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DRAFT
ENVIRONMENTAL IMPACT STATEMENT (DEIS) FOR TREATING TRANSURANIC (TRU)/ALPHA LOW-LEVEL WASTE AT THE OAK RIDGE NATIONAL LABORATORY OAK RIDGE, TENNESSEE

February 2000

COVER SHEET

RESPONSIBLE AGENCY: U.S. Department of Energy (DOE)

TITLE: Draft Environmental Impact Statement (EIS) for Treating Transuranic (TRU)/Alpha Low-Level Waste at the Oak Ridge National Laboratory, Oak Ridge, Tennessee

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ABSTRACT: DOE proposes to construct, operate, and decontaminate/decommission a TRU Waste Treatment Facility in Oak Ridge, Tennessee. The four waste types that would be treated at the proposed facility would be remote-handled TRU mixed waste sludge, liquid low-level waste associated with the sludge, contact-handled TRU/alpha low-level waste solids, and remote-handled TRU/alpha low-level waste solids. The mixed sludge and some of the solid waste contain metals regulated under the Resource Conservation and Recovery Act and may be classified as mixed waste.

This document analyzes the potential environmental impacts associated with five alternatives—No Action, the Low-Temperature Drying Alternative (Preferred Alternative), the Vitrification Alternative, the Cementation Alternative, and Treatment and Waste Storage at Oak Ridge National Laboratory Alternative.

PUBLIC COMMENTS: Comments on this Draft Environmental Impact Statement (EIS) may be submitted to Dr. Clayton Gist (see address above) through the end of the 45-day comment period, which will begin with the issuance of a Notice of Availability by the U.S. Environmental Protection Agency. Comments received after the end of the comment period will be addressed to the extent practicable. Comments may be submitted in writing to the above address, or by facsimile or e-mail. Oral and written comments may also be submitted at the public hearing(s), which will be held during the comment period on dates and locations to be announced via other public media shortly after issuance of the Draft EIS.

CONTENTS

FIGURES

TABLES

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ACRONYMS AND ABBREVIATIONS

ALARA	as low as reasonably achievable
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
D&D	decontamination and decommissioning
DOE	U.S Department of Energy
DOT	U.S. Department of Transportation
DSSI	Diversified Scientific Services, Inc.
EA	environmental assessment
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
ETTP	East Tennessee Technology Park
FFA	Federal Facilities Agreement
Foster Wheeler	Foster Wheeler Environmental Corporation
FR	*Federal Register*
FSAR	Final Safety Analysis Report
HEME	high-efficiency mist eliminator
HEPA	high-efficiency particulate air
HVAC	heating, ventilation, and air conditioning
INEEL	Idaho National Engineering and Environmental Laboratory
ISCST3	Industrial Source Complex Modeling Code, Version 3
LCF	latent cancer fatality
LDR	Land Disposal Restriction
MEI	maximally exposed individual
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NESHAPs	National Emission Standards for Hazardous Air Pollutants
NFS	Nuclear Fuel Services
NPDES	National Pollutant Discharge Elimination System
ORNL	Oak Ridge National Laboratory
ORO	Oak Ridge Operations
ORR	Oak Ridge Reservation
PCB	polychlorinated biphenyl
PCF	probability of cancer fatality
PPE	personal protective equipment
PSD	prevention of significant deterioration
Rad-NESHAP	National Emission Standards for Hazardous Air Pollutants for Radionuclides
RCRA	Resource Conservation and Recovery Act
RIMS II	Regional Input-Output Modeling System II
SCR	selective catalytic reduction
SWSA	solid waste storage area
SWSA 5 North	Solid Waste Storage Area 5 North
TAAQS	Tennessee Ambient Air Quality Standards
TCLP	Toxicity Characteristic Leaching Procedure
TDEC	Tennessee Department of Environment and Conservation
TRU	transuranic
TSCA	Toxic Substances Control Act

TVA	Tennessee Valley Authority
UBC	uniform building code
UTS	Universal Treatment Standard
WM PEIS	*Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste* (DOE/EIS-0200-F, May 1997)
WIPP SEIS-II	*Waste Isolation Pilot Plant Disposal Phase Supplemental Environmental Impact Statement* (DOE/EIS-0026-S-2)

UNITS OF MEASURE

Bq	becquerel
Bq/g	becquerels per gram
C	Celsius
Ci	curie
Ci/g	curies per gram
cm	centimeter
dscf	dry standard cubic foot
dscfm	dry standard cubic feet per minute
F	Fahrenheit
ft	feet
ft^2	square feet
ft^3	cubic feet
gal	gallon
gpd	gallons per day
gpm	gallons per minute
gr/dscf	grains per dry standard cubic foot
Gy/d	gray (absorbed dose, energy) per day
h	hour
ha	hectare
in	inch
km	kilometer
kV	kilovolt
kW	kilowatt
L	liter
lb	pound
lb/ft^3	pounds per cubic foot
lbs/h	pounds per hour
Leq	equivalent sound or noise level
m	meter
m^3	cubic meters
mg/L	milligrams per liter
mph	miles per hour
mrem	millirem (one thousandth of a rem)
mrem/h	millirem per hour
MW	megawatt
nCi/g	nanocuries per gram
ng/L	nanograms per liter

pCi/g	picocuries (one trillionth of a curie) per gram
ppm	parts per million
psig	pounds per square inch gauge
rad/d	rads per day
rem	roentgen equivalent man
rpm	revolutions per minute
wt %	weight percent
$\mu g/m^3$	micrograms per cubic meter
μR	microroentgen

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SUMMARY

S1.1 INTRODUCTION

U.S. Department of Energy (DOE) facilities on the Oak Ridge Reservation (ORR) in the Oak Ridge, Tennessee area, have performed nuclear energy research and radiochemical production since the early 1940s. The reservation encompasses 13,974 contiguous hectares (ha) (34,516 acres), and the Y-12 Plant, the East Tennessee Technology Park (ETTP), and the Oak Ridge National Laboratory (ORNL) are major DOE facilities within it.

ORNL was constructed during World War II as a pilot-scale plant to support nuclear energy research and the construction of larger plutonium production facilities at Hanford, Washington. ORNL is located on approximately 1,174 ha (2,900 acres) (Figure S-1) in a water-rich environment, with numerous small tributaries that flow into the Clinch River located to the south and west. ORNL is in the Tennessee Valley between the Great Smoky Mountains (located approximately 80 km or 50 miles east) and the Cumberland Plateau (about 45 km or 25 miles west).

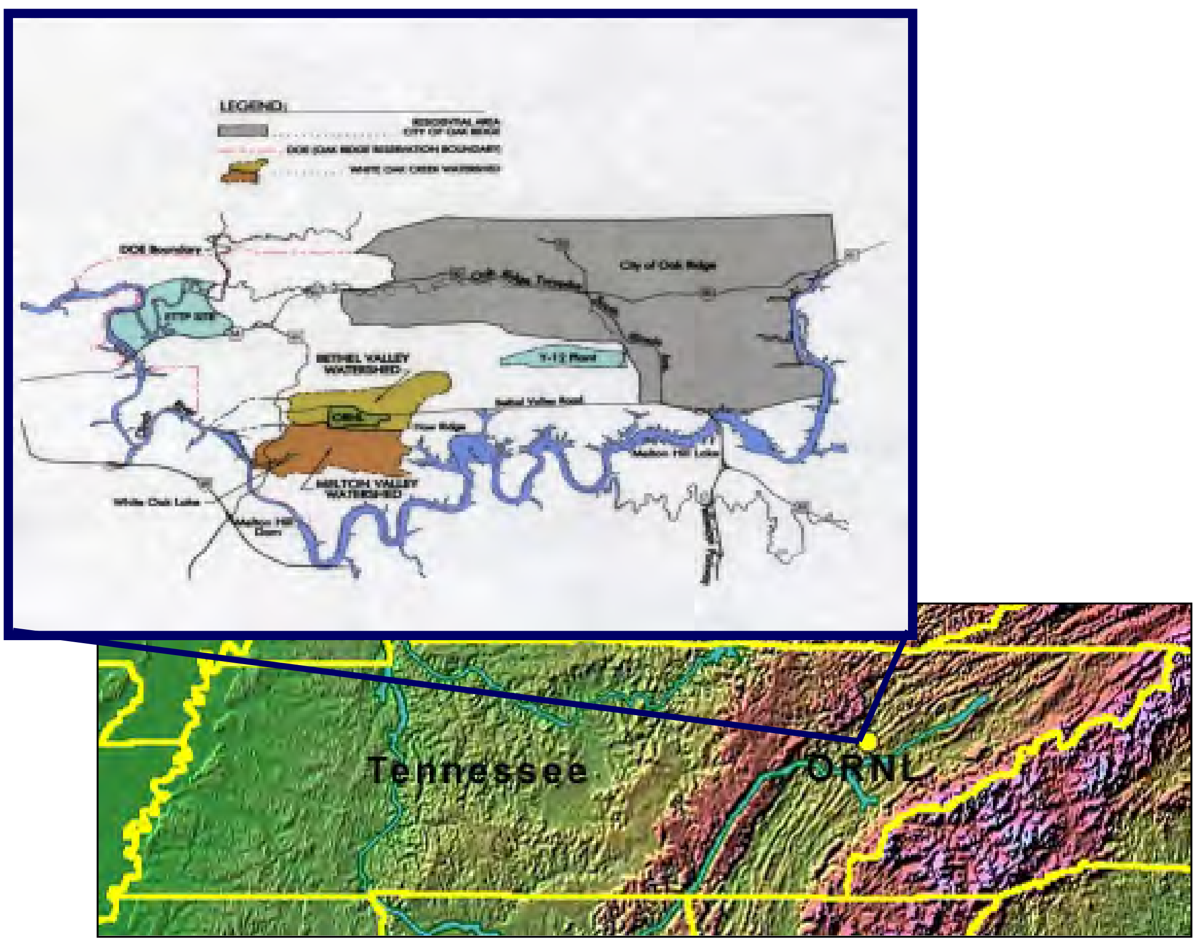

Figure S-1. Location of Oak Ridge National Laboratory in relation to the City of Oak Ridge and other DOE facilities on the Oak Ridge Reservation, and in the State of Tennessee.

ORNL continues to be used for DOE operations and is internationally known as a premier research facility. Research and development activities support national defense and energy initiatives. Ongoing waste management and environmental management activities continue to address legacy[1] and newly generated low-level radioactive[2], transuranic (TRU)[3], and hazardous wastes resulting from research and development activities. Meeting the cleanup challenges associated with legacy and newly generated wastes at ORNL is a high priority for the DOE Oak Ridge Operations (ORO), the Tennessee Department of Environment and Conservation (TDEC), and stakeholders. The treatment and disposal of legacy TRU waste at ORNL is an important component of the DOE cleanup at the site. Currently, no facilities exist at ORNL, or the ORR, for treating TRU mixed[4] waste sludges and associated low-level waste supernate, and contact-handled[5] and remote-handled[6] TRU/alpha low-level[7] waste solids, before disposal.

S1.2 BACKGROUND

During early research activities, little was known about the effects of exposure to radiation and other hazardous substances. Wastes generated from research and development activities, and isotope production, were managed using the best available practices at the time. Liquid radioactive waste was stored in underground storage tanks. Contaminated solid waste was buried in pits and trenches. Although waste management practices have changed as the hazards became better understood, legacy waste remains in storage at ORNL as described below.

S1.2.1 Waste Types

The four legacy waste types that would be treated under the proposed action are:

- remote-handled TRU mixed waste sludge,
- low-level radioactive waste supernate (liquid portion) associated with the TRU sludge waste,
- contact-handled TRU/alpha low-level waste solids, and
- remote-handled TRU/alpha low-level waste solids.

[1]Legacy waste is defined as waste generated from past isotope production and research and development activities.

[2]Low-level waste is defined as any radioactive waste not classified as high-level, spent nuclear fuel TRU, byproduct material, or mixed waste [based on Implementation Guide for Use with DOE M 435.1-1, DOE G 435.1-1, July 1999 (DOE 1999)].

[3]TRU waste is waste not classified as high-level radioactive waste but as waste which contains more than 100 nanocuries per gram (nCi/g) of alpha-emitting TRU isotopes (atomic numbers greater than 92) with half-lives greater than 20 years (based on DOE 1999).

[4]Mixed waste is a waste that contains radioactive waste regulated under the Atomic Energy Act of 1954 as amended, and a hazardous component subject to the Resource Conservation and Recovery Act (based on DOE 1999).

[5]Contact-handled TRU waste contains beta- and gamma-emitting isotopes in addition to alpha-emitting isotopes, with a surface dose rate of 200 millirem per hour (mrem/h) or less [*Internal Dose Conversion Factors for Calculation of Dose to the Public*, DOE/EH-0071, July 1998 (DOE 1998a)].

[6]Remote-handled TRU waste contains beta- and gamma-emitting isotopes in addition to alpha-emitting isotopes, with a surface dose rate greater than 200 mrem/h (DOE 1998a).

[7]Alpha low-level radioactive waste is low-level waste that contains alpha-emitting isotopes.

ORNL currently has the largest inventory of remote-handled TRU waste in the DOE complex, and a smaller portion of the contact-handled TRU waste. The remote-handled TRU waste sludges are solids that precipitated out of the liquid waste during waste storage and settled to the bottom of the underground storage tanks. The contact-handled and remote-handled TRU/alpha low-level waste solids at ORNL are a heterogeneous mixture of paper, glass, rubber, cloth, plastic, and metal from glove boxes, fuel processing facilities, hot cells, and reactors. Based on generator records, the stored solid wastes have been classified as either TRU or alpha low-level radioactive waste. Because the nature of the solid waste can only be confirmed after retrieval and characterization, these solid wastes were characterized as "TRU/alpha low-level radioactive waste" in the Notice of Intent for this draft EIS [*Federal Register* (*FR*) Vol. 64, No. 17, January 27, 1999] to note the current uncertainty.

The remote-handled TRU waste sludge and potentially some of the contact-handled and remote-handled TRU/alpha low-level waste solids contain metals regulated under the Resource Conservation and Recovery Act (RCRA) and, therefore, may be classified as mixed waste due to toxicity. Generator records for the solid wastes do not indicate the presence of any RCRA regulated materials in the solid waste containers; however, if found, solid mixed waste would be segregated from solid non-mixed waste.

Supernate (the liquid portion of the waste stored in the underground storage tanks at ORNL) is generally characterized as low-level waste.

S1.2.2 Waste Storage at ORNL

Approximately 30% of the legacy tank waste is currently stored in aging, underground storage tanks in the Bethel Valley portion of ORNL. These inactive tanks are currently undergoing waste retrieval operations. The retrieved sludge and supernate wastes are being transferred to the Melton Valley Storage Tanks (Figure S-2). See additional discussion in Section S1.3 below. The remainder of ORNL's TRU mixed waste sludge is already stored in the Melton Valley Storage Tanks. Sampling and analyses have been performed on all of the tank waste at ORNL. The radiological and chemical properties of the sludge and supernate have been measured, and a bounding analysis was performed on each constituent to provide a range of waste characteristics. The legacy contact-handled and remote-handled TRU/alpha low-level solid wastes at ORNL are currently stored in subsurface trenches, bunkers, and metal buildings.

Figure S-2. Aerial view of the Melton Valley Storage Tanks–Capacity Increase Project during installation of the six 100,000-gallon tanks, which are located south of the eight 50,000-gallon Melton Valley Storage Tanks.

S1.2.3 PUBLIC SCOPING AND PARTICIPATION

A Notice of Intent to prepare an EIS for the TRU Waste Treatment Project was published in the *Federal Register* (*FR*) on January 27, 1999 (in Appendix A.1). The Notice of Intent identified the public scoping period to encourage early public involvement in the EIS process and to solicit public comments on the proposed scope of the EIS, including the issues and alternatives it would analyze. Two meetings were held in Oak Ridge, Tennessee, on February 11 and 16, 1999, to provide an opportunity for people to comment or make a presentation. Oral and written comments are summarized in Appendix A.3. Most of the comments requested clarification of the proposed action and the alternatives. There was some concern that the High Flux Isotope Reactor access road and the construction of the proposed TRU Waste Treatment Facility would have an impact on the Old Hydrofracture Facility wells. However, these wells are located away from the road and proposed facility and would not be disturbed during any construction activities. The scoping period ended on February 26, 1999.

S1.3 PURPOSE AND NEED FOR AGENCY ACTION

DOE needs to treat the legacy TRU and alpha low-level waste at ORNL in order to reduce the risk to human health and the environment and to comply with legal mandates from the TDEC and the ORNL Site Treatment Plan. In addition, newly generated TRU waste needs to be treated and is included in the waste volumes described below.

The approximate quantities of the waste streams requiring treatment and analyzed in this EIS are:

- 900 m^3 (31,784 ft^3) of remote-handled TRU sludge (mixed waste), which is, or will be, located in the Melton Valley Storage Tanks;
- 1,600 m^3 (56,505 ft^3) of low-level supernate associated with the TRU mixed waste sludge, which is, or will be, located in the Melton Valley Storage Tanks;
- 550 m^3 (19,423 ft^3) of remote-handled TRU waste/alpha low-level radioactive waste solids (may consist of some mixed waste), located in bunkers and subsurface trenches; and
- 1,000 m^3 (35,316 ft^3) of contact-handled TRU waste/alpha low-level radioactive waste solids (may consist of some mixed waste), located in metal buildings.

Waste retrieval operations are currently under way to prepare many of the inactive TRU waste storage tanks in the Bethel Valley area of ORNL for closure. The wastes retrieved from the inactive tanks in Bethel Valley are being consolidated into the Melton Valley Storage Tanks and have been included in the stated waste quantities needing treatment.

Legal mandates require DOE to address legacy TRU waste management. DOE has been directed by the TDEC and the U.S. Environmental Protection Agency (EPA) to address environmental issues including disposal of its legacy TRU waste. DOE is under a TDEC Commissioner's Order (September 1995) to implement the Site Treatment Plan (under the Federal Facility Compliance Act) that mandates specific requirements for the treatment and disposal of ORNL's TRU waste. The primary milestone in the TDEC Commissioner's Order requires that DOE begin treating legacy TRU mixed waste sludge in order to make the first shipment to the Waste Isolation Pilot Plant (WIPP) by the end of January 2003.

Due to the water-rich environment in East Tennessee, legacy TRU/alpha low-level solid wastes contained in the subsurface trenches at ORNL pose a risk to the area's water quality. Removal, treatment, and disposal of the retrievable TRU waste from portions of the Solid Waste Storage Area (SWSA) 5 North is a major component of the proposed remedy for the Melton Valley Watershed at

ORNL according to the Draft Record of Decision for the Melton Valley Watershed at ORNL (DOE 1997a). In addition, an Interim Record of Decision [issued in connection with the Federal Facilities Agreement (FFA) among EPA, TDEC, and DOE under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)] for the Gunite and Associated Tanks Remediation Project (DOE 1997b), and an Action Memorandum for the Old Hydrofracture Facility Tanks Remediation Project (DOE 1997c) requires that the waste contained in these tanks be treated and disposed of along with the TRU waste contained in the Melton Valley Storage Tanks. This tank waste is included in the total waste volume proposed for treatment in the TRU Waste Treatment Project. Currently, no facilities exist at ORNL, or on the ORR, for treating TRU or alpha low-level radioactive waste.

S1.4 PROPOSED ACTION AND ALTERNATIVES

S1.4.1 Proposed Action

DOE proposes to construct, operate, and decommission and decontaminate (D&D) a waste treatment facility (Figure S-3) for the treatment of legacy ORNL TRU, alpha low-level waste, and newly generated TRU waste. All the legacy waste DOE proposes to treat is currently stored at ORNL. The newly generated TRU waste would be treated in the proposed facility until it is closed for D&D.

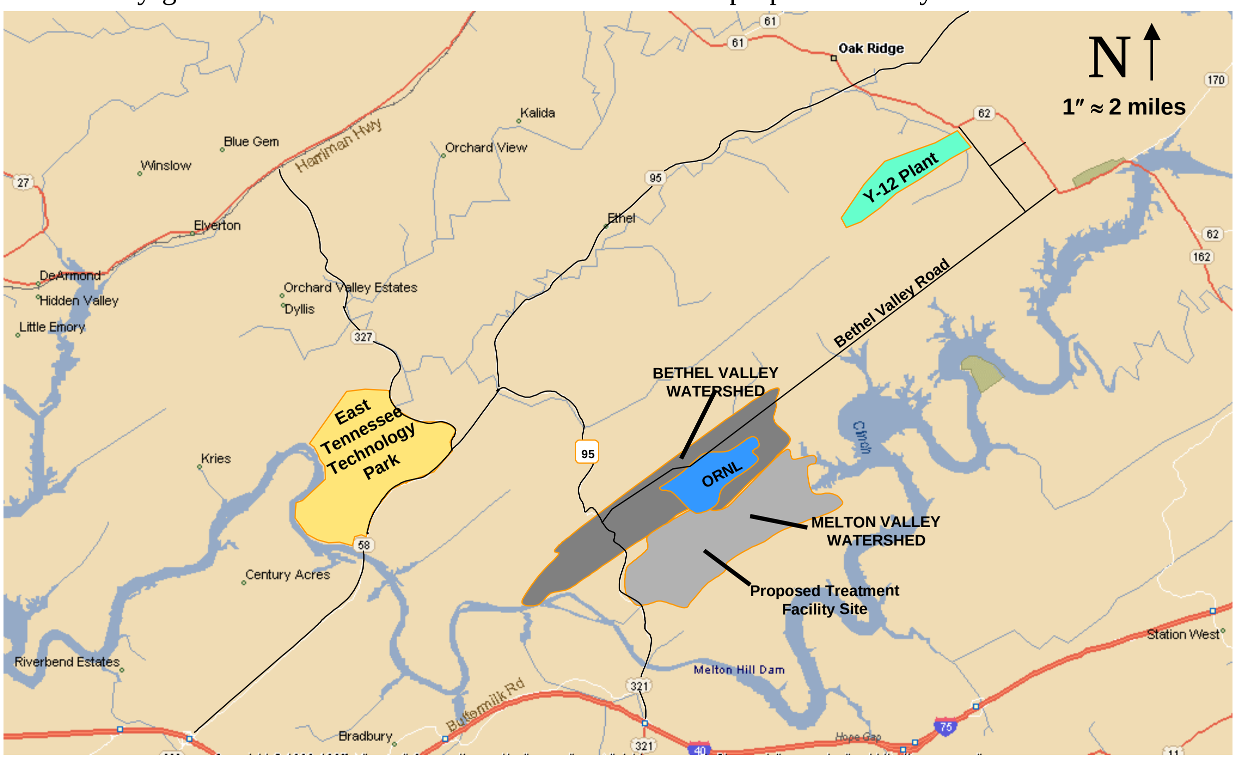

Figure S-3. General site location of the proposed TRU Waste Treatment Project facility on the Oak Ridge Reservation.

TRU waste generated after closure of the proposed facility is not within the scope of the proposed action. Following the waste treatment and packaging operations at the proposed treatment facility, DOE would certify the TRU waste for shipment and disposal at the WIPP, located near Carlsbad, New Mexico [*Record of Decision for the Department of Energy's Waste Isolation Pilot Plant Disposal Phase, FR*, Vol. 63, No. 15, January 1998 (DOE 1998b)]. Low-level waste resulting from the treatment processes would be certified by DOE for disposal at the DOE site(s) to be selected in the *Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste* (WM PEIS) (DOE 1997d) Record of Decision for low-level waste that should be issued before the final EIS for the ORNL TRU Waste Treatment project is completed.

DOE prepared a characterization report for the site of the proposed action and sponsored an independent study of treatment technologies and contracting alternatives, known as the Parallax study [ORNL/M-4693, *Feasibility Study for Processing ORNL TRU Waste In Existing and Modified Facilities*, September 15, 1995 (Parallax 1995)]. This facility is needed to reduce the risk to human health and the environment, and to comply with the TDEC Commissioner's Order of 1995, which requires DOE to make the first shipment of treated TRU sludge to the WIPP in New Mexico by January 2003.

This EIS is being prepared according to the National Environmental Policy Act (NEPA) of 1969, the Council on Environmental Quality NEPA regulations [40 *Code of Federal Regulations* (*CFR*) 1500–1508], and DOE's NEPA Implementing Procedures (10 *CFR* Part 1021). This draft EIS incorporates pertinent analyses performed as part of the DOE's *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement* (WIPP SEIS-II) (DOE 1997e), and the WM PEIS (DOE 1997d). Treatment of ORNL TRU waste onsite, and disposal at the WIPP, is consistent with the Record of Decision for the WIPP disposal phase (DOE 1998b) and for DOE's WM PEIS Record of Decision for treatment and storage of TRU waste [*FR* Vol. 63, No. 15, January 23, 1998) (DOE 1998c)] both issued for management of the TRU waste. The disposal of low-level radioactive waste included in the scope of this draft EIS will be consistent with the WM PEIS Record of Decision for low-level waste that has yet to be issued (i.e., disposed of at the Nevada Test Site or another designated disposal facility).

DOE has awarded a contract to the Foster Wheeler Environmental Corporation (Foster Wheeler) for the construction, operation, and D&D of a treatment facility for the TRU and alpha low-level wastes, contingent upon the completion of the NEPA review (if it includes a Record of Decision selecting the contractor's proposed treatment process). The contract would be carried out in four phases including:

- Phase I, Permitting (includes DOE's NEPA analysis and contractor preliminary design activities);
- Phase II, Construction and Pre-Operational Testing;
- Phase III, Waste Treatment, Packaging, and Certification; and
- Phase IV, Decontamination and Decommissioning.

Phase I is a 2.5-year period during which the permitting and preliminary design process is completed for the proposed facility. DOE will complete the NEPA process concurrent with Phase I of the contract. If the current NEPA review results in the selection of a treatment process other than the selected contractor's proposal, Phase II of the contract would not be implemented. The contract also allows DOE to identify, during Phase I, other potential waste streams for treatment at this facility (e.g., small amounts of legacy TRU waste from other sites). An example of such waste is discussed under cumulative impacts. As part of any consideration to send additional waste to ORNL, further NEPA review, as appropriate, would be conducted.

The phased procurement approach described above is consistent with DOE's NEPA regulations at 10 *CFR* 1021.216, which address integration of DOE's procurement and NEPA review processes, and requires a phased procurement that is contingent upon completion of the NEPA review process before a "go/no-go" decision. DOE's Request for Proposal required bids to include environmental data and analysis, to the extent that they were available. The environmental data provided in the three bids received were independently evaluated, and an Environmental Critique was prepared. DOE also prepared an Environmental Synopsis that was issued in January 1999 (Appendix A.2), which was based on the Environmental Critique. The Synopsis was filed with EPA and is publicly available. In addition, prior to selection of the contractor, DOE held two public meetings with stakeholders and had ongoing discussions with regulators.

The proposed site for the treatment facility is adjacent to the Melton Valley Storage Tanks (the storage area for the TRU mixed waste sludge and associated low-level supernate). DOE would lease the Melton Valley Storage Tanks and an adjacent land area totaling up to approximately 4 ha (10 acres) to the contractor selected for the construction of the facility (Figure S-4), subject to notification of the EPA and the State of Tennessee. Once the facility is closed and D&D of the facility is completed, the land used for the facility would no longer be leased to the selected contractor and would revert to DOE.

Figure S-4. DOE would lease the Melton Valley Storage Tanks facility and an adjacent area of land to construct the waste treatment facility. The location is isolated from ORNL by Haw Ridge.

The proposed facility location is based on the factors listed below:

- The treatment facility should be located close to the existing Melton Valley Storage Tanks to minimize the length of a new sludge/supernate transfer line and reduce the environmental disturbance due to construction as recommended in the *Feasibility Study for Processing ORNL Transuranic Waste in Existing and Modified Facilities* (Parallax 1995).

- The existing terrain should provide natural shielding for the proposed facility and facilitate material handling.

DOE would require that all activities associated with the proposed action be performed safely and in compliance with applicable federal and state regulatory requirements. The contractor would be responsible for achieving compliance with all applicable environmental and safety and health laws and regulations as required in the awarded contract. Regulatory agencies would be responsible for monitoring compliance by the contractor. The State of Tennessee would regulate the contractor according to permits under the state's purview (the RCRA Part B permit issued by the State of Tennessee). DOE would regulate occupational safety and health and nuclear safety according to specific environment, safety, and health requirements, as stipulated in the contract between DOE and Foster Wheeler.

S1.4.2 Alternatives

DOE analyzed five alternatives for the proposed action: a no action alternative; three alternative technologies for treating the wastes followed by shipment to an appropriate disposal facility; and treatment by any of the three alternative treatment technologies, followed by long-term storage at ORNL. Section S1.4.2 summarizes the following five alternatives:

1. **No Action** (i.e., continued on-site storage) for all of the legacy TRU tank waste and legacy contact-handled and remote-handled TRU/alpha low-level solid wastes.

2. **Low-Temperature During (Preferred Alternative)** for the Melton Valley Storage Tanks wastes (sludge and supernate) and segregation and compaction for the solid wastes (contact-handled and remote-handled TRU/alpha low-level heterogeneous debris).

3. **Vitrification** for the Melton Valley Storage Tanks wastes (sludge and supernate) and segregation and compaction for the solid wastes (contact-handled and remote-handled TRU/alpha low-level heterogeneous debris).

4. **Cementation** for the Melton Valley Storage Tanks wastes (sludge and supernate) and segregation and compaction for the solid wastes (contact-handled and remote-handled TRU/alpha low-level heterogeneous debris).

5. **Treatment and Waste Storage at ORNL** would provide treatment by one of the above treatment alternatives followed by long-term (indefinite) waste storage at ORNL.

The Treatment and Waste Storage at ORNL Alternative was analyzed as a contingency in case off-site waste disposal facilities would not be available for any reason.

Each treatment alternative analyzed included treatment approaches that would solidify the sludges and supernate, compact the solid wastes, and provide treatment for some mixed wastes to meet the land disposal restriction (LDR) standards. After waste treatment, DOE would certify the waste for disposal as low-level radioactive waste (including remote-handled low-level and alpha low-level radioactive waste), mixed low-level waste, or TRU waste (including mixed TRU waste). The contractor would be required to treat all wastes to meet specified waste acceptance criteria for disposal. For each treatment alternative, this section describes the treatment approach and general features (with detailed flow diagrams), waste products generated, waste minimization measures, land use requirements, and the proposed schedule.

Treated TRU waste resulting from the proposed action would be disposed of at the WIPP, consistent with the Records of Decision from the WIPP SEIS II (DOE 1998b) and the WM PEIS (DOE 1998c). The waste treatment methods analyzed in this draft EIS will treat remote-handled TRU sludge waste to meet RCRA LDR standards. This will allow the treated remote-handled TRU sludge waste to be stored onsite in the event that WIPP is not accepting remote-handled TRU waste in time to meet the TDEC Commissioner's Order.

The supernate, which is generally classified as low-level waste, would be disposed of at a DOE site, (i.e., the Nevada Test Site, or another facility designated in the WM PEIS Record of Decision for low-level waste). For impacts analysis purposes, all low-level waste resulting from the proposed TRU Waste Treatment Facility is assumed to be disposed of at the Nevada Test Site. This assumption is based on the initial characterization information for the low-level waste, which indicates that this waste meets the waste acceptance criteria of the Nevada Test Site. The final decision on the disposal site for low-level waste treated at the proposed TRU Waste Treatment Facility will be consistent with the pending Record of Decision for low-level waste from the WM PEIS. The Nevada Test Site is one of six candidate DOE low-level waste sites identified in the WM PEIS. On December 10, 1999, DOE issued a Notice of Preferred Alternatives (*FR* Vol. 64, No. 237, December 10, 1999), naming its specific preferred sites for low-level waste and mixed low-level waste disposal as the Hanford Site in Washington and the Nevada Test Site. The WM PEIS Record of Decision is expected to be issued before the ORNL TRU Waste Treatment Project Final EIS is completed. Because the ORNL TRU Waste Treatment Project would generate small quantities of low-level waste in comparison to the 1.5 million m^3 of low-level waste analyzed for the entire DOE complex in the WM PEIS, the assumption of the Nevada Test Site as a disposal site for low-level waste does not prejudice DOE's pending WM PEIS low-level waste disposal Record of Decision.

Because most of the current solid waste containers do not meet U.S. Department of Transportation (DOT) regulations (49 *CFR* 173), the solid waste would need to be repackaged prior to shipment. DOE would better characterize the solid waste during the repackaging efforts to achieve final DOE waste certification before disposal. Contact-handled and remote-handled solids containing RCRA regulated wastes would be isolated and treated to meet RCRA LDR standards.

S1.4.2.1 No Action Alternative

The No Action Alternative involves continued storage of mixed waste (RCRA hazardous and radioactive) TRU sludges and the associated low-level waste supernate in the Melton Valley Storage Tanks. Storage of contact-handled and remote-handled TRU/alpha low-level waste solids in the SWSA 5 North trenches would also continue. The remote-handled TRU/alpha low-level waste solids that are stored in Buildings 7855 and 7883 would remain in these units, and contact-handled TRU/alpha low-level solids currently stored in Buildings 7572, 7574, 7842, 7878, and 7879 would also remain in those units. In addition, the remote-handled TRU and certain contact-handled TRU wastes currently stored in the below-grade concrete cells in SWSA 5 North (Buildings 7826 and 7834) would be removed as part of a removal action under CERCLA and moved to existing facilities for remote-handled and contact-handled wastes at ORNL (described in Section 2.3.1 of this draft EIS).

No treatment facility would be constructed under the No Action Alternative. The No Action Alternative assumes institutional control for 100 years. Implementation of this alternative would result in noncompliance with the milestone established in the TDEC Commissioner's Order requiring the submittal of a Project Management Plan, which includes schedules for treatment and shipment of ORNL's TRU waste, by September 30, 2001, and would jeopardize the existing milestone established in the Commissioner's Order for initiation of shipment of the treated remote-handled TRU sludges to WIPP by January 2003.

S1.4.2.2 Low-Temperature Drying Alternative

The Low-Temperature Drying Alternative (Preferred Alternative: contingent contract to Foster Wheeler Environmental Corporation) would treat the TRU mixed waste sludge and associated low-level waste supernate by low-temperature drying. The solid wastes would be characterized, sorted, and compacted to result in stable waste forms for final disposal. A waste treatment facility would be constructed immediately adjacent to the Melton Valley Storage Tanks. Construction of the treatment facility would require the development of 2 ha (5 acres) of forested land for industrial use.

This alternative would entail evaporating and drying the TRU mixed waste sludges and associated low-level waste supernates. Treatment by low-temperature drying is expected to substantially reduce the waste volume, generate minimal amounts of secondary wastes, and meet the waste acceptance criteria of the final disposal facilities. All waste streams would meet the RCRA LDR standards in the event that unanticipated, on-site storage of the waste is required in order to coincide with the schedules of the appropriate disposal facilities. TRU waste streams would be treated to meet the waste acceptance criteria of the WIPP. Low-level waste streams would be treated to meet the waste acceptance criteria of the Nevada Test Site or another designated disposal site identified in the WM PEIS Record of Decision to be issued for management of low-level and low-level mixed waste.

The simplified block flow diagram for the tank waste treatment system (TRU mixed waste sludge and associated low-level supernate) is illustrated in Figure S-5. Treatment of the supernate and sludge could occur independently. Supernate would be pumped from the existing Melton Valley Storage Tanks through a double-contained, aboveground pipeline to the proposed treatment facility and collected into mixing/sample tanks. The supernate may be transferred to an evaporator for volume reduction before transfer to the mixing/sample tanks. In order to meet waste acceptance criteria for a low-level waste disposal facility evaluated in the WM PEIS (i.e., the Nevada Test Site, or another designated disposal facility), additives would be mixed with the supernate in these tanks. The supernate dryer would receive feed batches from the mixing/sample tanks for final concentration and drying into a stabilized particulate product. The treated waste would be loaded directly into a disposal container that is pre-loaded in a transportation cask for shipment. Vapors from the dryer would be routed through an air-cooled condenser. Condensate may be stored in a reservoir for reuse in sludge retrieval, or evaporated and discharged as part of the building ventilation flow through appropriate high-efficiency particulate air (HEPA) filtration.

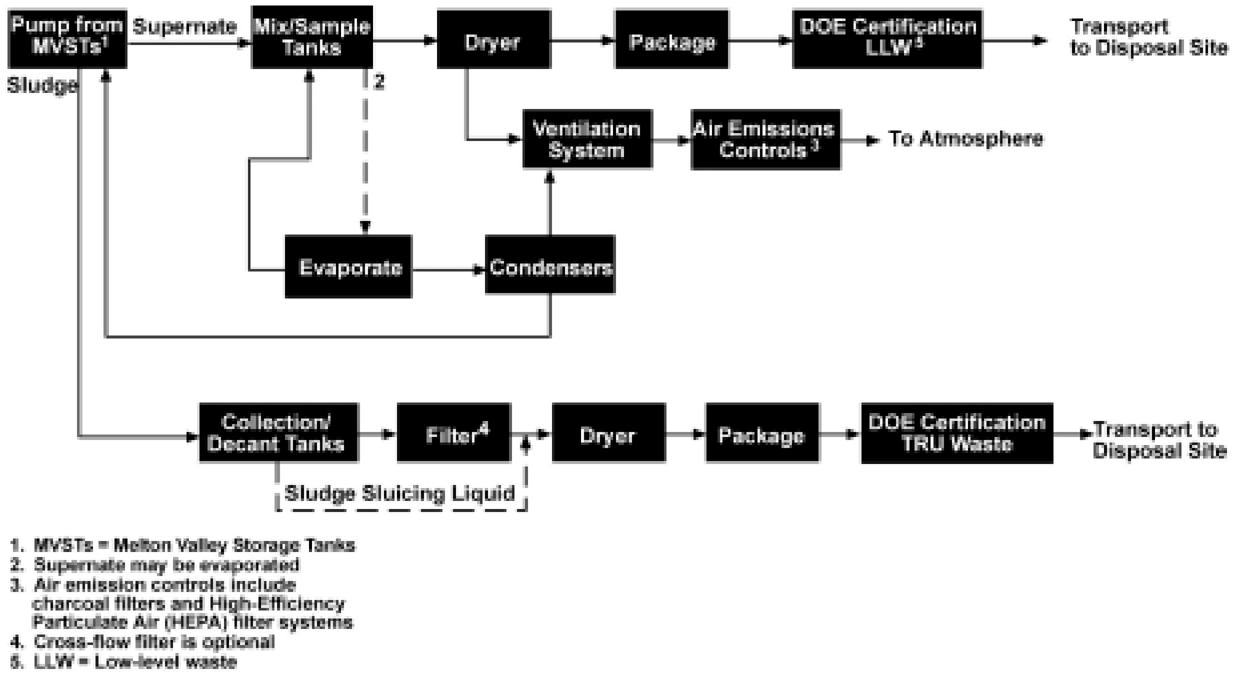

Figure S-5. Tank waste treatment flow diagram for the Low-Temperature Drying Alternative.

Sludge would be retrieved from the Melton Valley Storage Tanks by sluicing. The sluiced sludge would be transferred in a double-contained, aboveground pipeline to the sludge collection/decant tanks in the facility. The sludge would be concentrated by gravity settling in these tanks. Sluiced sludge may be filtered before transfer to the dryer. For optimum efficiency, the dried sludge solids would be packaged and loaded directly into WIPP TRU canisters.

DOE would deliver drums and boxes of the contact-handled and remote-handled TRU/alpha low-level solid wastes to the proposed treatment facility. Foster Wheeler would perform visual inspections and radiation and contamination surveys prior to acceptance of the waste containers. The drum contents would be characterized by performing a non-destructive examination and assay in an adjoining enclosure before transfer to a staging area. Any alpha low-level waste drums that do not contain TRU waste, or RCRA regulated waste, would be treated in a drum compactor for a 50% volume reduction, overpacked, weighed, and conveyed back to the shipping/receiving area for final certification by DOE. The simplified block flow diagram for the solid waste treatment systems is illustrated in Figure S-6.

The remote-handled TRU/alpha low-level waste drums would be moved to a hot cell in order to sort and separate any contact-handled waste from the remote-handled waste. Any contact-handled and remote-handled waste containing RCRA regulated waste would be treated to meet LDR standards by macroencapsulation. Waste that is compliant with LDR standards would be compacted and loaded into canisters docked at a load-out port on the hot cell. Over-sized remote-handled waste would be size reduced to fit into the canisters.

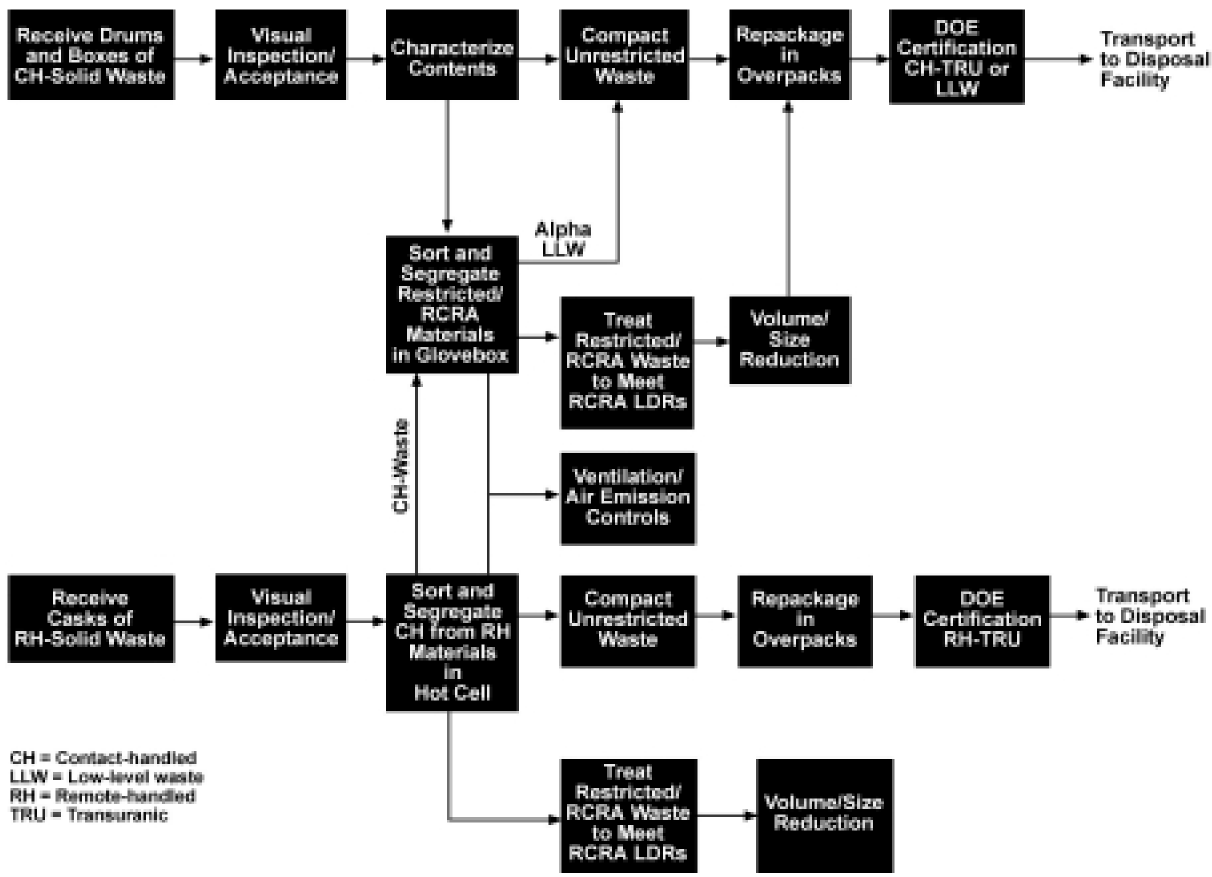

Figure S-6. Solid waste treatment flow diagram for the Low-Temperature Drying Alternative.

The contact-handled TRU/alpha low-level waste drums contents would be moved to a glovebox after the initial characterization, where RCRA regulated waste would be segregated for treatment by macroencapsulation to meet LDR standards. Unrestricted, contact-handled solid waste would be compacted in drums before transfer to the assay area for DOE certification. Secondary waste such as empty waste containers and personal protective equipment (PPE), etc., would be compacted prior to DOE certification for disposal at an appropriate facility.

The Low-Temperature Drying Alternative would result in a total of approximately 10,833 m^3 (3,843,546 ft^3) of waste; the largest portion of the total waste volume (5,550 m^3 or 19,423 ft^3) would be debris from D&D activities. Approximately 607 m^3 (21,439 ft^3) of treated TRU waste; 23 m^3 (812 ft^3) of mixed low-level waste; and 2,778 m^3 (98,108 ft^3) of low-level waste would be generated by this alternative. Pollution prevention and waste minimization measures would be implemented. For example, storm water would be diverted around the treatment facility, and gate valves would be installed in the diversion basins, in the event of a spill.

The total project duration for the Low-Temperature Drying Alternative is 11.5 years with a treatment time of approximately 5 years.

S1.4.3 Vitrification Alternative

The Vitrification Alternative would include vitrification of the TRU mixed waste sludge and associated low-level supernate (melting the waste to form a stabilized waste glass) in the Melton Valley Storage Tanks (Figure S-7). The contact-handled and remote-handled TRU/alpha low-level solid wastes would be segregated and compacted in a supercompactor. Some solids, however, that are smaller than the RCRA definition of debris, would be treated by vitrification. The vitrification waste treatment facility would be constructed next to the Melton Valley Storage Tanks. Construction of the treatment facility would require the development of 2.8 ha (7 acres) of forested land for industrial use.

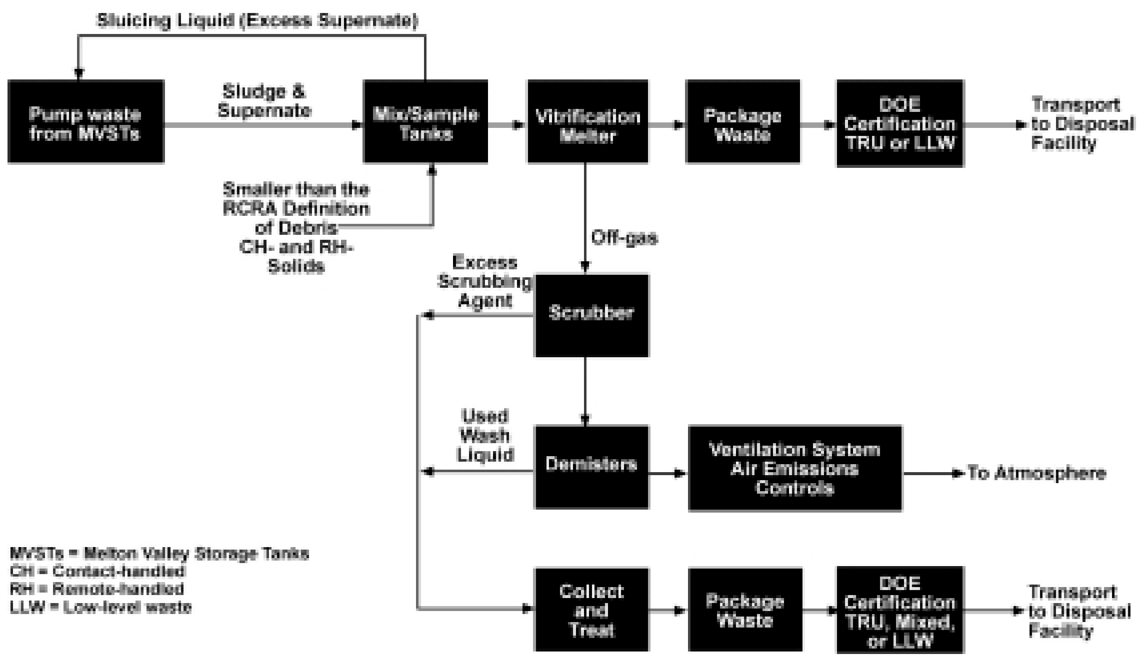

Figure S-7. Treatment flow diagram for sludge, supernate, and solid waste smaller than the RCRA definition of debris for the Vitrification Alternative.

Waste sludge and supernate would be pumped to the treatment facility through an aboveground, double-contained pipeline after retrieval by pulsed jet mixing. The waste would be homogenized in mix/sample tanks and the required glass-former blend would be determined after sampling the homogenized waste.

Dry glass-forming chemicals would be mixed with the homogenized waste, which would then be fed into the vitrification melter. The resulting molten glass waste would be poured into waste containers and allowed to harden. The final glass waste form would be certified by DOE as TRU or low-level waste for disposal at the appropriate disposal facility.

Off-gas from the melter would be minimized by maintaining a cold cap floating on top of the melted glass surface. The off-gas system, including a scrubber, demisters, and HEPA filters would remove over 99% of the off-gas particulates. Excess scrubbing agents and liquid from the demisters would be recycled or collected, treated, and packaged for DOE certification as TRU, mixed, or low-level waste before disposal at the appropriate disposal facility.

The remote-handled and contact-handled TRU/alpha low-level solid waste containers would be delivered to the facility by DOE (Figure S-8). Upon receipt, the surface dose rate would be monitored. The containers would be characterized and then their contents sorted in a hot cell. Some solid waste classified as smaller than the RCRA definition of debris would be sent to the vitrification treatment train. Any contact-handled or remote-handled waste containing RCRA regulated wastes would be macroencapsulated. Special waste materials such as batteries, aerosol cans, or glass bottles would be sent to a special treatment cell for treatment and packaging, or the vitrification treatment train if the waste matrix is compatible. The remaining remote-handled and contact-handled solid wastes would be sorted and segregated, and then volume and size reduced if required. Sorted waste containers would be characterized and weighed before compaction to provide DOE with information for waste certification. The compacted waste pucks would be placed in 55-gallon drums, grouted, and then placed in a buffer storage area until the grout hardens.

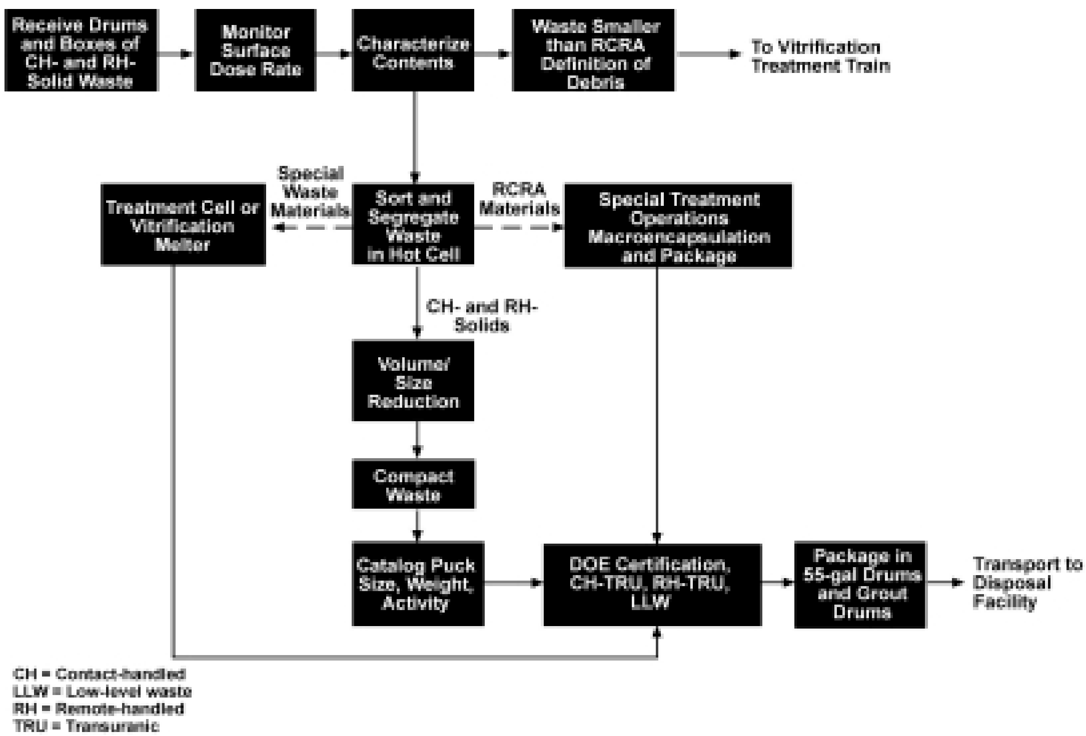

Figure S-8. Vitrification Alternative flow diagram for solid waste treatment.

The Vitrification Alternative would result in an estimated total of 34,000 m^3 (1,200,744 ft^3) of waste. Approximately 20,712 m^3 (731,464 ft^3) of debris from D&D activities and 6,283 m^3 (221,890 ft^3) of sanitary wastewater account for the largest portion of the total waste volume. Approximately 1,060 m^3 (3,743 ft^3) of TRU waste; 4 m^3 (141 ft^3) of mixed low-level waste; and 4,983 m^3 (175,979 ft^3) of low-level waste would result from the implementation of the Vitrification Alternative.

Pollution prevention and waste minimization measures would be implemented. For example, storm water would be diverted around the treatment facility, and gate valves would be installed in the diversion basins, in the event of a spill.

The total project duration of the Vitrification Alternative would be approximately 10 years, with about 3 years of waste treatment. Following 3 months of cold operations (with non-radioactive materials) after construction of the facility, hot operations (with radioactive materials) would be conducted for about 2.75 years.

S1.4.4 Cementation Alternative

The Cementation Alternative would include hydrocyclone and centrifuge pre-treatment separation of the TRU mixed waste sludge and associated low-level supernate contained in the Melton Valley Storage Tanks, followed by cementation of the pre-treated wastes. The contact-handled and remote-handled TRU/alpha low-level solid wastes would be characterized, then segregated and compacted similar to the treatment methods described in the Vitrification Alternative for solid waste. The Cementation Alternative would require the construction of a treatment facility that would be located on 2 ha (5 acres) of land that would change from forested land to industrial use.

Sludge and supernate would be retrieved from the Melton Valley Storage Tanks by sluicing. The waste slurry would be pumped through an aboveground double-contained pipeline to storage tanks inside the cementation treatment facility (Figure S-9). A hydrocyclone in series with a centrifuge would separate the sludge from the supernate. The majority of supernate would be recycled through the Melton Valley Storage Tanks to aid in sludge retrieval operations. The slurry discharge from the centrifuge would be maintained at 25% weight total suspended solids and would be collected in feed tanks, which would allow continuous transfer to the cementation facility mixer.

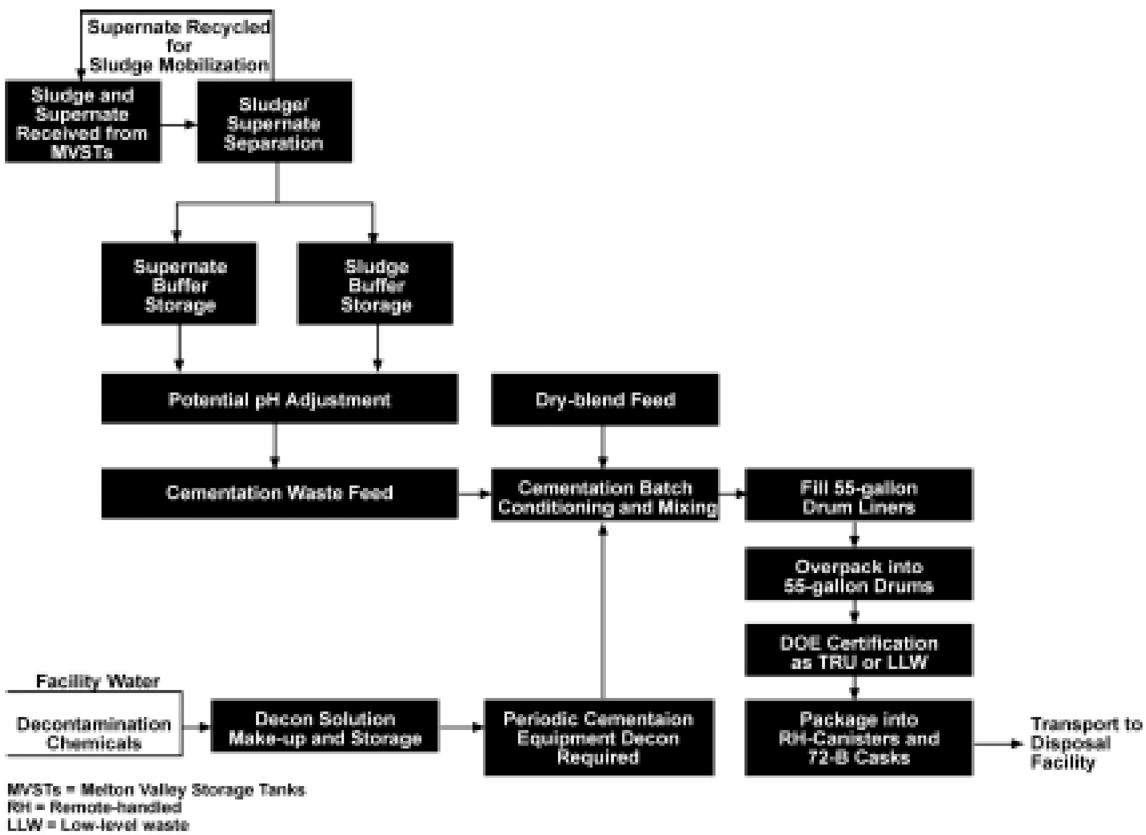

Figure S-9. Flow diagram for tank waste treatment for the Cementation Alternative.

A dry blend storage tank would store premixed cementation/stabilization agents. Treatment would oscillate between the supernate and sludge wastes from the feed tanks. Approximately 3.1 kg (7 lbs) of dry blend would be added per gallon of sludge from the centrifuge process, and 5 kg (1l lbs) of dry blend would be added per gallon of supernate from the centrifuge process to obtain a stabilized waste form. The dry blend would be transferred to the cementation mixer via a weigh belt feeder. After mixing the dry blend and waste, the resulting grout mixture would be pumped into 50-gallon drum liners, which would remain on a conveyor system until hardened, and then be placed inside 55-gallon carbon steel overpack drums. After passing remote external surface contamination analysis, the drums would be placed in remote-handled canisters and then into 72-B casks. The treated TRU sludge waste would be certified by DOE and disposed at the WIPP. The treated supernate would be remote-handled low-level waste and would be disposed of at the Nevada Test Site or another facility designated in the WM PEIS Record of Decision for low-level waste.

The Cementation Alternative would treat the contact-handled and remote-handled TRU/alpha low-level solid wastes with the same methods described previously for the Vitrification Alternative (Section S1.4.3), with the exception that none of the solid waste classified as smaller than debris by RCRA would be segregated and treated separately. This waste would be treated with the larger solid waste. Any RCRA regulated waste would be segregated and treated by macroencapsulation.

The Cementation Alternative would result in an estimated total of 28,826 m^3 (1,018,019 ft^3) of waste. Debris from D&D activities (14,111 m^3 or 498,344 ft^3) and sanitary wastewater and solids (7,237 m^3 or 255,581 ft^3) account for most of the total waste volume. The Cementation Alternative would result in 1,793 m^3 (63,321 ft^3) of treated TRU wastes; 2,540 m^3 (89,702 ft^3) of remote-handled low-level waste; 2,833 m^3 (100,050 ft^3) of low-level waste; and 3 m^3 (106 ft^3) of mixed low-level waste.

Pollution prevention and waste minimization measures would be implemented. For example, storm water would be diverted around the treatment facility, and gate valves would be installed in the diversion basins, in the event of a spill. The off-gas system would minimize air emissions, and liquid used for the decontamination of the cementation treatment system would be transferred back into the cementation treatment system as waste minimization measures.

The total project duration of the Cementation Alternative is approximately 12.5 years, with 6 years involving waste treatment. The Cementation Alternative would require a longer waste treatment time than the other waste treatment alternatives, which would reduce the radiochemical and particulate emissions in a given year. The longer treatment time is the result of the shipment capacity allotment given by the WIPP to each approved shipper of certified TRU waste. If the shipment allotment from the WIPP were not a limiting factor, and an assumption was made that the treated waste could be stored at ORNL in the interim, then the sludge and supernate could be treated by the cementation treatment method in 1 or 2 years.

S1.4.5 Treatment and Waste Storage at ORNL Alternative

This alternative analyzes the treatment of the sludge and supernate contained in the Melton Valley Storage Tanks, by either low-temperature drying, vitrification, or cementation. The contact-handled and remote-handled TRU/alpha low-level solid waste currently stored in bunkers, subsurface trenches, and metal buildings would be sorted, segregated, and treated by compaction as described in the previous treatment alternatives. This alternative would include long-term storage of the treated waste at ORNL following waste treatment in case off-site waste disposal facilities are not available. It is assumed that waste storage would be for 100 years. Depending upon the selected treatment method, an additional 0.3 to 0.8 ha (0.75 to 2.0 acres) of land would be required for on-site storage of the low-level and TRU waste that would result from the treatment method selected (Table S-1). Implementation of this alternative would result in noncompliance with the milestone established in the TDEC Commissioner's Order requiring the submittal of a Project Management Plan (which includes schedules for treatment and shipment) by September 30, 2001, and would also jeopardize the existing milestone established in the Commissioner's Order that requires the initiation of shipment of the stabilized remote-handled TRU sludges to the WIPP by January 2003.

It may be possible to use the existing remote-handled TRU waste bunkers for storage of the treated TRU, mixed low-level waste, and remote-handled handled low-level wastes; however, these two bunkers (Buildings 7855 and 7883) only have a total waste storage capacity of 320 m^3 (11,318 ft^3). It is also assumed that the existing facilities for contact-handled TRU waste, which have a combined capacity of 1,631 m^3 (57,632 ft^3), could be used for treated low-level waste storage. Table S-1 provides a summary of the resulting waste volumes of the three waste treatment alternatives and the space required for the construction of the waste storage facilities. If this alternative were chosen, it is assumed that an engineering analysis would indicate that the existing TRU waste bunkers could be used to store treated remote-handled TRU waste, remote-handled low-level waste, and mixed waste. It is assumed that new waste storage facilities would be located in the Melton Valley area of ORNL, preferably near the waste treatment facility, or the existing TRU waste storage facilities. It was also assumed that the new storage building footprints would be similar to the existing storage facilities, and have a similar waste storage capacity [approximately 150 m^3 (5,297 ft^3) for remote-handle TRU waste, remote-handled low-level waste, and mixed waste, and approximately 300 m^3 (10,594 ft^3) for other waste types].

The schedule for waste treatment for the Treatment and Waste Storage at ORNL Alternative would be similar to the schedule for the treatment alternatives selected (please refer to previous sections for a description of the schedules that would be implemented for waste processing by low-temperature drying, vitrification, or cementation). It is assumed that the time needed to construct waste storage facilities would be similar to the time needed to construct the treatment facility (about 2 years).

Table S-1. Summary of the TRU, mixed low-level, remote-handled low-level, and low-level waste volumes, the resulting new storage space required for each treatment alternative, and the land area required for additional storage facilities

	Low-Temperature Drying	Vitrification	Cementation
Table S-1a. Summary of the TRU, mixed low-level, and remote-handled low-level waste volumes and new storage space required			
Treated TRU waste volume (m^3)	607	1,060	1,793
Mixed low-level waste volume (m^3)	23	4	3
Treated remote-handled low-level waste volume (m^3)	–	–	2,540[a]
***Total TRU, mixed, and remote-handled low-level waste requiring on-site storage* (m^3)**	630	1,064	4,336
Existing waste bunkers storage capacity (m^3)	320	320	320
***New storage capacity needed* (m^3)[b]**	310	744	4,016
Assumed capacity of single new waste bunker (m^3)	150	150	150
Number of new waste bunkers needed	3	5	27
Assumed area of new waste bunker (m^2)	234	234	234
***Total Storage Facility Area required for TRU, mixed, and remote-handled low-level wastes* (m^2)**	702	1,161	6,265
Table S-1b. Summary of low-level waste volumes and new storage space required			
***Total low-level waste requiring on-site storage* (m^3)**	2,778 [a]	4,983 [a]	2,833 [a]
Existing storage capacity (metal building)	1,631	1,631	1,631
***New storage capacity needed* (m^3) [b]**	1,147	3,352	1,202
Assumed capacity of single new metal building (m^3)	300	300	300
Number of new metal buildings needed	4	11	4
Area of new metal buildings (m^2)	375	375	375
***Total area required for low-level wastes* (m^2)**	1,434	4,190	1,503
Table S-1c. Total area required for all waste types and the associated land requirements for the new storage facilities			
TOTAL FACILITY SPACE REQUIRED FOR ALL WASTE TYPES (m^2)	**2,136**	**5,351**	**7,768**
TOTAL HECTARES REQUIRED FOR NEW WASTE STORAGE FACILITIES[c]	**0.3**	**0.6**	**0.8**

[a]Total waste volumes include alpha-low-level waste.

[b]Determined by subtracting available capacity from resulting waste volume and dividing by assumed storage capacity of new facility (150 m^3 for TRU, mixed, and remote-handle low-level wastes, and 300 m^3 for low-level wastes).

[c]Determined by summing storage space required for all waste types, for each treatment method, and converting to hectares.

S1.5 ALTERNATIVES CONSIDERED BUT NOT EVALUATED IN DETAIL

S1.5.1 Off-site Waste Treatment

Currently there is no facility available or planned at any DOE site that could treat remote-handled TRU mixed waste sludge and associated low-level waste supernate stored at ORNL. The Idaho National Engineering and Environmental Laboratory (INEEL) is planning to process its contact-handled TRU on-site waste at the planned Advanced Mixed Waste Treatment Project facility; however, using the planned INEEL facility to treat ORNL TRU waste would be difficult for the following reasons:

- Because the planned INEEL facility is being constructed to process the contact-handled TRU waste at INEEL, the ORNL remote-handled TRU waste may not meet the planned facility's waste acceptance criteria.

- Most of the ORNL remote-handled and contact-handled TRU/alpha low-level solid waste containers do not meet DOT standards (49 *CFR* 173). These containers would require repackaging prior to transport offsite; therefore, it would be safer and more economical for the treatment of solid waste to be conducted at ORNL, and for the treated waste to be shipped directly to the WIPP or the low-level waste disposal sites.

- After treatment at INEEL, the ORNL treated waste would require a second redundant step of repackaging and DOE certification before the waste could be transported to the WIPP or low-level waste disposal site for disposal, resulting in additional worker exposures and cost.

Treatment of the ORNL TRU wastes at INEEL is unreasonable because of the increased costs and risks associated with preparing the tank waste for shipment, repackaging and certifying the waste twice, transporting the waste to INEEL for treatment, and then transporting the treated waste to the WIPP or the low-level waste disposal sites.

S1.5.2 Alternate On-site Treatment Facility Locations

Several factors were considered in selecting the site of the proposed on-site treatment facility. These factors are discussed in Section S1.4 and include minimizing the length of any sludge/supernate waste transfer line from the Melton Hill Valley Storage Tanks to the proposed treatment facility, using the terrain to provide natural shielding for the proposed facility, and considering recommendations made in a feasibility study that focused on dealing with the tank wastes.

The proposed site is directly west of the Melton Valley Storage Tanks, which is the current storage area for the TRU mixed waste sludge and associated low-level supernate. This location reduces the potential risks associated with transporting the liquid and sludge tank wastes from the Melton Valley Storage Tanks to the proposed treatment facility over public or laboratory roads. Since the solid waste storage facilities are also located in Melton Valley, the transportation of the solid wastes would only occur on laboratory roads, also reducing the risk to the public. Melton Valley, while considered part of ORNL, is separated from the ORNL main plant area by the Haw Ridge (Figure S-1), thus reducing potential risks to the main body of workers at ORNL from accidental releases. Alternative site locations were not evaluated in detail because other on-site locations did not meet the siting factors.

S1.5.3 Alternative Disposal Locations

TRU waste will be disposed of at the WIPP in accordance with the WIPP SEIS-II Record of Decision (DOE 1998b) for TRU waste. The analysis in this EIS assumes that all low-level waste resulting from the ORNL TRU Waste Treatment Facility will be disposed of at the Nevada Test Site. The Nevada Test Site waste acceptance criteria would allow disposal of alpha low-level waste; however, the disposal of any low-level waste generated from this action will be consistent with the pending Record of Decision for low-level waste from the WM PEIS. The WM PEIS Record of Decision for low-level waste is expected to be issued before completion of the final EIS for the TRU Waste Treatment Project at ORNL. Because the project would generate small quantities of low-level waste in comparison to the 1.5 million m^3 of low-level waste analyzed for the entire DOE complex in the WM PEIS, the assumption of disposal of low-level waste at the Nevada Test Site does not prejudice the WM PEIS Record of Decision for low-level waste.

S1.5.4 Alternative Treatment Technologies

Sixteen stabilization and solidification technologies were identified and evaluated as candidates for processing TRU waste sludge in the *Feasibility Study for Processing ORNL Transuranic Waste at Existing and Modified Facilities* (Parallax 1995), but were not analyzed further because they were not considered reasonable (see Chapter 2, Table 2-5). One of the technologies, plasma arc vitrification, was also identified as potentially useful for solid remote-handled and contact-handled TRU/alpha low-level waste. However, it would not be feasible to use a technology for the solid wastes unless it was also used for the sludge and supernate. Because of cost, scaling, and permitting issues, this technology was eliminated from further consideration.

S1.6 AFFECTED ENVIRONMENT

Chapter 3 of this EIS describes the existing environment in and around ORNL which would be affected by the construction, operation, and D&D of the proposed TRU Waste Treatment Project facility. Site-specific information for the area surrounding the proposed facility site and the adjacent Melton Valley Storage Tanks at ORNL is also included. Current, pertinent information is provided for the Region of Influence for the various resource areas, and the supporting references are cited.

S1.6.1 Land Use

The proposed site is in a forested area immediately west and adjacent to the Melton Valley Storage Tanks and approximately 2 km (1.25 miles) east of Tennessee State Route 95. The Melton Valley Storage Tanks are active waste storage tanks, which store legacy TRU mixed waste sludge and its associated remote-handled low-level supernate. The area west of the proposed facility site is industrial. The proposed site for the treatment facility does not contain prime or unique farmland. The landscape at the proposed site is a mixture of industrial facilities, roads, and utility buildings and equipment.

S1.6.2 Cultural Resources

The proposed site has no known archaeological, cultural, or historic resources. This has been confirmed by site investigations and by consultation with the State Historic Preservation Officer. However, two pre-1940s home sites—known respectively as the Jenkins and Jones sites—are located within 600 feet of proposed site location. There are no known areas of historical importance to Native Americans at the proposed project site.

S1.6.3 Ecological Resources

Succession on the fields of former homesteads has produced a relatively young to mid-age open forest of pines and cedars with dominant tree species of shortleaf and Virginia pine, yellow poplar, red bud, and maples in the vicinity of the proposed project site. Fauna at the site include rat snakes, black racers, red-eyed vireos, pine warblers, scarlet tanagers, wild turkey, red-tailed hawks, white-footed mice, coyotes, gray squirrels, flying squirrels, and white-tailed deer. There are no federally listed terrestrial plant species on the proposed site; the only federally listed animal species recently observed on the ORR are the gray bat and the bald eagle, and these are migratory or transient individuals and not permanent residents.

No federally listed aquatic plant species was found in the proposed project site area; however, two Tennessee State-listed wetland species, the purple fringeless orchid and the river bulrush, may be present in wetlands adjacent to the proposed site. The only Tennessee State-listed aquatic-related fauna is the osprey, which is a common nester in Melton Valley.

S1.6.4 Geology and Seismicity

The ORR is located in the Tennessee Section of the Valley and Ridge physiographic province. The Conasauga Group underlies the Melton Valley, and the proposed project site would be situated over the Cambrian-age Nolichucky Shale. Tectonic activity has produced extensive fracturing and localized folding of bedrock units. Soil contamination exists in many locations in the Melton Valley area of ORNL, which is heavily used for waste storage.

The ORR is located in Seismic Zone 2, where the probability of seismic damage is moderate.

S1.6.5 Water and Water Quality

The proposed project site is within the Melton Valley Watershed portion of the White Oak Creek Watershed, which has a drainage area of 6.15 square miles. Although there are no permanent water bodies within the site boundary, two perennial streams (White Oak Creek and Melton Branch) and an unnamed tributary to White Oak Creek, and one lake (White Oak lake) would be close to the proposed facility.

Surface water from White Oak Creek, White Oak Lake, and Melton Branch contains elevated levels of radionuclides, mercury, and polychlorinated biphenyls (PCBs) relative to reference streams. However, overall water quality is good, such that no toxicity to aquatic organisms had been observed for several years and the toxicity testing was discontinued in 1997.

Groundwater is being contaminated from wastes in the unlined trenches at SWSA 5 North. According to the *Remedial Investigation Report on the Melton Valley Watershed at Oak Ridge, Tennessee* (DOE 1997f), these unlined trenches at SWSA 5 North are estimated to contain 14,000 curies and contribute about 6% of the total strontium-90 and 3.6% of the cesium-137 released to surface water in Melton Valley. The rate of release of radioactive constituents will likely reduce with respect to time because of radioactive decay. The contaminated soils around the underground trenches, and between the trenches and White Oak Creek, will also act as a secondary source of contamination to groundwater. Well samples taken adjacent to the SWSA 5 North trenches also showed elevated levels of americium-241 and curium-244 ranging as high as 5,940 pCi/L.

There are six wetlands within 0.8 km (0.5 miles) of the proposed TRU Waste Treatment Facility. The site is not within a floodplain, but the 100-year and 500-year floodplains associated with White Oak Creek are immediately north of the proposed site.

S1.6.6 Waste Management

The estimated waste volumes associated with CERCLA cleanup actions for the ORR range between 170,495 m^3 and 841,005 m^3 (223,000 to 1.1 million yd^3). Remote-handled TRU sludge will no longer be generated at ORNL after Fiscal Year 2000, but approximately 5.5 m^3 of remote-handled TRU waste would be generated annually at the Radiological Engineering Development Center at ORNL.

S1.6.7 Climate and Air Quality

The proposed facility is in an air quality control region, which is an attainment area for all criteria pollutants. ORR and ORNL are in compliance with all federal air regulations and TDEC air-permit requirements for non-radioactive hazardous air pollutants. The ORR is within a Class II prevention of significant deterioration area. Prevailing winds in the area are up-valley in the daytime and down-valley at night.

S1.6.8 Transportation

Transportation corridors in the region and immediately adjacent to the ORR boundary consist of local access roads such as Tennessee State Routes 95, 1700, and 62, and Interstates I-40 and I-75. The High Flux Isotope Reactor access road provides direct access from Tennessee State Route 95 to the proposed site.

S1.6.9 Utility Requirements

The Tennessee Valley Authority provides electric power to the ORR, which has a current site load of 166 MW. Water is supplied to ORNL by the DOE Oak Ridge Water Treatment Facility, which draws water from the Clinch River.

S1.6.10 Human Health

The calculated doses to the off-site (public) maximally exposed individual at ORNL and ORR are shown in Table S-2 (ORNL 1998). Airborne releases of radionuclides for the ORNL maximally exposed individual in 1997 resulted in a probability of cancer fatality of 2E-07. ORNL contributed about 58% of the ORR collective effective dose equivalent, or about 5.8 person-rem for the population, which corresponds to a Latent Cancer Fatality (LCF) of 3E-03 annually. For airborne releases the estimated probability of cancer fatality for the maximally exposed individual at ORR in 1997 was 2E-07, and the LCF for the collective population was 5E-03 annually.

Table S-2. Calculated effective dose equivalent to the maximally exposed off-site individual and the collective population effective dose equivalent from airborne releases of radionuclides in 1997 (ORNL 1998)

Location	Effective dose equivalent to a maximally exposed individual (mrem)	Probability of cancer fatality for the maximally exposed individual	Collective population effective dose equivalent (person-rem)	Latent Cancer Fatalities for collective population
ORNL	0.38	2E-07	5.8	3E-03
ORR	0.41	2E-07	10.0	5E-03

Doses from ingestion of fish contaminated from the Clinch River are estimated at 0.045 mrem (effective dose equivalent) for a maximally exposed individual, which would result in the probability of a cancer fatality of 2.3E-08. The collective population dose is 0.017 person-rem, which would result in an LCF of 8.5E-04. A fisherman spending 250 hours per year along the bank of the Clinch River would receive a dose from direct radiation of 1 mrem, which would result in a probability of a cancer fatality of 5E-07.

External exposure rates from background sources in Tennessee average about 6.4 microroentgens per hour (μR/hour) and range from 2.9 to 11 μR/hour. These exposure rates are equivalent to an average annual effective dose equivalent of 42 mrem/year and range from 19 to 72 mrem/year. The total average dose due to background radiation received by an individual in the United States, including the 42 mrem, each year is about 300 mrem.

Operations at ORNL result in the release of small quantities of chemicals (NAAQS criteria pollutants) to the atmosphere. A steam plant and two small, oil-fired boilers are the largest emission sources and account for 98% of all allowable emissions at ORNL. Data for these non-radiological sources are presented in Table 3.17 of this EIS.

S1.6.11 Accidents

The total recorded injuries at ORNL for 1999 were 170 or 4.65 per 100 full-time employees working one year.

S1.6.12 Noise

The results of a noise survey conducted at the site for the proposed treatment facility in July 1999 indicated the area was relatively quiet. Daily equivalent noise levels ranged from 50 to 70 dBA and were highest when the High Flux Isotope Reactor access road was under construction. A secondary night-time noise peak reflected wildlife noises.

S1.6.13 Socioeconomics

Approximately 7,500 people reside within 8 km (5 miles) of the center of the ORR, and 880,000 people reside within 80 km (50 miles) of the proposed facility. Total regional income in 1996 was $12.0 billion.

S1.6.14 Minority and Low-Income Populations

Oak Ridge City census tracts in 1990 indicated a 10% or less African-American population, with the exception of one tract, which had a 34.4% African-American population. These values compare to an African-American population of 24.1% nationally and 17% for the State of Tennessee. There are two census tracts with low-income populations exceeding both the national average and the Tennessee state average. There are no federally recognized Native American groups within 80 km (50 miles) of the proposed site.

S1.7 ENVIRONMENTAL CONSEQUENCES

Table S-3 provides a summary of the potential environmental impacts associated with implementing the alternatives, and allows a comparison of the alternatives. All impacts are expected to be small. The primary differences among alternatives are in potential impacts to water resources, the volume of waste generated, the number of transportation shipments and associated accidents, and utility requirements.

Table S-3. Comparison of impacts among alternatives

	No Action Alternative	Low-Temperature Drying Alternative (Preferred)	Vitrification Alternative	Cementation Alternative	Treatment and Waste Storage at ORNL Alternative
Land use (Chapter 4, Section 4.1)	• No change in land use, land use classifications, or impacts to visual resources	• No change in land use classification • 2 hectares (ha) (5 acres) would change from underdeveloped to industrial use • Buildings and other structures would be visible to workers but not the public	• No change in land use classification • 2 to 2.8 ha (5 to 7 acres) would change from underdeveloped to industrial use • Buildings and other structures would be visible to workers but not the public	• No change in land use classification • 2 ha (5 acres) would change from underdeveloped to industrial use • Buildings and other structures would be visible to workers but not the public	• No change in land use classification • 2 to 2.8 ha (5 to 7 acres) would change from underdeveloped to industrial use • For waste storage after treatment, an additional 0.3 ha (0.75 acre) of land would be required if treatment was by low-temperature drying, 0.6 ha (1.5 acres) of land if by vitrification, or 0.8 ha (2.0 acres) of land if by cementation • Buildings and other structures would be visible to workers but not the public
Cultural and historic resources (Chapter 4, Section 4.2)	• No cultural, archeological, or historic resources in project area	• Same as No Action Alternative	• Same as No Action Alternative	• Same as No Action Alternative	• Same as No Action Alternative

Table S-3. Comparison of impacts among alternatives (continued)

	No Action Alternative	Low-Temperature Drying Alternative (Preferred)	Vitrification Alternative	Cementation Alternative	Treatment and Waste Storage at ORNL Alternative
Ecological resources (Chapter 4, Section 4.3)	• Continued release of waste constituents from SWSA 5 North trenches to soils and groundwater affecting biota • No habitat destruction under normal operations	• 2 ha (5 acres) of forested habitat lost and converted to industrial use (revegetated after facility D&D) • Reduction of soil and water contamination because treatment would be available for waste to be removed from trenches under CERCLA	• 2 to 2.8 ha (5 to 7 acres) of forested habitat lost and converted to industrial use (revegetated after facility D&D) • Reduction of soil and water contamination because treatment would be available for waste to be removed from trenches under CERCLA	• 2 ha (5 acres) of forested habitat lost and converted to industrial use (revegetated after facility D&D) • Reduction of soil and water contamination because treatment would be available for waste to be removed from trenches under CERCLA	• 2 to 2.8 ha (5 to 7 acres) of forested habitat lost and converted to industrial use • Low-quality habitat indefinitely lost for on-site waste storage facility construction; 0.3 ha (0.75 acre) of land required if treatment by low-temperature drying, 0.6 ha (1.5 acres) of land if by vitrification, and 0.8 ha (2.0 acres) of land if by cementation • Reduction of soil and water contamination because treatment would be available for waste to be removed from trenches under CERCLA

Table S-3. Comparison of impacts among alternatives (continued)

	No Action Alternative	Low-Temperature Drying Alternative (Preferred)	Vitrification Alternative	Cementation Alternative	Treatment and Waste Storage at ORNL Alternative
Geology and seismicity (Chapter 4, Section 4.4)	• No impact to geology or regional seismicity • No construction-related impacts to soils or geology • Continued release of waste constituents from the SWSA 5 North trenches to soils	• No impact to geology or regional seismicity • 2 ha of soil disturbed • Reduction of soil and water contamination because treatment would be available for waste to be removed from trenches under CERCLA	• No impact to geology or regional seismicity • 2.8 ha of soil disturbed • Reduction of soil and water contamination because treatment would be available for waste to be removed from trenches under CERCLA	• No impact to geology or regional seismicity • 2 ha of soil disturbed • Reduction of soil and water contamination because treatment would be available for waste to be removed from trenches under CERCLA	• No impact to geology or regional seismicity • 2 to 2.8 ha of soil disturbed • Reduction of soil and water contamination because treatment would be available for waste to be removed from trenches under CERCLA
Surface water (Chapter 4, Section 4.5.1)	• Continued release of waste constituents from the SWSA 5 North trenches to surface water	• Potential for increased siltation in White Oak Creek, Melton Branch, and an unnamed tributary • Reduction of soil and water contamination because treatment would be available for waste to be removed from trenches under CERCLA	• Same as Low-Temperature Drying Alternative	• Same as Low-Temperature Drying Alternative	• Same as Low-Temperature Drying Alternative
Groundwater (Chapter 4, Section 4.5.2)	• No groundwater use • Continued release of waste constituents from SWSA 5 North trenches	• No groundwater use • Positively impacts groundwater due to waste removal and treatment of waste from SWSA 5 North trenches	• Same as Low-Temperature Drying Alternative	• Same as Low-Temperature Drying Alternative	• Same as Low-Temperature Drying Alternative

Table S-3. Comparison of impacts among alternatives (continued)

	No Action Alternative	Low-Temperature Drying Alternative (Preferred)	Vitrification Alternative	Cementation Alternative	Treatment and Waste Storage at ORNL Alternative
Wetlands & Floodplains (Chapter 4, Section 4.5.3)	• Continued impacts to White Oak Creek floodplain due to SWSA 5 North contamination • No impact to wetlands	• Small impact to the 100-year or 500-year floodplains during construction phase • Wetland B (0.012 ha or 0.03 acres) would be eliminated by construction	• Same as Low-Temperature Drying Alternative	• Same as Low-Temperature Drying Alternative	• Same as Low-Temperature Drying Alternative
Waste Management (Chapter 4, Section 4.6)	• TRU sludge wastes and associated low-level supernate in the Melton Valley Storage Tanks, solid wastes in SWSA 5 North trenches, and solid waste in storage facilities would remain untreated • Would require continued surveillance and maintenance of untreated legacy waste inventory and associated on-site facilities indefinitely at ORNL • Would result in violation of legal mandate due to continued waste storage, potentially resulting in fines	• All legacy wastes in proposed action would be treated • Approximately 10,833 m^3 of total generated waste, including: – 607 m^3 contact-handled and remote-handled TRU waste; – 2,778 m^3 low-level waste; – 23 m^3 of low-level mixed waste; – 1,560 m^3 of sanitary wastewater; and – 5,550 m^3 debris from D&D activities	• Same as Low-Temperature Drying Alternative • Approximately 34,128 m^3 of total waste generated, including: – 1,060 m^3 contact-handled and remote-handled TRU waste; – 4,980 m^3 low-level waste; – 4 m^3 of low-level mixed waste; – 7,201 m^3 of sanitary wastewater; and – 20,760 m^3 debris from D&D activities	• Same as Low-Temperature Drying Alternative – Approximately 28,826 m^3 of total waste generated, including: – 1,793 m^3 contact-handled and remote-handled TRU waste; – 2,833 m^3 low-level waste; – 2,540 m^3 of remote-handled low-level waste; – 3 m^3 of low-level mixed waste; – 7,437 m^3 of sanitary wastewater; and – 14,143 m^3 debris from D&D activities	• Same as Low-Temperature Drying Alternative • 10,833 to 34,128 m^3 of waste generated, depending on the treatment selected, and stored on-site • Would require continued surveillance and maintenance of waste inventory indefinitely onsite at ORNL • Would require construction of additional waste storage facilities—using 0.3 to 0.8 ha of land depending upon treatment process selected

Table S-3. Comparison of impacts among alternatives (continued)

	No Action Alternative	Low-Temperature Drying Alternative (Preferred)	Vitrification Alternative	Cementation Alternative	Treatment and Waste Storage at ORNL Alternative
Climate and Air Quality (Chapter 4, Section 4.7)	• No impact to air quality	• Minor emissions during normal operations	• Same as Low-Temperature Drying Alternative	• Same as Low-Temperature Drying Alternative	• Same as Low-Temperature Drying Alternative
Transportation (Chapter 4, Section 4.8)	• No off-site shipments	• 397 shipments of TRU waste with 3.2E-01 accidents and 4.4E-02 fatalities predicted • Non-accident latent cancer fatalities (LCFs) of 8.7E-02 for CH TRU and 3.1E-02 for RH TRU waste • 277 low-level waste shipments with 2.6E-01 accidents and 3.6E-02 accident fatalities predicted • 2.1E-09 non-accident LCFs predicted	• 987 shipments of TRU waste with 8.0E-01 accidents and 1.1E-01 fatalities predicted • Non-accident LCFs of 5.3E-03 for CH TRU and 9.3E-02 for RH TRU waste • 281 low-level waste shipments with 2.6E-01 accidents and 3.6E-02 accident fatalities • 2.1E-09 non-accident LCFs predicted	• 2,425 shipments of TRU waste with 2.2 accidents and 3.0E-01 fatalities predicted • Non-accident LCFs of 5.3E-02 for CH TRU and 2.7E-01 for RH TRU waste • 914 low-level waste shipments with 8.8E-01 accidents and 1.2E-01 accident fatalities predicted • 7.5E-09 non-accident LCFs predicted	• No off-site shipment of TRU waste or low-level waste • Requires on-site transportation of processed waste to on-site waste storage facilities

Table S-3. Comparison of impacts among alternatives (continued)

	No Action Alternative	Low-Temperature Drying Alternative (Preferred)	Vitrification Alternative	Cementation Alternative	Treatment and Waste Storage at ORNL Alternative
Utility Requirements (Chapter 4, Section 4.9)	• Total estimated power usage 2,200 MW • 5 million gallons of water use projected over 100-year institutional control period	• About 15,000 MW of total electricity usage • 5 million gallons of water use during project life	• About 45,000 MW of total electricity usage • 7 million gallons of water use during project life	• About 11,250 MW of total electricity usage • 15 million gallons of water use during project life	• Electricity use varies by alternative from 13,450 MW to 47,200 MW total, which includes electricity use for long-term storage • Water use varies by alternative (10 million to 20 million gallons), which includes water use for long-term storage
Human Health (Chapter 4, Section 4.10)	• LCF for involved worker population estimated to be 2E-02 • Risk to public and non-involved worker would be negligible	• Probability of cancer fatalities (PCF) from radiological releases to involved worker estimated to be 3.0E-05; non-involved worker estimated to be 2.0E-05; and off-site MEI estimated to be 1.0E-05 • Collective dose to the affected off-site pubic population would be 1.2E-01 person-rem, resulting in 6.0E-05 LCFs	• PCF from radiological releases to involved worker estimated to be 9.0E-05; non-involved workers estimated to be 7.0E-05; off-site MEI estimated to be 5.0E-05 • Collective dose to the affected off-site pubic population would be 6.8E-01 person-rem, resulting in 3.0E-04 LCFs	• PCF from radiological releases to involved worker estimated to be 6.0E-06; non-involved workers estimated to be 5.0E-06; and off-site MEI estimated at 3.0E-06 • Collective dose to the affected off-site pubic population would be 2.8E-02 person-rem, resulting in 1.0E-06 LCFs	• LCF for involved worker population estimated to be 2E-02 • PCF for the non-involved worker and off-site MEI would be equal to that estimated for the treatment technology selected • Collective dose and number of fatalities for the affected off-site population would be equal to that for the treatment technology selected

Table S-3. Comparison of impacts among alternatives (continued)

	No Action Alternative	Low-Temperature Drying Alternative (Preferred)	Vitrification Alternative	Cementation Alternative	Treatment and Waste Storage at ORNL Alternative
Noise (Chapter 4, Section 4.12)	• Noise levels should decrease to 50 to 60 dBA when the High Flux Isotope Reactor access road construction is complete	• Site construction and D&D noise up to 70 dBA • Noise levels during operations at 50 to 60 dBA • Noise increases are temporary and minor	• Same as Low-Temperature Drying Alternative	• Same as Low-Temperature Drying Alternative	• Same as Low-Temperature Drying Alternative during treatment and would decrease, similar to the levels of No Action, during long-term storage

Table S-3. Comparison of impacts among alternatives (continued)

	No Action Alternative	Low-Temperature Drying Alternative (Preferred)	Vitrification Alternative	Cementation Alternative	Treatment and Waste Storage at ORNL Alternative
Accidents (Chapter 4, Section 4.11)	• **Melton Valley Storage Tank (MVST) Breach** – MEI – 1.1E-05 PCF – Population – 1.1 LCF – Non-involved workers – 9.2E-04 PCF • **Vehicle impact (CH TRU and RH TRU waste)** – MEI – 1.6E-06 PCF – Population – 0.024 LCF – Non-involved workers – 1.3E-04 PCF • **Earthquake** – MEI – 1.6E-05 PCF – Population – 0.24 LCF – Non-involved workers – 1.4E-03 PCF • **Vehicle impact/fire (CH TRU and RH TRU waste)** – MEI – 1.4E-07 PCF – Population – 2.1E-03 LCF – Non-involved workers – 1.2E-05 PCF	• **MVST Breach** - NA • **MVST transfer line failure** – MEI – 3.2E-06 PCF – Population – 0.16 LCF – Non-involved workers – 2.8E-04 PCF • **Vehicle impact** - negligible • **Earthquake** – MEI – 4.8E-07 PCF – Population – 7.2E-03 LCF – Non-involved workers – 4.2E-05 PCF • **Vehicle impact/fire** - negligible	• Same as Low-Temperature Drying Alternative	• **MVST Breach** - NA • **MVST transfer line** failure – MEI – 6.3E-06 PCF – Population – 0.31 LCF – Non-involved workers – 5.5E-04 PCF • **Vehicle impact** - negligible • **Earthquake** – MEI – 9.6E-07 PCF – Population – 0.014 LCF – Non-involved workers – 8.4E-05 PCF	• **MVST transfer line failure** – MEI – 3.2E-06 to 6.6E-06 PCF – Population – 0.16 to 0.31 LCF – Non-involved workers – 2.8E-04 to 5.5E-04 PCF • **Vehicle impact** - negligible • **Earthquake (CH TRU and RH TRU waste)** – MEI – 4.8E-07 to 9.6E-07 PCF – Population – 7.2E-03 to 1.4E-02 LCF – Non-involved workers – 4.2E-05 to 8.4E-05 PCF • **Vehicle impact/fire (after processing)** – MEI – 1.4E-07 PCF – Population – 2.1E-03 LCF – Non-involved workers – 1.2E-05 PCF

Table S-3. Comparison of impacts among alternatives (continued)

	No Action Alternative	Low-Temperature Drying Alternative (Preferred)	Vitrification Alternative	Cementation Alternative	Treatment and Waste Storage at ORNL Alternative
Socioeconomic (Chapter 4, Section 4.13)	• No change in economic activity	• No significant impacts • Earnings represent 0.1% of the income for the region	• No significant impacts • Earnings represent 0.2% of the income for the region	• No significant impacts • Earnings represent 0.1% of the income for the region	• No significant impacts • Earnings represent 0.1% of the income for the region
Environmental Justice (Chapter 4, Section 4.14)	• No environmental justice impacts expected	• Same as No Action Alternative	• Same as No Action Alternative	• Same as No Action Alternative	• Same as No Action Alternative

CH TRU = contact-handled transuranic waste.
D&D = decontamination and decommissioning.
HFIR = High Flux Isotope Reactor.
LCF = latent cancer fatality.
MEI = maximally exposed individual.
NA = Not applicable.
ORNL = Oak Ridge National Laboratory.
PCF = probability of cancer fatality.
RH TRU = remote-handled transuranic waste.
TRU = transuranic.

S1.8 CUMULATIVE IMPACTS

The evaluation of cumulative impacts couples impacts of the proposed action and, where appropriate, the bounding alternative for each resource area, with impacts from other past, present, and reasonably foreseeable future actions.

The proposed action would be consistent with the existing industrial land use classification in Melton Valley. The cumulative impact on land use would be small because only 3.4 ha (9 acres) would be developed for the treatment and storage facilities (based on the Treatment and Waste Storage at ORNL Alternative, using vitrification as the treatment technology for the bounding case). Construction and operation of a vitrification treatment facility would only result in 2.8 ha (7 acres) of forested land disturbed for a period of at least a decade, thereby resulting in a small incremental increase in the loss of habitat in the lower reaches of Melton Valley.

Cumulatively, impacts to water resources in the White Oak Creek watershed are expected to be mostly beneficial. The proposed action would augment several ongoing CERCLA actions in the watershed designed to reduce strontium-90 and other contamination in groundwater and in the soil. By implementing the proposed action, waste in the SWSA 5 North trenches would be treated. Sedimentation that could occur from the proposed action would be small and would help renew ongoing sediment depletions in the White Oak Embayment; sedimentation is beneficial because it provides shielding. However, a 0.016-ha (0.03-acre) wetland on the proposed project site is expected to be eliminated by construction.

There are 65 ha (160 acres) of land in Melton Valley devoted to waste storage and operation (DOE 1997a). For the Treatment and Waste Storage at ORNL Alternative, additional on-site storage space up to 0.8 ha (2 acres) would be required. Given the extensive area already devoted to waste storage in Melton Valley, this would not be cumulatively significant.

Ongoing and future projects involving ground disturbance activities that would likely result in fugitive dust emissions include the Old Melton Valley Access Road upgrade and the proposed Spallation Neutron Source. There should not be a direct cumulative impact to air quality from fugitive dust emissions from the proposed action; however, deposition of particulates from the proposed action combined with emissions from the Old Melton Valley Road upgrade and other large construction projects, such as the Spallation Neutron Source, could indirectly affect vegetation by coating leaves with dust.

The Toxic Substances Control Act (TSCA) Incinerator at the ETTP, the Bull Run Steam Plant 8 km (5 miles) east of ORNL, and the Kingston Steam Plant [approximately 48 km (30 miles) northwest of ORNL] near Kingston, Tennessee, are major atmospheric emission sources in the region which affect the air quality at ORNL. The TSCA Incinerator is a source of radionuclide emissions at the ETTP. All action alternatives considered for the proposed action would contribute a small amount to the overall emissions in the air shed.

The transportation of TRU Waste Treatment Project waste would be a subset of the total volume of waste evaluated in the WM PEIS. At ORR, the DOE WM PEIS estimated that transport of all waste types would result in 8.1E-04 accidents per shipment and 1.1E-04 fatalities per shipment (DOE 1997c). For the proposed action, the greatest number of waste shipments would occur under the Cementation Alternative (2,425 shipments of TRU and 914 shipments of low-level waste), which represents the bounding alternative. Under the Cementation Alternative, the TRU waste shipments are estimated to result in 2.2 accidents and 3.0E-01 fatalities.

Regarding human health risk, all action alternatives would eventually result in reducing long-term exposure to chemical and radiological contaminants; however, during the treatment and repackaging effort, some process releases and resulting risks to humans would occur. The bounding alternative for this resource area, the Vitrification Alternative, would contribute 6.8E-01 person-rem to the affected population and a corresponding 3E-04 latent cancer fatality risk to that population. Cumulatively, this risk, combined with existing risks and risks form the Spallation Neutron Source Project, would result in 3.1E-01 latent cancer fatalities.

The proposed TRU Waste Treatment Project would contribute very little additional employment, and the project's contribution to cumulative socioeconomics impacts would be very small.

S1.9 MITIGATION

Several best management practices are identified as mitigation measures. These practices include erosion and dust control measures, covering open truck beds during hauling, minimizing time that vehicles idle, and periodic vehicle inspections.

A 0.016-ha (0.03-acre) wetland on the proposed project site is expected to be eliminated by construction. Potential mitigation measures include avoidance, minimization, or compensation. Redesigning the layout of the TRU waste treatment facility could potentially avoid or minimize impact to this wetland. Should this not be practical, then compensatory mitigation, such as new wetland construction, would be done. For example, redesign of the sediment/storm water detention basin could result in a constructed wetland. Mitigation measures to achieve no net loss of wetlands will be provided in a Mitigation Action Plan.

S1.10 UNAVOIDABLE ADVERSE IMPACTS AND IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

Despite mitigation measures, there would be some small, but unavoidable adverse impacts resulting from the implementation of the proposed action. Depending on the treatment process, 2 to 2.8 ha (5 to 7 acres) of forested land would be used for construction of the proposed waste treatment facility, resulting in the loss of this habitat by plants and animals for a period of at least a decade (Sections 4.1 and 4.3). The area would be revegetated after closure and D&D of the facility.

Approximately 0.8 ha (2 acres) of land would be required indefinitely (which some may consider to be irreversibly and irretrievably committed) for the waste storage facilities if the Treatment and Waste Storage at ORNL Alternative is implemented. Land indefinitely committed as storage space would be approximately 0.2 ha (0.75 acres) for the low-temperature drying treatment, 0.6 ha (1.5 acres) for the vitrification treatment, or 0.8 ha (2.0 acres) for the cementation treatment (Section 4.1). This would constitute an irreversible and irretrievable commitment of land. There would, however, be no loss of federally protected threatened or endangered species or critical habitat (Section 4.5.3). The proposed action would also involve the irreversible or irretrievable commitment of energy and materials. Approximately 11,250 to 45,000 MW of electrical energy would be committed and consumed depending on the alternative selected (Section 4.9).

S1.11 APPLICABLE LAWS AND REGULATIONS

A number of laws, regulations, and agreements would apply to the Proposed Action. These are discussed in detail in Chapter 8, and some highly relevant ones are summarized here.

The Resource Conservation and Recovery Act (RCRA), as amended (42 U.S.C. §6901 et seq.), regulates the treatment, storage, and disposal of hazardous wastes. Regulation is by permit, meaning that the State of Tennessee and EPA study the alternative chosen by DOE and then establish a permit specific to the project that describes how the project is to be carried out. Whether DOE chooses the No Action Alternative, or any other alternative under consideration in this EIS, some type of RCRA permit will be required.

Selection of any of the action alternatives would require a RCRA permit to treat and store the waste. The land disposal restrictions would be addressed though the TDEC Commissioner's Order (dated September 1995).

Under the TDEC Commissioner's Order, DOE is required to implement the Site Treatment Plan (under the Federal Facility Compliance Act) that mandates specific requirements for the treatment and shipment of ORNL's mixed TRU waste. The primary milestone in the Commissioner's Order is that DOE begin treating legacy TRU sludge in order to make the first shipment to the WIPP (a DOE transuranic waste disposal facility) in New Mexico by January 2003.

If the No Action Alternative were selected, DOE is potentially subject to fines and penalties due to non-compliance with the Tennessee Commissioner's Order, which requires treatment and shipment offsite of the TRU waste.

Should the Treatment and Waste Storage at ORNL Alternative be undertaken, modification of the Commissioner's Order would be required, as the Order requires wastes to be treated and shipped. In addition, new storage units could be required in order to accommodate increasing volumes of stored wastes.

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended (42 U.S.C. §9601 et seq.), is the authority under which the TRU wastes currently stored in the SWSA 5 North trenches would be removed. After removal of the waste from the SWSA 5 North trenches, residual contamination in the surrounding media (soils and groundwater) may still need to be addressed under a subsequent CERCLA action. In addition, from a cumulative impacts perspective, the proposed action would assist the CERCLA cleanup at Melton Valley.

S1.12 REFERENCES

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DOE 1997d. *Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste* (WM PEIS), DOE/EIS-0200-F, U.S. Department of Energy, Washington, D.C., May 1997.

DOE 1997e. *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement* (WIPP SEIS-II), DOE/EIS-0026-FS2, U.S. Department of Energy, Washington, D.C., September 1997.

DOE 1997f. *Remedial Investigation Report on the Melton Valley Watershed at Oak Ridge National Laboratory, Oak Ridge, Tennessee, Volume 1. Evaluation, Interpretation, and Data Summary*, DOE/OR/01-1576/V1&V2, May 1997.

DOE 1998a. *Internal Dose Conversion Factors for Calculation of Dose to the Public*, DOE/EH-071, July 1998.

DOE 1998b. *WIPP SEIS-II, Record of Decision for the Department of Energy's Waste Isolation Pilot Plant Disposal Phase, Federal Register*, Vol. 63, No. 15, January 23, 1998, pages 3624–3629.

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1. INTRODUCTION AND BACKGROUND

1.1 INTRODUCTION

U.S. Department of Energy (DOE) facilities have performed nuclear energy research and radiochemical production since the early 1940s. The Oak Ridge Reservation (ORR) encompasses 13,974 contiguous hectares (ha) (34,516 acres) owned by the DOE in the Oak Ridge, Tennessee, area. The Y-12 Plant, the East Tennessee Technology Park, and the Oak Ridge National Laboratory (ORNL) are major DOE facilities within the ORR. ORNL was constructed during World War II as a pilot-scale plant to support nuclear energy research and the construction of larger plutonium production facilities at Hanford, Washington. ORNL is located on approximately 1,174 hectares (ha) (2,900 acres), 40 km (25 miles) northwest of the city of Knoxville, in eastern Tennessee (Figure 1-1). The site is located in a water-rich environment that contains numerous small tributaries that flow into the Clinch River located south and west of the site. ORNL is located in the Tennessee Valley between the Great Smoky Mountains (located approximately 80 km or 50 miles east) and the Cumberland Plateau (about 45 km or 25 miles west).

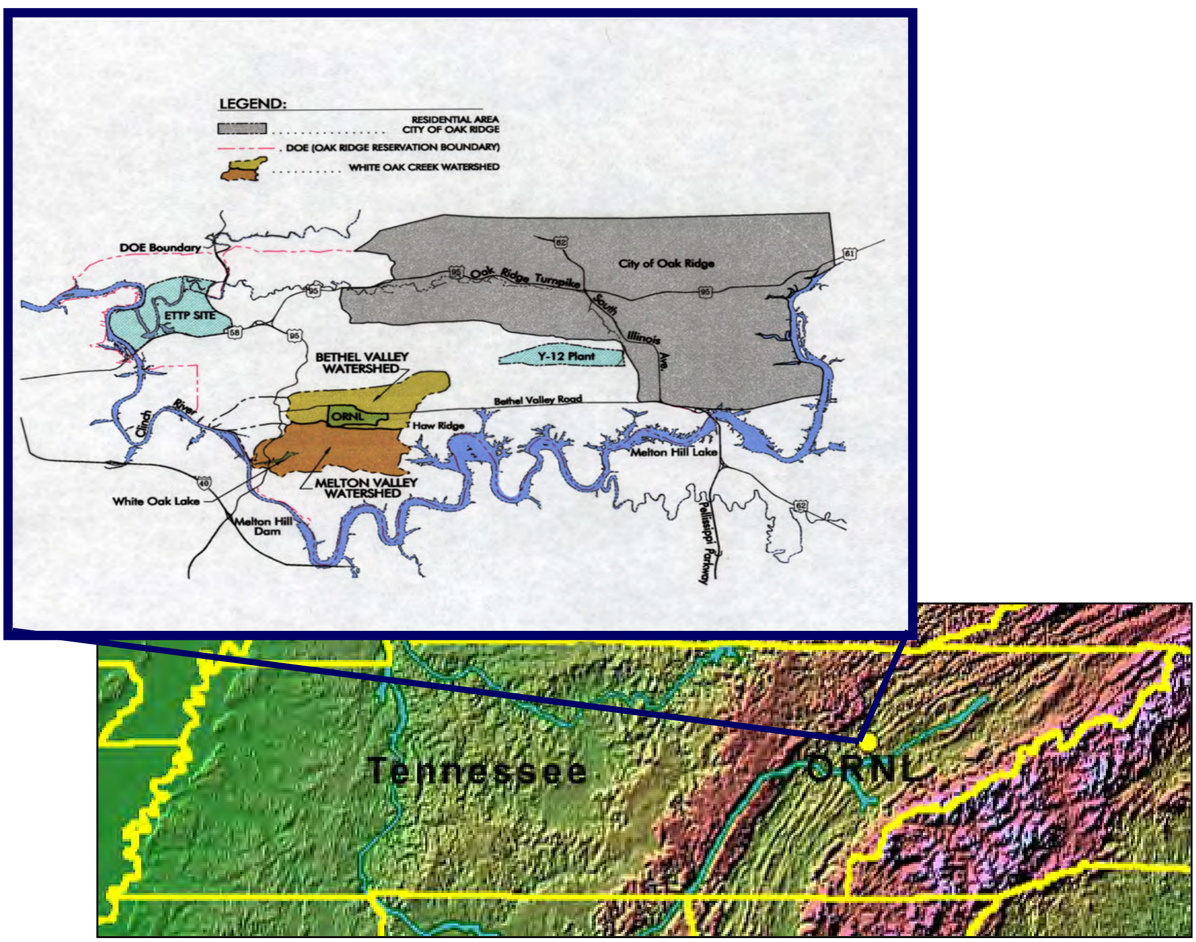

Figure 1-1. Location of Oak Ridge National Laboratory in relation to the City of Oak Ridge, other DOE facilities in the area, and the State of Tennessee.

ORNL continues to be used for DOE operations and is internationally known as a premier research facility. Research and development activities support national defense and energy initiatives. Ongoing waste management and environmental management activities continue to address legacy[1] and newly generated low-level radioactive[2], transuranic (TRU)[3], and hazardous wastes resulting from research and development activities. Meeting the cleanup challenges associated with legacy and newly generated wastes at ORNL is a high priority for the DOE Oak Ridge Operations (ORO), the Tennessee Department of Environment and Conservation (TDEC), and stakeholders. The treatment and disposal of legacy TRU waste at ORNL is an important component of the DOE cleanup at the site. Currently, no facilities exist at ORNL, or the ORR, for treating TRU mixed[4] waste sludges and associated low-level waste supernate, and contact-handled[5] and remote-handled[6] TRU/alpha low-level[7] waste solids, before disposal.

1.2 BACKGROUND

During early research activities, little was known about the effects of exposure to radiation and other hazardous substances. Waste management practices changed as the hazards were better understood. Wastes generated from research and development activities and isotope production were managed with the best available practices at the time. Liquid radioactive waste was stored in underground storage tanks. Lower activity liquid waste was transferred to ponds for storage and settling before release into White Oak Creek. Contaminated solid waste was buried in pits and trenches.

1.2.1 Waste Types

Legacy waste stored at ORNL resulted from past isotope production, and from research and development activities at DOE facilities. The four legacy waste types that would be treated under the proposed action are: remote-handled TRU waste sludge, low-level radioactive waste supernate (liquid portion) associated with the TRU sludge waste, contact-handled TRU/alpha low-level waste solids, and remote-handled TRU/alpha low-level waste solids. Much of the sludge waste contains metals regulated under the Resource Conservation and Recovery Act (RCRA) and, therefore, may be classified as mixed waste. ORNL currently has the largest inventory of remote-handled TRU waste in the DOE complex and a smaller portion of the contact-handled TRU waste.

Supernate, the liquid portion of the waste stored in the underground storage tanks at ORNL, is generally characterized as low-level waste. Sludge waste, found on the bottoms of the underground storage tanks,

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[1]Legacy waste is defined as waste generated from past isotope production and research and development activities.

[2]Low-level waste is defined as any radioactive waste not classified as high-level, spent nuclear fuel TRU, byproduct material, or mixed waste [based on Implementation Guide for Use with DOE M 435.1-1, DOE G 435.1-1, July 1999 (DOE 1999a)].

[3]TRU waste is waste not classified as high-level radioactive waste but as waste which contains more than 100 nanocuries per gram (nCi/g) of alpha-emitting TRU isotopes (atomic numbers greater than 92) with half-lives greater than 20 years (based on DOE 1999a).

[4]Mixed waste is a waste that contains radioactive waste regulated under the Atomic Energy Act of 1954 as amended, and a hazardous component subject to the Resource Conservation and Recovery Act (based on DOE 1999a).

[5]Contact-handled TRU waste contains beta- and gamma-emitting isotopes in addition to alpha-emitting isotopes, with a surface dose rate of 200 millirem per hour (mrem/h) or less [*Internal Dose Conversion Factors for Calculation of Dose to the Public*, DOE/EH-0071, July 1998 (DOE 1998a)].

[6]Remote-handled TRU waste contains beta- and gamma-emitting isotopes in addition to alpha-emitting isotopes, with a surface dose rate greater than 200 mrem/h (DOE 1998a).

[7]Alpha low-level radioactive waste is low-level waste that contains alpha-emitting isotopes.

formed from precipitants that settled out of the supernate during waste storage. The sludge waste has been characterized as TRU waste.

The solid waste at ORNL is a heterogeneous mixture consisting of paper, glass, rubber, cloth, plastic, and metal from glove boxes, fuel processing, hot cells, and reactors. Based on generator records, the solid waste has been classified as either TRU or alpha low-level radioactive waste. Because the nature of the solid waste can only be confirmed after retrieval and characterization, solid wastes were characterized as "TRU/alpha low-level radioactive waste" in the Notice of Intent to note the current uncertainty. The solid waste may contain metals regulated under RCRA, but generator records do not indicate the presence of any RCRA-listed constituents.

1.2.2 Waste Storage at ORNL

Approximately 30% of the legacy TRU tank waste is in the form of sludge, which is currently stored in aging, underground storage tanks that are undergoing waste retrieval operations. The retrieved waste is being transferred to the Melton Valley Storage Tanks. The remainder of the TRU sludge waste is already stored in the Melton Valley Storage Tanks. Sampling and analysis has been performed on all of the tank waste at ORNL. The radiological and chemical properties of the sludge and supernate have been measured, and a bounding analysis was performed on each constituent to provide a range of waste characteristics. The legacy TRU solid waste at ORNL is currently stored in subsurface trenches, vaults, and metal buildings.

Approximately 60 m^3 (15,850 gal) of low-level liquid waste and about 20 m^3 (706 ft^3) of TRU waste (5 m^3 of remote-handled TRU solid, 10 m^3 of contact-handled TRU solid, and 5 m^3 of sludge) are generated each year at ORNL. New waste generated after the proposed TRU Waste Treatment Facility is closed and D&D begins is not within the scope of this Environmental Impact Statement (EIS). When the proposed TRU Waste Treatment Facility is closed for decontamination and decommissioning (D&D), DOE plans to treat TRU liquid wastes at the main TRU waste generator facility known at the Radiological Engineering Development Center (REDC) in order to avoid future large inventories of TRU liquid or sludge waste. Newly generated liquid low-level waste would be processed through the ORNL waste management system and stored in the Melton Valley Storage Tanks–Capacity Increase Project tanks (Figure 1-2). Solid TRU waste would be packaged at the generating facility for disposal at the Waste Isolation Pilot Plant.

1.2.2.1 Liquid and sludge wastes storage

The liquid low-level waste system at ORNL includes underground storage tanks for the accumulation of mixed (RCRA and radioactive) TRU and low-level sludges and liquids. The supernate (liquid layer covering the sludge in underground storage tanks) is considered a low-level waste. It does not contain hazardous constituents and is not regulated under RCRA. The sludge developed from particulates settling out of the liquid waste and forming a sludge layer on the tank bottoms. The sludge waste is characterized as TRU waste, and it contains RCRA metals including mercury, chromium, cadmium, and lead.

From 1966 until 1984, the primary method for liquid low-level waste disposition at ORNL was hydrofracture. Hydrofracture involved mixing the waste with grout and injecting the resulting waste slurry into shale formations located more than 1,000 ft below ground. Liquid low-level waste was prepared and disposed of primarily at the Old Hydrofracture Facility. The New Hydrofracture Facility was also used for a short period of time. Since 1984, underground piping has been used to transfer liquid low-level waste to the ORNL evaporator facility for volume reduction. The evaporator bottoms are pumped in shielded, aboveground lines to the Melton Valley Storage Tanks following volume reduction operations.

Wastewater treatment units are specifically excluded from federal RCRA permitting requirements pursuant to 40 *Code of Federal Regulations* (*CFR*) 170.1(c)(2)(v). The Melton Valley Storage Tanks are classified as waste water treatment units under TDEC's administered water program and are subject to ORNL's Tennessee Pollutant Discharge Elimination System Permit (TPDES). The Melton Valley Storage Tanks are also permitted by rule under the State of Tennessee's RCRA program because, under Tennessee rules [TNRule 1200-1-11-.07(1)(c)], TPDES-permitted units are granted permit by rule status. Under the Federal Facilities Agreement (FFA) between the U.S. Environmental Protection Agency (EPA), TDEC, and DOE, the Melton Valley Storage Tanks are classified as existing, in-service tanks with secondary containment.

Under the FFA, these tanks must continue to undergo annual integrity assessments and maintain their release detection monitoring capabilities throughout their active lives. The tanks are allowed to remain in service unless a release is detected. Results of the assessments continue to demonstrate that the Melton Valley Storage Tanks are not releasing hazardous constituents or radionuclides to the environment.

The Melton Valley Storage Tanks facility (Figure 1-2) provides a number of measures to prevent, detect, and minimize potential releases to the environment and groundwater. Each of the eight cylindrical tanks is of 3.7-m (12-ft) diameter and is 18.7 m (61.3 ft) long. The tanks are constructed from welded, 0.5-in.-thick, type 304L stainless steel (SS) that is compatible with the primary components of the waste and provides optimum structural integrity. Type 304L SS is very corrosion resistant to neutral or alkaline oxidizing salts such as nitrates, nitrites, or chromates. The tanks were designed for service pressure of 15 pounds per square inch, gauge (psig) and service temperatures up to 150°F. The tanks were hydrostatically tested at 22.5 psig prior to operation. The tanks are fitted with level switches and specific gravity and temperature elements that are connected to recorders/alarms in the local control house.

Figure 1-2. Aerial view of the Melton Valley Storage Tanks–Capacity Increase Project during installation of the six 100,000-gallon tanks located south of the Melton Valley Storage Tanks.

Two underground concrete vaults provide secondary containment for the Melton Valley Storage Tanks (Figure 1-2). Each vault provides containment for four tanks. Both vaults are 19.5 m (64 ft) wide by 20 m (67 ft) long and have an internal height of 5.8 m (19 ft). The walls, floors, and ceilings of the vaults are constructed from 0.8- to 1.5-m (2.5- to 5.0-ft)-thick reinforced concrete. The vaults are internally lined by a 16-gauge, type 304 SS, welded construction "floor pan" to a height of about 2 m (7 ft). The vaults contain an integral sump pump for the collection and detection of any tank leakage. The vaults meet the requirements for Seismic Zone 2 under the Uniform Building Code (UBC). The tanks' piping, valve, and pump gallery is located in an adjacent, similarly constructed under-ground vault that is internally lined with a type 304 SS floor pan to a height of about 0.9 m (3 ft).

The waste volumes in the Melton Valley Storage Tanks began to approach capacity limits in the early 1990s from the continued generation of liquid low-level waste at ORNL. The Emergency Avoidance Solidification Campaign solidified about 25,000 gal of the supernate layer that had separated from the sludge during storage in an effort to reduce some of the waste volume in the Melton Valley Storage Tanks. ORNL conducted additional volume reduction campaigns and other operations, including in-tank evaporation and out-of-tank evaporation to maintain capacity at the Melton Valley Storage Tanks.

In 1998, ORNL completed the Melton Valley Storage Tanks–Capacity Increase Project, which involved construction of facilities adjacent to the existing Melton Valley Storage Tanks and installation of six 100,000-gal cylindrical, SS storage tanks (Figure 1-2). An Environmental Assessment (EA) was completed for these tanks in 1995 (*Environmental Assessment of the Melton Valley Storage Tanks–Capacity Increase Project*, DOE/EA-1044) (DOE 1995). The new facility has the capability to transfer liquids and pumpable sludges between the six new tanks and the eight original Melton Valley Storage Tanks. Pipes from the new tanks also allow transfers of waste to the liquid low-level waste evaporator and the solidification facility at ORNL. Based on a projected generation rate of approximately 60 m^3/year (15,770 gal/year) of liquid low-level waste from the evaporator bottoms (sludge and supernate), the new tanks will provide sufficient storage capacity for low-level waste for approximately 24 years.

1.2.2.2 Solid waste storage

Solid remote-handled and contact-handled TRU waste is currently packaged in metal boxes, drums, and concrete overpacks, and stored in RCRA-permitted facilities (metal buildings and bunkers). Most of the legacy solid waste containers do not meet the current U.S. Department of Transportation (DOT) regulations and would require repackaging prior to shipment offsite.

Solid TRU waste is also buried in metal and wood boxes found in 27 trenches and 8 auger holes used for the retrievable storage of TRU waste in the Solid Waste Storage Area 5 North (SWSA 5 North). The trenches have seasonal infiltration and inundation of groundwater intermittently throughout the year that causes a “bathtubbing” effect. Soil sampling around the trenches and White Oak Creek indicate gamma contamination at the soil surface equal to 50 μRem/h. These trenches also contribute to surface water and groundwater contamination in the Melton Valley Watershed. The primary contamination sources in the SWSA 5 North area are soils and sediments found on 1.54 ha (3.8 acres). The primary source volume is 1.1 million cubic feet (ft^3) of waste, soils, and sediment containing a total of 14,000 curies. Secondary contamination of soil and groundwater ocurrs on 1.54 ha (3.8 acres). The secondary contamination media include contaminated soils and groundwater between the TRU trenches and White Oak Creek. The SWSA 5 North trenches are estimated to contribute to 6% of the total strontium-90 and 3.6% of the cesium-137 released to surface water in Melton Valley [*Remedial Investigation Report on the Melton Valley Watershed at Oak Ridge National Laboratory, Oak Ridge, Tennessee, Volume 1. Evaluation, Interpretation, and Data Summary*, DOE/OR/01-1576/V1&D2, May 1997 (DOE 1997a)].

1.3 PURPOSE AND NEED FOR DOE ACTION

DOE has a need to treat the legacy TRU waste at ORNL in order to reduce the risk to human health and the environment and to comply with legal mandates from the TDEC and the ORNL Site Treatment Plan. The four types of legacy TRU waste that require treatment at ORNL are: remote-handled TRU waste sludge; low-level radioactive waste supernate associated with the sludge; contact-handled TRU/alpha low-level radioactive waste solids; and remote-handled TRU/alpha low-level radioactive waste solids. The approximate quantities of the four waste streams requiring treatment and analyzed in this EIS are:

- 900 m^3 (31,784.4 ft^3) of remote-handled TRU sludge (mixed waste), which is or will be located in the Melton Valley Storage Tanks;
- 1,600 m^3 (56,505.6 ft^3) of low-level supernate, which is or will be (associated with the TRU sludge) located in the Melton Valley Storage Tanks;
- 550 m^3 (19,423.8 ft^3) of remote-handled TRU waste/alpha low-level radioactive waste solids, located in vaults and trenches; and
- 1,000 m^3 (35,316 ft^3) of contact-handled TRU waste/alpha low-level radioactive waste solids, located in metal buildings.

Due to the water-rich environment in East Tennessee, legacy TRU waste contained in underground trenches at ORNL poses a risk to the area's water quality. Waste retrieval operations are currently under way to prepare many of the TRU waste storage tanks in the Bethel Valley area of ORNL for closure. The wastes retrieved from the tanks in Bethel Valley are being consolidated into the Melton Valley Storage Tanks prior to treatment at the proposed TRU Waste Treatment Facility. DOE will ensure the safe and efficient retrieval, and transfer, of legacy TRU tank waste to the Melton Valley Storage Tanks at ORNL for consolidation. Following the waste treatment and packaging operations, DOE will certify the TRU waste for shipment and disposal at the Waste Isolation Pilot Plant.

There are legal mandates that require DOE to address legacy TRU waste management needs. DOE has been directed by the TDEC and the EPA to address environmental issues including disposal of its legacy TRU waste. DOE is under a TDEC Commissioner's Order (September 1995) to implement the Site Treatment Plan (under the Federal Facility Compliance Act) that mandates specific requirements for the treatment and disposal of ORNL's TRU waste. The primary milestone in the Commissioner's Order is that DOE begin treating legacy TRU sludge in order to make the first shipment to the Waste Isolation Pilot Plant (a DOE transuranic waste disposal facility) in New Mexico by January 2003.

Removal, treatment, and disposal of the retrievable TRU waste from portions of the SWSA 5 North area is considered a major component of the selected remedy for the Melton Valley Watershed at ORNL according to the Record of Decision for the Melton Valley Watershed (DOE 1997b). In addition, two Interim Records of Decision [issued in connection with the FFA among EPA, TDEC, and DOE under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)] require the waste from the Gunite and Associated Tanks Remediation Project (DOE 1997c) and the Old Hydrofracture Facility Tanks Remediation Project (DOE 1997d) to be treated and disposed of along with the TRU waste from the Melton Valley Storage Tanks. This tank waste is included in the total waste volume slated for treatment in the TRU Waste Treatment Project. Currently, no facilities exist at ORNL or the ORR for treating TRU sludges and the associated low-level waste supernate, or the contact-handled and remote-handled TRU/alpha low-level radioactive solid waste.

Low-level radioactive waste must be certified by DOE for shipment and disposal at the DOE site(s) selected in a Record of Decision for the *Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste* (WM PEIS), DOE/EIS-0200-F, May 1997 (DOE 1997e). Disposal of this waste will be consistent with the WM PEIS for low-level waste (e.g., the Nevada Test Site or another designated disposal facility).

1.4 SCOPE OF ENVIRONMENTAL IMPACT STATEMENT

DOE has prepared this EIS under the National Environmental Policy Act (NEPA) and its implementing regulations on the proposed construction, operation, and D&D of a TRU Waste Treatment Facility at ORNL in Oak Ridge, Tennessee. As part of this EIS, DOE will evaluate alternative approaches for achieving the proposed action. Since much of the tank sludge waste displays RCRA characteristics, the proposed facility would be permitted under RCRA. Most of the waste is currently stored in the Melton Valley area of ORNL in underground waste storage tanks, bunkers, metal buildings, and subsurface trenches.

This EIS is being prepared according to the NEPA of 1969, the Council on Environmental Quality NEPA regulations (40 *CFR* 1500–1508), and DOE's NEPA Implementing Procedures (10 *CFR* Part 1021). In accordance with the NEPA process, a Notice of Intent was published in the *Federal Register* (Appendix A.1). This draft EIS incorporates pertinent analyses performed as part of the DOE's *Waste Isolation Pilot Plant Disposal Phase Supplemental Environmental Impact Statement* (WIPP SEIS-II), DOE/EIS-0026-S-2, September 1997 (DOE 1997f) and the WM PEIS. Treatment of ORNL TRU waste onsite, and disposal at the Waste Isolation Pilot Plant, is consistent with the Records of Decision issued for management of the transuranic waste for the aforementioned EISs (63 *FR* 3624 and 3629, respectively, January 23, 1998) (DOE 1998b; DOE 1998c). The disposal of low-level radioactive waste included in the scope of this draft EIS will be consistent with the WM PEIS Record of Decision for low-level waste that has yet to be issued (e.g., Nevada Test Site or another designated disposal facility).

DOE addressed issues associated with the potential environmental impacts of the alternatives for the proposed action in this draft EIS, including:

- potential effects on air, soil, and water quality from normal operations and reasonably foreseeable accidents;
- potential effects on the public, including minority and low-income populations, and workers from exposure to radiological and hazardous materials from normal operations and reasonably foreseeable accidents;
- compliance with applicable federal, state, and local requirements and agreements;
- pollution prevention, waste minimization, and energy and water use reduction technologies to eliminate or reduce use of energy, water, and hazardous substances and to minimize environmental impacts;
- potential socioeconomic impacts, including potential impacts associated with the workforce needed for operations;
- potential cumulative environmental impacts of past, present, and reasonably foreseeable future operations; and
- potential irreversible and irretrievable commitment of resources.

1.5 PUBLIC SCOPING AND PARTICIPATION

Figure 1-3. Stakeholder meetings have been held as part of the TRU Waste Treatment Project.

A Notice of Intent to prepare an EIS for the TRU Waste Treatment Project was published in the *Federal Register* on January 27, 1999. The Notice of Intent identified the public scoping period to encourage early public involvement in the EIS process and to solicit public comments (Figure 1-3) on the proposed scope of the EIS, including the issues and alternatives it would analyze. Two meetings were held in Oak Ridge, Tennessee, on February 11 and 16, 1999, to provide an opportunity for all people who wished to comment or make a presentation. Comment cards were available for those who preferred to submit written comments. Individuals made various comments at the two public scoping meetings, which were formally documented in transcripts. These transcripts were reviewed and summarized in Appendix A.3 that was utilized to address the public comments in this EIS. Most of the comments requested clarification of the proposed action and the alternatives. There was some concern expressed about the High Flux Isotope Reactor access road and the construction of the facility having an impact on the Old Hydrofracture Facility wells, but these wells are located away from these areas and would not be disturbed during any construction activities. The scoping period ended on February 26, 1999.

Project-related and other environmental materials are available for public review in the following reading rooms:

Washington, D.C.	U.S. Department of Energy Freedom of Information Public Reading Room, Forrestal Building, Room I E-190, 1000 Independence Avenue, S.W. Washington, DC 20585 Telephone: (202) 586-3142
Oak Ridge, Tennessee	U.S. Department of Energy, Oak Ridge Operations Office 200 Administration Road, Room G-217 Oak Ridge, TN 37831 Telephone: (423) 241-4780

1.6 RELATIONSHIP TO OTHER NEPA DOCUMENTS

DOE has prepared and issued a number of EISs and EAs that present analysis of environmental consequences that are relevant to the proposed action. These include:

- *Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste*, DOE/EIS-0200-F, May 1997 (DOE 1997e). Low-level radioactive waste must be certified by DOE for shipment and disposal at the DOE site(s) selected in a Record of Decision for low-level and mixed waste under the WM PEIS, which has not yet been issued. In addition, the treatment of TRU waste onsite at ORNL is consistent with DOE's January 1998 WM PEIS Record of Decision for TRU waste treatment and storage, which decided that DOE sites would treat and store their own TRU waste onsite, before shipment to WIPP for disposal.

- *Waste Isolation Pilot Plant Disposal Phase Supplemental Environmental Impact Statement*, DOE/EIS-0026-S-2, September 1997 (DOE 1997f). The WIPP SEIS-II evaluates the impacts of various treatment options; the transportation of TRU waste to the Waste Isolation Pilot Plant, using trucks, and both regular and dedicated rail service; and the disposal of the waste at the Waste Isolation Pilot Plant. The Waste Isolation Pilot Plant has waste acceptance criteria that Oak Ridge TRU waste must meet following treatment.

- *Advanced Mixed Waste Treatment Project at the Idaho National Engineering and Environmental Laboratory Environmental Impact Statement (AMWTP EIS)*, DOE/EIS-0290-F, issued in January 1999 (DOE 1999a). This EIS analyzes the environmental impacts of several similar treatment alternatives and the construction of the Advanced Mixed Waste Treatment Facility in Idaho.

- *Final Environmental Impact Statement for the Construction and Operation of the Spallation Neutron Source*, DOE/EIS-0247, April 1999 (DOE 1999b). This document addresses the regional environment on the ORR.

1.7 REFERENCES

DOE (U.S. Department of Energy) 1995. *Environmental Assessment of the Melton Valley Storage Tanks–Capacity Increase Project*, DOE/EA-1044, U.S. Department of Energy, Washington, D.C.

DOE 1997a. *Remedial Investigation Report on the Melton Valley Watershed at Oak Ridge National Laboratory, Oak Ridge, Tennessee, Volume 1. Evaluation, Interpretation, and Data Summary*, DOE/OR/01-1576/V1&D2, May 1997.

DOE 1997b. *Record of Decision for the Melton Valley Watershed at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-1826&D1.

DOE 1997c. *Record of Decision for Interim Action: Sludge Removal from the Gunite and Associated Tanks Operable Unit, Waste Area Grouping 1, Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/OR2-1591&D3, August 1997.

DOE 1997d. *Action Memorandum for the Old Hydrofracture Facility Tanks and Impoundment, Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-1751&D3.

DOE 1997e. *Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste,* DOE/EIS-0200-F, U.S. Department of Energy, Washington, D.C., May 1997.

DOE 1997f. *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement*, DOE/EIS-0026-s-2, U.S. Department of Energy, Washington, D.C., September 1997.

DOE 1998a. *Internal Dose Conversion Factors for Calculation of Dose tot he Public,* DOE/EH-071, July 1998.

DOE 1998b. *WIPP SEIS-II, Record of Decision for the Department of Energy's Waste Isolation Pilot Plant Disposal Phase, Federal Register*, Vol. 63, No. 15, January 23, 1998, pages 3624–3629.

DOE 1998c. *WM PEIS, Record of Decision for the Department of Energy's Waste Management Program: Treatment and Storage of Transuranic Waste, Federal Register*, Vol. 63, No. 15, January 23, 1998, pages 3629–3633.

DOE 1999a. *Implementation Guide for Use with DOE M 435.1-1*, DOE G 435.1-1, July 1999.

DOE 1999b. *Advanced Mixed Waste Treatment Project Final Environmental Impact Statement*, DOE/EIS-0290, U.S. Department of Energy, Idaho National Engineering and Environmental Laboratory, Idaho Falls, Idaho, January 1999.

DOE 1999c. *Final Environmental Impact Statement for the Construction and Operation of the Spallation Neutron Source*, DOE/EIS-0247, U.S. Department of Energy, Office of Science, Washington, D.C., April 1999.

2. DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES

2.1 PROPOSED ACTION

DOE proposes to construct, operate, and decontaminate and decommission (D&D) a waste treatment facility for the treatment of legacy ORNL TRU, alpha low-level waste, and newly generated TRU waste (Figure 2-1) in order to reduce the risk to human health and the environment, and to comply with the TDEC Commissioner's Order of 1995, which has a primary milestone that requires DOE to make the first shipment of treated TRU sludge to the Waste Isolation Pilot Plant in New Mexico by January 2003. Impacts relative to the construction, operation, and D&D[1] of any treatment facility are presented in Chapter 4, in detail, for each treatment alternative evaluated in this EIS. All the legacy waste DOE proposes to treat as part of the TRU Waste Treatment Project is currently stored at ORNL. The newly generated TRU waste would be treated at the proposed facility until it is closed for D&D. TRU waste generated after closure of the proposed facility is not within the scope of the proposed action.

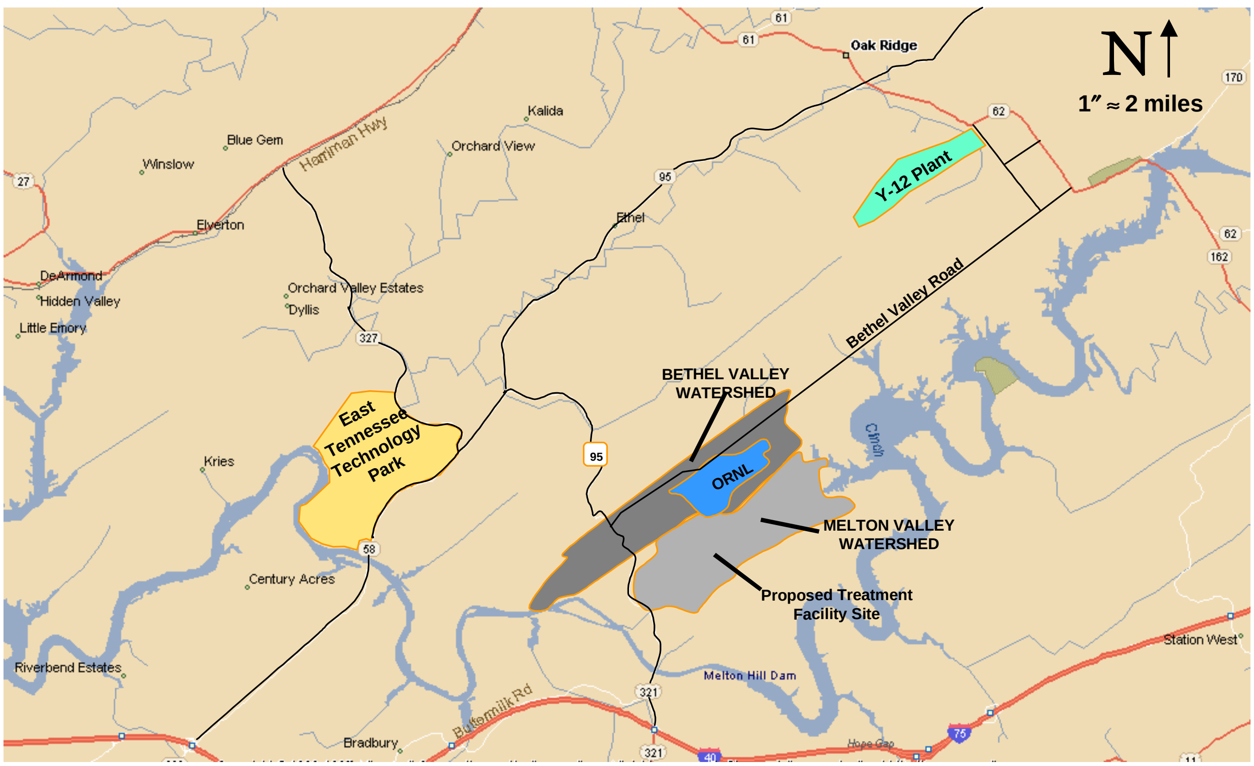

Figure 2-1. General site location of the proposed TRU Waste Treatment Project facility at Oak Ridge National Laboratory (ORNL) on the Oak Ridge Reservation (ORR).

DOE's proposed action would entail the award of a privatization contract, contingent upon the completion of the NEPA review, for the construction, operation, and D&D of the proposed waste treatment facility to a private contractor. DOE solicited bids from contractors for a treatment facility for the TRU wastes. The privatization contract request for proposal was structured so that the selected contractor would be required to use its own funds for the construction of the facility, and so that payment

[1]Specific information on impacts resulting from D&D activities can be found in Chapter 4 on pages 4-9, 4-13, 4-25, 4-50, and 4-61.

for the construction portion of the contract would not be made until the waste was treated to meet the appropriate waste acceptance criteria and certified by DOE. Three bids were received and evaluated. DOE incorporated environmental information very early in the project planning. For example, DOE required proposals to include environmental data and analysis. Prior to selection of the contractor, DOE held two public meetings with stakeholders and had ongoing discussions with regulators. In addition, DOE prepared a characterization report for the site of the proposed action and sponsored an independent study of treatment technologies and contracting alternatives, known as the Parallax study [ORNL/M-4693, *Feasibility Study for Treatment ORNL TRU Waste In Existing and Modified Facilities*, September 15, 1995 (Parallax 1995)]. DOE independently evaluated the environmental information provided in the bids. DOE developed an environmental synopsis of the environmental information in accordance with 10 *CFR* 1021.216 and published the *Environmental Synopsis for the Transuranic Waste Treatment Project at the Oak Ridge Reservation* in January 1999 (Appendix A.2). This synopsis has been filed with the EPA and made available to the public.

The proposed site for the treatment facility is adjacent to the Melton Valley Storage Tanks (the current storage area for the waste sludge and supernate). DOE would lease the Melton Valley Storage Tanks and an adjacent land area totaling up to 4 ha (10 acres) to the selected contractor for the construction of the facility (Figure 2-2), subject to notification of the EPA and the State of Tennessee to clarify the change in land use. Once the facility is closed and D&D of the facility is completed, the Melton Valley Storage Tanks and the land used for the facility would no longer be leased to the selected contractor.

The proposed facility location is based on three factors listed below:

- The treatment facility should be located close to the existing Melton Valley Storage Tanks to minimize the length of a new sludge/supernate transfer line and reduce the environmental disturbance due to construction as recommended in the *Feasibility Study for Processing ORNL Transuranic Waste in Existing and Modified Facilities* (Parallax 1995).

- The existing terrain should provide natural shielding for the proposed facility and facilitate material handling.

1. The location of the proposed facility near the Melton Valley Storage Tanks would reduce the risk associated with transporting the liquid and sludge tank waste from the Melton Valley Storage Tanks to the proposed treatment facility over public or laboratory roads. The Melton Valley Storage Tanks are located in Melton Valley, separated from the main plant area at ORNL by the Haw Ridge. The proposed treatment facility site would be fenced, with controlled access to Tennessee State Highway 95, which is located west of the proposed site. DOE would provide electrical, water, and telephone service to the edge of the leased area on the east side of the facility. DOE is upgrading the existing single-lane road from State Route 95 to the proposed facility to provide improved emergency access from the High Flux Isotope Reactor. This road will become the main access to the proposed facility. A categorical exclusion under NEPA was completed for this road upgrade (CX-TRU-98-007, *Categorical Exclusion for Construction/Relocation of Access Road at Oak Ridge National Laboratory*) (DOE-ORO 1998). Because most of the sludge is regulated under RCRA, the proposed facility would be permitted under RCRA.

The proposed action would be carried out in four phases:

- Phase I, Licensing and Permitting [includes DOE's NEPA analysis and contractor preliminary design activities; U.S. Nuclear Regulatory Commission (NRC) license is not required as the facility will only be treating DOE wastes];
- Phase II, Construction and Pre-Operational Testing;
- Phase III, Waste Treatment, Packaging, and Certification; and
- Phase IV, Decontamination and Decommissioning.

DOE will complete the NEPA process concurrent with Phase I of the contract. Phase I is a 2.5-year period during which the permitting and preliminary design process is completed for the proposed facility. If the NEPA review results in another alternative being selected, the contract would be terminated before Phase II of the contract begins.

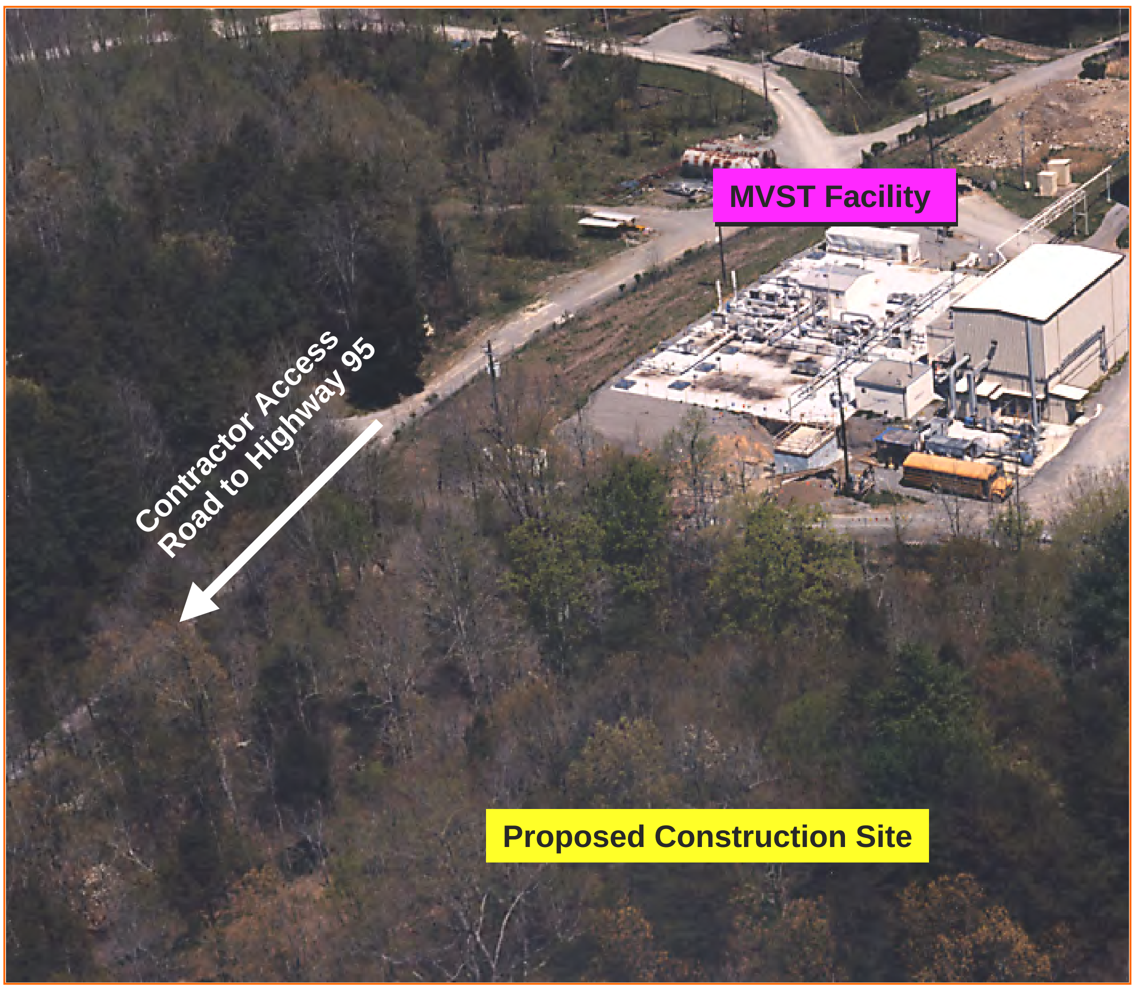

Figure 2-2. DOE would lease the Melton Valley Storage Tanks facility and an adjacent area of land to construct the waste treatment facility. The location is isolated from ORNL by Haw Ridge.

DOE requires that all activities associated with the proposed action be performed safely and in compliance with applicable federal and state regulatory requirements. The selected contractor would be responsible for achieving compliance with all applicable environmental, safety and health laws and regulations. Regulatory agencies would be responsible for monitoring compliance by the contractor. The State of Tennessee would regulate the selected contractor according to permits under the state's purview (the RCRA Part B permit issued by the State of Tennessee). DOE would regulate occupational safety and health and nuclear safety according to specific environment, safety, and health requirements.

Waste volume reduction would be a major consideration for the proposed action. Waste volume reduction would minimize waste generation during the treatment process, conserve resources, and would result in lower disposal costs. The waste treatment technique used in the proposed action would need to be flexible enough to address a wide range of waste properties, substantially reduce the TRU waste volume, and generate minimal secondary waste during treatment. After waste treatment, DOE would certify the waste for disposal as low-level radioactive waste, alpha low-level radioactive waste, or TRU waste. The contractor would be required to treat all wastes to meet specified waste acceptance criteria for disposal. In the event that the Waste Isolation Pilot Plant is not accepting remote-handled TRU waste in time to meet the TDEC Commissioner's Order, the selected contractor would be required to reduce the solubility of the RCRA metals in the sludge waste in order to form stable compounds. The stabilized sludge would not exceed the RCRA Toxicity Characteristic Leaching Procedure (TCLP) limits and would no longer exhibit RCRA characteristics. This would ensure that the treated waste meets RCRA Land Disposal Restriction (LDR) standards, required by the ORNL Site Treatment Plan, in the event that the treated waste is stored onsite before transport to the Waste Isolation Pilot Plant.

The proposed action calls for the segregation of the legacy sludge and supernate contained in the waste storage tanks. The segregation of these wastes would result in significant life cycle cost avoidance when compared to disposal of both the sludge and supernate at the Waste Isolation Pilot Plant. The supernate, which is generally classified as low-level waste, would be reduced in volume during waste treatment, and packaged for final disposal at, for example, the Nevada Test Site. For impacts analysis purposes, all low-level waste resulting from the TRU Waste Treatment Facility is assumed to be disposed of at the Nevada Test Site. This assumption is based on the initial characterization information for the low-level waste, which indicates that this waste meets the waste acceptance criteria of the Nevada Test Site. The final decision on the disposal site for low-level waste treated at the proposed TRU Waste Treatment Facility will be consistent with the pending Record of Decision from the Waste Management Programmatic Environmental Impact Statement (WM PEIS). The Nevada Test Site is one of six DOE low-level waste sites identified in the WM PEIS. The WM PEIS Record of Decision is expected to be issued before the ORNL TRU Waste Treatment Project Final EIS is completed. Because the ORNL TRU Waste Treatment Project would generate small quantities of low-level waste in comparison to the 1.5 million m^3 of low-level waste analyzed for the entire DOE complex in the WM PEIS, the assumption of the Nevada Test Site as a disposal site for low-level waste does not prejudice DOE's pending WM PEIS low-level waste disposal Record of Decision.

Because most of the current solid waste containers do not meet U.S. Department of Transportation (DOT) regulations, the proposed action would provide for repackaging the solid waste prior to shipment. The waste would be certified for disposal by DOE as either low-level radioactive, alpha low-level radioactive, or TRU waste and transported to appropriate disposal facilities that are consistent with the WM PEIS. The proposed action includes repackaging with some compaction to obtain a 50% volume reduction for the bulk of the solid waste that is not regulated under RCRA. The solid waste would be better characterized during the repackaging efforts to achieve final waste certification by DOE before disposal. Any items displaying RCRA characteristics would be isolated and treated to meet RCRA LDR standards.

2.2 CONSIDERATION OF ALTERNATIVES

DOE analyzed five alternatives in this EIS: a no action alternative; three alternative technologies for treating the legacy wastes followed by shipment to an appropriate disposal facility; and treatment by any of the three alternative treatment technologies, followed by long-term storage at ORNL. Shipment of the TRU wastes to other DOE sites for treatment was also considered, but not analyzed in detail for reasons discussed in Section 2.8.2. Other potential treatment technologies were also evaluated, but were not analyzed in detail for various reasons (Table 2-5, Section 2.8.2).

