
Pb-214	--	--	--	--	--	--	--	--	5.25E-01	7.54E-02	5.25E-01
Pu-238	--	--	9.00E-04	5.00E-04	8.60E-04	7.60E-04	3.20E-04	1.70E-04	--	--	6.93E-04
Pu-239	--	--	1.40E-02	2.00E-03	8.20E-03	2.10E-03	8.60E-03	1.20E-03	--	--	1.03E-02
Ru-106	--	--	--	--	<-1.50E-02	3.80E-01	<1.30E-01	2.00E-01	3.67E-02	1.45E-01	5.06E-02
Sr-90	--	--	7.66E+00	1.40E+00	4.90E+00	1.20E+00	4.10E+00	7.70E-01	--	--	5.55E+00
Tc-99	--	--	--	--	--	--	--	--	--	--	--
U (total)	--	--	3.91E-01	1.27E-1	1.70E-01	1.00E-01	3.00E-01	9.50E-02	--	--	2.87E-01
Zn-65	--	--	--	--	<1.30E-02	4.60E-02	--	--	-1.71E-02	3.70E-02	-1.51E-02
Zr-95	--	--	--	--	<-1.20E-03	3.40E-02	<2.60E-02	2.80E-02	1.15E-02	4.75E-02	1.21E-02

Table A-2.2 Results of Fenceline Soil Sampling (pCi/g)
Location A-TF-W1

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Ce-141	--	--	--	--	<-2.00E-02	3.70E-02	<-3.50E-02	2.70E-02	-1.20E-01	1.33E-01	-5.23E-02
Ce-144	--	--	--	--	<-7.50E-02	1.20E-01	--	--	9.25E-02	1.59E-01	8.75E-03
Co-58	*	--	--	--	2.10E-02	1.50E-02	--	--	-1.79E-02	3.96E-02	1.55E-03
C0-60	*	--	--	--	3.00E-02	1.70E-02	--	--	6.26E-03	2.16E-02	1.81E-02
Cs-134	*	--	2.90E-02	2.70E-02	7.50E-02	2.70E-02	<-5.00E-02	1.90E-02	-1.03E-02	2.24E-02	1.09E-02
Cs-137	6.76E-01	9.30E-02	2.89E+00	3.07E-01	3.70E+00	3.80E-01	1.90E+00	2.00E-01	2.02E+00	2.22E-01	2.24E+00
Eu-152	*	--	--	--	1.10E-01	7.60E-02	8.10E-02	7.10E-02	7.88E-02	1.14E-01	8.99E-02
Eu-154	1.21E-01	9.80E-02	--	--	<9.20E-03	4.70E-02	<-3.40E-02	5.40E-02	1.10E-02	7.22E-02	2.68E-02
Eu-155	*	--	--	--	<1.40E-02	7.50E-02	<2.00E-02	6.50E-02	5.74E-02	8.75E-02	3.05E-02
I-129	--	--	--	--	--	--	--	--	--	--	--
K-40	--	--	--	--	--	--	--	--	1.49E+01	1.77E+00	1.49E+01
Mn-54	*	--	--	--	<-1.50E-02	2.00E-02	2.20E-02	1.60E-02	1.22E-02	2.43E-02	6.40E-03
Nb-95	*	--	--	--	--	--	--	--	-4.25E-02	8.78E-02	-4.25E-02
Pb-212	--	--	--	--	--	--	--	--	6.41E-01	9.38E-02	6.41E-01
Pb-214	--	--	--	--	--	--	--	--	5.96E-01	9.92E-02	5.96E-01
Pu-238	*	--	--	--	<1.80E-04	2.40E-04	1.80E-04	1.40E-04	--	--	1.80E-04
Pu-239	1.00E-03	1.00E-03	3.00E-03	1.00E-03	5.10E-03	1.30E-03	3.40E-03	6.60E-04	--	--	3.13E-03
Ru-106	--	--	--	--	<-1.60E-01	1.80E-01	1.80E-01	1.40E-01	1.13E-01	2.24E-01	4.43E-02
Sr-90	6.62E-01	1.23E-01	1.02E+00	1.90E-01	1.80E+00	4.40E-01	9.50E-01	1.80E-01	--	--	1.11E+00
Tc-99	--	--	--	--	--	--	--	--	--	--	--
U (total)	2.75E-01	9.50E-02	3.18E-01	1.06E-01	2.70E-01	1.30E-01	1.90E-01	6.40E-02	--	--	2.63E-01
Zn-65	*	--	--	--	<-2.40E-02	4.10E-02	--	--	-4.76E-02	6.89E-02	-3.58E-02
Zr-95	*	--	--	--	4.40E-02	3.20E-02	<1.70E-02	2.60E-02	1.20E-02	8.00E-02	2.43E-02

Table A-2.2 Results of Fenceline Soil Sampling (pCi/g)
Location A-TF-W2

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Ce-141	--	--	--	--	<1.90E-02	2.50E-02	<1.50E-03	3.90E-02	-6.55E-02	1.00E-01	-1.50E-02
Ce-144	--	--	--	--	<2.10E-02	8.40E-02	--	--	-4.79E-02	1.32E-01	-1.35E-02
Co-58	*	--	--	--	<1.70E-03	1.30E-02	--	--	-3.25E-02	3.36E-02	-1.54E-02
C0-60	*	--	--	--	<5.90E-03	1.40E-02	--	--	5.30E-03	2.17E-02	5.60E-03
Cs-134	*	--	3.50E-02	3.20E-02	2.60E-02	1.80E-02	<-1.60E-02	2.60E-02	5.47E-03	1.69E-02	1.26E-02
Cs-137	1.69E+00	1.70E-01	8.31E-01	1.09E-01	1.70E+00	1.80E-01	1.20E+01	1.20E+00	3.19E-01	4.87E-02	3.31E+00
Eu-152	*	--	--	--	<3.90E-02	6.10E-02	9.10E-02	7.20E-02	2.45E-02	9.71E-02	5.15E-02
Eu-154	*	--	--	--	<2.00E-02	4.40E-02	<3.40E-02	5.50E-02	-8.79E-02	6.81E-02	-1.13E-02
Eu-155	*	--	--	--	<4.70E-02	5.00E-02	<3.40E-02	9.20E-02	6.67E-02	7.42E-02	4.92E-02
I-129	--	--	--	--	--	--	--	--	--	--	--
K-40	--	--	--	--	--	--	--	--	1.55E+01	1.77E+00	1.55E+01
Mn-54	*	--	--	--	<2.20E-04	1.30E-02	2.40E-02	1.70E-02	3.40E-03	2.28E-02	9.21E-03
Nb-95	*	--	--	--	--	--	--	--	-1.52E-01	7.54E-02	-1.52E-01
Pb-212	--	--	--	--	--	--	--	--	9.38E-01	1.08E-01	9.38E-01
Pb-214	--	--	--	--	--	--	--	--	8.16E-01	1.06E-01	8.16E-01
Pu-238	*	--	3.00E-04	2.00E-04	<1.60E-04	2.20E-04	2.30E-04	1.50E-04	--	--	2.30E-04
Pu-239	2.00E-03	1.00E-03	1.00E-03	1.00E-03	1.30E-03	5.50E-04	3.30E-03	6.10E-04	--	--	1.90E-03
Ru-106	*	--	--	--	<-6.20E-02	1.20E-01	<3.40E-02	2.60E-01	1.74E-01	1.87E-01	4.87E-02
Sr-90	2.45E+00	4.40E-01	7.64E-01	1.45E-01	1.10E+00	2.70E-01	7.60E+00	1.40E+00	--	--	2.98E+00
Tc-99	--	--	--	--	--	--	--	--	--	--	--
U (total)	2.90E-01	9.80E-02	5.10E-01	1.67E-01	2.20E-01	1.10E-01	2.40E-01	7.80E-02	--	--	3.15E-01
Zn-65	*	--	--	--	<1.80E-02	3.50E-02	--	--	-1.02E-01	7.19E-02	-4.20E-02
Zr-95	*	--	--	--	3.30E-02	2.30E-02	<2.80E-02	3.20E-02	5.20E-02	6.63E-02	3.77E-02

Table A-2.2 Results of Fenceline Soil Sampling (pCi/g)
Location AW-TF-E

	1985		1986		1987		1988		1989		
Radionuclide	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Average Result
Ce-141					<2.70E-03	2.00E-02	<-2.00E-02	4.20E-02			-8.65E-03
Ce-144					<5.30E-04	6.80E-02					5.30E-04
Co-58	*				<-1.30E-02	1.40E-02					-1.30E-02
C0-60	*		3.60E-02	1.80E-02	<-1.40E-02	1.30E-02					1.10E-02
Cs-134	6.30E-02	5.30E-02	7.10E-02	2.50E-02	<4.30E-02	1.40E-02	<-2.30E-02	2.80E-02			3.85E-02
Cs-137	9.30E-02	5.00E-02	2.16E-01	4.30E-02	<3.10E-01	4.10E-02	<6.90E-01	9.50E-02			3.27E-01
Eu-152	*				<4.70E-02	5.10E-02	<-8.20E-03	1.40E-01			1.94E-02
Eu-154	*				<1.20E-02	4.10E-02	<-1.90E-02	8.30E-02			-3.50E-03
Eu-155	*				<5.80E-03	3.70E-02	<-1.30E-02	1.00E-01			-3.60E-03
I-129											
K-40											
Mn-54	5.70E-02	4.00E-02			<4.80E-03	1.10E-02	<1.10E-02	2.40E-02			2.43E-02
Nb-95	1.05E-02	7.70E-02									1.05E-01
Pb-212											
Pb-214											
Pu-238	2.20E-03	7.00E-04			<3.30E-04	2.30E-04	2.80E-04	1.70E-04			9.37E-04
Pu-239	7.10E-02	7.00E-03	1.00E-03	1.00E-03	<5.20E-03	9.80E-04	4.20E-03	7.40E-04			2.04E-02
Ru-106	4.39E-01	4.28E-01			<-6.10E-02	1.00E-01	<-1.90E-01	2.60E-01			6.27E-02
Sr-90	3.40E-02	1.90E-02	3.66E-01	7.30E-02	<1.60E-01	4.00E-02	6.10E-01	1.201E-01			2.93E-01
Tc-99											
U (total)	2072E-01	4.38E-01	4.38E-01	1.43E-01	<5.10E-01	2.80E-01	3.10E-01	9.80E-02			3.83E-01
Zn-65	*				<1.10E-02	3.10E-02					1.10E-02
Zr-95	*				<5.60E-03	1.90E-02	<-2.00E-03	5.20E-02			1.80E-03

Table A-2.2 Results of Fenceline Soil Sampling (pCi/g)
Location C-TF-NE

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Ce-141	--	--	--	--	<1.00E-02	9.40E-02	<6.30E-03	3.40E-02	2.27E-02	1.65E-01	1.30E-02
Ce-144	--	--	--	--	<1.50E-01	3.20E-01	--	--	6.36E-03	2.00E-01	7.82E-02
Co-58	3.90E-02	2.40E-02	--	--	<6.30E-03	1.90E-02	--	--	-3.93E-03	3.42E-02	1.38E-02
C0-60	*	--	--	--	3.00E-02	1.60E-02	--	--	-2.50E-03	2.18E-02	1.38E-02
Cs-134	4.60E-02	4.40E-02	5.10E-02	3.30E-02	6.50E-02	2.60E-02	<1.60E-02	1.80E-02	-2.79E-02	2.92E-02	3.00E-02
Cs-137	3.25E+00	2.74E-01	4.62E+00	4.88E-01	8.20E+01	8.20E+00	1.00E+01	1.00E+00	1.75E+01	1.76E+00	2.35E+01
Eu-152	*	--	--	--	<6.80E-02	8.40E-02	<2.70E-02	6.60E-02	6.01E-02	1.04E-01	5.17E-02
Eu-154	1.35E-01	7.80E-02	1.69E-01	8.50E-02	<1.70E-02	5.20E-02	<-7.90E-03	4.50E-02	1.17E-02	6.53E-02	6.50E-02
Eu-155	*	--	--	--	<2.20E-02	1.80E-01	<6.70E-02	6.90E-02	6.78E-02	8.75E-02	5.23E-02
I-129	--	--	--	--	--	--	--	--	--	--	--
K-40	--	--	--	--	--	--	--	--	1.45E+01	1.70E+00	1.45E+01
Mn-54	*	--	--	--	<-3.30E-03	2.00E-02	<6.70E-03	1.40E-02	8.29E-03	2.38E-02	3.90E-03
Nb-95	*	--	1.88E-01	1.17E-01	--	--	--	--	-5.48E-02	9.35E-02	6.66E-02
Pb-212	--	--	--	--	--	--	--	--	7.40E-01	9.95E-02	7.40E-01
Pb-214	--	--	--	--	--	--	--	--	6.75E-01	1.17E-01	6.57E-01
Pu-238	*	--	1.00E-03	5.00E-04	<3.90E-04	6.30E-04	2.40E-04	1.60E-04	--	--	5.43E-04
Pu-239	1.00E-03	1.00E-03	3.40E-02	4.00E-03	2.20E-02	4.10E-03	1.60E-02	2.00E-03	--	--	1.83E-02
Ru-106	*	--	--	--	<-5.90E-02	5.10E-01	<5.50E-02	1.70E-01	-2.46E-01	3.14E-01	-8.33E-02
Sr-90	4.74E+00	8.75E-01	3.63E+00	6.67E-01	1.10E+01	2.60E+00	2.80E+00	5.30E-01	--	--	5.54E+00
Tc-99	--	--	--	--	--	--	--	--	--	--	--
U (total)	2.70E-01	9.30E-02	3.63E-01	1.19E-01	2.70E-01	1.30E-01	4.40E-01	1.30E-01	--	--	3.36E-01
Zn-65	7.90E-02	7.00E-02	--	--	<-7.70E-03	3.80E-02	--	--	-2.55E-02	5.45E-02	1.53E-02
Zr-95	*	--	--	--	<5.80E-03	3.30E-02	<6.70E-03	2.90E-02	-2.52E-02	7.46E-02	-4.23E-03

Table A-2.2 Results of Fenceline Soil Sampling (pCi/g)
Location C-TF-SE

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Result
Ce-141	–	–	–	–	<4.90E-03	5.40E-02	<-2.60E-02	2.80E-02	1.27E-02	2.56E-01	-2.80E-03
Ce-144	–	–	–	–	<-2.50E-02	1.90E-01	–	–	-1.32E-01	3.20E-01	-7.85E-02
Co-58	–	–	–	–	<-1.10E-02	1.70E-02	–	–	5.39E-03	3.23E-02	-2.81E-03
C0-60	–	–	–	–	2.20E-02	1.50E-02	–	–	1.91E-02	2.06E-02	2.06E-02
Cs-134	–	–	–	–	6.90E-02	2.40E-02	<-5.90E-02	2.00E-02	-5.76E-02	4.60E-02	-1.59E-02
Cs-137	–	–	3.90E+01	–	2.30E+01	2.30E+00	3.70E+00	3.80E-01	6.20E+01	6.21E+00	3.19E+01
Eu-152	–	–	–	–	9.50E-02	6.80E-02	9.60E-02	3.10E-02	3.37E-02	9.79E-02	7.49E-02
Eu-154	–	–	–	–	<-1.00E-02	6.20E-02	<1.80E-02	5.40E-02	1.52E-03	6.05E-02	3.17E-03
Eu-155	–	–	–	–	<-3.20E-02	1.00E-01	6.90E-02	6.30E-02	1.06E-01	1.53E-01	4.77E-02
I-129	–	–	–	–	–	–	–	–	–	–	–
K-40	–	–	–	–	–	–	–	–	1.56E+01	1.79E+00	1.56E+01
Mn-54	–	–	–	–	<2.00E-03	1.60E-02	<-4.30E-04	1.50E-02	4.42E-03	2.19E-02	2.00E-03
Nb-95	–	–	–	–	–	–	–	–	-8.14E-02	8.43E-02	-8.14E-02
Pb-212	–	–	–	–	–	–	–	–	6.19E-01	1.18E-01	6.19E-01
Pb-214	–	–	–	–	–	–	–	–	5.56E-01	1.39E-01	5.56E-01
Pu-238	–	–	–	–	7.50E-04	6.40E-04	7.50E-04	2.60E-04	–	–	7.50E-04
Pu-239	–	–	–	–	1.50E-02	2.90E-03	4.60E-03	7.50E-04	–	–	9.80E-03
Ru-106	–	–	–	–	<2.50E-01	2.50E-01	<2.00E-03	1.40E-01	-3.05E-01	4.58E-01	-1.77E-02
Sr-90	–	–	3.20E+01	–	1.50E+01	3.50E+00	3.40E+00	6.40E-01	–	–	1.68E+01
Tc-99	–	–	–	–	–	–	–	–	–	–	–
U (total)	–	–	–	–	2.70E-01	1.30E-01	2.40E-01	7.80E-02	–	–	2.55E-01
Zn-65	–	–	–	–	<-1.60E-02	4.00E-02	–	–	-2.20E-02	5.19E-02	-1.90E-02
Zr-95	–	–	–	–	<0.00E+00	2.80E-02	<1.50E-02	2.70E-02	7.82E-02	6.41E-02	3.11E-02

NOTE: Negative values indicate concentrations at or near background levels of radioactivity.
Dashes indicate a positive detection, the result is larger than the error.
An Asterisk (*) indicates that radionuclide concentration is less than detectable. The detection limits are as follow: Mn-54=2.0E-02, Co-58=2.0E-02, Co-60=2.0E-02, Zn-65=4.0e-02, Sr-90=5.0e-03, Nb-95=3.0E-02, Zr-95=3.0E-02, Ru-106-1.7E01, Cs-134=2.0E-02, Cs-137=2.0E-02, Eu-152=1.1E-01, Eu-154=5.0E-02, Eu-155=5.0E-02, Pu-238=6.0E-04, Pu239=6.0E-04, and U total = 1.0E-02.
Source: Schmidt et al. 1990; Elder et al. 1986, 1987, 1988, 1989.

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Table A-2.3. Results of Air Monitoring for 1991 (pCi/m³).

Radionuclide		Location N158		Location N969		Location N970		Location N972		Location N977	
		Result	Error	Result	Error	Result	Error	Result	Error	Result	Error
Be-7	Quarters 1-2	7.20E-02	4.60E-02	2.30E-02	4.80E-02	8.90E-02	4.90E-02	8.00E-02	4.10E-02	4.60E-02	5.20E-02
	Quarters 3-4	8.80E-02	2.20E-02	7.90E-02	2.00E-02	9.90E-02	2.00E-02	5.20E-02	1.60E-02	8.30E-02	2.20E-02
	Average	8.00E-02	3.40E-02	5.10E-02	3.40E-02	9.40E-02	3.50E-02	6.60E-02	2.90E-02	6.40E-02	3.70E-02
CePr-144	Quarters 1-2	-9.20E-04	2.90E-03	5.40E-04	2.80E-03	8.10E-04	2.30E-03	-2.40E-03	3.00E-03	-9.40E-04	3.30E-03
	Quarters 3-4	9.00E-04	2.20E-03	-1.10E-03	2.10E-03	1.90E-03	2.00E-03	1.40E-03	2.00E-03	-1.20E-03	2.20E-03
	Average	-1.30E-05	2.60E-03	-2.90E-04	2.70E-03	1.30E-03	2.20E-03	-5.10E-04	2.50E-03	-1.10E-03	2.70E-03
Co-60	Quarters 1-2	2.00E-04	4.80E-04	1.70E-04	3.30E-04	8.70E-05	1.20E-04	-4.70E-05	2.80E-04	-4.80E-05	2.90E-04
	Quarters 3-4	1.20E-04	2.50E-04	-9.50E-05	1.80E-04	1.20E-05	2.10E-04	-5.40E-05	2.90E-04	5.70E-05	1.50E-04
	Average	1.60E-04	3.70E-04	3.90E-05	2.60E-04	5.00E-05	1.60E-04	-5.10E-05	2.90E-04	4.40E-06	2.20E-04
Cs-134	Quarters 1-2	1.70E-04	2.70E-04	5.30E-05	2.60E-04	3.40E-05	2.70E-04	-8.30E-05	1.70E-04	-9.70E-05	2.40E-04
	Quarters 3-4	-1.10E-04	2.30E-04	-1.60E-04	1.90E-04	1.40E-04	2.00E-04	-7.00E-06	2.10E-04	-9.10E-05	2.20E-04
	Average	2.90E-05	2.50E-04	-5.20E-05	2.30E-04	8.60E-05	2.30E-04	-4.50E-05	1.90E-04	-9.40E-05	2.30E-04
Cs-137	Quarters 1-2	9.50E-04	4.30E-04	1.40E-04	2.40E-04	1.80E-04	2.30E-04	3.30E-05	2.80E-04	1.90E-04	2.20E-04
	Quarters 3-4	7.90E-04	3.50E-04	5.00E-05	2.20E-04	-5.40E-05	1.90E-04	5.40E-04	2.60E-04	6.80E-05	1.80E-04
	Average	8.70E-04	3.90E-04	9.70E-05	2.30E-04	6.20E-05	2.10E-04	2.90E-04	2.70E-04	1.30E-04	2.00E-04
Eu-154	Quarters 1-2	-4.40E-04	7.70E-04	3.50E-04	6.60E-04	-6.80E-04	1.00E-03	1.90E-04	6.30E-04	-1.30E-04	7.50E-04
	Quarters 3-4	4.60E-04	6.10E-04	7.20E-04	6.50E-04	-2.30E-04	7.30E-04	4.30E-04	5.80E-04	-3.00E-04	6.00E-04
	Average	1.10E-05	6.90E-04	5.40E-04	6.60E-04	-4.60E-04	8.70E-04	3.10E-04	6.00E-04	-2.10E-04	6.70E-04
Eu-155	Quarters 1-2	1.90E-04	3.60E-04	-9.00E-05	4.10E-04	2.50E-05	3.70E-04	-8.60E-05	6.00E-04	-3.40E-04	5.20E-04
	Quarters 3-4	6.80E-05	4.50E-04	2.80E-04	4.30E-04	2.60E-04	4.10E-04	-8.10E-06	4.90E-04	-1.50E-04	4.10E-04
	Average	1.30E-04	5.40E-04	9.30E-05	4.20E-04	1.40E-04	3.90E-04	-4.70E-05	5.40E-04	-2.50E-04	4.60E-04
K-40	Quarters 1-2	8.30E-03	4.20E-03	6.00E-03	4.20E-03	8.60E-04	3.70E-03	2.90E-03	4.10E-03	2.20E-03	3.50E-03
	Quarters 3-4	3.80E-03	3.00E-03	4.90E-03	2.30E-03	1.40E-03	3.00E-03	6.90E-03	3.80E-03	3.40E-03	2.80E-03
	Average	6.00E-03	3.60E-03	5.50E-03	3.30E-03	1.10E-03	3.30E-03	4.90E-03	3.90E-03	2.80E-03	3.10E-03

Table A-2.3. Results of Air Monitoring for 1991 (pCi/m^3).

Radionuclide		Location N158		Location N969		Location N970		Location N972		Location N977	
		Result	Error	Result	Error	Result	Error	Result	Error	Result	Error
Pu-238	Quarters 1-2	7.90E-07	9.00E-07	5.90E-07	7.90E-07	4.60E-07	7.70E-07	-8.20E-08	5.50E-07	6.40E-08	4.10E-07
	Quarters 3-4	6.60E-07	6.70E-07	1.20E-06	9.90E-07	4.00E-07	5.60E-07	3.10E-07	5.80E-07	1.60E-08	4.20E-07
	Average	7.20E-07	7.80E-07	9.00E-07	8.90E-07	4.30E-07	6.60E-06	1.10E-07	5.60E-07	4.00E-08	4.10E-07
Pu-239, 240	Quarters 1-2	3.10E-06	1.60E-06	2.60E-06	1.60E-06	3.60E-06	2.10E-06	2.30E-06	1.30E-06	1.70E-06	1.20E-06
	Quarters 3-4	3.10E-06	1.40E-06	2.40E-06	1.50E-06	1.70E-06	1.10E-06	2.50E-06	1.20E-06	3.70E-06	1.80E-06
	Average	3.10E-06	4.50E-06	2.50E-06	1.50E-06	2.70E-06	1.60E-06	2.40E-06	1.20E-06	2.70E-06	1.50E-06
Ru-106	Quarters 1-2	-1.30E-04	2.90E-03	1.10E-04	3.40E-03	-7.80E-04	3.00E-03	-1.40E-03	3.40E-03	1.90E-03	3.20E-03
	Quarters 3-4	7.40E-04	2.20E-03	0.00E+00	1.60E-03	3.70E-04	1.90E-03	6.30E-04	1.60E-03	5.00E-04	1.60E-03
	Average	3.10E-04	2.50E-03	5.30E-05	2.50E-03	-2.00E-04	2.50E-03	4.00E-04	2.50E-03	1.20E-03	2.40E-03
Sb-125	Quarters 1-2	-3.70E-04	7.10E-04	2.90E-05	5.40E-04	1.40E-04	5.90E-04	-1.70E-04	6.00E-04	-2.90E-04	6.60E-04
	Quarters 3-4	1.20E-04	6.10E-04	4.00E-04	4.90E-04	5.80E-04	4.20E-04	-2.40E-04	5.20E-04	1.30E-04	5.80E-04
	Average	-1.30E-04	6.60E-04	2.10E-04	5.20E-04	3.60E-04	5.00E-04	-2.00E-04	5.60E-04	-8.30E-05	6.20E-04
Sr-90	Quarters 1-2	2.80E-04	8.80E-05	2.30E-05	2.00E-05	1.30E-04	4.80E-05	9.70E-05	3.90E-05	2.10E-05	1.90E-05
	Quarters 3-4	2.10E-04	5.40E-05	6.20E-05	3.10E-05	1.50E-05	1.90E-05	9.00E-05	3.30E-05	3.80E-05	2.30E-05
	Average	2.40E-04	7.10E-05	4.30E-05	2.60E-05	7.30E-05	3.30E-05	9.40E-05	3.60E-05	3.00E-05	2.10E-05
U-234	Quarters 1-2	2.40E-05	6.70E-06	6.70E-06	2.80E-06	1.60E-05	3.90E-06	8.50E-06	3.90E-06	8.80E-06	3.10E-06
	Quarters 3-4	1.40E-05	3.50E-06	1.20E-05	3.00E-06	9.50E-06	2.40E-06	2.00E-05	4.00E-06	1.00E-05	3.40E-06
	Average	1.90E-05	5.10E-06	9.20E-06	2.90E-06	1.30E-05	3.10E-06	1.40E-05	4.00E-06	9.40E-06	3.20E-06
U-235	Quarters 1-2	1.70E-06	3.10E-06	6.40E-07	8.50E-07	8.60E-07	8.50E-07	-2.60E-08	7.60E-07	9.30E-07	9.20E-07
	Quarters 3-4	4.00E-07	6.60E-07	6.80E-07	7.40E-07	4.20E-07	5.40E-07	1.40E-06	9.00E-07	3.10E-07	1.00E-06
	Average	1.00E-06	1.90E-06	6.60E-07	7.90E-07	6.40E-07	7.00E-07	6.80E-07	8.30E-07	6.20E-07	9.60E-07
U-238	Quarters 1-2	2.50E-05	7.20E-06	6.30E-06	2.70E-06	1.80E-05	4.10E-06	8.70E-06	4.00E-06	7.20E-06	2.70E-06
	Quarters 3-4	1.50E-05	3.70E-06	1.20E-05	2.90E-06	8.30E-06	2.20E-06	2.50E-05	4.60E-06	8.70E-06	3.30E-06
	Average	2.00E-05	5.50E-06	9.00E-06	2.80E-06	1.30E-05	3.20E-06	1.70E-05	4.30E-06	8.00E-06	3.00E-06

Table A-2.3. Results of Air Monitoring for 1991 (pCi/m³).

Radionuclide		Location N158		Location N969		Location N970		Location N972		Location N977	
		Result	Error	Result	Error	Result	Error	Result	Error	Result	Error
Zn-65	Quarters 1-2	2.80E-04	1.10E-03	2.40E-04	9.30E-04	1.10E-03	9.40E-04	-1.00E-03	1.30E-03	-7.30E-05	1.00E-03
	Quarters 3-4	-2.00E-04	6.90E-04	-2.20E-05	7.90E-04	-4.80E-04	5.70E-04	6.40E-04	6.40E-04	-2.50E-04	6.50E-04
	Average	4.10E-05	8.80E-04	1.10E-04	8.60E-04	2.80E-04	7.50E-04	-1.80E-04	9.50E-04	-1.60E-04	8.40E-04
ZrNb-95	Quarters 1-2	2.80E-03	6.00E-03	-2.70E-03	5.80E-03	-1.00E-03	6.60E-03	3.80E-03	6.10E-03	-2.30E-04	5.20E-03
	Quarters 3-4	-6.90E-04	2.20E-03	9.60E-04	1.80E-03	-1.30E-03	1.80E-03	-4.00E-04	1.90E-03	9.40E-04	1.60E-03
	Average	1.00E-03	4.10E-03	-8.80E-04	3.80E-03	-1.20E-03	4.20E-03	1.70E-03	4.00E-03	3.60E-04	3.40E-03

Table A-2.3. Results of Air Monitoring for 1991 (pCi/m³)

Radionuclide		Location N978		Location N984		Location N985		Location N991		Location N992	
		Result	Error	Result	Error	Result	Error	Result	Error	Result	Error
Be-7	Quarters 1-2	5.40E-02	3.50E-02	-2.40E-03	5.90E-02	7.60E-02	5.00E-02	1.20E-01	4.80E-02	2.50E-02	4.50E-02
	Quarters 3-4	7.30E-02	1.80E-02	6.40E-02	1.90E-02	7.90E-02	1.90E-02	9.40E-02	1.90E-02	8.90E-02	2.00E-02
	Average	6.30E-02	2.70E-02	3.10E-02	3.90E-02	7.80E-02	3.40E-02	1.10E-01	3.40E-02	5.70E-02	3.20E-02
CePr-144	Quarters 1-2	-5.30E-04	2.10E-03	-1.10E-03	3.40E-03	1.90E-03	3.10E-03	-1.20E-03	2.50E-03	-7.50E-04	2.70E-03
	Quarters 3-4	7.90E-04	2.20E-03	-4.80E-04	2.00E-03	9.60E-04	2.00E-03	-5.10E-04	2.30E-03	3.40E-04	1.80E-03
	Average	1.30E-04	2.10E-03	-7.70E-04	2.70E-03	1.40E-03	2.50E-03	-8.70E-04	2.40E-03	-2.10E-04	2.20E-03
Co-60	Quarters 1-2	8.00E-05	2.20E-04	1.40E-04	1.70E-04	-2.40E-05	2.00E-04	-7.50E-05	3.70E-04	1.50E-04	2.50E-04
	Quarters 3-4	1.90E-05	2.30E-04	5.00E-05	1.70E-04	-5.60E-05	2.40E-04	7.90E-05	1.90E-04	2.90E-04	2.80E-04
	Average	1.40E-04	2.20E-04	9.70E-05	1.70E-04	-4.00E-05	2.20E-04	1.80E-06	2.80E-04	2.20E-04	2.60E-04
Cs-134	Quarters 1-2	1.80E-04	2.50E-04	-2.00E-04	3.30E-04	-1.00E-04	2.10E-04	8.80E-06	2.90E-04	-1.00E-04	2.60E-04
	Quarters 3-4	-2.80E-05	1.80E-04	-7.40E-05	2.10E-04	-9.60E-05	1.90E-04	-1.10E-04	2.20E-04	-1.40E-04	2.00E-04
	Average	7.70E-05	2.20E-04	-1.40E-04	2.70E-04	-9.80E-05	2.00E-04	-4.80E-05	2.50E-04	-1.20E-04	2.30E-04
Cs-137	Quarters 1-2	1.70E-04	2.20E-04	5.90E-04	3.30E-04	4.50E-04	2.80E-04	1.20E-04	2.30E-04	1.70E-04	2.00E-04
	Quarters 3-4	2.00E-04	1.90E-04	9.50E-04	3.10E-04	1.90E-04	2.30E-04	6.40E-04	2.00E-04	6.50E-05	1.80E-04
	Average	1.90E-04	2.00E-04	7.70E-04	3.20E-04	3.20E-04	2.50E-04	3.80E-04	2.20E-04	1.20E-04	1.90E-04
Eu-154	Quarters 1-2	3.20E-04	6.10E-04	3.10E-04	1.00E-03	-5.60E-04	8.00E-04	-1.00E-03	9.10E-04	3.90E-04	5.60E-04
	Quarters 3-4	-2.90E-04	7.40E-04	5.00E-04	4.70E-04	2.20E-04	7.20E-04	4.20E-04	3.40E-04	1.40E-04	5.00E-04
	Average	1.70E-05	6.70E-04	4.00E-04	7.60E-04	-1.70E-04	7.60E-04	-3.10E-04	6.30E-04	2.70E-04	5.80E-04
Eu-155	Quarters 1-2	2.70E-04	3.10E-04	-2.80E-04	6.50E-04	-1.70E-04	4.20E-04	1.20E-04	4.80E-04	9.80E-05	4.70E-04
	Quarters 3-4	-2.40E-05	4.40E-04	-2.80E-04	5.10E-04	1.10E-04	5.00E-04	2.60E-04	4.80E-04	6.10E-05	4.70E-04
	Average	1.20E-04	3.80E-04	-2.80E-04	5.80E-04	-3.20E-05	4.60E-04	1.90E-04	4.80E-04	7.90E-05	4.70E-04
K-40	Quarters 1-2	5.20E-03	3.40E-03	1.20E-02	5.40E-03	2.00E-03	3.90E-03	5.80E-03	4.00E-03	1.00E-03	3.50E-03
	Quarters 3-4	1.10E-03	2.00E-03	2.30E-03	2.70E-03	3.90E-03	3.00E-03	7.10E-03	3.00E-03	5.20E-03	2.90E-03
	Average	3.10E-03	2.70E-03	6.90E-03	4.10E-03	3.00E-03	3.40E-03	6.50E-03	3.50E-03	3.10E-03	3.20E-03

