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**DRAFT**

# Environmental Assessment for the U-233 Disposition, Medical Isotope Production, and Building 3019 Complex Shutdown at the Oak Ridge National Laboratory, Oak Ridge, Tennessee

**August 2004**

**U. S. Department of Energy**
**Oak Ridge Operations**

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**SCIENCE APPLICATIONS INTERNATIONAL CORPORATION**

contributed to the preparation of this document and should not
be considered an eligible contractor for its review.

# Environmental Assessment for the U-233 Disposition, Medical Isotope Production, and Building 3019 Complex Shutdown at the Oak Ridge National Laboratory, Oak Ridge, Tennessee

Date Issued—August 2004

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# CONTENTS

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# FIGURES



# TABLES

blank page

# ACRONYMS

| | |
|---|---|
| ACM | asbestos-containing material |
| BJC | Bechtel Jacobs Company LLC |
| CEQ | Council on Environmental Quality |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act of 1980 |
| cfm | cubic feet per minute |
| *CFR* | *Code of Federal Regulations* |
| Ci | curie |
| CO | carbon monoxide |
| CRK | Clinch River kilometer |
| D&D | decontamination and decommissioning |
| DNFSB | Defense Nuclear Facilities Safety Board |
| DOE | U. S. Department of Energy |
| DOT | U. S. Department of Transportation |
| $DUO_3$ | depleted uranium oxide |
| EA | environmental assessment |
| EDE | effective dose equivalent |
| EID | equivalent inhalation dose |
| EIS | environmental impact statement |
| EM | Environmental Management |
| EPA | U. S. Environmental Protection Agency |
| ETTP | East Tennessee Technology Park |
| FDDI | Fiber Distributed Data Interface |
| FONSI | finding of no significant impact |
| FTE | full-time equivalent |
| gpd | gallons per day |
| gpm | gallons per minute |
| HEPA | high-efficiency particulate air |
| HEU | highly enriched uranium |
| HFIR | High Flux Isotope Reactor |
| HI | hazard index |
| HQ | hazard quotient |
| HVAC | heating, ventilation, and air-conditioning |
| LLLW | liquid low-level waste |
| LLW | low-level (radioactive) waste |
| LWS | Laboratory Waste Services |
| M&I | Management and Integration |
| MeV | mega electronvolt |
| mrem | millirem |
| MSRE | Molten Salt Reactor Experiment |
| NAAQS | National Ambient Air Quality Standards |
| NaF | sodium fluoride |
| NaOH | sodium hydroxide |
| NEPA | National Environmental Policy Act |
| NFS | Nuclear Fuel Services |
| NNSA | National Nuclear Security Administration |
| $NO_x$ | nitrogen oxides |
| NPDES | National Pollutant Discharge Elimination System |
| NRC | Nuclear Regulatory Commission |

| | |
|---|---|
| NRHP | National Register of Historic Places |
| NTS | Nevada Test Site |
| ORNL | Oak Ridge National Laboratory |
| OSHA | Occupational Safety and Health Administration/Act |
| PC | Performance Category |
| PCB | polychlorinated biphenyl |
| PDSA | Preliminary Documented Safety Analysis |
| PPE | personal protective equipment |
| ppm | parts per million |
| psi | pounds per square inch |
| R&D | research and development |
| RCRA | Resource Conservation and Recovery Act of 1976 |
| RDF | Radiochemical Development Facility |
| RFP | request for proposal |
| ROI | region of influence |
| S&M | surveillance and maintenance |
| SAA | satellite accumulation area |
| SAR | Safety Analysis Report |
| SLLW | solid low-level waste |
| SNF | spent nuclear fuel |
| SNS | Spallation Neutron Source |
| $SO_2$ | sulfur dioxide |
| SR | state route |
| SRS | Savannah River Site |
| TDEC | Tennessee Department of Environment and Conservation |
| TN-SHPO | Tennessee State Historic Preservation Officer |
| TRU | transuranic |
| TSCA | Toxic Substances Control Act of 1976 |
| $U_3O_8$ | uranium oxide |
| VOC | volatile organic compound |
| WAC | waste acceptance criteria |
| Y-12 Complex | Y-12 National Security Complex |
| $^{131}I$ | iodine-131 |
| $^{138}Cs$ | cesium-138 |
| $^{208}Tl$ | thallium-208 |
| $^{213}Bi$ | bismuth-213 |
| $^{220}Rn$ | radium-220 |
| $^{225}Ac$ | actinum-225 |
| $^{229}Th$ | thorium-229 |
| $^{232}U$ | uranium-232 |
| $^{233}U$ | uranium-233 |
| $^{3}H$ | tritium |
| $^{41}Ar$ | argon-41 |

# 1. INTRODUCTION

## 1.1 PURPOSE AND NEED

The purpose of the proposed action evaluated in this environmental assessment (EA) is the processing of uranium-233 ($^{233}$U) stored at the Oak Ridge National Laboratory (ORNL) and other small quantities of similar material currently stored at other U. S. Department of Energy (DOE) sites in order to render it suitable for safe, long-term, economical storage. The $^{233}$U is stored within Bldg. 3019A, which is part of the Bldg. 3019 Complex. The location of the Bldg. 3019 Complex is shown on Fig. 1.1. Additionally, the proposed action would increase the availability of medical isotopes needed for research and treatment and place the Bldg. 3019 Complex in safe and stable shutdown for transfer to the DOE program for decontamination and decommissioning (D&D). DOE has determined that there is no programmatic use for the $^{233}$U currently in storage at ORNL other than as a possible source of medical isotopes.

Since $^{233}$U is a special nuclear material, continued long-term storage of the ORNL inventory in its current configuration represents a significant financial liability for DOE. Continued long-term storage in Bldg. 3019A would require major capital upgrades and retrofits to critical facility systems that have deteriorated due to aging or that may not meet current standards. Storing the material in its current form requires significant annual operating expenses to meet the material-handling requirements and to provide protection against nuclear criticality accidents or theft of the material.

The ORNL inventory of $^{233}$U represents most of the readily available source of thorium-229 ($^{229}$Th) in the Western Hemisphere. Actinum-225 ($^{225}$Ac) and its daughter product, bismuth-213 ($^{213}$Bi), are isotopes in the decay chain of $^{233}$U/$^{229}$Th that are showing significant promise for ongoing cancer research, including clinical trials for treatment of acute myelogenous leukemia. These isotopes are also being explored for treatment of other cancers of the lungs, pancreas, and kidneys. Figure 1.2 shows a simplified example of the $^{233}$U decay chain.

DOE action is needed to (1) render the $^{233}$U material suitable for safe, long-term, economical storage eliminating the need for safeguards, security and nuclear criticality controls; (2) provide isotopes for medical research for providing treatment for several types of cancer; and (3) remove the $^{233}$U material, allowing the building to be deactivated and transferred to the D&D program, which would reduce DOE's landlord costs and meet the requirements of the Defense Nuclear Facilities Safety Board (DNFSB) Recommendation 97-1, which addresses the safe storage of $^{233}$U (DNFSB 1997). Recommendation 97-1 describes actions that the DNFSB considers necessary to ensure the safe storage of $^{233}$U-bearing materials in the interim and the longer term.

## 1.2 BACKGROUND/OVERVIEW

### 1.2.1 Project Procurement Process

DOE issued a request for proposal (RFP) on June 13, 2002, to procure a contractor for the disposition of DOE's inventory of $^{233}$U stored at ORNL. DOE's National Environmental Policy Act of 1969 (NEPA) regulations at 10 *Code of Federal Regulations* (*CFR*) Subpart D, Sect. 1021.216, specify that DOE shall require offerors to submit environmental data and analysis as a discrete part of their proposals. Prior to making a selection, DOE completed an environmental critique to evaluate the environmental data submitted by the offerors, and any supplemental information developed by DOE. The environmental