A summary of the environmental impacts for the five alternatives is included in Section 2.9. The remainder of Chapter 2 discusses the following five alternatives in detail:

2. **No Action** (i.e., continued on-site storage) for all of the legacy TRU tank waste and legacy contact-handled and remote-handled TRU/alpha low-level solid wastes.
3. **Low-Temperature Drying** (**Preferred Alternative**) for the Melton Valley Storage Tanks wastes (sludge and supernate) and segregation and compaction for the solid wastes (contact-handled and remote-handled TRU/alpha low-level heterogeneous debris).
4. **Vitrification** for the Melton Valley Storage Tanks wastes (sludge and supernate) and segregation and compaction for the solid wastes (contact-handled and remote-handled TRU/alpha low-level heterogeneous debris).
5. **Cementation** for the Melton Valley Storage Tanks wastes (sludge and supernate) and segregation and compaction for the solid wastes (contact-handled and remote-handled TRU/alpha low-level heterogeneous debris).
6. **Treatment and Waste Storage at ORNL** would provide treatment by one of the above treatment alternatives followed by long-term (indefinite) waste storage at ORNL

2.3 NO ACTION ALTERNATIVE

Under the No Action Alternative, DOE would continue to store legacy TRU waste at ORNL in underground waste storage tanks, subsurface trenches, vaults, bunkers, and metal buildings. Long-term storage, consistent with the No Action Alternative, is not permissible under RCRA, which does not allow storage of untreated hazardous wastes indefinitely.

2.3.1 Facility Description

No facility would be constructed under the No Action Alternative for the continued storage of legacy TRU waste. Existing facilities at ORNL would be used for the continued storage of the legacy TRU waste. Legacy mixed (RCRA hazardous and radioactive) TRU sludge and the associated low-level supernate wastes would continue to be stored in the Melton Valley Storage Tanks and the Melton Valley Storage Tanks–Capacity Increase Project tanks (Figure 2-2). There is slightly over 1,400 m^3 (about 370,000 gal) of storage capacity available in the existing storage tanks.

Legacy solid remote-handled and contact-handled wastes would be stored in their current facilities described below.

- Solid Waste Storage Area 5 North (SWSA 5 North) is at capacity and stores remote-handled TRU solid wastes and TRU mixed wastes in casks buried underground in trenches.

- Buildings 7855 and 7883 are bunkers, which would continue to store remote-handled TRU waste. Building 7855 is at capacity, with 157.2 m^3 (5,552 ft^3) of remote-handled TRU waste in storage. Building 7883 currently stores 10.7 m^3 (377 ft^3) of remote-handled TRU solids and has an available storage capacity of 146.7 m^3 (5,179 ft^3) ;

- Buildings 7572, 7574, 7842, 7878, and 7879 are metal buildings that would continue to store contact-handled TRU waste. These storage buildings currently store over 906 m^3 (32,000 ft^3) of contact- handled TRU wastes. Building 7842 is at capacity, but the other buildings have a combined available storage capacity of 722 m^3 about (25,500 ft^3) for contact-handled TRU wastes.

- Buildings 7826 and 7834, the below-grade concrete cells in SWSA 5 North, which currently store a total of about 68 m^3 (2,400 ft^3) of remote-handled TRU and contact-handled waste, are not RCRA permitted. This waste is scheduled to be moved to the appropriate existing facilities for contact-handled and remote-handled wastes (described above) as a legacy waste action under CERCLA in Fiscal Year 2000, thus reducing the amount of permitted storage space that is available.

Buildings 7826 and 7834, the below-grade concrete cells in SWSA 5 North which currently store a total of about 68 m^3 (2,400 ft^3) of remote-handled TRU and contact-handled TRU waste, are not RCRA permitted. This waste is scheduled to be moved to the appropriate existing facilities for contact-handled and remote-handled wastes (described above) as a legacy waste action under CERCLA in Fiscal Year 2000, thus reducing the amount of permitted space that is available.

2.3.2 Treatment Description

There would be no waste treatment under the No Action Alternative for TRU wastes.

2.3.2.1 Sludge and supernate

The No Action Alternative involves continued storage of legacy mixed (RCRA and radioactive) TRU sludge and low-level waste and supernate in the Melton Valley Storage Tanks at ORNL.[2] If this alternative were chosen, the interim Records of Decision for the Gunite and Associated Tanks (DOE 1997a) and the Old Hydrofracture Facility tanks (DOE 1997b) would require amendment since these Records of Decision indicated that the waste is being consolidated in the Melton Valley Storage Tanks in

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[2]Basic research and environmental remediation activities at ORNL would continue to generate new waste at a rate of approximately 60 m^3 (15,850 gal) of liquid low-level waste and 5 m^3 (175 ft^3) of TRU sludge annually. These wastes would be added to the legacy sludge and supernate to be treated in the proposed facility. After the proposed treatment facility is closed, newly generated waste would be stored in the Melton Valley Storage Tanks and Capacity Increase Project tanks, which have enough tank capacity for approximately 21 years. In the event that construction of any new waste storage tanks would be needed, these facilities would be evaluated in a separate NEPA review, as the scope of the proposed action is for treatment of legacy TRU sludge and its associated low-level waste, and not storage of waste generated after the proposed facility's closure.

preparation of treatment prior to disposal at the Waste Isolation Pilot Plant. In addition, the continued storage of this waste onsite at ORNL would be in violation of DOE Order 435.1.

2.3.2.2 Remote-handled and contact-handled solid wastes

Remote-handled and contact-handled solid wastes would continue to be stored at ORNL in the existing solid waste storage facilities and in the SWSA 5 North trenches under the No Action Alternative.[3] If this alternative were chosen, the Record of Decision for the Melton Valley Watershed (DOE 1997c) would have to be amended, since removal of the retrievable TRU waste in the SWSA 5 North trenches is a main component of the selected remedy for the Melton Valley Watershed.

2.3.3 Schedule of Activities

The No Action Alternative assumes institutional control of the waste identified for treatment under the proposed action in this EIS for 100 years.

2.4 LOW-TEMPERATURE DRYING ALTERNATIVE (PREFERRED ALTERNATIVE)

DOE has awarded a contract with the Foster Wheeler Environmental Corporation (Foster Wheeler) to construct a waste treatment facility and to treat and package the TRU wastes for disposal offsite. The contract with Foster Wheeler was awarded contingent on the completion of the NEPA review and selection of the Foster Wheeler proposal. DOE continues to analyze environmental impacts and evaluate alternative actions while Phase I (Licensing and Permitting) of the contract awarded to Foster Wheeler is under way. If the current NEPA review results in the selection of an alternative other than the preferred alternative, Phase II (construction and pre-operational testing) of the contract would not be executed.

Foster Wheeler proposes to use a low-temperature drying treatment for the tank waste, and sorting, compaction, and repackaging for the solid waste, before the waste is certified by DOE for final disposition at a disposal facility that is consistent with the WM PEIS. The contract allows DOE and Foster Wheeler to identify other potential waste streams for treatment at this facility during Phase I of the contract and may include newly generated waste from the ORR, or small amounts of legacy TRU waste from other sites. Before any such waste streams would be considered or shipped to ORNL, they would be subject to further NEPA review, as appropriate.

2.4.1 Facility Description

The Low-Temperature Drying Alternative (Preferred Alternative) would involve the construction of a three-and-one-half-story waste treatment facility approximately 37 m (120 ft) west of the Melton Valley Storage Tank area. The proposed site would encompass 2 ha (5 acres), the approximately 4 ha (10 acres) that would be included in the lease.

The proposed waste treatment and treatment facility would have a partial floor for treatment the supernate between the first and second floors. The facility would be a steel-framed structure with concrete and steel shielding. An attached steel building would house the administrative and personnel areas on the

[3]There would be enough storage capacity for newly generated remote-handled TRU solid waste for approximately 14.5 years, assuming a generation rate of approximately 10 m^3 (350 ft^3) per year. There would be enough storage space for contact-handled TRU waste for approximately 100 years, assuming a generation rate of approximately 5 m^3 (175 ft^3) per year. In the event that construction of any additional storage facilities for newly generated remote-handled and contact-handled solid waste would be needed, these facilities would be evaluated under a separate NEPA review.

north side of the facility, and trailers for the nondestructive examination and assay of the contact-handled solid wastes would be located on the south side of the facility. The total floor area of the facility would be approximately 3,440 m2 (37,000 ft2), comprised of an estimated 1,160 m2 (12,500 ft2) of process area, 1,720 m2 (18,500 ft2) of process support area, and 560 m2 (6,000 ft2) of administration area.

The first floor would contain the remote-handled solid waste cask receiving and staging area as well as the treated solid waste cask and load-out area. Supernate treatment would be performed on the partial floor above the low-level waste load-out area. The dried supernate would be discharged by gravity to liners positioned on truck trailers for final packaging and shipping. The second floor would contain the contact-handled solid waste receiving and characterization area and the contact-handled and remote-handled solids treatment equipment. Facilities to support the building heating, ventilation, and air conditioning (HVAC) and equipment maintenance activities would be located on the third floor. TRU sludge treatment equipment would be located on the fourth floor to receive and dry sludge that would be discharged to canisters located on the second floor. The facility ventilation exhaust stack would be located on the southeast corner of the building and would extend approximately 9 m (30 ft) above the highest point on the building. As shown in Figure 2-3, the facility's first floor elevation would be approximately 235 m (770 ft) above mean sea level, which is above the 100- and 500-year flood elevations. Site development would require an approximate 6-m (20-ft) cut into the west ridge, with fill in the low areas around the facility and roadway areas. Detailed information about the proposed floor plans can be found in Appendix B.

Storm water drainage would be directed around the facility by a series of culverts and drainage ditches as shown in Figure 2-3. This would prevent the facility from receiving storm water runoff from the ridgeline south of the facility. This runoff would be diverted west of the facility by a ditch along the third floor access ramp, and to the east by a berm and culvert arrangement. The drainage ditches would be lined with riprap, as required. Culverts carrying storm water off the facility site would be equipped with gate valves to allow sampling and analysis of the storm water and to provide storm water containment in case of potential contamination. Storm water collected from the top of the Melton Valley Storage Tank vaults would be controlled in a similar manner. In addition, drainage grates would be installed at paved exits to capture and direct runoff from paved areas to the culverts equipped with the gate valves.

Figure 2-3. Proposed site layout for the Low-Temperature Drying Alternative facility, including the locations of the existing Melton Valley Storage Tanks, the process building with truck access and turnaround areas to the first and third floors, and storm water drainage modifications. Site excavation would be minimized by optimizing the topography of the site with the layout of the Low-Temperature Drying Alternative

2.4.2 Waste Treatment Description

This alternative would entail evaporating and drying the sludges and supernates and is flexible enough to cover a wide range of waste properties. Treatment by low-temperature drying would substantially reduce the waste volume, generate minimal amounts of secondary wastes, and meet the waste acceptance criteria of the final disposal facilities. All waste streams would meet the RCRA LDR standards. TRU waste streams would be treated to meet the waste acceptance criteria of the Waste Isolation Pilot Plant. Low-level waste streams would be treated to meet the waste acceptance criteria of the Nevada Test Site or another designated disposal site identified in the Record of Decision for the WM PEIS. Several pollution prevention and waste minimization measures would be implemented with the Low-Temperature Drying Alternative. As pollution prevention measures, storm water would be diverted around the treatment facility and gate valves would be installed in the diversion basins to contain spills. Waste minimization is accomplished by the following methods:

- The Melton Valley Storage Tanks would be sluiced with recycled supernate during sludge retrieval activities.
- Sludge would be washed with recycled condensate from the air-cooled condenser, which receives the ventilation from the low-temperature dryers.
- Dried sludge solids would be loaded directly into TRU canisters to avoid additional secondary waste.
- Low-level solid waste drums that do not contain RCRA waste would be sent directly to the compactor for a 50% volume reduction.
- Secondary solid waste would be compacted for a 50% volume reduction.
- The off-gas system would minimize air emissions.

A summary of the projected volumes of primary, secondary, and decontamination and decommissioning waste is included in Table 2-1. The primary waste volumes would be reduced by low-temperature drying from 4,050 m^3 to 1,391 m^3.

Table 2-1. Summary of projected waste volumes for the Low-Temperature Drying Alternative

Waste Stream	Category	Projected Volume Out[a]	Treatment Requirement
Primary Waste Streams			
Sludge (remote-handled)	TRU	180 m^3	Dry, stabilize
Supernate/sludge wash water	Low-level waste	588 m^3	Dry, stabilize
contact-handled solids	TRU	324 m^3	Various
remote-handled solids	TRU	99 m^3	Various
Solids	Low-level waste	200 m^3	Various
Secondary Waste Streams			
Primary waste containers			
Remote-handled casks	Low-level waste	1,217 m^3	None
Contact-handled drums and boxes	Low-level waste	44 m^3	Compaction
Construction debris	Sanitary	~200 m^3	None
PPE (gloves, booties, etc.)	Low-level waste	214 m^3	Compaction
HEPA filters	Low-level waste	88 m^3	Compaction
Consumables (rags, towels, etc.)	Low-level waste	272 m^3	Compaction
Mechanical parts	Low-level waste/TRU	4 m^3	None
Aqueous waste filter media	Low-level waste	<20 m^3	Compaction
Steam from wet treatment	N/A	N/A	Condense/HEPA filter
Changing/maintenance fluids	Low-level waste/mixed waste	<1 m^3	Stabilize, if required
Laboratory solvents and residues	Low-level waste/mixed waste/TRU	1 m^3	Thermal, none
Laboratory acid digistatis	Mixed waste	<20 m^3	Neutralize/stabilize
Sanitary wastewater	Sanitary	1,560 m^3	Capture
Decontamination and Decommissioning Waste Streams			
Category C, Concrete rubble	Construction debris	5,510 m^3	None
Category A, Free release metals	Recycle, reuse	115 m^3	None
Category B, Non-contaminated metals	Construction debris	30 m^3	None
Category B, Contaminated materials	Low-level waste	135 m^3	Compaction
Category D, Miscellaneous	Construction debris	<10 m^3	None
Category E, Special materials	Low-level waste/mixed waste	<1 m^3	Stabilize

[a]Volumes are waste product volumes in final disposal containers based on total inventory of waste (base + optional volumes) expected to be processed at the facility.

HEPA - High-Efficiency Particulate Air.
PPE - personal protective equipment.
TRU - transuranic.
~ - approximately.

2.4.2.1 Tank waste treatment (sludge and supernate)

The simplified block flow diagram for the tank waste treatment systems is illustrated in Figure 2-4. Supernate would be pumped from the existing Melton Valley Storage Tanks using equipment moved from tank to tank. The supernate would be pumped through a double-contained, aboveground pipeline to the proposed treatment facility and collected into mixing/sample tanks. The supernate from the Melton Valley Storage Tanks may be transferred to an evaporator for volume reduction before transfer to the mixing/sample tanks. In order to meet RCRA LDR standards and waste acceptance criteria for a WM PEIS-approved, low-level waste disposal facility (e.g., Nevada Test Site, or another designated disposal facility), additives would be mixed with the supernate in these tanks, as required for the downstream treatment operations. The supernate dryer would receive feed batches from the mixing/sample tanks for final concentration and drying into a stabilized particulate product. The treated

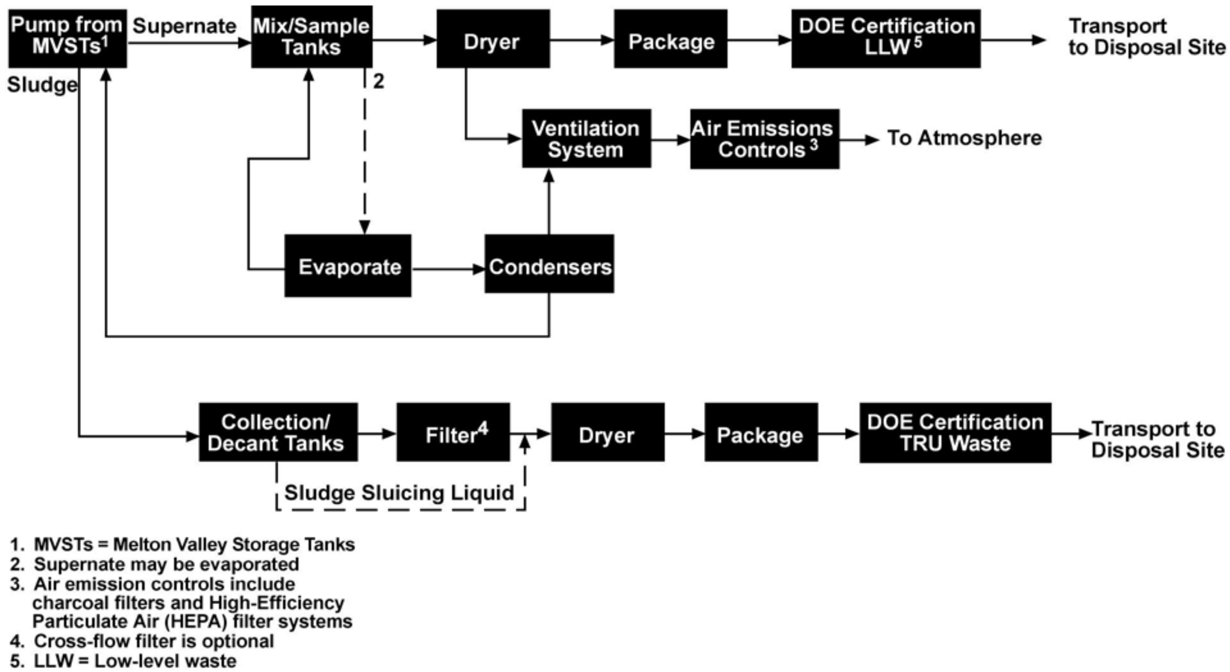

Figure 2-4. Tank waste treatment flow diagram for the Low-Temperature Drying Alternative.

waste would be loaded directly into a disposal container that is pre-loaded in a transportation cask for shipment. Vapors from the dryer would be routed through an air-cooled condenser. Condensate may be stored in a reservoir for reuse in sludge retrieval, or evaporated and discharged as part of the building ventilation flow through appropriate high-efficiency particulate air (HEPA) filtration.

Sludge that would be retrieved from the Melton Valley Storage Tanks by sluicing with recycled liquids would be directed to the supernate, condensate, or water. Recycled condensate or water would be preferentially used to allow washing of the sludge solids to separate soluble solids. The sluiced sludge would be transferred in a double-contained, aboveground pipeline to the sludge collection/decant tanks in the facility. These tanks would have the potential for concentrating the sludge by gravity settling. Sluiced sludge would be analyzed, mixed with appropriate additives, and concentrated for drying.

After analysis, the concentrated sludge/additive mixture would be transferred in batches to the sludge dryer. The sludge drying system would function in a similar fashion to the supernate dryer. For optimum efficiency, the dried sludge solids would be loaded directly into Waste Isolation Pilot Plant TRU canisters. Sludge distillate may be condensed or directed to the supernate treatment system.

2.4.2.2 Solid waste treatment (remote-handled and contact-handled solids)

DOE would deliver drums and boxes of the contact-handled solid waste to the proposed treatment facility. Foster Wheeler would perform visual inspections and radiation and contamination surveys prior to acceptance of the waste containers. The drum contents would be characterized by performing a non-destructive examination and assay in an adjoining enclosure before transfer to a staging area. The low-level waste drums that do not contain RCRA waste would be treated in a drum compactor for a 50% volume reduction, overpacked, weighed, and conveyed back to the shipping/receiving area for final certification by DOE. The simplified block flow diagram for the tank waste treatment systems is illustrated in Figure 2-5.

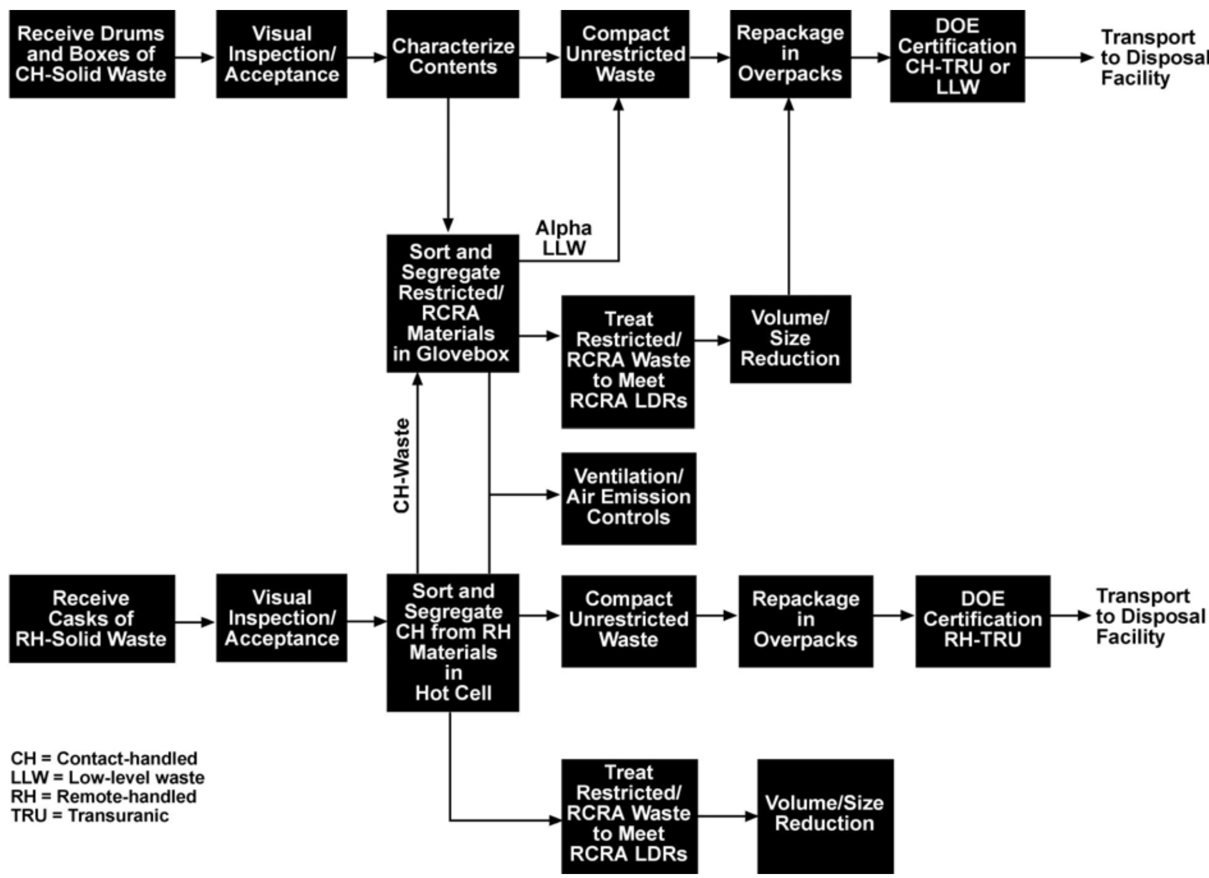

Figure 2-5. Solid waste treatment flow diagram for the Low-Temperature Drying Alternative.

The remaining drums would be transported to the process line area. The drums would be moved into a glovebox, opened, and the contents would be tipped onto a sorting tray where restricted/RCRA waste materials would be segregated manually via glove ports. The segregated low-level waste would be treated as described above. The RCRA/restricted waste materials would be treated by macroencapsulation or other techniques to meet RCRA LDR standards. Following treatment the solid waste would be volume and size reduced. Depending on the TRU activity, the waste would be repackaged to meet the appropriate waste acceptance criteria, and certified for shipment by DOE.

Incoming boxes of waste would be moved into a glovebox. Waste would be removed from the boxes and placed on the sorting trays using waste removal tools attached to manipulators. RCRA/restricted waste would be segregated for handling in an adjacent treatment station. The remaining waste would be placed in drums and compacted "in-drum" prior to transfer back to the nondestructive examination and assay area for final certification by DOE and shipment to the Waste Isolation Pilot Plant. Secondary waste, such as empty waste containers, personal protective equipment, etc., would also be compacted prior to final certification by DOE and shipment offsite by the contractor to an appropriate disposal facility.

DOE would deliver the concrete casks containing remote-handled solid waste to the proposed waste treatment facility. Foster Wheeler would inspect and survey the waste upon receipt and then transfer the cask inside the facility. Treatment is initiated by raising the cask into a docking position with a hot cell to allow access to the cask lid from inside the hot cell. The contents of the cask would be removed using waste removal tools mounted on an overhead crane. Any oversized remote-handled TRU waste that is too large to fit into a canister would be size reduced. Waste would be placed in trays and conveyed through a nondestructive examination and assay station. A local gamma detector would identify any contact-handled waste, which would be routed directly to the contact-handled solids treatment glove box for treatment as discussed above. Waste that is compliant with LDR standards would be compacted and loaded into canisters docked at the load-out port on the hot cell. Higher activity low-level waste segregated in the sorting operation would be loaded into shielded drums at a separate load-out port for waste certification by DOE. Waste that does not meet RCRA LDR standards will be treated via macroencapsulation or other methods to meet RCRA LDR standards in the event that unanticipated storage is required.

2.4.3 Schedule of Activities

The total duration of the Low-Temperature Drying Alternative would be approximately 11.5 years, with less than 5 years of waste treatment. The proposed waste treatment schedule minimizes environmental impacts by combining the tank and solid waste treatment timelines, thus optimizing the sorting and segregation of TRU wastes for shipment to the Waste Isolation Pilot Plant and low-level waste for shipment to the Nevada Test Site, or another facility to be designated in the Record of Decision for the WM PEIS. The schedule is designed to enable shipments to be certified by DOE for acceptance at the designated disposal facility within a reasonable time frame. It also allows the reduction in peak personnel loading and related personnel support facilities. The Low-Temperature Drying Alternative would consist of four phases. The four phases are depicted in Figure 2-6, with further schedule detail provided in Figure 2-7 for the treatment of the tank wastes and solid wastes.

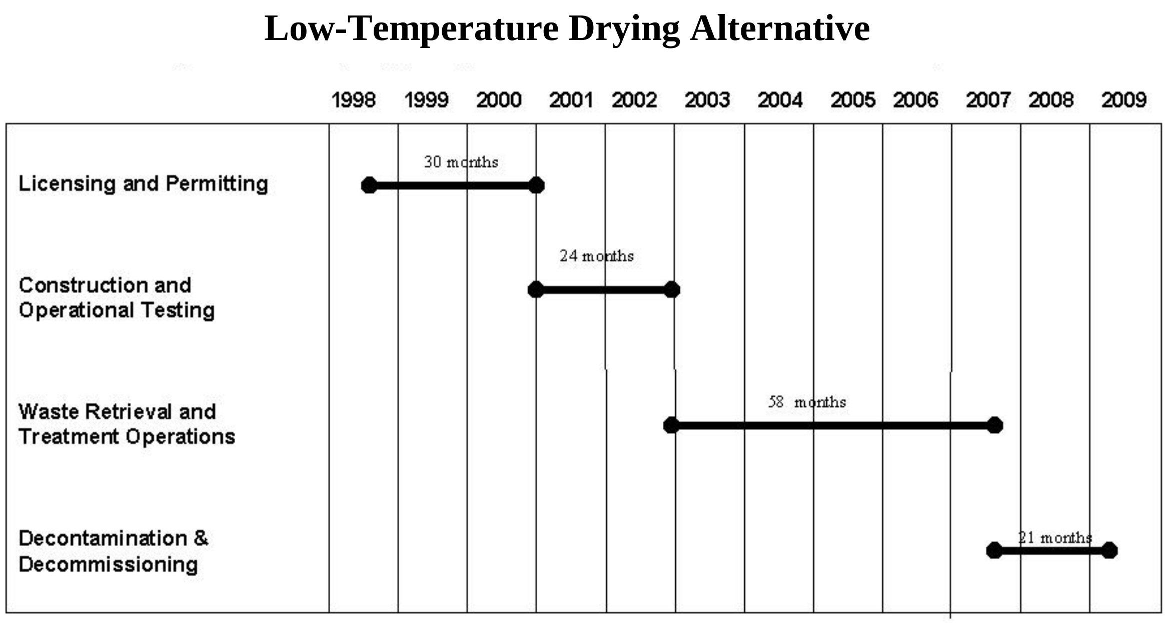

Figure 2-6. The Low-Temperature Drying Alternative would take place over a period of approximately 11.5 years.

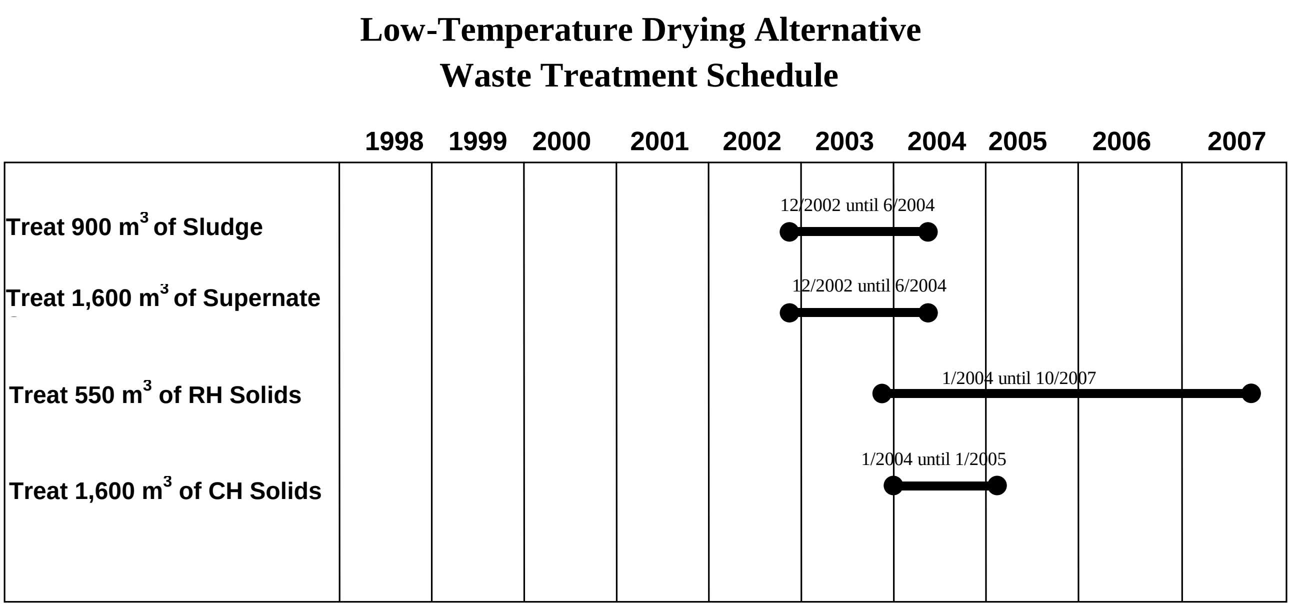

Figure 2-7. Waste treatment would be completed in approximately 3.5 years utilizing the Low-Temperature Drying Alternative.

2.5 VITRIFICATION ALTERNATIVE

The Vitrification Alternative would convert the sludge and supernate waste into a stabilized glass form, and segregate and super-compact the solid contact-handled TRU and remote-handled TRU solid wastes.

2.5.1 Facility Description

The facility for the Vitrification Alternative would be located on 2 to 2.8 ha (5 to 7 acres) west of the Melton Valley Storage Tank facility as indicated in the Proposed Action. The vitrification facility would be a three-and-one-half-story, steel-framed structure measuring 46 m × 76 m × 14 m (150 ft × 250 ft × 45 ft) with concrete and steel shielding. The total floor area would be approximately 7,400 m^2 (80,000 ft^2), with an estimated 2,800 m^2 (30,000 ft^2) for the process area and 4,600 m^2 (50,000 ft^2) for the process support area. Doublewide trailers would be brought onsite to provide a detached administration area of approximately 740 m^2 (8,000 ft^2).

2.5.2 Waste Treatment Description

The waste treatment for the Vitrification Alternative consists of sorting, compaction, grouting, and vitrification (changing the waste to a stable glass form by melting) to treat the waste (Figure 2-8). The vitrification system would treat liquids, soils, sludges, and other materials that are smaller than the RCRA definition of debris. A first-pass material balance for the vitrification treatment of remote handled TRU sludges, a material balance for the contact-handled TRU solid waste, and three material balances for the remote-handled TRU solid waste are presented in Appendix B, in the section covering Vitrification Alternative details. Assumptions used to develop these material balances and to determine a final stabilized waste form were based on information about the vitrification facilities at West Valley, New York, and Hanford, Washington, and the Melton Valley Storage Tanks treatability studies (Spence and Gilliam 1998). The assumptions also considered the characteristics of the existing waste. The Vitrification Alternative would implement several pollution prevention and waste minimization measures. As pollution prevention measures, storm water would be diverted around the facility and gate valves would be installed in the diversion basins to contain spills. Waste minimization would be accomplished by the following methods:

- Tank supernate would be used as the mixing media for sludge retrieval in the Melton Valley Storage Tanks.
- A cold cap would be maintained on the molten glass in the melter to minimize the loss of volatile organics to the atmosphere.
- The solid waste drums would go through an initial characterization process. Drums not needing sorting and repackaging would be sent directly to the super-compactor for a 50% to 80% volume reduction.
- The off-gas system would minimize air emissions.

A summary of volumes of primary, secondary, and decontamination and decommissioning waste streams are included in Table 2-2.

Table 2-2. Summary of projected waste volumes for the Vitrification Alternative

Waste Stream	Category	Projected Volume Out[a]	Treatment Requirement
Primary Waste Streams			
Sludge/Supernate	TRU	577 m^3	Vitrification
Contact-handled solids	TRU	260 m^3	Various
Remote-handled solids	TRU	116 m^3	Various
Remote-handled solids	Low-level waste	87 m^3	Various
Secondary Waste Streams			
Primary waste containers			
Remote-handled casks	Low-level waste	946 m^3	Volume reduction
Contact-handled drums and boxes	Low-level waste	44 m^3	Volume reduction
Construction debris	Sanitary	200 m^3	None
PPE (gloves, booties, etc.)[b]	Low-level waste	315 m^3	Volume reduction
HEPA filters[b]	Low-level waste	82 m^3	Volume reduction
Consumables (rags, towels, etc.)[b]	Low-level waste	181 m^3	Volume reduction
Mechanical/maintenance items	Low-level waste/TRU	97 m^3	Volume reduction
Industrial waste water	Low-level waste/ sanitary	1,108 m^3	Capture
Evaporator concentrate	Low-level waste	326 m^3	Cementation
Laboratory solvents and residues	Low-level waste/mixed waste/TRU	2 m^3	Vitrification, stabilization
Sanitary solids	Sanitary	718 m^3	Capture
Sanitary wastewater	Sanitary	6,283 m^3	Capture
Decontamination and Decommissioning Waste Streams			
Concrete rubble	Construction debris	20,712 m^3	None
Free release metals	Recycle, reuse	120 m^3	None
Non-contaminated metals	Construction debris	48 m^3	None
Contaminated materials	Low-level waste	1,894 m^3	Volume reduction
Vitrified and residual material	TRU	10 m^3	None
Special materials	Low-level waste/mixed waste	2 m^3	Stabilize, special treatment

[a]Volumes are waste product volumes in the final disposal containers.
[b]If the waste is determined to be hazardous, the waste would also be macroencapsulated
HEPA - High-Efficiency Particulate Air. TRU - transuranic.
PPE - personal protective equipment.

2.5.2.1 Tank waste treatment (sludge and supernate)

Retrieved sludge and supernate from the Melton Valley Storage Tanks would remain commingled and then immobilized in a soda-lime-silica glass matrix to form a TRU waste product that meets both RCRA LDR standards and the Waste Isolation Pilot Plant waste acceptance criteria. In the Melton Valley Storage Tanks sludge treatability study (Spence and Gilliam 1998), tests were conducted on the Melton Valley Storage Tanks sludge using soda-lime-silica glass formers. The treated waste (i.e., glass sample - Melton Valley Storage Tank - V-18) had a specific gravity of 2.8, which indicated a waste loading (by mass) of 41%. The specific gravity helps to correlate the leachability of the waste and the stability of the waste form, and helps determine if the volume of treated waste is optimized. The sludge and supernate treatment process can be subdivided into four subsystems: the waste retrieval/receipt system, the melter feed preparation system, the melter system, and the off-gas treatment system.

Retrieved waste sludge and supernate would enter the treatment facility through the waste retrieval/receipt system (Figure 2-8). This system would provide buffer storage between the treatment facility and the waste retrieval system, and homogenize the sludge and supernate mixture for feed characterization (which will also determine the required glass former blend). Sludge and supernate retrieval operations would be conducted in the Melton Valley Storage Tanks using pulsed jet mixing, rather than sluicing, which would allow the existing supernate in the Melton Valley Storage Tanks to be used as the "mixing" media. Treatment one tank at a time, the sludge would be mobilized and pumped to one of two sludge/supernate waste receipt tanks at the facility. Waste retrieval operations would be conducted only during day shifts with operations personnel stationed at a control module at the Melton Valley Storage Tanks and at the treatment facility control room.

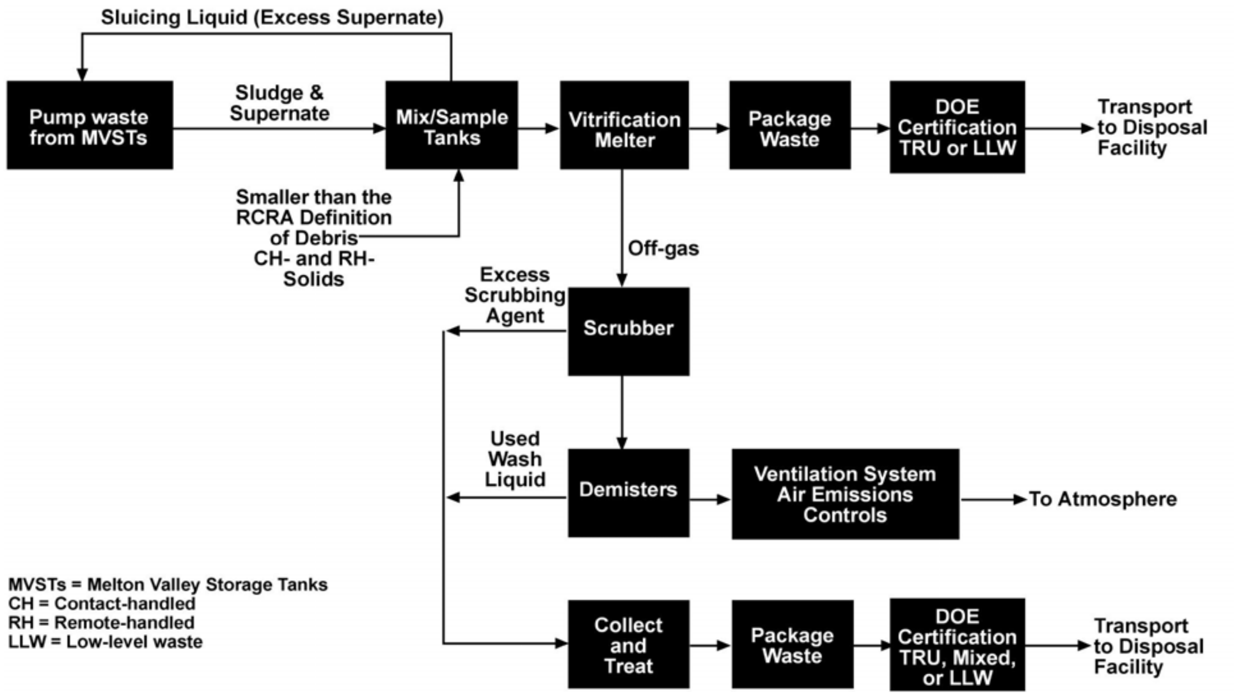

Figure 2-8. Treatment flow diagram for sludge, supernate, and solid waste smaller than the RCRA definition of debris for the Vitrification Alternative.

The stainless steel waste receipt tanks would provide feed for 7 days of full operations for the melter system. This would minimize the impact on waste treatment due to downtime in the retrieval system, or hard-to-retrieve sludge. The waste receipt tank would be isolated from the retrieval system once it is filled. The second tank, if available, becomes the waste retrieval tank. A mechanical agitator would homogenize the waste to prevent solids from settling in the waste receipt tank. Homogenized waste would be sampled to determine the chemical and radiochemical composition for Waste Isolation Pilot Plant waste certification requirements, and to confirm that the treatment facility is meeting operational parameters. Once the analysis results confirm that the composition is acceptable, the waste receipt tank is considered part of the melter feed preparation system.

The melter feed operations include preparation of the dry glass-forming chemicals, mixing the dry chemicals with the homogenized waste stream, and feeding the resultant slurry to the melter. Glass-forming chemicals anticipated to be used for waste treatment include: soda (Na_2CO_3 - to get the alkali component: Na_2O), lime (CaO), and silica (SiO_2 - for glass forming). Alumina may also be used for glass forming. Based on the average concentrations and information provided from the treatability studies

(Spence and Gilliam 1998), the glass former blend would be approximately 14.3% $CaCO_3$, 41% dried waste, and 44.7% SiO_2. Batches of waste and glass-forming compounds would be prepared for 24 hours of melter operations. The appropriate quantity of glass-forming components would be measured and fed into a hopper. An appropriate amount of homogenized waste would be transferred into a feed preparation tank along with the glass-forming chemicals from the hopper. Once the waste and dry chemicals are blended, a pump would transfer the blend to the melter feed tank. A mechanical agitator in the feed tank would keep the contents homogenous and to prevent solids settling.

The melter would have a throughput of 2 metric tons of glass per day and a minimum availability of 70%, equivalent to 260 operating days per year on a 7-day, around-the-clock basis. The glass product would occasionally be sampled to confirm that chemical composition is within the required range to produce acceptable quality glass. The melter would be a slurry-fed, joule-heated, ceramic unit, operating at a temperature of approximately 1,150^{o}C (2,100^{o}F). The melter would include a few safety features, such as a water-cooled refractory to contain the glass and a cold cap of unmelted glass floating on the glass surface. The cold cap helps minimize the loss of volatile chemicals to the off-gas system. Most of the feed components would be converted to their oxides, which dissolve in the molten glass. During the decomposition process, gases would be formed, heated, and released into the melter plenum and routed to the off-gas system. A fraction of the feed components would be directly carried over to the off-gas system without incorporation into the glass. However, some components would be volatile in the melter, and a significant fraction of these materials would be released to the off-gas system. The solids and semi-volatile components would be recycled back to the melter from the off-gas system to increase the incorporation rate for these components in the glass.

The major components of the off-gas resulting from the melter's thermal processes would be nitrogen and oxygen due to air in-leakage to the melter and decomposition reactions occurring in the melter. Other major components of the off-gas would be superheated steam from the evaporation of water, and NO_x from decomposition of metal nitrates. Chloride, fluoride, and SO_x would also be present due to feed decomposition, although in low concentrations compared to NO_x. The off-gas treatment system would exhaust gases from the melter plenum, maintain the melter at a negative pressure in relation to its cell, and clean the off-gas prior to stack discharge. The off-gas treatment system would consist of a primary system and a secondary system.

The primary off-gas treatment system would consist of three components: a film cooler, an off-gas quencher/scrubber, and a demister. This system would remove particulate carryover from the melter into the off-gas, the majority of radionuclides, a substantial amount of the acid gasses, and cool the off-gas prior to further treatment. The film cooler would cool the exiting off-gas to between 350 and 400^{o}C (662 to 752^{o}F) by injecting compressed air into the off-gas stream. The off-gas would then be drawn into an off-gas quencher/scrubber to further cool the off-gas. Hastelloy C or other similar metal alloys would be used for construction of the scrubber due to the high corrosion rate [> 0.05 in./year (Perry and Chilton 1973)] caused by the heat and high concentrations of halogen acid gases in the off-gas. The scrubbing agent could be water or slightly basic caustic. The scrubbing agent liquid would be collected and recycled back into the treatment process (as sluicing water that has better solubility capacity than supernate), or treated and disposed of as a secondary waste. Immediately downstream of the scrubber would be a pair of demisters. The demisters would remove mist and particulates from the off-gas stream, including the 90% or more of the remaining radionuclides in particulate form. The demisters would be washed regularly to prevent damaging downstream equipment such as pumps. Used demister wash liquid would be collected in a sump and recycled to help mobilize the sludge, or reprocessed.

The secondary off-gas treatment system performs final particulate filtration prior to stack discharge and consists of four HEPA filters in parallel sets of two. Each HEPA filter removes up to 99.95% of the remaining particulates in the off-gas stream. Gases (primarily air) leaving the HEPA filters are directed to the off-gas stack. Previous vitrification analysis conducted at DOE's Hanford site indicates that approximately 40% of the nitrate feed would be converted to nitrogen by the melter. Thus, it is possible that emissions from this treatment method would be below the Tennessee permit exemption levels without additional off-gas treatment systems.

2.5.2.2 Solid waste treatment (remote-handled and contact-handled solids)

In general, the remote-handled and contact-handled solid wastes would be sorted, treated, repackaged, compacted, overpacked, grouted, certified by DOE, and packed in appropriate transport containers. Certified TRU waste would be disposed at the Waste Isolation Pilot Plant, and low-level waste would be disposed in a manner consistent with the WM PEIS Record of Decision for low-level waste (e.g., the Nevada Test Site or another designated disposal facility). A small amount of the contact-handled and remote-handled solid wastes would be treated by vitrification if their size is smaller than what RCRA defines as debris. Mixed wastes that are primarily solids with RCRA metal constituents are expected to meet the definition of debris and would be macroencapsulated per the alternative treatment standards found in 40 *CFR* 268.45, Table 1. The treated waste would meet RCRA LDR standards in the event that unanticipated storage is required onsite. Materials not considered debris would be segregated and treated at the facility to allow disposal.

The solid waste treatment train would be remotely operated, and primary subsystems include solid waste receipt, the solid waste pretreatment system, the compaction and repackaging systems, and the macroencapsulation system (Figure 2-9). Solid waste containers would be unloaded in the solid waste receipt area and monitored for surface radiation dose level and contamination. Remote-handled solid waste would not be received until all of the contact-handled solid waste is processed. The wastes would be brought to the second floor bay area. This buffer storage area would remain at a minimal level (approximately one full week of treatment).

Solid waste would be characterized by nondestructive examination and assay methods, such as High Resolution Gamma Spectroscopy and passive and active neutron analysis, to determine the fissile content. Some containers may not require repackaging if their contents are confirmed as debris by real-time radiography. All other waste containers would be transferred to the hot cell for characterization. Solid wastes that may contain hazardous constituents, such as lead and mercury, would be treated in the Special Treatment Operations area. Special waste material such as batteries, aerosols, and gas bottles, would be sorted from the debris waste, collected, and sent to a special treatment cell, or some other applicable treatment facility. The sorting would be done with a remote manipulator; however, if dose limits are sufficiently low (e.g., less than 10 mrem/hour), some of the wastes contained in 30- and 55-gallon drums may be sorted by hand. Some material (e.g., metal) may be resized in order to maximize the waste volume in a sorted container. Sorted waste containers would be sent to the supercompactor.

Drums of repackaged contact-handled and remote-handled solid wastes would be characterized and weighed before compaction to provide the information for DOE waste certification. The compacted repackaged waste would be in the form of a puck between one-half to one-fifth of the height of the original container. Waste pucks would be cataloged for size, weight, and activity and then placed in 55-gallon drums in such a manner to ensure full encapsulation by the grout (the assumed macroencapsulating material). Grout would be metered to ensure encapsulation around the pucks. The grouted overpack container would be placed into the buffer storage area until the grout has set.

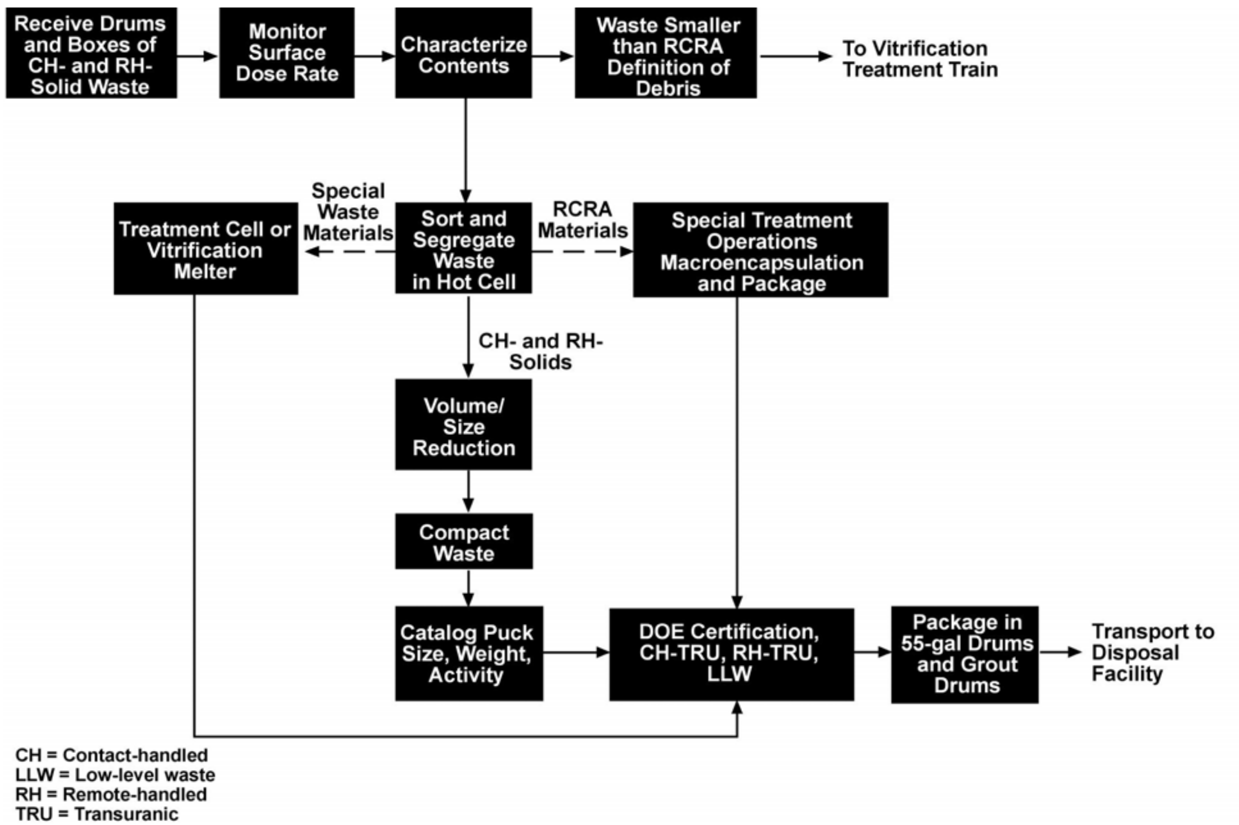

Figure 2-9. Vitrification Alternative flow diagram for solid waste treatment.

2.5.3 Schedule of Activities

The total project duration of the Vitrification Alternative would be approximately 10 years, with about 3 years of waste treatment. Following 3 months of cold commissioning after construction of the facility, hot operations would be conducted for a period of 2.75 years. This treatment schedule combines the tank and solid waste treatment timelines and adjusts shift requirements to balance the life cycle of operations while minimizing duplication of treatment unit operations and treatment equipment. This approach would allow for reduction in peak personnel loading (except during construction activities) and related personnel support facilities. Contact-handled solids would be treated first and would normally proceed at a rate of approximately 13 drum equivalents per day on a 2-shift, 5-day basis. The remote-handled solids treatment would proceed at a rate of approximately 0.7 casks per shift on a 2-shift, 5-day basis. Contact-handled solid waste treatment would require approximately 1.25 years of operations, and remote-handled solid waste treatment would require 1.5 years. The overall project schedule is depicted in Figure 2-10, and details of the waste treatment schedule are provided in Figure 2-11.

Vitrification Alternative Schedule

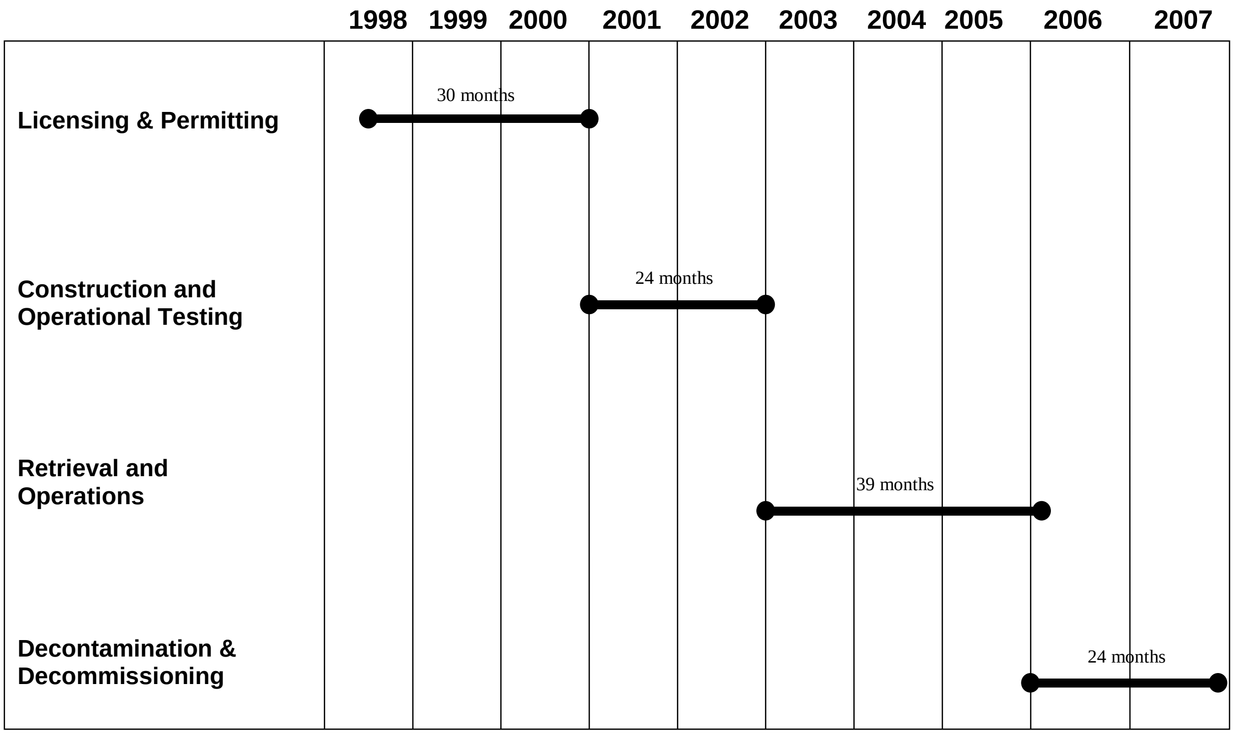

Figure 2-10. Vitrification Alternative project schedule.

Vitrification Alternative Waste Treatment Schedule

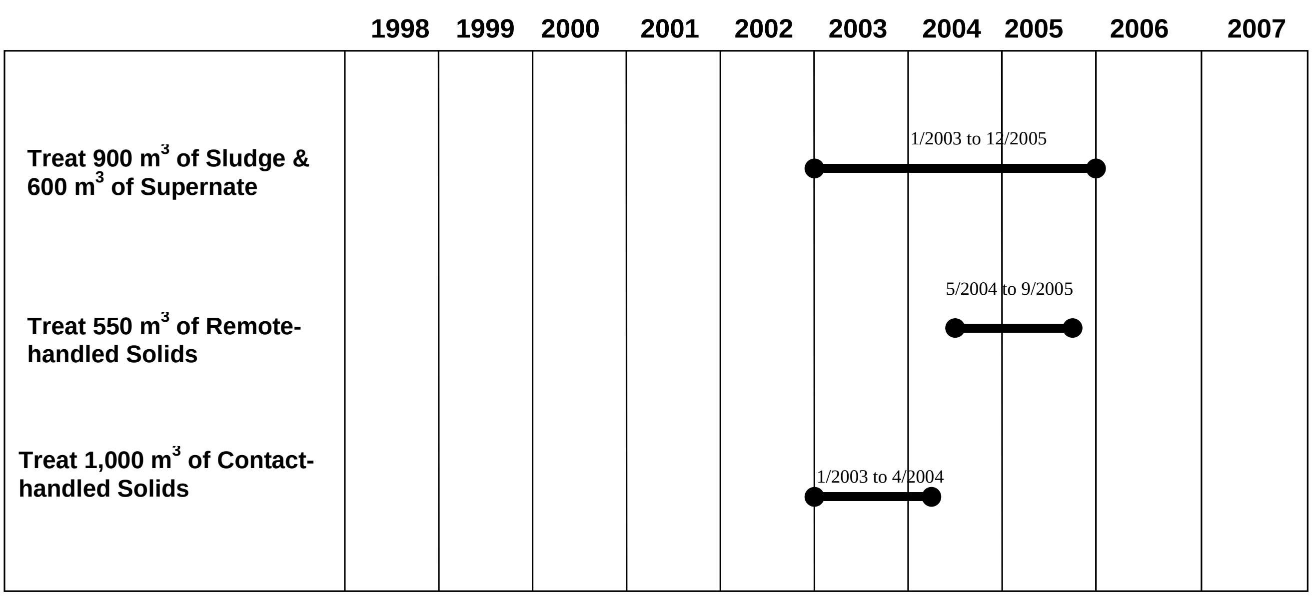

Figure 2-11. Vitrification Alternative waste treatment schedule.

2.6 CEMENTATION ALTERNATIVE

The Cementation Alternative consists of sludge and supernate separation by hydrocyclone/centrifuge pre-treatment and subsequent cementation for the tank wastes, and segregation and supercompaction for the contact-handled and remote-handled solid wastes.

2.1.1 Facility Description

The facility for the Cementation Alternative would be located within an approximate 2-ha (5-acre) plot of land located immediately west of the Melton Valley Storage Tanks. The process building would be a three-and-one-half-story structure. The facility would be a 3.7 m × 61 m × 14 m (120 ft × 200 ft × 45 ft) steel-framed structure with concrete and steel shielding. The total floor area of the cementation facility would be approximately 5,575 m^2 (60,000 ft^2), with an estimated 1,860 m^2 (20,000 ft^2) for the process area and 3,720 m^3 (40,000 ft^2) for the process support area. Doublewide trailers would be brought onto the site to provide approximately 560 m^2 (6,000 ft^2) for the administration area that would be detached from the process building.

2.6.1 Waste Treatment Description

The cementation technology is based on operations conducted at DOE's Hanford facility near Richland, Washington, and information provided in a feasibility study (Parallax 1995). As pollution prevention measures, storm water would be diverted around the facility and gate valves would be installed in the diversion basins to retain spills. The off-gas system would minimize air emissions, and liquid used for the decontamination of the cementation treatment system would be transferred back into the cementation treatment system as waste minimization measures. A summary of volumes of primary, secondary, and decontamination and decommissioning waste is included in Table 2-3.

2.6.1.1 Tank waste treatment (sludge and supernate)

The Cementation Alternative would use hydrocyclone and centrifuge waste pre-treatment to separate the supernate from the sludge. The majority of the liquids would be recycled through the Melton Valley Storage Tanks for sludge mobilization. After separation, the pretreated sludges would be treated by cementation (Figure 2-12). The facility would oscillate between treatment for supernate and treatment for sludge.

The initial step would be pretreatment to remove excess liquid from the sludge/supernate mixture following sludge retrieval. The pretreatment process would include storage tanks for the sludge/supernate, feed tanks for the cement mixer, metering equipment for pH adjustment additives, and associated pumps and instrumentation. A hydrocyclone in series with a centrifuge would separate the sludge from the supernate. The hydrocyclone is a centrifugal device with no moving parts. Solids from the hydrocyclone would gravity drain into the feed tank. The centrifuge would receive the effluent from the hydrocyclone and then provide a sufficiently high gravity force to effectively remove suspended solids ranging from 1 to 20% weight, with particle sizes ranging from 2 to 150 µm, at a flow rate up to 60 gallons per minute (actual flow rate would be dependent on the rate of sludge and supernate retrieval from the Melton Valley Storage Tanks). A back-drive system would be included with the centrifuge design to maintain a desired slurry discharge of 25% weight total suspended solids. A supernate collection tank would temporarily hold the liquid streams from the hydrocyclone and centrifuge before the supernate is pumped back for sludge mobilization.

Table 2-3. Summary of projected waste volumes for the Cementation Alternative

Waste Stream	Category	Projected Volume Out[a]	Treatment Requirement
Primary Waste Streams			
Sludge	TRU	1,287 m^3	Cementation
Supernate	remote-handled low-level waste	2,453 m^3	Cementation
Contact-handled solids	TRU	260 m^3	Various
Remote-handled solids	TRU	116 m^3	Various
Remote-handled solids	remote-handled low-level waste	87 m^3	Various
Secondary Waste Streams			
Primary waste containers			
Remote-handled casks	Low-level waste	946 m^3	Volume reduction
Contact-handled drums and boxes	Low-level waste	36 m^3	Volume reduction
Construction debris	Sanitary	200 m^3	None
PPE (gloves, booties, etc.)[b]	Low-level waste	384 m^3	Volume reduction
HEPA filters [b]	Low-level waste	83 m^3	Volume reduction
Consumables (rags, towels, etc.) [b]	Low-level waste	257 m^3	Volume reduction
Mechanical/maintenance items	Low-level waste/TRU	130 m^3	Volume reduction
Laboratory solvents and residues	Low-level waste/ mixed waste/TRU	2 m^3	Vitrification, stabilization
Sanitary solids	Sanitary	2,217 m^3	Capture
Sanitary wastewater	Sanitary	5,020 m^3	Capture
Decontamination and Decommissioning Waste Streams			
Concrete rubble	Construction debris	14,111 m^3	None
Free release metals	Recycle, reuse	77 m^3	None
Non-contaminated metals	Construction debris	32 m^3	None
Contaminated materials	Low-level waste	1,127 m^3	Volume reduction
Special materials	Low-level waste/ mixed waste	1 m^3	Stabilize, special treatment

[a]Volumes are waste product volumes in the final disposal containers.
[b]If the waste is determined to be hazardous, the waste would also be macroencapsulated .
HEPA - High-Efficiency Particulate Air. TRU - transuranic.
PPE - personal protective equipment.

The stainless steel feed tanks would be sized to allow continuous transfer of the sludge and supernate to the cementation facility. The feed tanks would be filled by the bottoms discharge of the hydrocyclone and centrifuge, and would contain approximately 25% weight total suspended solids. The feed tanks could also perform as settling tanks, if maintenance downtime is required for the centrifuge or hydrocyclone. Agitators would provide the required continuous mixing of the sludge, and a decant pump would remove any excess effluent. The feed tanks would be plumbed for metering the pH adjustment solution (e.g., HCl and NaOH). The metered waste slurry would be transferred from the feed tanks to the cementation batch process system using positive displacement pumps (Figure 2-12).

A dry blend storage tank assembly would store the premixed cementation/stabilization agents, and would consist of feed input, storage, and feed transfer systems. Premixed cementation/stabilization blends would be conveyed pneumatically to the storage bin. In-line sampling capability would be provided for the pneumatic feed conveyance system to verify the premix chemistry. Storage of the stabilization mixture would be provided by a vibrating bottom hopper fitted with mechanically activated level switches, and air pulse mixing that would be ducted to a baghouse and eventually to HEPA filters for air discharge. The feed transfer system would include a weigh belt feeder, transfer conveyor, transport

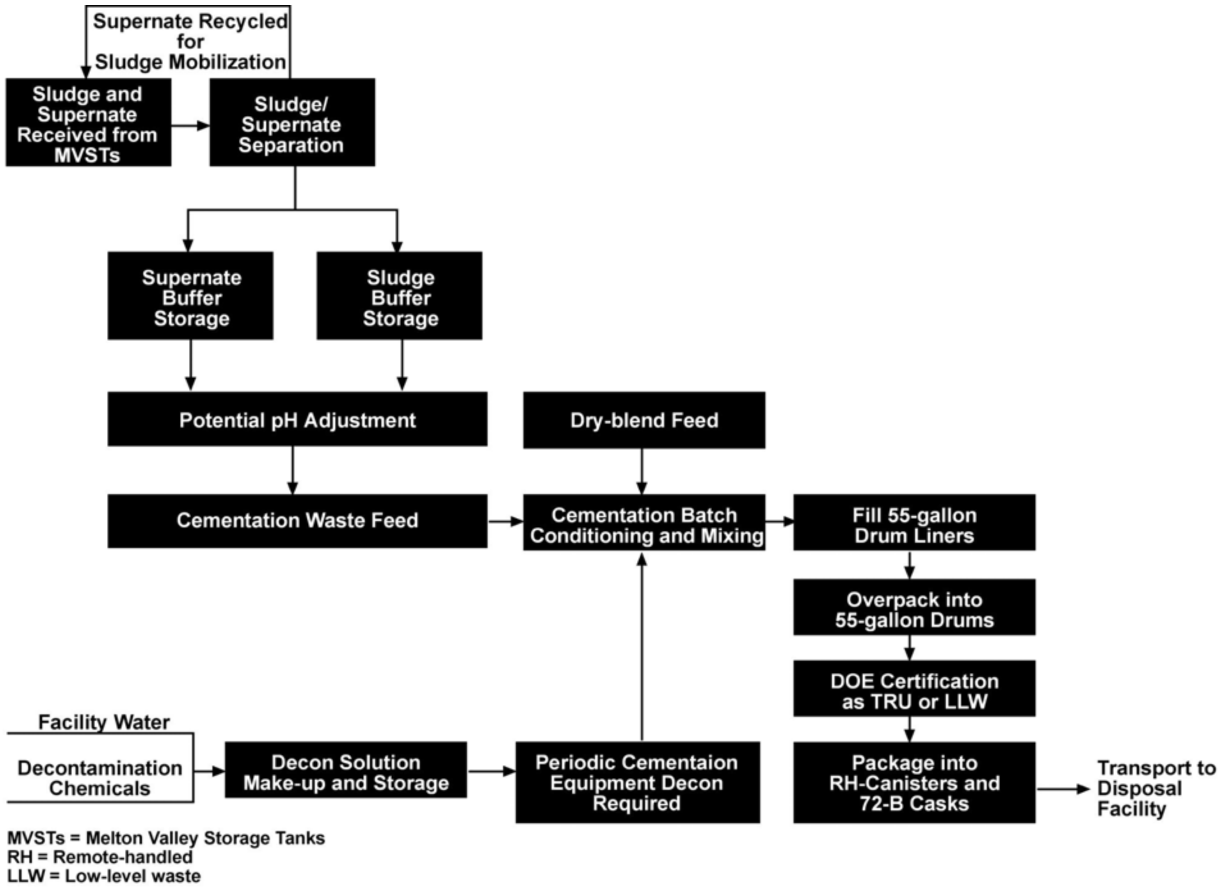

Figure 2-12. Flow diagram for tank waste treatment for the Cementation Alternative.

blower, and tramp screen that feeds stabilization mixtures through a rotary valve. A truck would deliver the dry blend to the treatment facility, for deposit into the dry blend storage tank, which would contain enough premixed blend to process sludge for 5 to 7 days. Approximately 7 lbs of dry blend consisting of 33, 20, 19, 20, and 20% weight of slag, cement, fly ash, perlite, and Indian Red Pottery Clay, respectively (Spence and Gilliam 1998), would be added per gallon of sludge to obtain a stable treated waste product. Approximately 11 lbs of dry blend would be added per gallon of supernate, and would consist of 40, 40, 16, and 4% weight of slag, cement, fly ash, and perlite, respectively.

The dry blend premix would be transferred through the vibrating bin bottom and injected with air for fluidization, then through a rotary airlock to a weigh belt feeder into the cementation mixer. The feed tank metering pump would transfer the waste slurry to the mixer. The cementation mixer is a high-energy, low-shear, twin-screw device that gravity discharges the cement blend into a conical surge tank. The surge tank includes an agitator, and an integral pump controls its level. A grout pump would discharge the waste slurry mixture into 50-gallon drum liners. The drum liners would be filled by weighing and float control instrumentation. Approximately three 50-gallon carbon steel liners could be filled on an hourly basis. The filled liners would remain on the conveyor system for a minimum of 4 hours to allow the cement to harden, then the liners would be placed inside 55-gallon carbon steel overpack drums. A remote manual manipulator would perform external surface contamination analysis of the overpack drums. After passing the analysis, the drums would be transferred to the interim storage area before placement into remote-handled canisters and, ultimately, 72-B casks. It is anticipated that operations would oscillate between cementation of sludge and cementation of supernate on a weekly basis. The treated supernate would be remote-handled low-level waste and would be disposed of at the Nevada Test Site or another facility designated in the WM PEIS Record of Decision for low-level waste.

In addition to the dust collection and filtration (i.e., a baghouse and HEPA filters) for the grout dry blending mixture, particulate emissions would be collected using HEPA filters. The cementation mixing process would contain several spray nozzles to clean the mixer, conveyors, surge tank, and the liquid collection tank. Decontamination chemicals would be used with a cementation pipeline-clearing pump to flush the lines each time the process is stopped, with discharge routed to a liquid collection tank. The contents of the liquid collection tank would be pumped to the pretreatment process for separation and transfer to the supernate collection tank for cementation treatment.

2.6.1.2 Solid waste treatment (remote-handled and contact-handled solids)

In general, treatment of the remote-handled and contact-handled solid waste would include: waste receipt, assaying, opening, sorting, treatment, repacking, compaction, overpacking, grouting, DOE certification, packing in transport containers, and transport to the appropriate disposal facility. The solids treatment for the Cementation Alternative is identical to the Vitrification Alternative. Please refer to Section 2.4.2.2 for detailed information about this process.

2.6.2 Schedule of Activities

The total project duration of the Cementation Alternative is approximately 12.5 years, with 6 years involving waste treatment. The Cementation Alternative would require a longer waste treatment time, which would reduce the radiochemical and particulate emissions in a given year. The longer treatment time is due to the availability of shipments to the Waste Isolation Pilot Plant. The longer treatment time is a result of the shipment capacity allotment given by Waste Isolation Pilot Plant to each approved shipper of certified TRU waste. (If the allocated shipment allotment from Waste Isolation Pilot Plant were not a limiting factor, the sludge and supernate could be treated by this alternative treatment method in 1 or 2 years. The Cementation Alternative's treatment schedule for the waste streams was developed to keep the same number of operating shifts as required for sludge treatment to minimize operating the equipment. This approach would also allow for reduction in peak personnel loading and related personnel support facilities. The overall project schedule is depicted in Figure 2-13. Further schedule detail for the tank and solid waste treatment is provided in Figure 2-14.

Waste treatment would be conducted in the cementation facility for a period of 6 years with a designed treatment rate of 1.25 gallons per minute of sludge/supernate. In order to process the sludge and supernate in 6 years, the cementation facility would need to be operational at least 70% of the year and would require one 8-hour shift per day for 5 days a week. Contact-handled solids would be treated first and would normally proceed at a rate of approximately 6.5 drum equivalents per day on a 1-shift, 5-day basis. Contact-handled solid waste treatment would require approximately 2.5 years of operations. The remote-handled solid wastes would be treated after the contact-handled solids and would proceed at a rate of approximately 0.7 casks per shift on an 8-hour shift per day, 5-day basis. Remote-handled solid waste treatment would require 3 years, based on the facility being operational 80% of the year.

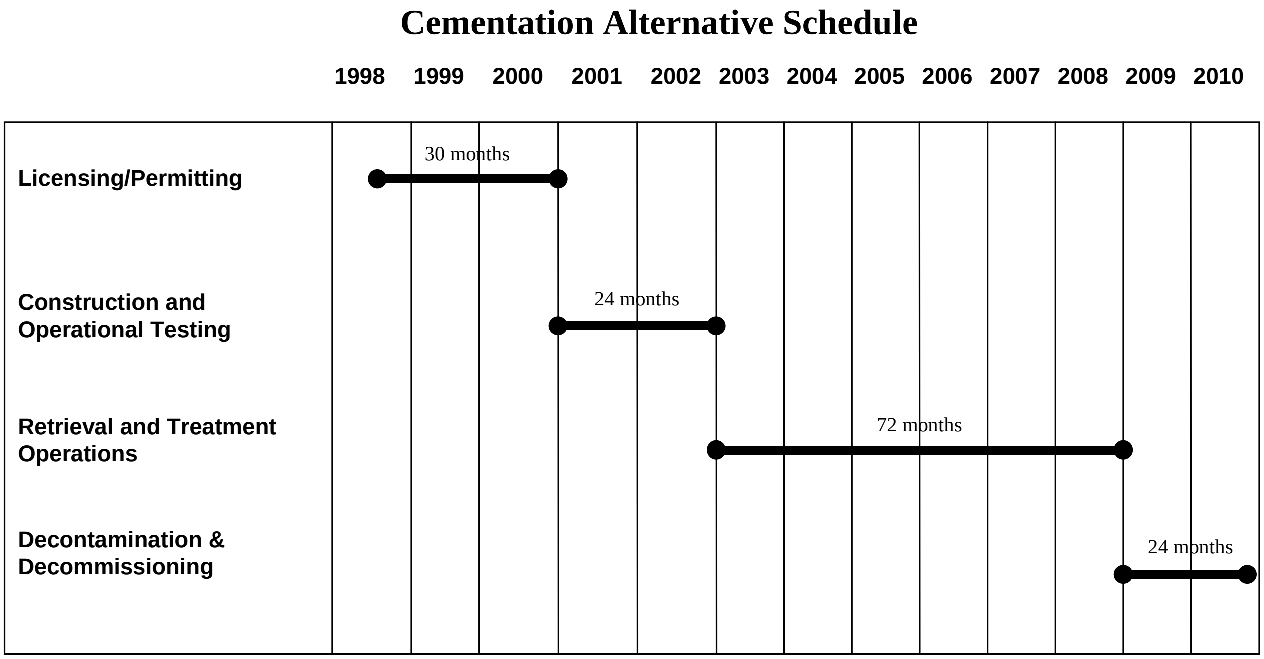

Figure 2-13. The Cementation Alternative Schedule shows the project would take approximately 12.5 years to complete.

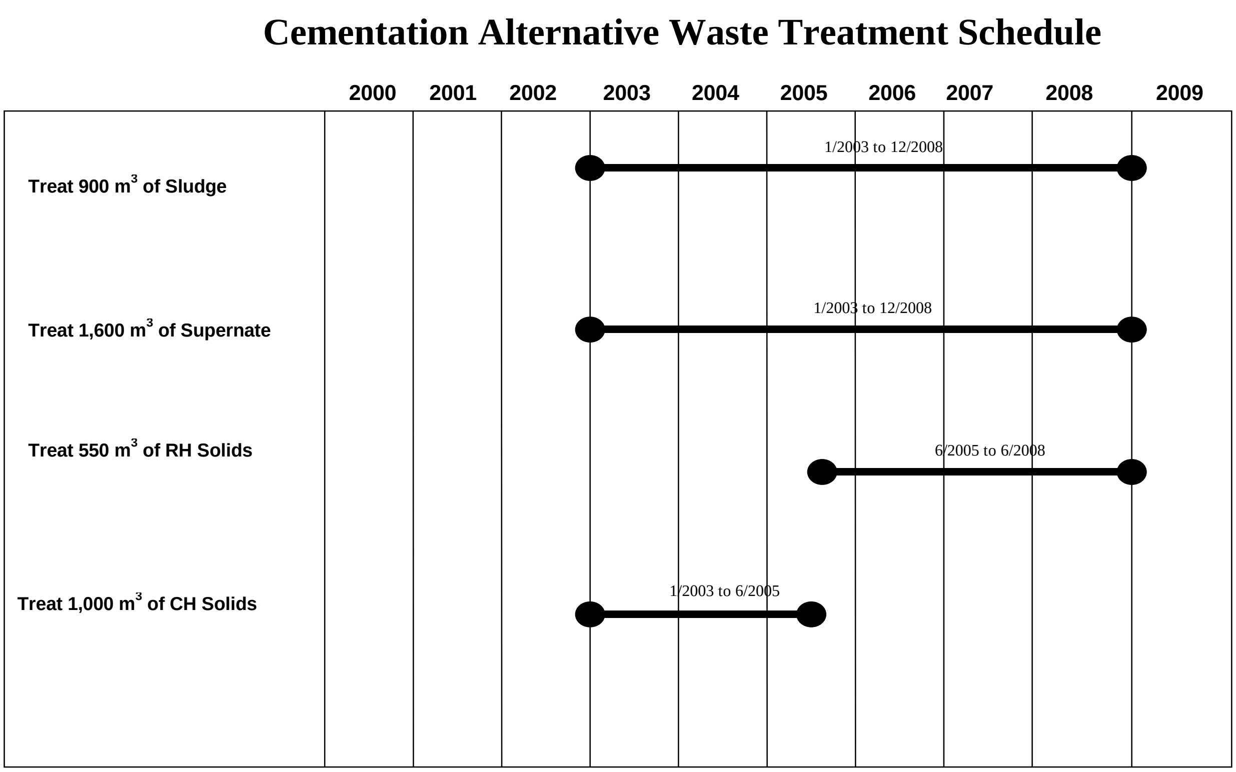

Figure 2-14. The Cementation Alternative waste treatment schedule would take approximately 6 years.

2.7 TREATMENT AND WASTE STORAGE AT ORNL ALTERNATIVE

This alternative would entail waste treatment by any of the three previous treatment alternatives (low-temperature drying, vitrification, or cementation) and indefinite waste storage at ORNL rather than shipment to an off-site disposal facility (e.g., the Waste Isolation Pilot plant for TRU waste, and the Nevada Test Site or another designated facility in the WM PEIS for low-level waste). Treated remote-handled wastes would require remote handling during on-site storage at ORNL because of the associated doses. Implementation of this alternative would result in noncompliance with the milestone established in the Commissioner's Order from Tennessee requiring the submittal of a Project Management Plan (which includes schedules for treatment and shipment) by September 30, 2001. In addition, this alternative would jeopardize the existing "target date" established in the Order for initiation of shipment of the stabilized remote-handled-TRU sludges to the Waste Isolation Pilot Plant by January 2003.

2.7.1 Facility Description

2.7.1.1 Waste treatment facility

Since this alternative would include waste treatment by any of the three treatment alternatives previously described, please refer to these previous sections for a description of the waste treatment facilities for low-temperature drying, vitrification, and cementation.

Waste Treatment Facility Description	Section
Low-Temperature Drying	Section 2.4.1
Vitrification	Section 2.5.1
Cementation	Section 2.6.1

2.7.1.2 Waste storage facilities

On-site waste treatment would result in primary, secondary, and D&D waste streams that would consist of remote-handled TRU waste; contact-handled TRU wastes; low-level waste; remote-handled low-level waste; and mixed waste, which would require on-site storage at ORNL. This alternative would require the construction of new waste storage facilities. Several assumptions were made to determine the storage space required for the waste streams resulting from waste treatment.

1. It was assumed that a required engineering analysis would indicate that the existing storage bunkers for remote-handled and mixed waste (Buildings 7855 and 7883) could be used to store treated remote-handled TRU and remote-handled low-level wastes. These bunkers would provide 320 m^3 of storage capacity.
2. It was assumed that the existing metal buildings that store contact-handled TRU waste (Buildings 7572, 7574, 7842, 7878, and 7879) would be used for treated low-level waste storage. These buildings would provide 1,631 m^3 (57,632 ft^3) of storage capacity for low-level waste.
3. It was assumed that the new storage facilities would have similar waste storage capacities [approximately 150 m^3 for each remote-handle waste bunker, and approximately 300 m^3 (11,318 ft^3) for each metal building].
4. It was assumed that the building footprints (area) for the new storage facilities, and for their construction, would be similar to the existing storage facilities (234 m^2 remote-handled waste storage bunkers and 375 m^2 metal storage buildings for low-level waste).

5. It was assumed that the new waste storage facilities would be located in the Melton Valley area of ORNL, preferably near the waste treatment facility or the existing TRU waste storage facilities.

Tables 2-4a, -b, and -c provide a summary of the resulting waste volumes of the three waste treatment alternatives and the new storage space required for the resulting waste streams. The construction of new waste storage facilities would need to coincide with the construction of the selected waste treatment facility in order to be ready for the receipt of the treated waste streams. The number of new storage facilities needed for the treated wastes would be dependent on the treatment method chosen.

Table 2-4. Summary of the TRU, mixed low-level, remote-handled low-level, and low-level waste volumes, the resulting new storage space required for each treatment alternative, and the land area required for additional storage facilities

	Low-Temperature Drying	**Vitrification**	**Cementation**
Table 2-4a. Summary of the TRU, mixed low-level, and remote-handled low-level waste volumes and new storage space required			
Treated TRU waste volume (m^3)	607	1,060	1,793
Mixed low-level waste volume (m^3)	23	4	3
Treated remote-handled low-level waste volume (m^3)	–	–	2,540[a]
Total TRU, mixed, and remote-handled low-level waste requiring on-site storage **(m^3)**	630	1,064	4,336
Existing waste bunkers storage capacity (m^3)	320	320	320
New storage capacity needed **(m^3)[b]**	310	744	4,016
Assumed capacity of single new waste bunker (m^3)	150	150	150
Number of new waste bunkers needed	3	5	27
Assumed area of new waste bunker (m^2)	234	234	234
Total Storage Facility Area required for TRU, mixed, and remote-handled low-level wastes **(m^2)**	702	1,161	6,265
Table 2-4b. Summary of low-level waste volumes and new storage space required			
Total low-level waste requiring on-site storage **(m^3)**	2,778[a]	4,983[a]	2,833[a]
Existing storage capacity (metal building)	1,631	1,631	1,631
New storage capacity needed **(m^3)[b]**	1,147	3,352	1,202
Assumed capacity of single new metal building (m^3)	300	300	300
Number of new metal buildings needed	4	11	4
Area of new metal buildings (m^2)	375	375	375
Total area required for low-level wastes **(m^2)**	1,434	4,190	1,503
Table 2-4c. Total area required for all waste types and the associated land requirements for the new storage facilities			
TOTAL FACILITY SPACE REQUIRED FOR ALL WASTE TYPES (m^2)	**2,136**	**5,351**	**7,768**
TOTAL HECTARES REQUIRED FOR NEW WASTE STORAGE FACILITIES[c]	**0.3**	**0.6**	**0.8**

[a]Total waste volumes include alpha-low-level waste.
[b]Determined by subtracting available capacity from resulting waste volume and dividing by assumed storage capacity of new facility (150 m^3 for TRU, mixed, and remote-handle low-level wastes, and 300 m^3 for low-level wastes).
[c]Determined by summing storage space required for all waste types, for each treatment method, and converting to hectares.

2.7.2 Waste Treatment Description

This alternative would include waste treatment by any of the three treatment approaches previously described (low-temperature drying, vitrification, or cementation), and then indefinite storage onsite at ORNL. Please refer to these previous sections for the descriptions of the waste treatments that would be implemented if this alternative were selected.

Waste Treatment Description	Section
Low-Temperature Drying	Section 2.4.2
Vitrification	Section 2.5.2
Cementation	Section 2.6.2

2.7.3 Schedule of Activities

This alternative would include indefinite storage of the waste at ORNL following waste treatment. It is assumed that storage would be for a minimum of 100 years. The schedules for waste treatment were discussed in previous sections, as noted below. Construction of additional waste storage facilities would need to coincide with the construction of the waste treatment facility in order to have facilities available to store the treated wastes following waste treatment and repackaging. It is assumed that the schedules would be similar to the facility construction schedule, which would allow for about 2 years for construction.

Waste Treatment and D&D Schedule	Section
Low-Temperature Drying Alternative	Section 2.4.3
Vitrification Alternative	Section 2.5.3
Cementation Alternative	Section 2.6.3

2.8 ALTERNATIVES CONSIDERED BUT NOT EVALUATED IN DETAIL

2.8.1 Off-site Waste Treatment

Currently there is no facility available or planned at any DOE site that could treat remote-handled TRU mixed waste sludge and associated low-level waste supernate stored at ORNL. The Idaho National Engineering and Environmental Laboratory (INEEL) is planning to process its contact-handled TRU on-site waste at the planned Advanced Mixed Waste Treatment Project facility; however, using the planned INEEL facility to treat ORNL TRU waste would be difficult for the following reasons:

- Because the planned INEEL facility is being constructed to process the contact-handled TRU waste at INEEL, the ORNL remote-handled TRU waste may not meet the planned facility's waste acceptance criteria.

- Most of the ORNL remote-handled and contact-handled TRU/alpha low-level solid waste containers do not meet DOT standards (49 *CFR* 173). These containers would require repackaging prior to transport offsite; therefore, it would be safer and more economical for the treatment of solid waste to be conducted at ORNL, and for the treated waste to be shipped directly to the WIPP or the low-level waste disposal sites.

- After treatment at INEEL, the ORNL treated waste would require a second redundant step of repackaging and DOE certification before the waste could be transported to the WIPP or low-level waste disposal site for disposal, resulting in additional worker exposures and cost.

- Treatment of the ORNL TRU wastes at INEEL is unreasonable because of the increased costs and risks associated with preparing the tank waste for shipment, repackaging and certifying the waste twice, transporting the waste to INEEL for treatment, and then transporting the treated waste to the WIPP or the low-level waste disposal sites.

2.8.2 Alternate On-site Treatment Facility Locations

Several factors were considered in selecting the site of the proposed on-site treatment facility. These factors are discussed in Section 2.1 and include minimizing the length of any sludge/supernate waste transfer line from the Melton Hill Valley Storage Tanks to the proposed treatment facility, using the terrain to provide natural shielding for the proposed facility, and considering recommendations made in a feasibility study that focused on dealing with the tank wastes.

The proposed site is directly west of the Melton Valley Storage Tanks, which is the current storage area for the TRU mixed waste sludge and associated low-level supernate. This location reduces the potential risks associated with transporting the liquid and sludge tank wastes from the Melton Valley Storage Tanks to the proposed treatment facility over public or laboratory roads. Since the solid waste storage facilities are also located in Melton Valley, the transportation of the solid wastes would only occur on laboratory roads, also reducing the risk to the public. Melton Valley, while considered part of ORNL, is separated from the ORNL main plant area by the Haw Ridge (Figure 2-1), thus reducing potential risks to the main body of workers at ORNL from accidental releases. Alternative site locations were not evaluated in detail because other on-site locations did not meet the siting factors.

2.8.3 Alternative Disposal Locations

TRU waste will be disposed of at the WIPP in accordance with the WIPP SEIS-II Record of Decision (DOE 1998) for TRU waste. The analysis in this EIS assumes that all low-level waste resulting from the ORNL TRU Waste Treatment Facility will be disposed of at the Nevada Test Site. The Nevada Test Site waste acceptance criteria would allow disposal of alpha low-level waste; however, the disposal of any low-level waste generated from this action will be consistent with the pending Record of Decision for low-level waste from the WM PEIS. The WM PEIS Record of Decision for low-level waste is expected to be issued before completion of the final EIS for the TRU Waste Treatment Project at ORNL. Because the project would generate small quantities of low-level waste in comparison to the 1.5 million m^3 of low-level waste analyzed for the entire DOE complex in the WM PEIS, the assumption of disposal of low-level waste at the Nevada Test Site does not prejudice the WM PEIS Record of Decision for low-level waste.

2.8.4 Alternative Treatment Technologies

Sixteen stabilization and solidification technologies were identified and evaluated as candidates for processing TRU waste sludge in the *Feasibility Study for Processing ORNL Transuranic Waste at Existing and Modified Facilities* (Parallax 1995), but were not analyzed further because they were not considered reasonable (Table 2-5). One of the technologies, plasma arc vitrification, was also identified as potentially useful for solid remote-handled and contact-handled TRU/alpha low-level waste. However, it would not be feasible to use a technology for the solid wastes unless it was also used for the sludge and supernate. Because of cost, scaling, and permitting issues, this technology was eliminated from further consideration.

Table 2-5. Summary of alternatives considered but not evaluated for sludge and supernate waste treatment

Treatment name	Summary description	Rationale for not evaluating
Aquaset II-H®	A non-thermal process that utilizes a powdered solidification agent developed for the immobilization of sludge through the action of complex bonding mechanisms and ion exchange reactions.	Not a proven technology, inability to treat multiple waste streams, its lack of ease with retreatment capabilities, and the excess amount of water used during the process.
Catalytic extraction	A thermal process that introduces sludge into a molten metal bath which acts as a catalyst to break down the waste into its elemental constituents.	Extensive chemical formulation is required for each changing waste stream.
Glass-ceramic vitrification	A thermal process that combines sludge with a ceramic feed material, then calcines in a spray calciner.	Not a proven technology for this type of waste and has a low tolerance to feed variations.
Bitumen solidification	A non-thermal process that uses either bitumen or asphalt as a high molecular weight hydrocarbon to encapsulate the sludge.	Gas generation from the degradation of the hydrocarbon material by alpha-emitting radionuclides.
Ceramic vitrification	A thermal process that combines sludge with ceramic powder and glass frits and then forms and heats into bricks in a brick former.	Not a proven technology for this type of waste and has a lower flexibility with treatment various wastes.
Microwave vitrification	A thermal process that combines glass frits and sludge, places the mixture into a microwave cavity, and melts.	Not proven at large scale; lower flexibility with treatment various waste.
In-can glass melting	A thermal process that first dries the sludge to a fine powder in a spray calciner, then combines the fine powder with glass frits and feeds it into a drum for heating.	Lacks multiple waste stream capabilities, lacks retreatment capabilities, and is not a proven technology for ORNL's waste stream.
Titanate	A thermal process that involves mixing supercalcine (a silicate-based material) with sludge and then calcining.	Increased waste loading, sensitivity to sodium waste streams, lack of multiple waste stream capabilities, lack of retreatment capabilities, and not being a proven technology for ORNL's waste stream.

Synroc hot-isostatic pressing	A thermal process that involves calcination of the sludge and then mixing it with synroc additives. Synroc is an acronym for a synthetic, igneous rock system that consists of thermodynamic-compatible minerals having the ability to capture radioactive waste elements in their crystal lattices.	Similar to the Titanate process.
Supercalcine hot-isostatic pressing	A thermal process that involves mixing supercalcine (a silicate-based material) with sludge and then calcining.	Similar to the Titanate process.
Cermet	A thermal process that involves dissolving and mixing sludge and cermet-forming additives in molten urea.	Similar to the Titanate process.
Fluetap concrete	This process combines the sludge with water, cement, fly ash, and clay in a mixer, then transfers the mix into a drum, and places it into an autoclave for 64 hours to accelerate hardening. The drum is then placed in an air-storage for several years to remove the free water from the concrete.	Failed to meet the schedule constraints.
Molten salts	A thermal process that introduces air to the sludge under a surface of a sodium carbonate-containing melt.	Failed to meet Resource Conservation and Recovery Act (RCRA) Land Disposal Restrictions (LDR) standards.
Supercalcine pellets-in-metal	A thermal process that combines supercalcine with sludge. Binders are added and the material is pelletized. The pellets are sintered to form the desired mineral phase, placed in drums, and encapsulated in lead.	Failed to meet RCRA LDR standards.
Marbles-in-lead matrix	A thermal process that creates marbles from a joule-heated molten glass/sludge mixture and then casts the marbles in lead.	Failed to meet RCRA LDR standards.
Polymer encapsulation	A non-thermal process that involves mixing vinyl ester styrene with sludge and then allows to cure in an in-drum mixer.	Failed to meet the Waste Isolation Pilot Plant waste acceptance criteria.

2.9 SUMMARY OF ENVIRONMENTAL IMPACTS

Table 2-6 is a summary of the potential environmental impacts associated with implementing the various alternatives considered in the EIS. These impacts are discussed in detail in Chapter 4, but are summarized here to allow comparison of the alternatives.

Table 2-6. Comparison of impacts among alternatives

	No Action Alternative	Low-Temperature Drying Alternative (Preferred)	Vitrification Alternative	Cementation Alternative	Treatment and Waste Storage at ORNL Alternative
Land use (Chapter 4, Section 4.1)	• No change in land use, land use classifications, or impacts to visual resources	• No change in land use classification • 2 hectares (ha) (5 acres) would change from underdeveloped to industrial use • Buildings and other structures would be visible to workers but not the public	• No change in land use classification • 2 to 2.8 ha (5 to 7 acres) would change from underdeveloped to industrial use • Buildings and other structures would be visible to workers but not the public	• No change in land use classification • 2 ha (5 acres) would change from underdeveloped to industrial use • Buildings and other structures would be visible to workers but not the public	• No change in land use classification • 2 to 2.8 ha (5 to 7 acres) would change from underdeveloped to industrial use • For waste storage after treatment, an additional 0.3 ha (0.75 acre) of land would be required if treatment was by low-temperature drying, 0.6 ha (1.5 acres) of land if by vitrification, or 0.8 ha (2.0 acres) of land if by cementation • Buildings and other structures would be visible to workers but not the public
Cultural and historic resources (Chapter 4, Section 4.2)	• No cultural, archeological, or historic resources in project area	• Same as No Action Alternative	• Same as No Action Alternative	• Same as No Action Alternative	• Same as No Action Alternative

Table 2-6. Comparison of impacts among alternatives (continued)

	No Action Alternative	Low-Temperature Drying Alternative (Preferred)	Vitrification Alternative	Cementation Alternative	Treatment and Waste Storage at ORNL Alternative
Ecological resources (Chapter 4, Section 4.3)	• Continued release of waste constituents from SWSA 5 North trenches to soils and groundwater affecting biota • No habitat destruction under normal operations	• 2 ha (5 acres) of forested habitat lost and converted to industrial use (revegetated after facility D&D) • Reduction of soil and water contamination because treatment would be available for waste to be removed from trenches under CERCLA	• 2 to 2.8 ha (5 to 7 acres) of forested habitat lost and converted to industrial use (revegetated after facility D&D) • Reduction of soil and water contamination because treatment would be available for waste to be removed from trenches under CERCLA	• 2 ha (5 acres) of forested habitat lost and converted to industrial use (revegetated after facility D&D) • Reduction of soil and water contamination because treatment would be available for waste to be removed from trenches under CERCLA	• 2 to 2.8 ha (5 to 7 acres) of forested habitat lost and converted to industrial use • Low-quality habitat indefinitely lost for on-site waste storage facility construction; 0.3 ha (0.75 acre) of land required if treatment by low-temperature drying, 0.6 ha (1.5 acres) of land if by vitrification, and 0.8 ha (2.0 acres) of land if by cementation • Reduction of soil and water contamination because treatment would be available for waste to be removed from trenches under CERCLA

Table 2-6. Comparison of impacts among alternatives (continued)

	No Action Alternative	Low-Temperature Drying Alternative (Preferred)	Vitrification Alternative	Cementation Alternative	Treatment and Waste Storage at ORNL Alternative
Geology and seismicity (Chapter 4, Section 4.4)	• No impact to geology or regional seismicity • No construction-related impacts to soils or geology • Continued release of waste constituents from the SWSA 5 North trenches to soils	• No impact to geology or regional seismicity • 2 ha of soil disturbed • Reduction of soil and water contamination because treatment would be available for waste to be removed from trenches under CERCLA	• No impact to geology or regional seismicity • 2.8 ha of soil disturbed • Reduction of soil and water contamination because treatment would be available for waste to be removed from trenches under CERCLA	• No impact to geology or regional seismicity • 2 ha of soil disturbed • Reduction of soil and water contamination because treatment would be available for waste to be removed from trenches under CERCLA	• No impact to geology or regional seismicity • 2 to 2.8 ha of soil disturbed • Reduction of soil and water contamination because treatment would be available for waste to be removed from trenches under CERCLA
Surface water (Chapter 4, Section 4.5.1)	• Continued release of waste constituents from the SWSA 5 North trenches to surface water	• Potential for increased siltation in White Oak Creek, Melton Branch, and an unnamed tributary • Reduction of soil and water contamination because treatment would be available for waste to be removed from trenches under CERCLA	• Same as Low-Temperature Drying Alternative	• Same as Low-Temperature Drying Alternative	• Same as Low-Temperature Drying Alternative
Groundwater (Chapter 4, Section 4.5.2)	• No groundwater use • Continued release of waste constituents from SWSA 5 North trenches	• No groundwater use • Positively impacts groundwater due to waste removal and treatment of waste from SWSA 5 North trenches	• Same as Low-Temperature Drying Alternative	• Same as Low-Temperature Drying Alternative	• Same as Low-Temperature Drying Alternative

Table 2-6. Comparison of impacts among alternatives (continued)

	No Action Alternative	Low-Temperature Drying Alternative (Preferred)	Vitrification Alternative	Cementation Alternative	Treatment and Waste Storage at ORNL Alternative
Wetlands & Floodplains (Chapter 4, Section 4.5.3)	• Continued impacts to White Oak Creek floodplain due to SWSA 5 North contamination • No impact to wetlands	• Small impact to the 100-year or 500-year floodplains during construction phase • Wetland B (0.012 ha or 0.03 acres) would be eliminated by construction	• Same as Low-Temperature Drying Alternative	• Same as Low-Temperature Drying Alternative	• Same as Low-Temperature Drying Alternative
Waste Management (Chapter 4, Section 4.6)	• TRU sludge wastes and associated low-level supernate in the Melton Valley Storage Tanks, solid wastes in SWSA 5 North trenches, and solid waste in storage facilities would remain untreated • Would require continued surveillance and maintenance of untreated legacy waste inventory and associated on-site facilities indefinitely at ORNL • Would result in violation of legal mandate due to continued waste storage, potentially resulting in fines	• All legacy wastes in proposed action would be treated • Approximately 10,833 m^3 of total generated waste, including: - 607 m^3 contact-handled and remote-handled TRU waste; - 2,778 m^3 low-level waste; - 23 m^3 of low-level mixed waste; - 1,560 m^3 of sanitary wastewater; and - 5,550 m^3 debris from D&D activities	• Same as Low-Temperature Drying Alternative • Approximately 34,128 m^3 of total waste generated, including: - 1,060 m^3 contact-handled and remote-handled TRU waste; - 4,980 m^3 low-level waste; - 4 m^3 of low-level mixed waste; - 7,201 m^3 of sanitary wastewater; and - 20,760 m^3 debris from D&D activities	• Same as Low-Temperature Drying Alternative - Approximately 28,826 m^3 of total waste generated, including: - 1,793 m^3 contact-handled and remote-handled TRU waste; - 2,833 m^3 low-level waste; - 2,540 m^3 of remote-handled low-level waste; - 3 m^3 of low-level mixed waste; - 7,437 m^3 of sanitary wastewater; and - 14,143 m^3 debris from D&D activities	• Same as Low-Temperature Drying Alternative • 10,833 to 34,128 m^3 of waste generated, depending on the treatment selected, and stored on-site • Would require continued surveillance and maintenance of waste inventory indefinitely onsite at ORNL • Would require construction of additional waste storage facilities—using 0.3 to 0.8 ha of land depending upon treatment process selected

Table 2-6. Comparison of impacts among alternatives (continued)

	No Action Alternative	Low-Temperature Drying Alternative (Preferred)	Vitrification Alternative	Cementation Alternative	Treatment and Waste Storage at ORNL Alternative
Climate and Air Quality (Chapter 4, Section 4.7)	• No impact to air quality	• Minor emissions during normal operations	• Same as Low-Temperature Drying Alternative	• Same as Low-Temperature Drying Alternative	• Same as Low-Temperature Drying Alternative
Transportation (Chapter 4, Section 4.8)	• No off-site shipments	• 397 shipments of TRU waste with 3.2E-01 accidents and 4.4E-02 fatalities predicted • Non-accident latent cancer fatalities (LCFs) of 8.7E-02 for CH TRU and 3.1E-02 for RH TRU waste • 277 low-level waste shipments with 2.6E-01 accidents and 3.6E-02 accident fatalities predicted • 2.1E-09 non-accident LCFs predicted	• 987 shipments of TRU waste with 8.0E-01 accidents and 1.1E-01 fatalities predicted • Non-accident LCFs of 5.3E-03 for CH TRU and 9.3E-02 for RH TRU waste • 281 low-level waste shipments with 2.6E-01 accidents and 3.6E-02 accident fatalities • 2.1E-09 non-accident LCFs predicted	• 2,425 shipments of TRU waste with 2.2 accidents and 3.0E-01 fatalities predicted • Non-accident LCFs of 5.3E-02 for CH TRU and 2.7E-01 for RH TRU waste • 914 low-level waste shipments with 8.8E-01 accidents and 1.2E-01 accident fatalities predicted • 7.5E-09 non-accident LCFs predicted	• No off-site shipment of TRU waste or low-level waste • Requires on-site transportation of processed waste to on-site waste storage facilities

Table 2-6. Comparison of impacts among alternatives (continued)

	No Action Alternative	Low-Temperature Drying Alternative (Preferred)	Vitrification Alternative	Cementation Alternative	Treatment and Waste Storage at ORNL Alternative
Utility Requirements (Chapter 4, Section 4.9)	• Total estimated power usage 2,200 MW • 5 million gallons of water use projected over 100-year institutional control period	• About 15,000 MW of total electricity usage • 5 million gallons of water use during project life	• About 45,000 MW of total electricity usage • 7 million gallons of water use during project life	• About 11,250 MW of total electricity usage • 15 million gallons of water use during project life	• Electricity use varies by alternative from 13,450 MW to 47,200 MW total, which includes electricity use for long-term storage • Water use varies by alternative (10 million to 20 million gallons), which includes water use for long-term storage
Human Health (Chapter 4, Section 4.10)	• LCF for involved worker population estimated to be 2E-02 • Risk to public and non-involved worker would be negligible	• Probability of cancer fatalities (PCF) from radiological releases to involved worker estimated to be 3.0E-05; non-involved worker estimated to be 2.0E-05; and off-site MEI estimated to be 1.0E-05 • Collective dose to the affected off-site pubic population would be 1.2E-01 person-rem, resulting in 6.0E-05 LCFs	• PCF from radiological releases to involved worker estimated to be 9.0E-05; non-involved workers estimated to be 7.0E-05; off-site MEI estimated to be 5.0E-05 • Collective dose to the affected off-site pubic population would be 6.8E-01 person-rem, resulting in 3.0E-04 LCFs	• PCF from radiological releases to involved worker estimated to be 6.0E-06; non-involved workers estimated to be 5.0E-06; and off-site MEI estimated at 3.0E-06 • Collective dose to the affected off-site pubic population would be 2.8E-02 person-rem, resulting in 1.0E-06 LCFs	• LCF for involved worker population estimated to be 2E-02 • PCF for the non-involved worker and off-site MEI would be equal to that estimated for the treatment technology selected • Collective dose and number of fatalities for the affected off-site population would be equal to that for the treatment technology selected

Table 2-6. Comparison of impacts among alternatives (continued)

	No Action Alternative	Low-Temperature Drying Alternative (Preferred)	Vitrification Alternative	Cementation Alternative	Treatment and Waste Storage at ORNL Alternative
Noise (Chapter 4, Section 4.12)	• Noise levels should decrease to 50 to 60 dBA when the High Flux Isotope Reactor access road construction is complete	• Site construction and D&D noise up to 70 dBA • Noise levels during operations at 50 to 60 dBA • Noise increases are temporary and minor	• Same as Low-Temperature Drying Alternative	• Same as Low-Temperature Drying Alternative	• Same as Low-Temperature Drying Alternative during treatment and would decrease, similar to the levels of No Action, during long-term storage

Table 2-6. Comparison of impacts among alternatives (continued)

	No Action Alternative	Low-Temperature Drying Alternative (Preferred)	Vitrification Alternative	Cementation Alternative	Treatment and Waste Storage at ORNL Alternative
Accidents (Chapter 4, Section 4.11)	• **Melton Valley Storage Tank (MVST) Breach** - MEI – 1.1E-05 PCF - Population – 1.1 LCF - Non-involved workers – 9.2E-04 PCF • **Vehicle impact (CH TRU and RH TRU waste)** - MEI – 1.6E-06 PCF - Population – 0.024 LCF - Non-involved workers – 1.3E-04 PCF • **Earthquake** - MEI – 1.6E-05 PCF - Population – 0.24 LCF - Non-involved workers – 1.4E-03 PCF • **Vehicle impact/fire (CH TRU and RH TRU waste)** - MEI – 1.4E-07 PCF - Population – 2.1E-03 LCF - Non-involved workers – 1.2E-05 PCF	• **MVST Breach** - NA • **MVST transfer line failure** - MEI – 3.2E-06 PCF - Population – 0.16 LCF - Non-involved workers – 2.8E-04 PCF • **Vehicle impact** - negligible • **Earthquake** - MEI – 4.8E-07 PCF - Population – 7.2E-03 LCF - Non-involved workers – 4.2E-05 PCF • **Vehicle impact/fire** - negligible	• Same as Low-Temperature Drying Alternative	• **MVST Breach** - NA • **MVST transfer line** failure - MEI – 6.3E-06 PCF - Population – 0.31 LCF - Non-involved workers – 5.5E-04 PCF • **Vehicle impact** - negligible • **Earthquake** - MEI – 9.6E-07 PCF - Population – 0.014 LCF - Non-involved workers – 8.4E-05 PCF	• **MVST transfer line failure** - MEI – 3.2E-06 to 6.6E-06 PCF - Population – 0.16 to 0.31 LCF - Non-involved workers – 2.8E-04 to 5.5E-04 PCF • **Vehicle impact** - negligible • **Earthquake (CH TRU and RH TRU waste)** - MEI – 4.8E-07 to 9.6E-07 PCF - Population – 7.2E-03 to 1.4E-02 LCF - Non-involved workers – 4.2E-05 to 8.4E-05 PCF • **Vehicle impact/fire (after processing)** - MEI – 1.4E-07 PCF - Population – 2.1E-03 LCF - Non-involved workers – 1.2E-05 PCF

Table 2-6. Comparison of impacts among alternatives (continued)

	No Action Alternative	Low-Temperature Drying Alternative (Preferred)	Vitrification Alternative	Cementation Alternative	Treatment and Waste Storage at ORNL Alternative
Socioeconomic (Chapter 4, Section 4.13)	• No change in economic activity	• No significant impacts • Earnings represent 0.1% of the income for the region	• No significant impacts • Earnings represent 0.2% of the income for the region	• No significant impacts • Earnings represent 0.1% of the income for the region	• No significant impacts • Earnings represent 0.1% of the income for the region
Environmental Justice (Chapter 4, Section 4.14)	• No environmental justice impacts expected	• Same as No Action Alternative	• Same as No Action Alternative	• Same as No Action Alternative	• Same as No Action Alternative

CH TRU = contact-handled transuranic waste.
D&D = decontamination and decommissioning.
HFIR = High Flux Isotope Reactor.
LCF = latent cancer fatality.
MEI = maximally exposed individual.
NA = Not applicable.
ORNL = Oak Ridge National Laboratory.
PCF = probability of cancer fatality.
RH TRU = remote-handled transuranic waste.
TRU = transuranic.

2.10 REFERENCES

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3. AFFECTED ENVIRONMENT

Chapter 3 of this EIS describes the existing environment in and around Oak Ridge National Laboratory (ORNL) and the Oak Ridge Reservation (ORR), which would be affected by the construction, operation, and D&D of the proposed TRU Waste Treatment Project facility. ORNL is one of three major DOE facilities located within the ORR. Site-specific information for the area surrounding the proposed facility site and the adjacent Melton Valley Storage Tanks at ORNL is also included. Current, pertinent information is provided for the regions influenced in the various resource areas, and the supporting references are cited.

3.1 LAND USE

This section describes the past, current, and planned land uses on and around the proposed TRU Waste Treatment Project facility site, which would be located within the boundaries of ORNL and the ORR. The ORR contains approximately 140 square miles of federally owned land in Anderson and Roane Counties of East Tennessee. The area includes forests, public use areas, and operational areas. The facility is located within the city limits of Oak Ridge, Tennessee, and the surrounding lands are predominantly rural with residences, small farms, forests, and cattle pastures. This section includes descriptions of environmentally sensitive land areas on and around the ORR that are set aside for public use, environmental protection, or research. These sensitive land areas include parks, natural areas, environmental education centers, and public recreation areas.

3.1.1 Past Land Use

The land surrounding the ORR was predominantly forested wilderness prior to the 18th century. During the late 18th and early 19th centuries, the area was settled by emigrants who established three major uses of the land, including: forestry, agriculture, and residential. Gradually, commercial, mining, transportation, waterways, and industrial land uses developed. The land that composes the ORR was purchased from private landowners by the United States Government in 1942. The predominant land uses at that time were forestry, agriculture, and residential. Government activities during World War II changed the overall pattern of land use on the ORR to industrial with the establishment of the X-10 Plant (ORNL), the Y-12 Plant (Y-12), the K-25 Site [now known as the East Tennessee Technology Park (ETTP)], and various support facilities. With the exception of some agriculture-related research activities in later years, agricultural use of the land on the ORR nearly disappeared, and the land was allowed to revert to an increasingly natural forested state after its purchase by the government. Residential land use ended over most of the ORR with the exception of the northeastern corner, which housed government workers. Residential and commercial land uses increased rapidly on the north side of the reservation, and in the late 1950s this area was separated from the ORR and incorporated as the City of Oak Ridge. The current land use pattern on the ORR and at ORNL gradually evolved between 1942 and the present day (DOE 1999a).

3.1.2 Current Land Use

The current uses of land in the vicinity of the ORR are forestry, agriculture, residential, commercial, industrial, mining, transportation, waterways, recreation, and several other uses. The largest use is commercial forestry, followed in order by agriculture, other uses, residential, waterways, and transportation. The remaining uses are quite small, each accounting for less than 3,000 ha

(7,410 acres) of land. The closest urban center to the reservation is the City of Oak Ridge. The predominant land use in most urban areas is residential (MMES 1994).

DOE classifies land use on the ORR according to five primary categories: Institutional/Research, Industrial, Mixed Industrial, Institutional/Environmental Laboratory, and Mixed Research/Future Initiatives. The Institutional/Research category applies to land occupied by the central research facilities at ORNL. Land in the Industrial category includes the Y-12 Plant, which is used for defense support, manufacturing, and storage. The Mixed/Industrial category includes the ETTP, which is used for environmental management and reindustrialization of DOE land by private sector businesses. The Oak Ridge Institute for Science and Education, operated by Oak Ridge Associated Universities, provides training and research support to DOE and uses the land within the boundaries of the Institutional/Environmental Laboratory category. The Mixed Research/Future Initiatives category applies to land currently used, or available for use, in field research, and land reserved for future DOE initiatives, including new research facilities.

The proposed TRU Waste Treatment Project site is a small 2- to 2.8-ha (5- to 7-acre), forested area almost immediately west of the Melton Valley Storage Tanks and approximately 2 km (1.25 miles) east of Tennessee State Route 95. The Melton Valley Storage Tanks are active waste storage tanks, which store legacy TRU sludge waste and its associated remote-handled low-level supernate. The area east of the proposed facility site is industrial and contains the Melton Valley Storage Tanks, associated waste bunkers, and Melton Valley Storage Tanks–Capacity Increase Project tanks. Just west of the proposed TRU Waste Treatment Project site, the High Flux Isotope Reactor access road is being upgraded to DOT standards. Gravel access roads from the ORNL main plant area connect with the High Flux Isotope Reactor access road, which will be the main road running to the proposed waste treatment facility site. The proposed site for the waste treatment facility does not contain prime or unique farmland.

3.1.3 Planned Land Use

The Spallation Neutron Source (SNS) is a national research project being developed as a cooperative effort of the national laboratories. The SNS will be located at ORNL 4 km (2.5 miles) from the proposed TRU Waste Treatment Facility. A CERCLA waste disposal facility is also planned for construction at the Y-12 Plant and would be located in Bear Creek Valley approximately 6 m (3.7 miles) from the proposed TRU Waste Treatment Facility. These planned projects have already undergone an environmental review as discussed in the “Cumulative Impacts” section of DOE 1999a, and a Record of Decision has been issued for the disposal site.

3.1.4 Parks, Preserves, and Recreational Resources

The University of Tennessee Arboretum is located approximately 0.4 km (0.25 mile) east of the ORR. This facility contains 101 ha (250 acres) of land and functions as a living botanical education center for the general public. Several trails with botanical themes run throughout the arboretum and are open to the public for hiking. The University of Tennessee also operates a forest experiment station on 810 ha (2,000 acres) of land adjacent to the arboretum (LMES 1996). This area is not open to the public.

Large portions of the ORR are devoted to nature preservation and biological research. About 8,899 ha (21,980 acres) of undeveloped and geographically fragmented areas of land at ORNL, Y-12 Plant, and ETTP comprise the Oak Ridge National Environmental Research Park. The National Environmental Research Park is used by the U.S. scientific community as an outdoor environmental science laboratory to study the current and future environmental consequences of the DOE mission in

Oak Ridge (LMES 1995a). Numerous areas within the National Environmental Research Park are designated for the protection of rare species. A number of reference areas have been established to serve as examples of regional plant communities and unique biotic features (Pounds et al. 1993). A portion of the ORR is operated as the Oak Ridge Wildlife Management Area through a cooperative agreement between DOE and the Tennessee Wildlife Resources Agency (DOE-ORO 1996). This agreement was initiated in 1984 to reduce traffic accidents involving deer by opening the ORR to hunting by the public (Saylor et al. 1990).

The Clark Center Recreational Park, located on the north shore of Melton Hill Lake, occupies 36 ha (90 acres) of land within the southeast corner of the ORR. It is open to the public for swimming, picnicking, fishing, pleasure boating, and athletic activities such as softball. Management of the Freels Bend area, directly east of the Clark Center Recreational Area on the north side of Melton Hill Lake, was recently granted to the State of Tennessee by the Secretary of Energy. Several public recreation areas are located along Melton Hill Lake, which is outside the ORR but adjacent to a large portion of the ORR's southeast boundary. This body of water is a Tennessee Valley Authority (TVA) reservoir that was formed by impounding the Clinch River with Melton Hill Dam. The body of water on the downstream side of Melton Hill Dam is Watts Bar Lake, which is adjacent to the southwest boundary of the ORR. Melton Hill Dam is located approximately 4.3 km (2.7 miles) southwest of the central ORNL plant, but land used for laboratory activities extends south to the shore of Melton Hill Lake. A large TVA public recreation area is located at the Melton Hill Dam on the opposite shore from ORNL land and the ORR. This recreation area is used for pleasure boating, fishing, swimming, and picnicking. Other TVA recreational areas with similar uses are located along Melton Hill Lake upstream from the dam and ORNL, including 425 ha (1,051 acres) of recreational lands within the city limits of Oak Ridge (MMES 1994). A TVA boat ramp is located on the ORNL side of Watts Bar Lake, approximately 2.4 km (1.5 miles) downstream from Melton Hill Dam. Watts Bar Lake is used for pleasure boating, fishing, and swimming.

3.1.5 Scenic Resources

The steep, linear ridges; intervening valleys; and lakes in the vicinity of ORNL create beautiful, natural scenery. However, many parcels of rural land are used for agricultural and residential purposes so the visual field at many locations includes various combinations of houses, barns, roads, and utility features. In heavily developed areas of Oak Ridge, views are predominated by these features, along with numerous commercial structures, industrial plants, and public service buildings. Natural scenery abounds on the ORR, since much of it has been allowed to return to its natural state. However, the landscape in developed areas of the ORR, such as those in the vicinity of ORNL and the proposed TRU Waste Treatment Project site, is a mixture of natural features with buildings, industrial facilities, roads, and utility features.

3.2 CULTURAL AND HISTORIC RESOURCES

The ORR area is rich in cultural resources, both prehistoric and historic. Preservation of these resources is mandated by Section 106 of the National Historic Preservation Act [16 U.S.C. 470(f)]. Several reconnaissance-level (walkover) surveys for cultural resources have been conducted on the ORR in the vicinity of the proposed project. These include Faulkner (1988) and DuVall (1992a, 1993b, and 1996). Based on these previously conducted investigations, it appears that the proposed TRU Waste Treatment Facility site has no known archaeological, cultural, or historical resources. In addition, no such resources are known to exist in areas immediately contiguous to the proposed site. The nearest potential site, located approximately 183 m (600 ft) southwest of the project site, is the pre-1942 homestead site known as the Jenkins Site (State of Tennessee registration number 40RE188).

The pre-1942 homestead site known as the Jones Site (State of Tennessee registration number 40RE189) is located approximately 244 m (800 ft) northeast of the project site (Figure 3-1). An archaeological assessment of these two sites utilized subsurface testing to determine if artifact concentrations were present on the two sites (Faulkner 1988). The Jones Site and support structures were recommended for inclusion in the National Register of Historic Places due to the relatively intact nature of the site and its early occupation date (ca. 1820). The Jenkins Site has been severely affected by modern intrusions and was not considered eligible for inclusion in the National Register of Historic Places.

In accordance with the programmatic agreement concerning management of historical and cultural properties at the ORR among the DOE-Oak Ridge Operations Office, the Tennessee State Historic Preservation Officer, and the Advisory Council on Historic Preservation, DOE sent a letter submitted to the State Historic Preservation Officer on June 28, 1999, to address Section 106 for the TRU Waste Treatment Project. Enclosed with the letter was a summary of the Archaeological and Historical Review for the TRU Waste Treatment Project facility site prepared for the proposed action. DOE requested and received concurrence with their findings from the State Historic Preservation Officer regarding this proposed project (Appendix E).

DOE has consulted with Native American groups regarding the status of the ORR as a site of potential importance to Native Americans. While some isolated findings of arrowheads, pottery shards, and charcoal have been found in some project studies over the years, no tribe or group representing Native Americans has ever expressed interest in the ORR as a site of historical importance to Native Americans (Moore 1999). There are no known sensitive areas near the proposed project site.

3.3 ECOLOGICAL RESOURCES

This section provides descriptions of the terrestrial and aquatic resources, including threatened and endangered species, identified at the proposed TRU Waste Treatment Facility site. Basis for the following information was derived from the 1988 field surveys conducted in preparation of the previously proposed Waste Handling and Packaging Plant (Campbell et al. 1989). The field surveys included an area located southeast of the proposed TRU Waste Treatment Facility site. The southwestern boundary of the surveys slightly overlaps the southeastern most corner of the proposed site. The survey area’s northern edge came within less than 91 m (300 ft) of the proposed TRU waste facility’s northeast corner fence line. Surveys for sensitive plant and animal species were completed for the proposed site in April 1999, and a report on survey findings is included in Appendix C.

3.3.1 Terrestrial Resources

The proposed site for the TRU Waste Treatment Facility is at the northwest base of Copper Ridge and Melton Hill and includes a small portion of Copper Ridge. During the 1988 surveys, the area was noted to have been previously disturbed by homesteading prior to 1942 (Campbell et al. 1989). Currently, the surrounding area, including the High Flux Isotope Reactor access road, is undergoing clearing for a road expansion and fence relocation. A thin layer of deciduous leaf litter accompanies slash, moss-covered surface debris, and small rocks on the soil surface. The soil surface is firm and gravelly, with a minimum buildup of organic matter. No caves or large rock outcrops are present in the proposed area.

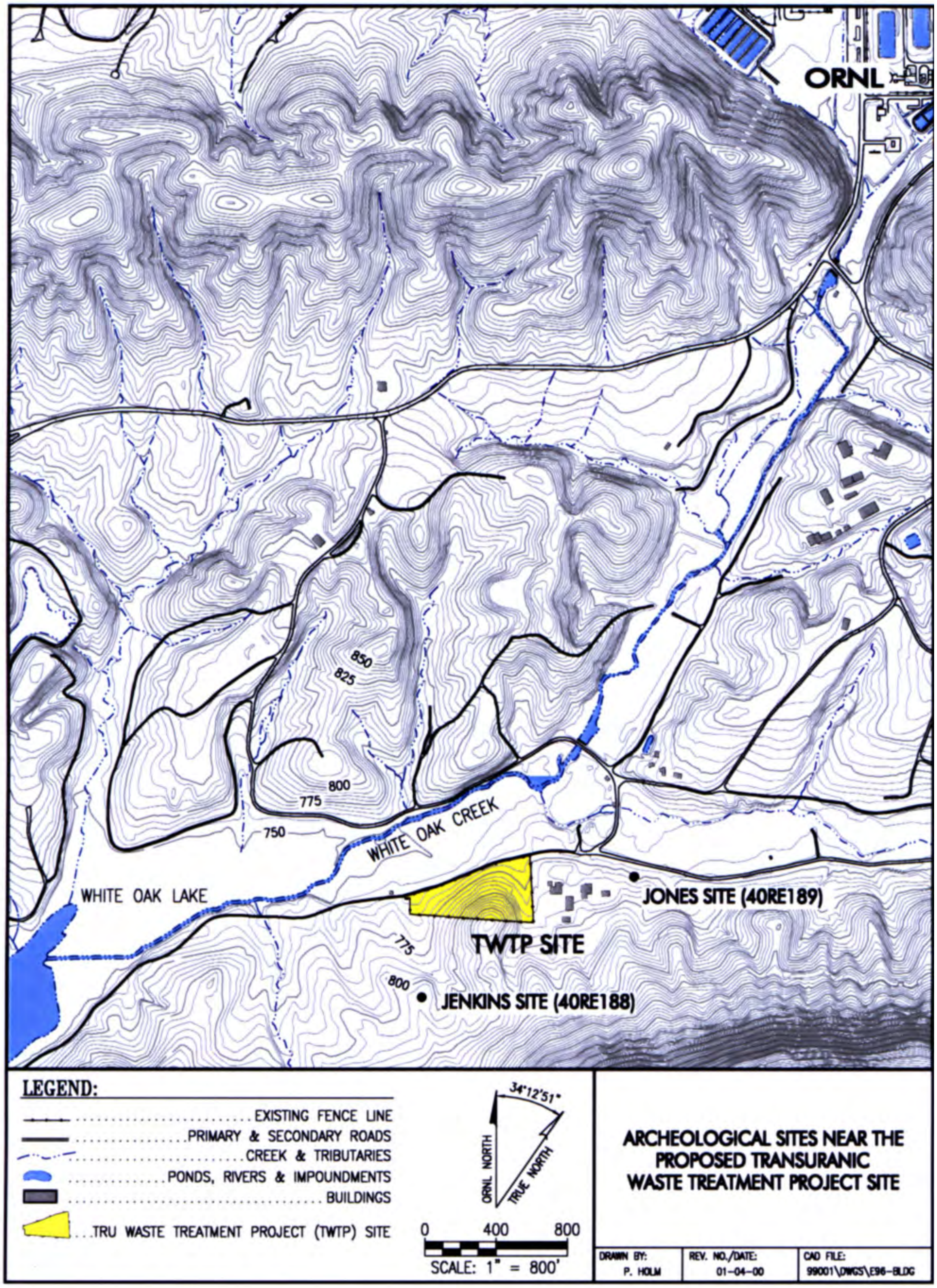


Figure 3-1. Archeological sites near the proposed TRU Waste Treatment Project site at ORNL include the Jones Site and the Jenkins Site.

3.3.1.1 Flora

Succession on the fields of the former homesteads has produced a relatively young to mid-age open forest of pines and cedars with some hardwood species at the proposed TRU Waste Treatment Facility site. No hollow trees, living or dead, were observed in the parcel. The dominant tree species identified included shortleaf and Virginia pines in the west, fading to hardwood species such as yellow-poplar, oaks, hickories, red bud, and maples in the east (Appendix C.3). The forest on the steep slopes of Melton Hill above the proposed site is relatively undisturbed. In open areas, herbaceous species make up the ground cover of the area. Species identified in the 1999 surveys include exotic species, such as Japanese honeysuckle and Nepal grass, as well as blueberries, rusty viburnum, juneberry, and hophornbeam (Appendix C.3). A previously fenced small area is to be included in the proposed site. This area currently contains no native vegetation and consists of buildings, paved areas, and lawns.

3.3.1.2 Fauna

Because of its small size, the proposed TRU Waste Treatment Facility site possesses relatively few habitat types and supports only a fraction of the number of faunal species found within the ORR. The site's vertebrate fauna consists of species common to the second-growth, mixed hardwood-pine forest. A few species suspected to be present are snakes (rat snake and black racer); birds (red-eyed vireo, pine warbler, scarlet tanager, wild turkey, and red-tailed hawk); rodents (white-footed mouse); and mammals (coyote, gray squirrel, flying squirrel, and white-tailed deer).

3.3.2 Terrestrial Threatened and Endangered Species

3.3.2.1 Flora

Surveys for sensitive plant species that are specific to the proposed TRU Waste Treatment Facility site were completed in May 1999 and were accomplished by walking the entire proposed area. No federally listed terrestrial plant species have been reported on the proposed site (Appendix C.3). No state-listed terrestrial plant species were observed at the proposed site during the 1999 survey. Compatible habitats for four state-listed terrestrial species that are known to occur on the ORR exist within the proposed area. These species and their preferred habitats are represented in Table 3-1. Two additional rare wetland species may occur in the site. These are discussed in Section 3.3.4.1.

Table 3-1. State-listed terrestrial plant species with compatible habitats exhibited in the proposed site

Common name	Species	Preferred habitat
Heavy sedge	*Carex gravida*	Dry woods or open areas
Pink Lady's Slipper	*Cypripedium acaule*	Pine or mixed pine-hardwood
Butternut	*Juglans cinera*	Deciduous forest
Canada Lily	*Lilium canadense*	Moist, shaded drainages

3.3.2.2 Fauna

A sensitive animal survey was completed in April 1999 and was accomplished by visual identification, trapping, and installation of artificial ground covers at the proposed TRU Waste Treatment Facility site. The only federally listed animal species that have been recently observed on the ORR (the gray bat, bald eagle, and peregrine falcon) are represented by migratory or transient individuals rather than by permanent residents. The federally endangered Indiana bat has not been identified in the area, but the ORR does fall into its geographic range. Suitable habitat for the bat at the proposed site is marginal (Appendix C.2).

Several local species are listed by the State of Tennessee as "in need of management." These species may be present in the vicinity of the proposed site based on the reasoning that the proposed TRU Waste Treatment Facility site falls within their acceptable home ranges and the proposed area contains compatible habitat for them. Species listed as "in need of management" that may occur in the proposed area are presented in Table 3-2, although none of these species was observed or captured during the 1999 survey (Appendix C.2).

Table 3-2. Tennessee State-listed "in need of management" terrestrial animal species with compatible habitats exhibited in the proposed site

Common name	Scientific name	In home range	Suitable habitat present
	Aves		
Cooper's hawk	*Accipiter cooperii*	Yes	Yes
Sharp-shinned hawk	*Accipiter striatus*	Yes	Yes
Bachman's sparrow	*Aimophila aestivalis*	Yes	Marginal
Grasshopper sparrow	*Ammodramus savannarum*	Yes	Marginal
Lark sparrow	*Chondestes grammacus*	Yes	Marginal
Vesper sparrow	*Pooecetes gramineus*	Yes	Marginal
Yellow-bellied sapsucker	*Sphyrapicus varius*	Winter only	Yes
Bewick's wren	*Thryomanes bewickii bewickii*	Yes	Marginal
	Mammals		
Star-nosed mole	*Condylura cristata parva*	Marginal	Marginal
Eastern big-eared bat	*Corynorhinus rafinesquii*	Yes	Marginal
Eastern small-footed bat	*Myotis leibii*	Yes	Marginal
Hairy-tailed mole	*Parascalops breweri*	Yes	Marginal
Southeastern shrew	*Sorex longirostris*	Yes	Yes
Southern bog lemming	*Synaptomys cooperi*	Yes	Yes
Meadow jumping mouse	*Zapus hudsonius*	Yes	Marginal
	Amphibians		
Four-toed salamander	*Hemidactylium scutatum*	Yes	Marginal
	Reptiles		
Northern coal skink	*Eumeces A. anthracinus*	Marginal	Marginal
Southern coal skink	*Eumeces anthracinus pluvialis*	Marginal	Marginal
Eastern slender glass lizard	*Ophisaurus attenuatus longicaudus*	Yes	Yes
Northern pine snake	*Pituophis M. melanoleucus*	Yes	Marginal

3.3.3 Aquatic Resources

A thorough description of the hydrology of the White Oak Creek Watershed is found in Section 3.5. The proposed TRU Waste Treatment Facility site is located in the White Oak Creek Watershed. Surface water draining from the site would flow either into White Oak Creek, or the lower portions of the Melton Branch, a tributary to White Oak Creek. From there the surface water route would continue to White Oak Lake and on to the Clinch River. White Oak Creek, Melton Branch, and White Oak Lake receive treated and untreated process wastewater, treated sanitary sewage effluent, and reactor cooling water from ORNL facilities. A small, unnamed tributary drains into the headwaters of White Oak Lake near the proposed facility site on the northern slope of Copper Ridge. The tributary is believed to be an intermittent stream, although it is not gauged and there are no known hydrological or water quality data available (Campbell et al. 1989).

White Oak Lake is a shallow impoundment created in 1941 by the construction of White Oak Lake Dam located approximately 1 km (0.6 mile) above the confluence of White Oak Creek with the Clinch River. White Oak Lake functions as a final settling basin for waste effluents discharged to White Oak Creek, Melton Branch, and other small streams in the White Oak Creek Watershed. White Oak Lake extends 0.7 km (0.4 mile) upstream from the dam and has a surface area of about 8 ha (20 acres).

Off-site aquatic invertebrate and fish surveys in the 1980s were reported to have observed several invertebrate species, and 3, 12, and 18 fish species in the Melton Branch, White Oak Creek, and White Oak Lake, respectively (ORNL 1998). Bioaccumulation studies in sunfish and largemouth bass (*Micropterus salmoides*) to monitor mercury and polychlorinated biphenyl (PCB) contamination in White Oak Creek and White Oak Lake have been conducted since at least 1994. In 1997, mercury concentrations in redbreast sunfish (*Lepomis auritis*) from White Oak Creek (White Oak Creek kilometer 2.9) and bluegill sunfish (*L. macrochirus*) and largemouth bass from White Oak Lake were approximately five-fold higher than concentrations in fish from sampled reference streams. Concentrations in the largemouth bass were greater than those in the sunfish, which is consistent with the bass's position in the food chain. In 1997, no fish from the White Oak Creek Watershed contained mercury concentrations higher than 0.50 mg/kg. Mean PCB concentrations in sunfish from White Oak Creek kilometer 2.9 and White Oak Lake during 1997 were 0.39 ± 0.10 mg/kg and 0.69 ± 0.06 mg/kg, respectively. Reference location sunfish that were analyzed at the same time averaged <0.02 mg/kg PCB. The PCB concentrations in largemouth bass from White Oak Lake ranged from 0.43 to 3.8 mg/kg PCB. Since 1994, the PCB concentrations in sunfish and largemouth bass from White Oak Creek have remained approximately two- to three-fold higher than the concentrations reported from the early 1990s (ORNL 1998).

DOE Order 5400.5, Chapter II, sets an interim absorbed dose rate limit of 1 rad/day (0.01 Gy/day) to native aquatic organisms. ORNL demonstrated compliance with this limit for aquatic biota exposed to surface water and sediments in the White Oak Creek Watershed by calculating absorbed doses to fish, crustacea (such as crayfish), and muskrats (*Mustela erminea*) (ORNL 1998). Doses to these receptors at Melton Branch kilometer 0.2, as well as at White Oak Creek kilometer 2.6, and White Oak Lake Dam kilometer 1.0, were all significantly less than the 1 rad/day limit (Table 3-3).

Table 3-3. Doses of radionuclides to aquatic receptors at ORNL surface water locations in 1997[a,b]

Measurement location	Fish		Crustacea		Muskrat	
	Avg. (rad/day)	Max. (rad/day)	Avg. (rad/day)	Max. (rad/day)	Avg. (rad/day)	Max. (rad/day)
Melton Branch (K 0.2)	1E-03	2E-03	3E-04	6E-04	3E-03	6E-03
White Oak Creek (K 1.0)	8E-04	2E-03	3E-04	5E-04	2E-03	3E-03
White Oak Creek (K 2.6)	4E-04	7E-04	1E-04	2E-04	1E-03	2E-03
White Oak Creek (K 6.8)	7E-08	1E-07	7E-08	1E-07	1E-07	2E-07

[a]Total dose rate includes the contribution of internally deposited radionuclides, sediment exposure (derived from water concentration), and water immersion.

[b]To convert from rad/day to Gy/day, divide by 100.

K = kilometer.

ORNL = Oak Ridge National Laboratory.

Source: Adapted from ORNL 1998.

3.3.4 Aquatic Threatened and Endangered Species

3.3.4.1 Flora

Surveys for sensitive plant species that are specific to the proposed TRU Waste Treatment Facility area were completed on May 12, 1999, and were accomplished by walking the entire proposed impact area. No federally listed aquatic plant species were found to occur on, or adjacent to, the survey area. Two Tennessee State-listed wetland species, the purple fringeless orchid (*Platanthera peramoena*) and river bulrush (*Scirpus fluviatilis*), have been identified on the ORR and may be present in wetland areas adjacent to the proposed site. Neither of these species was identified during the 1999 field survey report for rare plants (Appendix C.3).

3.3.4.2 Fauna

No federally listed aquatic animal species were found to occur on or adjacent to the survey area (Appendix C.2). The only Tennessee State-listed aquatic-related species observed in 1995 near the proposed site was the osprey, which occurred at the nearby White Oak Lake. Platforms have been established on Melton Lake, and this bird has become a common nester of the Melton Valley area (Mitchell et al. 1996). Species in the surrounding area listed as "in need of management" by the State of Tennessee include the little blue heron and great egret. Both species were sighted on White Oak Lake during the 1995 ORO survey (Figure 3-2) and are considered to be uncommon migrant species to the area (Mitchell et al. 1996).

3.4 GEOLOGY AND SEISMICITY

The ORR is located in the Tennessee Section of the Valley and Ridge physiographic province (Figure 3-3). This province extends more than 1,287 km (800 miles) from northeast Alabama into central Pennsylvania. Four main features distinguish the Valley and Ridge Province: long, parallel ridges and valleys oriented from northeast to southwest; similar ridge summit elevations suggesting former erosional surfaces; major traverse streams that cut through ridges with subsequent streams forming a trellis drainage pattern parallel to the valleys; and numerous water and wind gaps through the ridges. The Tennessee section encompasses the southwestern half of the Valley and Ridge province extending from northeast Alabama into southwestern Virginia. This section of the Valley and Ridge province ranges from 40 to 113 km (25 to about 70 miles) wide. In the vicinity of the ORR, the width is approximately 80 km (50 miles). Within the ORR, the principal valley and ridge landforms include, from southeast to northwest, Copper Ridge, Melton Valley (containing the proposed TRU Waste Treatment Facility site), Haw Ridge, Bethel Valley (containing the main ORNL plant area), Chestnut Ridge (separating ORNL and the Y-12 Plant), Bear Creek Valley (containing the Y-12 Plant), and Pine Ridge (separating the Y-12 Plant from the City of Oak Ridge). The proposed TRU Waste Treatment Facility site lies within Melton Valley at an elevation of about 224 m (780 ft) above mean sea level. Elevations on the ORR range from 212 to 386 m (738 to 1,345 ft) above mean sea level.

The characteristic topography that defines this province is largely a result of regional tectonic activity that occurred during the Alleghenian orogeny from the middle Pennsylvanian through the early Permian periods (300 to 250 million years ago). This tectonism produced a majority of the prominent Appalachian landforms and deformed underlying bedrock through intense compressional folding and low-angle (<10º) thrust faulting (overthrusting). The folding and faulting process produced repeated stratigraphic sequences aligned northeast-southwest, perpendicular to the direction of greatest stress, and characteristically dipping to the southeast. Differential erosion of alternating bedrock units

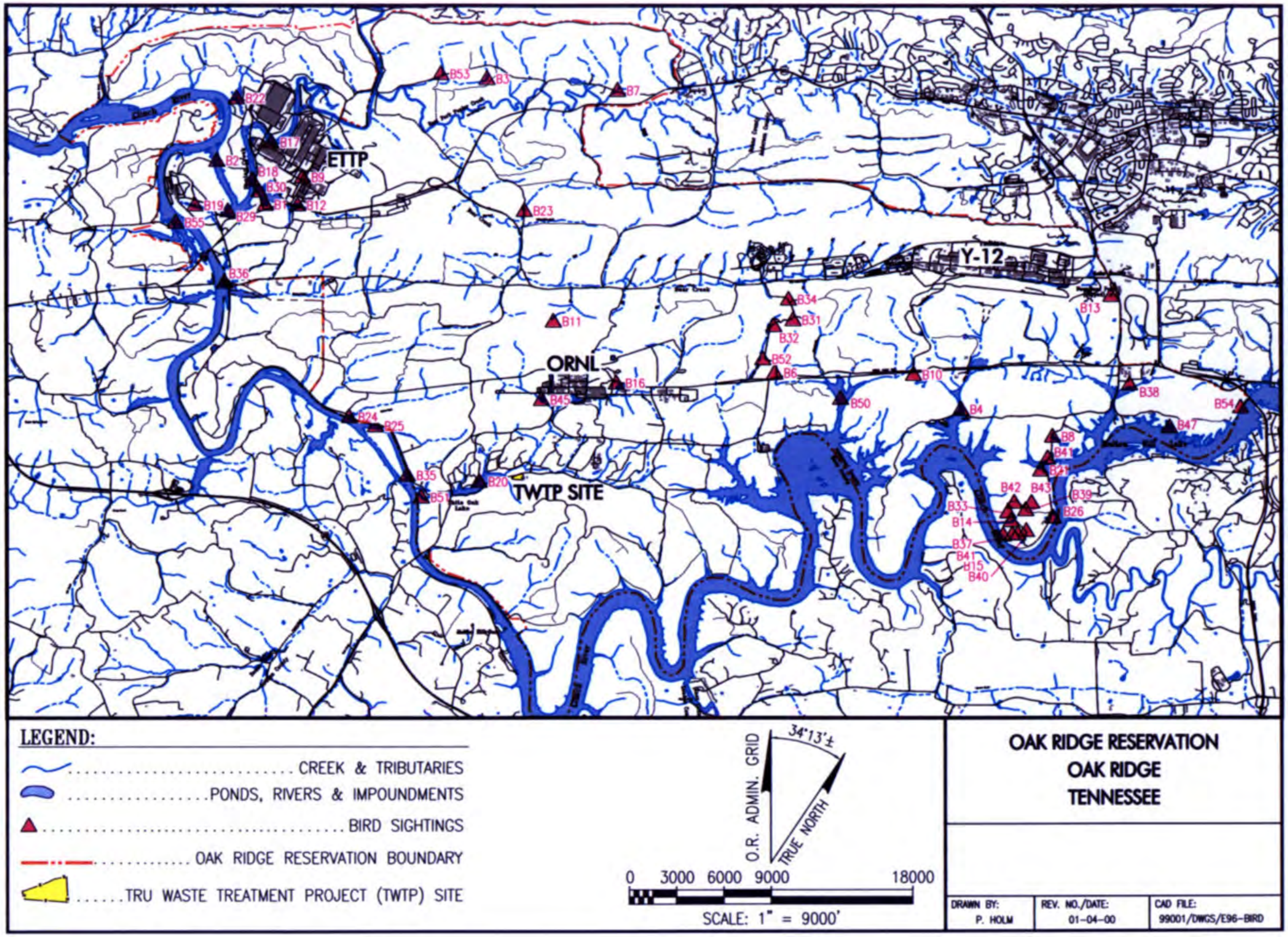


Figure 3-2. Locations of sightings of protected bird species on the ORR – 1995 survey.

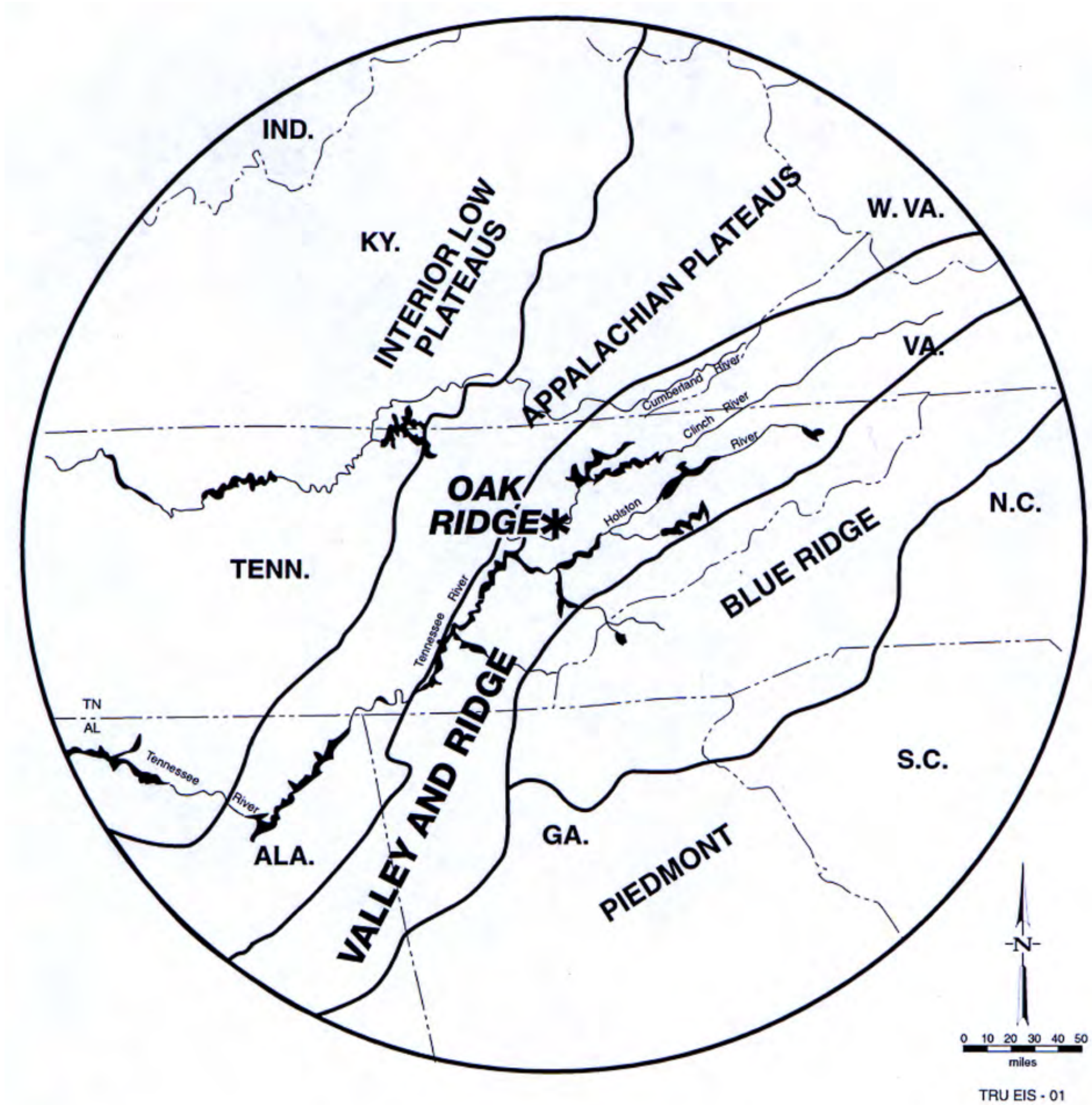


Figure 3-3. Physiographic map of the Southern Appalachian Region.

subsequently produced the characteristic topography, with resistant units forming ridges and easily eroded units forming valleys. Typically, the scarp (northwest facing) slopes of the ridges are relatively short, steep, and smooth. The dip slopes (southeast facing) are longer, have a gentler slope, and are dissected by surface streams.

3.4.1 Stratigraphy

Bedrock in the ORR vicinity is of Early Cambrian (about 570 million years ago) to Mississippian (320 to 345 million years ago) age (Figure 3-4). The bedrock units encompass a wide variety of lithologies ranging from pure limestone to dolostone to fine sandstone. The total thickness of the stratigraphic section on the ORR is about 2.5 km (1.6 miles). Four primary geologic units occur on the ORR; these include (from oldest to youngest) the Rome Formation, Conasauga Group, Knox Group, and Chickamauga Group. Younger geologic formations, including Silurian-, Devonian-, and Mississippian-age units, occur in East Fork Valley immediately north of the ORR. The Conasauga Group, Knox Group, and Chickamauga Group are comprised of individual geologic formations that have been combined based on general lithology types and age. Because of their unique lithologies, each of the major stratigraphic units possesses different mechanical characteristics and has responded differently to the strains imparted on them through time. In general, the Maynardville Limestone of the Conasauga Group, the Knox Group, and most of the overlying Chickamauga Group act as brittle, but competent, units within the major thrust sheets in the ORR vicinity. The Rome Formation, all of the Conasauga Group below the Maynardville Limestone, and the Moccasin Formation of the Chickamauga Group (weak units) readily deform under stress; these units often contain fault planes along which movement has occurred. The Rome Formation and Knox Group are chemically resistant to weathering; thus, these units form the principal ridges on the ORR. The Chickamauga Group and Conasauga Group formations underlie the valleys.

The Consauga Group underlies the Melton Valley which contains the proposed TRU Waste Treatment Facility site (Figure 3-5). Strata within the Consauga Group include (from the oldest to youngest) the Pumpkin Valley Shale, Friendship Formation (stratigraphically equivalent to the Rutledge Limestone), Rogersville Shale, Dismal Gap Formation (stratigraphically equivalent to the Maryville Limestone), Nolichucky Shale, and the Maynardville Limestone. Strata within the Conasauga Group consist of variable limestone and shale lithologies. The Pumpkin Valley, Rogersville, and Nolichucky Shale are comprised primarily of shale with subordinate limestone content present as thin interbeds or discontinuous stringers. The Friendship and Dismal Gap Formations contain a significant percentage of carbonate (about 40%, respectively); limestone beds up to 6 m (21 ft) thick exist at the base of the Friendship Formation, whereas limestone beds typically are 0.5 m (1.7 ft) in the Dismal Gap Formation (Hatcher et al. 1992). The Maynardville Limestone consists of relatively pure limestone and dolostone; only a minor percentage of shale occurs in the upper portion of the unit.

The TRU Waste Treatment Facility site would be situated over the Cambrian-age Nolichucky Shale. At the proposed location, the Nolichucky Shale consists of dark gray to lesser amounts of dark green, olive green, brown, and black shale and silty shale. Shale beds range from about 2.5 cm (1 in.) to 3 m (10.5 ft) thick and are often fissile in outcrop. The shale-to-limestone content ratio is about 1:1.75. Informally, the Nolichucky is divided into lower, middle, and upper members. The total thickness of the Nolichucky Shale is approximately 57 m (187 ft) in the Copper Creek Thrust Sheet. The surface contact with the Maynardville Limestone lies about 230 m (800 ft) south of the proposed TRU Waste Treatment Facility site. The underlying Maryville Limestone is about 160 m (550 ft) to the north.