Table A-2.3. Results of Air Monitoring for 1991 (pCi/m³)

Radionuclide		Location N978		Location N984		Location N985		Location N991		Location N992	
		Result	Error	Result	Error	Result	Error	Result	Error	Result	Error
Pu-238	Quarters 1-2	3.50E-07	5.00E-07	6.10E-08	2.90E-07	2.80E-07	4.30E-07	-8.70E-08	4.80E-07	-8.30E-08	3.90E-07
	Quarters 3-4	6.20E-07	8.60E-07	4.20E-07	7.00E-04	6.00E-07	6.20E-07	1.20E-06	8.70E-07	6.50E-07	6.50E-07
	Average	4.80E-07	6.80E-07	2.40E-07	5.00E-07	4.40E-07	5.20E-07	5.40E-07	6.70E-07	2.80E-07	5.20E-07
Pu-239, 240	Quarters 1-2	4.00E-06	1.60E-06	3.60E-06	1.50E-06	3.00E-06	1.20E-06	2.90E-06	1.40E-06	5.90E-06	1.90E-06
	Quarters 3-4	8.60E-07	7.90E-07	3.90E-06	2.00E-06	3.70E-06	1.50E-06	1.10E-05	2.80E-06	5.00E-06	1.80E-06
	Average	2.40E-06	1.20E-06	3.80E-06	1.80E-06	3.30E-06	1.40E-06	7.00E-06	2.10E-06	5.50E-06	1.80E-06
Ru-106	Quarters 1-2	-3.40E-04	2.40E-03	2.10E-04	3.80E-03	2.30E-03	2.10E-03	-1.20E-03	3.40E-03	9.60E-05	2.40E-03
	Quarters 3-4	-8.20E-04	2.10E-03	3.50E-04	2.00E-03	-8.50E-04	2.10E-03	-8.70E-04	2.40E-03	-1.10E-04	1.80E-03
	Average	-5.80E-04	2.20E-03	2.80E-04	2.90E-03	7.20E-04	2.10E-03	-1.10E-03	2.90E-03	-6.50E-06	2.10E-03
Sb-125	Quarters 1-2	3.00E-04	4.90E-04	5.80E-04	5.20E-04	-8.10E-04	7.40E-04	-1.80E-04	6.40E-04	2.40E-04	6.50E-04
	Quarters 3-4	-4.10E-04	4.80E-04	-6.10E-05	4.90E-04	1.70E-05	5.20E-04	5.30E-05	5.00E-04	-2.70E-04	5.90E-04
	Average	-5.70E-05	4.80E-04	2.60E-04	5.00E-04	-4.00E-04	6.30E-04	-6.50E-05	5.70E-04	-1.80E-05	6.20E-04
Sr-90	Quarters 1-2	3.30E-05	2.30E-05	1.00E-04	3.90E-05	5.60E-05	2.80E-05	4.00E-06	1.60E-05	2.20E-05	2.10E-05
	Quarters 3-4	1.20E-04	3.80E-05	3.60E-04	8.30E-05	2.30E-05	2.30E-05	3.70E-05	2.30E-05	1.40E-05	1.90E-05
	Average	7.50E-05	3.10E-05	2.30E-04	6.10E-05	3.90E-05	2.60E-05	2.10E-05	2.00E-05	1.80E-05	2.00E-05
U-234	Quarters 1-2	8.40E-06	2.80E-06	7.90E-06	2.90E-06	1.60E-05	4.10E-06	1.10E-05	3.10E-06	1.30E-05	3.60E-06
	Quarters 3-4	9.20E-06	2.80E-06	1.70E-05	5.80E-06	1.60E-05	4.00E-06	9.40E-06	3.60E-06	1.20E-05	2.90E-06
	Average	8.80E-06	2.80E-06	1.20E-05	4.30E-06	1.60E-05	4.00E-06	1.00E-05	3.40E-06	1.20E-05	3.30E-06
U-235	Quarters 1-2	1.80E-07	5.10E-07	1.30E-07	5.70E-07	9.40E-07	9.30E-07	2.60E-07	3.10E-07	6.50E-07	7.50E-07
	Quarters 3-4	2.30E-07	5.40E-07	1.00E-05	4.30E-06	7.10E-07	8.70E-07	6.50E-07	8.70E-07	1.10E-06	7.70E-07
	Average	2.00E-07	5.20E-07	5.20E-06	2.40E-06	8.30E-07	9.00E-07	4.60E-07	7.40E-07	8.80E-07	7.60E-07
U-238	Quarters 1-2	7.30E-06	2.70E-06	1.10E-05	3.20E-06	2.10E-05	4.70E-06	1.30E-05	3.40E-06	1.20E-05	3.50E-06
	Quarters 3-4	6.70E-06	2.40E-06	2.20E-05	6.60E-06	1.50E-05	3.70E-06	1.10E-05	3.90E-06	1.50E-05	3.30E-06
	Average	7.00E-06	2.50E-06	1.60E-05	4.90E-06	1.80E-05	4.20E-06	1.20E-05	3.70E-06	1.40E-05	3.40E-06

Table A-2.3. Results of Air Monitoring for 1991 (pCi/m³)

Radionuclide		Location N978		Location N984		Location N985		Location N991		Location N992	
		Result	Error	Result	Error	Result	Error	Result	Error	Result	Error
Zn-65	Quarters 1-2	-1.40E-03	1.20E-03	-3.60E-04	1.00E-03	3.80E-04	9.60E-04	1.00E-04	9.20E-04	-4.60E-04	1.20E-03
	Quarters 3-4	-9.90E-05	7.70E-04	-1.20E-04	5.20E-04	-4.80E-04	6.60E-04	1.30E-04	7.20E-04	4.00E-04	5.30E-04
	Average	-7.30E-04	9.90E-04	-2.40E-04	7.70E-04	-5.10E-05	8.10E-04	1.10E-04	8.20E-04	-3.10E-05	8.80E-04
ZrNb-95	Quarters 1-2	1.60E-03	7.40E-03	-3.60E-03	7.40E-03	3.70E-03	5.50E-03	-1.20E-03	3.40E-03	8.20E-04	5.30E-03
	Quarters 3-4	-4.20E-04	1.30E-03	2.80E-04	1.50E-03	1.30E-04	1.80E-03	-2.10E-03	2.10E-03	-3.30E-04	2.20E-03
	Average	5.70E-04	4.40E-03	-1.70E-03	4.40E-03	1.90E-03	3.60E-03	-1.70E-03	2.70E-03	2.50E-04	3.80E-03

Source: Schmidt et al. 1992.
Negative values indicate concentrations at or near background levels of radioactivity.
Shaded areas indicate a positive detection, the result is greater than the error.

Table A-2.4. Result of Grid Site Vegetation Sampling 1985-1989 (pCi/g).
Location 2E11

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Results
Be-7	–	–	–	–	–	–	–	–	–	–	–
Ce-141	–	–	–	–	–	–	< -1.802E-02	8.30E-02	–	–	< -1.80E-02
Co-60	*	–	–	–	–	–	< 1.10E-03	2.10E-02	–	–	< 1.10E-03
Cs-134	–	–	8.81E-02	4.44E-02	–	–	a/	–	–	–	8.81E-02
Cs-137	3.23E-01	3.14E-02	3.92E-01	6.68E-02	–	–	1.40E-01	3.10E-02	–	–	2.85E-01
Eu-152	7.00E-02	6.10E-02	–	–	–	–	< 4.70E-02	9.70E-02	–	–	5.85E-02
Eu-154	*	–	2.23E-01	1.40E-01	–	–	< -4.10E-02	7.10E-02	–	–	9.10E-02
Eu-155	–	–	1.13E-01	1.07E-01	–	–	< -1.80E-04	5.80E-02	–	–	5.64E-02
I-129	–	–	–	–	–	–	b/	–	–	–	–
K-40	–	–	–	–	–	–	–	–	–	–	–
Nb-95	–	–	–	–	–	–	< -5.60E-02	5.40E-02	–	–	< -5.60E-02
Pb-212	–	–	–	–	–	–	9.30E-01	–	–	–	9.30E-01
Pb-214	–	–	–	–	–	–	2.00E+00	–	–	–	2.00E+00
Pu-238	*	–	–	–	–	–	b/	–	–	–	–
Pu-239	*	–	–	–	–	–	b/	–	–	–	–
Ru-103	*	–	–	–	–	–	b/	–	–	–	–
Ru-106	*	–	–	–	–	–	a/	–	–	–	–
Sr-90	*	–	–	–	–	–	b/	–	–	–	–
Tc-99	–	–	–	–	–	–	–	–	–	–	–
Zr-95	*	–	1.38E-01	1.02E-01	–	–	< 4.20E-02	4.50E-02	–	–	< 4.20E-02

Table A-2.4. Result of Grid Site Vegetation Sampling 1985-1989 (pCi/g).
Location 2E12

	1985		1986		1987		1988		1989		
Radionuclide	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Average Results
Be-7	--	--	--	--	--	--	--	--	1.85E+00	3.19E-01	1.85E+00
Ce-141	--	--	--	--	--	--	< 1.40E-04	5.90E-02	2.78E-03	2.65E-03	1.46E-03
Co-60	*	--	--	--	1.80E-02	1.50E-02	7.70E-03	1.50E-02	2.45E-03	2.15E-02	9.38E-03
Cs-134	--	--	1.79E-01	4.25E-02	3.20E-02	1.80E-02	a/	--	--	--	1.06E-01
Cs-137	3.31E-01	3.51E-02	4.28E-01	6.52E-02	2.70E-01	3.70E-02	3.60E-01	4.40E-02	2.27E-01	3.69E-02	3.23E-01
Eu-152	*	--	1.44E-01	6.94E-02	5.30E-02	5.80E-02	-6.40E-02	6.80E-02	-4.68E-02	8.90E-02	2.16E-02
Eu-154	*	--	--	--	2.00E-03	4.90E-02	1.20E-02	5.00E-02	2.56E-02	6.14E-02	1.32E-02
Eu-155	*	--	--	--	-3.20E-02	4.30E-02	-6.80E-04	3.70E-02	1.60E-02	5.72E-02	-5.56E-03
I-129	--	--	--	--	b/	--	b/	--	6.08E-02	3.19E-01	6.08E-02
K-40	--	--	--	--	--	--	--	--	1.06E+01	1.30E+00	1.06E+01
Nb-95	*	--	--	--	< 1.40E-02	2.10E-02	-4.00E-02	5.30E-02	-2.49E-03	2.30E-02	-9.50E-03
Pb-212	--	--	--	--	--	--	--	--	2.78E-02	3.42E-02	2.78E-02
Pb-214	--	--	--	--	--	--	--	--	4.11E-02	3.52E-02	4.11E-02
Pu-238	*	--	--	--	b/	--	b/	--	3.03E-04	2.23E-04	3.03E-04
Pu-239	*	--	--	--	b/	--	b/	--	1.08E-03	3.99E-04	1.08E-03
Ru-103	*	--	1.13E-01	7.04E-02	--	--	--	--	--	--	1.13E-01
Ru-106	*	--	--	--	a/	--	a/	--	--	--	--
Sr-90	*	--	--	--	b/	--	3.40E+00	6.60E-01	1.06E-01	2.11E-02	1.75E+00
Tc-99	--	--	--	--	b/	--	b/	--	7.38E-01	1.15E+00	7.38E-01
Zr-95	*	--	--	--	< 1.70E-02	2.90E-02	3.70E-02	4.60E-02	-1.06E-02	3.73E-02	1.45E-02

Table A-2.4. Result of Grid Site Vegetation Sampling 1985-1989 (pCi/g).
Location 2E17

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Results
Be-7	--	--	--	--	--	--	--	--	2.64E+00	3.71E-01	2.64E+00
Ce-141	--	--	--	--	--	--	-2.20E-02	6.20E-02	5.19E-03	2.06E-02	-8.41E-03
Co-60	3.71E-02	1.92E-02	--	--	1.70E-02	1.30E-02	1.80E-02	1.70E-02	1.27E-02	1.68E-02	2.12E-02
Cs-134	--	--	4.50E-01	8.66E-02	4.20E-02	1.80E-02	a/	--	--	--	2.46E-01
Cs-137	1.16E+00	7.93E-02	1.04E+00	1.34E-01	5.40E-01	6.40E-02	3.50E-01	4.50E-02	3.07E-01	4.34E-02	6.79E-01
Eu-152	*	--	--	--	2.80E-02	6.30E-02	-2.80E-02	6.90E-02	6.96E-03	7.05E-02	2.32E-03
Eu-154	2.15E-01	5.81E-02	--	--	-2.40E-02	5.10E-02	2.20E-02	5.20E-02	3.41E-02	4.87E-02	6.18E-02
Eu-155	2.95E-01	6.37E-02	--	--	4.00E-02	5.00E-02	1.80E-02	4.10E-02	4.03E-02	3.84E-02	9.83E-02
I-129	--	--	--	--	b/	--	9.20E-03	2.90E-01	-5.51E-02	2.67E-01	-2.30E-02
K-40	--	--	--	--	--	--	--	--	1.39E+01	1.57E+00	1.39E+01
Nb-95	*	--	1.29E-01	9.82E-02	-1.20E-02	2.30E-02	-5.60E-02	5.40E-02	-1.07E-02	1.77E-02	1.26E-02
Pb-212	--	--	--	--	--	--	--	--	7.77E-02	3.41E-02	7.77E-02
Pb-214	--	--	--	--	--	--	--	--	8.68E-02	3.97E-02	8.68E-02
Pu-238	4.30E-03	9.00E-04	7.00E-04	5.00E-04	3.30E-04	2.10E-04	4.10E-04	2.50E-04	5.85E-04	3.42E-04	1.27E-03
Pu-239	1.43E-02	1.90E-03	2.00E-03	9.00E-04	2.10E-03	5.70E-04	1.10E-02	1.70E-03	3.38E-03	9.07E-04	6.56E-03
Ru-103	*	--	4.85E-01	1.17E-01	b/	--	--	--	--	--	4.85E-01
Ru-106	5.49E-01	1.38E-01	9.01E-01	3.86E-01	a/	--	a/	--	--	--	7.25E-01
Sr-90	2.73E+01	5.42E+00	9.43E+00	1.74E+00	1.00E+01	2.40E+00	7.20E+00	1.50E+00	5.81E+00	1.15E+00	1.19E+01
Tc-99	--	--	--	--	b/	--	2.70E+00	3.00E+00	8.15E-01	1.16E+00	1.76E+00
Zr-95	2.54E-02	2.48E-02	--	--	< 1.70E-02	2.80E-02	4.20E-02	4.50E-02	-1.47E-02	3.06E-02	1.74E-02

Table A-2.4. Result of Grid Site Vegetation Sampling 1985-1989 (pCi/g).
Location 2E18

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Results
Be-7	--	--	--	--	--	--	--	--	2.63E+00	3.80E-01	2.63E+00
Ce-141	--	--	--	--	--	--	-3.30E-02	6.20E-02	-6.82E-03	2.15E-02	-1.99E-02
Co-60	*	--	--	--	< 4.30E-03	2.10E-02	4.80E-03	1.40E-02	1.08E-02	1.88E-02	6.63E-03
Cs-134	--	--	2.23E-01	5.48E-02	7.60E-02	2.80E-02	a/	--	--	--	1.50E-01
Cs-137	5.28E-01	4.17E-02	1.85E+00	2.13E-01	9.10E-01	1.10E-01	7.00E-01	7.90E-02	4.73E-01	6.02E-02	9.83E-01
Eu-152	*	--	1.92E-01	9.24E-02	2.60E-02	9.10E-02	0.00E+00	6.40E-02	-1.27E-02	8.80E-02	5.13E-02
Eu-154	*	--	--	--	-3.50E-02	6.90E-02	-1.20E-02	4.70E-02	8.42E-03	6.78E-02	-1.29E-02
Eu-155	*	--	--	--	3.70E-02	6.10E-02	3.20E-02	3.70E-02	1.40E-02	4.50E-02	2.77E-02
I-129	--	--	--	--	b/	--	3.50E-01	2.50E-01	2.20E-01	2.30E-01	2.76E-01
K-40	--	--	--	--	--	--	--	--	1.45E+01	1.64E+00	1.45E+01
Nb-95	*	--	--	--	< 1.00E-02	2.90E-02	-1.90E-02	4.60E-02	6.23E-03	2.17E-02	-8.93E-04
Pb-212	--	--	--	--	--	--	--	--	5.86E-02	3.03E-02	5.86E-02
Pb-214	--	--	--	--	--	--	--	--	8.79E-02	3.47E-02	8.79E-02
Pu-238	*	--	--	--	4.50E-04	2.70E-04	2.50E-04	2.00E-04	1.17E-04	1.31E-04	2.72E-04
Pu-239	*	--	--	--	1.90E-03	5.70E-04	2.00E-03	6.20E-04	1.00E-03	4.06E-04	1.63E-03
Ru-103	*	--	2.16E-01	1.18E-01	--	--	--	--	--	--	2.16E-01
Ru-106	3.23E-01	1.20E-01	--	--	a/	--	a/	--	--	--	3.23E-01
Sr-90	*	--	--	--	2.10E-01	5.40E-02	1.10E+00	2.10E-01	5.18E-01	1.04E-01	6.09E-01
Tc-99	--	--	--	--	b/	--	2.40E+00	3.00E+00	3.26E-01	1.12E+00	1.36E+00
Zr-95	*	--	--	--	5.60E-02	4.30E-02	3.80E-02	4.30E-02	-4.72E-03	2.94E-02	2.98E-02

Table A-2.4. Result of Grid Site Vegetation Sampling 1985-1989 (pCi/g).
Location 2E23

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Results
Be-7	--	--	--	--	--	--	--	--	--	--	--
Ce-141	--	--	--	--	--	--	2.10E-02	7.70E-02	--	--	2.10E-02
Co-60	*	--	--	--	< -1.70E-02	2.30E-02	-5.40E-03	2.20E-02	--	--	-1.12E-02
Cs-134	--	--	7.80E-02	3.31E-02	a/	--	a/	--	--	--	7.80E-02
Cs-137	1.53E-01	3.02E-02	2.02E-01	4.16E-02	1.10E-01	3.30E-02	1.40E-01	2.90E-02	--	--	1.51E-01
Eu-152	*	--	--	--	-8.70E-02	9.70E-02	2.50E-02	8.10E-02	--	--	-3.10E-02
Eu-154	*	--	--	--	-3.80E-03	7.00E-02	-1.70E-02	7.20E-02	--	--	-1.04E-02
Eu-155	*	--	--	--	-1.70E-02	6.30E-02	-2.50E-02	5.30E-02	--	--	-2.10E-02
I-129	--	--	--	--	--	--	-3.80E-01	4.10E-01	--	--	-3.80E-01
K-40	--	--	--	--	--	--	--	--	--	--	--
Nb-95	*	--	--	--	< -3.40E-03	3.60E-02	-4.40E-02	6.50E-02	--	--	-2.37E-02
Pb-212	--	--	--	--	--	--	--	--	--	--	--
Pb-214	--	--	--	--	--	--	--	--	--	--	--
Pu-238	4.00E-04	2.00E-04	--	--	8.60E-05	1.70E-04	9.60E-05	1.30E-04	--	--	1.94E-04
Pu-239	4.10E-03	8.00E-04	6.00E-04	5.00E-04	2.90E-03	1.10E-03	2.20E-03	6.10E-04	--	--	2.45E-03
Ru-103	1.43E-01	4.19E-02	8.81E-01	1.47E-01	--	--	--	--	--	--	5.12E-01
Ru-106	9.45E-01	2.83E-01	8.46E+00	1.02E+00	a/	--	3.40E-01	2.00E-01	--	--	3.25E+00
Sr-90	1.39E+00	2.80E-01	1.69E-01	4.75E-02	3.50E-02	1.20E-02	1.40E-01	2.90E-02	--	--	4.34E-01
Tc-99	--	--	--	--	b/	--	1.10E+00	2.90E+00	--	--	1.10E+00
Zr-95	*	--	--	--	< -5.20E-03	4.90E-02	-3.60E-02	6.10E-02	--	--	-2.06E-02

Table A-2.4. Result of Grid Site Vegetation Sampling 1985-1989 (pCi/g).
Location 2E24

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Results
Be-7	–	–	–	–	–	–	–	–	3.23E+00	4.34E-01	3.23E+00
Ce-141	–	–	–	–	–	–	2.30E-02	8.80E-02	-1.92E-02	2.87E-02	1.90E-03
Co-60	7.21E-02	4.77E-02	–	–	3.90E-03	1.40E-02	9.70E-03	1.90E-02	2.41E-02	1.84E-02	2.75E-02
Cs-134	–	–	1.97E-01	3.95E-02	5.50E-02	1.80E-02	a/	–	–	–	1.26E-01
Cs-137	3.51E-01	7.66E-02	1.24E+00	1.40E-01	1.50E+00	1.60E-01	1.30E+00	1.40E-01	1.09E+00	1.21E-01	1.10E+00
Eu-152	*	–	7.31E-02	5.95E-02	1.30E-02	6.70E-02	2.70E-02	8.50E-02	-7.86E-02	1.01E-01	8.63E-03
Eu-154	*	–	–	–	5.10E-02	4.70E-02	5.50E-02	6.20E-02	2.29E-02	5.96E-02	4.30E-02
Eu-155	*	–	–	–	-3.30E-02	4.00E-02	2.60E-02	5.00E-02	8.13E-04	6.03E-02	-2.06E-03
I-129	–	–	–	–	-3.90E-01	4.10E-01	1.50E-01	2.60E-01	2.48E-01	2.91E-01	2.67E-03
K-40	–	–	–	–	–	–	–	–	1.30E+01	1.49E+00	1.30E+01
Nb-95	*	–	–	–	-6.60E-03	2.00E-02	-1.40E-02	7.10E-02	-4.73E-03	2.18E-02	-8.44E-03
Pb-212	–	–	–	–	–	–	–	–	5.13E-02	3.59E-02	5.13E-02
Pb-214	–	–	–	–	–	–	–	–	9.76E-02	4.52E-02	9.76E-02
Pu-238	1.40E-03	1.20E-03	–	–	7.80E-05	1.60E-04	1.90E-04	2.50E-04	8.90E-04	5.04E-04	6.40E-04
Pu-239	9.50E-03	3.10E-03	9.00E-03	1.70E-03	5.90E-03	1.20E-03	1.20E-02	2.10E-03	8.09E-03	1.80E-03	8.90E-03
Ru-103	1.67E-01	1.01E-01	3.46E-01	9.68E-02	–	–	–	–	–	–	2.57E-01
Ru-106	6.67E-01	4.46E-01	1.66E+00	3.18E-01	a/	–	a/	–	4.42E+00	5.42E-01	2.25E+00
Sr-90	2.51E+00	5.04E-01	4.28E-01	8.72E-02	3.80E-01	9.70E-02	8.90E-01	1.70E-01	7.79E-01	1.49E-01	9.97E-01
Tc-99	–	–	–	–	2.00E-01	8.40E-01	2.30E+00	3.00E+00	1.48E+00	1.26E+00	1.33E+00
Zr-95	*	–	–	–	-1.80E-02	2.70E-02	2.80E-02	6.80E-02	-1.68E-02	3.27E-02	2.27E-03

Table A-2.4. Result of Grid Site Vegetation Sampling 1985-1989 (pCi/g).
Location 2E29

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Results
Be-7	–	–	–	–	–	–	–	–	2.01E+00	3.33E-01	2.01E+00
Ce-141	–	–	–	–	–	–	< -5.20E-02	7.40E-02	-2.07E-02	2.37E-02	-3.64E-02
Co-60	*	–	2.63E-02	2.40E-02	–	–	< 1.20E-02	2.10E-02	8.53E-03	1.87E-02	1.56E-02
Cs-134	–	–	1.16E-01	3.39E-02	–	–	a/	–	–	–	1.16E-00
Cs-137	*	–	2.49E-01	4.83E-02	–	–	7.60E-02	3.10E-02	4.52E-02	2.26E-02	1.23E-01
Eu-152	*	–	–	–	–	–	< -3.10E-02	8.70E-02	-8.29E-02	9.26E-02	-5.70E-02
Eu-154	*	–	–	–	–	–	< 4.40E-02	6.20E-02	-2.53E-02	5.36E-02	9.35E-03
Eu-155	*	–	–	–	–	–	< -2.50E-02	4.60E-02	3.59E-03	3.70E-02	-1.07E-02
I-129	–	–	–	–	–	–	–	–	0.00E+00	1.94E-01	0.00E+00
K-40	–	–	–	–	–	–	–	–	1.49E+01	1.71E+00	1.49E+01
Nb-95	*	–	–	–	–	–	< -3.00E-02	7.00E-02	1.42E-03	2.12E-02	-1.43E-02
Pb-212	–	–	–	–	–	–	–	–	1.98E-02	2.96E-02	1.98E-02
Pb-214	–	–	–	–	–	–	–	–	3.28E-02	2.96E-02	3.28E-02
Pu-238	*	–	4.00E-04	4.00E-04	–	–	b/	–	9.47E-05	1.35E-04	2.47E-04
Pu-239	9.00E-04	6.00E-04	1.70E-03	7.00E-04	–	–	b/	–	9.24E-04	3.50E-04	1.17E-03
Ru-103	*	–	5.38E-01	1.17E-01	–	–	–	–	–	–	5.38E-01
Ru-106	4.52E-01	3.43E-01	6.21E+00	7.38E-01	–	–	a/	–	–	–	3.33E+00
Sr-90	2.01E-01	5.41E-02	1.42E-01	3.53E-02	–	–	1.90E-01	3.80E-02	1.10E-01	2.20E-02	1.61E-01
Tc-99	–	–	–	–	–	–	b/	–	1.11E+00	1.23E+00	1.11E+00
Zr-95	*	–	–	–	–	–	< 1.70E-02	6.40E-02	1.16E-02	3.25E-02	1.43E-02

Table A-2.4. Result of Grid Site Vegetation Sampling 1985-1989 (pCi/g).
Location 2E30

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Results
Be-7	--	--	--	--	--	--	--	--	1.50E+00	2.50E-01	1.50E+00
Ce-141	--	--	--	--	--	--	< 2.10E-02	7.20E-02	-1.49E-02	1.94E-02	3.05E-03
Co-60	--	--	--	--	--	--	< 1.00E-02	1.50E-02	1.87E-03	1.44E-02	5.94E-03
Cs-134	--	--	--	--	--	--	a/	a/	--	--	--
Cs-137	--	--	--	--	--	--	3.90E-01	4.80E-02	7.68E-02	2.31E-02	2.33E-01
Eu-152	--	--	--	--	--	--	< 1.80E-02	6.30E-02	-4.89E-02	7.49E-02	-1.55E-02
Eu-154	--	--	--	--	--	--	< -2.30E-02	4.80E-02	-2.38E-02	4.71E-02	-2.34E-02
Eu-155	--	--	--	--	--	--	< -2.50E-03	4.00E-02	1.97E-02	3.19E-02	8.60E-03
I-129	--	--	--	--	--	--	--	--	7.35E-02	2.49E-01	7.35E-02
K-40	--	--	--	--	--	--	--	--	1.09E+01	1.25E+00	1.09E+01
Nb-95	--	--	--	--	--	--	< 1.40E-02	4.90E-02	-2.10E-02	1.96E-02	-3.05E-03
Pb-212	--	--	--	--	--	--	--	--	7.60E-02	3.18E-02	7.60E-02
Pb-214	--	--	--	--	--	--	--	--	7.13E-02	2.78E-02	7.13E-02
Pu-238	--	--	--	--	--	--	b/	--	5.30E-04	3.70E-04	5.30E-04
Pu-239	--	--	--	--	--	--	b/	--	4.67E-03	1.15E-03	4.67E-03
Ru-103	--	--	--	--	--	--	--	--	--	--	--
Ru-106	--	--	--	--	--	--	2.80E+00	3.60E-01	6.62E-01	1.75E-01	1.73E+00
Sr-90	--	--	--	--	--	--	4.70E-01	9.00E-02	5.69E-01	1.06E-01	5.20E-01
Tc-99	--	--	--	--	--	--	b/	--	5.78E-01	1.19E+00	5.78E-01
Zr-95	--	--	--	--	--	--	< 4.30E-02	4.70E-02	5.86E-03	2.69E-02	2.44E-02

Table A-2.4. Result of Grid Site Vegetation Sampling 1985-1989 (pCi/g).
Location 2ED

Radionuclide	1985		1986		1987		1988		1989		Average Results
	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	
Be-7	--	--	--	--	--	--	--	--	--	--	--
Ce-141	--	--	--	--	--	--	-9.50E-02	9.60E-02	--	--	-9.50E-02
Co-60	*	--	--	--	1.90E-02	1.80E-02	-1.40E-03	2.00E-02	--	--	8.80E-03
Cs-134	--	--	2.50E-01	6.93E-02	6.80E-02	2.40E-02	3.80E-02	2.00E-02	--	--	1.19E-01
Cs-137	2.43E-01	7.05E-02	1.95E+00	2.30E-01	3.00E-01	4.40E-02	6.40E-01	7.50E-02	--	--	7.83E-01
Eu-152	*	--	--	--	0.00E+00	8.40E-02	3.00E-02	8.60E-02	--	--	1.50E-02
Eu-154	*	--	--	--	-1.90E-02	6.00E-02	-1.10E-01	6.70E-02	--	--	-6.45E-02
Eu-155	*	--	--	--	1.40E-03	4.50E-02	3.40E-02	5.10E-02	--	--	1.77E-02
I-129	--	--	--	--	-2.80E-01	3.10E-01	3.40E-01	8.40E-01	--	--	3.00E-02
K-40	--	--	--	--	--	--	--	--	--	--	--
Nb-95	*	--	2.10E-01	1.25E-01	-2.30E-02	3.30E-02	2.10E-02	7.00E-02	--	--	6.93E-02
Pb-212	--	--	--	--	--	--	--	--	--	--	--
Pb-214	--	--	--	--	--	--	--	--	--	--	--
Pu-238	*	--	--	--	3.10E-05	6.50E-05	1.50E-04	1.50E-04	--	--	9.05E-05
Pu-239	*	--	--	--	8.00E-03	1.30E-03	1.50E-02	2.10E-03	--	--	1.15E-02
Ru-103	*	--	2.36E-01	1.51E-01	--	--	--	--	--	--	2.36E-01
Ru-106	*	--	--	--	a/	--	1.10E+00	2.70E-01	--	--	1.10E+00
Sr-90	*	--	--	--	3.70E-01	9.40E-02	3.00E-01	5.70E-02	--	--	3.35E-01
Tc-99	--	--	--	--	3.80E-01	8.50E-01	1.40E+00	3.00E+00	--	--	8.90E-01
Zr-95	*	--	1.23E-01	1.15E-01	4.90E-03	3.90E-02	6.90E-02	6.60E-02	--	--	6.56E-02

Table A-2.4. Result of Grid Site Vegetation Sampling 1985-1989 (pCi/g).
Location 2EDB

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Results
Be-7	--	--	--	--	--	--	--	--	--	--	--
Ce-141	--	--	--	--	--	--	--	--	--	--	--
Co-60	--	--	--	--	< 1.40E-02	1.60E-02	--	--	--	--	1.40E-02
Cs-134	--	--	--	--	5.20E-02	2.10E-02	--	--	--	--	5.20E-02
Cs-137	--	--	--	--	2.80E-01	3.90E-02	--	--	--	--	2.80E-01
Eu-152	--	--	--	--	< 4.80E-02	6.40E-02	--	--	--	--	4.80E-02
Eu-154	--	--	--	--	< -2.90E-02	4.90E-02	--	--	--	--	-2.90E-02
Eu-155	--	--	--	--	< 1.40E-02	3.80E-02	--	--	--	--	1.40E-02
I-129	--	--	--	--	< -1.40E-01	3.70E-01	--	--	--	--	-1.40E-01
K-40	--	--	--	--	--	--	--	--	--	--	--
Nb-95	--	--	--	--	< 1.80E-02	2.90E-02	--	--	--	--	1.80E-02
Pb-212	--	--	--	--	--	--	--	--	--	--	--
Pb-214	--	--	--	--	--	--	--	--	--	--	--
Pu-238	--	--	--	--	< 8.90E-05	1.30E-04	--	--	--	--	8.90E-05
Pu-239	--	--	--	--	8.00E-03	1.50E-03	--	--	--	--	8.00E-03
Ru-103	--	--	--	--	--	--	--	--	--	--	--
Ru-106	--	--	--	--	a/	--	--	--	--	--	--
Sr-90	--	--	--	--	3.30E-01	8.40E-02	--	--	--	--	3.30E-01
Tc-99	--	--	--	--	9.60E-01	8.80E-01 --	--	-- --	--	--	9.60E-01
Zr-95	--	--	--	--	< 8.90E-03	3.90E-02 --	--	-- --	--	--	8.90E-03