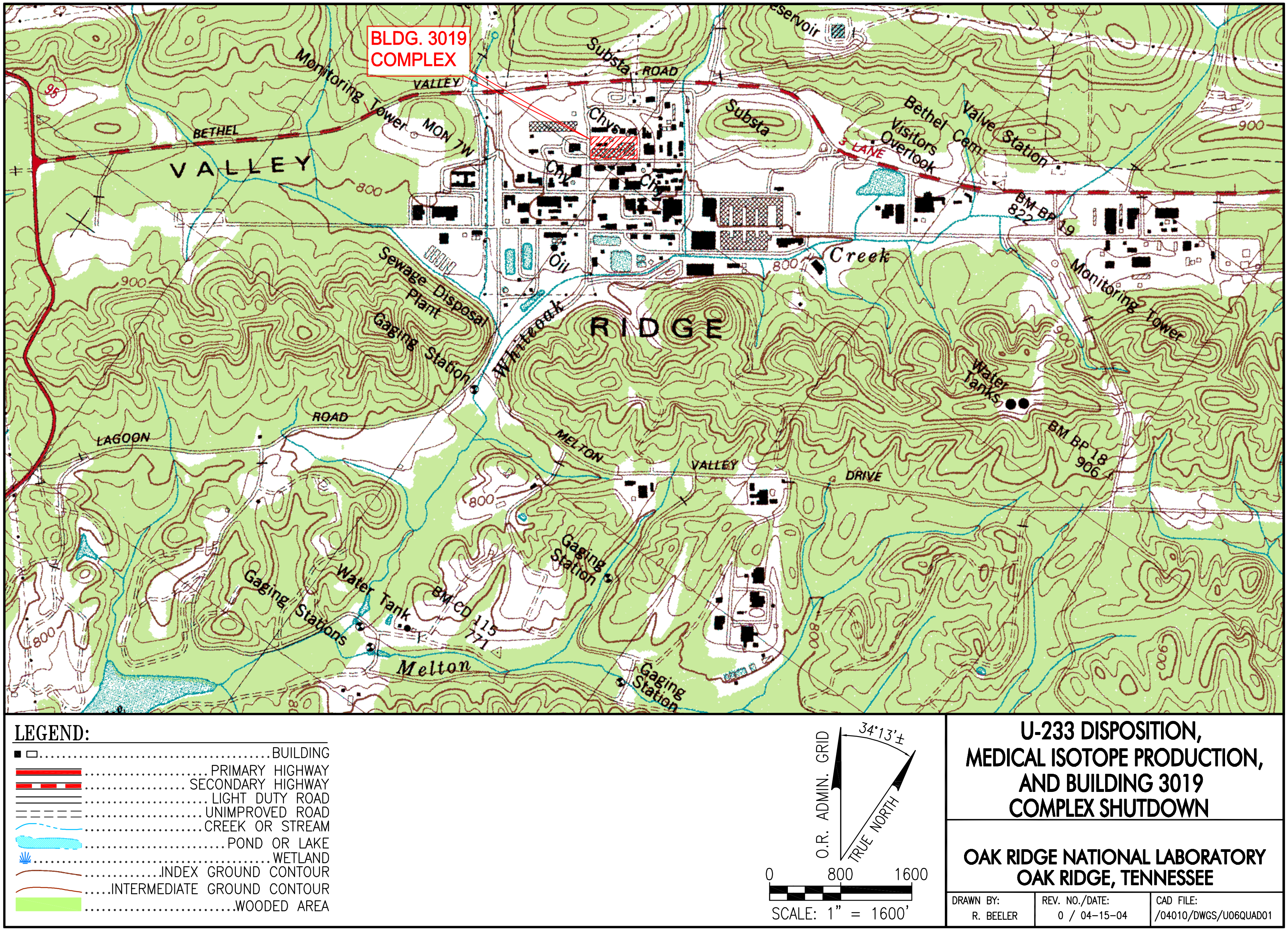
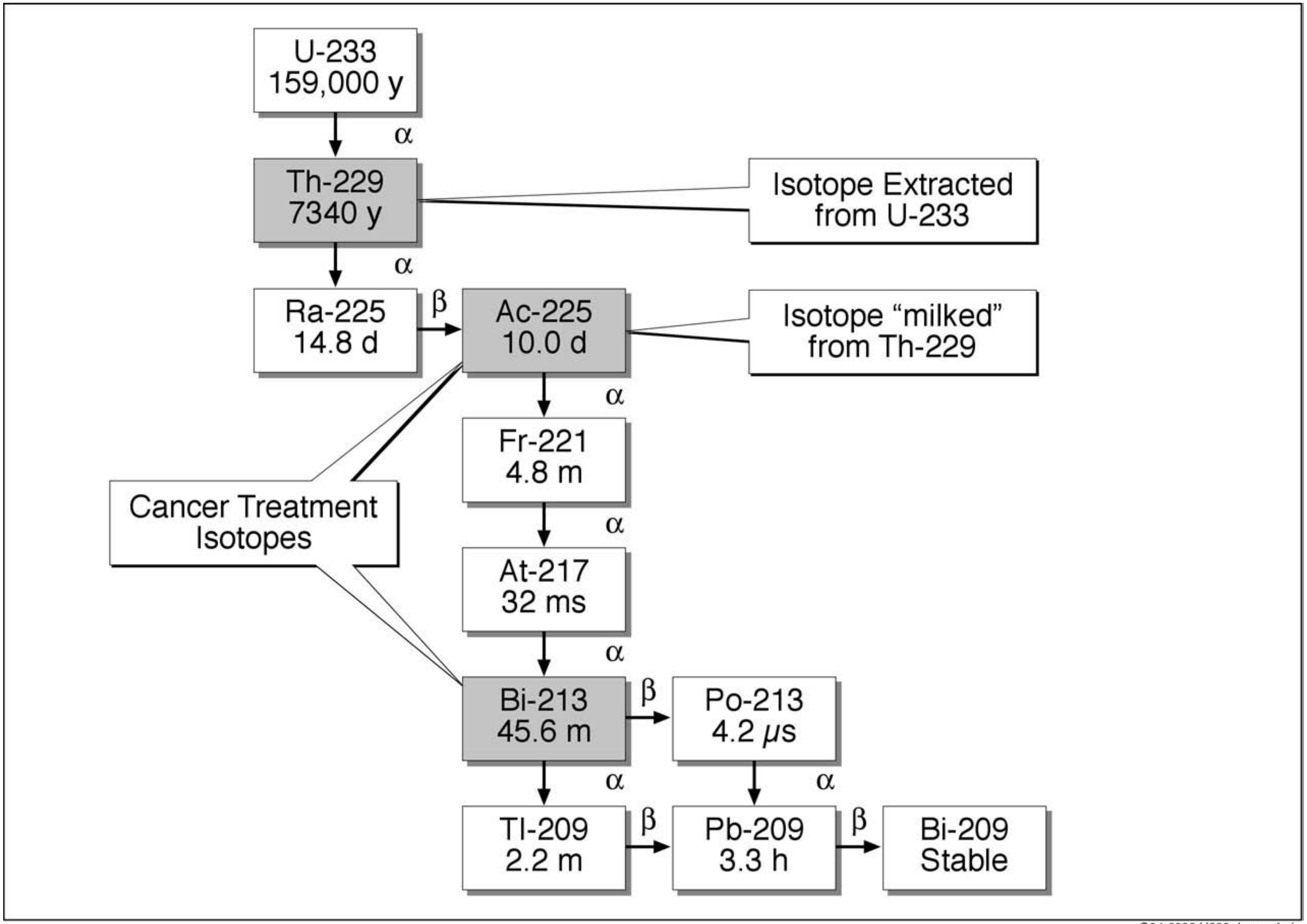



**Fig 1.1. Location of the Bldg. 3019 Complex.**




G04-0032 U233 decay chain

**Fig. 1.2. Uranium-233 decay chain.**

environmental impacts for each proposal received in response to the RFP and deemed to be within the competitive range.

As a result of the procurement process, DOE announced on October 9, 2003, that it would award the $^{233}U$ disposition contract to Isotek Systems, LLC (Isotek) located in Oak Ridge, Tennessee. Isotek is a limited liability corporation formed by Duratek Federal Services, Inc., Nuclear Fuel Services, Inc., and Burns and Roe Enterprises, Inc. Additionally, DOE's Pacific Northwest National Laboratory would provide technical expertise, and commercial production partners would partner with Isotek for the medical isotope production and delivery. The base contract award is for Phase I of the project. Phases II and III would take place pursuant to the unilateral exercise of options by the government. Phase I will encompass preliminary planning and design activities. Phase II involves project execution and will be contingent upon successful completion of Phase I. Phase III would be the Bldg. 3019 Complex shutdown phase, in accordance with shutdown/transition plans developed in Phase II. Phase III would also be contingent upon successful completion of Phase II. All three phases of the project are covered under this EA.

To inform the public of DOE's environmental considerations during the competitive process, an environmental synopsis was completed and filed with the U. S. Environmental Protection Agency (EPA) on April 5, 2004. The synopsis is based on the environmental critique, and it documents DOE's consideration of environmental factors and records the relevant environmental consequences and the alternatives evaluated in the selection process.

### 1.2.2 $^{233}U$ Inventory Description

The ORNL inventory consists of approximately 450 kg of $^{233}U$ contained in approximately 1.5 tons of total uranium. Forms of $^{233}U$ located at the Idaho National Engineering and Environmental Laboratory are not part of this effort. Other small quantities of similar material currently stored at other DOE sites could be shipped to Bldg. 3019A for downblending. Uranium-233 is a special nuclear material and, as such, requires stringent safeguards, security, and criticality controls. Approximately 50 g of $^{229}Th$, contained in the $^{233}U$ stored in Bldg. 3019A, are available for extraction. The inventory is primarily in the form of uranium oxides, but includes metals and other compounds. Uranium-232 ($^{232}U$) impurities are present in the $^{233}U$ inventory at concentrations ranging from 1 to about 220 parts per million (ppm) of total uranium.

The bulk of the material is contained in over one thousand outer packages stored in shielded tube vaults within the building. Figures 1.3 and 1.4 show some representative container types and $^{233}U$ forms. Approximately 400 packages and approximately 1100 kg of the total inventory [Consolidated Edison Uranium Solidification Project (CEUSP) material] contain relatively large amounts of $^{232}U$ and its daughter product thallium-208 ($^{208}Tl$), which represent a significant radiation hazard. The facility is also receiving $^{233}U$ from the remediation of the Molten Salt Reactor Experiment (MSRE) at ORNL. The interim remedial action for the material from the MSRE was addressed in the *Record of Decision for Interim Action to Remove Fuel and Flush Salts from the Molten Salt Reactor Experiment Facility at the Oak Ridge National Laboratory, Oak Ridge, Tennessee* (DOE 1998). In addition to the material stored within Bldg. 3019A and planned receipts, the contents of the P-24 Tank, which is attached to the building, would also be included in the proposed action. The P-24 Tank stores about 2100 kg of natural thorium with 0.13 kg of $^{233}U$ in approximately 4000 gal of thorium nitrate solution.