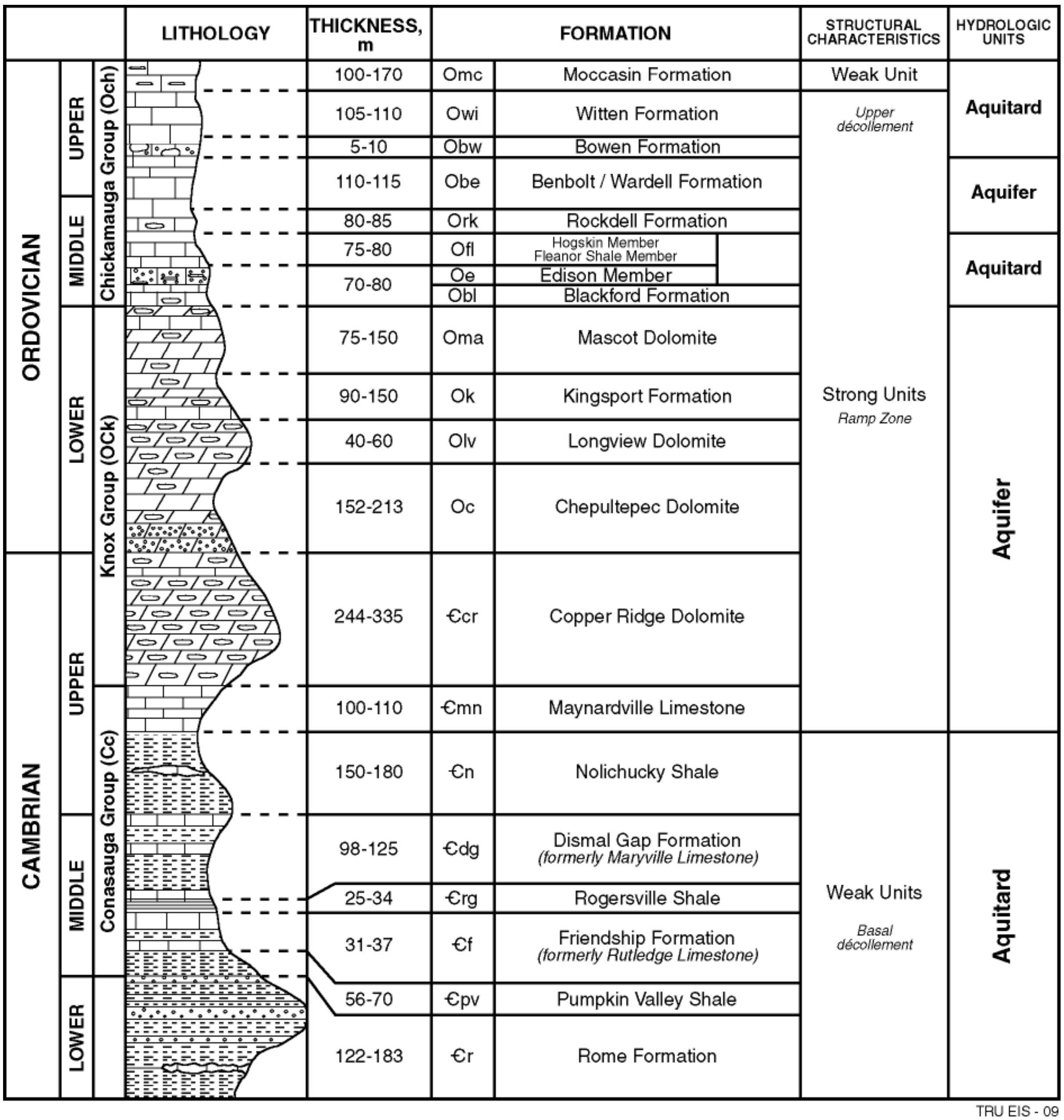


Figure 3-4. Stratigraphic column for the Oak Ridge Reservation.

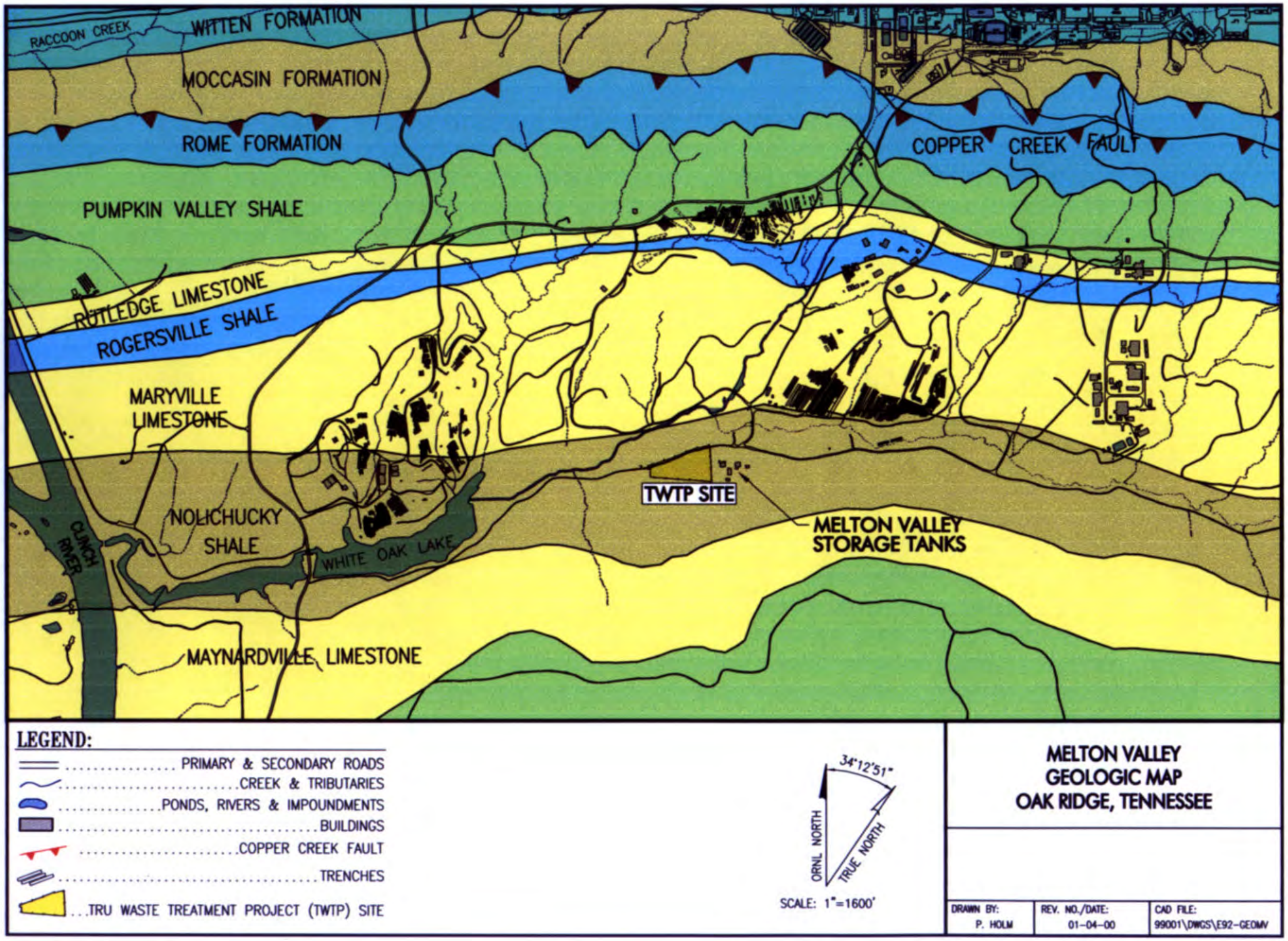


Figure 3-5. Geologic map for Melton Valley.

3.4.2 Structure

Strata at the proposed TRU Waste Treatment Facility site are oriented in a northeast-southwest direction (average geologic strike is about north 55º east) and dip about 45º to the southeast. The regional compressive tectonic activity that produced the orientation of the bedrock strata also resulted in the development of two major thrust faults: the Copper Creek Fault and the White Oak Mountain Fault (Figure 3-6). The strata that overlie and are bounded by these faults are referred to as thrust sheets. The White Oak Mountain thrust sheet is bounded at depth (i.e., soled) by the White Oak Mountain thrust fault and includes all strata between Pine Ridge and Copper Ridge (Figure 3-5). The Copper Creek thrust sheet includes strata south of Copper Ridge extending off of the ORR. Both thrust faults are regional in extent and exhibit several kilometers of translation. As noted previously, these faults formed during the Pennsylvanian-Permian Alleghenian orogeny and have not been historically active.

Bedrock on the ORR is covered with a mantle of residual soil formed by weathering of bedrock in place (saprolite). These residual soils tend to have a clay content over limestone and dolostone bedrock units and are silty clays over shale-dominated units. The saprolite tends to retain visible parent bedrock characteristics such as fractures and bedding planes and normally has a higher porosity and permeability than the parent material. The residual soils tend to be absent where erosion has removed them near streams and thicker in upland areas and where bedrock contains higher limestone or dolostone content.

Localized folding of bedrock units is prevalent on the ORR. Incompetent strata, such as the Nolichucky Shale, exhibit numerous small-scale folds ranging from less than a meter to several meters in size. Folds within the Copper Creek Thrust Sheet are typically parallel (flexural slip), range from symmetric to asymmetric, plunge gently (<30º) to the northeast or southwest, generally are open, and are upright to steeply inclined (axial surface dip >60º) (Hatcher et al. 1992).

Tectonic activity has also produced extensive fracturing and localized folding of bedrock units. Fractures are abundant within shallow and intermediate bedrock [to depths of about 91 m (300 ft)] and are also retained in bedrock that has been weathered in place (i.e., saprolite). Studies of the orientation of fractures indicate three orientation sets are evident: one that roughly parallels bedding, one steeply dipping set that parallels bedding, and one that is steeply dipping and perpendicular to bedding (Drier et al. 1987). The fractures form a three-dimensional rectangular network within the bedrock (DOE 1997a). The average fracture density within the Maynardville Limestone and Nolichucky Shale is about 5 per meter in unweathered bedrock. Up to 200 fractures per meter have been measured within saprolite. Fracture densities between 3 and 200 per meter have been observed in outcrops near ORNL (Drier et al. 1987). Typical fracture lengths are short, ranging from a few centimeters to several meters. Within the Maynardville Limestone, and to a lesser degree in the carbonate sections of the Friendship and Dismal Gap Formations, chemical weathering and solution enlargement of fractures have produced karst features (i.e., conduits and cavities). Cross-cutting fractures and fracture zones play a significant role in the movement of groundwater across the geologic structure of the area. The presence of such features is of concern when considering movement of contaminant at depth, such as deep hydrofracture-injected wastes (DOE 1997a). Additional discussion of groundwater fracture flow is presented in Section 3.5.2.

3.4.3 Soils

Soil contamination exists in many locations of the Melton Valley at ORNL. This valley is primarily used for waste storage and contains many existing above grade and below grade waste storage facilities. TRU constituents have been identified in the soil at the SWSA 5 North trench area.

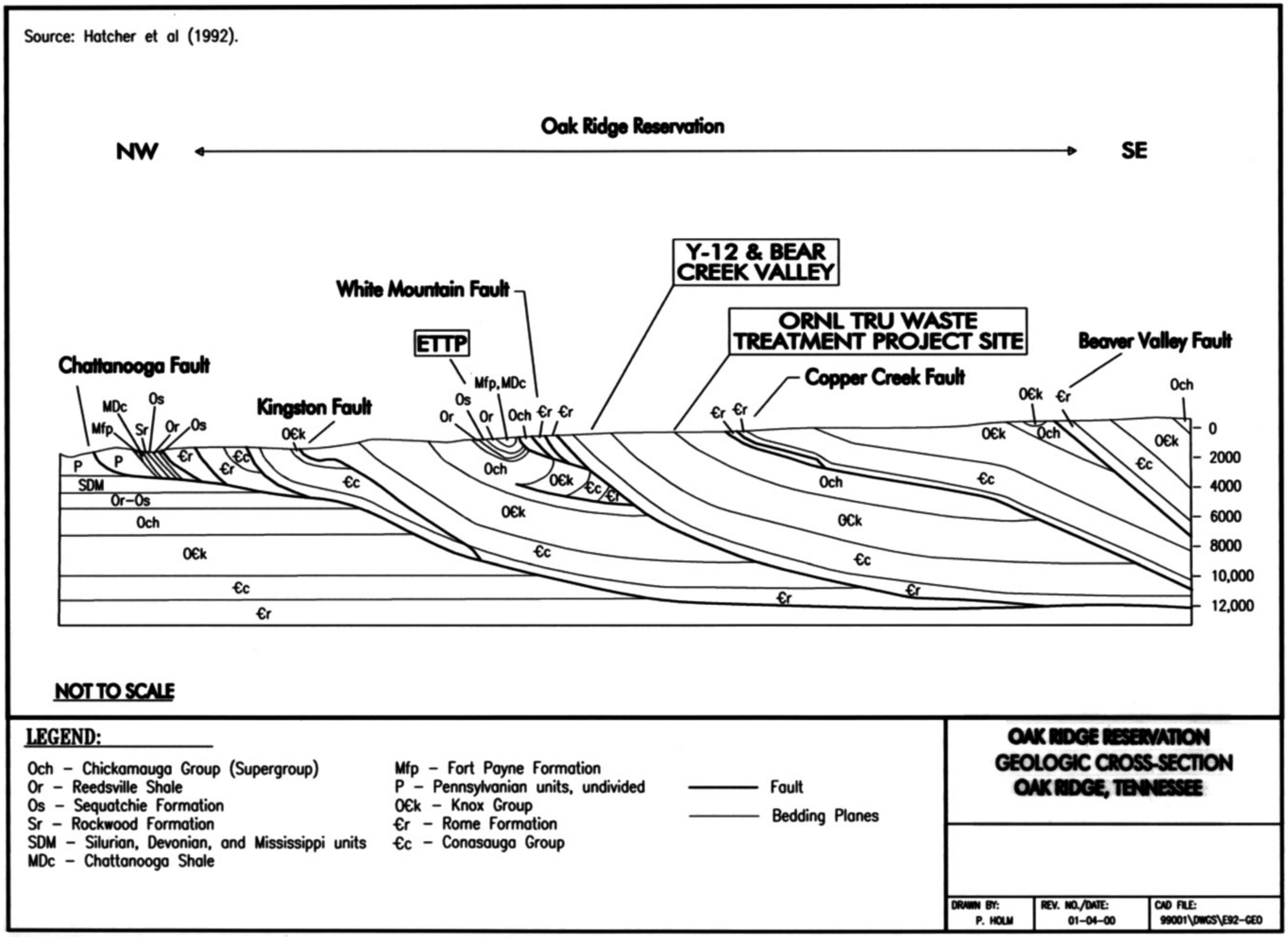


Figure 3-6. Geologic cross-section of the Oak Ridge Reservation.

TRU waste is stored in SWSA 5 North in underground trenches. The waste was stored in either 4-inch-thick concrete casks, or a combination of wood and metal boxes, and then buried in one of six identified trenches. In 1983, one of the casks was removed to evaluate the integrity of the containment vessel. Although the hoisting cables were severely rusted and eventually broke during removal, the vessel itself remained in generally good condition. Similar evaluation steps have not been taken for the other containment vessels. Water level data collected in 1993 from in-trench standpipes and nearby monitoring wells show that most of the TRU trenches in the main group of trenches are at least partially inundated during the wet season (DOE 1995). The trench inundation and/or bathtubbing are the most likely mechanisms responsible for the potential release from the TRU trenches to the surrounding soils. Impacted groundwater from these trenches has the potential of discharging into White Oak Creek to the west or to the D-1 Tributary to the south and impacting the subsurface soils and bedrock along this flow path.

Soils at the site are closely tied to local geology and geomorphic processes. Soils at the proposed site formed from rock weathered in place from the underlying Nolichucky Shale bedrock (residuum), from soil and rock transported downslope by gravity from higher topographic positions (colluvium), or from soil and rock transported by Melton Branch and other tributary streams (alluvium) (Hatcher et al.1992). Soil properties are summarized in Table 3-4.

Table 3-4. Select properties of soils at the proposed TRU Waste Treatment Facility site

Series Number	Parent material	Drainage	Depth	Erosion potential	Roads		Small buildings
					Paved	***Unpaved***	
300	Nolichucky residuum	Moderately well to somewhat poorly drained	50 to 125 cm (20 to 49 in.)	Low to moderate	Poor	Poor (wetness and high clay content)	Poor (wetness)
301	Nolichucky residuum	Moderately well drained	50 to 100 cm (20 to 39 in.)	High	Fair	Poor (high clay content)	Fair to poor (differential settling)
302	Nolichucky residuum	Moderately well to well drained	50 to 125 cm (20 to 49 in.)	Moderate to high	Poor (high clay content)	Poor (unstable base)	Fair (high clay content)
221	Colluvium from Maynardville and Copper Ridge	Well drained	>150 cm (>59 in.)	High	Fair	Fair (unstable base)	Fair to good
995	Alluvium	Moderately well to well drained	50 to 125 cm (20 to 49 in.)	Very high	Poor (high silt content)	Very poor (very unstable base and high silt content)	Very poor (wetness and high silt content)

3.4.3.1 Residual soils

Soils formed in Nolichucky residuum at the proposed TRU Waste Treatment Facility site include three unnamed soil series, coded as Series Numbers 300, 301, and 302 (Hatcher et al. 1992). Number 300 soils occur on lower side slopes where overland flow and subsurface lateral flow keep the lower subsoil horizons wet during winter and spring. Number 301 soils occupy topographic positions higher in the landscape than Number 300 soils and occupy the largest area underlain by the Nolichucky Shale. Most areas of Number 301 soils were cultivated in the past and led to severe erosion. The high silt and clay content throughout Number 301 soils contributes to frequent downslope movement when these soils become saturated with water. Number 302 soils occur on very gentle slopes (<6%) underlain by the Nolichucky Shale. They are most often found near the top of the formation where beds of clayey limestone are interspersed among the shale layers. Number 302 soils have a clay-enriched subsurface horizon, which is related somewhat to the high clay content of the parent material.

3.4.3.2 Colluvial soils

Colluvial soils at the site include Series Number 221 (Hatcher et al. 1992). These soils formed in material that was transported downslope by gravity from the Maynardville Limestone or Copper Ridge Dolomite, which overlie the Nolichucky on Copper Ridge. Number 221 soils overlie Nolichucky residuum on toeslopes along the bottom of ridges and fan terraces at the bottom of first-order drainageways. Different hydraulic properties of the colluvium and the underlying residuum interrupt the vertical migration of water through the soil profile, resulting in a seasonally perched water in the top part of the soil profile in winter and spring.

3.4.3.3 Alluvial soils

Alluvial soils, coded Series Number 995, formed in alluvium deposited in floodplains of larger (second-order and higher) streams (Hatcher et al. 1992). Number 995 soils occur in the floodplain of Melton Branch, which abuts the proposed TRU Waste Treatment Facility site on the northwest. These soils generally have a high silt and fine sand content in the upper part of the soil profile, which leads to some significant engineering problems. Number 995 soils cannot be compacted and have a very low load-bearing capacity.

3.4.4 Site Stability

A 1989 site characterization study conducted for a previously proposed TRU waste handling and packaging plant about 287 m (1,000 ft) west of the Melton Valley Storage Tanks included installation of 47 soil borings and collection of samples for geotechnical parameters (MMES 1989; EDGE 1989). Data from this investigation showed that residual soils at the site ranged from depths of 0.48 to 5.7 m (1.7 to 20.1 ft). No evidence for sinkhole or karst development was observed. Soils overlying limestone-dominant bedrock were cohesive and stiff to very stiff. Blow counts for these types of soils typically ranged between 2 to 8 counts per 0.14 m (0.5 ft). Samples of residual soil overlying the shale-dominant zones of the Nolichucky Shale were dense and noncohesive. Blow counts typically ranged between 10 and 50 per 0.14 m (0.5 ft). The 1989 geotechnical studies were conducted for the purpose of construction suitability testing in the region around the Melton Valley Storage Tanks, located east of the proposed TRU Waste Treatment Facility site. Borings were generally excavated to 5 m (15 ft) below ground surface or auger refusal, whichever came first. Standard penetration tests were collected in the field, and select samples were collected by standard engineering characteristics analysis (e.g., grain size analysis, moisture content, specific gravity, and Atterberg limits) (EDGE 1989). In general, the results of these suitability tests found that the soils on the proposed TRU Waste Treatment Facility site are typical of the ORR, suitable for construction, and not susceptible to liquefaction or mass movement.

Regional seismicity data for the southeastern United States presented in this EIS are derived from the assessment for the Advanced Neutron Source (ANS) site (Blasing et al. 1992). The ANS site was located about 1.6 km (1 mile) north of the proposed TRU Waste Treatment Facility site. Five tectonic provinces in the southeastern United States have experienced historical strong-motion earthquakes: the Mississippi Embayment, the Atlantic Coastal Plain, the Appalachian Basin, the Piedmont Plateau, and the Interior Low Plateau. The ORR is located within the Appalachian Basin province. Strong-motion earthquakes are those with a Modified Mercalli Intensity of VII or higher, or a magnitude (Richter Scale) greater than or equal to 6.0 (Tables 3-5 and 3-6). The Modified Mercalli Intensity scale is currently the preferred indicator for identifying the relative strength of earth movements. Earthquakes of high magnitude have the potential, but may not necessarily equate to a high Modified Mercalli Intensity value if they occur in an unpopulated, remote location where little measurable damage to human structures occurs.

Table 3-5. Modified Mercalli Intensity Scale for earthquakes, developed 1931

Magnitude	Earthquake Effects
I	Not felt except by a few under exceptionally favorable circumstances.
II	Felt by a few persons at rest, especially on upper floors of buildings.
III	Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Vibration like the passing of a truck.
IV	Felt indoors by many; outdoors by few during the day. Dishes, windows, doors disturbed; walls make creaking sounds. Sensation like a heavy truck striking the building.
V	Felt by nearly everyone; many awakened if sleeping. Some objects broken; cracked plaster in a few places. Disturbances of trees, poles, and other tall objects sometimes noticed.
VI	Felt by all; many scared and run outdoors. Some heavy furniture moved. Structural damage is slight.
VII	Everybody runs outdoors. Damage negligible in buildings of good design and construction. Slight to moderate damage in well built ordinary structures; considerable damage in poorly built or badly designed structures.
VIII	Damage slight in specially designed structures; considerable in ordinary substantial buildings with partial collapse; great damage in poorly built or badly designed structures. Fall of chimneys, factory stacks columns, monuments, and walls. Sand and mud ejected in small amounts. Changes in well water levels.
IX	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb; great damage in substantial buildings. Buildings shifted off of foundations. Underground pipes broken.
X	Some well-built structures destroyed most masonry and frame structures with foundations destroyed. Steel rails bent. Ground badly cracked. Landslides considerable from riverbanks and steep slopes.
XI	Few if any structures remain standing. Bridges destroyed. Steel rails bent greatly. Broad fissures in the ground. Underground pipelines out of service. Earth slumps and land slips in soft ground.
XII	Damage total. Waves seen on ground surface. Lines of sight and level distorted. Objects thrown into the air.

Table 3-6. Richter Scale of earthquake magnitude

Magnitude	Earthquake Effects
<3.5	Generally not felt, but recorded by instrumentation
3.5 – 5.4	Often felt, but only minor damage detected
5.5 – 6.0	Slight damage to structures
6.1 – 6.9	Can be destructive to populous regions
7.0 – 7.9	Major earthquake inflicting serious damage
>8.0	Great earthquake with total destruction to nearby communities

Historical seismicity in the southeastern United States has largely been correlative with surface or shallow geologic structures above the crystalline basement rock. A large majority of seismic activity associated with geologic structures above basement rocks is of low intensity. Of the large historical earthquakes in the southeastern United States, most have been determined to be associated with two types of structures: basement rifts and Triassic Basins. Some large earthquakes have not been correlated with any specific geologic structures. Little is known about the precise relationships between earthquakes and basement structures because the historical seismic record is too short, and the types and locations of basement structures are poorly understood. Basement rifts typically are late Precambrian to early Cambrian age and underlie the Interior Low Plateau, Mississippi Embayment, and Appalachian Basin provinces. The Precambrian rift basins are believed to have formed about 820 million years ago during separation of the North American ancestral continent from the African, European, and South American ancestral continent. Triassic basins are rift basins associated with the early opening of the Atlantic Ocean during the late Triassic period (about 200 million years ago). Triassic rift basins are buried beneath the Atlantic Coastal Plain in Georgia and South Carolina, are exposed at the surface in North Carolina and Virginia, and are exposed within the Appalachian Basin from Maryland to Connecticut. The closest Triassic Basin is located about 515 km (320 miles) east of the ORR. Earthquakes detected in association with Triassic Basins are thought to be a result of reactivated faults bounding them. The following discussion presents information regarding the 10 strongest historical quakes in the southeastern United States.

The strongest historical earthquakes in the southeast occurred in the Mississippi Embayment in 1812 along the New Madrid Fault in northwest Tennessee, northeast Arkansas, and southeast Missouri (Site Numbers 1, 2, 3, 4, and 6; Figure 3-7). This fault zone, associated with the Precambrian Reelfoot Rift and Rough Creek Graben, is sourced from basement rock and offsets Holocene (recent) rocks of the Mississippi Embayment. The strongest quake within the Atlantic Coastal Plain province occurred in 1886 and had an epicenter located at Charleston, South Carolina (Site Number 5; Figure 3-7). The geologic structure suspected of producing this earthquake is faulting associated with the rifted eastern

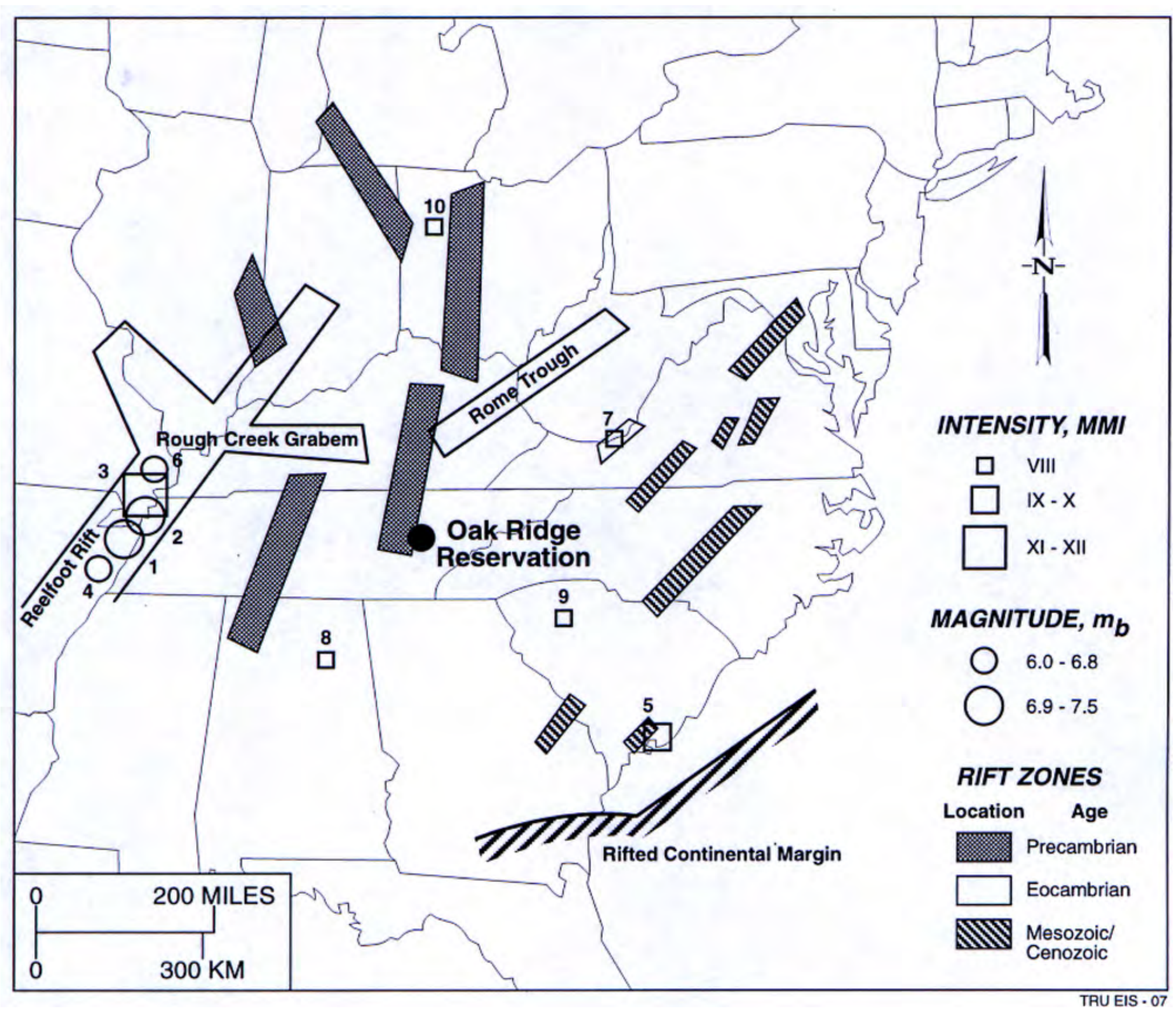


Figure 3-7. Southeast region basement structures and major earthquakes. Depending on the method of measurements when the earthquake occurred, this graphic indicates the measurements as either intensity (Modified Mercalli Index) or magnitude (Richter Scale).

continental margin (Triassic age). Within the Appalachian Basin, the strongest historical quake occurred in 1897 near Giles County, Virginia (Site Number 7; Figure 3-7). The epicenter for this quake correlates to a late Precambrian to early Cambrian basement rift structure buried beneath Paleozoic sedimentary rocks. Another strong-motion quake occurred in northeast Alabama and is not associated with any known basement structure or Triassic rift basin. The strongest known earthquake within the Piedmont Plateau province occurred in 1913 with an epicenter near Spartanburg, South Carolina (Site Number 9; Figure 3-7). This quake is not associated with any known basement structure or Triassic Rift basin. Within the Interior Low Plateau province, the strongest known earthquake occurred near Anna, Ohio, in 1937. The epicenter for this earthquake was near the junction of two Precambrian basement rift zones. Within 100 km (60 miles) of the ORR, the strongest historical earthquake occurred near Maryville and Alcoa, Tennessee, in 1973 and had a magnitude of 4.7 (Richter Scale). The intensity at ORNL has been estimated at about IV (Modified Mercalli), and there was no observed damage (DOE 1979). An earthquake having a magnitude of 4.2 (Richter Scale) was recorded in 1844 in the vicinity of west Knoxville, located about 38 km (25 miles) from the proposed TRU Waste Treatment Facility site (USGS 1999). An additional quake having a magnitude of 4.1 occurred in 1913 in the west Knoxville vicinity. No associated basement structure is identified with these seismic events.

No evidence for capable faults exists within the Appalachian Basin in the vicinity of the ORR (Blasing et al. 1992). Available seismic data and geologic studies do not indicate that Paleozoic faults exposed at the surface have been reactivated during modern times. The closest capable fault (defined as having the capacity for seismic movement) is within the New Madrid fault zone, approximately 480 km (300 miles) west of the ORR. However, earthquake energies could be transmitted from adjacent physiographic provinces where strong earthquakes have occurred in historical times. The ORR is located in Seismic Zone 2, where a probability of seismic damage is moderate (BOCA 1990). Based on available historical seismic data and factoring in dampening effects of distance, the expected earthquake intensities for the ORR as a result of historical strong-motion earthquakes may be estimated. Table 3-7 presents the maximum expected seismic intensity at the ORR based on the strongest intensity historical earthquakes in each of the five tectonic provinces discussed above.

Table 3-7. Maximum historical earthquakes and the maximum Modified Mercalli Intensity and their peak ground accelerations at the ORR[a]

Province	Maximum historical MMI[b]	Distance to ORR km (miles)	Maximum MMI[b] expected at ORR
Appalachian Basin	VIII	N/A[c]	VIII
Atlantic Coastal Plain	X	320 (200)	VII
Interior Low Plateau	VIII	50 (30)	VII
Reelfoot Rift Zone	XI–XII	400 (250)	VII
Piedmont Province	VII–VIII	200 (125)	V–VI

[a]Blasing et al. 1992.
[b]MMI - Modified Mercalli Intensity.
[c]The Oak Ridge Reservation (ORR) is located within the Appalachian Basin; maximum expected intensity for this province is based on the 1897 Giles County, Virginia, earthquake.

Additional studies of potential seismic movement on the ORR have been conducted in support of final safety analysis reports (FSARs) in accordance with DOE-STD-1020. Specific studies have not been conducted at the proposed TRU Waste Treatment Facility site; however, data compiled for the South Tank Farm, located in the main plant area of ORNL in Bethel Valley, and ground-supported facilities at the Y-12 Plant in Bear Creek Valley (DOE 1998a) provide reasonable indicators of annual probability of exceedance and expected peak ground acceleration. Figure 3-8 shows the results of these

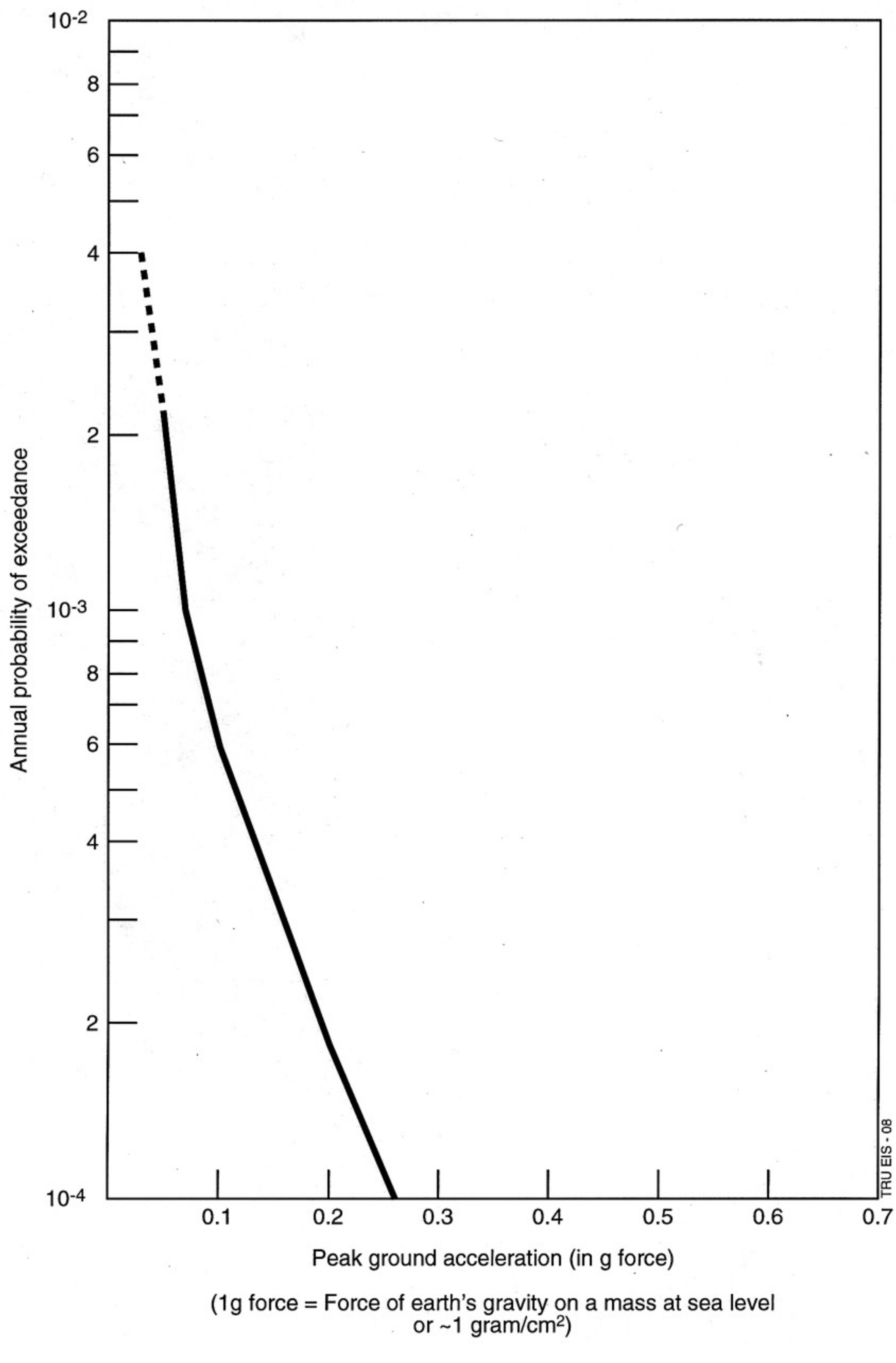


Figure 3-8. Peak ground acceleration and associated annual probability of exceedance for the Oak Ridge Reservation.

seismic hazard studies for peak horizontal rock acceleration. Those soil-supported facilities include an amplification factor of about 2.5 and are shown in Table 3-8. The design earthquake for a 50-year-life facility, with a 100-year seismic event probability is 0.06 peak ground acceleration.

Table 3-8. Seismic ground acceleration for soil-supported facilities[a]

Effective peak ground acceleration (g)	Recurrence interval (year)
0.15	500
0.20	1,000
0.30	2,000
0.65	10,000

[a]Source: DOE 1998a.

g = g force.

3.5 WATER AND WATER QUALITY

This section discusses the surface water resources (Section 3.5.1) and groundwater resources (Section 3.5.2) for the White Oak Creek Watershed, which includes the Melton Valley Watershed, where the site of the proposed TRU Waste Treatment Facility is located. The White Oak Creek Watershed defines the resource area most likely to be effected by the proposed action.

3.5.1 Surface Water

The proposed TRU Waste Treatment Facility site would be located within the Melton Valley Watershed portion of the White Oak Creek Watershed (Figure 3-9). The total drainage area of the White Oak Creek Watershed is approximately 6.15 square miles. There are no permanent surface water bodies or springs within the proposed facility site borders. However, there are two perennial streams (White Oak Creek and Melton Branch), one unnamed wet-weather tributary to White Oak Creek, and one lake (White Oak Lake) within close proximity to the proposed facility. Melton Branch, a tributary to White Oak Creek, is about 61 m (200 ft) from the northern border of the proposed facility. White Oak Creek, which flows south into White Oak Lake, is approximately 152 m (500 ft) to the west of the proposed facility site border and is the main nearby surface water body. White Oak Lake is approximately 0.4 km (0.25 mile) downstream from where the proposed facility is adjacent to White Oak Creek. White Oak Lake discharges into the Clinch River, approximately 2.4 km (1.5 miles) downstream from the proposed TRU Waste Treatment Facility site.

White Oak Creek is a fourth-order stream that originates from springs on the southeast slopes of Chestnut Ridge, which separates ORNL from the Y-12 Plant. The creek receives natural runoff and water from the spring, as well as process water discharges, treated sewage effluent, and cooling water from ORNL facilities located in Bethel Valley, before flowing though the gap in Haw Ridge where it enters Melton Valley. Melton Branch is a third-order stream (relative to the branching of the primary stream and defines the stream's or tributary's position in the watershed) and the primary tributary to White Oak Creek. Melton Branch flows westerly in the Melton Valley portion of the White Oak Creek Watershed, joining White Oak Creek approximately 114 m (375 ft) from the proposed TRU Waste Treatment Facility site border. White Oak Lake is impounded by White Oak Dam and has a normal pool elevation of 227.1 m (745 ft) above mean sea level. Flow from the White Oak Dam discharges into the White Oak Creek Embayment, approximately 0.97 km (0.6 mile) above the confluence with the Clinch River.

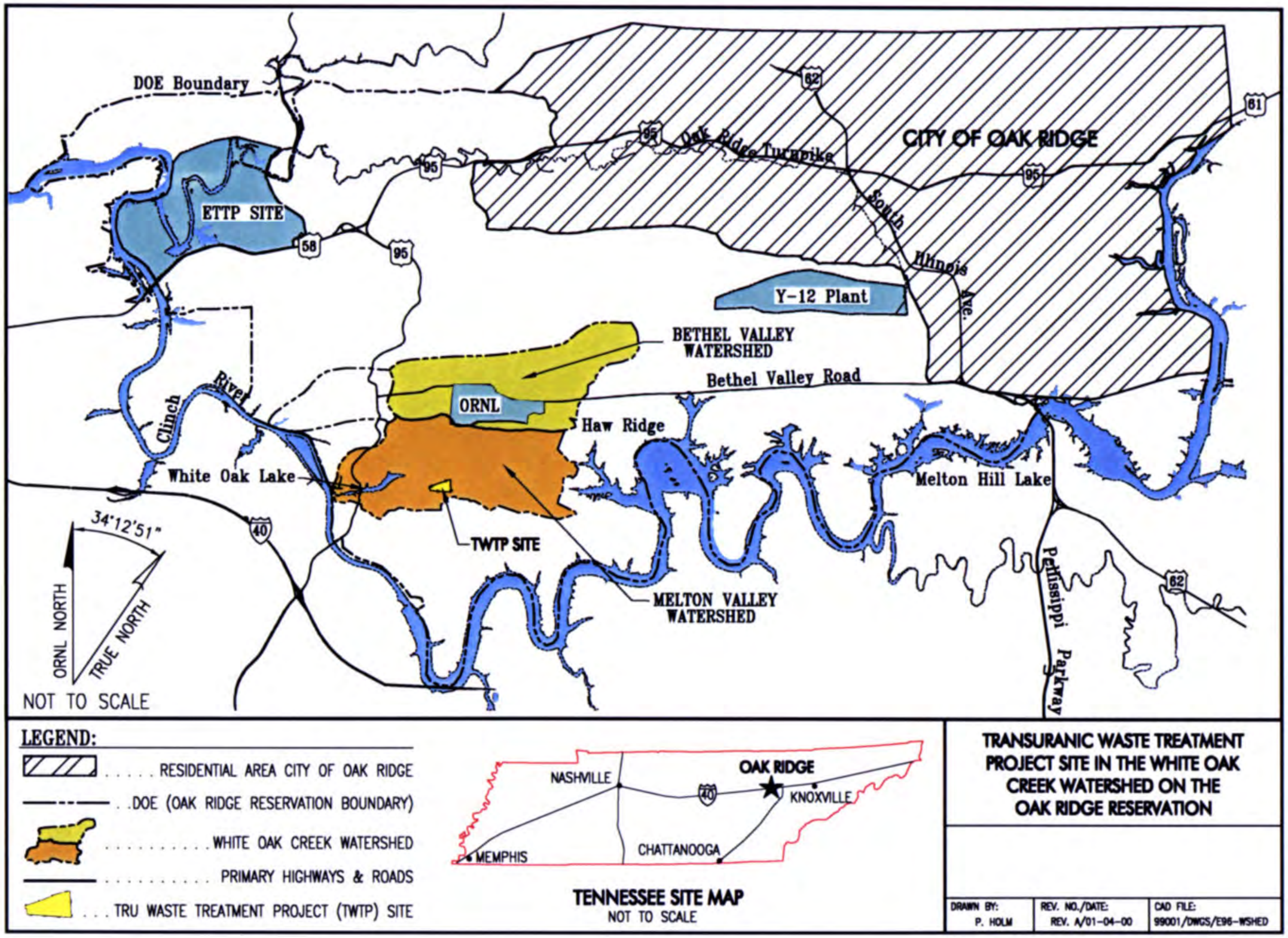


Figure 3-9. Map showing the location of the White Oak Creek Watershed in relation to the Oak Ridge Reservation and the proposed TRU Waste Treatment Project Site.

Continuous stream discharge data have been collected from several water monitoring stations on the White Oak Creek Watershed for years. Monitoring locations that are relatively close to the proposed TRU Waste Treatment Facility site are shown in Figure 3-10. Average discharges at these locations for 1993 and 1994 are summarized in the Melton Valley Remedial Investigation (DOE 1997a). The average discharge at White Oak Creek weir, which is approximately 183 m (600 ft) upstream of the confluence of Melton Branch into White Oak Creek, was 328 L/s. This discharge represents the surface water input to the system. The average discharge at Melton Branch weir on Melton Branch, which is approximately 213 m (700 ft) upstream of the proposed facility border, is 87.9 L/s. The average discharge at the White Oak Dam was 481 L/s, which represents output from the White Oak Creek Watershed.

Surface water sampling for chemical and radionuclide analyses has been ongoing for several years in White Oak Creek (Sample Station X14), Melton Branch (Sample Station X13), and White Oak Lake Dam (Sample Station X15) as part of the Biological Monitoring and Abatement Program requirements for the ORNL 1997 National Pollutant Discharge Elimination System (NPDES) Permit TN0002941, as well as the ORR Environmental Monitoring Plan. The permit limits and compliance statistics for the NPDES sampling are presented in Table 3-9. Table 3-9 shows the daily and monthly permit limits for a variety of water quality parameters. It also shows the number of noncompliances per parameter in relation to the number of samples taken for that parameter. For example, in 1997 there were two exceedances of in-stream chlorine at the Melton Branch X-16 location out of 147 samples [14 of the 19 noncompliance measurements were for total residual chlorine (TRC)]. Dechlorination systems were upgraded to guard against reoccurrences (ORNL 1998), resulting in only two noncompliances for TRC at ORNL in 1998 (ORNL 1999a). The exceedances for the daily maximum concentration and daily maximum loading of the carbonaceous biochemical oxygen demand (CBOD) limit on October 9, 1997, were addressed by a corrective measure on the dechlorination system feed modification at the Sewage Treatment Plant, which resulted in no more exceedances after the one on October 9, 1997 (ORNL 1999a). One Category IV outfall, 302, had one pH measurement of 9.1 on November 17, 1997, which exceeded the permit upper limit of 9.0. A corrective action to identify and repair an underground leak in a waste treatment system component prevented any additional pH noncompliances at the outfall that year, but did allow an additional exceedance of pH 9.6 on January 13, 1998 (ORNL 1999a).

Concentrations of total strontium at all three locations were greater than 4% of the relevant derived concentration guides in 1997 (ORNL 1998). Concentrations of tritium at Melton Branch (Sample Station X-13) and White Oak Lake Dam (Sample Station X15) were greater than 4% of the derived concentration guidelines in 1997 sampling. Figure 3-11, from the Annual Site Environmental Report (ORNL 1998), shows the discharges in curies of several radionuclides at White Oak Dam from 1993–97.

Water samples were collected from four locations on White Oak Creek in November 1997 and analyzed for mercury (ORNL 1998). The most upstream location from ORNL (White Oak Creek kilometer 6.8) had 11 ng/L, which was similar to background or reference streams in East Tennessee. The mercury concentrations at White Oak Creek kilometer 2.9 and White Oak Lake Dam were 160 and 63 ng/L, respectively.

In-stream toxicity monitoring at White Oak Creek, Melton Branch, and White Oak Lake, as part of the Biological Monitoring and Abatement Program, was terminated in 1997 because toxicity had not been detected for the previous several years (ORNL 1998). Although wastewater from the Sewage Treatment Plant and two other facilities at ORNL is evaluated for toxicity, these facilities are too far upstream from the proposed TRU Waste Treatment Facility site for the toxicity results to be relevant.

Detailed results of the water sampling under the Environmental Monitoring Plan for White Oak Creek, White Oak Lake, and Melton Branch for 1997 are presented in ORNL 1998. The sampling frequency and sample parameters for these locations are presented in Table 3-10.

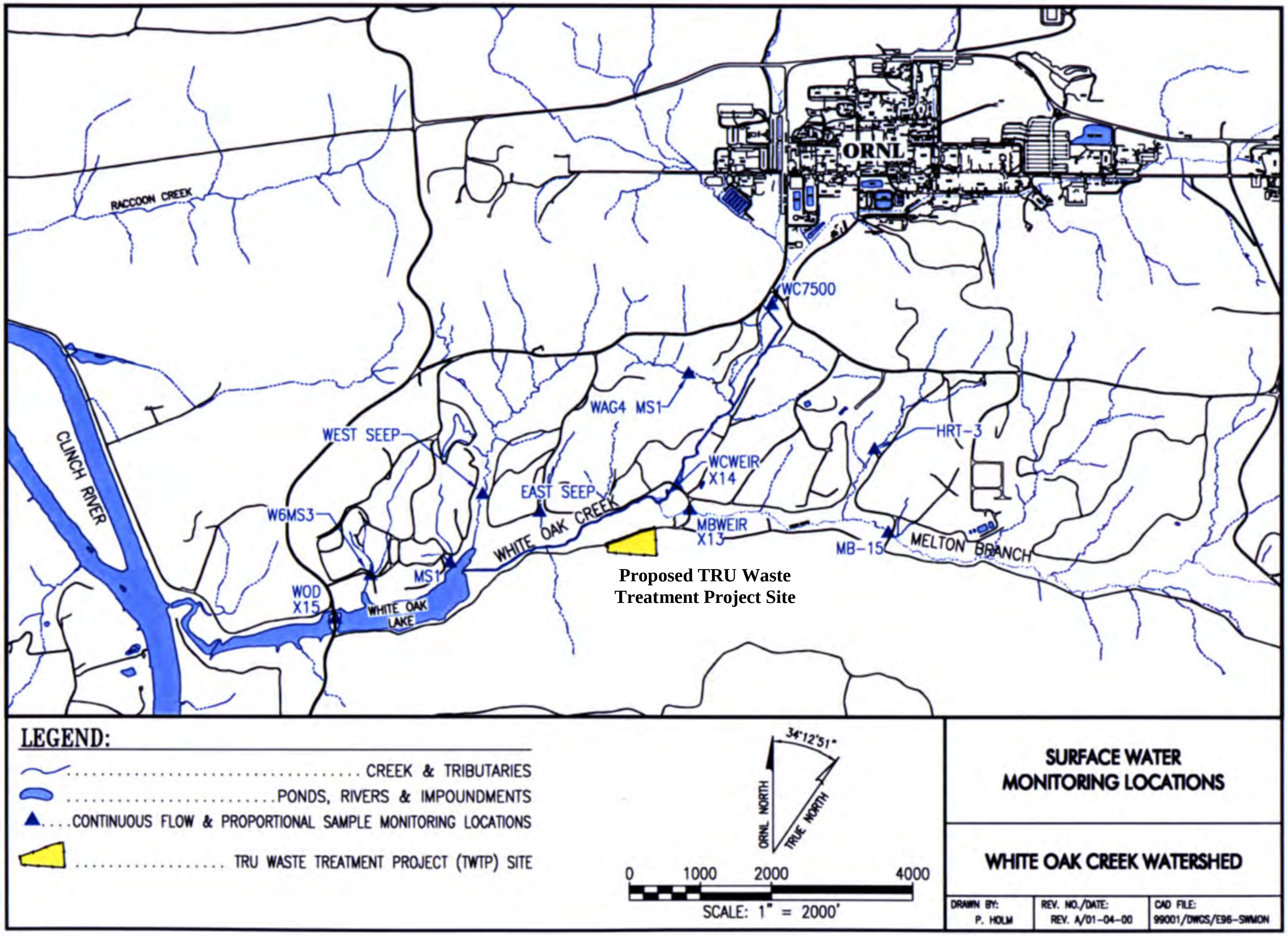


Figure 3-10. Map of surface water monitoring locations in White Oak Creek Watershed near the proposed TRU Waste Treatment Facility.

Table 3-9. ORNL NPDES Permit TN0002941 permit limits and compliance statistics (1997)

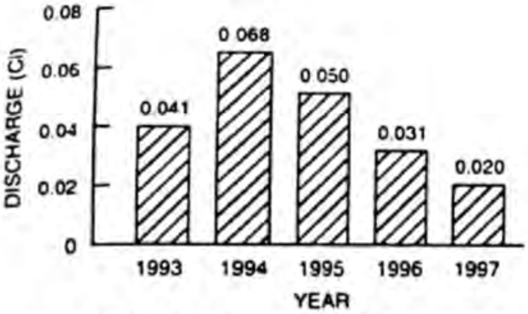
Discharge point	Effluent parameters	Permit limits: Monthly avg. (kg/d)	Permit limits: Daily max. (kg/d)	Permit limits: Monthly avg. (mg/L)	Permit limits: Daily max. (mg/L)	Permit limits: Daily min. (mg/L)	Permit compliance: Number of noncompliances	Permit compliance: Number of samples	Permit compliance: Percentage of compliance[a]
X01 (Sewage Treatment Plant)	96-h LC_{50} for *Cerodaphnia* (%)					41.1	0	3	100
	96-h LC_{50} for fathead minnows (%)					41.1	0	3	100
	Ammonia, as N (summer)	2.84	4.26	2.5	3.75		0	79	100
	Ammonia, as N (winter)	5.96	8.97	5.25	7.9		0	64	100
	Carbonaceous biochemical oxygen demand	8.7	13.1	10	15		2	143	99
	Dissolved oxygen					6	0	144	100
	Fecal coliform (col/100 mL)			1000	5000		0	144	100
	No-observed-effect conc. for *Ceriodaphnia* (%)					12.3	0	3	100
	No-observed-effect conc. for fathead minnows (%)					12.3	0	3	100
	Oil and grease	8.7	13.1	10	15		0	144	100
	pH (std. units)				9	6	0	144	100
	Total residual chlorine			0.038	0.066		2	147	99
	Total suspended solids	26.2	39.2	30	45		0	143	100
X02 (Coal Yard Runoff Treatment Facility)	96-h LC_{50} for *Ceriodaphnia* (%)					4.2	0	4	100
	96-h LC_{50} for fathead minnows (%)					4.2	0	4	100
	Copper, total			0.07	0.11		0	22	100
	Iron, total			1.0	1.0		0	22	100
	No-observed-effect conc. for *Ceriodaphnia* (%)					1.3	0	2	100
	No-observed-effect conc. for fathead minnows (%)					1.3	0	2	100
	Oil and grease			10	15		0	48	100
	pH (std. Units)				9.0	6.0	0	48	100
	Selenium, total			0.22	0.95		0	22	100
	Silver, total				0.008		0	22	100
	Total suspended solids				50		0	48	100
	Zinc, total			0.87	0.95		0	22	100

Table 3-9. ORNL NPDES Permit TN0002941 permit limits and compliance statistics 1997 (continued)

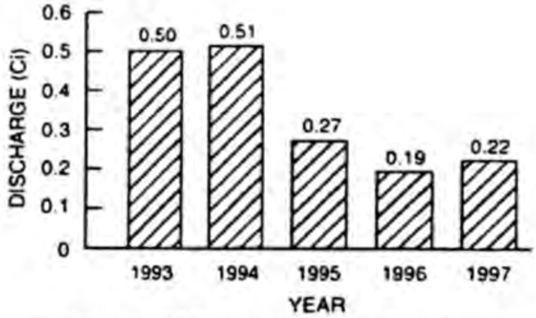
		Permit limits					Permit compliance		
Discharge point	**Effluent parameters**	**Monthly avg. (kg/d)**	**Daily max. (kg/d)**	**Monthly avg. (mg/L)**	**Daily max. (mg/L)**	**Daily min. (mg/L)**	**Number of noncompliances**	**Number of samples**	**Percentage of compliance[a]**
X12 (Nonradiological Wastewater Treatment Facility)	96-h LC_{50} for *Ceriodaphnia* (%)					100	0	4	100
	96-h LC_{50} for fathead minnows (%)					100	0	4	100
	Cadmium, total	0.79	2.09	0.008	0.034		0	48	100
	Chromium, total	5.18	8.39	0.22	0.44		0	48	100
	Copper, total	6.27	10.24	0.07	0.11		0	48	100
	Cyanide, total	1.97	3.64	0.008	0.046		0	4	100
	Lead, total	1.3	2.09	0.028	0.69		0	48	100
	Nickel, total	7.21	12.06	0.87	3.98		0	48	100
	No-observed-effect conc. for *Ceriodaphnia* (%)					30.9	0	4	100
	No-observed-effect conc. for fathead minnows (%)					30.9	0	4	100
	Oil and grease	30.3	45.4	10	15		0	48	100
	pH (std. units)				9.0	6.0	0	144	100
	Silver, total	0.73	1.3		0.008		0	48	100
	Temperature (°C)				30.5		0	144	100
	Total toxic organics		6.45		2.13		0	11	100
	Zinc, total	4.48	7.91	0.87	0.95		0	48	100
In-stream chlorine monitoring points	Total residual oxidant			0.011	0.019		2	242	99
Steam condensate outfalls	pH (std. units)				9.0/8.5	6.0/6.5	0	17	100
Groundwater/ pump water outfalls	pH (std. units)				9.0/8.5	6.0/6.5	0	8	100
Cooling tower blowdown outfalls	pH (std. units)				9.0	6.0	0	2	100
Category I outfalls	pH (std. units)				9.0	6.0	0	13	100
Category II outfalls	pH (std. units)				9.0	6.0	0	15	100
Category III outfalls	pH (std. units)				9.0	6.0	0	63	100
Category IV outfalls	pH (std. units)				9.0	6.0	1	296	100
Cooling tower blowdown/ cooling water outfalls	pH (std. units)				9.0	6.0	0	44	100
	Total residual oxidant			0.11	0.019		12	53	77

[a]Percent compliance = 100 – [(number of noncompliances/number of samples) * 100].
d = day; kg = kilogram; L = liter; and mg = milligram.
NPDES = National Pollutant Discharge Elimination System.

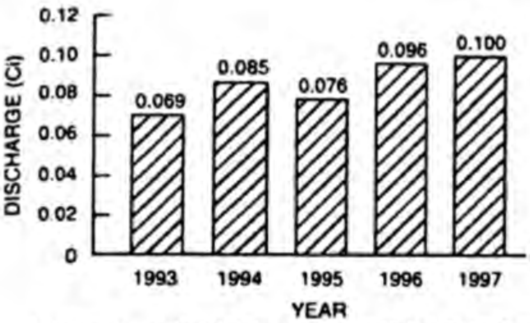
Period of coverage – January 1 to December 31, 1997.
Source: Oak Ridge National Laboratory (1998).



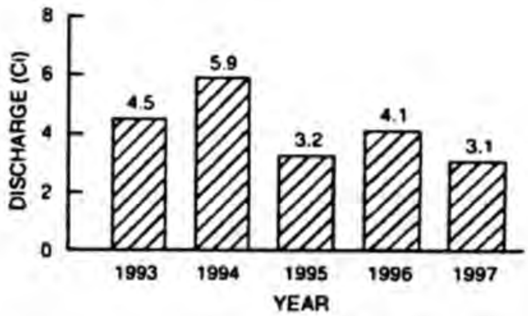
(a) Cobalt-60 discharges at White Oak Dam, 1993–97.



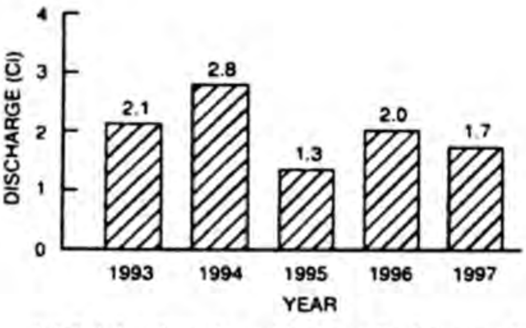
(b) Cesium-137 discharges at White Oak Dam, 1993–97.



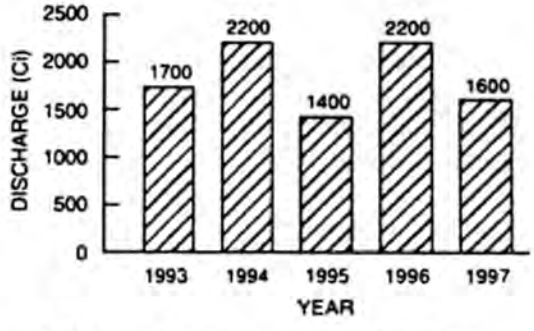
(c) Gross alpha discharges at White Oak Dam, 1993–97.



(d) Gross beta discharges at White Oak Dam, 1993–97.



(e) Total radioactive strontium discharges at White Oak Dam, 1993–97.



(f) Tritium discharges at White Oak Dam, 1993–97.

Figure 3-11. Discharge (in curies) of various radionuclides at White Oak Dam, 1993–97.

Table 3-10. Locations, frequency, and parameters for the Environmental Monitoring Plan surface water sampling at ORNL

Location (K indicates kilometer)	Frequency	Parameters
Melton Branch (K 0.2); Mitchell Branch downstream from ORNL	Bimonthly (Jan., Mar., May, July, Sept., Nov.)	Gross alpha, gross beta, gamma scan, total radioactive strontium, tritium, and field measurements[a]
White Oak Creek (K 1.0); White Oak Lake at White Oak Dam	Monthly	PCBs, gross alpha, gross beta, gamma scan, total radioactive strontium, tritium, and field measurements[a]
White Oak Creek (K 2.6); White Oak Creek downstream from ORNL	Bimonthly (Jan., Mar., May, July, Sept., Nov.)	Gross alpha, gross beta, gamma scan, total radioactive strontium, tritium, and field measurements[a]
White Oak Creek (K 6.8); White Oak Creek upstream from ORNL	Quarterly (Feb., May, Aug., Nov.)	Gross alpha, gross beta, gamma scan, total radioactive strontium, tritium, and field measurements[a]

[a]Dissolved oxygen, pH, and temperature.
ORNL = Oak Ridge National Laboratory.
PCB = polychlorinated biphenyl.
Source: ORNL (1998).

Radionuclides were detected (statistically significant at the 95% confidence interval) at all three locations (Table 3-11). The highest levels of gross beta, total radioactive strontium, and tritium were at these three locations; however, there is no regulatory standard for gross levels of radioactivity, as standards are done on a radionuclide basis. PCB Aroclor-1254 was detected in 5 of 12 samples at the White Oak Lake Dam (0.36 ± 0.087 mg/L).

Table 3-11. Summary of radionuclide activities during the 1997 Environmental Monitoring Plan surface water sampling

Parameter (all activities are pCi/L, mean ± one standard deviation)	Location		
	White Oak Creek (White Oak Creek kilometer 2.0) M = 12	White Oak Lake (White Oak Creek kilometer 1.0) M = 6	Melton Branch (Melton Branch kilometer 0.2) M = 6
Gross beta	280 ± 19	180 ± 20	490 ± 63
Total radioactive strontium	130 ± 8.3	82 ± 7.7	250 ± 41
Tritium	99,000 ±12,000	18,000 ± 2,000	470,000 ± 90,000

Source = ORNL (1998).
M = number of samples.
ORR = Oak Ridge Reservation.

ORNL treats over 180 million gallons per year of non-radiological wastewater, and typically has over 650,000 gallons of hold-up capacity for this type of wastewater upon receipt at their waste water treatment facility. The Y-12 Plant is permitted to discharge up to 1.4 million gallons per day to the City of Oak Ridge's wastewater treatment system, and during 1996, this flow averaged about 0.854 million gallons per day. The ETTP provides its own treatment of sanitary wastewater and is currently operating under capacity. The City of Oak Ridge has overall design capacity for treating up to 5.87 million gallons per day and is currently operating under capacity (Roy 1999).

In summary, the surface water from White Oak Creek, White Oak Lake, and Melton Branch contains elevated concentrations of radionuclides (total strontium and tritium), mercury, and PCBs relative to background or reference streams. The elevated surface water concentrations of mercury and PCBs have resulted in elevated concentrations of these constituents in fish from these locations as indicated in Section 3.3.3. However, the overall water quality is good, such that no toxicity to aquatic organisms had been observed for several years and the toxicity testing was discontinued in 1997.

3.5.2 Groundwater

The *Remedial Investigation Report on the Melton Valley Watershed at Oak Ridge National Laboratory, Oak Ridge, Tennessee* (DOE 1997a), served as the primary source of information for the current groundwater conditions in the Melton Valley Watershed on the ORR.

3.5.2.1 Regional conceptual model

Solomon et al. (1992) developed a generalized conceptual hydrologic framework for the entire ORR including the Melton Valley Watershed at ORNL. The geologic units of the ORR were assigned to two broad hydrologic groups: (1) the Knox aquifer (formed by the Knox Group and the Maynardville Limestone), which is dominated by solution conduits and stores and transmits relatively large volumes of water, and (2) the ORR aquitards (made up of all other geologic units of the ORR), in which flow is controlled by fractures that may store fairly large volumes of groundwater, but transmit only limited amounts. The Melton Valley Watershed is underlain by both geologic units as shown in Figure 3-12. In vertical cross-sections, both the Knox aquifer and the ORR aquitards are further divided into zones, including the storm flow zone, the vadose zone, and the groundwater zone, shown conceptually in Figure 3-13. The storm flow zone is a thin region at the surface in which transient, precipitation-generated flow accounts for a large portion of the water moving through the subsurface. This zone is a major pathway for transporting contaminants from the subsurface to the surface. The vadose zone is a mostly unsaturated zone above the water table. The groundwater zone, which is continuously saturated, is the region where most of the remaining subsurface flow occurs. Zones where permeability is low and groundwater movement is extremely slow are called aquitards.

In most of the Melton Valley Watershed, the water table lies at or somewhat above the bedrock/soil weathering interface. Recharge to the water table can occur both as porous medium flow through the soil and as flow through relict bedding planes and fractures in the soil connecting the surficial soil to the water table. Below the water table, the spatial density, aperture, orientation, and connectivity of fractures control the transmissivity and actual flow paths of groundwater. The predominant groundwater flow and contaminant migration direction in the shallow groundwater system is parallel to local geologic strike because of the abundance of open bedding planes and bed-normal fractures. Small-scale (tens of meters) folds and fracture sets control seepage pathways. Shallow groundwater is observed to migrate via fractures, generally along strike, to local surface water streams. Anthropogenic features, including pipeline trenches and waste burial trenches, can conduct groundwater along their orientations and provide pathways for contaminant transport.

The hydraulic conductivity of subsurface materials is observed to decrease rapidly with increasing depth below the water table. At increasing depths below the water table, the degree of bedrock weathering decreases; thus, fractures tend not to be enlarged. Additionally, overburden pressure tends to keep fractures tightly closed at great depths. Analysis of conductivity tests in screened wells suggests that the spacing of hydraulic active fractures ranges from 7 m (23 ft) near the water table to >35 m (115 ft) at depths of >60 m (197 ft) (Solomon et al. 1992). This decrease in fracture density equates to a

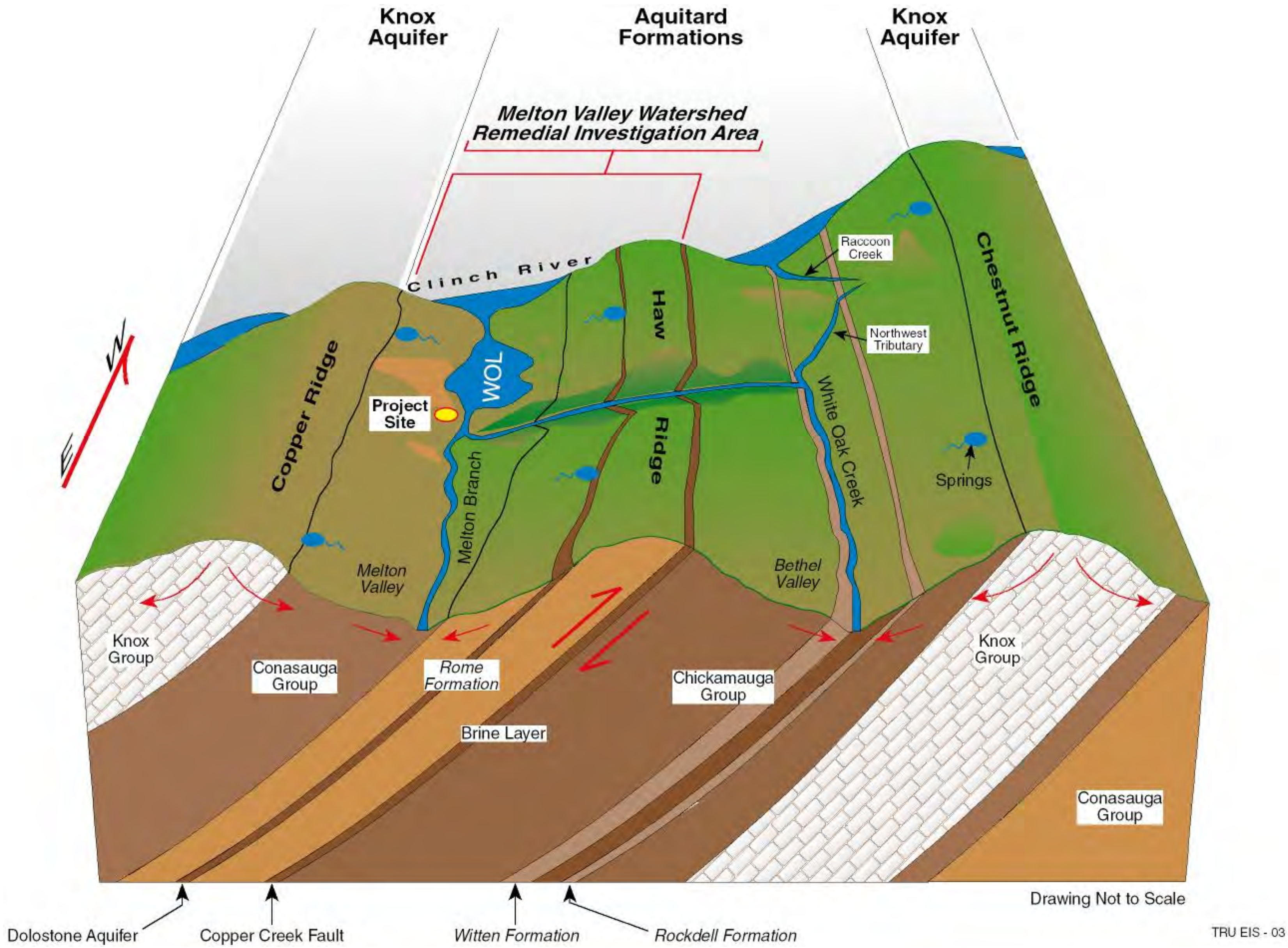


Figure 3-12. Distribution of geologic units in the Melton Valley Watershed Remedial Investigation Area that are assigned to two broad hydrologic groups: the Knox Aquifer and the ORR aquitards.

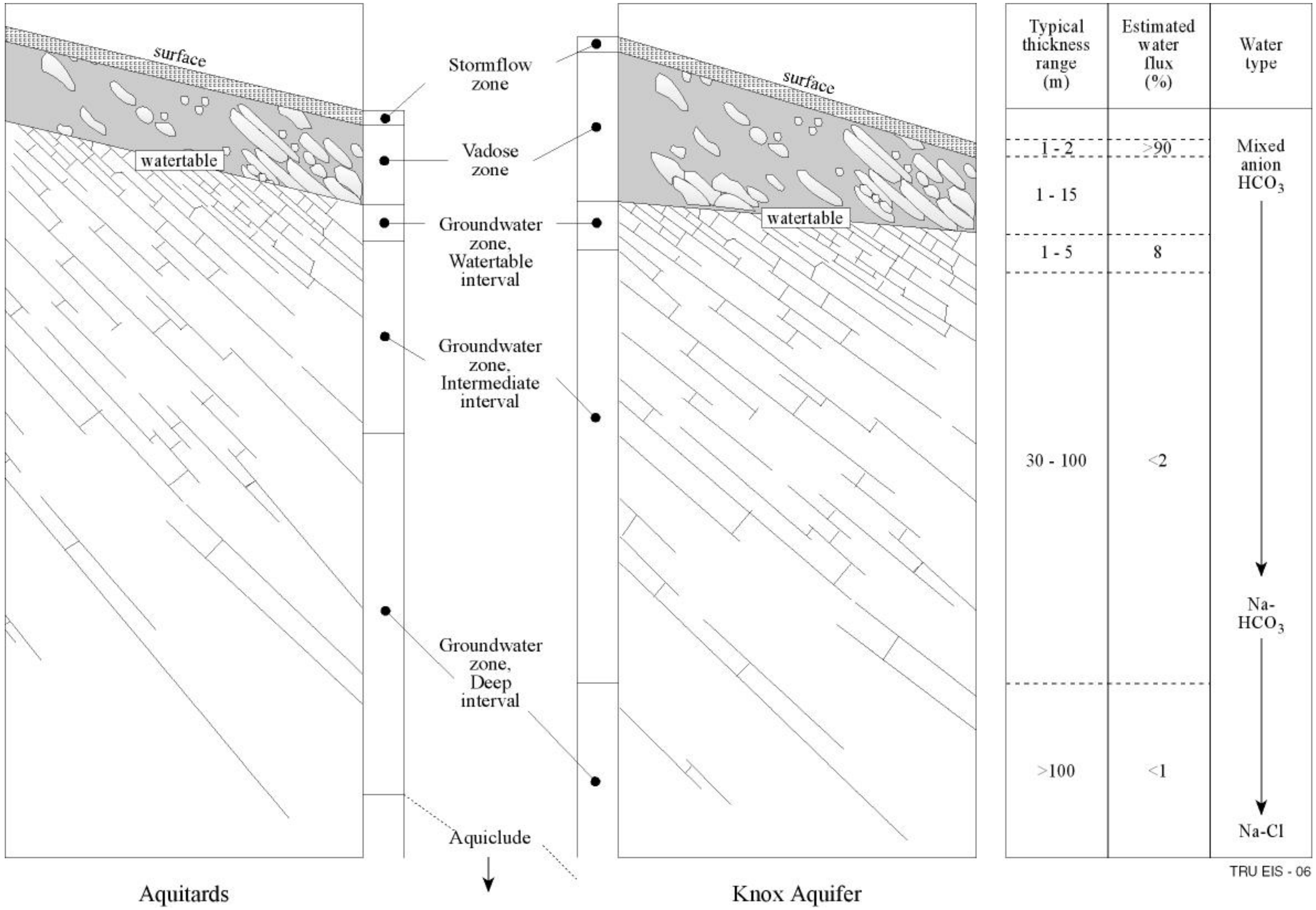


Figure 3-13. Near-surface hydrogeologic zones.

decrease in water-transmitting capability in the rock mass with increasing depths. The geochemical profile typically observed in the ORR groundwater system is $CaHCO_3$ groundwater in the Water table interval, Na-Ca-HCO_3 groundwater in the Intermediate interval, and NaCl brines in the Deep interval, which reflects fresh water flushing near surface, mixing of water types at intermediate depths, and stagnation of groundwater in the Deep interval.

A compilation of information from numerous investigations performed at specific locations throughout the ORR allowed the development of a valley-wide conceptual model of groundwater flow in Melton Valley. From the large-scale groundwater flow concept, general conditions can be inferred that will control solute of contaminant transport. The key factors that determine the groundwater flow system are soil characteristics, land cover, topography, stratigraphy, and geologic structure. Soil characteristics exert a strong influence on the amount of precipitation that infiltrates the soil and is available for lateral storm flow movement in undisturbed areas of percolation to the water table in areas of disturbed soil profiles. Land cover type exerts a strong influence on evapotranspiration, which effectively removes water from the shallow soils by plant transpiration. Soil characteristics are also important in groundwater flow because much of the “soil” in Melton Valley is residuum of bedrock, and numerous relict fractures are retained in the deeply weathered material. These fractures form a network of avenues for percolation of recharge downward to the water table and also provide avenues for groundwater flow in areas where the water table interval lies in the base of the soil. Stratigraphy and geologic structure influence the groundwater flow system in Melton Valley by determining the types of solid material, and flaws in those materials, through which the groundwater flows. Most of the bedrock materials that underlie Melton Valley have extremely low effective porosity (connected intergranular pores), and most groundwater movement occurs in weathered zones (including residuum near the water table) or in fractures (either in residuum or in bedrock).

Geologic structure in Melton Valley occurs at several scales, each of which has importance to the groundwater flow system. The regional geologic structure is defined by the regional thrust faults such as the Copper Creek Fault. At the regional scale, strike and dip of geologic formations define the three-dimensional orientation and location of the geologic formations. Water-bearing and transmitting properties of the geologic formations vary with the stratigraphic makeup and degree of structural deformation. In Melton Valley the geologic formations with the best water-bearing potential include the Rome Formation and the Maryville Limestone. At the valley-wide scale, there are zones of intraformational folds and faults and various cross-cutting fracture and shear zone orientations that are locally important to groundwater flow. The dimensions of these zones are difficult to define in the Valley and Ridge Province because of extensive soil cover over bedrock. These zones are best identified in large excavations. The thickness of such zones, or outcrop width, is highly variable and, to date, no correlations of individual features within this type of deformation zone have been demonstrated. There is evidence of such intraformational folding and faulting in the Maryville Limestone in a nearly strike-parallel band extending just north of the proposed TRU Waste Treatment Facility. The hydrogeologic importance of such zones varies depending upon the type of bedrock and structural deformation involved. In cases where limestone bedrock is intensely deformed, fracture density can be increased, bedrock weathering may be enhanced, and groundwater flow may increase. Conversely, if such deformation involves mostly shaley bedrock and the deformation causes extensive shearing, fractures may become sealed with rock flour or “gouge,” and such zones can become less permeable than surrounding, less deformed bedrock. At the outcrop scale and smaller, individual folds, fractures, or shears ranging from meter or centimeter size down to microscopic features exist. Structural features at these scales are important when they are part of a connected network of fractures and are capable of transmitting groundwater along with its dissolved or suspended constituents. Outcrop-scale structural features are sometimes the observed points of groundwater emanation in seeps or springs.

Hydraulic conductivity measurements have been taken in many wells in the Melton Valley Watershed. Most of the available test results are from various types of single-well tests such as slug tests, rising head recovery tests, and packer tests. Hydraulic conductivity values, obtained by such methods in fractured rock, represent a value obtained by dividing the discharge of the test by the total borehole length included in the test, and thus provide an averaged conductivity value. Such tests overestimate the conductivity of unfractured materials and underestimate the conductivity of the fractures themselves. Hydraulic conductivity measurements collected from the Melton Valley Watershed suggest much higher conductivity in the shallow portion of the groundwater zone than at greater depths.

Borehole testing and empirical observations indicate that in the ORR the combination of stratigraphy (and the orientation of more soluble bedrock zones) and geologic structure combine to provide many dipping, strike-parallel zones of high transmissivity (Lee and Ketelle 1987; Ketelle and Lee 1992). Detailed site investigations at several sites throughout the ORR demonstrate that highly transmissive zones in bedrock are frequently on the order of one to several meters thick. Many of these transmissive zones are confined between lower transmissivity zones, and groundwater flow is parallel to the direction of highest permeability. An example of this condition is seen in the confined freshwater zone in the Upper Rome Formation beneath Melton Valley (DOE 1995). The results of a three-dimensional monitored pumping test (Lee et al. 1992) show that there may be little or no hydraulic connection in the direction perpendicular to confining beds.

In classical analyses of groundwater flow derived from porous media hydraulics, groundwater flow lines that originate from recharge areas near a stream or discharge boundary follow shallow pathways. In the same idealized porous medium case, groundwater flow lines that originate from recharge areas near a groundwater basin boundary show seepage downward and laterally beneath the shallower seepage paths to the discharge boundary. The conceptual model of groundwater movement in the Melton Valley area, derived from site observations, includes similarities and differences in comparison to the classical flow net concept.

Historically, groundwater system descriptions for the Melton Valley area have postulated groundwater zonation on the basis of depth below ground surface citing observed depth-dependent decreases in hydraulic conductivity measurements and geochemical stratification. These observations broadly describe the general conditions; however, they lead the reader to infer that groundwater flow zones are, likewise, nearly horizontally distributed. The combination of interbedded stratigraphy, dipping and fractured structural conditions, and rugged topography leads to highly discrete, local-scale groundwater flow zones with irregular geochemical interfaces in the subsurface. Hydrogeologic investigations performed in the Melton Valley Watershed within the past several years reveal the strong roles that stratigraphy, geologic structure, and topographically derived head differentials play in the groundwater system.

The most prominent features with respect to hydraulic head are a high-head zone in the Rome Formation extending down-dip beneath Haw Ridge and extending beneath the confining layer formed by the Pumpkin Valley Shale. Fresh water recharge on Haw Ridge associated with the Rome Formation and fractured and weathered bedrock in the Copper Creek Fault Zone are responsible for this feature (DOE 1995). A well that penetrated this interval flowed artesian at 40 gallons per minute for several days before it was plugged with no apparent decrease. Fresh water was observed to flow down-dip in this system and actually lies beneath the transition zone sodium-calcium bicarbonate groundwater present in overlying beds. Wells that penetrate this zone tend to be flowing artesian, and springs are observed in this interval along Haw Ridge where stream erosion has dissected the ridge. Head pressure derived from this zone may extend down-dip in the Rome Formation beneath the axis of Melton Valley; although deep monitoring data from hydrofracture-associated wells indicate that artesian heads are present, the water is saline in this zone at depth. No estimates have been made of the volume of groundwater flow in this confined zone. The proposed TRU Waste Treatment Facility site is located over the Nolichucky Shale. The Nolichucky Shale outcrops along the southeastern floor of Melton Valley and underlies Melton Branch and lower White Oak Creek and White Oak Lake. The Nolichucky acts as a weak confining unit overlying the Maryville Limestone. In general, the hydraulic head observed in the Nolichucky Shale is consistent with its low topographic position. All factors favor regional groundwater flow parallel to strike toward White Oak Lake and the Clinch River.

3.5.2.2 Site-specific groundwater conceptual model

Flow within the shallow groundwater flow system is generally limited to the uppermost 31 m (100 ft) of saturated regolith, saprolite, and bedrock (DOE 1996a). This area is generally a zone of groundwater discharge, and any contributions to the groundwater from surface sources from the proposed TRU Waste Treatment Facility site could be expected to discharge to either White Oak Creek or Melton Branch. These general points of discharge are illustrated on the potentiometric surface map presented as Figure 3-14. Any groundwater recharge at the proposed TRU Waste Treatment Facility site would be expected to remain in the Nolichucky Shale until discharge at the nearby stream(s). In a worst-case scenario, recharge would reach the underlying Maryville Limestone, but even then groundwater would only flow into the more conductive Maryville Limestone in order to more quickly reach the discharge boundary (Melton Branch or White Oak Creek).

Details of the deep groundwater flow system, as outlined previously in the regional conceptual model, generally hold for the deep flow system at the proposed TRU Waste Treatment Facility site. However, at great depth [approximately 305 m (1,000 ft) below ground surface and in the presence of natural brines], waste/grout mixtures were injected by the hydrofracture waste disposal process into the underlying lower Pumpkin Valley Shale. The injected material is suspected to have moved primarily updip, or to the north (DOE 1996a), simultaneously propagating and filling fractures. The hydrofracture waste disposal process resulted in the emplacement of approximately 38,228 m^3 (10.1 million gallons) of radioactive wastes and grout containing an aggregate of approximately 1.4 million curies of radioactivity in the 43 grout injections performed between 1959 and 1984. Most of these injections took place at the New Hydrofracture Facility located adjacent to and east of the proposed TRU Waste Treatment Facility site location, or at the Old Hydrofracture Facility located to the northeast across Melton Branch. These waste/grout injection actions are expected to have reduced the permeability of this deep flow system, and consequently limited groundwater flow at this depth. The locations of the Old and New Hydrofracture Facilities, and the anticipated lateral extent of the waste/grout sheets, and of the impacted brine water, are illustrated in Figure 3-15.

3.5.2.3 Groundwater quality

According to the *Remedial Investigation Report on the Melton Valley Watershed at Oak Ridge, Tennessee* (DOE 1997a), the unlined trenches at SWSA 5 North are estimated to contain 14,000 curies and contribute about 6% of the total strontium-90 and 3.6% of the cesium-137 released to surface water in Melton Valley. This rate of release will likely reduce with respect to time because of radioactive decay. The contaminated soils around the underground trenches, and between the trenches and White Oak Creek, will also act as a secondary source of contamination to groundwater. Well samples taken adjacent to the SWSA 5 North trenches also showed elevated levels of americium-241 and curium-244 ranging as high as 5,940 pCi/L.

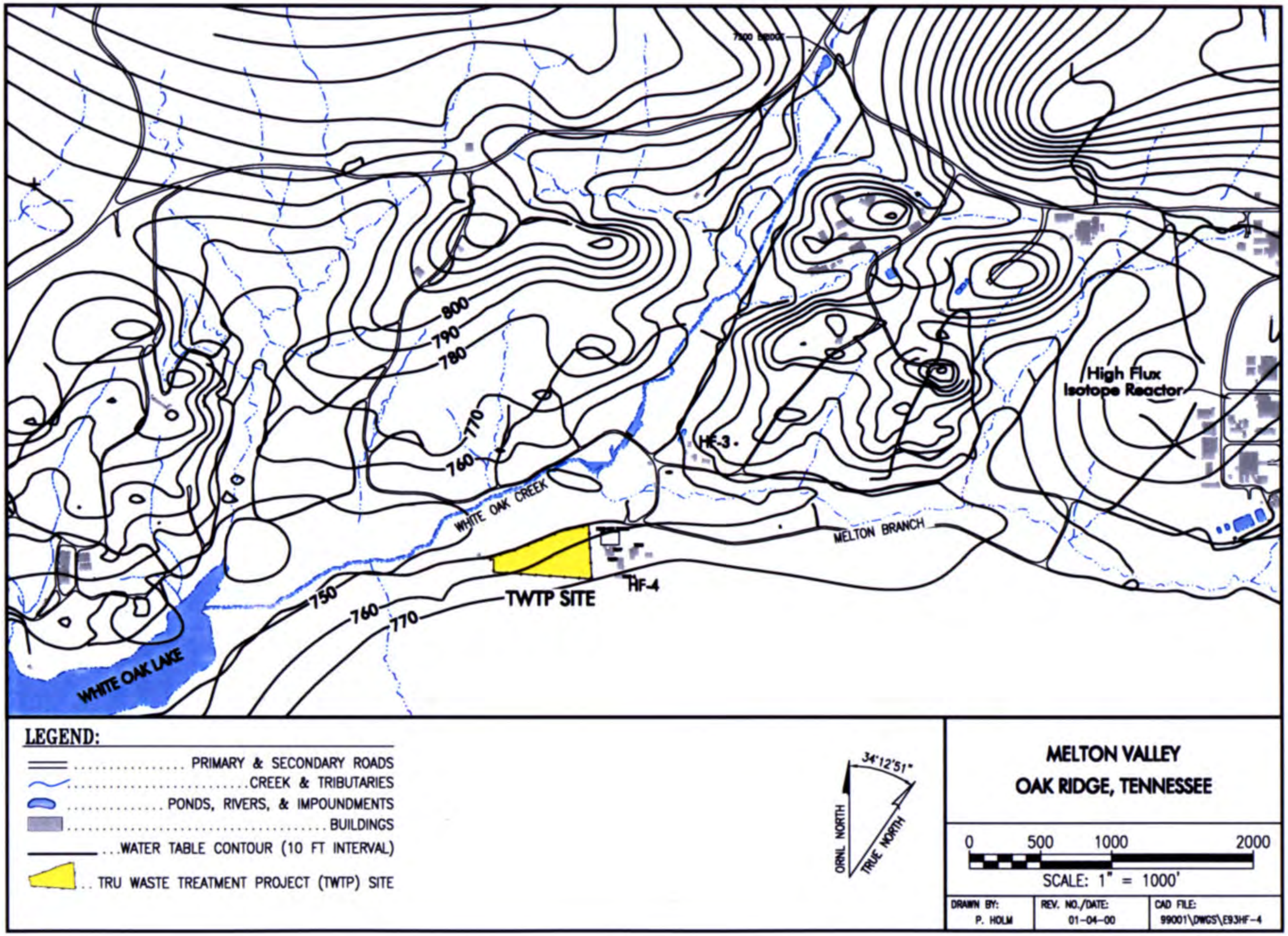


Figure 3-14. Average water table elevation in the Melton Valley Watershed.

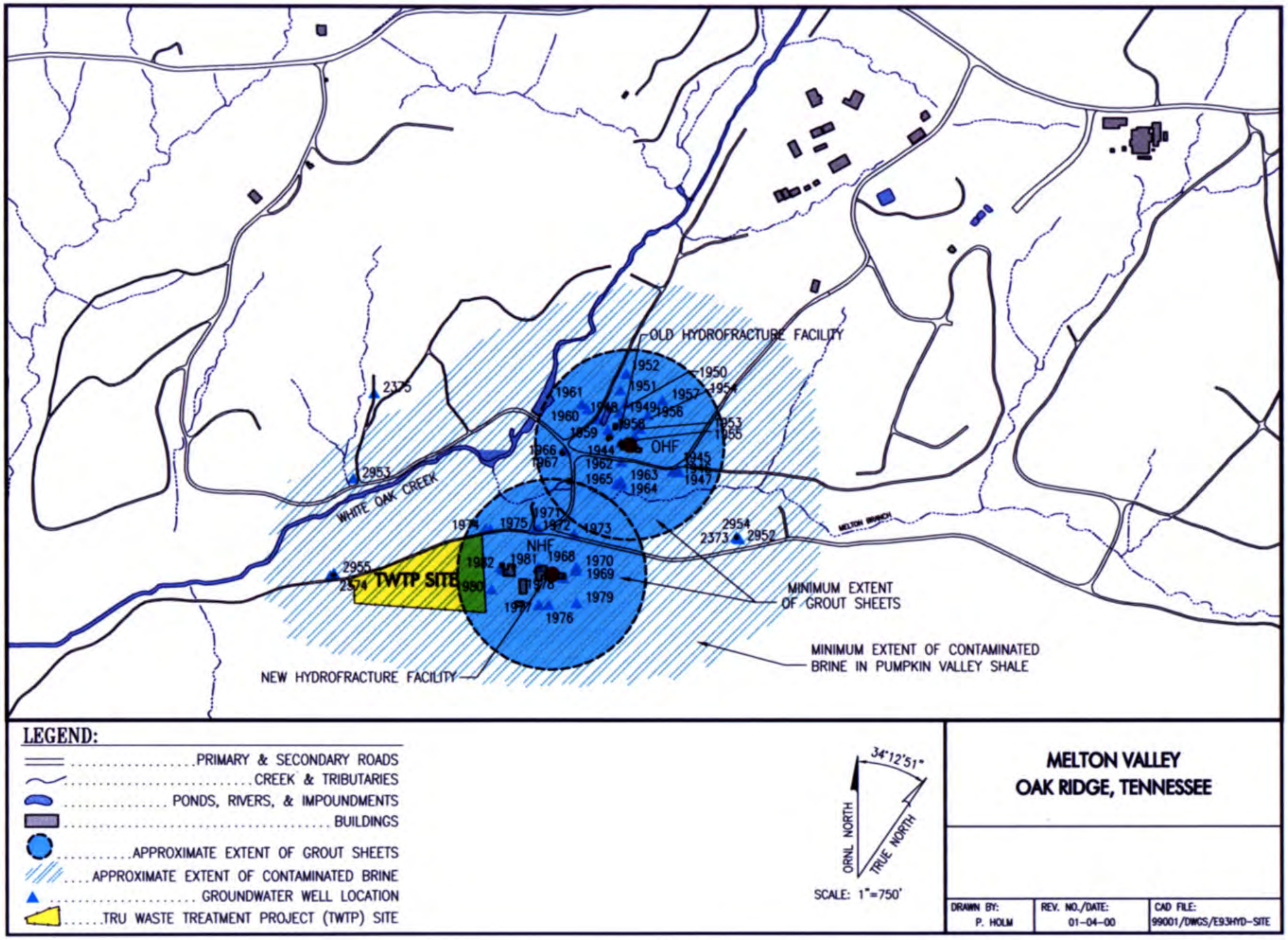


Figure 3-15. Locations of the hydrofracture facility sites, contaminated brine area, injected waste/grout sheets, and groundwater wells.

Groundwater quality at the location for the proposed TRU Waste Treatment Facility site must be considered in two separate categories: (1) deep groundwater quality and (2) shallow groundwater quality. The deep groundwater brine approximately 305 m (1,000 ft) below ground surface has been impacted with the radioactive waste injected during the operation of the hydrofracture facilities. However, these past waste disposal processes have done little to impact the shallow groundwater quality. There has been some minor impact to the shallow groundwater as would be expected near a historic industrial facility.

3.5.2.4 Groundwater exit pathways

Shallow groundwater at the proposed TRU Waste Treatment Facility site can be expected to discharge to the north into either Melton Branch or White Oak Creek. Due to the site's close proximity to this regional discharge boundary, it is unlikely that groundwater from the site could discharge anywhere else. A contaminant groundwater discharge point known as "Seep D" is located in the Melton Branch streambed just upstream of the Melton Branch-White Oak Creek confluence. This seep contains high concentrations of strontium-90 and tritium and was part of a previous removal/remedial action. The contaminant source for Seep D is suspected to be groundwater originating in Solid Waste Storage Area 5 and not from the hydrofracture grout sheets. The presence of this seep suggests a good connection with the underlying Nolichucky Shale.

3.5.3 Wetlands and Floodplains

There are six wetlands within 0.8 km (0.5 mile) of the proposed TRU Waste Treatment Facility site, herein labeled as Wetlands A, B, C, D, E, and F (Figure 3-16). The wetlands were identified using three sources of information, including: (1) a report on wetland delineation on the proposed TRU Waste Treatment Facility site (Jacobs and Rosensteel 1999); (2) an on-site reconnaissance by wetland scientists from SAIC on June 2, 1999; and (3) review of National Wetland Inventory maps. The six wetlands are briefly described below. A wetlands assessment was also performed (Appendix C.6).

Jacobs and Rosensteel (1999) identified and delineated four small wetlands (Wetlands A, B, C, and D) on, or adjacent to, the TRU Waste Treatment Facility site (Figure 3-16). A copy of the report, which contains detailed descriptions of the wetlands along with copies of the field data sheets, is presented in Appendix C.1. Wetlands A, B, and C were delineated during the field survey of the TRU Waste Treatment Facility site on April 20, 1999. Wetland D was initially identified in April 1992 by B. Rosensteel and was not delineated again. Wetland A is approximately 0.146 ha (0.36 acres) and is located approximately 91 m (298 ft) south of the southwest corner of the TRU Waste Treatment Facility site (Figure 3-16). It is a saturated, temporarily flooded, palustrine emergent wetland in an intermittent stream drainage. The stream originates upslope near the base of Copper Ridge and flows through a clearing where the wetland has developed around seeps that contribute to the stream flow. Soil samples from several locations in the wetland had low chroma color matrix, mottles, and oxidized rhizopheres (root channels). Dominant vegetation at Wetland A included several obligate species [sweetflag (*Acorus calamus*), black willow (*Salix nigra*), monkey flower (*Mimulus ringens*), bugleweed (*Lycopus virginicus*), and cattail (*Typha latifolia*)], as well as several faculative wet species [soft rush (*Juncus effusus*), silky dogwood (*Cornus amomum*), boxelder (*Acer negundo*), green ash (*Fraxinus pennsylvanica*), and turnflower rush (*Juncus biflorus)*].

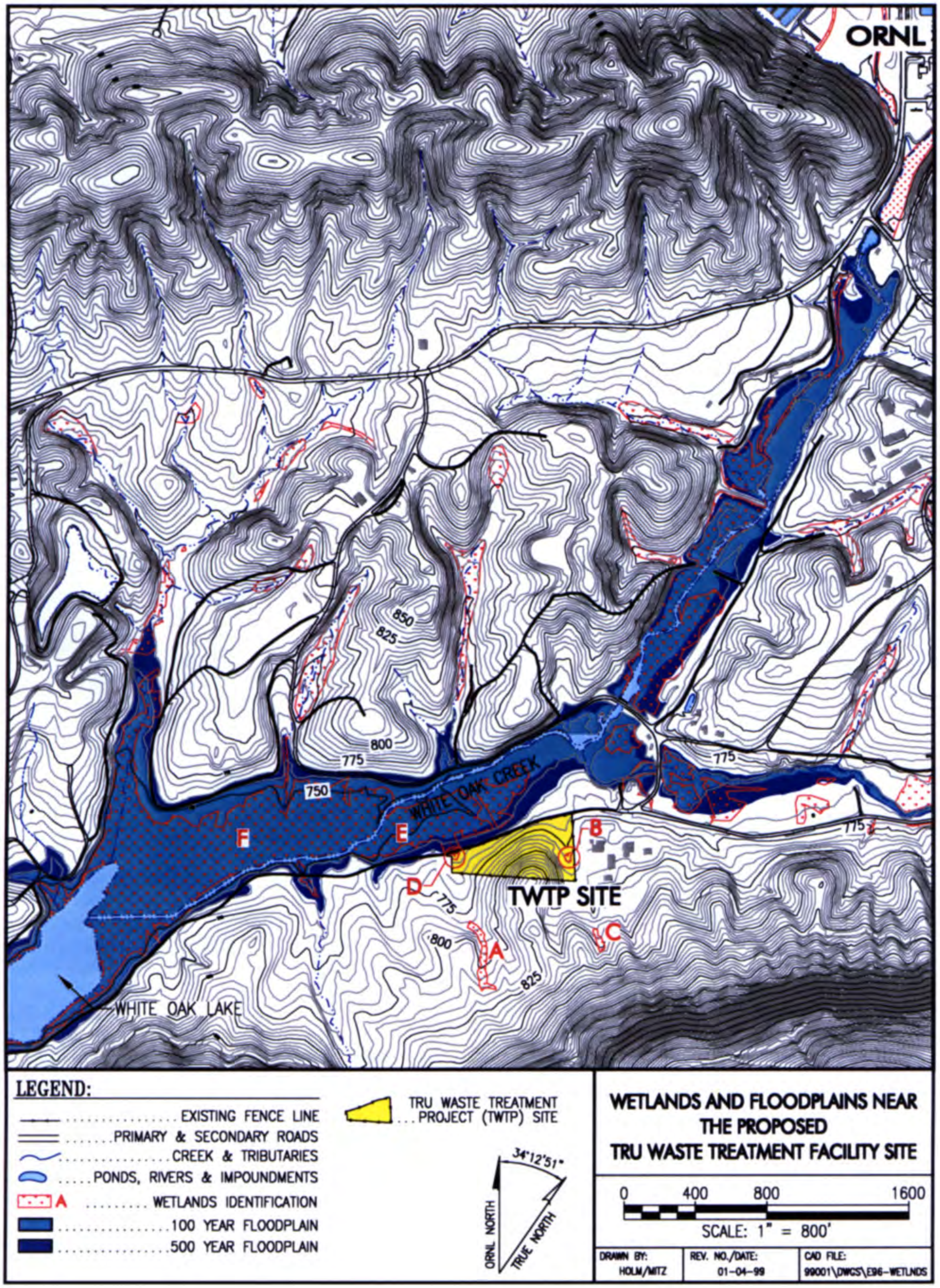


Figure 3-16. Wetlands, 100-, and 500-year floodplains near the proposed TRU Waste Treatment Facility site.

Wetland B is only 0.012 ha (0.03 acres) and is located in an intermittent stream along the eastern side of the proposed TRU Waste Treatment Facility site (Figure 3-16). This wetland is temporarily flooded and saturated and is palustrine scrub-shrub (Jacobs and Rosensteel 1999). An old road-crossing culvert located downstream from the site acts to slow and retain stream flow, thereby causing the riparian zone saturation at the wetland. The soil included fine gravel alluvium and silt loam with low chroma matrix, mottles, and partially decomposed plant fragments. Dominant plant species include sweetgum (*Liquidambar styraciflua*), green ash saplings, silky dogwood, sedges (*Carex* spp. and *Scirpus* spp.), sweetflag, and meadow spike-moss (*Selaginella apoda*).

Wetland C is 0.036 ha (0.09 acres) and is located approximately 91 m (298 ft) south of the proposed TRU Waste Treatment Facility site's southeast corner (Figure 3-16). Wetland C is saturated, palustrine emergent, and located in a disturbed, grassy area upslope (Jacobs and Rosensteel 1999). Wetland C is periodically mowed, so the wetland is in a topographic low area that might have contained a section of intermittent stream prior to land disturbance and hydrological alterations. Water discharges from seeps in the wetland and then re-enters the ground at the downslope end of the wetland.

Wetland D is 0.016 ha (0.04 acres) and is located in the northwest corner of the proposed TRU Waste Treatment Facility site (Figure 3-16). This wetland is a saturated, emergent wetland. The wetland has developed in a seep area, but there is wetland hydrology due to slowing of the water flow by a culvert under the High Flux Isotope Reactor access road. Standing and flowing water were present in the wetland during the April 1999 site visit. The soil matrix color during the initial delineation in April 1992 was described as dark gray (per Munsell soil color charts) and grayish brown, with strong brown, and very dark gray mottles. Dominant plant species identified in the April 1992 survey included several obligate species such as black willow, soft rush, monkey flower, cattail, fox sedge (*Carex vulpinoidea*), shallow sedge (*Carex lurida*), and rice cutgrass (*Leersia oryzoides*).

Wetland E includes most of the floodplain of Melton Branch north of the High Flux Isotope Reactor access road along the northern perimeter of the proposed TRU Waste Treatment Facility (Figure 3-16). This wetland covers several hectares (acres). Because of potential radiological contamination of the floodplain soils, walkover and intrusive sampling of the floodplain area were not performed. This wetland was identified from National Wetland Inventory maps, which depict the area as palustrine forested wetland dominated by broad-leaved deciduous trees. Dominant plant species include boxelder, sycamore (*Platanus occidentalis*), and black willow.

Wetland F includes the shoreline and upper reaches of White Oak Lake and covers several hectares (Figure 3-16). National Wetland Inventory maps depict this area as lacustrine wetland. The shoreline includes a mixture of trees, shrubs, and persistent and nonpersistent wetland plants.

The proposed TRU Waste Treatment Facility site is not within a floodplain. The 100-year and 500-year floodplains associated with White Oak Creek are immediately north of the proposed site location, with the 500-year floodplain bordering the High Flux Isotope Reactor access road (Figure 3-16).

3.6 WASTE MANAGEMENT

The estimated waste volumes associated with the CERCLA cleanup actions for the ORR range between 170,495 m^3 and 841,005 m^3 (223,000 to 1.1 million yd^3) (DOE 1999b). In addition to the existing legacy TRU waste at ORNL, stored in the Melton Valley Storage Tanks and various storage buildings and bunkers, an additional 3,500 m^3 (4,578 yd^3) of TRU wastes are expected to be generated over the life cycle of operations (DOE 1998b). Approximately 41,000 m^3 (53,624 yd^3) of mixed low-level waste are currently in the DOE ORR inventory, and nearly 31 million cubic meters (40.5 million yd^3) are expected to be generated over the life cycle of operations (DOE 1998b). After undergoing a range of treatments, approximately 16 million cubic meters (20.9 million yd^3) of treated effluent will be discharged under an NPDES permit (DOE 1998b). The existing legacy liquid, sludge and solid wastes, and waste storage facilities at ORNL are described in Chapter 1, Section 1.2.2. Recent historical and projected generation rates for remote-handled TRU and contact-handled TRU debris are shown in Table 3-12.

Table 3-12. Historical and projected remote-handled TRU and contact-handled TRU debris generation rates at ORNL

Waste	FY 1997	FY 1998	FY 1999	FY 2000
Remote-handled TRU	5.0 m^3	6.6 m^3	6.6 m^3	5.0 m^3
Contact-handled TRU	12.2 m^3	23.6 m^3	7.5 m^3	10.0 m^3

FY = fiscal year.
ORNL = Oak Ridge National Laboratory.
TRU = transuranic.
Source: Bechtel Jacobs (1999).

Remote-handled TRU sludge will no longer be generated after Fiscal Year 2000 due to the completion of the ORNL inactive tank wastes retrieval projects, but approximately 5.5 m^3 of TRU waste are projected to be generated annually at the Radiological Engineering Development Center at ORNL. Pretreatment of this newly generated waste is expected to be conducted in the Radiological Engineering Development Center hot cells beginning in Fiscal Year 2001 and will be an ongoing operation at the facility. Thus, over 20 m^3 of TRU waste per year is projected to be generated at ORNL. Low-level waste generation is estimated at approximately 60 m^3 per year (Scott 1999).

3.7 CLIMATE AND AIR QUALITY

3.7.1 Climate

The Oak Ridge area has a temperate, continental climate. Summers are warm and humid; winters are typically cool. Spring and fall are transitional seasons, normally warm and sunny. Severe weather—such as tornadoes or high winds, severe thunderstorms with damaging lightning or precipitation, extreme temperatures, or heavy precipitation—is uncommon. The Cumberland Mountains to the northwest help to shield the region from cold air masses that frequently penetrate far south over the plains and prairies in the central United States during winter months. During the summer, tropical air masses from the south provide warm and humid conditions that often produce thunderstorms; however, anticyclonic circulation around high-pressure systems centered in the western Gulf of Mexico can bring dry air from the southwest into the region, leading to periods of drought.

3.7.1.1 Temperature

Over the period from January 1990 through December 1996, the mean annual temperature for the Oak Ridge area was 14.6°C (58.3°F) (NOAA 1997). The coldest month is usually January, with temperatures averaging about 3.7°C (38.7°F). July is usually the hottest month of the year, with temperatures averaging 25.8°C (78.4°F). In the course of a year, the difference between maximum and minimum daily temperatures averages 12.5°C (22.5°F).

3.7.1.2 Wind

Winds in the Oak Ridge area are controlled, in large part, by the Valley and Ridge topography. Prevailing winds are either up-valley (northeasterly) daytime winds or down-valley (southwesterly) nighttime winds. Wind speeds are less than 11.9 km/hour (7.4 mph) 75% of the time; tornadoes and winds exceeding 30 km/hour (18.5 mph) are rare. Air stagnation is relatively common in eastern Tennessee (about twice that of western Tennessee). An average of about two multiple-day air stagnation episodes occurs annually in eastern Tennessee, to cover an average of about 8 days/year. August, September, and October are the most likely months for air stagnation episodes. Figure 3-17 presents the diurnal wind patterns for the ORR.

3.7.1.3 Precipitation

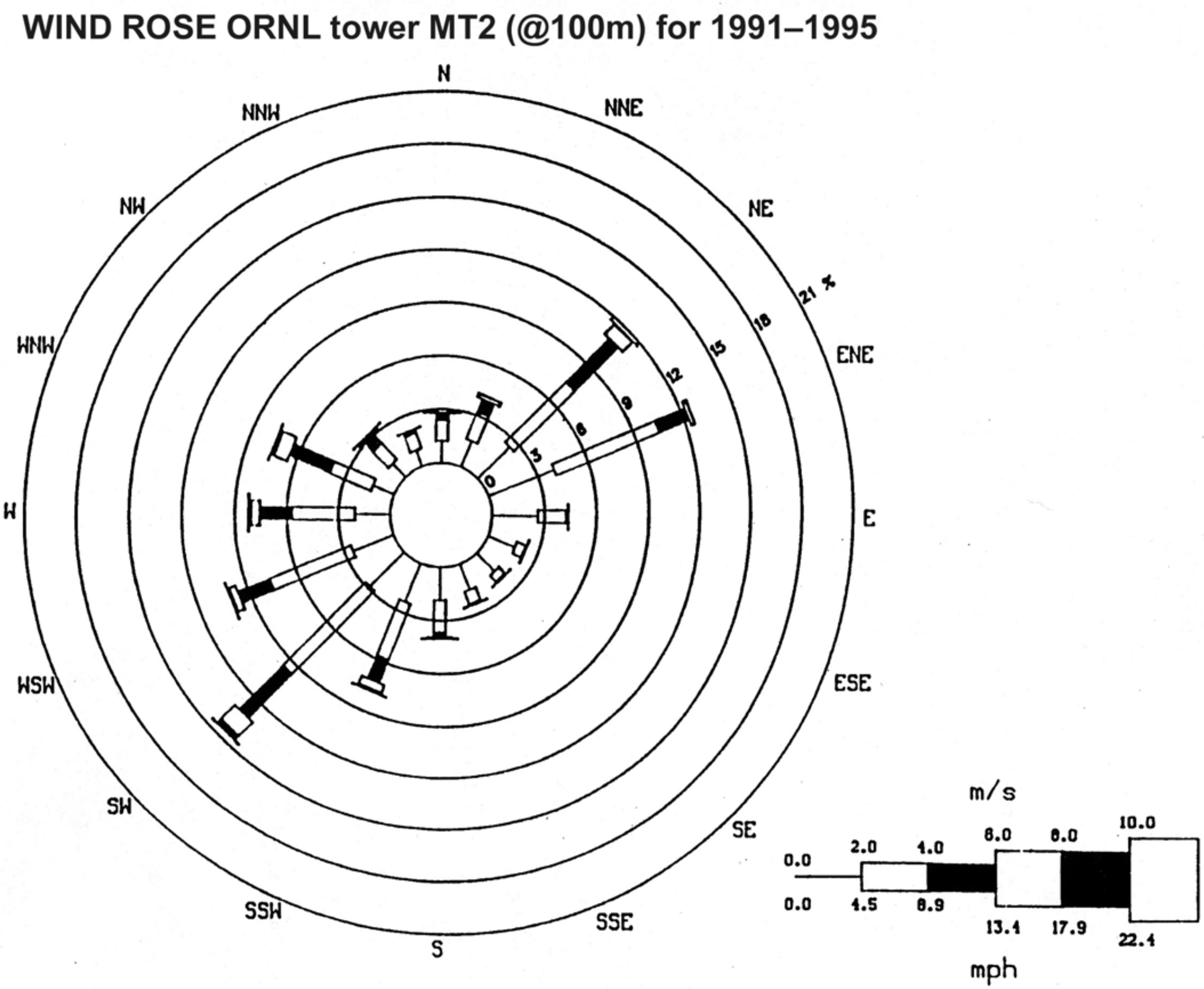
The 30-year annual average precipitation is 138.5 cm (54.5 in.), including about 24 cm (9.3 in.) of snowfall (NOAA 1997). Regional precipitation for the period 1990–96 was 149.1 cm (58.7 in.) with a maximum of 169 cm (66.5 in) in 1995 and a minimum of 111.8 cm (44 in.) in 1992. Precipitation in the region is greatest in the winter months (December through February). Precipitation in the spring exceeds the summer rainfall, but the summer rainfall may be locally heavy because of thunderstorm activity. The driest periods generally occur during the fall months, when high-pressure systems are most frequent.

3.7.2 Air Quality

The proposed TRU Waste Treatment Facility site is located in the EPA Air Quality Control Region 207, which includes east Tennessee and southwest Virginia. As of 1991, the area within the Air Quality Control Region was designated as an attainment area with respect to all National Ambient Air Quality Standards (NAAQS) criteria pollutants (Table 3-13) (ORNL 1998). The Oak Ridge area is an attainment area with respect to NAAQS for all criteria pollutants (SO_2, particulate matter, NO_2, CO, ozone, and Pb) (ORNL 1998). ORR and ORNL sources are in compliance with all federal air regulations and TDEC air-permit requirements for non-radioactive hazardous air pollutants.

The ORR is located within a Class II prevention-of-significant deterioration (PSD) area. The Great Smoky Mountains National Park is the only PSD Class I area in the vicinity of ORNL, and it is located approximately 35 miles (56 km) southeast of ORR. All areas not designated as Class I PSD areas are designated as Class II. No PSD permits have been required for any emissions source at ORNL since the promulgation of the regulations.

Air monitoring at the DOE Oak Ridge installations consists of both facility exhaust stack and ambient air monitoring adjacent to the facilities to measure radiological parameters (Table 3-14). Ambient air monitoring allows facility personnel to determine the relative level of contaminants at the monitoring locations during an emergency, measures the contributions of fugitive and diffuse sources, and permits checks on dose-modeling calculations. There are four ambient air monitoring stations in the ORNL network. Station 1 is west, southwest of ORNL; station 2 is southeast of ORNL; station 3 is on the northeast corner of the ORNL site; and station 7 is nearly on the northwest corner of ORNL (Table 3-14). Station 52 is a reference station located at Fort Loudon Dam, approximately 16 km (10 miles) from ORNL. Sampling is conducted at each station to measure absorbable gases (e.g., iodine), and gross alpha, gross beta, and gamma-emitting radionuclides, and then compared with air sampling data from the reference station (station 52).



Adapted from 1996 ORNL Permit Application for TRU and Class III/IV Storage Areas (TNHW-097).

FOSTER WHEELER ENVIRONMENTAL CORPORATION

Figure 3-17. Wind rose detected at the ORNL Tower MT2 (@ 100 m) for 1991–1995.

Table 3-13. Summary of 1997 air monitoring data in the vicinity of the ORR

Pollutant/averaging time	Nearest monitor location	Maximum per quarter 1st	2nd	3rd	4th	NAAQS TAAQS	Number of exceedances
Particulate Matter-10/24 hours	Knox Co.	69.0 μg/m^3	67.0	61.0	60.0	150 μg/m^3	0
Particulate Matter-10/annual	Knox Co.	33.0 μg/m^3				50 μg/m^3	0
Total Suspended Particles/24 hours	Knox Co.	107.0 μg/m^3	87.0	77.0	77.0	260.0 μg/m^{3a}	0
Ozone/1 hour	Anderson Co.	0.109 ppm	0.107	0.106	0.105	0.12 ppm	0
Nitrogen Oxide/annual	Loudon Co.	0.015 ppm				0.05 ppm	0
Sulfur Dioxide/3 hours	Anderson Co.	0.152 ppm	0.125			0.5 ppm	0
Sulfur Dioxide/24 hours	Anderson Co.	0.032 ppm	0.025			0.14 ppm	0
Sulfur Dioxide/annual	Anderson Co.	0.005 ppm				0.03 ppm	0
Carbon Monoxide/1 hour	Knox Co.	10.3 ppm	9.6			35.0 ppm	0
Carbon Monoxide/8 hours	Knox Co.	4.9 ppm	4.8			9.0 ppm	0
Lead/quarterly	Roane Co.	0.13 μg/m^3	0.11	0.07		1.5 μg/m^3	0

[a]260.0 μg/m^3 primary standard, 150.0 μg/m^3 secondary standard for total suspended particulates (TSP).
NAAQS -National Ambient Air Quality Standards.
ORR - Oak Ridge Reservation.
ppm - parts per million.
TAAQS - Tennessee Ambient Air Quality Standards.
μg - micrograms.
Source: DOE 1999a. Final EIS for Construction and Operation of the Spallation Neutron Source.

Table 3-14. Radionuclide parameter concentrations and other parameters measured at ORNL air monitoring stations, 1997

Parameter	Stations 1 (μCi/mL)	2 (μCi/mL)	3 (μCi/mL)	7 (μCi/mL)	52[a] (μCi/mL)
Beryllium-7	1.6E-14	1.0 E-14	9.8E-15	9.9E-15	1.6E-14
Cesium-137	3.1E-17	2.0E-17	5.2E-17	2.1E-17	2.3E-17
Cobalt-60	3.0E-17	ND	1.6E-17	ND	1.1E-17
Hydrogen-3	ND	7.8E-11	ND	2.6E-12	ND
Iodine-131	8.5E-16	1.5E-15	2.4E-15	9.4E-16	NA
Iodine-133	ND	2.3E-15	2.6E-15	3.7E-15	NA
Iodine-135	7.5E-15	5.6E-14	1.5E-14	ND	NA
Potassium-40	8.3E-16	9.1E-16	1.2E-15	9.3E-16	2.3E-15
Uranium-234	3.0E-17	3.6E-17	2.9E-17	4.0E-17	4.1E-17
Uranium-235	3.5E-18	ND	ND	ND	3.6E-18
Uranium-238	2.9E-17	2.6E-17	3.3E-17	3.0E-17	3.7E-17
Gross alpha	5.3E-15	4.5E-15	4.2E-15	6.3E-15	
Gross beta	1.1E-14	1.1E-14	1.0E-14	1.1E-14	

[a]Reference station located at Fort Loudon Dam.
NA = not available. ND = not detected. ORNL = Oak Ridge National Laboratory.
Source: Adapted from ORNL 1998.

3.7.2.1 Clean Air Act

Authority for enforcement of the Clean Air Act (CAA) is shared between the TDEC for nonradioactive emission sources, and the EPA for radioactive emission sources. The EPA also enforces rules issued pursuant to the 1990 CAA Amendments, Title VI - Stratospheric Ozone Protection. The

TDEC Air Permit Program ensures compliance with most of the federal CAA and TDEC rules for air emission sources.

There are a number of sources at ORNL that are exempt from the permitting requirements under the State of Tennessee rules. At the end of Calendar Year 1997, ORNL had 21 active TDEC-issued operating permits covering 250 sources.

3.7.2.2 National Emission Standards for Hazardous Air Pollutants for Radionuclides (Rad-NESHAPs)

All ORNL facilities met the emissions and test procedures found at 40 *CFR* 61, Subpart H, in 1997. Operations at ORNL are in compliance with all Federal and State air regulations and TDEC air permit requirements. In addition, continuous air monitoring is conducted at seven stacks at ORNL (Table 3-14).

The ORR facilities were in compliance with the National Emission Standards for Hazardous Air Pollutants for Radionuclides (RAD-NESHAPs) dose limit of 10 mrems/year to the maximally exposed individual of the public during 1997 (Table 3-14). Based on modeling of emissions from major and minor sources, the effective dose equivalent was 0.41 mrem/year in 1997.

3.8 TRANSPORTATION

Section 3.8.1 addresses local transportation routes, ongoing and planned road upgrades and waste shipment information. In Section 3.8.2, national transportation routes and waste shipment data are provided as baseline information.

3.8.1 Local Transportation

Transportation in the region in and immediately adjacent to the ORR boundary consists of local access roads (such as Tennessee State Routes 95, 1700, and 62) and major interstates. The main access to the cities of Nashville and Knoxville, Tennessee, is provided by I-40, located 2.4 km (1.5 miles) south of the ORR boundary and 8 km (5 miles) from the proposed TRU Waste Treatment Facility site. The major interstate running north and south is provided by I-75, located 24 km (15 miles) south of the proposed TRU Waste Treatment Facility site. Railroad service is provided by the Southern Railway and the L&N Railway. An L&N rail line runs adjacent to the proposed TRU Waste Treatment Facility site boundary.

Transportation elements include the number of rail and truck shipments to and from the DOE sites. According to the 1993 Shipment Mobility/Accountability Collection and the Waste Manifest System for Fiscal Year 1993, ORR had 197 incoming radioactive truck shipments with a total weight of 175,662 kg (387,269 lbs), and 843 outgoing radioactive truck shipments weighing 10,496,492 kg (23,140,823 lbs). There were also 8 outgoing radioactive rail shipments totaling 451,623 kg (995,658 lbs). This shipment information includes all radioactive material, not just radioactive waste. In 1998, a total of 3,080 m^3 (108,825 ft^3) of waste was shipped from the ORR to a commercial facility (EnviroCare) in Utah without incident.

The High Flux Isotope Reactor access road begins near the south end of White Oak Dam on the east side of Tennessee State Route 95 and continues east along the north side of the proposed TRU Waste Treatment Facility site. Upgrade of this road was assessed as part of non-project-related site activities in a categorical exclusion (CX-TRU-98-007). Scheduled road improvements at the intersection of Tennessee State Route 95 and the High Flux Isotope Reactor access road will accommodate Tennessee Department of Transportation sight distance and other technical requirements. The Tennessee Department of Transportation reported that 6,140 vehicles used Tennessee State Route 95 in 1998. A portion of Tennessee State Highway 58, located west of the ETTP, is scheduled to be upgraded to four lanes in the near future. Tennessee State Route 62 leading into the City of Oak Ridge, from Knoxville, bordering the ORR on the east side, is currently being upgraded.

3.8.2 National Transportation

Transportation of hazardous and radioactive materials, substances, and wastes is governed by DOT, NRC, and EPA regulations, and by the Hazardous Materials Transportation Act. These regulations are found in 49 *CFR* Parts 171-178, 49 *CFR* Parts 383-397, 10 *CFR* Part 71, and 40 *CFR* Parts 262 and 265.

Transportation mode and routing analyses were presented by DOE for TRU wastes in both the *Waste Isolation Pilot Plant Disposal Phase Supplemental Environmental Impact Statement* (WIPP SEIS-II) (DOE 1997b) and the *Final Waste Management Programmatic Environmental Impact Statement* (WM PEIS) (DOE 1997c). These documents established the national transportation environment in terms of the applicable government regulations and DOE policy related to transporting radiological and hazardous material, general risk criteria, and the methodology for determining national transportation routes. Transportation routes described in the WM PEIS were derived from the HIGHWAY program model and the INTERLINE model, which consider population densities along the routes. These routes are depicted in the following figures: Figure 3-18 describes the TRU waste route to the Waste Isolation Pilot Plant, and the low-level waste route to the Nevada Test Site is described in Figure 3-19.

Waste Transportation Route from the Oak Ridge National Laboratory (ORNL) to the Waste Isolation Pilot Plant (WIPP)

Figure 3-18. Transportation route from the ORNL in east Tennessee to the Waste Isolation Pilot Plant in southeast New Mexico.

Waste Transportation Route from the Oak Ridge National Laboratory (ORNL) to the Nevada Test Site (NTS)

Figure 3-19. Transportation route from the ORNL in east Tennessee to the Nevada Test Site.

TRU waste route description (Waste Isolation Pilot Plant SEIS-II Fact Sheet) (DOE 1999c)

High Flux Isotope Reactor access road west to Tennessee State Route 95, west of ORNL
Tennessee State Route 95 south to I-40 south of Oak Ridge, Tennessee
I-40 east to I-75, southwest of Knoxville, Tennessee
I-75 south to I-24, east of Chattanooga, Tennessee
I-24 west to I-59, southwest of Chattanooga, Tennessee
I-59 to I-459, northeast of Birmingham, Alabama
I-459 to I-20, southwest of Birmingham, Alabama
I-20 west to I-220, east of Shreveport, Louisiana
I-220 to I-20, around the north side of Shreveport, Louisiana
I-20 west to US-285, at Pecos, Texas
US-285 to US-180/62, at Carlsbad, New Mexico
US-180/62 to the Waste Isolation Pilot Plant, North Access Road
Waste Isolation Pilot Plant, North Access Road

Low-level waste route description (ORNL Transportation Work Instructions) (LMES 1995b)

High Flux Isotope Reactor access road west to Tennessee State Route 95, west of ORNL
Tennessee State Route 95 south to I-40, south of Oak Ridge, Tennessee
Continue on I-40, west to U.S-95, north of Needles, California
U.S-95 north to Mercury, Nevada

On the national level, about 100 million packages, classified as hazardous materials, are shipped each year (NRC 1997). A more recent radioactive materials transport study stated that, excluding DOE shipments, approximately 2 million shipments of radioactive materials consisting of 2.79 million packages are made each year (DOE 1997a). For more than 40 years, radioactive materials have been shipped in the United States with no known adverse health effects due to accidental releases. Information about accidents involving radioactive materials has been collected over a 23-year period. During that period, 349 air, highway, and rail transportation accidents occurred. Of these accidents, 307 were highway, 20 were rail related, and the remaining 22 were air related. Packages used for shipping quantities or types of radioactive materials, which could have serious consequences if released, are designed to withstand accident conditions. Accidents involving these packages have resulted in no release of radioactive material. The NRC has concluded that at least half of the radiation exposure resulting from shipments of radiological materials would be received by transportation workers, but the doses would be below allowable limits (DOE 1997a).

3.9 UTILITY REQUIREMENTS

The Tennessee Valley Authority (TVA) supplies power to the ORR, which has a current site load of 116 MW. Coal and natural gas are also used (DOE 1997b), although no gas pipeline exists in the vicinity of the proposed TRU Waste Treatment Facility site. Water is supplied to ORNL by the DOE Oak Ridge Water Treatment Facility located on Pine Ridge in the northeastern portion of the ORR. This facility draws water from the Clinch River (near the Y-12 Plant, upriver from ORNL) and provides approximately 1.2 million gallons per day to ORNL, 4.0 million gallons per day to Y-12, and 8.8 million gallons per day to the City of Oak Ridge. The facility is currently operating at approximately 50% of its 28 million gallons per day capacity (McWilliams 1999).

3.10 HUMAN HEALTH

This section contains an overview of the potentially affected environment on and around the ORR and discusses the potential exposure pathways, and cites pertinent references concerning population exposure and its effects. This information has been used to evaluate the impacts and potential risks to the off-site maximally exposed individual and the collective dose to the population within 80 km (50 miles) from current ORR operations.

3.10.1 Exposure Pathways

The analyzed human exposure pathways included in this EIS are inhalation, direct radiation, ingestion, and direct contact. A primary exposure pathway is inhalation of contaminants from stack emissions. Radiological airborne effluents from ORNL consist mainly of ventilation air from radioactively contaminated areas and ventilation from reactor facilities. These discharges are treated and pass through HEPA filters before being released to the environment. NESHAPs regulations and DOE orders define a major radionuclide effluent source as an emission point that has the potential to discharge radionuclides in quantities that could result in an effective dose equivalent of 0.1 mrem or more to the public. ORR has a comprehensive air monitoring program to ensure regulatory compliance. Four exhaust stacks located in the Bethel and Melton valleys at ORNL are major radionuclide emission point sources. In 1997, ORNL had 21 minor sources, 3 of which were continuously sampled (ORNL 1998). In 1997, ORNL released approximately 148 curies of hydrogen-3 and 0.55 curies of iodine-131. The major contributor to off-site dose in 1997 was argon-141, of which 10,000 curies were released (ORNL 1998). In addition to exhaust stack monitoring, ambient air monitoring is performed to directly measure the airborne concentrations of radionuclides and pollutants at the site perimeter. Reference data are collected from a remote location not affected by activities at the ORR. Airborne radionuclides and airborne chemicals and their effects on the population within the Region of Influence are discussed in Sections 3.10.2.1 and 3.10.3.1, respectively.

Direct radiation is also an exposure pathway of concern. External gamma radiation measurements are recorded weekly at the ORR boundary to ensure that radioactive effluents from the ORR are not increasing external radiation levels significantly above background radiation levels. Direct radiation, and its effects on the nearby population, is discussed in Section 3.10.2.4. Another exposure pathway is the ingestion of contaminated vegetation and animal products produced in the surrounding areas. Samples of food that could be potentially contaminated are collected and analyzed to determine their effects and potential exposure through ingestion. This information is presented in Section 3.10.2.2

Additional exposure pathways include contact with contaminated surface water and drinking contaminated groundwater. Under the ORR Environmental Monitoring Plan, samples are collected and analyzed from 22 locations around the ORR to determine the quality of local surface water. Surface water at ORNL is collected downstream from the facility and compared to the surface water at reference locations. The water is analyzed for radionuclides and inorganic pollutants. Most residents in the Oak Ridge area do not rely on groundwater for potable supplies. Local groundwater provides some domestic, municipal, farm, irrigation, and industrial uses. Storm water and most groundwater at ORR discharge at surface water drainages. Therefore, monitoring springs, seeps, and surface water quality is a way to assess the extent to which groundwater from a large portion of the ORR transports contaminants. The groundwater monitoring program at ORNL consists of a network of two types of wells: (1) water quality monitoring wells built to RCRA specifications and used for site characterization and compliance purposes, and (2) piezometer wells used to characterize groundwater flow conditions.

Melton Valley is one of the major waste storage areas on the reservation. In addition to surface structures, it is the location of shallow waste burial trenches and auger holes, landfills, tanks, impoundments, seepage pits, hydrofracture wells and grout sheets, and waste transfer pipelines and associated leak sites, all of which can affect the groundwater of the region. Groundwater plumes within Melton Valley generally enter the surface water system where contaminants may be encountered. Information on the affected population due to surface water and groundwater exposure is presented in Section 3.10.3.3.

3.10.2 Pathway Modeling

Risks from the ORR operations are calculated for the maximally exposed off-site individual and the collective off-site population. The off-site population is defined as the public within 80 km (50 miles) of the ORR (ORNL 1995). The computer software program CAP-88 was used to perform the radiological dose and risk assessments for the collective off-site population and the maximally exposed off-site individual from radionuclides released into the atmosphere from ORR operations. Small quantities of chemicals are released into the atmosphere due to operations at ORR. These chemical releases are allowable under air pollution controls and are not a threat to human health. Therefore, chemical modeling is not required (ORNL 1998).

The radiological consequences from airborne contaminants are calculated using the CAP-88 program, which is a package of computer codes (contains the EPA-approved version of the AIRDOS and DARTAB) designed to demonstrate compliance with the Rad-NESHAPs, 40 *CFR* 61, Subpart H. CAP-88 is only applicable for chronic low-level exposures and is not appropriate for modeling short-term or accidental releases. The program uses a Gaussian plume equation to determine the average dispersion of radionuclides emitted from a source or stack. This model assumes that an effluent is released from a point source and is normally distributed around the central axis of the plume. It is also assumed that the atmospheric stability and wind speed determine how the contaminant is dispersed downwind from the source. Uneven terrain and fluctuations in meteorological conditions contribute to the uncertainty of the model. The CAP 88 program also models the ingestion and immersion pathways and determines the radionuclide concentrations in air and rates of deposition on ground surfaces. The concentrations in food, and intake rates to people from ingestion of vegetation and animal products in the affected area, are calculated by using Regulatory Guide 1.109 (NRC 1997) food-chain models. Radionuclide concentrations are estimated for produce, leafy vegetables, milk, and meat. Total dose and risk estimates are then calculated by combining the inhalation and ingestion intake rates with the air and ground surface concentrations. Risks are based on a lifetime risk of 5E-04 cancers per rem (risk of cancer in a lifetime is 5 in 10,000 individuals per rem of exposure) (DOE 1997d).

3.10.3 Radionuclides

3.10.3.1Airborne Radionuclides

In 1997, 42 emission points on the ORR were modeled with CAP-88, including 25 points at ORNL, in order to estimate the effective dose equivalent to the off-site maximally exposed individual and the collective effective dose equivalent to persons residing within 80 km (50 miles) of the ORR. The effective dose equivalent calculations are conservative, and it is assumed that each person remained outside of the house, unprotected for the entire year. It was also assumed that 70% of the vegetables and produce, 44.2% of the meat, and 39.9% of the milk consumed by each individual were produced locally (e.g., a home garden). It was assumed that the remaining portion of food was produced within 80 km (50 miles) of the ORR (ORNL 1998).

The effective dose equivalent received by the off-site maximally exposed individual from airborne emissions was estimated to be 0.41 mrem for the ORR and 0.38 mrem for ORNL. This corresponds to a fatal cancer risk of 2E-07 for each of the effective dose equivalents, and can be calculated by multiplying the effective dose equivalent by the probability of an individual dying of cancer (4.1E-04 rem × 5E-04/rem). The fatal cancer risk for the general public is 5E-04/rem based on International Commission on Radiological Protection (ICRP) Publication No. 60 (ICRP 1990). The NESHAPs standard is 10 mrem, so the risk associated with these doses is minimal. In perspective, the average person receives approximately 300 mrem annually from natural background radiation. The collective effective dose equivalent to the affected population, about 879,546 persons, within 80 km (50 miles) was estimated to be 10 person-rem. This corresponds to a fatal cancer risk of 5E-03. A person-rem is the collective dose to a population group; for example, a dose of 1 rem to 10 individuals results in a collective dose of 10 person-rem. Emissions from ORNL contributed about 58% of the ORR collective effective dose equivalent, or about 5.8 person-rem, which corresponds to a calculated cancer risk of 3E-03. The estimated doses to the off-site maximally exposed individual and the affected population are shown in Table 3-15 (ORNL 1998).

Table 3-15. Calculated effective dose equivalent to the maximally exposed individual and the collective population effective dose equivalent from airborne releases in 1997

Location	Effective dose equivalent to a maximally exposed individual (mrem)	Fatal cancer risk to a maximally exposed individual	Collective population effective dose equivalent (person-rem)	Fatal cancer risk to collective population
ORNL	0.38	2E-07	5.8	5E-03
ORR	0.41	2E-07	10.0	3E-03

ORNL - Oak Ridge National Laboratory.
ORR - Oak Ridge Reservation.

These estimated doses were compared to the dose calculated from measured air concentrations of radionuclides at monitoring stations located at the ORR perimeter and remote locations. A hypothetical individual residing at the perimeter in 1997 could have received an effective dose equivalent from 0.11 to 0.32 mrem, which would result in a calculated fatal cancer risk of 6E-08 and 2E-07, respectively. This dose would include contributions from naturally occurring airborne radionuclides, radionuclides released from the ORR, and radionuclides released from any other non-DOE source. Other potential sources of radioactive emissions include a waste processing facility, a depleted uranium processing facility, a decontamination facility in Oak Ridge, and a waste processing facility in Kingston. A hypothetical person residing at the remote monitoring location would have received an effective dose equivalent of 0.13 mrem (ORNL 1998), which corresponds to a fatal cancer risk of 7E-08.

3.10.3.2Radionuclides in food

Samples of hay, tomatoes, lettuce, turnips, milk, and fish are collected and analyzed to determine potential exposure through ingestion. The CAP-88 program was used to determine radiation doses from the ingestion of meat, milk, and vegetables due to the deposition of radionuclides from the ORR. A total of 5.283 mrem was calculated for the maximally exposed individual from all sources, which are discussed below. When compared to the average annual background radiation for individuals of 300 mrem the risk associated with the ingestion is small.

The milk sampling program in 1997 consisted of grab samples collected every other month from three locations near the ORR. The milk samples are analyzed at ORNL for iodine-131, potassium-40, total strontium (strontium-89 and strontium-90), and hydrogen-3, all of which are found in the natural environment. Only strontium and potassium-40 were detected in the milk, and potassium-40 is not emitted from the ORR. It was assumed that if a hypothetical person drank 310 L (328 quarts) of this milk during the year, the individual would receive an effective dose equivalent between 0.66 and 1.5 mrem (ORNL 1998), which corresponds to a hypothetical cancer risk of 3E-07 and 8E-07, respectively. Hay samples were cut from six areas in 1997, and an additional site, near Fort Loudon, was used as a reference site. The samples were analyzed for gross alpha and beta, and gamma emitters. Composite samples (from areas 1, 2, and 3, and areas 2, 4, and 5) had statistically significant results for cesium-137, gross beta, and beryllium-7. The two individual locations, area 6 and area 8 (the reference location), had statistically significant results for gross beta and beryllium-7. Beryllium-7 is a naturally occurring isotope. There were no other statistically significant radiological results in the 1997 hay samples.

Tomatoes, lettuce, and turnips were purchased from five farmers near the ORR in 1997. These vegetables represent the fruit-bearing, leafy, and root vegetables. The sampled locations were chosen based on availability and the likelihood of the produce being affected by routine operations on the ORR. A hypothetical person was assumed to have eaten 32 kg (71 lbs) of homegrown tomatoes, 10 kg (22 lbs) of homegrown leafy vegetables, and 37 kg (82 lbs) of homegrown root vegetables during the year. This would result in a conservative total effective dose equivalent of 3.4 mrem, practically all of which results from potassium-40, which is a naturally occurring radionuclide and is not emitted from the ORR. If potassium-40 is excluded, this hypothetical person would receive about 0.008 mrem (ORNL 1998), which corresponds to a calculated cancer risk of 4E-09.

Annual deer, geese, and wild turkey hunts are held on the ORR. Bone and tissue samples are analyzed from each group of animals, and the geese and turkey are subjected to whole-body gamma scans. Hunters take their deer to various stations on the ORR where bone and tissue samples are analyzed in the field to ensure that release criteria are met. If 20 picocuries per gram (pCi/g) of beta activity is found in the bone or 5 pCi/g of cesium-137 in edible tissue, the deer is confiscated. In 1997, 429 of the 438 deer killed were released to hunters. An individual who consumed one average-weight deer (about 37 kg or 82 lbs) with the average concentration of 0.07 pCi/g of cesium-137 would have received an effective dose equivalent of about 0.07 mrem; a calculated fatal cancer risk would be 4E-08. Tissue samples were not analyzed for strontium-90 in 1997, but the maximum concentration in 1996 was 0.002 pCi/g. The maximum hypothetical effective dose equivalent, about 3 mrem, was assumed to result from eating the heaviest deer with the highest concentration of cesium-137 (1.37 pCi/g) and of strontium-90 (0.002 pCi/g) (ORNL 1998). This would result in a hypothetical cancer risk of 2E-06.

During 1997, eighty-three geese were collected and only one was retained. Approximately one-half of the weight of the goose is edible, and the average cesium-137 concentration in 1997 was 0.07 pCi/g. Analysis for strontium-90 was not performed in 1997, but in 1995, the average concentration in tissue was approximately 7 pCi/g. Most hunters kill an average of one or two geese per hunting season. If a person consumed an average-weight goose (about 4 kg or 9 lbs) with 0.07 pCi/g of cesium-137 and 7 pCi/g of strontium-90, the individual would receive an effective dose equivalent of about 2 mrem. The calculated fatal cancer risk would be 1E-06. The highest possible effective dose equivalent in 1997 would have been about 4.5 mrem, which corresponds to a hypothetical cancer risk of 2E-06, and would have resulted from eating a hypothetical goose (the heaviest goose with the maximum cesium-137 and strontium-90 concentrations) (ORNL 1998).

A total of 90 wild turkeys were killed on the ORR during 1997, and one of these was retained. The average weight of the turkeys was 8.5 kg (19 lbs), and the average cesium-137 concentration was 0.1 pCi/g. The strontium-90 concentration was determined from tissue samples analyzed in 1997 to be

0.22 pCi/g. A person who ate an average turkey would have received an effective dose equivalent of about 0.021 mrem. A person who ate a hypothetical turkey (a combination of the heaviest turkey and the highest cesium-137 concentration) would have received an effective dose equivalent of about 0.17 mrem (ORNL 1998).

Dose estimates were also performed from eating fish from the Clinch and Tennessee River systems. Fish are collected from three locations on the Clinch River, and the edible portion is analyzed for selected metals, pesticides, PCBs, cobalt-60, cesium-137, and total strontium. A maximally exposed individual was assumed to have eaten 21 kg (46 lbs) of fish in 1997 for this analysis, with the average person consuming 6.9 kg (15 lbs). Based on the fish samples, a maximally exposed individual would have received an effective dose equivalent of 0.045 mrem, and the collective population effective dose equivalent was 0.017 person-rem (ORNL 1998).

3.10.3.3Waterborne radionuclides

Radionuclides discharged to surface waters from the ORR enter the Tennessee River system via the Clinch River and various feeder streams. Discharges from ORNL enter the Clinch River via White Oak Creek and White Oak Lake. Two methods are used to estimate radiation doses to persons who drink the water, swim, boat, and use the shoreline at various locations along the Clinch and Tennessee Rivers. The first method analyzes water samples for radionuclide concentrations. This allows for the direct measurement of contaminants in the samples, but also includes naturally occurring radionuclides. The presence of some radionuclides may be overstated, since all radionuclides are reported even if the concentration is below the detection limit (ORNL 1998). The second method uses radionuclide concentrations in water that were calculated from measured radionuclide discharges and known or estimated stream flows. The advantage of this method is that most, if not all, radionuclides discharged from ORR are quantified, and naturally occurring radionuclides are not considered. The disadvantage is that computer models estimate the concentrations of radionuclides in fish and water.

A maximally exposed individual drinking water directly from Melton Hill Lake would have received an effective dose equivalent of about 0.096 mrem according to the analyzed water samples. The collective population dose for the estimated 37,510 persons who would drink this water would be about 1.8 person-rem. This would result in a calculated fatal cancer risk of 9E-04. The dose estimates obtained from the water samples are high, since it was assumed that the individuals drank the water directly from Melton Hill Lake. If the dose estimates are calculated using the amount of radionuclides discharged from ORR to Melton Hill Lake, the doses would be about 300 times lower (ORNL 1998).

There are several water treatment plants along the Clinch and Tennessee River systems that could be affected by discharges from the ORR. The ETTP water plant draws water from the upper Clinch River. Based on water samples taken from the Clinch River, a worker who drank 370 L (391 quarts) of this water in 1997 would have received an effective dose equivalent of about 0.15 mrem (calculated cancer risk of 8E-08), and the collective population effective dose equivalent to the approximately 2,000 workers at ETTP would have been about 0.29 person-rem (fatal cancer risk of 1E-04). Using radionuclide discharge data, the maximally exposed individual was estimated to receive 0.025 mrem (fatal cancer risk of 1E-08), and the collective effective dose equivalent was 0.05 person-rem (fatal cancer risk of 3E-05) (ORNL 1998). The Kingston municipal water plant is located near the upper Watts Bar Lake and draws water from the Tennessee River. Dose assessments were performed assuming a maximally exposed individual drank 730 L (771 quarts) of water during 1997 and an average person drank 370 L (391 quarts). Based on water samples, a maximally exposed individual would receive about 0.40 mrem (calculated cancer risk of 2E-07), and the collective population effective dose equivalent to the approximately 7,438 users from the Kingston plant would be about 1.5 person-rem (ORNL 1998), which would result in a calculated cancer risk of 9E-06.

Other potential exposure pathways analyzed by the ORR for radionuclides in water include swimming or wading, boating, and use of the shoreline. A maximally exposed individual was assumed to swim or wade 27 hours/year, boat for 63 hours/year, and use the shoreline for 67 hours/year. Based on water samples collected around the ORR, a maximally exposed individual would have received a maximum effective dose equivalent of 0.015 mrem (calculated cancer risk of 8E-09) at Melton Hill Lake, and the maximum collective population dose was 0.032 person-rem, which would result in a calculated cancer risk of 2E-05.

After summing the worst-case effective dose equivalents for all water pathways in the Region of Influence, the maximum estimated effective dose equivalent would have been about 1.4 mrem in 1997, with a calculated cancer risk of 7E-07. The maximum estimated collective population effective dose equivalent would have been about 5.7 person-rem (ORNL 1998).

3.10.3.4Direct radiation

External exposure rates from background sources in Tennessee average about 6.4 microroentgens per hour (μR/hour) and range from 2.9 to 11 μR/hour. These exposure rates are equivalent to an average annual effective dose equivalent of 42 mrem/year and range from 19 to 72 mrem/year. The total average background exposure received by an individual each year is about 300 mrem. Contributing to this background dose is direct exposure from terrestrial radiation, inhalation and ingestion of naturally occurring radionuclides, and exposure to cosmic radiation. The average exposure rate at the perimeter of the ORR during 1997 was about 5.4 μR/hour or 36 mrem/year. All of the measured exposure rates at, or near, the ORR are near background levels except for two locations. Exposure rate measurements taken along a 1.7-km (1.1-mile) length of Clinch River bank averaged 8.4 μR/hour and were about 3 μR/hour above the average exposure rate at the perimeter of ORR. The potentially maximally exposed individual is a hypothetical fisherman who was assumed to have spent 5 hours/week (250 hours/year) near the point of average exposure, which would have resulted in an effective dose equivalent of about 0.25 mrem. The calculated cancer risk from this exposure would be 1E-07. The second elevated exposure measurement is at Poplar Creek, which runs through ETTP. Exposure rate measurements taken at nine locations along Poplar Creek in 1997 ranged from 3.5 to 9.5 μR/hour. The average reading was 6.1 μR/hour or 0.0046 mrem/h. Using the hypothetical fisherman who spent 250 hours/year along the bank, the effective dose equivalent would be about 1 mrem. The calculated risk for this exposure would be 5E-07.

3.10.3.5Five-year trends

The dose equivalents associated with various exposure pathways for the years 1993–97 are provided in Table 3-16. The dose estimates for direct radiation along the Clinch River and Poplar Creek have been corrected for background. The estimates for direct radiation along the Clinch River in 1994, 1995, and 1996 are overestimated because the source of the radiation was remediated in 1993 and 1994 (ORNL 1998).

Table 3-16. Five-year trends in the total effective dose equivalent for selected pathways

Pathway	Effective dose equivalent (mrem)				
	1993	1994	1995	1996	1997
All inhalation	1.4	1.7	0.5	0.45	0.41
Fish ingestion	0.2	1.6	0.9	1.2	0.96
Water ingestion (Kingston)	0.07	0.04	0.15	0.32	0.40
Direct radiation (Clinch River)	1	1	1	1	0.25
Direct radiation (Poplar Creek)	1	1	1	1	1

3.10.4 Chemicals

Non-radioactive emissions are regulated by the TDEC Division of Air Pollution Control. The small quantities of chemicals released by the ORR to the atmosphere are allowed under the air pollution control rules and do not pose a threat to human health.

3.10.4.1Airborne chemicals

Operations at ORNL result in the release of small quantities of chemicals to the atmosphere and do not require stack sampling or monitoring. A steam plant and two small, oil-fired boilers are the largest emission sources and account for 98% of all allowable emissions at ORNL. Airborne contaminants released by ORNL are shown in Table 3-17 (ORNL 1998).

Table 3-17. Actual versus allowable[a] air emissions from ORNL steam production during 1997

Pollutant	Emissions (tons/year)		Percentage of allowable
	Actual	Allowable	
Particulate	2	441	0.5
Sulfur dioxide	1072	9062	11.8
Nitrogen oxides	103	531	19.4
Volatile organic compounds	1	3	33.3
Carbon monoxide	82	336	24.4

[a]Per the Clean Air Act Title V permit.
ORNL = Oak Ridge National Laboratory.

There have been a total of fourteen 6-minute release periods of excess emissions and seven occasions where air monitors were out of service at the Y-12 Plant in 1997. The majority of nonradiological contaminants were from the Y-12 Steam Plant. Nonradiological emissions include sulfur oxides, nitrogen oxides, particulates, hydrochloric acid, and carbon monoxide. The ETTP operated 12 major emission sources under the Tennessee Title V Major Source Operating Permit Program Rules. The major sources of emissions were the three remaining steam-generated units in operation at the K-1501 Steam Plant and the Toxic Substances Control Act Incinerator. The major contaminants emitted included sulfur dioxide, nitrogen oxides, volatile organic compounds, and carbon monoxide (ORNL 1998).

3.10.4.2Waterborne chemicals

Current risk assessment methodology uses the term “hazard quotient” to evaluate noncarcinogenic health effects. A hazard quotient value less than one indicates that the potential for adverse health effects is unlikely. The hazard quotient is a ratio that compares the estimated exposure dose or intake to a reference dose. The reference dose is an estimate of a daily exposure level in humans that is unlikely to result in harmful effects during a lifetime. Most of the reference doses are obtained from research involving animals. Therefore, a safety factor of 10 to 1,000 is added for use in humans (i.e., the safe doses in humans are set at 10 to 1,000 times lower than the dose that results in no effect or a non-life-threatening effect in animals) (ORNL 1998).