Table A-2.4. Result of Grid Site Vegetation Sampling 1985-1989 (pCi/g).
Location 2EDC

Radionuclide	1985		1986		1987		1988		1989		Average Results
	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	
Be-7	--	--	--	--	--	--	--	--	2.98E+00	4.80E-01	2.98E+00
Ce-141	--	--	--	--	--	--	--	--	-2.25E-02	3.41E-02	-2.25E-02
Co-60	--	--	--	--	--	--	--	--	6.69E-03	2.04E-02	6.69E-03
Cs-134	--	--	--	--	--	--	--	--	--	--	--
Cs-137	--	--	--	--	--	--	--	--	4.27E+00	4.37E-01	4.27E+00
Eu-152	--	--	--	--	--	--	--	--	6.64E-02	7.72E-02	6.64E-02
Eu-154	--	--	--	--	--	--	--	--	6.04E-02	5.72E-02	6.04E-02
Eu-155	--	--	--	--	--	--	--	--	2.10E-02	5.15E-02	2.10E-02
I-129	--	--	--	--	--	--	--	--	-5.80E-02	2.86E-01	-5.80E-02
K-40	--	--	--	--	--	--	--	--	1.32E+01	1.49E+00	1.32E+01
Nb-95	--	--	--	--	--	--	--	--	7.19E-03	2.58E-02	7.19E-03
Pb-212	--	--	--	--	--	--	--	--	1.06E-01	3.57E-02	1.04E-01
Pb-214	--	--	--	--	--	--	--	--	9.76E-02	4.39E-02	9.76E-02
Pu-238	--	--	--	--	--	--	--	--	4.83E-04	2.94E-04	4.83E-04
Pu-239	--	--	--	--	--	--	--	--	1.60E-02	2.43E-03	1.60E-02
Ru-103	--	--	--	--	--	--	--	--	--	--	--
Ru-106	--	--	--	--	--	--	--	--	5.09E-01	1.80E-01	5.09E-01
Sr-90	--	--	--	--	--	--	--	--	4.19E-01	8.42E-02	4.19E-01
Tc-99	--	--	--	--	--	--	--	--	7.47E-01	1.10E+00	7.47E-01
Zr-95	--	--	--	--	--	--	--	--	2.16E-02	3.53E-02	2.16E-02

Table A-2.4. Result of Grid Site Vegetation Sampling 1985-1989 (pCi/g).
Location GRT1

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Results
Be-7	--	--	--	--	--	--	--	--	3.00E+00	4.75E-01	3.00E+00
Ce-141	--	--	--	--	--	--	-7.50E-03	1.40E-02	-1.93E-02	4.76E-02	-1.34E-02
Co-60	--	--	--	--	< 5.50E-03	1.70E-02	-1.60E-03	1.40E-02	0.00E+00	2.24E-02	1.30E-03
Cs-134	--	--	--	--	6.10E-02	2.20E-02	a/	--	--	--	6.10E-02
Cs-137	--	--	--	--	3.60E-01	4.90E-02	3.40E-01	4.30E-02	1.03E+00	1.19E-01	5.77E-01
Eu-152	--	--	--	--	6.90E-02	6.70E-02	3.80E-03	4.70E-02	8.00E-02	9.64E-02	5.09E-02
Eu-154	--	--	--	--	< -5.80E-02	5.90E-02	7.60E-03	4.10E-02	7.66E-03	7.02E-02	-1.42E-02
Eu-155	--	--	--	--	< -2.50E-02	4.30E-02	7.20E-03	3.40E-02	-6.40E-03	5.45E-02	-8.70E-03
I-129	--	--	--	--	< -3.50E-01	3.00E-01	3.30E-01	2.10E-01	-1.23E-01	2.79E-01	-4.77E-02
K-40	--	--	--	--	--	--	--	--	1.18E+01	1.46E+00	1.18E+01
Nb-95	--	--	--	--	< -1.10E-02	2.80E-02	7.60E-03	1.20E-02	-1.15E-02	3.07E-02	-6.17E-03
Pb-212	--	--	--	--	--	--	--	--	9.51E-02	3.75E-02	9.51E-02
Pb-214	--	--	--	--	--	--	--	--	3.71E-02	4.51E-02	3.71E-02
Pu-238	--	--	--	--	3.20E-04	2.60E-04	9.60E-05	1.90E-04	1.59E-04	1.82E-04	1.92E-04
Pu-239	--	--	--	--	6.00E-03	1.30E-03	6.30E-03	1.30E-03	7.04E-03	1.24E-03	6.45E-03
Ru-103	--	--	--	--	--	--	--	--	--	--	--
Ru-106	--	--	--	--	a/	--	1.50E+00	2.30E-01	5.97E-01	2.70E-01	1.05E+00
Sr-90	--	--	--	--	2.20E-01	5.70E-02	2.70E-01	5.10E-02	4.56E-01	8.47E-02	3.15E-01
Tc-99	--	--	--	--	b/	--	2.40E+00	3.10E+00	5.59E-01	1.08E+00	1.48E+00
Zr-95	--	--	--	--	< 1.40E-02	4.20E-02	3.50E-03	2.10E-02	4.70E-03	4.51E-02	7.40E-03

Table A-2.4. Result of Grid Site Vegetation Sampling 1985-1989 (pCi/g).
Location GRT2

Radionuclide	1985		1986		1987		1988		1989		Average Results
	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	
Be-7	--	--	--	--	--	--	--	--	2.61E+00	4.09E-01	2.61E+00
Ce-141	--	--	--	--	--	--	< -1.50E-03	1.90E-02	-4.05E-03	3.18E-02	-2.78E-03
Co-60	--	--	--	--	3.40E-02	2.50E-02	-1.60E-02	1.90E-02	-1.91E-02	1.97E-02	-3.67E-04
Cs-134	--	--	--	--	8.30E-02	3.00E-02	a/	--	--	--	8.30E-02
Cs-137	--	--	--	--	3.60E-01	5.00E-01	1.70E-01	3.70E-02	2.03E+00	2.15E-01	8.53E-01
Eu-152	--	--	--	--	< 7.50E-02	9.20E-02	1.20E-02	8.10E-02	3.94E-02	8.52E-02	4.21E-02
Eu-154	--	--	--	--	< 2.70E-02	7.70E-02	6.40E-02	5.50E-02	-1.52E-02	6.52E-02	2.53E-02
Eu-155	--	--	--	--	< 2.00E-02	6.10E-02	1.30E-03	4.30E-02	-1.06E-02	4.78E-02	3.57E-03
I-129	--	--	--	--	< -1.10E-01	2.20E-01	1.30E-01	2.20E-01	-2.49E-01	2.75E-01	-7.63E-02
K-40	--	--	--	--	--	--	--	--	1.30E+01	1.48E+00	1.30E+01
Nb-95	--	--	--	--	< 7.00E-03	2.50E-02	-1.20E-02	1.70E-02	3.09E-03	2.68E-02	-6.37E-04
Pb-212	--	--	--	--	--	--	--	--	1.05E-01	3.59E-02	1.05E-01
Pb-214	--	--	--	--	--	--	--	--	1.37E-01	4.24E-02	1.37E-01
Pu-238	--	--	--	--	< 1.90E-04	2.70E-04	7.90E-05	1.50E-04	4.45E-04	3.09E-04	2.38E-04
Pu-239	--	--	--	--	2.90E-03	1.10E-03	1.60E-03	7.90E-04	6.36E-03	1.29E-03	3.62E-03
Ru-103	--	--	--	--	--	--	--	--	--	--	--
Ru-106	--	--	--	--	a/	--	2.20E-01	1.70E-01	2.85E-01	1.37E-01	2.53E-01
Sr-90	--	--	--	--	3.60E-01	9.00E-02	1.10E-01	2.40E-02	2.75E-01	5.25E-02	2.48E-01
Tc-99	--	--	--	--	4.70E+00	1.10E+00	2.50E+00	3.10E+00	5.49E-01	1.08E+00	2.58E+00
Zr-95	--	--	--	--	< -1.30E-03	3.70E-02	1.00E-02	2.80E-02	1.70E-02	3.59E-02	8.57E-03

Table A-2.4. Result of Grid Site Vegetation Sampling 1985-1989 (pCi/g).
Location GRT4

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Results
Be-7	--	--	--	--	--	--	--	--	3.22E+00	4.44E-01	3.22E+00
Ce-141	--	--	--	--	--	--	2.30E-02	2.10E-02	1.61E-02	3.17E-02	1.96E-02
Co-60	--	--	--	--	< 1.50E-02	1.80E-02	5.30E-03	1.80E-02	6.96E-03	1.95E-02	9.09E-03
Cs-134	--	--	--	--	5.00E-02	2.20E-02	a/	--	--	--	5.00E-02
Cs-137	--	--	--	--	4.80E-01	6.10E-02	1.80E-01	3.40E-02	4.11E-01	5.21E-02	3.57E-01
Eu-152	--	--	--	--	< 2.90E-02	7.70E-02	-2.30E-02	7.90E-02	6.38E-02	8.01E-02	2.33E-02
Eu-154	--	--	--	--	< 4.30E-02	5.30E-02	-1.20E-02	6.10E-02	-5.42E-03	6.01E-02	8.53E-03
Eu-155	--	--	--	--	< -2.40E-02	5.00E-02	-1.90E-02	5.40E-02	3.29E-02	5.02E-02	-3.37E-03
I-129	--	--	--	--	< 4.60E-02	2.80E-01	3.30E-01	3.40E-01	-4.59E-03	1.75E-01	1.24E-01
K-40	--	--	--	--	--	--	--	--	1.17E+01	1.34E+00	1.17E+01
Nb-95	--	--	--	--	< 2.60E-03	3.20E-02	4.40E-03	1.80E-02	-1.78E-02	2.57E-02	-3.60E-03
Pb-212	--	--	--	--	--	--	--	--	7.78E-02	2.91E-02	7.78E-02
Pb-214	--	--	--	--	--	--	--	--	1.15E-01	3.76E-02	1.15E-01
Pu-238	--	--	--	--	< 9.90E-04	1.40E-04	-4.90E-05	1.10E-04	4.74E-04	2.99E-04	1.75E-04
Pu-239	--	--	--	--	7.30E-03	1.50E-03	2.60E-03	8.00E-04	7.74E-03	1.42E-03	5.88E-03
Ru-103	--	--	--	--	--	--	--	--	--	--	--
Ru-106	--	--	--	--	a/	--	2.50E+00	3.90E-01	2.17E+00	3.19E-01	2.34E+00
Sr-90	--	--	--	--	3.40E-01	8.50E-02	1.90E-01	3.70E-02	1.87E-01	3.82E-02	2.39E-01
Tc-99	--	--	--	--	< 2.30E-01	8.40E-01	2.10E+00	3.00E+00	6.03E-01	1.09E+00	9.78E-01
Zr-95	--	--	--	--	< -3.60E-02	4.10E-02	-5.60E-03	3.20E-02	1.80E-02	3.48E-02	-7.87E-03

Table A-2.4. Result of Grid Site Vegetation Sampling 1985-1989 (pCi/g).
Location GRT5

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Results
Be-7	--	--	--	--	--	--	--	--	2.82E+00	4.53E-01	2.82E+00
Ce-141	--	--	--	--	--	--	8.30E-03	1.60E-02	7.36E-03	4.07E-02	7.83E-03
Co-60	--	--	--	--	< 9.70E-03	1.50E-02	-2.70E-03	1.50E-02	-1.77E-02	2.23E-02	-3.57E-03
Cs-134	--	--	--	--	8.50E-02	1.90E-02	a/	--	--	--	8.50E-02
Cs-137	--	--	--	--	4.60E-01	5.60E-02	2.30E-01	3.30E-02	2.04E-01	3.82E-02	2.98E-01
Eu-152	--	--	--	--	< -8.20E-03	7.00E-02	-2.10E-02	5.80E-02	-1.30E-02	1.02E-01	-1.41E-02
Eu-154	--	--	--	--	< -3.30E-02	5.00E-02	-1.50E-02	4.80E-02	-2.51E-02	6.20E-02	-2.44E-02
Eu-155	--	--	--	--	< -3.20E-02	4.30E-02	2.00E-02	4.20E-02	-6.03E-02	6.44E-02	-2.41E-02
I-129	--	--	--	--	< -1.00E-01	2.80E-01	-9.20E-03	2.60E-01	6.63E-02	2.33E-01	-1.43E-02
K-40	--	--	--	--	--	--	--	--	1.29E+01	1.55E+00	1.29E+01
Nb-95	--	--	--	--	< 1.10E-02	2.10E-02	-5.50E-03	1.40E-02	4.98E-03	2.93E-02	3.49E-03
Pb-212	--	--	--	--	--	--	--	--	6.58E-02	3.42E-02	6.58E-02
Pb-214	--	--	--	--	--	--	--	--	5.77E-02	3.69E-02	5.77E-02
Pu-238	--	--	--	--	< 8.30E-05	9.80E-05	1.90E-04	2.60E-04	4.69E-04	2.84E-04	2.47E-04
Pu-239	--	--	--	--	4.00E-03	7.90E-04	2.30E-03	7.30E-04	2.42E-03	6.87E-04	2.91E-03
Ru-103	--	--	--	--	--	--	--	--	--	--	--
Ru-106	--	--	--	--	a/	--	4.60E-01	1.80E-01	--	--	4.60E-01
Sr-90	--	--	--	--	1.40E-01	3.70E-02	2.20E-01	4.20E-02	4.12E-01	7.91E-02	2.57E-01
Tc-99	--	--	--	--	< 2.10E-02	8.30E-01	2.00E+00	3.00E+00	1.74E+00	1.18E+00	1.25E+00
Zr-95	--	--	--	--	< -3.90E-03	2.90E-02	5.60E-03	2.40E-02	-2.31E-03	4.01E-02	-2.03E-04

Table A-2.4. Result of Grid Site Vegetation Sampling 1985-1989 (pCi/g).
Location GRT6

Radionuclide	1985 Result	1985 Error	1986 Result	1986 Error	1987 Result	1987 Error	1988 Result	1988 Error	1989 Result	1989 Error	Average Results
Be-7	--	--	--	--	--	--	--	--	2.09E+00	3.56E-01	2.09E+00
Ce-141	--	--	--	--	--	--	-5.10E-03	1.90E-02	4.61E-03	2.99E-02	-2.54E-04
Co-60	--	--	--	--	< 1.10E-02	1.50E-02	2.40E-03	1.70E-02	4.45E-03	1.86E-02	5.95E-03
Cs-134	--	--	--	--	8.00E-02	2.10E-02	3.10E-02	1.40E-02	--	--	5.55E-02
Cs-137	--	--	--	--	4.90E-01	5.90E-02	4.00E-01	5.10E-02	4.10E-01	5.69E-02	4.33E-01
Eu-152	--	--	--	--	< 1.00E-02	7.10E-02	-2.20E-02	7.00E-02	9.45E-02	8.75E-02	2.75E-02
Eu-154	--	--	--	--	< -3.70E-02	5.40E-02	1.40E-02	4.90E-02	-3.45E-02	6.40E-02	-1.92E-02
Eu-155	--	--	--	--	< 0.00E+00	3.80E-02	2.90E-02	4.60E-02	-7.63E-03	4.07E-02	7.12E-03
I-129	--	--	--	--	< 1.70E-01	3.70E-01	9.20E-03	2.60E-01	1.79E-01	1.68E-01	1.19E-01
K-40	--	--	--	--	--	--	--	--	1.10E+01	1.35E+00	1.10E+01
Nb-95	--	--	--	--	< 1.90E-02	2.80E-02	-1.40E-02	1.50E-02	-1.92E-02	2.85E-02	-4.73E-03
Pb-212	--	--	--	--	--	--	--	--	5.95E-02	3.52E-02	5.95E-02
Pb-214	--	--	--	--	--	--	--	--	7.84E-02	4.78E-02	7.84E-02
Pu-238	--	--	--	--	< -1.50E-06	8.10E-04	-3.90E-05	1.90E-04	1.75E-04	1.72E-04	4.48E-05
Pu-239	--	--	--	--	9.40E-03	3.50E-03	6.70E-03	1.30E-03	6.95E-03	1.33E-03	7.68E-03
Ru-103	--	--	--	--	--	--	--	--	--	--	--
Ru-106	--	--	--	--	a/	--	5.10E-01	1.70E-01	3.37E-01	1.85E-01	4.24E-01
Sr-90	--	--	--	--	2.40E-01	6.00E-02	2.70E-01	5.00E-02	5.04E-01	1.02E-01	3.38E-01
Tc-99	--	--	--	--	< 6.40E-01	8.60E-01	1.40E+00	3.00E+00	8.79E-01	1.11E+00	9.79E-01
Zr-95	--	--	--	--	< 3.70E-02	3.30E-02	-4.80E-03	2.50E-02	-1.54E-02	3.79E-02	5.60E-03

Source: Schmidt et al. 1990; Elder et al. 1986, 1987, 1988, 1989.
Negative values indicate concentrations at or near background levels of radioactivity.
Shaded areas indicate a positive detection, the result is larger than the errer.
Dashes indicate no data are available.
An asterisk indicates that radionuclide concentration is less than detectable. The detection limits are as follows: Co-60 = 3.0E-02, Sr-90 = 5.0E-03, Nb-95 = 5.0E-02, Zr-95 = 5.0E-02, Ru-103 = 3.0E-02, Ru-106 = 2.6E-01, Cs-137 = 3.0E-02, Eu-152 = 1.7E-01, Er-154 = 8.0E-02, Eu-155 = 7.0E-02, Pu-238 = 6.0E-04, Pu-239 = 6.0E-04.
a/ Not routinely reported.
b/ Not analyzed for this radionuclide.

Table A-2.5. Results of Vegetation Sampling for 1990 and 1991 (pCi/g).
Location 67

Radionuclide	1990 Result	1990 Error	1991 Result	1991 Error	Average Result
Be-7	--	--	-3.00E+00	1.40E+01	3.00E+00
CePr-144	--	--	-2.00E+00	2.00E+00	2.00E+00
Co-60	--	--	3.70E-01	2.10E-01	3.70E-01
Cs-134	--	--	1.60E-01	1.80E-01	1.60E-01
Cs-137	--	--	4.10E-01	1.80E-01	4.10E-01
Eu-154	--	--	3.70E-01	5.20E-01	3.70E-01
Eu-155	--	--	8.30E-02	3.90E-01	8.30E-02
K-40	--	--	2.70E+01	6.40E+00	2.70E+01
Pb-212	--	--	--	--	--
Pb-214	--	--	--	--	--
Pu-238	--	--	4.05E-05	2.90E-04	4.05E-05
Pu-239/240	--	--	8.00E-04	5.50E-04	8.00E-04
Ru-106	--	--	-1.60E+00	2.00E+00	1.60E+00
Sb-125	--	--	-1.00E-02	4.20E-01	1.00E-02
Sr-90	--	--	3.80E-01	8.10E-02	3.80E-01
U-234	--	--	9.00E-02	1.70E-02	9.00E-02
U-235	--	--	3.70E-04	2.60E-03	3.70E-04
U-238	--	--	2.40E-02	7.60E-03	2.40E-02
U (Total)	--	--	--	--	--
Zn-65	--	--	-5.20E-01	6.10E-01	5.20E-01
ZrNb-95	--	--	-3.50E-01	2.10E+00	3.50E-01

Table A-2.5. Results of Vegetation Sampling for 1990 and 1991 (pCi/g).
Location 78

Radionuclide	1990 Result	1990 Error	1991 Result	1991 Error	Average Result
Be-7	9.96E+00	1.19E+01	-4.10E+00	6.70E+00	7.03E+00
CePr-144	8.16E-02	3.04E-01	-2.30E-01	7.80E-01	1.56E-01
Co-60	-9.40E-03	1.76E-02	1.80E-02	6.10E-02	1.37E-02
Cs-134	-3.54E-02	2.07E-00	-9.10E-03	5.50E-02	2.23E-02
Cs-137	7.67E-02	2.14E-02	2.90E-01	8.40E-02	1.83E-01
Eu-154	-2.24E-02	5.88E-02	1.30E-01	1.60E-01	7.62E-02
Eu-155	3.89E-03	5.06E-02	1.10E-02	1.60E-01	7.45E-03
K-40	1.60E+01	1.74E+00	1.20E+01	2.00E+00	1.40E+01
Pb-212	3.66E-02	2.23E-02	--	--	3.66E-02
Pb-214	*	--	--	--	--
Pu-238	1.65E-04	1.30E-04	4.60E+05	1.00E+04	1.06E+04
Pu-239/240	9.32E-03	1.30E-03	9.90E-04	3.10E-04	5.16E-03
Ru-106	8.69E-03	2.55E-01	-1.90E-01	6.50E-01	9.93E-02
Sb-125	-2.08E-02	4.49E-02	4.60E-02	1.60E-01	3.34E-02
Sr-90	1.54E-02	4.74E-03	3.60E-02	1.00E-02	2.57E-02
U-234	--	--	1.80E-02	5.70E-03	1.80E-02
U-235	--	--	-5.60E-04	1.60E-03	5.60E-04
U-238	--	--	1.00E-02	4.10E-03	1.00E-02
U (Total)	4.53E-02	1.43E-02	--	--	4.53E-02
Zn-65	-1.44E-01	1.45E-01	-6.70E-03	2.50E-01	7.54E-02
ZrNb-95	3.21E-01	1.52E+00	1.80E-01	1.10E+00	2.51E-01

Table A-2.5. Results of Vegetation Sampling for 1990 and 1991 (pCi/g).
Location 79

Radionuclide	1990 Result	1990 Error	1991 Result	1991 Error	Average Result
Be-7	--	--	1.80E+00	6.80E+00	1.80E+00
CePr-144	--	--	1.40E-01	1.10E+00	1.40E-01
Co-60	--	--	6.80E-02	7.90E-02	6.80E-02
Cs-134	--	--	-1.10E-01	9.00E-02	1.10E-01
Cs-137	--	--	-7.00E-02	9.20E-02	7.00E-02
Eu-154	--	--	1.80E-01	2.60E-01	1.80E-01
Eu-155	--	--	2.80E-02	2.30E-01	2.80E-02
K-40	--	--	2.90E+01	4.00E+00	2.90E+01
Pb-212	--	--	--	--	--
Pb-214	--	--	--	--	--
Pu-238	--	--	9.20E-05	1.10E-04	9.20E-05
Pu-239/240	--	--	1.90E-03	4.30E-04	1.90E-03
Ru-106	--	--	-1.10E+00	1.10E+00	1.10E+00
Sb-125	--	--	-1.10E-01	2.20E-01	1.10E-01
Sr-90	--	--	1.30E-01	2.70E-02	1.30E-01
U-234	--	--	5.90E-02	1.10E-02	5.90E-02
U-235	--	--	3.40E-04	1.90E-03	3.40E-04
U-238	--	--	2.10E-02	6.30E-03	2.10E-02
U (Total)	--	--	--	--	--
Zn-65	--	--	-3.50E-01	3.50E-01	3.50E-01
ZrNb-95	--	--	9.80E-01	1.00E+00	9.80E-01

Source: Schmidt et al. 1992.
Negative values indicate concentrations at or near background levels of radioactivity.
Shaded areas indicate a positive detection, the result is greater than the error.
Dashes indicate no data are available.
The detection limits are as follows: Mn-54 = 2.0E-02, Co-58 = 2.0E-02, Co-60 = 2.0E-02, Zn-65 = 4.0E-02, Sr-90 = 5.0E-03, Nb-95 = 3.0E-02, Zr-95 = 3.0E-02, Ru-106 = 1.7E-01, Cs-134 = 2.0E-02, Cs-137 = 2.0E-02, Eu-152 = 1.1E-01, Eu-154 = 5.0E-02, Eu-155 = 5.0E-02, Pu-238 = 6.0E-04, Pu-239 = 6.0E-04, and U (Total) = 1.0E-02.

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Table A-2.6. Results of Air Monitoring 1955 - 1989 (pCi/m^3)
Location N006

		1985		1986		1987		1988		1989		Average Result
Radionuclide		Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	
Sr-90	max	--	--	--	--	--	--	2.9E-04	1.3E-04	2.92E-04	1.46E-04	2.91E-04
	min	--	--	--	--	--	--	< 5.8E-05	7.3E-05	-0.00000	8.46E-05	2.90E-05
	avg	--	--	--	--	--	--	1.5E-04	1.1E-04	1.42E-04	1.15E-04	1.46E-04
Cs-137	max	--	--	--	--	--	--	7.1E-04	5.2E-04	4.07E-04	7.68E-04	5.59E-04
	min	--	--	--	--	--	--	3.0E-05	6.4E-04	-1.21E-04	4.82E-04	-4.55E-04
	avg	--	--	--	--	--	--	3.8E-04	3.1E-04	1.43E-04	6.25E-04	2.62E-04
Pu-239	max	--	--	--	--	--	--	1.8E-05	9.9E-06	1.06E-05	5.00E-06	1.43E-05
	min	--	--	--	--	--	--	< 9.9E-07	1.8E-06	1.50E-06	3.48E-06	1.25E-06
	avg	--	--	--	--	--	--	6.5E-06	8.9E-06	6.05E-06	4.24E-06	6.28E-06
U(total)	max	--	--	--	--	--	--	-9.6E-07	1.9E-06	5.48E-06	2.84E-05	2.26E-06
	min	--	--	--	--	--	--	-1.2E-05	3.0E-05	3.02E-06	1.97E-05	-4.49E-06
	avg	--	--	--	--	--	--	-6.1E-06	7.4E-06	4.25E-06	2.41E-05	-9.25E-07

Table A-2.6. Results of Air Monitoring 1955 - 1989 (pCi/m³)
Location N007

		1985		1986		1987		1988		1989		Average Result
Radionuclide		Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	
Sr-90	max	--	--	--	--	--	--	3.9E-04	1.5E-04	1.31E-04	9.62E-05	2.61E-04
	min	--	--	--	--	--	--	< 2.0E-05	6.9E-05	-0.00003	7.04E-05	-5.00E-06
	avg	--	--	--	--	--	--	1.9E-04	1.6E-04	4.73E-05	8.33E-05	1.19E-04
Cs-137	max	--	--	--	--	--	--	< 8.4E-04	1.1E-03	9.64E-05	4.67E-04	4.68E-04
	min	--	--	--	--	--	--	< -9.6E-05	4.0E-04	-4.97E-05	7.98E-04	-7.29E-05
	avg	--	--	--	--	--	--	2.1E-04	5.3E-04	2.33E-04	6.33E-04	1.17E-04
Pu-239	max	--	--	--	--	--	--	1.2E-05	7.9E-06	1.54E-06	2.99E-06	6.77E-06
	min	--	--	--	--	--	--	< 1.3E-06	2.6E-06	-0.00000	1.34E-06	6.50E-07
	avg	--	--	--	--	--	--	4.2E-06	6.2E-06	7.25E-07	2.17E-06	2.46E-06
U(total)	max	--	--	--	--	--	--	3.5E-05	3.3E-05	1.13E-05	2.12E-05	2.32E-05
	min	--	--	--	--	--	--	< -1.0E-05	3.0E-05	-0.00000	2.47E-05	-5.00E-06
	avg	--	--	--	--	--	--	7.9E-06	2.1E-05	5.50E-06	2.30E-05	6.70E-06

Table A-2.6. Results of Air Monitoring 1955 - 1989 (pCi/m³)
Location N008

		1985		1986		1987		1988		1989		Average Result
Radionuclide		Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	
Sr-90	max	--	--	--	--	--	--	4.0E-04	1.5E-04	1.44E-04	8.85E-05	2.72E-04
	min	--	--	--	--	--	--	< 3.9E-05	1.3E-04	-0.00000	7.75E-05	1.95E-05
	avg	--	--	--	--	--	--	1.5E-04	1.7E-04	6.96E-05	8.30E-05	1.10E-04
Cs-137	max	--	--	--	--	--	--	< 2.6E-04	7.1E-04	6.03E-04	3.86E-04	4.32E-04
	min	--	--	--	--	--	--	< -3.0E-04	9.3E-04	-1.63E-04	6.05E-04	-2.32E-04
	avg	--	--	--	--	--	--	-4.9E-05	3.8E-04	2.20E-04	4.95E-04	8.55E-05
Pu-239	max	--	--	--	--	--	--	< 2.5E-06	2.8E-06	1.00E-05	4.65E-06	6.25E-06
	min	--	--	--	--	--	--	< 1.9E-07	2.8E-06	6.56E-07	2.00E-06	4.23E-07
	avg	--	--	--	--	--	--	1.5E-06	3.2E-06	5.33E-06	3.33E-06	3.42E-06
U(total)	max	--	--	--	--	--	--	< 2.4E-05	2.8E-05	5.47E-05	2.92E-05	3.94E-05
	min	--	--	--	--	--	--	< -9.3E-06	1.8E-05	7.58E-06	2.57E-05	-8.60E-07
	avg	--	--	--	--	--	--	9.4E-06	1.6E-05	3.11E-05	2.75E-05	2.03E-05

Table A-2.6. Results of Air Monitoring 1955 - 1989 (pCi/m^3)
Location N012

		1985		1986		1987		1988		1989		Average Result
Radionuclide		Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	
Sr-90	max	--	--	--	--	--	--	6.6E-04	2.2E-04	5.00E-05	7.26E-05	3.55E-04
	min	--	--	--	--	--	--	1.6E-04	1.3E-04	-0.00000	6.66E-05	8.00E-05
	avg	--	--	--	--	--	--	4.1E-04	5.1E-04	2.60E-05	6.41E-05	2.18E-04
Cs-137	max	--	--	--	--	--	--	< 8.9E-04	9.6E-04	7.97E-04	7.47E-04	8.44E-04
	min	--	--	--	--	--	--	5.9E-04	4.3E-04	5.44E-05	5.71E-04	3.22E-04
	avg	--	--	--	--	--	--	7.4E-04	6.1E-04	3.65E-04	6.17E-04	5.53E-04
Pu-239	max	--	--	--	--	--	--	4.5E-06	3.9E-06	3.36-06	3.06E-06	3.93E-06
	min	--	--	--	--	--	--	< 1.5E-06	4.8E-06	-0.00000	1.35E-06	7.50E-07
	avg	--	--	--	--	--	--	3.0E-06	3.2E-06	1.97E-06	2.64E-06	2.49E-06
U(total)	max	--	--	--	--	--	--	< -4.2E-06	1.8E-05	1.93E-05	1.35E-05	7.55E-06
	min	--	--	--	--	--	--	< -5.2E-05	3.7E-05	-0.00000	1.94E-05	-2.60E-05
	avg	--	--	--	--	--	--	-2.8E-05	5.1E-05	9.88E-06	1.92E-05	-9.06E-06

Table A-2.6. Results of Air Monitoring 1955 - 1989 (pCi/m^3)
Location N158: 241-AX Tank Farm

		1985		1986		1987		1988		1989		Average Result
Radionuclide		Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	
Sr-90	max	2.83E-03	--	4.19E-04	--	5.44E-04	--	6.7E-04	2.2E-04	1.24E-03	3.33E-04	1.14E-03
	min	3.00E-04	--	3.29E-04	--	1.49E-04	--	1.3E-04	8.9E-05	4.57E-05	8.70E-05	1.91E-04
	avg	1.57E-03	2.38E-03	3.81E-04	8.98E-05	3.55E-04	3.44E-04	3.5E-04	2.4E-04	3.78E-04	1.49E-04	6.07E-04
Cs-137	max	4.36E-03	--	5.57E-03	--	3.16E-03	--	1.7E-03	7.8E-04	1.93E-03	9.69E-04	3.34E-03
	min	1.29E-03	--	7.56E-04	--	2.81E-04	--	< 1.8E-04	5.5E-04	1.39E-04	6.71E-04	5.29E-04
	avg	2.37E-03	2.74E-03	2.42E-03	4.31E-03	1.64E-03	2.36E-03	1.2E-03	7.3E-04	9.45E-04	7.33E-04	1.72E-03
Pu-239	max	6.15E-05	--	1.83E-05	--	1.21E-05	--	3.0E-05	9.8E-06	2.37E-03	2.42E-04	4.98E-04
	min	2.64E-05	--	2.12E-06	--	3.56E-06	--	< -5.6E-07	5.0E-06	1.17E-06	2.03E-06	6.54E-06
	avg	4.64E-05	3.02E-05	9.72E-06	1.65E-05	6.56E-06	7.66E-06	1.1E-05	1.4E-06	5.95E-04	6.25E-05	1.34E-04
U(total)	max	1.64E-04	--	8.55E-05	--	3.50E-05	--	3.7E-05	2.7E-05	9.43E-05	3.48E-05	8.32E-05
	min	3.29E-05	--	2.21E-05	--	1.94E-05	--	< 4.2E-06	2.0E-05	-0.00000	1.88E-05	1.57E-05
	avg	1.03E-04	1.31E-04	4.80E-05	5.80E-05	2.63E-06	1.31E-05	1.7E-05	1.5E-05	3.85E-05	2.42E-05	4.18E-05