### 1.2.3 $^{233}U$ Inventory Condition

A risk assessment was performed by ORNL to develop a conservative characterization of the expected condition of the $^{233}U$ material and packages based on available package records and a recently completed inspection of selected inventory packages. This assessment was based on the types of packages, considering the materials of construction, the number of container layers and method of closure, and on the chemical and


**Fig. 1.3. Representative container types stored in the Bldg. 3019A tube vaults.**

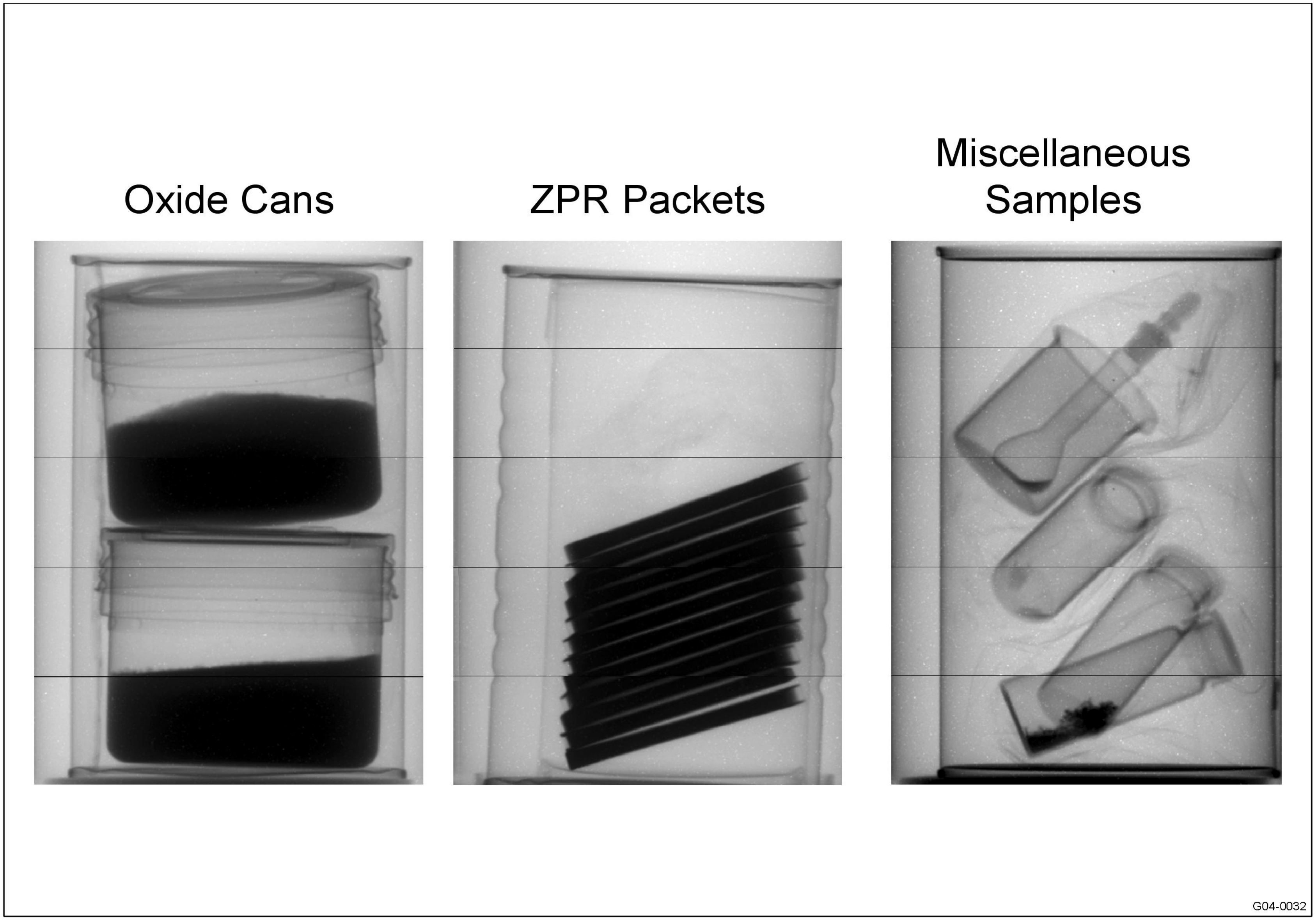



**Fig. 1.4. Radiographs of examples of the $^{233}U$ inventory stored in Bldg. 3019A.**

physical form of the $^{233}$U. The results of this assessment are documented in the *Oak Ridge National Laboratory Site Assessment Report on the Storage of $^{233}$U* (ORNL 2002a). Preparation of the site assessment was a commitment in the DOE Implementation Plan, *Safe Storage of Uranium-233* (DOE 1997a), in response to DNFSB Recommendation 97-1.

Sampling data from the off-gas system that ventilates the storage tubes and visual inspections of empty storage tubes indicates that there has not been a gross failure of the packages. It should be noted that some storage tubes are contaminated, and others are suspected to be contaminated, from packages that were contaminated when originally stored. There is evidence of limited corrosion and pitting of the carbon steel storage tubes due to atmospheric moisture, but no evidence of condensate or accumulated water in the empty storage tubes. While the containers at the bottom of many storage tubes have not been inspected, a few containers have been removed from the tubes from time to time to allow uses such as extraction of the $^{229}$Th that is being used as source material in ongoing clinical trials. Some containers have also been removed from the bottom of the Cell 4 tube vaults for purposes other than $^{229}$Th extraction with no indications of condensate or accumulated water. No evidence of outer container degradation has been found, and there are no indications of other problems for materials remaining in storage.

Over 120 packages have been successfully retrieved from the vaults as part of the inspections. All the outer canisters appeared to be in good physical condition, with only minor indications of some surface rust. No holes or penetrations were observed in any outer canisters, and all were lifted from the vault and handled without incident. There was also no indication of internal pressurization or leakage of material that was observed.

### 1.2.4 Building 3019 Complex

For the purpose of this project, the Bldg. 3019 Complex consists of a main building, several support facilities, grounds defined by a perimeter fence, and access driveways located in the north-central area of the Bethel Valley site of ORNL (Fig. 1.5). Building 3019A, the main building, was originally constructed in 1943 as a chemical separations pilot plant for the Manhattan Project.

Building 3019A is a hazard category 2 nuclear facility. Building 3019B, the former High-Radiation-Level Analytical Facility, is attached to the west end of Bldg. 3019A. A portion of Bldg. 3001, the Graphite Reactor, is the ground floor under the east end of Bldg. 3019A. Doorways between these attached buildings are sealed. Both Bldg. 3019B and Bldg. 3001 are out of service and not part of the scope for this action. However, a shower/change room in Bldg. 3001 is currently being used to support ongoing operations at Bldg. 3019A. This room would continue to be used as part of the proposed action. The support facilities are: Bldg. 3100 (storage vault); Bldgs. 3091 and 3108 (off-gas filter houses); Bldg. 3020 (off-gas stack); Bldg. 3121 (unused, contaminated filter house); Bldg. 3136 (uncontaminated mockup and storage building); and Bldgs. 3123, 3131, and 3146 (standby power generators).

Building 3019A is a nominal 30,000-ft$^2$, three-story (ground, first, and second floors) structure. The building is situated on a hillside with the grade level on the north side, about 3 ft below the first floor (or main level). On the south side, the ground level (or basement) is at grade level. At the core of the building are seven shielded processing cells positioned from east to west. Above the processing cell is a high-bay structure (or Penthouse) with a 10-ton-capacity bridge crane.

Building 3019A contains four sets of top-loaded, shielded, storage tube vaults for solid containerized fissile materials. These tube vaults are accessible from the Penthouse area. Three of the sets are in-wall storage tube vaults. The fourth set, is installed in the former hatch of one of the processing cells described above. The lower ends of these vaults are sealed, and each vault is ventilated at the upper end. There are also a number of security features associated with the stored nuclear materials. Building 3019A also contains operational laboratories with glove boxes and hoods and several areas with out-of-service glove boxes.