Fish samples were taken upstream and downstream of the ORR and analyzed for a number of metals, pesticides, and PCBs. The hazard quotients for 1997 from the fish samples are summarized in Table 3-18. In many cases, the hazard quotients, especially for pesticides and PCBs, were calculated using concentrations estimated at or below the analytical detection limit. Because of the analytical

Table 3-18. Chemical Hazard Quotients for metals in fish (ORNL 1997)

Parameters	Sunfish			Catfish		
	CRK70[a]	CRK32[b]	CRK16[c]	CRK70[a]	CRK32[b]	CRK16[c]
Hazard Quotients for Metals						
Antimony	[d]			<3E+00	<3E+00	<3E+00
Arsenic				<4E+00	<4E+00	<4E+00
Beryllium				<4E-03	<4E-03	<4E-03
Cadmium				<1E-01	<2E-01	<1E-01
Chromium	~4E-02[e]		~7E-02	<5E-02	<5E-02	<5E-02
Copper	7E-03	8E-03	5E-03			
Lead				<3E+0	<3E+0	<3E+00
Mercury	~6E-01	6E-01	2E+00			
Nickel			~8E-03	<1E-02	<1E-02	<1E-02
Selenium		<2E-01		<2E-01	<3E-01	<2E-01
Silver				<3E0-2	<3E-02	<3E-02
Zinc	4E-02	4E-02	5E-02			
Hazard Quotients for Pesticides and Aroclors						
Chlordane			1E-01			
Benzine Hexachloride			~1E+00			
Gamma BHC			~6E-01			
4,4′DDT			~2E-02			
Endosulfan I			~7E-04			
Endosulfan II			~1E-03			
Endosulfan sulfate			~3E-03			
Endrin			~3E-02			
Endrin aldehyde			~4E-01			
Heptachlor			~8E-03			
Heptachlor epoxide			~3E-01			
Methoxychlor			~8E-03			
Aroclor-1016			~7E-01			
Aroclor-1221			~4E+03			
Aroclor-1232			~4E+03			
Aroclor-1242			~4E+03			
Aroclor-1248			~4E+03			
Aroclor-1254			~3E+00			
Aroclor-1260	~2E+03	~1E+03	~2E+03			

[a]Melton Hill Reservoir, above Oak Ridge City input.
[b]Clinch River, downstream of ORNL.
[c]Clinch River, downstream of all DOE inputs.
[d]A blank space indicates the parameter was undetected.
[e]A tilde (~) indicates that estimated values and/or detection limits were used in the calculation.
Source: Adapted from ORNL 1998.

detection limitations, the actual fish tissue concentrations are unknown. Drinking water was analyzed upstream and downstream of the ORR discharge points for various metals and chemicals. Elevated aluminum and iron hazard quotients were found both upstream and downstream of the ORR. The hazard quotients for drinking water are shown in Table 3-19.

For carcinogens, the estimated dose or intake from ingestion of water or fish is divided by the chronic daily intake, which corresponds to a 1E-05 lifetime risk of developing cancer. In sunfish collected downstream of the ORR and analyzed for carcinogens, there was a cancer risk of 1E-05 due to aldrin, dieldrin, and toxaphene. Because of analytical detection limitations, the actual fish tissue concentrations are not known (ORNL 1998).

Table 3-19. Chemical Hazard Quotients for drinking water (ORNL 1997)

Chemical	Hazard Quotient		
	CRK 70[a]	CRK 23[b]	CRK 16[c]
Metals			
Aluminum	~1.3[d]	~1.4	~2.1
Antimony	[e]	~3.2	
Barium	~3E-02	~3E-02	4E-02
Boron	6E-03	7E-03	7E-03
Chromium	~5E-02	~5E-02	~5E-02
Copper	~4E-03	~7E-03	
Iron	~1E-02	~1	1.6
Lead	~3E+01	~3	
Manganese	~4E-02	3E-02	4E-02
Strontium	4E-03	4E-03	4E-03
Thallium	~2E+01		
Uranium	~4E-03	~4E-03	~4E-03
Vanadium	~1.3	~1.3	
Zinc	~3E-03	~2E-03	~2E-03
Volatile Organics			
Acetone	~2E-03	~2E-03	~2E-03
2-Butanone	~4E-04	~4E-04	~4E-04
Toluene	~6E-04		
Xylene	~6E-05		

[a]Melton Hill Reservoir, above Oak Ridge City input.
[b]Clinch River, downstream of ORNL.
[c]Clinch River, downstream of all DOE inputs.
[d]A tilde (~) indicates that estimated values and/or detection limits were used in the calculation.
[e]A blank space indicates the parameter was undetected.
Source: Adapted from ORNL 1998.

3.11 ACCIDENTS

The potential for accidents from human error, equipment failure, or natural phenomena would result in the release of radiation, radioactive materials, or hazardous materials. Based on data obtained from the ORNL Safety Information Database Module on the Injury/Illness Historical Performance Report for January 1, 1999, through December 31, 1999, the total recorded injuries at ORNL for 1999 were 170, which is a rate of 4.56 per 100 full-time employees working for one year (ORNL 1999b).

3.12 NOISE

The area around the Melton Valley Storage Tanks is industrial, with the site serving as a waste storage area. The activities in this area are sporadic and associated with traffic and occasional equipment use. A baseline noise survey was conducted for the project site area in July 1999 by Bechtel Jacobs; details of the survey are included in Appendix C.4. The High Flux Isotope Reactor access road that connects with Tennessee State Route 95 [roughly 1.6 km (1 mile) west of the proposed site] is currently being upgraded, so heavy construction equipment was in use during the survey. Eleven noise monitoring stations were established (Figure 3-20). The monitoring stations ranged in location from west of the proposed site and immediately adjacent to Tennessee State Route 95, to east of the proposed site adjacent to the Melton Valley Storage Tanks. The entire surveyed area is relatively quiet. Daily equivalent noise level (Leq) values were generally in the 50 to 70 dBA range. By comparison, normal human speech is approximately 60 to 65 dBA. The Leq is a metric that measures all noise within the frequency range of the instrument over a given time interval (in this case one hour), computes an average noise level, and assumes this noise level was continuous over the total interval measured. Results of the monitoring effort are presented in Appendix C.4.

The noise levels adjacent to State Route 95 (monitoring location 1) were relatively constant over a 24-hour period with daily Leqs of 61.1 and 64.7 for the 2 days data were collected (Table 3-20). Monitoring location 2, adjacent to the Old Melton Valley Road (High Flux Isotope Reactor access road), shows substantially greater noise levels (20 dBA Leqs greater) during hours when heavy equipment associated with the road upgrade was present. For one day, monitoring location 7 also shows noise levels greatest during periods when construction workers were present. The other locations either had a relatively constant noise environment or they showed diurnal peaks when workers were not generally present. It is probable that wildlife such as frogs and crickets contributed to the late-night noise peaks at several locations (Table 3-20).

3.13 SOCIOECONOMIC AND DEMOGRAPHIC ENVIRONMENT

The Region of Influence for the proposed action includes Anderson, Knox, Loudon, and Roane Counties (Figure 3-21). Approximately 90% of ORR employees reside in this region (DOE 1998c). The region includes the cities of Clinton, Oak Ridge, Knoxville, Loudon, Lenoir City, Harriman, and Kingston. This section provides a description of the characteristics, housing, infrastructure, and the local economy.

3.13.1 Demographic Characteristics

Approximately 7,500 people live within 8 km (5 miles) of the center of the ORR. Excluding the residential area of Oak Ridge with a population of 27,310, the population density within 10 km (6 miles) of the proposed TRU Waste Treatment Facility generally averages less than 38 people/square kilometer (100 people/square mile). Oliver Springs lies 11 km (7 miles) northwest of the ORR and has a population of 3,400. Clinton, Tennessee, located 16 km (10 miles) to the northeast of the ORR, has a population of 9,000. Approximately 6,100 people live in Lenoir City, 11 km (7 miles) southeast of the ORR. Kingston is located 11 km (7 miles) to the southwest of the ORR and has 4,600 residents. Approximately 7,100 people reside in Harriman, Tennessee, which is 13 km (8 miles) west of the ORR. Knoxville is the largest metropolitan area within 80 km (50 miles) of the facility and has a population of 165,000 people. In all, approximately 880,000 people reside within 80 km (50 miles) of the facility (ORNL 1995).

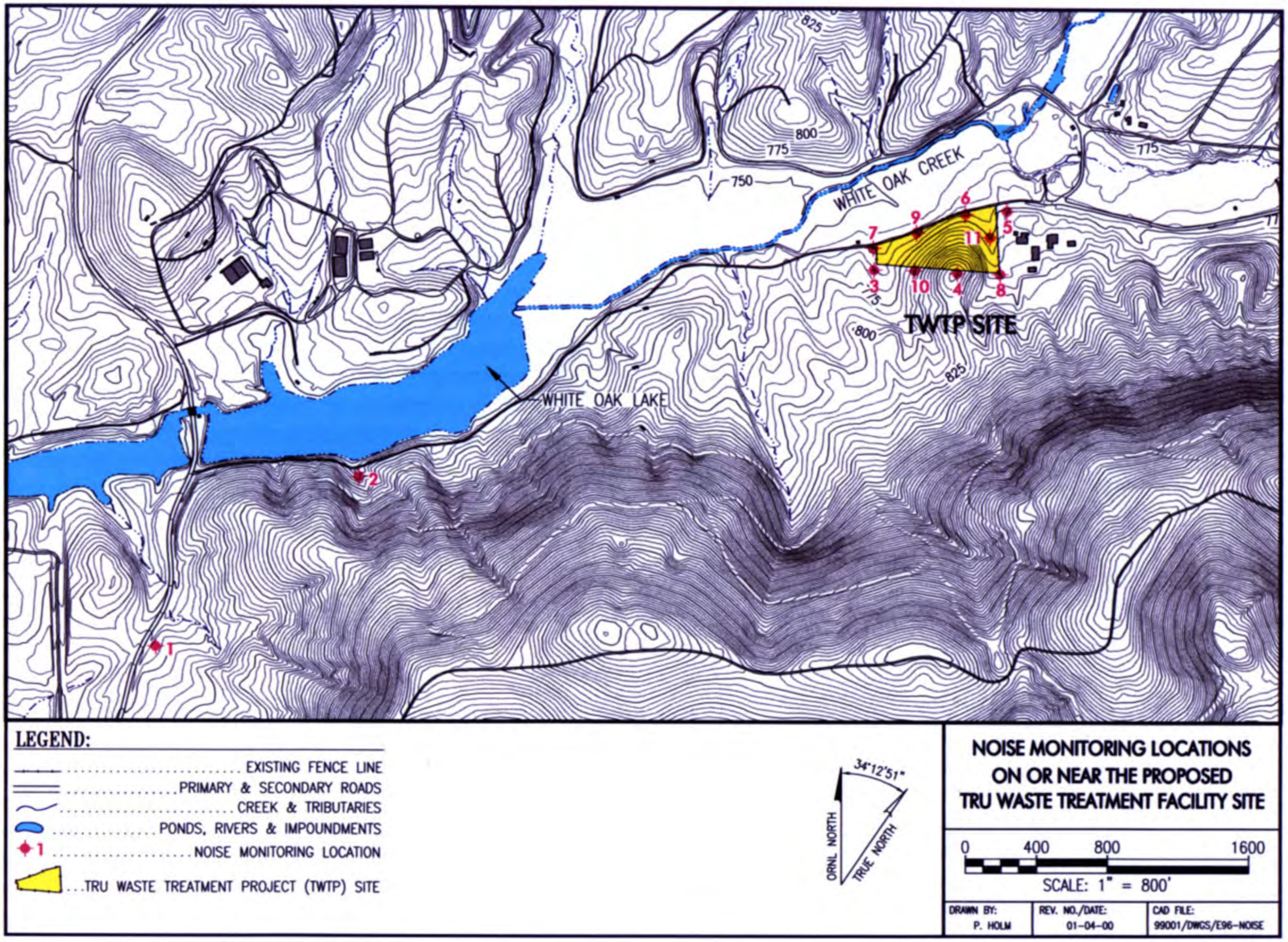


Figure 3-20. Eleven noise monitoring stations were located on, or near the proposed TRU Waste Treatment Facility site boundary.

Table 3-20. Noise monitoring data for Melton Valley proposed TRU waste facility
[noise levels (Leq per hour) in Melton Valley, Oak Ridge, Tennessee]

Location number and sample event	1a	1b	2a	2b	2e	3a	3b	3d	4a	4b	4c	5a	5b	6e	7c	7e	8d	9d	9e	10d	10e	11d
Hour (military)																						
0	60.5	61.9	53.1	53.5	55.4	56.1	61.2	58.2	58.4	58.7	59.3	59.6	59.0	57.4	55.9	63.6	63.1	60.5	59.9	57.2	58.8	62.6
1	59.0	60.3	51.7	51.3	54.5	53.3	54.5	57.4	55.8	55.5	57.7	58.6	58.2	56.0	53.8	58.6	60.5	59.4	58.9	56.3	57.6	61.5
2	56.7	56.6	49.4	48.7	53.3	50.1	50.4	55.1	52.3	51.1	55.3	57.8	56.9	54.5	51.9	57.9	59.3	58.0	57.9	54.1	55.3	60.4
3	52.7	55.9	46.6	46.6	51.3	49.3	49.9	53.1	50.6	49.5	51.3	57.3	56.4	52.9	49.8	56.2	58.5	54.0	55.2	51.0	51.6	57.1
4	52.9	57.5	42.9	42.4	47.6	47.6	48.2	47.3	49.1	48.2	48.9	57.1	56.2	54.2	48.0	56.4	57.6	48.8	53.5	46.9	52.9	55.0
5	60.9	64.6	43.4	43.2	46.6	46.6	48.5	45.1	48.2	47.9	47.8	57.1	55.9	47.5	47.0	53.2	57.1	48.5	49.1	42.5	43.5	54.6
6	60.6	68.4	45.6	45.3	47.0	50.6	50.5	58.8	49.3	48.1	50.3	56.6	56.3	48.3	51.8	57.6	60.8	57.3	49.3	61.7	43.5	61.4
7	59.4	67.8	45.8	66.2	71.0	50.4	52.5	52.1	49.6	51.1	49.6	56.8	57.1	49.0	56.7	50.0	58.4	54.5	51.2	52.8	43.4	57.9
8	58.9	66.3	44.8	73.1	72.5	50.3	52.5	55.1	49.9	53.0	51.8	57.3	57.0	51.8	72.6	55.2	59.3	56.0	59.2	56.5	46.9	60.7
9	55.6	64.9	43.9	78.2	74.7	50.0	52.4	51.3	50.1	51.4	53.5	58.0	56.8	50.9	77.4	52.7	57.7	51.0	57.0	49.8	52.1	57.3
10	54.0	63.1	43.8	69.6	71.7	49.8	50.2	47.1	49.0	52.3	58.2	57.7	57.2	54.2	80.7	55.6	57.0	52.4	59.0	47.5	54.5	55.3
11	55.9	64.7	45.8	48.5	65.0	49.5	51.3	46.1	49.2	51.3	54.0	57.8	56.7	51.9	71.2	50.7	56.3	48.4	56.5	45.3	51.8	56.5
12	55.8	63.5	44.9	46.4	59.4	51.6	50.1	50.3	51.2	49.9	58.7	58.0	56.8	49.3	51.9	51.1	57.2	55.8	55.3	51.8	50.5	56.8
13	55.6	64.0	63.5	47.4	70.3	50.4	49.8	50.8	49.7	49.9	53.6	57.8	57.2	48.6	51.9	51.2	56.1	56.2	55.1	51.0	51.1	58.4
14	56.4	64.0	54.7	55.8	61.7	50.8	49.7	48.9	50.5	49.0	53.0	57.2	56.5	50.7	50.8	52.5	55.4	54.2	54.5	48.2	51.6	55.4
15	59.7	67.7	46.3	54.5	77.2	49.9	48.9	49.6	49.4	48.8	52.3	56.9	56.4	49.4	57.1	46.3	54.7	64.2	50.3	49.7	47.4	57.7
16	59.7	67.0	46.4	49.7		49.4	47.6	59.0	49.6	48.5	52.4	57.1	56.2	51.1	52.3		56.1	53.2		54.3	46.4	54.9
17	63.1	67.1	45.6	49.3	49.4	48.1	46.0	58.6	48.5	48.3	49.4	57.0	56.3	53.4	47.3	46.4	55.0	53.3	47.8	53.7	44.7	53.3
18	61.7	64.3	44.1	46.2	49.8	47.8	47.1	42.4	48.9	48.3	47.7	57.4	56.4	49.0	44.8	45.6	55.7	45.8	44.1	41.1	42.9	53.0
19	60.8	64.2	43.3	43.7	50.3	47.7	46.3	43.2	48.7	48.3	47.9	57.6	56.9	51.2	44.7	44.5	56.1	43.9	46.1	42.0	42.6	52.8
20	58.1	61.5	45.3	43.8	56.5	48.0	49.0	47.5	48.8	49.5	48.9	57.8	57.3	52.2	46.1	47.4	57.1	48.7	49.4	46.1	48.8	54.6
21	63.0	65.2	50.6	52.7	57.2	55.4	58.1	58.8	55.8	57.7	59.2	60.2	59.5	60.1	57.9	61.8	62.8	60.7	61.0	57.7	58.5	64.6
22	62.3	64.7	54.9	56.2	57.0	59.1	60.4	60.4	60.1	60.5	61.1	61.1	59.9	59.7	63.5	65.7	62.6	62.1	62.5	58.9	60.2	65.4
23	57.9	63.4	53.8	55.0	57.0	58.1	59.8	59.9	59.8	59.4	60.4	60.4	59.4	58.6	59.0	66.7	61.8	61.3	62.2	57.9	59.6	63.8
daily Leq	61.1	64.7	61.0	66.4	67.3	52.7	53.6	55.4	53.6	53.7	55.5	58.2	57.4	54.3	69.4	58.7	58.9	57.0	57.1	54.5	54.1	59.7
Lmax	87.6	90.0	87.8	104.4	96.8	70.0	64.8	78.8	72.1	73.2	75.9	74.4	68.0	81.5	90.5	82.7	81.6	93.0	88.8	90.1	81.7	82.5

For locations, see Figure 3-20 and text descriptions.

Sample Events:
a - 7/13-14/99
b - 7/14-15/99
c - 7/15-16/99
d - 7/19-20/99
e - 7/20-21/99

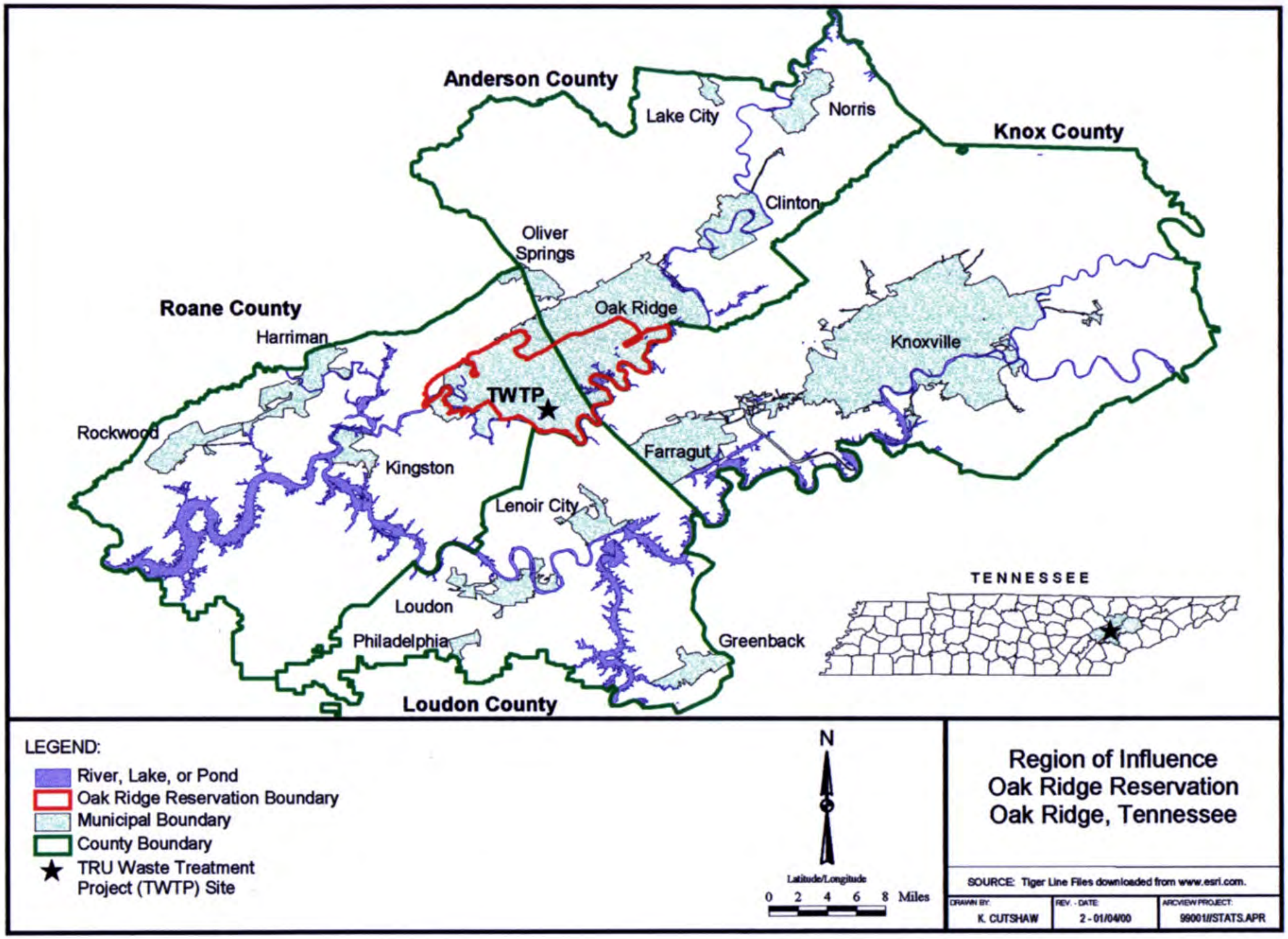


Figure 3-21. Region of Influence for the Oak Ridge Reservation.

Population trends and projections for each of the counties in the four-county Region of Influence are presented in Table 3-21. Of the four counties, Knox has the largest population, with 70% of the 1996 regional population of 523,252. Anderson County accounted for 14% of the regional population, Roane County for 9%, and Loudon County accounted for the remaining 7%. The region represents approximately 10% of the state's population. The TDEC has indicated that the population in the region will likely decline to 512,399 by year 2000 and then increase slightly by year 2005. Roane County is the exception to this trend, as it is projected to grow 24%.

Table 3-21. Regional population trends and projections in the Oak Ridge Region of Influence

County	1980	1990	1996	2000	2005
Anderson	67,346	68,250	71,587	68,181	66,347
Knox	319,694	335,749	364,566	353,721	360,033
Loudon	28,553	31,255	37,240	34,149	36,458
Roane	48,425	47,277	49,859	56,348	61,984
Region Total	464,018	482,531	523,252	512,399	524,822
State	4,591,023	4,877,185	5,235,358	5,178,587	5,305,137

Sources: U.S. Bureau of Census 1990a; TEDC 1994–97.

Population data for the cities in the region are presented in Table 3-22. Between 1990 and 1996, the populations of the four-county region and the state both grew less than 1% per year.

Table 3-22. Population for incorporated areas within the ORR region

Communities	1990	1996	Percent growth
Clinton	8,972	9,320	3.9
Oak Ridge	27,310	27,742	1.6
Knoxville	169,761	167,535	-1.3
Loudon	4,288	4,544	6.0
Lenoir	6,147	8,890	44.6
Harriman	7,119	7,006	-1.6
Kingston	4,552	4,935	8.4

Source: U.S. Bureau of Census 1990a; DOE 1999a.
ORR - Oak Ridge Reservation.

Population by race and ethnicity for the region is presented in Table 3-23. The 1990 census data reflect racial and ethnic compositions in the four counties. There is little variation among the four counties, and Caucasians make up more than 90% of the combined population. African-Americans compose 7% of the population.

Table 3-23. 1990 Population by race and ethnicity for the ORR region

All persons, race/ ethnicity	Anderson		Knox		Loudon		Roane		Total	
	Number	%[a]	Number	%[a]	Number	%[a]	Number	%[a]	Number	%[a]
All Persons	68,250	100	335,749	100	31,255	100	47,277	100	482,531	100
Caucasian	64,745	95	301,788	90	30,762	98	45,422	96	442,717	92
African-American	2,681	4	29,299	9	362	1	1,534	3	33,876	7
American Indian[b]	195	<1	996	<1	46	<1	87	<1	1,324	<1
Asian/ Pacific Islander	540	<1	3,136	<1	55	<1	177	<1	3,908	1
Hispanic of any race[c]	582	1	1,935	1	107	<1	273	1	2,897	1
Other races	89	<1	530	<1	30	<1	57	<1	706	<1

[a]Percentages may not total to 100 due to rounding.
[b]Numbers for Aleuts and Eskimos were placed in the "other" category, given their small number.
[c]In the 1990 Census, Hispanics classified themselves as White, Black, Asian/Pacific Islander, American Indian, Eskimo, or Aleut. To avoid double counting, the number of Hispanics was subtracted from each of the race categories.
ORR - Oak Ridge Reservation.
Source: U.S. Bureau of Census 1990a.

3.13.2 Housing

Regional housing characteristics are presented in Table 3-24. In 1990, vacancy rates in the region ranged between a low of 6% in Loudon County to a high of 9% in Roane County. Among all occupied housing units in the region, approximately two-thirds were owner occupied.

Housing vacancy rates for selected regional cities and towns are similar to county rates. In 1990, the county vacancy rate for all units was 7%, while the combined vacancy rate for the seven selected communities (refer to Table 3-24) was 8%. Median home value was similar in Roane, Loudon, and Anderson Counties, ranging between $48,700 to $55,100. Knox County median home values were higher at $63,900. Rents ranged from $280 to $351 across the Region of Influence.

Table 3-24. Housing summary for the ORR region, 1990, by county

	Anderson County		Knox County		Loudon County		Roane County	
	Number	%[a]	Number	%[a]	Number	%[a]	Number	%[a]
Total housing units	29,323	100	143,582	100	12,995	100	20,334	100
Occupied	27,384	93	133,639	93	12,155	93	18,453	91
Vacant	1,939	7	9,943	7	840	6	1,881	9
Median home Value	$55,100	NA	$63,900	NA	$51,000	NA	$48,700	NA
Gross rent	$342	NA	$351	NA	$280	NA	$287	NA

NA - Not applicable.
[a]May not total 100 due to rounding.
Sources: U.S. Bureau of Census 1990a; U.S. Bureau of Census 1996.

3.13.3 Infrastructure

The infrastructure section characterizes the region's community services with indicators such as education, health care, and public safety.

3.13.3.1Education

There are eight school districts within the four-county Region of Influence. Information regarding these districts is presented in Table 3-25. The school districts in the region receive funding from local, state, and federal sources, but the percentage received from each source varies. Local funding varies from a low of 31% in Loudon County to a high of 52% in Knox County. State funding varies between 43% in Knox County and 63% in Loudon County, and federal funding ranges between a low of 5% in Knox County and a high of 12% in Anderson County.

Table 3-25. Public school statistics in the ORR region, 1996–97 school year

County	Number of schools	Student enrollment[a]	Teachers[a]	Teacher/student ratio	Per-student operational expenditures
Anderson	27	13,867	840	1:16	$5,206
Knox	84	57,693	3153	1:18	$4,191
Loudon	13	6,900	335	1:21	$3,870
Roane	19	8,356	455	1:18	$4,343

[a]Full-time equivalent figures.
ORR - Oak Ridge Reservation.
Source: Tennessee Department of Education 1997.

3.13.3.2Health care

There are eight hospitals currently serving the region. Table 3-26 presents data on hospital capacity and usage. Average statistics for the hospitals indicate that there are approximately 2,400 acute-care hospital beds in the region, about 46% of which are available on any given day. This capacity is considered adequate to serve the health needs of the local population.

Table 3-26. Hospital capacity and usage in the ORR region

Hospital	Number of hospitals	Number of beds[a]	Annual bed-days used[b] (%)
Anderson	1	281	63
Knox	5	1923	53
Loudon	1	62	23
Roane	1	94	50

[a]The number of acute-care beds.
[b]Based on the number of people discharged and the average length of stay divided by total beds available annually.
ORR - Oak Ridge Reservation.
Source: The American Hospital Directory, Inc. 1999.

3.13.3.3Police and fire protection

The Knoxville Police Department has 400 officers with an approved Fiscal Year 1998 budget of $26.4 million. In addition, the Oak Ridge Police Department has 45 officers with an approved Fiscal Year 1996 budget of $2.3 million. The Knoxville County Fire Department has 13 fire stations, staffed by 118 Fire Department personnel. The Oak Ridge Fire Department provides fire suppression, medical/rescue, and fire prevention services to both ORNL and the Oak Ridge community (DOE 1999a).

3.13.4 Local Economy

This subsection provides information on the economy of the region, including employment, income, and fiscal characteristics.

3.13.4.1Employment

Regional employment data for 1991–96 are summarized in Table 3-27. The 1998 average unemployment rate for the Region of Influence was 3.4%, ranging from 3.1% in Knox County to 5.0% in Roane County (Tennessee Department of Employment Security 1999).

Table 3-27. Region of Influence employment data, 1991–96

County	Number employed		Percent change
	1991	1996	
Anderson	37,395	41,001	9.64
Knox	185,704	210,506	13.36
Loudon	9,538	11,142	16.82
Roane	21,305	23,646	10.99
Region	253,942	28,6295	12.74

Source: Bureau of Economic Analysis 1999.

DOE-related facilities and contractor employment declined from 18,165 workers in 1995 to 14,534 in 1997, of which 13,154 lived in the four-county impact region (DOE 1996b, 1998b;

Bridgeman 1997; Neal 1998). Table 3-28 shows the distribution of ORR-related employment across the relevant counties in 1996. The distribution in 1997 was similar, although the later figures included Oak Ridge residents in both Anderson and Roane County totals. Knox County held the largest share of the region's ORR-related employment (45%), followed by Anderson County with 32%, and Roane County with 16%. Loudon County accounted for the remaining 6%.

Table 3-28. Distribution of DOE-related employment in Region of Influence, 1996

	1996	
County	**Number employed**	**Percent**
Anderson	4,956	32
Knox	6,939	45
Loudon	962	6
Roane	2,493	16
Region of Influence Total	15,350	100

DOE - U.S. Department of Energy.
Source: Bridgeman 1997.

Table 3-29 presents employment by industry for the Region of Influence with government, manufacturing, retail trade, and services being the principal economic sectors. Services employment is the largest employment sector in the region, although manufacturing is nearly as large in Loudon County.

Table 3-29. Employment distribution by industry for the four-county Region of Influence

Industry	Anderson County	Knox County	Loudon County	Roane County	Region of Influence	State of Tennessee
			Number employed by industry (1996)			
Farm	582	1,453	1,214	606	3,855	93,383
Agriculture Services	319	2,202	229	105	2,855	28,435
Mining	123	587	18	32	760	7,125
Construction	4,258	15,829	1068	981	22,136	187,246
Manufacturing	11,114	24,875	3,040	6,539	45,568	534,099
Transportation and Public Utility	1,838	12,244	811	633	15,526	165,715
Wholesale Trade	647	16,088	290	448	17,473	151,914
Retail Trade	(D)	46,614	2,180	(D)	48,794	545,934
Finance, Insurance, and Real Estate	2,177	17,554	894	713	21,338	212,589
Services	(D)	76,010	3,412	(D)	79,422	879,043
Government	5,421	37,474	1,733	4,067	48,695	405,205

(D) - Data withheld to avoid disclosure when there are less than four businesses in an industry classification.
Source: Bureau of Economic Analysis 1996.

3.13.4.2Income

The total regional income in 1996 was approximately $12.0 billion. DOE-related payroll accounted for about 6% of that income ($725 million). In 1997, DOE-related payroll in the region declined to $680 million (DOE 1998c), reflecting a downward trend in DOE activities that is expected to continue. Per capita income data for the region and the state are presented in Table 3-30. Over the period from 1991 to 1996, the per capita incomes in the four-county Region of Influence grew between 23 and 26%. This growth rate was slightly below the statewide increase in income of 28%.

Table 3-30. Per capita income data for the four-county Region of Influence and the State of Tennessee

Area	Per Capita Income		Percent Increase
	1991 ($)	1996 ($)	
Anderson County	18,040	22,292	24
Knox County	18,970	23,952	26
Loudon County	15,697	19,341	23
Roane County	15,551	19,601	26
State of Tennessee	16,976	21,808	28

ORR - Oak Ridge Reservation.
Source: Bureau of Economic Analysis 1999.

Table 3-31 shows the percentage of persons whose incomes were below the poverty level in 1990 for the four-county Region of Influence. The percentage ranged from 13.4% in Loudon County to 15.8% in Roane County, compared to a state average of 15.7%.

Table 3-31. Percent of individuals with incomes below poverty line in the four-county Region of Influence and the State of Tennessee, 1990

Area	Percent
Anderson County	14.2
Knox County	13.6
Loudon County	13.4
Roane County	15.8
State of Tennessee	15.7

ORR - Oak Ridge Reservation.
Source: Bureau of the Census 1995.

3.13.4.3Fiscal characteristics

Municipal and county general fund revenues in the Region of Influence are presented in Table 3-32. The general fund supports the ongoing operations of local governments, as well as community services, such as police protection and parks and recreation. The State of Tennessee does not have state or local personal income tax. Under Tennessee constitutional law, property taxes are assessed as follows:

Residential property equals 25% of the appraised value.
Commercial/industrial property equals 40% of the appraised value.
Personal property equals 30% of the appraised value.

The largest revenue sources for the counties' general fund have traditionally been local taxes (which include taxes on property, real estate, hotel/motel receipts, and sales) and intergovernmental transfers from the federal or state government. Over 80% of the 1999 general fund revenue came from these combined sources (DOE 1999a).

Table 3-32. Municipal and county general fund revenues in the ORR region, Fiscal Year 1997

Revenue by source	Anderson County		Knox County		Loudon County		Roane County	
	($1,000)	%	($1,000)	%	($1,000)	%	($1,000)	%
Local taxes[a]	12,732	40	232,145	56	4,147	68	22,970	45

Licenses and permits	34	<1	1,633	<1	178	3	102	<1
Fines and forfeitures	56	<1	3,086	1	157	3	302	1
Charges for service	2,640	8	21,811	5	43	1	1,167	2
Intergovernmental[b]	14,483	45	145,582	35	638	11	22,826	45
Interest	1,285	4	10,982	3	—[c]	NA	1,183	2
Miscellaneous income	680	2	483	<1	911	14	2,474	5
Total	31,910	100	415,722	100	6,074	100	51,024	100

[a]Local taxes include real and personal property taxes, hotel/motel taxes, and local sales taxes.
[b]Intergovernmental includes state transfers and federal funds.
[c]Interest revenue not identified separately for Loudon County.
NA - not available.
Source: DOE 1999a.

3.14 ENVIRONMENTAL JUSTICE

Figure 3-22 illustrates the distribution of minority populations in the census tracts that immediately surround the ORR. A minority population consists of any census tract with a minority population proportion greater than the national average of 24.1% (Bureau of the Census 1990a). Minorities include individuals classified as Black not of Hispanic origin, Hispanic, Asian or Pacific Islander, and American Indian or Alaskan Native (CEQ 1997).

In 1990, African-Americans comprised 34.4% of the population in tract 201, and other minorities comprised 6.9% (Bureau of the Census 1990a). For all other Oak Ridge City tracts, minorities comprised 10% or less of the population. For comparison, minorities represented 24.1% of the population nationally and 17% of the population in Tennessee.

There are no federally recognized Native American groups within 80 km (50 miles) of the proposed site. DOE has consulted with Native American groups regarding the status of the ORR as a site of potential importance to Native Americans. While some isolated findings of arrowheads, pottery shards, and charcoal have been found in some project studies over the years, no tribe or group representing Native Americans has ever expressed interest in the ORR as a site of historical importance to Native Americans (Moore 1999). There are no known sensitive areas near the proposed project site. The closest Native American tribe is the Eastern Band of the Cherokee Indians in Cherokee, North Carolina, approximately 110 km (100 miles) southeast of the proposed site.

Figure 3-23 shows the location of low-income populations for the same area. In this analysis, a low-income population includes any census tract in which the percentage of persons with income below the poverty level is greater than the national average of 13.1%. The Tennessee state average is 15.7% (Bureau of the Census 1990b). The highest percentages are in tract 201 (22.9%) and tract 205 (20.4%). The lowest percentages are in tracts 206 (0.3%), 5802 (1.5%), and 301 (1.9%) (Bureau of the Census 1995).

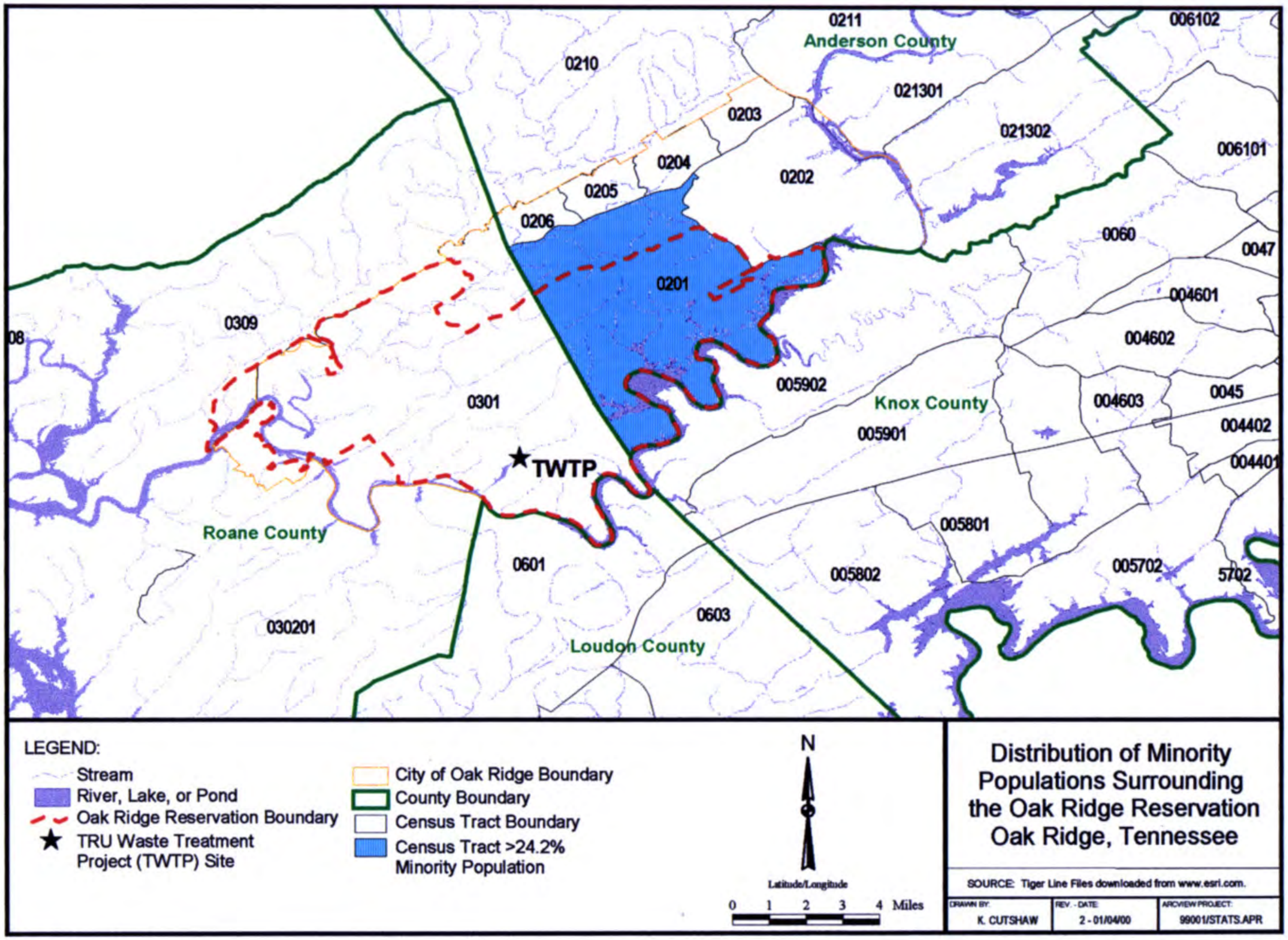


Figure 3-22. Census tracts with a minority population greater than the national average of 24.1%.

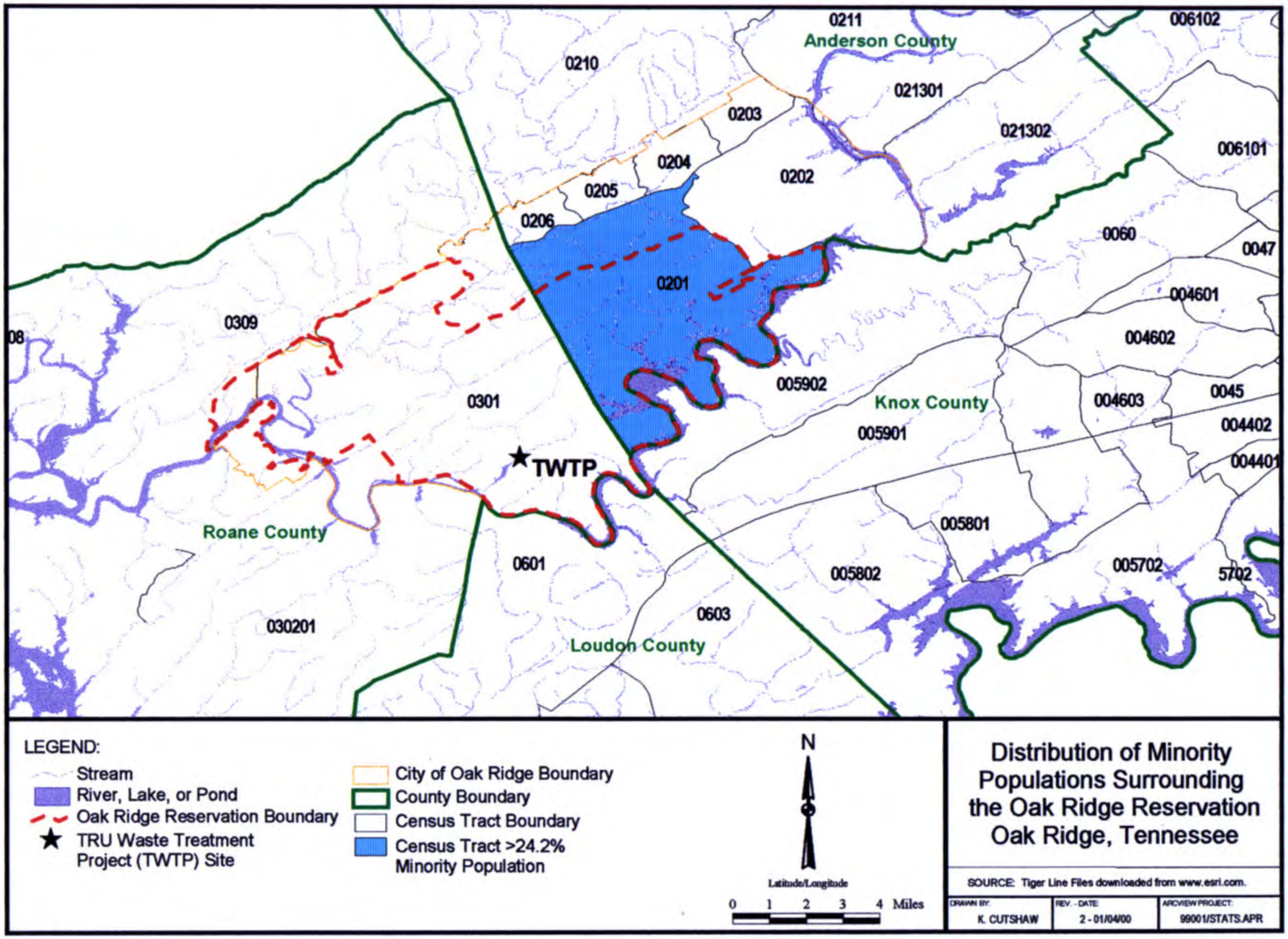


Figure 3-23. Census tracts with a low-income population greater than the national average of 13.1%.

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4. ENVIRONMENTAL CONSEQUENCES

Chapter 4 presents the environmental impacts and consequences associated with implementing each alternative for the proposed action. The proposed action is the construction of a facility to treat legacy TRU waste stored at ORNL, followed by disposal at a facility designated in the Record of Decision for the *Waste Isolation Pilot Plant Disposal Phase Supplemental Environmental Impact Statement* (WM SEIS-II). Disposal of low-level waste would be consistent with the pending Record of Decision for the WM PEIS for low-level waste (e.g., the Nevada Test Site or another designated disposal facility). The Low-Temperature Drying Alternative, which involves waste stabilization and volume reduction through treatment by a low-temperature drying process for tank sludge and supernate, and sorting and compaction for the solid waste, is the preferred alternative.

The Low-Temperature Drying Alternative is the preferred alternative because it would result in the lowest overall impacts of all the treatment alternatives. Implementation of this alternative would result in the lowest risks for off-site transportation, accident scenarios, and human health of the treatment alternatives evaluated in this EIS. It would also result in the least amount of waste generated and the lowest number of off-site waste shipments. Emissions from this alternative would be minor during treatment operations. Waste treatment would result in a reduction in risk in Melton Valley at ORNL due to the treatment of the TRU wastes stored in the SWSA 5 North trenches, which currently release contaminants into the environment.

The methods used to determine the impacts and consequences are discussed at the beginning of each resource area. The assumptions and factors used in the analysis and prediction of the impacts are discussed for each resource area and in the appendices. The impacts or consequences for the No Action Alternative and each action alternative are then described. In addition, a comparison of the impacts of the alternatives is presented for each resource area. A summary of the environmental impacts for all of the alternatives is found at the end of Chapter 2.

4.1 LAND USE IMPACTS

This section discusses the impacts of the alternatives on land use and land use classification, and aesthetic and scenic resources in the nearby areas.

4.1.1 Methodology

Methods used to determine the environmental impacts for each of the alternatives on land use are listed below.

- Compared the facility footprint (in hectares and acreage) for each alternative.
- Determined if a change to the existing land use classification is required due to the implementation of an alternative.
- Identified changes to the scenic and aesthetic resources of the area.

4.1.2 No Action Alternative

The No Action Alternative would result in no change to the existing land or land use classification. The Melton Valley Storage Tanks would continue to store liquid and sludge waste, and the existing solid waste storage facilities would continue to store contact-handled and remote-handled TRU solids. Retrievable TRU and alpha low-level wastes would continue to be stored in the trenches in SWSA 5 North. Institutional control is assumed for 100 years. Scenic and aesthetic resources in the area would remain unchanged.

4.1.3 Low-Temperature Drying Alternative

The Low-Temperature Drying Alternative would result in land use impacts, compared to no land use impacts for the No Action Alternative. About 2 ha (5 acres) of land west and adjacent to the Melton Valley Storage Tanks would be altered from forest to direct industrial use due to the construction of the proposed waste treatment facility. The site would be revegetated after D&D of the facility.

The proposed facility site has been designated for industrial land use. The construction, operation, and D&D of the facility would require no change to the overall land use classification for the area.

The proposed site is isolated from the main plant area at ORNL and is not visible to the general public; however, 2 ha (5 acres) of forest would be cleared, impacting the scenic resources in the immediate area. The construction, operation, and D&D activities would be visible to workers at the site and to personnel traveling the High Flux Isotope Reactor access road, which would become the main road to the proposed treatment facility.

4.1.4 Vitrification Alternative

The Vitrification Alternative would result in land use impacts, compared to no land use impacts for the No Action Alternative. Approximately 2.8 ha (7 acres) of land west and adjacent to the Melton Valley Storage Tanks would be altered from forest to direct industrial use due to the construction of a vitrification waste treatment facility. The site would be revegetated after D&D of the facility. The proposed facility site has been designated for industrial land use. The construction, operation, and D&D of the facility would require no change to the overall land use classification for the area.

The proposed site is isolated from the main plant area at ORNL and is not visible to the general public; however, about 2.8 ha (7 acres) of forest would be cleared, impacting the scenic resources in the immediate area. The construction, operation, and D&D activities would be visible to workers at the site and to personnel traveling the High Flux Isotope Reactor access road, which would become the main road to the proposed treatment facility.

4.1.5 Cementation Alternative

The Cementation Alternative would result in land use impacts, compared to no land use impacts for the No Action Alternative. About 2 ha (5 acres) of land west and adjacent to the Melton Valley Storage Tanks would be altered from forest to direct industrial use due to the construction of a cementation waste treatment facility. The site would be revegetated after D&D of the facility.

The proposed facility site has been designated for industrial land use. The construction, operation, and D&D of the facility would require no change to the overall land use classification for the area.

The proposed site is isolated from the main plant area at ORNL and is not visible to the general public; however, 2 ha (5 acres) of forested land would be cleared, impacting the scenic resources in the immediate area. The cementation waste treatment facility would be visible to workers at the site and to personnel traveling the High Flux Isotope Reactor access road during construction, operation, and D&D activities.

4.1.6 Treatment and Waste Storage at ORNL Alternative

This alternative would result in land use impacts, as compared to no land use impacts for the No Action Alternative. About 2 to 2.8 ha (5 to 7 acres) of land west and adjacent to the Melton Valley Storage Tanks would be altered from forest to direct industrial use for the construction of a waste treatment facility (either low-temperature drying, vitrification, or cementation treatment facility). In addition, waste storage facilities would be required to store the treated wastes, further impacting the land. Based on the assumption that the existing solid waste storage facilities (Buildings 7572, 7574, 7842, 7878, and 7879 for contact-handled waste, and Buildings 7855 and 7883 for remote-handled waste) could be used for storage of the treated wastes, an additional 0.3 to 0.8 ha (0.75 to 2 acres) of land would still be required for the construction of additional waste storage facilities, depending on the treatment method selected. The land required for storage of treated waste onsite by the treatment alternatives would be: 0.3 ha (0.75 acres) for treatment by low-temperature drying, 0.6 ha (1.5 acres) for treatment by vitrification, and 0.8 ha (2 acres) for treatment by cementation.

The proposed facility site and storage areas have been designated for industrial land use. The construction, operation, and D&D of the treatment facility, and the construction of waste storage facilities, would require no change to the overall land use classification for the area.

The proposed site is isolated from ORNL's main plant area and not visible to the general public; however, 2 to 2.8 ha (5 to 7 acres) of forested land would be cleared for the waste treatment facility, and an additional 0.3 to 0.8 ha (0.75 to 2 acres) of land would be required for the construction of waste storage facilities, thus impacting the scenic resources in the immediate area. The waste treatment facility would be visible to workers at the site and to personnel traveling the High Flux Isotope Reactor access road during construction, operation, and D&D activities. The waste storage facilities would continue to be visible to workers in the area for an indefinite period of time.

4.1.7 Land Use Impacts Summary

There would be no change in land use with the implementation of the No Action Alternative. By comparison, approximately 2 to 2.8 ha (5 to 7 acres) of currently forested land would be developed for a waste treatment facility if any of the alternatives that include waste treatment are implemented. An additional 0.2 to 0.8 ha (0.5 to 2 acres) of land would be required for the construction of waste storage facilities if the Treatment and Waste Storage at ORNL Alternative is implemented.

There would be no change in the current land use classification resulting from the implementation of any of the alternatives; the land, currently classified as industrial, would remain industrial.

The No Action Alternative would result in no change to the existing scenic resources. If a treatment alternative is chosen, the scenic resources of the area would be impacted by the clearing of the currently forested land.

4.2 CULTURAL AND HISTORIC RESOURCES

This section discusses potential impacts to the cultural or historic resources in the area, which includes the Jenkins Site and the Jones Site described in Chapter 3, Section 3.2. The Jenkins Site, located east of the proposed TRU Waste Treatment Facility site, is a pre-1942 homestead site consisting of a deteriorated house and outbuilding (Figure 3-1). A late 1980s evaluation of its eligibility for listing as a historic place by the University of Tennessee concluded that the site was not eligible for listing on the National Register of Historic Places (ORNL 1989). The Jones Site, located east of the proposed TRU Waste Treatment Facility site, dates from 1820 and was recommended for inclusion on the National Historic Register (DOE 1989). DOE consulted with the Tennessee State Historic Preservation Officer under the provisions of the National Historic Preservation Act regarding any potential adverse consequences associated with the proposed action and the alternatives. The Deputy State Historic Preservation Officer concluded that no properties eligible for the National Register of Historic Places would be affected and had no objections to the TRU Waste Treatment Project (Appendix E).

4.2.1 Methodology

Impacts to cultural and historic resources were assessed by determining where activities would occur for each of the alternatives. Potential impacts, such as destruction of resources by bulldozing and other site preparation activities, were identified by determining if sensitive resources were present in the area to be disturbed. This presence/absence of cultural and historic resources is based on several reconnaissance-level (walk-down) surveys conducted from 1988 through 1996 (Faulkner 1988; Duvall, 1992, 1993 and 1996) on and near the sites included in each alternative.

4.2.2 No Action Alternative

No archeological, cultural, or historical resources have been identified immediately next to the Melton Valley Storage Tanks, or the legacy TRU solid waste storage facilities. In addition, the No Action Alternative would have no impact on the historic resources identified in the general area, i.e., the Jones Site and Jenkins Site.

4.2.3 Low-Temperature Drying Alternative

The proposed 2-ha (5-acre) site for a low-temperature drying waste treatment facility has no known archaeological, cultural, or historical resources within or contiguous to its boundaries; thus, no impacts are expected. It is conceivable that surface or subsurface resources may be identified during construction activities, such as the use of heavy equipment for land clearing, grading, and other construction-related work. Appropriate measures such as avoidance, where possible, or data recovery operations, including detailed recording of surface features and/or archaeological excavation, would be implemented to mitigate any identified effects on these resources. The Low-Temperature Drying Alternative would not impact the Jones and Jenkins Sites.

4.2.4 Vitrification Alternative

The proposed 2.8-ha (7-acre) site for a vitrification waste treatment facility has no known archaeological, cultural, or historical resources within or contiguous to its boundaries; thus, no impacts are expected. It is possible that surface or subsurface resources may be identified during construction activities, and appropriate measures such as avoidance, where possible, or data recovery operations, including detailed recording of surface features and/or archaeological excavation, would be implemented to mitigate any identified effects on these resources. The Vitrification Alternative would not impact the Jones and Jenkins Sites.

4.2.5 Cementation Alternative

The proposed 2-ha (5-acre) site for a cementation waste treatment facility has no known archaeological, cultural, or historical resources within or contiguous to its boundaries; thus, no impacts are expected. It is conceivable that surface or subsurface resources may be identified during construction activities, such as the use of heavy equipment for land clearing, grading, and other construction-related work. Appropriate measures such as avoidance, where possible, or data recovery operations, including detailed recording of surface features and/or archaeological excavation, would be implemented to mitigate any identified effects on these resources. The Cementation Alternative would not impact the Jones and Jenkins Sites.

4.2.6 Treatment and Waste Storage at ORNL Alternative

The proposed 2- to 2.8-ha (5- to 7-acre) site for the waste treatment facility, and the 0.2- to 0.8-ha (0.5- to 2-acre) area needed for the waste storage facilities required for the implementation of this alternative have no known archaeological, cultural, or historical resources within or contiguous to its boundaries; thus, no impacts are expected. It is conceivable that surface or subsurface resources may be identified during construction activities, such as the use of heavy equipment for land clearing, grading, and other construction-related work. Appropriate measures such as avoidance, where possible, or data recovery operations, including detailed recording of surface features and/or archaeological excavation, would be implemented to mitigate any identified effects on these resources. The Treatment and Waste Storage at ORNL Alternative would not impact the Jones and Jenkins Sites.

4.2.7 Cultural and Historic Resource Impacts Summary

There are no known archaeological or cultural resources within the area of the proposed site. None of the alternatives would impact any properties registered, or eligible for registration, in the National Register of Historic Places. The alternatives that include waste treatment would take appropriate measures (avoidance, data recovery, etc.) if any surface or subsurface archeological, cultural, or historic resources were detected during construction, operation, or D&D of the proposed treatment facility.

4.3 ECOLOGICAL RESOURCES

This section discusses impacts to the ecological resources of the area, including flora and fauna, that would result from the implementation of each of the alternatives. Field surveys conducted in the summer of 1999 (Appendices C.3 and C.4) indicated that there were no federal or Tennessee state-listed sensitive plant species, aquatic resources, no threatened or endangered animal species identified on the proposed facility site. As a result of these surveys, it is assumed there would be no impacts to sensitive plant species, aquatic resources, or threatened or endangered species associated with the construction of the proposed facility. DOE also consulted with the U.S. Fish and Wildlife Service and the Tennessee Department of Environment and Conservation (Appendix E). There are no aquatic biota within the proposed facility site area.

4.3.1 Methodology

Methods used to determine impacts from the implementation of the proposed action are listed below.

- Quantified changes to the environment, such as the destruction of vegetation and wildlife habitat associated with construction of any facilities.

- Conducted field surveys to determine the presence or absence of sensitive animal (Appendix C.2) and plant species (Appendix C.3), and consulted with appropriate agencies.

- Determined the potential impact of process and sanitary wastewater discharges to the area's biota. The effects to biota from fugitive dust are discussed in Section 4.5 and other air emissions in Section 4.7.

- Qualitatively discussed changes to the environment due to human activities, such as traffic and noise.

4.3.2 No Action Alternative

The implementation of the No Action Alternative would include long-term continued storage of TRU wastes in their present locations and would not result in the clearing of any land, nor loss of habitat. The No Action Alternative would continue to impact terrestrial plant, animal, and aquatic species in the SWSA 5 North trench area, as the site would continue to exist in the present state. TRU and alpha low-level wastes currently stored in the below-grade trenches at SWSA 5 North are a source of radionuclide contamination to soils, groundwater, surface water, and the biota. This contamination source would continue if this alternative were implemented.

4.3.3 Low-Temperature Drying Alternative

The clearing of trees and vegetation in preparation of the 2-ha (5-acre) site for facility construction would impact the area habitats. The habitat is young to mid-successional forest. The area of proposed disturbance is small in relation to the surrounding similar habitat, 2 ha (5 acres) in comparison to 14,569 ha (36,000 acres) included in the ORR; therefore, impacts on terrestrial plant and animal species habitat are expected to be small. The most affected animal species are small vertebrates such as mice and amphibians, which have home ranges less than 2 ha (5 acres); thus, clearing this land would result in complete loss of their habitat.

There are no aquatic biota within the proposed facility site. The proposed low-temperature drying facility would not treat or release wastewater; thus, there would be no impact to the area's aquatic biota from wastewater discharges. In addition, treatment of the waste in the SWSA 5 North trenches would positively impact terrestrial and aquatic biota in this area when the contamination sources from these trenches is removed.

In addition to the loss of habitat, construction noise and increased area activity would cause temporary displacement of local wildlife populations. These wildlife populations are expected to return once activities are completed at the proposed site. Estimated impacts outside of the fenced facility area are expected to be minimal because of restricted employee access and limited anticipated activities outside the defined facility area. Impacts resulting from increased vehicular traffic could be represented by small animal displacement, instances of road kills, and a shift in vegetation composition to more disturbance-tolerant species. These impacts would be primarily associated with increased vehicular traffic on the High Flux Isotope Reactor access road.

Impacts resulting from the D&D of the facility would be very similar, although less intense, to the early clearing, construction, and operation of the proposed treatment facility. Site cleanup, breakdown of equipment, dismantling of the facility, and final waste transportation out of the area are activities that would be expected during the D&D project phase. After completion of the D&D activities, the site would be revegetated, in order to reestablish animal and plant species.

4.3.4 Vitrification Alternative

The clearing of trees and vegetation in preparation of the 2.8-ha (7-acre) site for facility construction would impact area habitats. The construction, operation, and D&D of the proposed treatment facility, and increased human presence, would also result in impacts from the implementation of this alternative. These anticipated impacts would be similar to the impacts discussed for the Low-Temperature Drying Alternative. An additional 0.8 ha (2 acres) of land would be disturbed, since this alternative requires a slightly larger facility area than the other alternatives.

Because the facility would not treat or release process or sanitary wastewater, the aquatic biota would not be impacted by wastewater discharges. Steam may be a byproduct of the vitrification process but, due to placement of engineering controls within the treatment system, harmful contaminants should be extracted from the steam; thus, there are no anticipated impacts from temperature changes in the surrounding area due to the release of steam or heat from the facility. Correct implementation of treatment procedures would not result in any additional measurable impacts to terrestrial flora or fauna of the area. The treatment of the waste in the SWSA 5 North trenches would positively impact terrestrial and aquatic biota in this area when the contamination sources from the trenches is removed. Air emissions such as fugitive dust are discussed in Section 4.5.

Following closure and D&D of the vitrification facility, the site would be revegetated in order to reestablish animal and plant species.

4.3.5 Cementation Alternative

The clearing of trees and vegetation in preparation of the 2-ha (5-acres) site for facility construction would impact the area habitats. The anticipated impacts resulting from the implementation of the Cementation Alternative would include impacts associated with clearing of the proposed site, construction of the treatment facility, and increased human presence, which are similar to those impacts discussed for the Low-Temperature Drying Alternative.

The Cementation Alternative would not treat or release process or sanitary wastewater, and no waste discharge resulting from waste treatment is expected; thus, aquatic biota would not be impacted from wastewater discharge. The treatment of the waste in the SWSA 5 North trenches would positively impact terrestrial and aquatic biota in this area when the contamination sources from the trenches is removed. Air emissions such as fugitive dust are discussed in Section 4.5.

Following closure and D&D of the cementation facility, the site would be revegetated in order to reestablish animal and plant species.

4.3.6 Treatment and Waste Storage at ORNL Alternative

The impacts resulting from implementation of this alternative are associated with clearing the proposed site, construction of the proposed treatment facility and waste storage units, and increased human presence, as discussed previously for the three alternatives that involve waste treatment (low-temperature drying, vitrification, and cementation). A total of 0.3 to 0.8 ha (0.75 to 2 acres) of habitat would be lost due to the construction of the additional and waste storage facilities. These new facilities would be located adjacent to the Melton Valley Storage Tanks storage area (see Figure 2-4) and at SWSA 5 North.

The additional waste storage facilities would be required for the treated wastes, because under this alternative the treated wastes would continue to be stored at ORNL rather than shipped to an off-site disposal facility. It is assumed for analyses purposes that the existing storage facilities for contact-handled and remote-handled TRU waste would be the storage location of some of the treated wastes; however, additional land would be required for the construction of waste storage facilities, the size of which is dependent on the type of treatment selected. An additional 0.3 ha (0.75 acre) of land would be required for the Low-Temperature Drying Alternative, and 0.6 ha (1.5 acres) would be required for the Vitrification Alternative. The Cementation Alternative would require an additional 0.8 ha (2.0 acres) of land for waste storage. This land is relatively low-quality habitat consisting of cleared industrial areas for the existing waste storage facilities or wooded areas adjacent to the existing cleared storage sites. This habitat would be permanently lost to the flora and fauna that currently use it.

4.3.7 Ecological Impacts Summary

Impacts to terrestrial and aquatic biota due to the continued storage of TRU and alpha low-level wastes in the below-grade trenches in SWSA 5 North would continue under the No Action Alternative. The four action alternatives would result in this waste being treated and the primary source of contamination in SWSA 5 North would be removed.

The No Action Alternative would not involve the clearing of any land or loss of habitat. Alternatives that include waste treatment would involve the construction of a single, compact process building affecting approximately 2 to 2.8 ha (5 to 7 acres) of young to mid-successional forested habitat, depending on the treatment selected. The Treatment and Waste Storage at ORNL Alternative would require an additional 0.3 to 0.8 ha of land (0.75 to 2 acres) for the construction of storage facilities needed to implement this alternative. Some construction-related wildlife displacement would be likely, and there is a potential for an increase in road kill during the construction, operations, and D&D activities.

There have been no sensitive plant species, either federal or state listed, identified to occur exclusively in the proposed site area. Therefore, the land clearing and increased area activity that would result from implementation of the four alternatives that include waste treatment would not result in the loss of compatible habitat for any listed plant species. No threatened or endangered species, either state or federal, were identified at the proposed site during a survey conducted in the summer of 1999. No impacts to threatened and endangered species or aquatic biota are expected from the implementation of any of the treatment alternatives.

4.4 GEOLOGY AND SEISMICITY IMPACTS

The potential impacts to geology and seismicity were analyzed for each alternative for the proposed TRU Waste Treatment Facility.

4.4.1 Methodology

Methods used to determine the environmental impacts for each alternative are listed below.

- Identified activities that could affect near-surface geology (pile driving, blasting, etc.) or deep geology.
- Identified major load-bearing structures that could potentially affect geologic faults.
- Identified the seismic zone for the proposed facility location and required building requirements.
- Quantified the amount of soil disturbed.

4.4.2 No Action Alternative

There would be no construction under the No Action Alternative; therefore, no soils would be disturbed. However, impacts from the ongoing release of contaminants into soils would continue.

The waste stored in the SWSA 5 North trenches would continue to be a source of primary contamination to soils and secondary contamination to soils and groundwater in the SWSA 5 North area. Approximately 14,000 curies of radiation is estimated in the waste contained in these trenches.

The TRU and alpha low-level waste contained in the trenches is stored in 4-inch-thick concrete casks, or a combination of wood and metal boxes. Radioactive contaminants have been identified in the soil and groundwater in SWSA 5 North, and over the 100-year life of this alternative, the waste would continue to impact the soils in this area.

The TRU waste currently stored in the Melton Valley Storage Tanks, and the various storage buildings and bunkers, poses little threat to the site soils or geology. The nature of the sludge and supernate waste currently contained within the Melton Valley Storage Tanks, and the 0.5-inch-thick stainless steel construction of these tanks, suggest a breach in tank integrity is unlikely in the near future. Likewise, the materials stored in the various buildings and bunkers are primarily solids, and although the individual containment vessels (drums, rolloff boxes, etc.) lack the overall integrity of the Melton Valley Storage Tanks, a release is not expected.

The No Action Alternative would not affect geologic faults or regional seismicity, as there would be no construction.

4.4.3 Low-Temperature Drying Alternative

The activities associated with the Low-Temperature Drying Alternative proposed facility construction, operation, or D&D activities would be expected to have a small impact on the immediate site area geology and soils. No blasting or pile driving are expected to be required. The proposed facility has been designed to take advantage of the existing topography contours of the site, in order to minimize the amount of cut and fill (less than 22,937 m^3 or 30,000 yd^3) during construction of the proposed facility, based on the facility design discussed in Chapter 2.

No significant removal or addition to the indigenous soils from the site is expected; however, 2 ha (5 acres) would be graded and the soils disturbed during construction of the low-temperature drying waste treatment facility. Further, the removal of the TRU waste from the SWSA 5 North trenches would beneficially impact the area by removing the primary source of contamination to the soils.

Upon competition of the facility D&D activities, the original site contours would be largely restored. The impacts from erosion and other undesirable downhill or downstream effects of storm water runoff are expected to be negligible due to the proposed site layout plan, including passive diversion and hold-up features (see Section 4.5.1.3 for a discussion of soil erosion and dust control). Essentially no change would be made to the current storm water flows, directions, or collection points beyond the boundaries of the facility due to soil disturbance.

The Low-Temperature Drying Alternative would not affect geologic faults or regional seismicity. The proposed facility for the Low-Temperature Drying Alternative is located in Seismic Zone 2, and would be designed with consideration to the Uniform Building Code (UBC) requirements of Seismic Zone 2 facilities. The low-temperature drying waste treatment facility has a projected life of 11 years, and would be designated as a non-reactor nuclear facility as defined in DOE Order 5480.23, which dictates two containment barriers to the release of contamination during waste treatment operations and shielding/confinement for worker protection and contamination control. The facility would be compact, cubic in dimensions, and heavily shielded, all of which facilitate meeting the required standards.

4.4.4 Vitrification Alternative

The activities associated with the vitrification facility construction, operation, or D&D activities would be expected to have a small impact on immediate site geology and soils. No blasting or driving would be required; therefore, on-site activities should not impact the local subsurface materials. However, 2.8 ha (7 acres) would be graded and the soils disturbed during construction of the vitrification waste treatment facility. Erosion impacts are expected to be negligible and are discussed further in Section 4.5.1.4.

The Vitrification Alternative would not affect geologic faults or regional seismicity. Since the proposed facility for the Vitrification Alternative is located in Seismic Zone 2, it would be designed with consideration to the UBC requirements of Seismic Zone 2 facilities. The facility would be designated as a non-reactor nuclear facility as defined in DOE Order 5480.23, which dictates two containment barriers to the release of contamination during waste treatment operations and shielding/confinement for worker protection and contamination control. The facility would be compact, cubic in dimensions, and heavily shielded, all of which facilitate meeting the required standards.

The removal of the TRU waste from the SWSA 5 North trenches would beneficially impact the area by removing the primary source of contamination to the soils. Following completion of the scheduled project D&D activities, the site contours would be largely returned to preexisting conditions.

4.4.5 Cementation Alternative

The activities associated with the cementation facility construction, operation, or D&D activities would be expected to have a small impact on the immediate site geology and soils. No blasting or pile driving would be required; therefore, on-site activities should not impact the local subsurface materials. However, 2 ha (5 acres) would be graded and the soils disturbed during construction of the cementation waste treatment facility. No significant removal or addition to the indigenous soils from the site is expected.

The Cementation Alternative would not affect geologic faults or regional seismicity. The proposed facility would be located in Seismic Zone 2, and designed with consideration to the UBC requirements of Seismic Zone 2 facilities. The facility would be designated as a non-reactor nuclear facility as defined in DOE Order 5480.23, which dictates two containment barriers to the release of contamination during waste treatment operations and shielding/confinement for worker protection and contamination control. The facility would be compact, cubic in dimensions, and heavily shielded, all of which facilitate meeting the required standards.

Impacts from erosion and other undesirable downhill or downstream effects of storm water runoff are expected to be negligible due to the proposed site layout plan (see further discussion in Section 4.5.1.5). The removal of the TRU waste from the SWSA 5 North trenches would beneficially impact the area by removing the primary source of contamination to the soils. Following completion of the scheduled project D&D activities, the site contours would be largely returned to preexisting conditions.

4.4.6 Treatment and Waste Storage at ORNL Alternative

Small impacts to site geology and soils would be expected with the implementation of the Treatment and Waste Storage at ORNL Alternative. This alternative would involve treatment by low-temperature drying, vitrification, or cementation. These impacts are discussed in the previous sections. Following treatment, the waste would be stored onsite at ORNL in the existing storage facilities for contact-handled and remote-handled TRU waste or new waste storage facilities as required to handle the volume of treated wastes. The new waste storage facilities would require an additional 0.3 to 0.8 ha (0.75 to 2 acres) of land depending on the selected treatment method.

4.4.7 Geology and Seismicity Impacts Summary

None of the alternatives would impact deep or near-surface geology because there would be no blasting or pile driving involved with any of the alternatives. None of the alternatives would impact the regional seismicity. Under the No Action Alternative the waste in the trenches in SWSA 5 North would continue to release radiological contamination to the soils in these unlined trenches. The four action alternatives would treat the waste that is the primary source of soil contamination in the SWSA 5 North area, but some contaminated soils would likely remain in place until addressed under a CERCLA action. Each alternative that includes waste treatment would disturb soils due to construction and demolition activities; however, the impacts are expected to be small because no significant removal or addition of indigenous soils from the site is expected and the proposed facility would take advantage of site contours. By comparison, no soil disturbance would occur with the implementation of the No Action Alternative

4.5 WATER AND WATER QUALITY IMPACTS

The impacts to surface water (Section 4.5.1) and groundwater (Section 4.5.2), and wetlands and floodplain resources (Section 4.5.3), were analyzed for all alternatives to the proposed action.

4.5.1 Surface Water Impacts

This section discusses the environmental impacts to the proposed area’s surface water resources. Impacts from the construction, operation, and D&D phases of the proposed facilities are discussed, as applicable, for each alternative. Water use is evaluated in the Utility Requirements Impacts, Section 4.9.

4.5.1.1 Surface water impacts methodology

Methods used to determine potential impacts to surface water for each alternative are listed below.

- Determined changes in surface water quality due to runoff or contamination releases.
- Estimated potential sediment loading using the Revised Universal Soil Loss Equation (Toy and Foster 1998).
- Described storm water control and monitoring measures.
- Calculated the amount of sanitary wastewater and process wastewater volumes and compared these volumes to the capacity of the existing wastewater systems expected to process these waste waters.

4.5.1.2 No Action Alternative

Currently, the SWSA 5 North trenches and nearby areas in this watershed sub-basin release 6% of the total measured strontium-90 and 3.6% of the total measured cesium-137 to the surface waters of the Melton Valley Watershed, which is part of the White Oak Creek Watershed [*Remedial Investigation Report on the Melton Valley Watershed at Oak Ridge National Laboratory, Oak Ridge Tennessee, Volume 1*, DOE/OR/02-1546/V1&D2 (DOE 1997a)]. The No Action Alternative would continue to impact the surface waters of White Oak Creek due to the continued storage of the waste in the SWSA 5 North trenches, which contain 14,000 curies of radiation.

Continued storage of the wastes in the Melton Valley Storage Tanks is not expected to result in a release to the surface waters in Melton Branch, White Oak Creek, White Oak Lake, and the unnamed tributary west of the Melton Valley Storage Tanks under normal operations. The existing sludge and supernate inventories are stored in corrosion-resistant 304 SS tanks that have secondary containment provided by 304 SS-lined concrete vaults. The Melton Valley Storage Tanks undergo annual integrity assessments, which are required by RCRA, and must maintain their release detection monitoring capabilities. Results of these annual assessments continue to demonstrate that the Melton Valley Storage Tanks are not releasing hazardous constituents or radionuclides to the environment.

In addition, the No Action Alternative would not generate wastewater. Any wastewater that results from spill clean-ups in the vaults would be managed as mixed wastes, or bottled and transported to the low-level waste evaporator at ORNL. Storm water runoff from the Melton Valley Storage Tanks area would continue to be collected in open channels and storm water culverts and diverted to Melton Branch.

4.5.1.3 Low-Temperature Drying Alternative

Impacts to White Oak Creek, Melton Branch, and White Oak Lake during the construction period are expected to be negligible because soil erosion and dust control measures would be implemented (silt fences, etc.). However, if soil erosion and fugitive dust were not controlled during the construction period, surface water quality would be impacted from increased siltation and turbidity. Soil erosion rates are based on the general climatic conditions for eastern Tennessee, the soil types, the length and slope of the construction cut, and the amount of time the soil would be exposed. The Revised Universal Soil Loss Equation (Toy and Foster 1998) estimates approximately 405 metric tonnes/ha/year (181 tons/acre/year) of soil loss in the absence of controls (Appendix F.1 contains the detailed calculations and assumptions used for these data). Normal soil loss for unexposed but similar soils would be at a rate of approximately 6.7 metric tonnes/ha/year (3 tons/acre/year) (Moneymaker 1981).

For instance, the clearing of approximately 2 ha (5 acres), and digging the foundation for the low-temperature drying waste treatment facility, could potentially result in soil erosion from wind and especially precipitation runoff.

The unnamed tributary to White Oak Creek that flows along the eastern edge of the proposed facility boundary would likely experience some increased siltation during construction in order to route this tributary through a culvert. Impacts should be minor because the tributary is small with very little actual flow. Soil erosion, especially during rain events, could be deposited onto the floodplains for Melton Branch and White Oak Creek, causing increased short-term siltation and turbidity in the streams and White Oak Lake.

Impacts to Melton Branch, White Oak Creek, and White Oak Lake resulting from the operation of a low-temperature drying waste treatment facility are expected to be negligible for the reasons described below. During operations, the facility would not treat process and sanitary wastewater onsite and no wastewater would be released to surface waters. Sanitary wastewater would be contained and transported offsite by vendors for disposal at an NPDES-permitted wastewater treatment plant. Any excess water that may be generated from the facility would be collected, contained, and transported offsite by vendors for treatment and/or disposal at an appropriate permitted facility. The total amount of sanitary wastewater that would be generated for this alternative is estimated to be 1,560 m^3 (412,000 gallons) (Roy 1999). NPDES-permitted wastewater treatment plants that potentially could be used to treat this wastewater include plants located on the ORR (ORNL, Y-12, or ETTP), or those located offsite such as the city of Oak Ridge or the Kingston wastewater treatment plants. These wastewater treatment plants have capacities to treat sanitary wastewater that range from 681,000 m^3/day [180,000,000 gallons per day (gpd)] at the ORNL plant, to 22,200 m^3/day (5,870,000 gpd) at the city of Oak Ridge plant. All of these wastewater treatment plants are operating below their design capacities, so the impact of this additional waste stream from the low-temperature drying waste treatment facility would be negligible to the sanitary wastewater systems.

The treatment of the wastes removed from the SWSA 5 North trenches would have a positive impact on the surface waters of the Melton Valley and White Oak Creek Watersheds by reducing the amount of radionuclides that could be released to the surface waters.

During facility operations, storm water would be controlled and monitored according to the requirements of the facility's storm water permit to minimize any potential impacts. For example, storm water runoff originating outside the facility boundary would be directed either beneath or around the site (Section 2.4.1). Both off-site and on-site storm water would be managed, so the volumes, rate of flow, direction, or final destination of these flows would not significantly be changed. The facilities' paved areas and parking lots would generally drain west to a detention basin, and the basin outlet would drain through a gate valve to a drainage ditch along the main access road to the facility and eventually cross to the north via an existing culvert under the road. The facility roof and eastern edge of the facility's paved area would drain east to a catch basin that is also equipped with a gate valve. This flow would be directed through a culvert under the High Flux Isotope Reactor access road to an existing drainage area located on the north side of this road. The storm water flow from this ditch would eventually reach White Oak Creek. Although the storm water falling on the site would travel more quickly to the retention ditches and areas, the design and hold-up capacity for the retention ditches and areas would result in a rate and location of discharge that is comparable to the pre-development characteristics. In the unlikely event of an outdoor spill or leak of hazardous materials, the gate valves would be closed to contain the event during its cleanup. Storm water drainage off the Melton Valley Storage Tanks vault roof would be captured and diverted to an eastern, gated drainage culvert to be installed for the proposed facility.

The impacts to surface water from D&D activities of the proposed facility are expected to be negligible, and generally similar to those discussed for construction and operation activities. No discharges of wastewater would take place during the facility's D&D activities. Mitigation measures to control soil erosion and fugitive dust during D&D activities would be used to minimize the transport of soil to surface water.

4.5.1.4 Vitrification Alternative

The impacts to White Oak Creek, Melton Branch, and White Oak Lake during the construction phase are expected to be negligible because soil erosion and fugitive dust control measures would be implemented (described in Section 4.5.1.3). In the absence of such controls, potential construction-related soil loss is estimated at a rate of 405 metric tonnes/ha/year (181 tons/acre/year) (Appendix F.1), and the impacts would be similar to those described in Section 4.5.1.3.

The impacts to Melton Branch, White Oak Creek, and White Oak Lake from the 3-year operations of the proposed facility are also expected to be negligible. No sanitary wastewater or process wastewater would be discharged directly to the environment. The amount of sanitary wastewater generated over the life of the vitrification facility would be 6,283 m^3 (1.66 million gallons). There is a slightly higher probability that contaminants could be released into the environment because of additional treatment of process wastewater for this alternative. Process wastewater would be recycled to the extent possible, but occasional "bleeding" of excess water in the system would be required. The process wastewater that is occasionally drawn off the system would be sent to an evaporator, with the condensate sent to a wastewater treatment facility for discharge into an NPDES-approved outfall. The extra step of sending excess process wastewater to the evaporator slightly increases the risk of releasing contaminants to the environment. The condensate would meet applicable NPDES permit limits, and should not have any adverse impacts to surface water. The concentrate left in the evaporator would be mixed with grout binders to form a stabilized waste form that would have no impacts to the surface water quality.

The removal of the wastes from the SWSA 5 North trenches would have a positive impact on the surface waters of the Melton Valley and White Oak Creek Watersheds by reducing the amount of radionuclides that could be released to the surface waters.

Storm water would be managed similar to the methods discussed previously for the Low-Temperature Drying Alternative. The impacts of treating the additional wastewaters at the chosen wastewater treatment plant should be negligible for the same reasons discussed for the Low-Temperature Drying Alternative.

The impacts to surface water from D&D activities for the Vitrification Alternative are expected to be negligible and generally similar to those discussed for construction and operation phase activities. No discharges of wastewater would take place during the D&D phase, and overall impacts to surface water during the approximate 2-year D&D phase should be negligible.

4.5.1.5 Cementation Alternative

Impacts to the surface waters of White Oak Creek, Melton Branch, and White Oak Lake during the construction phase are expected to be negligible because soil erosion and dust control measures would be implemented as described in Section 4.5.1.3. In the absence of such controls, soil loss at a rate of approximately 405 metric tonnes/ha/year (181 tons/acre/year) (Appendix F.1) could be expected, and the impacts would be similar to those described in Section 4.5.1.3.

The impacts to Melton Branch, White Oak Creek, and White Oak Lake associated with facility operations are also expected to be negligible. The proposed facility would not release process and sanitary wastewater, and no sanitary water or process wastewater would be discharged directly to the environment. The total amount of sanitary wastewater generated over the life of the cementation facility would be 5,020 m^3 (1.23 million gallons). The impacts of treating the additional wastewater at area wastewater treatment plants should be negligible for the same reasons discussed for the Low-Temperature Drying Alternative. Storm water would be managed similar to the methods Low-Temperature Drying Alternative.

The removal of the wastes from the SWSA 5 North trenches would have a positive impact on the surface waters of the Melton Valley and White Oak Creek Watersheds by reducing the amount of radionuclides that could be released to the surface waters of the area.

The impacts to surface water from D&D activities are expected to be negligible and generally similar to those discussed for construction and operations phase activities. No discharges of wastewater would take place during the D&D phase, and overall impacts to surface water during the D&D activities should be negligible.

4.5.1.6 Treatment and Waste Storage at ORNL Alternative

Impacts to White Oak Creek, Melton Branch, and White Oak Lake from the construction of waste treatment and storage facilities required for this alternative are expected to be negligible because soil erosion and dust control measures would be implemented during the construction of these facilities. In the absence of effective soil erosion controls, soil loss would be at a rate of 405 metric tonnes/ha/year (181 tons/acre/year) for this alternative (Appendix F.1), which would result in similar impacts to those described in Section 4.5.1.3.

The impacts to Melton Branch, White Oak Creek, and White Oak Lake during the facility operations of the waste treatment and storage facilities are also expected to be negligible. No sanitary wastewater or process wastewater would be discharged directly to the environment, with the exception of the vitrification treatment process wastewater, as discussed in Section 4.5.1.4. The impact of treating the additional waste at area wastewater treatment plants should be negligible for the reasons stated for the Low-Temperature Drying Alternative. Storm water would be managed as discussed for each of the previous treatment alternatives.

The indefinite storage of the TRU, remote-handled low-level, low-level, and mixed waste residuals in the new and existing waste storage facilities at ORNL should have no adverse impacts to the surface water because the wastes would be contained. The treatment of wastes removed from the SWSA 5 North trenches would have a positive impact on the surface waters of the Melton Valley and White Oak Creek Watersheds by reducing the amount of radionuclides released to surface water.

The impacts to surface water from D&D activities are expected to be negligible and generally similar to those discussed for construction and operations phase activities. No discharges of wastewater would take place during the D&D phase. Thus, overall impacts to surface water during D&D activities should be negligible.

4.5.1.7 Summary of Surface Water Impacts

The surface waters of the Melton Valley watershed would continue to be negatively impacted with the implementation of the No Action Alternative. Currently, the trenches in SWSA 5 North account for 6% of the strontium-90 and 3.6% of the cesium-137 in the surface waters measured at White Oak Dam for the Melton Valley Watershed (ORNL et al. 1997). The No Action Alternative would not involve any waste treatment, and the continued release of contaminants in the SWSA 5 North trenches would be a continuing source of contamination to the surface waters of the Melton Valley and White Oak Creek Watersheds. By comparison the treatment alternatives would treat the primary source of contamination that impact the surface waters of the Melton Valley Watershed. Facility operation impacts to surface water quality would be negligible for any of the treatment alternatives. Wastewater would not be treated onsite under the Low-Temperature Drying and Cementation Alternatives. The process wastewater from the vitrification facility would be occasionally drawn off the system and sent to an evaporator, with the condensate sent to a wastewater treatment facility for discharge into an NPDES-approved outfall. The extra step of sending excess process wastewater to the evaporator slightly increases the risk of releasing contaminants to the environment. Some construction-related erosion and storm water runoff would occur, but it is expected to be a minor influence on White Oak Creek and White Oak Lake.

4.5.2 Groundwater Impacts

This section discusses the environmental impacts to the area's groundwater resources. None of the alternatives would use groundwater as a direct source of water; therefore, impacts to groundwater quality from usage were not evaluated. Water usage is discussed in Section 4.9.

4.5.2.1 Methodology

Methods used to analyze the impacts to groundwater conditions are listed below.

- Identifying pathways through which groundwater contamination could occur.
- Quantitatively describe the types and levels of existing groundwater contamination.

4.5.2.2 No Action Alternative

Under the No Action Alternative waste storage in the unlined trenches at SWSA 5 North would continue. The trenches have infiltration and seasonal inundation of groundwater, and have a "bathtubbing" effect intermittently throughout the year. These trenches are a source of contamination to groundwater and would continue to impact the groundwater in the Melton Valley and White Oak Creek Watersheds. The volume of contaminated groundwater is estimated to be approximately 1.3E+05 ft^3. Well samples in the area indicate elevated levels of americium-241 and curium-244 ranging up to 5,940 pCi/L [*Remedial Investigation Report on the Melton Valley Watershed at Oak Ridge*, *Tennessee* (DOE 1997a)].

Under the No Action Alternative, the TRU waste contained in the Melton Valley Storage Tanks and the various storage buildings and bunkers poses little threat to groundwater. A breach in tank integrity is unlikely in the near future under normal operating conditions, due to the nature of the sludge and supernate waste currently contained within the Melton Valley Storage Tanks and the 0.5-inch-thick 304 SS construction of these tanks. The materials stored in the various buildings and bunkers are primarily solids, and although the individual containment vessels (drums, rolloff boxes, etc.) lack the overall integrity of the Melton Valley Storage Tanks, an impact to groundwater is not expected.

4.5.2.3 Low-Temperature Drying Alternative

No direct groundwater impacts are anticipated from the construction, operation, and D&D activities of a low-temperature drying waste treatment facility, as the only discharge would be storm water runoff. Facility containment systems would keep spills (if they occur) from leaving the facility or site and percolating into the ground. Most loading and unloading of waste materials would be performed in paved areas that are not exposed to the weather or storm water runoff.

Groundwater elevation data obtained from an ORNL monitoring well located almost directly in the center of the proposed treatment facility site indicate that the groundwater is well below the foundation level of the facility. Due to very impervious material (silty clay); however, a potential of perched groundwater exists during wet-weather seasons. Any perched groundwater buildup behind the retaining wall and the south wall of the building would be relieved and diverted to the modified drainage area implemented for this alternative.

In addition, the facility would treat wastes contained in the SWSA 5 North trenches, thereby reducing the primary source of contamination in the SWSA 5 North area. As a result, the operation of this facility would have a beneficial impact on the groundwater of the area.

4.5.2.4 Vitrification Alternative

No direct impacts to groundwater would be expected from the construction, operation, and D&D activities of the vitrification facility, as the only discharge would be storm water runoff. Containment systems incorporated into the facility design would keep spills (if they occur) from leaving the facility or site and percolating into the ground. Most loading and unloading of waste materials would be performed in paved areas that are not exposed to the weather or storm water runoff.

Groundwater elevation data obtained from an ORNL monitoring well located almost directly in the center of the proposed treatment facility site indicate that the groundwater is well below the foundation level of the facility. Due to very impervious material (silty clay); however, a potential of perched groundwater exists during wet-weather seasons. Any perched groundwater buildup would be relieved and diverted to the modified drainage area implemented for this alternative.

In addition, the vitrification facility would treat the wastes contained in the SWSA 5 North trenches and thereby reduce the primary source of contamination in the SWSA 5 North area. As a result, the operation of this facility would have a beneficial impact on the groundwater of the area.

4.5.2.5 Cementation Alternative

No direct impacts to groundwater would be expected as a result from the construction, operation, and D&D activities of a cementation facility, as the only discharge from the facility would be storm water runoff. Containment systems are incorporated into the facility design, which would keep spills (if they occur) from leaving the facility or site and percolating into the ground. Most loading and unloading of waste materials would be performed in paved areas that are not exposed to the weather or storm water runoff.

Groundwater elevation data obtained from an ORNL monitoring well located almost directly in the center of the proposed treatment facility site indicate that the groundwater is well below the foundation level of the facility. Due to very impervious material (silty clay); however, a potential of perched groundwater exists during wet-weather seasons. Any perched groundwater buildup would be relieved and diverted to the modified drainage area implemented for this alternative.

In addition, the cementation facility would treat the waste contained in the SWSA 5 North trenches, thus reducing the primary source of contamination in the SWSA 5 North area. As a result, the operation of this facility would have a beneficial impact on the groundwater of the area.

4.5.2.6 Treatment and Waste Storage at ORNL Alternative

No direct impacts to groundwater would be expected from the construction, operation, and D&D activities of a treatment facility, or the construction and operation of storage facilities under this alternative, as the only discharge would be storm water runoff. Containment systems incorporated into the design for each facility would keep spills, if they occur, from leaving the facility or site and percolating into the ground. Most loading and unloading of waste materials would be performed in paved areas that are not exposed to the weather or storm water runoff.

The existing TRU waste bunkers are partially underground and are constructed in a manner to facilitate potential containment vessel failure. New waste storage facilities required for indefinite storage of the treated waste at ORNL would be constructed in a similar manner, so there would be no impact to the groundwater under normal waste storage conditions. In addition, a waste treatment facility would treat the waste contained in the SWSA 5 North trenches and thereby eliminate the primary source of contamination in the SWSA 5 North area. As a result the operation of a waste treatment facility would have a positive effect on the environment.

4.5.2.7 Summary of Groundwater Impacts

No groundwater would be pumped for any of the alternatives; therefore, there are no groundwater impacts to groundwater quality expected as a result of any alternative. The implementation of the No Action Alternative would result in the continued release of radioactive contaminants from the SWSA 5 North trenches, especially strontium-90, into the near-surface groundwater and eventually into the surface water of White Oak Creek. By comparison, the four action alternatives would remove and treat this waste, eliminating the primary source of groundwater contamination in the SWSA 5 North area.

4.5.3 Wetlands and Floodplains Impacts

This section discusses the environmental consequences and impacts to wetlands and floodplains that would result from the implementation of the alternatives for the proposed action.

4.5.3.1 Methodology

Methods used to analyze the impacts to wetlands and floodplains are listed below.

- Determined whether a floodplain or wetland assessment was needed by:
  - determining the 100-year or 500-year floodplain from Federal Emergency Management Agency (FEMA) maps for the Melton Valley watershed; and
  - identifying and mapping wetlands during a field survey performed in 1999 (Appendix C.1).
  - comparing the locations of wetlands and floodplains with the areas expected to be disturbed by the construction, operations, and D&D activities of the treatment facility;
- Prepared as needed, a floodplain or wetland assessment.
- Evaluated whether stormwater runoff would affect wetlands or floodplains.

4.5.3.2 No Action Alternative

The TRU and alpha low-level waste currently stored in the Melton Valley Storage tanks and the RCRA-permitted storage facilities under the No Action Alternative would not impact the six wetlands

(Figure 4-1) located in the area, nor the Melton Branch and White Oak Creek floodplains. Because essentially no wastes would be released from these facilities, no impacts to the wetlands and floodplains in the area would result from continued normal operations of this facility.

Radionuclide migration from the TRU and alpha low-level wastes stored in the unlined trenches at SWSA 5 North would continue to impact the floodplain in the SWSA 5 North area. The soils around the trenches and White Oak Creek indicated gamma contamination at the surface equal to 50 µrem/hour (DOE 1997a), which would continue to exist in the White Oak Creek floodplain.

4.5.3.3 Low-Temperature Drying Alternative

There would be an impact to Wetland B associated with the implementation of the Low-Temperature Drying Alternative. Wetland B, located on the eastern edge of the project site, would be adversely affected by construction of the proposed facility. Wetland B (Figure 4-1) is a 0.012-ha (0.03-acre) intermittent stream/seep that would be eliminated by construction, since installation of a culvert in this area would effectively drain this wetland. A wetlands assessment for this wetland (Appendix C.6) was performed per 10 *CFR* 1022, and coordination is ongoing with the State of Tennessee regarding possible mitigation for Wetland B.

Impacts to Wetlands D, E, and F (Figure 4-1) should be negligible as long as soil erosion is successfully controlled during construction. However, if soil erosion is not controlled during the construction phase, Wetlands D, E, and F could be adversely impacted temporarily by excessive siltation, which would be detrimental to aquatic biota in the wetlands. Impacts to Wetlands A and C (Figure 4-1) should be negligible because their locations are outside the areas to be cleared for construction and, due to mitigation measures, they would not be affected by siltation.

Under this alternative, there would be no construction in the Melton Branch and White Oak Creek floodplains, and a floodplains assessment per 10 *CFR* 1022 is not required. The construction impacts to the floodplains of Melton Branch and White Oak Creek are expected to be small as long as soil erosion measures are successfully instituted, as described for surface water (Section 4.5.1.3). Some deposition of soil would occur, but the impacts are only likely to be adverse if the soil erosion is unchecked.

Impacts to wetlands and floodplains from the operation and D&D of the proposed treatment facility are expected to be negligible. These impacts would be similar to those discussed for the construction and operation phase activities for surface water in Section 4.5.1.3.

The TRU and alpha low-level wastes stored in the unlined trenches at SWSA 5 North would be removed for treatment in the proposed facility. The removal of this waste would eliminate the primary source of contamination to the White Oak Creek floodplain in the area; however, secondary contamination from the soil and groundwater would continue to impact the White Oak Creek floodplain in the SWSA 5 North area. The soils around the trenches and White Oak Creek indicated gamma contamination at the surface equal to 50 µrem/hour (DOE 1997a), which would continue to exist in the White Oak Creek floodplain. This soil contamination would have to be remediated as a separate CERCLA action.

4.5.3.4 Vitrification Alternative

There would be an impact to Wetland B associated with the implementation of the Vitrification Alternative. Under this alternative, Wetland B (Figure 4-1) would also be eliminated by facility construction, since the installation of a culvert in this area would drain the wetland. A wetlands

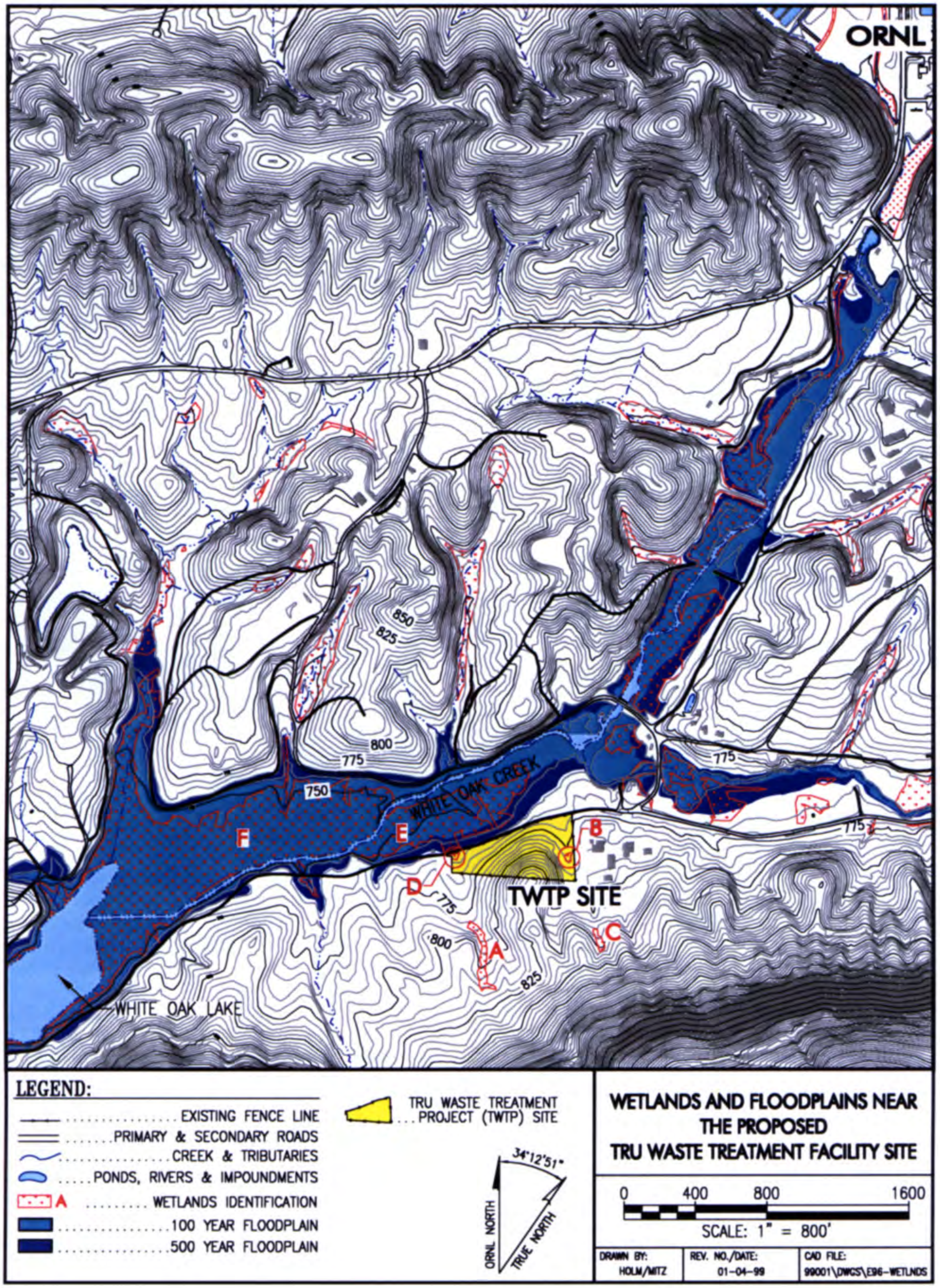

Figure 4-1. Wetlands near the proposed TRU Waste Treatment Facility site.

assessment (Appendix C.6) was performed per 10 *CFR* 1022, and coordination is ongoing with the State of Tennessee regarding possible mitigation for Wetland B. Impacts to Wetlands D, E, and F (Figure 4-1) should be negligible as long as soil erosion is successfully controlled during construction. However, if soil erosion is not controlled during the construction phase, Wetlands D, E, and F could be adversely impacted temporarily by excessive siltation, which would be detrimental to aquatic biota in the wetlands. Impacts to Wetlands A and C (Figure 4-1) should be negligible because their locations are outside the areas to be cleared for construction and, due to mitigation measures, they would not be impacted by excess siltation.

Under this alternative, there would be no construction in the Melton Branch and White Oak Creek floodplains, and a floodplains assessment per 10 *CFR* 1022 is not required. The construction impacts to the floodplains of Melton Branch and White Oak Creek are expected to be small as long as soil erosion measures are successfully instituted, as described for surface water (Section 4.5.1.3). Some deposition of soil would occur, but the impacts to the floodplain would only be adverse if the soil erosion is unchecked.

Impacts to wetlands and floodplains from the operation and D&D activities of the treatment facility are expected to be negligible. These impacts would be similar to those discussed for the construction and operation phase activities for surface water in Section 4.5.1.3.

The TRU and alpha low-level wastes stored in the unlined trenches at SWSA 5 North would be removed for treatment in the proposed facility. The removal of this waste would eliminate the primary source of contamination to the White Oak Creek floodplain in the area; however, secondary contamination from the soil and groundwater would continue to impact the White Oak Creek floodplain in the SWSA 5 North area. The soils around the trenches and White Oak Creek indicated gamma contamination at the surface equal to 50 µrem/hour (DOE 1997a), which would continue to have an impact on the White Oak Creek floodplain. This soil contamination would have to be remediated as a separate CERCLA action.

4.5.3.5 Cementation Alternative

There would be an impact to Wetland B associated with the implementation of the Cementation Alternative, since Wetland B (Figure 4-1) would be eliminated by facility construction. Installation of a culvert in this area would effectively drain this wetland. A wetlands assessment (Appendix C.6) was performed per 10 *CFR* 1022, and coordination is ongoing with the State of Tennessee regarding possible mitigation for Wetland B. Impacts to Wetlands D, E, and F (Figure 4-1) should be negligible as long as soil erosion is successfully controlled during construction. However, if soil erosion is not controlled during the construction phase, Wetlands D, E, and F could be adversely impacted temporarily by excessive siltation. Impacts to Wetlands A and C (Figure 4-1) should be negligible because their locations are outside the areas to be cleared for construction and, due to mitigation measures, they would not be impacted by excess siltation.

Under this alternative, there would be no construction in the Melton Branch and White Oak Creek floodplains, and a floodplains assessment per 10 *CFR* 1022 is not required. The construction impacts to the floodplains of Melton Branch and White Oak Creek are expected to be small as long as soil erosion measures are successfully instituted, as described for surface water (Section 4.5.1.3). Some deposition of soil is likely to occur, but the impacts are only likely to be adverse if the soil erosion is unchecked.

Impacts to wetlands and floodplains from the operations and D&D activities of the treatment facility are expected to be negligible. These impacts would be similar to those discussed for the construction and operations and D&D phase activities for surface water in Section 4.5.1.3.

The TRU and alpha low-level wastes stored in the unlined trenches at SWSA 5 North would be removed for treatment in the proposed facility. The removal of this waste would eliminate the primary source of contamination to the White Oak Creek floodplain in the area; however, secondary contamination from the soil and groundwater would continue to impact the White Oak Creek floodplain in the SWSA 5 North area. The soils around the trenches and White Oak Creek indicated gamma contamination at the surface equal to 50 µrem/hour (DOE 1997a), which would continue to have an impact on the White Oak Creek floodplain. This soil contamination would have to be remediated as a separate CERCLA action.

4.5.3.6 Treatment and Waste Storage at ORNL Alternative

Impacts to floodplains and wetlands would be dependent on the treatment option selected. These impacts, which are discussed in Sections 4.5.3.3, 4.5.3.4, and 4.5.3.5, would include the elimination of Wetland B. The construction of additional waste storage facilities required for the indefinite storage of the treated wastes at ORNL should not impact any wetlands or floodplains. It is assumed that these facilities would be located in the same area as the existing solid waste storage facilities in Melton Valley.

4.5.4 Wetlands and Floodplains Impacts Summary

Under the treatment alternatives, Wetland B (Figure 4-1) would be eliminated due to construction. Installation of a culvert in this area would effectively drain the wetland if any of the treatment alternatives is implemented. A field survey to characterize this and other wetlands (Appendix C.1) was performed per 10 *CFR* 1022.11. In addition, a wetlands assessment for Wetland B (Appendix C.6) was conducted, and coordination is ongoing with the State of Tennessee regarding possible mitigation measures for this wetland.

There would be no construction in floodplains and a floodplains assessment would not be required. The No Action Alternative would continue to impact the White Oak Creek floodplain due to radionuclide migration from the SWSA 5 North trenches.

4.6 WASTE MANAGEMENT AT ORNL

This section discusses the environmental impacts of the alternatives for the waste management operations at ORNL. Under the treatment alternatives, wastes included in the proposed action are:

- 900 m^3 of remote-handled TRU sludge,
- 1,600 m^3 of low-level supernate associated with the TRU sludges,
- 550 m^3 of remote-handled TRU waste/alpha low-level waste, and
- 1,000 m^3 of contact-handled TRU waste/alpha low-level waste.

The sludge and supernate contained in the Melton Valley Storage Tanks, which are highly mobile in the environment if spilled, would be changed to a much more environmentally benign waste form. Solid remote-handled and contact-handled solid wastes, and the wastes contained in the unlined trenches in SWSA 5 North, would be repackaged and compacted for off-site disposal.

Table 4-1 provides a comparison and summary of the estimated volumes of treated waste generated for each waste type for each alternative. Waste volumes were calculated by summing the wastes generated for the various waste categories for each treatment alternative shown in Tables 4-2, 4-3, and 4-4.

Table 4-1. Comparison of waste volumes generated by the alternatives that include waste treatment

Waste type	Low-Temperature Drying Alternative waste volumes (m^3)	Vitrification Alternative waste volumes (m^3)	Cementation Alternative waste volumes (m^3)
TRU	607	1,060	1,793
Remote-handled low-level waste	0	0	2,540
Low-level waste - primary	788	87	0
Low-level waste - secondary/D&D	1,990	4,893	2,833
Low-level waste/mixed - secondary	23	4	3
Sanitary wastes	1,760	7,201	7,437
Construction wastes	5,550	20,760	14,143
Recycle/reuse	115	120	77
TOTAL	10,833	34,128	28,826

m^3 = cubic meters.
D&D = decontamination and decommissioning.

The impacts of disposal of these wastes were evaluated separately (*Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste*, DOE/EIS-0200-F, May 1997, and *Waste Isolation Pilot Plant Disposal Phase Supplemental Environmental Impact Statement*, DOE/EIS-0026-S-2, September 1997).

4.6.1 Methodology

Methods used to analyze the impacts of each alternative are listed below.

- Determined the estimated waste volumes and waste classifications for each alternative (Appendix B)].
- Determined available solid waste storage capacity and calculated additional waste storage needs, as appropriate.

Table 4-2. Summary of projected waste volumes for the Low-Temperature Drying Alternative (the total of each waste category is summarized in Table 4-1)

Waste stream	Category	Projected volume out[a]	Treatment requirement
Primary Waste Streams			
Sludge (RH)	TRU	180 m^3	Dry, stabilize
Supernate/sludge wash water	Low-level waste	588 m^3	Dry, stabilize
CH solids	TRU	324 m^3	Various
RH solids	TRU	99 m^3	Various
Solids	Low-level waste	200 m^3	Various
Secondary Waste Streams			
Primary waste containers			
RH casks	Low-level waste	1,217 m^3	None
CH drums and boxes	Low-level waste	44 m^3	Compaction
Construction debris	Sanitary	~200 m^3	None
PPE (gloves, booties, etc.)	Low-level waste	214 m^3	Compaction
HEPA filters	Low-level waste	88 m^3	Compaction
Consumables (rags, towels, etc.)	Low-level waste	272 m^3	Compaction
Mechanical parts	Low-level waste/TRU	4 m^3	None
Aqueous waste filter media	Low-level waste	<20 m^3	Compaction
Steam from wet processing	N/A	N/A	Condense/HEPA filter
Changing/maintenance fluids	Low-level waste/mixed waste	<1 m^3	Stabilize, if required
Laboratory solvents and residues	Low-level waste/mixed waste/TRU	1 m^3	Thermal, none
Laboratory acid digistatis	Mixed waste	<20 m^3	Neutralize/stabilize
Sanitary wastewater	Sanitary	1,560 m^3	Capture
Decontamination and Decommissioning Waste Streams			
Category C, Concrete rubble	Construction debris	5,510 m^3	None
Category A, Free release materials	Recycle, reuse	115 m^3	None
Category B, Non-contaminated materials	Construction debris	30 m^3	None
Category B, Contaminated materials	Low-level waste	135 m^3	Compaction
Category D, Miscellaneous	Construction debris	<10 m^3	None
Category E, Special materials	Low-level waste/mixed waste	<1 m^3	Stabilize

[a]Volumes are waste product volumes in final disposal containers based on total inventory of waste (base + optional volumes) expected to be processed at the facility.

CH - contact-handled.
HEPA - High-Efficiency Particulate Air.
PPE - personal protective equipment.
RH – remote-handled
TRU - transuranic.
~ - approximately.

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Table 4-3. Summary of projected waste volumes for the Vitrification Alternative (the total of each waste category is summarized in Table 4-1)

Waste stream	Category	Projected Volume Out[a]	Treatment Requirement
Primary Waste Streams			
Sludge/Supernate	TRU	577 m^3	Vitrification
CH solids	TRU	260 m^3	Various
RH solids	TRU	116 m^3	Various
RH solids	Low-level waste	87 m^3	Various
Secondary Waste Streams			
Primary waste containers			
RH casks	Low-level waste	946 m^3	Volume reduction
CH drums and boxes	Low-level waste	44 m^3	Volume reduction
Construction debris	Sanitary	200 m^3	None
PPE (gloves, booties, etc.)[b]	Low-level waste	315 m^3	Volume reduction
HEPA filters[b]	Low-level waste	82 m^3	Volume reduction
Consumables (rags, towels, etc.)[b]	Low-level waste	181 m^3	Volume reduction
Mechanical/maintenance items	Low-level waste/TRU	97 m^3	Volume reduction
Industrial waste water	Low-level waste/ sanitary	1,108 m^3	Capture
Evaporator concentrate	Low-level waste	326 m^3	Cementation
Laboratory solvents and residues	Low-level waste/mixed waste/TRU	2 m^3	Vitrification, stabilization
Sanitary solids	Sanitary	718 m^3	Capture
Sanitary wastewater	Sanitary	6,283 m^3	Capture
Decontamination and Decommissioning Waste Streams			
Concrete rubble	Construction debris	20,712 m^3	None
Free release materials	Recycle, reuse	120 m^3	None
Non-contaminated materials	Construction debris	48 m^3	None
Contaminated materials	Low-level waste	1,894 m^3	Volume reduction
Vitrified and residual material	TRU	10 m^3	None
Special materials	Low-level waste/mixed waste	2 m^3	Stabilize, special treatment

[a]Volumes are waste product volumes in the final disposal containers.
[b]If the waste is determined to be hazardous, the waste would also be macroencapsulated

CH - contact-handled.
HEPA - High-Efficiency Particulate Air.
PPE - personal protective equipment.
RH - remote-handled.
TRU - transuranic.

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Table 4-4. Summary of projected waste volumes for the Cementation Alternative (the total of each waste category is summarized in Table 4-1)

Waste stream	Category	Projected Volume Out[a]	Treatment Requirement
Primary Waste Streams			
Sludge	TRU	1,287 m^3	Cementation
Supernate	RH low-level waste	2,453 m^3	Cementation
CH solids	TRU	260 m^3	Various
RH solids	TRU	116 m^3	Various
RH solids	RH low-level waste	87 m^3	Various
Secondary Waste Streams			
Primary waste containers			
RH casks	Low-level waste	946 m^3	Volume reduction
CH drums and boxes	Low-level waste	36 m^3	Volume reduction
Construction debris	Sanitary	200 m^3	None
PPE (gloves, booties, etc.)[b]	Low-level waste	384 m^3	Volume reduction
HEPA filters [b]	Low-level waste	83 m^3	Volume reduction
Consumables (rags, towels, etc.) [b]	Low-level waste	257 m^3	Volume reduction
Mechanical/maintenance items	Low-level waste/TRU	130 m^3	Volume reduction
Laboratory solvents and residues	Low-level waste/ mixed waste/TRU	2 m^3	Vitrification, stabilization
Sanitary solids	Sanitary	2,217 m^3	Capture
Sanitary wastewater	Sanitary	5,020 m^3	Capture
Decontamination and Decommissioning Waste Streams			
Concrete rubble	Construction debris	14,111 m^3	None
Free release materials	Recycle, reuse	77 m^3	None
Non-contaminated materials	Construction debris	32 m^3	None
Contaminated materials	Low-level waste	1,127 m^3	Volume reduction
Special materials	Low-level waste/ mixed waste	1 m^3	Stabilize, special treatment

[a]Volumes are waste product volumes in the final disposal containers.
[b]If the waste is determined to be hazardous, the waste would also be macroencapsulated

CH - contact-handled.
HEPA - High-Efficiency Particulate Air.
PPE - personal protective equipment.
RH - remote-handled.
TRU - transuranic.

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4.6.2 No Action Alternative

The No Action Alternative assumes institutional control of the wastes defined in the proposed action for 100 years, during which surveillance, maintenance, and tracking activities would be required for the wastes. Under the No Action Alternative, legacy sludge and supernate would continue to be stored in the Melton Valley Storage Tanks. Remote-handled and contact-handled TRU solid wastes would continue to be stored in the existing solid waste storage facilities for TRU waste.

- Buildings 7855 and 7883 are bunkers, which would continue to store remote-handled TRU waste. Building 7855 is at capacity, with 157.2 m^3 (5552 ft^3) of remote-handled TRU waste in storage. Building 7883 currently stores 10.7 m^3 (377 ft^3) of remote-handled TRU solids and has an available storage capacity of 146.7 m^3 (5179 ft^3) ;

- Buildings 7572, 7574, 7842, 7878, and 7879 are metal buildings that would continue to store contact-handled TRU waste. These storage buildings currently store over 906 m^3 (32,000 ft^3) of contact-handled TRU wastes. Building 7842 is at capacity, but the other buildings have a combined available storage capacity of 722 m^3 about (25,500 ft^3) for contact-handled TRU wastes.

- The below-grade concrete cells in SWSA 5 North (Buildings 7826 and 7834) currently store about 68 m^3 (2,400 ft^3) of remote-handled TRU and contact-handled TRU wastes, but are not RCRA permitted. This waste is scheduled to be moved to the appropriate existing storage facilities described above as a legacy waste action under CERCLA in Fiscal Year 2000, reducing the amount of available storage space in these facilities.

- Solid TRU waste would continue to be buried in 27 trenches and 8 auger holes used for the retrievable storage of TRU waste in SWSA 5 North.

Removal, treatment, and disposal of the retrievable TRU waste from portions of SWSA 5 North is considered a major component of the selected remedy for the Melton Valley Watershed at ORNL according to the Draft Record of Decision for the Melton Valley Watershed (*Record of Decision for the Melton Valley Watershed at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-1826&D1). In addition, two Interim Records of Decision (issued in connection with the FFA among EPA, TDEC, and DOE under CERCLA) require the TRU waste from the Gunite and Associated Tanks Remediation Project (DOE 1997b) and the Old Hydrofracture Facility Tanks Remediation Project (DOE 1997c) to be treated and disposed of along with the TRU waste from the Melton Valley Storage Tanks. This tank waste is included in the total waste volume slated for treatment in the TRU Waste Treatment Project. If the No Action Alternative were implemented, these two Interim Records of Decision for the ORNL tanks, the Draft Record of Decision for the Melton Valley Watershed, and potentially the upcoming Draft Record of Decision for the Bethel Valley Watershed at ORNL could be affected, and would require amendments and renegotiations with stakeholders and the appropriate regulatory agencies.

There are also legal mandates that require DOE to address legacy TRU waste management needs. DOE has been directed by the TDEC and the EPA to address environmental issues including disposal of its legacy TRU waste. DOE is under a TDEC Commissioner's Order (September 1995) to implement the Site Treatment Plan (under the Federal Facility Compliance Act) that mandates specific requirements for the treatment and disposal of ORNL's TRU waste. The primary milestone in the Commissioner's Order is that DOE begin treating legacy TRU sludge in order to make the first shipment to the Waste Isolation Pilot Plant in New Mexico by January 2003. The No Action Alternative would result in noncompliance with the ORNL Site Treatment Plan and the TDEC Commissioner's Order, which requires TRU waste treatment and off-site storage. Under RCRA, Section 3008(a), DOE could be fined up to $25,000 per day per noncompliance, in addition to any fines that could accumulate from the state if this legacy TRU waste is not treated and disposed offsite.

4.6.3 Low-Temperature Drying Alternative

The implementation of the Low-Temperature Drying Alternative would have a positive impact on waste management operations at ORNL. Since the treated wastes would be disposed offsite, the beneficial impact of this alternative on ORNL is a substantial reduction in the amount of waste stored onsite. Impacts from continued storage of the wastes at ORNL would be significantly reduced once the project treats, packages, and transports the waste offsite for disposal. Under this alternative, certain nonradioactive construction, office, sanitary, industrial, and demolition wastes would be disposed of at appropriate local facilities. An estimated total of 10,833 m^3 of waste would be generated under this alternative (Table 4-1). This is the lowest total combined volume for the treatment alternatives analyzed. Table 4-2 details the volumes by waste type.

4.6.3.1 Primary waste

The Low-Temperature Drying Alternative would treat and package the primary waste streams identified in the proposed action and summarized in Section 4.6 for final disposition. Table 4-2 provides details on the types and quantities of wastes generated from the Low-Temperature Drying Alternative. For comparative purposes, these data were summarized and compared to similar data for the other action alternatives in Table 4-1.

4.6.3.2 Secondary and other wastes

In addition to the treated primary waste streams, there would be several other waste streams generated by the Low-Temperature Drying Alternative, including: secondary wastes generated from the treatment and management of the primary waste streams [includes HEPA filters, sanitary wastewater and solids, personal protective equipment (PPE), etc.]; and D&D waste (includes contaminated materials, free release materials, concrete rubble, etc.).

The Low-Temperature Drying Alternative includes measures to minimize the quantity of secondary and D&D wastes that would be generated. Waste minimization was incorporated into the planning, design, and operations of the low-temperature drying waste treatment facility. Materials, equipment, and systems were selected based on consideration for potential waste generation. For example, steel used for certain construction materials or shielding was chosen over concrete due to the recycling opportunity and the reduction in volume of waste generated during D&D activities. Based on equipment design and facility operating requirements, other waste minimization techniques and objectives include:

- minimize contaminated work areas and spaces,
- reduce equipment maintenance requirements due to short service lives,
- avoid operations that lead to the spread of contamination,
- simplify segregated material handling and flow paths,
- limit work-in-progress waste inventories at the facility,
- minimize waste handling iterations at the facility, and
- use mechanical interfaces for contamination control.

During operations, secondary wastes such as consumables (e.g., PPE, step-off pads, rags, etc.) are generated and disposed of in packages being prepared for disposal at a low-level waste disposal facility. The solid waste containers used in delivering primary waste to the facility would also be considered secondary waste (e.g., drums, boxes, and concrete casks) and would be sized, volume reduced, and packaged for disposal. Volume-reduction (compaction, sorting, surveying, and segregation) techniques would be used to reduce the waste product volume prior to shipping and disposal.

Two nonradiological secondary waste streams generated during construction operations would be construction debris and sanitary waste. Sanitary waste would be generated at the highest rates during the construction phase of the project due to the number of personnel onsite. Sanitary wastewater would be routinely trucked offsite to a wastewater treatment plant. Only a minimal quantity of waste, generated through required maintenance and laboratory activities, has a potential for becoming a mixed low-level waste, thus requiring disposal at an appropriate mixed waste disposal facility.

D&D wastes would be generated following closure of the low-temperature drying waste treatment facility. Much of the equipment used for waste treatment would be classified as low-level waste and would require disposal at an appropriate low-level waste facility (e.g., the Nevada Test Site or another designated disposal facility in the WM PEIS). The surfaces of the treatment facility and most equipment would be kept relatively clean throughout the life of the facility. Therefore, although contamination would include TRU activity, the concentrations of the TRU radionuclides would be considerably less than the upper limit for low-level waste. Whenever safely and economically feasible, equipment and building components originating from the D&D activities of the low-temperature drying facility would be released for reuse or recycle for another waste remediation project. Uncontaminated building concrete would be sent to a construction debris landfill for permanent disposal.

Treatment of the legacy TRU waste and disposal offsite would result in compliance with the legal mandates regarding management of this waste. Once treatment is complete, existing solid waste storage facilities may be closed reducing the “mortgage” expenses required for maintaining these facilities. Upon completion of the project, the Melton Valley Storage Tanks would be returned to DOE control.

4.6.4 Vitrification Alternative

The implementation of the Vitrification Alternative would have a positive impact on waste management operations at ORNL. Since the treated wastes would be disposed offsite, the beneficial impact of the Vitrification Alternative on ORNL is a substantial reduction in the amount of primary legacy waste stored at the site. Impacts from continued storage of the wastes at ORNL would be reduced once the project treats, packages, and transports the waste offsite for disposal. Under this alternative, certain nonradioactive construction, office, sanitary, industrial, and demolition waste would be disposed of at appropriate local facilities. An estimated total of 34,128 m^3 of waste would be generated under this alternative. This is the largest total combined waste volume for the treatment alternatives although much of the waste volume is due to construction, sanitary, and D&D wastes. Table 4-3 details the types and quantities of wastes generated from the Vitrification Alternative.

4.6.4.1 Primary waste

The Vitrification Alternative would treat and package the primary waste streams identified in the proposed action for final disposition (see Section 4.6). The sludge and supernate contained in the Melton Valley Storage Tanks, which are highly mobile in the environment if spilled, would be treated by vitrification and changed into a stabilized, environmentally benign, waste glass form. Solid remote-handled and contact-handled solid wastes, and the wastes contained in the unlined trenches in SWSA 5 North, would be compacted and repackaged for off-site disposal.

4.6.4.2 Secondary and other waste

Sanitary waste would be generated at similar rates during the construction and operating phases of the Vitrification Alternative. As shown in Table 4-1, sanitary waste generation is five times greater than the amount produced by the Low-Temperature Drying Alternative. Only a minimal quantity (4 m^3) of low-level/mixed waste is expected to be produced by this alternative.

This alternative would generate approximately 20,760 m^3 of construction wastes, the largest volume of construction debris under any of the treatment alternatives. In general, there would be a substantially greater quantity of low-level secondary and D&D wastes generated from the Vitrification Alternative (4,893 m^3) because of the larger process building and the additional equipment required for the vitrification process. It is expected that much of the melter would have to be cut up and disposed of as TRU waste.

Treatment of the legacy TRU waste and offsite disposal of the treated waste would result in compliance with the legal mandates regarding management of this waste. Once treatment is complete, existing solid waste storage facilities may be closed, reducing the "mortgage" expenses for maintaining these facilities. Upon completion of the project, the Melton Valley Storage Tanks would be returned to DOE control.

4.6.5 Cementation Alternative

The implementation of the Cementation Alternative would have a positive impact on waste management operations at ORNL. Because the treated, wastes would be disposed offsite, the beneficial impact of this alternative on ORNL is a substantial reduction in the amount of primary legacy waste stored at the site. Impacts from continued storage of the wastes at ORNL would be reduced once the project treats, packages, and transports the waste for off-site disposal. Under this alternative, certain nonradioactive construction, office, sanitary, industrial, and demolition wastes would be disposed of at appropriate local facilities. An estimated total of 28,826 m^3 of waste would be generated under this alternative (Table 4-1). Table 4-4 details the types and quantities of wastes generated from the Cementation Alternative.

4.6.5.1 Primary waste

The Cementation Alternative would treat and package the primary waste streams (Section 4.6.) for final disposition. The sludge and supernate contained in the Melton Valley Storage Tanks, which are highly mobile in the environment if spilled, would be treated by cementation, which involves the mixing of the waste material with additives to form a stabilized, environmentally benign, cement-like waste product. Treatment by cementation would result in an increased volume of the primary waste stream (from 4,050 m^3 before treatment to 4,203 m^3 after treatment). By comparison, primary waste volumes are reduced by low-temperature drying from 4,050 m^3 to 1,391 m^3 and from 4,050 m^3 to 1,040 m^3 by vitrification. The treatment timeframe is longer for the Cementation Alternative in order to meet the requirements of the shipment capacity allotment given by WIPP to each approved shipper. Solid remote-handled and contact-handled solid wastes, and the wastes contained in the unlined trenches in SWSA 5 North, would be repackaged and compacted for off-site disposal.

4.6.5.2 Secondary and other waste

The Cementation Alternative requires more equipment than the Low-Temperature Drying Alternative and, therefore, would generate substantially more maintenance waste (130 m^3). In addition, the Cementation Alternative would produce 2,540 m^3 of remote-handled low-level waste compared to none for the other two treatment alternatives (Table 4-1). The D&D approach would be similar to the Vitrification Alternative (e.g., replace and remove the cementation process equipment). However, it is not expected that the processing equipment would be classified as TRU, so disposal at the Waste Isolation Pilot Plant should not be required.

Treatment of the legacy TRU waste followed by offsite disposal would result in compliance with the legal mandates regarding management of this waste. Once treatment is complete, existing solid waste storage facilities may be closed reducing the “mortgage” expenses for maintaining these facilities. Upon completion of the project, the Melton Valley Storage Tanks would be returned to DOE control.

4.6.6 Treatment and Waste Storage at ORNL Alternative

This alternative would consist of the treatment of the primary wastes followed by indefinite storage at ORNL. Due to volume reduction and other process differences, the lowest total waste volume (10,833 m^3) is associated with treatment by low-temperature drying. Treatment by vitrification would generate a total of 34,128 m^3 of wastes, and treatment by cementation would produce a total of 28,826 m^3 of wastes.

The construction of the additional storage facilities needed to handle the excess treated, secondary, and D&D wastes would have to coincide with the construction of the treatment facility in order to be ready for the receipt of the treated waste streams. If this alternative were chosen, it is assumed that the existing bunkers could be used to store treated remote-handled TRU wastes, and the new waste storage facilities would be located in the Melton Valley area of ORNL, preferably near the waste treatment facility. In addition, it is assumed that the storage facility footprint would be similar to the existing storage facilities and have a similar waste storage capacity (approximately 150 m^3 for remote-handled TRU waste, and 300 m^3 for other waste types). Existing storage facilities for storage of contact-handled TRU waste, which have a combined capacity of 1,631 m^3 (57,632 ft^3), could be used for storage of treated low-level waste. Table 4-5 provides a summary of the volumes of treated waste generated by each treatment alternative, and the space required for construction of additional waste storage facilities.

Following construction of the additional waste storage facilities, there would also be surveillance, maintenance, and tracking required to properly manage this waste and the associated facilities if this alternative were implemented.

4.6.7 Waste Management Impacts Summary

The waste volumes discussed in the proposed action and summarized in Section 4.6 would remain in their current state with the implementation of the No Action Alternative. This alternative would result in continued surveillance, maintenance, and tracking activities for the waste. This alternative would also be in violation of the ORNL Site Treatment Plan and the TDEC Commissioner’s Order (September 1995) requiring the treatment and off-site disposal of legacy TRU waste, which could result in large monetary fines for DOE, as compared to the alternatives that include waste treatment and off-site disposal (low-temperature drying, vitrification, and cementation), which would help DOE meet its regulatory requirements.

Table 4-5. Summary of the TRU, mixed low-level, remote-handled low-level, and low-level waste volumes, the resulting new storage space required for each treatment alternative, and the land area required for additional storage facilities

	Low-Temperature Drying	Vitrification	Cementation
Table 4-5a. Summary of the TRU, mixed low-level, and remote-handled low-level waste volumes and new storage space required			
Treated TRU waste volume (m^3)	607	1,060	1,793
Mixed low-level waste volume (m^3)	23	4	3
Treated remote-handled low-level waste volume (m^3)	–	–	2,540[a]
***Total TRU, mixed, and remote-handled low-level waste requiring on-site storage* (m^3)**	630	1,064	4,336
Existing waste bunkers storage capacity (m^3)	320	320	320
***New storage capacity needed* (m^3)[b]**	310	744	4,016
Assumed capacity of single new waste bunker (m^3)	150	150	150
Number of new waste bunkers needed	3	5	27
Assumed area of new waste bunker (m^2)	234	234	234
***Total Storage Facility Area required for TRU, mixed, and remote-handled low-level wastes* (m^2)**	702	1,161	6,265
Table 4-5b. Summary of low-level waste volumes and new storage space required			
***Total low-level waste requiring on-site storage* (m^3)**	2,778[a]	4,983[a]	2,833[a]
Existing storage capacity (metal building)	1,631	1,631	1,631
***New storage capacity needed* (m^3)[b]**	1,147	3,352	1,202
Assumed capacity of single new metal building (m^3)	300	300	300
Number of new metal buildings needed	4	11	4
Area of new metal buildings (m^2)	375	375	375
***Total area required for low-level wastes* (m^2)**	1,434	4,190	1,503
Table 4-5c. Total area required for all waste types and the associated land requirements for the new storage facilities			
TOTAL FACILITY SPACE REQUIRED FOR ALL WASTE TYPES (m^2)	**2,136**	**5,351**	**7,768**
TOTAL HECTARES REQUIRED FOR NEW WASTE STORAGE FACILITIES[c]	**0.3**	**0.6**	**0.8**

[a]Total waste volumes include alpha-low-level waste.

[b]Determined by subtracting available capacity from resulting waste volume and dividing by assumed storage capacity of new facility (150 m^3 for TRU, mixed, and remote-handle low-level wastes, and 300 m^3 for low-level wastes).

[c]Determined by summing storage space required for all waste types, for each treatment method, and converting to hectares.

For the alternatives that include waste treatment, secondary wastes would be generated during the construction, treatment, and D&D activities. Because of the volume reduction associated with the treatment method, the Low-Temperature Drying Alternative would result in the lowest total volume (10,833 m^3) of treated, secondary, and D&D wastes of the treatment alternatives. The Vitrification Alternative would produce a total of 34,128 m^3, and the Cementation Alternative would generate a total of 28,826 m^3 of wastes. These wastes would be disposed off-site in an appropriate permitted disposal facility for the treatment alternatives that include disposal. If the Treatment and Waste Storage at

ORNL Alternative were implemented, additional waste storage facilities would be required (total space ranging from 0.3 to 6.8 ha or 0.75 to 2.0 acres) depending upon the treatment process selected.

4.7 AIR QUALITY

This section discusses the impacts to air quality resulting from the construction, operation, and D&D of the proposed treatment facility. Because the alternatives would take place in an attainment area for all criteria air pollutants, no Clean Air Act conformity determination is required. Human health impacts from air emissions are addressed in Section 4.10. Impacts associated with accidental releases of air pollutants are addressed in Section 4.11.

4.7.1 Methodology

Methods used to determine the impacts from the alternatives are listed below.

- Qualitatively discussed vehicle and dust emissions.
- Calculated air emissions using mass balances for the treatment alternatives (Appendix B).
- Compared the projected air emissions to the National Ambient Air Quality Standards, and qualitatively to the Class I prevention-of-significant deterioration (PSD) areas.
- Calculated radiological emissions based on an assumed HEPA filter efficiency of 99% each for two filters used in sequence.
- Calculated metals emissions based on an assumed HEPA filter efficiency of 99% each for two filters used in sequence.
- Assumed organic constituents were completely emitted to provide a conservative estimate of total air emissions.
- Computed dose rates for the nearest off-site locations for the maximally exposed individual (MEI) using projected emission rates (Appendix B) and CAP88 model.

4.7.2 No Action Alternative

Under the No Action Alternative no air emissions are expected from the TRU waste storage at ORNL.

4.7.3 Low-Temperature Drying Alternative

Potential air contaminants would include vehicle emissions and fugitive dust from construction, which are both easily mitigated using proper equipment and control measures or techniques. During facility operations, air pollutants could potentially be emitted from the proposed facility (stationary source), and would be emitted by vehicles driven by workers, or used to transport waste to the facility and from the facility (mobile sources).

The Low-Temperature Drying Alternative is not expected to adversely impact air quality during facility operations. The emissions from the proposed treatment facility were estimated by considering all the constituents of the waste that would be processed in the facility. Calculations indicate that the air emissions from a low-temperature drying waste treatment facility during normal operations would be below the State of Tennessee limits for air permitting exemptions (Table 4-6). The estimated emissions would be 62% to 86% of the allowable exemption.

Table 4-6. Estimated air emissions from the proposed Low-Temperature Drying treatment facility and State of Tennessee permit exemptions

Compound	Emission	Exemption	Regulatory citation
Volatile organics	0.062 lb/h	0.1 lb/h	1200-3-9-.04(h)
Particulate matter	0.086 lb/h	0.1 lb/h	1200-3-9-.04(I)
Radionuclides	0.063 mrem/year	0.1 mrem/year	1200-3-9-.04(I)

The concentrations of hazardous air pollutants, except for uranium, projected for off-site locations are generally several orders of magnitude below recently measured concentrations (Table 4-7) at the same locations and, therefore, do not measurably contribute to the ambient air concentration. These treatment emissions were calculated based on the chemical and physical characteristics of the waste and the efficiency of removal by the HEPA filters. Uranium is projected to cause a small, but possibly detectable increase (less than 50%) in the measured ambient air concentrations of hazardous air pollutants.

Table 4-7. Average concentrations of hazardous air pollutants measured at ORR and projected maximum concentrations from the Low-Temperature Drying Alternative

Hazardous air pollutant	Measured ORR average concentration ($\mu g/m^3$)	Low-Temperature Drying alternative projected maximum concentration ($\mu g/m^3$)
Arsenic	6×10^{-4}	1×10^{-8}
Cadmium	2.7×10^{-4}	5.2×10^{-9}
Chromium	8×10^{-4}	1.9×10^{-7}
Lead	3.4×10^{-3}	2.5×10^{-7}
Uranium	7×10^{-5}	2.7×10^{-5}

The conservative total estimated radiological emissions of 5.44-03 curies/year for the Low-Temperature Drying Alternative is based upon a HEPA filter efficiency of only 99% for each filter in a series of two, instead of the design efficiency of 99.97% for each filter for very small particles. Higher efficiencies are likely for larger particles. CAP 88 was used to calculate doses. This emission rate yields a maximum dose of 0.063 mrem/year at about 100 m (328 ft) southwest of the stack and about 0.023 mrem/year at 1,250 m (4,101ft) southwest of the stack (closest off-site location) and 0.019 mrem/year at 1,250 m (4,101 ft) northeast of the site. The off-site dose of 0.023 mrem/year should be compared to the maximally exposed individual of the general public from airborne radionuclides from the ORR, or 0.41 mrem/year. The maximum estimated dose resulting from the Low-Temperature Drying Alternative based on the conservative emission rates, is generally within the uncertainty of the dose to the maximally exposed individual of the general public from airborne radionuclides. The use of HEPA efficiencies closer to the design efficiency would further reduce the estimated dose from the facility.

Virtually all of the radionuclides in the TRU waste are nonvolatile and would only be released during D&D activities as part of demolition dust and debris. The potential concentrations of radionuclides in the demolition dust would depend upon the contamination resulting from operations, the effectiveness of facility decontamination, and the demolition processes used for the D&D of the proposed facility.

4.7.4 Vitrification Alternative

Potential air contaminants for the Vitrification Alternative, during construction, would include vehicle emissions and fugitive dust, which are both easily mitigated using proper equipment and control measures or mitigation techniques. These potential releases during normal facility operations and during D&D activities include radionuclide emissions, particulate matter emissions, and volatile organic emissions (associated only with tank waste treatment).

The primary means of mitigating treatment-related air emissions is an effective off-gas system. The Vitrification Alternative off-gas consists of a complex mixture of entrained particulates, gases, and vapors that result from the thermal processes occurring in the melter. The vitrification off-gas system would exhaust gases from the melter plenum, maintain the melter at a negative pressure in relation to the cell, and clean the off-gas-to-stack discharge. Off-gas treatment for this alternative would be accomplished with two systems. The primary off-gas system for the Vitrification Alternative consists of three components: a film cooler, an off-gas quencher, and a high-efficiency mist eliminator (HEME) with condensate tank and scrubber. The primary off-gas system would be designed to provide a total decontamination factor of at least 2.5E+12 and a decontamination factor for semivolatile/condensing products of at least 8E+08. The decontamination factors were provided by personnel in the DOE Savannah River Plant design group who are working on a vitrification design (Savannah River Plant 1999). The system, up to and including the HEMEs, would remove up to 99% of radionuclide activity.

The secondary off-gas treatment system would remove acid gases from off-gas and perform final filtration of particulates prior to stack discharge. The secondary off-gas system consists of a selective catalytic (NO_x) reduction (SCR) unit, HEPA filters, and a wet scrubber. The SCR uses a catalyst bed and ammonia to convert NO_x to nitrogen and water. The SCR is expected to remove about 90% of the NO_x. HEPA filters would remove about 99.97% of the remaining particulates in the off-gas stream. A wet scrubber would eliminate the release of any remaining acid gases and any unreacted ammonia. Collected material from the off-gas system would be recycled back through the vitrification facility for processing, eliminating it as a waste stream. Since emissions from the vitrification system with state-of-the-art off-gas treatment would be similar to the Low-Temperature Drying Alternative, Low-Temperature Drying Alternative emissions are considered the bounding case.

The Vitrification Alternative is expected to comply with applicable air standards. Similar vitrification off-gas systems have been effectively employed for vitrification facilities at other DOE sites with emissions within exempted levels (Savannah River Plant 1999). Although highly unlikely, if emission exemption limits, as outlined in Table 4-6, could not be attained with the specific equipment, then air permits would be required.

4.7.5 Cementation Alternative

Potential air contaminants during construction of a cementation waste treatment facility would include vehicle emissions and fugitive dust, which are both easily mitigated. Most operational off-gas problems, and the associated environmental and health and safety risks, are eliminated with the cementation treatment method. These potential releases during normal operations, and to some extent during D&D activities, include radionuclide emissions, particulate matter emissions (primarily metals), and volatile organic emissions (associated only with process of tank wastes). The cementation mixing process has provisions for dust collection and filtration (i.e., a dust collection baghouse to prevent particulates and fine particles from entry into the building ventilation system). The dust collection baghouse would transfer the collected dust back into the cementation system by way of the mixer. With a properly designed dust and vapor collection system, the emissions from a cementation waste treatment facility, based on engineering judgement, are assumed to be similar to those for the

Low-Temperature Drying Alternative. The Low-Temperature Drying Alternative emissions are considered the bounding case. Therefore, the air emissions from the cementation facility during normal operations are projected to be below the State of Tennessee limits for air permitting exemptions, as indicated in Table 4-6.

4.7.6 Treatment and Waste Storage at ORNL Alternative

As discussed for the other treatment alternatives, potential air contaminants during construction would include vehicle emissions and fugitive dust, which are both easily mitigated. These potential releases during normal operations, and D&D activities, includes radionuclide emissions, particulate matter emissions (primarily metals), and volatile organic emissions (associated only with process of tank wastes). Air emissions from normal operations; and permit requirements (regulatory exemptions) would be the same as those discussed in the previous sections for the treatment alternatives (Sections 4.7.3, 4.7.4, and 4.7.5). Air quality is not expected to be impacted during storage of the treated waste.

4.7.7 Air Quality Impacts Summary

Under No Action, there are no known air emissions from the TRU waste in storage at ORNL. Construction and D&D activities associated with the other alternatives would result in minor, short-term fugitive dust emissions. Air emissions during normal operations of the proposed treatment facility would be below State of Tennessee permit exemption concentrations. Air quality is not expected to be impacted from storage of treated waste.

4.8 TRANSPORTATION IMPACTS

This section discusses the impacts and consequences associated with transportation for the alternatives. The truck transportation analysis was done using routing models following the general principle of minimizing distance and transportation time. They are representative of routes which serve to bound transportation impacts. They do not necessarily present actual routes. Actual routes would be determined in accordance with Federal and state authorities and DOE policy. Route changes constrained by regulation should not create a significant deviation in the effects described.

4.8.1 Methodology

Methods used to determine transportation impacts for each alternative are discussed below.

- Evaluated the impacts associated with the transportation of TRU waste using the analysis developed for the WIPP SEIS-II (DOE 1997d). Because the packaging requirements and routes are the same, all alternatives involving transportation to the Waste Isolation Pilot Plant in New Mexico would vary only by the number of shipments that would result from the implementation of the alternative.

- Evaluated truck accident statistics for each state, and by highway type. These were used to determine route-specific accident, injury, and fatality rates for the WIPP SEIS-II (DOE 1997b) analysis.

  — Obtained the route mileage through each state using HIGHWAY 3.1 model.

  — Multiplied the mileage by the state traffic, injury, or fatality rates.

  — Summed the products for the route, and divided the sums by the total route mileage.

- With the exception of the state of New Mexico, the accident rate data for federally aided interstate highways were used. For the New Mexico routes, the rate for federally aided primary roads was used since the waste would primarily travel U.S. Highway 285.
- Multiplied the route-specific accident, injury, and fatality rates by the number of shipments along each route to obtain the estimated number of accidents, injuries, and fatalities.

- Estimated transportation risks were for routine operations and accidents were obtained from the WM PEIS (DOE 1997e). These risks were based on state data on the frequency of accidents for trucks per mile traveled. National average rural, suburban, and urban population densities were used. The WM PEIS (DOE 1997e) used an external dose rate of 1 mrem/hour at 1 meter for DOE low-level waste shipments.

- Incorporated analysis for radiological impacts from accidents from two types of analyses conducted for the WIPP SEIS-II (DOE 1997d).

  - The first type of analysis used the RADTRAN code, a model used to compute radiological accident impacts, to estimate the radiological impact from accidents during transport from each of the major DOE sites. This analysis took into account eight different severity categories, their probabilities of occurrence, the distance from each site, and the number of shipments.
  - The second type of accident analysis was an assessment of four bounding accidents. These are described more fully in Appendix E of the WIPP SEIS-II (DOE 1997d). Accident-free radiological impacts due to transportation of the TRU wastes were determined in the WIPP SEIS-II by using the RADTRAN code to estimate the impacts due to this radiation.

- Assumed that all on-site untreated waste shipments to the proposed TRU Waste Treatment Facility would occur on non-public, DOE-controlled roads. The impacts of traffic accidents not related to the radioactive material or hazardous chemicals being transported were assumed to be the same as impacts resulting from the transport of nonhazardous material.

The accident impacts calculated as a number of injuries and fatalities were calculated on a per-shipment basis. Calculations were based on data presented in the WIPP SEIS-II and the WM PEIS (DOE 1997d; 1997e). It was determined that transportation for the entire DOE Waste Management Program to the Waste Isolation Pilot Plant could account for 56 accidents resulting in 5 fatalities. The ORR portion of this program was calculated as 8.1E-04 accidents per shipment and 1.1E-04 fatalities per shipment, which translates to a possibility that approximately 8 out of 10,000 shipments could potentially result in an accident, with the potential for 1 fatality occurring out of 10,000 shipments. Because the canisters are empty on the return trip, only half of these accidents would occur with a loaded canister. Most transportation accidents are unlikely to cause any radioactive material release, but very severe accidents may result in a release. A 1987 Nuclear Regulatory Commission study, cited in the WIPP SEIS-II (DOE 1997d), estimated that only 0.6% of accidents could cause a radiation hazard to the public.

Analysis of a hypothetical container breach assumed an accident occurred under conditions that maximized, within reasonable bounds, the impacts to exposed populations. The analysis concluded that, for the average concentration of radionuclides and hazardous chemicals in a TRUPACT II waste container, the estimated dose would result in three latent cancer fatalities (LCFs) in the exposed population. The estimated maximum individual dose would result in a 0.04 probability of a LCF. For a breached remote-handled 72B cask, the total population dose estimated would result in a 0.04 LCF in the exposed population. The estimated maximum individual dose would result in a 7E-04 probability of a LCF. Analysis of the ORR to Waste Isolation Pilot Plant route, which included both the probability of an accident and the consequences, estimated a total of 4E-03 LCFs for transuranic waste (WIPP SEIS-II, DOE 1997d).

The major routine risk to the public from truck transportation is from exposure during rest stops to travelers who are using the same rest stops. For the analysis of low-level waste, DOE assumed the average dose rate of each shipment would not exceed 1 mrem/hour at 1 meter from the shipping container, which is consistent with DOE's historical practices. On the basis of typical low-level waste densities, roughly 80 drums with a 208-L (55-gallon) capacity would be shipped per truck. The dose per shipment of low-level waste is estimated to be the same for all alternatives involving transportation. The dose to a maximally exposed individual stuck in traffic for 30 minutes next to a low-level waste shipment is estimated to be 0.5 mrem, representing a lifetime risk of fatal cancer of 3.0E-07 (based on International Commission on Radiological Protection Publication 60 health risk conversion factors).

An accident of severity Category VIII was used to calculate the exposure to the public in the event of an accident. A Category VIII accident represents the most severe accident scenario and assumes the maximum magnitude of mechanical forces (impact) and thermal forces (fire) to which a waste package may be subjected during a truck accident. It would result in the largest releases of radioactive material. Accidents of this severity are extremely rare, occurring once in every 70,000-truck accidents. On the basis of national accident statistics (Saricks and Kvitek 1994) for every 1.6 km (1 mile) of shipment (loaded), the probability of an accident of this severity is 6E-12. The WM PEIS (DOE 1997e) assumed the route distance from the ORR to the Nevada Test Site was 2,151 miles. Thus, for each shipment to the Nevada Test Site, the probability of an accident of this severity is 1.3E-08. DOE concluded that no accident of such severity is expected to occur for the WM PEIS waste alternatives . The estimated consequences for this improbable accident are given in Table 4-8. Because a waste with the highest transportation accident dose was used in the analysis, the accident consequence results are extremely conservative. These results are at least a factor of 10 greater than those anticipated for ORNL low-level waste shipments (DOE 1997e).

Table 4-8. Estimated consequences for the most severe accidents involving shipments of low-level waste

	Population		Maximally exposed individual	
	Dose (person rem)	Risk (cancer fatalities)	Dose (person rem)	Risk (cancer fatalities)
Accident location (neutral conditions)				
Urban	8.3E+03	4.2E+00	7.7E-01	3.9E-04
Suburban	1.6E+03	8.0E-01	7.7E-01	3.9E-04
Rural	1.5E-01	8.0E-03	7.7E-01	3.9E-04

4.8.2 No Action Alternative

There would be no transportation of wastes under the No Action Alternative; therefore, no transportation impacts would occur.

4.8.3 Low-Temperature Drying Alternative

It is estimated that there will be approximately 450 short hauls onsite from the solid waste storage facilities to the proposed treatment facility during the operations. The greatest frequency (approximately 175 short hauls) would occur during the second year of operation (Foster Wheeler 1999). The access route to the facility (the High Flux Isotope Reactor access road) is within the ORR and not accessible to the general public. There would be an estimated 397 shipments of TRU waste to the Waste Isolation Pilot Plant resulting from the implementation of the Low-Temperature Drying Alternative.

Non radiological effects of TRU waste shipments: The shipment of TRU waste would result in 1.7E-03 LCFs attributed to pollution health effects from the truck emissions. The WIPP SEIS-II stated the probability of an accident as 8.1E-4 per shipment and the probability of a fatality as 1.1 E-04 per shipment. This would yield a calculated probability of 3.2 E-01 for accidents and a 4.4E-02 probability of a fatality associated with the TRU shipments for the Low-Temperature Drying Alternative.

Radiological effects of TRU waste shipments: Table 4-9 presents the calculated total population LCFs for the waste shipment to Waste Isolation Pilot Plant resulting from the implementation of the Low-Temperature Drying Alternative.

Table 4-9. Calculated non-accident radiological LCFs for the Low-Temperature Drying Alternative[a]

Oak Ridge to Waste Isolation Pilot Plant	Contact-handled TRU waste shipments (87)	Remote-handled TRU waste shipments (310)
LCFs	8.7E-03	3.1E-02

[a]Data in table were derived from exposure/shipment data presented in the *Final Waste Isolation Pilot Plant Disposal Phase Supplemental Environmental Impact Statement*

LCFs = latent cancer fatalities.

Non-radiological effects of LLW shipments: The WM PEIS estimated fatalities with shipments of low level waste as approximately one fatality per 16 million shipment miles. Using a representative route distance of 2,151 miles from Oak Ridge to NTS, there would be an estimated 1.3 E-04 fatality per shipment. The Low-Temperature Drying Alternative represents 277 low-level waste shipments or 2.6E-01 accidents and 3.6E-02 accident fatalities.