Table A-2.6. Results of Air Monitoring 1955 - 1989 (pCi/m³)
Location N969: SW of PUREX Plant

		1985		1986		1987		1988		1989		Average Result
Radionuclide		Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	
Sr-90	max	1.26E-03	--	7.96E-04	--	2.37E-04	--	3.0E-04	1.3E-04	1.30E-03	3.63E-04	7.79E-04
	min	1.45E-04	--	9.74E-05	--	1.28E-05	--	< 1.3E-05	6.5E-05	2.85E-05	6.42E-05	5.93E-05
	avg	6.06E-04	1.05E-03	3.75E-04	5.95E-04	9.22E-05	2.45E-04	1.5E-04	1.6E-04	3.78E-04	1.47E-04	3.20E-04
Cs-137	max	5.45E-04	--	1.54E-03	--	-5.06E-05	--	< 2.0E-04	6.9E-04	2.50E-04	5.21E-04	4.97E-04
	min	-8.10E-04	--	2.45E-05	--	-4.33E-04	--	< -1.0E-04	5.8E-04	-3.05E-05	6.27E-04	-2.70E-04
	avg	-3.27E-05	1.13E-03	7.06E-04	1.26E-03	-2.56E-04	3.31E-04	8.9E-04	1.8E-04	1.46E-04	6.23E-04	1.30E-04
Pu-239	max	1.57E-04	--	2.37E-05	--	9.10E-06	--	5.5E-05	1.2E-05	9.72E-06	5.01E-06	5.09E-05
	min	5.65E-05	--	6.04E-06	--	6.29E-07	--	< 1.1E-06	2.5E-06	4.64E-07	1.55E-06	1.29E-05
	avg	9.01E-05	9.13E-05	1.62E-05	1.71E-05	4.82E-06	7.19E-06	1.9E-05	2.5E-05	3.53E-06	2.80E-06	2.67E-05
U(total)	max	8.75E-04	--	9.79E-05	--	3.69E-05	--	5.6E-05	3.1E-05	4.44E-05	2.07E-05	2.18E-04
	min	2.91E-05	--	1.83E-05	--	4.37E-06	--	< -1.2E-07	1.9E-05	2.07E-06	2.05E-05	1.07E-05
	avg	2.59E-04	8.01E-04	5.94E-05	7.04E-05	2.47E-05	2.86E-05	3.3E-05	2.5E-05	2.19E-05	1.99E-05	7.96E-05

Table A-2.6. Results of Air Monitoring 1955 - 1989 (pCi/m³)
Location N970

		1985		1986		1987		1988		1989		Average Result
Radionuclide		Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	
Sr-90	max	1.85E-03	--	2.31E-04	--	2.80E-04	--	2.5E-04	1.3E-04	9.79E-05	7.94E-05	5.42E-04
	min	9.94E-05	--	1.32E-04	--	-2.26E-05	--	1.1E-04	1.1E-04	-0.00003	5.70E-05	5.78E-05
	avg	6.11E-04	1.66E-03	1.81E-04	8.60E-05	8.76E-05	2.74E-04	1.7E-04	7.2E-05	5.45E-05	7.18E-05	2.21E-04
Cs-137	max	4.70E-04	--	4.72E-03	--	3.82E-04	--	3.9E-04	4.6E-04	4.78E-04	5.50E-04	1.29E-03
	min	-7.12E-04	--	5.42E-04	--	0.00E+00	--	< -3.0E-04	5.9E-04	-2.74E-04	5.85E-04	-1.49E-04
	avg	7.03E-05	1.08E-03	1.97E-03	3.92E-03	1.60E-04	3.41E-04	4.8E-05	3.3E-04	1.14E-04	6.12E-04	4.72E-04
Pu-239	max	1.71E-04	--	7.17E-05	--	1.25E-05	--	4.9E-05	1.2E-05	4.45E-05	1.07E-05	6.97E-05
	min	4.95E-05	--	5.59E-06	--	3.04E-06	--	1.3E-05	5.7E-06	1.04E-06	2.67E-06	1.44E-05
	avg	8.73E-05	1.13E-04	2.92E-05	5.87E-05	7.70E-06	8.88E-06	3.1E-05	1.5E-05	1.80E-05	5.97E-06	3.46E-05
U(total)	max	1.59E-04	--	3.91E-04	--	4.08E-05	--	4.0E-05	2.7E-05	4.67E-05	2.06E-05	1.36E-04
	min	4.62E-05	--	3.14E-05	--	1.07E-05	--	< -1.7E-06	1.9E-05	1.28E-05	2.15E-05	1.99E-05
	avg	9.72E-05	9.50E-05	1.40E-04	3.38E-04	2.28E-05	2.72E-05	2.0E-05	1.7E-05	2.94E-05	2.11E-05	6.10E-05

Table A-2.6. Results of Air Monitoring 1955 - 1989 (pCi/m^3)
Location N971

		1985		1986		1987		1988		1989		Average Result
Radionuclide		Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	
Sr-90	max	1.48E-02	--	5.44E-04	--	4.20E-04	--	2.7E-04	1.2E-04	7.50E-04	2.41E-04	3.21E-03
	min	2.81E-04	--	1.29E-04	--	2.30E-05	--	1.2E-04	1.1E-04	1.49E-05	6.12E-05	1.71E-04
	avg	4.18E-03	1.42E-02	3.18E-04	3.77E-04	1.35E-04	3.82E-04	1.9E-04	6.7E-05	3.03E-04	1.31E-04	9.65E-04
Cs-137	max	7.65E-04	--	1.41E-03	--	6.94E-04	--	7.0E-04	6.2E-04	6.35E-04	3.88E-04	5.77E-04
	min	0.00E+00	--	-7.63E-04	--	2.35E-04	--	< 5.8E-05	5.5E-04	-6.86E-04	5.58E-04	-1.07E-04
	avg	3.06E-04	6.52E-04	5.58E-04	1.87E-03	5.43E-04	4.16E-04	3.9E-04	3.2E-04	-6.52E-05	5.14E-04	3.59E-04
Pu-239	max	1.73E-04	--	1.58E-04	--	1.35E-05	--	3.1E-05	8.4E-06	1.76E-04	2.52E-05	7.52E-05
	min	7.17E-05	--	1.60E-05	--	3.57E-06	--	8.0E-06	4.8E-06	4.29E-07	1.66E-06	2.89E-05
	avg	1.20E-04	9.48E-05	5.55E-05	1.37E-04	6.54E-06	9.45E-06	2.2E-05	1.0E-05	4.52E-05	7.84E-06	4.08E-05
U(total)	max	1.14E-04	--	8.08E-05	--	3.02E-05	--	< 2.4E-05	2.5E-05	7.16E-05	2.79E-05	5.18E-05
	min	3.76E-05	--	1.49E-05	--	1.03E-05	--	< -7.4E-06	1.8E-05	1.01E-05	2.14E-05	1.85E-05
	avg	6.77E-05	6.96E-05	3.93E-05	5.77E-05	2.01E-05	1.66E-05	7.4E-06	1.3E-05	3.72E-05	2.34E-05	2.69E-05

Table A-2.6. Results of Air Monitoring 1955 - 1989 (pCi/m³)
Location N976

		1985		1986		1987		1988		1989		Average Result
Radionuclide		Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	
Sr-90	max	6.23E-03	--	1.19E-01	--	2.98E-04	--	5.0E-04	2.0E-04	4.36E-04	1.74E-04	2.53E-02
	min	5.51E-04	--	5.20E-04	--	1.46E-04	--	1.7E-04	1.2E-04	3.56E-05	8.79E-05	2.85E-04
	avg	2.50E-03	5.30E-03	6.27E-04	1.87E-04	2.51E-04	1.41E-04	2.9E-04	1.5E-04	2.08E-04	1.16E-04	7.75E-04
Cs-137	max	5.67E-04	--	1.81E-03	--	5.54E-04	--	< 1.7E-04	6.0E-04	7.00E-04	6.20E-04	7.60E-04
	min	-4.59E-04	--	3.43E-04	--	2.06E-04	--	<-1.1E-04	5.3E-04	-2.28E-04	5.41E-04	-4.96E-05
	avg	2.04E-04	9.39E-04	7.82E-04	1.38E-03	4.07E-04	3.02E-04	-3.0E-07	1.5E-04	2.39E-04	5.51E-04	3.26E-04
Pu-239	max	2.91E-05	--	4.99E-06	--	6.83E-06	--	< 5.5E-07	1.6E-06	1.99E-06	2.97E-06	8.69E-06
	min	1.36E-05	--	6.81E-07	--	1.90E-06	--	< -1.7E-06	1.6E-06	-0.00000	3.28E-06	2.90E-06
	avg	1.94E-05	1.39E-05	3.64E-06	4.03E-06	3.88E-06	4.21E-06	-1.3E-07	1.1E-06	2.44E-07	2.25E-06	5.41E-06
U(total)	max	1.17E-04	--	4.83E-05	--	6.01E-05	--	< 9.9E-06	2.0E-05	2.21E-04	7.04E-05	9.13E-05
	min	1.97E-05	--	3.25E-05	--	1.65E-05	--	< -8.3E-07	1.9E-05	-0.00000	1.86E-05	1.36E-05
	avg	7.21E-05	8.89E-05	3.79E-05	1.43E-05	3.39E-05	3.71E-05	4.5E-06	4.7E-06	8.57E-05	3.73E-05	4.68E-05

Table A-2.6. Results of Air Monitoring 1955 - 1989 (pCi/m^3)
Location N977

		1985		1986		1987		1988		1989		Average Result
Radionuclide		Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	
Sr-90	max	5.88E-03	--	3.51E-04	--	2.90E-04	--	2.7E-04	1.4E-04	1.07E-04	9.90E-05	1.38E-03
	min	4.78E-04	--	2.14E-04	--	3.62E-05	--	1.1E-04	1.0E-04	-0.00003	1.07E-04	1.68E-04
	avg	2.08E-03	5.14E-03	2.86E-04	1.41E-04	1.23E-04	2.28E-04	1.9E-04	9.1E-05	2.19E-05	9.31E-05	5.40E-04
Cs-137	max	1.00E-03	--	8.76E-04	--	7.03E-04	--	8.5E-04	6.3E-04	3.69E-04	4.77E-04	7.60E-04
	min	1.05E-04	--	-3.73E-04	--	3.91E-04	--	< -1.1E-04	5.1E-04	-3.78E-04	6.14E-04	-7.48E-05
	avg	5.02E-04	8.08E-04	2.75E-04	1.23E-03	5.51E-04	2.57E-04	2.7E-04	4.7E-04	-6.22E-05	5.43E-04	3.07E-04
Pu-239	max	1.13E-04	--	2.39E-05	--	7.66E-06	--	4.4E-05	1.3E-05	6.83E-06	4.18E-06	3.91E-05
	min	3.20E-05	--	5.10E-06	--	5.31E-07	--	3.9E-06	3.2E-06	2.48E-07	1.64E-06	8.36E-06
	avg	7.29E-05	6.90E-05	1.24E-05	1.62E-05	3.56E-06	7.39E-06	1.5E-05	2.0E-05	2.61E-06	2.46E-06	2.13E-05
U(total)	max	1.61E-04	--	4.77E-05	--	4.27E-05	--	< 1.1E-05	2.3E-05	1.27E-04	4.35E-05	7.79E-05
	min	4.30E-05	--	1.20E-05	--	1.03E-05	--	< -4.3E-06	2.0E-05	9.56E-06	2.10E-05	1.41E-05
	avg	8.27E-05	1.07E-04	2.76E-05	3.31E-05	2.41E-05	2.95E-05	1.6E-06	7.6E-06	6.31E-05	3.04E-05	3.98E-05

Table A-2.6. Results of Air Monitoring 1955 - 1989 (pCi/m^3)
Location N984

		1985		1986		1987		1988		1989		Average Result
Radionuclide		Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	
Sr-90	max	2.71E-03	--	9.80E-04	--	7.88E-03	--	8.0E-04	2.6E-04	5.68E-04	2.15E-04	2.59E-03
	min	2.07E-04	--	2.73E-04	--	1.18E-04	--	2.7E-04	1.3E-04	2.01E-05	7.41E-05	1.78E-04
	avg	1.29E-03	2.15E-03	5.74E-04	6.95E-04	2.11E-03	7.70E-03	4.2E-04	2.6E-04	2.61E-04	1.40E-04	9.31E-04
Cs-137	max	3.79E-03	--	2.95E-03	--	3.12E-03	--	1.9E-03	7.8E-04	7.41E-04	4.53E-04	2.50E-03
	min	1.35E-04	--	-1.27E-04	--	4.48E-04	--	6.9E-04	4.8E-04	3.50E-04	7.40E-04	2.99E-04
	avg	2.32E-03	3.52E-03	1.37E-03	3.23E-03	1.58E-03	2.23E-03	1.1E-03	5.8E-04	5.89E-04	6.43E-04	1.39E-03
Pu-239	max	3.49E-05	--	6.60E-06	--	3.43E-06	--	5.6E-06	4.0E-06	4.17E-05	1.05E-05	1.84E-05
	min	1.51E-05	--	4.24E-06	--	6.76E-07	--	< 4.2E-07	2.0E-06	4.01E-06	4.34E-06	4.89E-06
	avg	2.29E-05	1.72E-05	5.24E-06	2.35E-06	2.12E-06	2.44E-06	2.6E-06	2.5E-06	1.48E-05	5.85E-06	9.53E-06
U(total)	max	1.46E-04	--	5.76E-05	--	1.51E-05	--	< 8.7E-07	1.9E-05	7.71E-05	3.03E-05	5.93E-05
	min	2.65E-05	--	2.19E-05	--	6.76E-06	--	< -5.6E-06	1.9E-05	-0.00000	2.00E-05	9.91E-06
	avg	7.93E-05	1.11E-04	3.94E-05	2.95E-05	1.11E-05	7.09E-06	-1.7E-06	2.9E-06	4.25E-05	2.58E-05	3.41E-05

Table A-2.6. Results of Air Monitoring 1955 - 1989 (pCi/m^3)
Location N985

		1985		1986		1987		1988		1989		Average Result
Radionuclide		Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	
Sr-90	max	1.02E-03	--	8.29E-04	--	5.48E-04	--	2.9E-04	1.3E-04	2.63E-04	1.16E-04	5.90E-04
	min	3.81E-04	--	3.37E-04	--	1.43E-04	--	<7.5E-05	8.1E-05	-0.00002	8.00E-05	1.87E-04
	avg	6.91E-04	6.40E-04	5.71E-04	4.16E-04	3.19E-04	3.43E-04	1.5E-04	1.0E-04	1.20E-04	9.46E-05	3.70E-04
Cs-137	max	9.62E-04	--	1.28E-03	--	4.08E-04	--	4.4E-04	4.2E-04	5.94E-04	5.28E-04	7.37E-04
	min	7.34E-04	--	5.52E-04	--	-3.02E-04	--	<-8.5E-05	6.9E-04	-1.52E-04	5.22E-04	1.49E-04
	avg	8.81E-04	2.55E-04	9.44E-04	6.96E-04	6.85E-05	7.43E-04	1.4E-05	2.8E-04	1.24E-04	5.94E-04	4.32E-04
Pu-239	max	4.68E-05	--	2.53E-05	--	5.28E-06	--	1.0E-04	2.1E-05	4.16E-04	5.56E-05	1.19E-04
	min	2.27E-05	--	1.44E-06	--	9.41E-07	--	<2.7E-06	3.8E-06	9.13E-07	1.73E-06	5.74E-06
	avg	3.70E-05	2.53E-05	1.54E-05	2.30E-05	3.15E-06	3.63E-06	3.3E-05	4.9E-05	1.05E-04	1.57E-05	3.87E-05
U(total)	max	2.20E-04	--	9.40E-05	--	3.14E-05	--	<2.4E-05	2.4E-05	7.65E-05	2.83E-05	8.92E-05
	min	2.52E-05	--	1.75E-05	--	1.34E-05	--	<2.4E-06	2.0E-05	2.61E-05	2.41E-05	1.69E-05
	avg	1.23E-04	1.95E-04	4.33E-05	6.88E-05	2.32E-05	1.48E-05	1.3E-05	9.7E-06	4.48E-05	2.48E-05	4.95E-05

Table A-2.6. Results of Air Monitoring 1955 - 1989 (pCi/m^3)
Location N991

		1985		1986		1987		1988		1989		Average Result
Radionuclide		Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	
Sr-90	max	1.56E-04	--	2.72E-04	--	1.05E-04	--	2.6E-04	1.2E-04	1.26E-04	8.37E-05	1.84E-04
	min	8.36E-05	--	1.50E-04	--	-8.84E-06	--	<2.1E-06	9.2E-05	1.94E-05	9.59E-05	4.93E-05
	avg	1.20E-04	1.02E-04	2.05E-04	1.10E-04	5.31E-05	9.64E-05	1.3E-04	1.1E-04	7.67E-05	8.69E-05	1.17E-04
Cs-137	max	8.58E-04	--	7.12E-04	--	4.85E-04	--	<6.8E-04	8.3E-04	3.97E-04	5.51E-04	6.21E-04
	min	2.73E-05	--	2.49E-04	--	-1.13E-05	--	<8.7E-05	6.8E-04	-1.93E-04	4.70E-04	3.18E-05
	avg	4.43E-04	1.17E-03	4.40E-04	4.46E-04	2.55E-04	3.91E-04	2.7E-04	3.2E-04	1.09E-04	5.50E-04	3.03E-04
Pu-239	max	5.47E-05	--	2.70E-05	--	3.64E-06	--	1.1E-05	6.0E-06	3.94E-05	1.03E-05	2.71E-05
	min	3.31E-05	--	1.59E-06	--	4.66E-08	--	<1.7E-06	2.6E-06	6.86E-07	1.50E-06	7.42E-06
	avg	4.39E-05	3.05E-05	1.24E-05	2.20E-05	1.62E-06	3.02E-06	6.3E-06	4.5E-06	1.07E-05	3.86E-06	1.50E-05
U(total)	max	2.00E-04	--	6.60E-05	--	2.84E-06	--	<1.1E-05	2.1E-05	5.57E-05	2.25E-05	6.71E-05
	min	3.04E-05	--	1.54E-05	--	1.23E-06	--	<-8.7E-06	2.0E-05	8.70E-07	1.98E-05	7.84E-06
	avg	1.15E-04	2.40E-04	4.43E-05	4.44E-05	1.35E-05	2.24E-05	1.5E-06	8.3E-06	2.41E-05	1.97E-05	3.97E-05

Table A-2.6. Results of Air Monitoring 1955 - 1989 (pCi/m^3)
Location N992

		1985		1986		1987		1988		1989		Average Result
Radionuclide		Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	
Sr-90	max	2.78E-04	--	2.78E-04	--	1.33E-04	--	--	--	6.02E-04	2.07E-04	2.58E-04
	min	2.78E-04	--	5.04E-05	--	3.79E-05	--	--	--	-0.00003	6.14E-05	7.33E-05
	avg	2.78E-04	2.50E-04	1.60E-04	1.86E-04	8.52E-05	8.78E-05	2.7E-04	1.5E-04	1.52E-04	1.03E-04	1.89E-04
Cs-137	max	-7.08E-04	--	1.15E-03	--	8.88E-04	--	--	--	4.09E-04	4.70E-04	3.48E-04
	min	-7.08E-04	--	-1.88E-04	--	-7.54E-04	--	--	--	-6.66E-05	4.73E-04	-3.43E-04
	avg	-7.08E-04	9.87E-04	5.06E-04	1.21E-03	1.87E-04	1.64E-03	<4.5E-04	5.4E-04	1.73E-04	4.77E-04	1.22E-04
Pu-239	max	0.00E+00	--	9.23E-06	--	3.65E-06	--	--	--	8.20E-07	1.77E-06	2.74E-06
	min	0.00E+00	--	1.04E-06	--	7.38E-07	--	--	--	-0.00000	2.26E-06	3.56E-07
	avg	0.00E+00	3.80E-06	6.29E-06	7.64E-06	2.10E-06	2.64E-06	<5.4E-07	1.8E-06	-0.00000	1.66E-06	1.79E-06
U(total)	max	2.03E-05	--	6.71E-05	--	2.06E-05	--	--	--	3.39E-05	1.66E-05	2.84E-05
	min	2.03E-05	--	1.67E-05	--	-1.77E-05	--	--	--	-0.00000	1.90E-05	3.86E-06
	avg	2.03E-05	3.36E-05	4.23E-05	4.40E-05	8.62E-06	3.57E-05	<1.3E-05	2.5E-05	2.09E-05	1.85E-05	2.10E-05

Table A-2.6. Results of Air Monitoring 1955 - 1989 (pCi/m³)
Location N993

		1985		1986		1987		1988		1989		Average Result
Radionuclide		Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	
Sr-90	max	1.05E-04	--	4.33E-04	--	1.66E-04	--	3.2E-04	1.4E-04	3.71E-04	1.45E-04	2.79E-04
	min	1.05E-04	--	1.38E-04	--	4.28E-05	--	<2.6E-05	9.5E-05	1.84E-05	7.23E-05	6.60E-05
	avg	1.05E-04	1.89E-04	3.04E-04	2.46E-04	1.02E-04	1.19E-04	1.7E-04	1.3E-04	1.33E-04	9.73E-05	1.63E-04
Cs-137	max	-5.45E-05	--	5.15E-03	--	1.28E-03	--	7.1E-04	6.3E-04	7.53E-04	5.89E-04	1.57E-03
	min	-5.45E-05	--	3.47E-04	--	-4.92E-06	--	<-9.7E-05	5.2E-04	-2.96E-04	5.75E-04	-2.99E-05
	avg	-5.45E-05	1.12E-03	2.31E-03	4.19E-03	8.65E-04	1.23E-03	3.2E-04	3.4E-04	2.76E-04	5.53E-04	7.43E-04
Pu-239	max	9.82E-07	--	3.26E-05	--	7.48E-06	--	8.0E-06	5.1E-06	4.19E-06	3.25E-06	1.07E-05
	min	9.82E-07	--	6.61E-06	--	3.05E-06	--	<1.5E-06	2.6E-06	1.29E-06	2.38E-06	2.69E-06
	avg	9.82E-07	1.97E-06	2.26E-05	2.36E-05	5.48E-06	4.53E-06	4.1E-06	3.2E-06	2.39E-06	2.58E-06	7.11E-06
U(total)	max	2.64E-05	--	2.16E-04	--	1.42E-04	--	4.5E-05	2.9E-05	9.30E-05	3.31E-05	1.04E-04
	min	2.64E-05	--	2.62E-05	--	2.46E-05	--	<9.9E-06	2.0E-05	7.65E-06	2.05E-05	1.90E-05
	avg	2.64E-05	3.45E-05	9.76E-05	1.69E-04	6.05E-05	1.10E-04	2.0E-05	1.8E-05	4.31E-05	2.43E-05	4.59E-05

Table A-2.6. Results of Air Monitoring 1955 - 1989 (pCi/m³)
Location N996

		1985		1986		1987		1988		1989		Average Result
Radionuclide		Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	
Sr-90	max	--	--	1.39E-04	--	8.43E-04	--	4.7E-04	1.7E-04	2.81E-04	2.09E-04	4.33E-04
	min	--	--	1.39E-04	--	1.89E-05	--	<7.8E-05	1.1E-04	4.76E-05	9.69E-05	7.09E-05
	avg	--	--	1.39E-04	2.44E-12	2.72E-04	7.67E-04	2.3E-04	2.0E-04	1.59E-04	1.40E-04	
Cs-137	max	--	--	6.41E-04	--	4.64E-04	--	6.2E-04	5.0E-04	1.80E-04	5.99E-04	4.76E-04
	min	--	--	2.74E-04	--	-3.25E-04	--	<-5.3E-04	6.5E-04	-4.45E-04	9.45E-04	-2.57E-04
	avg	--	--	4.58E-04	5.19E-04	9.02E-05	8.03E-04	2.4E-04	5.3E-04	-8.53E-05	7.01E-04	
Pu-239	max	--	--	2.40E-05	--	1.95E-05	--	7.3E-06	6.9E-06	2.65E-06	5.49E-06	1.34E-05
	min	--	--	1.73E-05	--	1.98E-06	--	<-5.6E-07	1.7E-06	-0.00000	2.23E-06	4.68E-06
	avg	--	--	2.06E-05	9.48E-06	7.26E-06	1.66E-05	2.6E-06	4.2E-06	1.20E-06	3.33E-06	
U(total)	max	--	--	6.42E-05	--	7.40E-05	--	<1.0E-05	2.4E-05	7.99E-05	3.62E-05	5.70E-05
	min	--	--	4.08E-05	--	2.45E-05	--	<3.3E-06	2.0E-05	2.71E-05	2.73E-05	2.39E-05
	avg	--	--	5.25E-05	3.31E-05	4.14E-05	4.58E-05	6.7E-06	3.5E-06	4.59E-05	3.07E-05	3.66E-05

Table A-2.6. Results of Air Monitoring 1955 - 1989 (pCi/m³)
Location N997

		1985		1986		1987		1988		1989		Average Result
Radionuclide		Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	
Sr-90	max	--	--	1.35E-03	--	7.17E-04	--	2.2E-04	1.1E-04	1.41E-04	1.27E-04	6.07E-04
	min	--	--	6.48E-04	--	4.77E-05	--	<1.5E-05	7.2E-05	-0.00008	1.60E-04	1.78E-04
	avg	--	--	9.99E-04	9.93E-04	2.51E-04	6.25E-04	1.4E-04	9.7E-05	3.79E-05	2.77E-04	
Cs-137	max	--	--	2.31E-03	--	1.23E-03	--	<5.9E-04	6.9E-04	2.53E-03	3.27E-03	1.67E-03
	min	--	--	1.78E-03	--	-2.64E-04	--	<2.9E-04	4.7E-04	-3.69E-05	6.68E-04	4.42E-04
	avg	--	--	2.04E-03	7.50E-04	3.31E-04	1.30E-03	4.9E-04	1.7E-04	1.01E-03	1.66E-03	
Pu-239	max	--	--	3.09E-05	--	3.70E-05	--	<3.1E-06	3.3E-06	5.52E-06	3.99E-06	1.91E-05
	min	--	--	4.29E-06	--	1.44E-06	--	<-5.6E-07	2.8E-06	-0.00000	1.47E-05	1.29E-06
	avg	--	--	1.76E-05	3.76E-05	1.47E-05	3.22E-05	1.2E-06	2.2E-06	5.51E-07	7.47E-06	8.51E-06
U(total)	max	--	--	1.18E-04	--	2.51E-05	--	<3.5E-06	2.1E-05	1.61E-04	8.87E-05	7.69E-05
	min	--	--	2.40E-05	--	2.04E-06	--	<-5.1E-06	2.0E-05	-0.00001	6.01E-05	5.24E-06
	avg	--	--	7.10E-05	1.33E-04	1.31E-05	2.10E-06	-2.0E-05	4.9E-06	4.46E-05	5.69E-05	3.17E-05

Source: Schmidt et al. 1990; Elder et al. 1986, 1987, 1988, 1989.
Shaded Areas indicate a positive detection, the result is larger than the error.
Negative values indicate concentrations at or near background levels of radioactivity.
Dashes indicate no data are available.
An asterix indicates sites sampled one quarter only show the overall counting error rather than the standard deviation of the mean of quarterly composites. Only one reading was taken in 1988.

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Table A-2.7. Results of Air Monitoring for 1990 (pCi/m^3)

Radionuclide		Location N158		Location N969		Location N970		Location N972		Location N977	
		Result	Error	Result	Error	Result	Error	Result	Error	Result	Error
Sr-90	Quarter 1	4.57E-05	8.70E-05	2.85E-05	6.42E-05	9.79E-05	7.94E-05	1.07E-04	8.38E-05	-4.89E-05	7.12E-05
	Quarters 2-4	3.68E-04	2.20E-04	-5.98E-06	1.80E-05	2.55E-05	9.10E-05	1.15E-04	4.10E-05	8.25E-06	9.30E-05
	Average	2.07E-04	1.54E-04	1.13E-05	4.11E-05	6.17E-05	8.52E-05	1.11E-04	6.24E-05	-2.03E-05	8.21E-05
Cs-137	Quarter 1	1.39E-04	6.71E-04	2.50E-04	5.21E-04	-2.74E-04	5.85E-04	4.92E-04	4.37E-04	-3.87E-04	6.14E-04
	Quarters 2-4	2.65E-03	7.50E-04	5.34E-05	5.50E-04	3.44E-04	5.20E-04	6.02E-04	3.10E-04	-6.59E-05	5.00E-04
	Average	1.39E-03	7.11E-04	1.52E-04	5.36E-04	3.50E-05	5.53E-04	5.47E-04	3.74E-04	-2.26E-04	5.57E-04
Pu-239	Quarter 1	4.21E-06	2.89E-06	1.04E-06	2.19E-06	1.04E-06	2.67E-06	2.00E-06	2.91E-06	2.02E-06	2.08E-06
	Quarters 2-4	3.24E-06	4.90E-06	4.22E-06	4.80E-06	6.98E-06	2.90E-06	5.87E-06	0.00E+00	9.74E-06	6.40E-06
	Average	3.73E-06	3.90E-06	2.63E-06	3.50E-06	4.01E-06	2.79E-06	3.94E-06	1.46E-06	5.88E-06	4.24E-06
U (total)	Quarter 1	9.43E-05	3.48E-05	4.44E-05	2.07E-05	4.00E-05	1.92E-05	5.34E-05	2.39E-05	1.27E-04	4.35E-05
	Quarters 2-4	2.61E-05	8.30E-06	1.97E-05	4.00E-06	2.49E-05	4.40E-06	3.00E-05	9.80E-06	1.55E-05	7.80E-06
	Average	6.02E-05	2.16E-05	3.21E-05	1.24E-05	3.25E-05	1.18E-05	4.17E-05	1.69E-05	7.13E-05	2.57E-05

Table A-2.7. Results of Air Monitoring for 1990 (pCi/m³)

Radionuclide		Location N978		Location N984		Location N985		Location N991		Location N992	
		Result	Error	Result	Error	Result	Error	Result	Error	Result	Error
Sr-90	Quarter 1	5.14E-05	8.98E-05	3.23E-04	1.32E-04	2.63E-04	1.16E-04	1.26E-04	8.37E-05	3.94E-07	6.08E-05
	Quarters 2-4	1.43E-05	2.00E-05	6.09E-04	6.90E-04	1.01E-04	1.80E-05	2.87E-05	6.10E-05	4.32E-05	9.90E-05
	Average	3.29E-05	5.49E-05	4.66E-04	4.11E-04	1.82E-04	6.70E-05	7.74E-05	7.24E-05	2.18E-05	7.99E-05
Cs-137	Quarter 1	-1.29E-04	4.79E-04	6.71E-04	8.58E-04	5.94E-04	5.28E-04	3.97E-04	5.51E-04	-6.66E-05	4.73E-04
	Quarters 2-4	1.11E-04	8.70E-04	1.13E-03	3.30E-04	3.01E-04	1.00E-04	2.38E-04	3.90E-04	5.79E-05	9.30E-04
	Average	-9.00E-06	6.75E-04	9.01E-04	5.94E-04	4.48E-04	3.14E-04	3.18E-04	4.71E-04	-4.35E-06	7.02E-04
Pu-239	Quarter 1	9.66E-06	4.56E-06	8.58E-06	4.74E-06	1.49E-06	2.31E-06	9.27E-07	1.42E-06	-3.19E-08	2.26E-06
	Quarters 2-4	5.87E-06	8.80E-06	9.65E-06	7.50E-06	3.50E-06	2.50E-06	9.22E-06	5.80E-06	9.72E-06	9.40E-06
	Average	7.77E-06	6.68E-06	9.12E-06	6.12E-06	2.50E-06	2.41E-06	5.07E-06	3.61E-06	4.84E-06	5.83E-06
U (total)	Quarter 1	9.77E-05	3.63E-05	7.05E-05	2.76E-05	7.65E-05	2.83E-05	2.54E-05	1.38E-05	2.96E-05	1.54E-05
	Quarters 2-4	1.38E-05	3.40E-06	3.58E-05	1.50E-05	3.14E-05	3.00E-05	2.33E-05	9.60E-06	2.86E-05	4.90E-06
	Average	5.58E-05	1.99E-05	5.32E-05	2.13E-05	5.40E-05	2.92E-05	2.44E-05	1.17E-05	2.91E-05	1.02E-05

Source: Schmidt et al. 1992.

Negative values indicate concentrations at or near background levels of radioactivity.

Shaded areas indicate a positive detection, the result is greater than the error.