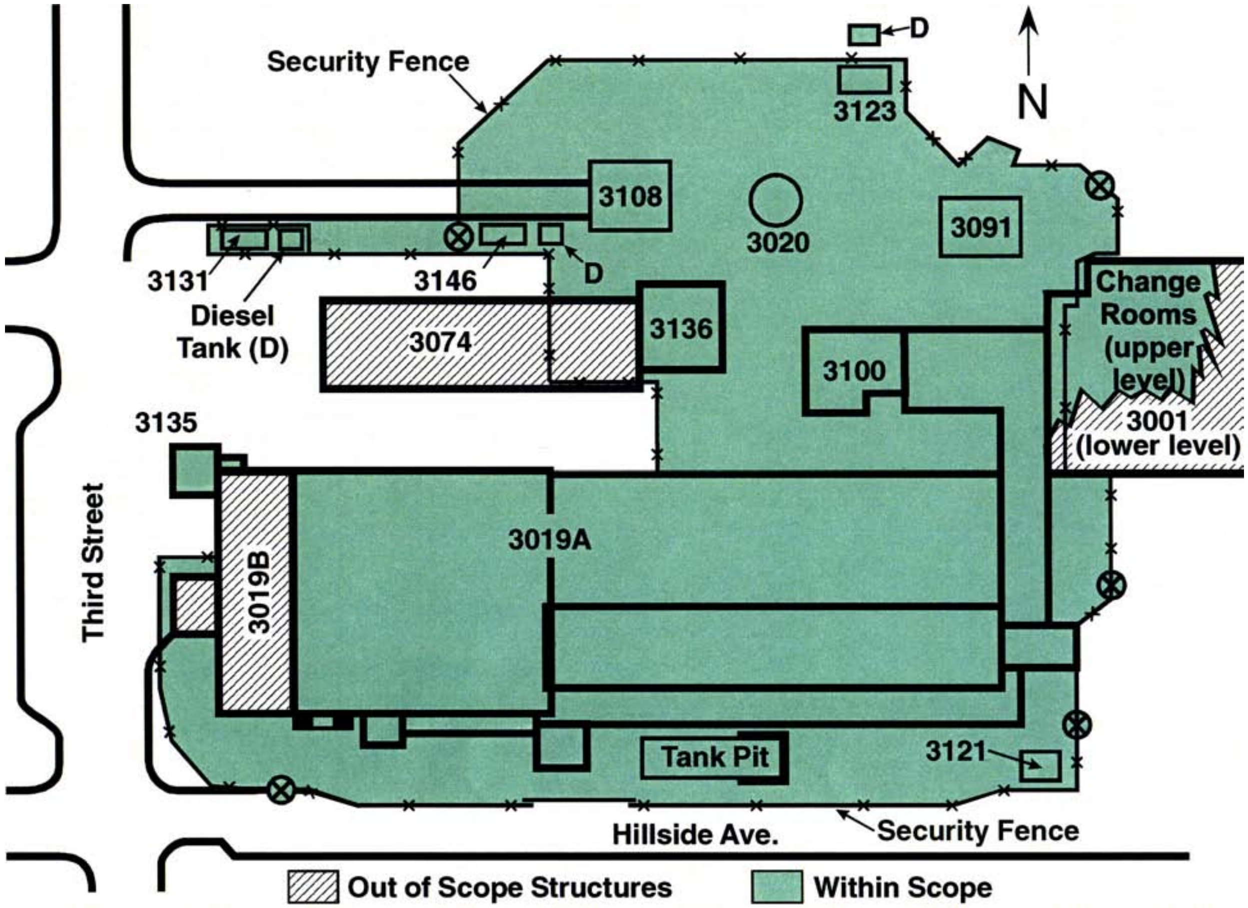



Fig. 1.5. Building 3019 Complex.

Building 3019A has four ventilation systems to maintain confinement and zoning of the facility. The four systems are the Vessel Off-Gas, Cell-Off Gas, Glove Box Off-Gas, and the Laboratory Off-Gas. The ventilation systems for the main building (a combination of the Laboratory and Cell Off-Gas systems) can exhaust approximately 40,000 cubic feet per minute (cfm), which passes through roughing and high-efficiency particulate air filters. The Laboratory and Cell Off-Gas systems also provide ventilation to the out-of-service hot cells in the adjoining 3019B facility. The Vessel Off-Gas, a low-flow, high-negative-pressure system, is provided by the 3039 Stack system, which is the responsibility of the Environmental Management (EM) Management and Integration (M&I) Contractor. Utilities available to Bldg. 3019A from ORNL include steam, potable, process and fire water, electricity, plant air, storm sewer, and sanitary sewer.

Because of the extended history of operations, there are a number of legacy issues in the Bldg. 3019 Complex:

- In 1959, a chemical explosion in a Bldg. 3019A cell distributed plutonium contamination throughout the interior and exterior of the building. Although extensive decontamination was performed, most surfaces of the building, interior and exterior, use paint bonding to prevent spread of the residual alpha contamination.
- Most areas of the facility contain out-of-service, contaminated equipment remaining from extensive pilot operations and special campaigns with spent nuclear fuel (SNF), plutonium, $^{233}$U, thorium, and other radionuclides. An extensive health physics program tracks potential migration of contamination, which is impeded by a combination of physical boundaries (e.g., glove boxes, cells, etc.) and multi-zoned ventilation control.
- In addition to the radioactive hazards, uncoated lead shielding, lead paint, polychlorinated biphenyls (PCBs), asbestos, combustible foam insulation, and perchlorate contamination are present within the facility.
- Tank P-24, which is enclosed in an underground ventilated bunker, contains approximately 4000 gal of thorium nitrate solution contaminated with $^{233}$U.
- The out-of-service sample conveyor, which crosses the roof from Bldg. 3019A to 3019B, has been a recurring source of contamination to areas of the exterior roof.
- The older exterior ventilation ducting requires periodic sealing to prevent leakage of radioactive contaminants.
- The facility produces Liquid Low-Level Waste (LLLW), Solid Low-Level Waste (SLLW), mixed wastes, Toxic Substances Control Act of 1976 (TSCA), and Resource Conservation and Recovery Act of 1976 (RCRA) wastes in the course of routine operations and maintenance.
- The extended age of much of the equipment in the facility requires a comprehensive Preventative and Corrective Maintenance Program.

## 1.3 SCOPE OF THIS ENVIRONMENTAL ASSESSMENT

This EA presents information on the potential impacts associated with the proposed $^{233}$U disposition, medical isotope production, and Bldg. 3019 Complex safe shutdown and transition to the D&D program. DOE has prepared this EA to assess the potential consequences of its activities on the human environment in accordance with the Council on Environmental Quality (CEQ) regulations [40 *CFR* Parts 1500–1508] implementing NEPA and DOE NEPA Implementing Procedures (10 *CFR* 1021). If the impacts associated with the proposed action are not identified as significant as a result of this EA, DOE shall issue a finding of no significant impact (FONSI) and will proceed with the action. If impacts are identified as potentially significant, an environmental impact statement (EIS) will be prepared.

This EA (1) describes the affected environment relevant to potential impacts of the proposed action and alternatives; (2) analyzes potential environmental impacts that could result from the proposed action; (3) identifies and characterizes cumulative impacts that could result from the proposed action in relation to other ongoing or proposed activities within the surrounding area; and (4) provides DOE with environmental information for use in prescribing restrictions to protect, preserve, and enhance the human environment and natural ecosystems.

# 2. PROPOSED ACTION AND ALTERNATIVES

## 2.1 PROPOSED ACTION

DOE proposes to (1) process and package the $^{233}U$ stored at ORNL and other small quantities of similar material currently stored at other DOE sites to eliminate the need for safeguards, security, and nuclear criticality controls rendering the material suitable for safe, long-term, economical storage; (2) extract $^{229}Th$ during $^{233}U$ processing to increase its availability for medical research and treatment, and (3) operate the Bldg. 3019 Complex during the $^{233}U$ processing and medical isotope production. These activities would be performed with an emphasis on ensuring safe interim storage of the $^{233}U$ and safe operations in the Bldg. 3019 Complex while achieving closure of DNFSB Recommendation 97-1 at ORNL.

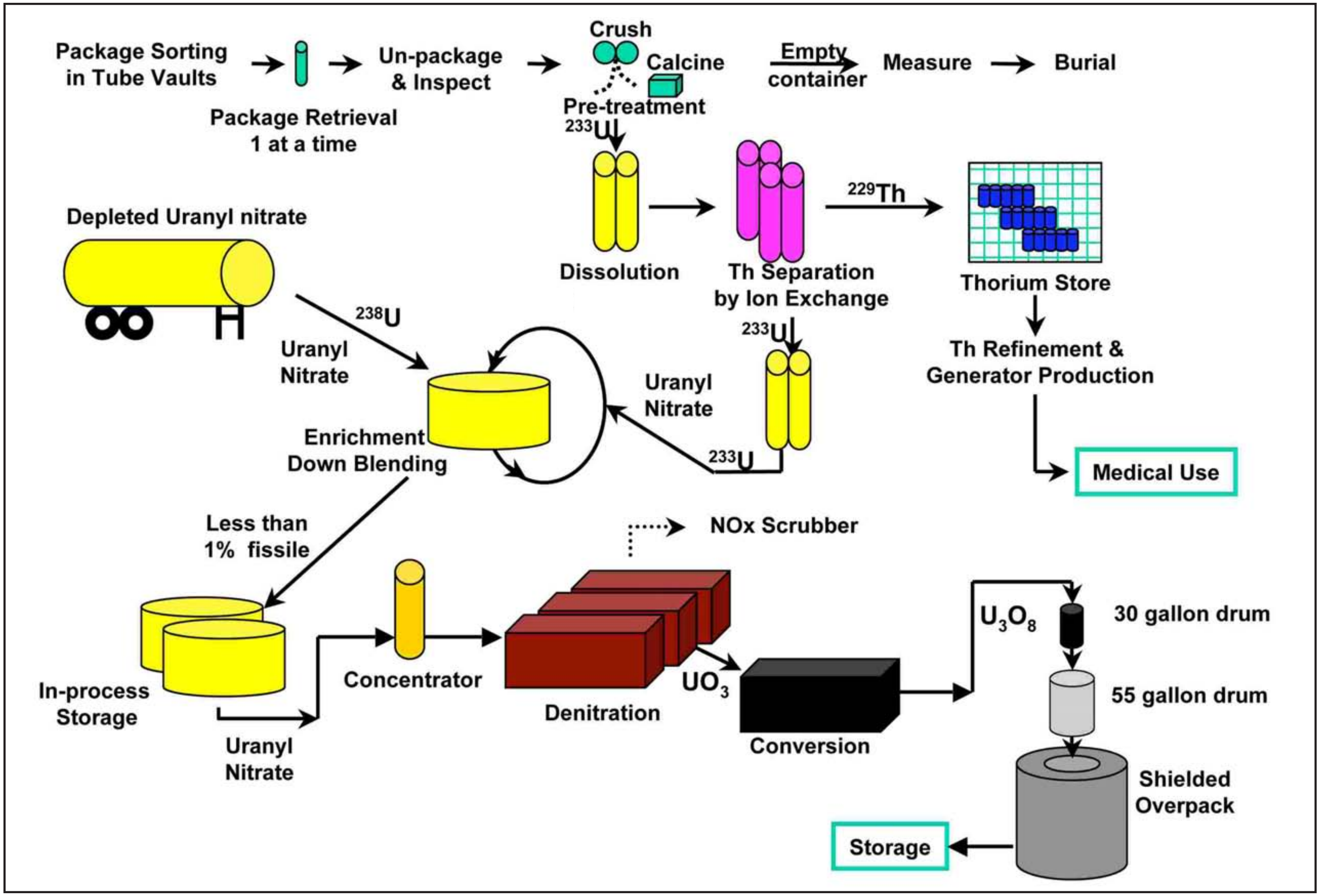
Other objectives of the proposed action include removal of the $^{233}U$ material from Bldg. 3019A and placing the Bldg. 3019 Complex in safe and stable shutdown for D&D. The D&D of the Bldg. 3019 Complex are outside of the scope of this proposed action. DOE would lease its $^{229}Th$ to Isotek for commercial beneficial uses.