Radiological effects of LLW shipments: The 277 shipments for this alternative represent a dose of 4.3E-06 person-rem and LCFs of 2.1E-09. The final waste disposal facility for low-level waste will be consistent with the Record of Decision of the WM PEIS for low-level waste (e.g., the Nevada Test Site or another designated disposal facility).

DOE would perform comprehensive waste certification before disposition of the waste to any disposal site. For each waste stream, the specific waste profile would be prepared in sufficient detail to provide reasonable assurance that the intended waste product, packaging, documentation, and shipping schedule meet the disposal site requirements and capacity. Table 4-10 shows the projected shipping schedule of waste for the Low-Temperature Drying Alternative. In nearly all cases, the waste generation projected for the Low-Temperature Drying Alternative is a small fraction of the disposal facility's capacity, or acceptance rate, for these wastes. The current national TRU program planning document anticipates, that the ORR would ship almost 16% of the total shipments of the remote-handled TRU waste to be disposed at the Waste Isolation Pilot Plant (DOE 1997d). The waste stream that demands the highest percentage of repository capacity from this alternative is the remote-handled TRU waste, and the projected number of shipments amounts to approximately 4% of the waste to be disposed of at the Waste Isolation Pilot Plant over the next 35 years.

The packaging and transportation equipment needed for safe transport is available to support the projected generation of all wastes. For example, the highest anticipated project usage rate for contact-handled TRU transport casks (TRUPACT II) is 70% of the casks made available to the ORR for this purpose (for only a 5-month period). Maximum demand for remote-handled TRU transport casks (72B) is only 35% of the casks available to the ORR for this purpose. The same is true for the low-level waste shipments projected from the facility; approximately 10% of the casks available commercially in the United States for this type of waste would be committed for approximately a 2-year period.

The largest volume of locally disposed material, approximately 5500 m^3 of concrete rubble from the facility demolition, equates to approximately 275 truckloads over a removal period of several weeks. This demand is easily satisfied by local transportation contractors. The handling and transportation systems necessary to remove and transfer the remaining project waste streams are common commercial equipment, readily available and entirely adequate to satisfy the needs of this alternative.

Table 4-10. Projected waste shipment schedule for the Low-Temperature Drying Alternative

	Calendar year and month																																						
	2003												2004												2005												2006	2007	
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	Total	Total	Total
Waste Isolation Pilot Plant shipments																																							
72B Cask shipping container:																																							
Treated TRU sludge shipments	12	11	12	11	12	11	12	11	12	11	12	6	12	11	12	11	12	9																					200
Treated RH TRU solids shipments													2	3	3	3	3	3	3	3	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	36	7[a]	110
Total	12	11	12	11	12	11	12	11	12	11	12	6	14	14	15	14	15	12	3	3	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	36	7	**310**
TRUPACT II shipping container:																																							
Nuclear Fuel Services Drum shipments													12	13	13	13	8																						59
CH TRU solids shipments													1	2	2	2	2	2	2	2	1	1	1	1			1			1			1			1	4	1	28
Total													13	15	15	15	10	2	2	2	1	1	1	1			1			1			1			1	4	1	**87**
Total TRU Shipments													27	29	30	29	25	14	5	5	3	3	3	3	3	3	4	3	3	4	3	3	4	3	3	4	40	8	***397***
Nevada Test Site shipments*																																							
Treated low-level supernate shipments, (208 ft^3 liners)	4	5	4	5	4	5	4	5	4	5	4	2	5	5	5	5	5	5	10	10	10	8																	119
Low-level waste solids shipments (compacted empty casks)													1	2	2	3	3	4	4	4	4	4	4	3	4	4	4	3	4	4	4	3	4	4	4	3			139
Other secondary waste shipments		1		1		1		1		1		1		1		1		1		1		1		1				1					1			1			19
Total low-level waste shipments	4	6	4	6	4	6	4	6	4	6	4	3	6	8	7	9	8	10	14	15	14	13	4	4	4	4	4	4	4	4	4	3	5	4	4	4			***277***
Total all shipments																																							**674**

[a]Pattern unchanged through February 2007, with remainder in March 2007.

*The final waste disposal facility for low-level waste will be consistent with the Record of Decision of the WM PEIS for low-level waste (e.g., the Nevada Test Site or another designated disposal facility).

RH = Remote-handled.

CH = Contact-handled.

4.8.4 Vitrification Alternative

Non radiological effects of TRU waste shipments: The Vitrification Alternative would result in an estimated 989 shipments of TRU waste. The pollution health effects resulting from vehicle emissions are determined to be 4.4E-03 LCFs, with an estimated 8.0E-01 accidents and 1.1E-01 fatalities.

Radiological effects of TRU waste shipments: Table 4-11 presents the LCFs calculated for the representative Oak Ridge to Waste Isolation Pilot Plant route, based on 939 shipments.

Table 4-11. Calculated non-accident radiological LCFs for the Vitrification Alternative[a]

ORNL to Waste Isolation Pilot Plant	Contact-handled TRU waste shipments (53)	Remote-handled TRU waste shipments (934)
LCFs	5.3E-03	9.3E-02

[a]Data in table were derived from exposure/shipment data presented in the *Final Waste Isolation Pilot Plant Disposal Phase Supplemental Environmental Impact Statement*.
LCFs = latent cancer fatalities.

Non radiological effects of LLW waste shipments: The effects of the transportation of low-level waste for the Vitrification Alternative are estimated as 281 shipments resulting in an estimated 2.6E-01 accidents and 3.6E-02 accident fatalities.

Radiological effects of LLW waste shipments: The 281 shipments correspond to a cumulative dose of 4.4E-06 rem to a person living along the ORR site entrance route. This represents a negligible lifetime risk of 2.1E-09 for this alternative.

The waste stream that demands the highest percentage of repository capacity among any of the disposal pathways identified is the remote-handled TRU waste treated and packaged by the Vitrification Alternative. The projected shipments amount to approximately 12% (instead of the presently planned 16%) of this type of waste to be disposed at the Waste Isolation Pilot Plant over the next 35 years (DOE 1997d). The packaging and transportation equipment needed to effect the safe transport is available to support the projected generation of all wastes. For example, the highest anticipated project usage rate for contact-handled TRU transport casks (TRUPACT II) is 20% (approximately 1 shipment/week) of the casks made available (5 shipments/week) for this purpose (for a 16-month period). However, the minimal demand over the 3-year operating period for remote-handled TRU transport casks (72B) is 65% to 70% of the casks made available (8 casks/week) to the ORR (over a period of 1 year), while the maximum demand is 100% of the casks available to the ORR (over a period of 1.5 years). Evaluation of the low-level waste shipments projected from the Vitrification Alternative facility indicates approximately 5% of the casks available commercially in the United States for this type of waste would be committed for approximately a 1-year period.

Shipping operations for this alternative are planned to require single-shift, 5-day-per-week operation. Since there is 100% utilization of available casks for a period of 1.5 years, it is likely that some of the processed waste would have to be shipped during the D&D phase of this alternative.

The largest volume of locally disposed material, approximately 21,000 m^3 of concrete rubble from the facility demolition, equates to approximately 1,250 truck loads over a period of several months. This demand is easily satisfied by local transportation contractors. The handling and transportation systems necessary to remove and transfer the remaining project waste streams are common commercial equipment, readily available and entirely adequate to satisfy the project's needs.

Construction traffic transportation impacts for the Vitrification Alternative are similar to those discussed for the Low-Temperature Drying Alternative (peak construction traffic is increased due to 2.5 times more workers than the Low-Temperature Drying Alternative), only the following transportation impacts are discussed in this section.

- Operations traffic impacts
  - waste transfers to the facility from ORR;
  - treated waste shipments; and
  - worker and operations-related traffic; and
- D&D traffic impacts.

The number of waste shipments to the Vitrification Alternative facility would be the same as the Low-Temperature Drying Alternative. The greatest short-haul frequency (approximately 175 short hauls) would occur during the second and third years of operation. Waste shipments of treated primary waste products from the Vitrification Alternative facility would occur over a 3-year period. Table 4-12 provides the waste shipment schedule for the Vitrification Alternative.

The D&D phase of the project is expected to begin in 2006 and extend for 2 years. The D&D traffic profile would be similar to the construction phase of the project, although reversed. Worker traffic would be approximately one-half to a one-third the peak construction force, reducing in later stages. Truck traffic would peak to several 15.3-m^3 (60-ft^3) debris hauls per day midway through the D&D period.

Table 4-12. Projected shipment schedule for the Vitrification Alternative

	2003												2004												2005												2006	2007	
	J	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**Total** [g,h]	**Total** [g,h]	**Total**
Waste Isolation Pilot Plant shipments																																							
72B Cask shipping container:																																							
Treated TRU sludge & supernate[a]				22	22	22	22	22	22	22	22	20	22	22	22	22	22	22	22	22	22	22	22	20	22	22	22	22	22	22	22	22	22	22	22	22			722
Treated RH TRU solids[b]																11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	4					202
D&D waste[c]																																					9	3	12
Total	0	0	0	22	22	22	22	22	22	22	22	20	22	22	22	33	33	33	33	33	33	33	33	31	33	33	33	33	33	33	33	33	33	26	22	22	9	3	**936**
TRUPACT II shipping container:																																							
CH solids[d]	2	3	4	3	4	3	4	3	4	3	4	3	4	3	4	2																							**53**
Total TRU shipments																																							***989***
Nevada Test Site shipments*																																							
RH low-level waste solids[e]																						2	2	2	2	2	2	2	2	2	2	2	2	2	1				27
Low-level waste solids[f]	2	4	4	3	3	4	3	3	4	3	3	4	3	3	4	3	3	4	3	3	4	3	3	4	3	3	4	3	3	4	3	3	4	3	3	4	96	38	254
Total low-level waste	2	4	4	3	3	4	3	3	4	3	3	4	3	3	4	3	3	4	3	3	4	5	5	6	5	5	6	5	5	6	5	5	6	5	4	4	96	38	***281***
Total all shipments																																							**1,270**

Notes:

*The final waste disposal facility for low-level waste will be consistent with the Record of Decision of the WM PEIS for low-level waste (e.g., the Nevada Test Site or another designated disposal facility).

[a]The sludge and supernate are put into HalfPACTs and then two HalfPACTs are placed into a 72B Cask. Each HalfPACT contains 0.4 m^3 of treated waste.

[b]Remote-handled (RH) solids that are being shipped to the Waste Isolation Pilot Plant are put into 55-gal drums which are then put into an RH Canister that is then placed in a 72B Cask.

[c]The decontamination and decommissioning (D&D) waste would be directly put into an RH Canister that would be placed into a 72B Cask.

[d]Contact-handled (CH) solids that are being shipped to the Waste Isolation Pilot Plant are put into 55-gal drums which are then put into a TRUPACT II. Although it is possible to have 14 drums per TRUPACT II and 3 TRUPACT II containers per shipment, it was assumed that only eight 55-gal drums could be placed into a TRUPACT II based upon weight limitations.

[e]RH low-level waste would be shipped in a Super Tiger shipping container, which limits the number of drums per shipment to 16.

[f]Other non-RH low-level waste would be shipped without a special shipping container, which would allow eight 55-gal drums per shipment.

[g]There would be approximately one 72B cask shipment per month from April 2006 to March 2007.

[h]There would be 8 Nevada Test Site shipments/month for the first 14 months in D&D, and then there would 6, 6, 5, and 5 shipments. All low-level waste shipments should be completed by June 2007.

RH = Remote-handled.

CH = Contact-handled.

4.8.5 Cementation Alternative

Non Radiological effects of TRU waste shipments: The Cementation Alternative is predicted to involve 2,425 shipments of transuranic waste. This exceeds the total number of shipments to the Waste Isolation Pilot Plant from ORR as proposed in the WIPP SEIS-II and would result in 2.2 accidents and 3.0E-01 fatalities. The pollution health effects are estimated at 1.2E-02 LCFs due to transportation of the waste.

Radiological effects of TRU waste shipments: Table 4-13 presents the LCFs calculated for the representative Oak Ridge to the Waste Isolation Pilot Plant route.

Table 4-13. Calculated non-accident radiological LCFs for the Cementation Alternative[a]

ORNL to Waste Isolation Pilot Plant	Contact-handled TRU waste shipments (53)	Remote-handled TRU waste shipments (2,372)
LCFs	5.3E-03	2.7E-01

[a]Data in table were derived from exposure/shipment data presented in the *Final Waste Isolation Pilot Plant Disposal Phase Supplemental Environmental Impact Statement*.
LCFs = latent cancer fatalities.

Non Radiological effects of LLW Waste shipments: The Cementation Alternative would result in 914 shipments of low-level waste and an estimated 8.8E-01 accidents and 1.2E-01 accident fatalities.

Radiological effects of LLW shipments: The potential cumulative dose to a person living along the ORR site entrance route for this alternative is estimated as 1.5E-05 person-rem corresponding to a calculated 7.5E-09 LCF.

The waste stream that demands the highest percentage of repository capacity among any of the disposal pathways identified is the remote-handled TRU waste packaged by the Cementation Alternative. The projected shipments amount to approximately 30% (instead of the presently planned 16%) of this type of waste to be sent to and disposed at the Waste Isolation Pilot Plant over the next 35 years (DOE 1997d). This amount of waste would greatly impact the Waste Isolation Pilot Plant remote-handled disposal capacity.

The packaging and transportation equipment needed to effect safe transport is available to support the projected generation of all wastes. For example, the highest anticipated project usage rate for contact-handled TRU transport casks (TRUPACT II) is 10% (approximately 5 shipments/week) of the casks made available for this purpose (for a 33-month period). However, the demand over the 6-year operating period for remote-handled TRU transport casks (72B) is 95% of the casks made available (8 casks/week) to the ORR. Evaluation of the remote-handled low-level waste shipments projected from the Cementation Alternative facility indicates approximately 70% of the casks currently available commercially in the United States for this type of waste would be committed for approximately a 6-year period. This is a significant resource use.

Calculations show that the average TRU concentration for the treated sludge is between 200 and 300 nanocuries per gram which indicates that, due to the high variability in the concentration in the waste, it is likely that there could be treated waste that is not TRU. An alternative approach for treatment, which affects transportation, would be to directly fill remote-handled canisters instead of 55-gal drums for the cementation process. If this were done, the total number of remote-handled shipments would decrease to approximately 1,750 shipments. This would allow the treatment schedule to be reduced to 5 years (from 6 years).

Shipping operations are planned to require single-shift, 5-day-per-week operation. However, due to the increased number of shipments on a weekly basis over the Low-Temperature Drying Alternative, it is likely that shipping operations would extend to two shifts or would be conducted in a shift different from operations, or both.

The largest volume of locally disposed material, approximately 14,000 m^3 (45,932 ft^3) of concrete rubble from the facility demolition, equates to approximately 850 truck loads over a period of several months. This demand is easily satisfied by local transportation contractors.

Since the construction traffic transportation impacts for the Cementation Alternative are similar to the Low-Temperature Drying Alternative, only the following transportation impacts are discussed in this section.

- Operations traffic impacts due to
  - — waste transfers to the facility; and
  - — treated waste shipments; and
  - •
- D&D traffic impacts.

The number of waste shipments to the Cementation Alternative facility is the same as for the Low-Temperature Drying Alternative. The greatest short-haul frequency (approximately 100 short hauls) would occur during the fourth, fifth, and sixth years of facility operations. Waste shipments of waste products from the proposed facility would occur over a 3-year period. Table 4-14 provides the waste shipment schedule for the Cementation Alternative.

The D&D phase for the Cementation Alternative is expected to begin in 2009 and extend for 2 years. The D&D traffic profile would be approximately three times the profile of the Low-Temperature Drying Alternative. Truck traffic would peak to several 15.3 m^3 (20 yd^3) debris hauls per day during the first year in the D&D period.

4.8.6 Treatment and Waste Storage at ORNL Alternative

The Treatment and Waste Storage at ORNL Alternative does not involve the shipment of any wastes off-site and would have no off-site transportation effects.

4.8.7 Transportation Impacts Summary

There would be no off-site transportation of waste for the No Action and the Treatment and Waste Storage at ORNL Alternatives. A comparison of the Low-Temperature Drying, Vitrification and Cementation Alternatives with regard to radiological and non-radiological effects of TRU and low-level waste shipments is presented in Table 4-15. As described in this table the non-radiological probability of a fatality for shipment of TRU waste to the Waste Isolation Pilot Plant range from 4.4E-02 (Low-Temperature Drying Alternative) to 3.0E-01 (Cementation Alternative). The probability of a fatality due to the shipment of low-level waste to NTS was determined as a miles-traveled proportion of the national low-level waste program. Because cementation would result in more shipments of low-level waste, this alternative represents the highest probability of a non-radiological fatality, 1.2E-01.

Table 4-14. Projected shipment schedule for the Cementation Alternative

	2003				**2004**				**2005**				**2006**				**2007**				**2008**				
	1	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**Total**
Waste Isolation Pilot Plant shipments																									
72B cask shipping container:																									
Treated TRU sludge[a]	99	99	99	99	99	99	99	99	99	99	85	85	85	85	85	85	85	85	85	85	85	85	80	80	2170
RH TRU solids[b]											14	14	14	14	14	14	14	14	14	14	14	14	17	17	202
Total	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	99	97	97	***2,372***
TRUPACT II shipping container:																									
CH solids[c]	3	5	5	5	5	5	5	5	5	5	5														53
Total TRU shipments	3	5	5	5	5	5	5	5	5	5	5														***53***
Nevada Test Site shipments*																									
Treated RH low-level solids[d]															3	3	3	3	3	3	3	3	3		27
Treated low-level supernate[e]	32	32	33	33	33	33	33	33	33	33	32	32	32	32	32	32	32	32	32	32	32	32	32	32	776
Low-level waste solids[f]	2	3	3	2	2	3	3	2	2	3	7	6	7	7	7	6	7	8	7	6	7	7	2	2	111
Total low-level waste	34	35	36	35	35	36	36	35	35	36	39	38	39	39	42	41	42	43	42	41	42	42	37	34	***914***
Total all shipments																									**3,339**

Notes:

*The final waste disposal facility for low-level waste will be consistent with the Record of Decision of the WM PEIS for low-level waste (e.g., the Nevada Test Site or another designated disposal facility).

[a]The sludge is put into a 50-gal liner, overpacked into a 55-gal drum, and then 3 55-gal drums are placed into a remote-handled (RH) canister and then a 72B Cask.

[b]Solids that are being shipped to the Waste Isolation Pilot Plant are put into 55-gal drums and three 55-gal drums are put into an RH canister and then a 72B Cask.

[c]Contact-handled (CH) solids that are being shipped to the Waste Isolation Pilot Plant are put into 55-gal drums, which are then put into a TRUPACT II. Although it is possible to have 14 drums per TRUPACT II and 3 TRUPACT II containers per shipment, it was assumed that only eight 55-gal drums could be placed into a TRUPACT II based upon weight limitations.

[d]RH low-level waste would be shipped in a Super Tiger (or similar) shipping container, which limits the number of drums per shipment to 16.

[e]The supernate is put into a 50-gal liner, overpacked into a 55-gal drum, and then placed into a Super Tiger (or similar shipping container).

[f]Other non-RH low-level waste would be shipped without a special shipping container, which would allow eighty 55-gal drums per shipment.

Table 4-15. Comparison of alternatives (calculated transportation accidents/fatalities based on total off-site shipments)

Alternative	No Action Alternative; Treatment and On-site Storage at ORNL Alternative	Low-Temperature Drying Alternative		Vitrification Alternative		Cementation Alternative	
Waste type		**TRU**	**LLW**	**TRU**	**LLW**	**TRU**	**LLW**
Shipments	No off-site shipments	397	277	989	281	2,425	914
Non-radiological effects							
Probability of an accident[a,c]		3.2E-01		8.0E-01		2.2	
Fatality due to non-radiological accident		4.4E-02	3.6E-02[C]	1.1E-01	3.6E-02	3.0E-01	1.2E-1
Pollution effects (LCFs due to truck emissions)[a]		1.7E-03		4.4E-03		1.2 E-02	
Radiological Effects							
Dose (person-rem)		17.4 (CH) 62 (RH)	4.3E-06 rem[b]	10.6 (CH) 180 (RH)	4.4E-06[b]	10.6 (CH) 540(RH)	1.5E-05[b]
LCF		8.7E-03 (CH) 3.1E-02 (RH)	2.2 E-09	5.3E-03 (CH) 9.3E-02 (RH)	2.2E-09	5.3E-03 (CH) 2.7E-01 (RH)	7.5E-09

[a]Analysis used route to Waste Isolation Pilot Plant.
[b]Dose to person at Oak Ridge Reservation site entrance.
[c]Calculated by mileage ratio.
LLW = low-level waste.
LCF = latent cancer fatalities.
CH = contact-handled
RH = remote-handled

In general, the radiological risks from routine transportation of radioactive materials are directly proportional to the external dose rate. Dose rates to the public are low and would typically be less than that of natural background radiation. The calculated latent cancer fatalities for both TRU and low-level waste are shown in Table 4-15. TRU waste has been divided into contact-handled and remote-handled.

4.9 UTILITY REQUIREMENT IMPACTS

This section discusses the impacts of the alternatives on utilities. There is currently 500 kW of electrical power available from the utilities lines in the vicinity. A 130-cm (12-inch) potable water main is available near the proposed facility for use. It is assumed for each alternative that involves waste treatment, that potable water, electricity, and telephones would be connected to sources on the adjacent Melton Valley Storage Tank facilities or other nearby locations. Water would be supplied for drinking, process needs, sanitation, and fire protection from the nearby water main. Electricity would be used for heating, lighting, and operations. Telephone service would be required for operations.

4.9.1 Methodology

The methods used to determine the utility requirement impacts for each alternative are listed below.

- Determined the projected electrical requirements for each alternative, and

- Determined project water usage for each alternative.

4.9.2 No Action Alternative

The energy requirements associated with the No Action Alternative for continued storage of the waste are limited to the power demands associated with the operation of facility lighting, ventilation, and security systems. The annual energy-related usage resulting from the operation of these systems at the current waste storage facilities ranges from 12 to 32 MW. Using an assumed mid-point for the usage, the total power usage for the lifetime of this alternative (100 years) is estimated at 2,200 MW.

The No Action Alternative would not require the use of any groundwater. Water for drinking, sanitation, and fire protection would continue to be used at present levels. Water use for continued storage is minimal compared to the water availability and current uses in the Melton Valley area at ORNL and the ORR. Water use is estimated to be less than 200 gallons per day for the current storage facilities. This is based on the use of 50 gallons per non-resident worker per day (FTH EIS 1999), and approximately 3.5 full-time equivalent workers, working 5 days per week, stationed at the Melton Valley Storage Tanks, and the existing solid waste storage facilities (Roy 2000, personal communication). The implementation of the No Action Alternative would result in the continued use of approximately 50,000 gallons of water per year, or 5 million gallons over the assumed 100-year institutional control period.

4.9.3 Low-Temperature Drying Alternative

Utility requirements during construction, operations, and D&D activities of a low-temperature drying waste treatment facility are summarized in Table 4-17. These utilities would be used throughout the life of the Low-Temperature Drying Alternative, but peak loads and the highest average utilization would occur during the 2 years of projected tank waste retrieval and treatment operations (i.e., 2003–2004).

The available electrical service at the treatment facility site is limited to 500 kW, but at least one source for the additional 2.1-MW peak demand from the facility systems is located less than a mile from the facility (Figure 4-2). An aboveground power line would be installed as part of the project to

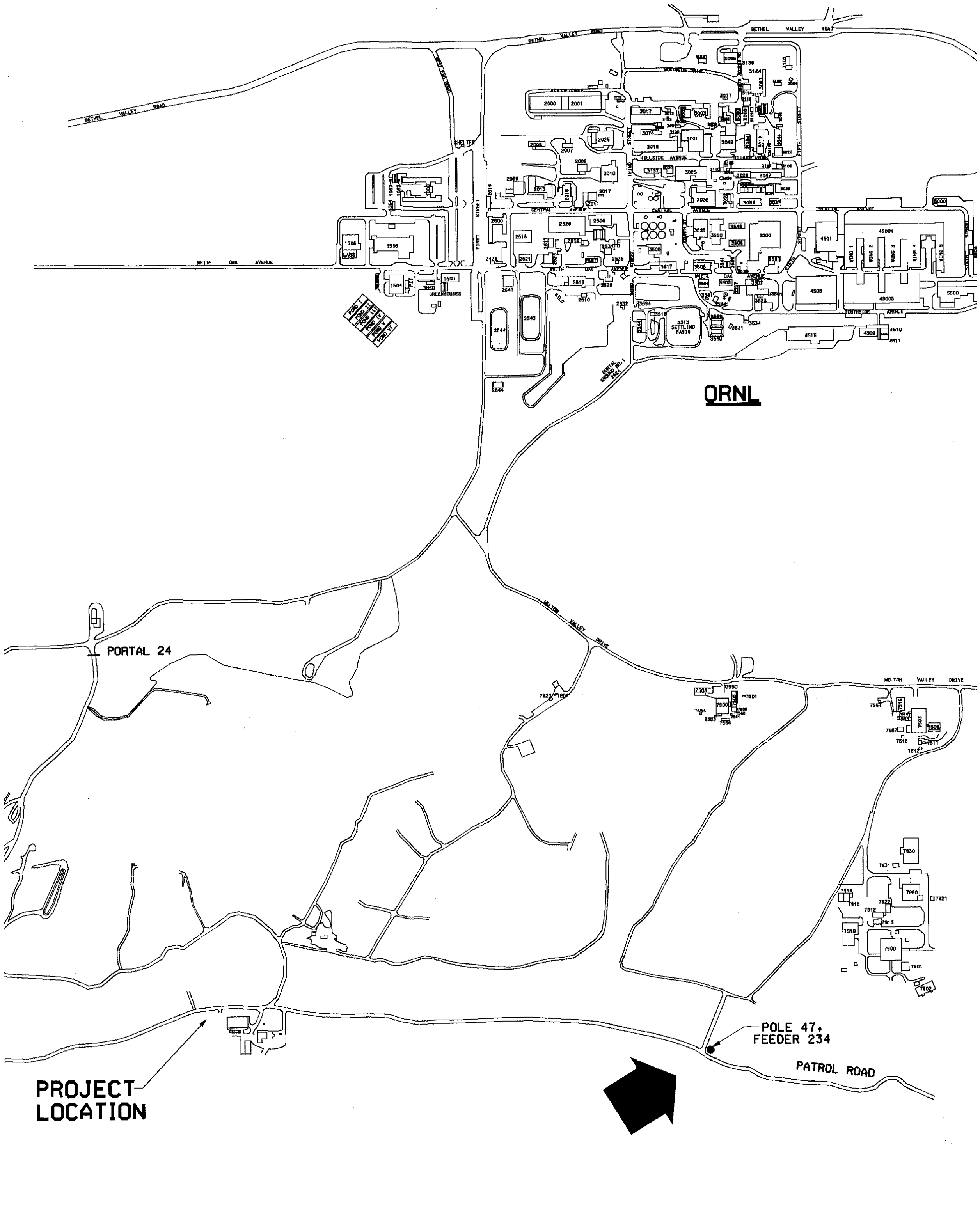

Figure 4-2. Location of additional power source.

provide the additional power required for the proposed facility. DOE has evaluated the proposed extension and connection of the proposed load at this point in its distribution system. It requires only a routine emplacement of poles and cable to accomplish this effort. Projected use of 2.1 MW is unlikely at any one time for the Low-Temperature Drying Alternative; however, if it were to occur, it would only be approximately 2% of the current ORR load. The conversion and dissipation of this electrical energy would be primarily to heat energy, both latent (in the form of evaporated water) and sensible (warmed air emitted from the building stack). Estimated electrical usage is based on the treatment process and mass balances computed in Appendix B. Total electrical usage is estimated at 13,000 MW. Considering the ORR's total energy input, the facility's contribution to local or area temperature influences from this energy would be insignificant.

The bulk of the proposed facility's electrical energy demands arise from two process requirements: (1) evaporate water from the raw waste to meet disposal site criteria and shipping requirements, and (2) evaporate the water used to mobilize the sludge from the Melton Valley Storage Tanks.

The low-temperature drying waste treatment facility would employ a treatment process that would use a minimal quantity of nonhazardous additives for the stabilization of the RCRA metals found in the waste. The stabilization process is accomplished at ambient temperatures and pressures; thus, only minimal energy is needed to handle, store, and control the required additives. No additional mixing is required for the additives beyond that already needed to maintain the tank waste solids in suspension for pumping and homogeneity. Minimal additives also imply minimal expended energy to elevate the process temperature to evaporate water from the waste. No energy-intensive chemical processes would be used in the facility. No other treatment process steps require intensive energy or resource consumption. Water not removed by treatment would be stabilized before disposal (e.g., cementation, absorption, etc.).

Other energy and resource needs related to the project are limited by the relatively short operating life of the low-temperature drying waste treatment facility. While operator hours of productivity/m^3 of waste are fairly standardized in the industry (especially for remote sorting and segregation of the solids that result in the majority of operational hours at the facility), limiting the hours of plant operation reduces management, monitoring, maintenance, and support resources and associated energy needs. The Low-Temperature Drying Alternative would optimally lower the life-cycle cost by balancing the cost of creating capital equipment needed to accommodate the resources with the combined operations and maintenance and D&D costs of operating, and then dismantling the facility with the same resources.

No groundwater would be used for the Low-Temperature Drying Alternative. Table 4-17 identifies the utilities immediately available at the facility site, via a short extension and connection service. Specific energy requirements for the treatment facility operations are provided in Table 4-18. Actual usage would be a fraction of the peak demand. Water usage over the life of this alternative is estimated at 5 million gallons (Jones 1999). On a daily basis, this treatment method would use less than 10% of the 1,000 gallons per minute (gpm) DOE has allotted for the proposed TRU Waste Treatment Facility. This is a minimal amount compared to the 1.2 million gallons per day (MGD) used at ORNL.

Table 4-17. Utility requirements of the Low-Temperature Drying Alternative facility

Utility	Requirements	Usage
Potable water	Fire protection, drinking, sanitation, and process	900 gpm (peak)
Electricity	Heating, lighting, and operations	2,600 kW
Telephone	On- and off-site communications	25 voice lines 1 data line
Sewage	Sanitation	Collected and removed by commercial vendor
Solid waste	Housekeeping	Collected in bins and removed by commercial vendor

gpm = gallons per minute.
kW = kilowatt.

Table 4-18. Facility energy requirements (connected load) for the Low-Temperature Drying Alternative

Consumer	hp	Electrical (kW)
Drying/filtration mechanical equipment	100	75
Sludge/supernate retrieval equipment	20	15
CH solids handling equipment	67	50
RH solids handling equipment	40	30
Process off-gas treatment	54	40
Process chillers	228	170
Shipping/receiving	40	30
Steam boiler	—	1,172
Steam boiler pumps	10	8
Instrument/plant air compressor	100	75
Building HVAC fans	200	149
HVAC chillers	335	250
Total operating	1,195	2,063
Total design	× 1.25 = 1,493	× 1.25 = 2,579

CH - contact-handled.
hp - horsepower.
HVAC - heating, ventilation, and air conditioning.
kW - kilowatt.
RH - remote-handled.

4.9.4 Vitrification Alternative

The Vitrification Alternative would require 45,000 MW of power. Similar to the Low-Temperature Drying Alternative, the conversion and dissipation of this electrical energy would be primarily to heat energy, both latent (in the form of evaporated water) and sensible (warmed air emitted from the building stack). The bulk of electrical energy demands for the Vitrification Alternative would be from vitrification of the tank waste to meet the Waste Isolation Pilot Plant waste acceptance criteria and shipping requirements. Another significant consumer of energy would be the HVAC systems.

The other utility demands, and the sources for these utilities, would be similar to those previously discussed for the Low-Temperature Drying Alternative. Water use is projected at 7 million gallons over the life of the Vitrification Alternative.

4.9.5 Cementation Alternative

The Cementation Alternative would require 11,250 MW. The substantial portion (25 to 30%) of electrical energy demands for the Cementation Alternative is from the HVAC systems. Water usage would be approximately 15 million gallons, which is still insignificant compared to the available water.

4.9.6 Treatment and Waste Storage at ORNL Alternative

Energy and water usage for this alternative depends primarily on the treatment alternative selected, which are discussed in the preceding sections. The utility requirements for waste storage are assumed to be similar to the requirements for the existing waste storage facilities (using 2,200 MW and 5 million gallons of water over the institutional control period for waste storage).

4.9.7 Utility Impacts Summary

None of the alternatives, including the No Action Alternative, would require the use of any groundwater. The No Action Alternative would require a total of 2,200 MW of electricity, compared to 15,000 MW for the Low-Temperature Drying Alternative; 45,000 MW for the Vitrification Alternative; and 11,250 MW for the Cementation Alternative. Water use would continue at present levels under the No Action Alternative, totaling 5 million gallons over the assumed 100 years of institutional control. The treatment alternatives would involve water use as part of waste treatment. The Low-Temperature Drying Alternative would require 5 million gallons of water, the Vitrification Alternative would require 7 million gallons, and the Cementation Alternative would require 15 million gallons, compared to 5 million gallons for the No Action Alternative. The Treatment and Waste Storage at ORNL Alternative would require an additional 5 million gallons of water and 2,200 MW of electricity for long-term storage of the treated wastes onsite.

4.10 HUMAN HEALTH IMPACTS

This section discusses the potential human health risks associated with routine operations of the proposed treatment facility for the four waste streams identified in the proposed action.

Since the proposed treatment facility would be located on 2 to 2.8 ha (5 to 7acres) in the Melton Valley area of ORNL, the population of concern is found in four Tennessee counties including: Anderson, Roane, Knox, and Loudon, which serve as the reference area for human health impacts. The nearest resident is located approximately 3.2 to 4.8 km (2 to 3 miles) from the proposed facility. The nearest sensitive subpopulation, such as children, is located at the residences surrounding the ORR, and the nearest high-risk receptors (e.g., nursing homes, hospitals, schools, or day care centers) are found in the city of Oak Ridge (population of 27,310) located northeast of the ORR. The nearest large metropolitan area within 80 km (50 miles) of the facility is Knoxville, Tennessee, (population of 165,000). Approximately 880,000 people live within 80 km (50 miles) of the ORR (ORNL 1995a).

The dose limit established by DOE for members of the general public from all sources of radiation (except natural background and radiation received as a medical patient) is 100 mrem/year. DOE recommends that remedial actions be sufficient enough that the likely potential dose to the public is less than 30 mrem from one year of exposure. However, since the facility is located at the ORR on federal property, institutional controls would prevent exposure to private residents for many years.

4.10.1 Methodology

The methods used to determine the potential impacts to human health are discussed below.

- Performed risk assessment using CAP-88, Version 1.0, which provided an estimate of the adverse effects to the offsite affected (public) population and maximally exposed individuals (involved worker, non-involved worker, and public). Fifty radionuclides from the predicted total emissions of all four waste streams were modeled. CAP-88 can model a maximum of 36 radionuclides in a single run, so two model runs were performed for each of the maximally exposed individual and population assessments; the first run included 36 radionuclides, the second run included 14 radionuclides, and the totals were summed.

- Determined radionuclide concentrations in air, rates of deposition on ground surfaces, concentrations in food, and intake rates from ingestion.

- Modeled exposure pathways including inhalation, ingestion, and immersion in an airborne plume.

- Estimated the plume dispersion using meteorological data described in Section 3.7. The following parameters and assumptions used in the CAP-88 model for alternatives involving waste treatment are stated below.

  — stack height = 27.43 m (90 ft),
  — stack diameter = 1.52 m (5 ft),
  — plume rise = 12.7 m/s (42 ft/s),
  — mixing height = 1000 m (3,281 ft),
  — 5E-04 fatal cancers per rem were assumed for the general public, and
  — 4E-04 fatal cancers per rem were assumed for workers.

- Computed the total exposure due to radionuclides and chemicals using the Industrial Source Complex Model Code, Version 3 (ISCST3), an EPA model that determines the dispersion of airborne pollutants. This model predicts atmospheric concentrations from a continuous point source based on a unit emission rate of 1 g/s, and was used to estimate the exposures to the combined concentrations of radionuclides, particulates, and volatile organics at various locations near the proposed facility. ISCST3 uses the average hourly meteorological data records to define the conditions for plume rise, transport, diffusion, and deposition. Concentrations are estimated for each block in a circular grid comprising 16 directional sectors (e.g., north, northeast, north-northeast, etc.) at 10 radial distances within 80 km (50 miles) of the facility. The calculated concentration at each location was multiplied by the estimated emission of each contaminant (EPA 1995).

- Determined the dose to the public from residual radioactive contamination using the DOE model RESRAD, Version 5.82, in order to comply with DOE Order 5400.5. Residual radioactivity after site D&D was estimated from anticipated air emissions that would occur during operations at the proposed facility. The following assumptions were made when RESRAD was used in this evaluation.

  — Excluded radionuclides with a short half-life, and unlikely to present a risk following D&D of the proposed treatment facility.

  — Excluded radionuclides already present in the environment, if their activity due to emissions from the treatment facility was determined less than the uncertainty of the measurement.

- Estimated the dose to a family living on the proposed facility site immediately following D&D activities using RESRAD. The following assumptions were used in this analysis.

  — Drinking water was obtained from an on-site well.

  — Ingested vegetables were grown onsite.

  — Raised cattle onsite to obtain their milk and meat supply.

  — Default values were used as a conservative bound.

- Calculated the hazard index (non-carcinogenic contaminants), which is an indicator of the total additive, non-cancer toxicity from exposure to mixtures of hazardous contaminants. The hazard index is calculated by summing the hazard quotients for each noncarcinogen. A hazard index less than or equal to 1.0 indicates the exposure is unlikely to produce adverse toxic effects. As the hazard index approaches 1.0, concern about the potential hazard increases. The hazard index does not provide a statistical probability that a particular mixture at a particular exposure level will cause a particular adverse effect; it is an indicator of the relative potential for causing harm (ORNL 1995b,c).

- Calculated the latent cancer fatalities (carcinogenic contaminants). Cancer resulting from risks below 1E-06 cannot be distinguished from the normal cancer rate in an exposed population (EPA 1991).

4.10.2 Exposure pathways

The primary exposure pathways from the proposed treatment facility are ingestion and inhalation of contaminants from stack emissions. Stack emissions would occur during the 7,200 hours that the treatment facility is operational. For all treatment alternatives, air released from the stack would pass through a series of two HEPA filters, with a removal efficiency of more than 99%. It is anticipated that the total radioactive material that would be released is 5.48E-03 curies. The majority of the radioactive emissions will be strontium-90, cesium-137, and europium-152. The anticipated maximum release rate for volatile organic compounds is 0.062 lb/hour. The anticipated maximum release rate for particulate matter is 0.086 lb/hour. Secondary exposure pathways include immersion in the plume and external exposure due to ground surface contamination.

The facility operations for the treatment alternatives do not involve any water or wastewater discharges directly to the environment. Surface storm water runoff would enter Melton Branch or White Oak Creek, which are monitored under the ORR Environmental Monitoring Plan. Facility operations would not affect the groundwater, and no known drinking water supplies exist within 0.8 km (0.5 miles) of the facility. Therefore, contaminated surface water or groundwater was not considered as a potential exposure pathway when estimating radiation doses using the CAP-88 computer program. Waterborne pathways were considered when estimating the dose to a hypothetical family living on the land immediately after the facility D&D activities using the RESRAD computer program.

4.10.3 No Action Alternative

The exposure to workers performing monitoring and maintenance activities for 100 years under the No Action Alternative would result in 2E-02 LCFs for the population of involved workers. There would be minimal risk to non-involved workers and the public during the institutional control period.

4.10.4 Low-Temperature Drying Alternative

4.10.4.1Population of concern

The on-site population would vary depending on the project phase. There would be an estimated peak of 97 full-time equivalents during construction of the proposed facility, and a minimum of 17 full-time equivalents at the end of D&D activities. During operations, the number of full-time equivalents would range from 50 to 88, but only a fraction of these would be directly involved in the processing action.

4.10.4.2Risk assessment

Radiation Exposure From Air - Maximally Exposed Individual

The maximally exposed involved worker would be located 100 m (328 ft) southwest of the stack, and the effective dose equivalent was calculated to be 6.4E-02 mrem. Based on the duration of stack emissions, the total exposure time would be 7,200 hours. The non-involved worker was assumed to be an average of 200 m (656 ft) southwest of the stack, which resulted in an effective dose equivalent of 5.5E-02 mrem. The nearest resident is approximately 3.2 to 4.8 km (2 to 3 miles) from the facility (ORNL 1995a). The off-site public maximally exposed individual is located 1,250 m (4,101 ft) southwest of the facility, and the effective dose equivalent is 2.2E-02 mrem. The annual dose each person receives from natural background radiation is about 300 mrem, and the NESHAPs limit is 10 mrem/year. The total probability of cancer fatalities to the maximally exposed worker (involved and non-involved) and the off-site public maximally exposed individual is 3E-05, 2E-05, and 1E-05, respectively.

Radiation Exposure - Affected Population

Risk analysis was performed for the population within 80 km (50 miles) of the facility. The collective dose to the affected population would be 1.2E-01 person-rem. The total latent cancer fatalities risk is 6E-5 fatalities per year. The doses and associated risks from radionuclide exposure are summarized in Table 4-19.

Table 4-19. Dose and risk due to radionuclide emissions from the Low-Temperature Drying Alternative

Receptor	Effective dose equivalent	Cancer fatalities
Maximally exposed individual (worker)	6.4E-02 mrem	3E-05 (probability)
Maximally exposed individual (non-involved worker)	5.5E-02 mrem	2E-05 (probability)
Maximally exposed individual (off-site)	2.2E-02 mrem	1E-05 (probability)
Population	1.2E-01 person-rem	6E-05 (deaths/year)

LCF = latent cancer fatalities

Radiation Exposure - Facility Worker

In order to protect workers, the facility walls would be designed to maintain exposures as low as reasonably achievable (ALARA). The two primary gamma emitters present in the waste are cobalt-60 (half-life of 5.27 years), and cesium-137 (half-life of 30.17 years). The wall thickness or shielding material would reduce the dose rate to 0.5 mrem/h in normally occupied radiological areas and to 0.25 mrem/h in normally occupied non-radiological areas. It is stated in 10 *CFR* 835 that radiological operations shall be controlled so that the annual total effective dose equivalent (TEDE) limit of 5 rem to radiological workers is not exceeded. The TEDE for any member of the public shall not exceed 100 mrem in a year. The ORR imposes an administrative control that limits doses to 20% of the DOE-allowable dose limit. Assuming a facility worker receives the maximum administrative control limit dose of 100 mrem in a year, the associated 70-year risk using a probability of 4E-04 fatal cancers per rem is 3E-03.

Total Exposure Due to Radionuclides and Chemicals From Air

The ISCST3 model as described in Section 4.10.1, was used to analyze chemical carcinogens and the CAP-88 model was used to analyze radionuclide concentrations. Estimated concentrations are determined for each block in a circular grid comprising 16 directional sectors (e.g., north, northeast, north-northeast, etc.) at 10 radial distances within 80 km (50 miles) of the proposed facility. The calculated concentration at each location was multiplied by the estimated emission of each contaminant (EPA 1995). The total exposure time was assumed to be equivalent to the operational time of the facility, or 7,200 hours. Like CAP-88, ISCST3 also uses the Gaussian plume equation to determine the dispersion of pollutants and includes the same assumptions and limitations discussed in Section 3.10.2. Table 4-20 summarizes the endpoints (health effects) that were estimated for the anticipated airborne emissions from the facility.

Table 4-20. Summary of health effect endpoints

Type of contaminant	Endpoint
Noncarcinogen	Hazard index[a]
Chemical carcinogen	Cancer incidence[a]
Radionuclide	Cancer fatality[b]

[a]Estimated with ISCST3.
[b]Estimated with CAP-88.

•

The results from the ISCST3 modeling were used to determine the hazard index at various locations near the facility. In all cases, the hazard index was zero. The data and parameters used in the ISCST3 code are provided in Appendix E of "Required Information for the National Environmental Policy Act for the Treating of Transuranic/Alpha Low-Level Waste at ORNL" (Foster Wheeler 1999).

The lifetime risk of cancer was estimated, and the highest-risk occupied area was 1,500 m (4,921 ft) northeast of the facility with a cancer risk of 4E-11. Cancer incidence resulting from risks below 1E-06 cannot be distinguished from the normal cancer rate in an exposed population and is considered acceptable by EPA (EPA 1991).

Residual Contamination After D&D

The pathways modeled by RESRAD, Version 5.82 were inhalation, ingestion of milk, ingestion of meat, vegetation, aquatic animals, drinking water, and inadvertent soil ingestion. The highest total dose from all exposure pathways was estimated to be 2.28 mrem, approximately 5 years after D&D of the facility. The data and parameters used in the RESRAD code are provided in Appendix F of "Required Information for the National Environmental Policy Act for the Treating of Transuranic/Alpha Low-Level Waste at ORNL" (Foster Wheeler 1999).

4.10.5 Vitrification Alternative

Emissions of concern for the Vitrification Alternative include radionuclides, particulates, and volatile organics. Mitigation of potential emissions is discussed in Section 4.7.4. It is anticipated that the use of off-gas treatment systems would result in compliance with applicable air standards. CAP-88 was used to estimate the dose and risk from radionuclide emissions from the proposed facility using the same assumptions and parameters discussed in Section 4.10.1. The maximally exposed involved worker was assumed to be located 300 m (984 ft) southwest of the stack. The dose and risk to the maximally exposed individuals and the surrounding population are shown in Table 4-21.

The average annual particulate and metal emissions using the Vitrification Alternative are significantly less than those from the Low-Temperature Drying Alternative. The impacts from non-radiological emissions would be negligible. The dose due to residual contamination after D&D is anticipated to be approximately equivalent to that for the Low-Temperature Drying Alternative since the total anticipated radionuclide emissions are approximately the same.

Table 4-21. Dose and risk due to radionuclide emissions from the Vitrification Alternative

Receptor	Effective dose equivalent	Cancer fatalities
Maximally exposed individual (worker)	2.2E-01 mrem	9E-05 (probability)
Maximally exposed individual (non-involved worker)	1.8E-01 mrem	7E-05 (probability)
Maximally exposed individual (offsite)	9.8E-02 mrem	5E-05 (probability)
Population	6.8E-01 person-rem	3E-04 (deaths/year)

LCF = latent cancer fatalities.

4.10.6 Cementation Alternative

Emissions of concern for the Cementation Alternative include radionuclides, particulates, and volatile organics. Contaminant emissions and human health impacts would be expected to be similar to than the Low-Temperature Drying Alternative. CAP-88 was used to estimate the dose and risk from radionuclide emissions from the proposed facility using the same assumptions and parameters discussed in Section 4.10.1. The maximally exposed involved worker was assumed to be located 100 m (328 ft) southwest of the stack. The dose and risk to the maximally exposed individuals and the surrounding population are shown in Table 4-22.

Table 4-22. Dose and risk due to radionuclide emissions from the Cementation Alternative

Receptor	Effective dose equivalent	Cancer fatalities
Maximally exposed individual (worker)	1.6E-02 mrem	6E-06 (probability)
Maximally exposed individual (non-involved worker)	1.3E-02 mrem	5E-06 (probability)
Maximally exposed individual (offsite)	5.1E-03 mrem	3E-06 (probability)
Population	2.8E-02 person-rem	1E-05 (deaths/year)

LCF = latent cancer fatalities

The average annual particulate and metal emissions using the Cementation Alternative are significantly less than those from the Low-Temperature Drying Alternative. The impacts from non-radiological emissions would be negligible. The dose due to residual contamination after D&D is anticipated to be approximately equivalent to that for the Low-Temperature Drying Alternative since the total anticipated radionuclide emissions are approximately the same.

4.10.7 Treatment and Waste Storage at ORNL Alternative

The impact to public health from this alternative would be dependent on the treatment alternative selected and would be equivalent to the impact for that alternative, as previously summarized in Tables 4-19, 4-21, and 4-22. Storage of the waste onsite at ORNL following treatment would not result in additional risk to the public or to non-involved workers. There would be an additional risk to the involved worker population due to radiological exposure, since the stored waste would be inspected and routine surveillance and maintenance performed. Involved workers are currently performing maintenance and surveillance tasks and are currently in compliance with the annual administrative control dose limit of 100 mrem/person/year. Similarly, it is anticipated that the administrative control limit will be met over the 100-year institutional control period for waste storage. Assuming the total number of involved workers over the 100-year period averages 5 per year, and the 100 mrem annual administrative control limit is maintained, the total dose to the involved worker population would be 50 person-rem, and the associated LCF would be 2E-02.

4.10.8 Human Health Impacts Summary

There would be minimal risks to non-involved workers and the public for the No Action Alternative. Involved workers would continue to receive the exposure they currently receive during surveillance and maintenance activities. Over the 100 year institutional control period for onsite waste storage this would result in 2E-02 LCFs. There would be no additional impact to the public and non-involved workers under the Treatment and Waste Storage at ORNL Alternative. Table 4-23 summarizes the probability of cancer fatalities for the treatment alternatives.

Table 4-23. Total probability of cancer fatality summary table for the treatment alternatives[a]

Alternative	On-site maximally exposed worker	Non-involved maximally exposed worker	Off-site maximally exposed individual (public)
No Action	NA	Negligible	Negligible
Low-Temperature Drying	3E-05	2E-05	1E-05
Vitrification	9E-05	7E-05	5E-05
Cementation	6E-06	5E-06	3E-06

[a]For the Treatment and Waste Storage at ORNL Alternative, risks would be dependent on the treatment method selected, although there would be no additional risk to non-involved workers or the public. Involved workers for both the No Action and Treatment and Waste Storage at ORNL Alternatives would have 2E-02 LCFs due to 100-year surveillance and maintenance activities.

NA - not applicable.

The collective dose to the population from the Low-Temperature Drying Alternative would be 0.12 person-rem and 6E-05 deaths/year. The collective dose to the population for the Vitrification Alternative would result in 3E-04 deaths/year. The collective dose to the population from the Cementation Alternative would be 6.8E-01 person-rem and 1E-05 deaths/year. For the Treatment and Waste Storage at ORNL Alternative, there would be some additional exposure due to the storage of the treated wastes onsite at ORNL.

4.11 ACCIDENT IMPACTS

This section addresses potential accident scenarios caused by equipment failures, human errors, or natural phenomena, which could result in the release of radiation, radioactive or hazardous materials, and have adverse effects on environment and the health of workers and the public. Accident scenarios were evaluated for each of the alternatives. The types of accident scenarios evaluated include:

- A breach of the Melton Valley Storage Tanks;
- A breach of the transfer line between the Melton Valley Storage Tanks and the proposed TRU Waste Treatment Facility;
- Failure of a waste slurry line inside the proposed TRU Waste Treatment Facility;
- Failure of a waste slurry line and HEPA filters inside the proposed TRU Waste Treatment Facility;
- Failure of contact-handled or remote-handled solid waste containers before, during, and after waste treatment;
- Accidents unique to each alternative; and
- Industrial accidents occurring during operations of the TRU Waste Treatment Facility or storage.

The scenarios analyzed represent the range of potential hazards associated with each alternative. Seismic risk to the Melton Valley Storage Tanks is more important for the No Action Alternative than the other alternatives, due to the long-term storage (100 years institutional control) of the untreated waste in the tanks. The analysis assumes that all of the accidents would occur within the proposed TRU Waste Treatment Facility, with the exception of a breach of the Melton Valley Storage Tanks, a breach of the transfer line between the Melton Valley Storage Tanks and the proposed TRU Waste Treatment Facility, or waste containers stored before and after treatment.

4.11.1 Methodology

The estimated accident consequences were based on the inventories and material characteristics of the waste contained in the Melton Valley Storage Tanks and the solid TRU wastes stored on the ORNL site. Atmospheric and surface water transport characteristics were obtained from the *Safety Analysis Report for the Liquid Low-Level Waste Management Systems* (Bechtel Jacobs 1999). Methods used to evaluate the significance of the potential adverse effects from the described accidents are listed below.

- Estimated the frequencies of potential accidents occurring for each alternative.
  - "anticipated" accidents have a frequency of greater than 1 in 100 per year (>1E-02 per year);
  - "unlikely" accidents have a frequency ranging between 1 in 100 to 1 in 10,000 per year (1E-02 to 1E-04 per year); and
  - "extremely unlikely" accidents have a frequency ranging between 1 in 10,000 to 1 in 1,000,000 per year (1E-04 to 1E-06 per year). These accidents were not considered credible as evaluation basis events, and were not evaluated.

- Quantified the estimated amount of any release to the environment (air or surface water) resulting from an accident.

- Quantified the radiological dose to an MEI at the ORR boundary, and the radiological does to the surrounding public populations due to the releases. There is no public MEI for the ingestion pathway.

- Evaluated the radiological effects of accidents on workers:

  — Quantified the ingestion doses to the maximally exposed individual and worker population at ETTP (the only workers assumed to ingest the contaminated water released in an accident are those at ETTP with a downstream potable water intake).

  — Quantified the inhalation doses to maximally exposed, non-involved workers at 80 m (or more) from the release point. For elevated releases from the 27 m high stack, the maximum ground level concentration and dose occur at the site boundary and are equal to those for the public MEI at the ORR boundary.

- Qualitatively evaluated the accident effects on involved facility workers:

  — Leaks/fires in process areas are expected to be exhausted directly (via filters) and to not affect unprotected workers in other treatment building areas.

  — Workers in process areas are expected to have appropriate breathing and other protective clothing and equipment. These workers are expected to evacuate the vicinity of an accident without significant consequence.

  — Workers outside the treatment building are considered non-involved unless they are performing specific tasks with appropriate protective equipment.

Based on these assumptions, the risk to involved workers is maintained acceptably low by the use of appropriate protective equipment and risk is not analyzed or discussed further.

Determined the health consequences associated with the doses in terms of “Latent Cancer Fatalities” (LCF) for populations and probability of cancer fatalities for individuals that would result from the exposures and doses. Cancer fatality consequences to the affected populations were based on the fatal cancer incidence rates of 4E-04 LCF per person-rem in the worker populations and 5E-04 LCF per person-rem in the off-site public population as described in Chapter 3, Affected Environment. These risk factors also were applied to MEI and maximally exposed non-involved worker doses. The product of the dose and the fatal cancer incident rate is an estimate of the probability the exposed individual will experience a cancer fatality.

Risk was measured as the average consequence that accounts for both the consequence and likelihood of an accident. For example, an accident with a low likelihood and high consequence can have the same risk as an accident with a high likelihood and low consequence. For the comparison of accidents affecting the No Action and treatment alternatives, the risk measure selected is total expected fatalities. This risk is computed as the product of the accident frequency, the time period in which the accident can occur, and the computed consequence. The risk is used to compare the expectation of fatalities for the no action and treatment alternatives on a consistent basis.

$$Total\ Expected\ Fatalities = \frac{Accidents}{Year} \times \frac{Years}{Alternative} \times \frac{Cancer\ \ fatalities}{Accident}$$

•

The likelihood of industrial injuries, fatalities, and risks was estimated based upon the labor estimates discussed in Section 4.13, Socioeconomic Impacts.

The evaluation of each of the accidents scenarios follow. The consequences and likelihoods of process and storage accidents are based on those defined for the Melton Valley Storage Tanks in the *Safety Analysis Report for the Liquid Low-Level Waste Management Systems* (Bechtel Jacobs 1999). An accident scenario and associated assumptions are presented first, followed by the impacts for each alternative. A summary is provided at the end of each accident scenario to provide an easy comparison of the alternatives.

4.11.2 Accidental Breach of the Melton Valley Storage Tanks

An accidental breach of the Melton Valley Storage Tanks could result in the release of TRU sludge and its associated low-level liquid waste into the secondary containment of the Melton Valley Storage Tanks facility and potentially into the environment. The impacts associated with the alternatives were based on the assumption that the Melton Valley Storage Tanks and their secondary containment could withstand the evaluation basis earthquake (0.2g ground acceleration) (Bechtel Jacobs 1999) that occurs with a frequency of 1E-03 per year over a 10- to 20-year period. For facility operating periods of approximately 20 years or less, it is reasonable to assume that only evaluation basis-type accidents and natural phenomena and limited accident consequences would occur.

4.11.2.1No Action Alternative

For the analysis of the No Action Alternative, it was assumed that the radioactive liquid wastes would be stored in the Melton Valley Storage Tanks without treatment for the 100 years of institutional control, and that a more severe, "Beyond Evaluation Basis" accident would occur. The No Action Alternative is assumed to begin after current Melton Valley Storage Tanks waste transfer operations are terminated. Within this storage period, an earthquake with approximately double the intensity of the evaluation basis earthquake could occur with equal likelihood (i.e., 10 years × 1E-03 per year = 100 years × 1E-04 per year = 0.01). If a "Beyond Evaluation Basis" earthquake were to occur, there is a potential for the Melton Valley Storage Tanks and their secondary containment to fail causing the liquid wastes to be discharged via White Oak Creek to the Clinch River. The affected populations would include the workers at ETTP and the off-site population in Kingston, Tennessee, that use the Clinch River as a drinking water source.

A "Beyond Evaluation Basis Accident" resulting in liquid waste release from the Melton Valley Storage Tanks and a limited failure of the secondary containment was addressed in the *Safety Analysis Report for the Liquid Low-Level Waste Management Systems* (Bechtel Jacobs 1999). In this accident, the total volume of liquid released to the environment was assumed to be limited to 50,000 gallons, and it was also assumed that the use of this water as a drinking water supply was not banned. The resulting consequence was estimated to range between 4 and 28 rem to a maximally exposed individual at ETTP (assumed to drink 1 L of this water), depending on the dilution flow rate in the Clinch River. For purposes of this analysis, the midpoint of 16 rem was assumed as the dose from ingestion at ETTP.

The human health consequences of an accidental release due to an earthquake were based on the airborne and waterborne pathways, doses, and a fatal cancer incidence rate (4E-04 LCF/person-rem for workers and 5E-04 LCF/person-rem for the public). The 16 rem accidental dose to the maximally exposed individual at ETTP due to a release from the Melton Valley Storage Tanks is a factor of 107,000 times higher than would occur due to expected releases from ORNL (0.15 mrem) (ORNL et al. 1997). By proportion, the corresponding affected population doses (assuming a limited ingestion of 1 L/person of contaminated water) are 31,000 person-rem (0.29 person-rem due to normal releases) to the ETTP population and 160,000 person-rem (1.5 person-rem due to normal releases) to the Kingston population (ORNL et al. 1997). The projected consequences are 12 LCFs in the ETTP worker population and 80 LCF in the Kingston population due to ingestion of contaminated drinking water (Table 4-24).

Table 4-24. Frequencies and consequences of the No Action Alternative for Melton Valley Storage Tanks storage accidents

Accident	Accident frequency	MEI accident boundary doses[a] (rem)	Affected population dose per accident (person-rem)	Total LCF per accident
Beyond Evaluation Basis Earthquake	1E-04 per year	Ingestion - 16	Ingestion -	
			(ETTP) 31,000	12
			(Kingston) 160,000	80
		Inhalation - 2.1	Inhalation - 32,000	<u>16</u>
		Total		108

[a]Accident frequencies and MEI boundary doses based on Bechtel Jacobs 1999. Inhalation boundary doses are at the Oak Ridge Reservation boundary (public MEI), and the ingestion boundary doses are at ETTP (non-involved worker).

Airborne releases from ORNL occurring in 1997 resulted in a 0.38 mrem dose to the off-site maximally exposed individual and a collective dose of 5.8 person-rem to the surrounding population of 879,546 within 80 km (50 miles). The corresponding affected population doses due to an accidental release from the Melton Valley Storage Tanks due to an earthquake under the No Action Alternative were obtained by proportion. The ratio of the “Beyond Evaluation Basis” earthquake site boundary MEI inhalation dose of 2.12 rem to the 1997 ORNL MEI site boundary dose is 5,600. Comparably, the affected population inhalation dose for the earthquake scenario is 5,600 times the 5.8 person-rem 1997 population dose, or 32,000 person-rem. The inhalation dose consequence to the surrounding population due to the earthquake is 16 LCF in addition to the ingestion consequence. The corresponding consequence to the 2.1 rem MEI dose is a 1.1E-03 probability of a cancer fatality.

The inhalation dose to an non-involved worker 80 m from the ground-level release point is computed based on the 2.1 rem ORR MEI boundary dose (Bechtel Jacobs 1999), and the ratio of the χ/Q values at 80 m and the ORR boundary (1,439 m). For F-stability conditions and a wind speed of 1 m/s, the ratio of the χ/Q values is 108 (Turner 1969). The resulting dose to the non-involved worker is 230 rem. The corresponding consequence is a 0.092 probability of a cancer fatality.

The associated risk computed for the “Beyond Evaluation Basis” earthquake accident is 1.1 expected fatalities based on the 108 LCF, the 1E-04/year frequency, and the 100-year institutional period of control. The risks to the MEI and non-involved worker are 1.1E-05 and 9.2E-04 expected fatalities, respectively.

A breach of the Melton Valley Storage Tanks from an earthquake resulting in a 50,000-gallon release of radioactive waste would contaminate approximately 0.56 ha (1.37 acres) of land and 24,526 m^3 (32,083 yd^3) of soil. Complete calculations and assumptions are presented in Appendix F.3. Until an environmental cleanup could occur, and the waste and impacted soil be removed, the land use would be significantly altered from its present condition and would be unusable for other purposes. Aquatic biota in a 1-kilometer (0.6-mile) reach of Melton Branch and White Oak Creek would be killed by chemical toxicity, perhaps by high pH, and possibly by acute external radiation exposure (Appendix F.2). Recolonization of this reach would take up to a year. Herons and other fish-eating biota could be harmed by acute external radiation exposure if they remain in close proximity to the released water. The contaminants would likely move quickly downstream to White Oak Creek, where radiation toxicity is also probable. Dilution of the non-radioactive contaminants in White Oak Lake would rapidly (in a few days) reduce the concentrations of contaminants below levels causing chemical toxicity, and the pH would probably change to non-toxic levels. However, chronic radiation doses to aquatic biota and fish-eating predators in White Oak Lake would remain above benchmarks for acceptable chronic radiation levels for a few days to a few weeks. The predominant exposures are to cesium-137 from Melton Valley Storage Tank W-26, or to cesium-137, cobalt-60, and strontium-90 from Melton Valley Storage Tank W-28. Dilution of contaminants by their release into the Clinch River would reduce radiation doses to aquatic biota and fish-eating predators to acceptable levels.

In this accident scenario for the No Action Alternative with 50,000 gallons of liquid waste released to the environment, there is a potential impact to the soil and groundwater. (Appendix F.3 details the evaluation of the impacts of such a release). For evaluation purposes, it was assumed that liquid waste would leak from the secondary containment in a band as wide as 45.72 m (150 ft) across the lower front edge of the vault, in a zone parallel to slope down to the Melton Branch. Furthermore, it is assumed that the waste would initially leak through the unsaturated overburden impacting a volume of soil 45.72 × 22.86 × 3.96 m (150 × 75 × 13 ft) prior to reaching the groundwater surface. Once the waste reaches the water table/groundwater surface, it is further assumed that waste would mix with the shallow groundwater and ultimately discharge out to Melton Branch approximately 121.92 m (400 ft) away. Details of this conceptual model are depicted in Appendix F.3, Figure 1. Such a release could potentially impact 0.557 ha (5,573.6 m^2) of area and 24,526 m^3 (866,160 ft^3) of soil.

The impacts to the groundwater from a breach of the Melton Valley Storage Tanks under the No Action Alternative included the assumption that Melton Valley Storage Tank W-28 would breach and spill its entire contents (approximately 50,000 gallons). The strontium-90 concentrations in this tank were reported to be 1.5 E+05 Becquerels/ml (Keeler 1996). This concentration in tank W-28 indicates that strontium-90 accounts for approximately 15% of the total radioactive material in that tank (as measured in Becquerels). Assuming that the concentrations reported are accurate for all the waste in tank W-28, approximately 766 curies of strontium-90 would be released to the environment from this accident scenario. If the mass of strontium-90 were evenly distributed across the potentially impacted area described above, the concentrations in the soil and groundwater would equate to 2.08E+07 pCi/kg and 1.04E+06 pCi/L, respectively. Based on assumed soil/water partitioning interactions, the maximum values that could be expected would be equal to 8.09E+10 pCi/kg in the soil and 4.05E+09 pCi/L in the groundwater. All calculations are detailed in Appendix F.3.

These resulting concentrations in the soil and groundwater would be significant if this accident scenario were to occur, since little to any previous impact for strontium-90 has been reported for the soil and groundwater near the proposed TRU Waste Treatment Facility and south of the Melton Branch. Furthermore, these concentrations reflect an apparent driver for remediation when compared to the 10^{-6} residential risk scenario values of 0.014 pCi/kg and 0.85 pCi/l for soil and water (RAIS, 1/11/2000). If remediation (soil removal and replacement) is assumed, then over 24,526 m^3 of contaminated soil would have to be removed and stored onsite. This would require approximately 2.4 ha (6 acres) of storage space based on the storage volumes presented in Table 2-4 for similar waste. In addition, the 100-year and 500-year floodplains and wetlands between the High Flux Isotope Reactor access road and Melton Branch would be adversely impacted by both the contaminant plume (Figure 1, Appendix F.3) and the earthmoving associated with remediation.

4.11.2.2 Low-Temperature Drying Alternative

Since the Low-Temperature Drying Alternative would be completed in less than 10 years, the probability of a "Beyond Evaluation Basis" earthquake occurring is small, and therefore was not evaluated.

4.11.2.3 Vitrification Alternative

Since the Vitrification Alternative would be completed in less than 10 years, the probability of a "Beyond Evaluation Basis" earthquake occurring is small, and therefore was not evaluated.

4.11.2.4 Cementation Alternative

Since the Cementation Alternative would be completed in less than 10 years, the probability of a "Beyond Evaluation Basis" earthquake occurring is small, and therefore was not evaluated.

4.11.2.5 Treatment and Waste Storage at ORNL Alternative

Since waste treatment under this alternative would be completed in less than 10 years, the probability of a " Beyond Evaluation Basis" earthquake occurring is small, and therefore was not evaluated.

4.11.3 Breach of the Transfer Line Between the Melton Valley Storage Tanks and the Proposed TRU Waste Treatment Facility

The frequency and consequences of a transfer line failure between the Melton Valley Storage Tanks and the proposed TRU Waste Treatment Facility are the same for all of the alternatives that include waste treatment. This type of accident has been evaluated in the *Safety Analysis Report for the Liquid Low-Level Waste Management Systems* (Bechtel Jacobs 1999); two accidents were evaluated:

Accident	MEI Inhalation dose	Ingestion dose[a]
Component failure during sludge transfer	2.1 rem	0
Tank overfill during sludge transfer	Approximately 0	6.1 rem

[a]Inhalation boundary doses are at the ORR boundary (public MEI) and the ingestion boundary doses are at ETTP (non-involved workers)

Due to Melton Valley Storage Tanks operational and design considerations, these two accidents do not result from a single cause. However, during waste transfer operations, both consequences could result from a complete line failure and direct release to the air and surface waters.

4.11.3.1 No Action Alternative

Since construction of a waste treatment facility would not be implemented for this alternative, this accident scenario was not analyzed.

4.11.3.2 Low-Temperature Drying Alternative

A breach of the transfer line between the Melton Valley Storage Tanks and the proposed waste treatment facility was estimated to occur in the "extremely unlikely" frequency range, 1E-04 to 1E-06 per year (Bechtel Jacobs 1999). Since sludge transfers to the proposed treatment facility are expected to be semi-continuous, the estimated frequency category is increased to the "unlikely" frequency range (1E-02 to 1E-04 per year).

To present a bounding analysis, the maximally exposed non-involved worker at ETTP is assumed to ingest surface waters and receive the bounding 6.1-rem dose. Based on the 6.1-rem boundary dose, the affected ETTP population ingestion dose is 12,000 person-rem and the corresponding consequence is 4.7 LCF. The public population at Kingston receives a dose of 61,000 person-rem with a consequence of 31 LCF.

The public MEI at the ORR boundary would be exposed to the airborne release and receive the bounding 2.1 rem dose. The inhalation dose to the public population within 50 miles, based on the ORR MEI boundary dose, is 32,000 person-rem. The corresponding consequence to this population is 16 LCF. The consequence of the 2.1 rem MEI dose is 1.1E-03 probability of a cancer fatality.

The ORR MEI (public) boundary inhalation dose for the transfer line failure is the same as that for the tank rupture accident, 2.1 rem. Therefore, the inhalation dose and consequence to the non-involved worker is also the same, 230 rem and 0.092 probability of a cancer fatality.

The estimated frequency for this accident is in the range of 1E-02 to 1E-04 per year for this accident; the midpoint frequency of 1E-03 per year was used to calculate the risk. The risk estimate is based on a total of 35 LCF due to ingestion in the ETTP and Kingston populations, and 16 LCF due to inhalation in the surrounding population within 50 miles. The total calculated risk is 0.16 expected fatalities. The risks to the public MEI and non-involved worker are 3.2E-06 and 2.8E-04 expected fatalities.

4.11.3.3 Vitrification Alternative

The frequency, consequences, and risks of a transfer line failure between the Melton Valley Storage Tanks and the proposed waste treatment facility are the same as those determined for the Low-Temperature Drying Alternative.

4.11.3.4 Cementation Alternative

The frequency and consequences of a transfer line failure between the Melton Valley Storage Tanks and the proposed waste treatment facility are the same as those determined for the Low-Temperature Drying Alternative. However, due to the increased period of the tank waste treatment under this alternative (6 years), the calculated risk is 0.31 expected fatalities in all affected populations. The risks to the public MEI and non-involved worker are 6.3E-06 and 5.5E-04 expected fatalities, respectively.

4.11.3.5 Treatment and Waste Storage at ORNL Alternative

The frequency and consequences of a transfer line failure between the Melton Valley Storage Tanks and the proposed waste treatment facility are the same as those determined for the Low-Temperature Drying Alternative. However, due to the variation of the tank processing period from 3 to 6 years, the risk ranges from a total of 0.16 to 0.31 expected fatalities in all affected populations.

4.11.4 A Slurry Line Failure Within the TRU Waste Treatment Facility

The slurry line failure within the proposed TRU Waste Treatment Facility is similar to the transfer line failure between the Melton Valley Storage Tanks and the treatment facility, except this accident scenario assumes that major leaks would be confined within the proposed treatment facility and would be detected more rapidly (1 hour vs. 2 hours). This accident could potentially occur during any of the treatment alternatives**.**

4.11.4.1 No Action Alternative

Since construction of a waste treatment facility would not be implemented for this alternative, this accident scenario was not analyzed.

4.11.4.2 Low-Temperature Drying Alternative

The slurry line failure accident within the proposed treatment facility is estimated to occur in the per year "unlikely" frequency range (1E-02 to 1E-04 per year).

Since the proposed facility would be designed as a "zero-release" facility, no direct release to surface waters would be possible. Any airborne releases would occur via HEPA filters and the 27-m (89-ft)-high stack. The shorter exposure reduces the dose by a factor of 2, the HEPA filters (assumed to be in a degraded state) provide a factor of 100 reduction, and the elevated (versus ground level) release reduces the dose by a factor of 3 (χ/Q = 1.2E-04 s/m^3 vs. 3.7E-04 s/m^3) (Turner 1969). The resulting ORR boundary dose becomes 3.4E-03 rem.

$$Dose = 2.1\ rem \times \frac{1\ h}{2\ h} \times 0.01 \times \frac{1.2E-04}{3.7E-04} = 0.0034\ rem$$

Since the suspended radionuclides are released for the stack at an elevation of 27 m, the maximum ground-level dose occurs at the ORR boundary. Therefore, the maximum non-involved worker dose is equal to the public MEI dose at the ORR boundary. The corresponding consequences are 1.7E-06 and 1.4E-06 probabilities of a cancer fatality for the public MEI and non-involved worker, respectively.

The corresponding affected population inhalation dose resulting from this release is 52 person-rem to the surrounding population within 50 miles and a resulting consequence of 0.026 LCF. The corresponding risk, based on a 3-year risk period (corresponds to the tank waste treatment period), is 7.8E-05 expected fatalities. The risks to the MEI and non-involved worker are negligible.

4.11.4.3 Vitrification Alternative

The slurry line failure inside the proposed treatment facility would result in the same impacts as those calculated for the Low-Temperature Drying Alternative.

4.11.4.4 Cementation Alternative

The slurry line failure inside the proposed treatment facility would result in the same dose and consequence to the surrounding population within 50 miles as those calculated for the Low-Temperature Drying Alternative. The risk increases to 1.6E-04 expected fatalities due to the longer tank waste treatment period of six years. The risks to the public MEI and non-involved worker are negligible.

4.11.4.5 Treatment and Waste Storage at ORNL Alternative

The slurry line failure inside the proposed treatment facility would result in the same dose and consequence to the surrounding population within 50 miles as those calculated for the

Low-Temperature Drying Alternative. The risk ranges from 7.8E-05 to 1.6E-04 expected fatalities depending on the tank waste treatment period for the selected treatment process. The risks to the MEI and non-involved worker are negligible.

4.11.5 Failure of the Slurry Line and the HEPA Filters in the Proposed TRU Waste Treatment Facility

This slurry line failure within the proposed TRU Waste Treatment Facility is similar to the slurry line failure discussed above, except this accident scenario assumes that the filters are in a degraded state. It is assumed that the HEPA filters are damaged, or removed and not replaced, and a slurry line accident occurred in the building. The suspended hazardous particles in the air are assumed exhausted without filtration. This accident could potentially occur during any of the treatment alternatives.

4.11.5.1No Action Alternative

Since construction of a waste treatment facility would not be implemented for this alternative, this accident scenario was not analyzed.

4.11.5.2Low-Temperature Drying Alternative

Since the filter failure and the line failure are not coupled events, the estimated frequency of the combined events is estimated to be in the per year "extremely unlikely" (1E-04 to 1E-06) frequency range. A dose of 0.34 rem to a MEI at the ORR boundary would result if this accident occurred while the HEPA filters were in a failed state since the HEPA filters would not be able to provide the reduction factor of 100 assumed in the slurry line failure accident. Based on this ORR boundary dose, an inhalation dose of 5200 person-rem in the surrounding population within 50 miles in estimated. The corresponding consequence and risk in this population are 2.6 LCF and 7.8E-05 expected fatalities.

As with the slurry line failure with filtration, the maximum dose to the MEI and non-involved worker occurs at the ORR boundary and is equal to 0.34 rem. The corresponding consequences are 1.7E-04 and 1.4E-04 probabilities of a cancer fatality. The risks are the same as for the slurry line failure risks and are negligible for the public MEI and non-involved worker.

4.11.5.3Vitrification Alternative

The slurry line failure and HEPA filters failure inside the proposed treatment facility would result in the same impacts as those calculated for the Low-Temperature Drying Alternative.

4.11.5.4Cementation Alternative

The slurry line failure and HEPA filters failure inside the proposed treatment facility would result in the same dose and consequence to the surrounding population within 50 miles as those calculated for the Low-Temperature Drying Alternative. The risk increases to 1.6E-04 expected fatalities due to the longer tank waste treatment period of six years. The risks to the public MEI and non-involved worker would be negligible.

4.11.5.5Treatment and Waste Storage at ORNL Alternative

The slurry line failure and HEPA filters failure inside the proposed treatment facility would result in the same dose and consequence to the surrounding population within 50 miles as those calculated for the Low-Temperature Drying Alternative. The corresponding risk ranges from 7.8E-05 to 1.6E-04 expected fatalities depending on the length of the tank waste treatment period. The risks to the public MEI and non-involved worker would be negligible.

4.11.6 Failure of Contact-Handled or Remote-Handled Solid Waste Containers Before, During, and After Waste Treatment

The failure of contact-handled or remote-handled solid waste containers before, during, and after waste treatment includes several accident scenarios. The contact-handled and remote-handled solids are stored within steel containers and casks in their current storage facilities. The risk of storage is expected to be small because the wastes are not in a dispersible form; they are confined within waste packages. Releases occurring as a result of postulated accidents would be confined within the storage buildings. However, bounding estimates of the frequency categories and consequences of accidents have been made. Three types of accidents were evaluated for the pre-treated wastes stored in the existing waste storage facilities. These include a vehicle impact (e.g. a forklift truck accident), earthquake, and a vehicle impact/fire. During waste treatment, the solid wastes would be sorted and repackaged. Three types of accidents were evaluated that could occur during solid waste treatment: vehicle impact, a vehicle impact/fire, and a processing fire with degraded filters. Following waste treatment, a vehicle impact/fire was evaluated for the alternatives.

The following assumptions are made to estimate accident consequences:

- The contact-handled wastes have an average concentration of 8.1 Ci/m^3 equivalent plutonium-239, and the remote-handled wastes have an average concentration of 0.62 Ci/m^3equivalent plutonium-239. (An equivalent curie of plutonium-239 is the inhaled activity of the mixture of radionuclides that produces the same radiological dose as the inhaled dose of the mixture of other radionuclides.) These concentrations were calculated based on data in the *TRU Waste Baseline Inventory Report* (1997) (see Appendix B for data summary). However, in all consequence calculations involving these wastes, the bounding concentration of 8.1 Ci/m^3 is used.

- The total volume of contact-handled solid wastes to be processed is 1,000 m^3, and the total remote-handled solid waste volume is 550 m^3.

- For the vehicle impact and earthquake accidents, damage to the affected waste packages is expected, but the waste packages are not completely destroyed. Under these conditions, it is assumed that 10% of the radionuclides are released from the base waste materials as a powder, a fraction of 6E-04 of the powder is suspended as a respirable aerosol, and 10% of the aerosol is released from the waste package(s) (DOE 1994).

- In the event of a postulated local fire (e.g., a forklift accident and ignition of the fuel), 50% of the contents of the waste packages affected are assumed combustible. A bounding estimated fraction of 5E-04 of packaged combustible wastes becomes suspended as a respirable aerosol in a fire.

- None of the released radionuclides is held up in the storage buildings.

- The distance from each waste site to the ORR boundary is assumed to average 1,439 m (4,721 ft), the distance from the Melton Valley Storage Tanks to the ORR boundary (Bechtel Jacobs 1999). Using F-stability conditions and 1 m/s wind velocities, the computed χ/Q is 3.7E-04 s/m^3 (Turner 1969). The χ/Q at the non-involved worker, 80 m from the release, is 4E-02 s/m^3 as previously discussed.

- The inhalation dose to the surrounding population within 80 km (50 miles) is computed based on the airborne pathway model discussed in Section 3 (ORNL et al. 1997).

4.11.6.1No Action Alternative

Since there would be no treatment under the No Action Alternative, only three accident scenarios are postulated to affect the remote-handled and contact-handled waste packages that would continue to be stored in the existing storage facilities. Due to the expected infrequent vehicle activity, significant vehicle accidents are estimated to occur in the 1E-02 to 1E-04 per year "unlikely" frequency range. The combination of a vehicle accident and a fire reduces the frequency by one category to 1E-04 to 1E-06 per year ("extremely unlikely" frequency range). The evaluation basis earthquake occurs in the 1E-02 to 1E-04 per year category.

A vehicle impact accident (without an assumed fire) is postulated to affect 1% of the contact-handled stored wastes (10 m^3 or four ST-90 boxes). An earthquake (without an assumed fire) is postulated to affect 10% of the stored wastes (155 m^3 or 57 ST-90 boxes). A vehicle impact and fuel ignition accident is postulated to affect the contents of one contact-handled ST-90 box (2.7 m^3 containing 50% combustible wastes). In the vehicle impact/fire accident, 1% of the wastes are also affected due to the mechanical impact. However, due to the noncombustible waste containers, the spread of fire to other containers is not considered likely.

The radiological dose to the public MEI standing on the ORR site boundary in the center of the plume is computed as the product of the respirable source term (Assumptions 1 to 5), a χ/Q of 3.7E-04 s/m^3 (Assumption 6), a breathing rate of 1.2 m^3/h or 3.3E-04 m^3/s (Bechtel Jacobs 1999), and an inhalation dose conversion factor of 5.1E+08 rem/Ci for plutonium-239 (DOE/EH-0071) (DOE 1998a). The estimated source terms and risks for each accident scenario are listed in Tables 4-25 and 4-26, respectively.

Consequences to the surrounding population within 80 km (50 miles) due to airborne releases are estimated as described for the Melton Valley Storage Tanks accidents, based on the pathway modeling and the incidence rate of 5E-04 LCF per person-rem described in Section 3. Consequences to the non-involved worker are based on an incidence rate of 4E-04 cancer fatalities per person rem (ORNL et al. 1997).

Table 4-25. Estimated source terms for the No Action Alternative contact-handled and remote-handled waste storage accidents

Accident	Volume of waste affected (m^3)	Total suspension fraction	Respirable aerosol source term (Ci plutonium-239)
Vehicle impact	10	6E-06	4.9E-04
Earthquake	155	6E-06	5.1E-03
Vehicle impact/fire			
Effect of impact	10	6E-06	4.9E-04
Effect of fire	1	5E-04	4.1E-03
Total source term			4.5E-03

Table 4-26. Estimated frequencies and consequences for the No Action Alternative contact-handled and remote-handled waste storage accidents

Accident	Public MEI site boundary dose (rem)	Population dose (person-rem/ accident)	Consequence (LCF/accident)	Frequency range	Risk to population (expected fatalities)[a]
Vehicle impact	0.031	470	0.24	1E-02 to 1E-04 per year	0.024
Earthquake	0.32	4,900	2.4	1E-02 to 1E-04 per year	0.24
Vehicle impact/ fire	0.28	4,300	2.1	1E-04 to 1E-06 per year	0.0021

[a]The risk computations are based on the midpoint frequency in the frequency range.

The doses to the non-involved worker 80 m from the release point are estimated based on the MEI ORR boundary doses in Table 4-26 and the ratio of the χ/Q values, 108. The non-involved worker doses for the vehicle impact, earthquake, and vehicle impact/fire are 3.3, 35, and 30 rem, respectively.

The risks to the public MEI are 1.6E-06, 1.6-05, and 1.4-07 expected fatalities for the three accidents. The corresponding risks to the non-involved worker are 1.4E-04, 1.4E-03, and 1.2E-05 expected fatalities.

4.11.6.2Low-Temperature Drying Alternative

For this alternative, the consequences resulting from accidents before treatment would be the same as those discussed in the No Action Alternative. Table 4-27 presents the frequency, consequences, and risks of the various accident scenarios for the Low-Temperature Drying Alternative.

As shown, the population risks are a factor of 30 smaller than for the No Action Alternative due to much smaller time periods at risk (3 vs. 100 years). The risks to the MEI are 4.7E-08, 4.8E-07, and 4.2E-09 expected fatalities for the three accidents. The corresponding risks to the non-involved worker are 4.0E-06, 4.1E-05, and 3.6E-07 expected fatalities.

Once the solid waste packages are brought into the proposed treatment facility, the consequences of accidents are reduced due to HEPA filtration and elevated release point. Within the facility, the wastes are sorted, repackaged, and macroencapsulated; it is anticipated the waste packages will be placed in storage or shipped. The maximum release and suspension of radionuclides can result from accidents occurring while the wastes are being sorted in an unconfined state. Once the solid wastes are treated and encapsulated, the consequences of non-fire accidents are expected to be decreased by a factor at least 10 to 100 since the macroencapsulants effectively prevent suspension of respirable aerosols. For the vehicle impact/fire accident, a reduction in consequences is expected even with combustible macroencapsulants since the reduced waste surface area prevents self-sustained combustion. For conservatism, however, it is assumed that treated packaged wastes with combustible macroencapsulants have the same consequence as the untreated packaged wastes.

As a bounding case, it is assumed that after contact-handled wastes are removed from their waste package, a fire affecting 2.7 m^3 (95 ft^3) of waste (50% combustible) occurs. It is further assumed that the fire damages all HEPA filters, resulting in a combined efficiency of 99% (1% bypass). For unconfined contaminated cellulose and plastic wastes in a fire, 1% of the contaminants will be suspended. The inhalation dose to the public MEI at the ORR boundary is computed as:

$$\text{Dose} = 2.7\ m^3 \times 8.11 \text{ curies plutonium-239 equivalent } /m^3 \times 50\% \text{ combustible} \times 0.01 \times 0.01 \times 1.2\text{E-04 s}/m^3 \times 3.3\text{E-04 } m^3/s \times 5.1\text{E+08 rem/Ci} = 0.022 \text{ rem}$$

Table 4-27. Frequency and consequences of contact-handled and remote-handled solid waste treatment accidents for the Low-Temperature Drying Alternative

Accident	Frequency range	Pubic MEI site boundary dose (rem/ accident)	Inhalation population dose (person-rem/ accident)	Consequence (cancer fatalities/ accident)	Risk to population (expected fatalities)[a]
Bounding storage accidents before waste treatment					
Vehicle impact	1E-02 to 1E-04 per year	0.031	470	0.24	7.1 E-04
Earthquake	1E-02 to 1E-04 per year	0.32	4900	2.4	7.2E-03
Vehicle impact/fire	1E-04 to 1E-06 per year	0.28	4300	2.1	6.3E-05
Bounding accidents during waste treatment					
Vehicle impact	1E-02 to 1E-04 per year	<0.001	<15	<0.0075	2.3E-05
Vehicle impact/fire	1E-04 to 1E-06 per year	<0.001	<15	<0.0075	2.3E-05
Processing fire with degraded filters	1E-04 to 1E-06 per year	0.022	340	0.17	5.1E-06
Bounding accidents after waste treatment					
Vehicle impact/fire	1E-04 to 1E-06 per year	0.28	4300	2.1	6.3E-05

[a]The risk computations are based on the midpoint frequency in the frequency range and a treatment time of 3 years.

The corresponding affected population inhalation dose and consequence are 340 person-rem and 0.17 LCF. The likelihood of this accident depends on the probability that a relatively small fire can degrade multiple-series filters to a total estimated efficiency of 99% (from an initial efficiency of more than 99.9% for each filter stage). The frequency of the fire, given the lack of significant ignition sources, is estimated to be in the "unlikely" frequency range (1E-02 to 1E-04 per year). The probability of significant degradation of multiple-filter banks decreases this frequency to the "extremely unlikely" frequency range (1E-04 to 1E-06 per year) or lower.

Due to the elevated release point, the dose to the non-involved worker is the same as for the MEI at the ORR boundary, 0.022 rem. The risks to the MEI and non-involved worker are a factor of a thousand lower than the population risk and are considered negligible.

4.11.6.3Vitrification Alternative

A drop or impact of the bare solidified glass matrix could result in a very small quantity of suspended respirable-sized particles (DOE 1994). With the metal casing enclosing the matrix, the quantity suspended is negligible. The solidified glass matrix is not combustible or susceptible to suspension due to an external fire. The consequences of this event are negligible. The contact-handled and remote-handled solid waste repackaging processes are comparable to the Low-Temperature Drying Alternative. The principal difference is the use of a noncombustible macroencapsulant (grout) for RH and CH solids in the Vitrification Alternative. This eliminates the small consequence of the vehicle/fire accident involving processed waste packages resulting in negligible consequence and risk after treatment.

4.11.6.4 Cementation Alternative

Similar to the Vitrification Alternative, the consequences of accidents affecting solid waste containers are considered negligible.

4.11.6.5 Treatment and Waste Storage at ORNL Alternative

Similar to the Low-Temperature Drying Alternative, the consequences of accidents affecting solid waste containers during treatment are considered negligible. It is assumed that combustible macroencapsulant is used, so the bounding accident dose to the public MEI at the ORR boundary is 0.28 rem for the vehicle impact/fire accident after waste treatment. This dose is based on the conservative assumption that the release in a fire involving a treated package is the same as the release from an untreated package. The corresponding inhalation dose and consequence to the surrounding population within 50 miles are 4,300 person-rem and 2.1 LCF. For a midpoint frequency of 1E-05 accidents per year, and an assumed risk period of 100 years (based on indefinite waste storage at ORNL), the risk is 2.1E-03 expected fatalities in the surrounding population within 50 miles. The risks to the public MEI and non-involved worker would be 1.4E-07 and 1.2E-05 probabilities of fatalities.

4.11.7 Accidents Unique to An Alternative

4.11.7.1 No Action Alternative

No unique accidents were identified for this alternative with the exception of the breach of the Melton Valley Storage Tanks, which was previously addressed in Section 4.11.2.1.

4.11.7.2 Low-Temperature Drying Alternative

No unique accidents were identified for this alternative.

4.11.7.3 Vitrification Alternative

Loss of Cooling Water to Quench Scrubber

In the event of a complete loss of cooling water, high-temperature melter off-gases (300 to 400°C) would be exhausted through the HEPA filters to the 27-m-high stack. Filter failure is assumed. The following source terms have been estimated to result from the melter off-gas release (the source terms were calculated based on mass balance estimates presented in Appendix B):

Radionuclides: 5.3 curies equivalent plutonium-239 processed over 3 years or
2.0E-04 curies equivalent plutonium-239/per hour

NO_X: 60,000 kg NO_2/3 years or
634 mg NO_2/s

Assuming a 1-hour release/exposure, χ/Q of 1.2E-04 s/m^3, a breathing rate of 3.33E-04 m^3/s (1.2 m^3/h), and a dose conversion factor of 5.1E+08 rem/Ci, the resulting dose to the public MEI at the ORR boundary is:

$$\text{Dose} = 2.0\text{E-04 curies} \times 1.2\text{E-04 s/m}^3 \times 3.3\text{E-04 m}^3\text{/s} \times 5.1\text{E+08 rem/Ci}$$
$$= 0.0040 \text{ rem}$$

The corresponding affected population inhalation dose in the surrounding population within 50 miles is 61 person-rem resulting in 0.031 LCF.

The peak NO_2 concentration (C) at the ORR site boundary is:

$$C = 700 \text{ mg } NO_2/s \times 1.2E\text{-}04 \text{ s/m}^3$$
$$= 0.076 \text{ mg } NO_2/m^3$$

This value is well below continuous exposure limits for NO_2 (1.9 mg/m^3 time-weighted average) and shorter duration exposure limits such as the Emergency Response Planning Guideline–Level 2 (ERPG-2) concentration of 29 mg/m^3.

Since both the radiological contaminants and the NO_2 are released via the 27-m-high stack, the maximum doses to the non-involved worker are the same as the public MEI dose at the ORR boundary.

This accident is estimated to occur in the 1E-02 to 1E-04 per year "unlikely" frequency range depending on the types of controls and interlocks incorporated into the design. Assuming the midpoint frequency of 1E-03 per year, a consequence of 0.031 probability of cancer fatalities, and a risk period of 3 years, the corresponding risk for this accident scenario is 9.3E-05 expected fatalities. The risks to the MEI and non-involved worker are negligible.

Failure of the Melter Exhaust

Failure of the building HEPA filters would not result in any direct release since the hazardous constituents are not suspended in the building air. However, the filters in the melter exhaust path actively filter particulates on a continuous basis. This accident is assumed to occur in the E-02 to E-04 per year "unlikely" frequency range. The source term at the outlet of the mist eliminators defines the release for this accident:

Source Term = 0.62 curies equivalent plutonium-239/3 years (waste treatment period)
= 2.4E-05 curies equivalent plutonium-239 per hour

For a 1-hour release, the estimated inhalation dose to the public MEI at the ORR boundary is:

$$\text{Dose} = 2.4E\text{-}05 \text{ curies} \times 1.2E\text{-}04 \text{ s/m}^3 \times 3.3E\text{-}04 \text{ m}^3\text{/s (respiration rate)} \times 5.1E\text{+}08 \text{ rem/Ci}$$
$$= 4.9E\text{-}04 \text{ rem}$$

Since the radionuclides are released via the 27 m stack, the maximum dose to the non-involved worker is the same as the MEI dose at the ORR boundary.

The corresponding inhalation dose and consequence in the surrounding population within 50 miles are 7.5 person-rem, and the consequence is 3.8E-03 LCF. The accident is estimated to occur in the 1E-02 to 1E-04 per year "unlikely" frequency range. Based on the midpoint of the frequency range, 1E-03/year and a risk period of three years (based on the tank waste treatment period) the risk is 1.1E-05 expected fatalities. The risks to the public MEI and non-involved worker are negligible.

Release of Molten Waste Glass

Unspecified failures in the melter subsystem could result in a release of molten glass to the treatment facility. The direct hazard of the release is the potential to ignite local fires. This is considered a standard industrial hazard. It is assumed that materials in the vicinity of the melter are noncombustible and a general building fire will not result. In addition, it is assumed that wastes would continue to be fed to the melter and released into the building. It is not expected that significant amounts of NO_2 will be generated, or that the building HEPA filters will fail as a result of the accident. However, the presence of the molten glass and other hot surfaces is estimated to increase the fraction of radionuclides suspended by a factor of 10 over the "Slurry Line Failure within Treatment Facility" accident. The resulting dose to the public MEI at the ORR boundary is:

$$\text{Dose} = 0.003 \text{ rem} \times 10 = 0.03 \text{ rem}$$

Since the radionuclides are released via the 27 m stack, the maximum dose to the non-involved worker is the same as the public MEI dose at the ORR boundary.

The inhalation dose and consequence to the surrounding population within 50 miles are 460 person-rem and 0.23 LCF. This accident is estimated to occur in the 1E-04 to 1E-06 per year "extremely unlikely" frequency range. Using the midpoint of the frequency range1E-05/year, results in a risk to the surrounding population of 6.9E-06 expected fatalities. The risks to the MEI and non-involved worker are negligible.

4.11.7.4Cementation Alternative

An accident involving catastrophic failure of the centrifuge is postulated. It is assumed that rotating elements within the centrifuge fail and have sufficient energy to penetrate the centrifuge casing. Due to the higher internal fluid pressures, a higher fraction of slurry is suspended as a respirable aerosol in the event of containment failure. A bounding respirable suspension fraction of 2E-03 is applied to this accident, a factor of 20 higher than the factor for low-pressure releases (DOE 1994), resulting in a public MEI dose of 0.06 rem at the ORR boundary. The corresponding inhalation dose and consequence to the surrounding population within 50 miles are 920 person-rem, with a consequence of 0.46 LCF. The potential for catastrophic failure of the centrifuge is estimated to be one frequency category lower than for piping failures, or "extremely unlikely" frequency range (1E-04 to 1E-06 per year). Using the frequency midpoint of 1E-05/year and a 6-year risk period, the risk to the surrounding population is 2.8E-05 expected fatalities.

Since the radionuclides are released via the 27-m-high stack, the maximum dose to the non-involved worker is the same as the public MEI dose at the ORR boundary, 0.06 rem. The risks to the public MEI and non-involved worker are negligible.

4.11.7.5Treatment and Waste Storage at ORNL Alternative

Unique accidents for this alternative are described in the previous sections, since this alternative would involve waste treatment by either low-temperature drying, vitrification, or cementation.

4.11.8 Industrial Accidents

The risks of industrial accidents in each treatment alternative are computed in terms of expected injuries and expected fatalities. These risks are computed directly from the estimated labor (person-hours) per labor category in each treatment alternative defined in Section 4.13, Socioeconomic Impacts, and DOE estimates of the injuries and fatalities per person-hour (DOE 1999).

4.11.8.1No Action Alternative

The only expected activity occurring during the No Action Alternative is surveillance requiring approximately 2 full-time equivalents or 4,000 person-hours/year. The DOE injury rate for operations is 3.7/200,000 person-hours, and the fatality rate is 3.4E-03/200,000 person-hours (DOE 1999). Assuming institutional control for 100 years, the No Action Alternative results in industrial risks of 7.4 injuries and 6.8E-03 fatalities.

4.11.8.2Low-Temperature Drying Alternative

The manpower plan for the Low-Temperature Drying Alternative is shown in Section 4.13, "Socioeconomic Impacts" (Table 4-32). The labor expended during the design phase is principally office work and is not counted toward the industrial accident totals. During construction, treatment, and D&D operations, it is assumed that 10% of the technical labor is spent in the field and counted toward the industrial accident totals.

The DOE injury rate for construction is 6.4/200,000 person-hours (versus 3.7/200,000 for operations). The construction fatality rate for this alternative is the same as operations, 3.4E-03/200,000 person-hours. The weighted total labor (including 10% of technical labor) over the 2-year construction phase and 4-year treatment and D&D phase is 470,000 person-hours. The expected industrial risks for the Low-Temperature Drying Alternative are 11 injuries and 8.0E-03 fatalities.

4.11.8.3Vitrification Alternative

The manpower plan for the Vitrification Alternative is shown in Section 4.13, "Socioeconomic Impacts" (Table 4-35). The assumptions made to estimate the industrial accident risks have been described in Section 4.11.8.2 for the Low-Temperature Drying Alternative. The weighted total labor over the 2-year construction phase and 5-year processing and D&D phases is 1,400,000 person-hours, approximately three times higher than the Low-Temperature Drying Alternative totals. The expected industrial risks for the Vitrification Alternative are 32 injuries and 0.024 fatalities.

4.11.8.4Cementation Alternative

The manpower plan for the Cementation Alternative is shown in Section 4.13, "Socioeconomic Impacts" (Table 4-38). The assumptions made to estimate the industrial accident risks have been described in Section 4.11.8.2 for the Low-Temperature Drying Alternative. The weighted total labor over the 2-year construction phase and 8-year processing and D&D phases is 920,000 person-hours, approximately two times higher than the Low-Temperature Drying Alternative totals. The expected industrial risks for the Cementation Alternative are 20 injuries and 0.016 fatalities.

4.11.8.5Treatment and Waste Storage at ORNL Alternative

The incremental labor required for surveillance and maintenance activities is approximately 4000 person-hours/year, the same as the No Action Alternative. Based on this labor rate, the incremental industrial accident risks for the Treatment and Waste Storage at ORNL Alternative are 0.074 injuries/year and 6.8E-05 fatalities/year. For calculation purposes, it was assumed that storage at ORNL would continue for 100 years resulting in 7.4 injuries and 6.8E-03 fatalities. Adding these incremental risks to the treatment risks of the selected treatment alternative yields the total industrial risks of this alternative. The total injuries range from 18 to 39 and the total fatalities range from 0.015 to 0.031.

4.11.9 Summary of Accident Analysis Results

The five alternatives to the proposed action have been analyzed to assess the risks to the public and ETTP populations, the public MEI at the ORR boundary, and the maximally exposed non-involved worker associated with the postulated accidents. The accident consequences and frequencies of each alternative are summarized in Table 4-28.

The risk in total expected fatalities to the surrounding public and ETTP populations has been calculated for each alternative and is summarized in Table 4-29. As shown, the overall risks for the treatment alternatives are comparable. The accident risks calculated for the No Action Alternative are higher than those calculated for the three action alternatives (Low-Temperature Drying, Vitrification, or Cementation). It should be noted that the risk of the No Action Alternative was estimated over 100 years. Eventually, the Melton Valley Storage Tanks and their secondary containment can be expected to fail, potentially resulting in 108 LCF.

Table 4-30 provides a summary of the maximum consequences and risks to the public MEI on the site boundary and the non-involved worker 80 m or more from the treatment facility and Melton Valley Storage Tanks. These consequences and risks result from inhalation; ingestion consequences are not defined for a public MEI at ETTP.

Table 4-28. Summary of accident consequences and frequencies for the alternatives[a]

Alternative/bounding accident	Accident frequency	Population dose[b] (person-rem)	Consequence (LCF/ accident)
No Action Alternative			
• Earthquake: Melton Valley Storage Tanks and confinement failure	1E-04 per year	ETTP - 31,000 Public - 192,000	108
• Earthquake (stored solid wastes)	1E-02 to 1E-04 per year	4,900	2.4
• Vehicle impact/fire	1E-04 to 1E-06 per year	4,300	2.1
Low-Temperature Drying, Vitrification, and Cementation Alternatives			
• Melton Valley Storage Tanks transfer line failure	1E-02 to 1E-04 per year	ETTP - 12,000 Public - 93,000	52
• Earthquake (stored solid wastes until processed)	1E-02 to 1E-04 per year	4,900	2.4
Treatment and Waste Storage at ORNL Alternative			
• Vehicle impact/fire (following Low-Temperature Drying Alternative only)	1E-04 to 1E-06 per year	4,300	2.1

[a]Accidents listed are those with a risk greater than 1E-03 expected fatalities.
[b]ETTP ingestion dose and public ingestion dose combined.

The estimated cancer fatality consequences to individuals are computed as the product of the dose and the cancer fatality rates: 5E-04 cancer fatality /rem to the MEI and 4E-04 cancer fatality /rem to the non-involved worker. The risks are computed the same as the population risks: the product of the accident frequency, the operating period, and the cancer fatality consequence.

Table 4-31 provides a summary of the accident frequencies and consequences for the three treatment alternatives associated with waste treatment.

Table 4-29. Summary of total risks to the surrounding public and ETTP populations for the alternatives

Alternative/bounding accident[c]	Average accident frequency[a] (accidents/year)	Accident consequences (fatalities/accident)	Operating period (years)	Risk[c] (total expected fatalities)
No Action Alternative				
Breach of the Melton Valley Storage Tanks due to an earthquake	1E-04	108	100	1.1
Contact-handled and remote-handled solid waste container accidents				
Vehicle impact	1E-03	0.24	100	0.024
Earthquake	1E-03	2.4	100	0.24
Vehicle impact/fire	1E-05	2.1	100	0.0021
Industrial accidents	[b]	[b]	100	0.007
Low-Temperature Drying Alternative				
Transfer line failure between the Melton Valley Storage Tanks and Proposed treatment facility	1E-03	52	3	0.16
Contact-handled and remote-handled solid waste container accidents				
Earthquake – stored solid wastes prior to processing	1E-03	2.4	3	0.0072
Industrial accidents	[b]	[b]	6	0.008
Vitrification Alternative				
Transfer line failure between the Melton Valley Storage Tanks and Proposed treatment facility	1E-03	52	3	0.16
Contact-handled and remote-handled solid waste container accidents				
Earthquake – stored solid wastes (prior to processing)	1E-03	2.4	3	0.0072
Industrial accidents	[b]	[b]	7	0.024
Cementation Alternative				
Transfer line failure between the Melton Valley Storage Tanks and Proposed treatment facility	1E-03	52	6	0.31
Contact-handled and remote-handled solid waste container accidents				
Earthquake - stored solid wastes (prior to processing)	1E-03	2.4	6	0.014
Industrial accidents	[b]	[b]	10	0.016
Treatment and Waste Storage at ORNL Alternative				
Transfer line failure between the Melton Valley Storage Tanks and Proposed treatment facility	1E-03	52	3-6	0.16 – 0.31
Contact-handled and remote-handled solid waste container accidents				
Earthquake - stored solid wastes (prior to processing)	1E-03	2.4	3-6	0.0072 – 0.014
Vehicle impact/fire-after processing	1E-05	2.1	100	0.0021
Industrial accidents	[b]	[b]	100	0.015 – 0.031

[a]Accident frequencies are midpoint values in the estimated ranges for process accidents.
[b]Individual accident frequencies and fatalities/accident are not defined. The risk is computed as the product of the labor hours over the operating period and the expected fatalities per labor hour.
[c]Accidents with risks <1E-03 expected fatalities are considered negligible and are not listed.

Table 4-30. Summary of risks for the public MEI and non-involved worker

Alternative/bounding accident[b]	Average accident frequency[a] (accidents/year)	Operating period (years)	MEI		Non-involved worker	
			Inhalation dose (rem)	Risk (probability of cancer fatality)	Inhalation dose (rem)	Risk (probability of cancer fatality)
No Action Alternative						
Breach of the Melton Valley Storage Tanks due to an earthquake	1E-04	100	2.1	1.1E-05	230	9.2E-04
Contact-handled and remote-handled solid waste container accidents						
Vehicle	1E-03	100	0.031	1.6E-06	3.3	1.4E-04
Earthquake	1E-03	100	0.32	1.6E-05	35	1.4E-03
Vehicle impact/fire	1E-05	100	0.28	1.4E-07	30	1.2E-05
Low-Temperature Drying Alternative						
Transfer line failure between the Melton Valley Storage Tanks and Proposed treatment facility	1E-03	3	2.1	3.2E-06	230	2.8E-04
Contact-handled and remote-handled solid waste container accidents						
Earthquake - stored solid wastes prior to processing	1E-03	3	0.32	4.8E-07	35	4.1E-05
Vitrification Alternative						
Transfer line failure between the Melton Valley Storage Tanks and Proposed treatment facility	1E-03	3	2.1	3.2E-06	230	2.8E-04
Contact-handled and remote-handled solid waste container accidents						
Earthquake - stored solid wastes (prior to processing)	1E-03	3	0.32	4.8E-07	35	4.1E-05
Cementation Alternative						
Transfer line failure between the Melton Valley Storage Tanks and Proposed treatment facility	1E-03	6	2.1	6.3E-06	230	5.5E-04
Contact-handled and remote-handled solid waste container accidents						
Earthquake - stored solid wastes (prior to processing)	1E-03	6	0.32	9.6E-07	35	8.3E-05
Treatment and Waste Storage at ORNL Alternative						
Transfer line failure between the Melton Valley Storage Tanks and Proposed treatment facility	1E-03	3-6	2.1	3.2E-06 to 6.3E-06	230	2.8E-04 to 5.5E-04
Contact-handled and remote-handled solid waste container accidents						
Earthquake - stored solid wastes (prior to processing)	1E-03	3-6	0.32	4.8E-07 to 9.6E-07	35	4.1E-05 to 8.3E-05
Vehicle impact/fire-after processing	1E-05	100	0.28	1.4E-07	30	1.2E-05

[a]Accident frequencies are median values in the estimated ranges for process accidents and average fatal accident frequencies (assuming an average number of person/years and 1 fatality/accident) for industrial accidents.

[b]Accidents with population risks <1E-03 expected fatalities are considered negligible and are not listed.

Table 4-31. Summary of the treatment alternatives accident frequencies and consequences

Accident	Accident frequency range	MEI site boundary dose (rem/ accident)	Population dose (person-rem/ accident)	Accident consequences (LCF/accident)
Low-Temperature Drying Alternative				
Melton Valley Storage Tanks transfer Line failure	1E-02 to 1E-04 per year	6.1 - Ingestion 2.1 - Inhalation	ETTP - 12,000 Kingston - 61,000 32,000	4.7 31 16
Slurry line failure Within process Building	1E-02 to 1E-04 per year	0.003	46	0.023
Solid waste container Failure	--	Negligible	Negligible	Negligible
Solid waste container Impact/fire	--	Negligible	Negligible	Negligible
Building filtration Failure: Building filters plus slurry line failure	1E-04 to 1E-06 per year	0.3	4600	2.3
Vitrification Alternative				
Melton Valley Storage Tanks transfer line failure	1E-02 to 1E-04 per year	6.1 - Ingestion 2.1 - Inhalation	ETTP - 12,000 Kingston - 61,000 32,000	4.7 31 16
Slurry line failure within Process building	1E-02 to 1E-04 per year	0.003 rem	46	0.023
Loss of cooling water to Quench scrubber	1E-02 to 1E-04 per year	0.004 rem 0.084 mg NO_2/m^3	61	0.031
Release of molten waste glass	1E-04 to 1E-06 per year	0.03 rem	460	0.23
Solid waste container Impact	--	Negligible	Negligible	Negligible
Solid waste container Impact/fire	--	Negligible	Negligible	Negligible
Building filtration failure				
Off-gas flow path	1E-02 to 1E-04 per year	5E-04 rem	7.5	0.0038
Building filters plus slurry line failure	1E-04 to 1E-06 per year	0.3 rem	4,600	2.3
Cementation Alternative				
Melton Valley Storage Tanks transfer line failure	1E-02 to 1E-04 per year	6.1 - Ingestion 2.1 - Inhalation	ETTP - 12,000 Kingston - 61,000 32,000	4.7 31 16
Slurry line failure within process building	1E-02 to 1E-04 per year	0.003 rem	46	0.023
Catastrophic release of Slurry from centrifuge	1E-04 to 1E-06 per year	0.06 rem	920	0.46
Solid waste Container impact	--	Negligible	Negligible	Negligible
Solid waste Container impact/fire	--	Negligible	Negligible	Negligible
Building filtration failure				
Building filters plus slurry line failure	1E-04 to 1E-06 per year	0.3	4600	2.3

4.12 NOISE IMPACTS

This section discusses noise impacts that would result from the implementation and the alternatives.

4.12.1 Methodology

Methods used to determine the noise impacts from each alternative are listed below.

- Determined construction-related noise using noise data collected from a noise survey of the site (Appendix C.4), assuming the noise levels would be comparable to those measured during construction of the High Flux Isotope Reactor access road.

- Determined operations-related noise levels.

4.12.2 No Action Alternative

Under this alternative, noise levels at the site are expected to decrease slightly when the construction upgrade of the High Flux Isotope Reactor access road is complete. The site would be expected to experience noise ranging from rural to light industrial (50 to 60 dBA Leq).

4.12.3 Low-Temperature Drying Alternative

Construction and operation of the proposed treatment facility, and traffic of construction workers and operations personnel would be comparable to currently noise levels (70 dB during construction, and 50 to 60 dB during operations) due to the road construction near the site. D&D would also result in construction-related noise level increases. However, all these noise impacts are temporary and relatively minor. Noise effects on wildlife would be negligible.

4.12.4 Vitrification Alternative

Noise impacts are expected to be up to 70 dB during construction and D&D activities, and 50 to 60 dB during operations. Noise associated with operations would last 3 years

4.12.5 Cementation Alternative

Noise impacts are expected to be up to 70 dB during construction, and 50 to 60 dB during operations. Noise associated with operations would last 6 years. The Cementation Alternative would result in more traffic noise for a longer period, which is associated with the larger volume of waste shipments off-site.

4.12.6 Treatment and Waste Storage at ORNL Alternative

Noise impacts are expected to be similar to the various treatment alternatives during construction and operations. There would be no off-site transportation-related noise. However, continued storage of the waste on-site would require transportation of the treated wastes within the ORNL boundaries.

4.12.7 Noise Impacts Summary

Noise levels for the No Action Alternative should range from rural to light industrial (50 to 60 daily dBA Leq). For the treatment alternatives, noise levels would be very similar to the noise levels experienced during construction of the High Flux Isotope Reactor access road, or 50 to 70 daily dBA Leq. For the Treatment and Waste Storage at ORNL Alternative, construction noise would be 50 to 70 dBA, with noise in the 50 to 60 dBA range during long-term storage at ORNL.

4.13 SOCIOECONOMIC IMPACTS

Socioeconomic impacts resulting from the implementation of the alternatives are discussed in this section. The socioeconomic impacts analyses assumes that all impacts would occur within the four-county region of influence, which includes Roane, Anderson, Knox, and Loudon counties. This assumption was used to identify the maximum potential socioeconomic impact. The employment and earnings impacts were based on an input-output analysis using the Bureau of Economic Analysis Regional Input-Output Modeling System (RIMS II) (Bureau of Economic Analysis 1999). The RIMS II analysis identifies the indirect employment and earnings effects that result from changes in economic activity through purchases made in the local economy by both the facility and the facility's employees and their dependents (wage and salary expenditures). A more detailed discussion of RIMS II is included in Appendix D. In general, no significant employment or earnings impacts were identified for any of the alternatives; the impacts represented less than 1% of baseline economic activity for all of the alternatives. As a result, fiscal impacts are also assumed to be negligible for all alternatives.

The socioeconomic impacts analyses also assumed that employees for any new facility would come from within the region of influence. Therefore, no significant change in population is anticipated, and no impact on housing or other infrastructure within the region is expected.

4.13.1 Methodology

Methods used to determine socioeconomic impacts for each alternative are listed below.

- Determined the direct employment based on the manpower plan for the alternative.
- Obtained industry-specific RIMS II multipliers from the Bureau of Economic Analysis for the four-county Region of Influence.
- Determined indirect employment impacts by applying RIMS II input-output multipliers to the direct employment.
- Estimated the direct earnings based on direct employment for each phase of the treatment alternative, and average DOE-related wage in the Region of Influence for the design and operations periods and Tennessee average wage for heavy construction during the construction and D&D periods.
- Determined indirect earnings impacts by applying the RIMS II earning multipliers to direct earnings, and
- Computed the percentage change in employment and earnings impacts with respect to the No Action Alternative.

4.13.2 No Action Alternative

Under the No Action Alternative, there would be no change in economic activity and, therefore, no change in population, housing, infrastructure, or economic environment.

4.13.3 Low-Temperature Drying Alternative

The employment and earnings impacts for the Low-Temperature Drying Alternative for the years 2000 to 2010 are discussed below.

4.13.3.1Employment

Table 4-32 shows the estimated direct employment associated with the Low-Temperature Drying Alternative. Table 4-33 estimates the total employment impact and compares it to an employment baseline calculated for each year from 2000 to 2010. This alternative would have no significant impact on region of influence employment. Estimated impacts in each year total less than 0.1% of baseline wage and salary employment for the duration of the proposed action. No employment effects would carry over beyond project completion in 2006.

Table 4-32. Manpower plan for the Low-Temperature Drying Alternative[a]

	Design											Construction								Operations												D&D		
	1998			1999				2000				2001				2002				2003				2004				2005				2006		
	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3
Technical	27	35	38	38	38	35	35	35	32	27	27	18	18	18	21	24	23	19	12	12	13	12	13	12	13	13	13	13	13	13	13	13	13	9
Craft/Operators	0	0	0	0	0	0	0	0	0	0	0	4	6	6	14	62	61	56	24	47	63	27	27	63	36	36	36	47	20	8	5	5	0	0
Non-Tech	3	3	3	3	3	3	3	3	3	3	3	11	11	11	11	11	11	17	11	11	12	11	11	12	11	11	11	11	11	11	11	11	8	8
Total	30	38	41	41	41	38	38	38	35	30	30	33	35	35	46	97	95	92	47	70	88	50	51	87	60	60	60	71	44	32	29	29	21	17

[a]Full-time equivalents.

Table 4-33. Estimated region of influence employment impacts by year for the Low-Temperature Drying Alternative

Year	Employment base[a]	Direct employment impact[b]	Indirect employment impact
2000	280,357	33.25	30.9
2001	281,704	37.3	38.0
2002	283,057	82.8	84.4
2003	284,416	64.8	100.3
2004	285,782	66.8	103.4
2005	287,154	44.3	35.2
2006	288,533	16.8	13.4
2007	289,919	0.0	0.0
2008	291,312	0.0	0.0
2009	292,711	0.0	0.0
2010	294,116	0.0	0.0

[a]Based on Tables 3-21 and 3-27. Assumes wage and salary employment grows at the same rate as population and that growth rate is constant from 1996–2000 and 2000–2010.
[b]Annual average full-time equivalents based on quarterly totals in Table 4-32.

4.13.3.2Earnings

Direct earnings for the Low-Temperature Drying Alternative were based on the direct employment estimates presented in Table 4-32. Table 4-34 shows the estimated direct and indirect earnings associated with the employment figures in Section 4.13.2.1 and compares them with the region-of-influence baseline income for each year. The income calculation uses the conservative assumption that real per capita income remains at the 1996 level in order to determine the maximum potential impact. Any increase in real per capita income during the analysis period would reduce the relative economic impact. As the table shows, there would be no significant impact associated with this alternative. Earnings for all years represent less than 0.1% of income for the region.

Table 4-34. Estimated region of influence earnings impacts by year for the Low-Temperature Drying Alternative

Year	Direct earnings[a] ($000)	Indirect earnings ($000)	Total earnings ($000)	ROI baseline income[b] ($000)	Percent of ROI income
2000	$1,578	$986	$2,563	$11,775,954	0.02%
2001	$1,149	$1,130	$2,279	$11,832,509	0.02%
2002	$2,552	$2,510	$5,062	$11,889,336	0.04%
2003	$3,072	$3,306	$6,378	$11,946,436	0.05%
2004	$3,167	$3,408	$6,575	$12,003,810	0.05%
2005	$1,365	$985	$2,349	$12,061,459	0.02%
2006	$517	$508	$1,025	$12,119,386	0.01%
2007	$0	$0	$0	$12,177,590	0.00%
2008	$0	$0	$0	$12,236,074	0.00%
2009	$0	$0	$0	$12,294,839	0.00%
2010	$0	$0	$0	$12,353,887	0.00%

[a]Based on Table 4-33 and the following assumptions: average U.S. Department of Energy-related wage ($47,445) for Phases I and III; Tennessee average wage for heavy construction ($30,839) for Phases II and IV.
[b]Assumes constant population growth rate from 2000 to 2010 and average per capita income for the region of influence (ROI) in 1996 ($22,982).

4.13.4 Vitrification Alternative

The employment and earnings impacts for Vitrification for the years 2000 to 2010 are discussed below.

4.13.4.1Employment

Expected direct employment is shown for the Vitrification Alternative in full-time equivalents for each quarter in Table 4-35. Table 4-36 shows the total estimated employment impact and compares it to an employment baseline calculated for each year from 2000 to 2010. This alternative would have no significant impact on region of influence employment. Estimated impacts in each year total less than 0.1% of baseline wage and salary employment for the duration of the alternative. No employment effects would carry over beyond completion of the alternative in 2007.

4.13.4.2Earnings

Direct earnings for this alternative were based on the direct employment estimates in Table 4-35. Table 4-37 shows the estimated direct and indirect earnings associated with the employment figures in Section 4.13.3.1 and compares them with region-of-influence baseline income for each year. The income calculation uses the conservative assumption that real per capita income remains at the 1996 level in order to determine the maximum potential impact. Any increase in real per capita income during the analysis period would reduce the relative economic impact. As the table shows, there would be no significant impact associated with this alternative. Earnings for all years represent less than 0.2% of income for the region.

4.13.5 Cementation Alternative

The project schedule for the Cementation Alternative is the longest, generating the largest cumulative impact of the alternatives discussed. The employment and earnings impacts for the Cementation Alternative for the years 2000 to 2010 are discussed below.

4.13.5.1Employment

Table 4-38 shows the estimated direct employment associated with the Cementation Alternative. Table 4-39 estimates the total employment impact and compares it to an employment baseline calculated for each year from 2000 to 2010. This alternative would have no significant impact on region of influence employment. Estimated impacts in each year total less than 0.1% of baseline wage and salary employment for the duration of the alternative. No employment effects would carry over beyond project completion in 2010.

Table 4-35. Manpower plan for the Vitrification Alternative[a]

	Design										Construction								Operations												D&D							
	1998		**1999**				**2000**				**2001**				**2002**				**2003**				**2004**				**2005**				**2006**				**2007**			
	Q3	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**
Technical	52	65	71	71	71	65	65	58	58	52	39	48	58	58	58	48	39	33	49	49	36	36	24	24	22	22	22	22	22	22	22	22	20	20	19	19	17	17
Craft/Operators	0	0	0	0	0	0	0	0	0	0	16	32	96	192	192	192	102	76	103	103	97	97	92	92	92	92	82	82	77	66	50	62	62	50	50	37	37	25
Non-Tech	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	17	17	14	14	14	14	14	14	14	14	17	17	14	14	14	14	14	14	9	9
Total	59	72	78	78	78	72	72	65	65	59	62	87	161	257	257	247	148	116	169	169	147	147	130	130	128	128	118	118	116	105	86	98	96	84	83	70	63	51

[a] Full-time equivalents.

Table 4-36. Estimated region of influence employment impacts by year for the Vitrification Alternative

Year	Employment base[a]	Direct employment impact[b]	Indirect employment impact	Total employment impact	Percent of employment base
1996	286,295				
2000	280,357	62.5	58.2	120.7	0.04
2001	281,704	141.8	144.5	286.2	0.10
2002	283,057	192.0	195.7	387.7	0.14
2003	284,416	158.0	244.7	402.7	0.14
2004	285,782	129.0	199.8	328.8	0.12
2005	287,154	114.3	177.0	291.2	0.10
2006	288,533	91.0	72.3	163.3	0.06
2007	289,919	66.8	53.0	119.8	0.04
2008	291,312				
2009	292,711				
2010	294,116				

[a]Based on Tables 3-21 and 3-27. Assumes wage and salary employment grows at the same rate as population and that growth rate is constant from 1996–2000 and 2000–2010.
[b]Annual average full-time equivalents based on quarterly totals in Table 4-35.

Table 4-37. Estimated region of influence earnings impacts by year for the Vitrification Alternative

Year	Direct earnings[a] ($000)	Indirect earnings ($000)	Total earnings ($000)	ROI baseline income[b] ($000)	Percent of ROI income
2000	$2,966	$1,853	$4,820	$11,775,954	0.04
2001	$4,371	$4,300	$8,672	$11,832,509	0.07
2002	$5,921	$5,825	$11,746	$11,889,336	0.10
2003	$7,496	$8,066	$15,562	$11,946,463	0.13
2004	$6,120	$6,586	$12,706	$12,003,810	0.11
2005	$5,421	$5,833	$11,253	$12,061,459	0.09
2006	$2,806	$2,761	$5,567	$12,119,386	0.05
2007	$2,050	$2,025	$4,083	$12,177,590	0.03
2008	$0	$0	$0	$12,236,074	0.00
2009	$0	$0	$0	$12,294,839	0.00
2010	$0	$0	$0	$12,353,887	0.00

[a]Based on Table 4-36 and the following assumptions: (1) average U.S. Department of Energy-related wage ($47,445) for Phases I and III; and (2) Tennessee average wage for heavy construction ($30,839) for Phases II and IV.
[b]Assumes constant population growth rate from 2000 to 2010 and average per capita income for the region of influence (ROI) in 1996 ($22,982).

Table 4-38. Manpower plan for the Cementation Alternative[a]

	Design									
	1998		1999				2000			
	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Technical	30	37	41	41	41	41	41	37	37	30
Craft/Operators	0	0	0	0	0	0	0	0	0	0
Non-Tech	5	5	5	5	5	5	5	5	5	5
Total	35	42	46	46	46	46	46	42	42	35

	Construction							
	2001				2002			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Technical	20	22	25	25	22	22	20	17
Craft/Operators	8	16	24	48	64	64	54	44
Non-Tech	12	12	12	12	12	12	12	12
Total	40	50	61	85	98	98	86	73

	Operations											
	2003				2004				2005			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Technical	25	25	18	18	12	12	12	12	12	12	12	12
Craft/Operators	39	39	39	39	39	39	39	58	38	38	38	38
Non-Tech	12	12	12	12	10	10	10	10	10	10	10	10
Total	76	76	69	69	61	61	61	80	60	60	60	60

	Operations											
	2006				2007				2008			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Technical	12	12	12	12	12	12	12	12	12	12	12	12
Craft/Operators	38	38	38	57	38	38	38	38	38	38	26	26
Non-Tech	10	10	10	10	10	10	10	10	10	10	12	12
Total	60	60	60	79	60	60	60	60	60	60	50	50

	D&D							
	2009				2010			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Technical	12	12	9	9	7	7	7	5
Craft/Operators	40	36	27	13	9	4	0	0
Non-Tech	12	12	9	9	7	7	7	5
Total	64	60	45	31	23	18	14	10

[a]Full-time equivalents.

Table 4-39. Estimated region of influence employment impacts by year for the Cementation Alternative

Year	Employment base[a]	Direct employment impact[b]	Indirect employment impact	Total employment impact	Percent of employment base
1996	286,295				
2000	280,357	41.3	38.4	79.6	0.03%
2001	281,704	59.0	60.1	119.1	0.04%
2002	283.057	88.8	90.5	179.2	0.06%
2003	284,416	72.5	112.3	184.8	0.06%
2004	285,782	65.8	101.8	167.6	0.06%
2005	287,154	60.0	92.9	152.9	0.05%
2006	288,533	64.8	100.3	165.0	0.06%
2007	289,919	60.0	92.9	152.9	0.05%
2008	291,312	55.0	85.2	140.2	0.05%
2009	292,711	50.0	39.7	89.7	0.03%
2010	294,116	16.3	12.9	29.2	0.01%

[a]Based on Tables 3-21 and 3-27. Assumes wage and salary employment grows at the same rate as population and that growth rate is constant from 1996–2000 and 2000–2010.
[b]Annual average full-time equivalents based on quarterly totals in Table 4-38.

4.13.5.2Earnings

Direct earnings for the Cementation Alternative were based on the direct employment estimates presented in Table 4-38. Table 4-40 shows the estimated direct and indirect earnings associated with the employment figures in Section 4.13.5.1 and compares them with baseline income for each year. The income calculation uses the conservative assumption that real per capita income remains at the 1996 level in order to determine the maximum potential impact. Any increase in real per capita income during the analysis period would reduce the relative economic impact. As the table shows, there would be no significant impact associated with this alternative. Earnings for all years represent less than 0.1% of income for the region.

Table 4-40. Estimated region of influence earnings impacts by year for the Cementation Alternative

Year	Direct earnings[a] ($000)	Indirect earnings ($000)	Total earnings ($000)	ROI baseline income[b] ($000)	Percent of ROI income
2000	$1,957	$1,223	$3,180	$11,775,954	0.03
2001	$1,820	$1,790	$3,609	$11,832,509	0.03
2002	$2.737	$2,692	$5,429	$11,889,336	0.05
2003	$3.440	$3.701	$7.141	$11.946.463	0.06
2004	$3,120	$3,357	$6,476	$12,003,810	0.05
2005	$2,847	$3,063	$5,910	$12,061,459	0.05
2006	$3,072	$3,306	$6,378	$12,119,386	0.05
2007	$2,847	$3,063	$5,910	$12,177,590	0.05
2008	$2,609	$2,808	$5,417	$12,236,074	0.04
2009	$1,542	$1,517	$3,059	$12,294,839	0.02
2010	$501	$493	$994	$12,353,887	0.01

[a]Based on Table 4-39 and the following assumptions: (1) average U.S. Department of Energy-related wage ($47,445) for Phases I and III; and (2) Tennessee average wage for heavy construction ($30,839) for Phases II and IV.
[b]Assumes constant population growth rate from 2000 to 2010 and average per capita income for the region of influence (ROI) in 1996 ($22,982).

4.13.6 Treatment and Waste Storage at ORNL Alternative

4.13.6.1Employment

This alternative would have no significant impact on the region-of-influence employment, which includes Anderson, Roane, Knox, and Loudon counties. Table 4-41 provides the estimated employment impact and compares it to an employment baseline calculated for each year from 2000 to 2010. Table 4-41 provides the estimated direct employment data associated with the Treatment and Waste Storage at ORNL Alternative. The estimated impacts in each year total less than 0.1% of baseline wage and salary employment for the duration of this alternative. This alternative would require continued monitoring activities of the treated waste following the D&D of the proposed treatment facility. The current monitoring requirements associated with the TRU waste slated for treatment at the proposed facility is estimated at 1 to 2 full-time equivalents. It is assumed that the post-treatment monitoring for the waste, which would continue to be stored onsite at ORNL, would have similar monitoring requirements, resulting in no net change in employment following D&D of the proposed treatment facility.

4.13.6.2Earnings

There would be no significant impact with respect to earnings associated with the Treatment and Waste Storage at ORNL Alternative. The earnings for all years represent less than 0.1% of income for the four county region of influence. The direct earnings for this alternative were based on the estimated direct employment data presented in Table 4-42. Table 4-43 provides information on the estimated direct and indirect earnings associated with the employment figures provided in Table 4-41, and compares them with baseline income for each year. The income calculation uses the conservative assumption that real per capita income remains at the 1996 level in order to determine the maximum potential impact. Any increase in real per capita income during the analysis period would reduce the relative economic impact.

Table 4-41. Estimated employment impacts by year for the Treatment and Waste Storage at ORNL Alternative for the region-of-influence

Year	Employment base[a]	Direct employment impact[b]	Indirect employment impact	Total employment impact	Percent of employment base
2000	280,357	33.25	30.9	64.2	0.02
2001	281,704	37.3	38.0	75.2	0.03
2002	283,057	82.8	84.4	167.1	0.06
2003	284,416	64.8	100.3	165.0	0.06
2004	285,782	66.8	103.4	170.1	0.06
2005	287,154	44.3	35.2	79.4	0.03
2006	288,533	16.8	13.4	30.1	0.01
2007	289,919	0.0	0.0	0.0	0.00
2008	291,312	0.0	0.0	0.0	0.00
2009	292,711	0.0	0.0	0.0	0.00
2010	294,116	0.0	0.0	0.0	0.00

[a]Based on Tables 3-21 and 3-27. Assumes wage and salary employment grows at the same rate as population and that growth rate is constant from 1996–2000 and 2000–2010.
[b]Annual average full-time equivalents based on quarterly totals in Table 4-42.

Table 4-42. Manpower plan for the Treatment and Waste Storage at ORNL Alternative [a]

	Design											Construction								Operations							D&D									
	1998			1999				2000				2001				2002				2003				2004				2005				2006		
	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3
Technical	27	35	38	38	38	35	35	35	32	27	27	18	18	18	21	24	23	19	12	12	13	12	13	12	13	13	13	13	13	13	13	13	13	9
Craft/Operators	0	0	0	0	0	0	0	0	0	0	0	4	6	6	14	62	61	56	24	47	63	27	27	63	36	36	36	47	20	8	5	5	0	0
Non-Tech	3	3	3	3	3	3	3	3	3	3	3	11	11	11	11	11	11	17	11	11	12	11	11	12	11	11	11	11	11	11	11	11	8	8
Total	30	38	41	41	41	38	38	38	35	30	30	33	35	35	46	97	95	92	47	70	88	50	51	87	60	60	60	71	44	32	29	29	21	17

[a] Full-time equivalents.

Table 4-43. Estimated earnings impacts by year for the Treatment and Waste Storage at ORNL Alternative for the region-of-influence

Year	Direct earnings[a] ($000)	Indirect earnings ($000)	Total earnings ($000)	ROI baseline income[b] ($000)	Percent of ROI income
2000	$1,578	$986	$2,563	$11,775,954	0.02
2001	$1,149	$1,130	$2,279	$11,832,509	0.02
2002	$2,552	$2,510	$5,062	$11,889,336	0.04
2003	$3,072	$3,306	$6,378	$11,946,463	0.05
2004	$3,167	$3,408	$6,575	$12,003,810	0.05
2005	$1,365	$985	$2,349	$12,061,459	0.02
2006	$517	$508	$1,025	$12,119,386	0.01
2007	$0	$0	$0	$12,177,590	0.00
2008	$0	$0	$0	$12,236,074	0.00
2009	$0	$0	$0	$12,294,839	0.00
2010	$0	$0	$0	$12,353,887	0.00

ROI = Region of Influence

[a] Based on Table 4-41 and the following assumptions: (1) average U.S. Department of Energy-related wage ($47,445) for Phases I and III; and (2) Tennessee average wage for heavy construction ($30,839) for Phases II and IV.

[b] Assumes constant population growth rate from 2000 to 2010 and average per capita income for the ROI in 1996 ($22,982).

4.13.7 Summary of Socioeconomic Impacts

For the No Action Alternative there would no change in economic activity. For the treatment alternatives, economic activity in the region-of-influence would increase very slightly (0.1% for the Low-Temperature Drying, and Cementation and Treatment and Waste Storage Alternatives, and 0.2% for the Vitrification Alternative.

4.14 ENVIRONMENTAL JUSTICE

This section describes environmental justice impacts, which involve high and adverse human health or environmental impacts that have a disproportionate effect on minority or low-income populations. Each resource area was evaluated to determine if potential pathways would exist which could affect human populations in general and low-income and/or minority populations in particular. For example, land use impacts of the various alternatives were evaluated for significance and to determine if low-income or minority populations would be disproportionately affected. Likewise, biota (such as deer or fish) contaminated by project-related releases were considered in evaluating the relationship between ecological resources and environmental justice. Human health and accidents would have the largest potential impact on human populations. The other resource areas were insignificant for all alternatives and are not discussed further.

4.14.1 Methodology

Methods used to determine the environmental justice impacts for each alternative are listed below.

- Using the census tract maps and considering any special pathways (e.g. subsistence farming), determined for each resource area whether there would be any potential significant adverse impacts on the minority or low-income populations.

- If there would be any potential significant adverse impacts on the minority or low-income populations, determined if the impacts would be disproportionately high and adverse, when compared to the impacts to the general population.

4.14.2 No Action Alternative

Under the No Action Alternative, there are no significant impacts to low-income or minority populations during normal operations. The largest potential impacts involve human health effects. As discussed in Section 4.10, the maximum potential human health effects under normal operations are too small to constitute a significant impact. As discussed in Section 4.11.2 an accident could result in significant human health impacts to the general population, including low-income or minority populations. However, in all of the accidents evaluated, public exposure would result from either surface water transport or airborne release, and impacts are likely to be the same for minority or low-income populations as for the general public, as discussed below.

The surface water exposure would affect populations south and west of the ORR along the Clinch River. Census tracts in this direction include no minority populations and a mixture of low-income and higher income populations (Figures 4-3 and 4-4); therefore, a disproportionate impact on low-income or minority populations from such a release is unlikely. The airborne release pathway is similarly unlikely to have disproportionate effects on minority/low-income populations. Prevailing winds follow the general topography of the ridges. Daytime winds come from the southwest up the valley, and

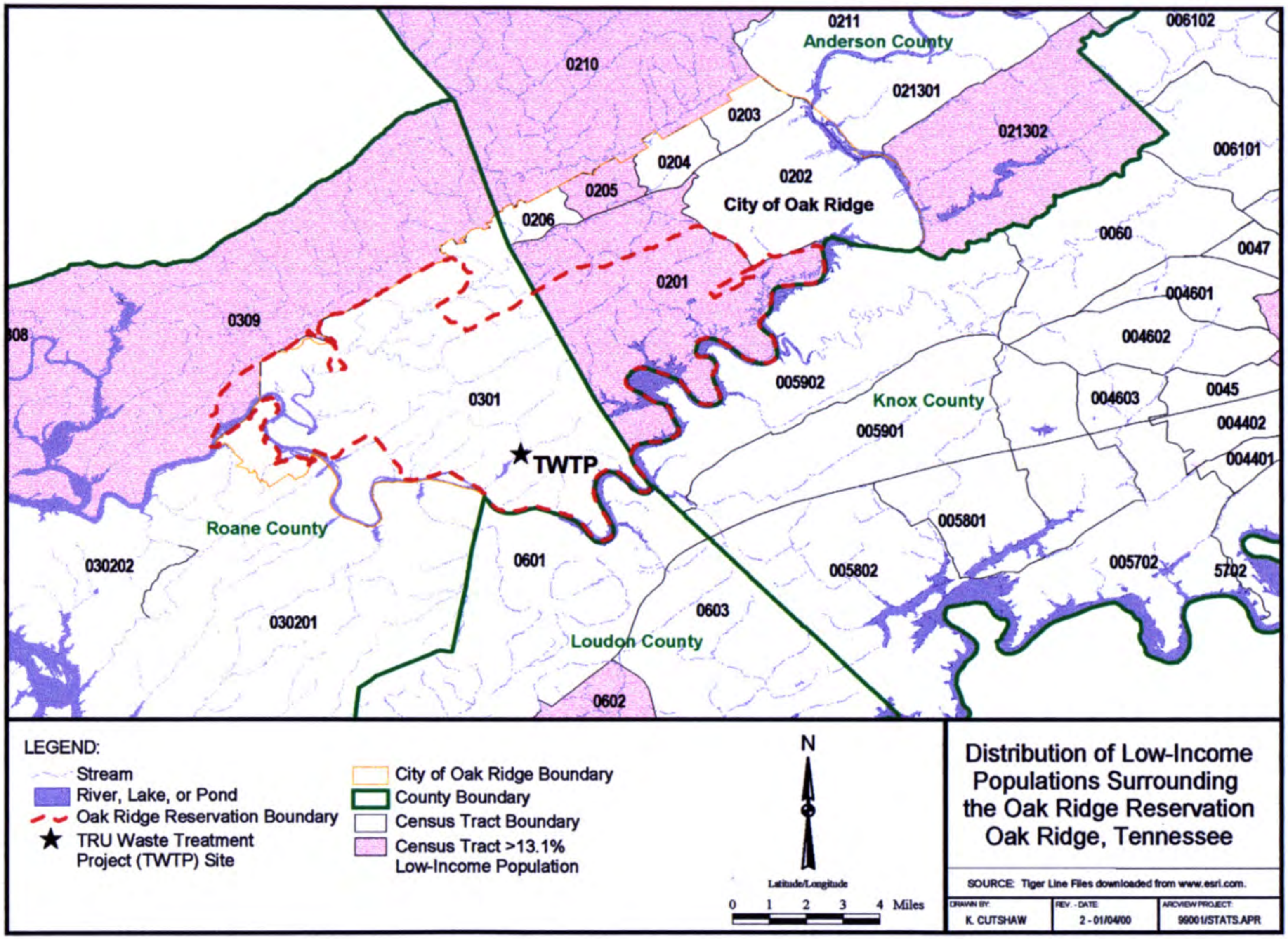

Figure 4-3. Census tracts with a minority population greater than the national average of 24.2%. All residences are restricted to locations outside the ORR boundaries, even though the tract boundaries shown on this map include portions of the ORR.

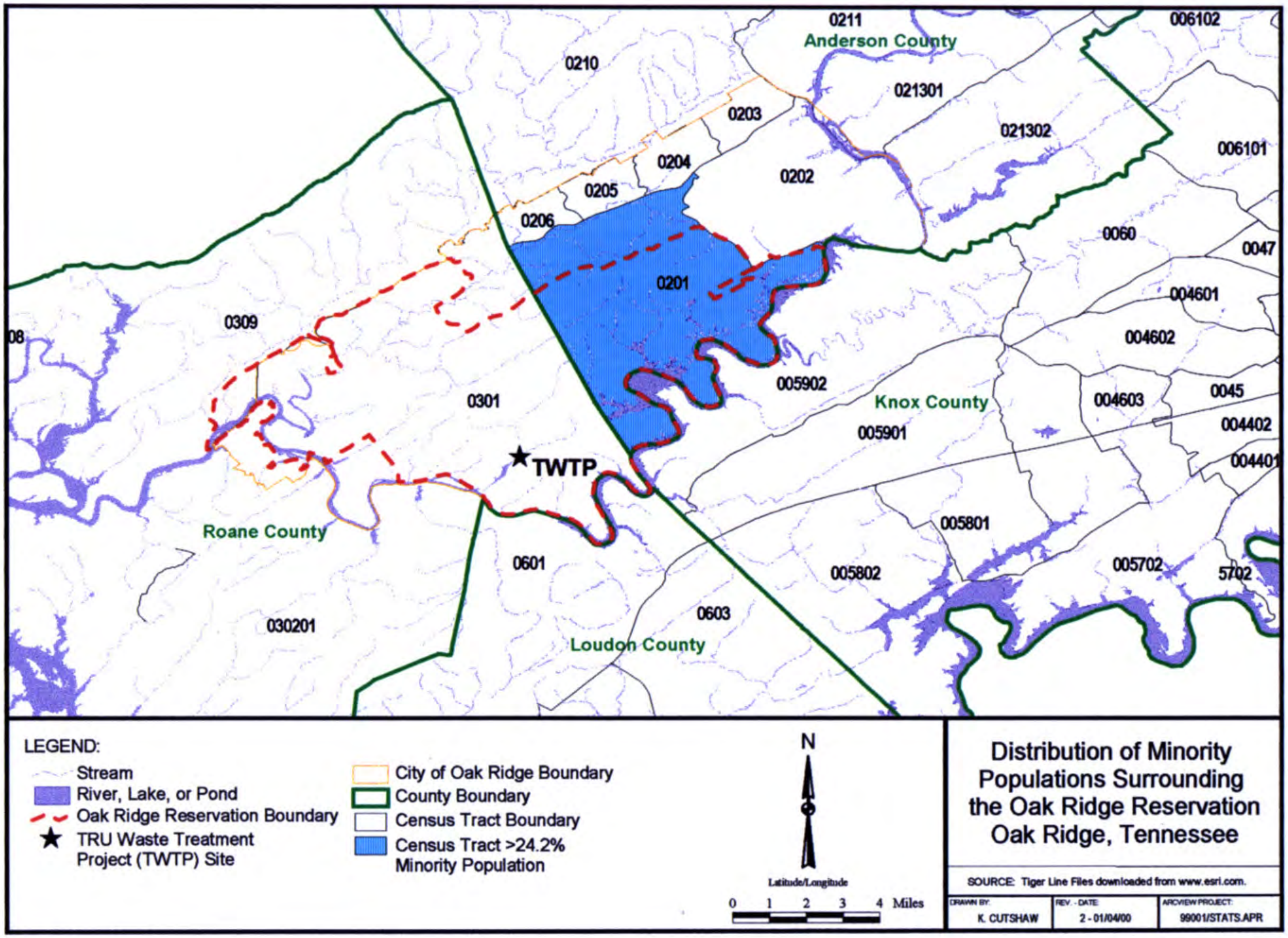

Figure 4-4. Census tracts with a low-income population greater than the national average of 13.1%. All residences are restricted to locations outside the ORR boundaries, even though the tract boundaries shown on this map include portions of the ORR.

nighttime winds come down the valley from the northeast (DOE 1998b, p. 5-36). As in the case of a release via surface water, a nighttime release would affect all populations south and west of the ORR, and would be unlikely to affect minority or low-income populations more than others. A daytime release is likely to have similar effects on both minority and nonminority populations north and east of the ORR. Therefore, even in the unlikely event of an accident, there would be no disproportionately high and adverse impacts on low-income or minority populations.

4.14.3 Low-Temperature Drying Alternative

As in the No Action Alternative, under normal operations environmental impact and risk to low income and minority populations would be minimal. Human health impacts of potential accidents are discussed in Section 4.11.3; in all of the accidents evaluated, public exposure would result from either surface water transport or airborne release. As discussed in Section 4.14.2, release via either of these pathways is unlikely to have disproportionate effects on minority or low-income populations, and therefore no environmental justice impacts would occur.

4.14.4 Vitrification Alternative

As in the No Action Alternative, contaminant emissions and human health impacts under normal operations for the Vitrification Alternative are expected to be minimal. Human health impacts of potential accidents are discussed in Section 4.11.4; in all of the accidents evaluated, public exposure would result from either surface water transport or airborne release. As discussed in Section 4.14.2, release via either of these pathways is unlikely to have disproportionate effects on minority or low-income populations, and therefore no environmental justice impacts would occur.

4.14.5 Cementation Alternative

Contaminant emissions and human health impacts under normal operations for the Cementation Alternative are expected to be minimal. Human health impacts of potential accidents are discussed in Section 4.11.5; in all of the accidents evaluated, public exposure would result from either surface water transport or airborne release. As discussed in Section 4.14.2, release via either of these pathways is unlikely to have disproportionate effects on minority or low-income populations, and therefore no environmental justice impacts would occur.

4.14.6 Treatment and Waste Storage at ORNL Alternative

As in the No Action Alternative, contaminant emissions and human health impacts under normal operations for the Vitrification Alternative are expected to be minimal. Human health impacts of potential accidents are discussed in Section 4.11.6; in all of the accidents evaluated, public exposure would result from either surface water transport or airborne release. As discussed in Section 4.14.2, release via either of these pathways is unlikely to have disproportionate effects on minority or low-income populations, and therefore no environmental justice impacts would occur.

4.14.7 Summary of Environmental Justice Impacts

There would be no environmental justice-related impacts associated with any of the alternatives.

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5. CUMULATIVE IMPACTS

This section summarizes the potential cumulative environmental impacts for treating TRU/alpha low-level waste at the Oak Ridge National Laboratory. Cumulative impacts result

> "… from the incremental impact of the action when added to past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time" (40 *CFR* 1508.7).

The proposed action is to treat and repackage waste by one of three treatment methods and to ship the waste offsite, or for one alternative to treat and store the waste onsite. The evaluation of cumulative impacts adds the impacts of the proposed action for each resource area with impacts from past and existing operations and reasonably foreseeable future actions. Cumulative impacts are analyzed for the bounding case alternative for each resource area. The general methodology used to determine if a potential cumulative impact might result from implementation of the proposed action was to first determine if either an adverse or beneficial impact was documented (Chapter 4) for a given resource area. If none would occur (which is the case for cultural and archaeological resources for example) then, by definition, a cumulative impact could not exist for this resource area. Next, past, present, and reasonably foreseeable future projects which are affecting, have affected, or could affect the Region of Influence for each resource area were evaluated and their impacts were added to the impacts of the bounding case alternative.

Potential cumulative impacts to resource areas are discussed in Sections 5.1 through 5.7. Table 5-1 presents the past, present, and reasonably foreseeable future actions which have the potential for producing cumulative impacts.

Table 5-1. Past, present, and reasonably foreseeable future actions with potential for cumulative impacts

Past, present, or reasonably foreseeable future actions	Location	Description	Applicable resource area
Construction and Operation of the Spallation Neutron Source[a]	To be located approximately 4 km (2.5 miles) from the proposed TRU Waste Treatment Project site, northeast between ORNL and the Y-12 Plant	This high-energy physics facility would increase employment by 1,700 persons and affect the ORR land use by developing 45 ha (110 acres) of land.	Applicable to land use, socioeconomics, and human health.
Construction and Operation of the Joint Institute for Neutron Science[a]	To be located at ORNL approximately 1.6 km (1 mile) east of the proposed TRU Waste Treatment Project site	This facility, which was originally planned to be open in 2000 but is currently delayed, would provide office space, meeting rooms, and hotel accommodations for visiting scientists. The facility would require about 4 ha (10 acres).	Applicable to land use.
Construction and Operation of the Laboratory for Comparative and Functional Genomics[a]	To be located at ORNL approximately 2.0 km (1.25 miles) east of the TRU Waste Treatment Project site	This would be a genetic research laboratory. About 2 ha (10 acres) would be needed for the buildings and parking lots.	Applicable to land use.
Relocate ORNL Personnel at Y-12 Plant back to ORNL[b]	ORNL	This effort would relocate 300 to 320 ORNL staff currently housed at the Y-12 Plant back to ORNL. Office, laboratory, and parking space would require approximately 10 ha (25 acres).	Applicable to land use and socioeconomics.
Implementation of the White Oak Embayment Project[c]	Located at the mouth of White Oak Creek approximately 2.1 km (1.3 miles) west of the TRU Waste Treatment Project site	A CERCLA project completed in 1992, which resulted in construction of a coffer dam on White Oak Creek. Purpose was to renew and retain sediment in White Oak Lake, covering exposed cesium-137 sediments.	Applicable to water resources.
Old Melton Valley Road Upgrade Construction[d]	Immediately west of the TRU Waste Treatment Project site and Melton Valley Storage Tanks	This 1.8-km (1.1-mile) road upgrade project to be completed in 2000 affects approximately 4 ha (10 acres) along the south side of White Oak Creek.	Applicable to land use and ecological resources.