The detection limits are as follows:

Mn-54 = 2.0E-02, Co-58 = 2.0E-02, Co-60 = 2.0E-02, An-65 = 4.0E-02, Sr-90 = 5.0E-03, Nb-95 = 3.0E-02, Zr-95 = 3.0E-02, Ru-106 = 1.7E-01, Cs-134 = 2.0E-02, Cs-137 = 2.0E-02, Eu-152 = 1.1E-01, Eu-154 = 5.0E-02, Eu-155 = 5.0E-02, Pu-238 = 6.0E-04, Pu-239 = 6.0E-04, and U total = 1.0E-02.

Table A-2.8. Results of Soil Sampling for 1990 and 1991 (pCi/g)
Location 64

Radionuclide	1990 Result	1990 Error	1991 Result	1991 Error	Average Result
Be-7	-2.06E+01	3.15E+01	1.90E+01	1.70E+01	2.25E+01
CePr-144	3.94E-02	5.62E-01	-1.30E-01	8.50E-01	8.47E-02
Co-60	-5.27E-03	2.03E-02	1.20E-02	5.10E-02	8.64E-03
Cs-134	-1.41E-01	3.21E-02	-2.50E-001	8.40E-02	1.96E-01
Cs-137	2.37E+00	2,47E-01	3.50E+00	3.80E-01	2.94E+00
Eu-154	4.38E-02	6.11E-02	2.80E-02	1.50E-01	3.59E-02
Eu-155	9.90E-02	7.88E-02	5.30E-03	1.40E-01	5.22E-02
K-40	1.42E+01	1.58E+00	1.80E+01	2.20E+00	1.61E+01
Pb-212	7.01E-01	8.22E-02	--	--	7.01E-01
Pb-214	5.34E-01	7.78E-02	--	--	5.34E-01
Pu-238	3.81E-04	3.04E-04	4.50E-04	2.30E-04	4.16E-04
Pu-239/240	1.12E-02	2.05E-03	1.70E-02	2.10E-03	1.41E-02
Ra-226	5.66E-01	7.92E-02	--	--	5.66E-01
Ru-106	-1.16E-01	3.51E-01	-9.10E-02	6.70E-01	1.04E-01
Sb-125	-4.55E-02	6.96E-02	-4.20E-02	1.60E-01	4.38E-02
Sr-90	2.82E+00	4.91E-01	3.20E+00	5.60E-01	3.01E+00
U-234	--	--	7.30E-01	8.80E-02	7.30E-01
U-235	1.31E-02	1.26E-02	1.90E-02	9.60E-03	1.61E-02
U-238	7.62E-01	1.07E-01	6.60E-01	8.10E-02	7.11E-01
U (Total)	8.18E-01	1.13E-01	--	--	8.18E-01
Zn-65	-3.75E-01	1.54E-01	-3.90E-01	2.60E-01	3.74E-01
ZrNb-95	1.75E+00	2.83E+00	-3.50E-02	2.10E+00	8.93E-01

Table A-2.8. Results of Soil Sampling for 1990 and 1991 (pCi/g)
Location 65

Radionuclide	1990 Result	1990 Error	1991 Result	1991 Error	Average Result
Be-7	-1.72E+01	5.30E+01	1.50E+01	3.30E+01	1.61E+01
CePr-144	-3.45E-01	7.64E-01	-9.50E-03	1.30E+00	1.77E-01
Co-60	-9.58E-04	2.15E-02	2.30E-02	4.60E-02	1.20E-02
Cs-134	-3.16E-02	3.11E-02	-3.70E-01	1.00E-01	2.01E-01
Cs-137	7.02E+00	7.13E-01	1.70E+01	1.70E+00	1.20E+01
Eu-154	-8.80E-02	1.60E-01	-8.80E-02	1.60E-01	5.49E-02
Eu-155	2.37E-02	9.15E-02	-1.70E-02	2.00E-01	2.04E-02
K-40	1.44E+01	1.61E+00	1.70E+01	2.30E+00	1.57E+01
Pb-212	6.33E-01	7.91E-02	--	--	6.33E-01
Pb-214	4.77E-01	8.15E-02	--	--	4.77E-01
Pu-238	7.85E-04	4.79E-04	3.10E-04	2.20E-04	5.48E-04
Pu-239/240	5.18E-02	6.31E-03	8.20E-03	1.40E-03	3.00E-02
Ra-226	4.32E-01	7.28E-02	--	--	4.31E-01
Ru-106	3.84E-02	4.18E-01	8.00E-02	9.60E-01	5.92E-02
Sb-125	2.75E-02	1.10E-01	-2.20E-02	3.00E-01	2.48E-02
Sr-90	2.93E+00	5.36E-01	1.80E+00	3.40E-01	2.37E+00
U-234	--	--	7.30E-01	9.10E-02	7.30E-01
U-235	3.73E-02	1.96E-02	2.10E-02	1.10E-02	2.92E-02
U-238	7.64E-01	1.06E-01	7.50E-01	9.20E-02	7.57E-01
U (Total)	7.04E-01	1.01E-001	--	--	7.04E-01
Zn-65	-1.42E-01	1.45E-01	-1.90E-01	2.50E-01	1.66E-01
ZrNb-95	-1.91E+00	3.00E+00	1.20E+00	2.20E+00	1.56E+00

Table A-2.8. Results of Soil Sampling for 1990 and 1991 (pCi/g)
Location 66

Radionuclide	1990 Result	1990 Error	1991 Result	1991 Error	Average Result
Be-7	-2.91E+00	6.34E+01	-3.30E+00	2.10E+01	1.62E+00
CePr-144	-4.60E-01	8.53E-01	6.40E-01	7.90E-01	5.50E-01
Co-60	1.06E-02	2.04E-02	-3.60E-02	3.80E-02	2.33E-02
Cs-134	-3.69E-01	6.08E-02	-8.60E-02	5.20E-02	2.28E-01
Cs-137	1.19E+01	1.20E+00	1.00E+01	1.10E+00	1.10E+01
Eu-154	-1.48E-02	7.23E-02	2.70E-02	1.00E-01	2.09E-02
Eu-155	5.72E-02	1.12E-01	1.50E+01	1.90E+00	1.56E+01
K-40	1.62E+01	1.79E+00	1.50E+01	1.90E+00	1.56E+01
Pb-212	8.22E-01	1.00E-01	--	--	8.22E-01
Pb-214	7.06E-01	1.08E-01	--	--	7.06E-01
Pu-238	4.07E-05	2.51E-04	2.60E-04	2.00E-04	1.50E-04
Pu-239/240	7.38E-03	1.67E-03	9.00E-03	1.40E-03	8.19E-03
Ra-226	--	--	--	--	
Ru-106	1.11E-01	5.44E-01	-2.40E-01	6.30E-01	1.76E-01
Sb-125	3.62E-02	1.33E-01	9.30E-02	1.90E-01	6.46E-02
Sr-90	1.84E+00	3.36E-01	1.80E+00	3.20E-01	1.82E+00
U-234	--	--	7.50E-01	9.00E-02	7.50E-01
U-235	3.02E-02	1.74E-02	2.20E-02	1.20E-02	2.61E-02
U-238	7.76E-01	1.07E-01	6.80E-01	8.30E-02	7.28E-01
U (Total)	7.17E-01	1.02E-01	--	--	7.17E-01
Zn-65	-3.11E-01	1.77E-01	-1.40E-01	1.70E-01	2.26E-01
ZrNb-95	-4.95E-01	3.39E+00	2.40E-01	1.50E+00	3.68E-01

Table A-2.8. Results of Soil Sampling for 1990 and 1991 (pCi/g)
Location 67

Radionuclide	1990 Result	1990 Error	1991 Result	1991 Error	Average Result
Be-7	1.34E+01	3.84E+01	-7.50E-01	1.20E+01	7.08E+00
CePr-144	-1.41E-01	8.65E-01	-7.60E-02	6.30E-01	1.09E-01
Co-60	-4.78E-03	2.47E-02	-2.00E-02	4.10E-02	1.24E-02
Cs-134	-3.05E-01	5.36E-02	-8.90E-02	4.50E-02	1.97E-01
Cs-137	1.01E+00	1.19E-01	5.30E-01	9.50E-02	7.70E-01
Eu-154	-6.26E-02	8.01E-02	1.20E-02	1.20E-01	3.73E-02
Eu-155	-5.52E-02	1.04E-01	-2.04E-02	1.20E-01	3.96E-02
K-40	1.26E+01	1.50E+00	1.60E+01	2.00E+00	1.43E+01
Pb-212	7.51E-01	9.28E-02	--	--	7.51E-01
Pb-214	5.72E-01	8.90E-02	--	--	5.72E-01
Pu-238	-1.54E-05	1.68E-04	1.30E-04	1.40E-04	6.77E-05
Pu-239/240	5.18E-03	1.25E-03	3.90E-03	7.10E-04	4.54E-03
Ra-226	5.56E-01	9.14E-02	--	--	5.56E-01
Ru-106	-4.02E-01	4.31E-01	4.00E-02	4.70E-01	2.21E-01
Sb-125	1.45E-02	7.76E-02	-9.60E-03	9.50E-02	1.21E-02
Sr-90	1.04E+00	1.87E-01	7.60E-01	1.50E-01	9.00E-01
U-234	--	--	6.50E-01	8.30E-02	6.50E-01
U-235	5.16E-02	2.16E-02	2.30E-02	1.20E-02	3.73E-02
U-238	7.84E-01	1.06E-01	7.30E-01	9.10E-02	7.57E-01
U (Total)	9.14E-01	1.20E-01	--	--	9.14E-01
Zn-65	-2.93E-01	2.09E-01	-2.40E-01	1.90E-01	2.67E-01
ZrNb-95	1.17E+00	4.05E+00	2.10E-01	1.70E+00	6.90E-01

Table A-2.8. Results of Soil Sampling for 1990 and 1991 (pCi/g)
Location 68

Radionuclide	1990 Result	1990 Error	1991 Result	1991 Error	Average Result
Be-7	-2.48E+01	3.31E+01	4.60E+00	1.40E+01	1.47E+01
CePr-144	-1.17E-02	5.60E-01	6.30E-02	7.60E-01	
Co-60	-5.66E-03	2.34E-02	-3.80E-02	5.70E-02	2.18E-02
Cs-134	-1.46E-01	3.42E-02	-7.00E-02	5.30E-02	1.08E-01
Cs-137	4.35E-01	5.65E-02	4.50E-01	8.40E-02	4.43E-01
Eu-154	-5.13E-02	7.37E-02	-1.30E-01	1.70E-01	9.07E-02
Eu-155	-3.07E-03	7.64E-02	3.00E-02	1.40E-01	1.65E-02
K-40	1.59E+01	1.77E+00	1.70E+01	2.30E+00	8.80E+00
Pb-212	7.51E-01	8.77E-02	--	--	7.51E-01
Pb-214	7.67E-01	9.96E-02	--	--	7.67E-01
Pu-238	4.79E-04	3.53E-04	8.90E-04	3.10E-04	6.85E-04
Pu-239/240	6.04E-03	1.32E-03	1.10E-02	1.40E-03	8.52E-03
Ra-226	6.03E-01	8.67E-02	--	--	6.03E-01
Ru-106	1.20E-01	3.30E-01	-5.00E-01	5.80E-01	3.10E-01
Sb-125	3.68E-02	5.86E-02	-6.80E-02	1.50E-01	5.24E-02
Sr-90	3.53E+00	6.55E-01	8.00E-01	1.60E-01	2.17E+00
U-234	--	--	7.30E-01	8.80E-02	7.30E-01
U-235	4.87E-02	2.17E-02	2.50E-02	1.10E-02	3.69E-02
U-238	6.23E-02	9.38E-02	7.10E-01	8.50E-02	6.67E-01
U (Total)	5.91E-01	9.20E-02	--	--	5.91E-01
Zn-65	-4.02E-01	1.77E-01	-2.70E-01	2.50E-01	3.36E-01
ZrNb-95	-1.08E+00	3.59E+00	1.40E+00	2.00E+00	1.24E+00

Table A-2.8. Results of Soil Sampling for 1990 and 1991 (pCi/g)
Location 69

Radionuclide	1990 Result	1990 Error	1991 Result	1991 Error	Average Result
Be-7	-3.55E-01	3.85E+01	-7.30E+00	1.60E+01	3.83E+00
CePr-144	3.66E-01	6.05E-01	1.80E-01	7.60E-01	2.73E-01
Co-60	8.16E-03	2.12E-02	8.00E-02	3.70E-02	4.41E-02
Cs-134	-2.89E-01	4.96E-02	-3.30E-01	7.50E-02	3.10E-01
Cs-137	2.98E+00	3.09E-01	8.70E-01	1.20E-01	1.93E+00
Eu-154	1.17E-02	6.37E-02	-3.40E-02	1.40E-01	2.29E-02
Eu-155	4.71E-02	8.39E-02	8.00E-02	1.20E-01	6.36E-02
K-40	1.39E+01	1.57E+00	1.50E+01	2.00E+00	1.45E+01
Pb-212	6.82E-01	8.14E-02	--	--	6.82E-01
Pb-214	6.19E-01	9.04E-02	--	--	6.19E-01
Pu-238	2.24E-04	2.16E-04	2.60E-04	2.00E-04	2.42E-04
Pu-239/240	3.06E-03	8.93E-04	2.30E-03	6.50E-04	2.68E-03
Ra-226	5.77E-01	8.48E-02	--	--	5.77E-01
Ru-106	-1.07E-01	3.76E-01	5.70E-01	5.90E-01	3.39E-01
Sb-125	8.35E-03	7.84E-02	-4.40E-02	1.20E-01	2.62E-02
Sr-90	6.17E-01	1.09E-01	4.60E-01	8.90E-02	5.39E-01
U-234	--	--	9.70E-01	1.20E-01	9.70E-01
U-235	3.73E-03	9.13E-02	3.50E-02	1.40E-02	1.94E-02
U-238	9.21E-01	4.36E-01	9.60E-01	1.20E-01	9.41E-01
U (Total)	1.15E+00	4.99E-01	--	--	1.15E+00
Zn-65	-4.63E-01	1.77E-01	-3.30E-01	2.60E-01	3.97E-01
ZrNb-95	-3.08E+00	3.54E+00	0.00E-01	1.80E+00	1.99E+00

Table A-2.8. Results of Soil Sampling for 1990 and 1991 (pCi/g)
Location 70

Radionuclide	1990 Result	1990 Error	1991 Result	1991 Error	Average Result
Be-7	-1.87E+01	2.69E+01	1.20E+00	1.10E+01	9.41E+00
CePr-144	7.97E-02	4.81E-01	3.40E-02	6.80E-01	5.69E-02
Co-60	1.49E-02	1.81E-02	9.30E-03	4.00E-02	1.21E-02
Cs-134	-3.01E-02	2.19E-02	-9.60E-02	4.80E-02	6.31E-02
Cs-137	5.65E-01	6.81E-02	2.80E-01	5.90E-02	4.23E-01
Eu-154	-1.11E-03	5.89E-02	-3.50E-02	1.20E-01	1.81E-02
Eu-155	2.59E-02	6.65E-02	4.50E-02	1.20E-01	3.55E-02
K-40	1.46E+01	1.61E+00	1.80E+01	2.20E+00	1.63E+01
Pb-212	6.43E-01	7.51E-02	--	--	6.43E-01
Pb-214	5.54E-01	7.27E-02	--	--	5.54E-01
Pu-238	9.19E-05	1.61E-04	1.10E-04	1.10E-04	1.01E-04
Pu-239/240	9.36E-04	4.09E-04	5.40E-03	8.70E-04	3.17E-03
Ra-226	5.48E-01	7.33E-02	--	--	5.48E-01
Ru-106	1.19E-01	2.59E-01	-5.90E-02	4.90E-01	1.25E-01
Sb-125	-1.76E-02	5.53E-02	-3.20E-03	9.80E-02	1.04E-02
Sr-90	6.89E-01	1.25E-01	2.30E-01	4.50E-02	4.60E-01
U-234	--	--	7.50E-01	9.20E-02	7.50E-01
U-235	3.86E-02	1.83E-02	3.30E-02	1.30E-02	3.58E-02
U-238	8.44E-01	1.11E-01	7.50E-01	9.10E-02	7.97E-01
U (Total)	8.52E-01	1.13E-01	--	--	8.52E-01
Zn-65	-3.14E-01	1.29E-01	-2.80E-01	2.10E-01	2.97E-01
ZrNb-95	1.04E+00	2.93E+00	-3.20E-01	1.60E+00	6.80E-01

Table A-2.8. Results of Soil Sampling for 1990 and 1991 (pCi/g)
Location 71

Radionuclide	1990 Result	1990 Error	1991 Result	1991 Error	Average Result
Be-7	-2.54E-01	2.35E+01	4.00E-01	1.20E+01	1.29E+01
CePr-144	5.45E-01	4.79E-01	4.60E-01	8.00E-01	5.03E-01
Co-60	-1.61E-02	1.80E-02	-1.50E-02	4.60E-02	1.56E-02
Cs-134	-3.16E-02	1.82E-02	-2.40E-01	6.00E-02	1.36E-01
Cs-137	5.58E-01	6.62E-02	4.50E-01	7.70E-02	5.04E-01
Eu-154	-3.91E-02	5.19E-02	-4.30E-02	1.30E-01	4.11E-02
Eu-155	5.14E-02	6.16E-02	2.70E-03	1.30E-01	2.71E-02
K-40	1.26E+01	1.40E+00	1,50E+01	1.90E+00	1.38E+01
Pb-212	5.77E-01	6.70E-02	--	--	5.77E-01
Pb-214	4.81E-01	6.41E-02	--	--	4.81E-01
Pu-238	3.46E-05	2.27E-04	1.30E-04	1.80E-04	8.23E-05
Pu-239/240	1.73E-03	6.25E-04	2.50E-03	6.70E-04	2.12E-03
Ra-226	4.01E-01	5.83E-02	--	--	4.01E-01
Ru-106	8.63E-02	2.36E-01	-6.30E-01	4.80E-01	3.58E-01
Sb-125	2.63E-03	5.09E-02	-1.60E-02	1.10E-01	9.32E-03
Sr-90	9.04E-01	1.59E-01	5.50E-01	1.00E-01	7.27E-01
U-234	--	--	8.50E-01	1.00E-01	8.50E-01
U-235	6.43E-02	2.40E-02	3.90E-02	1.40E-02	5.17E-02
U-238	9.89E-01	1.27E-01	8.60E-01	1.00E-01	9.25E-01
U (Total)	1.12E+00	1.42E-01	--	--	1.12E+00
Zn-65	-2.78E-01	1.32E-01	-4.00E-01	2.30E-01	3.39E-01
ZrNb-95	1.13E+00	2.59E+00	2.90E-01	1.70E+00	7.10E-01

Table A-2.8. Results of Soil Sampling for 1990 and 1991 (pCi/g)
Location 72

Radionuclide	1990 Result	1990 Error	1991 Result	1991 Error	Average Result
Be-7	-9.43E+00	3.32E+01	9.60E+00	7.80E+00	9.52E+00
CePr-144	-1.10E-01	6.35E-01	-4.20E-01	5.50E-01	2.65E-01
Co-60	1.36E-02	2.31E-02	8.90E-03	3.10E-02	1.13E-02
Cs-134	-5.52E-02	2.76E-02	-2.60E-01	5.10E-02	1.58E-01
Cs-137	5.56E-01	7.29E-02	4.80E-02	3.00E-02	3.02E-01
Eu-154	2.01E-02	7.69E-02	5.10E-02	8.70E-02	3.56E-02
Eu-155	7.11E-02	7.90E-02	5.80E-02	8.00E-02	6.46E-02
K-40	1.27E+01	1.51E+00	1.50E+01	1.80E+00	1.39E+01
Pb-212	5.59E-01	7.33E-02	--	--	5.59E-01
Pb-214	5.02E-01	8.02E-02	--	--	5.02E-01
Pu-238	8.97E-04	5.33E-04	7.40E-05	9.10E-05	4.86E-04
Pu-239/240	2.15E-02	3.53E-03	1.70E-03	4.30E-04	1.16E-02
Ra-226	4.53E-01	7.78E-02	--	--	4.53E-01
Ru-106	4.70E-02	3.48E-01	2.50E-01	3.60E-01	1.49E-01
Sb-125	5.88E-02	6.71E-02	5.40E-02	6.80E-02	5.64E-02
Sr-90	8.13E-01	1.44E-01	9.00E-02	1.90E-02	4.52E-01
U-234	--	--	5.50E-01	7.90E-02	5.50E-01
U-235	2.09E-02	1.41E-02	2.80E-02	1.40E-02	2.45E-02
U-238	6.66E-01	9.28E-02	6.30E-01	8.70E-02	6.48E-01
U (Total)	6.86E-01	9.61E-02	--	--	6.86E-01
Zn-65	-2.78E-01	1.79E-01	-1.60E-01	1.60E-01	2.19E-01
ZrNb-95	-1.08E-01	3.94E-00	-6.20E-01	1.20E+00	3.64E-01

Table A-2.8. Results of Soil Sampling for 1990 and 1991 (pCi/g)
Location 73

Radionuclide	1990 Result	1990 Error	1991 Result	1991 Error	Average Result
Be-7	-2.78E+01	1.02E+02	-8.30E+00	2.60E+01	1.81E+01
CePr-144	1.01E+00	1.52E+00	6.70E-01	9.20E-01	8.40E-01
Co-60	7.65E-03	2.23E-02	-1.20E-02	3.70E-02	9.83E-03
Cs-134	-1.54E-01	5.65E-02	-7.80E-02	5.50E-02	1.16E-01
Cs-137	2.05E+01	2.07E+00	1.70E+01	1.70E+00	1.88E+01
Eu-154	1.23E-01	7.45E-02	7.50E-02	9.60E-02	9.90E-02
Eu-155	4.03E-02	2.01E-01	9.20E-02	1.60E-01	6.62E-02
K-40	1.13E+01	1.36E+00	1.30E+01	1.70E+00	1.22E+01
Pb-212	5.24E-01	1.01E-01	--	--	5.24E-01
Pb-214	4.73E-01	1.13E-01	--	--	4.73E-01
Pu-238	6.56E-03	1.38E-03	6.50E-05	1.40E-04	3.31E-03
Pu-239/240	1.76E-01	2.08E-02	4.10E-03	7.90E-04	9.01E-02
Ra-226	5.05E-01	9.69E-02	--	--	5.05E-01
Ru-106	-1.88E-01	7.82E-01	-9.70E-02	6.40E-01	1.43E-01
Sb-125	8.39E-02	2.09E-01	-4.60E-02	2.00E-01	6.50E-02
Sr-90	1.01E+01	1.92E+00	1.40E+00	2.70E-01	5.75E+00
U-234	--	--	6.60E-01	8.30E-02	6.60E-01
U-235	1.73E-02	1.36E-02	2.00E-02	1.00E-02	1.87E-02
U-238	8.12E-01	1.09E-01	6.60E-01	8.30E-02	7.36E-01
U (Total)	7.91E-01	1.09E-01	--	--	7.91E-01
Zn-65	-3.69E-01	1.80E-01	-2.20E-01	1.70E-01	2.95E-01
ZrNb-95	-4.89E+00	3.99E+00	-1.70E+00	1.50E+00	3.30E+00

Table A-2.8. Results of Soil Sampling for 1990 and 1991 (pCi/g)
Location 74

Radionuclide	1990 Result	1990 Error	1991 Result	1991 Error	Average Result
Be-7	-6.82E-02	3.53E-01	-5.30E+00	1.70E+01	2.68E+00
CePr-144	-1.51E-01	3.68E-01	1.30E-01	8.00E-01	1.41E-01
Co-60	2.33E-02	2.38E-02	-3.60E-02	6.30E-02	2.97E-02
Cs-134	-1.64E-01	3.72E-02	-7.20E-02	5.60E-02	1.18E-01
Cs-137	6.32E-01	8.27E-02	8.40E-01	1.20E-01	7.36E-01
Eu-154	3.51E-02	8.16E-02	-1.60E-02	1.60E-01	2.56E-02
Eu-155	2.34E-02	1.01E-01	2.40E-02	1.30E-01	2.37E-02
K-40	1.33E+01	1.62E+00	1.80E-01	2.40E+00	1.57E+01
Pb-212	5.68E-01	8.56E-02	--	--	5.68E-01
Pb-214	--	--	--	--	
Pru-238	-4.69E-05	4.66E-05	2.80E-04	2.10E-04	1.63E-04
Pu-239/240	2.75E-03	8.98E-04	9.20E-03	1.40E-03	5.98E-03
Ra-226	--	--	--	--	
Ru-106	1.10E-01	2.40E-01	-1.70E-01	5.80E-01	1.40E-01
Sb-125	5.45E-02	6.03E-02	-3.70E-02	1.40E-01	4.58E-02
Sr-90	8.35E-02	1.71E-02	1.00E-01	2.00E-02	9.18E-02
U-234	--	--	8.00E-01	9.50E-02	8.00E-01
U-235	1.49E-02	1.28E-02	1.80E-02	9.90E-03	1.65E-02
U-238	6.78E-01	9.54E-02	6.90E-01	8.50E-02	6.84E-01
U (Total)	7.02E-01	9.89E-02	--	--	7.02E-01
Zn-65	-8.83E-02	6.82E-02	-1.50E-01	2.30E-01	1.19E-01
ZrNb-95	-5.98E-02	8.15E-02	-1.80E+00	2.10E+00	9.30E-01

Table A-2.8. Results of Soil Sampling for 1990 and 1991 (pCi/g)
Location 75

Radionuclide	1990 Result	1990 Error	1991 Result	1991 Error	Average Result
Be-7	1.24E+01	2.71E+01	-9.00E+00	1.00E+01	1.07E+01
CePr-144	4.36E-01	5.17E-01	-3.20E-02	6.10E-02	2.34E-01
Co-60	-1.01E-02	1.96E-02	-1.50E-02	3.10E-02	1.26E-02
Cs-134	-1.65E-01	3.32E-02	-3.40E-01	5.90E-02	2.53E-01
Cs-137	7.87E-01	8.94E-02	1.30E+00	1.50E-01	1.04E+00
Eu-154	-8.76E-03	5.97E-02	-1.70E-02	9.50E-02	1.29E-02
Eu-155	4.64E-02	6.82E-02	4.50E-03	1.00E-01	2.55E-02
K-40	1.48E+01	1.63E+00	1.70E+01	2.00E+00	1.59E+01
Pb-212	6.28E-01	7.39E-02	--	--	--
Pb-214	5.82E-01	7.77E-02	--	--	--
Pu-238	1.54E-03	6.57E-04	1.20E-03	4.30E-04	1.37E-03
Pu-239/240	4.08E-02	5.92E-03	1.40E-02	2.10E-03	2.74E-02
Ra-226	4.82E-01	6.88E-02	--	--	--
Ru-106	1.05E+00	3.34E-01	-1.70E-01	4.10E-01	6.10E-01
Sb-125	4.93E-02	5.65E-02	4.90E-03	1.00E-01	2.71E-02
Sr-90	1.78E+00	3.36E-01	4.00E-01	7.40E-02	1.09E+00
U-234	--	--	8.90E-01	1.10E-01	8.90E-01
U-235	1.47E-02	1.40E-02	3.30E-02	1.30E-02	2.39E-02
U-238	6.81E-01	1.02E-01	8.30E-01	9.90E-02	7.56E-01
U (Total)	7.36E-01	1.09E-01	--	--	--
Zn-65	-3.81E-01	1.68E-01	-4.03E-01	1.90E-01	4.06E-01
ZrNb-95	-1,44E+00	2.85E+00	7.80E-01	1.20E+00	1.11E+00

Table A-2.8. Results of Soil Sampling for 1990 and 1991 (pCi/g)
Location 76

Radionuclide	1990 Result	1990 Error	1991 Result	1991 Error	Average Result
Be-7	-3.27E+01	2.63E+01	-1.80E-01	8.60E+00	1.64E+01
CePr-144	-5.87E-02	5.43E-01	-7.10E-02	5.50E-01	6.49E-02
Co-60	-9.08E-04	2.14E-02	-8.60E-03	3.20E-02	4.75E-03
Cs-134	-4.93E-02	2.28E-02	-6.40E-02	3.80E-02	5.67E-02
Cs-137	2.61E-01	3.81E-02	1.30E-01	3.60E-02	1.96E-01
Eu-154	-1.00E-02	5.87E-02	3.50E-02	1.10E-01	2.25E-02
Eu-155	5.59E-02	6.69E-02	1.40E-01	1.00E-01	9.80E-02
K-40	1.32E+01	1.48E+00	1.40E+01	1.80E+00	1.36E+01
Pb-212	7.43E-01	8.53E-02	--	--	7.43E-01
Pb-214	5.85E-01	7.76E-02	--	--	5.85E-01
Pu-238	7.10E-04	3.91E-04	4.60E-04	2.10E-04	5.85E-04
Pu-239/240	7.56E-02	9.36E-03	5.90E-03	9.00E-04	4.08E-02
Ra-226	5.84E-01	7.81E-02	--	--	5.84E-01
Ru-106	9.51E-02	2.61E-01	8.00E-02	4.40E-01	8.76E-02
Sb-125	-7.24E-03	5.50E-02	-5.30E-03	8.90E-02	6.27E-03
Sr-90	2.92E-01	5.67E-02	1.40E-01	3.60E-02	2.16E-01
U-234	--	--	7.20E-01	1.20E-01	7.20E-01
U-235	3.69E-02	1.6E-02	1.80E-02	2.80E-02	2.75E-02
U-238	8.80E-01	1.12E-01	6.80E-01	1.10E-01	7.80E-01
U (Total)	9.11E-01	1.16E-01	--	--	9.11E-01
Zn-5	-3.26E-01	1.48E-01	-1.90E-01	1.70E-01	2.58E-01
ZrNb-95	-1.89E+00	2.86E-00	1.00E+00	1.40E+00	1.45E+00

Table A-2.8. Results of Soil Sampling for 1990 and 1991 (pCi/g)
Location 77

Radionuclide	1990 Result	1990 Error	1991 Result	1991 Error	Average Result
Be-7	-1.86E+00	2.73E+01	-1.60E-01	7.50E+00	1.01E+00
CePr-144	-6.19E-02	4.14E-01	-3.20E-01	5.40E-01	1.91E-01
Co-60	-7.10E-03	2.00E-02	8.10E-03	2.80E-02	7.60E-03
Cs-134	-7.70E-02	2.53E-02	-3.10E-01	5.40E-02	1.94E-01
Cs-137	8.60E-01	9.89E-02	9.70E-02	3.80E-02	4.79E-01
Eu-154	-1.10E-02	5.29E-02	-1.80E-03	8.40E-02	6.40E-03
Eu-155	6.22E-02	5.25E-02	6.30E-03	9.20E-02	3.43E-02
K-40	1.46E+01	1.63E+00	1.50E+01	1.80E+00	1.48E+01
Pb-212	5.96E-01	7.07E-02	--	--	5.96E-01
Pb-214	5.46E-01	7.64E-02	--	--	5.46E-01
Pu-238	8.45E-04	3.87E-04	3.10E-04	1.90E-04	5.78E-04
Pr-239/240	2.56E-02	3.44E-03	4.40E-03	7.70E-04	1.50E-02
Ra-226	5.28E-01	7.87E-02	--	--	5.28E-01
Ru-106	-1.23E-01	2.92E-01	-2.00E-01	3.70E-01	1.62E-01
Sb-125	2.28E-02	5.79E-02	-9.20E-02	7.80E-02	5.74E-02
Sr-90	1.76E-01	3.43E-02	1.20E-01	2.90E-02	1.48E-01
U-234	--	--	7.20E-01	1.20E-01	7.20E-01
U-235	3.30E-02	1.74E-02	3.90E-02	2.20E-02	3.60E-02
U-238	7.02E-01	9.88E-02	6.90E-01	1.10E-01	6.96E-01
U (Total)	6.74E-01	9.73E-02	--	--	6.74E-01
Zn-65	-4.67E-02	1.16E-01	-3.40E-01	1.60E-01	1.93E-01
ZrNb-95	-3.82E+00	3.10E+00	3.20E-01	1.10E+00	2.07E+00

Table A-2.8. Results of Soil Sampling for 1990 and 1991 (pCi/g)
Location 78

Radionuclide	1990 Result	1990 Error	1991 Result	1991 Error	Average Result
Be-7	-1.31E+01	3.22E+01	-6.70E+00	1.20E+01	9.90E+00
CePr-144	-2.75E-02	5.92E-01	2.10E-01	6.90E-01	1.19E-01
Co-60	-8.37E-03	2.31E-02	2.80E-02	4.00E-02	1.82E-02
Cs-134	-2.97E-01	5.01E-02	-5.20E-02	4.20E-02	1.75E-01
Cs-137	5.91E-01	7.54E-02	2.10E+00	2.40E-01	1.35E+00
Eu-154	-2.29E-02	8.80E-02	-2.60E-02	1.20E-01	2.45E-02
Eu-155	1.78E-02	7.65E-02	5.70E-02	1.20E-01	3.74E-02
K-40	1.69E+01	1.90E+00	1.90E+01	2.30E+00	1.80E+01
Pb-212	7.83E-01	92.0E-=02	--	--	7.83E-01
Pb-214	6.46E-01	8.93E-02	--	--	6.46E-01
Pr-238	2.91E-04	2.35E-04	1.90E-03	5.20E-04	1.10E-03
Pr-239/240	1.94E-02	2.83E-03	6.70E-02	7.50E-03	4.32E-02
Ra-226	6.20E-01	8.87E-02	--	--	6.20E-01
Ru-106	5.12E-02	2.61E-01	-4.80E-02	4.70E-01	4.97E-02
Sb-125	-3.62E-02	6.42E-02	-2.30E-02	1.00E-01	2.96E-02
Sr-90	2.00E-01	3.90E-02	4.10E-01	9.20E-02	3.05E-01
U-234			8.90E-01	1.10E-01	8.90E-01
U-235	2.56E-02	1.69E-02	1.80E-02	1.10E-02	2.18E-02
U-238	8.99E-01	1.19E-01	9.80E-01	1.20E-01	9.40E-01
U (Total)	7.58E-01	1.07E-01	--	--	7.58E-01
Zn-65	-6.20E-01	2.08E-01	-2.05E-01	1.80E-01	4.35E-01
ZrNb-95	1.68E+00	3.82E+00	-1.30E+00	1.40E+00	1.49E+00

Table A-2.8. Results of Soil Sampling for 1990 and 1991 (pCi/g)
Location 79

Radionuclide	1990 Result	1990 Error	1991 Result	1991 Error	Average Result
Be-7	-1.65E+01	5.08E+01	1.40E+00	7.50E+00	8.95E+00
CePr-144	5.91E-02	7.28E-01	-8.20E-02	5.20E-01	7.11E-02
Co-60	-9.50E-03	2.88E-02	2.70E-03	3.10E-02	6.10E-03
Cs-134	-3.71E-01	6.58E-02	-2.60E-01	5.40E-02	3.16E-01
Cs-137	3.02E+00	3.21E-01	2.90E-01	5.70E-02	1.66E+00
Eu-154	1.24E-01	7.89E-02	-4.00E-02	9.90E-02	8.20E-02
Eu-155	1.07E-01	9.59E-02	2.80E-02	8.80E-02	6.75E-02
K-40	1.39E+01	1.69E+00	1.30E_01	1.60E+00	1.35E+01
Pb-212	6.43E-01	8.54E-02	--	--	6.43E-01
Pb-214	7.25E-01	1.13E-01	--	--	7.25E-01
Pu-238	5.18E-03	1.09E-03	5.60E-04	2.50E-04	2.87E-03
Pr-239/24-0	1.74E-01	1.97E-02	1.00E-02	1.40E-03	9.20E-02
Ra-226	5.93E-01	1.04E-01	--	--	5.93E-01
Ru-106	1.58E-01	4.92E-01	-3.70E-02	3.90E-01	9.75E-02
Sb-125	-4.16E-02	1.07E-01	1.50E-01	7.50E-02	2.83E-02
Sr-90	8.42D-01	1.55E-01	1.20E-01	2.40E-02	4.81E-01
U-234	--	--	7.50E-01	9.00E-02	7.50E-01
U-235	2.98E-02	2.09E-02	1.80E-02	9.70E-03	2.39E-02
U-238	8.31E-01	1.27E-01	7.10E-01	8.60E-02	7.71E-01
U (Total)	9.15E-01	1.37E-01	--	--	9.15E-01
Zn-65	-6.62E-01	2.50E-01	-4.50E-01	1.80E-01	5.56E-01
ZrNb-95	2.81E+00	4.39E+00	-6.70E-01	1.20E+00	1.74E+00

Source: Schmidt et al. 1992
Negative values indicate concentrations at or near background levels of radioactivty.
Shaded areas indicate a postive detection, the result is great than the error.
The detection limits are as follows: Mn-54 = 2.0E-02, Co-58 = 2.0E-02, Co-60 = 2.0E-02, Zn-65 = 4.03-02, Sr-90 = 5.0E-03, Nb-95 = 3.0E-02, Zr-95 = 3.0E-02, Ru-106 = 1.7E-01, Cs-134 = 2.0E-02, Cs-137 = 2.0E-02, Cs-137 = 2.0E-02, Eu-152 = 1.1E-01, Eu = 154 = 5.0E-02, Eu-155 = 5.0E-02, Pu-238 = 6.0E-04, Pu-239 = 6.0E-04, and U total = 1.0E-02
Dashes indicate data are not available.