Other small quantities of similar material currently stored at other DOE sites are included in this assessment for processing. Currently, there are no plans to ship these materials to ORNL. However, if it is determined that these materials need to be shipped, they would be in full compliance with U. S. Department of Transportation (DOT) and DOE regulations. DOE would conduct additional NEPA reviews for such shipments from other sites, if warranted.

The proposed project would involve several different activities in order to complete the disposition, medical isotope production, and building shutdown. These activities include

- retrieval and inspection of $^{233}U$ containers within Bldg. 3019A;
- $^{233}U$ dissolution and $^{229}Th$ extraction;
- shipment of depleted uranium oxide ($DUO_3$), conversion to depleted uranyl nitrate at Erwin, Tennessee, and receipt of depleted uranyl nitrate at Bldg. 3019A;
- downblending of the $^{233}U$ inventory and conversion of downblended material to a stable oxide;
- isotope leasing and production; and
- facility shutdown and stabilization.

Brief descriptions of these activities are presented in the following sections, and Fig. 2.1 shows a summary of the $^{233}U$ downblending and $^{229}Th$ separation process.




G04-0032 Downblending Process

**Fig. 2.1. Conceptual $^{233}$U downblending and $^{299}$Th separation process.**

Isotek would be responsible for design and construction of modifications to Bldg. 3019A and its associated facilities in order to implement the proposed action. Building 3019A would be modified, and shielded workstations would be installed to conduct high-radiation work. Criticality safety controls would be in place to prevent an inadvertent nuclear criticality.

Safe storage of the $^{233}U$ stored in Bldg. 3019A would be continued, while operations are ongoing, through the revisions of the existing safeguards and security program, configuration management program, authorization basis, and permit(s). Following removal and processing of the stored $^{233}U$, other waste and equipment would be removed as applicable.

### 2.1.1 Retrieval and Inspection of $^{233}U$ Containers Within Building 3019A

The $^{233}U$ containers would be retrieved, opened, and inspected in shielded workstations using remote-handling equipment. The type of retrieval equipment would depend upon the configuration of the container to be retrieved. The inspection equipment would allow visual inspection of the container surface and labels.

### 2.1.2 Dissolution of $^{233}U$ and Extraction of $^{229}Th$

After retrieval of the $^{233}U$ containers and their inspection, the uranium would be oxidized, if necessary, in a small furnace and then dissolved in nitric acid. Following dissolution, the total uranium in a batch would be determined using a certified analytical procedure. The storage containers and packing material would be assayed prior to being disposed. Size reduction techniques (e.g., crushing) to enhance the dissolution process may be used. The nitric acid supply tank would be exterior to Bldg. 3019A, along with a sodium hydroxide (NaOH) storage tank. The furnace, crushing station, and dissolvers would be housed in a shielded workstation.

Once dissolution of the $^{233}U$ into uranyl nitrate is completed, the solution would be passed through a resin-filled, ion-exchange column to extract the $^{229}Th$. The resin would be eluted using nitric acid to recover the thorium. Once the resin is spent, it would be disposed. The extracted thorium solution would be concentrated, put into vials, and potentially reduced to dryness depending upon the desired final form. The vials would be placed in shielded containers and staged at a thorium storage area in a new process cell prior to shipment to commercial customers for further processing and distribution.

### 2.1.3 Shipment of $DUO_3$ and Conversion to Depleted Uranyl Nitrate at Erwin, Tennessee

In order to accomplish the isotopic downblending of the $^{233}U$ after processing, approximately 255,000 kg of $DUO_3$ would be needed. Currently, the only available source of $DUO_3$, in the required amount, is in storage at the DOE Savannah River Site (SRS). Isotek would be responsible for repackaging/packaging and transportation of this material according to applicable DOE and DOT requirements. Approximately 400 drums of $DUO_3$ would be shipped from SRS to the Nuclear Fuel Services (NFS) uranium-processing facility located in Erwin, Tennessee. Each truck shipment would consist of approximately 30 drums of $DUO_3$ at a time. At the NFS processing facility, the drums of $DUO_3$ would be stored temporarily until being converted to a depleted uranyl nitrate solution. The uranyl nitrate blend stock produced at NFS would then be shipped to ORNL in a Nuclear Regulatory Commission (NRC)-licensed, DOT-certified, 3500-gal tanker truck at a rate of one to three tank trailer shipments each month, as required to support downblending. Once at ORNL, the solution would be transferred from the tanker truck to a tank external to Bldg. 3019A. After completion of the downblending activities, Isotek would return any excess $DUO_3$ to DOE in containers suitable for off-site shipment for return to SRS.

### 2.1.4 Downblending of the $^{233}$U Inventory

After extracting the $^{229}$Th, the $^{233}$U inventory would be isotopically downblended with the depleted uranyl nitrate solution to render it non-weapons usable and to eliminate criticality concerns. The downblended non-fissile uranyl nitrate solution would then be converted to an oxide through direct thermal denitrification for stabilization and to remove moisture and other volatile materials. The steam and $NO_x$ from the thermal denitrification process would be collected in a scrubber and off-gas collection system. The solid uranium oxide ($U_3O_8$) product would be packaged for handling and storage in doubly contained (i.e., exclusive of any over-pack that may be used for shielding), robust containers approved by DOE. These containers would then be transported to a Hazard Category 2 storage facility located in Melton Valley. While the downblended material would be non-weapons usable and not pose criticality concerns, it would continue to generate $^{229}$Th through radioactive decay and, thus, potentially be a source of future $^{225}$Ac.

### 2.1.5 Isotope Leasing and Production

Isotek would lease the Department's existing inventory of purified $^{229}$Th and the additional $^{229}$Th extracted from processing the $^{233}$U stored in Bldg. 3019A. The extracted $^{229}$Th may contain small quantities of uranium and plutonium. In order to produce $^{225}$Ac in accordance with the lease requirements, the $^{229}$Th would have to be purified.

Additional processing, testing, packaging, and distribution of $^{225}$Ac produced from the separated $^{229}$Th would be carried out by NRC-licensed, private-sector companies in existing or new facilities, which would be distribution points to the ultimate users of the isotopes. Isotek has identified several possible candidates for commercial production partners, and they would finalize this selection during Phase II of the project.

### 2.1.6 Facility Shutdown and Stabilization

Isotek would be responsible for developing plans to place the Bldg. 3019 Complex in safe and stable shutdown for transition to the D&D program. These plans would be consistent with applicable functional end points specified by DOE to meet facility stabilization/transition requirements. As part of this transition, Isotek would clean up all processing systems and equipment used for the $^{229}$Th extraction and $^{233}$U down-blending operations. In particular, Isotek would ensure the removal of unattached solid waste materials, and would flush and clean piping and tanks to remove residual materials. After cleanup, these systems and equipment would be characterized. Additionally, Isotek would remove and dispose any left over process materials or wastes.

Because only a portion of Bldg. 3019A would be utilized for the production phase of the project, at DOE's direction, shutdown activities could begin earlier in unused portions of the facility. Activities would include removal of processing residues and nuclear and hazardous materials. Radiological control practices and procedures would be implemented to minimize the potential for airborne contamination and spread of contamination, with particular emphasis on in-use areas.

## 2.2 NO-ACTION ALTERNATIVE

The no-action alternative provides an environmental baseline with which impacts of the proposed action and alternatives can be compared and is required by the DOE NEPA Regulations.

Under the no-action alternative, DOE would continue to have responsibility for the operation of the Bldg. 3019 Complex, and the ORNL inventory of $^{233}U$ would remain stored within Bldg. 3019A. Continued storage in the Bldg. 3019A would require major capital upgrades and retrofits to critical facility systems that have deteriorated due to aging or that may not meet current standards. Significant additional annual operating expenses would also be incurred to meet the material-handling requirements associated with repackaging about 400 packages to meet the DOE storage standard for $^{233}U$ and to provide protection against potential nuclear criticality accidents or theft of the material.

As of 2001, annual operation and maintenance costs for Bldg. 3019A were about $5–6 million per year, not including the DNFSB 97-1 Inspection and Repackaging Program at an additional approximately $8–10 million per year for a 5- to 6-year period. Extended storage of the $^{233}U$ in Bldg. 3019A would require additional structural and confinement systems upgrades with a preliminary estimated cost of $20 million. However, no engineering analysis of the upgrades has been completed. The no-action alternative would also still require revising safeguards and security controls to ensure protection as a weapons material under new guidance. Additionally, no action would impose costly safeguards and criticality safety measures (with their associated hazards) for its utilization as a long-term source of medical isotopes for cancer treatment.

## 2.3 ALTERNATIVES CONSIDERED BUT ELIMINATED

In addition to the proposed action and no-action alternatives, the following alternatives were considered but determined not to be reasonable or they did not meet DOE's purpose and need. Therefore, they were eliminated from further evaluation.