Table 5-1. Past, present, and reasonably foreseeable future actions with potential for cumulative impacts (continued)

Past, present, or reasonably foreseeable future actions	Location	Description	Applicable resource area
Waste Area Group 5 Seep C and D Remediation[c]	Seep D is approximately 0.3 km (.19 miles) northeast of the TRU Waste Treatment Project site; Seep C is 0.14 km (0.09 miles) north	These two CERCLA actions, completed in the mid-1990s, significantly reduced strontium-90 releases to the White Oak Creek watershed.	Applicable to soils, water resources, and ecological resources.
Waste Area Group 4 Seeps Remediation[c]	These seeps are approximately 0.75 km (0.5 miles) north of the TRU Waste Treatment Project site	This CERCLA action, completed in 1996, helped reduce strontium-90 releases into the White Oak Creek watershed.	Applicable to soils, water resources, and ecological resources.
Old Hydrofracture Tanks Remediation[c]	Located approximately 0.10 km (0.06 miles) east of the TRU Waste Treatment Project site	This project is an ongoing CERCLA action, but the TRU wastes in these tanks have already been transferred to the Melton Valley Storage Tanks.	Applicable to water resources and waste management.
WAG 13 Cesium Test Plots Remediation[c]	Located approximately 2.1. km (1.32 miles) west of the TRU Waste Treatment Project site on the banks of the Clinch River	This CERCLA action, completed in the mid-1990s, reduced cesium-137 releases into the Clinch River.	Applicable to soils and water resources.
Molten Salt Reactor Remediation[c]	Located approximately 1.6 km (1.0 mile) east of the TRU Waste Treatment Project site	An ongoing CERCLA action intended to reduce the risk of nuclear criticality.	Potentially applicable to waste management.
Transfer of TRU debris waste from Paducah to Oak Ridge	Paducah, Kentucky	Approximately 15 m^3 (20 yd^3) of TRU debris waste could be sent to ORNL in 2005	Waste management.
Operation of the TSCA Incinerator	Located at ETTP (formerly K-25 Site) approximately 7 km (4.4 miles) from TRU Waste Treatment Project Site	Future plans are to phase out entirely the operation of this incinerator, thus eliminating a source of airborne radionuclides.	Applicable to air quality.
Operation of the TVA Steam Plants[e]	Bull Run Steam Plant is a 900 MW plant approximately 8 km (5 miles) east of ORNL; Kingston Steam Plant is a 1,640 MW plant approximately 48 km (30 miles) northwest of ORNL	Both electric-generating plants are coal-fired with emissions typical of such plants. These plants are major air pollutant sources for NO_x, SO_2, CO_2, lead, and particulates.	Applicable to air quality.

Table 5-1. Past, present, and reasonably foreseeable future actions with potential for cumulative impacts (continued)

Past, present, or reasonably foreseeable future actions	Location	Description	Applicable resource area
Construction and Operation of the ETTP Reindustrialization Projects[f]	Located at ETTP	Three reindustrialization projects (ETTP, ED-1, and ED-3) would increase area employment by up to 17,700 direct jobs. The three projects, involving approximately 2,025 ha (5,000 acres) of DOE land leased to the Community Reuse Organization of East Tennessee, are intended to spur economic development as DOE reduces direct employment in the Oak Ridge, Tennessee, area.	Applicable to socioeconomics and land use.
Macedonia Industrial Park in Roane County[f]	A private industrial park in Roane County off the ORR	This 280-ha (700-acre) site is expected to employ approximately 3,500 workers.	Applicable to socioeconomics and land use.

[a]DOE 1999. *Final Environmental Impact Statement, Construction and Operation of the Spallation Neutron Source,* U.S. Department of Energy, Office of Science, DOE/EIS-0247, April 1999.

[b]Personal communication with Tony Medley, ORNL Capital Assets Manager, January 7, 2000.

[c]DOE 1999. *Remedial Effectiveness Report for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee,* DOE OR/01-1790&D0.

[d]DOE 1998. *Categorical Exclusion for Construction/Relocation of Access Road at Oak Ridge National Laboratory*, CX-TRU-98-007, Oak Ridge, Tennessee.

[e]TVA internet web site.

[f]DOE 1999. *Draft Environmental Assessment, Lease of Parcel ED-3 of the Oak Ridge Reservation to the Community Reuse Organization of East Tennessee*, U.S. Department of Energy, Oak Ridge Operations Office, Oak Ridge, Tennessee.

5.1 LAND USE

The proposed action's incremental contributions to land use classification changes or land use practices (Chapter 4, Section 4.1), when combined with past, present, and reasonable foreseeable future classifications and practices, are evaluated. The zoning of reservation land for future use is the same as the current land use pattern, as reflected in the *ORNL Land and Facilities Use Plan* (LMER and LMES 1998). DOE plans to use the land in ways compatible with the current pattern of use. A number of mission-related projects are now planned for the ORR. These projects, with some likelihood of cumulatively affecting land use, would be at or near ORNL. These include the Spallation Neutron Source, the Joint Institute for Neutron Science, the Laboratory for Comparative and Functional Genomics (Hall 2000), and Relocation of ORNL Personnel from the Y-12 Plant (Medley 2000). These projects would require development of 45, 4, 2, and 10 ha, respectively, as described in Table 5-1. Because of the relatively large scale of development, the ETTP Reindustrialization projects and the Macedonia Industrial

Park are also considered (Table 5-1). Two of the ETTP projects (ED-1 and ED-3) would involve developing industrial land zoned as industrial but not currently developed.

The proposed action would be consistent with the existing industrial land use classification in Melton Valley. Construction and operation of a waste treatment and repackaging facility adjacent to the Melton Valley Storage Tanks would help continue the trend of industrial development at ORNL. The bounding alternative would be the Treatment and Waste Storage at ORNL Alternative using vitrification as the treatment process. The proposed facility would require 3.3 ha (8.2 acres) for the treatment facility and additional on-site storage space. The cumulative impact on land use would be small.

5.2 ECOLOGICAL RESOURCES

Forested and other undeveloped lands used by wildlife are rapidly being converted to residential, commercial, and industrial uses throughout the Tennessee Valley. The ORR, and ORNL specifically, by virtue of land use planning and restricted access, provide a refuge where habitat and species of wildlife are especially abundant. The proposed action would slightly reduce wildlife habitat at ORNL. The Melton Valley Access Road upgrade (Table 5-1) resulted in approximately 4 ha (10 acres) of forest habitat being permanently lost to wildlife. This disturbance is immediately adjacent to the proposed treatment site. The bounding alternative would be the Treatment and Waste Storage at ORNL Alternative using vitrification as the treatment process. The proposed facility would require 2.8 ha (7 acres) of forested land for the treatment facility and an additional 0.6 ha (1.5 acres) of cleared and/or forested land for on-site storage space. This wildlife habitat would be lost for a period of at least a decade, thereby resulting in a small incremental increase in the loss of habitat in the lower reaches of Melton Valley.

Waste removal from the SWSA 5 North trenches would, when combined with remediation of the Waste Area Group 5 Seeps C and D and Waste Area Group 4 seeps, result in a beneficial cumulative impact to area biota.

5.3 WATER RESOURCES

Potential cumulative impacts to water resources in the defined Region of Influence, the White Oak Creek Watershed, are evaluated by combining the impacts identified in Section 4.5 with other impacts occurring in that watershed. To the extent known, specific projects such as the five completed projects [the White Oak Creek Embayment Project, Waste Area Group (WAG) 5 Seep C, WAG 5 Seep D, WAG 4 Seeps, and WAG 13 Cesium Test Plots] and two ongoing CERCLA cleanup actions (Old Hydrofracture Tanks and Molten Salt Reactor projects) in the Melton Valley Watershed (Figure 5-1), and other actions or activities, are identified (Table 5-1). The impacts of these projects are then combined with those of the bounding alternative for the proposed action to determine the cumulative impact to water resources that would be expected to result if the proposed action were implemented.

5.3.1 White Oak Creek Embayment Project

Cesium-137 concentrations in the near-surface sediments of White Oak Lake are thought to be a potential human health and ecological risk. Erosion of lake bed sediments from water surging into and out of White Oak Lake was caused by daily releases of water from Melton Hill Dam and storm water flows,

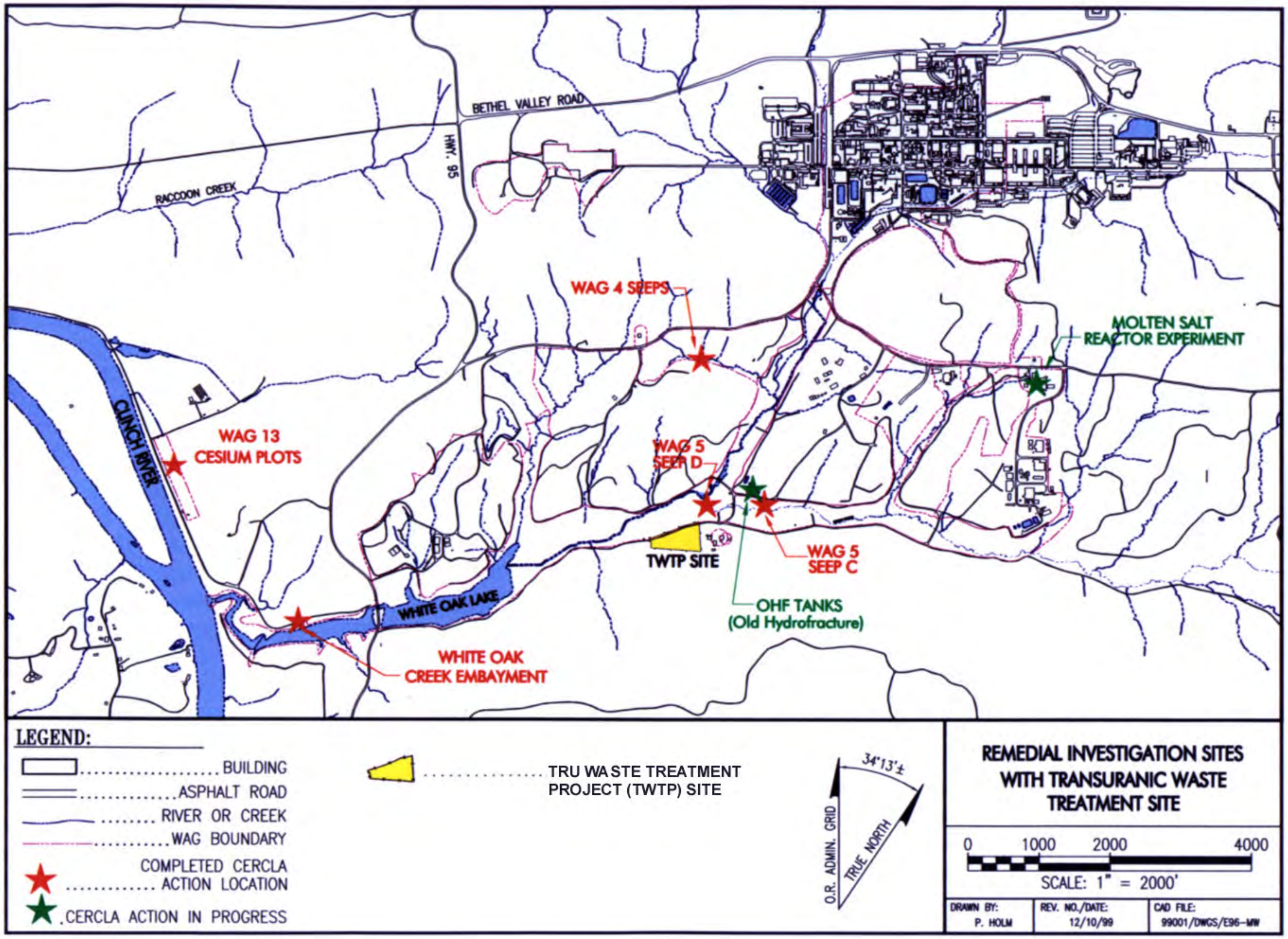

Figure 5-1. Melton Valley Watershed Remedial Investigation site map with proposed Treatment Site Location.

especially during the winter months when the lake was at low-pool elevation. Loss of the surface sediment, which served as a physical barrier for the buried radionuclides, exposed the cesium-137-bearing layers. In 1992, DOE completed a CERCLA action resulting in the construction of a coffer dam at the mouth of White Oak Creek to help retain and renew sediment deposition in White Oak Lake (DOE 1999a).

The proposed action would contribute some sediment loading into White Oak Creek and White Oak Lake, although best management practices would be followed to minimize soil erosion and sedimentation in surface waters. Potentially beneficial cumulative impacts could result from inadvertent or unpreventable releases of sediments that would incrementally contribute to sediment renewal in White Oak Lake.

5.3.2 Old Melton Valley Access Road Upgrade

Minor erosion-related sediment releases from the Old Melton Valley Access Road upgrade are occurring into the surface waters of White Oak Lake. This road upgrade was evaluated for environmental impacts by DOE, and a categorical exclusion was prepared for it.

Storm water runoff from the proposed TRU Waste Treatment Project would contribute to sediment releases in the White Oak Creek/White Oak Lake watershed. As mentioned above, while best management practices, such as the use of silt fences, would be followed during construction of the treatment facility, some minor additional siltation of White Oak Creek and White Oak Lake is likely from project activities.

5.3.3 Waste Area Group 5 Seep C and D

WAG 5 Seep C and Seep D (Figure 5-1) were determined to be major contributors to strontium-90 releases into White Oak Creek. In 1993-1994, Seep C contributed 30 to 40% of the total strontium-90 monitored at White Oak Dam, and Seep D contributed an additional 7% (DOE 1999a). CERCLA removal actions using ion-exchange technology were implemented to treat the groundwater discharge to Melton Branch. Removal efficiencies ranging from 90 to greater than 99% have been documented for both removal actions.

As part of the proposed action, low-level waste would be removed from the SWSA 5 North trenches, which are a significant source of strontium-90 and cesium-137 releases in the White Oak Creek Watershed presently (6% of the strontium-90 and 3.6% of the cesium-137 releases to the White Oak Creek Watershed in 1995). Approximately 14,000 curies of radiation is estimated to be in the waste in these trenches. To further clarify the improvements made in the watershed, Table 5-2 shows the yearly monitoring results of tritium and strontium-90 flux at White Oak Dam. The Seep C contribution to Melton Branch in 1998 is calculated at 86.4 pCi/L with a flux rate of 17.8 mCi, and Seep D's contribution is 12.1 pCi/L with a flux rate of 3.2 mCi. (DOE 1999a). Cumulatively, the proposed action would contribute to recent efforts to improve the groundwater and surface water quality in this watershed by treating the waste containing strontium-90 and cesium-137 in the SWSA 5 North trenches.

Table 5-2. Changes in tritium and strontium flux at White Oak Dam, 1993–1998[a]

Year[b]	White Oak Dam flux (Ci)	
	^{3}H	^{90}Sr
CY 1993	2,141	2.44
CY 1994	2,783	3.37
CY 1995	2,340	1.55
FY 1996	2,250	2.04
FY 1997	1,860	1.99
FY 1998	937	1.37

[a]DOE 1999. *Remedial Effectiveness Report for the U.S. Department of Energy, Oak Ridge Reservation, Oak Ridge, Tennessee*, DOE/OR/01-1790&D0.

[b]In past years estimates have been made for the 12-month calendar year (CY). Since 1996, estimates are provided for the 12-month fiscal year (FY) (October 1997 through September 1998).

5.3.4 Waste Area Group 4 Seeps

The WAG 4 seeps (Figure 5-1) were determined to contribute approximately 25% of the strontium-90 measured at White Oak Dam in 1996. As noted above, the total flux rates at White Oak Dam are presented in Table 5-2. The WAG 4 Seeps contribute to these fluxes. The CERCLA remedy implemented in 1996 was to grout several trenches in WAG 4 to improve their physical stability and reduce hydraulic conductivity. DOE estimates that the trench grouting will reduce strontium-90 releases from these trenches by 75% over 10 years (DOE 1999a). The proposed action would treat wastes that are removed under this CERCLA cleanup action thereby reducing the strontium-90 source.

5.3.5 Other CERCLA Actions

Other CERCLA actions in the general vicinity of Melton Valley area that may impact water resources include the Old Hydrofracture Facility Tanks and the WAG 13 Cesium Test Plots. The Old Hydrofracture Facility Tanks Removal Action (Figure 5-1) is not complete, but the TRU waste in these tanks has already been transferred to the Melton Valley Storage Tanks and is part of the waste inventory to be treated under the proposed action. The completed WAG 13 Cesium Test Plots Project resulted in the reduction of cesium releases near the Clinch River (DOE 1999a). The WAG 13 area is substantially downstream from the proposed TRU Waste Treatment Project site. Both of the actions are expected to have beneficial impacts on ground and surface water resources. There would be little cumulative impact from the proposed action.

5.3.6 Summary of Water Resource Impacts

Cumulatively, impacts to water resources in the White Oak Creek watershed are expected to be mostly beneficial. By implementing the proposed action waste in the SWSA 5 North trenches would be treated and the strontium-90 and cesium-137 releases would be reduced. Sedimentation, while expected to be small because of use of best management practices, would tend to be greatest for the Treatment and Waste Storage at ORNL Alternative using vitrification as the treatment process. Sedimentation would help renew the depleted sediment in the White Oak Embayment.

5.4 WASTE MANAGEMENT

Melton Valley has several waste storage facilities including the Melton Valley Storage Tanks, the Melton Valley Capacity Increase Project Tanks, and eight Waste Area Groupings located along an east-west axis in Melton Valley. The Record of Decision for the Melton Valley Watershed (DOE 1997a) at ORNL addresses the cleanup of the Melton Valley Watershed under CERCLA. The actions conducted as part of the Melton Valley Watershed Record of Decision, in conjunction with the TRU waste treatment and disposal conducted as part of the proposed action would have beneficial impacts on the Melton Valley Watershed, by the cleanup of the majority of contamination in this valley. In addition to the cleanup actions implemented under the Record of Decision for the Melton Valley Watershed, the Molten Salt Reactor Experiment Project remediation is ongoing, and efforts are being directed at reducing the risk of nuclear criticality (DOE 1999a).

Approximately 15 m^3 (20 yd^3) of TRU debris waste may be transferred from DOE's Paducah Plant to ORNL in 2005. Thus, a small amount of off-site waste would be added to the local inventory for treatment and disposal. If the DOE Paducah site, or any other DOE site, ships any TRU waste to ORNL for treatment, DOE would need to conduct further NEPA review as appropriate. This additional waste would add 0.6% to the 2,450 m^3 of TRU/alpha low-level waste inventory at ORNL, a minimal impact to waste management operations.

For the Treatment and Waste Storage at ORNL Alternative and using the cementation process would produce 34,128 m3 of waste. An additional on-site storage space of 0.8 hectares (2 acres) would be required. There are 65 ha (160 acres) of area in Melton Valley devoted to waste storage and operation (DOE 1997c). Given the extensive space already devoted to waste storage in Melton Valley, this would not be cumulatively significant.

5.5 AIR QUALITY

ORNL is an attainment area for all criteria pollutants including particulates. In 1997, the maximum 24-hour particulate concentration was 69.0 $\mu g/m^3$ which is 46% of the 150 $\mu g/m^3$ National Ambient Air Quality Standard. The annual concentration of 33 $\mu g/m^3$ was 66% of the 50 $\mu g/m^3$ standard. Ongoing and future projects involving ground disturbance activities that would likely result in fugitive dust emissions include the Old Melton Valley Access Road upgrade and the proposed Spallation Neutron Source. These emissions would be negligible. The Treatment and Waste Storage at ORNL Alternative using the vitrification treatment process would result in the greatest impacts because vitrification would require the most land for construction of the treatment facility (2.8 ha or 7 acres) and onsite storage (0.6 ha or 1.5 acres) would also result in construction-related fugitive dust emissions. Construction would result in short-term, elevated levels of particulate matter in the localized area around the construction site. There would also be temporary, elevated levels of air pollutant emissions from worker and construction vehicles. However, emissions are estimated to be negligible. Since the access road is complete, construction schedules would not overlap. The distance between the Spallation Neutron Source and the TRU Waste Treatment Project would minimize any cumulative effects, even assuming that construction periods of the projects overlapped. Cumulatively, deposition of particulates from the proposed action combined with emissions from the Old Melton Valley Road upgrade and other large construction projects, such as the Spallation Neutron Source, could indirectly affect vegetation by coating leaves with dust. Such impacts would be very localized and relatively minor.

The background offsite (public maximally exposed individual) airborne radionuclide dose from the ORR is 0.41 mrem/year. The radionuclide dose of 0.23 mrem/year to the public maximally exposed individual from the Low-Temperature Drying Alternative is the bounding case. Cumulatively, the total public maximally exposed individual dose would be 0.64 mrem/year.

The Toxic Substances Control Act (TSCA) Incinerator at the ETTP, the Bull Run Steam Plant 8 km (5 miles) east of ORNL, and the Kingston Steam Plant [approximately 48 km (30 miles) northwest of ORNL] near Kingston, Tennessee, are major emission sources in the region which affect the air quality at ORNL. The TSCA Incinerator is a source of radionuclide emissions at the ETTP. The Incinerator emits several non-radionuclides (metals, chlorine, and particulates) but actual emissions in 1998 ranged from <1% to 7% of the emissions allowed by permit (ORNL 1999). The various alternatives considered under the proposed action would contribute a small amount to the overall emissions in the airshed.

5.6 TRANSPORTATION

DOE estimates the transport of waste by truck, from DOE facilities nationwide, to result in a combined total of between 12 and 69 fatalities for the shipment of low-level mixed wastes, low-level wastes, transuranic wastes, high-level wastes, and hazardous wastes. The majority of these fatalities would result from physical trauma directly related to potential accidents and truck fuel emissions. These fatalities from physical trauma are independent of the shipment contents (WM PEIS, DOE 1997b). The Oak Ridge contribution to these accidents and fatalities would be 8.1E-04 accidents per shipment and 1.1E-04 fatalities per shipment. Comparatively, from 1971 through 1993, over one million persons were killed in vehicular accidents in the United States (WM PEIS, DOE 1997b).

Cumulatively, the non-DOE transport of radioactive material accounts for approximately 80% of the collective dose to workers and the public. At ORR, DOE has estimated the effects of waste transportation over a 10-year period to be a radiation dose to the off-site maximally exposed individual of 3.2E-07 to 1.4E-03 rem (WM PEIS, DOE 1997b). Because off-site waste shipment is not part of either the No Action or the Treatment and Waste Storage at ORNL Alternatives, no cumulative off-site transportation impacts would occur for these alternatives.

5.7 HUMAN HEALTH

The reservation has a number of radiological sources including the Melton Valley Storage Tanks. These DOE sources, combined with natural background, help constitute the radiological baseline for the area. As noted in Section 5.3, DOE has an active cleanup program under way under CERCLA. This program is designed to reduce radiological and other contaminant sources and releases in Melton Valley. Using 1998 effective dose equivalent data for the ORR (ORNL 1999), the latent cancer fatalities risk computed for population within 90 km (50 miles) of the ORR is 6.6E-03. The Treatment and Waste Storage at ORNL Alternative using the vitrification process would result in 6.8E-01 person-rem to the affected public population and a corresponding 3E-04 latent cancer fatalities risk to that population. The latent cancer fatalities risk attributed to the Spallation Neutron Source project is 3.0E-01 (DOE 1999b). Cumulatively, the latent cancer fatalities risk from all these sources would be 3.1E-01.

When the wastes associated with the proposed action are treated and shipped offsite, the total expected fatalities (public population), the maximally exposed individual (public) probability of cancer fatality and non-involved worker probability of cancer fatality associated with potential accidental releases from a breach of the Melton Valley Storage Tanks would be eliminated. The projected risk to the affected public population from both inhalation and ingestion from a release of untreated wastes from a tank breach would be 1.1 total expected fatalities; the maximally exposed individual (public) probability of cancer fatality would be 1.1E-05 and the non-involved worker probability of cancer fatality would be

9.2E-04. These risks would be eliminated by adopting any of the treatment options under the proposed action. The most significant accident associated with waste treatment would be the breach of the Melton Valley Storage Tank transfer line during treatment operations for the Cementation Alternative. Risks from this type of accident would be 0.31 total expected fatalities. Risks from this type of accident would vary by treatment process for the Treatment and Waste Storage at ORNL Alternative but would be greatest if the cementation process were used.

5.8 SOCIOECONOMICS

The cumulative socioeconomic impacts from this project are determined by adding the impacts identified in Section 4.13 with expected future development project effects on employment and wages. Projected changes over the next 10 years in the future DOE and contractor workforce in Oak Ridge are factored into the analysis. As noted in Chapter 4, the TRU Waste Treatment Project would contribute very little to the regional economy and the overall employment picture regardless of the alternative selected. However, the Treatment and Waste Storage at ORNL Alternative would be the bounding case. These impacts must be viewed in context. Several planned re-industrialization projects at ETTP (Table 5-1) would, under full realization, produce up to 14,700 direct and indirect jobs, or 5% of 1996 Region of Influence employment. In addition, Roane County is working on plans for the Macedonia Industrial Park (Table 5-1) near the ETTP site, which would be located off the ORR.

The potential gains in employment from these regional projects are likely to be offset by the large cuts in DOE-related jobs during the same time period. An estimated 4,000 direct and indirect jobs were lost between 1996 and 1998, and more jobs could be lost in the next 10 years. If we assume that 5,000 direct jobs are lost during this period, the cumulative total direct and indirect jobs lost from 1996 to 2010 would total 10,950. This exceeds the lower-bound estimate of total jobs created by the ETTP initiatives. When we subtract this from the upper bound, the net new jobs created would represent roughly 1% of the 1996 region of influence employment. Even if other DOE employment (such as construction-related employment for the Spallation Neutron Source and Y-12 Modernization) is considered, the incremental increase in employment from the proposed action would be minor. The proposed action would contribute very little additional employment, and the project's contribution to cumulative socioeconomics impacts regardless of the treatment process would be very small.

5.9 REFERENCES

DOE (U.S. Department of Energy) 1997a. *Record of Decision for the Melton Valley Watershed at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, DOE/OR/01-1826&D1.

DOE 1997b. *Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste*, DOE/EIS-0200-F, U.S. Department of Energy, Washington, D.C., May 1997.

DOE 1997c. *Remedial Investigation Report on the Melton Valley Watershed at Oak Ridge National Laboratory, Oak Ridge, Tennessee: Volume 1, Evaluation, Interpretation, and Data Summary*. DOE/OR/01-1546 V1&D2.

DOE 1998. *Categorical Exclusion for Construction/Relocation of Access Road at Oak Ridge National Laboratory*, CX-TRU-98-007, Oak Ridge, Tennessee.

DOE 1999a. *Remedial Effectiveness Report for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee*, DOE/OR/01-1790&D0.

DOE 1999b. *Final Environmental Impact Statement—Construction and Operation of the Spallation Neutron Source*, DOE/EIS-0247, U.S. Department of Energy, Office of Science, April 1999.

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LMER and LMES (Lockheed Martin Energy Research Corp. and Lockheed Martin Energy Systems, Inc.) 1998. *Comprehensive Integrated Planning: A Process for the Oak Ridge Reservation, Oak Ridge, Tennessee*, ES/ENSFP-49, Oak Ridge, Tennessee, January 1998.

Medley, T. 2000. Personal communication with Wayne Tolbert, Science Applications International Corporation, January 7, 2000, from Tony Medley, Oak Ridge National Laboratory Capital Assets Manager.

ORNL (Oak Ridge National Laboratory) 1999. *Oak Ridge Reservation Annual Site Environmental Report for 1998*, DOE/ORO/2091.

6. MITIGATION MEASURES

A variety of design features were built into the various alternatives to help minimize adverse environmental impacts. These best management practices serve to reduce or eliminate potentially harmful secondary waste streams. Further, it is generally assumed that best management practices would be followed regarding erosion control, minimization of secondary waste, and safe handling of materials to minimize accidents or the effect of accidents. Specific mitigation measures are described below.

Impacts to cultural and archaeological resources are best minimized by avoidance. Although no such resources have been identified in the project site area, should any cultural or archaeological resources be encountered, construction would be immediately stopped, and the appropriate DOE personnel and the Tennessee State Historic Preservation Officer would be notified. Specific mitigation would follow the advice and guidance of these individuals.

Erosion control measures, such as silt fences, combined with timely construction of buildings and parking lots would reduce the potential for increased siltation and turbidity in White Oak Creek and White Oak Lake from runoff. Also, proper maintenance of drainage culverts, gate valves, and the detention basin would reduce the likelihood of soil erosion from storm water overflows.

Air quality mitigation measures that may be used during the construction phase to control dust include:

use of water or chemicals during site clearing, digging, and grading;

application of asphalt, concrete, water, or grass seed on roadways, fill stockpiles, and other surfaces that can yield dust; and

covering of open truck beds.

Impacts of vehicular exhaust may be reduced by refraining from unnecessary idling of equipment and implementation of transportation controls that reduce work-related vehicle miles to the minimum required to the task (WM PEIS, DOE 1997a).

Impacts from waste treatment processes utilize efficient emission controls designed for the specific process as described above.

Inspecting and maintaining the trucks transporting waste on a regular basis would mitigate transportation impacts. Drivers would be required to meet strict selection and training criteria. Planning of specific transportation routes using DOT routing guidelines would minimize risk. The TRANSCOM system would be used to monitor shipments to the Waste Isolation Pilot Plant. Extensive emergency response capability exists and would be maintained at DOE, the trucking contractor, and in communities along the transportation routes (WIPP SEIS-II, DOE 1997b).

A 0.016-ha (0.03-acre) wetland on the proposed project site is expected to be destroyed by construction. Potential mitigation measures include avoidance, minimization, or compensation. Redesigning the layout of the TRU waste treatment facility could potentially avoid or minimize impact to this wetland. Should this not be practical, then compensatory mitigation such as new method construction could be done. Redesign of the sediment/storm water detention basin could result in a constructed wetland.

REFERENCES

DOE 1997a. Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste, DOE/EIS-0200-F, U.S. Department of Energy, Washington, D.C., May 1997.

DOE 1997b. *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact* Statement, DOE/EIS-0026-s-2, U.S. Department of Energy, Washington, D.C., September 1997.

7. UNAVOIDABLE ADVERSE IMPACTS AND IRREVERSIBLE IRRETRIEVABLE COMMITMENT OF RESOURCES

7.1 UNAVOIDABLE ADVERSE IMPACTS

Despite the mitigation measures identified in Chapter 6, there would be some unavoidable adverse impacts resulting from the implementation of the proposed action alternatives. These include the clearing of 2 to 2.8 ha (5 to 7 acres) of forested land resulting from the construction of the proposed waste treatment facility and loss of this habitat by plants and animals for a period of at least a decade (Sections 4.1 and 4.3). The area would be revegetated after closure and D&D of the facility. An additional 0.3 to 0.8 ha (0.5 to 2 acres) of land would be required indefinitely if the Treatment and Waste Storage at ORNL Alternative is implemented. This land would be used for the waste storage facilities, which would be required for this alternative.

Some secondary wastes and emissions would be created despite best efforts at source reduction, recycling, and other best management practices (Section 4.6). The potential for transportation and other accidents can be reduced by best management practices but not entirely eliminated. Some potential risks are unavoidable as a function of the treatment and transportation process (Section 4.10). Some slight, temporary increases in noise are also unavoidable (Section 4.12).

7.2 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

The proposed action would involve the irreversible or irretrievable commitment of land, energy, and materials. The commitment of a resource is irreversible if its primary or secondary impacts limit future options for the resource. An irretrievable commitment refers to the use or consumption of resources that are neither renewable nor recoverable for later use by future generations. Construction, operation, and eventual D&D would result in a permanent commitment of materials such as steel and concrete, and would consume energy in forms such as gasoline, diesel fuel, and electricity. Water use would support construction, operation and D&D. There would be an irreversible and irretrievable commitment of current natural resources.

The 11,250 to 45,000 MW of electrical energy required for the project, depending on the alternative selected, would be committed and consumed (Section 4.9). Some building materials, steel and concrete, for the process building and related facility support would be used. Some portion of these materials cannot be reused. Waste packaging and storage materials would also be irreversibly committed to this use.

The waste storage locations, as part of the Treatment and Waste Storage Alternative at ORNL, would require what some may consider an irreversible and irretrievable commitment of storage space up to 0.8 ha (2.0 acres). The Treatment and Waste Storage at ORNL Alternative would require a commitment of land for storage space. Depending on the treatment alternative selected, land indefinitely committed as storage space would be approximately 0.2 ha (0.75 acres) for the low-temperature drying process, 0.6 ha (1.5 acres) for the vitrification process, or 0.8 ha (2.0 acres) for the cementation process (Section 4.1). As a practical matter, this would constitute an irreversible and irretrievable commitment of this space. The land, which is forested, would be permanently converted to industrial use. In addition, 0.012 ha (0.03 acre) of wetland would be irreversibly lost when it is drained.

There would, however, be no losses of federally protected threatened or endangered species or critical habitat (Section 4.5.3).

Although not directly related to this proposed action, the High Flux Isotope Reactor access road (Old Melton Valley Road) upgrade, which provides access to both the High Flux Isotope Reactor and the proposed site, also resulted in an irreversible and irretrievable commitment of 4 ha (10 acres) of formerly forest habitat to industrial use. This action was evaluated under a separate NEPA action, and a categorical exclusion was prepared.

8. APPLICABLE LAWS AND REGULATIONS

This section identifies and summarizes the major laws, regulations, and requirements that may apply to the different alternatives analyzed in this TRU Waste Treatment Project EIS. Section 8.1 first lists those laws, regulations, and requirements and describes how those requirements may apply to this project specifically. In addition to laws, regulations, and requirements discussed below, there may be additional project-specific contractual requirements in any contract entered into between DOE and Foster Wheeler if the preferred alternative is selected. The rules and regulations that govern the transportation of all goods and commodities on our nation's highways can be found in 49 *CFR* §100–199 and the Western Governor's Association Waste Isolation Pilot Plant Program Implementation Guide.

8.1 FEDERAL AND STATE ENVIRONMENTAL STATUTES AND REGULATIONS

***National Environmental Policy Act of 1969* (NEPA), as amended (42 U.S.C. §4321 et seq.), the Council on Environmental Quality Implementing Regulations (40 *CFR* §1500 et seq.), and DOE Implementing Regulations (10 *CFR* §1021 et seq.).** This EIS is being prepared to comply with NEPA—the Federal law that requires agencies of the Federal government to study the possible environmental impacts of major Federal action significantly affecting the quality of the human environment. Although the proposed project is envisioned as one that would be executed primarily by a private entity, this EIS assesses potential impacts before DOE decides whether to proceed with the project. The unique process described in §1021.216 allows DOE to compare potential environmental impacts between approaches suggested by competing offerors when in the process of a private sector procurement. DOE compares these impacts in the Environmental Critique. Those environmental considerations that are detailed in the Critique are made available to the Source Evaluation Board considering the procurement and become a part of the technical criteria against which the competing offerors are evaluated during the procurement process.

As a result of this competition and the comparison of potential environmental impacts associated with the competing proposals, the Source Evaluation Board chose Foster Wheeler as the winning contractor for Phase I of the project.

This EIS considers whether Foster Wheeler should be allowed to continue with the remainder of the project as it was proposed to DOE, or whether one of the various alternative courses of action is the better decision for DOE. As required by NEPA, the potential environmental impacts of each alternative are analyzed and are being considered in this EIS.

***Atomic Energy Act of 1954* (AEA), as amended (42 U.S.C. §2011 et seq.).** The AEA is the statute that requires DOE to establish standards to protect health and safety with respect to atomic materials. Ordinarily, this is accomplished through DOE orders, standards, and procedures to ensure the safe operation of its facilities. In the project under consideration in this EIS, because the proposed TRU Waste Treatment Facility would not be considered a DOE facility, but instead would be a privately owned and operated facility, DOE orders, standards, and procedures are not necessarily applicable. Nonetheless, DOE remains ultimately responsible for its atomic or nuclear materials. Thus, the environmental, safety, and health standards that would apply to this project are those established in the contract between DOE and Foster Wheeler, particularly those set out in the Environmental Safety and Health Program Operating Plan that would result from negotiations between Foster Wheeler and DOE.

***Clean Air Act* (CAA), as amended (42 U.S.C. §7401 et seq.).** This Federal statute and its regulations are important to this proposed project and its alternatives. In addition, the Tennessee statute and regulations promulgated under the CAA authority are also important. The heart of the CAA is the National Ambient Air Quality Standards (NAAQS). These are national standards set by the EPA for certain pervasive pollutants; the standards are set at a level designed to protect human health with a conservative margin of safety. States have the primary responsibility of assuring that the air quality within state borders is maintained at a level that meets the NAAQS. This is achieved by states through the establishment of source-specific state requirements that are described in State Implementation Plans. Also under the Federal law is the requirement that new sources of air pollutants meet established New Source Performance Standards (NSPS) set by EPA. These NSPS can be described as design standards, equipment standards, work practices, or operational standards, in addition to the other approach of numerical emissions limitations.

Because of the significance of this body of law, these different concepts will be examined in the discussion in Section 8.2 according to each alternative being considered.

***Resource Conservation and Recovery Act* (RCRA), as amended (42 U.S.C. §6901 et seq.).** This body of law regulates the treatment, storage, and disposal of hazardous wastes. Regulation under these laws is by permit, meaning that the State of Tennessee and EPA study the alternative chosen by DOE and then establish a permit specific to the project that describes how the project is to be carried out. Whether DOE chooses the No Action Alternative, or any other alternative under consideration in this EIS, some type of RCRA permit will be required. As with the CAA discussion above, the discussion in Section 8.3 considers each alternative and the likely RCRA permitting scheme that would exist for each alternative.

***Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA), as amended (42 U.S.C. §9601 et seq.).** This body of law does not play a predominant role in the proposed project. However, after the removal of the waste from the SWSA 5 North trenches, residual contamination in the surrounding media (soils and groundwater) may still need to be addressed under a subsequent CERCLA action. In addition, from a cumulative impacts perspective, the proposed action would contribute beneficially to the CERCLA cleanup of Melton Valley.

***Emergency Planning and Community Right-to-Know Act of 1986* (EPCRA), as amended (42 U.S.C. §11001 et seq.).** This statute requires that inventories of specific chemicals used or stored in either the storage facility or the proposed TRU Waste Treatment Facility would be communicated to the State of Tennessee for purposes of emergency response planning. If DOE chooses the No Action Alternative, the responsibility for this reporting activity will lie with the management and operating (M&O) contractor for the ORNL. Alternatively, if DOE chooses one of the "action" alternatives, Foster Wheeler, or another contractor, will have the responsibility of reporting to the State and preparing emergency response plans.

***Occupational Safety and Health Act of 1970*, as amended (29 U.S.C. §651 et seq.).** If DOE chooses any of the "action" alternatives, compliance with the Occupational Safety and Health Act will be the responsibility of Foster Wheeler, or another contractor, according to Occupational Safety and Health Act standards. If DOE chooses the No Action Alternative, protection of the workforce will remain with the M&O contractor and DOE. The occupational safety requirements of the U.S. Department of Labor's Occupational Safety and Health Administration (OSHA) are not directly applicable to DOE's government-owned, contractor-operated facilities by virtue of Section 4(b)(i) of the Occupational Safety and Health Act of 1970. However, DOE requires a written worker protection program that integrates all requirements contained in DOE 440.1:29 *CFR* Part 1960, *Basic Program Elements for Federal Employee*

Occupational Safety and Health Programs and Related Matters, and other related site-specific worker protection activities.

National Historic Preservation Act of 1966, as amended. Section 106 of the National Historic Preservation Act (NHPA) requires that Federal agencies take into account the effects of their undertakings on properties included in or eligible for inclusion in the *National Register of Historic Places.* To comply with Section 106 of the NHPA, and its implementing regulations at 36 *CFR* 800, DOE-ORO ratified a programmatic agreement among DOE-ORO, the Tennessee State Historic Preservation Officer (SHPO), and the Advisory Council on Historic Preservation concerning management of historical and cultural resources and properties on the ORR. As part of the programmatic agreement, DOE-ORO has developed a cultural resources management plan for the ORR and conducted surveys to identify significant historical properties on the ORR. Compliance with NHPA at the DOE Oak Ridge facilities is achieved and maintained in conjunction with NEPA compliance. The scope of proposed actions is reviewed in accordance with the programmatic agreement and, if warranted, consultation is initiated with the SHPO and the Advisory Council on Historic Preservation, and the appropriate level of documentation is prepared and submitted. Consultation was performed for this project. While no cultural resources are known from the proposed site, should any resources be discovered, the reporting and coordination requirements under this Act would continue to be implemented.

Clean Water Act of 1970, as amended. The various alternatives were examined to ensure that no dredge or fill material would be produced and surface water bodies in the area would not receive any dredge or fill materials. Thus, Section 404(r) of the Act was determined not to apply. The Melton Valley Storage Tanks are classified as wastewater treatment units under the Tennessee Department of Environment and Conservation-administered water program.

8.2 OTHER PERTINENT REQUIREMENTS

Federal Facilities Agreement. DOE, EPA, and the Tennessee Department of Environment and Conservation (TDEC) entered into the ORR Federal Facilities Agreement (FFA) on January 1, 1992. The FFA coordinates remediation activities undertaken on the Reservation pursuant to the requirements of CERCLA, RCRA, and NEPA. The FFA established a mechanism to ensure that environmental impacts associated with ORR are thoroughly investigated and remediated, as necessary to protect the public health and welfare and the environment. It is a binding agreement that governs the total processes by which the corrective actions and remedial actions are conducted, from the investigation of individual units through their remediation, and describes procedures for the parties to set annual work priorities and schedules for each process. As such, the FFA is designed to integrate the CERCLA response action process with the corrective measures provisions of Sections 3002(u) and (v) of RCRA, as well as to ensure that remedial actions are in compliance with appropriate, relevant, and applicable requirements (ARARs). The FFA parties, EPA and TDEC, will review this EIS in light of remediation actions in Melton Valley.

Tennessee Department of Environment and Conservation: Commissioner's Order (September 1995). DOE is required to implement the Site Treatment Plan (under the Federal Facility Compliance Act) that mandates specific requirements for the treatment and shipment of ORNL's TRU waste. The primary milestone in the Commissioner's Order is that DOE begin treating legacy TRU sludge in order to make the first shipment to the Waste Isolation Pilot Plant (a DOE transuranic waste disposal facility) in New Mexico by January 2003.

Executive Order 12898: Environmental Justice. This Executive Order is applicable to DOE for any of the alternatives being considered; therefore, an analysis of the possible impacts to minority and low-income populations has been done in the EIS (Section 4.13).

Executive Order 11988: Floodplain Management. This Executive Order is applicable to DOE for any alternatives being considered; therefore, an analysis of possible impacts to floodplain function has been performed in this EIS (Section 4.5).

Executive Order 11990: Protection of Wetlands. This Executive Order is applicable to DOE for any alternatives being considered; therefore, an analysis of possible impacts to wetlands has been performed in this EIS (Section 4.5).

Executive Order 12088: Federal Compliance with Pollution Control Standards. This Executive Order is applicable to DOE for any alternatives being considered; therefore, pollution control standards were integrated into the various treatment alternatives considered in this EIS.

***Executive Order 13007*: *Indian Sacred Sites*.** This Executive Order is applicable to DOE for any of the alternatives being considered; therefore, and analysis of the possible impacts to land use, cultural resources, and environmental justice, has been completed in the EIS (Sections 4.1, 4.3, and 4.14).

8.3 REGULATORY COMPARISONS BETWEEN ALTERNATIVES

If the No Action Alternative were selected, DOE is potentially subject to fines and penalties due to noncompliance with the Tennessee Commissioner’s Order. Any modification to the timeframes specified within the Order for treatment and disposal of the radioactive mixed waste have to be negotiated with the State of Tennessee. RCRA permits would likely not be necessary, provided that the tanks were maintained as wastewater treatment units which are specifically excluded from RCRA permitting requirements pursuant to 40 *CFR* (c)(2)(v).

Selection of the preferred alternative would require an RCRA permit to treat and store the waste. The treatment permit would cover the low-temperature drying operation with additional submissions for storage required. In addition, a permit for emissions might be required depending upon potential emissions of radionuclides or other contaminants from the operation. In any event a permit to construct will be required under RCRA prior to construction. In addition, the unit will be classified as a Subpart X unit under RCRA. Wastes to be treated consist of characteristic hazardous wastes regulated under RCRA. Due to this fact the land disposal restrictions require that the applicable waste be treated not only for the hazardous characteristic constituents, but also for any underlying constituents found in the universal treatment standards.

If DOE selects the Vitrification Alternative, an RCRA permit will be required for operation of the vitrification unit and storage of wastes similar to those required in the discussion relating to the proposed action above. Pre-construction permits will also be required prior to construction of the unit(s). The land disposal restrictions applicable to the wastes would have to be addressed as outlined above.

The Cementation Alternative would also require an RCRA permit for treatment and storage of hazardous wastes under RCRA. The land disposal restrictions would be addressed though the TDEC Commissioner’s Order (dated September 1995). An evaluation of emissions would be required to determine if modification of the ORR NESHAPs permit would be required.

Should the Treatment and Storage Onsite Alternative be undertaken, an RCRA permit would still be applicable for waste treatment unless the treatment occurred as a part of the wastewater treatment system regulated under the Clean Water Act. In any event modification of the Commissioner's Order would be required, as the Order requires wastes to be treated and disposed. In addition, new storage units could be required in order to accommodate increasing volumes of stored wastes. Since it is assumed that treatment will render the wastes non-hazardous and meet the requirements of the applicable land disposal restriction standards, the wastes, after treatment, would not be required to be stored in a permitted hazardous waste storage unit.

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9. LIST OF PREPARERS

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Organization:	Science Applications International Corporation
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Signature: Reginald Hall

Date: January 14, 2000

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Organization: Advanced Integrated Management Services, Inc.

Title: President/CEO

APPENDIX A

NOTICE OF INTENT, ENVIRONMENTAL SYNOPSIS, AND PUBLIC ISSUES

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Appendix A contains a copy of the Notice of Intent to prepare this Environmental Impact Statement, a copy of the Environmental Impact Statement, a copy of the Environmental Synopsis which was prepared as part of the selection process for Foster Wheeler and the preferred alternative of low-temperature drying proposed by Foster Wheeler, and a summary of issues raised during the public scoping process for this Environmental Impact Statement.

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APPENDIX A.1

NOTICE OF INTENT

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Individuals with disabilities may obtain a copy of the application package in an alternate format, also, by contacting that person. However, the Department is not able to reproduce in an alternate format the standard forms included in the application package.

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Dated: January 22, 1999.

Gerald N. Tirozzi,

Assistant Secretary for Elementary and Secondary Education.

[FR Doc. 99–1866 Filed 1–26–99; 8:45 am]

BILLING CODE 4000–01–M

DEPARTMENT OF ENERGY

Notice of Intent To Prepare an Environmental Impact Statement for a Transuranic Waste Treatment Facility at Oak Ridge, TN

AGENCY: Department of Energy.

ACTION: Notice of Intent.

SUMMARY: The U. S. Department of Energy (DOE) intends to prepare an Environmental Impact Statement (EIS) under the National Environmental Policy Act (NEPA) and its implementing regulations on the proposed construction, operation, and decontamination/decommissioning of a Transuranic (TRU) Waste Treatment Facility at Oak Ridge, Tennessee. The four types of TRU waste that would be treated at the facility are remote-handled (RH)–TRU waste sludge, low-level radioactive waste supernatant associated with the sludge, contact-handled (CH)–TRU/alpha low-level radioactive waste solids, and RH–TRU/alpha low-level radioactive waste solids. Because much of the waste displays Resource Conservation and Recovery Act (RCRA) characteristics, the proposed facility would be permitted under RCRA. All the waste DOE proposes to treat currently is stored at Oak Ridge National Laboratory (ORNL) in Oak Ridge, Tennessee. The proposed site for the treatment facility is adjacent to the Melton Valley Storage Tanks, where the waste sludge and supernatant are being stored.

DOE invites the public, organizations, and agencies to present oral or written comments concerning the scope of the EIS, including the issues the EIS should address and the alternatives it would analyze.

DATES: The public scoping period begins on the date of this publication and continues until February 26, 1999. Written comments submitted by mail should be postmarked by the closing date to ensure consideration. Comments mailed after that date will be considered to the extent practicable.

DOE will conduct public scoping meetings to assist in defining the appropriate scope of the EIS and to identify significant environmental issues to be addressed. These meetings will be held at the following time(s) and location:

February 11, 1999, American Museum of Science and Energy, 300 South Tulane Avenue, Oak Ridge, Tennessee 37830; Time: 6:30–9:30 p.m.

February 16, 1999, American Museum of Science and Energy, 300 South Tulane Avenue, Oak Ridge, Tennessee 37830; Time: 6:30–9:30 p.m.

ADDRESSES: Please direct comments or suggestions on the scope of the EIS, requests to speak at the public scoping meetings, requests for special accommodations to enable participation at scoping meetings (e.g., interpreter for the hearing-impaired), and questions concerning the project to: Gary L. Riner, U.S. Department of Energy, Oak Ridge Operations Office, P.O. Box 2001, Oak Ridge, Tennessee 37831, telephone: (423) 241–3498, facsimile: (423) 576–5333, or e-mail rinerg@oro.doe.gov.

For general information on the DOE NEPA process, please contact: Carol M. Borgstrom, Director, Office of NEPA Policy and Assistance, EH–42, U.S. Department of Energy, 1000 Independence Avenue, SW, Washington, D.C. 20585–0119, telephone: (202) 586–4600 or leave a message at (800) 472–2756.

SUPPLEMENTARY INFORMATION:

Background

Research and development activities supporting national defense and energy initiatives have been performed at ORNL since its construction in eastern Tennessee in 1943, generating radioactive and hazardous waste legacies that now pose environmental concerns. Meeting the cleanup challenges associated with legacy TRU waste is a high priority for the DOE, Tennessee Department of Environment and Conservation (TDEC), and stakeholders. The TRU waste treatment project at the ORNL will be an important component of DOE cleanup efforts at the site.

TRU waste is radioactive waste that is not classified as high-level radioactive waste and that contains more than 100 nanocuries per gram of alpha-emitting transuranic (atomic numbers greater than 92) isotopes with half-lives greater than 20 years. Alpha low-level radioactive waste contains alpha-emitting transuranic isotopes with half-lives greater than 20 years at concentrations less than 100 nanocuries per gram.

The TRU waste to be treated also contains beta- and gamma-emitting isotopes in addition to alpha-emitting isotopes, which result in its classification as either CH (surface dose rate of 200 mrem/hr or less) or RH (surface dose rate of greater than 200 mrem/hr).

Solid waste at ORNL is a heterogeneous mixture consisting of paper, glass, rubber, cloth, plastic, and metal from glove boxes, fuel processing, hot cells, and reactors. Solid waste is currently packaged in metal boxes, drums and concrete overpacks, and stored in RCRA permitted facilities. Most of the solid waste containers do not meet current Department of Transportation regulations and would require repackaging prior to shipment.

Based on generator records, the solid waste has been classified as either TRU or alpha low-level radioactive waste. However, because the nature of the solid waste can only be confirmed after retrieval and characterization, solid wastes addressed in this Notice of Intent are characterized as ''TRU/alpha low-level radioactive waste'' to note the current uncertainty. The solid waste may contain RCRA characteristic metals, but generator records do not indicate the presence of any RCRA listed constituents. The supernatant, the liquid layer covering the sludge in the tanks, is considered a low-level waste but is not considered hazardous under the RCRA definitions.

Approximately 62 percent of the legacy TRU wastes are currently stored in 50 year-old tanks. The remaining 38 percent of the legacy TRU wastes are currently stored in subsurface trenches, vaults, and metal buildings.

Approximate quantities of the four primary waste streams needing treatment are: 900 m^3 of RH–TRU sludge, located in the tanks; 1600 m^3 of low-level supernatant, located in tanks; 550 m^3 of RH–TRU waste/alpha low-level radioactive waste solids in vaults and trenches; and 1,000 m^3 of CH–TRU waste/alpha low-level radioactive waste solids in metal buildings.

Purpose and Need for Agency Action

The DOE needs to ensure the safe and efficient retrieval, processing, certification, and disposition of legacy TRU waste at ORNL. There are legal mandates for DOE to address TRU waste management needs. DOE has been directed by the TDEC and the U. S. Environmental Protection Agency (EPA) to address environmental issues including disposal of its legacy TRU waste. DOE is under a Commissioner's Order issued by the State of Tennessee (September 1995) to implement the Site Treatment Plan, under the Federal Facility Compliance Act, that mandates specific requirements for the processing and disposal of ORNL's TRU waste. The primary milestone in the Commissioner's Order is that DOE begin processing TRU sludge in order to make the first shipment to the Waste Isolation Pilot Plant (WIPP) (a DOE transuranic waste disposal facility) in New Mexico by January 2003. In addition, two Records of Decision issued in connection with the Federal Facility Agreement among EPA, TDEC, and DOE, under the Comprehensive Environmental Response, Compensation, and Liability Act, mandate that the waste from the Gunite and Associated Tanks Project (in Bethel Valley) and the Old Hydrofracture Facility Tanks Project (in Melton Valley) be processed and disposed of along with the TRU waste from the Melton Valley Storage Tanks.

Waste retrieval operations are currently underway to prepare ORNL TRU waste storage tanks for closure, and the waste removed from the Bethel Valley tanks will be consolidated in the Melton Valley Storage Tanks before processing. After processing, TRU waste must be certified for shipment to and disposal at WIPP, and any low-level radioactive waste resulting from TRU waste processing must be certified for shipment to and disposal at the DOE site(s) to be selected in a Record of Decision for the Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste (WM PEIS) (DOE/EIS–0200–F, May 1997). No facilities for processing TRU/alpha low level radioactive waste exist at the Oak Ridge Reservation.

Proposed Action and Alternatives

Proposed Action

Under the proposed action, a waste treatment facility for the ORNL legacy TRU waste would be constructed, operated, and decontaminated/decommissioned under a contract awarded to the Foster Wheeler Environmental Corporation. Under the contract, the action would be carried out in four phases: Phase I, Licensing and Permitting (currently in process, includes DOE's NEPA analysis and contractor design activities); Phase II, Construction and Pre-Operational Testing; Phase III, Treatment and Packaging; Phase IV, Decontamination and Decommissioning. If the current NEPA review results in the selection of an alternative other than the proposed action, Phase II (Construction and Pre-Operational Testing) of the contract would not be executed. Waste volume reduction would be a major component of the processing in order to minimize waste generation and costs and to conserve resources. After processing, the waste would be certified for disposal as either low-level radioactive, alpha low-level radioactive, or TRU waste, as discussed above.

All activities associated with the proposed action must be performed safely and in compliance with applicable Federal and state regulatory requirements. Foster Wheeler Environmental Corporation would be responsible for achieving compliance with all applicable environmental, safety and health laws and regulations, and regulatory agencies would be responsible for monitoring the Corporation's compliance. The State of Tennessee and EPA would regulate the Corporation according to permits under their purview. DOE would regulate occupational safety and health and nuclear safety according to specific environment, safety and health requirements.

DOE would lease the Melton Valley Storage Tanks, subject to notification of EPA and the State of Tennessee, and an adjacent land area totaling approximately 10 acres to Foster Wheeler Environmental Corporation for construction of the facility. The Melton Valley Storage Tanks are separate from ORNL's main plant area. The proposed treatment facility would be fenced, with controlled access to Tennessee State Highway 95.

Foster Wheeler Environmental Corporation has proposed a process of evaporating and drying the sludges and supernatant that is flexible enough to address a wide range of waste properties. The low temperature treatment would reduce waste volume, generate additional waste as a result of treatment, and meet specified waste acceptance criteria. To ensure that the waste would meet RCRA Land Disposal Restrictions (LDR) standards, additives that reduce the solubility of the RCRA metals in the waste would be added to form stable compounds. The dried stabilized sludge would pass the Toxic Characteristic Leaching Procedures and no longer exhibit a RCRA characteristic. The relatively inexpensive stabilization process could be easily performed during the overall treatment process and would result in waste that meets the LDR treatments standards and could be stored on site, if necessary, pending disposal. The supernatant would be dried for final disposal at an approved DOE low-level radioactive waste disposal site consistent with a WM PEIS Record of Decision yet to be issued for low-level radioactive waste. Segregation of the supernatant from the sludge would result in significant life-cycle cost avoidance when compared to disposal at WIPP.

The proposed action includes no treatment for the bulk of the solid waste that is not regulated under RCRA other than repackaging with some compaction to meet the 50% volume reduction required by the contract. The solid waste would be better characterized during the repackaging effort to achieve final waste form certification before disposal. RCRA characteristic items would be isolated for macroencapsulation or other processing techniques to comply with applicable RCRA LDRs. This would ensure that alpha low-level radioactive waste would meet non-RCRA low-level waste disposal requirements and comply with RCRA LDRs if interim storage is required on site.

Alternatives

DOE will consider alternatives to the proposed action, such as shipment of TRU wastes to other DOE sites for processing, alternative technologies for sludge waste, and no action. Under a shipment alternative, DOE would ship CH-TRU/alpha low-level and RH–TRU/alpha low-level radioactive waste solids to other DOE site(s) for processing. Most of the solid waste containers do not meet current Department of Transportation regulations and would require repackaging prior to shipment. After processing, the waste would be certified for disposal as either low-level radioactive, alpha low-level radioactive, or TRU waste and transported to appropriate disposal facilities. Under a treatment alternative, DOE would process RH–TRU sludge waste and the low-level radioactive waste supernatant associated with the sludge by using vitrification or grouting technology. This alternative would include no treatment for the bulk of the solid waste that is not regulated under RCRA other than repackaging with some compaction. The solid waste would be better characterized during the repackaging effort to achieve final waste form certification before disposal. RCRA characteristic items would be isolated for macroencapsulation or other processing techniques to comply with applicable RCRA LDRs. This would ensure that alpha low-level radioactive waste would meet non-RCRA low-level waste disposal requirements and comply with RCRA LDRs if interim storage is required on site.

As required by the Council on Environmental Quality's (CEQ's) Regulations for Implementing the Procedural Provisions of NEPA (40 CFR Parts 1500–1508), a no action alternative will be evaluated. Under this alternative, DOE would continue to store the TRU waste in tanks, subsurface trenches, vaults, and metal buildings, as discussed in the Background section, above.

Preliminary Environmental Analysis

DOE incorporated environmental information very early in the project planning. Prior to selection of the contractor, DOE held two public meetings with stakeholders, had ongoing discussions with regulators, prepared a characterization report for the site of the proposed action, and sponsored an independent study of treatment technologies and contracting alternatives known as the Parallax study (ORNL/M–4693, Feasibility Study for Processing ORNL TRU Waste in Existing and Modified Facilities, September 15, 1995) (available in the public reading rooms listed below). Bidders were required to submit environmental data, and DOE prepared an environmental critique (under 10 CFR 1021.216) for consideration in the procurement process. A synopsis of this critique has been filed with the EPA and made available to the public.

NEPA Process

The EIS for the proposed project will be prepared according to the National Environmental Policy Act of 1969, the CEQ NEPA regulations, and DOE's NEPA Implementing Procedures (10 CFR Part 1021).

Through the NEPA process begun with this Notice of Intent, DOE will continue to analyze environmental impacts and evaluate alternative actions while Phase I of the awarded contract is underway. The EIS for the proposed TRU waste treatment will incorporate pertinent analyses performed as part of the DOE's WIPP Disposal Phase Supplemental Environmental Impact Statement (DOE/EIS–0026–S–2, September, 1997) and the WM PEIS. Processing the ORNL TRU waste in Oak Ridge is consistent with the Records of Decision issued for management of the transuranic waste for the aforementioned Environmental Impact Statements (63 FR 3624 and 3629, respectively, January 23, 1998). The disposal of low-level radioactive waste included in this contract will be consistent with the WM PEIS ROD for low-level waste that is yet to be issued.

The contract allows DOE and Foster Wheeler Environmental Corporation to identify during Phase I other potential waste streams for processing at this facility. Any such waste streams would be considered in this EIS and subject to further NEPA review, as appropriate.

Preliminary Identification of EIS Issues

DOE intends to address the following issues when assessing the potential environmental impacts of the alternatives in this EIS. DOE invites comment on these and any other issues that should be addressed in the EIS.

—Potential effects on air, soil, and water quality from normal operations and reasonably foreseeable accidents.
—Potential effects on the public, including minority and low-income populations, and workers from exposure to radiological and hazardous materials from normal operations and reasonably foreseeable accidents.
—Compliance with applicable Federal, state, and local requirements and agreements.
—Pollution prevention, waste minimization, and energy and water use reduction technologies to eliminate or reduce use of energy, water, and hazardous substances and to minimize environmental impacts.
—Potential socioeconomic impacts, including potential impacts associated with the workforce needed for operations.
—Potential cumulative environmental impacts of past, present, and reasonably foreseeable future operations, including impacts from using the proposed facility for potential waste streams other than those currently being proposed.
—Potential irreversible and irretrievable commitment or resources.

Related NEPA Reviews

Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste (DOE/EIS–0200–F, May 1997); Waste Isolation Pilot Plant Disposal Phase Supplemental Environmental Impact Statement (DOE/EIS–0026–S–2, September 1997); and Advanced Mixed Waste Treatment Project at the Idaho National Engineering and Environmental Laboratory Environmental Impact Statement (DOE/EIS–0290–F, to be issued January 1999).

Scoping Meetings

The purpose of this NOI is to encourage early public involvement in the EIS process and to solicit public comments on the proposed scope of the EIS, including the issues and alternatives it would analyze. DOE plans to hold public scoping meetings in Oak Ridge to solicit both oral and written comments from interested parties. See **DATES** and **ADDRESSES**, above, for the times and locations of these meetings.

DOE will designate a presiding officer for the scoping meetings. The scoping meetings will not be conducted as evidentiary hearings, and there will be no questioning of the commentors.

However, DOE personnel may ask for clarification of statements to ensure that they fully understand the comments and suggestions. The presiding officer will establish the order of speakers. At the opening of each meeting, the presiding officer will announce any additional procedures necessary for the conduct of the meetings. If necessary to ensure that all persons wishing to make a presentation are given the opportunity, a five-minute limit may be applied for each speaker, except for public officials and representatives of groups who would be allotted ten minutes each. Comment cards will also be available for those who would prefer to submit written comments.

DOE will make transcripts of the scoping meetings and other environmental and project-related materials available for public review in the following reading rooms:

U.S. Department of Energy, Freedom of Information Public Reading Room, Forrestal Building, Room 1 E–190, 1000 Independence Avenue, SW, Washington, DC 20585, Telephone: (202) 586–3142

U.S. Department of Energy, Oak Ridge Operations Office, 200 Administration Road, Room G–217, Oak Ridge, Tennessee 37831, Telephone: (423) 241–4780.

EIS Schedule

The draft EIS is scheduled to be published by August 1999. A 45-day comment period on the draft EIS is planned, and public hearings to receive comments will be held approximately one month after issuance. Availability of the draft EIS, the dates of the public comment period, and information about the public hearings will be announced in the **Federal Register** and in the local news media.

The final EIS, which will incorporate public comments received on the draft EIS, is scheduled for January 2000. A Record of Decision would be issued no sooner than 30 days after a notice of availability of the final EIS is published in the **Federal Register**.

Signed in Washington, DC, this 21st day of January 1999.

Peter N. Brush,

Principal Deputy Assistant Secretary Environment, Safety and Health.

[FR Doc. 99–1856 Filed 1–26–99; 8:45 am]

BILLING CODE 6450–01–P

DEPARTMENT OF ENERGY

Federal Energy Regulatory Commission

[Docket No. CP99–156–000]

Columbia Gas Transmission Corporation; Notice of Request Under Blanket Authorization

January 21, 1999.

Take notice that on January 14, 1999, Columbia Gas Transmission Corporation (Columbia), 12801 Fair Lakes Parkway, Fairfax, Virginia 22030–1046, filed in Docket No. CP99–156–000 a request pursuant to Sections 157.205 and 157.216, of the Commission's Regulations under the Natural Gas Act (18 CFR 157.205, 157.216) for authorization to abandon approximately 0.05 miles of 4- and 8-inch pipeline and a point of delivery under Columbia's blanket certificate issued in Docket No. CP83–76–000 pursuant to Section 7 of the Natural Gas Act, all as more fully set forth in the request that is on file with the Commission and open to public inspection.

Columbia requests authorization to abandon approximately 0.05 miles of 4- and 8-inch pipeline and a point of delivery to Columbia Gas of Pennsylvania, Inc. (CPA), all located in Elk County, Pennsylvania. Columbia states that the pipeline will be abandoned in place and all above ground facilities will be removed. CPA states that it no longer requires service from this point of delivery.

Any person or the Commission's staff may, within 45 days after issuance of the instant notice by the Commission, file pursuant to Rule 214 of the Commission's Procedural Rules (18 CFR 385.214) a motion to intervene or notice of intervention and pursuant to Section 157.205 of the Regulations under the Natural Gas Act (18 CFR 157.205) a protest to the request. If no protest is filed within the time allowed therefor, the proposed activity shall be deemed to be authorized effective the day after the time allowed for filing a protest. If a protest is filed and not withdrawn within 30 days after the time allowed for filing a protest, the instant request shall be treated as an application for authorization pursuant to Section 7 of the Natural Gas Act.

David P. Boergers,

Secretary.

[FR Doc. 99–1819 Filed 1–26–99; 8:45 am]

BILLING CODE 6717–01–M

DEPARTMENT OF ENERGY

Federal Energy Regulatory Commission

[Docket No. CP99–155–00]

Columbia Gas Transmission Corporation; Notice of Application

January 21, 1999.

Take notice that on January 13, 1999, Columbia Gas Transmission Corporation (Columbia), filed in Docket No. CP99–155–000 an application pursuant to Section 7(b) of the Natural Gas Act for permission and approval to abandon natural gas service currently provided by Columbia to Orange and Rockland Utilities, Inc. (O&R) and UGI Corporation (UGI) under its Rate Schedule X–124, and to abandon the operation of two segments of pipeline owned by O&R and UGI, all as more fully set forth in the application on file with the Commission and open to public inspection.

Specifically, Columbia proposes to abandon: (i) the transportation service currently provided under its Rate Schedule X–124 and, (ii) the certificate authority to operate the facilities located in Steuben and Allegany Counties, New York, that were constructed to provide the service proposed to be abandoned. Columbia states that its Rate Schedule X–124 provided for firm transportation service by Columbia to O&R for 4,600 Dth/d and to UGI Utilities, Inc., the successor in interest to UGI, for 22,400 Dth/d. Columbia states that the service, facilities and Columbia's authorization to lease and operate the facilities were approved by the Commission on June 28, 1984 in Docket No. CP83–478. Columbia also states that as it does not own the subject facilities, no facilities will be physically abandoned or removed by Columbia as a result of the proposed abandonment.

Any person desiring to be heard or to make any protest with reference to said application should on or before February 11, 1999, file with the Federal Energy Regulatory Commission, 888 First Street, NE, Washington, DC 20426, a motion to intervene or a protest in accordance with the requirements of the Commission's Rules of Practice and Procedure (18 CFR 385.214 or 385.211) and the Regulations under the Natural Gas Act (18 CFR 157.10). All protests filed with the Commission will be considered by it in determining the appropriate action to be taken but will not serve to make the protestants parties to the proceeding. Any person wishing to become a party to a proceeding or to participate as a party in any hearing therein must file a motion to intervene in accordance with the Commission's Rules.

Take further notice that, pursuant to the authority contained in and subject to the jurisdiction conferred upon the Federal Energy Regulatory Commission by Sections 7 and 15 of the Natural Gas Act and the Commission's Rules of Practice and Procedure, a hearing will be held without further notice before the Commission or its designee on this application if no motion to intervene is filed within the time required herein, if the Commission on its own review of the matter finds that permission and approval for the proposed abandonment are required by the public convenience and necessity. If a motion for leave to intervene is timely filed, or if the Commission on its own motion believes that a formal hearing is required, further notice of such hearing will be duly given.

Under the procedure herein provided for, unless otherwise advised, it will be unnecessary for Columbia to appear or be represented at the hearing.

David P. Boergers,

Secretary.

[FR Doc. 99–1820 Filed 1–26–99; 8:45 am]

BILLING CODE 6717–01–M

APPENDIX A.2

DOE ENVIRONMENTAL SYNOPSIS FOR THE TRANSURANIC WASTE TREATMENT PROJECT JANUARY 1999

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U.S. Department of Energy
Oak Ridge Operations
Environmental Management Division

ENVIRONMENTAL SYNOPSIS FOR THE

TRANSURANIC WASTE TREATMENT PROJECT

AT THE OAK RIDGE RESERVATION

January 1999

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Table of Contents

Abbreviations and Acronyms

CAA	Clean Air Act
CFR	Code of Federal Regulations
CH	Contact Handled
DOE	Department of Energy
DOT	Department of Transportation
EIS	Environmental Impact Statement
FR	Federal Register
gpm	gallons per minute
kVA	thousand volt amps
m^3	cubic meters
MVST	Melton Valley Storage Tanks
NEPA	National Environmental Policy Act
NPDES	National Pollution Discharge Elimination System
NTS	Nevada Test Site
ORNL	Oak Ridge National Laboratory
ORO	Oak Ridge Operations
ORR	Oak Ridge Reservation
RCRA	Resource Conservation and Recovery Act
RFP	Request for Proposal
RH	Remote Handled
ROD	Record of Decision
SEIS	Supplemental Environmental Impact Statement
SWTF	Solid Waste Treatment Facility
TRU	Transuranic
TWTF	Tank Waste Treatment Facility
WAC	Waste Acceptance Criteria
WIPP	Waste Isolation Pilot Plant
WM PEIS	Waste Management Programmatic Environmental Impact Statement

U.S. Department of Energy - Oak Ridge Operations Office

ENVIRONMENTAL SYNOPSIS FOR THE TRANSURANIC WASTE TREATMENT PROJECT AT THE OAK RIDGE RESERVATION

1. INTRODUCTION

The U.S. Department of Energy (DOE), as a Federal agency, must comply with the National Environmental Policy Act of 1969 (NEPA) by considering potential environmental issues associated with its actions prior to undertaking the actions. DOE regulations for NEPA implementation provide directions specific to procurement actions that DOE may undertake or fund [10 *Code of Federal Regulation* (CFR) Section 1021.216] before completing the NEPA process. Per these regulations, an environmental critique shall be prepared to support the procurement selection process. A synopsis of the environmental critique shall then be published to inform the public of the findings of the critique while protecting confidential information regarding proposals from offerors.

This document is a synopsis of the environmental critique prepared to identify and evaluate potential environmental impacts associated with the submitted proposals to treat and package transuranic (TRU) mixed wastes at Oak Ridge National Laboratory (ORNL) and ship the treated waste to an approved disposal site. These wastes would be processed as part of the TRU Waste Treatment Project, which would be located in Melton Valley at ORNL in eastern Tennessee. A contract was awarded by the DOE Oak Ridge Operations (ORO) in August of 1998 for construction and operation of a facility to treat the TRU waste.

TRU waste is radioactive waste that is not classified as high-level radioactive waste and that contains more than 100 nanocuries per gram of alpha-emitting transuranic (atomic numbers greater than 92) isotopes with half-lives greater than 20 years. Alpha low-level radioactive waste contains alpha-emitting transuranic isotopes with half-lives greater than 20 years at concentrations less than 100 nanocuries per gram.

The TRU waste to be treated also contains beta- and gamma- emitting isotopes in addition to alpha-emitting isotopes, which result in its classification as either contact-handled (CH) (surface dose rate of 200 mrem/hr or less) or remote-handled (RH) (surface dose rate of greater than 200 mrem/hr).

Solid waste at ORNL is a heterogeneous mixture consisting of paper, glass, rubber, cloth, plastic, and metal from glove boxes, fuel processing, hot cells, and reactors. Solid waste is currently packaged in metal boxes, drums and concrete overpacks, and stored in Resource Conservation and Recovery Act (RCRA) permitted facilities. Most of the solid waste containers do not meet current Department of Transportation regulations and would require repackaging prior to shipment.

Based on generator records, the solid waste has been classified as either TRU or alpha low-level radioactive waste. However, because the nature of the solid waste can only be confirmed after retrieval and characterization, solid wastes addressed in this synopsis are characterized as "TRU/alpha low-level radioactive waste" to note the current uncertainty. The solid waste may contain RCRA characteristic metals, but generator records do not indicate the presence of any RCRA listed constituents. The supernatant, the liquid layer covering the sludge in the tanks, is considered a low-level waste but is not considered hazardous under the RCRA definitions.

Approximately 62 percent of the legacy TRU wastes are currently stored in 50 year-old tanks. The remaining 38 percent of the legacy TRU wastes are currently stored in subsurface trenches, vaults, and metal buildings.

Approximate quantities of the four primary waste streams needing treatment are: 900 m^3 of RH-TRU sludge, located in the tanks; 1600 m^3 of low-level supernatant, located in tanks; 550 m^3 of RH-TRU waste/alpha low-level radioactive waste solids in vaults and trenches; and 1,000 m^3 of CH-TRU waste/alpha low-level radioactive waste solids in metal buildings.

For the near term, the waste is safely contained and stored. However, it is essential to accurately characterize, process and repackage the waste so that it can be transported off the Oak Ridge Reservation (ORR) to a final disposal site. The processed waste must meet the applicable disposal site waste acceptance criteria (WAC) for the disposal facility and the Department of Transportation (DOT) requirements.

DOE ORO is currently operating under a Site Treatment Plan with set goals and milestones for processing legacy mixed waste that was mandated by the State of Tennessee in 1995. There are no TRU mixed waste disposal facilities currently operating in the United States. The Department decided to dispose of TRU waste at the Waste Isolation Pilot Plant (WIPP) (a DOE transuranic waste disposal facility located in southeastern New Mexico), in the Record of Decision (ROD) for the WIPP Supplemental Environmental Impact Statement (SEIS) (63 *Federal Register* (FR) 3624, January 23, 1998).

An independent preliminary study, known as the Parallax study (ORNL/M-4693, Feasibility Study for Processing ORNL TRU Waste in Existing and Modified Facilities, September 15, 1995) was conducted to look at viable alternatives for the safe and cost-effective processing of TRU waste. This study determined that waste processing by the private sector was a viable option that could provide significant savings compared to traditional cost plus contracting approach. The TRU Waste Treatment Project procurement at Oak Ridge will secure TRU waste processing by a private sector contractor.

Construction and operation of a TRU waste treatment facility constitutes a "major federal action" and appears to fall within those classes of actions normally requiring an Environment Impact Statement (EIS). Therefore, DOE will prepare an EIS for the project. Two DOE NEPA documents will be used for information on baseline data for the project-specific EIS, the *Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste* (DOE/EIS-0200-F, May 1997) and the *Waste Isolation Pilot Plant Disposal Phase Supplemental Environmental Impact Statement* (DOE/EIS-0026-S-2, September 1997).

2. ASSESSMENT METHODS

In accordance with DOE's NEPA regulations, the request for proposal (RFP) required that each offeror provide environmental data and analyses, as available, for each proposal submitted. The RFP listed the type of necessary environmental data, as well as the level of detail that was required for the preparation of a critique (Section L.f. of the RFP). The RFP also required each offeror to clearly identify all site, process, or system information that was not specified at that time of the proposal. This information was submitted as a separate package.

Much of the information submitted and presented by the offerors was preliminary as it was based on anticipated events, such as approval of a permit or planned activities, and successful completion of process setup. Following contract award, DOE will monitor project progress and address any deviation from the proposal information.

Only the environmental data and analyses submitted by the two offerors determined to be in the competitive range were used to prepare the critique. The information in the critique provides the basis for this synopsis. The offerors evaluated in this synopsis are designated as Offeror #1 and Offeror #2 to protect business confidential information. Evaluations for this procurement considered the reasonably foreseeable environmental impacts that could arise from each offeror's proposed approach to waste treatment, repackaging, and shipment to a designated waste disposal site (see Section 4). The evaluations also identified aspects of each offeror's proposed activities that were not adequately described for purposes of analyzing possible environmental impacts at the time. The evaluations identified differences between the offerors' proposed approaches and impacts, and where the offerors provided insufficient data.

Additional information for the evaluation included the data submitted in the proposals and the revised "Best and Final" offers. Various documents written by DOE and ORNL that describe the overall environment in the Melton Valley were also used. The environmental impacts of TRU waste at ORR will be further analyzed in an EIS as discussed in Section 1.

3. DESCRIPTION OF THE PROPOSALS

The proposals submitted by the offerors are not available for review by the public as they contain confidential business information. The descriptions of each proposal in this synopsis does not contain business, confidential, trade secrets, or other information that can not be disclosed pursuant to the competitive procure process.

The proposals include information on the personnel, facilities, equipment, materials, supplies, vehicles, other services required for the treatment, packaging of the TRU wastes at ORNL, and the shipment of the wastes from ORNL to a designated disposal site.

Each offeror proposed to use treatment processes that include:

- physical processes for solid waste volume reduction,
- low-temperature drying and chemical immobilization of sludge and supernate, and
- stabilization and encapsulation techniques for RCRA material.

These processes would produce a treated waste (TRU, TRU mixed, and LLW) that complies with DOT requirements and, for purposes of submitting a proposal, would meet the WAC for TRU and LLW necessary for disposal at WIPP and NTS, respectively.

Each offeror proposed using low-temperature thermal treatment for the tank wastes with minor variations. Offeror #1 would treat the tank waste as a single waste stream, use sulfide additives to immobilize RCRA metals in the tank wastes, and use macroencapsulation for the solid wastes. Offeror #2 would use separate treatment lines for the tank supernate and sludge, and use sulfide additives only on the sludge portion of the tank wastes to immobilize RCRA metals. A wider array of potential technologies may be used for the solid wastes.

Each offeror suggested they would use the RCRA "Debris Rule" to minimize waste volumes triggering waste-specific treatment requirements under RCRA. In short, the rule allows some waste materials that are contaminated with more than one hazardous constituent to be categorized as "debris" thereby not triggering some treatment requirements under the RCRA land disposal restrictions at 40 CFR Part 268. Offeror #1 would use the rule to facilitate streamlining treatment of solids, using only macroencapsulation. Offeror #2 was less clear how the rule would influence the proposed treatment process.

The MVST consist of eight 50,000 gallon tanks located in a concrete underground vault. Since their construction, these tanks have received filtrate from the ORNL liquid low-level waste system. Each offeror proposed constructing the waste treatment facility west and adjacent to the MVST in Melton Valley, thus the environmental baseline for the analyses of possible significant environmental impacts due to the proposed site location was identical for each offeror. However, the location of the proposed waste treatment facility varied slightly in relation to its environmental impacts associated with facility construction and the acreage (3 acres versus 3.5 acres) each offeror expected to affect. Offeror #1 did not propose to alter the topography of the site. Offeror #2 proposed to cut into the hillside to construct a two-lane ramp to the upper floor of its facility.

3.1 Offeror #1 Proposal

Offeror #1 proposed to construct and operate a 10,400 ft^2 waste processing building that would contain the Tank Waste Treatment Facility (TWTF) and the Solid Waste Treatment Facility (SWTF), a 150 ft long shielded transfer line to the MVST, and ancillary buildings. Two treatment trains would be developed with separate hot cell facilities. The TWTF would process sludge and supernate currently stored in the MVST. The SWTF would first process CH-TRU wastes and then RH-TRU solid wastes. The TWTF and the SWTF would share infrastructure and support operations. There would be a single Clean Air Act (CAA) permitted ventilation stack and a single National Pollution Discharge Elimination System (NPDES) permitted outfall for process water discharges and storm water. The facility would operate under a Part B RCRA permit.

3.2 Offeror #2 Proposal

Offeror #2 would construct and operate a 37,000 ft^2 waste processing facility, a 120 ft long shielded transfer line from the MVST, and ancillary buildings. Four treatment trains would be developed to separately process the wastes. The sludge and the supernate currently stored in the MVST, and the CH-TRU and RH-TRU solid wastes would each have a separate treatment train. The facilities would be co-located in a multi-level building and share many infrastructure and support operations. There would be a CAA permitted ventilation stack, but no process water discharges, therefore a Clean Water Act permit for storm water discharges would be required. The facility would operate under a Part B RCRA permit.

4. EVALUATION OF POTENTIAL ENVIRONMENTAL IMPACTS

The ORR occupies about 34,500 acres of federal land within the corporate limits of the city of Oak Ridge, and within Roane and Anderson counties in eastern Tennessee. In 1989, the three main plant complexes, including ORNL, the East Tennessee Technology Park, and the Y-12 Plant encompassed a fenced area of 24,400 acres, with the remaining acreage designated as a National Environmental Research Park. The region is relatively hilly and averages 54 inches of precipitation annually. Although there are both perennial and intermittent streams near the proposed treatment site, the site does not contain any surface water bodies or wetlands. Mixed hardwoods and pines dominate the area. No state listed, federally listed, or candidate species have been observed at the proposed site. A locked gate at the junction of the access road to the proposed site and the State Highway 95 restricts public access to the area. The proposed site is approximately 1.25 miles from this junction. Other important nearby highways include I-40, I-75 and State Highways 62 and 162. Nearby local communities range from urban to rural.

4.1 Land Use

The specific facility location (within a 32 acre parcel identified by DOE in the Request for Proposal) selected by both offerors does not appear to have been previously disturbed. The proximity of the location to the MVST lessens the amount of impact associated with utility construction and minimizes handling and transport of the liquid wastes. Potential adverse land use effects include the loss of habitat for wildlife and loss of the area for other potential uses while the facility is in operation. The facility could have a visual impact outside the fenced boundary due to its height. The potential impacts to visual resources by this action is not expected to be significant due to the hillside to the north, abundant vegetation, and restrictions to public access. Both proposals minimize some of the possible land use effects, particularly infrastructure, by locating their facilities within the current ORNL boundary. Both offerors proposed adding a driveway that loops around the facility, and planned to take advantage of the local topography to gravity feed the tank wastes to the treatment building. There were no significant differences between the two offerors with respect to proposed land use.

4.2 Cultural and Historic Resources

Potential effects to cultural and historic resources were tied to the location of the facility and are, therefore, the same. Both offerors proposed to limit impacts to cultural resources by training workers to avoid a nearby homestead, which would be outside the facility fence line. DOE has a programmatic agreement with the State Historic Preservation Officer for ORR and ORNL that would include a Phase I survey prior to disturbing the proposed treatment site. The impacts analysis for the EIS would be based on findings of this survey.

4.3 Habitat and Wildlife

One impact of the proposed treatment facility would be the loss of land and associated habitat that could be used by plants and animals. This would lead to displacement and disturbance of some individual animals. This loss of land and habitat alone would not be likely to have a significant environmental effect on local wildlife or plant populations. There could be adverse impacts on breeding potential due to stress from construction or interference in the reproductive cycles of local fauna. The impacts are not expected to be significant to the area because the habitat is not unique, nor does it create a new barrier to free ranging animals. The proposed treatment facility would contribute incrementally to potential indirect cumulative effects to habitat and wildlife including a loss of biodiversity on the ORR.

Both offerors would limit environmental impacts by using a site adjacent to other disturbed areas, minimizing the footprint of the buildings, and eliminating the need to transfer tank contents using trucks. The site would be revegetated after the facility is decommissioned.

4.4 Floodplain and Wetlands

Offeror #2 identified the proposed site as being just above the United States Geological Service 100-year maximum floodplain [10 CFR 1022.4(b)]. This means that there is minimal danger of flooding the facility. Both offerors indicated that the dangers of flooding would be reduced due to existing flood capacity at White Oak Lake. The same assumptions can be made for Offeror #1's facility since it would be constructed in the same location, however this was not stated in the proposal. Both proposals indicated that the proposed facility location would be within the 500-year maximum floodplain [10 CFR 1022.4(I)]. The presence of the facility would have a minimal effect on the local capacity for floodwater attenuation, dispersion, or control. There would be no impact to wetlands because there are no wetlands in the immediate area.

4.5 Geology and Seismicity

The proposed site has underlying layers of shale, limestone, and siltstone lithologies of the Cambrian Conasauga Group. The White Oak Creek fault is in the middle of Melton Valley. The earthquake design for the 50-year facility life, with a 100-year seismic event return period, is 0.06g-peak ground acceleration. Because both offerors need to build the proposed facility to code to withstand seismic events, there is no significant difference in this regard between the proposals. The source terms, both hazardous and radioactive, associated with this waste do not change and the potential release pathways would remain the same.

4.6 Water and Water Quality

The only process identified that could impact water quality during normal operation of the facility would be the discharge of treated process waters to White Oak Creek proposed by Offeror #1. Offeror #1 stated that 1 part per billion of mercury would meet permit release criteria, however, the basis for this statement was not referenced. This level is above the State of Tennessee ambient water quality criteria of 12 parts per trillion of mercury, which would apply to White Oak Creek. Offeror #2 did not address the possibility that condensate water from drying the tank contents might have quantities of mercury but also did not indicate any discharges to local waters. Offeror #2 stated the waste treatment facility would have no liquid effluent discharges.

Storm water management could impact water quality and both offerors would have storm water pollution prevention plans to meet their regulatory requirements. Offeror #2 proposed extensive diversion ditches and a retention basin to capture and sample any overland flow of storm water before it reaches White Oak Creek.

Both proposals contained data relating to water use, however, it was not evident how the data compared. Offeror #1 expected to require less than 900 gallons per minute (gpm) flow rate based on the design assumptions that they would process enough TRU waste to fill three WIPP TRU waste containers and an unspecified amount of solids each week. Offeror #2 expected to require approximately 1000 gpm flow rate based on the design assumption that they would process enough TRU waste to fill four WIPP TRU waste containers and an unspecified amount of solids each week. The expected water requirements for both offerors included fire protection water. The water requirement data were not certain or detailed and did not indicate why Offeror #1 would have half the production rate for a similar amount of water. Because the processes proposed by both offerors were similar, the explanation may be that Offeror #2 planned to run four treatment lines simultaneously, while Offeror #1 would run only two at a time. Cooling was not a major component of water usage because high temperature thermal treatment was not proposed.

Offeror #2 proposed a closed water system that would minimize the opportunity of groundwater or surface water contamination. The storm water pollution prevention measures proposed by Offeror #2 were more extensive than those proposed by Offeror #1, but may be more than what is required for worst case storm or accident scenarios. Offeror #1 requires a permit for the discharge of treated process water to White Oak Creek. Both offerors would recycle process water within their treatment trains for the MVST.

4.7 Air Quality

Both offerors proposed using low-temperature treatment processes on the same total volume of waste. The primary means of mitigating process related air emissions is an effective off-gas system, which was identified in both proposals. In addition, both offerors would conduct most of the retrieval and process operation in an enclosed building. Continuous air monitoring was a component of both proposals. Offeror #1's proposal contained a table of anticipated total emissions, but did not include information as to the rate of emissions. Offeror #2 provided little specific information on anticipated emissions, however, because the treatment processes are similar, the emissions are likely be similar to Offeror #1. Neither offeror mentioned how their off-gas systems would function in case of emergency, nor was there any contingency plan for this event. Air emissions would be regulated through air quality standards and permits which both offerors planned to obtain.

Dust would be generated during the construction phase of the project. The potential for fugitive emissions would be more extensive for Offeror #2 because it proposes cutting into the hillside and would have more extensive ground disturbance during the construction phase. The operation of equipment and trucks would generate hydrocarbon related emissions that could incrementally increase cumulative air impacts. Construction and traffic related air emissions could be controlled and minimized with wetting techniques to prevent dust, and by properly maintaining equipment and vehicles.

4.8 Transportation

Because of increased use of the roads near the proposed site, there would be increased fuel usage and a need for additional road maintenance. Transportation from the proposed site could present some hazards for public exposure to radiation due to accidents, as discussed in section 4.13. The estimated number of trips to the final disposal sites was not clear in the proposals, so no comparison could be made. Both proposals discuss optimizing waste shipments.

Offeror #2 proposed employing more workers and constructing a larger facility that would result in greater, but not significant, transportation impacts than Offeror #1's proposal. The effect of commuter transportation should not be significant because the number of workers is relatively small in both proposals. Transportation activities, transport of materials during waste processing, and traffic control measures were not adequately addressed in either proposal. The delivery of solid waste from ORNL to the waste treatment facility would be the same for both offerors.

4.9 Energy Requirements

The proposals did not contain enough specific information to draw a conclusion on energy consumption. Offeror #1 would require 1,000 thousand-volt amps (kVA) of power, and Offeror #2 would require 2,600 kVA of power. This was a potentially significant difference in energy requirements and efficiency between the two offerors, but a definitive comparison could not be made. The proposals did not contain adequate information on the total system or individual system power requirements, nor did they discuss the energy required to support transportation. DOE has proposed providing 500 kVA of power to the site, so both offerors would need to obtain a supplemental power supply. Neither offeror discussed power or minimizing energy consumption. Potential adverse effects resulting from the use of energy to operate the waste treatment facility have not yet been considered.

4.10 Health Effects

Both offerors proposed to meet industry standards and adopt acceptable administrative controls for exposure to radioactive and hazardous waste. However, neither proposal contained any details on specific administration controls. There should not be a significant difference between the two offerors with respect to effects on health, since both offerors must satisfy regulations regarding worker safety and radiation exposure for employees and the public. In theory, Offeror #2 might place more workers at risk because they proposed involving 50 more people than Offeror #1. Offeror #2's proposal also described more treatment and processing units, which could increase the potential for an accident or break in the system. Alternatively, the multiple units offer processing flexibility in the event of breakdowns so that processing might be more quickly restored. The proposals did not contain specific information regarding radiation or hazardous chemical exposure, so a comparison could not be made of long-term, low-dose exposure for increased cancer or birth defect risks. Both offerors would be required to integrate "As Low As Reasonably Achievable" considerations into the radiological safety program, and provide detailed plans of access control, facility design, safety analysis, inspection and surveillance prior to facility start up. For purposes of comparison, there was no quantifiable difference between the proposals.

4.11 Noise

The proposals contained no information on occupational noise levels, so a comparison could not be made between the offerors. Both offerors stated they did not anticipate noise impacts to the environment, but their statements were not substantiated and the potential impacts to the environment could not be evaluated.

4.12 Socioeconomics

An overall decline in employment at the ORR region of influence is anticipated. The employment levels proposed by both offerors were not significantly different, and the impact on total employment levels for the region would not be great. Offeror #2 would have a slightly greater positive effect by employing an average of 90 people compared to Offeror #1's plan to employ an average of 40 people. The project would have some economic benefit during the construction phase of the project.

4.13 Accidents

Due to the radioactive and hazardous substances involved with this project, there is a potential for adverse environmental effects if an accident were to occur. The general nature of the information provided precluded detailed calculations on the probability of accidents taking place. However, the humid environment, the close proximity to surface water bodies, and shallow groundwater provides greater than average opportunities for contamination migration should a release escape the building containment.

Operations in Offeror #1's proposal were based on the ground floor, and vertical range would occur within, but not between, processes. Treatment trains were developed for two basic waste streams, so the facility required fewer liquid holding/mixing tanks. Because liquids migrate more rapidly than solids, this reduces the inventory of mobile contaminants should an accident occur.

Offeror #2's proposal included more treatment steps and associated process units, and a greater number of treatment trains operating concurrently. The ramped roadway leading to the upper deck of the waste treatment facility loading area for solid waste could be more susceptible to an accident than a level driveway. The vertical staging area of the treatment trains could provide greater potential for cross contamination if an accidental release occurred. The ramped roadway and vertical equipment arrangement do reduce the number and frequency of waste container lifts and movements, a significant offsetting benefit of both features.

Facility-specific accidents, such as nuclear criticality or an explosion, were considered while reviewing the proposed approaches. Processes and equipment have an individual probability for failure or accident and the greater the number of process units and equipment lines, the greater the probability of some failure or accident occurrence. Differences between the two proposals might lead to differences in accident probability, however, the likelihood of a significant release of hazardous and radioactive substances due to an accident seemed quite low under both proposals.

5. SUMMARY

Based on the information provided by each offeror, there were a number of resource areas where there was no discernible difference. Such areas included: socioeconomic, geology and seismicity, wildlife and habitat, and wetlands and floodplains. The proposals did not provide enough information to define or analyze differences for other resource areas such as noise, water usage and quality, transportation, utility requirements, safety precautions, and waste minimizations.

Despite the uncertainties and insufficient information for a full analysis of some topics, some distinctions between the proposals regarding differences in environmental impacts could be made. One such distinction relates to energy usage. Offeror #2 appeared to use approximately 2.6 times the energy as Offeror #1 (2,600 vs. 1,000 kVA, respectively). Facility size also differed. The facility that was proposed by Offeror #2 was more than 3 times as large than the facility proposed by Offeror #1 (37,000 vs. 10,400 ft^2, respectively). The facility proposed by Offeror #2 also had more extensive construction related to a ramp roadway, surface water controls, and a retention basin. However, the footprint of the two proposed facilities did not vary significantly. Offeror #1 had a greater potential to affect water quality with planned discharges of treated water to White Oak Creek, requiring an NPDES permit, and the more limited degree of controls for storm water.

Both offerors would be required to obtain a CAA permit. Because the treatment processes are similar, however, there were no expected differences between the proposed processes regarding air emissions. Both offerors would use vacuum dryers and planned to utilize closed systems with multiple filters and a single emission stack.

APPENDIX A.3

PUBLIC ISSUES AND COMMENTS

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Public Scoping Meetings Issues for the Oak Ridge Operations Transuranic Waste Treatment Project

No.	Comments by	Issue	Answer
1	Herman Weeren	Terminology – saying that this project is processing all of the TRU waste, when in actuality, all waste will be processed with the exception of the TRU waste mixed with grout and injected approximately 1000 ft underground by hydrofracture.	Issue acknowledged by Gary Riner.
2	Barbara Walton	Where will time-certified TRU waste from REDC be processed, and is it from a DOD mission?	WIPP – will accept TRU waste regardless of the type of project it came from. The proposed waste treatment facility will be used to treat legacy waste; newly generated waste will be time certified and shipped directly to WIPP and will not require processing at the proposed facility.
3	Craig Turnbow	Is the Bethel Valley Evaporator Service Tanks waste removal complete?	Three tanks are completed , the other two are in process; waste was successfully retrieved from tanks similar in construction to the Melton Valley Storage Tanks (MVSTs) – Riner, Monk.
4	Herman Weeren	Clarification - OHF is only the surface facility?	Referring to the OHF tanks and their contained wastes which are now empty following successful waste retrieval – Riner.
5	Herman Weeren	Should comments on the EIS be written or spoken?	Either send in written comments, or leave a message at the listed telephone number, and the message will be transcribed – Wayne Tolbert. Comments from tonight's meeting will go on record also – in the transcript – Riner.
6	Barbara Walton	▪ Does construction of the facility wait until the Record of Decision? ▪ Are there terms to deal with inflation? ▪ Is the contract Fixed Price?	▪ Yes – Riner. ▪ Yes, the contract was set up so that phase 1 (a 2 ½-year period) allowed for permitting the facility and the completion of the EIS. Yes – so long as we stay within the timeframe for phase 1, we're okay.

No.	Comments by	Issue	Answer
7	Marilyn Green	Federal Register note says scoping ends February 26th.	Committing tonight to extend period until March 18th – Riner.
8	Barbara Walton	Concern over obtaining a copy.	Hard copies will be available – Riner.
9	Herman Weeren	What is the temperature for drying the tank waste?	180 to 190 degrees Fahrenheit – Bryan Roy.
10	Herman Weeren	What happens to the sodium nitrate?	It's a predominate compound that becomes part of the waste and goes to the repository.
11	Herman Weeren	Is the stuff hydroscopic ?	Yes, it will absorb water – Riner.
12	Herman Weeren	Is there any possibility for explosion in the processing of the waste – referring to an incident in Texas City with ammonium nitrate, and that nitrates are not the most stable compounds in the world.	After review of the process, it was not thought a hazard – Riner.
13	Mildred Sears	Expressed that ammonium had not been analyzed, and even though there might not be a lot there, she felt some additional tests were needed.	
14	Unidentified Speaker	Does Alternative 2 presuppose that shipments will be made to WIPP?	Shipments will be made to both WIPP and a low-level waste repository, which will be finally decided as part of the ROD.
15	Barbara Walton	Have they moved forward with the RH-TRU waste containers? Last she'd heard they weren't approved yet.	The 72B canister has been approved – Riner.
16	Barbara Walton	Is the canister approved for CH-TRU?	No – it's different; you're talking about the 72B cast – Riner.
17	Barbara Walton	The approval comes from whom – are you not involved with the approval?	The NRC to the DOE and, no, it's up to the NRC.
18	Herman Weeren	What is the cost advantage of drying the waste over cementation of the waste?	Drying the waste is the ultimate waste minimization and reduces the amount of waste shipped to WIPP from 1500 m^3 to 200 m^3 – cost for disposal at WIPP is $20,000 per cubic meter - Riner, Roy.
19	Herman Weeren	If you use cement and dilute the waste until it is no longer TRU, what is the advantage – you no longer have to ship to WIPP – what does this do?	Low-level waste could be shipped to NTS or possibly Hanford. Cost at the NTS is approximately $1000 per cubic meter, and there would be a lot more shipments.
20	Barbara Walton	It's in our budget rather than the WIPP budget.	Good point – Riner.
21	Herman Weeren	Is a comparison of this type going to be part of the EIS?	These kinds of comparisons will be analyzed – Riner.

No.	Comments by	Issue	Answer
22	Unidentified Speaker	Are these all the alternatives?	Yes – if there are other things you think we should look at, then that's why we're here tonight – Riner.
23	Herman Weeren	You will look at what you would do if you don't send it to WIPP?	Alternative 1 deals with that – Riner.
24	Herman Weeren	I was referring to alternative 4 – grouting the tank waste.	Yes, it will look at the type of final waste form we have and it still may be TRU after it's grouted – I don't know that, but if it comes out as LLW after the analysis, we will make a comparison – Riner.
25	Herman Weeren	Are you looking at that analysis?	Yes – Riner.
26	Barbara Walton	Questions about alternative 3 (Vitrification) – the waste is also diluted to some extent – is it diluted as much as with grout?	You get higher waste loafing with vitrification than you do with grout.
27	Barbara Walton	It could be diluted out of being TRU under alternative 3?	We would have to analyze it – Riner.
28	Barbara Walton	Was this process bid on by one of the bidders?	Yes – Riner.
29	Barbara Walton	Were they in the competitive range?	No – Riner.
30	Mildred Sears	▪ What are we going to do about the smaller, inactive tanks that contain TRU waste residuals – taking into account that waste retrievals for those tank sludges were cancelled – two tanks in my analysis contained TRU waste (WC-5 and WC-10). C-20 has never been analyzed but received waste from the REDC, and also tanks T-1 and T-2. ▪ What about TRU waste generated during D&D of contaminated buildings 10 years down the road?	What two tanks are those? – Riner. There is TRU waste in those tanks, at a much higher activity than had ever been measured before. The FFA tanks program still has funding, and we are in dispute with the State of Tennessee over cleanup of those tanks and possibly other tanks. Tank WC-14 recently had all of the TRU waste and PCBs removed. Tanks that contain PBCs will not be commingled with other tank waste. Any waste that meets the WAC for the LLLW system will be transferred to the MVST – Riner, Monk.
31	Herman Weeren	If you go through the procedure and go ahead with the preferred alternative based on the assumption that WIPP will open, and then it doesn't, where does this lead you?	We have a commitment from the State of Tennessee to process this waste under a site treatment plan, and if it's processed to meet RCRA Land Disposal Requirements (LDRs), it falls out from under RCRA and can be stored on the site for eternity – Riner. WIPP is not the driver; our driver is the RCRA site treatment plan and complying with RCRA requirements whether WIPP opens or not – Riner.

No.	Comments by	Issue	Answer
32	Herman Weeren	Are you going to look at the risks from the hydrofracture wells?	No – Riner. We propose building the facility next to the MVSTs so that we don't have the environmental impact of having a long run of pipeline if we build the facility elsewhere on the reservation – Riner. There are no hydrofracture or other wells that we are aware of within the proposed building area for the facility – Roy.
33	Herman Weeren	What about damage to the wells from vehicles, and there is a well located up the hill; contamination can easily migrate.	You would have a hard time getting a truck into the area – Riner. Only about 25ft would be excavated from the knoll – Roy. The people preparing the Melton Valley ROD are looking at the hydrofracture wells, as of now there is no effect either way – Riner. We will look into effects in terms of the construction of the facility, but there should be no effects since they're are hundreds of feet away. The wells would be undamaged, during and after construction of the facility, and will still be there after D&D of the processing facility.
34	Herman Weeren	What about the roads in? There are 4 wells by the existing road.	AVISCO was awarded the contract for upgrading the road, and they have a tentative layout for the road, which does not impact any hydrofracture wells – Riner. The upgraded road will be south of the existing gravel road. The road was surveyed along the route and verified with existing drawings from the Environmental Sciences Division at ORNL – we have stayed away from all wells – Monk.
35	Herman Weeren	Which way is south?	Up the hill? – Monk.

No.	Comments by	Issue	Answer
36	Lorene Sigal	Is the existing road within the floodplain of the embankment and the creek, and are you covering up contaminated soils or sediments?	No, and it is not within the 500-year floodplain – Riner, Roy. The road also serves as an emergency exit for HFIR and is documented under several operational safety reviews – we are moving forward on the road under a NEPA category exclusion, CX. The contract has been let and the road will not be analyzed as part of this EIS – we want to get the road done before construction begins.
37	Lorene Sigal	You're justifying the exclusion on the basis that the road serves other purposes?	Yes – and the fact that there is a road already there – Riner.
38	Lorene Sigal	How much wider is the new road?	About twice as wide – so that 2 vehicles or 2 tractor trailers can pass – Riner.
39	Lorene Sigal	Does the existing road provide roadbed for the new road?	No – Monk.
40	Lorene Sigal	So you're really building a brand new road – not just upgrading the existing road?	The elevation of the new road is higher than the existing road, so they are going up higher and taking the excavated dirt, moving it down, and raising the whole elevation rather than having to haul a lot of dirt away – Riner. Also, the existing road had washouts earlier this year – and rendered the emergency route from HIFR impassible. Also, we didn't want heavy trucks on a road directly adjacent to the lake for obvious reasons – Monk.
41	Barbara Walton	How much more does it cost to do 4 alternatives instead of 2 (referring to the EIS analysis)?	About $100,000 an alternative – Riner.
42	Barbara Walton	The other alternative would cost a lot more than the contract we have?	I don't think that's a considering factor.
43	Herman Weeren	Are you talking about adding alternatives – I would strongly oppose omitting alternative 4.	No – I think she was talking about doing away with alternatives 3 & 4 and, therefore, the need to have them analyzed.
44	Josh Johnson	Do you know how many curies we're getting rid of by going through all of this?	The tank waste is roughly 135,000 curies. On the solid waste it's hard to quantify curies – Riner. Its on the order of 50,000 to 60,000 curies for the solid waste – but it's a skewed distribution – Monk.

No.	Comments by	Issue	Answer
45	Josh Johnson	You have about a million gallons of water a day for processing; what is all the water used for? Is this recycled? You won't be bringing that in and discharging it.	That's the consumption for all uses, fire protection and so forth. The water won't be discharged.
46	Lorene Sigal	I recommend you get rid of alternative 3 – why are you going to assess something that doesn't make very much sense?	It could be looked at as a raised and dismissed alternative - Riner.
47	Unidentified speaker	Can you provide the information from the bid package?	No – it's proprietary information.
48	Barbara Walton	Have you considered the location of your MEI (Most Exposed Individuals)?	They would be ORNL workers across the fence for short-term exposure. Long-term exposure would be workers across the ridge in downtown ORNL – Riner. The highest exposure is in the woods to the southeast of the facility, but no one is there – Roy. We are going to bound this EIS to real-world conditions.
49	Barbara Walton	Where, what your credible accident scenarios might be? – Do you have accident scenarios on the other alternatives? Is the worst hazard a pipe rupturing? And the time it takes to shut down?	We could think of liquid release due to earthquakes, pressure breaking the transfer line, tornadoes, and internal fire – Roy.
50	Herman Weeren	How about floods?	The facility is designed with a lot of drainage between the MVSTs and the facility – we will examine floods that are reasonable. Herman, what are you requesting? – We will examine floods and the potential impact for them.
51	Lorene Sigal	Have you done anything to protect from a break in the pipeline?	Yes – Roy. Secondary containment is seismically designed – Riner.
52	Lorene Sigal	You talk about the general public – the general public doesn't read these documents – and most of the comments you get are from people who have an understanding of the reservation.	That's right – most of the people who come to these meetings are the ones who read them and comment – Riner.
53	Lorene Sigal	I agree that the EIS should be reader friendly, but don't make it so simplified that you miss the technical issues.	We will address the technical issues – Riner.
54	Dr. Gawarecki	You talk about geology and seismicity and the White Oak Creek fault – but this is not an active fault?	Right – Riner.

No.	***Comments by***	***Issue***	***Answer***
55	Mr. Mulvenon	Have details on the amount of energy to be used been worked out?	We don’t have a full-blown analysis – but vitrification will take more energy, cementation will take less, and somewhere in the middle will be the drying alternative.
56	Mr. Mulvenon	In the synopsis it mentions 2.6 megawatts and 80% of that going to water evaporation – that energy is not being parted on the waste as much as the water, but it is in the waste?	Right?
57	Mr. Mulvenon	Have we got the utilities to do that?	We have 500 kW near the HFIR reactor, which is where we are going to get the power for the facility – Foster Wheeler has to get the power to the facility.
58	Mr. Mulvenon	Is there any waste water associated with this drying process?	100% No water effluent – Riner.
59	Dr. Gawarecki	Is there any tritium in the water vapor?	There was no analysis for tritium – Riner. We assumed all the tritium would be released, but it is a very small amount as it is a fairly small contributor to the waste – Roy.

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APPENDIX B

EMISSIONS AND MATERIALS BALANCE DATA FOR THE PROPOSED ACTION AND THE VITRIFICATION AND CEMENTATION ALTERNATIVES

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Appendix B contains details and data relevant to the proposed action and alternatives. Specifically, this appendix contains information on emissions associated with the proposed action, materials balance and emissions for the vitrification process, and similar material for the cementation alternative. Floor plans for the proposed action/preferred alternative are also included.

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APPENDIX B.1

SUMMARIES OF TRU WASTE REMEDIATION

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Table B.1-1. Summary of annualized radionuclide emissions (Ci/year) for the Proposed Action

Radionuclide	Sludge emissions	Supernate emissions	Solids emissions	Total emissions
Ac-227	0.00E+00	0.00E+00	6.55E-13	6.55E-13
Ag-110	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ag-110m	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Am-241	0.00E+00	4.99E-10	4.12E-07	4.12E-07
Am-243	0.00E+00	0.00E+00	8.37E-09	8.37E-09
Au-196	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Au-198	8.10E-06	0.00E+00	0.00E+00	810E-06
Bk-249	0.00E+00	0.00E+00	2.30E-11	2.30E-11
C-14	0.00E+00	1.24E-07	1.36E-13	1.24E-07
Ce-144	2.31E-05	1.60E-08	0.00E+00	2.31E-05
Cf-249	0.00E+00	0.00E+00	1.20E-11	1.20E-11
Cf-252	8.30E-08	6.80E-10	9.69E-09	9.34E-08
Cm-240	0.00E+00	0.00E+00	1.25E-39	1.25E-39
Cm-242	0.00E+00	0.00E+00	5.27E-08	5.27E-08
Cm-243	2.24E-05	0.00E+00	0.00E+00	2.24E-05
Cm-244	7.89E-05	9.40E-07	1.74E-06	8.16E-05
Cm-245	0.00E+00	0.00E+00	2.46E-12	2.46E-12
Cm-246	0.00E+00	0.00E+00	8.00E-15	8.00E-15
Cm-248	0.00E+00	0.00E+00	2.11E-11	2.11E-11
Co-60	7.27E-05	5.47E-07	2.36E-09	7.33E-05
Cs-134	1.06E-05	1.99E-06	0.00E+00	1.26E-05
Cs-137	1.25E-03	3.16E-04	2.36E-06	1.57E-03
Es-253	0.00E+00	0.00E+00	2.79E-44	2.79E-44
Es-254m	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Eu-152	2.85E-04	3.94E-06	3.71E-13	2.89E-04
Eu-154	1.51E-04	1.41E-06	0.00E+00	1.53E-04
Eu-155	4.59E-05	6.29E-07	0.00E+00	4.65E-05
Fe-59	0.00E+00	0.00E+00	1.74E-25	1.74E-25
Gd-153	0.00E+00	0.00E+00	0.00E+00	0.00E+00
H-3	7.53E-08	1.64E-07	0.00E+00	2.40E-07
I-129	0.00E+00	1.95E-10	0.00E+00	1.95E-10
I-131	0.00E+00	0.00E+00	2.28E-100	2.28E-100
Nb-95	4.98E-06	5.29E-24	0.00E+00	4.98E-06
Ni-63	0.00E+00	0.00E+00	8.49E-14	8.49E-14
Np-237	1.69E-08	0.00E+00	6.73E-10	1.75E-08
Pa-231	0.00E+00	0.00E+00	2.52E-10	2.52E-10
Pm-147	0.00E+00	0.00E+00	6.54E-10	6.54E-10
Po-209	0.00E+00	0.00E+00	1.53E-15	1.53E-15
Pu-238	1.34E-05	5.27E-09	3.03E-06	1.65E-05
Pu-239	6.58E-06	4.53E-09	8.25E-07	7.41E-06
Pu-240	2.06E-06	4.41E-09	7.70E-07	2.84E-06
Pu-241	2.32E-05	6.74E-08	4.58E-05	6.91E-05
Pu-242	4.45E-09	2.21E-10	1.91E-10	4.86E-09
Pu-244	4.12E-10	2.60E-11	0.00E+00	4.38E-10
Ra-223	0.00E+00	0.00E+00	8.83E-76	8.83E-76
Ra-226	0.00E+00	0.00E+00	1.29E-09	1.29E-09
Ru-106	3.96E-05	8.58E-08	0.00E+00	3.97E-05
Sb-125	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-90	4.01E-03	1.26E-05	1.46E-06	4.03E-03
Tc-99	8.08E-07	1.50E-06	1.37E-07	2.44E-06

Table B.1-1 (continued)

Radionuclide	Sludge Emissions	Supernate Emissions	Solids Emissions	Total Emissions
Te-123	0.00E+00	0.00E+00	2.08E-14	2.08E-14
Te-123m	0.00E+00	0.00E+00	5.71E-19	5.71E-19
Th-230	0.00E+00	0.00E+00	9.63E-15	9.63E-15
Th-232	5.61E-08	5.20E-11	1.43E-12	5.62E-08
U-232	0.00E+00	2.47E-08	2.36E-10	2.49E-08
U-233	4.64E-06	1.86E-07	8.45E-08	4.91E-06
U-234	2.06E-06	3.77E-09	1.33E-08	2.08E-06
U-235	5.39E-08	1.56E-10	5.95E-12	5.41E-08
U-236	4.49E-09	9.11E-11	7.78E-14	4.58E-09
U-238	2.05E-06	4.97E-09	3.48E-11	2.05E-06
U-239	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-90	0.00E+00	0.00E+00	2.65E-286	2.65E-286
Zn-65	0.00E+00	0.00E+00	2.44E-15	2.44E-15
Zr-95	5.71E-05	1.85E-16	0.00E+00	5.71E-05
Total radionuclides	6.12E-03	3.40E-04	5.67E-05	6.52E-03

Ci = curie.

Table B.1-2. Estimated radionuclide emissions for TRU waste treatment of sludge for the Proposed Action

Radionuclide	Radionuclide composition[a] (Bq/g)	(Ci/g)	Radionuclide[b] half life, $t_{1/2}$ (year)	Decayed[b] radionuclide composition (Ci/g)	Uncontrolled[c,d] radionuclide Emissions (Ci)	Radionuclide emissions after control: Project life[e] (Ci)	Annualized[f] (Ci/year)
Ac-227	0		2.18E+01				0.00E+00
Ag-110	0		7.80E-07				0.00E+00
Ag-110m	0		6.84E-01				0.00E+00
Am-241			4.32E+02		0.00E+00	0.00E+00	0.00E+00
Am-243	0		7.37E+03				0.00E+00
Au-196	0		1.69E-02				0.00E+00
Au-198	3732.39	1.01E-07	7.38E-03	1.01E-07	1.01E-01	1.01E-05	8.10E-06
Bk-249	0		8.76E-01				0.00E+00
C-14	0		5.73E+03				0.00E+00
Ce-144	10647.08	2.88E-07	7.80E-01	2.88E-07	2.89E-01	2.89E-05	2.31E-05
Cf-249	0		3.51E+02				0.00E+00
Cf-252	38.27	1.03E-09	2.65E+00	1.03E-09	1.04E-03	1.04E-07	8.30E-08
Cm-240	0		7.39E-02				0.00E+00
Cm-242	0		1.63E+02				0.00E+00
Cm-243	10330.07	2.79E-07	2.91E+01	2.79E-07	2.80E-01	2.80E-05	2.24E-05
Cm-244	36370.20	9.83E-07	1.81E+01	9.83E-07	9.86E-01	9.86E-05	7.89E-05
Cm-245	0		8.50E+03				0.00E+00
Cm-246	0		4.73E+03				0.00E+00
Cm-248	0		3.40E+05				0.00E+00
Co-60	33519.35	9.06E-07	5.27E+00	9.06E-07	9.09E-01	9.09E-05	7.27E-05
Cs-134	4893.24	1.32E-07	2.06E+00	1.32E-07	1.33E-01	1.33E-05	1.06E-05
Cs-137	577076.13	1.56E-05	3.01E+01	1.56E-05	1.56E+01	1.56E-03	1.25E-03
Es-253	0		5.60E-02				0.00E+00
Es-254m	0		4.48E-03				0.00E+00
Eu-152	131531.25	3.55E-06	1.35E+01	3.55E-06	3.57E+00	3.57E-04	2.85E-04
Eu-154	69723.86	1.88E-06	8.59E+00	1.88E-06	1.89E+00	1.89E-04	1.51E-04
Eu-155	21166.34	5.72E-07	4.76E+00	5.72E-07	5.74E-01	5.74E-05	4.59E-05
Fe-59	0		1.22E-01				0.00E+00
Gd-153	0		6.61E-01				0.00E+00
H-3	34.73	9.39E-10	1.23E+01	9.39E-10	9.42E-04	9.42E-08	7.53E-08
I-129	0		1.57E+07				0.00E+00
I-131	0		2.20E-02				0.00E+00
Nb-95	2296.02	6.21E-08	9.58E-02	6.21E-08	6.23E-02	6.23E-06	4.98E-06
Ni-63	0		1.00E+02				0.00E+00
Np-237	7.77	2.10E-10	2.14E+06	2.10E-10	2.11E-04	2.11E-08	1.69E-08
Pa-231	0		3.28E+04				0.00E+00
Pm-147	0		2.62E+00				0.00E+00
Po-209	0		1.02E+02				0.00E+00
Pu-238	6198.78	1.68E-07	8.77E+01	1.68E-07	1.68E-01	1.68E-05	1.34E-05
Pu-239	3031.95	8.19E-08	2.41E+04	8.19E-08	8.22E-02	8.22E-06	6.58E-06
Pu-240	950.28	2.57E-08	6.56E+03	2.57E-08	2.58E-02	2.58E-06	2.06E-06
Pu-241	10716.94	2.90E-07	1.44E+01	2.90E-07	2.91E-01	2.91E-05	2.32E-05
Pu-242	2.05	5.54E-11	3.73E+05	5.54E-11	5.56E-05	5.56E-09	4.45E-09
Pu-244	0.19	5.14E-12	8.00E+05	5.14E-12	5.15E-06	5.15E-10	4.12E-10
Ra-223	0		3.13E-02				0.00E+00
Ra-226	0		1.60E+03				0.00E+00
Ru-106	18256.71	4.93E-07	1.02E+00	4.93E-07	4.95E-01	4.95E-05	3.96E-05
Sb-125	0		2.76E+00				0.00E+00
Sr-90	1850860.69	5.00E-05	2.88E+01	5.00E-05	5.02E+01	5.02E-03	4.01E-03
Tc-99	372.46	1.01E-08	2.11E+05	1.01E-08	1.01E-02	1.01E-06	8.08E-07
Te-123	0		1.00E+08				0.00E+00
Te-123m	0		3.28E-01				0.00E+00
Th-230	0		7.54E+04				0.00E+00
Th-232	25.88	6.99E-10	1.41E+10	6.99E-10	7.02E-04	7.02E-08	5.61E-08
U-232	0		6.89E+01				0.00E+00
U-233	2136.82	5.78E-08	1.59E+05	5.78E-08	5.79E-02	5.79E-06	4.64E-06
U-234	950.46	2.57E-08	2.46E+05	2.57E-08	2.58E-02	2.58E-06	2.06E-06

Table B.1-2 (continued)

Radionuclide	Radionuclide composition[a] (Bq/g)	Radionuclide composition[a] (Ci/g)	Radionuclide[b] half life, $t_{1/2}$ (year)	Decayed[b] radionuclide Composition (Ci/g)	Uncontrolled[c,d] radionuclide Emissions (Ci)	Radionuclide emissions after control: Project life[e] (Ci)	Radionuclide emissions after control: Annualized[f] (Ci/year)
U-235	24.86	6.72E-10	3.80E+06	6.72E-10	6.74E-04	6.74E-08	5.39E-08
U-236	2.07	5.59E-11	2.34E+07	5.59E-11	5.61E-05	5.61E-09	4.49E-09
U-238	943.56	2.55E-08	4.47E+09	2.55E-08	2.56E-02	2.56E-06	2.05E-06
U-239	0		4.46E-05				0.00E+00
Y-90	0		7.31E-03				0.00E+00
Zn-65	0		6.69E-01				0.00E+00
Zr-95	26302.35	7.11E-07	1.75E-01	7.11E-07	7.13E-01	7.13E-05	5.71E-05
Total							6.12E-03

[a]Composition data obtained from U.S. Department of Energy Report, *Statistical Description of Liquid Low-Level Waste System Transuranic Wastes at Oak Ridge National Laboratory, Oak Ridge, Tennessee,* Document Number ORNL/TM-13351.

[b]The amount of curies present for each radionuclide is reduced by the corresponding half life to account for the species decay. The equation for estimating radionuclide decay is:

$$A = A_o \times \exp -[\ln(2) / t_{1/2} * T] .$$

The half-life of each radionuclide was obtained from the web site www.dne.bnl.gov/CoN/index.html.

T is the time between the time of sample analysis (December 1996) to the time of process startup (January 2003):

T = 6.08 years.

[c]An emissions factor for the amount of airborne radionuclides is obtained from Appendix D to 40 *Code of Federal Regulations (CFR)* 61.

Emission Factor = 0.001 fraction of the amount used.

[d]The uncontrolled emissions are estimated by the following expression:

Uncontrolled Rate = Sludge Processing Rate × Emissions Factor × Composition.

The processing rate and the operating schedule obtained from the FWEC proposal are:

Total Sludge Processing Rate = 1,003,256 kg for 15 months
Total Project Life = 15 months life

[e]The emissions after control are estimated by using the U.S. Environmental Protection Agency adjustment factors from Table 1 of Appendix D to 40 *CFR* 61. The adjustment factors are:

High-Efficiency Particulate Air (HEPA)
Filters System 1 Adjustment Factor = 0.01
HEPA Filters System 2 Adjustment Factor = 0.01

[f]The annualized emissions are calculated by the following equation:

Annualized Emissions = Total Emissions × 12 months/Total Project Life.

*Emissions of ^{241}Am were calculated as a decay product of ^{241}Pu by the following equation:

$$A_{Am\,241} = \frac{\lambda_{Am\,241} \times A_{Pu\,241} \times \left(e^{-\lambda_{Pu\,241}T} - e^{-\lambda_{Am\,241}T}\right)}{\lambda_{Am\,241} - \lambda_{Pu\,241}}$$

where $\lambda = \ln(2)/t_{1/2}$.

Bq = becquerel.

Ci = curie.

g = gram.

TRU = transuranic.

Table B.1-3. Estimated radionuclide emissions for waste treatment of supernate for the Proposed Action

Radionuclide	Radionuclide composition[a] (Bq/mL)	(Bq/g)	(Ci/g)	Radionuclide[b] half life, $t_{1/2}$ (year)	Decayed[b] radionuclide composition (Ci/g)	Uncontrolled[c,d] radionuclide emissions (Ci)	Radionuclide emissions after control: Project life[e] (Ci)	Annualized[f] (Ci/year)
Ac-227	0			2.18E+01				0.00E+00
Ag-110	0			7.80E-07				0.00E+00
Ag-110m	0			6.84E-01				0.00E+00
Am-241				4.32E+02		6.24E-06	6.24E-10	4.99E-10
Am-243	0			7.37E+03				0.00E+00
Au-196	0			1.69E-02				0.00E+00
Au-198	0			7.38E-03				0.00E+00
Bk-249	0			8.76E-01				0.00E+00
C-14	95.45	83.00	2.24E-09	5.73E+03	2.24E-09	1.55E-03	1.55E-07	1.24E-07
Ce-144	1305.38	1135.11	3.07E-08	7.80E-01	2.89E-10	2.00E-04	2.00E-08	1.60E-08
Cf-249	0			3.51E+02				0.00E+00
Cf-252	2.07	1.80	4.86E-11	2.65E+00	1.23E-11	8.50E-06	8.50E-10	6.80E-10
Cm-240	0			7.39E-02				0.00E+00
Cm-242	0			1.63E+02				0.00E+00
Cm-243	0			2.91E+01				0.00E+00
Cm-244	883.44	768.21	2.08E-08	1.81E+01	1.70E-08	1.18E-02	1.18E-06	9.40E-07
Cm-245	0			8.50E+03				0.00E+00
Cm-246	0			4.73E+03				0.00E+00
Cm-248	0			3.40E+05				0.00E+00
Co-60	838.97	729.54	1.97E-08	5.27E+00	9.89E-09	6.84E-03	6.84E-07	5.47E-07
Cs-134	8903.12	7741.84	2.09E-07	2.06E+00	3.59E-08	2.49E-02	2.49E-06	1.99E-06
Cs-137	273946.86	238214.66	6.44E-06	3.01E+01	5.70E-06	3.95E+00	3.95E-04	3.16E-04
Es-253	0			5.60E-02				0.00E+00
Es-254m	0			4.48E-03				0.00E+00
Eu-152	3959.72	3443.23	9.31E-08	1.35E+01	7.11E-08	4.92E-02	4.92E-06	3.94E-06
Eu-154	1651.86	1436.40	3.88E-08	8.59E+00	2.54E-08	1.76E-02	1.76E-06	1.41E-06
Eu-155	1037.85	902.48	2.44E-08	4.76E+00	1.14E-08	7.86E-03	7.86E-07	6.29E-07
Fe-59	0			1.22E-01				0.00E+00
Gd-153	0			6.61E-01				0.00E+00
H-3	169.53	147.42	3.98E-09	1.23E+01	2.97E-09	2.05E-03	2.05E-07	1.64E-07
I-129	0.15	0.13	3.53E-12	1.57E+07	3.53E-12	2.44E-06	2.44E-10	1.95E-10
I-131	0			2.20E-02				0.00E+00
Nb-95	129.69	112.77	3.05E-09	9.58E-02	9.55E-26	6.61E-20	6.61E-24	5.29E-24
Ni-63	0			1.00E+02				0.00E+00
Np-237	0			2.14E+06				0.00E+00
Pa-231	0			3.28E+04				0.00E+00
Pm-147	0			2.62E+00				0.00E+00
Po-209	0			1.02E+02				0.00E+00
Pu-238	4.22	3.67	9.92E-11	8.77E+01	9.51E-11	6.58E-05	6.58E-09	5.27E-09
Pu-239	3.48	3.03	8.18E-11	2.41E+04	8.18E-11	5.66E-05	5.66E-09	4.53E-09
Pu-240	3.39	2.95	7.97E-11	6.56E+03	7.96E-11	5.51E-05	5.51E-09	4.41E-09
Pu-241	66.80	58.09	1.57E-09	1.44E+01	1.22E-09	8.43E-04	8.43E-08	6.74E-08
Pu-242	0.17	0.15	4.00E-12	3.73E+05	4.00E-12	2.76E-06	2.76E-10	2.21E-10
Pu-244	0.02	0.02	4.70E-13	8.00E+05	4.70E-13	3.25E-07	3.25E-11	2.60E-11
Ra-223	0			3.13E-02				0.00E+00
Ra-226	0			1.60E+03				0.00E+00
Ru-106	2314.29	2012.43	5.44E-08	1.02E+00	1.55E-09	1.07E-03	1.07E-07	8.58E-08
Sb-125	0			2.76E+00				0.00E+00
Sr-90	11018.92	9581.67	2.59E-07	2.88E+01	2.28E-07	1.58E-01	1.58E-05	1.26E-05
Tc-99	1149.98	999.98	2.70E-08	2.11E+05	2.70E-08	1.87E-02	1.87E-06	1.50E-06
Te-123	0			1.00E+08				0.00E+00
Te-123m	0			3.28E-01				0.00E+00
Th-230	0			7.54E+04				0.00E+00
Th-232	0.04	0.03	9.40E-13	1.41E+10	9.40E-13	6.51E-07	6.51E-11	5.20E-11
U-232	20.00	17.39	4.70E-10	6.89E+01	4.46E-10	3.09E-04	3.09E-08	2.47E-08
U-233	143.14	124.47	3.36E-09	1.59E+05	3.36E-09	2.33E-03	2.33E-07	1.86E-07
U-234	2.90	2.52	6.82E-11	2.46E+05	6.82E-11	4.72E-05	4.72E-09	3.77E-09
U-235	0.12	0.10	2.82E-12	3.80E+06	2.82E-12	1.95E-06	1.95E-10	1.56E-10
U-236	0.07	0.06	1.65E-12	2.34E+07	1.65E-12	1.14E-06	1.14E-10	9.11E-11
U-238	3.82	3.32	8.98E-11	4.47E+09	8.98E-11	6.21E-05	6.21E-09	4.97E-09
U-239	0			4.46E-05				0.00E+00
Y-90	0			7.31E-03				0.00E+00

Table B.1-3 (continued)

Radionuclide	Radionuclide composition[a] (Bq/mL)	(Bq/g)	(Ci/g)	Radionuclide[b] half life, $t_{1/2}$ (year)	Decayed[b] radionuclide composition (Ci/g)	Uncontrolled[c,d] radionuclide emissions (Ci)	Radionuclide emissions after control: Project life[e] (Ci)	Annualized[f] (Ci/year)
Zn-65	0			6.69E-01				0.00E+00
Zr-95	147.69	128.43	3.47E-09	1.75E-01	3.34E-18	2.31E-12	2.31E-16	1.85E-16
Total								3.40E-04

[a]Composition data obtained from U.S. Department of Energy Report, *Statistical Description of Liquid Low-Level Waste System Supernatant Liquids at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, Document Number ORNL/TM-13551, Addendum 1. An average density value for supernate was obtained from Table 4.1, p. 3, of the above report to calculate a mass faction for each metal.

Supernate Density = 1.15 g/mL.

[b]The amount of curies present for each radionuclide is reduced by the corresponding half-life to account for the species decay. The equation for estimating radionuclide decay is:

$$A = A_o \times \exp -[\ln(2) / t_{1/2} * T].$$

The half-life of each radionuclide was obtained from the web site www.dne.bnl.gov/CoN/index.html.

T is the time between the time of sample analysis (October 1997) to the time of process startup (January 2003):

T = 5.25 years.

[c]An emissions factor for the amount of airborne radionuclides is obtained from Appendix D to 40 *Code of Federal Regulations (CFR)* 61.

Emission Factor = 0.001 fraction of the amount used.

[d]The uncontrolled emissions are estimated by the following expression:

Uncontrolled Rate = Sludge Processing Rate × Emissions Factor × Composition.

The processing rate and the operating schedule obtained from the FWEC proposal are:

Total Supernate Processing Rate = 692,000 kg for 15 months
Total Project Life = 15 months life

[e]The emissions after control are estimated by using the U.S. Environmental Protection Agency adjustment factors from Table 1 of Appendix D to 40 *CFR* 61. The adjustment factors are:

High-Efficiency Particulate Air (HEPA)
Filters System 1 Adjustment Factor = 0.01
HEPA Filters System 2 Adjustment Factor = 0.01

[f]The annualized emissions are calculated by the following equation:

Annualized Emissions = Total Emissions × 12 months/Total Project Life.

*Emissions of ^{241}Am were calculated as a decay product of ^{241}Pu by the following equation:

$$A_{Am\,241} = \frac{\lambda_{Am\,241} \times A_{Pu\,241} \times \left(e^{-\lambda_{Pu\,241} T} - e^{-\lambda_{Am\,241} T}\right)}{\lambda_{Am\,241} - \lambda_{Pu\,241}}$$

where $\lambda = \ln(2)/t_{1/2}$.

Bq = becquerel.
Ci = curie.
g = gram.
mL = milliliter.

Table B.1-4. Estimated radionuclide emissions for TRU waste treatment of solids for the Proposed Action

Radionuclide	Radionuclide[a] composition (Ci)	Radionuclide[b] half life, $t_{1/2}$ (year)	Decayed[b] radionuclide composition (Ci)	Uncontrolled[c,d] radionuclide emissions (Ci)	Radionuclide emissions after control	
					Project life[e] (Ci)	Annualized[f] (Ci/year)
Ac-227	1.01E-03	2.18E+01	8.19E-04	8.19E-07	8.19E-13	6.55E-13
Ag-110	0.00E+00	7.80E-07				0.00E+00
AG-110m	0.00E+00	6.84E-01				0.00E+00
Am-241		4.32E+02		5.14E-01	5.14E-07	4.12E-07
Am-243	1.05E+01	7.37E+03	1.05E+01	1.05E-02	1.05E-08	8.37E-09
Au-196	0.00E+00	1.69E-02				0.00E+00
Au-198	0.00E+00	7.38E-03				0.00E+00
Bk-249	5.25E+00	8.76E-01	2.87E-02	2.87E-05	2.87E-11	2.30E-11
C-14	1.70E-04	5.73E+03	1.70E-04	1.70E-07	1.70E-13	1.36E-13
Ce-144	0.00E+00	7.80E-01				0.00E+00
Cf-249	1.52E-02	3.51E+02	1.50E-02	1.50E-05	1.50E-11	1.20E-11
Cf-252	6.80E+01	2.65E+00	1.21E+01	1.21E-02	1.21E-08	9.69E-09
Cm-240	1.00E-03	7.39E-02	1.56E-30	1.56E-33	1.56E-39	1.25E-39
Cm-242	6.77E+01	1.63E+02	6.59E+01	6.59E-02	6.59E-08	5.27E-08
Cm-243	0.00E+00	2.91E+01				0.00E+00
Cm-244	2.79E+03	1.81E+01	2.17E+03	2.17E+00	2.17E-06	1.74E-06
Cm-245	3.07E-03	8.50E+03	3.07E-03	3.07E-06	3.07E-12	2.46E-12
Cm-246	1.00E-05	4.73E+03	9.99E-06	9.99E-09	9.99E-15	8.00E-15
Cm-248	2.63E-02	3.40E+05	2.63E-02	2.63E-05	2.63E-11	2.11E-11
Co-60	7.01E+00	5.27E+00	2.95E+00	2.95E-03	2.95E-09	2.36E-09
Cs-134	0.00E+00	2.06E+00				0.00E+00
Cs-137	3.43E+03	3.01E+01	2.95E+03	2.95E+00	2.95E-06	2.36E-06
Es-253	8.00E+00	5.60E-02	3.49E-35	3.49E-38	3.49E-44	2.79E-44
Es-254m	1.09E+01	4.48E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Eu-152	6.50E-04	1.35E+01	4.64E-04	4.64E-07	4.64E-13	3.71E-13
Eu-154	0.00E+00	8.59E+00				0.00E+00
Eu-155	0.00E+00	4.76E+00				0.00E+00
Fe-59	4.01E+00	1.22E-01	2.18E-16	2.18E-19	2.18E-25	1.74E-25
Gd-153	0.00E+00	6.61E-01				0.00E+00
H-3	0.00E+00	1.23E+01				0.00E+00
I-129	0.00E+00	1.57E+07				0.00E+00
I-131	5.00E-01	2.20E-02	2.84E-91	2.84E-94	2.84E-100	2.28E-100
Nb-95	0.00E+00	9.58E-02				0.00E+00
Ni-63	1.11E-04	1.00E+02	1.06E-04	1.06E-07	1.06E-13	8.49E-14
Np-237	8.41E-01	2.14E+06	8.41E-01	8.41E-04	8.41E-10	6.73E-10
Pa-231	3.15E-01	3.28E+04	3.15E-01	3.15E-04	3.15E-10	2.52E-10
Pm-147	4.65E+00	2.62E+00	8.17E-01	8.17E-04	8.17E-10	6.54E-10
Po-209	2.00E-06	1.02E+02	1.91E-06	1.91E-09	1.91E-15	1.53E-15
Pu-238	3.99E+03	8.77E+01	3.79E+03	3.79E+00	3.79E-06	3.03E-06
Pu-239	1.03E+03	2.41E+04	1.03E+03	1.03E+00	1.03E-06	8.25E-07
Pu-240	9.63E+02	6.56E+03	9.63E+02	9.63E-01	9.63E-07	7.70E-07
Pu-241	7.86E+04	1.44E+01	5.72E+04	5.72E+01	5.72E-05	4.58E-05
Pu-242	2.39E-01	3.73E+05	2.39E-01	2.39E-04	2.39E-10	1.91E-10
Pu-244	0.00E+00	8.00E+05				0.00E+00
Ra-223	2.20E-03	3.13E-02	1.10E-66	1.10E-69	1.10E-75	8.83E-76
Ra-226	1.61E+00	1.60E+03	1.61E+00	1.61E-03	1.61E-09	1.29E-09
Ru-106	0.00E+00	1.02E+00				0.00E+00
Sb-125	0.00E+00	2.76E+00				0.00E+00
Sr-90	2.13E+03	2.88E+01	1.82E+03	1.82E+00	1.82E-06	1.46E-06
Tc-99	1.71E+02	2.11E+05	1.71E+02	1.71E-01	1.71E-07	1.37E-07
Te-123	2.60E-05	1.00E+08	2.60E-05	2.60E-08	2.60E-14	2.08E-14
Te-123m	7.95E-04	3.28E-01	7.14E-10	7.14E-13	7.14E-19	5.71E-19
Th-230	1.20E-05	7.54E+04	1.20E-05	1.20E-08	1.20E-14	9.63E-15
Th-232	1.79E-03	1.41E+10	1.79E-03	1.79E-06	1.79E-12	1.43E-12
U-232	3.15E-01	6.89E+01	2.95E-01	2.95E-04	2.95E-10	2.36E-10
U-233	1.06E+02	1.59E+05	1.06E+02	1.06E-01	1.06E-07	8.45E-08
U-234	1.67E+01	2.46E+05	1.67E+01	1.67E-02	1.67E-08	1.33E-08
U-235	7.44E-03	3.80E+06	7.44E-03	7.44E-06	7.44E-12	5.95E-12
U-236	9.73E-05	2.34E+07	9.73E-05	9.73E-08	9.73E-14	7.78E-14
U-238	4.35E-02	4.47E+09	4.35E-02	4.35E-05	4.35E-11	3.48E-11
U-239	0.00E+00	4.46E-05				0.00E+00
Y-90	3.40E-06	7.31E-03	3.31E-277	3.31E-280	3.31E-286	2.65E-286

Table B.1-4 (continued)

Radionuclide	Radionuclide[a] composition (Ci)	Radionuclide[b] half life, $t_{1/2}$ (year)	Decayed[b] radionuclide composition (Ci)	Uncontrolled[c,d] radionuclide emissions (Ci)	Radionuclide emissions after control	
					Project life[e] (Ci)	Annualized[f] (Ci/year)
Zn-65	2.80E-03	6.69E-01	3.05E-06	3.05E-09	3.05E-15	2.44E-15
Zr-95	0.00E+00	1.75E-01				0.00E+00
Total						5.67E-05

[a]Composition data obtained from U.S. Department of Energy Memorandum: "TRU Waste Baseline Inventory Report for Oak Ridge," June 1996.

[b]The amount of curies present for each radionuclide is reduced by the corresponding half-life to account for the species decay. The equation for estimating radionuclide decay is:

$$A = A_o \times \exp -[\ln(2) / t_{1/2} * T].$$

The half-life of each radionuclide was obtained from the web site www.dne.bnl.gov/CoN/index.html.

T is the time between the time of sample analysis (June 1996) to the time of process startup (January 2003):

T = 6.58 years.

[c]An emissions factor for the amount of airborne radionuclides is obtained from Appendix D to 40 *Code of Federal Regulations (CFR)* 61.

Emission Factor = 0.001 fraction of the amount used.

[d]The uncontrolled emissions are estimated by the following expression:

Uncontrolled Rate = Retrievable Curies × Emissions Factor.

[e]The emissions after control are estimated by using the U.S. Environmental Protection Agency adjustment factors from Table 1 of Appendix D to 40 *CFR* 61. The adjustment factors are:

Glovebox/Hot Cell High-Efficiency Particulate Air (HEPA) Filters Adjustment Factor	= 0.01
Glovebox/Hot Cell Carbon Filters Adjustment Factor	= 0.10
HEPA Filters System 1 Adjustment Factor	= 0.01
HEPA Filters System 2 Adjustment Factor	= 0.01

Note that no emissions reduction credit is taken for the carbon system, since this factor only applied to iodine gas and no iodine is present in the solid waste.

[f]The annualized emissions are calculated by the following equation:

Annualized Emissions = Total Emissions × 12 months/15-month Project Life.

*Emissions of ^{241}Am were calculated as a decay product of ^{241}Pu by the following equation:

$$A_{Am241} = \frac{\lambda_{Am241} \times A_{Pu241} \times \left(e^{-\lambda_{Pu241}T} - e^{-\lambda_{Am241}T}\right)}{\lambda_{Am241} - \lambda_{Pu241}}$$

where l = ln(2) / $t_{1/2}$.

Ci = curie.

TRU = transuranic.

Table B.1-5. CAP.88-PC Exposure modeling results summary for the Proposed Action

Radionuclide	Total emissions (Ci/year)	Effective dose equivalent (mrem/year)	Total lifetime fatal cancer risk
Ac-227	6.55E-13	8.97E-11	5.80E-16
Ag-110	0.00E+00	0.00E+00	0.00E+00
Ag-110m	0.00E+00	0.00E+00	0.00E+00
Am-241	5.58E-07	7.63E-05	3.87E-10
Am-243	8.37E-09	1.17E-06	6.24E-12
Au-196	0.00E+00		
Au-198	5.25E-254		
Bk-249	2.30E-11		
C-14	1.24E-07	4.35E-10	1.06E-14
Ce-144	1.20E-07	6.59E-08	9.17E-13
Cf-249	1.20E-11		
Cf-252	2.72E-08	8.45E-07	9.51E-12
Cm-240	1.25E-39		
Cm-242	5.27E-08	1.84E-07	1.82E-12
Cm-243	1.94E-05	1.84E-03	1.20E-08
Cm-244	6.52E-05	4.60E-03	2.76E-08
Cm-245	2.46E-12	3.56E-10	1.95E-15
Cm-246	8.00E-15	1.10E-12	5.30E-18
Cm-248	2.11E-11	1.07E-08	5.19E-14
Co-60	3.32E-05	8.37E-04	2.04E-08
Cs-134	3.37E-06	3.77E-05	9.40E-10
Cs-137	1.41E-03	4.90E-03	1.28E-07
Es-253	2.79E-44		
Es-254m	0.00E+00		
Eu-152	2.13E-04	5.34E-03	1.27E-07
Eu-154	9.40E-05	1.85E-03	4.42E-08
Eu-155	1.96E-05	1.44E-05	3.09E-10
Fe-59	1.74E-25	7.92E-26	1.78E-30
Gd-153	0.00E+00		
H-3	2.18E-07	1.31E-11	3.55E-16
I-129	1.95E-10	6.42E-09	3.74E-14
I-131	2.28E-100	0.00E+00	0.00E+00
Nb-95	5.66E-24	2.19E-24	3.61E-29
Ni-63	8.49E-14	2.56E-15	4.58E-20
Np-237	1.75E-08	2.44E-06	1.24E-11
Pa-231	2.52E-10	3.76E-08	1.31E-13
Pm-147	6.54E-10	2.21E-11	3.14E-16
Po-209	1.53E-15		
Pu-238	1.59E-05	1.74E-03	9.63E-09
Pu-239	7.41E-06	9.00E-04	4.70E-09
Pu-240	2.83E-06	3.43E-04	1.80E-09
Pu-241	6.32E-05	1.50E-04	5.68E-10
Pu-242	4.86E-09	5.62E-07	2.93E-12
Pu-244	4.38E-10	5.01E-08	2.66E-13
Ra-223	8.83E-76	0.00E+00	0.00E+00
Ra-226	1.29E-09	4.50E-08	2.49E-13
Ru-106	7.28E-07	5.19E-07	8.24E-12
Sb-125	0.00E+00	0.00E+00	0.00E+00
Sr-90-	3.48E-03	3.98E-02	6.70E-07
Tc-99	2.44E-06	5.04E-06	1.83E-10

Table B.1-5 (continued)

Radionuclide	Total emissions (Ci/year)	Effective dose equivalent (mrem/year)	Total lifetime fatal cancer risk
Te-123	2.08E-14		
Te-123m	5.71E-19		
Th-230	9.63E-15	2.46E-13	1.42E-18
Th-232	5.62E-08	1.69E-06	7.95E-12
U-232	2.49E-08	2.51E-06	1.40E-11
U-233	4.91E-06	1.74E-04	1.16E-09
U-234	2.08E-06	7.32E-05	4.86E-10
U-235	5.41E-08	2.43E-06	2.66E-11
U-236	4.58E-09	1.52E-07	1.01E-12
U-238	2.05E-06	6.47E-05	4.56E-10
U-239	0.00E+00		
Y-90	2.65E-286	0.00E+00	0.00E+00
Zn-65	2.44E-15	7.45E-15	1.93E-19
Zr-95	2.22E-15	8.36E-16	1.78E-20
Totals	5.44E-03	6.28E-02	1.05E-06

Ci = curie.
mrem = millirem.

Table B.1-6. Summary of TRU waste treatment hourly particulate emissions (lbs/h) for the Proposed Action

Particulate contaminant	Classification	Average hourly emissions (lbs/h) Sludge	Supernate	Solids	Total	Maximum[a] hourly emissions (lbs/h)	Average[b] annual emissions (tons/year)
TSP		3.43E-01	3.43E-01	3.43E-03	6.89E-01	8.61E-01	2.07E+00
Total HAP		3.81E-04	4.83E-06	2.23E-08	3.86E-04	4.82E-04	1.16E-03
Antimony (Sb)	HAP	9.36E-06	2.95E-07	0.00E+00	9.66E-06	1.21E-05	2.90E-05
Arsenic (As)	HAP	5.89E-06	5.99E-07	0.00E+00	6.49E-06	8.11E-06	1.95E-05
Beryllium (Be)	HAP	6.27E-07	2.98E-09	0.00E+00	6.30E-07	7.88E-07	1.89E-06
Cadmium (Cd)	HAP	3.15E-06	1.16E-07	2.02E-09	3.27E-06	4.09E-06	9.82E-06
Chromium (Cr)	HAP	1.16E-04	2.03E-06	0.00E+00	1.18E-04	1.47E-04	3.53E-04
Cobalt (Co)	HAP	1.25E-06	4.77E-08	0.00E+00	1.30E-06	1.62E-06	3.89E-06
Lead (Pb)	HAP	1.58E-04	7.54E-07	1.82E-08	1.59E-04	1.99E-04	4.78E-04
Manganese (Mn)	HAP	3.57E-05	9.84E-08	0.00E+00	3.58E-05	4.48E-05	1.07E-04
Mercury (Hg)	HAP	2.25E-05	2.36E-07	2.02E-09	2.27E-05	2.84E-05	6.82E-05
Nickel (Ni)	HAP	2.17E-05	3.67E-07	0.00E+00	2.21E-05	2.76E-05	6.63E-05
Selenium (Se)	HAP	6.42E-06	2.80E-07	0.00E+00	6.70E-06	8.38E-06	2.01E-05
Aluminum (Al)		2.75E-03	4.20E-06	0.00E+00	2.75E-03	3.44E-03	8.25E-03
Barium (Ba)		3.21E-05	5.46E-07	0.00E+00	3.27E-05	4.08E-05	9.80E-05
Bismuth (Bi)		0.00E+00	8.05E-07	0.00E+00	8.05E-07	1.01E-06	2.41E-06
Boron (B)		4.29E-06	3.76E-07	0.00E+00	4.66E-06	5.83E-06	1.40E-05
Calcium (Ca)		8.26E-03	4.07E-04	0.00E+00	8.67E-03	1.08E-02	2.60E-02
Cerium (Ce)		0.00E+00	1.10E-07	0.00E+00	1.10E-07	1.38E-07	3.31E-07
Cesium (Cs)		1.36E-06	5.37E-07	0.00E+00	1.89E-06	2.37E-06	5.68E-06
Copper (Cu)		1.83E-05	2.56E-07	0.00E+00	1.86E-05	2.33E-05	5.58E-05
Gallium (Ga)		0.00E+00	9.84E-08	0.00E+00	9.84E-08	1.23E-07	2.95E-07
Iodine (I)		0.00E+00	4.41E-06	0.00E+00	4.41E-06	5.51E-06	1.32E-05
Iron (Fe)		1.48E-03	3.25E-06	0.00E+00	1.48E-03	1.86E-03	4.45E-03
Lanthanum (La)		0.00E+00	1.19E-08	0.00E+00	1.19E-08	1.49E-08	3.58E-08
Lithium (Li)		0.00E+00	7.96E-06	0.00E+00	7.96E-06	9.95E-06	2.39E-05
Magnesium (Mg)		1.39E-03	5.32E-05	0.00E+00	1.44E-03	1.80E-03	4.33E-03
Molybdenum (Mo)		0.00E+00	3.70E-07	0.00E+00	3.70E-07	4.62E-07	1.11E-06
Niobium (Nb)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Phosphorus (P)		4.51E-03	2.08E-05	0.00E+00	4.53E-03	5.67E-03	1.36E-02
Potassium (K)		2.19E-03	3.38E-03	0.00E+00	5.57E-03	6.96E-03	1.67E-02
Rubidium (Rb)		0.00E+00	3.52E-07	0.00E+00	3.52E-07	4.40E-07	1.06E-06
Silicon (Si)		7.79E-04	1.64E-05	0.00E+00	7.96E-04	9.95E-04	2.39E-03
Silver (Ag)		2.70E-06	5.96E-08	4.77E-10	2.76E-06	3.45E-06	8.29E-06
Sodium (Na)		1.50E-02	1.63E-02	0.00E+00	3.14E-02	3.92E-02	9.42E-02
Strontium (Sr)		3.04E-05	3.84E-06	0.00E+00	3.43E-05	4.28E-05	1.03E-04
Thallium (Th)		2.01E-03	3.28E-06	0.00E+00	2.02E-03	2.52E-03	6.05E-03
Thallium (Tl)		4.13E-06	5.28E-07	0.00E+00	4.66E-06	5.82E-06	1.40E-05
Tin (Sn)		0.00E+00	1.13E-07	0.00E+00	1.13E-07	1.42E-07	3.40E-07
Titanium (Ti)		0.00E+00	1.52E-07	0.00E+00	1.52E-07	1.90E-07	4.56E-07
Tungsten (W)		0.00E+00	1.37E-07	0.00E+00	1.37E-07	1.71E-07	4.11E-07
Uranium (U)		1.65E-02	1.30E-04	0.00E+00	1.66E-02	2.08E-02	4.99E-02
Vanadium (V)		9.87E-07	2.68E-08	0.00E+00	1.01E-06	1.27E-06	3.04E-06
Zinc (Zn)		4.57E-05	4.14E-06	0.00E+00	4.98E-05	6.23E-05	1.49E-04
Zirconium (Zr)		0.00E+00	8.94E-09	0.00E+00	8.94E-09	1.12E-08	2.68E-08

[a]Maximum hourly is estimated by multiplying the average hourly by 1.25.
[b]Average annual emissions are the average hourly emissions multiplied by 6000 h/year.
h = hour.
HAP = hazardous air pollutant.
lb = pound.
TRU = transuranic.