Table A-2.9. Results of External Radiation Monitoring, 1985 through 1989 TLDs (mrem/yr).

Site	1985	1986	1987	1988	1989	Average Total
2E 5: 218-E-12B						
Max	84	108	125	123	N/A	
Min	72	73	85	98	N/A	
Total	79	88	100	110	N/A	94
2E 6: 200-E NE						
Max	85	101	132	119	N/A	
Min	64	72	83	92	N/A	
Total	77	83	101	103	N/A	91
2E 11: 218-E-12B N						
Max	97	96	112	134	128	
Min	69	80	83	107	92	
Total	85	89	97	117	114	100
2E 12: 218-E-12B E						
Max	85	100	103	119	N/A	
Min	68	74	69	93	N/A	
Total	78	84	88	105	N/A	89
2E 17: 241-C TF W						
Max	104	121	122	134	140	
Min	76	83	92	108	104	
Total	89	98	104	124	119	107
2E 18: 241-C TF E						
Max	102	124	137	139	N/A	
Min	84	90	104	117	N/A	
Total	96	109	115	125	N/A	111
2E 23: PUREX N						
Max	100	135	132	138	N/A	
Min	67	81	90	65	N/A	
Total	85	107	106	115	N/A	103
2E 24: PUREX NE						
Max	112	129	131	148	N/A	
Min	85	94	100	70	N/A	
Total	100	111	117	114	N/A	111
2E 29: PUREX S						
Max	73	96	92	104	N/A	
Min	64	68	75	64	N/A	
Total	68	77	84	89	N/A	80

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Table A-2.9. Results of External Radiation Monitoring, 1985 through 1989 TLDs (mrem/yr).

Site	1985	1986	1987	1988	1989	Average Total
2E 30: PUREX SE						
Max	76	85	94	114	N/A	
Min	63	68	71	65	N/A	
Total	68	78	81	92	N/A	80
2E 35: 200-E S						
Max	80	93	96	111	N/A	
Min	62	68	74	59	N/A	
Total	70	77	84	89	N/A	80
2E 36: 200-E SW						
Max	75	96	90	109	124	
Min	58	66	75	62	72	
Total	67	77	81	89	96	82
2E D: 216-A-29 Ditch E						
Max	94	116	108	122	120	
Min	69	79	84	72	100	
Total	81	91	96	103	111	96
216-A-29 Ditch						
Max	90	92	91	114	124	
Min	67	72	71	62	84	
Total	75	81	81	90	105	86
216-A-36B Crib #1						
Max	80	89	87	110	132	
Min	69	70	56	56	76	
Total	74	82	77	88	110	86
216-A-36B Crib #2						
Max	127	135	89	104	128	
Min	90	99	55	54	96	
Total	107	120	79	83	112	100
216-A-10 Crib #1						
Max	82	99	92	110	136	
Min	70	73	71	59	88	
Total	74	83	83	88	112	88
216-A-10 Crib #2						
Max	76	96	89	107	108	
Min	85	63	72	51	88	
Total	67	77	82	84	101	82

Table A-2.9. Results of External Radiation Monitoring, 1985 through 1989 TLDs (mrem/yr).

Site	1985	1986	1987	1988	1989	Average Total
PUREX #1						
Max	73	98	91	117	120	
Min	66	60	74	51	88	
Total	69	77	83	88	106	85
PUREX #2						
Max	80	118	101	110	124	
Min	68	67	78	52	76	
Total	73	90	88	88	103	88
PUREX #3						
Max	84	119	98	105	128	
Min	67	70	81	70	76	
Total	76	98	90	90	105	92
241-A TF #1						
Max	278	272	264	295	348	
Min	176	237	210	176	200	
Total	230	248	237	233	273	244
241-A TF #2						
Max	178	137	156	153	1,812	
Min	133	111	127	97	136	
Total	154	121	138	123	562	220
241-A TF #3						
Max	119	119	126	151	2,840	
Min	112	86	107	96	116	
Total	115	101	118	129	1,158	324
241-A TF #4						
Max	93	107	113	140	9,636	
Min	82	90	93	86	112	
Total	88	98	102	119	2,545	590
241-A TF #5						
Max	81	97	104	119	140	
Min	74	66	77	80	108	
Total	78	79	89	101	125	94
231-A TF #6						
Max	109	111	108	126	164	
Min	72	73	84	77	100	
Total	88	91	97	106	125	101

Table A-2.9. Results of External Radiation Monitoring, 1985 through 1989 TLDs (mrem/yr).

Site	1985	1986	1987	1988	1989	Average Total
241-A TF #7						
Max	240	133	149	149	196	
Min	85	125	110	110	108	
Total	127	129	120	132	151	132
241-A TF #8						
Max	6,348	1,918	2,036	2,778	3,832	
Min	1,956	1,393	1,535	1,316	1,660	
Total	4,693	1,721	1,781	2,212	2,519	2,585
241-A TF #9						
Max	775	823	809	864	844	
Min	353	657	438	464	652	
Total	555	748	666	616	740	665
241-A TF #10						
Max	1,585	1,418	832	1,075	1,316	
Min	463	822	649	453	848	
Total	899	1,045	729	742	998	883
241-A TF #11						
Max	120	141	125	150	152	
Min	20	99	103	104	108	
Total	81	120	115	122	136	115

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Table A-2.10. Results of External Radiation Monitoring TLDs 1990 and 1991 (mrem/yr).

Location	1990	1991	Average Total
215: 200-E SE			
Max	108	109	
Min	92	70	
Total	96	90	93
216: E-67 Baseline Site			
Max	112	110	
Min	88	78	
Total	101	91	96
217: 216-A-37-1 E			
Max	116	107	
Min	100	81	
Total	107	95	101
218: 216-A-37-1 N			
Max	124	103	
Min	96	73	
Total	103	93	98
219: Grout Facility			
Max	116	115	
Min	100	72	
Total	107	97	102
220: N of Grout Vaults			
Max	120	121	
Min	92	80	
Total	103	102	103
221: Grout Facility			
Max	118	111	
Min	88	83	
Total	95	98	97
222: 216-A-29			
Max	104	108	
Min	88	0	
Total	98	67	83
223: 216-A-8 S			
Max	120	122	
Min	100	90	
Total	106	107	107

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Table A-2.10. Results of External Radiation Monitoring TLDs 1990 and 1991 (mrem/yr).

Location	1990	1991	Average Total
224: 216-A-8 E			
Max	132	114	
Min	100	78	
Total	121	100	111
225: 216-B-3-3			
Max	152	157	
Min	92	88	
Total	119	130	125
231: 218-E-12			
Max	116	112	
Min	100	71	
Total	105	101	103
234: 221-B NE			
Max	140	133	
Min	96	101	
Total	114	120	117
242: 216-A-10-1			
Max	112	105	
Min	92	69	
Total	99	91	95
243: 216-A-10-2			
Max	120	111	
Min	96	69	
Total	107	94	101
244: 216-A-36-1			
Max	112	123	
Min	92	75	
Total	100	100	100
245: 216-A-36-B-2			
Max	120	111	
Min	88	76	
Total	100	96	98
246: 202-A SE			
Max	112	104	
Min	96	81	
Total	100	95	98

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Table A-2.10. Results of External Radiation Monitoring TLDs 1990 and 1991 (mrem/yr).

Location	1990	1991	Average Total
247: 202-A-SE			
Max	108	122	
Min	96	78	
Total	104	102	103
248: 202-A Parking Lot			
Max	280	115	
Min	96	0	
Total	194	57	126
249: ATF #1			
Max	332	335	
Min	136	284	
Total	216	304	260
250: ATF #2			
Max	160	159	
Min	116	119	
Total	132	143	138
251: ATF #3			
Max	144	141	
Min	108	93	
Total	122	125	124
252: ATF #4			
Max	140	130	
Min	100	89	
Total	113	115	114
253: ATF #5			
Max	124	120	
Min	104	84	
Total	110	107	109
254: ATF #6			
Max	128	127	
Min	96	93	
Total	116	109	113

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Table A-2.10. Results of External Radiation Monitoring TLDs 1990 and 1991 (mrem/yr).

Location	1990	1991	Average Total
255: ATF #7			
Max	2300	130	
Min	112	107	
Total	1100	120	610
256: ATF #8			
Max	2000	1497	
Min	384	542	
Total	1200	837	1019
258: ATF #10			
Max	190	390	
Min	384	111	
Total	908	195	552
259: ATF #11			
Max	576	143	
Min	132	124	
Total	236	133	185
261: ATF #13			
Max	156	127	
Min	92	86	
Total	112	110	111
262: E Corner 241-AP Tank Farm			
Max	136	103	
Min	96	78	
Total	117	94	106

Source: Schmidt et al. 1992.

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APPENDIX B

HEALTH AND SAFETY PLAN

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ACRONYMS AND ABBREVIATIONS

AAMS	aggregate area management study
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980
CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
EII	Environmental Investigations Instructions
HEHF	Hanford Environmental Health Foundation
HSP	Health and Safety Plan
HWOP	Hazardous Waste Operations Permit
JSA	Job Safety Analysis
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
RCRA	Resource Conservation and Recovery Act
RWP	radiation work permit
SCBA	self-contained breathing apparatus
WISHA	Washington Industrial Safety and Health Act

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1.0 GENERAL CONSIDERATIONS AND REQUIREMENTS

1.1 INTRODUCTION

The purpose of this Health and Safety Plan (HSP) is to outline standard health and safety procedures for Westinghouse Hanford employees and contractors engaged in investigation activities for the PUREX Plant Aggregate Area Management Study (AAMS). These activities will include surface investigation, drilling and sampling boreholes, and environmental sampling in areas of known chemical and radiological contamination. Appropriate site-specific safety documents (e.g., Hazardous Waste Operations Permit [HWOP] or Job Safety Analysis [JSA]) will be written for each task or group of tasks. A more complete discussion of Westinghouse Hanford environmental safety procedures is presented in the Westinghouse Hanford manual *Health and Safety for Hazardous Waste Field Operations*, WHC-CM-4-3 Vol. 4 (WHC 1992).

All employees of Westinghouse Hanford or any other contractors who are participating in onsite activities for the PUREX Plant AAMS shall read the site-specific safety document and attend a pre-job safety or tailgate meeting to review and discuss the task.

1.2 DESIGNATED SAFETY PERSONNEL

The field team leader and site safety officer are responsible for site safety and health. Specific individuals will be assigned on a task-by-task basis by project management, and their names will be properly recorded before the task is initiated.

All activities onsite must be cleared through the field team leader. The field team leader has responsibility for the following:

- Allocating and administering resources to successfully comply with all technical and health and safety requirements
- Verifying that all permits, supporting documentation, and clearances are in place (e.g., electrical outage requests, welding permits, excavation permits, HWOP or JSA, sampling plan, radiation work permits [RWPs], and onsite/offsite radiation shipping records)
- Providing technical advice during routine operations and emergencies
- Informing the appropriate site management and safety personnel of the activities to be performed each day
- Coordinating resolution of any conflicts that may arise between RWPs and the implementation of the HWOP or JSA with health physics

- Handling emergency response situations as may be required
- Conducting pre-job and daily tailgate safety meetings
- Interacting with adjacent building occupants and/or inquisitive public.

The site safety officer is responsible for implementing the HWOP at the site. The site safety officer shall do the following:

- Monitor chemical, physical, and (in conjunction with the health physics technician) radiation hazards to assess the degree of hazard present; monitoring shall specifically include organic vapor detection, radiation screening, and confined space evaluation where appropriate.
- Determine protection levels, clothing, and equipment needed to ensure the safety of personnel in conjunction with the health physics department.
- Monitor the performance of all personnel to ensure that the required safety procedures are followed.
- Halt operations immediately, if necessary, due to safety or health concerns.
- Conduct safety briefings as necessary.
- Assist the field team leader in conducting safety briefings as necessary.

The health physics technician is responsible for ensuring that all radiological monitoring and protection procedures are being followed as specified in the Radiation Protection Manual and in the appropriate RWP. Westinghouse Hanford Industrial Safety and Fire Protection personnel will provide safety overview during drilling operations consistent with Westinghouse Hanford policy and, as requested, will provide technical advice. Also, downwind sampling for hazardous materials and radiological contaminants and other analyses may be requested from appropriate contractor personnel as required.

The ultimate responsibility and authority for employee's health and safety lies with the employee and the employee's colleagues. Each employee is responsible for exercising the utmost care and good judgment in protecting his or her personal health and safety and that of fellow employees. Should any employee observe a potentially unsafe condition or situation, it is the responsibility of that employee to immediately bring the observed condition to the attention of the appropriate health and safety personnel, as designated previously. In the event of an immediately dangerous or life-threatening situation, the employee automatically has temporary "stop work" authority and the responsibility to immediately notify the field team leader or site safety officer. When work is temporarily halted because of a safety or

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health concern, personnel will exit the exclusion zone and meet at a predetermined place in the support zone. The field team leader, site safety officer, and health physics technician will determine the next course of action.

1.3 MEDICAL SURVEILLANCE

All field team members engaged in operable unit activities at sites governed by an HWOP must have baseline physical examinations and be participants in Westinghouse Hanford (or an equivalent) hazardous waste worker medical surveillance program.

Medical examinations will be designed to identify any pre-existing conditions that may place an employee at high risk, and will verify that each worker is physically able to perform the work required by this plan without undue risk to personal health. The physician shall determine the existence of conditions that may reduce the effectiveness or prevent the employee's use of respiratory protection. The physician shall also determine the presence of conditions that may pose undue risk to the employee while performing the physical tasks of this work plan using level B personal protection equipment. This would include any condition that increases the employee's susceptibility to heat stress.

The examining physician's report will not include any nonoccupational diagnoses unless directly applicable to the employee's fitness for the work required.

1.4 TRAINING

Before engaging in any onsite activities, each team member is required to have received 40 hours of health and safety training related to hazardous waste site operations and at least 8 hours of refresher training each year thereafter as specified in 29 Code of Federal Regulations (CFR) 1910.120. In addition, each inexperienced employee (never having performed site characterization) will be directly supervised by a trained/experienced person for a minimum of 24 hours of field experience.

The field team leader and the site safety officer shall receive an additional 8 hours of training (in addition to the refresher training previously discussed).

1.5 TRAINING FOR VISITORS

For the purposes of this plan, a visitor is defined as any person visiting the Hanford Site, who is not a Westinghouse Hanford employee or a Westinghouse Hanford contractor directly involved in the Resource Conservation and Recovery Act (RCRA)/Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) facility investigation activities, including but not limited to those engaged in surveillance, inspection, or observation activities.

Visitors who must, for whatever reason, enter a controlled (either contamination reduction or exclusion) zone, shall be subject to all of the applicable training, respirator fit testing, and medical surveillance requirements discussed in Westinghouse Hanford Environmental Investigations Instructions (EII) 1.1 and Appendix B to EII 1.1 (WHC 1991).

All visitors shall be informed of potential hazards and emergency procedures by their escorts and shall conform to EII 1.1 (WHC 1991).

1.6 RADIATION DOSIMETRY

All personnel engaged in onsite activities shall be assigned dosimeters according to the requirements of the RWP applicable to that activity. All visitors shall be assigned basic dosimeters, as a minimum, that will be exchanged annually.

1.7 REQUIREMENTS FOR THE USE OF RESPIRATORY PROTECTION

All employees of Westinghouse Hanford and subcontractors who may be required to use air-purifying or air-supplied respirators must be included in the medical surveillance program and be approved for the use of respiratory protection by the Hanford Environmental Health Foundation (HEHF) or other licensed physician. Each team member must be trained in the selection, limitations, and proper use and maintenance of respiratory protection (existing respiratory protection training may be applicable towards the 40-hour training requirement).

Before using a negative pressure respirator, each employee must have been fit-tested (within the previous year) for the specific make, model, and size according to Westinghouse Hanford fit-testing procedures. Beards (including a few days' growth), large sideburns, or moustaches that may interfere with a proper respirator seal are not permitted.

Subcontractors must provide evidence to Westinghouse Hanford that personnel are participants in a medical surveillance and respiratory protection program that complies with 29 CFR 1910.120 and 29 CFR 1910.134, respectively.

2.0 GENERAL PROCEDURES

The following personal hygiene and work practice guidelines are intended to prevent injuries and adverse health effects. A hazardous waste site poses a multitude of health and safety concerns because of the variety and number of hazardous substances present. These guidelines represent the minimum standard procedures for reducing potential risks associated with this project and are to be followed by all job-site employees <u>at all times</u>.

2.1 GENERAL WORK SAFETY PRACTICES

2.1.1 Work Practices

The following work practices must be observed:

- Eating, drinking, smoking, taking certain medications, chewing gum, and similar actions are prohibited within the exclusion zone. All sanitation facilities shall be located outside the exclusion zone; decontamination is required before using such facilities.

- Personnel shall avoid direct contact with contaminated materials unless necessary for sample collecting or required observation. Remote handling of such things as casings and auger flights will be practiced whenever practical.

- While operating in the controlled zone, personnel shall use the "buddy system" where appropriate, or be in visual contact with someone outside of the controlled zone.

- The buddy system will be used where appropriate for manual lifting.

- Requirements of Westinghouse Hanford radiation protection and RWP manuals shall be followed for all work involving radioactive materials or conducted within a radiologically controlled area.

- Onsite work operations shall only be carried out during daylight hours, unless the entire control zone is adequately illuminated with artificial lighting. A new tour (shift) will operate the drilling rig after completion of each shift.

- Do not handle soil, waste samples, or any other potentially contaminated items unless wearing the protective equipment specified in the HWOP or JSA.

- Whenever possible, stand upwind of excavations, boreholes, well casings, drilling spoils, and the like, as indicated by an onsite windsock.

- Stand clear of trenches during excavation. Always approach an excavation from upwind.

- Be alert to potentially changing exposure conditions as evidenced by such indications as perceptible odors, unusual appearance of excavated soils, or oily sheen on water.

- Do not enter any test pit or trench deeper than 1.2 m (4 ft) unless in accordance with procedures specified in the HWOP.

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- Do not under any circumstances enter or ride in or on any backhoe bucket, materials hoist, or any other similar device not specifically designed for carrying passengers.

- All drilling team members must make a conscientious effort to remain aware of their own and others' positions in regards to rotating equipment, cat heads, or u-joints. Drilling operations members must be extremely careful when assembling, lifting, and carrying flights or pipe to avoid pinch-point injuries and collisions.

- Tools and equipment will be kept off the ground whenever possible to avoid tripping hazards and the spread of contamination.

- Personnel not involved in operation of the drill rig or monitoring activities shall remain a safe distance from the rig as indicated by the field team leader.

- Follow all provisions of each site-specific hazardous work permit as addressed in the HWOP, including cutting and welding, confined space entry, and excavation.

- Catalytic converters on the underside of vehicles are sufficiently hot to ignite dry prairie grass. Team members should not drive over dry grass that is higher than the ground clearance of the vehicle and should be aware of the potential fire hazard posed by catalytic converters at all times. Never allow a running or hot vehicle to sit in a stationary location over dry grass or other combustible materials.

- Follow all provisions of each site-specific RWP.

- Team members will attempt to minimize truck tire disturbance of all stabilized sites.

2.1.2 Personal Protective Equipment

- Personal protective equipment will be selected specifically for the hazards identified in the HWOP. The site safety officer in conjunction with Westinghouse Hanford Health Physics and Industrial Hygiene and Safety is responsible for choosing the appropriate type and level of protection required for different activities at the job site.

- Levels of protection shall be appropriate to the hazard to avoid either excessive exposure or additional hazards imposed by excessive levels of protection. The HWOP will contain provisions for adjusting the level of protection as necessary. These personal protective equipment specifications must be followed at all times, as directed by the field team leader, health physics technician, and site safety officer.

- Each employee must have a hard hat, safety glasses, and substantial protective footwear available to wear as specified in the HWOP or JSA.

- The exclusion zone around drilling or other noisy operations will be posted "Hearing Protection Required" and team members will have had noise control training.

- Personnel should maintain a high level of awareness of the limitations in mobility, dexterity, and visual impairment inherent in the use of level B and level C personal protective equipment.

- Personnel should be alert to the symptoms of fatigue, heat stress, and cold stress and their effects on the normal caution and judgment of personnel.

- Rescue equipment as required by Occupational Safety and Health Administration (OSHA), Washington Industrial Safety and Health Act (WISHA), or standards for working over water will be available and used.

2.1.3 Personal Decontamination

- The HWOP will describe in detail methods of personnel decontamination, including the use of contamination control corridors and step-off pads when appropriate.

- Thoroughly wash hands and face before eating or putting anything in the mouth to avoid hand-to-mouth contamination.

- At the end of each work day or each job, disposable clothing shall be removed and placed in (chemical contamination) drums, plastic-lined boxes or other containers as appropriate. Clothing that can be cleaned may be sent to the Hanford Site laundry.

- Individuals are expected to thoroughly shower before leaving the work site or Hanford Site if directed to do so by the health physics technician, site safety officer, or field team leader.

2.1.4 Emergency Preparation

- A multipurpose dry chemical fire extinguisher, a fire shovel, a complete field first-aid kit, and a portable pressurized spray wash unit shall be available at every site where there is potential for personnel contamination.

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- Prearranged hand signals or other means of emergency communication will be established when respiratory protection equipment is to be worn, because this equipment seriously impairs speech.

- The Hanford Fire Department shall be initially notified before the start of the site investigation project. This notification shall include the location and nature of the various types of field work activities as described in the work plan. A site location map shall be included in this notification.

2.2 CONFINED SPACE/TEST PIT ENTRY PROCEDURES

The following procedures apply to the entry of any confined space, which for the purpose of this document shall be defined as any space having limited egress (access to an exit) and the potential for the presence or accumulation of a toxic or explosive atmosphere. This includes manholes, certain trenches (particularly those through waste disposal areas), and all test pits greater than 1 m (4 ft) deep. If confined spaces are to be entered as part of the work operations, a hazardous work permit (filled out for confined space entry) must be obtained from Industrial Safety and Fire Protection.

The identified remedial investigation activities on the PUREX Plant AAMS should not require confined space entry. Nevertheless, the hazards associated with confined spaces are of such severity that all employees should be familiar with the safe work discussed in the following paragraphs.

No employee shall enter any test pit or trench deeper than 1 m (4 ft) unless the sides are shored or laid back to a stable slope as specified in OSHA 29 CFR 1926.652 or equivalent state occupational health and safety regulations.

When an employee is required to enter a pit or trench 1 m (4 ft) deep or more, an adequate means of access and egress, such as a slope of at least 2:1 to the bottom of the pit or a secure ladder or steps shall be provided.

Before entering any confined space, <u>including any test pit</u>, the atmosphere will be tested for flammable gases, oxygen deficiency, and organic vapors. If other specific contamination, such as radioactive materials or other gases and vapors may be present, additional testing for those substances shall be conducted. Depending on the situation, the space may require ventilation and retesting before entry.

An employee entering a confined or partially confined space must be equipped with an appropriate level of respiratory protection in keeping with the monitoring procedures discussed previously and the action levels for airborne contaminants (see "Warnings and Action Levels" in HWOP).

No employee shall enter any test pit requiring the use of level B protection, unless a backup person also equipped with a pressure-demand self-contained breathing apparatus (SCBA) is present. No backup person shall attempt any emergency rescue unless a second backup person equipped with an SCBA is present, or the appropriate emergency response authorities have been notified and additional help is on the way.

3.0 SITE BACKGROUND

Specific details on the PUREX Plant AAMS background and known and suspected contamination are described in Sections 2.0 through 10.0 of the plan. The PUREX Plant Aggregate Area is situated within the 200 East Area of the U.S. Department of Energy's (DOE) Hanford Site, in the south-central portion of the state of Washington. The 200 East Area is located in Benton County in the central portion of the Hanford Site. It is adjacent to the 200 West Area, located roughly 5 km (3 mi) to the east.

The PUREX Plant Aggregate Area at the Hanford Site was used by the U.S. Government as a chemical separations area in the process to produce plutonium for nuclear weapons. These operations resulted in the release of chemical and radioactive wastes into the soil, air, and water of the area. Each waste site in the aggregate area is described separately in this document. Close relationships between waste units, such as overflow from one to another, are also discussed.

4.0 SCOPE OF WORK AND POTENTIAL HAZARDS

While the information presented in Sections 2.0 through 10.0 of the plan are believed to be representative of the constituents and quantities of wastes at the time of discharge, the present chemical nature, location, extent, and ultimate fate of these wastes in and around the liquid disposal facilities are largely unknown. The emphasis of the investigation in the PUREX Plant AAMS will be to characterize the nature and extent of contamination in the vadose (unsaturated subsurface soil) zone.

4.1 WORK TASKS

Work tasks are described in Section 5.0 of the plan.

4.2 POTENTIAL HAZARDS

Onsite tasks will involve noninvasive surface sampling procedures and invasive soil sampling either directly in or immediately adjacent to areas known or suspected to contain potentially hazardous chemical substances, toxic metals, and radioactive materials.

Surface radiological contamination and fugitive dust will be the potential hazards of primary concern during noninvasive mapping and sampling activities.

Existing data indicate that hazardous substances may be encountered during invasive sampling; these include radionuclides, heavy metals, and corrosives. In addition, volatile organics may also be associated with certain facilities such as the solvent storage buildings or underground storage tanks.

Potential hazards include the following:

- External radiation (gamma and to a lesser extract, beta) from radioactive materials in the soil
- Internal radiation resulting from radionuclides present in contaminated soil entering the body by ingestion or through open cuts and scratches
- Internal radiation resulting from inhalation of particulate (dust) contaminated with radioactive materials
- Inhalation of toxic vapors or gases such as volatile organics or ammonia
- Inhalation or ingestion of particulate (dust) contaminated with inorganic or organic chemicals, and toxic metals
- Dermal exposure to soil or groundwater contaminated with radionuclides
- Dermal exposure to soil or groundwater contaminated with inorganic or organic chemicals, and toxic metals
- Physical hazards such as noise, heat stress, and cold stress
- Slips, trips, falls, bumps, cuts, pinch points, falling objects, other overhead hazards, crushing injuries, and other hazards typical of a construction-related job site
- Unknown or unexpected underground utilities
- Biological hazards; snakes, spiders, etc.

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4.3 ASSESSMENT AND MITIGATION OF POTENTIAL HAZARDS

The likelihood of significant exposure (100 mR/h or greater) to external radiation is remote and can be readily monitored and controlled by limiting exposure time, increasing distance, and employing shielding as required.

Internal radiation by inhalation or inadvertent ingestion of contaminated dust is a realistic concern and must be continuously evaluated by the health physics technician. Appropriate respiratory protection, protective clothing, and decontamination procedures will be implemented as necessary to reduce potential inhalation, ingestion, and dermal exposure to acceptable levels.

Dermal exposure to toxic chemical substances is not expected to pose a significant problem for the identified tasks given the use of the designated protective clothing. The appropriate level of personal protective clothing and respiratory protection will vary from work site to work site.

5.0 ENVIRONMENTAL AND PERSONAL MONITORING

The site safety officer or authorized delegate shall be present at all times during work activities which require an HWOP, and shall be in charge of all environmental/personal monitoring equipment. Industrial Hygiene and Safety shall review all activities involving or potentially involving radiological exposure or contamination control and shall prescribe the appropriate level of technical support and/or monitoring requirements. Other equipment deemed necessary by the site safety officer or Industrial Hygiene and Safety shall be obtained at their direction; work will be initiated or continued until such equipment is in place. These instruments are to be used only by persons who are trained in their usage and who understand their limitations. No work shall be done unless instrumentation is available and in proper working order.

Air sampling may be required downwind of the referenced waste sites to monitor particulates and vapors before job startup. Siting of such sampling devices will be determined by Health Physics, the site safety officer, and HEHF, if appropriate. Any time personnel exposure monitoring, other than radiological, is required to determine exposure levels, it must be done by HEHF. Discrete sampling of ambient air within the work zone and breathing zones will be conducted using a direct-reading instrument, as specified in the

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site-specific safety document, and other methods as deemed appropriate (e.g., pumps with tubes, O_2 meters). The following standards will be used in determining critical levels:

- "Radionuclide Concentrations in Air," in Chapter XI, DOE Order 5480.1B (DOE 1986)
- "Air Contaminants - Permissible Exposure Limits," in 29 CFR 1910.1000
- *Threshold Limit Values and Biological Exposure Indices for 1990-1991* (ACGIH 1991)
- *Occupational Safety and Health Standards*, 29 CFR 1910.1000
- *Pocket Guide to Chemical Hazards* (NIOSH 1991), which provides National Institute for Occupational Safety and Health (NIOSH)-recommended exposure limits for substances that do not have either a threshold limit value or a permissible exposure limit.

5.1 AIRBORNE RADIOACTIVE AND RADIATION MONITORING

An onsite health physics technician will monitor airborne radioactive contamination levels and external radiation levels. Action levels will be consistent with derived air concentrations and applicable guidelines as specified in the radiation protection manual WHC-CM-4-10 (WHC 1988).