### 2.3.1 Continued Storage of the $^{233}U$ Inventory at Another Location

The storage requirements for $^{233}U$ materials must take into consideration containment, criticality control, security and safeguards, and shielding. Uranium-233 has some similar properties to other fissile materials [i.e., highly enriched uranium (HEU) and plutonium], but it has its own unique properties, which require differences in storage/handling. In addition to the criticality and safeguards requirements, a portion of the $^{233}U$ inventory stored at Bldg. 3019A contains quantities of the impurity $^{232}U$. Uranium-232 decays to $^{208}Tl$, which, in turn, decays and emits a 2.6-MeV gamma ray. This associated radioactive decay requires heavy radiation shielding and remote-handling operations to protect workers. Very few facilities within the DOE complex, outside of Bldg. 3019A, are capable of meeting the requirements for storing the $^{233}U$ inventory. The requirements also substantially increase the costs of preparing and storing the material at a new facility. Costs for this alternative include initial inspection and repackaging, facility preparation, inventory transportation (including heavily armed security escort), and facility recurring costs. Because of the various constraints associated with the storage of $^{233}U$, including cost, DOE decided that this alternative was not feasible and it was eliminated from further evaluation.

### 2.3.2 Tag for Russian Highly Enriched Uranium

This alternative would require the use of a small amount of the $^{233}U$ inventory as a tag for Russian HEU to reduce the risk of theft or diversion and allow identification of the source of stolen or diverted material. This use would only require about 30 kg (< 7%) of the current $^{233}U$ inventory and could be obtained while preparing the bulk of the $^{233}U$ for disposition. However, the National Nuclear Security Administration's (NNSA's) Office of Defense Nuclear Nonproliferation has determined that this proposed use of the $^{233}U$ material is not feasible due to problems such as the difficulty in mixing a $^{233}U$ tag uniformly into the HEU, and difficulties associated with negotiating arrangements already agreed to by the Russian Federation.

### 2.3.3 Thorium Fuel Cycle Development

Under this alternative, the $^{233}U$, which is a fissile material, would be used in the development and testing of a more advanced and proliferation-resistant thorium fuel cycle. Researchers in various DOE laboratories have proposed this alternative. This use would probably only use the higher isotopic quality portion of the $^{233}U$ inventory. The Office of Nuclear Energy, Science and Technology currently has no plans for the research and development (R&D) of the thorium fuel cycle that would use the $^{233}U$ inventory, and, therefore, maintaining an inventory of $^{233}U$ for this purpose is not justified.

### 2.3.4 Analytical Safeguards Procedures

Pure $^{233}U$ is used as a calibration spike in the determination of uranium concentrations and isotopic compositions in materials containing natural uranium or uranium enriched in $^{235}U$. This type of analytical procedure is used in many safeguards and production operations and other analytical applications. The quantities of material used are very small (typically fractions of a gram for each use) and can be obtained independently from the proposed action or from retained materials designated by DOE.

# 3. AFFECTED ENVIRONMENT

## 3.1 LAND USE

The main ORNL site (also commonly referred to as X-10) encompasses facilities in two valleys (Bethel and Melton) on approximately 1100 acres of land within the Oak Ridge Reservation (ORR). ORNL facilities are also located on other parts of the more than 21,000 acres for which ORNL is responsible, including some at the nearby Y-12 National Security Complex (Y-12 Complex) and field research areas. Within the main site, the DOE land use designation is “institutional and research.” The site supports ORNL R&D mission activities in science and technology, energy resources, environmental quality, and national security. In addition, a number of facilities located within the developed, central areas of ORNL are currently in the EM D&D Program or planned for other non-EM surplus programs. At the eastern end of the main ORNL site is the Spallation Neutron Source (SNS) facility site, which is located near Chestnut Ridge.

The Bldg. 3019 Complex is located within the Central Complex of ORNL. The Central Complex contains over 2 million $ft^2$ of facilities centered around the buildings in the 4500 series. Facilities in the Central Complex range from offices to high-performance computing and wet chemistry laboratories. Primary facilities include the Central Research and Administration Buildings (4500N and S), the High-Temperature Materials Laboratory (Bldg. 4515), and the Metals and Ceramics Laboratory (Bldg. 4508). Other facilities located nearby to the Bldg. 3019 Complex include the ORNL Cafeteria (Bldg. 2010), High-Rad-Level Analytical Facility (Bldg. 2026), Chemical Technical Division Annex (Bldg. 3017), Waste Operations Control Center (Bldg. 3130), and the Surface Sciences Laboratory (Bldg. 3137).

## 3.2 AIR QUALITY AND NOISE

The ORR and surrounding area continue to be classified as an attainment area for the National Ambient Air Quality Standards (NAAQS). The state of Tennessee has adopted these national standards, and the Tennessee Department of Environment and Conservation (TDEC) has also adopted regulations to guide the evaluation of hazardous air pollutants and toxics to specify permissible short- and long-term concentrations.

The TDEC Division of Air Pollution Control issues air permits for nonradiological airborne emissions for ORNL. ORNL has a total of 12 Clean Air Act permits (11 operating permits and 1 construction permit). The primary sources of nonradioactive emissions at ORNL include the steam plant on the main ORNL site. The steam plant and four small package-unit boilers located at the 7600-area complex and the SNS account for approximately 75% of ORNL's allowable emissions. Nitrogen oxides ($NO_x$) and opacity from one of the newer boilers at the steam plant are subject to continuous monitoring and quarterly reporting requirements. During 2003, no exceedances of $NO_x$ or opacity limits occurred. During 2003, TDEC inspected all permitted emission sources at ORNL, and all were found to be in compliance.

Radioactive airborne discharges at ORNL consist primarily of ventilation air from radioactively contaminated or potentially contaminated areas, vents from tanks and processes, and ventilation for reactor facilities. These airborne emissions are treated and then filtered with high-efficiency particulate air (HEPA) filters and/or charcoal filters before discharge. Radiological airborne emissions from ORNL consist of solid particulates; adsorbable gases (e.g., iodine); tritium ($^{3}H$); and nonadsorbable gases (i.e., noble gases). The major radiological emission point sources for ORNL consist of the following five stacks located in Bethel and Melton Valleys:

- 2026 High Radiation Level Analytical Laboratory;
- 3020 Radiochemical Processing Plant (i.e., Bldg. 3019 Complex);
- 3039 central off-gas and scrubber system, which includes the 3019A vessel off-gas system, and serves the 3500 and 4500 Areas' cell ventilation system, 3525 ventilation system, 3025 and 3026 Areas' cell ventilation system, 3042 ventilation system, and 3092 central off-gas system;
- 7503 (formerly 7512) MSRE remediation; and
- 7911 Melton Valley complex, which serves the High Flux Isotope Reactor (HFIR) and the Radionuclide Engineering Development Center.

In 2002, there were 24 minor point/group sources, and emission calculations/estimates were made for each of these sources.

The $^{3}H$ emissions for 2002 totaled approximately 86 Ci, which is almost double the value of 2001 but still lower than the values for 1998 through 2000. The $^{131}I$ emission for 2002 decreased from that for 2001 to 0.09 Ci. The major contributor to off-site doses at ORNL is usually $^{41}Ar$, which is emitted as a nonadsorbable gas from the HFIR facility stack (7911). However, 2001 was a non-operating year for HFIR due to a long maintenance period. In 2002, full operational capacity was not yet achieved. Therefore, for 2002, $^{138}Cs$, which totaled 1590 Ci, was the major contributor to the off-site dose at ORNL (DOE 2003).

Noise sources at ORNL can be categorized into two major groups: transportation and stationary. Transportation noise sources are associated with moving vehicles that generally result in fluctuating noise levels above ambient noise levels for a short period of time. Stationary noise sources are those that do not move or that move relatively short distances. Stationary noise sources in the vicinity of the Bldg. 3019 Complex include ventilation systems, air compressors, generators, power transformers, and construction equipment. During peak hours, Bethel Valley Road traffic is a major contributor to traffic noise levels in the area.

## 3.3 GEOLOGY AND SOILS

Bedrock beneath the main plant area of ORNL in Bethel Valley is composed of limestone, siltstone, and calcareous shale facies of the Ordovician Chickamauga Group. Bedrock beneath the area surrounding the Bldg. 3019 Complex includes the Fleanor Formation, Rockdell Formation, and the lower portion of the Benbolt Formation. Heterogeneous soils overlying bedrock include a mixture of fill, reworked soils, and native residual soils. During construction of site facilities, soils were extensively modified by excavation and refilling of areas around waste storage tanks, underground piping, and buildings (DOE 1999).

## 3.4 WATER RESOURCES

### 3.4.1 Surface Hydrology

The Bldg. 3019 Complex is located in the Bethel Valley Watershed. White Oak Creek is the main receiving surface water body in Bethel Valley. Its watershed comprises approximately 2098 acres of Bethel Valley and includes the following tributaries: Northwest Tributary (runs along the west side of the West Campus); First Creek (divides the west end of ORNL from the central area and receives drainage from both); and Fifth Creek (runs through the middle of central ORNL). Flow from White Oak Creek in Bethel Valley flows downstream to White Oak Lake, and eventually discharges to the Clinch River (DOE 1999). Surface runoff from the impervious surfaces surrounding the Bldg. 3019 Complex is routed to Fifth Creek via storm drains. Fifth Creek discharges into White Oak Creek via National Pollutant Discharge Elimination System (NPDES)-permitted stormwater outfalls. No wetlands are present in the immediate vicinity of the Bldg. 3019 Complex, and the area is not located within any floodplain.