Table B.1-7. Estimated metals emissions for TRU/sludge waste treatment for the Proposed Action

Metals	Metals[a] composition (mg/kg)	Metals mass fraction (g/total g)	Metals[b] concentration (g/dscf)	Uncontrolled metal[c] emissions for the project		Emissions after[d] control for the project		Average[e] hourly emissions (lbs/h)
				(g)	(lbs)	(g)	(lbs)	
TSP			1.30E-01	1.12E+09	2.47E+06	1,120,731	2468.57	3.43E-01
Silver (Ag)	7.88	7.88E-06	1.02E-06	8.83E+03	1.95E+01	8.83E+00	1.95E-02	2.70E-06
Aluminum (Al)	8012.46	8.01E-03	1.04E-03	8.98E+06	1.98E+04	8.98E+03	1.98E+01	2.75E-03
Arsenic (As)	17.18	1.72E-05	2.23E-06	1.93E+04	4.24E+01	1.93E+01	4.24E-02	5.89E-06
Boron (B)	12.51	1.25E-05	1.62E-06	1.40E+04	3.09E+01	1.40E+01	3.09E-02	4.29E-06
Barium (Ba)	93.65	9.37E-05	1.21E-05	1.05E+05	2.31E+02	1.05E+02	2.31E-01	3.21E-05
Beryllium (Be)	1.83	1.83E-06	2.37E-07	2.05E+03	4.52E+00	2.05E+00	4.52E-03	6.27E-07
Bismuth (Bi)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Calcium (Ca)	24100.46	2.41E-02	3.13E-03	2.70E+07	5.95E+04	2.70E+04	5.95E+01	8.26E-03
Cadmium (Cd)	9.20	9.20E-06	1.19E-06	1.03E+04	2.27E+01	1.03E+01	2.27E-02	3.15E-06
Cerium (Ce)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cobalt (Co)	3.64	3.64E-06	4.72E-07	4.08E+03	8.99E+00	4.08E+00	8.99E-03	1.25E-06
Chromium (Cr)	337.40	3.37E-04	4.38E-05	3.78E+05	8.33E+02	3.78E+02	8.33E-01	1.16E-04
Cesium (Cs)	3.96	3.96E-06	5.14E-07	4.44E+03	9.78E+00	4.44E+00	9.78E-03	1.36E-06
Copper (Cu)	53.51	5.35E-05	6.94E-06	6.00E+04	1.32E+02	6.00E+01	1.32E-01	1.83E-05
Iron (Fe)	4319.89	4.32E-03	5.60E-04	4.84E+06	1.07E+04	4.84E+03	1.07E+01	1.48E-03
Gallium (Ga)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mercury (Hg)	65.61	6.56E-05	8.51E-06	7.35E+04	1.62E+02	7.35E+01	1.62E-01	2.25E-05
Iodine (I)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Potassium (K)	6381.12	6.38E-03	8.28E-04	7.15E+06	1.58E+04	7.15E+03	1.58E+01	2.19E-03
Lanthanum (La)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lithium (Li)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Magnesium (Mg)	4052.20	4.05E-03	5.26E-04	4.54E+06	1.00E+04	4.54E+03	1.00E+01	1.39E-03
Manganese (Mn)	104.16	1.04E-04	1.35E-05	1.17E+05	2.57E+02	1.17E+02	2.57E-01	3.57E-05
Molybdenum (Mo)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sodium (Na)	43892.46	4.39E-02	5.69E-03	4.92E+07	1.08E+05	4.92E+04	1.08E+02	1.50E-02
Niobium (Nb)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel (Ni)	63.42	6.34E-05	8.23E-06	7.11E+04	1.57E+02	7.11E+01	1.57E-01	2.17E-05
Phosphorus (P)	13158.71	1.32E-02	1.71E-03	1.47E+07	3.25E+04	1.47E+04	3.25E+01	4.51E-03
Lead (Pb)	462.24	4.62E-04	6.00E-05	5.18E+05	1.14E+03	5.18E+02	1.14E+00	1.58E-04
Rubidium (Rb)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Antimony (Sb)	27.30	2.73E-05	3.54E-06	3.06E+04	6.74E+01	3.06E+01	6.74E-02	9.36E-06
Selenium (Se)	18.73	1.87E-05	2.43E-06	2.10E+04	4.62E+01	2.10E+01	4.62E-02	6.42E-06
Silicon (Si)	2272.82	2.27E-03	2.95E-04	2.55E+06	5.61E+03	2.55E+03	5.61E+00	7.79E-04
Tin (Sn)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Strontium (Sr)	88.75	8.88E-05	1.15E-05	9.95E+04	2.19E+02	9.95E+01	2.19E-01	3.04E-05
Thallium (Th)	5867.64	5.87E-03	7.61E-04	6.58E+06	1.45E+04	6.58E+03	1.45E+01	2.01E-03
Titanium (Ti)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thallium (Tl)	12.05	1.21E-05	1.56E-06	1.35E+04	2.97E+01	1.35E+01	2.97E-02	4.13E-06
Uranium (U)	48161.88	4.82E-02	6.25E-03	5.40E+07	1.19E+05	5.40E+04	1.19E+02	1.65E-02
Vanadium (V)	2.88	2.88E-06	3.74E-07	3.23E+03	7.11E+00	3.23E+00	7.11E-03	9.87E-07
Tungsten (W)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zinc (Zn)	133.22	1.33E-04	1.73E-05	1.49E+05	3.29E+02	1.49E+02	3.29E-01	4.57E-05
Zirconium (Zr)		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

[a]Composition data obtained from U.S. Department of Energy Report, *Statistical Description of Liquid Low-Level Waste System Transuranic Wastes at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, Document Number ORNL/TM-13351.

[2]The amount of total suspended particulate (TSP) matter reaching the first exhaust system High-Efficiency Particulate Air (HEPA) filter is assumed to be:

Airborne Particulate Conc. = 2.0 gr/dscf.

[c]The uncontrolled emissions are estimated by the following expression:

Uncontrolled Rate = Exhaust Stream Flowrate × TSP Concentration × Metal Mass Fraction.

Operating schedule data were obtained from the FWENC proposal:

Air Flow Rate	=	20,000 dscfm assumed rate from sludge process
Project Operating Schedule	=	15 months life
		4 weeks/month
		5 d/week
		24 h/d
Calculated Operating Hours	=	7,200 h for the 15 months

[d]The two HEPA filtration systems are assumed to have the following removal efficiencies:

HEPA Filter 1 Removal = 99%
HEPA Filter 2 Removal = 90%

[e]The average hourly emissions are calculated by the following expression:

Average Hourly = Pounds Emitted for Project/Project Operating Hours.

d = day.

dscf = dry standard cubic foot.

dscfm = dry standard cubic feet per minute.

g = gram.

gr/dscf = grains per dry standard cubic foot.

h = hour.

lb = pound.

kg = kilogram.

mg = milligram.

TRU = transuranic.

Table B.1-8. Estimated metals emissions for supernate waste treatment for the Proposed Action

Metals	Metals[a] composition (mg/L)	Metals[b] composition (g/total g)	Metalsc concentration (g/dscf)	Uncontrolled metal[d] for the project		Emissions after[e] control for the project		Average[f] hourly emissions (lbs/h)
				(g)	(lbs)	(g)	(lbs)	
TSP			1.30E-01	1.12E+09	2.47E+06	1,120,731	2468.57	3.43E-01
Silver (Ag)	0.20	1.74E-07	2.26E-08	1.95E+02	4.29E-01	1.95E-01	4.29E-04	5.96E-08
Aluminum (Al)	14.08	1.22E-05	1.59E-06	1.37E+04	3.02E+01	1.37E+01	3.02E-02	4.20E-06
Arsenic (As)	2.01	1.75E-06	2.27E-07	1.96E+03	4.31E+00	1.96E+00	4.31E-03	5.99E-07
Boron (B)	1.26	1.10E-06	1.42E-07	1.23E+03	2.70E+00	1.23E+00	2.70E-03	3.76E-07
Barium (Ba)	1.83	1.59E-06	2.06E-07	1.78E+03	3.93E+00	1.78E+00	3.93E-03	5.46E-07
Beryllium (Be)	0.01	8.70E-09	1.13E-09	9.75E+00	2.15E-02	9.75E-03	2.15E-05	2.98E-09
Bismuth (Bi)	2.70	2.35E-06	3.05E-07	2.63E+03	5.80E+00	2.63E+00	5.80E-03	8.05E-07
Calcium (Ca)	1363.88	1.19E-03	1.54E-04	1.33E+06	2.93E+03	1.33E+03	2.93E+00	4.07E-04
Cadmium (Cd)	0.39	3.39E-07	4.40E-08	3.80E+02	8.37E-01	3.80E-01	8.37E-04	1.16E-07
Cerium (Ce)	0.37	3.22E-07	4.17E-08	3.61E+02	7.94E-01	3.61E-01	7.94E-04	1.10E-07
Cobalt (Co)	0.16	1.39E-07	1.80E-08	1.56E+02	3.43E-01	1.56E-01	3.43E-04	4.77E-08
Chromium (Cr)	6.82	5.93E-06	7.69E-07	6.65E+03	1.46E+01	6.65E+00	1.46E-02	2.03E-06
Cesium (Cs)	1.80	1.57E-06	2.03E-07	1.75E+03	3.86E+00	1.75E+00	3.86E-03	5.37E-07
Copper (Cu)	0.86	7.48E-07	9.70E-08	8.38E+02	1.85E+00	8.38E-01	1.85E-03	2.56E-07
Iron (Fe)	10.89	9.47E-06	1.23E-06	1.06E+04	2.34E+01	1.06E+01	2.34E-02	3.25E-06
Gallium (Ga)	0.33	2.87E-07	3.72E-08	3.22E+02	7.08E-01	3.22E-01	7.08E-04	9.84E-08
Mercury (Hg)	0.79	6.87E-07	8.91E-08	7.70E+02	1.70E+00	7.70E-01	1.70E-03	2.36E-07
Iodine (I)	14.79	1.29E-05	1.67E-06	1.44E+04	3.17E+01	1.44E+01	3.17E-02	4.41E-06
Potassium (K)	11335.07	9.86E-03	1.28E-03	1.10E+07	2.43E+04	1.10E+04	2.43E+01	3.38E-03
Lanthanum (La)	0.04	3.48E-08	4.51E-09	3.90E+01	8.59E-02	3.90E-02	8.59E-05	1.19E-08
Lithium (Li)	26.69	2.32E-05	3.01E-06	2.60E+04	5.73E+01	2.60E+01	5.73E-02	7.96E-06
Magnesium (Mg)	178.49	1.55E-04	2.01E-05	1.74E+05	3.83E+02	1.74E+02	3.83E-01	5.32E-05
Manganese (Mn)	0.33	2.87E-07	3.72E-08	3.22E+02	7.08E-01	3.22E-01	7.08E-04	9.84E-08
Molybdenum (Mo)	1.24	1.08E-06	1.40E-07	1.21E+03	2.66E+00	1.21E+00	2.66E-03	3.70E-07
Sodium (Na)	54828.38	4.77E-02	6.18E-03	5.34E+07	1.18E+05	5.34E+04	1.18E+02	1.63E-02
Niobium (Nb)	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel (Ni)	1.23	1.07E-06	1.39E-07	1.20E+03	2.64E+00	1.20E+00	2.64E-03	3.67E-07
Phosphorus (P)	69.88	6.08E-05	7.88E-06	6.81E+04	1.50E+02	6.81E+01	1.50E-01	2.08E-05
Lead (Pb)	2.53	2.20E-06	2.85E-07	2.47E+03	5.43E+00	2.47E+00	5.43E-03	7.54E-07
Rubidium (Rb)	1.18	1.03E-06	1.33E-07	1.15E+03	2.53E+00	1.15E+00	2.53E-03	3.52E-07
Antimony (Sb)	0.99	8.61E-07	1.12E-07	9.65E+02	2.13E+00	9.65E-01	2.13E-03	2.95E-07
Selenium (Se)	0.94	8.17E-07	1.06E-07	9.16E+02	2.02E+00	9.16E-01	2.02E-03	2.80E-07
Silicon (Si)	55.11	4.79E-05	6.22E-06	5.37E+04	1.18E+02	5.37E+01	1.18E-01	1.64E-05
Tin (Sn)	0.38	3.30E-07	4.29E-08	3.70E+02	8.16E-01	3.70E-01	8.16E-04	1.13E-07
Strontium (Sr)	12.87	1.12E-05	1.45E-06	1.25E+04	2.76E+01	1.25E+01	2.76E-02	3.84E-06
Thallium (Th)	11.01	9.57E-06	1.24E-06	1.07E+04	2.36E+01	1.07E+01	2.36E-02	3.28E-06
Titanium (Ti)	0.51	4.43E-07	5.75E-08	4.97E+02	1.09E+00	4.97E-01	1.09E-03	1.52E-07
Thallium (Tl)	1.77	1.54E-06	2.00E-07	1.72E+03	3.80E+00	1.72E+00	3.80E-03	5.28E-07
Uranium (U)	434.76	3.78E-04	4.90E-05	4.24E+05	9.33E+02	4.24E+02	9.33E-01	1.30E-04
Vanadium (V)	0.09	7.83E-08	1.02E-08	8.77E+01	1.93E-01	8.77E-02	1.93E-04	2.68E-08
Tungsten (W)	0.46	4.00E-07	5.19E-08	4.48E+02	9.87E-01	4.48E-01	9.87E-04	1.37E-07
Zinc (Zn)	13.89	1.21E-05	1.57E-06	1.35E+04	2.98E+01	1.35E+01	2.98E-02	4.14E-06
Zirconium (Zr)	0.03	2.61E-08	3.38E-09	2.92E+01	6.44E-02	2.92E-02	6.44E-05	8.94E-09

[a]Composition data obtained from U.S. Department of Energy Report, *Statistical Description of Liquid Low-Level Waste System Supernate Liquids at Oak Ridge National Laboratory*, *Oak Ridge, Tennessee*, Document Number ORNL/TM-13551, Addendum 1.

[b]An average density value was obtained from Table 4.1, p. 3, of the above report to calculate a mass faction for each metal.

Supernate Density = 1.15 g/mL.

[c]The amount of total suspended particulate (TSP) matter reaching the first exhaust system High-Efficiency Particulate Air (HEPA) filter is assumed to be:

Airborne Particulate Conc. = 2.0 gr/dscf.

[d]The uncontrolled emissions are estimated by the following expression:

Uncontrolled Rate = Exhaust Stream Flowrate × TSP Concentration × Metal Mass Fraction.

Operating schedule data were obtained from the FWENC proposal:

Air Flow Rate	=	20,000 dscfm assumed rate from supernate process
Project Operating Schedule	=	15 months life
		4 weeks/month
		5 d/week
		24 h/d
Calculated Operating Hours	=	7,200 h for the 15 months

[e]The two HEPA filtration systems are assumed to have the following removal efficiencies:

HEPA Filter 1 Removal = 99%
HEPA Filter 2 Removal = 99%

[e]The average hourly emissions are calculated by the following expression:

Average Hourly	=	Pounds Emitted for Project/Project Operating Hours
Airborne Particulate Conc.	=	2.0 gr/dscf
Project Operating Schedule	=	15 months life
		4 weeks/month
		5 d/week
		24 h/d

d = day.

dscf = dry standard cubic foot.

dscfm = dry standard cubic feet per minute.

g = gram.

gr/dscf = grains per dry standard cubic foot.

h = hour.

L = liter.

lb = pound.

mg = milligram.

Table B.1-9. Metal emissions for TRU/RH solid wastes tretment for the Proposed Action using 40 *CFR* 61 Appendix D calculation procedures

Metal	Mass of[a] metals in waste (kg)	Uncontrolled[b,c] metals emissions (g)	Uncontrolled[b,c] metals emissions (lbs)	Metals emissions[d] after control (g)	Metals emissions[d] after control (lbs)	Average[e] hourly emissions (lbs/h)
Silver (Ag)	20	2.00E+01	4.41E-02	2.00E-04	4.41E-07	1.10E-10
Cadmium (Cd)	100	1.00E+02	2.20E-01	1.00E-03	2.20E-06	5.51E-10
Mercury (Hg)	100	1.00E+02	2.20E-01	1.00E-03	2.20E-06	5.51E-10
Lead (Pb)	980	9.80E+02	2.16E+00	9.80E-03	2.16E-05	5.40E-09
Total	1200					
	Concentration[f] (g/dscf)	**Uncontrolled TSP emissions (g)**	**Uncontrolled TSP emissions (lbs)**	**TSP emissions after control (g)**	**TSP emissions after control (lbs)**	**Average hourly (lbs/h)**
TSP Hot Cell	0.13	3.11E+08	6.86E+05	3.11E+03	6.86E+00	1.71E-03

[a]Quantities are based on U.S. Department of Energy analysis and knowledge of process for the Resource Conservation and Recovery Act metals in the solid wastes.

[b]An emissions factor for the amount of airborne metals is obtained from Appendix D to 40 *Code of Federal Regulations (CFR)* 61.

Emission Factor = 0.001 fraction of the amount used.

[c]The uncontrolled emissions are estimated by the following expression:

Uncontrolled Rate = Metals Mass in Waste × Emissions Factor.

The operating schedule was obtained from the FWENC proposal:

Project Operating Schedule = 80 h/week
50 weeks/year
Calculated Operating Hours = 4000 h total

[d]The emissions after control are estimated by using the U.S. Environmental Protection Agency adjustment factors from Table 1 of Appendix D to 40 *CFR* 61. The adjustment factors are:

Glovebox/Hot Cell High-Efficiency Particulate Air (HEPA) Filters Adjustment Factor = 0.01
Glovebox/Hot Cell Carbon Filters Adjustment Factor = 0.10
HEPA Filters System 1 Adjustment Factor = 0.01
HEPA Filters System 2 Adjustment Factor = 0.10

Note that no emissions reduction credit is taken for the carbon system, since this factor only applied to iodine gas and no iodine is present in the solid waste.

[e]The average hourly emissions are calculated by the following expression:

Average Hourly = Pounds Emitted for Project / Project Operating Hours.

[f]The total suspended particulate (TSP) emissions from the hot cell are calculated based on an assumed inlet concentration of 2 gr/dscf to the HEPA filter system on the cell exhaust. The TSP emissions are calculated using an assumed exhaust flow rate for this closed system.

Exhaust Flowrate = 10,000 dscf assumed for hot cell.

dscf = dry standard cubic foot.

g = gram.

gr/dscf = grains per dry standard cubic foot.

h = hour.

kg = kilogram.

lb = pound.

RH = remote handled.

TRU = transuranic.

Table B.1-10. Metal emissions for TRU/CH solid wastes treatment for the Proposed Action using 40 *CFR* 61 Appendix D of NESHAP calculation procedures

Metal	Mass of[a] metals in waste (kg)	Uncontrolled[b,c] metals emissions (g)	Uncontrolled[b,c] metals emissions (lbs)	Metals emissions[d] after control (g)	Metals emissions[d] after control (lbs)	Average[e] hourly emissions (lbs/h)
Silver (Ag)	100	1.00E+02	2.20E-01	1.00E-03	2.20E-06	3.67E-10
Cadmium (Cd)	400	4.00E+02	8.81E-01	4.00E-03	8.81E-06	1.47E-09
Mercury (Hg)	400	4.00E+02	8.81E-01	4.00E-03	8.81E-06	1.47E-09
Lead (Pb)	3500	3.50E+03	7.71E+00	3.50E-02	7.71E-05	1.28E-08
Total	4400					
	Concentration[f] (g/dscf)	**Uncontrolled TSP emissions (g)**	**Uncontrolled TSP emissions (lbs)**	**TSP emissions after control (g)**	**TSP emissions after control (lbs)**	**Average hourly (lbs/h)**
TSP Glove Box	0.13	4.67E+08	1.03E+06	4.67E+03	1.03E+01	1.71E-03

[a]Quantities are based on U.S. Department of Energy analysis and knowledge of process for the Resource Conservation Recovery Act metals in the solid wastes.

[b]An emissions factor for the amount of airborne metals is obtained from Appendix D to 40 *Code of Federal Regulations (CFR)* 61.
Emission Factor = 0.001 fraction of the amount used.

[c]The uncontrolled emissions are estimated by the following expression:
Uncontrolled Rate = Metals Mass in Waste × Emissions Factor.

The operating schedule was obtained from the FWENC proposal:

Project Operating Schedule = 120 h/week
50 weeks/year
Calculated Operating Hours = 6000 h total

[d]The emissions after control are estimated by using the U.S. Environmental Protection Agency adjustment factors from Table 1 of Appendix D to 40 *CFR* 61. The adjustment factors are:

Glovebox/Hot Cell High-Efficiency Particulate Air (HEPA) Filters Adjustment Factor = 0.01
Glovebox/Hot Cell Carbon Filters Adjustment Factor = 0.10
HEPA Filters System 1 Adjustment Factor = 0.01
HEPA Filters System 2 Adjustment Factor = 0.10

Note that no emissions reduction credit is taken for the carbon system, since this factor only applied to iodine gas and no iodine is present in the solid waste.

[e]The average hourly emissions are calculated by the following expression:
Average Hourly = Pounds Emitted for Project/Project Operating Hours.

[f]The total suspended particulate (TSP) emissions from the hot cell are calculated based on an assumed inlet concentration of 2 gr/dscf to the HEPA filter system on the cell exhaust. The TSP emissions are calculated using an assumed exhaust flow rate for this closed system.
Exhaust Flowrate = 10,000 dscf assumed for hot cell.

CH = contact handled.

dscf = dry standard cubic foot.

g = gram.

gr/dscf = grains per dry standard cubic foot.

h = hour.

kg = kilogram.

lb = pound.

NESHAP = National Emission Standards for Hazardous Air Pollutants.

TRU = transuranic.

Table B.1-11. Particulate emissions from TRU solid wastes treatment (lbs/h) for the Proposed Action

Metal	RH waste emissions	CH waste emissions	Particulate emissions from solid waste
TSP	1.71E-03	1.71E-03	3.43E-03
Silver (Ag)	1.10E-10	3.67E-10	4.77E-10
Cadmium (Cd)	5.51E-10	1.47E-09	2.02E-09
Mercury (Hg)	5.51E-10	1.47E-09	2.02E-09
Lead (Pb)	5.40E-09	1.28E-08	1.82E-08

CH = contact handled.
h = hour.
lb = pound.
RH = remote handled.
TRU = transuranic.
TSP = total suspended particulate.

Table B.1-12. Summary of volatile organic emissions for the Proposed Action

Tank farm	Sludge organic emissions (lbs)	Sludge organic emissions (lbs/h)	Supernate organic emissions (lbs)	Supernate organic emissions (lbs/h)	Total hourly organic emissions (lbs)	Total hourly organic emissions (lbs/h)
Bethel Valley	89.10	0.062	0.15	1.06E-04	89.25	0.062
GAAT	21.86	0.013	6.71	7.14E-04	28.57	0.014
Melton Valley	150.18	0.039	7.01	4.36E-04	157.30	0.039
OHF	1.48	0.007	1.40	6.61E-05	2.88	0.007
Total	**262.62**		**15.28**		**277.89**	

GAAT = Gunite and Associate Tanks.
h = hour.
lb = pound.
OHF = Old Hydrofracture Facility.

Table B.1-13. Estimated total organic emissions for the Proposed Action

Air contaminant	Classified as: VOC	Classified as: HAP	Maximum[a] hourly emissions (lbs/h)	Average[b] hourly emissions (lbs/h)	Average[c] annual emissions (tons/year)
Total VOC			6.21E-02	5.18E-02	0.11
Total HAP			1.33E-03	1.11E-03	0.01
2-Butanone (MEK)	Yes	Yes	1.22E-06	1.02E-06	1.80E-04
Benzene	Yes	Yes	0.00E+00	0.00E+00	1.33E-06
Bis-(2-ethylhexyl)phthalate	Yes	Yes	0.00E+00	0.00E+00	7.80E-03
Bromomethane	Yes	Yes	5.07E-04	4.23E-04	2.90E-04
Carbon tetrachloride	Yes	Yes	0.00E+00	0.00E+00	1.47E-04
Chlorobenzene	Yes	Yes	0.00E+00	0.00E+00	8.60E-07
Chloroform	Yes	Yes	0.00E+00	0.00E+00	4.88E-06
Chloromethane	Yes	Yes	6.73E-06	5.61E-06	1.55E-06
Di-n-butylphthalate	Yes	Yes	7.02E-04	5.85E-04	2.17E-03
Ethylbenzene	Yes	Yes	0.00E+00	0.00E+00	1.42E-07
Hexachlorobenzene	Yes	Yes	0.00E+00	0.00E+00	2.97E-04
Methyl alcohol	Yes	Yes	0.00E+00	0.00E+00	1.95E-03
Methylene chloride	No	Yes	0.00E+00	0.00E+00	9.22E-06
Naphthalene	Yes	Yes	0.00E+00	0.00E+00	2.88E-04
Polychlorinated biphenyls	Yes	Yes	1.10E-04	9.13E-05	6.31E-05
Tetrachloroethene	Yes	Yes	0.00E+00	0.00E+00	6.84E-06
Toluene	Yes	Yes	0.00E+00	0.00E+00	3.71E-06
Trichloroethane	Yes	Yes	0.00E+00	0.00E+00	6.71E-08
Trichloroethene	Yes	Yes	0.00E+00	0.00E+00	2.94E-06
1,2-Dichoroethene	Yes	No	0.00E+00	0.00E+00	9.84E-07
1-Decanol	Yes	No	2.63E-04	2.19E-04	1.52E-04
1-Docosene	Yes	No	0.00E+00	0.00E+00	1.76E-04
1-Dotriacontanol	Yes	No	0.00E+00	0.00E+00	1.76E-04
1-Hexanol, 2-ethyl	Yes	No	2.37E-03	1.97E-03	1.50E-03
1-Methyldecyl-benzene	Yes	No	9.43E-04	7.86E-04	5.43E-04
1-Methylundecyl-benzene	Yes	No	7.23E-04	6.03E-04	4.17E-04
1-Nonadecanol	Yes	No	2.15E-04	1.79E-04	4.13E-04
1-Octanamine, N-nitroso-*n*-octyl-	Yes	No	0.00E+00	0.00E+00	1.88E-04
1-Propyl alcohol	Yes	No	0.00E+00	0.00E+00	1.89E-04
2,4,5-Trichlorophenol	Yes	No	0.00E+00	0.00E+00	7.71E-07
2,4-Dichlorophenol	Yes	No	0.00E+00	0.00E+00	1.61E-06
2-Butanamine	Yes	No	0.00E+00	0.00E+00	1.16E-06
2-Ethyl-1-hexanol	Yes	No	4.28E-06	3.57E-06	9.87E-07
2-Hexanone	Yes	No	0.00E+00	0.00E+00	1.14E-06
2-Methylnaphalene	Yes	No	0.00E+00	0.00E+00	6.72E-05
2-Nitrophenol	Yes	No	0.00E+00	0.00E+00	2.74E-05
4-Methyl-2-pentanone	Yes	No	0.00E+00	0.00E+00	6.18E-05
Benzene, 1,3-*bis*(1-methylethyl)-	Yes	No	0.00E+00	0.00E+00	8.05E-04
Benzene, diethyl-	Yes	No	0.00E+00	0.00E+00	1.78E-03
Benzenesulfonamide, *N*-butyl	Yes	No	0.00E+00	0.00E+00	1.73E-05
Benzo(*a*)anthrecene	Yes	No	0.00E+00	0.00E+00	5.72E-05
Benzo(*a*)pyrene	Yes	No	0.00E+00	0.00E+00	7.66E-05
Benzo(*b*)fluoroanthene	Yes	No	0.00E+00	0.00E+00	8.13E-05
Benzo(*g*,*h*,*i*)perylene	Yes	No	0.00E+00	0.00E+00	6.05E-05
Benzoic Acid	Yes	No	0.00E+00	0.00E+00	2.94E-04
Benzophenone	Yes	No	0.00E+00	0.00E+00	4.11E-04
Bromodichloromethane	Yes	No	0.00E+00	0.00E+00	7.52E-08
Chrysene	Yes	No	0.00E+00	0.00E+00	5.21E-05

Table B.1-13 (continued)

Air contaminant	Classified as: VOC	HAP	Maximum[a] hourly emissions (lbs/h)	Average[b] hourly emissions (lbs/h)	Average[c] annual emissions (tons/year)
Dibromonitrophenol	Yes	No	0.00E+00	0.00E+00	1.39E-04
Diethyl benzene	Yes	No	1.67E-03	1.39E-03	1.66E-03
Diethylphthalate	Yes	No	0.00E+00	0.00E+00	1.22E-04
dimethyl sulfone	Yes	No	0.00E+00	0.00E+00	1.51E-06
Di-n-octylphthalate	Yes	No	0.00E+00	0.00E+00	2.13E-03
Dodecane	Yes	No	4.49E-03	3.74E-03	3.69E-03
Ethanone, 1-(2,3,4-trimethylphenyl)-	Yes	No	1.15E-03	9.59E-04	6.63E-04
Ethanone, 1-(4-ethylphenyl)-	Yes	No	2.50E-04	2.08E-04	3.26E-04
Ethyl alcohol	Yes	No	0.00E+00	0.00E+00	3.82E-04
Ethylphenylethanone	Yes	No	8.55E-04	7.12E-04	4.92E-04
Fluoroanthene	Yes	No	0.00E+00	0.00E+00	2.19E-04
Hepatanone	Yes	No	7.15E-05	5.96E-05	4.22E-05
Heptadecane	Yes	No	0.00E+00	0.00E+00	1.58E-04
Heptanal	Yes	No	0.00E+00	0.00E+00	1.63E-06
Heptane, 4-ethyl-2,2,6,6-tetrameethyl	Yes	No	0.00E+00	0.00E+00	6.21E-04
Hexadecanoic acid	Yes	No	0.00E+00	0.00E+00	2.12E-04
n-Butyl alcohol	Yes	No	0.00E+00	0.00E+00	2.40E-04
Nonadecane	Yes	No	0.00E+00	0.00E+00	1.70E-04
Octadecane	Yes	No	0.00E+00	0.00E+00	2.11E-04
Pentadecane	Yes	No	2.32E-04	1.94E-04	3.04E-04
Phenanthrene	Yes	No	0.00E+00	0.00E+00	3.16E-04
Phosphoric acid, *tris*-(2-ethylhexyl)-	Yes	No	2.71E-03	2.26E-03	1.56E-03
Pyrene	Yes	No	0.00E+00	0.00E+00	2.11E-04
Tetradecane	Yes	No	6.15E-03	5.12E-03	5.33E-03
Tetrahydrofuran	Yes	No	0.00E+00	0.00E+00	9.30E-07
Tributyl phosphate	Yes	No	5.16E-03	4.30E-03	5.05E-03
Tridecane	Yes	No	1.04E-02	8.70E-03	8.17E-03
Trimethyl decane	Yes	No	5.48E-04	4.57E-04	3.16E-04
Tris(ethylhexyl)phosphate	Yes	No	9.67E-04	8.06E-04	5.57E-04
Undecane	Yes	No	1.62E-03	1.35E-03	2.00E-03
Total unknowns	Yes	No	2.00E-02	1.66E-02	5.27E-02

[a]The maximum hourly emissions are those for the Bethel Valley tank farm, which had the highest calculated hourly emissions for sludge and supernate.

[b]The average hourly emissions are estimated by scaling down the maximum hourly emissions by the ratio of 6000 annual operating hours over the 7200-h project life.

h = hour.

HAP = hazardous air pollutant.

lb = pound.

VOC = volatile organic compound.

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APPENDIX B.2

SUMMARIES OF MATERIAL BALANCE FOR VITRIFICATION PROCESS

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Table B.2-1. Material balance for vitrification process in the Vitrification Alternative

Stream No.	Units	1 Sludge/ supernate in MVSTs	2 Mobilized sludge/ supernate	3 Mixed sludge/ supernate	4 To melter feed preparation	5 Melter feed	6 Glass from melter	7 Contain-erized glass	8 Glass to certifi-cation	9 Load into 72B cask	10 Ship to WIPP	11 Non-debris solid waste	12 Glass former blend	13 Melter off-gas	14 Air leakage into melter	15 Film cooler air	16 To quencher/ scrubber	17 Off-gas from CH/RH special wastes	18 Off-gas to mist eliminator	19 Off-gas from mist eliminator
									Metals/oxides											
Ag/Ag2O	kg	10	10	10	10	10	10	10	10	10	10	0	0	0			0	0	0	0
Al/Al2O3	kg	17,756	17,755	17,755	17,755	17,755	17,578	17,578	17,578	17,578	17,578	0	0	178			178	0	36	4
As/As2O3	kg	31	31	31	31	31	30	30	30	30	30	0	0	0			0	0	0	0
B/B2O3	kg	54	54	54	54	54	53	53	53	53	53	0	0	1			1	0	0	0
Ba/BaO	kg	126	126	126	126	126	124	124	124	124	124	0	0	1			1	0	0	0
Be/BeO	kg	6	6	6	6	6	6	6	6	6	6	0	0	0			0	0	0	0
Bi/Bi2O3	kg	5	5	5	5	5	5	5	5	5	5	0	0	0			0	0	0	0
Ca/CaO	kg	42,507	42,507	42,507	42,507	320,409	314,001	314,001	314,001	314,001	314,001	0	277,902	6,408			6,408	0	1,282	128
Cd/CdO	kg	13	13	13	13	13	13	13	13	13	13	0	0	0			0	0	0	0
Ce/Ce2O3	kg	1	1	1	1	1	1	1	1	1	1	0	0	0			0	0	0	0
Co/CoO	kg	6	6	6	6	6	6	6	6	6	6	0	0	0			0	0	0	0
Cr/Cr2O3	kg	593	593	593	593	593	587	587	587	587	587	0	0	6			6	0	1	0
Cs/Cs2O	kg	11	11	11	11	11	10	10	10	10	10	0	0	1			1	0	0	0
Cu/CuO	kg	80	80	80	80	80	79	79	79	79	79	0	0	1			1	0	0	0
Fe/Fe2O3	kg	7,251	7,251	7,251	7,251	7,251	7,179	7,179	7,179	7,179	7,179	0	0	73			73	0	15	1
Ga/Ga2O3	kg	1	1	1	1	1	1	1	1	1	1	0	0	0			0	0	0	0
Hg/HgO	kg	84	84	84	84	84	0	0	0	0	0	0	0	84			84	0	17	2
I/I2O5	kg	31	31	31	31	31	0	0	0	0	0	0	0	31			31	0	6	1
K/K2O	kg	30,840	30,840	30,840	30,840	30,840	30,531	30,531	30,531	30,531	30,531	0	0	308			308	0	62	6
La/La2O3	kg	0	0	0	0	0	0	0	0	0	0	0	0	0			0	0	0	0
Li/Li2O	kg	92	92	92	92	92	91	91	91	91	91	0	0	1			1	0	0	0
Mg/MgO	kg	8,335	8,335	8,335	8,335	8,335	8,251	8,251	8,251	8,251	8,251	0	0	83			83	0	17	2
Mn/MnO	kg	280	280	280	280	280	278	278	278	278	278	0	0	3			3	0	1	0
Mo/MoO3	kg	3	3	3	3	3	3	3	3	3	3	0	0	0			0	0	0	0
Na/Na2O	kg	187,475	187,475	187,475	187,475	187,475	185,600	185,600	185,600	185,600	185,600	0	0	1,875			1,875	0	375	37
Nb/NbO	kg	0	0	0	0	0	0	0	0	0	0	0	0	0			0	0	0	0
Ni/NiO	kg	97	97	97	97	97	96	96	96	96	96	0	0	1			1	0	0	0
P/P2O5	kg	35,533	35,533	35,533	35,533	35,533	35,178	35,178	35,178	35,178	35,178	0	0	355			355	0	71	7
Pb/PbO	kg	587	587	587	587	587	581	581	581	581	581	0	0	6			6	0	1	0
Rb/Rb2O	kg	2	2	2	2	2	2	2	2	2	2	0	0	0			0	0	0	0
Sb/Sb2O3	kg	40	40	40	40	40	40	40	40	40	40	0	0	0			0	0	0	0
Se/SeO	kg	28	28	28	28	28	28	28	28	28	28	0	0	0			0	0	0	0
Si/SiO2	kg	5,878	5,877	5,877	5,877	874,564	857,072	857,072	857,072	857,072	857,072	0	868,686	17,491			17,491	0	3,498	350
Sn/SnO2	kg	1	1	1	1	1	1	1	1	1	1	0	0	0			0	0	0	0
Sr/SrO	kg	147	147	147	147	147	146	146	146	146	146	0	0	1			1	0	0	0
Th/ThO2	kg	7,832	7,832	7,832	7,832	7,832	7,754	7,754	7,754	7,754	7,754	0	0	78			78	0	16	2
Ti/TiO2	kg	1	1	1	1	1	1	1	1	1	1	0	0	0			0	0	0	0
Tl/Tl2O5	kg	20	20	20	20	20	20	20	20	20	20	0	0	0			0	0	0	0
U/U2O5	kg	66,631	66,631	66,631	66,631	66,631	65,964	65,964	65,964	65,964	65,964	0	0	666			666	0	133	13
V/VO	kg	5	5	5	5	5	5	5	5	5	5	0	0	0			0	0	0	0
W/WO3	kg	1	1	1	1	1	1	1	1	1	1	0	0	0			0	0	0	0
Zn/ZnO	kg	222	222	222	222	222	219	219	219	219	219	0	0	2			2	0	0	0
Zr/ZrO2	kg	0	0	0	0	0	0	0	0	0	0	0	0	0			0	0	0	0
Grout binder	kg																			

Table B.2-1 (continued)

Stream No.	Units	1 Sludge/ supernate in MVSTs	2 Mobilized sludge/ supernate	3 Mixed sludge/ supernate	4 To melter feed preparation	5 Melter feed	6 Glass from melter	7 Contain-erized glass	8 Glass to certifi-cation	9 Load into 72B cask	10 Ship to WIPP	11 Non-debris solid waste	12 Glass former blend	13 Melter off-gas	14 Air leakage into melter	15 Film cooler air	16 To quencher/ scrubber	17 Off-gas from CH/RH special wastes	18 Off-gas to mist eliminator	19 Off-gas from mist eliminator
Anions																				
CO3-	kg	0	0	0	0	0	0	0	0	0	0	0	0	0			0	0	0	0
Br-	kg	5,400	5,400	5,400	5,400	5,400	0	0	0	0	0	0	0	0			0	0	0	0
CO3--	kg	188	188	188	188	188	0	0	0	0	0	0	0	0			0	0	0	0
Cl-	kg	10,610	10,610	10,610	10,610	10,610	5,305	5,305	5,305	5,305	5,305	0	0	0			0	0	0	0
CrO4--	kg	3,857	3,857	3,857	3,857	3,857	2,314	2,314	2,314	2,314	2,314	0	0	1,543			1,543	0	309	31
F-	kg	1,674	1,674	1,674	1,674	1,674	1,172	1,172	1,172	1,172	1,172	0	0	0			0	0	0	0
OH-	kg	515	515	515	515	515	0	0	0	0	0	0	0	0			0	0	0	0
NO3-	kg	27,781	27,781	27,781	27,781	27,781	5,556	5,556	5,556	5,556	5,556	0	0	0			0	0	0	0
NO2-	kg	300,200	300,199	300,199	300,199	300,199	60,040	60,040	60,040	60,040	60,040	0	0	0			0	0	0	0
PO4-	kg	8,047	8,047	8,047	8,047	8,047	4,828	4,828	4,828	4,828	4,828	0	0	3,219			3,219	0	644	322
SO4--	kg	6,682	6,682	6,682	6,682	6,682	4,009	4,009	4,009	4,009	4,009	0	0	0			0	0	0	0
CN-	kg	4,106	4,106	4,106	4,106	4,106	0	0	0	0	0	0	0	0			0	0	0	0
C2H3O2-	kg	0	0	0	0	0	0	0	0	0	0	0	0	0			0	0	0	0
C6H5O7---	kg	397	397	397	397	397	0	0	0	0	0	0	0	0			0	0	0	0
HCO2-	kg	142	142	142	142	142	0	0	0	0	0	0	0	0			0	0	0	0
C2O4--	kg	301	301	301	301	301	0	0	0	0	0	0	0	0			0	0	0	0
Phthalates	kg	390	390	390	390	390	0	0	0	0	0	0	0	0			0	0	0	0
Water and gases																				
H2O	kg	2,212,350	2,212,350	2,212,350	2,212,350	2,287,080	0	0	0	0	0	74,730	0	2,938,108	650,514	334,446	3,272,554	0	6,340,079	6,340,079
Ar	kg		0	0	0	0	0	0	0	0	0	0	0	48,221	48,221	24,791	73,012	0	73,012	73,012
CO2	kg		0	0	0	0	0	0	0	0	0	0	0	61,251	1,704	876	62,127	0	62,127	62,127
N2	kg		0	0	0	0	0	0	0	0	0	0	0	4,097,532	4,031,327	2,072,607	6,170,140	0	6,170,140	6,170,140
NH3	kg		0	0	0	0	0	0	0	0	0	0	0	0			0	0	0	0
O2	kg		0	0	0	0	0	0	0	0	0	0	0	1,142,094	1,081,402	555,976	1,698,070	0	1,679,338	1,675,069
HBr (gas)	kg		0	0	0	0	0	0	0	0	0	0	0	5,467			5,467	0	1,093	1,093
HCl (gas)	kg		0	0	0	0	0	0	0	0	0	0	0	5,455			5,455	0	545	273
HF (gas)	kg		0	0	0	0	0	0	0	0	0	0	0	529			529	0	53	26
NOx (gas)	kg		0	0	0	0	0	0	0	0	0	0	0	95,991			95,991	0	67,194	60,474
SO2 (gas)	kg		0	0	0	0	0	0	0	0	0	0	0	1,782			1,782	0	178	89
Totals																				
Carbon	kg	13,879	13,879	13,879	13,879	13,879	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Metal oxides	kg	412,613	412,613	412,613	412,613	1,559,201	1,531,544	1,531,544	1,531,544	1,531,544	1,531,544	0	1,146,588	27,657	0	0	27,657	0	5,531	553
Anions	kg	370,290	370,289	370,289	370,289	370,289	83,225	83,225	83,225	83,225	83,225	0	0	4,762	0	0	4,762	0	952	353
Dry gases	kg	0	0	0	0	0	0	0	0	0	0	0	0	5,458,321	5,162,654	2,654,251	8,112,572	0	8,053,681	8,042,304
H20	kg	2,212,350	2,212,350	2,212,350	2,212,350	2,287,080	0	0	0	0	0	74,730	0	2,938,108	650,514	334,446	3,272,554	0	6,340,079	6,340,079
Mass	kg	3,009,132	3,009,131	3,009,131	3,009,131	4,230,449	1,614,769	1,614,769	1,614,769	1,614,769	1,614,769	74,730	1,146,588	8,428,848	5,813,167	2,988,696	11,417,544	0	14,400,244	14,383,289
Miscellaneous																				
Flowrate	kg/h	155.29	155.29	155.29	155.29	218.32	83.33	83	83	83	83		59.17	434.99	300.00	154.24	589.22	0.00	743.15	742.28
Flowrate	gpm	0.568	0.568	0.568	0.568	0.598	0.131	0	0	0	0	0.000	0.098	478.298	1,115.294	573.401	1,051.699		2,000.234	2,000.234
Flowrate	scfm																			
Flowrate	acfm																			
Temperature	°C	25	25	25	25	25	25	25	25	25	25	25	25	529	25	25	350		25	25
Specific gravity		1.20	1.20	1.20	1.20	1.61	2.80	3	3	3	3	1.00	2.67	0.0040	0.0012	0.0012	0.0025		0.0016	0.0016
Density	lb/ft^3	75.14	75.16	75.16	75.16	100.33	174.80	175	175	175	175	1.00	166.37	0.2500	0.0739	0.0739	0.1540	0.0000	0.1021	0.1020

Table B.2-1 (continued)

Stream No.	Units	1 Sludge/ supernate in MVSTs	2 Mobilized sludge/ supernate	3 Mixed sludge/ supernate	4 To melter feed preparation	5 Melter feed	6 Glass from melter	7 Contain-erized glass	8 Glass to certifi-cation	9 Load into 72B cask	10 Ship to WIPP	11 Non-debris solid waste	12 Glass former blend	13 Melter off-gas	14 Air leakage into melter	15 Film cooler air	16 To quencher/ scrubber	17 Off-gas from CH/RH special wastes	18 Off-gas to mist eliminator	19 Off-gas from mist eliminator
									Radiochemical constituents (in Ci)											
Au-198		7.43E-257	7.43E-257	7.43E-257	7.43E-257	7.43E-257	7.35E-257	7.35E-257	7.35E-257	7.35E-257	7.35E-257		0.00E+00	7.43E-259	0.00E+00	0.00E+00	7.43E-259		1.49E-259	1.49E-260
Bk-249			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00
C-14		4.12E+00	4.12E+00	4.12E+00	4.12E+00	4.12E+00	4.08E+00	4.08E+00	4.08E+00	4.08E+00	4.08E+00		0.00E+00	4.12E-02	0.00E+00	0.00E+00	4.12E-02		8.24E-03	4.12E-03
Ce-144		1.42E+00	1.42E+00	1.42E+00	1.42E+00	1.42E+00	1.40E+00	1.40E+00	1.40E+00	1.40E+00	1.40E+00		0.00E+00	1.42E-02	0.00E+00	0.00E+00	1.42E-02		2.83E-03	2.83E-04
Cf-252		2.48E-01	2.48E-01	2.48E-01	2.48E-01	2.48E-01	2.45E-01	2.45E-01	2.45E-01	2.45E-01	2.45E-01		0.00E+00	2.48E-03	0.00E+00	0.00E+00	2.48E-03		4.96E-04	4.96E-05
Cm-243		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00
Cm-244		9.32E+02	9.31E+02	9.31E+02	9.31E+02	9.31E+02	9.22E+02	9.22E+02	9.22E+02	9.22E+02	9.22E+02		0.00E+00	9.31E+00	0.00E+00	0.00E+00	9.31E+00		1.86E+00	1.86E-01
Co-60		4.76E+02	4.76E+02	4.76E+02	4.76E+02	4.76E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00	4.76E+02	0.00E+00	0.00E+00	4.76E+02		9.52E+01	9.52E+00
Cs-134		6.41E+01	6.40E+01	6.40E+01	6.40E+01	6.40E+01	5.76E+01	5.76E+01	5.76E+01	5.76E+01	5.76E+01		0.00E+00	6.40E+00	0.00E+00	0.00E+00	6.40E+00		1.28E+00	6.40E-01
Cs-137		2.60E+04	2.60E+04	2.60E+04	2.60E+04	2.60E+04	2.34E+04	2.34E+04	2.34E+04	2.34E+04	2.34E+04		0.00E+00	2.60E+03	0.00E+00	0.00E+00	2.60E+03		5.19E+02	2.60E+02
Eu-152		1.24E+02	1.24E+02	1.24E+02	1.24E+02	1.24E+02	1.22E+02	1.22E+02	1.22E+02	1.22E+02	1.22E+02		0.00E+00	1.24E+00	0.00E+00	0.00E+00	1.24E+00		2.47E-01	1.24E-02
Eu-154		4.28E+01	4.28E+01	4.28E+01	4.28E+01	4.28E+01	4.24E+01	4.24E+01	4.24E+01	4.24E+01	4.24E+01		0.00E+00	4.28E-01	0.00E+00	0.00E+00	4.28E-01		8.56E-02	4.28E-03
Eu-155		1.78E+01	1.78E+01	1.78E+01	1.78E+01	1.78E+01	1.76E+01	1.76E+01	1.76E+01	1.76E+01	1.76E+01		0.00E+00	1.78E-01	0.00E+00	0.00E+00	1.78E-01		3.56E-02	1.78E-03
H-3		5.13E+00	5.12E+00	5.12E+00	5.12E+00	5.12E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00	5.12E+00	0.00E+00	0.00E+00	5.12E+00		2.56E+00	2.56E+00
I-129		6.48E-03	6.48E-03	6.48E-03	6.48E-03	6.48E-03	6.41E-03	6.41E-03	6.41E-03	6.41E-03	6.41E-03		0.00E+00	6.48E-05	0.00E+00	0.00E+00	6.48E-05		1.30E-05	1.30E-06
Nb-95		7.21E-20	7.20E-20	7.20E-20	7.20E-20	7.20E-20	7.13E-20	7.13E-20	7.13E-20	7.13E-20	7.13E-20		0.00E+00	7.20E-22	0.00E+00	0.00E+00	7.20E-22		1.44E-22	1.44E-23
Pu-238		1.73E-01	1.73E-01	1.73E-01	1.73E-01	1.73E-01	1.72E-01	1.72E-01	1.72E-01	1.72E-01	1.72E-01		0.00E+00	1.73E-03	0.00E+00	0.00E+00	1.73E-03		3.47E-04	3.47E-05
Pu-239		1.50E-01	1.50E-01	1.50E-01	1.50E-01	1.50E-01	1.49E-01	1.49E-01	1.49E-01	1.49E-01	1.49E-01		0.00E+00	1.50E-03	0.00E+00	0.00E+00	1.50E-03		3.00E-04	3.00E-05
Pu-240		1.46E-01	1.46E-01	1.46E-01	1.46E-01	1.46E-01	1.45E-01	1.45E-01	1.45E-01	1.45E-01	1.45E-01		0.00E+00	1.46E-03	0.00E+00	0.00E+00	1.46E-03		2.93E-04	2.93E-05
Pu-241		2.13E+00	2.13E+00	2.13E+00	2.13E+00	2.13E+00	2.11E+00	2.11E+00	2.11E+00	2.11E+00	2.11E+00		0.00E+00	2.13E-02	0.00E+00	0.00E+00	2.13E-02		4.25E-03	4.25E-04
Pu-242		7.35E-03	7.34E-03	7.34E-03	7.34E-03	7.34E-03	7.27E-03	7.27E-03	7.27E-03	7.27E-03	7.27E-03		0.00E+00	7.34E-05	0.00E+00	0.00E+00	7.34E-05		1.47E-05	1.47E-06
Pu-244		8.64E-04	8.63E-04	8.63E-04	8.63E-04	8.63E-04	8.55E-04	8.55E-04	8.55E-04	8.55E-04	8.55E-04		0.00E+00	8.63E-06	0.00E+00	0.00E+00	8.63E-06		1.73E-06	1.73E-07
Ru-106		1.35E+00	1.35E+00	1.35E+00	1.35E+00	1.35E+00	1.34E+00	1.34E+00	1.34E+00	1.34E+00	1.34E+00		0.00E+00	1.35E-02	0.00E+00	0.00E+00	1.35E-02		2.71E-03	2.71E-04
Sr-90		4.09E+02	4.08E+02	4.08E+02	4.08E+02	4.08E+02	4.04E+02	4.04E+02	4.04E+02	4.04E+02	4.04E+02		0.00E+00	4.08E+00	0.00E+00	0.00E+00	4.08E+00		8.17E-01	4.08E-02
Tc-99		4.97E+01	4.96E+01	4.96E+01	4.96E+01	4.96E+01	2.48E+01	2.48E+01	2.48E+01	2.48E+01	2.48E+01		0.00E+00	2.48E+01	0.00E+00	0.00E+00	2.48E+01		4.96E+00	4.96E-02
Th-232		1.73E-03	1.73E-03	1.73E-03	1.73E-03	1.73E-03	1.71E-03	1.71E-03	1.71E-03	1.71E-03	1.71E-03		0.00E+00	1.73E-05	0.00E+00	0.00E+00	1.73E-05		3.45E-06	3.45E-07
U-233		6.19E+00	6.18E+00	6.18E+00	6.18E+00	6.18E+00	6.12E+00	6.12E+00	6.12E+00	6.12E+00	6.12E+00		0.00E+00	6.18E-02	0.00E+00	0.00E+00	6.18E-02		1.24E-02	1.24E-03
U-234		1.25E-01	1.25E-01	1.25E-01	1.25E-01	1.25E-01	1.24E-01	1.24E-01	1.24E-01	1.24E-01	1.24E-01		0.00E+00	1.25E-03	0.00E+00	0.00E+00	1.25E-03		2.50E-04	2.50E-05
U-235		5.19E-03	5.18E-03	5.18E-03	5.18E-03	5.18E-03	5.13E-03	5.13E-03	5.13E-03	5.13E-03	5.13E-03		0.00E+00	5.18E-05	0.00E+00	0.00E+00	5.18E-05		1.04E-05	1.04E-06
U-236		3.03E-03	3.02E-03	3.02E-03	3.02E-03	3.02E-03	2.99E-03	2.99E-03	2.99E-03	2.99E-03	2.99E-03		0.00E+00	3.02E-05	0.00E+00	0.00E+00	3.02E-05		6.04E-06	6.04E-07
U-238		1.65E-01	1.65E-01	1.65E-01	1.65E-01	1.65E-01	1.63E-01	1.63E-01	1.63E-01	1.63E-01	1.63E-01		0.00E+00	1.65E-03	0.00E+00	0.00E+00	1.65E-03		3.30E-04	3.30E-05
Zr-95		8.25E-11	8.24E-11	8.24E-11	8.24E-11	8.24E-11	8.16E-11	8.16E-11	8.16E-11	8.16E-11	8.16E-11		0.00E+00	8.24E-13	0.00E+00	0.00E+00	8.24E-13		1.65E-13	1.65E-14
TRU activity		7.26E-01	2.60E+00	2.60E+00	2.60E+00	2.60E+00	2.58E+00	2.58E+00	2.58E+00	2.58E+00	2.58E+00	0.00E+00	0.00E+00	2.60E-02	0.00E+00	0.00E+00	2.60E-02	0.00E+00	5.21E-03	5.21E-04

Stream No.	Units	20 Off-gas to HEPAs	21 Off-gas to stack discharge	22 Clean sluicing water	23 Decanted supernate	24 Water to quencher/ scrubber	25 Quencher/ scrubber blowdown	26 Water to mist eliminator	27 Mist eliminator blowdown	28 Wastewater from blowdowns	29 Wastewater for sluicing	30 Wastewater to treatment	31 Wastewater evaporator condensate	32 Evaporator concentrate	33 Treated concentrate	34 Binder	35 HEPA filters	36 Half-PACT canisters	37 Tank vents
									Metals/oxides										
Ag/Ag2O	kg	0.002	0.000	0	0	0	0	0	0	0	0.000	0.100	0.000	0.100	0.100		0.002		0.000
Al/Al2O3	kg	3.569	0.000	0	0	0	142	0	32	174	0.000	174.004	0.000	174.004	174.004		3.568		0.018
As/As2O3	kg	0.006	0.000	0	0	0	0	0	0	0	0.000	0.302	0.000	0.302	0.302		0.006		0.000
B/B2O3	kg	0.011	0.000	0	0	0	0	0	0	1	0.000	0.525	0.000	0.525	0.525		0.011		0.000
Ba/BaO	kg	0.025	0.000	0	0	0	1	0	0	1	0.000	1.231	0.000	1.231	1.231		0.025		0.000
Be/BeO	kg	0.001	0.000	0	0	0	0	0	0	0	0.000	0.059	0.000	0.059	0.059		0.001		0.000

Table B.2-1 (continued)

Stream No.	Units	20 Off-gas to HEPAs	21 Off-gas to stack discharge	22 Clean sluicing water	23 Decanted supernate	24 Water to quencher/ scrubber	25 Quencher/ scrubber blowdown	26 Water to mist eliminator	27 Mist eliminator blowdown	28 Wastewater from blowdowns	29 Wastewater for sluicing	30 Wastewater to treatment	31 Wastewater evaporator condensate	32 Evaporator concentrate	33 Treated concentrate	34 Binder	35 HEPA filters	36 Half-PACT canisters	37 Tank vents
Bi/Bi2O3	kg	0.001	0.000	0	0	0	0	0	0	0	0.000	0.047	0.000	0.047	0.047		0.001		0.000
Ca/CaO	kg	128.206	0.013	0	0	0	5,127	0	1,153	6,280	0.000	6280.011	0.000	6280.011	6,280.011		128.193		0.043
Cd/CdO	kg	0.003	0.000	0	0	0	0	0	0	0	0.000	0.127	0.000	0.127	0.127		0.003		0.000
Ce/Ce2O3	kg	0.000	0.000	0	0	0	0	0	0	0	0.000	0.007	0.000	0.007	0.007		0.000		0.000
Co/CoO	kg	0.001	0.000	0	0	0	0	0	0	0	0.000	0.056	0.000	0.056	0.056		0.001		0.000
Cr/Cr2O3	kg	0.119	0.000	0	0	0	5	0	1	6	0.000	5.811	0.000	5.811	5.811		0.119		0.001
Cs/Cs2O	kg	0.022	0.000	0	0	0	1	0	0	1	0.000	1.080	0.000	1.080	1.080		0.022		0.000
Cu/CuO	kg	0.016	0.000	0	0	0	1	0	0	1	0.000	0.785	0.000	0.785	0.785		0.016		0.000
Fe/Fe2O3	kg	1.457	0.000	0	0	0	58	0	13	71	0.000	71.061	0.000	71.061	71.061		1.457		0.007
Ga/Ga2O3	kg	0.000	0.000	0	0	0	0	0	0	0	0.000	0.007	0.000	0.007	0.007		0.000		0.000
Hg/HgO	kg	1.685	0.000	0	0	0	67	0	8	76	0.000	75.826	0.000	75.826	75.826		1.685		0.000
I/I2O5	kg	0.622	0.000	0	0	0	25	0	0	25	0.000	24.898	0.000	24.898	24.898		0.622		0.000
K/K2O	kg	6.199	0.001	0	0	0	247	0	56	302	0.000	302.230	0.000	302.230	302.230		6.198		0.031
La/La2O3	kg	0.000	0.000	0	0	0	0	0	0	0	0.000	0.001	0.000	0.001	0.001		0.000		0.000
Li/Li2O	kg	0.018	0.000	0	0	0	1	0	0	1	0.000	0.901	0.000	0.901	0.901		0.018		0.000
Mg/MgO	kg	1.675	0.000	0	0	0	67	0	15	82	0.000	81.679	0.000	81.679	81.679		1.675		0.008
Mn/MnO	kg	0.056	0.000	0	0	0	2	0	1	3	0.000	2.748	0.000	2.748	2.748		0.056		0.000
Mo/MoO3	kg	0.001	0.000	0	0	0	0	0	0	0	0.000	0.029	0.000	0.029	0.029		0.001		0.000
Na/Na2O	kg	37.682	0.004	0	0	0	1,500	0	337	1,837	0.000	1837.251	0.000	1837.251	1,837.251		37.679		0.187
Nb/NbO	kg	0.000	0.000	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000		0.000		0.000
Ni/NiO	kg	0.019	0.000	0	0	0	1	0	0	1	0.000	0.950	0.000	0.950	0.950		0.019		0.000
P/P2O5	kg	7.142	0.001	0	0	0	284	0	64	348	0.000	348.226	0.000	348.226	348.226		7.141		0.036
Pb/PbO	kg	0.118	0.000	0	0	0	5	0	1	6	0.000	5.752	0.000	5.752	5.752		0.118		0.001
Rb/Rb2O	kg	0.000	0.000	0	0	0	0	0	0	0	0.000	0.020	0.000	0.020	0.020		0.000		0.000
Sb/Sb2O3	kg	0.008	0.000	0	0	0	0	0	0	0	0.000	0.393	0.000	0.393	0.393		0.008		0.000
Se/SeO	kg	0.006	0.000	0	0	0	0	0	0	0	0.000	0.276	0.000	0.276	0.276		0.006		0.000
Si/SiO2	kg	349.831	0.035	0	0	0	13,993	0	3,148	17,141	0.000	17,141	0.000	17141.448	17,141		349.796		0.006
Sn/SnO2	kg	0.000	0.000	0	0	0	0	0	0	0	0.000	0.008	0.000	0.008	0.008		0.000		0.000
Sr/SrO	kg	0.030	0.000	0	0	0	1	0	0	1	0.000	1.442	0.000	1.442	1.442		0.030		0.000
Th/ThO2	kg	1.574	0.000	0	0	0	63	0	14	77	0.000	76.753	0.000	76.753	76.753		1.574		0.008
Ti/TiO2	kg	0.000	0.000	0	0	0	0	0	0	0	0.000	0.013	0.000	0.013	0.013		0.000		0.000
Tl/Tl2O5	kg	0.004	0.000	0	0	0	0	0	0	0	0.000	0.198	0.000	0.198	0.198		0.004		0.000
U/U2O5	kg	13.393	0.001	0	0	0	533	0	120	653	0.000	652.982	0.000	652.982	652.982		13.391		0.067
V/VO	kg	0.001	0.000	0	0	0	0	0	0	0	0.000	0.045	0.000	0.045	0.045		0.001		0.000
W/WO3	kg	0.000	0.000	0	0	0	0	0	0	0	0.000	0.009	0.000	0.009	0.009		0.000		0.000
Zn/ZnO	kg	0.045	0.000	0	0	0	2	0	0	2	0.000	2.172	0.000	2.172	2.172		0.045		0.000
Zr/ZrO2	kg	0.000	0.000	0	0	0	0	0	0	0	0.000	0.001	0.000	0.001	0.001		0.000		0.000
Grout binder	kg														268,030	268,030			
Anions																			
CO3-	kg	0.000	0.000	0	0	0	0	0	0	0	0	0	0.000	0	0		0.000		0.000
Br-	kg	0.005	0.000	0	0	0	4,320	0	0	4,320	0	4,320	0.000	4,320	4,320		0.005		0.005
CO3--	kg	0.000	0.000	0	0	0	0	0	0	0	0	0	0.000	0	0		0.000		0.000
Cl-	kg	0.011	0.000	0	0	0	4,775	0	265	5,040	0	5,040	0.000	5,040	5,040		0.011		0.011
CrO4--	kg	30.858	0.003	0	0	0	1,234	0	278	1,512	0	1,512	0.000	1,512	1,512		30.855		0.004
F-	kg	0.002	0.000	0	0	0	452	0	25	477	0	477	0.000	477	477		0.002		0.002
OH-	kg	0.001	0.000	0	0	0	0	0	0	0	0	0	0.000	0	0		0.001		0.001
NO3-	kg	0.028	0.000	0	0	0	46,705	0	10,898	57,603	0	57,603	0.000	57,603	57,603		0.028		0.028
NO2-	kg	0.300	0.000	0	0	0	235	0	55	289	0	289	0.000	289	289		0.300		0.300
PO4-	kg	321.899	0.032	0	0	0	2,575	0	322	2,897	0	2,897	0.000	2,897	2,897		321.866		0.008

Table B.2-1 (continued)

Stream No.	Units	20 Off-gas to HEPAs	21 Off-gas to stack discharge	22 Clean sluicing water	23 Decanted supernate	24 Water to quencher/ scrubber	25 Quencher/ scrubber blowdown	26 Water to mist eliminator	27 Mist eliminator blowdown	28 Wastewater from blowdowns	29 Wastewater for sluicing	30 Wastewater to treatment	31 Wastewater evaporator condensate	32 Evaporator concentrate	33 Treated concentrate	34 Binder	35 HEPA filters	36 Half-PACT canisters	37 Tank vents
SO4--	kg	0.007	0.000	0	0	0	2,406	0	134	2,539	0	2,539	0.000	2,539	2,539		0.007		0.007
CN-	kg	0.004	0.000	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0		0.004		0.004
C2H3O2-	kg	0.000	0.000	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0		0.000		0.000
C6H5O7---	kg	0.000	0.000	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0		0.000		0.000
HCO2-	kg	0.000	0.000	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0		0.000		0.000
C2O4--	kg	0.000	0.000	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0		0.000		0.000
Phthalates	kg	0.000	0.000	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0		0.000		0.000
Water and gases																			
H2O	kg	7,586,847	7,586,847	0	0	3,334,267	266,741	152,797	152,797	419,539	0.000	419,539	209,769	209,769	209,769		0.000		1,246,768
Ar	kg	165,431	165,431	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0		0.000		92,419
CO2	kg	65,392	65,392	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0		0.000		3,265
N2	kg	13,896,536	13,896,536	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0		0.000		7,726,396
NH3	kg		0	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0		0.000		
O2	kg	3,747,672	3,747,672	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0		0.000		2,072,603
HBr (gas)	kg	1,093	1,093	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0		0.000		
HCl (gas)	kg	273	273	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0		0.000		
HF (gas)	kg	26	26	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0		0.000		
NOx (gas)	kg	60,474	60,474	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0		0.000		
SO2 (gas)	kg	89	89	0	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0		0.000		
Totals																			
Carbon	kg	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0		0
Metal oxides	kg	554	0	0	0	0	22,126	0	4,966	27,091	0	27,091	0	27,091	295,122		553		0
Anions	kg	353	0	0	0	0	62,701	0	11,976	74,677	0	74,677	0	74,677	74,677		353		0
Dry gases	kg	17,936,987	17,936,987	0	0	0	0	0	0	0	0	0	0	0	0		0	0	9,894,684
H20	kg	7,586,847	7,586,847	0	0	3,334,267	266,741	152,797	152,797	419,539	0	419,539	209,769	209,769	209,769		0	0	1,246,768
Mass	kg	25,524,741	25,523,835	0	0	3,334,267	351,568	152,797	169,740	521,307	0	521,307	209,769	311,538	579,568		907	0	11,141,452
Miscellaneous																			
Flowrate	kg/hr	1,317.25	1,317.21			172.07	18.14	7.89	8.76	26.90	0.00	26.90	10.83	16.08	29.91		0.05		402
Flowrate	gpm	4,137.794	4,137.794			0.758	0.208	0.035	0.035	0.095	0.000	0.095	0.048	0.047	0.069				1,496
Flowrate	scfm																		200
Flowrate	acfm																		
Temperature	°C	25	25			25	80	25	25	25	25	25					25		25
Specific gravity		0.0014	0.0014			1.00	1.32	1.00	1.11	1.25	1.25	1.25	1.00	1.50	1.90		1.50		0.0012
Density	lb/ft^3	0.0875	0.0875			62.43	82.28	62.43	69.35	78.07	78.07	78.07	62.43	93.92	118.61		93.64		0.0739
Radiochemical constituents (in Ci)																			
Au-198		8.92E-260	1.49E-264			0.00E+00	5.94E-259	0.00E+00	1.34E-259	7.28E-259	0.00E+00	7.28E-259	0.00E+00	0.000	7.28E-259		1.48E-260		7.43E-260
Bk-249		0.00E+00	0.00E+00			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.000	0.00E+00		0.00E+00		0.00E+00
C-14		8.24E-03	4.12E-07			0.00E+00	3.29E-02	0.00E+00	4.12E-03	3.71E-02	0.00E+00	3.71E-02	0.00E+00	0.037	3.71E-02		4.12E-03		4.12E-03
Ce-144		1.70E-03	2.83E-08			0.00E+00	1.13E-02	0.00E+00	2.55E-03	1.39E-02	0.00E+00	1.39E-02	0.00E+00	0.014	1.39E-02		2.83E-04		1.42E-03
Cf-252		2.98E-04	4.96E-09			0.00E+00	1.98E-03	0.00E+00	4.46E-04	2.43E-03	0.00E+00	2.43E-03	0.00E+00	0.002	2.43E-03		4.96E-05		2.48E-04
Cm-243		0.00E+00	0.00E+00			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.000	0.00E+00		0.00E+00		0.00E+00
Cm-244		1.12E+00	1.86E-05			0.00E+00	7.45E+00	0.00E+00	1.68E+00	9.12E+00	0.00E+00	9.12E+00	0.00E+00	9.123	9.12E+00		1.86E-01		9.32E-01
Co-60		1.00E+01	9.52E-04			0.00E+00	3.81E+02	0.00E+00	8.57E+01	4.66E+02	0.00E+00	4.66E+02	0.00E+00	466.479	4.66E+02		9.52E+00		4.76E-01
Cs-134		7.05E-01	6.40E-05			0.00E+00	5.12E+00	0.00E+00	6.40E-01	5.76E+00	0.00E+00	5.76E+00	0.00E+00	5.764	5.76E+00		6.40E-01		6.41E-02
Cs-137		2.86E+02	2.60E-02			0.00E+00	2.08E+03	0.00E+00	2.60E+02	2.34E+03	0.00E+00	2.34E+03	0.00E+00	2337.282	2.34E+03		2.60E+02		2.60E+01
Eu-152		1.36E-01	1.24E-06			0.00E+00	9.88E-01	0.00E+00	2.35E-01	1.22E+00	0.00E+00	1.22E+00	0.00E+00	1.223	1.22E+00		1.24E-02		1.24E-01
Eu-154		4.71E-02	4.28E-07			0.00E+00	3.42E-01	0.00E+00	8.13E-02	4.24E-01	0.00E+00	4.24E-01	0.00E+00	0.424	4.24E-01		4.28E-03		4.28E-02
Eu-155		1.96E-02	1.78E-07			0.00E+00	1.43E-01	0.00E+00	3.39E-02	1.76E-01	0.00E+00	1.76E-01	0.00E+00	0.176	1.76E-01		1.78E-03		1.78E-02

Table B.2-1 (continued)

Stream No.	Units	20 Off-gas to HEPAs	21 Off-gas to stack discharge	22 Clean sluicing water	23 Decanted supernate	24 Water to quencher/ scrubber	25 Quencher/ scrubber blowdown	26 Water to mist eliminator	27 Mist eliminator blowdown	28 Wastewater from blowdowns	29 Wastewater for sluicing	30 Wastewater to treatment	31 Wastewater evaporator condensate	32 Evaporator concentrate	33 Treated concentrate	34 Binder	35 HEPA filters	36 Half-PACT canisters	37 Tank vents
H-3		2.57E+00	2.56E-04			0.00E+00	2.56E+00	0.00E+00	0.00E+00	2.56E+00	0.00E+00	2.56E+00	0.00E+00	2.562	2.56E+00		2.56E+00		5.13E-03
I-129		7.78E-06	1.30E-10			0.00E+00	5.18E-05	0.00E+00	1.17E-05	6.35E-05	0.00E+00	6.35E-05	0.00E+00	0.000	6.35E-05		1.30E-06		6.48E-06
Nb-95		8.65E-23	1.44E-27			0.00E+00	5.76E-22	0.00E+00	1.30E-22	7.06E-22	0.00E+00	7.06E-22	0.00E+00	0.000	7.06E-22		1.44E-23		7.21E-23
Pu-238		2.08E-04	3.47E-09			0.00E+00	1.39E-03	0.00E+00	3.12E-04	1.70E-03	0.00E+00	1.70E-03	0.00E+00	0.002	1.70E-03		3.47E-05		1.73E-04
Pu-239		1.80E-04	3.00E-09			0.00E+00	1.20E-03	0.00E+00	2.70E-04	1.47E-03	0.00E+00	1.47E-03	0.00E+00	0.001	1.47E-03		3.00E-05		1.50E-04
Pu-240		1.76E-04	2.93E-09			0.00E+00	1.17E-03	0.00E+00	2.63E-04	1.43E-03	0.00E+00	1.43E-03	0.00E+00	0.001	1.43E-03		2.92E-05		1.46E-04
Pu-241		2.55E-03	4.25E-08			0.00E+00	1.70E-02	0.00E+00	3.83E-03	2.08E-02	0.00E+00	2.08E-02	0.00E+00	0.021	2.08E-02		4.25E-04		2.13E-03
Pu-242		8.81E-06	1.47E-10			0.00E+00	5.87E-05	0.00E+00	1.32E-05	7.19E-05	0.00E+00	7.19E-05	0.00E+00	0.000	7.19E-05		1.47E-06		7.35E-06
Pu-244		1.04E-06	1.73E-11			0.00E+00	6.91E-06	0.00E+00	1.55E-06	8.46E-06	0.00E+00	8.46E-06	0.00E+00	0.000	8.46E-06		1.73E-07		8.64E-07
Ru-106		1.63E-03	2.71E-08			0.00E+00	1.08E-02	0.00E+00	2.44E-03	1.33E-02	0.00E+00	1.33E-02	0.00E+00	0.013	1.33E-02		2.71E-04		1.35E-03
Sr-90		4.50E-01	4.08E-06			0.00E+00	3.27E+00	0.00E+00	7.76E-01	4.04E+00	0.00E+00	4.04E+00	0.00E+00	4.044	4.04E+00		4.08E-02		4.09E-01
Tc-99		9.93E-02	4.96E-06			0.00E+00	1.99E+01	0.00E+00	4.91E+00	2.48E+01	0.00E+00	2.48E+01	0.00E+00	24.774	2.48E+01		4.96E-02		4.97E-02
Th-232		2.07E-06	3.45E-11			0.00E+00	1.38E-05	0.00E+00	3.11E-06	1.69E-05	0.00E+00	1.69E-05	0.00E+00	0.000	1.69E-05		3.45E-07		1.73E-06
U-233		7.42E-03	1.24E-07			0.00E+00	4.94E-02	0.00E+00	1.11E-02	6.06E-02	0.00E+00	6.06E-02	0.00E+00	0.061	6.06E-02		1.24E-03		6.19E-03
U-234		1.50E-04	2.50E-09			0.00E+00	1.00E-03	0.00E+00	2.25E-04	1.23E-03	0.00E+00	1.23E-03	0.00E+00	0.001	1.23E-03		2.50E-05		1.25E-04
U-235		6.22E-06	1.04E-10			0.00E+00	4.14E-05	0.00E+00	9.33E-06	5.08E-05	0.00E+00	5.08E-05	0.00E+00	0.000	5.08E-05		1.04E-06		5.19E-06
U-236		3.63E-06	6.04E-11			0.00E+00	2.42E-05	0.00E+00	5.44E-06	2.96E-05	0.00E+00	2.96E-05	0.00E+00	0.000	2.96E-05		6.04E-07		3.03E-06
U-238		1.98E-04	3.30E-09			0.00E+00	1.32E-03	0.00E+00	2.97E-04	1.62E-03	0.00E+00	1.62E-03	0.00E+00	0.002	1.62E-03		3.30E-05		1.65E-04
Zr-95		9.90E-14	1.65E-18			0.00E+00	6.59E-13	0.00E+00	1.48E-13	8.07E-13	0.00E+00	8.07E-13	0.00E+00	0.000	8.07E-13		1.65E-14		8.25E-14
TRU activity		3.13E-03	5.21E-08	0.00E+00	0.00E+00	0.00E+00	2.08E-02	0.00E+00	4.69E-03	2.55E-02	0.00E+00	2.55E-02	0.00E+00	2.55E-02	2.55E-02		5.21E-04	0.00E+00	2.61E-03

CH = contact handled.
Ci = curie.
gpm = gallons per minute.
h = hour.
HEPA = high-efficiency particulate air.
kg = kilogram.
lb = pound.
MVST = Melton Valley Storage Tank.
RH = remote handled.
scfm = standard cubic feet per minute.
TRU = transuranic.
WIPP = Waste Isolation Pilot Plant (New Mexico).

Table B.2-2. ORNL RH solid waste stream, OR-W106, volume/mass balance

Stream No.	**301**	**302**	**303**	**306**	**307**	**308**	**309**	**310**	**311**	**312**	**314**	**315**	**316**	**317**	**319**
Source	**Feed**	**Removed waste**	**Debris**	**After size reduce**	**45-gal drums**	**To com-paction**	**To buffer storage**	**Pucks to 55-gal drums**	**55-gal drums**	**Grouted drums**	**To certifi-cation**	**Pack to ship**	**Grout feed**	**Grout wash**	**Process waste water**
						Component volume (m^3)									
Grout						0.0	0.0	0.0	0.0	14.9	14.9	14.9	16.4	1.5	1.5
Liquid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.9	9.9
Solids (i.e., misc.)	369.0	369.0	369.0	369.0	0.0	295.2	157.5	157.5	0.0	157.5	157.5	157.5	0.0	0.0	0.0
Metal debris	0.0	0.0	0.0	0.0	4.1	4.1	4.1	4.1	0.0	4.1	4.1	4.1	0.0	0.0	0.0
Glass debris	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Plastic/rubber debris	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Paper/cloth debris	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Electronic equipment	9.5	9.5	9.5	9.5	0.0	7.6	5.0	5.0	0.0	5.0	5.0	5.0	0.0	0.0	0.0
Total volume (m^3)	378.5	378.5	378.5	378.5	4.1	306.9	166.6	166.6	0.0	181.6	181.6	181.6	16.4	11.4	11.4
Density (kg/m^3)	619	619	619	619	7,800	868	1,599	1,599	0	1,615	1,615	1,615	1,800	1,105	1,105
Net mass (kg)	234,150	234,150	234,150	234,150	32,278	266,428	266,428	266,428	0	293,266	293,266	293,266	29,521	12,585	12,585
						Activities									
Total activity (Ci)	283	283	283	283	0	283	283	283	0	283	283	283	0	0	0
Total TRU activity (Ci)	19.4	19.4	19.4	19.4	0.0	19.4	19.4	19.4	0.0	19.4	19.4	19.4	0	0	0
TRU Concentration(nCi/g)	82.9	82.9	82.9	82.9	0.0	72.8	72.8	72.8		66.2	66.2	66.2			

Notes per Stream No:

Defer to Notes in Table B.2-3 unless otherwise specified.

301: The remote-handled (RH) Solids are contained in 91 C4 casks, 87 C6 casks, 19 C12 casks, 13 wood boxes, and three 55-gal drums per the Transuranic Waste Baseline Inventory Report (TWBIR).

306: No size reduction was assumed since the specific gravity was at 0.6.

311: Due to inconsistencies in puck sizes and no requirement for grout (non-Resource Conservation and Recovery Act), there will be ~15% more 55-gal drums than needed by volume.

ORNL = Oak Ridge National Laboratory.

TRU = transuranic.

Table B.2-3. ORNL RH solid waste (excluding OR-W106) volume/mass balance

Stream No.	**301**	**302**	**303**	**306**	**307**	**308**	**309**	**310**	**311**	**312**	**314**	**315**	**316**	**317**	**319**
Source	**Feed**	**Removed waste**	**Debris**	**After size reduce**	**45-gal drums**	**To com-paction**	**To buffer storage**	**Pucks to 55-gal drums**	**55-gal drums**	**Grouted drums**	**To certifica-tion**	**Pack to ship**	**Grout feed**	**Grout wash**	**Process waste water**
						Component volume (m^3)									
Grout						0.0	0.0	0.0	0.0	5.6	5.6	5.6	6.2	0.6	0.6
Liquid	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	2.5
Solids (i.e., misc.)	137.9	137.9	137.9	137.9	0.0	69.0	33.4	33.4	0.0	33.4	33.4	33.4	0.0	0.0	0.0
Metal debris	4.1	4.1	4.1	3.0	1.2	2.7	1.8	1.8	0.0	1.8	1.8	1.8	0.0	0.0	0.0
Glass debris	3.1	3.1	3.1	3.1	0.0	1.6	0.6	0.6	0.0	0.6	0.6	0.6	0.0	0.0	0.0
Plastic/rubber debris	9.7	9.7	9.7	9.7	0.0	4.9	1.2	1.2	0.0	1.2	1.2	1.2	0.0	0.0	0.0
Paper/cloth debris	9.3	9.3	9.3	9.3	0.0	4.7	1.2	1.2	0.0	1.2	1.2	1.2	0.0	0.0	0.0
Electronic equipment	6.4	6.4	6.4	6.4	0.0	3.2	1.6	1.6	0.0	1.6	1.6	1.6	0.0	0.0	0.0
Total volume (m^3)	171.5	171.5	170.5	169.5	1.2	85.9	39.8	39.8	0.0	45.4	45.4	45.4	6.2	3.0	3.0
Density (kg/m^3)	311	311	313	315	7,800	726	1,569	1,569	0	1,598	1,598	1,598	1,800	1,148	1,148
Net mass (kg)	53,366	53,366	53,366	53,366	9,036	62,402	62,402	62,402	0	72,518	72,518	72,518	11,128	3,487	3,487
						Activities									
Total activity (Ci)	425	425	425	425	0	425	425	425	0	425	425	425	0	0	0.00E+0
TRU activity (Ci)	56	56	56	56	0	56	56	56	0	56	56	56	0	0	0.00E+0
TRU conc. (nCi/g)	1,040	1,040	1,040	1,040	0	889	889	889		765	765	765			

Notes per Stream No.:

Defer to notes for worksheet "RH" unless otherwise specified in worksheet "RH 106" or in this worksheet.
ORNL = Oak Ridge National Laboratory.
RH = remote handled.
TRU = transuranic.

Table B.2-4. Summary of annualized radionuclide emissions for the Vitrification Alternative (Ci/year)

Radionuclide	Sludge/ supernate emissions	CH solids emissions	RH solids emissions	Total solids emissions	Total emissions
Ac-227	0.00E+00	7.16E-18	5.80E-16	3.19E-16	3.19E-16
AG-110	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
AG-110m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Am-241	4.56E-06	4.74E-10	2.65E-11	2.30E-10	4.56E-06
Am-243	0.00E+00	9.26E-12	6.66E-17	4.21E-12	4.21E-12
Au-196	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Au-198	2.76E-264	0.00E+00	0.00E+00	0.00E+00	2.76E-264
Bk-249	0.00E+00	2.53E-14	2.72E-19	1.15E-14	1.15E-14
C-14	1.65E-07	1.50E-16	0.00E+00	6.82E-17	1.65E-07
Ce-144	5.26E-08	0.00E+00	0.00E+00	0.00E+00	5.26E-08
Cf-249	1.80E-10	1.32E-14	9.89E-15	1.14E-14	1.80E-10
Cf-252	9.02E-09	2.98E-12	4.47E-12	3.80E-12	9.03E-09
Cm-240	6.76E-07	1.39E-42	0.00E+00	6.31E-43	6.76E-07
Cm-242	3.46E-05	5.80E-11	0.00E+00	2.64E-11	3.46E-05
Cm-243	2.33E-06	0.00E+00	0.00E+00	0.00E+00	2.33E-06
Cm-244	9.79E-04	1.60E-09	2.47E-10	8.61E-10	9.79E-04
Cm-245	4.51E-08	2.71E-15	0.00E+00	1.23E-15	4.51E-08
Cm-246	1.56E-08	8.82E-18	0.00E+00	4.01E-18	1.56E-08
Cm-248	6.47E-09	2.32E-14	0.00E+00	1.06E-14	6.47E-09
Co-60	2.66E-05	1.45E-15	1.86E-12	1.01E-12	2.66E-05
Cs-134	2.33E-06	0.00E+00	0.00E+00	0.00E+00	2.33E-06
Cs-137	9.46E-04	2.28E-09	7.43E-11	1.08E-09	9.46E-04
Es-253	1.26E-10	3.01E-47	0.00E+00	1.37E-47	1.26E-10
Es-254m	1.09E-10	0.00E+00	0.00E+00	0.00E+00	1.09E-10
Eu-152	1.14E-04	4.09E-16	0.00E+00	1.86E-16	1.14E-04
Eu-154	4.97E-05	0.00E+00	0.00E+00	0.00E+00	4.97E-05
Eu-155	1.03E-05	0.00E+00	0.00E+00	0.00E+00	1.03E-05
Fe-59	6.29E-13	2.06E-28	0.00E+00	9.35E-29	6.29E-13
Gd-153	9.85E-10	0.00E+00	0.00E+00	0.00E+00	9.85E-10
H-3	3.63E-07	0.00E+00	0.00E+00	0.00E+00	3.63E-07
I-129	1.81E-07	0.00E+00	0.00E+00	0.00E+00	1.81E-07
I-131	1.25E-12	0.00E+00	2.42E-120	1.32E-120	1.25E-12
Nb-95	4.51E-09	0.00E+00	0.00E+00	0.00E+00	4.51E-09
Ni-63	9.09E-11	9.36E-17	0.00E+00	4.26E-17	9.09E-11
Np-237	8.94E-09	5.65E-13	1.33E-13	3.29E-13	8.94E-09
Pa-231	2.20E-12	2.78E-13	0.00E+00	1.26E-13	2.32E-12
Pm-147	1.20E-10	7.20E-13	0.00E+00	3.27E-13	1.20E-10
Po-209	6.00E-20	1.69E-18	0.00E+00	7.67E-19	8.27E-19
Pu-238	6.79E-06	3.23E-09	1.85E-11	1.48E-09	6.79E-06
Pu-239	3.49E-06	9.00E-10	4.87E-12	4.12E-10	3.49E-06
Pu-240	1.10E-06	8.50E-10	6.05E-18	3.86E-10	1.10E-06
Pu-241	9.16E-06	1.86E-09	4.24E-12	8.47E-10	9.16E-06
Pu-242	2.63E-09	2.11E-13	0.00E+00	9.59E-14	2.63E-09
Pu-244	2.50E-10	0.00E+00	0.00E+00	0.00E+00	2.50E-10
Ra-223	0.00E+00	5.51E-79	3.68E-91	2.51E-79	2.51E-79
Ra-226	0.00E+00	1.42E-12	0.00E+00	6.44E-13	6.44E-13

Table B.2-4 (continued)

Radionuclide	Sludge/ supernate emissions	CH solids emissions	RH solids emissions	Total solids emissions	Total emissions
Ru-106	3.35E-07	0.00E+00	0.00E+00	0.00E+00	3.35E-07
Sb-125	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-90	1.84E-03	1.36E-09	2.67E-11	6.31E-10	1.84E-03
Tc-99	2.42E-06	1.57E-11	0.00E+00	7.14E-12	2.42E-06
Te-123	0.00E+00	2.30E-17	0.00E+00	1.04E-17	1.04E-17
Te-123m	0.00E+00	6.42E-22	0.00E+00	2.92E-22	2.92E-22
Th-230	0.00E+00	1.06E-17	0.00E+00	4.81E-18	4.81E-18
Th-232	2.98E-08	6.98E-16	7.43E-16	7.23E-16	2.98E-08
U-232	3.01E-08	2.60E-13	0.00E+00	1.18E-13	3.01E-08
U-233	2.69E-06	8.92E-11	3.01E-12	4.22E-11	2.69E-06
U-234	1.10E-06	1.47E-11	0.00E+00	6.70E-12	1.10E-06
U-235	2.88E-08	6.29E-15	2.87E-16	3.02E-15	2.88E-08
U-236	2.49E-09	8.57E-17	0.00E+00	3.90E-17	2.49E-09
U-238	1.09E-06	3.83E-14	6.66E-17	1.75E-14	1.09E-06
U-239	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-90	0.00E+00	1.71E-280	0.00E+00	7.77E-281	7.77E-281
Zn-65	0.00E+00	2.71E-18	0.00E+00	1.23E-18	1.23E-18
Zr-95	3.94E-16	0.00E+00	0.00E+00	0.00E+00	3.94E-16

Ci = curie.
CH = contact handled.
RH = remote handled.

Table B.2-5. Estimated radionuclide emissions for remediation of sludge and supernate by the Vitrification Alternative[a]

Radionuclide	Sludge (Bq/g)	Supernate (Bq/g)	Sludge and supernate (Ci/g)	Radionuclide half life, $t_{½}$[b] (year)	Decayed radionuclide composition (Ci/g)	Uncontrolled radionuclide emissions[c,d] (Ci)	Process radionuclide emissions[e] (Ci)	Radionuclide emissions after control: Project life[f] (Ci)	Radionuclide emissions after control: Annualized[g] (Ci/year)[g]
Ac-227	0.00E+00	0.00E+00	0.00E+00	2.18E+01				0.00E+00	0.00E+00
AG-110	0.00E+00	0.00E+00	0.00E+00	7.80E-07				0.00E+00	0.00E+00
AG-110m	0.00E+00	0.00E+00	0.00E+00	6.84E-01				0.00E+00	0.00E+00
Am-241[h]	0.00E+00	0.00E+00	0.00E+00	4.32E+02		1.25E-01	1.49E-260	1.25E-05	4.56E-06
Am-243	0.00E+00	0.00E+00	0.00E+00	7.37E+03				0.00E+00	0.00E+00
Au-196	0.00E+00	0.00E+00	0.00E+00	1.69E-02				0.00E+00	0.00E+00
Au-198	3.73E+03	0.00E+00	3.92E-08	7.38E-03	2.47E-266	7.44E-260	1.49E-260	7.58E-264	2.76E-264
Bk-249	0	0	0	8.76E-01		0.00E+00	0.00E+00	0.00E+00	0.00E+00
C-14	0.00E+00	8.30E+01	1.37E-09	5.73E+03	1.37E-09	4.12E-03	4.12E-03	4.54E-07	1.65E-07
Ce-144	1.06E+04	1.14E+03	1.31E-07	7.80E-01	4.71E-10	1.42E-03	2.83E-04	1.45E-07	5.26E-08
Cf-249	0.00E+00	0.00E+00	0.00E+00	3.51E+02		0.00E+00	4.96E-05	4.96E-10	1.80E-10
Cf-252	3.83E+01	1.80E+00	4.32E-10	2.65E+00	8.25E-11	2.48E-04	0.00E+00	2.48E-08	9.02E-09
Cm-240	0.00E+00	0.00E+00	0.00E+00	7.39E-02		0.00E+00	1.86E-01	1.86E-06	6.76E-07
Cm-242	0.00E+00	0.00E+00	0.00E+00	1.63E+02		0.00E+00	9.52E+00	9.52E-05	3.46E-05
Cm-243	1.03E+04	0.00E+00	1.09E-07	2.91E+01		0.00E+00	6.40E-01	6.40E-06	2.33E-06
Cm-244	3.64E+04	7.68E+02	3.95E-07	1.81E+01	3.10E-07	9.32E-01	2.60E+02	2.69E-03	9.79E-04
Cm-245	0.00E+00	0.00E+00	0.00E+00	8.50E+03		0.00E+00	1.24E-02	1.24E-07	4.51E-08
Cm-246	0.00E+00	0.00E+00	0.00E+00	4.73E+03		0.00E+00	4.28E-03	4.28E-08	1.56E-08
Cm-248	0.00E+00	0.00E+00	0.00E+00	3.40E+05		0.00E+00	1.78E-03	1.78E-08	6.47E-09
Co-60	3.35E+04	7.30E+02	3.64E-07	5.27E+00	1.58E-07	4.77E-01	2.56E+00	7.33E-05	2.66E-05
Cs-134	4.89E+03	7.74E+03	1.79E-07	2.06E+00	2.13E-08	6.41E-02	1.30E-06	6.41E-06	2.33E-06
Cs-137	5.77E+05	2.38E+05	1.00E-05	3.01E+01	8.64E-06	2.60E+01	1.44E-23	2.60E-03	9.46E-04
Es-253	0.00E+00	0.00E+00		5.60E-02		0.00E+00	3.47E-05	3.47E-10	1.26E-10
Es-254m	0.00E+00	0.00E+00		4.48E-03		0.00E+00	3.00E-05	3.00E-10	1.09E-10
Eu-152	1.32E+05	3.44E+03	1.44E-06	1.35E+01	1.04E-06	3.13E+00	2.93E-05	3.13E-04	1.14E-04
Eu-154	6.97E+04	1.44E+03	7.56E-07	8.59E+00	4.54E-07	1.37E+00	4.25E-04	1.37E-04	4.97E-05
Eu-155	2.12E+04	9.02E+02	2.37E-07	4.76E+00	9.44E-08	2.84E-01	1.47E-06	2.84E-05	1.03E-05
Fe-59	0.00E+00	0.00E+00	0.00E+00	1.22E-01	0.00E+00	0.00E+00	1.73E-07	1.73E-12	6.29E-13
Gd-153	0.00E+00	0.00E+00	0.00E+00	6.61E-01	0.00E+00	0.00E+00	2.71E-04	2.71E-09	9.85E-10
H-3	3.47E+01	1.47E+02	2.80E-09	1.23E+01	1.96E-09	5.90E-03	4.08E-02	9.98E-07	3.63E-07
I-129	0.00E+00	1.30E-01	2.15E-12	1.57E+07	2.15E-12	6.48E-06	4.96E-02	4.97E-07	1.81E-07
I-131	0.00E+00	0.00E+00	0.00E+00	2.20E-02	0.00E+00	0.00E+00	3.45E-07	3.45E-12	1.25E-12
Nb-95	2.30E+03	1.13E+02	2.60E-08	9.58E-02	3.34E-28	1.01E-21	1.24E-03	1.24E-08	4.51E-09
Ni-63	0.00E+00	0.00E+00	0.00E+00	1.00E+02	0.00E+00	0.00E+00	2.50E-05	2.50E-10	9.09E-11
Np-237	7.77E+00	0.00E+00	8.16E-11	2.14E+06	8.16E-11	2.46E-04	1.04E-06	2.46E-08	8.94E-09
Pa-231	0.00E+00	0.00E+00	0.00E+00	3.28E+04	0.00E+00	0.00E+00	6.04E-07	6.04E-12	2.20E-12
Pm-147	0.00E+00	0.00E+00	0.00E+00	2.62E+00	0.00E+00	0.00E+00	3.30E-05	3.30E-10	1.20E-10
Po-209	0.00E+00	0.00E+00	0.00E+00	1.02E+02	0.00E+00	0.00E+00	1.65E-14	1.65E-19	6.00E-20
Pu-238	6.20E+03	3.67E+00	6.52E-08	8.77E+01	6.20E-08	1.87E-01	5.21E-04	1.87E-05	6.79E-06
Pu-239	3.03E+03	3.03E+00	3.19E-08	2.41E+04	3.19E-08	9.60E-02	3.00E-05	9.60E-06	3.49E-06
Pu-240	9.50E+02	2.95E+00	1.00E-08	6.56E+03	1.00E-08	3.02E-02	2.93E-05	3.02E-06	1.10E-06
Pu-241	1.07E+04	5.81E+01	1.14E-07	1.44E+01	8.37E-08	2.52E-01	4.25E-04	2.52E-05	9.16E-06
Pu-242	2.05E+00	1.48E-01	2.40E-11	3.73E+05	2.40E-11	7.22E-05	1.47E-06	7.23E-09	2.63E-09
Pu-244	1.90E-01	1.74E-02	2.28E-12	8.00E+05	2.28E-12	6.87E-06	1.73E-07	6.89E-10	2.50E-10

Table B.2-5 (continued)

Radionuclide	Sludge (Bq/g)	Supernate (Bq/g)	Sludge and supernate (Ci/g)	Radionuclide half life, $t_{½}$[b] (year)	Decayed radionuclide composition (Ci/g)	Uncontrolled radionuclide emissions[c,d] (Ci)	Process radionuclide emissions[e] (Ci)	Radionuclide emissions after control: Project life[f] (Ci)	Radionuclide emissions after control: Annualized[g] (Ci/year)[g]
Ra-223	0.00E+00	0.00E+00	0.00E+00	3.13E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ra-226	0.00E+00	0.00E+00	0.00E+00	1.60E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ru-106	1.83E+04	2.01E+03	2.25E-07	1.02E+00	3.05E-09	9.17E-03	2.71E-04	9.20E-07	3.35E-07
Sb-125	0.00E+00	0.00E+00	0.00E+00	2.76E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-90	1.85E+06	9.58E+03	1.96E-05	2.88E+01	1.68E-05	5.07E+01	4.08E-02	5.07E-03	1.84E-03
Tc-99	3.72E+02	1.00E+03	2.04E-08	2.11E+05	2.04E-08	6.15E-02	4.96E-02	6.65E-06	2.42E-06
Te-123	0.00E+00	0.00E+00	0.00E+00	1.00E+08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Te-123m	0.00E+00	0.00E+00	0.00E+00	3.28E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Th-230	0.00E+00	0.00E+00	0.00E+00	7.54E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Th-232	2.59E+01	3.48E-02	2.72E-10	1.41E+10	2.72E-10	8.20E-04	3.45E-07	8.20E-08	2.98E-08
U-232	0.00E+00	1.74E+01	2.87E-10	6.89E+01	2.70E-10	8.11E-04	1.62E-04	8.27E-08	3.01E-08
U-233	2.14E+03	1.24E+02	2.45E-08	1.59E+05	2.45E-08	7.37E-02	1.24E-03	7.39E-06	2.69E-06
U-234	9.50E+02	2.52E+00	1.00E-08	2.46E+05	1.00E-08	3.02E-02	2.50E-05	3.02E-06	1.10E-06
U-235	2.49E+01	1.04E-01	2.63E-10	3.80E+06	2.63E-10	7.91E-04	1.04E-06	7.91E-08	2.88E-08
U-236	2.07E+00	6.09E-02	2.28E-11	2.34E+07	2.28E-11	6.85E-05	6.04E-07	6.85E-09	2.49E-09
U-238	9.44E+02	3.32E+00	9.97E-09	4.47E+09	9.97E-09	3.00E-02	3.30E-05	3.00E-06	1.09E-06
U-239	0.00E+00	0.00E+00	0.00E+00	4.46E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-90	0.00E+00	0.00E+00	0.00E+00	7.31E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zn-65	0.00E+00	0.00E+00	0.00E+00	6.69E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zr-95	2.63E+04	1.28E+02	2.78E-07	1.75E-01	3.60E-18	1.08E-11	1.65E-14	1.08E-15	3.94E-16
TRU Activity	1.02E+04	1.16E+01	1.08E-07	2.90E+06	1.04E-07	4.39E-01	1.90E-02	4.41E-05	1.60E-05

[a]The data were obtained from U.S. Department of Energy Report, *Statistical Description of Liquid Low-level Waste System Transuranic Wastes at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, Document Nos. ORNL/TM/-13351 and ORNL/TM-13351, Addendum 1. The radionuclide concentration was then calculated for the elapsed time (6.33 years) from when the data were analyzed and the startup of the treatment process (April 1001) based on radionuclide decay. Also, an average density of 1.3 g/mL was used for the sludge which was calculated from sludge data provided in ORNL/TM-13351. An average density of 1.15 g/mL was obtained for the supernate from Table 4.1, p. 3, of ORNL/TM-13351, Addendum 1.

[b]The equation for estimating radionuclide decay is:

$$A = Ao \times \exp - [\ln(2)/t_{½} * T] ,$$

where:

A = decayed radionuclide composition;
Ao = the original concentration in Ci/g;
$t_{½}$ = the half-life of the specific radionuclide as obtained from the website www.dne.bnl.gov/CoN/index.html;
T = the time between sample analysis (December 1996) to the time of process startup (April 2003), which is 6.33 years.

[c]An emissions factor for the amount of airborne radionuclides is obtained from Appendix D of 40 *Code of Federal Regulations* (*CFR*) 61:

Emissions Factor = 0.001 fraction of the amount used.

[d]The uncontrolled emissions are estimated by the following equation:

Uncontrolled Rate = Retrievable Curies × Emissions Factor.

[e]The emissions after control are estimated by using the U.S. Environmental Protection Agency adjustment factors form Table 1 of Appendix D to 40 *CFR* 61. The adjustment factors are:

Demister Adjustment Factor = 0.10
First High-Efficiency Particulate Air (HEPA) Filter Adjustment Factor = 0.01
Second HEPA Filter Adjustment Factor = 0.01

The demister is only applicable for the gas from the vitrifier. The tank vents bypass the demister.

[f]A density of 2.6 g/mL was used for the treated waste (Spence 1998).

[g]The annualized emissions are calculated by taking the controlled emissions from the project life and dividing by the length of time (in years) the sludge/supernate will be processed (2.5 years).

[h]Emissions of ^{241}Am were calculated based on decay of the radionuclide composition and as a decay product of ^{241}Pu.

Bq = becquerel. mL = milliliter.
Ci = curie. TRU = transuranic.
g = gram.

Table B.2-6. Estimated radionuclide emissions for remediation of CH solids for the Vitrification Alternative

Radionuclide	Radionuclide composition[a] (Ci)	Radionuclide half life, $t_{½}$[b] (year)	Decayed radionuclide composition (Ci)	Uncontrolled radionuclide emissions[c,d] (Ci)	Radionuclide emissions	
					After control project life[e] (Ci)	Annualized[f] (Ci/year)
Ac-227	1.10E-05	2.18E+01	8.95E-06	8.95E-12	8.95E-18	7.16E-18
Ag-110		7.80E-07				
Ag-110m		6.84E-01				
Am-241[gf]	5.77E+02	4.32E+02	5.92E+02	5.92E-04	5.92E-10	4.74E-10
Am-243	1.16E+01	7.37E+03	1.16E+01	1.16E-05	1.16E-11	9.26E-12
Au-196		1.69E-02				
Au-198		7.38E-03				
Bk-249	5.77E+00	8.76E-01	3.16E-02	3.16E-08	3.16E-14	2.53E-14
C-14	1.88E-04	5.73E+03	1.87E-04	1.87E-10	1.87E-16	1.50E-16
Ce-144		7.80E-01				
Cf-249	1.68E-02	3.51E+02	1.66E-02	1.66E-08	1.66E-14	1.32E-14
Cf-252	2.09E+01	2.65E+00	3.73E+00	3.73E-06	3.73E-12	2.98E-12
Cm-240	1.10E-03	7.39E-02	1.73E-30	1.73E-36	1.73E-42	1.39E-42
Cm-242	7.46E+01	1.63E+02	7.25E+01	7.25E-05	7.25E-11	5.80E-11
Cm-243		2.91E+01				
Cm-244	2.57E+03	1.81E+01	2.00E+03	2.00E-03	2.00E-09	1.60E-09
Cm-245	3.39E-03	8.50E+03	3.39E-03	3.39E-09	3.39E-15	2.71E-15
Cm-246	1.10E-05	4.73E+03	1.10E-05	1.10E-11	1.10E-17	8.82E-18
Cm-248	2.90E-02	3.40E+05	2.90E-02	2.90E-08	2.90E-14	2.32E-14
Co-60	4.30E-03	5.27E+00	1.81E-03	1.81E-09	1.81E-15	1.45E-15
Cs-134		2.06E+00				
Cs-137	3.31E+03	3.01E+01	2.84E+03	2.84E-03	2.84E-09	2.28E-09
Es-253	8.83E+00	5.60E-02	3.76E-35	3.76E-41	3.76E-47	3.01E-47
Es-254m	1.20E+01	4.48E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Eu-152	7.17E-04	1.35E+01	5.12E-04	5.12E-10	5.12E-16	4.09E-16
Eu-154		8.59E+00	0.00E+00			
Eu-155		4.76E+00				
Fe-59	4.42E+00	1.22E-01	2.57E-16	2.57E-22	2.57E-28	2.06E-28
Gd-153		6.61E-01				
H-3		1.23E+01				
I-129		1.57E+07				
I-131		2.20E-02				
Nb-95		9.58E-02				
Ni-63	1.22E-04	1.00E+02	1.17E-04	1.17E-10	1.17E-16	9.36E-17
Np-237	7.06E-01	2.14E+06	7.06E-01	7.06E-07	7.06E-13	5.65E-13
Pa-231	3.48E-01	3.28E+04	3.48E-01	3.48E-07	3.48E-13	2.78E-13
Pm-147	5.13E+00	2.62E+00	9.00E-01	9.00E-07	9.00E-13	7.20E-13
Po-209	2.21E-06	1.02E+02	2.11E-06	2.11E-12	2.11E-18	1.69E-18
Pu-238	4.26E+03	8.77E+01	4.04E+03	4.04E-03	4.04E-09	3.23E-09
Pu-239	1.13E+03	2.41E+04	1.13E+03	1.13E-03	1.13E-09	9.00E-10
Pu-240	1.06E+03	6.56E+03	1.06E+03	1.06E-03	1.06E-09	8.50E-10
Pu-241	3.19E+03	1.44E+01	2.32E+03	2.32E-03	2.32E-09	1.86E-09
Pu-242	2.64E-01	3.73E+05	2.64E-01	2.64E-07	2.64E-13	2.11E-13
Pu-244		8.00E+05				
Ra-223	1.32E-03	3.13E-02	6.89E-67	6.89E-73	6.89E-79	5.51E-79

Table B.2-6 (continued)

Radionuclide	Radionuclide composition[a] (Ci)	Radionuclide half life, $t_{½}$[b] (year)	Decayed radionuclide composition (Ci)	Uncontrolled radionuclide emissions[c,d] (Ci)	Radionuclide emissions After control project life[e] (Ci)	Radionuclide emissions Annualized[f] (Ci/year)
Ra-226	1.78E+00	1.60E+03	1.77E+00	1.77E-06	1.77E-12	1.42E-12
Ru-106		1.02E+00				
Sb-125		2.76E+00				
Sr-90	1.99E+03	2.88E+01	1.70E+03	1.70E-03	1.70E-09	1.36E-09
Tc-99	1.96E+01	2.11E+05	1.96E+01	1.96E-05	1.96E-11	1.57E-11
Te-123	2.87E-05	1.00E+08	2.87E-05	2.87E-11	2.87E-17	2.30E-17
Te-123m	8.77E-04	3.28E-01	8.02E-10	8.02E-16	8.02E-22	6.42E-22
Th-230	1.32E-05	7.54E+04	1.32E-05	1.32E-11	1.32E-17	1.06E-17
Th-232	8.73E-04	1.41E+10	8.73E-04	8.73E-10	8.73E-16	6.98E-16
U-232	3.48E-01	6.89E+01	3.25E-01	3.25E-07	3.25E-13	2.60E-13
U-233	1.11E+02	1.59E+05	1.11E+02	1.11E-04	1.11E-10	8.92E-11
U-234	1.84E+01	2.46E+05	1.84E+01	1.84E-05	1.84E-11	1.47E-11
U-235	7.87E-03	3.80E+06	7.87E-03	7.87E-09	7.87E-15	6.29E-15
U-236	1.07E-04	2.34E+07	1.07E-04	1.07E-10	1.07E-16	8.57E-17
U-238	4.79E-02	4.47E+09	4.79E-02	4.79E-08	4.79E-14	3.83E-14
U-239		4.46E-05				
Y-90	1.99E+03	7.31E-03	2.14E-268	2.14E-274	2.14E-280	1.71E-280
Zn-65	3.09E-03	6.69E-01	3.38E-06	3.38E-12	3.38E-18	2.71E-18
Zr-95		1.75E-01				
TRU Activity	7.06E+03		6.84E+03	6.84E-03	6.84E-09	5.47E-09

[a]Composition data obtained from U.S. Department of Energy Memorandum: *TRU Waste Baseline Inventory Report for Oak Ridge*, June 1996. The data were then scaled up from 906.22m^3 to 1000m^3.

[b]The equation for estimating radionuclide decay is:

$$A = Ao \times \exp - [\ln(2)/t_{½} * T] ,$$

where:

A = Decayed radionuclide composition;

Ao = the original concentration in Ci/g;

$t_{½}$ = the half-life of the specific radionuclide as obtained from the website www.dne.bnl.gov/CoN/index.html;

T = the time between sample analysis (June 1996) to the time remote-handled (RH) processing begins (January 2003), which is 6.58 years.

[c]An emissions factor of the amount of airborne radionuclides is obtained from Appendix D to 40 *Code of Federal Regulations (CFR)* 61:

Emissions Factor = .000001 fraction of the amount used.

[d]The uncontrolled emissions are estimated by the following equation:

Uncontrolled Rate = Retrievable Curies × Emissions Factor.

[e]The emissions after control are estimated by using the U.S. Environmental Protection Agency adjustment factors from Table 1 of Appendix D to 40 *CFR* 61. The adjustment factors are:

Hot Cell High-Efficiency Particulate Air (HEPA) Filter Adjustment Factor	=	0.01
Hot Cell GAC Adjustment Factor	=	0.10
First HEPA Filter Adjustment Factor	=	0.01
Second HEPA Filter Adjustment Factor	=	0.01

The demister is only applicable for the gas from the vitrifier. The tank vents bypass the demister.

[f]The annualized emissions are calculated by taking the controlled emissions from the project life and dividing by the length of time (in years) the contact-handled (CH) solids will be processed (1.25 years).

[g]Emissions of ^{241}Am were calculated based on decay of the radionuclide composition and as a decay product of ^{241}Pu.

Ci = curie.

TRU = transuranic.

Table B.2-7. Estimated radionuclide emissions for TRU waste remediation of RH solids for the Vitrification Alternative

Radionuclide	Radionuclide Composition[a] (Ci)	Radionuclide half life, $t_{½}$[b] (year)	Decayed radionuclide composition (Ci)	Uncontrolled radionuclide emissions[c,d] (Ci)	Radionuclide emissions after control: Project life[e] (Ci)	Annualized[f] (Ci/year)
Ac-227	1.12E-03	2.18E+01	8.69E-04	8.69E-10	8.69E-16	5.80E-16
Ag-110		7.80E-07				
Ag-110m		6.84E-01				
Am-241[h]	4.02E+01	4.32E+02	3.97E+01	3.97E-05	3.97E-11	2.65E-11
Am-243	9.99E-05	7.37E+03	9.99E-05	9.99E-11	9.99E-17	6.66E-17
Au-196		1.69E-02				
Au-198		7.38E-03				
Bk-249	2.00E-04	8.76E-01	4.07E-07	4.07E-13	4.07E-19	2.72E-19
C-14		5.73E+03				
Ce-144		7.80E-01				
Cf-249	1.51E-02	3.51E+02	1.48E-02	1.48E-08	1.48E-14	9.89E-15
Cf-252	5.20E+01	2.65E+00	6.71E+00	6.71E-06	6.71E-12	4.47E-12
Cm-240		7.39E-02				
Cm-242		1.63E+02				
Cm-243		2.91E+01				
Cm-244	4.99E+02	1.81E+01	3.70E+02	3.70E-04	3.70E-10	2.47E-10
Cm-245		8.50E+03				
Cm-246		4.73E+03				
Cm-248		3.40E+05				
Co-60	7.81E+00	5.27E+00	2.79E+00	2.79E-06	2.79E-12	1.86E-12
Cs-134		2.06E+00				
Cs-137	1.33E+02	3.01E+01	1.11E+02	1.11E-04	1.11E-10	7.43E-11
Es-253		5.60E-02				
Es-254m		4.48E-03				
Eu-152		1.35E+01				
Eu-154		8.59E+00				
Eu-155		4.76E+00				
Fe-59		1.22E-01				
Gd-153		6.61E-01				
H-3		1.23E+01				
I-129		1.57E+07				
I-131	5.00E-01	2.20E-02	3.63E-108	3.63E-114	3.63E-120	2.42E-120
Nb-95		9.58E-02				
Ni-63		1.00E+02				
Np-237	2.00E-01	2.14E+06	2.00E-01	2.00E-07	2.00E-13	1.33E-13
Pa-231		3.28E+04				
Pm-147		2.62E+00				
Po-209		1.02E+02				
Pu-238	2.94E+01	8.77E+01	2.77E+01	2.77E-05	2.77E-11	1.85E-11
Pu-239	7.31E+00	2.41E+04	7.31E+00	7.31E-06	7.31E-12	4.87E-12
Pu-240	9.08E-06	6.56E+03	9.08E-06	9.08E-12	9.08E-18	6.05E-18
Pu-241	9.27E+00	1.44E+01	6.36E+00	6.36E-06	6.36E-12	4.24E-12
Pu-242		3.73E+05				
Pu-244		8.00E+05				
Ra-223	1.12E-03	3.13E-02	5.52E-79	5.52E-85	5.52E-91	3.68E-91

Table B.2-7 (continued)

Radionuclide	Radionuclide Composition[a] (Ci)	Radionuclide half life, $t_{½}$[b] (year)	Decayed radionuclide composition (Ci)	Uncontrolled radionuclide emissions[c,d] (Ci)	Radionuclide emissions after control Project life[e] (Ci)	Annualized[f] (Ci/year)
Ra-226		1.60E+03				
Ru-106		1.02E+00				
Sb-125		2.76E+00				
Sr-90	4.83E+01	2.88E+01	4.00E+01	4.00E-05	4.00E-11	2.67E-11
Tc-99		2.11E+05				
Te-123		1.00E+08				
Te-123m		3.28E-01				
Th-230		7.54E+04				
Th-232	1.12E-03	1.41E+10	1.12E-03	1.12E-09	1.12E-15	7.43E-16
U-232		6.89E+01				
U-233	4.51E+00	1.59E+05	4.51E+00	4.51E-06	4.51E-12	3.01E-12
U-234		2.46E+05				
U-235	4.30E-04	3.80E+06	4.30E-04	4.30E-10	4.30E-16	2.87E-16
U-236		2.34E+07				
U-238	9.99E-05	4.47E+09	9.99E-05	9.99E-11	9.99E-17	6.66E-17
U-239		4.46E-05				
Y-90	4.83E+01	7.31E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zn-65		6.69E-01				
Zr-95		1.75E-01				
TRU Activity	7.71E+01		7.49E+01	7.49E-05	7.49E-11	4.99E-11

[a]Composition data obtained from U.S. Department of Energy Memorandum: *TRU Waste Baseline Inventory Report for Oak Ridge*, June 1996.

[b]The equation for estimating radionuclide decay is:

$$A = Ao \times \exp - [\ln(2)/t_{½} * T] ,$$

where:

A = decayed radionuclide composition;

Ao = the original concentration in Ci/g;

$t_{½}$ = the half-life of the specific radionuclide as obtained from the website www.dne.bnl.gov/CoN/index.html;

T = the time between sample analysis (June 1996) to the time remote-handled (RH) processing begins (January 2004), which is 7.83 years.

[c]An emissions factor of the amount of airborne radionuclides is obtained from Appendix D to 40 *Code of Federal Regulations (CFR)* 61:

Emissions Factor = 0.000001 fraction of the amount used.

[d]The uncontrolled emissions are estimated by the following equation:

Uncontrolled Rate = Retrievable Curies × Emissions Factor.

[e]The emissions after control are estimated by using the U.S. Environmental Protection Agency adjustment factors from Table 1 of Appendix D to 40 *CFR* 61. The adjustment factors are:

Hot Cell High-Efficiency Particulate Air (HEPA) Filter Adjustment Facto	=	0.01
Hot Cell GAC Adjustment Factor	=	0.10
First HEPA Filter Adjustment Factor	=	0.01
Second HEPA Filter Adjustment Factor	=	0.01

The demister is only applicable for the gas from the vitrifier. The tank vents bypass the demister.

[f]The annualized emissions are calculated by taking the controlled emissions from the project life and dividing by the length of time (in years) the contact-handled (CH) solids will be processed (1.5 years).

[g]Emissions of ^{241}Am were calculated based on decay of the radionuclide composition and as a decay product of ^{241}Pu.

Ci = curie.

TRU = transuranic.

Table B.2-8. Summary of TRU waste remediation hourly particulate emissions (lbs/h) for the Vitrification Alternative

Metals	Classification	Average hourly emissions (lbs/h) Sludge and supernate	CH solids	RH solids	CH/RH solids	Total	Maximum hourly emissions[a] (lbs/h)	Average annual emissions[b] (tons/year)
TSP		6.86E-04	1.71E-04	1.71E-04	1.71E-04	7.78E-04	9.72E-04	2.43E-03
Total HAP		3.02E-07	5.13E-04	5.13E-04	5.12E-04	2.76E-04	3.45E-04	3.13E-04
Silver (Ag)		2.17E-09	1.71E-04	1.71E-04	1.71E-04	9.18E-05	1.15E-04	1.04E-04
Aluminum (Al)		2.14E-06				2.14E-06	2.68E-06	2.43E-06
Arsenic (As)	HAP	5.31E-09				5.31E-09	6.64E-09	6.03E-09
Boron (B)		3.79E-09				3.79E-09	4.74E-09	4.30E-09
Barium (Ba)		2.56E-08				2.56E-08	3.20E-08	2.91E-08
Beryllium (Be)	HAP	4.91E-10				4.91E-10	6.14E-10	5.58E-10
Bismuth (Bi)		9.84E-10				9.84E-10	1.23E-09	1.12E-09
Calcium (Ca)		6.92E-06				6.92E-06	8.65E-06	7.85E-06
Cadmium (Cd)	HAP	2.59E-09	1.71E-04	1.71E-04	1.71E-04	9.18E-05	1.15E-04	1.04E-04
Cerium (Ce)		1.35E-10				1.35E-10	1.69E-10	1.53E-10
Cobalt (Co)	HAP	1.03E-09				1.03E-09	1.29E-09	1.17E-09
Chromium (Cr)	HAP	9.24E-08				9.24E-08	1.16E-07	1.05E-07
Cesium (Cs)		1.71E-09				1.71E-09	2.14E-09	1.94E-09
Copper (Cu)		1.46E-08				1.46E-08	1.82E-08	1.65E-08
Iron (Fe)		1.16E-06				1.16E-06	1.44E-06	1.31E-06
Gallium (Ga)		1.20E-10				1.20E-10	1.50E-10	1.36E-10
Mercury (Hg)	HAP	1.78E-08	1.71E-04	1.71E-04	1.71E-04	9.18E-05	1.15E-04	1.04E-04
Iodine (I)		5.39E-09				5.39E-09	6.74E-09	6.12E-09
Potassium (K)		5.83E-06				5.83E-06	7.29E-06	6.62E-06
Lanthanum (La)		1.46E-11				1.46E-11	1.82E-11	1.65E-11
Lithium (Li)		9.73E-09				9.73E-09	1.22E-08	1.10E-08
Magnesium (Mg)		1.15E-06				1.15E-06	1.43E-06	1.30E-06
Manganese (Mn)	HAP	2.79E-08				2.79E-08	3.49E-08	3.16E-08
Molybdenum (Mo)		4.52E-10				4.52E-10	5.65E-10	5.13E-10
Sodium (Na)		3.17E-05				3.17E-05	3.96E-05	3.59E-05
Niobium (Nb)		0.00E+00				0.00E+00	0.00E+00	0.00E+00
Nickel (Ni)	HAP	1.74E-08				1.74E-08	2.17E-08	1.97E-08
Phosphorus (P)		3.53E-06				3.53E-06	4.42E-06	4.01E-06
Lead (Pb)	HAP	1.24E-07	1.71E-04	1.71E-04	1.71E-04	9.20E-05	1.15E-04	1.04E-04
Rubidium (Rb)		4.30E-10				4.30E-10	5.38E-10	4.88E-10
Antimony (Sb)	HAP	7.64E-09				7.64E-09	9.55E-09	8.66E-09
Selenium (Se)	HAP	5.33E-09				5.33E-09	6.67E-09	6.05E-09
Silicon (Si)		6.26E-07				6.26E-07	7.82E-07	7.10E-07
Tin (Sn)		1.39E-10				1.39E-10	1.73E-10	1.57E-10
Strontium (Sr)		2.83E-08				2.83E-08	3.54E-08	3.22E-08
Thorium (Th)		1.57E-06				1.57E-06	1.96E-06	1.78E-06
Titanium (Ti)		1.86E-10				1.86E-10	2.32E-10	2.11E-10
Thallium (Th)		3.86E-09				3.86E-09	4.82E-09	4.38E-09
Uranium (U)		1.30E-05				1.30E-05	1.62E-05	1.47E-05
Vanadium (V)		8.00E-10				8.00E-10	1.00E-09	9.08E-10
Tungsten (W)		1.68E-10				1.68E-10	2.10E-10	1.90E-10
Zinc (Zn)		4.06E-08				4.06E-08	5.07E-08	4.60E-08
Zirconium (Zr)		1.09E-11				1.09E-11	1.37E-11	1.24E-11

[a]Maximum hourly is estimated by multiplying average hourly rate by 1.25.
[b]Average annual emissions are the average hourly emissions multiplied by the operational hours and then divided by 2.75 years.
CH = contact handled.
h = hour.
HAP = hazardous air pollutant.
lb = pound.
RH = remote handled.
TSP = total suspended particulate.
TRU = transuranic.

Table B.2-9. Estimated metals emissions for remediation of sludge and supernate waste for the Vitrification Alternative

Metals	Metals mass fraction[a] (g/total g)	Metals concentration[b] (g/dscf)	Uncontrolled metal emissions for the project[c] (g)	Uncontrolled metal emissions for the project[c] (lbs)	Emissions after control for the project[d] (g)	Emissions after control for the project[d] (lbs)	Average hourly emissions[e] (lbs/h)
TSP		1.30E-01	5.34E+07	1.18E+05	5.34E+03	1.18E+01	6.86E-04
Silver (Ag)	3.17E-06	4.11E-07	1.69E+02	3.73E-01	1.69E-02	3.73E-05	2.17E-09
Aluminum (Al)	3.12E-03	4.05E-04	1.67E+05	3.67E+02	1.67E+01	3.67E-02	2.14E-06
Arsenic (As)	7.75E-06	1.00E-06	4.13E+02	9.12E-01	4.13E-02	9.12E-05	5.31E-09
Boron (B)	5.53E-06	7.17E-07	2.95E+02	6.51E-01	2.95E-02	6.51E-05	3.79E-09
Barium (Ba)	3.74E-05	4.84E-06	1.99E+03	4.40E+00	1.99E-01	4.40E-04	2.56E-08
Beryllium (Be)	7.17E-07	9.29E-08	3.83E+01	8.43E-02	3.83E-03	8.43E-06	4.91E-10
Bismuth (Bi)	1.44E-06	1.86E-07	7.66E+01	1.69E-01	7.66E-03	1.69E-05	9.84E-10
Calcium (Ca)	1.01E-02	1.31E-03	5.39E+05	1.19E+03	5.39E+01	1.19E-01	6.92E-06
Cadmium (Cd)	3.78E-06	4.90E-07	2.02E+02	4.45E-01	2.02E-02	4.45E-05	2.59E-09
Cerium (Ce)	1.97E-07	2.55E-08	1.05E+01	2.31E-02	1.05E-03	2.31E-06	1.35E-10
Cobalt (Co)	1.50E-06	1.94E-07	8.01E+01	1.76E-01	8.01E-03	1.76E-05	1.03E-09
Chromium (Cr)	1.35E-04	1.75E-05	7.19E+03	1.59E+01	7.19E-01	1.59E-03	9.24E-08
Cesium (Cs)	2.50E-06	3.23E-07	1.33E+02	2.94E-01	1.33E-02	2.94E-05	1.71E-09
Copper (Cu)	2.13E-05	2.75E-06	1.13E+03	2.50E+00	1.13E-01	2.50E-04	1.46E-08
Iron (Fe)	1.68E-03	2.18E-04	8.99E+04	1.98E+02	8.99E+00	1.98E-02	1.16E-06
Gallium (Ga)	1.75E-07	2.27E-08	9.36E+00	2.06E-02	9.36E-04	2.06E-06	1.20E-10
Mercury (Hg)	2.59E-05	3.36E-06	1.38E+03	3.05E+00	1.38E-01	3.05E-04	1.78E-08
Iodine (I)	7.86E-06	1.02E-06	4.20E+02	9.25E-01	4.20E-02	9.25E-05	5.39E-09
Potassium (K)	8.51E-03	1.10E-03	4.54E+05	1.00E+03	4.54E+01	1.00E-01	5.83E-06
Lanthanum (La)	2.13E-08	2.76E-09	1.13E+00	2.50E-03	1.13E-04	2.50E-07	1.46E-11
Lithium (Li)	1.42E-05	1.84E-06	7.57E+02	1.67E+00	7.57E-02	1.67E-04	9.73E-09
Magnesium (Mg)	1.67E-03	2.16E-04	8.91E+04	1.97E+02	8.91E+00	1.97E-02	1.15E-06
Manganese (Mn)	4.07E-05	5.27E-06	2.17E+03	4.78E+00	2.17E-01	4.78E-04	2.79E-08
Molybdenum (Mo)	6.59E-07	8.54E-08	3.52E+01	7.76E-02	3.52E-03	7.76E-06	4.52E-10
Sodium (Na)	4.62E-02	5.99E-03	2.47E+06	5.44E+03	2.47E+02	5.44E-01	3.17E-05
Niobium (Nb)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel (Ni)	2.53E-05	3.28E-06	1.35E+03	2.98E+00	1.35E-01	2.98E-04	1.74E-08
Phosphorus (P)	5.15E-03	6.68E-04	2.75E+05	6.06E+02	2.75E+01	6.06E-02	3.53E-06
Lead (Pb)	1.81E-04	2.35E-05	9.66E+03	2.13E+01	9.66E-01	2.13E-03	1.24E-07
Rubidium (Rb)	6.27E-07	8.13E-08	3.35E+01	7.38E-02	3.35E-03	7.38E-06	4.30E-10
Antimony (Sb)	1.11E-05	1.44E-06	5.94E+02	1.31E+00	5.94E-02	1.31E-04	7.64E-09
Selenium (Se)	7.78E-06	1.01E-06	4.15E+02	9.15E-01	4.15E-02	9.15E-05	5.33E-09
Silicon (Si)	9.13E-04	1.18E-04	4.87E+04	1.07E+02	4.87E+00	1.07E-02	6.26E-07
Tin (Sn)	2.02E-07	2.62E-08	1.08E+01	2.38E-02	1.08E-03	2.38E-06	1.39E-10
Strontium (Sr)	4.13E-05	5.36E-06	2.21E+03	4.86E+00	2.21E-01	4.86E-04	2.83E-08
Thorium (Th)	2.29E-03	2.96E-04	1.22E+05	2.69E+02	1.22E+01	2.69E-02	1.57E-06
Titanium (Ti)	2.71E-07	3.51E-08	1.45E+01	3.19E-02	1.45E-03	3.19E-06	1.86E-10
Thallium (Th)	5.62E-06	7.29E-07	3.00E+02	6.62E-01	3.00E-02	6.62E-05	3.86E-09
Uranium (U)	1.90E-02	2.46E-03	1.01E+06	2.23E+03	1.01E+02	2.23E-01	1.30E-05

Table B.2-9 (continued)

Metals	Metals mass fraction[a] (g/total g)	Metals concentration[b] (g/dscf)	Uncontrolled metal emissions for the project[c] (g)	(lbs)	Emissions after control for the project[d] (g)	(lbs)	Average hourly emissions[e] (lbs/h)
Vanadium (V)	1.17E-06	1.51E-07	6.23E+01	1.37E-01	6.23E-03	1.37E-05	8.00E-10
Tungsten (W)	2.45E-07	3.17E-08	1.31E+01	2.88E-02	1.31E-03	2.88E-06	1.68E-10
Zinc (Zn)	5.92E-05	7.67E-06	3.16E+03	6.96E+00	3.16E-01	6.96E-04	4.06E-08
Zirconium (Zr)	1.59E-08	2.07E-09	8.51E-01	1.88E-03	8.51E-05	1.88E-07	1.09E-11

[a]The data were obtained from U.S. Department of Energy Report, *Statistical Description of Liquid Low-level Waste System Transuranic Wastes at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, Document Nos. ONRL/TM-13351 and ORNL/TM-13351, Addendum 1. An average density of 1.3 g/mL was used for the sludge which was calculated from sludge data provided in ORNL/TM-13351. Given the volume stated in the request for proposal (RFP) of 900 m^3 of sludge, there is 1,700,000 kg of sludge mass. An average density of 1.15 g/mL was obtained for the supernate from Table 4.1, p. 3, of ORNL/TM-13351, Addendum 1. Given the volume stated in the RFP of 1600 m^3 of supernate, there is 1,840,000 kg of supernate mass.

[b]The amount of total suspended particulate (TSP) matter reaching the first exhaust system High-Efficiency Particulate Air (HEPA) filter is assumed to be:

Airborne Particulate Concentration = 2.0 gr/dscf = 0.1296 g/dscf.

[c]The uncontrolled emissions are estimated by the following expression:

Uncontrolled Rate = Exhaust Stream Flowrate × TSP Concentration × Metal Mass Fraction.

The operating schedule was presented from Sect. 2.3 of this Environmental Impact Statement:

Air Flow Rate	=	400 dscfm (calculated from a first pass material balance of the vitrification process)
Process Operating Schedule	=	2,l75 years life; 260 d/year; 24 h/d; and 60 min/h
Calculated Operating Hours	=	17,160 h

[d]The two HEPA filtration systems are assumed to have the following removal efficiencies:

First HEPA Filter Removal = 99%.

Second HEPA Filter Removal = 99%.

[e]The average hourly emissions are calculated by the following expression:

Average Hourly = Pound Emitted for Project/Project Operating Hours.

d = day.

dscf = dry standard cubic foot.

dscfm = dry standard cubic feet per minute.

g = gram.

gr/dscf = grains per dry standard cubic foot.

h = hour.

kg = killogram.

lb = pound.

m = meter.

mL = milliliter.

Table B.2-10. Metal emissions for remediation of TRU/RH solid wastes using 40 *CFR* 61 Appendix D calculation procedures for the Vitrification Alternative

Metals	Mass of metals in waste[a] (kg)	Uncontrolled metals emissions[b,c] (g)	Uncontrolled metals emissions[b,c] (lbs)	Metals emissions after control[d] (g)	Metals emissions after control[d] (lbs)	Average hourly emissions[e] (lbs/h)
Silver (Ag)	20	2.00E-02	4.41E-05	2.00E-08	4.41E-11	8.75E-15
Cadmium (Cd)	100	1.00E-01	2.20E-4	1.00E-07	2.20E-10	4.37E-14
Mercury (Hg)	100	1.00E-01	2.20E-04	1.00E-07	2.20E-10	4.37E-14
Lead (Pb)	980	9.80E-01	2.16E-03	9.80E-07	2.16E-09	4.29E-13
Total	1200					
	Concentration (g/dscf)[f]	**Uncontrolled TSP emissions (g)**	**Uncontrolled TSP emissions (lbs)**	**TSP emissions after control (g)**	**TSP emissions after control (lbs)**	**Average hourly emissions (lbs/h)**
TSP	0.1296	3.92E+08	8.64E+05	3.92E+02	8.64E-01	1.71E-04

[a]Quantities are based on U.S. Department of Energy analysis and process knowledge of the Resource Conservation and Recovery Act metals in solid wastes.

[b]An emission factor for the amount of airborne metals is obtained from Appendix D to 40 *Code of Federal Regulations (CFR)* 61.

Emissions Factor = 0.000001 fraction of the amount used (since this is solid waste).

[c]The uncontrolled emissions are estimated by the following expression:

Uncontrolled Rate = Metal Mass in Waste × Emissions Factor.

The operating schedule was presented from Sect. 2.3 of this Environmental Impact Statement:

Process Operating Schedule = 1.5 years life; 210 d/year; 16 h/d; and 60 min/h

Calculated Operating Hours = 5040 h

[d]The emissions after control are estimated by using the U.S. Environmental Protection Agency adjustment factors from Table 1 of Appendix D to 40 *CFR* 61. The adjustment factors are:

Hot Cell High-Efficiency Particulate Air
(HEPA) Filter Adjustment Factor = 0.01
First HEPA Filter Adjustment Factor = 0.01
Second HEPA Filter Adjustment Factor = 0.01

[e]The average hourly emissions are calculated by the following expression:

Average Hourly = Pounds Emitted for Project/Project Operating Hours.

[f]The total suspended particulate (TSP) emissions from the hot cell are calculated based on an assumed inlet concentration of 2 gr/dscf (0.13 g/dscf) to the HEPA filter system on the cell exhaust. The TSP emissions are calculated using an assumed exhaust flow rate for this closed system which is based on obtaining one complete volume change of air in the hot cell every 15 min. Given that the hot cell is approximately 50 ft wide × 100 ft long × 30 ft high (due to the bay area for overhead cranes), the exhaust flowrate is 10,000 dscfm.

d = day.
dscf = dry standard cubic foot.
ft = foot.
g = gram.
gr/dscf = grains per dry standard cubic foot.
h = hour.
kg = kilogram.
lb = pound.
min = minutes.
RH = remote handled.
TRU = transuranic.

Table B.2-11. Metal emissions for remediation of TRU/CH solid wastes using 40 *CFR* Appendix D calculation procedures for the Vitrification Alternative

Metals	Mass of metals in waste[a] (kg)	Uncontrolled metals emissions[b,c] (g)	(lbs)	Metals emissions after control[d] (g)	(lbs)	Average hourly emissions[e] (lbs/h)
Silver (Ag)	100	1.00E-01	2.20E-04	1.00E-07	2.20E-10	3.50E-14
Cadmium (Cd)	400	4.00E-01	8.82E-04	4.00E-07	8.82E-10	1.40E-13
Mercury (Hg)	400	4.00E-01	8.82E-04	4.00E-07	8.82E-10	1.40E-13
Lead (Pb)	3500	3.50E+00	7.72E-03	3.50E-06	7.72E-09	1.22E-12
Total	1200					
	Concentration[f] (g/dscf)	**Uncontrolled TSP emissions (g)**	**(lbs)**	**TSP emissions after control (g)**	**(lbs)**	**Average hourly emissions (lbs/h)**
TSP	0.1296	4.90E+08	1.08E+06	4.90+02	1.08E-00	1.71E-04

[a]Quantities are based on U.S. Department of Energy analysis and process knowledge of the Resource Conservation and Recovery Act metals in solid wastes.

[b]An emission factor for the amount of airborne metals is obtained from Appendix D to 40 *Code of Federal Regulations (CFR)* 61.

Emissions Factor = 0.000001 fraction of the amount used (since this is solid waste).

[c]The uncontrolled emissions are estimated by the following expression:

Uncontrolled Rate = Metal Mass in Waste × Emissions Factor.

The operating schedule was presented from Sect. 2.3 of this Environmental Impact Statement:

Process Operating Schedule = 1.25 years life; 210 d/year; 16 h/d; and 60 min/h

Calculated Operating Hours = 4200 h

[d]The emissions after control are estimated by using the U.S. Environmental Protection Agency adjustment factors from Table 1 of Appendix D to 40 *CFR* 61. The adjustment factors are:

Hot Cell High-Efficiency Particulate Air (HEPA) Filter Adjustment Factor	=	0.01
First HEPA Filter Adjustment Factor	=	0.01
Second HEPA Filter Adjustment Factor	=	0.01

[e]The average hourly emissions are calculated by the following expression:

Average Hourly = Pounds Emitted for Project/Project Operating Hours.

[f]The total suspended particulate (TSP) emissions from the hot cell are calculated based on an assumed inlet concentration of 2 gr/dscf (0.13 g/dscf) to the HEPA filter system on the cell exhaust. The TSP emissions are calculated using an assumed exhaust flow rate for this closed system which is based on obtaining one complete volume change of air in the hot cell every 15 min. Given that the hot cell is approximately 50 ft wide × 100 ft long × 30 ft high (due to the bay area for overhead cranes), the exhaust flowrate is 10,000 dscfm.

CH = contact handled.

d = day.

dscf = dry standard cubic foot.

ft = foot.

g = gram.

gr/dscf = grains per dry standard cubic foot.

h = hour.

kg = kilogram.

lb = pound.

min = minute.

TRU = transuranic.

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APPENDIX B.3

SUMMARIES OF MATERIAL BALANCE FOR CEMENTATION PROCESS

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Table B.3-1. Material balance for the cementation process in the Cementation Alternative for sludge

Stream No.	Units	101[a] Sludge in MVSTs	102 Stabilization additives	103 Setting additives	104[b] Decon water	105 Treated sludge	106 To 55-gal drums	108 Pack for shipping	110 pH Adj. additive	111 Cement dust
							6507 Drums	2170 72B Casks		
				Metals						
Ag	kg	9.2			0	9.2	9.2	9.2	0	0
Al	kg	9,374.6			0	9,374.6	9,374.6	9,374.6	0	0
As	kg	20.1			0	20.1	20.1	20.1	0	0
B	kg	14.6			0	14.6	14.6	14.6	0	0
Ba	kg	109.6			0	109.6	109.6	109.6	0	0
Be	kg	2.1			0	2.1	2.1	2.1	0	0
Bi	kg	0.0			0	0.0	0.0	0.0	0	0
Ca	kg	28,197.5			0	28,197.5	28,197.5	28,197.5	0	0
Cd	kg	10.8			0	10.8	10.8	10.8	0	0
Ce	kg	0.0			0	0.0	0.0	0.0	0	0
Co	kg	4.3			0	4.3	4.3	4.3	0	0
Cr	kg	394.8			0	394.8	394.8	394.8	0	0
Cs	kg	4.6			0	4.6	4.6	4.6	0	0
Cu	kg	62.6			0	62.6	62.6	62.6	0	0
Fe	kg	5,054.3			0	5,054.3	5,054.3	5,054.3	0	0
Ga	kg	0.0			0	0.0	0.0	0.0	0	0
Hg	kg	76.8			0	76.8	76.8	76.8	0	0
I	kg	0.0			0	0.0	0.0	0.0	0	0
K	kg	7,465.9			0	7,465.9	7,465.9	7,465.9	0	0
La	kg	0.0			0	0.0	0.0	0.0	0	0
Li	kg	0.0			0	0.0	0.0	0.0	0	0
Mg	kg	4,741.1			0	4,741.1	4,741.1	4,741.1	0	0
Mn	kg	121.9			0	121.9	121.9	121.9	0	0
Mo	kg	0.0			0	0.0	0.0	0.0	0	0
Na	kg	51,354.2			0	51,354.2	51,354.2	51,354.2	0	0
Nb	kg	0.0			0	0.0	0.0	0.0	0	0
Ni	kg	74.2			0	74.2	74.2	74.2	0	0
P	kg	15,395.7			0	15,395.7	15,395.7	15,395.7	0	0
Pb	kg	540.8			0	540.8	540.8	540.8	0	0
Rb	kg	0.0			0	0.0	0.0	0.0	0	0
Sb	kg	31.9			0	31.9	31.9	31.9	0	0
Se	kg	21.9			0	21.9	21.9	21.9	0	0
Si	kg	2,659.2			0	2,659.2	2,659.2	2,659.2	0	0
Sn	kg	0.0			0	0.0	0.0	0.0	0	0
Sr	kg	103.8			0	103.8	103.8	103.8	0	0
Th	kg	6,865.1			0	6,865.1	6,865.1	6,865.1	0	0
Ti	kg	0.0			0	0.0	0.0	0.0	0	0
Tl	kg	14.1			0	14.1	14.1	14.1	0	0
U	kg	56,349.4			0	56,349.4	56,349.4	56,349.4	0	0
V	kg	3.4			0	3.4	3.4	3.4	0	0
W	kg	0.0			0	0.0	0.0	0.0	0	0
Zn	kg	155.9			0	155.9	155.9	155.9	0	0
Zr	kg	0.0			0	0.0	0.0	0.0	0	0
				Concrete additives						
IRPC	kg		85,528			81,455	81,455	81,455	0	4,073
Perlite	kg			213,819		203,637	203,637	203,637	0	10,182
Fly Ash	kg		204,316			194,587	194,587	194,587	0	9,729

Table B.3-1 (continued)

Stream No.	Units	101[a] Sludge in MVSTs	102 Stabilization additives	103 Setting additives	104[b] Decon water	105 Treated sludge	106 To 55-gal drums	108 Pack for shipping	110 pH Adj. additive	111 Cement dust
Slag	kg		353,989			337,133	337,133	337,133	0	16,857
Cement	kg		213,819			203,637	203,637	203,637	0	10,182
Anions										
CO3-	kg	0.0			0	0.0	0.00E+00	0.00E+00	0	0
Br-	kg	592.8			0	592.8	5.93E+02	5.93E+02	0	0
CO3--	kg	0.0			0	0.0	0.00E+00	0.00E+00	0	0
Cl-	kg	550.7			0	550.7	5.51E+02	5.51E+02	0	0
CrO4--	kg	0.0			0	0.0	0.00E+00	0.00E+00	0	0
F-	kg	1,639.3			0	1,639.3	1.64E+03	1.64E+03	0	0
OH-	kg	0.0			0	0.0	0.00E+00	0.00E+00	0	0
NO3-	kg	22,816.3			0	22,816.3	2.28E+04	2.28E+04	0	0
NO2-	kg	1,767.6			0	1,767.6	1.77E+03	1.77E+03	0	0
PO4-	kg	3,185.9			0	3,185.9	3.19E+03	3.19E+03	0	0
SO4--	kg	4,465.8			0	4,465.8	4.47E+03	4.47E+03	0	0
CN-	kg	6.3			0	6.3	6.32E+00	6.32E+00	0	0
C2H3O2-	kg	0.0			0	0.0	0.00E+00	0.00E+00	0	0
C6H5O7---	kg	0.0			0	0.0	0.00E+00	0.00E+00	0	0
HCO2-	kg	0.0			0	0.0	0.00E+00	0.00E+00	0	0
C2O4--	kg	0.0			0	0.0	0.00E+00	0.00E+00	0	0
Phthlates	kg	0.0			0	0.0	0.00E+00	0.00E+00	0	0
Totals										
Carbon	kg	12,401				12,401	12,401	12,401	0	0
Metal	kg	189,234	0	0	0	189,234	189,234	189,234	0	0
Concrete	kg	0	857,652	213,819	0	1,020,449	1,020,449	1,020,449	0	51,022
Anions	kg	35,025	0	0	0	35,025	35,025	35,025	0	0
H20	kg	945,741	0	0	0	945,741	945,741	945,741	0	0
Mass	kg	1,244,450	857,652	213,819	0	2,264,899	2,190,449	2,190,449	0	51,022
SpG		1.3				1.76	1.76	1.76		
Radioisotopic activity										
Au-198	Ci	1.17E-246	0	0	0	1.17E-246	1.17E-246	1.17E-246	0	0
Ce-144	Ci	1.52E+00	0	0	0	1.52E+00	1.52E+00	1.52E+00	0	0
Cf-252	Ci	2.47E-01	0	0	0	2.47E-01	2.47E-01	2.47E-01	0	0
Cm-243	Ci	2.83E+02	0	0	0	2.83E+02	2.83E+02	2.83E+02	0	0
Cm-244	Ci	9.11E+02	0	0	0	9.11E+02	9.11E+02	9.11E+02	0	0
Co-60	Ci	4.76E+02	0	0	0	4.76E+02	4.76E+02	4.76E+02	0	0
Cs-134	Ci	2.00E+01	0	0	0	2.00E+01	2.00E+01	2.00E+01	0	0
Cs-137	Ci	1.59E+04	0	0	0	1.59E+04	1.59E+04	1.59E+04	0	0
Eu-152	Ci	3.04E+03	0	0	0	3.04E+03	3.04E+03	3.04E+03	0	0
Eu-154	Ci	1.35E+03	0	0	0	1.35E+03	1.35E+03	1.35E+03	0	0
Eu-155	Ci	2.76E+02	0	0	0	2.76E+02	2.76E+02	2.76E+02	0	0
H-3	Ci	7.80E-01	0	0	0	7.80E-01	7.80E-01	7.80E-01	0	0
Nb-95	Ci	5.70E-18	0	0	0	5.70E-18	5.70E-18	5.70E-18	0	0
Np-237	Ci	2.46E-01	0	0	0	2.46E-01	2.46E-01	2.46E-01	0	0
Pu-238	Ci	1.87E+02	0	0	0	1.87E+02	1.87E+02	1.87E+02	0	0
Pu-239	Ci	9.59E+01	0	0	0	9.59E+01	9.59E+01	9.59E+01	0	0
Pu-240	Ci	3.00E+01	0	0	0	3.00E+01	3.00E+01	3.00E+01	0	0
Pu-241	Ci	2.53E+02	0	0	0	2.53E+02	2.53E+02	2.53E+02	0	0
Pu-242	Ci	6.48E-02	0	0	0	6.48E-02	6.48E-02	6.48E-02	0	0
Pu-244	Ci	6.01E-03	0	0	0	6.01E-03	6.01E-03	6.01E-03	0	0
Ru-106	Ci	9.27E+00	0	0	0	9.27E+00	9.27E+00	9.27E+00	0	0

Table B.3-1 (continued)

Stream No.	Units	101[a] Sludge in MVSTs	102 Stabilization additives	103 Setting additives	104[b] Decon water	105 Treated sludge	106 To 55-gal drums	108 Pack for shipping	110 pH Adj. additive	111 Cement dust
Sr-90	Ci	5.06E+04	0	0	0	5.06E+04	5.06E+04	5.06E+04	0	0
Tc-99	Ci	1.18E+01	0	0	0	1.18E+01	1.18E+01	1.18E+01	0	0
Th-232	Ci	8.18E-01	0	0	0	8.18E-01	8.18E-01	8.18E-01	0	0
U-233	Ci	6.76E+01	0	0	0	6.76E+01	6.76E+01	6.76E+01	0	0
U-234	Ci	3.01E+01	0	0	0	3.01E+01	3.01E+01	3.01E+01	0	0
U-235	Ci	7.86E-01	0	0	0	7.86E-01	7.86E-01	7.86E-01	0	0
U-236	Ci	6.55E-02	0	0	0	6.55E-02	6.55E-02	6.55E-02	0	0
U-238	Ci	2.98E+01	0	0	0	2.98E+01	2.98E+01	2.98E+01	0	0
Zr-95	Ci	2.89E-08	0	0	0	2.89E-08	2.89E-08	2.89E-08	0	0
TRU Act.	Ci	5.66E+02	0	0	0	5.66E+02	5.66E+02	5.66E+02	0	0

[a]Stream No. 101: The mass includes the remote-handled/contact-handled (RH/CH) Non-Debris Waste Stream.
[b]Stream No. 104: Decontaminated waste water would be processed with the supernate.
Ci = curie.
MVST = Melton Valley Storage Tank.
TRU = transuranic.