Appropriate respiratory protection shall be required when conditions are such that the airborne contamination levels may exceed an 8-hour derived air concentration (e.g., the presence of high levels of uncontained, loose contamination on exposed surfaces or operations that may raise excessive levels of dust contaminated with airborne radioactive materials, such as excavation or drilling under extremely dry conditions).

Specific conditions requiring the use of respiratory protection because of radioactive materials in air will be incorporated into the RWP. If, in the judgment of the health physics technician, any of these conditions arise, work shall cease until appropriate respiratory protection is provided.

6.0 PERSONAL PROTECTIVE EQUIPMENT

The level of personal protective equipment required initially at a site will be specified in the site-specific safety document for each task or group of tasks. Personal protective

clothing and respiratory protection shall be selected to limit exposure to anticipated chemical and radiological hazards. Work practices and engineering controls may be used to control exposure.

7.0 SITE CONTROL

The field team leader, site safety officer, and health physics technician are designated to coordinate access control and security on the site. Special site control measures will be necessary to restrict public access. The zones will be clearly marked with rope and/or appropriate signs. The size and shape of the control zone will be dictated by the types of hazards expected, the climatic conditions, and specific operations required.

Control zone boundaries may be increased or decreased based on results of field monitoring, environmental changes, or work technique changes. The site RWP and the contractor's standard operating procedures for radiation protection may also dictate the boundary size and shape. All team members must be surveyed for radioactive contamination when leaving the controlled zone if in a radiation zone.

The onsite command post and staging area will be established near the upwind side of the control zone as determined by an onsite windsock. Exact location for the command post is to be determined just before start of work. Vehicle access, availability of utilities (power and telephone), wind direction, and proximity to sample locations should be considered in establishing a command post location.

8.0 DECONTAMINATION PROCEDURES

Remedial investigation activities will require entry into areas of known chemical and radiological contamination. Consequently, it is possible that personnel and equipment could be contaminated with hazardous chemical and radiological substances.

During site activities, potential sources of contamination may include airborne vapors, gases, dust, mists, and aerosols; splashes and spills; walking through contaminated areas; and handling contaminated equipment. Personnel who enter the exclusion zone will be required to go through the appropriate decontamination procedures on leaving the zone. Decontamination procedures shall be consistent with EII 5.4, "Field Decontamination of Drilling, Well Development, and Sampling Equipment," and EII 5.5, "Decontamination of Equipment for RCRA/CERCLA Sampling" (WHC 1991), or other approved decontamination procedures.

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9.0 CONTINGENCY AND EMERGENCY RESPONSE PLANS

As a general rule, in the event of an unanticipated, potentially hazardous situation indicated by instrument readings, visible contamination, unusual or excessive odors, or other indications, team members shall temporarily cease operations and move upwind to a predesignated safe area as specified in the site-specific safety documentation.

10.0 REFERENCES

ACGIH, 1991, *Threshold Limit Values and Biological Exposure Indices for 1990-1991*, American Conference of Governmental Industrial Hygienists, Cincinnati, Ohio.

DOE, 1986, *Environment, Safety & Health Program for DOE Operations*, DOE Order 5480.1B, U.S. Department of Energy, Washington, D.C.

NIOSH, 1991, *Pocket Guide to Chemical Hazards, National Institute for Occupational Safety and Health*, U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, Washington, D.C.

WHC, 1988, *Radiation Protection*, WHC-CM-4-10, Westinghouse Hanford Company, Richland, Washington.

WHC, 1991, *Environmental Investigations and Site Characterization Manual*, WHC-CM-7-7, Westinghouse Hanford Company, Richland, Washington.

WHC, 1992, *Health and Safety for Hazardous Waste Field Operations*, WHC-CM-4-3 Vol. 4, Westinghouse Hanford Company, Richland, Washington.

APPENDIX C

PROJECT MANAGEMENT PLAN

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C-1 Hanford Site RI/FS Technical Resources CT-1

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ACRONYMS AND ABBREVIATIONS

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
DOE	U.S. Department of Energy
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FS	feasibility study
MCS	Management Control System
PMP	Project Management Plan
PNL	Pacific Northwest Laboratory
RCRA	Resource Conservation and Recovery Act
RI	remedial investigation
Tri-Party Agreement	Hanford Federal Facility Agreement and Consent Order

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1.0 INTRODUCTION

This Project Management Plan (PMP) defines the administrative and institutional tasks necessary to support the PUREX Plant Aggregate Area investigations at the Hanford Site. Also, this PMP defines the responsibilities of the various participants, the organizational structure, and the project tracking and reporting procedures. This PMP is in accordance with the provisions of the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) dated August 1990 (Ecology et al. 1990). Any revisions to the Tri-Party Agreement that would result in changes to the project management requirements would supersede the provisions of this chapter.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

2.1 INTERFACE OF REGULATORY AUTHORITIES AND THE U.S. DEPARTMENT OF ENERGY

The PUREX Plant Aggregate Area consists of active and inactive waste management units to be remedied under either the Resource Conservation and Recovery Act (RCRA) or the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). The Washington State Department of Ecology (Ecology) has been designated as the lead regulatory agency, as defined in the Tri-Party Agreement. Accordingly, Ecology is responsible for overseeing remedial action activity at this aggregate area and ensuring that the applicable authorities of both the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Energy (DOE) are applied. The specific responsibilities of EPA, Ecology, and DOE are detailed in the Tri-Party Agreement.

2.2 PROJECT ORGANIZATION AND RESPONSIBILITIES

The project organization for implementing remedial activities at the PUREX Plant Aggregate Area is shown in Figure C-1. The following sections describe the responsibilities of the individuals shown in Figure C-1.

2.2.1 Project Managers

The EPA, DOE, and Ecology have each designated one individual as project manager for remedial activities at the Hanford Site. These project managers will serve as the primary point of contact for all activities to be carried out under the Tri-Party Agreement. The responsibilities of the project managers are given in Section 4.1 of the Tri-Party Agreement.

2.2.2 Unit Managers

As shown in Figure C-1, EPA, DOE, and Ecology will each designate an individual as a unit manager for the PUREX Plant Aggregate Area.

The unit manager from Ecology will serve as the lead unit manager. The Ecology unit manager will be responsible for regulatory oversight of all activities required for the PUREX Plant Aggregate Area.

The unit manager from EPA will be responsible for making decisions related to issues for which the supporting regulatory agency maintains authority. All such decisions will be made in consideration of recommendations made by the Ecology unit manager.

The unit manager from DOE will be responsible for maintaining and controlling the schedule and budget and keeping the EPA and Ecology unit managers informed as to the status of the activities at the PUREX Plant Aggregate Area, particularly the status of agreements and commitments.

2.2.3 Quality Assurance Lead

The quality assurance lead will be a designated person within the Westinghouse Hanford Quality Assurance Organization. This designated person will be responsible for monitoring overall environmental restoration activities for this project. The designated personnel shall have the necessary organizational independence and authority to identify conditions adverse to quality and to systematically seek corrective action.

This individual is responsible for the preplanned surveillance and audit activities for this project. A quality assurance report shall be provided to the technical lead, annually as a minimum, for inclusion in the project final report generated by the technical organization. The quality assurance report shall summarize the surveillance and audit activities as well as associated corrective actions that may have been taken during the interval.

2.2.4 Health and Safety Officer (Environmental Division/Environmental Field Services)

The health and safety officer is responsible for monitoring all potential health and safety hazards, including those associated with radioactive, volatile, and/or toxic compounds during sample handling and sampling decontamination activities. The health and safety officer has the responsibility and authority to halt field activities resulting from unacceptable health and safety hazards.

2.2.5 Technical Lead

The technical lead will be a designated person within the Westinghouse Hanford Environmental Engineering Group. The responsibilities of the technical lead will be to plan, authorize, and control work so that it can be completed on schedule and within budget, and to ensure that all planning and work performance activities are technically sound.

2.2.6 Remedial Investigation/Feasibility Study Coordinators

The remedial investigation (RI) and feasibility study (FS) coordinators will be responsible for coordinating all activities related to the RI and FS, respectively, including data collection, analysis, and reporting. The RI and FS coordinators will be responsible for keeping the technical lead informed as to the RI and FS work status and any problems that may arise.

2.2.7 Resource Conservation and Recovery Act Facility Investigation/Corrective Measures Study Contractor

Figure C-1 shows the organizational relationship of an offsite contractor. Assuming a contractor is used to perform the RI/FS for the PUREX Plant Aggregate Area, the contractor would assume responsibilities of the RI and FS coordinators, as described above. In this instance, the contractor will be directly responsible for planning data collection activities and for analyzing and reporting the results of the data-gathering in the RI and FS reports. However, the Westinghouse Hanford coordinator would retain the responsibility for securing and managing the field sampling efforts of the Hanford Site technical resource teams, described below. Figure C-2 shows a sample organizational structure for an RI/FS contractor team.

2.2.8 Hanford Site Technical Resources

The various technical resources available on the Hanford Site for performing the field studies are shown in Table C-1. These resources will be responsible for performing data collection activities and analyses, and for reporting the results of specific technical activities. Figures C-3 through C-6 show the detailed organizational structure of specific technical teams. Internal and external work orders and subcontractor task orders will be written by the Westinghouse Hanford technical lead to use these technical resources, which are under the control of the technical lead. Statements of work will be provided to the technical teams and will include a discussion of authority and responsibility, a schedule with clearly defined milestones, and a task description including specific requirements. Each technical team will keep the coordinator informed of the work status performed by that group and any problems that may arise.

3.0 DOCUMENTATION AND RECORDS

All plans and reports will be categorized as either primary or secondary documents as described by Section 9.1 of the Tri-Party Agreement. The process for document review and comment will be as described in Section 9.2 of the Tri-Party Agreement. Revisions, should they become necessary after finalization of any document, will be in accordance with Section 9.3 of the Tri-Party Agreement. Changes in the work schedule, as well as minor field changes, can be made without having to process a formal revision. The process for making these changes will be as stated in Section 12.0 of the Tri-Party Agreement. Administrative records, which must be maintained to support the Hanford Site activities, will be in accordance with Section 9.4 of the Tri-Party Agreement.

4.0 FINANCIAL AND PROJECT TRACKING REQUIREMENTS

4.1 MANAGEMENT CONTROL

Westinghouse Hanford will have the overall responsibility for planning and controlling the investigation activities, and providing effective technical, cost, and schedule baseline management. If a contractor is used, the contractor will assume the direct day-to-day responsibilities for these management functions. The management control system used for this project must meet the requirements of DOE Order 4700.1, Project Management System and DOE Order 2250.1C, Cost and Schedule Control Systems Criteria. The Westinghouse Hanford Management Control System (MCS) meets these requirements. The primary goals of the Westinghouse Hanford MCS are to provide methods for planning, authorizing, and controlling work so that it can be completed on schedule and within budget, and to ensure that all planning and work performance activities are technically sound and in conformance with management and quality requirements.

The schedule developed for the PUREX Plant Aggregate Area will be updated at least annually, to expand the new current fiscal year and the follow-on year. In addition, any approved schedule changes (see Section 12.0 of the Tri-Party Agreement for the formal change control system) would be incorporated at this time, if not previously incorporated. This update will be performed in the fourth quarter of the previous fiscal year (e.g., July to September) for the upcoming current fiscal year. The work schedule can be revised at any time during the year if the need arises, but the changes would be restricted to major changes that would not be suitable for the change control process.

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4.2 MEETINGS AND PROGRESS REPORTS

Both project and unit managers must meet periodically to discuss progress, review plans, and address any issues that have arisen. The project managers' meeting will take place at least quarterly, and is discussed in Section 8.1 of the Tri-Party Agreement.

Unit managers shall meet monthly to discuss progress, address issues, and review near-term plans pertaining to their respective operable units and/or treatment, storage, and disposal groups/units. The meetings shall be technical in nature, with emphasis on technical issues and work progress. The assigned DOE unit manager for the PUREX Plant Aggregate Area will be responsible for preparing revisions to the aggregate area schedule prior to the meeting. The schedule shall address all ongoing activities associated with the PUREX Plant Aggregate Area, including actions on specific source units (e.g., sampling). This schedule will be provided to all parties and reviewed at the meeting. Any agreements and commitments (within the unit manager's level of authority) resulting from the meeting will be prepared and signed by all parties as soon as possible after the meeting. Meeting minutes will be issued by the DOE unit manager and will summarize the discussion at the meeting, with information copies given to the project managers. The minutes will be issued within five working days following the meeting. The minutes will include, at a minimum, the following information:

- Status of previous agreements and commitments
- Any new agreements and commitments
- Schedules (with current status noted)
- Any approved changes signed off at the meeting in accordance with Section 12.1 of the Tri-Party Agreement.

Project coordinators for each operable unit also will meet on a monthly basis to share information and to discuss progress and problems.

The DOE shall issue a quarterly progress report for the Hanford Site within 45 days following the end of each quarter. Quarters end on March 31, June 30, September 30, and December 31. The quarterly progress reports will be placed in the public information repositories as discussed in Section 10.2 of the Tri-Party Agreement. The report shall include the following:

- Highlights of significant progress and problems.
- Technical progress with supporting information, as appropriate.
- Problem areas with recommended solutions. This will include any anticipated delays in meeting schedules, the reason(s) for the potential delay, and actions to prevent or minimize the delay.

- Significant activities planned for the next quarter.
- Work schedules (with current status noted).

5.0 REFERENCES

Ecology, EPA, and DOE, 1990, *Hanford Federal Facility Agreement and Consent Order*, (First Amendment), 89-10, Rev. 1, Olympia, Washington.

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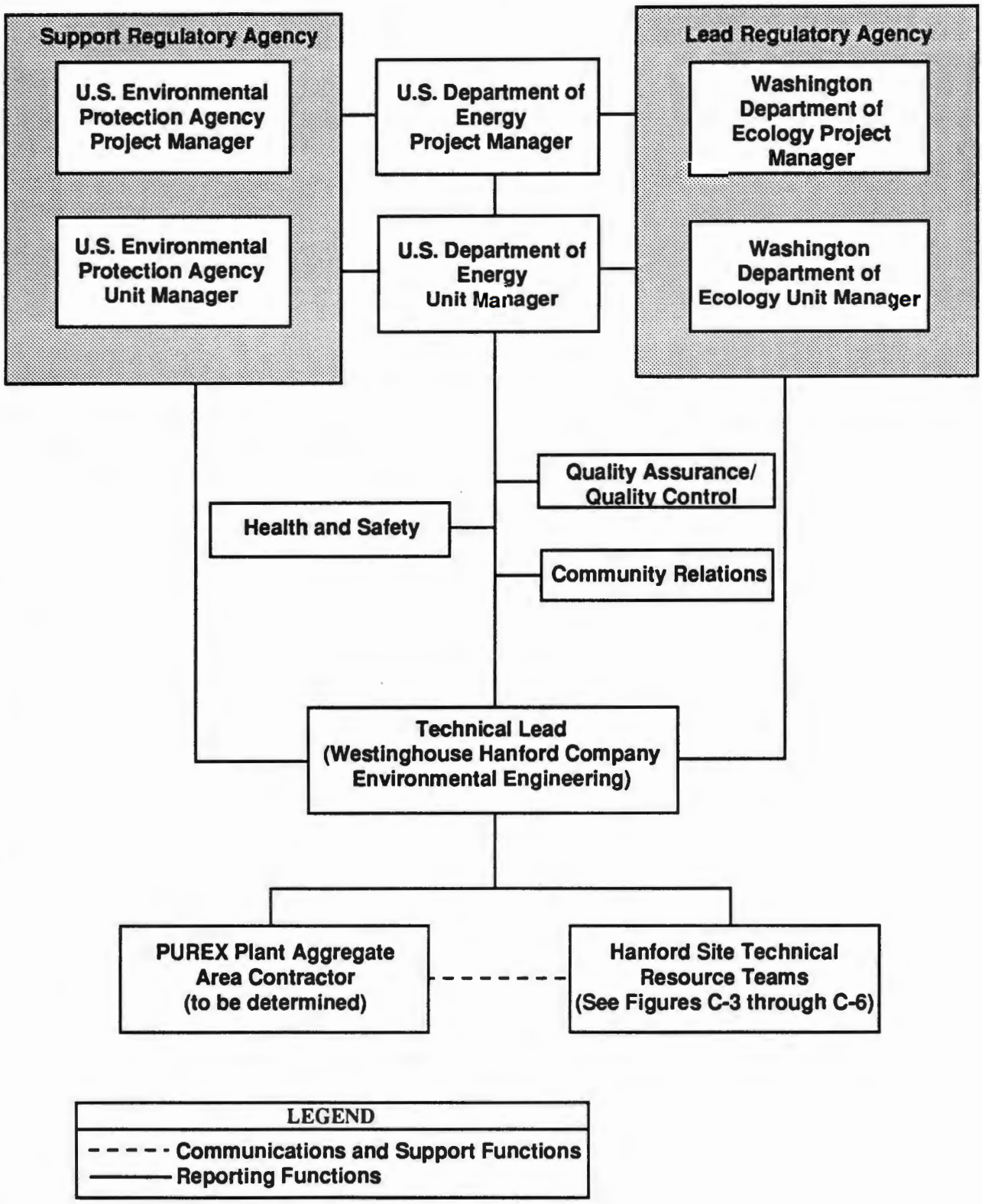
Figure C-1. Project Organization for the PUREX Plant Aggregate Area Project.



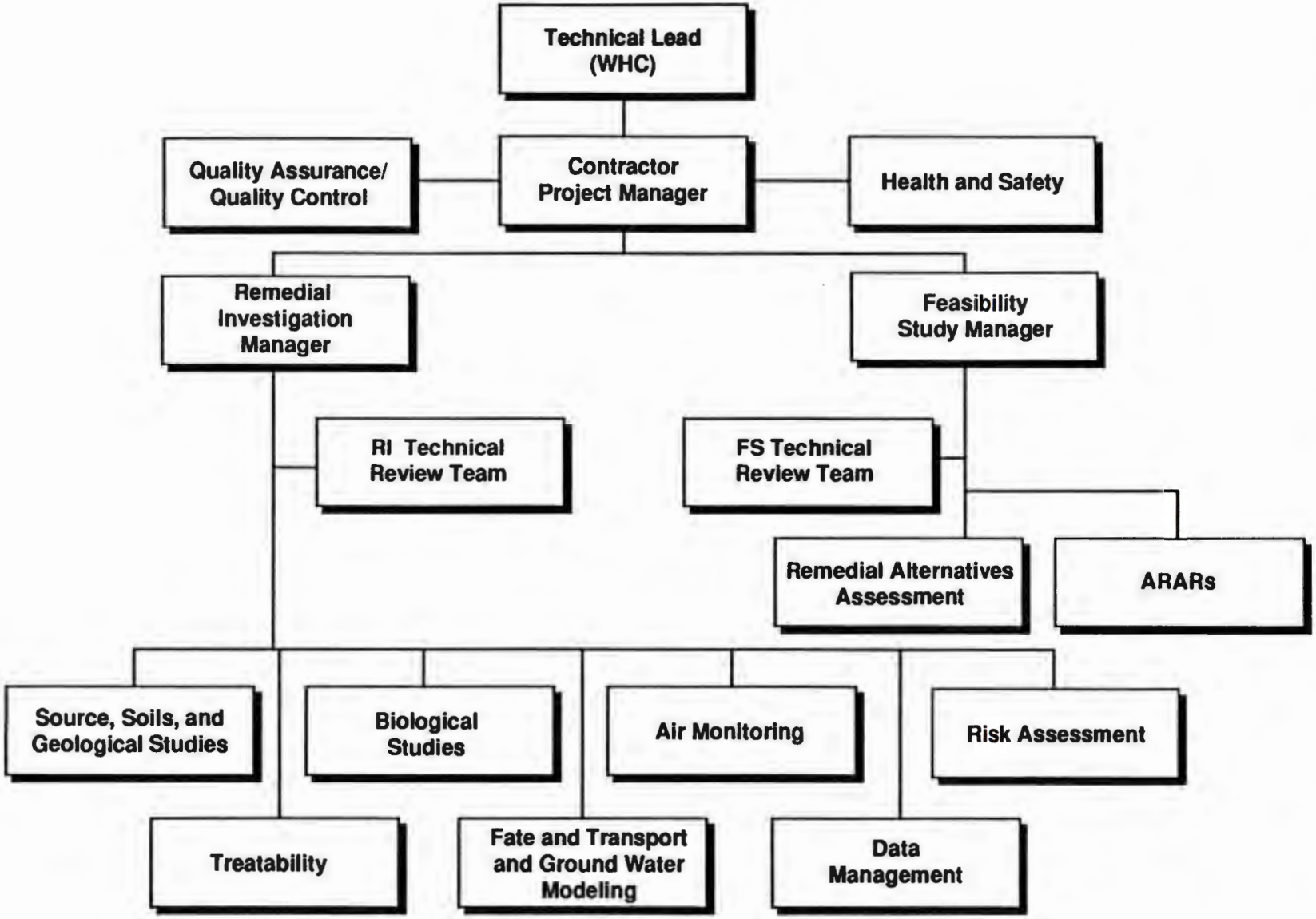


Figure C-2. Example Project Organization for the PUREX Plant Aggregate Area.

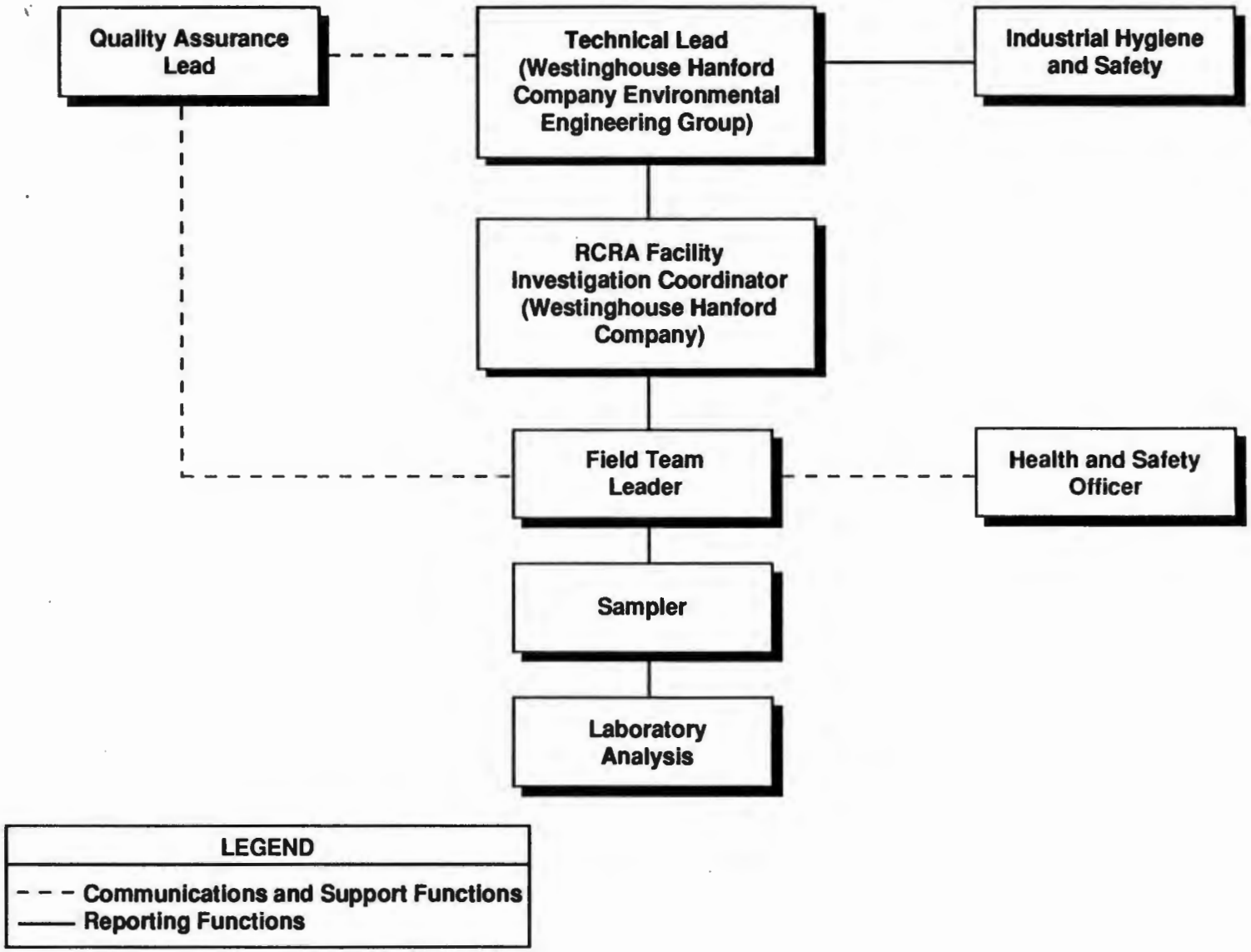


Figure C-3. The Hanford Site Soil Sampling Team.

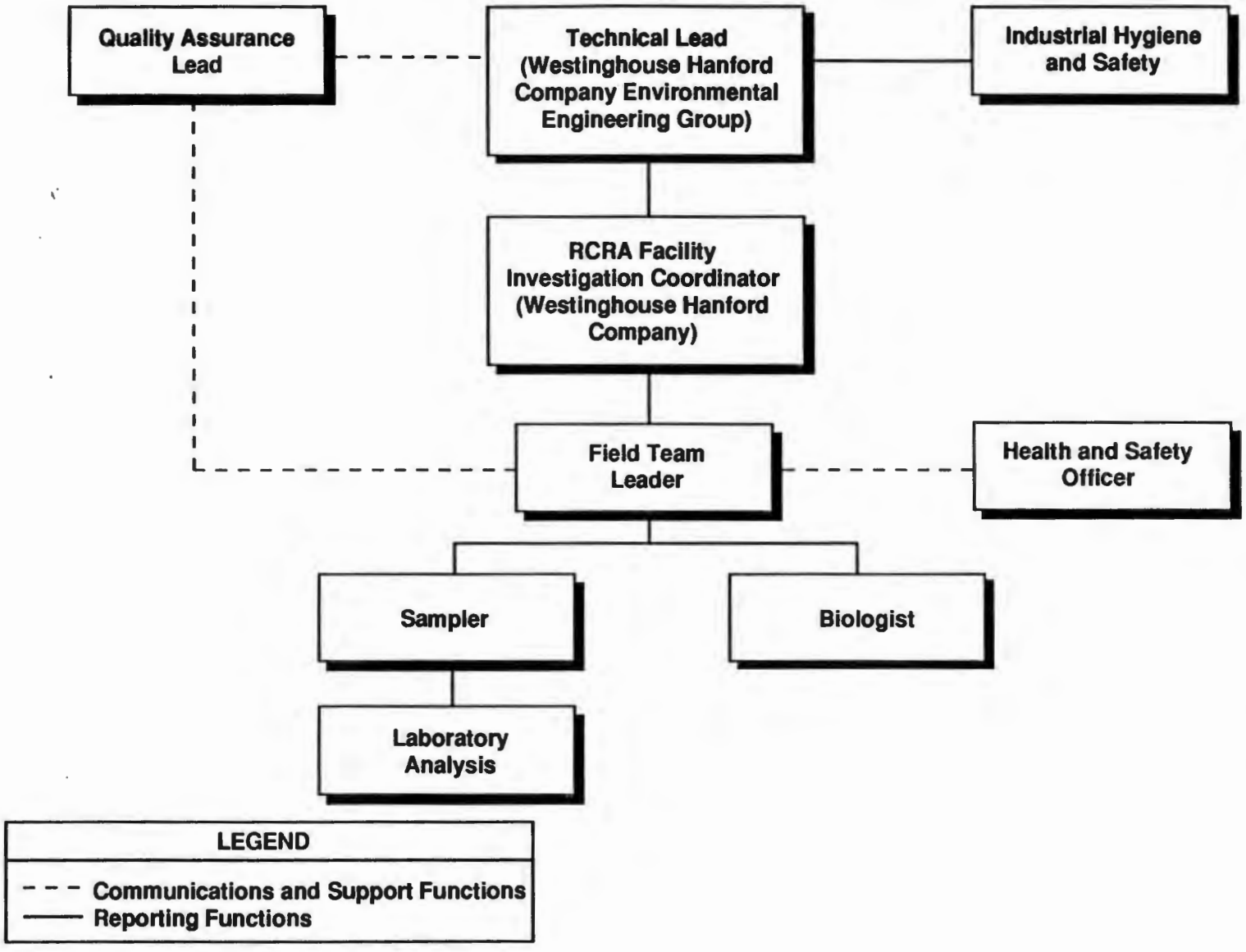


Figure C-4. The Hanford Site Biological Sampling Team.

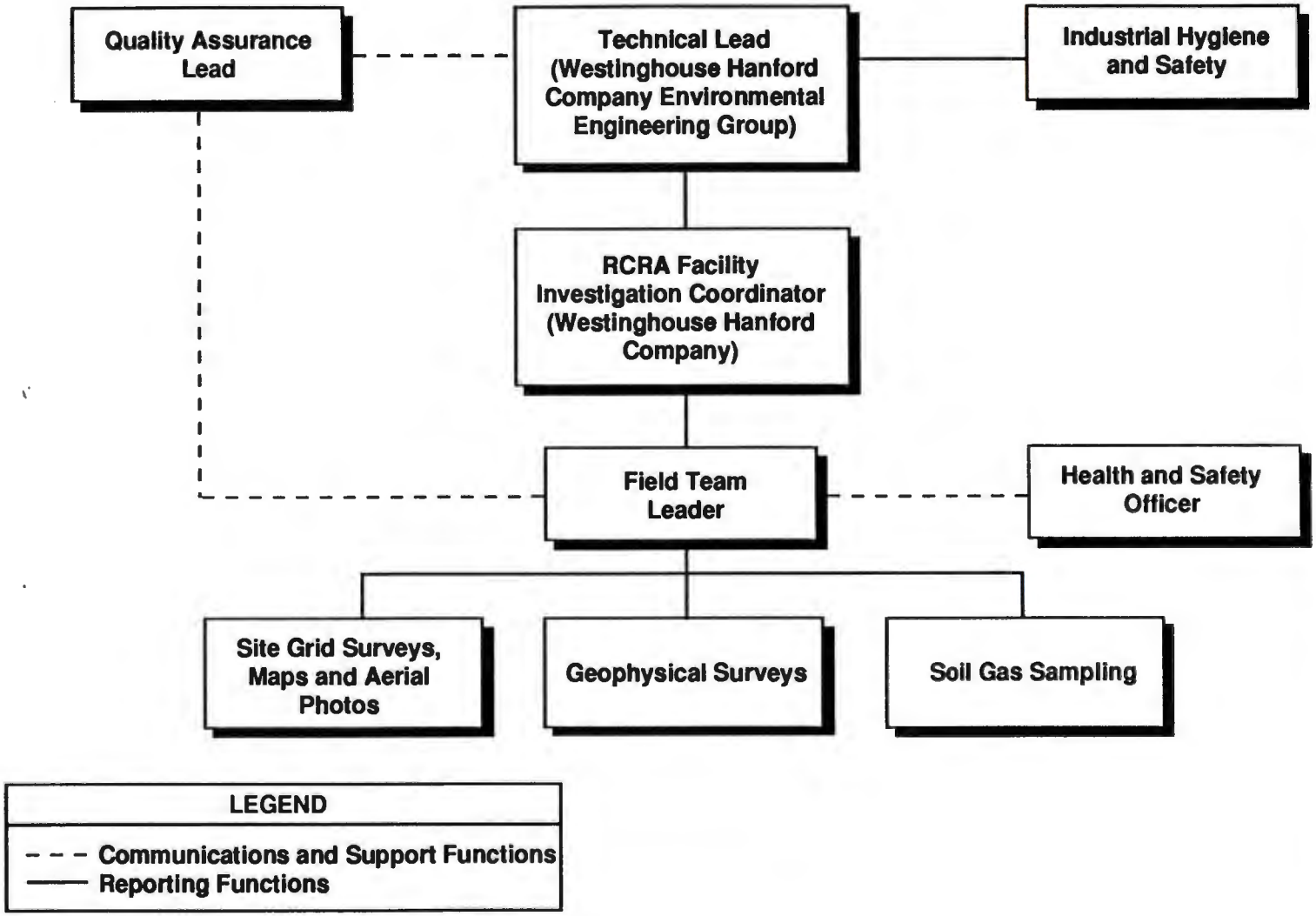


Figure C-5. The Hanford Site Physical and Geophysical Survey Team.