### 3.4.2 Groundwater

Groundwater flow in Bethel Valley is generally from the northeast to the southwest (i.e., parallel to the strike direction). Some of the limestone bedrock underlying the area is subject to chemical weathering and dissolution resulting in karst features, including cavities and conduits, which strongly influence groundwater flow and transport of contaminants. In addition, extensive modification of the soils profile has extensively altered the soil hydrology and created numerous preferential seepage pathways, which provides a preferred pathway for groundwater flow and contaminant transport in the shallow groundwater zone (DOE 1999).

Historic processes, programs, and waste management practices associated with laboratory operations have led to areas of groundwater contamination in Bethel Valley. Groundwater quality in Bethel Valley has been characterized during Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) investigations. Common contaminants detected in groundwater include volatile organic compounds (VOCs) [mostly solvents; i.e., trichloroethene, tetrachloroethene, 1,1-dichloroethene, benzene, and vinyl chloride] near the east end of ORNL; metals (primarily mercury) and an array of radionuclides are common contaminants detected under or near the central and west end of ORNL (DOE 2003).

## 3.5 ECOLOGICAL RESOURCES

Vegetation in the vicinity of the Bldg. 3019 Complex is limited, highly disturbed, and mostly maintained by mowing. Grasses and herbaceous vegetation dominate the vegetation cover except for some Virginia pines located to the north and south of the building.

Since there is very little habitat available for native animals, the majority of the animal species found in the vicinity are species that adapt well to disturbance and the presence of humans, including small rodents, birds such as starlings and pigeons, reptiles, and waterfowl, especially Canada geese. Larger animals and many smaller native animals are not found because of a lack of suitable habitat. This type of habitat also precludes the presence of rare, threatened, and endangered plant and animal species.

## 3.6 CULTURAL RESOURCES

Building 3019A is considered to be a contributing structure to the ORNL Main Facilities Complex historic district and is eligible for listing in the National Register of Historic Places (NRHP). The facility, which was part of the Manhattan Project, was completed in December 1943. The purpose of the building was to serve as a pilot plant to process and separate plutonium from irradiated slugs produced in the adjacent Graphite Reactor. The design and technology developed for this chemical processing plant were used for the construction of a full-scale plant at Hanford, Washington. Following World War II, Bldg. 3019 served as a pilot plant for the development of other chemical separation processes that have played a major role in the advancement of chemical reprocessing techniques used worldwide (Carver and Slater 1994).

The original facility was comprised solely of seven concrete cells rising from a basement level to approximately one story above ground and a wood-frame office and control gallery attached to the north side of the cells. In 1950, a new structure was built around the cells for containment, laboratory space, and control rooms. In 1954, a "hot analytical facility" was built onto the west end of the building (Bldg. 3019B). Interior alterations include the removal of all pre-Purex equipment, modernization of equipment in the control rooms, and installation of a new ventilation system (Carver and Slater 1994).

## 3.7 SOCIOECONOMICS

The region of influence (ROI) for this analysis includes Anderson, Knox, Loudon, and Roane counties. The region includes the cities of Clinton, Oak Ridge, Knoxville, Lenoir City, Loudon, Harriman, and Kingston. These counties are geographically close to ORNL and account for over 90% of DOE-related employment. This distribution has been relatively stable for the last decade (DOE 2002a). This results in a relatively conservative estimate of impacts, since Anderson County is also part of the Metropolitan Statistical Area for the city of Knoxville, and draws commuters from at least 12 counties in eastern Tennessee (DOE 2002a). Actual impacts may be distributed over a wider area, which would reduce the overall impact on the counties included in this analysis.

### 3.7.1 Demographic and Economic Characteristics

Table 3.1 summarizes population, per capita income, and wage and salary employment from 1997 to 2001, the latest year for which data are available. Population has increased slightly over the 5-year period, and employment for the region rose a little more than 1%, from 346,338 in 1997 to 363,862 in

**Table 3.1. Demographic and economic characteristics in the Oak Ridge Region of Influence**

| County | 1997 | 1998 | 1999 | 2000 | 2001 | Annual growth 1997–2001 (%) |
|---|---|---|---|---|---|---|
| ***Anderson*** | | | | | | |
| Population | 71,736 | 71,321 | 71,454 | 71,284 | 71,441 | -0.10% |
| Per capita income ($) | 23,392 | 24,500 | 24,994 | 26,473 | 27,194 | 3.84% |
| Total employment | 48,109 | 50,139 | 50,408 | 50,903 | 51,243 | 1.59% |
| ***Roane*** | | | | | | |
| Population | 51,179 | 51,462 | 51,736 | 51,944 | 51,982 | 0.39% |
| Per capita income ($) | 19,379 | 20,116 | 20,720 | 21,957 | 22,017 | 3.24% |
| Total employment | 25,753 | 25,541 | 24,772 | 24,008 | 22,840 | -2.96% |
| ***Knox*** | | | | | | |
| Population | 376,767 | 378,319 | 380,010 | 382,803 | 385,585 | 0.58% |
| Per capita income ($) | 24,559 | 26,092 | 26,749 | 28,440 | 29,426 | 4.62% |
| Total employment | 257,256 | 261,899 | 265,907 | 274,270 | 273,852 | 1.58% |
| ***Loudon*** | | | | | | |
| Population | 37,427 | 38,068 | 38,741 | 39,225 | 39,939 | 1.64% |
| Per capita income ($) | 22,227 | 23,301 | 24,144 | 25,946 | 26,257 | 4.25% |
| Total employment | 15,220 | 14,982 | 15,209 | 15,860 | 15,927 | 1.14% |
| ***Region Totals*** | | | | | | |
| Population | 537,109 | 539,170 | 541,941 | 545,256 | 548,947 | 0.55% |
| Per capita income ($) | 23,710 | 25,113 | 25,756 | 27,387 | 28,203 | 4.43% |
| Total employment | 346,338 | 352,561 | 356,296 | 365,041 | 363,862 | 1.24% |

***Source***: Bureau of Economic Analysis 2004.

2001. Total personal income grew from $12.7 billion to $15.5 billion over the same period (Bureau of Economic Analysis 2004). However, Knox County accounted for most of the growth, while population declined in Anderson County and employment declined in Roane County during these years.

### 3.7.2 Distribution of Minority and Economically Disadvantaged Populations for Environmental Justice Concerns

For the purposes of this analysis, a minority population consists of any census tract in which minority representation is greater than the national average of 30.7%. Minorities include individuals classified by the U. S. Bureau of the Census as Black or African-American, American Indian and Alaska Native, Asian, Native Hawaiian and Other Pacific Islander, and Hispanic or Latino, and those classified under “Two or more races.” This provides a conservative estimate consistent with Office of Management and Budget guidance (OMB 2000). Hispanics may be of any race and are excluded from the totals for individual races in order to avoid double counting.

The distribution of minority and economically disadvantaged populations changed little between 1990 and 2000. Only one of the census tracts that immediately surrounds the ORR currently includes a minority population. As of the 2000 census, minorities represented 40.1% of the population in tract 201. As in 1990, Black or African-American residents comprised the largest group (29.6%). The proportion of minority residents in all other Oak Ridge census tracts was below the national average, ranging from 17.4% in tract 205 to 8.8% in tract 206 (Census 2001). No federally recognized Native American groups live within 50 miles of the project area.

According to the 2000 Census, 12.4% of the U. S. population and 13.5% of the Tennessee population had incomes below the poverty level in 1999 (Census 2001). In this analysis, a low-income population consists of any census tract in which the proportion of individuals below the poverty level exceeds the national average. Within the ROI, 13.1% of the population in Anderson County had incomes below the poverty level. The proportion in Knox County was 12.6%, in Loudon County it was 10.0%, and in Roane County it was 13.9%. Within Oak Ridge, low-income populations were located in census tracts 201 (15.8% below poverty level) and 205 (27.9%). Tract 201 roughly corresponds to the Scarboro community, and tract 205 includes the area between Oak Ridge Turnpike and West Outer Drive, bounded on the west by Louisiana Avenue, and on the east by Highland Avenue and Robertsville Road. In other Oak Ridge census tracts, the percentages ranged from 12.1% in tract 204 to 1.9% in tract 301 (Census 2001).

### 3.7.3 Fiscal Characteristics

Oak Ridge City general fund revenues and expenditures for fiscal year 2003 and projected revenues and expenditures for 2004 are presented in Table 3.2. The general fund supports the ongoing operations of local governments, as well as community services, such as police protection and parks and recreation. The largest revenue sources 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 (City of Oak Ridge 2003).

**Table 3.2. City of Oak Ridge revenues and expenditures, FY 2003 and FY 2004 ($)**

| | 2003 Actual | 2004 Projected |
|---|---|---|
| **Revenues** | | |
| Taxes | 19,652,987 | 20,394,000 |
| Licenses and permits | 195,000 | 215,000 |
| Intergovernmental revenues | 10,906,717 | 11,083,380 |
| Charges for services | 1,391,461 | 1,392,621 |
| Fines and forfeitures | 281,400 | 319,000 |
| Other revenues | 447,500 | 447,500 |
| Total revenues | 32,875,065 | 33,851,501 |
| **Expenditures and other financing** | | |
| Expenditures | (14,693,586) | (14,833,127) |
| Other financing uses | (18,670,239) | (19,330,235) |
| Total expenditures and other financing | (33,363,825) | (34,163,362) |

*Source*: City of Oak Ridge 2003.
FY = Fiscal Year.