Table B.3-2. Material balance for the cementation process in the Cementation Alternative for supernate

Stream No.	Units	151 Supernate in MVSTs	152 Stabilization additives	153 Setting additives	154[a] Decon water	155 Treated supernate	156 To 55-gal drums	158 Pack for shipping	160 pH Adj. additive	161 Cement dust
							12,403 Drums	776 Super Tigers		
Metals										
Ag	kg	0.3			0	0.3	0.3	0.3	0	0
Al	kg	22.5			0	22.5	22.5	22.5	0	0
As	kg	3.2			0	3.2	3.2	3.2	0	0
B	kg	2.0			0	2.0	2.0	2.0	0	0
Ba	kg	2.9			0	2.9	2.9	2.9	0	0
Be	kg	0.0			0	0.0	0.0	0.0	0	0
Bi	kg	4.3			0	4.3	4.3	4.3	0	0
Ca	kg	2,182.2			0	2,182.2	2,182.2	2,182.2	0	0
Cd	kg	0.6			0	0.6	0.6	0.6	0	0
Ce	kg	0.6			0	0.6	0.6	0.6	0	0
Co	kg	0.3			0	0.3	0.3	0.3	0	0
Cr	kg	10.9			0	10.9	10.9	10.9	0	0
Cs	kg	2.9			0	2.9	2.9	2.9	0	0
Cu	kg	1.4			0	1.4	1.4	1.4	0	0
Fe	kg	17.4			0	17.4	17.4	17.4	0	0
Ga	kg	0.5			0	0.5	0.5	0.5	0	0
Hg	kg	1.3			0	1.3	1.3	1.3	0	0
I	kg	23.7			0	23.7	23.7	23.7	0	0
K	kg	18,136.1			0	18,136.1	18,136.1	18,136.1	0	0
La	kg	0.1			0	0.1	0.1	0.1	0	0
Li	kg	42.7			0	42.7	42.7	42.7	0	0
Mg	kg	285.6			0	285.6	285.6	285.6	0	0
Mn	kg	0.5			0	0.5	0.5	0.5	0	0
Mo	kg	2.0			0	2.0	2.0	2.0	0	0
Na	kg	87,725.4			0	87,725.4	87,725.4	87,725.4	0	0
Nb	kg	0.0			0	0.0	0.0	0.0	0	0
Ni	kg	2.0			0	2.0	2.0	2.0	0	0
P	kg	111.8			0	111.8	111.8	111.8	0	0
Pb	kg	4.0			0	4.0	4.0	4.0	0	0
Rb	kg	1.9			0	1.9	1.9	1.9	0	0
Sb	kg	1.6			0	1.6	1.6	1.6	0	0
Se	kg	1.5			0	1.5	1.5	1.5	0	0
Si	kg	88.2			0	88.2	88.2	88.2	0	0
Sn	kg	0.6			0	0.6	0.6	0.6	0	0
Sr	kg	20.6			0	20.6	20.6	20.6	0	0
Th	kg	17.6			0	17.6	17.6	17.6	0	0
Ti	kg	0.8			0	0.8	0.8	0.8	0	0
Tl	kg	2.8			0	2.8	2.8	2.8	0	0
U	kg	695.6			0	695.6	695.6	695.6	0	0
V	kg	0.1			0	0.1	0.1	0.1	0	0
W	kg	0.7			0	0.7	0.7	0.7	0	0
Zn	kg	22.2			0	22.2	22.2	22.2	0	0
Zr	kg	0.0			0	0.0	0.0	0.0	0	0
Concrete Additives										
IRPC	kg		0			0	0	0	0	0

Table B.3-2 (continued)

Stream No.	Units	151 Supernate in MVSTs	152 Stabilization additives	153 Setting additives	154[a] Decon water	155 Treated supernate	156 To 55-gal drums	158 Pack for shipping	160 pH Adj. additive	161 Cement dust
Perlite	kg			93,989		89,513	89,513	89,513	0	4,476
Fly Ash	kg		380,901			362,763	362,763	362,763	0	18,138
Slag	kg		999,247			951,664	951,664	951,664	0	47,583
Cement	kg		999,247			951,664	951,664	951,664	0	47,583
Anions										
CO3-	kg	0.0			0	0.0	0.00E+00	0.00E+00	0	0
Br-	kg	4,806.9			0	4,806.9	4.81E+03	4.81E+03	0	0
CO3--	kg	188.3			0	188.3	1.88E+02	1.88E+02	0	0
Cl-	kg	10,059.6			0	10,059.6	1.01E+04	1.01E+04	0	0
CrO4--	kg	3,856.8			0	3,856.8	3.86E+03	3.86E+03	0	0
F-	kg	34.4			0	34.4	3.44E+01	3.44E+01	0	0
OH-	kg	514.6			0	514.6	5.15E+02	5.15E+02	0	0
NO3-	kg	4,965.1			0	4,965.1	4.97E+03	4.97E+03	0	0
NO2-	kg	298,431.9			0	298,431.9	2.98E+05	2.98E+05	0	0
PO4-	kg	4,861.4			0	4,861.4	4.86E+03	4.86E+03	0	0
SO4--	kg	2,216.5			0	2,216.5	2.22E+03	2.22E+03	0	0
CN-	kg	4,099.8			0	4,099.8	4.10E+03	4.10E+03	0	0
C2H3O2-	kg	0.1			0	0.1	1.12E-01	1.12E-01	0	0
C6H5O7---	kg	396.6			0	396.6	3.97E+02	3.97E+02	0	0
HCO2-	kg	141.9			0	141.9	1.42E+02	1.42E+02	0	0
C2O4--	kg	301.1			0	301.1	3.01E+02	3.01E+02	0	0
Phthlates	kg	389.9			0	389.9	3.90E+02	3.90E+02	0	0
Totals										
Carbon	kg	1,478				1,478	1,478	1,478	0	0
Metal	kg	109,442	0	0	0	109,442	109,442	109,442	0	0
Concrete	kg	0	2,379,396	93,989	0	2,355,604	2,355,604	2,355,604	0	117,780
Anions	kg	335,265	0	0	0	335,265	335,265	335,265	0	0
H20	kg	1,395,293	0	0	220,000	1,615,293	1,395,293	1,395,293	0	0
Mass	kg	1,840,000	2,379,396	93,989	220,000	4,415,604	4,195,604	4,195,604	0	117,780
SpG		1.3			1	1.8	1.8	1.8		
Radioisotopic Activity										
C-14	Ci	4.12E+00	0	0	0	4.12E+00	4.12E+00	4.12E+00	0	0
Ce-144	Ci	5.31E-01	0	0	0	5.31E-01	5.31E-01	5.31E-01	0	0
Cf-252	Ci	2.27E-02	0	0	0	2.27E-02	2.27E-02	2.27E-02	0	0
Cm-244	Ci	3.12E+01	0	0	0	3.12E+01	3.12E+01	3.12E+01	0	0
Co-60	Ci	1.82E+01	0	0	0	1.82E+01	1.82E+01	1.82E+01	0	0
Cs-134	Ci	6.58E+01	0	0	0	6.58E+01	6.58E+01	6.58E+01	0	0
Cs-137	Ci	1.05E+04	0	0	0	1.05E+04	1.05E+04	1.05E+04	0	0
Eu-152	Ci	1.31E+02	0	0	0	1.31E+02	1.31E+02	1.31E+02	0	0
Eu-154	Ci	4.68E+01	0	0	0	4.68E+01	4.68E+01	4.68E+01	0	0
Eu-155	Ci	2.09E+01	0	0	0	2.09E+01	2.09E+01	2.09E+01	0	0
H-3	Ci	5.45E+00	0	0	0	5.45E+00	5.45E+00	5.45E+00	0	0
Nb-95	Ci	1.79E-16	0	0	0	1.79E-16	1.79E-16	1.79E-16	0	0
Pu-238	Ci	1.75E-01	0	0	0	1.75E-01	1.75E-01	1.75E-01	0	0
Pu-239	Ci	1.50E-01	0	0	0	1.50E-01	1.50E-01	1.50E-01	0	0
Pu-240	Ci	1.47E-01	0	0	0	1.47E-01	1.47E-01	1.47E-01	0	0
Pu-241	Ci	2.24E+00	0	0	0	2.24E+00	2.24E+00	2.24E+00	0	0
Pu-242	Ci	7.35E-03	0	0	0	7.35E-03	7.35E-03	7.35E-03	0	0
Pu-244	Ci	8.65E-04	0	0	0	8.65E-04	8.65E-04	8.65E-04	0	0
Ru-106	Ci	2.82E+00	0	0	0	2.82E+00	2.82E+00	2.82E+00	0	0

Table B.3-2 (continued)

Stream No.	Units	151 Supernate in MVSTs	152 Stabilization additives	153 Setting additives	154[a] Decon water	155 Treated supernate	156 To 55-gal drums	158 Pack for shipping	160 pH Adj. additive	161 Cement dust
Sr-90	Ci	4.20E+02	0	0	0	4.20E+02	4.20E+02	4.20E+02	0	0
Tc-99	Ci	4.97E+01	0	0	0	4.97E+01	4.97E+01	4.97E+01	0	0
Th-232	Ci	1.73E-03	0	0	0	1.73E-03	1.73E-03	1.73E-03	0	0
U-233	Ci	6.19E+00	0	0	0	6.19E+00	6.19E+00	6.19E+00	0	0
U-234	Ci	1.25E-01	0	0	0	1.25E-01	1.25E-01	1.25E-01	0	0
U-235	Ci	5.19E-03	0	0	0	5.19E-03	5.19E-03	5.19E-03	0	0
U-236	Ci	3.03E-03	0	0	0	3.03E-03	3.03E-03	3.03E-03	0	0
U-238	Ci	1.65E-01	0	0	0	1.65E-01	1.65E-01	1.65E-01	0	0
Zr-95	Ci	5.95E-09	0	0	0	5.95E-09	5.95E-09	5.95E-09	0	0
TRU Act.	Ci	2.72E+00	0	0	0	2.72E+00	2.72E+00	2.72E+00	0	0

[a]Stream No. 154: Includes grout washings and decon. from sludge and supernate processing - assumed to be ~3 gal/drum.
Ci = curie.
kg = kilogram.
MVST = Melton Valley Storage Tank.
TRU = transuranic.

Table B.3-3. Summary of annualized radionuclide emissions for the Cementation Alternative (Ci/year)

Radionuclide	Sludge emissions	Supernate emissions	CH solids emissions	RH solids emissions	Total solids emissions	Total emissions
Ac-227	0.00E+00	0.00E+00	3.58E-18	2.78E-16	1.54E-16	1.54E-16
Ag-110	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ag-110m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Am-241	3.55E-08	2.97E-10	2.37E-10	1.32E-11	1.15E-10	3.59E-08
Am-243	0.00E+00	0.00E+00	4.63E-12	3.33E-17	2.11E-12	2.11E-12
Au-196	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Au-198	1.95E-254	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.95E-254
Bk-249	0.00E+00	0.00E+00	1.27E-14	5.05E-20	5.75E-15	5.75E-15
C-14	0.00E+00	7.37E-08	7.50E-17	0.00E+00	3.41E-17	7.37E-08
Ce-144	2.53E-08	9.49E-09	0.00E+00	0.00E+00	0.00E+00	3.48E-08
Cf-249	0.00E+00	0.00E+00	6.62E-15	4.93E-15	5.70E-15	5.70E-15
Cf-252	4.11E-09	4.05E-10	1.49E-12	1.61E-12	1.56E-12	4.52E-09
Cm-240	0.00E+00	0.00E+00	6.94E-43	0.00E+00	3.15E-43	3.15E-43
Cm-242	0.00E+00	0.00E+00	2.90E-11	0.00E+00	1.32E-11	1.32E-11
Cm-243	4.71E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.71E-06
Cm-244	1.52E-05	5.58E-07	7.99E-10	1.18E-10	4.27E-10	1.57E-05
Cm-245	0.00E+00	0.00E+00	1.35E-15	0.00E+00	6.16E-16	6.16E-16
Cm-246	0.00E+00	0.00E+00	4.41E-18	0.00E+00	2.00E-18	2.00E-18
Cm-248	0.00E+00	0.00E+00	1.16E-14	0.00E+00	5.28E-15	5.28E-15
Co-60	7.94E-06	3.25E-07	7.24E-16	7.89E-13	4.31E-13	8.26E-06
Cs-134	3.33E-07	1.18E-06	0.00E+00	0.00E+00	0.00E+00	1.51E-06
Cs-137	2.64E-04	1.87E-04	1.14E-09	3.61E-11	5.37E-10	4.52E-04
Es-253	0.00E+00	0.00E+00	1.50E-47	0.00E+00	6.83E-48	6.83E-48
Es-254m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Eu-152	5.07E-05	2.34E-06	2.05E-16	0.00E+00	9.30E-17	5.31E-05
Eu-154	2.25E-05	8.35E-07	0.00E+00	0.00E+00	0.00E+00	2.33E-05
Eu-155	4.60E-06	3.73E-07	0.00E+00	0.00E+00	0.00E+00	4.98E-06
Fe-59	0.00E+00	0.00E+00	1.03E-28	0.00E+00	4.67E-29	4.67E-29
Gd-153	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
H-3	1.30E-08	9.74E-08	0.00E+00	0.00E+00	0.00E+00	1.10E-07
I-129	0.00E+00	1.16E-10	0.00E+00	0.00E+00	0.00E+00	1.16E-10
I-131	0.00E+00	0.00E+00	0.00E+00	9.51E-138	5.19E-138	5.19E-138
Nb-95	9.50E-26	3.19E-24	0.00E+00	0.00E+00	0.00E+00	3.28E-24
Ni-63	0.00E+00	0.00E+00	4.68E-17	0.00E+00	2.13E-17	2.13E-17
Np-237	4.09E-09	0.00E+00	2.82E-13	6.66E-14	1.65E-13	4.10E-09
Pa-231	0.00E+00	0.00E+00	1.39E-13	0.00E+00	6.32E-14	6.32E-14
Pm-147	0.00E+00	0.00E+00	3.60E-13	0.00E+00	1.64E-13	1.64E-13
Po-209	0.00E+00	0.00E+00	8.44E-19	0.00E+00	3.84E-19	3.84E-19
Pu-238	3.11E-06	3.13E-09	1.62E-09	9.14E-12	7.40E-10	3.12E-06
Pu-239	1.60E-06	2.69E-09	4.50E-10	2.43E-12	2.06E-10	1.60E-06
Pu-240	5.01E-07	2.62E-09	4.25E-10	3.03E-18	1.93E-10	5.03E-07
Pu-241	4.22E-06	4.01E-08	9.29E-10	2.00E-12	4.24E-10	4.26E-06
Pu-242	1.08E-09	1.31E-10	1.05E-13	0.00E+00	4.80E-14	1.21E-09
Pu-244	1.00E-10	1.54E-11	0.00E+00	0.00E+00	0.00E+00	1.16E-10
Ra-223	0.00E+00	0.00E+00	2.76E-79	1.75E-103	1.25E-79	1.25E-79
Ra-226	0.00E+00	0.00E+00	7.09E-13	0.00E+00	3.22E-13	3.22E-13
Ru-106	1.54E-07	5.04E-08	0.00E+00	0.00E+00	0.00E+00	2.05E-07
Sb-125	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-90	8.43E-04	7.50E-06	6.78E-10	1.29E-11	3.15E-10	8.50E-04
Tc-99	1.96E-07	8.88E-07	7.86E-12	0.00E+00	3.57E-12	1.08E-06

Table B.3-3 (continued)

Radionuclide	Sludge emissions	Supernate emissions	CH solids emissions	RH solids emissions	Total solids emissions	Total emissions
Te-123	0.00E+00	0.00E+00	1.15E-17	0.00E+00	5.22E-18	5.22E-18
Te-123m	0.00E+00	0.00E+00	3.21E-22	0.00E+00	1.46E-22	1.46E-22
Th-230	0.00E+00	0.00E+00	5.30E-18	0.00E+00	2.41E-18	2.41E-18
Th-232	1.36E-08	3.09E-11	3.49E-16	3.72E-16	3.61E-16	1.37E-08
U-232	0.00E+00	1.46E-08	1.30E-13	0.00E+00	5.92E-14	1.46E-08
U-233	1.13E-06	1.11E-07	4.46E-11	1.50E-12	2.11E-11	1.24E-06
U-234	5.01E-07	2.24E-09	7.37E-12	0.00E+00	3.35E-12	5.03E-07
U-235	1.31E-08	9.27E-11	3.15E-15	1.43E-16	1.51E-15	1.32E-08
U-236	1.09E-09	5.41E-11	4.29E-17	0.00E+00	1.95E-17	1.14E-09
U-238	4.97E-07	2.95E-09	1.92E-14	3.33E-17	8.73E-15	5.00E-07
U-239	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Y-90	0.00E+00	0.00E+00	8.55E-281	0.00E+00	3.89E-281	3.89E-281
Zn-65	0.00E+00	0.00E+00	1.35E-18	0.00E+00	6.15E-19	6.15E-19
Zr-95	4.82E-16	1.06E-16	0.00E+00	0.00E+00	0.00E+00	5.88E-16

Ci = curie.
CH = contact handled.
RH = remote handled.

Table B.3-4. Estimated radionuclide emissions for TRU waste remediation of sludge for the Cementation Alternative

Radionuclide	Radionuclide (Bq/g)	Composition[a] (Ci/g)	Radionuclide[b] half life, $t_{1/2}$ (year)	Decayed radionuclide composition (Ci/g)	Uncontrolled[c,d] radionuclide emissions (Ci)	Radionuclide emissions after control	
						Project life[e] (Ci)	Annualized[f] (Ci/year)
Ac-227			2.18E+01			0.00E+00	0.00E+00
Ag-110			7.80E-07			0.00E+00	0.00E+00
Ag-110m			6.84E-01			0.00E+00	0.00E+00
Am-241[g]			4.32E+02		2.13E-03	2.13E-07	3.55E-08
Am-243			7.37E+03			0.00E+00	0.00E+00
Au-196			1.69E-02			0.00E+00	0.00E+00
Au-198	3732.39	1.01E-07	7.38E-03	1.00E-255	1.17E-249	1.17E-253	1.95E-254
Bk-249	0		8.76E-01		0.00E+00	0.00E+00	0.00E+00
C-14	0		5.73E+03		0.00E+00	0.00E+00	0.00E+00
Ce-144	10647.08	2.88E-07	7.80E-01	1.30E-09	1.52E-03	1.52E-07	2.53E-08
Cf-249	0		3.51E+02		0.00E+00	0.00E+00	0.00E+00
Cf-252	38.27	1.03E-09	2.65E+00	2.11E-10	2.47E-04	2.47E-08	4.11E-09
Cm-240	0		7.39E-02		0.00E+00	0.00E+00	0.00E+00
Cm-242	0		1.63E+02		0.00E+00	0.00E+00	0.00E+00
Cm-243	10330.07	2.79E-07	2.91E+01	2.42E-07	2.83E-01	2.83E-05	4.71E-06
Cm-244	36370.20	9.83E-07	1.81E+01	7.79E-07	9.11E-01	9.11E-05	1.52E-05
Cm-245	0		8.50E+03		0.00E+00	0.00E+00	0.00E+00
Cm-246	0		4.73E+03		0.00E+00	0.00E+00	0.00E+00
Cm-248	0		3.40E+05		0.00E+00	0.00E+00	0.00E+00
Co-60	33519.35	9.06E-07	5.27E+00	4.07E-07	4.76E-01	4.76E-05	7.94E-06
Cs-134	4893.24	1.32E-07	2.06E+00	1.71E-08	2.00E-02	2.00E-06	3.33E-07
Cs-137	577076.13	1.56E-05	3.01E+01	1.36E-05	1.59E+01	1.59E-03	2.64E-04
Es-253	0		5.60E-02		0.00E+00	0.00E+00	0.00E+00
Es-254m	0		4.48E-03		0.00E+00	0.00E+00	0.00E+00
Eu-152	131531.25	3.55E-06	1.35E+01	2.60E-06	3.04E+00	3.04E-04	5.07E-05
Eu-154	69723.86	1.88E-06	8.59E+00	1.15E-06	1.35E+00	1.35E-04	2.25E-05
Eu-155	21166.34	5.72E-07	4.76E+00	2.36E-07	2.76E-01	2.76E-05	4.60E-06
Fe-59	0		1.22E-01		0.00E+00	0.00E+00	0.00E+00
Gd-153	0		6.61E-01		0.00E+00	0.00E+00	0.00E+00
H-3	34.73	9.39E-10	1.23E+01	6.66E-10	7.80E-04	7.80E-08	1.30E-08
I-129	0		1.57E+07		0.00E+00	0.00E+00	0.00E+00
I-131	0		2.20E-02		0.00E+00	0.00E+00	0.00E+00
Nb-95	2296.02	6.21E-08	9.58E-02	4.87E-27	5.70E-21	5.70E-25	9.50E-26
Ni-63	0		1.00E+02		0.00E+00	0.00E+00	0.00E+00
Np-237	7.77	2.10E-10	2.14E+06	2.10E-10	2.46E-04	2.46E-08	4.09E-09
Pa-231	0		3.28E+04		0.00E+00	0.00E+00	0.00E+00
Pm-147	0		2.62E+00		0.00E+00	0.00E+00	0.00E+00
Po-209	0		1.02E+02		0.00E+00	0.00E+00	0.00E+00
Pu-238	6198.78	1.68E-07	8.77E+01	1.60E-07	1.87E-01	1.87E-05	3.11E-06
Pu-239	3031.95	8.19E-08	2.41E+04	8.19E-08	9.59E-02	9.59E-06	1.60E-06
Pu-240	950.28	2.57E-08	6.56E+03	2.57E-08	3.00E-02	3.00E-06	5.01E-07
Pu-241	10716.94	2.90E-07	1.44E+01	2.16E-07	2.53E-01	2.53E-05	4.22E-06
Pu-242	2.05	5.54E-11	3.73E+05	5.54E-11	6.48E-05	6.48E-09	1.08E-09
Pu-244	0.19	5.14E-12	8.00E+05	5.14E-12	6.01E-06	6.01E-10	1.00E-10
Ra-223	0		3.13E-02		0.00E+00	0.00E+00	0.00E+00
Ra-226	0		1.60E+03		0.00E+00	0.00E+00	0.00E+00
Ru-106	18256.71	4.93E-07	1.02E+00	7.92E-09	9.27E-03	9.27E-07	1.54E-07
Sb-125	0		2.76E+00		0.00E+00	0.00E+00	0.00E+00
Sr-90	1850860.69	5.00E-05	2.88E+01	4.32E-05	5.06E+01	5.06E-03	8.43E-04
Tc-99	372.46	1.01E-08	2.11E+05	1.01E-08	1.18E-02	1.18E-06	1.96E-07
Te-123	0		1.00E+08		0.00E+00	0.00E+00	0.00E+00
Te-123m	0		3.28E-01		0.00E+00	0.00E+00	0.00E+00
Th-230	0		7.54E+04		0.00E+00	0.00E+00	0.00E+00

Table B.3-4 (continued)

Radionuclide	Radionuclide (Bq/g)	Composition[a] (Ci/g)	Radionuclide[b] half life, $t_{1/2}$ (year)	Decayed radionuclide composition (Ci/g)	Uncontrolled[c,d] radionuclide emissions (Ci)	Radionuclide emissions after control: Project life[e] (Ci)	Radionuclide emissions after control: Annualized[f] (Ci/year)
Th-232	25.88	6.99E-10	1.41E+10	6.99E-10	8.18E-04	8.18E-08	1.36E-08
U-232	0		6.89E+01		0.00E+00	0.00E+00	0.00E+00
U-233	2136.82	5.78E-08	1.59E+05	5.78E-08	6.76E-02	6.76E-06	1.13E-06
U-234	950.46	2.57E-08	2.46E+05	2.57E-08	3.01E-02	3.01E-06	5.01E-07
U-235	24.86	6.72E-10	3.80E+06	6.72E-10	7.86E-04	7.86E-08	1.31E-08
U-236	2.07	5.59E-11	2.34E+07	5.59E-11	6.55E-05	6.55E-09	1.09E-09
U-238	943.56	2.55E-08	4.47E+09	2.55E-08	2.98E-02	2.98E-06	4.97E-07
U-239	0		4.46E-05		0.00E+00	0.00E+00	0.00E+00
Y-90	0		7.31E-03		0.00E+00	0.00E+00	0.00E+00
Zn-65	0		6.69E-01		0.00E+00	0.00E+00	0.00E+00
Zr-95	26302.35	7.11E-07	1.75E-01	2.47E-17	2.89E-11	2.89E-15	4.82E-16

[a]Composition data obtained from U.S. Department of Energy Report, *Statistical Description of Liquid Low-Level Waste System Transuranic Wastes at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, Document No. ORNL/TM-13351.

[b]The equation for estimating radionuclide decay is:

$$A = Ao \times \exp -[\ln(2)/ t_{1/2} * T] ,$$

where:

A = the decayed radionuclide composition;

Ao = the original concentration in Ci/g;

$t_{1/2}$ = the half-life of the specific radionuclide as obtained from the web site www.dne.bnl.gov/CoN/index.html;

T = the time between sample analysis (December 1996) to the time of process startup (January 2003), which is 6.08 years.

[c]An emissions factor for the amount of airborne radionuclides is obtained from Appendix D to 40 *Code of Federal Regulations (CFR)* 61:

Emissions Factor = 0.001 fraction of the amount used.

[d]The uncontrolled emissions are estimated by the following equation:

Uncontrolled Rate = Retrievable Curies × Emissions Factor.

[e]The emissions after control are estimated by using the U.S. Environmental Protection Agency adjustment factors from Table 1 of Appendix D to 40 *CFR* 61. The adjustment factors are:

Cementation High-Efficiency Particulate Air (HEPA) Filters System 1 Adjustment Factor = 0.01

Cementation HEPA Filters System 2 Adjustment Factor = 0.01

[f]The annualized emissions are calculated by taking the controlled emissions from the project life and dividing by the length of time (in years) the remote-handled (RH) sludges will be processed (6 years).

[g]Emissions of ^{241}Am were calculated based on decay of the radionuclide composition and as a decay product of ^{241}Pu.

Bq = becquerel.

Ci = curie.

g = gram.

TRU = transuranic.

Table B.3-5. Estimated radionuclide emissions for waste remediation of supernate for the Cementation Alternative

Radionuclide	Radionuclide composition[a] (Ci/g)	Radionuclide[b] half life, $t_{1/2}$ (year)	Decayed radionuclide composition (Ci/g)	Uncontrolled[c,d] radionuclide emissions (Ci)	Radionuclide emissions after control	
					Project life[e] (Ci)	Annualized[f] (Ci/year)
Ac-227		2.18E+01			0.00E+00	0.00E+00
Ag-110		7.80E-07			0.00E+00	0.00E+00
Ag-110m		6.84E-01			0.00E+00	0.00E+00
Am-241[g]		4.32E+02		1.66E-05	1.66E-09	2.97E-10
Am-243		7.37E+03			0.00E+00	0.00E+00
Au-196		1.69E-02			0.00E+00	0.00E+00
Au-198		7.38E-03		0.00E+00	0.00E+00	0.00E+00
Bk-249		8.76E-01		0.00E+00	0.00E+00	0.00E+00
C-14	2.24E-09	5.73E+03	2.24E-09	4.12E-03	4.12E-07	7.37E-08
Ce-144	3.07E-08	7.80E-01	2.89E-10	5.31E-04	5.31E-08	9.49E-09
Cf-249		3.51E+02		0.00E+00	0.00E+00	0.00E+00
Cf-252	4.86E-11	2.65E+00	1.23E-11	2.27E-05	2.27E-09	4.05E-10
Cm-240		7.39E-02		0.00E+00	0.00E+00	0.00E+00
Cm-242		1.63E+02		0.00E+00	0.00E+00	0.00E+00
Cm-243		2.91E+01		0.00E+00	0.00E+00	0.00E+00
Cm-244	2.08E-08	1.81E+01	1.70E-08	3.12E-02	3.12E-06	5.58E-07
Cm-245		8.50E+03		0.00E+00	0.00E+00	0.00E+00
Cm-246		4.73E+03		0.00E+00	0.00E+00	0.00E+00
Cm-248		3.40E+05		0.00E+00	0.00E+00	0.00E+00
Co-60	1.97E-08	5.27E+00	9.88E-09	1.82E-02	1.82E-06	3.25E-07
Cs-134	2.09E-07	2.06E+00	3.58E-08	6.58E-02	6.58E-06	1.18E-06
Cs-137	6.44E-06	3.01E+01	5.71E-06	1.05E+01	1.05E-03	1.87E-04
Es-253		5.60E-02		0.00E+00	0.00E+00	0.00E+00
Es-254m		4.48E-03		0.00E+00	0.00E+00	0.00E+00
Eu-152	9.31E-08	1.35E+01	7.11E-08	1.31E-01	1.31E-05	2.34E-06
Eu-154	3.88E-08	8.59E+00	2.54E-08	4.68E-02	4.68E-06	8.35E-07
Eu-155	2.44E-08	4.76E+00	1.14E-08	2.09E-02	2.09E-06	3.73E-07
Fe-59		1.22E-01		0.00E+00	0.00E+00	0.00E+00
Gd-153		6.61E-01		0.00E+00	0.00E+00	0.00E+00
H-3	3.98E-09	1.23E+01	2.96E-09	5.45E-03	5.45E-07	9.74E-08
I-129	3.53E-12	1.57E+07	3.53E-12	6.49E-06	6.49E-10	1.16E-10
I-131		2.20E-02		0.00E+00	0.00E+00	0.00E+00
Nb-95	3.05E-09	9.58E-02	9.71E-26	1.79E-19	1.79E-23	3.19E-24
Ni-63		1.00E+02		0.00E+00	0.00E+00	0.00E+00
Np-237		2.14E+06		0.00E+00	0.00E+00	0.00E+00
Pa-231		3.28E+04		0.00E+00	0.00E+00	0.00E+00
Pm-147		2.62E+00		0.00E+00	0.00E+00	0.00E+00
Po-209		1.02E+02		0.00E+00	0.00E+00	0.00E+00
Pu-238	9.92E-11	8.77E+01	9.51E-11	1.75E-04	1.75E-08	3.13E-09
Pu-239	8.18E-11	2.41E+04	8.18E-11	1.50E-04	1.50E-08	2.69E-09
Pu-240	7.97E-11	6.56E+03	7.96E-11	1.47E-04	1.47E-08	2.62E-09
Pu-241	1.57E-09	1.44E+01	1.22E-09	2.24E-03	2.24E-07	4.01E-08
Pu-242	4.00E-12	3.73E+05	4.00E-12	7.35E-06	7.35E-10	1.31E-10
Pu-244	4.70E-13	8.00E+05	4.70E-13	8.65E-07	8.65E-11	1.54E-11
Ra-223		3.13E-02		0.00E+00	0.00E+00	0.00E+00
Ra-226		1.60E+03		0.00E+00	0.00E+00	0.00E+00
Ru-106	5.44E-08	1.02E+00	1.53E-09	2.82E-03	2.82E-07	5.04E-08

Table B.3-5 (continued)

Radionuclide	Radionuclide composition[a] (Ci/g)	Radionuclide[b] half life, $t_{1/2}$ (year)	Decayed radionuclide composition (Ci/g)	Uncontrolled[c,d] radionuclide emissions (Ci)	Radionuclide emissions after control	
					Project life[e] (Ci)	Annualized[f] (Ci/year)
Sb-125		2.76E+00		0.00E+00	0.00E+00	0.00E+00
Sr-90	2.59E-07	2.88E+01	2.28E-07	4.20E-01	4.20E-05	7.50E-06
Tc-99	2.70E-08	2.11E+05	2.70E-08	4.97E-02	4.97E-06	8.88E-07
Te-123		1.00E+08		0.00E+00	0.00E+00	0.00E+00
Te-123m		3.28E-01		0.00E+00	0.00E+00	0.00E+00
Th-230		7.54E+04		0.00E+00	0.00E+00	0.00E+00
Th-232	9.40E-13	1.41E+10	9.40E-13	1.73E-06	1.73E-10	3.09E-11
U-232	4.70E-10	6.89E+01	4.46E-10	8.20E-04	8.20E-08	1.46E-08
U-233	3.36E-09	1.59E+05	3.36E-09	6.19E-03	6.19E-07	1.11E-07
U-234	6.82E-11	2.46E+05	6.82E-11	1.25E-04	1.25E-08	2.24E-09
U-235	2.82E-12	3.80E+06	2.82E-12	5.19E-06	5.19E-10	9.27E-11
U-236	1.65E-12	2.34E+07	1.65E-12	3.03E-06	3.03E-10	5.41E-11
U-238	8.98E-11	4.47E+09	8.98E-11	1.65E-04	1.65E-08	2.95E-09
U-239		4.46E-05		0.00E+00	0.00E+00	0.00E+00
Y-90		7.31E-03		0.00E+00	0.00E+00	0.00E+00
Zn-65		6.69E-01		0.00E+00	0.00E+00	0.00E+00
Zr-95	3.47E-09	1.75E-01	3.23E-18	5.95E-12	5.95E-16	1.06E-16

[a]Composition data obtained from U.S. Department of Energy Report, *Statistical Description of Liquid Low-Level Waste System Transuranic Wastes at Oak Ridge National Laboratory, Oak Ridge, Tennessee,* Document No. ORNL/TM-13351, Addendum 1.

[b]The equation for estimating radionuclide decay is:

$$A = Ao \times \exp -[\ln(2)/ t_{1/2} * T] ,$$

where:

A = the decayed radionuclide composition;

Ao = the original concentration in Ci/g;

$t_{1/2}$ = the half-life of the specific radionuclide as obtained from the web site www.dne.bnl.gov/CoN/index.html;

T = the time between sample analysis (October 1997) to the time of process startup (January 2003), which is 5.25 years.

[c]An emissions factor for the amount of airborne radionuclides is obtained from Appendix D to 40 *Code of Federal Regulations (CRF)* 61:

Emissions Factor = 0.001 fraction of the amount used.

[d]The uncontrolled emissions are estimated by the following equation:

Uncontrolled Rate = Retrievable Curies × Emissions Factor.

[e]The emissions after control are estimated by using the U.S. Environmental Protection Agency adjustment factors from Table 1 of Appendix D to 40 *CFR* 61. The adjustment factors are:

Cementation High-Efficiency Particulate Air (HEPA) Filters System 1 Adjustment Factor = 0.01

Cementation HEPA Filters System 2 Adjustment Factor = 0.01

[f]The annualized emissions are calculated by taking the controlled emissions from the project life and dividing by the length of time (in years) the remote-handled (RH) sludges will be processed (6 years).

[g]Emissions of ^{241}Am were calculated based on decay of the radionuclide composition and as a decay product of ^{241}Pu.

Ci = curie.

g = gram.

Table B.3-6. Estimated radionuclide emissions TRU waste remediation of CH solids for the Cementation Alternative

Radionuclide	Radionuclide composition[a] (Ci)	Radionuclide[b] half life, $t_{1/2}$ (year)	Decayed radionuclide composition (Ci)	Uncontrolled[c,d] radionuclide emissions (Ci)	Radionuclide emissions after control	
					Project life[e] (Ci)	Annualized[f] (Ci/year)
Ac-227	1.10E-05	2.18E+01	8.95E-06	8.95E-12	8.95E-18	3.58E-18
Ag-110		7.80E-07				
Ag-110m		6.84E-01				
Am-241[g]	5.77E+02	4.32E+02	5.92E+02	5.92E-04	5.92E-10	2.37E-10
Am-243	1.16E+01	7.37E+03	1.16E+01	1.16E-05	1.16E-11	4.63E-12
Au-196		1.69E-02				
Au-198		7.38E-03				
Bk-249	5.77E+00	8.76E-01	3.16E-02	3.16E-08	3.16E-14	1.27E-14
C-14	1.88E-04	5.73E+03	1.87E-04	1.87E-10	1.87E-16	7.50E-17
Ce-144		7.80E-01				
Cf-249	1.68E-02	3.51E+02	1.66E-02	1.66E-08	1.66E-14	6.62E-15
Cf-252	2.09E+01	2.65E+00	3.73E+00	3.73E-06	3.73E-12	1.49E-12
Cm-240	1.10E-03	7.39E-02	1.73E-30	1.73E-36	1.73E-42	6.94E-43
Cm-242	7.46E+01	1.63E+02	7.25E+01	7.25E-05	7.25E-11	2.90E-11
Cm-243		2.91E+01				
Cm-244	2.57E+03	1.81E+01	2.00E+03	2.00E-03	2.00E-09	7.99E-10
Cm-245	3.39E-03	8.50E+03	3.39E-03	3.39E-09	3.39E-15	1.35E-15
Cm-246	1.10E-05	4.73E+03	1.10E-05	1.10E-11	1.10E-17	4.41E-18
Cm-248	2.90E-02	3.40E+05	2.90E-02	2.90E-08	2.90E-14	1.16E-14
Co-60	4.30E-03	5.27E+00	1.81E-03	1.81E-09	1.81E-15	7.24E-16
Cs-134		2.06E+00				
Cs-137	3.31E+03	3.01E+01	2.84E+03	2.84E-03	2.84E-09	1.14E-09
Es-253	8.83E+00	5.60E-02	3.76E-35	3.76E-41	3.76E-47	1.50E-47
Es-254m	1.20E+01	4.48E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Eu-152	7.17E-04	1.35E+01	5.12E-04	5.12E-10	5.12E-16	2.05E-16
Eu-154		8.59E+00	0.00E+00			
Eu-155		4.76E+00				
Fe-59	4.42E+00	1.22E-01	2.57E-16	2.57E-22	2.57E-28	1.03E-28
Gd-153		6.61E-01				
H-3		1.23E+01				
I-129		1.57E+07				
I-131		2.20E-02				
Nb-95		9.58E-02				
Ni-63	1.22E-04	1.00E+02	1.17E-04	1.17E-10	1.17E-16	4.68E-17
Np-237	7.06E-01	2.14E+06	7.06E-01	7.06E-07	7.06E-13	2.82E-13
Pa-231	3.48E-01	3.28E+04	3.48E-01	3.48E-07	3.48E-13	1.39E-13
Pm-147	5.13E+00	2.62E+00	9.00E-01	9.00E-07	9.00E-13	3.60E-13
Po-209	2.21E-06	1.02E+02	2.11E-06	2.11E-12	2.11E-18	8.44E-19
Pu-238	4.26E+03	8.77E+01	4.04E+03	4.04E-03	4.04E-09	1.62E-09
Pu-239	1.13E+03	2.41E+04	1.13E+03	1.13E-03	1.13E-09	4.50E-10
Pu-240	1.06E+03	6.56E+03	1.06E+03	1.06E-03	1.06E-09	4.25E-10
Pu-241	3.19E+03	1.44E+01	2.32E+03	2.32E-03	2.32E-09	9.29E-10
Pu-242	2.64E-01	3.73E+05	2.64E-01	2.64E-07	2.64E-13	1.05E-13
Pu-244		8.00E+05				
Ra-223	1.32E-03	3.13E-02	6.89E-67	6.89E-73	6.89E-79	2.76E-79
Ra-226	1.78E+00	1.60E+03	1.77E+00	1.77E-06	1.77E-12	7.09E-13
Ru-106		1.02E+00				

Table B.3-6 (continued)

Radionuclide	Radionuclide composition[a] (Ci)	Radionuclide[b] half life, $t_{1/2}$ (year)	Decayed radionuclide composition (Ci)	Uncontrolled[c,d] radionuclide emissions (Ci)	Radionuclide emissions after control: Project life[e] (Ci)	Radionuclide emissions after control: Annualized[f] (Ci/year)
Sb-125		2.76E+00				
Sr-90	1.99E+03	2.88E+01	1.70E+03	1.70E-03	1.70E-09	6.78E-10
Tc-99	1.96E+01	2.11E+05	1.96E+01	1.96E-05	1.96E-11	7.86E-12
Te-123	2.87E-05	1.00E+08	2.87E-05	2.87E-11	2.87E-17	1.15E-17
Te-123m	8.77E-04	3.28E-01	8.02E-10	8.02E-16	8.02E-22	3.21E-22
Th-230	1.32E-05	7.54E+04	1.32E-05	1.32E-11	1.32E-17	5.30E-18
Th-232	8.73E-04	1.41E+10	8.73E-04	8.73E-10	8.73E-16	3.49E-16
U-232	3.48E-01	6.89E+01	3.25E-01	3.25E-07	3.25E-13	1.30E-13
U-233	1.11E+02	1.59E+05	1.11E+02	1.11E-04	1.11E-10	4.46E-11
U-234	1.84E+01	2.46E+05	1.84E+01	1.84E-05	1.84E-11	7.37E-12
U-235	7.87E-03	3.80E+06	7.87E-03	7.87E-09	7.87E-15	3.15E-15
U-236	1.07E-04	2.34E+07	1.07E-04	1.07E-10	1.07E-16	4.29E-17
U-238	4.79E-02	4.47E+09	4.79E-02	4.79E-08	4.79E-14	1.92E-14
U-239		4.46E-05				
Y-90	1.99E+03	7.31E-03	2.14E-268	2.14E-274	2.14E-280	8.55E-281
Zn-65	3.09E-03	6.69E-01	3.38E-06	3.38E-12	3.38E-18	1.35E-18
Zr-95		1.75E-01				
TRU Activity	7.06E+03		6.84E+03	6.84E-03	6.84E-09	2.74E-09

[a]Composition data obtained from U.S. Department of Energy Memorandum, "TRU Waste Baseline Inventory Report for Oak Ridge," June 1996. The data were then scaled up from 906.22 m^3 to 1000 m^3.

[b]The equation for estimating radionuclide decay is:

$$A = Ao \times \exp -[\ln(2)/ t_{1/2} * T] ,$$

where:

A = the decayed radionuclide composition;

Ao = the original concentration in Ci/g;

$t_{1/2}$ = the half-life of the specific radionuclide as obtained from the web site www.dne.bnl.gov/CoN/index.html;

T = the time between sample analysis (June 1996) to the time remote-handled (RH) processing begins (January 2003), which is 6.58 years.

[c]An emissions factor for the amount of airborne radionuclides is obtained from Appendix D to 40 *Code of Federal Regulations (CRF)* 61:

0.000001 fraction of the amount used.

[d]The uncontrolled emissions are estimated by the following equation:

$$\text{Uncontrolled Rate} = \text{Retrievable Curies} \times \text{Emissions Factor.}$$

[e]The emissions after control are estimated by using the U.S. Environmental Protection Agency adjustment factors from Table 1 of Appendix D to 40 *CFR* 61. The adjustment factors are:

Glovebox/Hot Cell High-Efficiency Particulate Air (HEPA) Filters Adjustment Factor	=	0.01
Glovebox/Hot Cell HEPA Filters Adjustment Factor	=	0.10
Primary HEPA Filters Adjustment Factor	=	0.01
Secondary HEPA Filters Adjustment Factor	=	0.01

[f]The annualized emissions are calculated by taken the controlled emissions from the project life and dividing by the length of time (in years) the contact-handled (CH) solids will be processed (2.5 years).

[g]Emissions of ^{241}Am were calculated based on decay of the radionuclide composition and as a decay product of ^{241}Pu.

Ci = curie.

TRU = transuranic.

Table B.3-7. Estimated radionuclide emissions for waste remediation of RH solids for the Cementation Alternative

Radionuclide	Radionuclide composition[a] (Ci)	Radionuclide[b] half life, $t_{1/2}$ (year)	Decayed radionuclide composition (Ci)	Uncontrolled[c,d] radionuclide emissions (Ci)	Radionuclide emissions after control: Project life[e] (Ci)	Radionuclide emissions after control: Annualized[f] (Ci/year)
Ac-227	1.12E-03	2.18E+01	8.35E-04	8.35E-10	8.35E-16	2.78E-16
Ag-110		7.80E-07			0.00E+00	0.00E+00
Ag-110m		6.84E-01			0.00E+00	0.00E+00
Am-241[g]	4.02E+01	4.32E+02	3.96E+01	3.96E-05	3.96E-11	1.32E-11
Am-243	9.99E-05	7.37E+03	9.98E-05	9.98E-11	9.98E-17	3.33E-17
Au-196		1.69E-02			0.00E+00	0.00E+00
Au-198		7.38E-03			0.00E+00	0.00E+00
Bk-249	2.00E-04	8.76E-01	1.52E-07	1.52E-13	1.52E-19	5.05E-20
C-14		5.73E+03			0.00E+00	0.00E+00
Ce-144		7.80E-01			0.00E+00	0.00E+00
Cf-249	1.51E-02	3.51E+02	1.48E-02	1.48E-08	1.48E-14	4.93E-15
Cf-252	5.20E+01	2.65E+00	4.84E+00	4.84E-06	4.84E-12	1.61E-12
Cm-240		7.39E-02			0.00E+00	0.00E+00
Cm-242		1.63E+02			0.00E+00	0.00E+00
Cm-243		2.91E+01			0.00E+00	0.00E+00
Cm-244	4.99E+02	1.81E+01	3.53E+02	3.53E-04	3.53E-10	1.18E-10
Cm-245		8.50E+03			0.00E+00	0.00E+00
Cm-246		4.73E+03			0.00E+00	0.00E+00
Cm-248		3.40E+05			0.00E+00	0.00E+00
Co-60	7.81E+00	5.27E+00	2.37E+00	2.37E-06	2.37E-12	7.89E-13
Cs-134		2.06E+00			0.00E+00	0.00E+00
Cs-137	1.33E+02	3.01E+01	1.08E+02	1.08E-04	1.08E-10	3.61E-11
Es-253		5.60E-02			0.00E+00	0.00E+00
Es-254m		4.48E-03			0.00E+00	0.00E+00
Eu-152		1.35E+01			0.00E+00	0.00E+00
Eu-154		8.59E+00			0.00E+00	0.00E+00
Eu-155		4.76E+00			0.00E+00	0.00E+00
Fe-59		1.22E-01			0.00E+00	0.00E+00
Gd-153		6.61E-01			0.00E+00	0.00E+00
H-3		1.23E+01			0.00E+00	0.00E+00
I-129		1.57E+07			0.00E+00	0.00E+00
I-131	5.00E-01	2.20E-02	2.85E-125	2.85E-131	2.85E-137	9.51E-138
Nb-95		9.58E-02			0.00E+00	0.00E+00
Ni-63		1.00E+02			0.00E+00	0.00E+00
Np-237	2.00E-01	2.14E+06	2.00E-01	2.00E-07	2.00E-13	6.66E-14
Pa-231		3.28E+04			0.00E+00	0.00E+00
Pm-147		2.62E+00			0.00E+00	0.00E+00
Po-209		1.02E+02			0.00E+00	0.00E+00
Pu-238	2.94E+01	8.77E+01	2.74E+01	2.74E-05	2.74E-11	9.14E-12
Pu-239	7.31E+00	2.41E+04	7.30E+00	7.30E-06	7.30E-12	2.43E-12
Pu-240	9.08E-06	6.56E+03	9.08E-06	9.08E-12	9.08E-18	3.03E-18
Pu-241	9.27E+00	1.44E+01	5.99E+00	5.99E-06	5.99E-12	2.00E-12
Pu-242		3.73E+05			0.00E+00	0.00E+00
Pu-244		8.00E+05			0.00E+00	0.00E+00
Ra-223	1.12E-03	3.13E-02	5.25E-91	5.25E-97	5.25E-103	1.75E-103
Ra-226		1.60E+03			0.00E+00	0.00E+00
Ru-106		1.02E+00			0.00E+00	0.00E+00

Table B.3-7 (continued)

Radionuclide	Radionuclide composition[a] (Ci)	Radionuclide[b] half life, $t_{1/2}$ (year)	Decayed radionuclide composition (Ci)	Uncontrolled[c,d] radionuclide emissions (Ci)	Radionuclide emissions after control Project life[e] (Ci)	Annualized[f] (Ci/year)
Sb-125		2.76E+00			0.00E+00	0.00E+00
Sr-90	4.83E+01	2.88E+01	3.88E+01	3.88E-05	3.88E-11	1.29E-11
Tc-99		2.11E+05			0.00E+00	0.00E+00
Te-123		1.00E+08			0.00E+00	0.00E+00
Te-123m		3.28E-01			0.00E+00	0.00E+00
Th-230		7.54E+04			0.00E+00	0.00E+00
Th-232	1.12E-03	1.41E+10	1.12E-03	1.12E-09	1.12E-15	3.72E-16
U-232		6.89E+01			0.00E+00	0.00E+00
U-233	4.51E+00	1.59E+05	4.51E+00	4.51E-06	4.51E-12	1.50E-12
U-234		2.46E+05			0.00E+00	0.00E+00
U-235	4.30E-04	3.80E+06	4.30E-04	4.30E-10	4.30E-16	1.43E-16
U-236		2.34E+07			0.00E+00	0.00E+00
U-238	9.99E-05	4.47E+09	9.99E-05	9.99E-11	9.99E-17	3.33E-17
U-239		4.46E-05			0.00E+00	0.00E+00
Y-90	4.83E+01	7.31E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Zn-65		6.69E-01			0.00E+00	0.00E+00
Zr-95		1.75E-01			0.00E+00	0.00E+00

[a]Composition data obtained from U.S. Department of Energy Memorandum, "TRU Waste Baseline Inventory Report for Oak Ridge," June 1996.

[b]The equation for estimating radionuclide decay is:

$$A = Ao \times \exp -[\ln(2)/ t_{1/2} * T] ,$$

where:

A = the decayed radionuclide composition;
Ao = the original concentration in Ci/g;
$t_{1/2}$ = the half-life of the specific radionuclide as obtained from the web site www.dne.bnl.gov/CoN/index.html;
T = the time between sample analysis (June 1996) to the time remote-handled (RH) processing begins (July 2005), which is 9.08 years.

[c]An emissions factor for the amount of airborne radionuclides is obtained from Appendix D to 40 *Code of Federal Regulations (CFR)* 61:

Emissions Factor = 0.000001 fraction of the amount used.

[d]The uncontrolled emissions are estimated by the following equation:

Uncontrolled Rate = Retrievable Curies × Emissions Factor.

[e]The emissions after control are estimated by using the U.S. Environmental Protection Agency adjustment factors from Table 1 of Appendix D to 40 *CFR* 61. The adjustment factors are:

Glovebox/Hot Cell High-Efficiency Particulate Air (HEPA) Filters Adjustment Factor	=	0.01
Glovebox/Hot Cell HEPA Filters Adjustment Factor	=	0.10
Primary HEPA Filters Adjustment Factor	=	0.01
Secondary HEPA Filters Adjustment Factor	=	0.01

[f]The annualized emissions are calculated by taking the controlled emissions from the project life and dividing by the length of time (in years) the RH solids will be processed (1.5 years).

[g]Emissions of ^{241}Am were calculated based on decay of the radionuclide composition and as a decay product of ^{241}Pu.

Ci = curie.

Table B.3-8. Summary of TRU waste remediation hourly particulate emissions (lb/h) for the Cementation Alternative

Metals	Class.	Average hourly emissions (lbs/h) Sludge	Supernate	Sludge and supernate	CH solids	RH solids	CH/RH solids	Total	Maximum hourly emissions[a] (lbs/h)	Average annual emissions[b] (tons/year)
TSP		4.29E-03	4.29E-03	4.29E-03	1.71E-04	1.71E-04	1.71E-04	4.29E-03	5.37E-03	3.31E-03
Total HAP		4.76E-06	6.04E-08	1.75E-06	2.26E-12	5.16E-13	1.31E-12	4.57E-06	5.72E-06	1.29E-06
Silver (Ag)		3.38E-08	7.45E-10	1.26E-08	5.25E-14	8.75E-15	2.86E-14	3.25E-08	4.06E-08	9.34E-09
Aluminum (Al)		3.43E-05	5.25E-08	1.24E-05				3.30E-05	4.13E-05	9.16E-06
Arsenic (As)	HAP	7.36E-08	7.49E-09	3.13E-08				7.08E-08	8.84E-08	2.31E-08
Boron (B)		5.36E-08	4.70E-09	2.23E-08				5.15E-08	6.44E-08	1.65E-08
Barium (Ba)		4.01E-07	6.82E-09	1.49E-07				3.86E-07	4.82E-07	1.10E-07
Beryllium (Be)	HAP	7.84E-09	3.73E-11	2.84E-09				7.54E-09	9.42E-09	2.10E-09
Bismuth (Bi)		0.00E+00	1.01E-08	6.45E-09				0.00E+00	0.00E+00	4.77E-09
Calcium (Ca)		1.03E-04	5.08E-06	4.04E-05				9.93E-05	1.24E-04	2.99E-05
Cadmium (Cd)	HAP	3.94E-08	1.45E-09	1.51E-08	2.10E-13	4.37E-14	1.19E-13	3.79E-08	4.74E-08	1.12E-08
Cerium (Ce)		0.00E+00	1.38E-09	8.83E-10				0.00E+00	0.00E+00	6.54E-10
Cobalt (Co)	HAP	1.56E-08	5.96E-10	5.99E-09				1.50E-08	1.87E-08	4.43E-09
Chromium (Cr)	HAP	1.45E-06	2.54E-08	5.36E-07				1.39E-06	1.74E-06	3.97E-07
Cesium (Cs)		1.70E-08	6.71E-09	1.04E-08				1.63E-08	2.04E-08	7.69E-09
Copper (Cu)		2.29E-07	3.20E-09	8.45E-08				2.20E-07	2.75E-07	6.25E-08
Iron (Fe)		1.85E-05	4.06E-08	6.68E-06				1.78E-05	2.22E-05	4.94E-06
Gallium (Ga)		0.00E+00	1.23E-09	7.88E-10				0.00E+00	0.00E+00	5.83E-10
Mercury (Hg)	HAP	2.81E-07	2.94E-09	1.03E-07	2.10E-13	4.37E-14	1.19E-13	2.70E-07	3.38E-07	7.62E-08
Iodine (I)		0.00E+00	5.51E-08	3.53E-08				0.00E+00	0.00E+00	2.61E-08
Potassium (K)		2.73E-05	4.22E-05	3.69E-05				2.63E-05	3.29E-05	2.73E-05
Lanthanum (La)		0.00E+00	1.49E-10	9.55E-11				0.00E+00	0.00E+00	7.07E-11
Lithium (Li)		0.00E+00	9.95E-08	6.37E-08				0.00E+00	0.00E+00	4.71E-08
Magnesium (Mg)		1.74E-05	6.65E-07	6.67E-06				1.67E-05	2.09E-05	4.93E-06
Manganese (Mn)	HAP	4.46E-07	1.23E-09	1.61E-07				4.29E-07	5.36E-07	1.19E-07
Molybdenum (Mo)		0.00E+00	4.62E-09	2.96E-09				0.00E+00	0.00E+00	2.19E-09
Sodium (Na)		1.88E-04	2.04E-04	1.98E-04				1.81E-04	2.26E-04	1.47E-04
Niobium (Nb)		0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00
Nickel (Ni)	HAP	2.72E-07	4.58E-09	1.01E-07				2.61E-07	3.27E-07	7.45E-08
Phosphorus (P)		5.64E-05	2.60E-07	2.04E-05				5.42E-05	6.77E-05	1.51E-05
Lead (Pb)	HAP	1.98E-06	9.43E-09	7.18E-07	1.84E-12	4.29E-13	1.07E-12	1.90E-06	2.38E-06	5.31E-07
Rubidium (Rb)		0.00E+00	4.40E-09	2.82E-09				0.00E+00	0.00E+00	2.08E-09
Antimony (Sb)	HAP	1.17E-07	3.69E-09	4.44E-08				1.12E-07	1.41E-07	3.29E-08
Selenium (Se)	HAP	8.03E-08	3.50E-09	3.11E-08				7.71E-08	9.64E-08	2.30E-08
Silicon (Si)		9.74E-06	2.05E-07	3.63E-06				9.36E-06	1.17E-05	2.69E-06
Tin (Sn)		0.00E+00	1.42E-09	9.07E-10				0.00E+00	0.00E+00	6.71E-10
Strontium (Sr)		3.80E-07	4.80E-08	1.67E-07				3.66E-07	4.57E-07	1.24E-07
Thorium (Th)		2.51E-05	4.10E-08	9.07E-06				2.42E-05	3.02E-05	6.71E-06
Titanium (Ti)		0.00E+00	1.90E-09	1.22E-09				0.00E+00	0.00E+00	9.01E-10
Thallium (Th)		5.16E-08	6.60E-09	2.28E-08				4.96E-08	6.20E-08	1.69E-08
Uranium (U)		2.06E-04	1.62E-06	7.52E-05				1.98E-04	2.48E-04	5.57E-05
Vanadium (V)		1.23E-08	3.35E-10	4.65E-09				1.19E-08	1.48E-08	3.44E-09
Tungsten (W)		0.00E+00	1.71E-09	1.10E-09				0.00E+00	0.00E+00	8.13E-10
Zinc (Zn)		5.71E-07	5.18E-08	2.38E-07				5.49E-07	6.86E-07	1.76E-07
Zirconium (Zr)		0.00E+00	1.12E-10	7.16E-11				0.00E+00	0.00E+00	5.30E-11

[a]Maximum hourly is estimated by multiplying the average hourly rate by 1.25.
[b]Average annual emissions are the average hourly emissions multiplied by the operational hours and then divided by 6 years.
h = hour. HAP = hazardous air pollutant. lb = pound. TRU = transuranic. TSP = total suspended particulate.

Table B.3-9. Estimated metals emissions for remediation of the TRU sludge for the Cementation Alternative

Metals	Metals[a] mass fraction[a] (g/total g)	Metals concentration[b] (g/dscf)	Uncontrolled metal emissions for the project[c] (g)	Uncontrolled metal emissions for the project[c] (lbs)	Emissions after control for the project[d] (g)	Emissions after control for the project[d] (lbs)	Average hourly emissions[e] (lbs/h)
TSP		1.30E-01	6.21E+07	1.37E+05	6.21E+03	1.37E+01	4.29E-03
Silver (Ag)	7.88E-06	1.02E-06	4.89E+02	1.08E+00	4.89E-02	1.08E-04	3.38E-08
Aluminum (Al)	8.01E-03	1.04E-03	4.97E+05	1.10E+03	4.97E+01	1.10E-01	3.43E-05
Arsenic (As)	1.72E-05	2.23E-06	1.07E+03	2.35E+00	1.07E-01	2.35E-04	7.36E-08
Boron (B)	1.25E-05	1.62E-06	7.76E+02	1.71E+00	7.76E-02	1.71E-04	5.36E-08
Barium (Ba)	9.37E-05	1.21E-05	5.81E+03	1.28E+01	5.81E-01	1.28E-03	4.01E-07
Beryllium (Be)	1.83E-06	2.37E-07	1.14E+02	2.50E-01	1.14E-02	2.50E-05	7.84E-09
Bismuth (Bi)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Calcium (Ca)	2.41E-02	3.12E-03	1.50E+06	3.30E+03	1.50E+02	3.30E-01	1.03E-04
Cadmium (Cd)	9.20E-06	1.19E-06	5.71E+02	1.26E+00	5.71E-02	1.26E-04	3.94E-08
Cerium (Ce)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cobalt (Co)	3.64E-06	4.72E-07	2.26E+02	4.98E-01	2.26E-02	4.98E-05	1.56E-08
Chromium (Cr)	3.37E-04	4.37E-05	2.09E+04	4.62E+01	2.09E+00	4.62E-03	1.45E-06
Cesium (Cs)	3.96E-06	5.13E-07	2.46E+02	5.42E-01	2.46E-02	5.42E-05	1.70E-08
Copper (Cu)	5.35E-05	6.93E-06	3.32E+03	7.32E+00	3.32E-01	7.32E-04	2.29E-07
Iron (Fe)	4.32E-03	5.60E-04	2.68E+05	5.91E+02	2.68E+01	5.91E-02	1.85E-05
Gallium (Ga)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Mercury (Hg)	6.56E-05	8.50E-06	4.07E+03	8.98E+00	4.07E-01	8.98E-04	2.81E-07
Iodine (I)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Potassium (K)	6.38E-03	8.27E-04	3.96E+05	8.73E+02	3.96E+01	8.73E-02	2.73E-05
Lanthanum (La)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lithium (Li)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Magnesium (Mg)	4.05E-03	5.25E-04	2.51E+05	5.54E+02	2.51E+01	5.54E-02	1.74E-05
Manganese (Mn)	1.04E-04	1.35E-05	6.46E+03	1.42E+01	6.46E-01	1.42E-03	4.46E-07
Molybdenum (Mo)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sodium (Na)	4.39E-02	5.69E-03	2.72E+06	6.00E+03	2.72E+02	6.00E-01	1.88E-04
Niobium (Nb)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel (Ni)	6.34E-05	8.22E-06	3.94E+03	8.68E+00	3.94E-01	8.68E-04	2.72E-07
Phosphorus (P)	1.32E-02	1.71E-03	8.17E+05	1.80E+03	8.17E+01	1.80E-01	5.64E-05
Lead (Pb)	4.62E-04	5.99E-05	2.87E+04	6.32E+01	2.87E+00	6.32E-03	1.98E-06
Rubidium (Rb)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Antimony (Sb)	2.73E-05	3.54E-06	1.69E+03	3.73E+00	1.69E-01	3.73E-04	1.17E-07
Selenium (Se)	1.87E-05	2.43E-06	1.16E+03	2.56E+00	1.16E-01	2.56E-04	8.03E-08
Silicon (Si)	2.27E-03	2.95E-04	1.41E+05	3.11E+02	1.41E+01	3.11E-02	9.74E-06
Tin (Sn)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Strontium (Sr)	8.88E-05	1.15E-05	5.51E+03	1.21E+01	5.51E-01	1.21E-03	3.80E-07
Thorium (Th)	5.87E-03	7.60E-04	3.64E+05	8.03E+02	3.64E+01	8.03E-02	2.51E-05
Titanium (Ti)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thallium (Th)	1.21E-05	1.56E-06	7.48E+02	1.65E+00	7.48E-02	1.65E-04	5.16E-08
Uranium (U)	4.82E-02	6.24E-03	2.99E+06	6.59E+03	2.99E+02	6.59E-01	2.06E-04
Vanadium (V)	2.88E-06	3.73E-07	1.79E+02	3.94E-01	1.79E-02	3.94E-05	1.23E-08
Tungsten (W)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table B.3-9 (continued)

Metals	Metals[a] mass fraction[a] (g/total g)	Metals concentration[b] (g/dscf)	Uncontrolled metal emissions for the project[c] (g)	(lbs)	Emissions after control for the project[d] (g)	(lbs)	Average hourly emissions[e] (lbs/h)
Zinc (Zn)	1.33E-04	1.73E-05	8.27E+03	1.82E+01	8.27E-01	1.82E-03	5.71E-07
Zirconium (Zr)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

[a]The data were obtained from U.S. Department of Energy Report, *Statistical Description of Liquid Low-level Waste System Transuranic Wastes at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, Document No. ORNL/TM-13351. An average density of 1.3 g/mL was used for the sludge. Given the volume stated in the request for proposal of 900 m^3 of sludge, there is 1,170,000 kg of sludge mass.

[b]The amount of total suspended particulate (TSP) matter reaching the first exhaust system High-Efficiency Particulate Air (HEPA) filter is assumed to be:

Airborne Particulate Concentration = 1.0 gr/dscf = 0.1296 g/dscf.

[c]The uncontrolled emissions are estimated by the following expression:

Uncontrolled Rate = Exhaust Stream Flowrate × TSP Concentration × Metal Mass Fraction.

The operating schedule was presented from Sect. 2.4. of this Environmental Impact Statement:

The exhaust flow rate is based on obtaining one complete volume change of air in the cementation processing area every 15 min. Given that the hot cell is approximately 50 ft wide × 50 ft long × 15 ft high, the exhaust flowrate is 2500 dscfm.

Air Flow Rate = 2500 dscfm
Process Operating Schedule = 6 years life; 118.5 d/year, 8 h/d; and 60 min/h
Calculated Operating Hours = 5688 h

[d]The two HEPA filtration systems are assumed to have the following removal efficiencies:

HEPA Filter 1 Removal = 99%
HEPA Filter 2 Removal = 99%

[e]The average hourly emissions are calculated by the following expression:

Average Hourly = Pounds Emitted for Project/Project Operating Hours.

d = day.

dscf = dry standard cubic foot.

dscfm = dry standard cubic feet per minute.

g = gram.

gr/dscf = grains per dry standard cubic foot.

h = hour.

TRU = transuranic.

Table B.3-10. Estimated metals emissions for remediation of supernate waste for the Cementation Alternative

Metals	Metals mass fraction[a] (g/total g)	Metals concentration[b] (g/dscf)	Uncontrolled metal emissions for the project[c] (g)	Uncontrolled metal emissions for the project[c] (lbs)	Emissions after control for the project[d] (g)	Emissions after control for the project[d] (lbs)	Average hourly emissions[e] (lbs/h)
TSP		1.30E-01	1.11E+08	2.44E+05	1.11E+04	2.44E+01	4.29E-03
Silver (Ag)	1.74E-07	2.25E-08	1.92E+01	4.24E-02	1.92E-03	4.24E-06	7.45E-10
Aluminum (Al)	1.22E-05	1.59E-06	1.35E+03	2.98E+00	1.35E-01	2.98E-04	5.25E-08
Arsenic (As)	1.75E-06	2.27E-07	1.93E+02	4.26E-01	1.93E-02	4.26E-05	7.49E-09
Boron (B)	1.10E-06	1.42E-07	1.21E+02	2.67E-01	1.21E-02	2.67E-05	4.70E-09
Barium (Ba)	1.59E-06	2.06E-07	1.76E+02	3.88E-01	1.76E-02	3.88E-05	6.82E-09
Beryllium (Be)	8.70E-09	1.13E-09	9.62E-01	2.12E-03	9.62E-05	2.12E-07	3.73E-11
Bismuth (Bi)	2.35E-06	3.04E-07	2.60E+02	5.72E-01	2.60E-02	5.72E-05	1.01E-08
Calcium (Ca)	1.19E-03	1.54E-04	1.31E+05	2.89E+02	1.31E+01	2.89E-02	5.08E-06
Cadmium (Cd)	3.39E-07	4.40E-08	3.75E+01	8.27E-02	3.75E-03	8.27E-06	1.45E-09
Cerium (Ce)	3.22E-07	4.17E-08	3.56E+01	7.84E-02	3.56E-03	7.84E-06	1.38E-09
Cobalt (Co)	1.39E-07	1.80E-08	1.54E+01	3.39E-02	1.54E-03	3.39E-06	5.96E-10
Chromium (Cr)	5.93E-06	7.69E-07	6.56E+02	1.45E+00	6.56E-02	1.45E-04	2.54E-08
Cesium (Cs)	1.57E-06	2.03E-07	1.73E+02	3.82E-01	1.73E-02	3.82E-05	6.71E-09
Copper (Cu)	7.48E-07	9.69E-08	8.27E+01	1.82E-01	8.27E-03	1.82E-05	3.20E-09
Iron (Fe)	9.47E-06	1.23E-06	1.05E+03	2.31E+00	1.05E-01	2.31E-04	4.06E-08
Gallium (Ga)	2.87E-07	3.72E-08	3.17E+01	7.00E-02	3.17E-03	7.00E-06	1.23E-09
Mercury (Hg)	6.87E-07	8.90E-08	7.60E+01	1.67E-01	7.60E-03	1.67E-05	2.94E-09
Iodine (I)	1.29E-05	1.67E-06	1.42E+03	3.14E+00	1.42E-01	3.14E-04	5.51E-08
Potassium (K)	9.86E-03	1.28E-03	1.09E+06	2.40E+03	1.09E+02	2.40E-01	4.22E-05
Lanthanum (La)	3.48E-08	4.51E-09	3.85E+00	8.48E-03	3.85E-04	8.48E-07	1.49E-10
Lithium (Li)	2.32E-05	3.01E-06	2.57E+03	5.66E+00	2.57E-01	5.66E-04	9.95E-08
Magnesium (Mg)	1.55E-04	2.01E-05	1.72E+04	3.78E+01	1.72E+00	3.78E-03	6.65E-07
Manganese (Mn)	2.87E-07	3.72E-08	3.17E+01	7.00E-02	3.17E-03	7.00E-06	1.23E-09
Molybdenum (Mo)	1.08E-06	1.40E-07	1.19E+02	2.63E-01	1.19E-02	2.63E-05	4.62E-09
Sodium (Na)	4.77E-02	6.18E-03	5.27E+06	1.16E+04	5.27E+02	1.16E+00	2.04E-04
Niobium (Nb)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nickel (Ni)	1.07E-06	1.39E-07	1.18E+02	2.61E-01	1.18E-02	2.61E-05	4.58E-09
Phosphorus (P)	6.08E-05	7.88E-06	6.72E+03	1.48E+01	6.72E-01	1.48E-03	2.60E-07
Lead (Pb)	2.20E-06	2.85E-07	2.43E+02	5.36E-01	2.43E-02	5.36E-05	9.43E-09
Rubidium (Rb)	1.03E-06	1.33E-07	1.13E+02	2.50E-01	1.13E-02	2.50E-05	4.40E-09
Antimony (Sb)	8.61E-07	1.12E-07	9.52E+01	2.10E-01	9.52E-03	2.10E-05	3.69E-09
Selenium (Se)	8.17E-07	1.06E-07	9.04E+01	1.99E-01	9.04E-03	1.99E-05	3.50E-09
Silicon (Si)	4.79E-05	6.21E-06	5.30E+03	1.17E+01	5.30E-01	1.17E-03	2.05E-07
Tin (Sn)	3.30E-07	4.28E-08	3.65E+01	8.06E-02	3.65E-03	8.06E-06	1.42E-09
Strontium (Sr)	1.12E-05	1.45E-06	1.24E+03	2.73E+00	1.24E-01	2.73E-04	4.80E-08
Thorium (Th)	9.57E-06	1.24E-06	1.06E+03	2.33E+00	1.06E-01	2.33E-04	4.10E-08
Titanium (Ti)	4.43E-07	5.75E-08	4.90E+01	1.08E-01	4.90E-03	1.08E-05	1.90E-09
Thallium (Th)	1.54E-06	1.99E-07	1.70E+02	3.75E-01	1.70E-02	3.75E-05	6.60E-09
Uranium (U)	3.78E-04	4.90E-05	4.18E+04	9.22E+01	4.18E+00	9.22E-03	1.62E-06
Vanadium (V)	7.83E-08	1.01E-08	8.65E+00	1.91E-02	8.65E-04	1.91E-06	3.35E-10

Table B.3-10 (continued)

Metals	Metals mass fraction[a] (g/total g)	Metals concentration[b] (g/dscf)	Uncontrolled metal emissions for the project[c] (g)	(lbs)	Emissions after control for the project[d] (g)	(lbs)	Average hourly emissions[e] (lbs/h)
Tungsten (W)	4.00E-07	5.18E-08	4.42E+01	9.75E-02	4.42E-03	9.75E-06	1.71E-09
Zinc (Zn)	1.21E-05	1.57E-06	1.34E+03	2.94E+00	1.34E-01	2.94E-04	5.18E-08
Zirconium (Zr)	2.61E-08	3.38E-09	2.88E+00	6.36E-03	2.88E-04	6.36E-07	1.12E-10

[a]The data were obtained from U.S. Department of Energy Report, *Statistical Description of Liquid Low-level Waste System Transuranic Wastes at Oak Ridge National Laboratory, Oak Ridge, Tennessee*, Document No. ORNL/TM-13351, Addendum 1. An average density of 1.15 g/mL was obtained for the supernate from Table 4.1, p. 3 of ORNL/TM-13351, Addendum 1. Given the volume stated in the request for proposal of 1600 m^3 of supernate, there is 1,840,000 kg of supernate mass.

[b]The amount of total suspended particulate (TSP) matter reaching the first exhaust system High-Efficiency Particulate Air (HEPA) filter is assumed to be:

Airborne Particulate Concentration = 2.0 gr/dscf = 0.1296 g/dscf.

[c]The uncontrolled emissions are estimated by the following expression:

Uncontrolled Rate = Exhaust Stream Flowrate × TSP Concentration × Metal Mass Fraction.

The operating schedule was presented from Sect. 2.4. of this Environmental Impact Statement:

The exhaust flow rate is based on obtaining one complete volume change of air in the cementation processing area every 15 min. Given that the hot cell is approximately 50 ft wide × 50 ft long × 15 ft high, the exhaust flowrate is 2500 dscfm.

Air Flow Rate = 2500 dscfm
Process Operating Schedule = 6 years life; 118.5 d/year, 8 h/d; and 60 min/h
Calculated Operating Hours = 5688 h

[d]The two HEPA filtration systems are assumed to have the following removal efficiencies:

HEPA Filter 1 Removal = 99%
HEPA Filter 2 Removal = 99%

[e]The average hourly emissions are calculated by the following expression:

Average Hourly = Pounds Emitted for Project/Project Operating Hours.

d = day.

dscf = dry standard cubic foot.

dscfm = dry standard cubic feet per minute.

g = gram.

gr/dscf = grains per dry standard cubic foot.

h = hour.

lb = pound.

Table B.3-11. Metal emissions for remediation of TRU/CH solid wastes using 40 *CFR* 61 Appendix D calculation procedures for the Cementation Alternative

Metals	Mass of metals in waste[a] (kg)	Uncontrolled metals emissions[b,c] (g)	(lbs)	Metals emissions after control[d] (g)	(lbs)	Average hourly emissions[e] (lbs/h)
Silver (Ag)	100	1.00E-01	2.20-04	1.00E-07	2.20E-10	5.25E-14
Cadmium (Cd)	400	4.00E-01	8.82E-04	4.00E-07	8.82E-10	2.10E-13
Mercury (Hg)	400	4.00E-01	8.82E-04	4.00E-07	8.82E-10	2.10E-13
Lead (Pb)	3,500	3.50E+00	7.72E-03	3.50E-06	7.72E-09	1.84E-12
Total	4,400					

	Concentration[f] (g/dscf)	Uncontrolled TSP emissions (g)	(lbs)	TSP emissions after control (g)	(lbs)	Average hourly emissions (lbs/h)
TSP	0.1296	3.27E+08	7.20E+05	3.27E+02	7.02E-01	1.71E-04

[a]Quantities are based on U.S. Department of Energy analysis and process knowledge of the Resource Conservation and Recovery Act metals in solid wastes.

[b]An emission factor for the amount of airborne metals is obtained from Appendix D to 40 *Code of Federal Regulations (CFR)* 61.

Emission Factor = 0.000001 fraction of the amount used (since this is solid waste).

[c]The uncontrolled emissions are estimated by the following expression:

Uncontrolled Rate = Metal Mass in Waste × Emissions Factor.

The operating schedule was presented from Sect. 2.4 of this Environmental Impact Statement:

Process Operating Schedule = 3 years life; 210 d/year; 8 h/d; and 60 min/h
Calculated Operating Hours = 5040 h

[d]The emissions after control are estimated by using the U.S. Environmental Protection Agency adjustment factors from Table 1 of Appendix D to 40 *CFR* 61. The adjustment factors are:

Hot Cell High-Efficiency Particulate Air (HEPA) Filter Adjustment Factor = 0.01
First HEPA Filter Adjustment Factor = 0.01
Second HEPA Filter Adjustment Factor = 0.01

[e]The average hourly emissions are calculated by the following expression:

Average Hourly = Pounds Emitted for Project/Project Operating Hours.

[f]The total suspended particulate (TSP) emissions from the hot cell are calculated based on an assumed inlet concentration of 2 gr/dscf (0.13 g/dscf) to the HEPA filter system on the cell exhaust. The TSP emissions are calculated using an assumed exhaust flow rate for this closed system which is based on obtaining one complete volume change of air in the hot cell every 15 min. Given that the hot cell is approximately 50 ft wide × 100 ft long × 30 ft high (due to the bay area for overhead cranes), the exhaust flowrate is 10,000 dscfm.

Average Hourly = Pounds Emitted for Project/Project Operating Hours.

CH = contact handled.

dscf = dry standard cubic foot.

dscfm = dry standard cubic feet per minute.

g = gram.

gr/dscf = grains per dry standard cubic foot.

h = hour.

lb = pound.

TRU = transuranic.

Table B.3-12. Metal emissions for remediation of TRU/CH solid wastes using 40 *CFR* 61 Appendix D calculation procedures for the Cementation Alternative

Metals	Mass of metals in waste[a] (kg)	Uncontrolled metals emissions[b,c] (g)	Uncontrolled metals emissions[b,c] (lbs)	Metals emissions after control[d] (g)	Metals emissions after control[d] (lbs)	Average hourly emissions[e] (lbs/h)
Silver (Ag)	20	2.00E-02	4.41E-05	2.00E-08	4.41E-11	8.75E-15
Cadmium (Cd)	100	1.00E-01	2.20E-04	1.00E-07	2.20E-10	4.37E-14
Mercury (Hg)	100	1.00E-01	2.20E-04	1.00E-07	2.20E-10	4.37E-14
Lead (Pb)	980	9.80E-01	2.16E-03	9.80E-07	2.16E-09	4.29E-13
Total	1200					

	Concentration[f] (g/dscf)	Uncontrolled TSP emissions (g)	Uncontrolled TSP emissions (lbs)	TSP emissions after control (g)	TSP emissions after control (lbs)	Average hourly emissions (lbs/h)
TSP	0.1296	3.92E+08	8.64E+05	3.92E+02	8.64-01	1.71E-04

[a]Quantities are based on U.S. Department of Energy analysis and process knowledge of the Resource Conservation and Recovery Act metals in solid wastes.

[b]An emission factor for the amount of airborne metals is obtained from Appendix D to 40 *Code of Federal Regulations (CFR)* 61.

Emission Factor = 0.000001 fraction of the amount used (since this is solid waste).

[c]The uncontrolled emissions are estimated by the following expression:

Uncontrolled Rate = Metal Mass in Waste × Emissions Factor.

The operating schedule was presented from Sect. 2.4 of this Environmental Impact Statement:

Process Operating Schedule = 3 years life; 210 d/year; 8 h/d; and 60min/h
Calculated Operating Hours = 5040 h

[d]The emissions after control are estimated by using the U.S. Environmental Protection Agency adjustment factors from Table 1 of Appendix D to 40 *CFR* 61. The adjustment factors are:

Hot Cell High-Efficiency Particulate Air (HEPA) Filter Adjustment Factor = 0.01
First HEPA Filter Adjustment Factor = 0.01
Second HEPA Filter Adjustment Factor = 0.01

[e]The average hourly emissions are calculated by the following expression:

Average Hourly = Pounds Emitted for Project/Project Operating Hours.

[f]The total suspended particulate (TSP) emissions from the hot cell are calculated based on an assumed inlet concentration of 2 gr/dscf (0.13 g/dscf) to the HEPA filter system on the cell exhaust. The TSP emissions are calculated using an assumed exhaust flow rate for this closed system which is based on obtaining one complete volume change of air in the hot cell every 15 min. Given that the hot cell is approximately 50 ft wide × 100 ft long × 30 ft high (due to the bay area for overhead cranes), the exhaust flowrate is 10,000 dscfm.

Average Hourly = Pounds Emitted for Project/Project Operating Hours.

CH = contact handled.

dscf = dry standard cubic foot.

dscfm = dry standard cubic feet per minute.

g = gram.

gr/dscf = grains per dry standard cubic foot.

h = hour.

lb = pound.

TRU = transuranic.

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APPENDIX B.4

FLOOR PLANS FOR THE PROPOSED LOW-TEMPERATURE DRYING WASTE TREATMENT FACILITY

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Figure B.4-1. 1st floor plan/Preferred Alternative.

Figure B.4-2. 2nd floor plan/Preferred Alternative.

Figure B.4-3. 3rd floor plan/Preferred Alternative.

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APPENDIX C

FINDINGS OF SURVEYS FOR WETLANDS, TERRESTRIAL ANIMALS, RARE PLANTS, BASELINE NOISE, AND RADIOLOGICAL CONTAMINATION

APPENDIX C.1

FINDINGS OF WETLAND DELINEATION ON THE PROPOSED TRU WASTE FACILITY SITE

APPENDIX C.2

FINDINGS OF SURVEY FOR SENSITIVE TERRESTRIAL ANIMAL SPECIES AT THE PROPOSED TRU WASTE FACILITY SITE

APPENDIX C.3

FINDINGS OF SURVEY FOR RARE PLANTS
ON THE PROPOSED
TRU WASTE FACILITY SITE

APPENDIX C.4

BASELINE NOISE MONITORING IN MELTON VALLEY FOR THE PROPOSED TRU WASTE FACILITY SITE

APPENDIX C.5

RADIOLOGICAL SURVEY OF FOSTER WHEELER TRU FACILITY SITE

APPENDIX C.6

WETLANDS ASSESSMENT FOR CONSTRUCTION OF A NEW TRANSURANIC WASTE TREATMENT FACILITY OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, TENNESSEE

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APPENDIX D

RIMS II INPUT-OUTPUT METHODOLOGY

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RIMS II INPUT-OUTPUT METHODOLOGY

The Regional Input-Output Modeling System II (RIMS II) relies on an accounting framework called input-output (I-O) analysis, which focuses on identifying the linkages (inputs purchased and outputs sold) among the industries within an economy. For example, the impact of a new sports facility would include both its direct employment and sales, and its indirect effects through purchases from other industries (food for concessions, insurance, utilities, etc.) and the additional purchases households make with the money it pays them. RIMS II uses these linkages to trace the impacts of specific changes on detailed sectors of the economy and calculates multipliers for each industry included in the model. This provides an advantage over other models that rely on “aggregate” multipliers for the entire economy.

The U.S. Department of Commerce, Bureau of Economic Analysis (BEA), maintains a detailed I-O model of the national economy. RIMS II multipliers are based on this national model and BEA’s regional economic accounts, which are used to adjust the national table to account for a region’s industrial structure and trading patterns. The multipliers used in this analysis were based on the 1992 national I-O tables and the 1995 BEA regional accounts data—the most recent figures available at this time. They were developed specifically for the four-county region (Anderson, Knox, Loudon, and Roane Counties) defined as the economic region of influence for this analysis.

Each phase of the project involves a different type of activity and, therefore, a different industry multiplier. For the purposes of this analysis, the phases and the associated industries are identified below. Where there was some question about the most appropriate industrial category, the analysis used the industry with the larger multiplier in order to identify the maximum potential impacts. In no case was the difference in multipliers large enough to affect the relative size of the economic impacts or the conclusions drawn from the analysis.

Table D.1. Industrial categories used in economic analysis

Project phase	Industry
I. Licensing	73.0302 Engineering, architectural, and surveying services
II. Construction	11.0900 Other new construction
III. Operation	68.0302 Sanitary Services, steam supply, and irrigation1
IV. Decontamination and Decommissioning	12.0300 Other maintenance and repair construction

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APPENDIX E

AGENCIES CONTACTED

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Department of Energy

Oak Ridge Operations Office
P.O. Box 2001
Oak Ridge, Tennessee 37831—

June 2, 1999

Mr. Reginald Reeves, Director
Division of Natural Heritage
State of Tennessee
Department of Environment and Conservation
401 Church Street
Nashville, Tennessee 37243-0443

Dear Mr. Reeves:

INFORMAL CONSULTATION UNDER THE ENDANGERED SPECIES ACT FOR THE PROPOSED TRANSURANIC WASTE TREATMENT PROJECT AT THE OAK RIDGE RESERVATION, OAK RIDGE, TENNESSEE

The United States Department of Energy (DOE) needs to ensure the safe and efficient retrieval, processing, certification, and disposition of legacy transuranic (TRU) waste at Oak Ridge National Laboratory (ORNL). The regional location of ORNL is shown in Figure 1. Waste retrieval operations are currently underway to prepare ORNL TRU waste for processing.

Under the proposed action, a waste treatment facility for the ORNL legacy TRU waste would be constructed, operated for approximately six years, and decontaminated/decommissioned under a contract awarded to the Foster Wheeler Environmental Corporation. DOE would lease the Melton Valley Storage Tanks and adjacent land area totaling approximately 10 acres for construction of the facility. The proposed 37,000 square foot treatment facility would be located within an approximate 5 acre plot of land, fenced, and have controlled access to Tennessee State Highway 95 located 1.25 miles away. The first shipment of treated waste to the Waste Isolation Pilot Plant (WIPP) facility for disposal would be expected in 2003. The proposed construction area is shown in Figure 2.

The area can currently be described as second growth forest that consists of mixed hardwoods and pine plantations. This area is small in comparison to the almost 3,600 acres that comprise ORNL. In a 1988 survey of the surrounding area, executed for a formerly proposed treatment facility, no federally or State listed or candidate plant or animal species were observed adjacent to this site. Two species listed by the State of Tennessee as in need of management, the red-shouldered hawk and black vulture, may occur at the site but have not been documented as nesting there. Field surveys are currently ongoing at the proposed project site for both protected/rare plant and animal species. No rare plant species or federally protected animal species have been identified, although the animal survey has not yet been completed.

This letter is intended to serve as informal consultation under the Endangered Species Act. In this regard, DOE requests an updated list of protected species and habitat on or near the project site and solicits your recommendations and comments about the potential effects of this proposed action. Your input will be used in the preparation of an environmental impact statement for this action pursuant to the National Environmental Policy Act.

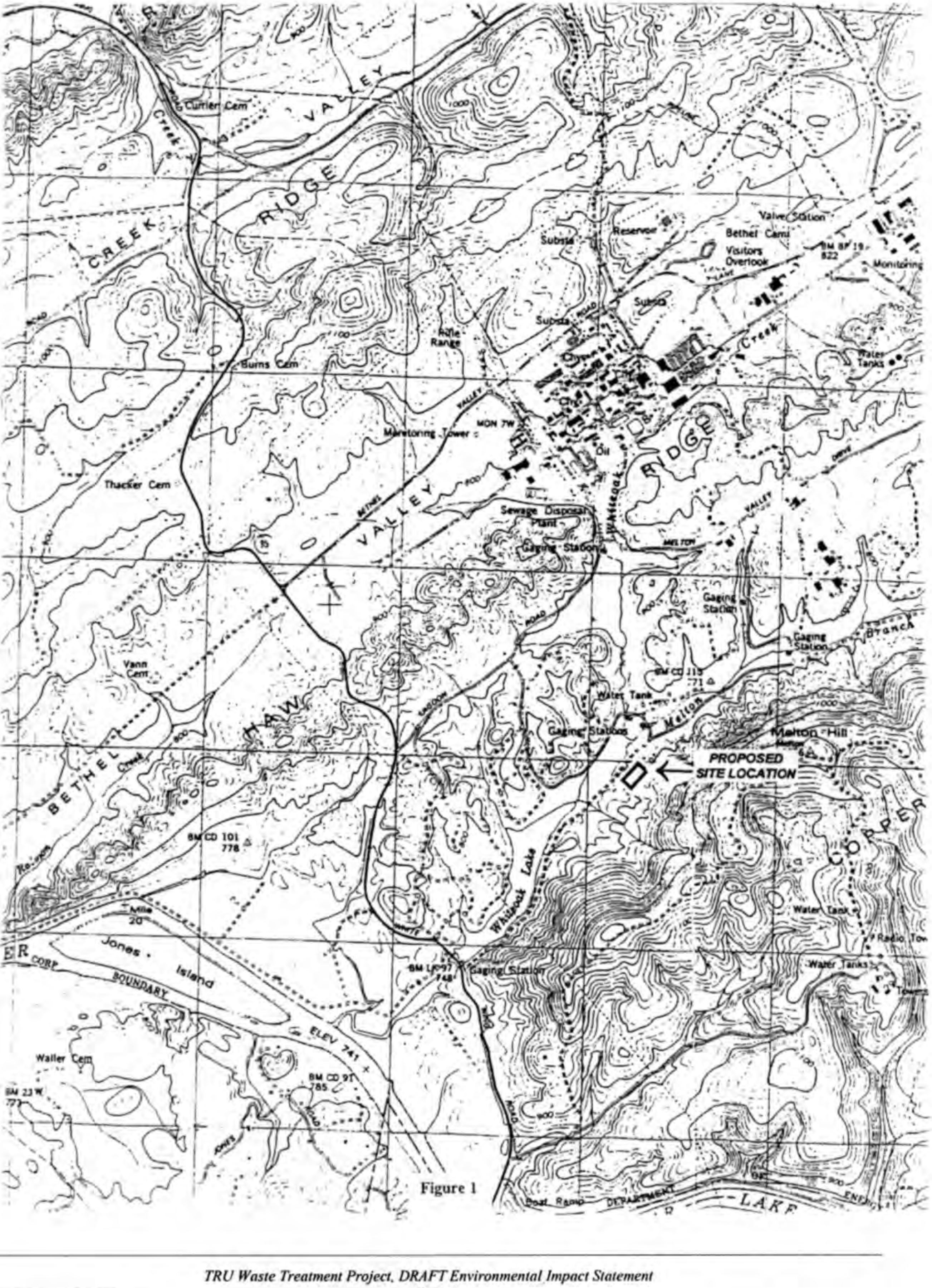

Curtier Cem
VALLEY
RIDGE
CREEK
Burns Cem
Thacker Cem
Rifle Range
Monitoring Tower
MON 7W
Valve Station
Bethel Cam
Visitors Overlook
Reservoir
Creek
Water Tanks
Monitoring
RIDGE
VALLEY
Sewage Disposal Plant
Gaging Station
Whiteoak
Gaging Station
Gaging Station
Branch
Vann Cem
HAW
BETHEL
Creek
BM CD 101 778
Water Tank
Melton
Gaging Station
Melton Hill
PROPOSED SITE LOCATION
COPPER
Whiteoak Lake
Mile 20
Jones Island
CORP BOUNDARY
ELEV 741
Gaging Station
Water Tank
Radio Tow
Water Tanks
Waller Cem
BM CD 97 785
ROAD
Boat Ramp
DEPARTMENT
LAKE

Figure 1

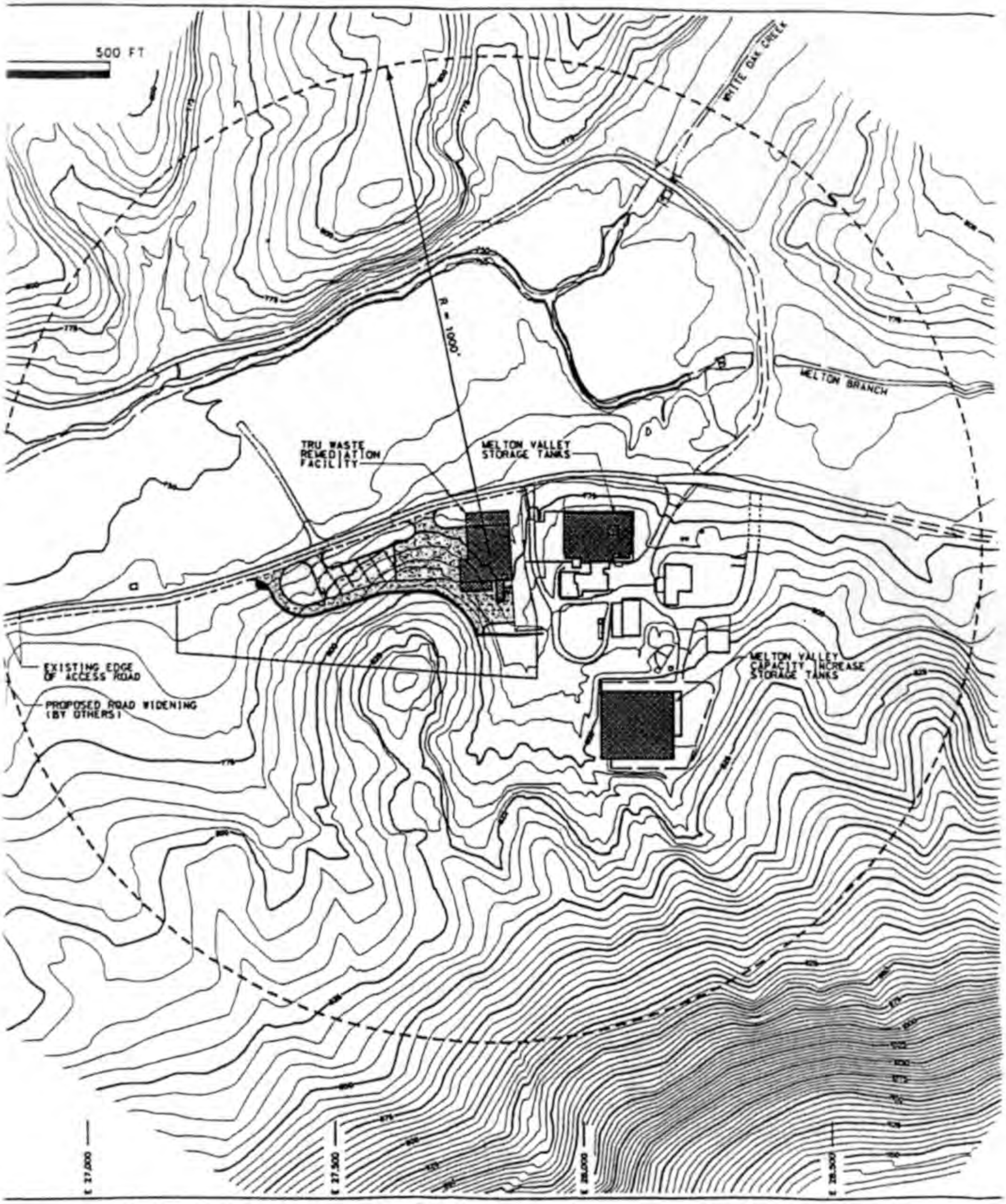

500 FT
WHITE OAK CREEK
MELTON BRANCH
R = 1000'
TRU WASTE
REMEDIATION
FACILITY
MELTON VALLEY
STORAGE TANKS
MELTON VALLEY
CAPACITY INCREASE
STORAGE TANKS
EXISTING EDGE
OF ACCESS ROAD
PROPOSED ROAD WIDENING
(BY OTHERS)

Figure 2

If you need further information on this request, please do not hesitate to call me at (423) 576-0938.

Sincerely,

James L. Elmore, Ph.D.
Alternate NEPA Compliance Officer

Enclosures

cc:
Gary L. Riner, EM-92
Wayne Tolbert, SAIC

Department of Energy

Oak Ridge Operations Office
P.O. Box 2001
Oak Ridge, Tennessee 37831—

June 2, 1999

Dr. Lee Barclay
U.S. Fish and Wildlife Service
446 Neal Street
Cookeville, Tennessee 37501

Dear Dr. Barclay:

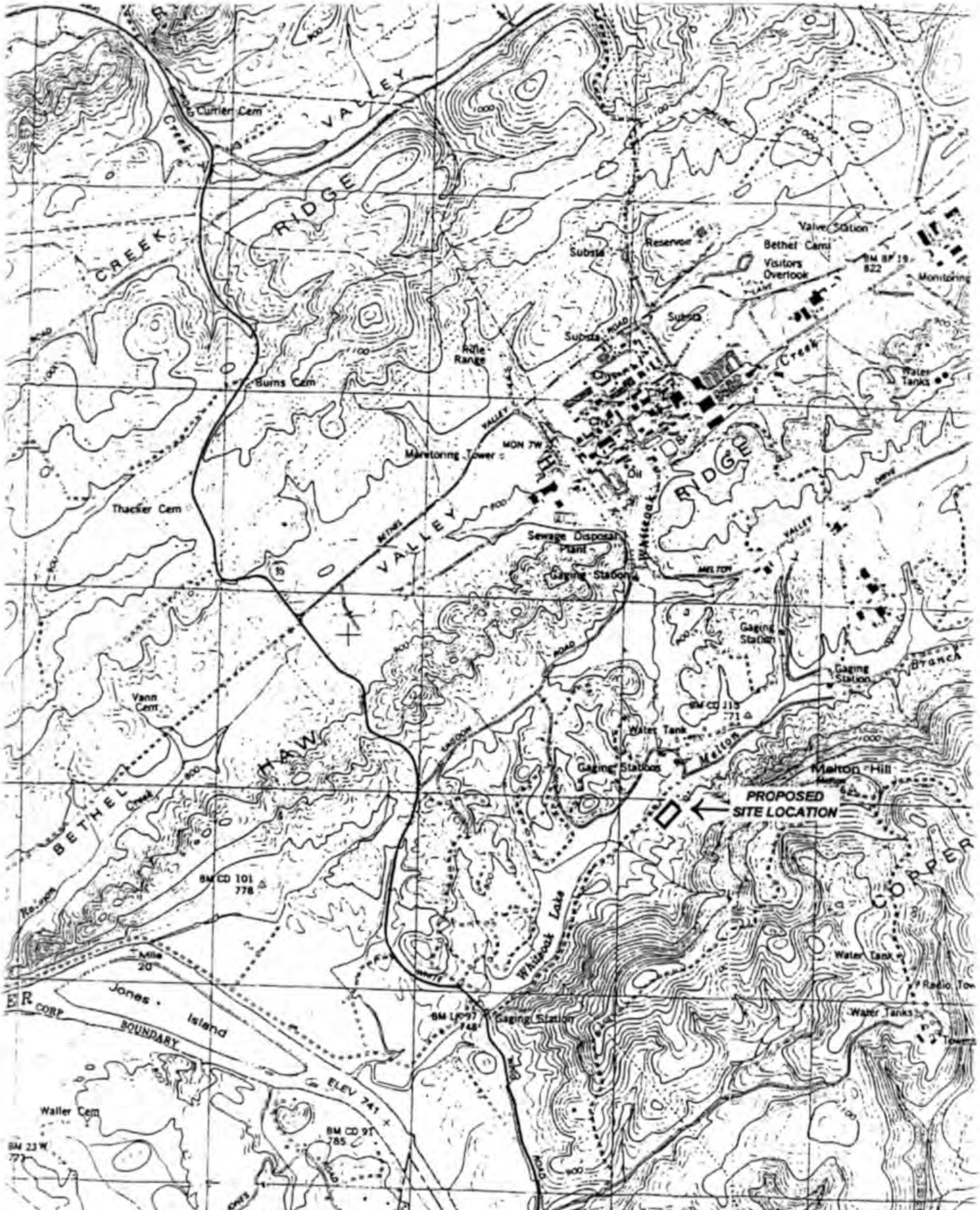
INFORMAL CONSULTATION UNDER SECTION 7 OF THE ENDANGERED SPECIES ACT FOR THE PROPOSED TRANSURANIC WASTE TREATMENT PROJECT AT THE OAK RIDGE RESERVATION, OAK RIDGE, TENNESSEE

The United States Department of Energy (DOE) needs to ensure the safe and efficient retrieval, processing, certification, and disposition of legacy transuranic (TRU) waste at Oak Ridge National Laboratory (ORNL). The regional location of ORNL is shown in Figure 1. Waste retrieval operations are currently underway to prepare ORNL TRU waste for processing.

Under the proposed action, a waste treatment facility for the ORNL legacy TRU waste would be constructed, operated for approximately six years, and decontaminated/decommissioned under a contract awarded to the Foster Wheeler Environmental Corporation. DOE would lease the Melton Valley Storage Tanks and adjacent land area totaling approximately 10 acres for construction of the facility. The proposed 37,000 square foot treatment facility would be located within an approximate 5 acre plot of land, fenced, and have controlled access to Tennessee State Highway 95 located 1.25 miles away. The first shipment of treated waste to the Waste Isolation Pilot Plant (WIPP) facility for disposal would be expected in 2003. The proposed construction area is shown in Figure 2.

The area can currently be described as second growth forest that consists of mixed hardwoods and pine plantations. This area is small in comparison to the almost 3,600 acres that comprise ORNL. In a 1988 survey of the surrounding area, executed for a formerly proposed treatment facility, no federally or State listed or candidate plant or animal species were observed adjacent to this site. Two species listed by the State of Tennessee as in need of management, the red-shouldered hawk and black vulture, may occur at the site but have not been documented as nesting there. Field surveys are currently ongoing at the proposed project site for both protected/rare plant and animal species. No rare plant species or federally protected animal species have been identified, although the animal survey has not yet been completed.

This letter is intended to serve as informal consultation under Section 7 of the Endangered Species Act. In this regard, DOE requests an updated list of protected species and habitat on or near the project site and solicits your recommendations and comments about the potential effects of this proposed action. Your input will be used in the preparation of an environmental impact statement for this action pursuant to the National Environmental Policy Act.



VALLEY
RIDGE
CREEK
Currier Cem
Creek
Reservoir
Valve Station
Bethel Cem
Visitors Overlook
Substa
Monitoring
Rifle Range
Burns Cem
Water Tanks
Monitoring Tower
MON 7W
RIDGE
Oil
Thacker Cem
VALLEY
Sewage Disposal Plant
Gaging Station
Whiteoak Creek
Vann Cem
BM CD 115 771
Water Tank
Gaging Station
Melton
Melton Hill
PROPOSED SITE LOCATION
HAW
BETHEL
Creek
BM CD 101 778
Whiteoak Lake
Mile 20
Jones Island
BOUNDARY
ELEV 741
Gaging Station
Water Tank
Radio Tow
Water Tanks
Waller Cem
BM CD 97 785
Boat Ramp
DEPARTMENT
LAKE

Figure 1

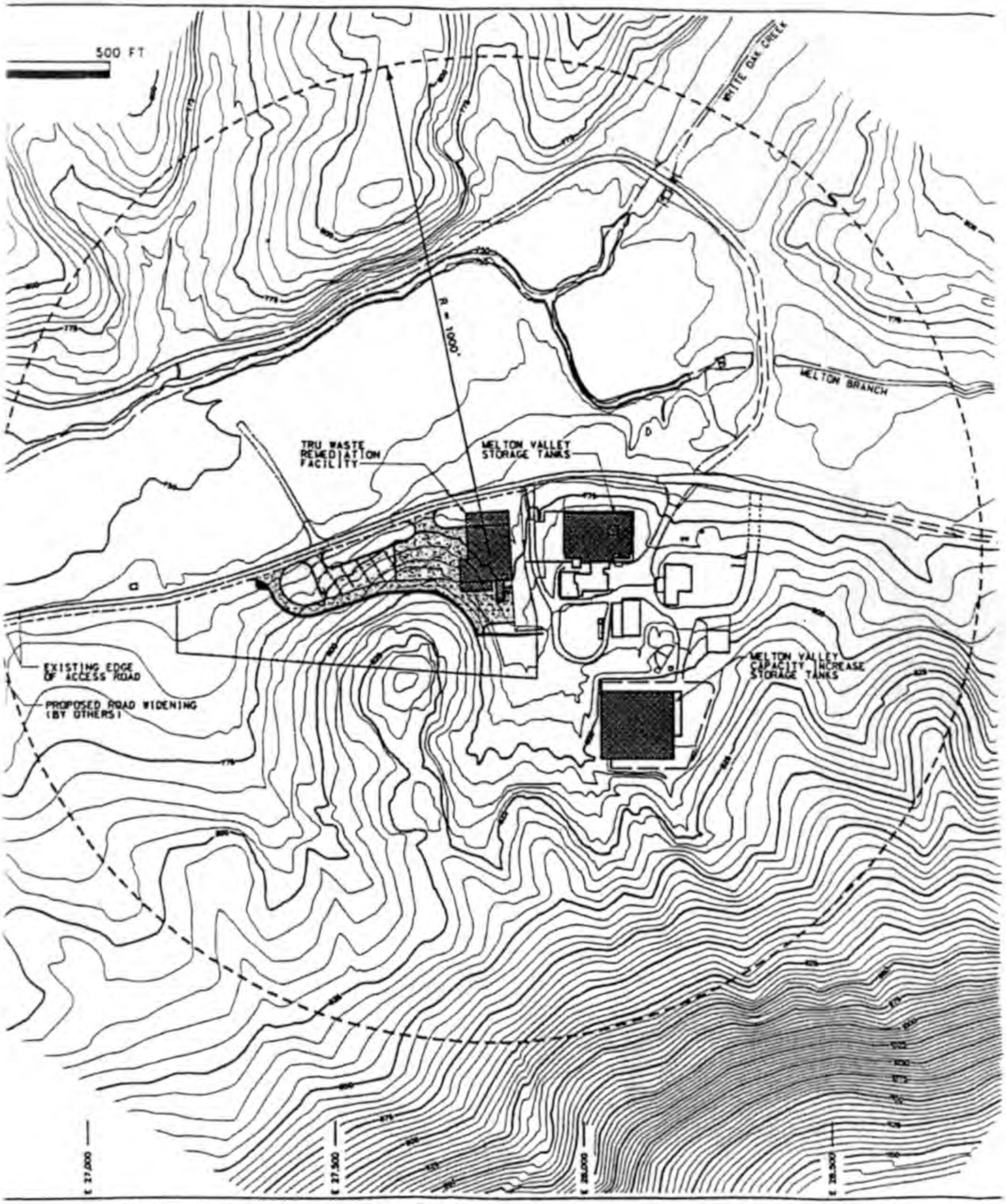

500 FT
WHITE OAK CREEK
R = 1000'
MELTON BRANCH
TRU WASTE
REMEDIATION
FACILITY
MELTON VALLEY
STORAGE TANKS
EXISTING EDGE
OF ACCESS ROAD
PROPOSED ROAD WIDENING
(BY OTHERS)
MELTON VALLEY
CAPACITY INCREASE
STORAGE TANKS
E 27,000
E 27,500
E 28,000
E 28,500

Figure 2

If you need further information on this request, please do not hesitate to call me at (423) 576-0938.

Sincerely,

James L. Elmore, Ph.D.
Alternate NEPA Compliance Officer

Enclosures

cc:
Gary Riner, EM-92
Wayne Tolbert, SAIC

United States Department of the Interior

FISH AND WILDLIFE SERVICE
446 Neal Street
Cookeville, TN 38501

July 8, 1999

Mr. James L. Elmore, Ph.D.
U.S. Department of Energy
Oak Ridge Operations Office
P.O. Box 2001
Oak Ridge, Tennessee 37831

Dear Dr. Elmore:

Thank you for your letter and enclosures of June 2, 1999, regarding the preparation of an Environmental Impact Statement (EIS) for the construction of a transuranic legacy waste treatment facility at the Oak Ridge Reservation in Roane County, Tennessee. U.S. Fish and Wildlife Service (Service) personnel have reviewed the information submitted and offer the following comments for consideration.

According to our records, the following federally listed endangered species are known to occur near the potential project impact area:

gray bat	(*Myotis grisescens*)
pink mucket pearlymussel	(*Lampsilis abrupta*)

Qualified biologists should assess potential impacts and determine if the proposed project may affect the species. We recommend that you submit a copy of your assessment and finding to this office for review and concurrence. A finding of "may affect" could require the initiation of formal consultation procedures.

These constitute the comments of the U.S. Department of the Interior in accordance with provisions of the Endangered Species Act (87 Stat. 884, as amended: 16 U.S.C. 1531 et seq.). We appreciate the opportunity to comment. Should you have any questions or need further assistance, please contact Steve Alexander of my staff at 931/528-6481, ext. 210.

Sincerely,

Timothy B. Merritt

for Lee A. Barclay, Ph.D.
Field Supervisor

Department of Energy

Oak Ridge Operations Office
P.O. Box 2001
Oak Ridge, Tennessee 37831—

June 28, 1999

Mr. Joseph Garrison
Tennessee Historical Commission
Department of Environment and Conservation
2941 Lebanon Road
Nashville, Tennessee 37243-0442

Dear Mr. Garrison:

NATIONAL HISTORIC PRESERVATION ACT, SECTION 106 COMPLIANCE, TRANSURANIC WASTE TREATMENT FACILITY, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE TENNESSEE

Enclosed is a Project Summary for the proposed construction, operation, and decontamination/decommission of a Transuranic (TRU) Waste Treatment Facility, Roane County, Tennessee. The Department of Energy Oak Ridge Operations (DOE ORO) has determined that the proposed project would have no affect on historical, archeological, or cultural resources included or eligible for inclusion in the National Register of Historic Places (National Register). This determination is included with the Project Summary. The proposed project is addressed in the *Programmatic Agreement Among The Department Of Energy Oak Ridge Operations Office The Tennessee State Historic Preservation Officer And The Advisory Council On Historic Preservation Concerning The Management Of Historical And Cultural Properties At The Oak Ridge Reservation (PA) at Section III.D.1.*

DOE ORO requests documentation of your concurrence with DOE ORO's determination for this proposed project. If you have questions or need additional information related to this proposed project please call me at (423) 576-9574.

Sincerely,

Ray T. Moore

Ray T. Moore
DOE ORO Cultural Resources
Management Coordinator

Enclosure

cc w/enclosure:
E.C. Document Center, Y-12, Bldg. 9734, MS-8130

cc w/o enclosure:
See Page 2

cc w/o enclosure:
Gary Riner, EM-91
Mark Belvin, ER-11, ORNL Site Office
James Hall, LMER, Bldg. 6026, MS-6395
Sheila Thornton, Bechtel Jacobs, Bldg. K-1550-E, MS 7235
Jennifer Webb, LMES, Bldg. 9115, MS 8219, Y-12
Mick Wiest, LMES, Bldg. 9116, MS 8098, Y-12
Jack Newman, Bechtel Jacobs, 55 Jefferson, Room 117, MS 7604
Wayne Tolbert, SAIC, 800 Oak Ridge Turnpike, Oak Ridge, TN 37831

United States Government | **Department of Energy**

Oak Ridge Operations Office

memorandum

DATE: July 21, 1999

REPLY TO
ATTN OF: SE-32:Moore

SUBJECT: **NATIONAL HISTORIC PRESERVATION ACT, SECTION 106 COMPLIANCE, TRANSURANIC WASTE TREATMENT FACILITY, OAK RIDGE NATIONAL LABORATORY, OAK RIDGE, TENNESSEE**

TO: Gary L. Riner, Program Manager, Transuranic Waste Treatment Facility, EM-921

Attached is a letter from the Tennessee State Historic Preservation Officer (SHPO) that concurs with the Department of Energy Oak Ridge Operations (DOE ORO) determination that the proposed construction, operation, and decontamination/decommission of a Transuranic (TRU) Waste Treatment Facility, Roane County, Tennessee, would have no adverse affect to properties included or eligible for inclusion in the National Register of Historic Places. With the SHPO's determination, DOE ORO has complied with Section 106 of the National Historic Preservation Act for this proposed project.

If you have questions or need additional information please call me at (423) 576-9574.

Ray T. Moore
DOE ORO Cultural Resources
Management Coordinator

Attachment

cc w/attachment:
E.C. Document Center, Y-12, Bldg. 9734, MS-8130

cc w/o attachments:
Mark Belvin, ER-11, ORNL Site Office
James Hall, LMER, Bldg. 6026, MS-6395
Sheila Thornton, Bechtel Jacobs, Bldg. K-1550-E, MS 7235
Jennifer Webb, LMES, Bldg. 9115, MS 8219, Y-12
Mick Wiest, LMES, Bldg. 9116, MS 8098, Y-12
Wayne Tolbert, SAIC, 800 Oak Ridge Turnpike, Oak Ridge, TN 37831
Jack Newman, Bechtel Jacobs, 55 Jefferson, Room 117, MS 7604

TENNESSEE HISTORICAL COMMISSION
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
2941 LEBANON ROAD
NASHVILLE, TN 37243-0442
(615) 532-1550

July 2, 1999

Mr. Ray T. Moore
USDOE/Oak Ridge Operations
Post Office Box 2001
Oak Ridge, Tennessee 37831-8739

RE: DOE, TRANSURANIC WASTE TREATMENT FAC., OAK RIDGE, ROANE COUNTY

Dear Mr. Moore:

Pursuant to your request received by this office on Wednesday, June 30, 1999, this office has reviewed documentation concerning the above-referenced undertaking. This review is a requirement of Section 106 of the National Historic Preservation Act for compliance by the participating federal agency or applicant for federal assistance. Procedures for implementing Section 106 of the Act are codified at 36 CFR 800 (RIN3010-AA04: June 17, 1999), and an Agreement Document.

Considering available information, we find that the project as currently proposed will not adversely affect any property that is eligible for listing in the National Register of Historic Places. Therefore, this office has no objection to the implementation of this project.. Please direct questions and comments to Joe Garrison (615)532-1559. We appreciate your cooperation.

Sincerely,

Herbert L. Harper
Executive Director and
Deputy State Historic
Preservation Officer

HLH/jyg

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Log No. C 0884
Date Received JUL 07 1999
File Code 2182.2

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APPENDIX F

CALCULATIONS PACKAGES

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APPENDIX F.1

UNIVERSAL SOIL LOSS CALCULATIONS

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APPENDIX F.1

UNIVERSAL SOIL LOSS CALCULATIONS

Erosion at the proposed Transuranic (TRU) Waste Treatment Project site was modeled using the Revised Universal Soil Loss Equation (RUSLE), Version 1.06 (Toy and Foster 1998). RUSLE is a set of mathematical equations that estimate soil loss resulting from interrill and rill erosion (Lal 1994). RUSLE utilizes the basic formula of the Universal Soil Loss Equation as developed by Wischmeier and Smith (1978):

$$A = R * K * LS * C * P$$

where:

- A = average annual soil loss in tons per acre,
- R = rainfall/runoff erosivity,
- K = soil erodibility,
- LS = hillside length and steepness,
- C = cover management,
- P = soil conservation practices.

For the purposes of this analysis, the RUSLE was run assuming three scenarios. For each of the three scenarios, the R, K, and LS factors values did not vary. The R factor (180) used the climatic database for Knoxville, Tennessee. The initial K factor (0.37) was selected from soils mapped in Anderson County, Tennessee (Moneymaker 1981), with similar lithology and parent material to soils mapped at the TRU site. The RUSLE further modifies the initial K values based on variations in climatic data (R factor) through the year. The LS value was calculated from RUSLE using a slope with a total length of 91.5 m (300 ft) and a 30 % slope.

The first scenario assumed a worst-case condition, in which virtually no cover management practices were utilized to protect bare soils at the proposed construction site from the erosive energy of precipitation. The second-case scenario was run under the assumption that minimal cover management and conservation practices (some mulching to protect bare soil from precipitation) were utilized to provide a small amount of erosion prevention. The third scenario assumed intensive conservation practices (mulching, silt fences, and sediment basins) to provide maximum protection from erosion.

Results of the model runs for scenarios 1, 2, and 3 are displayed in Table 1 below. Based on Scenario 1 (no cover management practices), predicted soil loss could be expected to be as high as 404.7 metric tons per hectare per year (180.5 tons per acre per year). The tolerable soil loss published for similar soils is 6.7 metric tons per hectare per year (3 tons per acre per year) (Moneymaker 1981). Based on Scenario 2 (minimal cover management practices), predicted soil loss would be somewhat less than for Scenario 1, but could still as high as 188.8 metric tons per hectare per year (84.2 tons per acre per year). The predicted soil loss is still much higher than the published tolerance value. In Scenario 3 (intensive cover management practices), predicted soil loss would be further reduced to 2.2 metric tons per hectare per year (1.0 ton per acre per year), well within the published tolerable limits.

Table 1. Predicted soil loss at proposed TRU waste facility under varying degrees of cover management practices

Scenario	R factor	K factor	LS factor	C factor	P factor	A
1	180	0.359	12.53	0.2229	1.00	180.5
2	180	0.359	12.53	0.1040	1.00	84.2
3	180	0.359	12.53	0.0011	1.00	1.0

REFERENCES

Lal, R. 1994. *Soil Erosion Research Methods*, Soil and Water Conservation Society, Ames, Iowa, and St. Lucie Press, Del Ray, Florida, second edition, 340 pp.

Moneymaker, R. H. 1981. *Soil Survey of Anderson County, Tennessee*, U.S. Department of Agriculture, Soil Conservation Service in cooperation with Tennessee Agricultural Experiment Station, 165 pp. plus maps.

Toy, T. J., and G. R. Foster. *Guidelines for the Use of the Revised Universal Soil Loss Equation (RUSLE) (Version 1.06) on Mined Lands, Construction Sites, and Reclaimed Lands*, Department of Interior, Office of Surface Mining, Denver, Colorado.

Wischmeier, W. H., and D. D. Smith 1978. *Predicting Rainfall Erosion Losses – a Guide to Conservation Planning*, U.S. Department of Agriculture, Agriculture handbook No. 537, 58 pp.

APPENDIX F.2

ECOLOGICAL IMPACTS FROM A SEISMICALLY INDUCED BREACH OF THE MELTON VALLEY STORAGE TANKS

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APPENDIX F.2

IMPACTS TO AQUATIC BIOTA FROM A SEISMICALLY INDUCED BREACH OF THE MELTON VALLEY STORAGE TANKS

ASSUMPTIONS

As a reasonable worst case, it was assumed that the release from the ruptured tank is rapid, so the tank contents would rapidly be transported to Melton Branch. Therefore, undiluted concentrations of radionuclides were used for the initial exposure and risk calculations. Releases of radionuclides were evaluated for two tanks, Tank 26, which has the highest gross beta/gamma, and Tank 28, which has the highest gross alpha (Keeler et al. 1996). It was assumed that White Oak Lake, with an area of 6 to 8 hectares (ha) (Loar 1992), has a volume of approximately 3 to 6 million cubic feet and an average daily flow of 1.3 million cubic feet. The tank volume of 50,000 gal is equal to approximately 6,400 cubic feet, resulting in a dilution factor of about 450 to 900 in White Oak Lake.

Radiological benchmarks for exposure of aquatic biota to radionuclides in water and sediment have been developed by Bechtel Jacobs (1998) and were used to evaluate exposure of aquatic biota to radionuclides in water from the Melton Valley tanks. Dietary and ingestion rate information for herons is presented in Table 1. Radionuclide decay energies and absorption factors are presented in Table 2.

Table 1. Receptor Parameters for Great Blue Heron

		Receptor:	**Great blue heron** *(Ardea herodias)*
Parameter	**Definition**	**Value**	**Reference/Notes**
BW	Body weight (kg)	2.39	Arithmetic mean, adult, both sexes, location not stated (EPA 1993)
HR	Home range (km)	3.1	Foraging distance, mean, adults, both sexes, South Dakota, stream (EPA 1993)
TUF	Temporal use factor	1	Will be 1 unless a specific value exists for a receptor
IR_F	Food ingestion rate (g/g-d = kg/kgBW/d)[a]	0.18	EPA (1993)
PF	Plant fraction	0	None listed as dietary intake in EPA (1993)
AF	Animal fraction	1	98% Aquatic vertebrates, lower Michigan, river (EPA 1993)
SF	Soil fraction	0	Not reported in EPA (1993); assumed to be negligible
IR_w	Water ingestion rate (g/g-d = L/kgBW/d)	0.045	Estimated (EPA 1993)

[a]Food ingestion rate (g/g-d) reexpressed as kg/kgBW/d is assumed not to include ingested soil; therefore, PF+AF = 1.0.
EPA = U.S. Environmental Protection Agency.

The acceptable chronic dose of radiation to aquatic biota is 1 rad/d (NCRP 1991), and it is assumed that an acute dose 100 times that number is also acceptable. For birds, the acceptable chronic dose is 0.1 rad/d (IAEA 1992), while acute doses of 10 rad/d appear unlikely to cause long-term deleterious effects (IAEA 1992).

Table 2. Radiological Exposure Parameters for Ecological Radiological Constituents of Potential Concern

Ecological constituent of potential concern		Decay energy and absorption parameters					
	DCF[a]	$E_a n_a$ [b]	F[c]	$E_b n_b$ [d]	F[e]	$E_g n_g$ [f]	F[e]
Radionuclides							
Cesium-134	9.50E-14	0.00E+00	1.00E+00	1.64E-01	1.00E+00	1.56E+00	4.10E-02
Cesium-137	1.29E-15	0.00E+00	1.00E+00	1.87E-01	1.00E+00	0.00E+00	1.00E+00
Cobalt-60	2.37E-11	0.00E+00	1.00E+00	9.70E-02	1.00E+00	2.50E+00	4.00E-02
Iodine-129	7.70E-14	0.00E+00	1.00E+00	6.40E-02	1.00E+00	2.50E-02	2.20E-01
Strontium-90	1.26E-15	0.00E+00	1.00E+00	1.96E-01	1.00E+00	0.00E+00	1.00E+00
Technetium-99	2.71E-16	0.00E+00	1.00E+00	1.01E-01	1.00E+00	0.00E+00	1.00E+00
Uranium-233	3.14E-15	4.82E+00	1.00E+00	1.30E-02	1.00E+00	2.00E-03	9.40E-01
Uranium-238	6.87E-16	4.19E+00	1.00E+00	1.00E-02	1.00E+00	1.00E-03	9.40E-01

[a]Dose conversion factor for immersion in water (Table III.2, Eckerman and Ryman 1993, converted to Sv/d per Bq/m^3).

[b]Alpha energy of the radionuclide (MeV) × proportion of disintegrations producing an a-particle (Table A.1, Eckerman and Ryman 1993).

[c]Absorbed fraction of energy E_a (assumed to be 1.0 for alpha radiations).

[d]Beta energy of the radionuclide (MeV) × proportion of disintegrations producing a b-particle (Table A.1, Eckerman and Ryman 1993).

[e]Absorbed fraction of energy E_b or E_g (Blaylock, Frank, and O'Neal 1993; DOE 1997).

[f]Photon energy emitted during transition from a higher to a lower energy state (MeV) × proportion of disintegrations producing a g-particle (Table A.1, Eckerman and Ryman 1993).

AQUATIC BIOTA

The concentrations of potassium, sodium, and nitrate are high. The combined concentrations of these ions (ionic strengths) are 10.4 M (mole/L, where mole is defined as a number of grams equal to the molecular weight of the constituent) in Tank 26 and 14.1 M in Tank 28. Concentrations are similar in the other tanks. The pH in Tanks 26 and 28 is 8.4 and 7.3, respectively, but the pH in Tank 31 is 10 and in the other tanks is above 12. These ionic strengths and the pH in all tanks other than Tanks 26 and 28 would be immediately lethal to aquatic biota [the toxicity benchmark for sodium is ~0.03 M (Suter and Tsao 1996)]. Sufficient dilution and neutralization to prevent lethality are not likely before the slug of contaminants reaches White Oak Lake. Therefore, an approximately 1-km (0.6-mile) stretch of Melton Branch and White Oak Creek would be depopulated of aquatic biota. The slug of contaminants would probably pass into White Oak Lake in a day or two. Recovery and repopulation of the creek stretches would likely require up to one year as contaminants are flushed out by cleaner water from upstream.

External radiological exposures to water were estimated as described by Bechtel Jacobs (1998). Concentrations of radionuclides in tank water were divided by benchmark values for exposure of aquatic biota (or a benchmark for I-129 derived by the same methods). The hazard quotient (HQ) was calculated for each radionuclide and summed to determine the hazard index (HI) for each tank. These calculations are shown in Table 3. The HIs were approximately 8,900 for Tank 26 and 3,700 for Tank 28. However, the benchmarks were derived for chronic exposure, and the calculated exposures were predominantly internal, resulting from bioconcentration of radionuclides and ingestion of contaminated biota. Acute external exposures to water alone in Melton Branch would be negligible (Table 3).

Table 3. Radiological Exposure of Aquatic Biota to Radionuclides in Storage Tanks 26 and 28

Ecological constituent of potential concern	Tank 26					Tank 28			
	Bench-mark pCi/L	Tank conc. (Bq/mL)	RME (pCi/L)	HQ RME/ Bench-mark	External Dose[a] (rad/d)	Tank conc. (Bq/mL)	RME (pCi/L)	HQ RME/ Benchmark	External Dose (rad/d)
Radionuclides									
Cesium-134	5.98E+03	2.00E+04	7.40E+05	1.24E+02	5.64E-02	2.40E+03	8.88E+04	1.48E+01	6.77E-03
Cesium-137	5.93E+03	1.40E+06	5.18E+07	8.74E+03	0.00E+00	5.70E+05	2.11E+07	3.56E+03	0.00E+00
Cobalt-60	5.31E+03	2.20E+03	8.14E+04	1.53E+01	1.00E-02	3.70E+03	1.37E+05	2.58E+01	1.68E-02
Iodine-129	3.35E+05	7.80E-02	2.89E+00	8.62E-06	2.88E-09	1.90E-02	7.03E-01	2.10E-06	7.01E-10
Strontium-90	5.77E+04	2.50E+04	9.25E+05	1.60E+01	0.00E+00	1.50E+05	5.55E+06	9.62E+01	0.00E+00
Technetium-99	1.94E+06	1.90E+03	1.94E+06	1.00E+00	0.00E+00	4.10E+02	1.52E+04	7.82E-03	0.00E+00
Uranium-233	4.00E+03	3.80E+00	1.41E+02	3.52E-02	8.62E-10	6.08E+01	2.25E+03	5.62E-01	1.38E-08
Uranium-238	4.55E+03	1.00E-01	3.70E+00	8.13E-04	1.13E-11	1.80E+00	6.66E+01	1.46E-02	2.04E-10
			Sum	8.89E+03	6.64E-02			3.69E+03	2.36E-02

[a]External dose = $5.11 \times 10^{-8} \times E_\gamma n_\gamma \times (1\text{-}\Phi_\gamma) \times$ RME (Bechtel Jacobs 1998).
HQ = hazard quotient.
RME = reasonable maximum exposure.

Dilution of the contaminants in White Oak Lake would result (after complete mixing) in HIs of approximately 10 to 20 for Tank 26 and 4 to 8 for Tank 28. Therefore, chronic radiation toxicity to aquatic biota in White Oak Lake is likely. If the radionuclides were not retained by White Oak Dam and the downstream containment system, they would rapidly be diluted in the Clinch River below levels of concern for aquatic biota.

The time required to dilute contaminants in White Oak Lake can be estimated from the estimated flow rate and volume of the lake, assuming rapid mixing and a constant flow rate. The rate of loss of total mass of radionuclides (-dM/dt) is the product of the flow rate and the concentration at any given time (FxC, where F is the flow rate and C is the concentration). C is defined as mass divided by volume, i.e., C = M/V (where V is the total volume of the lake). Therefore, -dM/dt = FxM/V. This formula is rearranged and integrated to find the mass (M) at any given time (t) relative to the starting mass (Mo):

$$\ln(M/Mo) = -t \times F/V ,$$

and

$$t = -\ln(M/Mo)/(F/V) .$$

Because F is assumed to be 1.3×10^6 ft^3/d and V is assumed to be 3 to 6×10^6 ft^3, F/V ranges between 0.2 and 0.4. To reduce the HI, which ranged from 8 to 20, to 1 requires a reduction of total mass to 1/4 to 1/20 of the initial mass, i.e., M/Mo ranges from 0.05 to 0.25. Substituting into the second equation above, the time t required to dilute the contaminants in White Oak Lake below the radiological benchmark is from 3 to 15 days. If mixing with fresh water entering the lake is slow, parts of the lake will require longer for concentrations to drop below benchmark levels.

HERONS

Radiological doses to herons were estimated by using methods described by Sample et al. (1997). Chronic and acute external radiation doses were assumed to result from standing in or near the contaminated water for half of each day. Chronic internal radiation doses were assumed to result from ingestion of fish contaminated by uptake of radionuclides from contaminated water. It was assumed that acute internal doses would not occur because uptake of radionuclides to levels described by the bioaccumulation factor (BCF) is a result of chronic exposure.

Results of exposure calculations are shown in Table 4 for Tank 26 and Table 5 for Tank 28. The calculations showed that external radiation would provide doses of 11 and 19 rad/d to herons standing for half of the day in or at the edge of the water. These doses are above the nominal acute dose of 10 rad/d that is assumed (IAEA 1992) not to cause adverse reproductive effects to birds. The likelihood that a heron would spend half a day exposed to this spill is probably low, but sufficient exposure to cause some harm seems to be possible.

The chronic benchmark for birds is 0.1 rad/d (IAEA 1992). Combined external and internal radiation HIs were about 1,900 for Tank 26 and 3,850 for Tank 28. Dilution of the contaminants in White Oak Lake would reduce radionuclide HIs to approximately 2 to 4 for Tank 26 and 4 to 8 for Tank 28. Therefore, chronic radiation toxicity to herons and other fish-eating predators in White Oak Lake is possible. If the radionuclides were not retained by White Oak Dam and the downstream containment system, they would rapidly be diluted in the Clinch River below levels of concern for herons and other fish-eating predators.

Using the equation developed for aquatic biota and a required reduction in mass of radionuclides of 1/2 to 1/8, the time required to bring HIs in White Oak Lake below 1 would be 2 to 10 days, or longer if mixing with clean water entering the lake is not rapid.

SUMMARY AND CONCLUSIONS

If one of the Melton Valley TRU-waste storage tanks ruptures and releases 50,000 gal of liquid radioactive waste into Melton Branch, aquatic biota would be killed by chemical toxicity, perhaps by high pH, and possibly by acute external radiation exposure. Herons and other fish-eating biota could be harmed by acute external radiation exposure if they remain in close proximity to the released water, which seems unlikely since the rapidly flowing nature of the water would not provide suitable conditions for a predator to fish.

The contaminants would likely move quickly downstream to White Oak Creek, where radiation toxicity is also probable. Dilution of the non-radioactive contaminants in White Oak Lake would rapidly reduce the concentrations of contaminants below levels causing chemical toxicity, and the pH would probably change to non-toxic levels. However, chronic radiation doses to aquatic biota and fish-eating predators in White Oak Lake would remain above benchmarks for acceptable chronic radiation levels for a few days to a few weeks. The predominant exposures are to cesium-137 from Tank 26 or cesium-137, cobalt-60, and strontium-90 from Tank 28.

Dilution of contaminants by release into the Clinch River would reduce radiation doses to aquatic biota and fish-eating predators to acceptable levels.

Table 4. Radiological Exposure of Great Blue Herons to Radionuclides in Storage Tank 26

Ecological constituent of potential concern	Tank conc. (Bq/mL)	RME (pCi/L)	BCF (L/kg)	BAFv	ADDA (pCi/gBW/d) RME × BCF × IA /1,000	ADDW (pCi/gBW/d) RME × IRW /1,000	ADDtotal (pCi/gBW/d) ADDP + ADDA + ADDS	Internal Dose (rad/d)	External Dose (rad/d)	Total Dose (rad/d) Internal + External	TRV (rad/d)	Site HQ ADD total / TRV
Radionuclides												
Cesium-134	2.00E+04	7.40E+05	2.00E+03	1.00E+00	2.66E+05	3.33E+01	2.66E+05	3.11E+00	4.16E-01	3.52E+00	1.00E-01	3.52E+01
Cesium-137	1.40E+06	5.18E+07	2.00E+03	1.00E+00	1.86E+07	2.33E+03	1.87E+07	1.79E+02	3.95E-01	1.79E+02	1.00E-01	1.79E+03
Cobalt-60	2.20E+03	8.14E+04	3.30E+02	1.00E+00	4.84E+03	3.66E+00	4.84E+03	4.88E-02	1.14E+01	1.15E+01	1.00E-01	1.15E+02
Iodine-129	7.80E-02	2.89E+00	5.00E+01	3.50E-01	2.60E-02	1.30E-04	2.61E-02	3.25E-08	1.32E-06	1.35E-06	1.00E-01	1.35E-05
Strontium-90	2.50E+04	9.25E+05	5.00E+01	1.50E-02	8.33E+03	4.16E+01	8.37E+03	1.26E-03	6.91E-03	8.17E-03	1.00E-01	8.17E-02
Technetium-99	1.90E+03	1.94E+06	1.50E+01	4.25E-01	5.24E+03	8.73E+01	5.33E+03	1.17E-02	3.12E-03	1.48E-02	1.00E-01	1.48E-01
Uranium-233	3.80E+00	1.41E+02	5.00E+01	1.00E-02	1.27E+00	6.33E-03	1.27E+00	6.27E-05	2.62E-06	6.54E-05	1.00E-01	6.54E-04
Uranium-238	1.00E-01	3.70E+00	5.00E+01	1.00E-02	3.33E-02	1.67E-04	3.35E-02	1.44E-06	1.50E-08	1.45E-06	1.00E-01	1.45E-05
											HI =	1.94E+03

RME = Reasonable maximum exposure.

BCF = Water-to-animal bioconcentration factor (Bechtel Jacobs 1998).

BAFv = Food-to-predator bioaccumulation factor (Baes et al. 1984).

ADDA = Average daily ingestion rate of animal tissue.

1,000 = Conversion from kilogram to gram body weight.

IA (kg/kgBW/d) = Animal ingestion rate.

ADDW = Average daily ingestion rate; drinking water.

IRW (L/kgBW/d) = Water ingestion rate.

ADDtotal = Average daily ingestion rate; total.

Internal Dose (rad/d) = CF1 × ADD_{total} × [(20 x $E_a n_{a)}$ + ($E_b n_b \times F_b$) + ($E_g n_g \times F_g$)].

External Dose (rad/d) = RME × F_{above} × DCF × CF2 × 2.

CF = Conversion factor, 5.11×10^{-8}.

F_{above} = Fraction of time spent at or in proximity to the water surface = 0.5.

CFa = Conversion factor, 5.92×10^{6}.

2 = Conversion factor for closer proximity of heron to external source than of humans, for whom parameters were derived (Bechtel Jacobs 1998).

TRV = Toxicity reference value.

HQ = Hazard quotient.

HI = Hazard index.

Table 5. Radiological Exposure of Great Blue Herons to Radionuclides in Storage Tank 28

Ecological constituent of potential concern	Tank conc. (Bq/mL)	RME (pCi/L)	BCF	BAFv	ADDA (pCi/gBW/d) RME × BCF × IA /1,000	ADDW (pCi/gBW/d) RME × IRW /1,000	ADDtotal (pCi/gBW/d) ADDP + ADDA + ADDS	Internal Dose (rad/d)	External Dose (rad/d)	Total Dose (rad/d) Internal + External	TRV (rad/d)	Site HQ ADD total/ TRV
Radionuclides												
Cesium-134	2.40E+03	8.88E+04	1.00E+04	1.00E+00	1.60E+05	4.00E+00	1.60E+05	1.86E+00	5.00E-02	1.91E+00	1.00E-01	1.91E+01
Cesium-137	5.70E+05	2.11E+07	1.00E+04	1.00E+00	3.80E+07	9.49E+02	3.80E+07	3.63E+02	1.61E-01	3.64E+02	1.00E-01	3.64E+03
Cobalt-60	3.70E+03	1.37E+05	1.50E+03	1.00E+00	3.70E+04	6.16E+00	3.70E+04	3.73E-01	1.92E+01	1.96E+01	1.00E-01	1.96E+02
Iodine-129	1.90E-02	7.03E-01	2.00E+02	3.50E-01	2.53E-02	3.16E-05	2.53E-02	3.16E-08	3.20E-07	3.52E-07	1.00E-01	3.52E-06
Strontium-90	1.50E+05	5.55E+06	3.00E+02	1.50E-02	3.00E+05	2.50E+02	3.00E+05	4.52E-02	4.14E-02	8.66E-02	1.00E-01	8.66E-01
Technetium-99	4.10E+02	1.52E+04	1.00E+02	4.25E-01	2.73E+02	6.83E-01	2.74E+02	6.02E-04	2.44E-05	6.26E-04	1.00E-01	6.26E-03
Uranium-233	6.08E+01	2.25E+03	5.00E+01	1.00E-02	2.02E+01	1.01E-01	2.03E+01	1.00E-03	4.19E-05	1.05E-03	1.00E-01	1.05E-02
Uranium-238	1.80E+00	6.66E+01	5.00E+01	1.00E-02	5.99E-01	3.00E-03	6.02E-01	2.58E-05	2.71E-07	2.61E-05	1.00E-01	2.61E-04
											HI =	3.85E+03

RME = Reasonable maximum exposure.

BCF = Water-to-animal bioconcentration factor (Bechtel Jacobs 1998).

BAFv = Food-to-predator bioaccumulation factor (Baes et al. 1984).

ADDA = Average daily ingestion rate of animal tissue.

1,000 = Conversion from kilogram to gram body weight.

IA (kg/kgBW/d) = Animal ingestion rate.

ADDW = Average daily ingestion rate; drinking water.

IRW (L/kgBW/d) = Water ingestion rate.

ADDtotal = Average daily ingestion rate; total.

Internal Dose (rad/d) = $CF1 \times ADD_{total} \times [(20 \times E_{\alpha}n_{\alpha}) + (E_{\beta}n_{\beta} \times \Phi_{\beta}) + (E_{\gamma}n_{\gamma} \times \Phi_{\gamma})]$.

External Dose (rad/d) = RME x $F_{above} \times DCF \times CF2 \times 2$.

CF = Conversion factor, 5.11×10^{-8}.

F_{above} = Fraction of time spent at or in proximity to the water surface = 0.5.

CFa = Conversion factor, 5.92×10^{6}.

2 = Conversion factor for closer proximity of heron to external source than of humans, for whom parameters were derived (Bechtel Jacobs 1998).

TRV = Toxicity reference value.

HQ = Hazard quotient.

HI = Hazard index.

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APPENDIX F.3

IMPACTS TO SOIL AND GROUNDWATER FROM A SEISMICALLY INDUCED BREACH OF THE MELTON VALLEY STORAGE TANKS

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APPENDIX F.3

IMPACTS TO SOIL AND GROUNDWATER BY A SEISMICALLY INDUCED BREACH OF THE MELTON VALLEY STORAGE TANKS

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1. CONCENTRATION CONVERSIONS

Strontium-90 was considered a representative constituent of concern (COC) to evaluate under the potential release scenario. Strontium-90 is a major COC and has significant environmental impact. Furthermore, strontium-90 in Tank W28, one tank with more heavily impacted wastes, accounts for approximately 15% of the total radioactive material (with respect to curies) in the tank. According to Keeler et al. (1996), strontium-90 concentrations in Tank W28 are **1.5E5 Becquerel/mL.** Assuming the analytical results reported in Keeler et al. (1996) are representative of the entire 50,000-gallon waste volume, this can be converted via equations taken from the U.S. Department of Health, Education and Welfare (1970):

1.5E5 B/mL × 2.7E-11 curies/1B × 1 g/141 curies
= 2.87E-8 g/mL × 1,000 mL/L
= 2.87E-5 g/L
= 2.87E-2 mg/L

2. ESTIMATE TOTAL MASS OF RELEASE

Total Mass = 2.87E-2 mg/L × 50,000 gallons released × 3.7859 L/gal
= 5,432.7665 mg
= 5.433 grams of strontium-90 or 766 curies

3. HOLDING CAPACITY OF THE SOIL

Assuming a reasonable worst-case scenario with respect to impact to the soil and groundwater, the extent of contaminant loading to the soil can be estimated. This can be done by evaluating the partitioning effect between the solute (waste) and the aquifer material. For such a calculation, it will be assumed that flow from the release would move as porous media flow and at such a rate that the system kinetics would allow the system to remain in chemical equilibrium (the conceptual model for the release scenario along with the potential resulting area of impacted soils is detailed in Figure 1).

To evaluate the partitioning relationship, consider the aquifer or soil media's distribution coefficient (Kd):

Kd = concentration of the COC on the solid/concentration of the COC in solution.

For strontium-90, a value of **20 L/kg** was used as suggested by Sheppard and Thibault (1990) for loam soils.

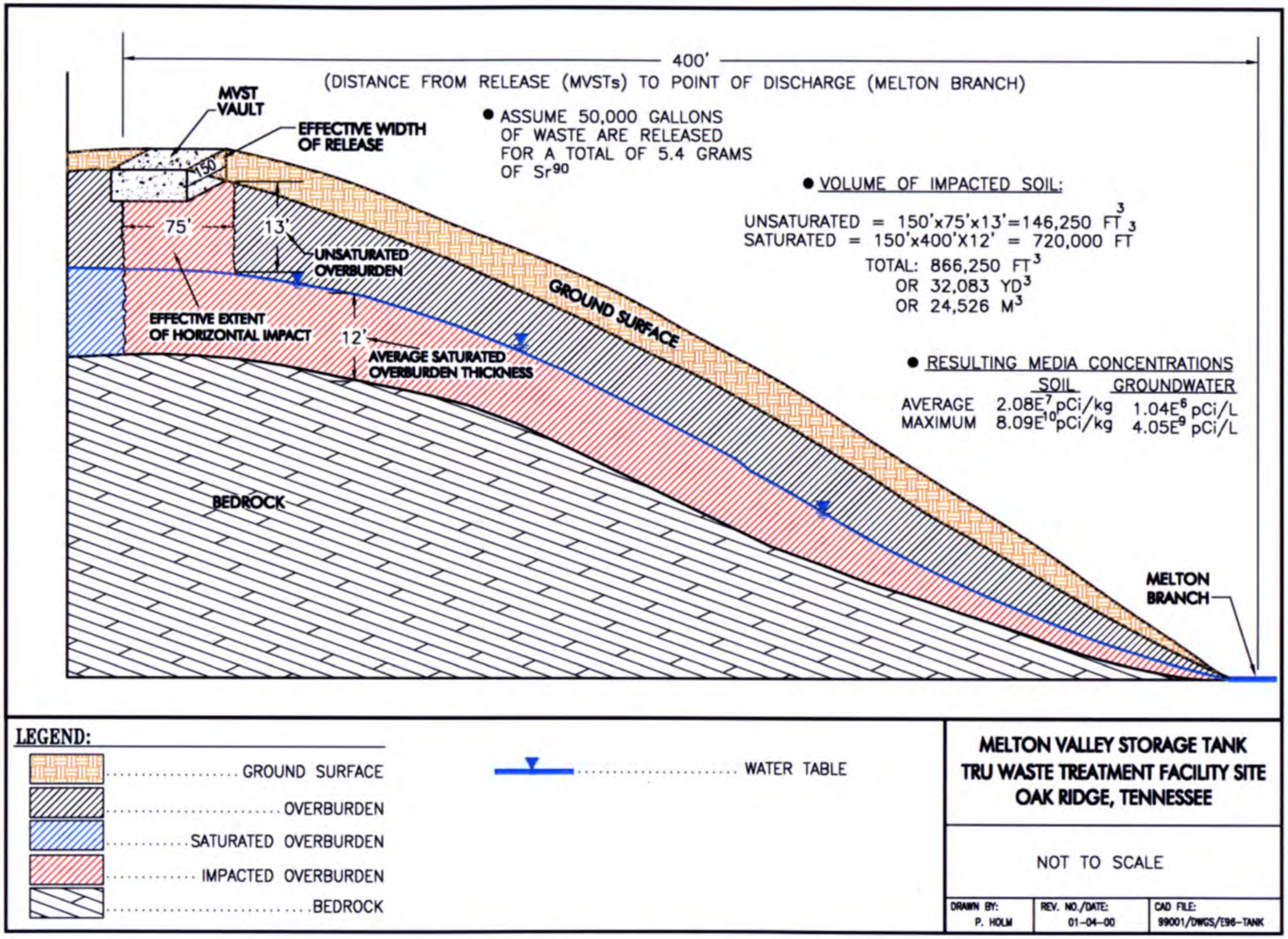

Figure 1. Conceptual Model for Melton Valley Storage Tank Release Scenario

Can the estimated area of contaminated soil adsorb the estimated quantity of strontium-90 that would be released? What is the soil's holding capacity?

As from the previous equation,

Concentration of the COC on the solid = Kd × concentration of the COC in solution
Holding capacity = 20 L/kg × 2.87E-2 mg/L
= 0.574 mg/kg (this is also the max. concentration to be expected in the soil)

if, as indicated on Figure 1, we could potentially have **866,250 ft^3** of impacted soils, then:

kilograms of potentially impacted soil = 866,250 ft^3 × 93.65 lb/ft^3 × 0.45359 kg/lb
= 3.68E7 kilograms (assuming a bulk density of 1.5 g/cm^3)

Effective Holding Capacity of the soil
= maximum concentration of the COC on the solid × total mass of potentially impacted soil
= 0.574 mg/kg × 3.68E7 kg
= 2.11E7 mg
= 2.11E4 g
= 21.12 kg

Based on past release information from the Melton Valley Storage Tanks area, such a release would greatly increase the level of localized impact.

4. FIRST-ORDER DECAY RATES FOR AN INDICATIVE CONSTITUENT OF CONCERN

As demonstrated previously, the rate of groundwater flushing from the impacted soil can be determined from the Kd equation. However, such a calculation is greatly dependent upon contaminant distribution, groundwater recharge, and flow rates. The concentration in the soil will also be directly dependent upon the radio decay coefficient of the constituent of concern (**29 years** for strontium-90 as referenced by Walton 1985).

The resulting concentration 100 years after release can be predicted by the following equation:

Resulting mass = original mass e^{-lt}
Where: l = -0.6931/ 29
= -0.0239
t = 100 years

Therefore, resulting mass = 5.433 g × $e^{-2.92}$
= 0.498 g (over a 90% reduction in total mass in 100 years).

Consequently, the radioactive decay process alone will greatly impact the strontium-90 mass and, correspondingly, soil and groundwater concentration after 100 years.

5. RESULTING CONCENTRATIONS IN SOIL AND GROUNDWATER

Based on the previously outlined assumptions, it is possible to calculate a reasonable maximum concentration in both groundwater and soil as well as average concentrations if the strontium-90 is evenly distributed across the suspected area of impact.

	Soil:	**Groundwater:**
Average	5.433 g/3.68E7 kg	= soil conc. / Kd
	= 1.476E-7 g/kg	= 1.476E-4 mg/kg / 20 L/kg
	= 1.476E-4 mg/kg	= 7.38E-6 mg/L
	= 1.476E-4 mg/kg × 141 Ci/g	= 7.38E-9 g/L × 141 Ci/g
	= 2.08E-5 Ci/kg	= 1.04E-6 Ci/L
	= 2.08E7 pCi/kg	**= 1.04E6 pCi/L**
Maximum	0.574 mg/kg	= soil conc. / Kd
	= 5.74E-4 g/kg × 141 Ci/g	= 0.574 mg/kg / 20 L/kg
	= 8.09E-2 Ci/kg	= 0.0287 mg/L
	= 8.09E10 pCi/kg	= 2.87E-5g/L × 141 Ci/g
		= 4.05E-3 Ci/L
		= 4.05E9 pCi/L

6. NARRATIVE AND CONCLUSIONS

In the event of the rupture and subsequent release of the contents of one of the eight Melton Valley Storage Tanks, up to 50,000 gallons of liquid waste could be released to the environment. In this appendix, the consequential impacts of such a release have been evaluated with respect to potential impact to the soil and groundwater. To evaluate such a release scenario, it was assumed that waste would leak from the vault in a band as wide as 150 ft across the lower front edge of the vault, in a zone parallel to slope down to Melton Branch. Furthermore, it was assumed that the waste would initially leak through the unsaturated overburden impacting an area of soil (150 ft × 75 ft × 13 ft) prior to reaching the groundwater surface. Once the waste reaches the water table/groundwater surface, it is further assumed that waste would mix with the shallow groundwater and ultimately discharge out to Melton Branch approximately 400 ft away. Details of this conceptual model are depicted in Figure 1. Such a release could potentially impact 5573.6 m^2 (0.557 hectares) of area and 24,526 m^3 of soil.

In order to assess the environmental impact, it was assumed that one of the more heavily impacted tanks, W28, would breach and spill its entire contents (approximately 50,000 gallons). Strontium-90 concentrations in this tank were reported in Keeler et al. (1996) to be 1.5E5 Becquerel/mL. This concentration in Tank W28 indicates that strontium-90 reflects approximately 15% of the total radioactive material in that tank (as measured in Becquerels). Assuming the concentrations reported are accurate for all the waste in Tank W28, 766 curies of strontium-90 would be released to the environment. If that mass of strontium-90 were evenly distributed across the potentially impacted area, concentrations in soil and groundwater would equate to 2.08E7 pCi/kg and 1.04E6 pCi/L, respectively. Based on assumed soil/water partitioning interactions, the maximum values that could be expected in soil and groundwater would equal 8.09E10 pCi/kg and 4.05E9 pCi/L, respectively. All calculations are detailed in this appendix.

These resulting concentrations are significant, as little to any previous impact for strontium-90 has been reported for the soil and groundwater near the proposed transuranic (TRU) waste treatment facility and South of Melton Branch. Furthermore, these concentrations reflect an apparent driver for remediation when compared to the 10^{-6} residential risk scenario values of 0.014 pCi/kg and 0.85 pCi/L for soil and water (RAIS 2000).

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