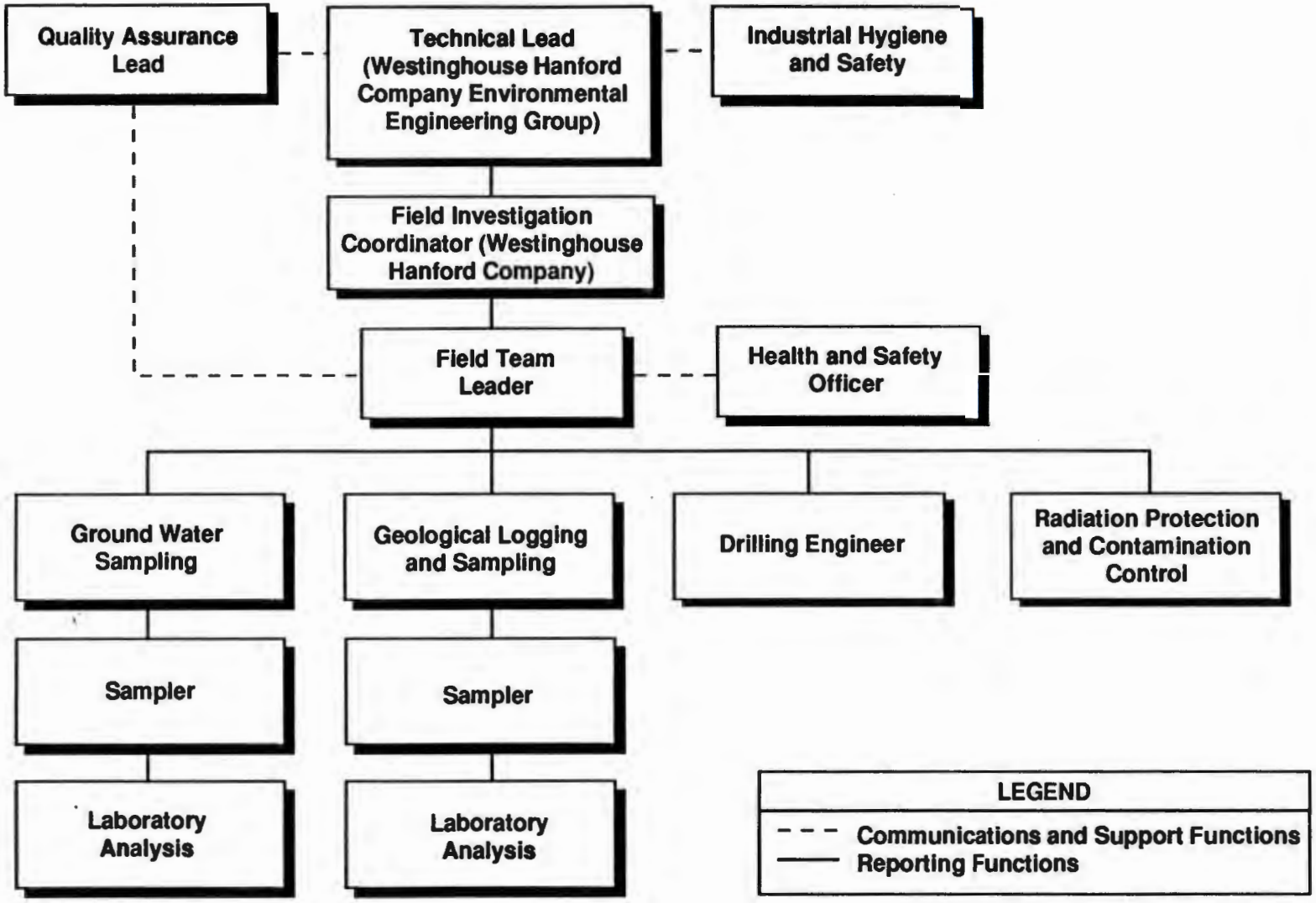


Figure C-6. Drilling, Sampling, and Well Development Team.

Table C-1. Hanford Site RI/FS Technical Resources. Page 1 of 2

Subject/Activity	Technical Resources	
	RI	FS
Hydrology and geology	Westinghouse Hanford/ Geosciences PNL/Earth and Environmental Sciences Center	Westinghouse Hanford/ Geosciences
Toxicology and risk/endangerment assessment	Westinghouse Hanford/ Environmental Technology PNL/Earth and Environmental Sciences Center PNL/Life Sciences Center	Westinghouse Hanford/ Environmental Technology
Environmental chemistry	Westinghouse Hanford/ Geosciences PNL/Earth and Environmental Sciences Center	Westinghouse Hanford/ Geosciences
Geotechnical and civil engineering	Westinghouse Hanford/ Geosciences (Planning) Environmental Field Services	NA
Geotechnical and civil engineering	NA	Westinghouse Hanford/ Environmental Engineering PNL/Waste Technology Center
Groundwater treatment engineering	NA	Westinghouse Hanford/ Environmental Engineering PNL/Waste Technology Center
Waste stabilization and treatment	NA	Westinghouse Hanford/ Environmental Engineering PNL/Waste Technology Center
Surveying	Kaiser Engineers Hanford	NA

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Table C-1. Hanford Site RI/FS Technical Resources.

	Technical Resources	
Subject/Activity	RI	FS
Soil and water sampling and analysis	Westinghouse Hanford/ Environmental Engineering Westinghouse Office of Sampling Management PNL/Earth and Environmental Sciences Center PNL/Materials and Chemical Sciences Center	NA
Drilling and well installation	Westinghouse Hanford/ Geosciences Environmental Field Services Kaiser Engineers	NA
Radiation monitoring	Westinghouse Hanford/ Operational Health Physics	NA

NA = Not applicable.

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APPENDIX D

INFORMATION MANAGEMENT OVERVIEW

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TABLE:

D-1 Types of Related Administrative Data DT-1

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ACRONYMS AND ABBREVIATIONS

AR	administrative record
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980
CMS	Corrective Measures Study
DOE	U.S. Department of Energy
DOE/RL	U.S. Department of Energy, Richland Operations Office
Ecology	Washington Department of Ecology
EDMC	Environmental Data Management Center
EHPSS	Environmental Health and Pesticide Services Section
EII	Environmental Investigations Instructions
EIMP	Environmental Information Management Plan
EPA	U.S. Environmental Protection Agency
ER	environmental restoration
ERRA	Environmental Restoration Remedial Action
FOMP	Field Office Management Plan
FS	feasibility study
GIS	geographic information system
HEHF	Hanford Environmental Health Foundation
HEIS	Hanford Environmental Information System
HLAN	Hanford Local Area Network
HMS	Hanford Meteorological Station
IMO	Information Management Overview
KEH	Kaiser Engineers Hanford
OSM	Office of Sample Management
PNL	Pacific Northwest Laboratory
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RFI	RCRA Facility Investigation
RI	remedial investigation
ROD	record of decision
TR	training records
Tri-Party Agreement	Hanford Federal Facility Agreement and Consent Order
TSD	treatment, storage, and disposal
Westinghouse Hanford	Westinghouse Hanford Company

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DEFINITIONS OF TERMS

Action Plan. Action plan for implementation of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1990). A negotiation between the U.S. Environmental Protection (EPA), the U.S. Department of Energy (DOE), and the State of Washington Department of Ecology (Ecology). The Action Plan defines the methods and processes by which hazardous waste permits will be obtained, and by which closure and post-closure actions under the Resource Conservation and Recovery Act of 1976 (RCRA) and by which remedial actions under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) will be conducted on the Hanford Site.

Administrative Record (AR). In CERCLA, the official file that contains all information that was considered or relied on by the regulatory agency in arriving at a final remedial action decision, as well as all documentation of public participation throughout the process. In RCRA, the official file that contains all documents to support a final RCRA permit determination.

Administrative Record File. The assemblage of documents compiled and maintained by an agency pertaining to a proposed project of administrative action and designated as AR or that are candidates for inclusion in the AR once a record of decision (ROD) is attained.

Data Management. The planning and control of activities affecting data.

Data Quality. The totality of features and characteristics of data that bears on its ability to satisfy a given purpose. The characteristics of major importance are accuracy, precision, completeness, representativeness, and comparability.

Data Validation. The process whereby data are accepted or rejected based on a set of criteria. This aspect of quality assurance involves establishing specified criteria for data validation. The quality assurance project plan (QAPP) must indicate the specified criteria that will be used for data validation.

ENCORE. The name given to the combination of hardware, software, and administrative subsystems that serve to integrate the management of the Hanford Site environmental data.

Environmental Data Management Center (EDMC). The central facility and services that provide a files management system for processing environmental information.

Environmental Information. Data related to the protection or improvement of the Hanford Site environment, including data required to satisfy environmental statutes, applicable DOE orders, or the Tri-Party Agreement.

Field File Custodian. An individual who is responsible for receipt, validation, storage, maintenance, control, and disposition of information or other records generated in support of Environmental Division activities.

Hanford Environmental Information System (HEIS). A computer-based information system under development as a resource for the storage, analysis, and display of investigative data collected for use in site characterization and remediation activities. Subject areas currently being developed include geophysics/soil gas, vadose zone soil (geologic), atmospherics, and biota.

Information System. Collection of components relate to the management of data and reporting of information. Information systems typically include computer hardware, computer software, operating systems, utilities, procedures, and data.

Lead Agency. The regulatory agency (EPA or Ecology) that is assigned the primary administrative and technical responsibility with respect to actions at a particular operable unit.

Nonrecord Material. Copies of material that are maintained for information, reference, and operating convenience and for which another office has primary responsibility.

Operable Unit. An operable unit at the Hanford Site is a group of land disposal and groundwater sites placed together for the purposes of doing a remedial investigation/ feasibility study. The primary criteria for placement of a site into an operable unit are geographic proximity, similarity of waste characteristics and site types, and the possibility for economies of scale.

Primary Document. A document that contains information on which key decisions are made with respect to the remedial action or permitting process. Primary documents are subject to dispute resolution and are part of the administrative record file.

Project Manager. The individual responsible for implementing the terms and conditions of the Action Plan on behalf of his respective party. The EPA, DOE, and Ecology will each designate one project manager.

Quality Affecting Record. Information contained on any media, including but not limited to, hard copy, sample material, photo copy, and electronic systems, that is complete in terms of appropriate content and that furnishes evidence of the quality of items and/or activities affecting quality.

Quality Assurance. The systematic actions necessary to provide adequate confidence that a material, component, system, process, or facility performs satisfactorily or as planned in service.

Quality Assured Data. Data developed under an integrated program for assurance of the reliability of data.

Raw Data. Unprocessed or unanalyzed information.

Record Validation. A review to determine that records are complete, legible, and meet records requirements. Documents are considered valid records only after the validation process has been completed.

Retention Period. The length of time records must be held before they can be disposed of. The time is usually expressed in years from the date of the record, but may also be expressed as contingent on the occurrence of an event.

Secondary Document. A document providing information that does not, in itself, reflect or support key decisions. A secondary document is subject to review by the regulatory agencies and may be part of the administrative record field. It is not subject to dispute resolution.

Validated Data. Data that meet criteria contained in an approved company procedure.

Verified Data. Data that have been checked for accuracy and consistency following a transfer action (e.g., from manual log to computer, or from distributed database to centralized data repository).

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1.0 INTRODUCTION AND OBJECTIVES

1.1 INTRODUCTION

An extensive amount of data will be generated over the next several years in connection with the activities planned for the PUREX Plant Aggregate Area. The quality of these data are extremely important to the full remediation of the aggregate area as agreed on by the U.S. Department of Energy (DOE), the U.S. Environmental Protection Agency (EPA) the Washington Department of Ecology (Ecology), and interested parties.

The Information Management Overview (IMO) provides an overview of the data management activities at the operable unit level. It identifies the type and quantity of data to be collected and references the procedures which control the collection and handling of data. It provides guidance for the data collector, aggregate area investigator, project manager, and reviewer to fulfill their respective roles.

This IMO addresses handling of data generated from activities associated with the aggregate area activities. All data collected will be in accordance with the Environmental Investigations Instructions (EII) contained in the Westinghouse Hanford Company's (Westinghouse Hanford) *Environmental Investigations and Site Characterization Manual* (WHC 1991a).

Development of a comprehensive plan for the management of all environmental data generated at the Hanford Site is under way. The *Environmental Information Management Plan* (EIMP) (Steward et al. 1989), released in March 1989, described activities in the Environmental Data Management Center (EDMC) and long-range goals for management of scientific and technical data. The scientific and technical data part of the EIMP was reviewed, revised, and expanded in fiscal year 1990 (Michael et al. 1990). An *Environmental Restoration Remedial Action Program Records Management Plan* (WHC 1991b) issued in July 1991, enables the program office to identify, control, and maintain the quality assurance (QA), decisional, or regulatory prescribed records generated and used in support of the Environmental Restoration Remedial Action (ERRA) Program.

1.2 OBJECTIVES

This IMO describes the process for the collection and control procedures for validated data, records, documents, correspondence, and other information associated with this aggregate area. This IMO addresses the following:

- Types of data to be collected
- Plans for managing data
- Organizations controlling data

- Databases used to store the data
- EIMP
- Hanford Environmental Information System (HEIS).

2.0 TYPES OF DATA

2.1 TYPES OF DATA

The general types of technical data to be collected and the associated controlling procedures are as follows:

Type of data	Procedure
Historical reports	EII 1.6
Aerial photos	EII 1.6
Chart recordings	EII 1.6
Technical memos	EII 1.6
Validated samples analyses	EII 1.6
Reports	EII 1.6
Logbooks	EII 1.5
Chain-of-custody forms	EII 5.1
Sample quality assurance/ quality control (QA/QC)	Office of Sample Management (OSM)

All such data are submitted to the EDMC for entry into the administrative record (AR).

General types of related administrative data is shown in Table D-1, which is organized in terms of general types of personnel and compliance/regulatory data. Table D-1 references the appropriate procedures and the record custodians. Data associated with aggregate area investigations will be submitted to the EDMC for entry into the AR, as appropriate.

2.2 DATA COLLECTION

Data will be collected according to the aggregate area sampling and analysis plans and the Quality Assurance Project Plan (QAPP). Section 2.1 listed the controlling procedures for data collection and handling before turnover to the organization responsible for data storage. All procedures for data collection shall be approved in compliance with the Westinghouse Hanford *Environmental Investigations and Site Characterization Manual* (WHC 1991a).

2.3 DATA STORAGE AND ACCESS

Data will be handled and stored according to procedures approved in compliance with applicable Westinghouse Hanford procedures (WHC 1988). The EDMC is the central files manager and process facility. All data entering the EDMC will be indexed, recorded, and placed into safe and secure storage. Data designated for placement into the AR will be copied, placed into the Hanford Site AR file, and distributed by the EDMC to the user community. The hard copy files are the primary sources of information; the various electronic data bases are secondary sources.

Normal access to data is through EDMC which is responsible for the AR. The Administrative Record Public Access Room is located in the 345 Hills Street Facility in Richland, Washington. This facility includes AR file documents (including identified guidance documents and technical literature).

Project participants may access data that are not in the AR by requesting it at the monthly unit managers' meeting for the operable unit of concern. As the project moves to completion, it is expected that all of the relevant data will be contained in the AR and the need to access data will be minimal.

The following types of data will be accessed from and reside in locations other than the EDMC:

Data Type	Data location
• QA/QC laboratory data	OSM (Westinghouse Hanford)
• Sample status	OSM (Westinghouse Hanford)
• Archived samples	Laboratory performing analyses
• Training records	Technical Training Support Section (Westinghouse Hanford)
• Meteorological data	Hanford Meteorological Station (HMS) (Pacific Northwest Laboratory [PNL])
• Health and safety records	Hanford Environmental Health Foundation (HEHF)
• Personal protective fitting	Environmental Health and Pesticide Services Section (Westinghouse Hanford)
• Radiological exposure	Pacific Northwest Laboratory.

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2.4 DATA QUANTITY

Data quantities for the investigative activities will be estimated based on the sampling and analysis plans developed for investigation of sites within the aggregate area.

3.0 DATA MANAGEMENT

3.1 OBJECTIVE

A considerable amount of data will be generated through the implementation of the aggregate area sampling and analysis plans. The QAPP will provide the specific procedural direction and control for obtaining and analyzing samples in conformance with requirements to ensure quality data results. The sampling and analysis plans will provide the basis for selecting the location, depth, frequency of collection, etc., of media to be sampled and methods to be employed to obtain samples of selected media for cataloging, shipment, and analysis. Figure D-1 displays the general data management model for data generated through work plan activities.

3.2 ORGANIZATIONS CONTROLLING DATA

This section addresses the organizations that will receive data generated from aggregate area activities.

3.2.1 Environmental Engineering Group

The Westinghouse Hanford Environmental Engineering Group provides the operable unit technical coordinator. The technical coordinator is responsible for maintaining and transmitting data to the designated storage facility.

3.2.2 Office of Sample Management

The Westinghouse Hanford OSM will validate all analytical data packages received from the laboratory. Validated summary data (sample results and copies of chain-of-custody forms) will be forwarded to the technical coordinator. Nonvalidated data will be forwarded to the technical coordinator on request. Preliminary data will be clearly labeled as such. The OSM will maintain raw sample data, QA/QC laboratory data, and the archived sample index.

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3.2.3 Environmental Data Management Center

The EDMC is the Westinghouse Hanford Environmental Division's central facility and service that provides a file management system for processing environmental information. The EDMC manages and controls the AR and Administrative Record Public Access Room at the Hanford Site. Part 1 of the EIMP (Michael et al. 1990) describes the central file system and services provided by the EDMC. The following procedures address data transmittal to the EDMC:

- EII 1.6, Records Management (WHC 1991a)
- EII 1.11, Technical Data Management (WHC 1991a)
- TPA-MP-02, Information Transmittals and Receipt Controls (DOE/RL 1990)
- TPA-MP-07, Administrative Record Collection and Management (DOE/RL 1990)

3.2.4 Information Resource Management

Information Resource Management is the designated records custodian (permanent storage) for Westinghouse Hanford. The procedural link from the EDMC to the Information Resource Management is currently under development.

3.2.5 Hanford Environmental Health Foundation

The HEHF performs the analyses on the nonradiological health and exposure data (Section 3.3.2) and forwards summary reports to the Fire and Protection Group and the Environmental Health and Pesticide Services Section within the Westinghouse Hanford Environmental Division. Nonradiological and health exposure data are maintained also for other Hanford Site contractors (PNL and Kaiser Engineers Hanford [KEH]) associated with aggregate area activities. The HEHF provides summary data to the appropriate site contractor. EII 2.1, Preparation of Hazardous Waste Operations Permits, and EII 2.2, Occupational Health Monitoring (WHC 1991a) address the preparation of health and safety plans and occupational health monitoring, respectively.

3.2.6 Environmental Health and Pesticide Services Section

The Westinghouse Hanford Environmental Health and Pesticide Services Section maintains personal protective equipment fitting records and maintains nonradiological health field exposure and exposure summary reports provided by HEHF for Westinghouse Hanford Environmental Division and subcontractor personnel.

3.2.7 Technical Training Records and Scheduling Section

The Westinghouse Hanford Technical Training Records and Scheduling Section provides training and maintains training records (Section 3.3.4).

3.2.8 Pacific Northwest Laboratory

The PNL operates the HMS and collects and maintains meteorological data (Section 3.3.1). Data management is discussed in Andrews (1988).

The PNL collects and maintains radiation exposure data (Section 3.3.3).

3.3 DATABASES

This section addresses databases that will receive data generated from the aggregate area activities. These and other databases are described in the EIMP (Michael et al. 1990). All of these databases exist independently of this aggregate area and serve other site functions. Data pertinent to the operable unit, housed in these databases, will be submitted to the AR.

3.3.1 Meteorological Data

The HMS collects and maintains meteorological data. Their database contains meteorological data from 1943 to the present, and Andrews (1988) is the document containing meteorological data management information.

3.3.2 Nonradiological Exposure and Medical Records

The HEHF collects and maintains data for all nonradiological exposure records and medical records.

3.3.3 Radiological Exposure Records

The PNL collects and maintains data on occupational radiation exposure. This database contains respiratory personal protective equipment fitting records, work restrictions, and radiation exposure information.

3.3.4 Training Records

Training records for Westinghouse Hanford and subcontractor personnel are managed by the Westinghouse Hanford Technical Training Support Section. Other Hanford Site contractors (PNL and KEH) maintain their own personnel training records. Training records for non-Westinghouse personnel are entered into the Westinghouse (soft reporting) database to document compliance.

Training records include:

- Initial 40-h hazardous waste worker training
- Annual 8-h hazardous waste worker training update
- Hazardous waste generator training
- Hazardous waste site specific training
- Radiation safety training
- Cardiopulmonary resuscitation
- Scott air pack
- Fire extinguisher
- Noise control
- Mask fit.

3.3.5 Environmental Information/Administrative Record

Environmental information and the AR are managed by Westinghouse Hanford EDMC personnel. They provide an index and key information on all data transmitted to the EDMC. This database is used to assist in data retrieval and to produce index lists as required.

3.3.6 Sample Status Tracking

The OSM maintains the sample status tracking database. This database contains information about each sample. Information maintained includes sample number, ship date, receipt date, and laboratory identification.

4.0 ENVIRONMENTAL INFORMATION AND RECORDS MANAGEMENT PLAN

This section briefly discusses the EIMP (Michael et al. 1990) that was developed to provide an overview of an integrated approach to managing Hanford Site environmental data, and the *Environmental Restoration Remedial Action Program Records Management Plan* (WHC 1991b).

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4.1 ENVIRONMENTAL INFORMATION MANAGEMENT PLAN

The EIMP provides an overview of how information is managed throughout the lifetime of Hanford Site environmental programs.

The Environmental Division of Westinghouse Hanford is responsible for the protection and improvement of the Hanford Site environment. To fulfill responsibility, the Environmental Division has assumed a management role with respect to Hanford Site environmental information. This management role includes (1) establishing standards for how data are validated and controlled, (2) developing and maintaining a supporting computer-based environment, and (3) sustaining a centralized file management system.

Hanford Site environmental information is defined as data related to the protection or improvement of the Hanford Site environment, including data required to satisfy environmental statutes, applicable DOE orders, or the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1990), (Tri-Party Agreement).

Environmental information falls into several overlapping categories, such as administrative versus technical and electronic versus manual or hard copy. A considerable amount of data are recorded in documents, which are governed by company-wide document and records control practices. Other data are collected or generated by computer and, therefore, exist in electronic form. The name ENCORE has been given to the combination of administrative, hardware, and software systems that serve to integrate the management of this electronic data.

Administrative information (e.g., budgets and schedules) is subject to accounting and other standard business practices. Scientific and technical data are subject to a different set of legal, classification, release, and engineering requirements.

Superimposed over these categories is the files management system for environmental information. This management system, has been developed to meet a number of Environmental Division needs, including requirements for compilation of AR files. The AR files are compilations of all material related to environmental restoration and remedial action records of decision (ROD) for each operable unit and treatment, storage, and disposal (TSD) group described in the Tri-Party Agreement.

Data in electronic form flows from information systems in the ENCORE realm to both scientific/technical and administrative documents. Environmental documents distributed within the Hanford Site and from regulatory agencies are received by the EDMC for storage and future processing.

Part I of the EIMP describes the overall Westinghouse Hanford systems that are generally applied to documents and records. Part I also describes, in greater detail, the files management system developed to manage the AR file information. The EDMC compiles the

AR files and provides controlled distribution of specified information to the AR files held by DOE, Ecology, and the EPA. The EDMC also provides controlled distribution of specified community relations information to regional information repositories.

Part II addresses computer-based information, with an emphasis on scientific and technical data. The long-term nature of environmental programs and the complex interrelationships of environmental data require that the data be preserved, retrievable, traceable, and sufficient for future use. To ensure data availability for response to regulatory and agency requirements, the plan is directed toward optimizing the use of automated techniques for managing data. The current processing environment and the proposed ENCORE realm are described, and the plans for implementation of ENCORE are addressed.

4.2 ENVIRONMENTAL RESTORATION REMEDIAL ACTION PROGRAM RECORDS MANAGEMENT PLAN

The ERRA Program records management plan was developed to fulfill the requirements of the U.S. Department of Energy, Richland Operations Office (DOE/RL) *Environmental Restoration Field Office Management Plan* (FOMP) (DOE/RL 1989). The FOMP describes the plans, organization, and control systems to be used for management of the Hanford Site ERRA Program. The Westinghouse Hanford ERRA Program Office has developed this ERRA Program records management plan to fulfill the requirements of the FOMP. This records management plan will enable the program office to identify, control, and maintain the quality assurance, decisional, or regulatory prescribed records generated and used in support of the ERRA Program.

The ERRA Program records management plan describes how the applicable records management requirements will be implemented for the ERRA Program. The plan also develops the criteria for identifying the appropriate requirements for each individual piece of information related to ERRA work activities.

This records management plan applies to all ERRA Program records and documents generated, used, or maintained in support of ERRA-funded work activities on the Hanford Site. The terms, information, documents, nonrecord material, records, record material, and QA records used throughout the ERRA records management plan are interpreted as ERRA information, ERRA documents, ERRA nonrecord material, ERRA records, ERRA record material, and ERRA QA records.

5.0 HANFORD ENVIRONMENTAL INFORMATION SYSTEM

5.1 OBJECTIVE

The Hanford Environmental Information System (HEIS) has been developed by PNL for Westinghouse Hanford as a primary resource for computerized storage, retrieval, and analysis of quality-assured technical data associated with Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) remedial investigation/ feasibility study (RI/FS) activities and RCRA Facility Investigation/Corrective Measures Study (RFI/CMS) activities being undertaken at the Hanford Site. The HEIS will provide a means of interactive access to data sets extracted from other databases relevant to implementation of the Tri-Party Agreement (Ecology et al. 1990). The HEIS will support graphics analysis, including a geographic information system. Implementation of HEIS will serve to ensure that data consistency, quality, traceability, and security are achieved through incorporation of all environmental data within a single controlled database.

The following is a list of data subjects proposed to be entered into HEIS:

- Geologic
- Geophysics
- Atmospheric
- Biotic
- Site characterization
- Soil gas
- Waste site information
- Surface monitoring
- Groundwater.

5.2 STATUS OF THE HANFORD ENVIRONMENTAL INFORMATION SYSTEM

The HEIS, a computerized database containing technical data and information used to support the Hanford environmental restoration (ER) activities, is operational. The data for the Hanford groundwater wells and groundwater samples is currently accessible via the Hanford Local Area Network (HLAN) to local users and to offsite users via a modem link to the HEIS database computer. Additional data, including geologic, biota, and other pertinent environmental sample results, are being entered into the HEIS database.

The *Hanford Environmental Information System (HEIS) User's Manual* (WHC 1990) was issued in October 1990. An operator manual is being prepared and is expected to be issued in 1992.

The HEIS geographic information system (GIS) will display detailed maps for the Hanford restoration sites including data from the HEIS database. Such spatially related data

will be used to support analysis of waste site technical issues and restoration options. The combination of the HEIS for data and the GIS spatial displays offers some powerful tools for many users to analyze and collectively evaluate the environmental data from the ER and site-wide monitoring programs.

6.0 REFERENCES

Andrews, G. L., 1988, *The Hanford Meteorological Data Collection System and Data Base,* PNL-6509, Pacific Northwest Laboratory, Richland, Washington.

DOE/RL, 1989, *Environmental Restoration Field Office Management Plan,* DOE/RL-89-29, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL, 1990, *Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) Handbook,* RL-TPA-90-0001, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Ecology, EPA, and DOE/RL, 1990, *Hanford Federal Facility Agreement and Consent Order,* First amendment, Two Volumes, 89-10 Revision 1, Washington Department of Ecology, Olympia, Washington, U.S. Environmental Protection Agency, Region X, Seattle, Washington, and U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Michael, L. E., G. C. Main, and E. J. See, 1990, *Environmental Information Management Plan,* WHC-EP-0219, Revision 1, Westinghouse Hanford Company, Richland, Washington.

Steward, J. C., G. C. Main, and E. J. See, 1989, *Environmental Information Management Plan,* WHC-EP-0219, Westinghouse Hanford Company, Richland, Washington.

WHC, 1988, *Quality Assurance Manual*, WHC-CM-4-2, Westinghouse Hanford Company, Richland, Washington.

WHC, 1991a, *Environmental Investigations and Site Characterization Manual,* WHC-CM-7-7, Westinghouse Hanford Company, Richland, Washington.

WHC, 1991b, *Environmental Restoration Remedial Action Program Records Arrangement Plan,* WHC-EP-0430, Westinghouse Hanford Company, Richland, Washington.

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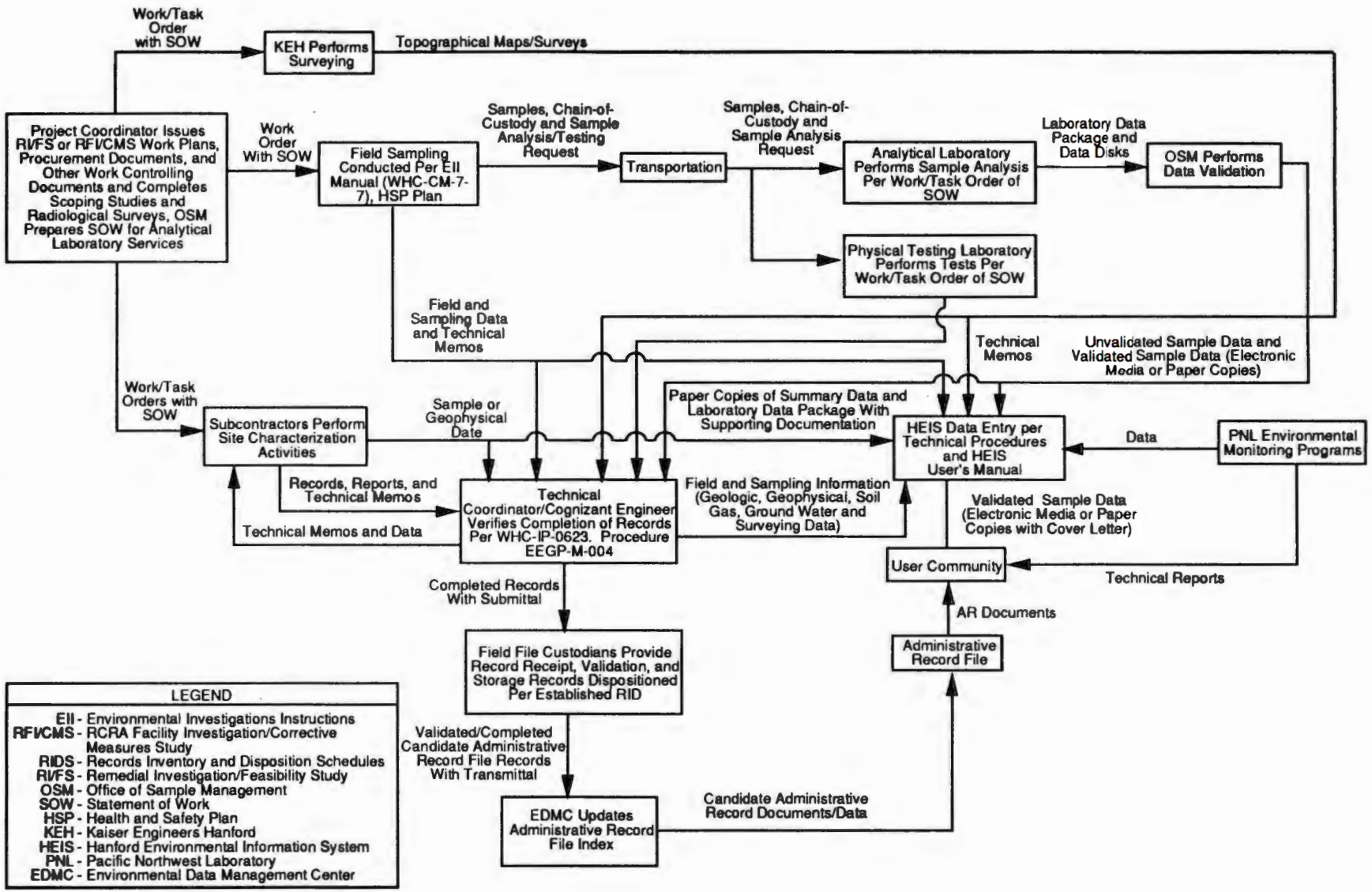

Figure D-1. Environmental Engineering, Technology, and Permitting Data Management Model.

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Table D-1. Types of Related Administrative Data.

Type of Data	Controlling document/procedure	Record Custodians				
		TR	HEHF	PNL	EDMC	EHPSS
Personnel						
Personnel training and qualifications	EII 1.7[a/]	X				
Occupational exposure records (nonradiological)	EII 2.2[a/]		X			X
Radiological exposure records				X		
Respiratory protection fitting						X
Personnel health and safety records	EII 2.1[a/]		X			X
Compliance/regulatory						
Action-specific requirements/ screening levels	EII 1.6[a/]				X	
Guidance document tracking	EII 1.6[a/]				X	
Compliance issues	EII 1.6[a/]				X	
Problem resolution	EII 1.6[a/]				X	
Administrative record	TPA-MP-11[b/]				X	

[a/] WHC 1991a, *Environmental Investigations and Site Characterization Manual.*

[b/] DOE/RL 1990, *Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) Handbook.*

EDMC = Environmental Data Management Center (Westinghouse Hanford Company).

EHPSS = Environmental Health and Pesticide Services Section (Westinghouse Hanford Company).

EII = Environmental Investigations Instructions.

HEHF = Hanford Environmental Health Foundation.

TR = training records (Westinghouse Hanford Company, Pacific Northwest Laboratory [PNL], Kaiser Engineers Hanford [KEH]).

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