## 3.8 INFRASTRUCTURE

ORNL is similar to a small city and is supported by a dedicated fire department, a medical center, a security force, a wastewater treatment plant, and a steam plant. Major utilities, including electricity, natural gas, water, and telecommunications, required by ORNL are available. These utilities are supplied by other entities. The Laboratory produces steam and compressed air and operates and maintains systems for the collection and treatment of sanitary, process, and industrial-type wastes. Utilities available to Bldg. 3019A from ORNL include steam, potable, process and fire water, electricity, plant air, storm sewer, and sanitary sewer.

The following information about the utility and transportation infrastructure serving ORNL is taken from the *Oak Ridge National Laboratory Land and Facilities Plan* (ORNL 2002b).

### 3.8.1 Utilities

**Electrical.** Electrical power used at ORNL is fed from the Tennessee Valley Authority Oak Ridge area from a 161-kV network through two feeders. Current capacity of the feeders is sufficient to accommodate virtually any facility or program that may be located at ORNL, but the ORNL substation would need to be upgraded if there was a major increase in the total energy usage at the laboratory. No on-site electrical power generation is conducted at ORNL; however, 34 backup generators have been installed at specific facilities. These standby generators provide essential power to allow functions associated with environment, safety, health, security, quality, and infrastructure to continue unaffected during power outages. Building 3019A has three backup generators.

**Natural Gas.** Natural gas is supplied to ORNL from the main line and the three pressure-reducing stations that make up the supply system to the ORR. The ORNL natural gas tap is at Metering Station B, located north of Bethel Valley Road at the Melton Valley Access Road intersection. Natural gas from the main is reduced to 100 pounds per square inch (psi) at the metering station. The 6-in. ORNL supply line runs south to a tee where a 2-in. line branches off to supply gas to the 7000 Area reducing station. Gas pressure is reduced at the station to 10 psi for distribution to user facilities in the 7000 Area. The gas supply for the remainder of ORNL runs to the Steam Plant. At the Steam Plant pressure is reduced to supply the distribution grid for the facilities in the main ORNL Bethel Valley complex.

**Sewage.** The ORNL sewage system includes the main system, the 7900 Area system, and the other minor systems. The main system serves Bethel Valley, which includes the areas of 1000, 2000, 3000, 4500, and 5500 building series. The ORNL Sewage Treatment Plant, built in 1985, consists of a DAVCO 300,000-gallon per day (gpd) packaged, extended aeration plant that provides primary and secondary treatment and a sand/gravel filter and ozonator system to provide tertiary treatment. Treated effluent is discharged into White Oak Creek. The subcomponents of the main sewage system are a collection system comprising 6-in., 8-in., and 10-in. vitrified clay pipes, pumping stations, treatment and discharge systems, and related services and equipment.

ORNL sends its sanitary sewage sludge to the city of Oak Ridge for inclusion in the city's biosolids land application program. While not all sludge can be transferred because of low levels of residual radiological contamination, the portion that can be disposed of in this manner reduces the quantity of solid, low-level contaminated waste generated. Efforts continue to determine possible sources of ground-based contamination that is leaching into the ORNL sewage collection system, and much of the system has been renovated to eliminate inflow and infiltration.

**Water.** Treated water to ORNL (Bethel Valley and Melton Valley) is supplied to ORNL by the city of Oak Ridge from the water treatment plant located across from the Y-12 Complex, on Bear Creek Road. Water to ORNL is provided via a single 24-in. gravity line from the water plant into the ORNL plant site. ORNL is responsible for compliance with the rules of the TDEC Division of Water Supply and operates and maintains the water distribution system. The water line feeds the ORNL reservoir system, which consists of one 3-million-gal concrete reservoir, a new 1.5-million-gal reservoir on Chestnut Ridge, and two 1.5-million-gal steel reservoir tanks on Haw Ridge. From these reservoirs, water flows by gravity in the plant distribution grid. The water is used for domestic, sanitary, fire protection, and process purposes. A new water reservoir has also been constructed for the SNS. Although constructed for the primary use of the SNS, it is on the ORNL distribution grid and is considered by TDEC in the reserve storage capacity compliance requirement. The potable water and process water distribution system at ORNL consists of 100,000 ft of piping. The general condition of the system can be described as fair to good and is continuously improved; system breaks are sporadic, and the cause of failure is primarily due to mechanical loading and deterioration. A number of expansions and improvements to the water system are in construction and more are being planned.

**Stormwater Collection System.** The stormwater collection system consists of drainage ditches, catch basins, manholes, and collection pipes, which transport stormwater, condensate, and cooling water flows to receiving streams. White Oak Creek traverses the site and ultimately receives the primary discharges from ORNL, as well as normal flows from the tributaries, which feed it. Rainfall, snowmelt, and other authorized flows are directed to the gravity-drainage system. The ORNL NPDES permit covers 164 outfalls; 146 of the outfalls are listed for constituents, including stormwater runoff from the stormwater collection system. These outfalls are periodically monitored at several instream points for various parameters as required by the NPDES permit.

**Fire Protection.** Most ORNL facilities are protected from fire by remotely monitored fire alarm and sensing systems coupled with automatic sprinkler devices. Fire protection is provided primarily through the potable water system and is crucial to the facilities and personnel protection. During the winter months, steam heating protects the fire protection water lines. Many of the old, outdated fire alarm systems in Laboratory facilities are being updated, and new systems are being added to facilities currently not covered. These improvements will enhance fire protection capability for the Laboratory and ensure compliance with requirements in fire protection standards.

**Compressed Air.** Compressed air powers all of ORNL's major pneumatically operated control systems, which include many experimental programs and processes, as well as many building ventilation systems. Clean, dry, instrument-quality, 100-psi compressed air is produced at the ORNL Steam Plant for users in the Bethel Valley area by one or more of six air compressors. In addition, a single, diesel-powered air compressor is used in emergency situations such as power outages or when maintenance or breakdowns on the other compressors require their use. The compressed air is distributed through an arterial-looped underground and aboveground piping system.

**Heating, Ventilating, and Air-Conditioning (HVAC).** Heating and cooling of the buildings and equipment are primarily provided by space conditioning units. The HVAC design in each building does include refurbishment of HVAC system heating and cooling equipment, ductwork, filters, stacks, scrubbers, and alarm and backup systems. The ORNL central chilled water system located in Bldg. 4509 generates the cooling water used in the air-conditioning of some 4500, 5500, and 6000 series buildings. The total chilled water system is comprised of seven compressor/chiller units with a total capacity of 5800 tons, about 8500 ft of distribution piping, and serves close to 1 million ft2 of floor area. Regardless of outside temperatures, several facilities require year-round cooling from the chilled water system for computers, accelerators, and some laboratories.

**Steam.** The steam production system consists of four dual-fired boilers and two package-type boilers located in the Steam Plant (Bldg. 2519). Total capacity of the six boilers is around 300,000 pounds per hour of saturated steam. The steam plant supplies steam to Bethel Valley and to the 7500 and 7900 series buildings in Melton Valley. Major refurbishment of the steam and air distribution systems took place in 1998, and the supply system was refurbished to convert systems to gas-fired with oil-fired backup. New projects are expected to upgrade system components for long-term gas operation. Approximately 90% of the steam produced is used primarily for heating approximately 135 buildings, and the remainder is used for driving the emergency off-gas turbines in the 3039 Stack in the event of power outage.

**Telecommunications.** ORNL had a state-of-the-art telephone system when upgraded in 1973. Double coaxial cables connect selected facilities in Bethel Valley with selected ORNL facilities at the Y-12 Complex. The ORNL network backbone will remain fiber-optic based but will evolve from its current Fiber Distributed Data Interface (FDDI) technology base to a set of parallel FDDI, Gigabit Ethernet, and automatic teller machine networks that provide the flexibility to accommodate almost any network-intensive computing project while holding the line on costs for less demanding applications.

### 3.8.2 Transportation

ORNL main site locations are accessible only by road. Although portions of the site border the Clinch River, there is no barge facility. Rail access is also limited as well, as no tracks run to the ORNL site. Vehicle circulation at ORNL may be divided into two sectors: off-site and on-site circulation. Off-site circulation consists of staff movements to and from work and between the various Oak Ridge installations on work assignments and of materials delivery. Off-site roads include State Route (SR) 95 (White Wing Road), which provides access to the west end of the Bethel Valley area, and SR 62 and Scarboro Road, which provide access to the eastern end of Bethel Valley and the ORNL facilities at the Y-12 Complex. On-site circulation consists of materials handling, movement of personnel between buildings and to and from parking lots, and contractor and vendor personnel movement.

The main road is Bethel Valley Road, which is currently closed to non-authorized traffic. This east–west road provides access to the site and leads to all the parking lots. Completion of several construction and expansion projects has helped alleviate some of the chronic parking problems experienced at the Bethel Valley site. Several main roads and access roads provide on-site transportation. The primary north and south corridors are First, Second, Third, Fourth, and Fifth streets. The major east and west corridors are White Oak and Central Avenues. Materials are transported via the same route used by employees and visitors.

The main roads in Melton Valley are Melton Valley Drive, Ramsey Drive, and Melton Valley Access Road. These roads lead to the principal experimental facilities, including the HFIR, the Consolidated Fuel Reprocessing Center, and the Robotics and Process Systems Complex. Several other access roads serve the numerous solid waste storage areas.

By far, the largest portion of the off-site traffic circulation generated by ORNL is personnel commuting to and from work. The average commute of an ORNL employee working in Bethel Valley is about 35 miles. Peak traffic occurs between 7 and 8 a.m. with the arrival of workers at the site, and between 4 and 5 p.m. with their departure. Minimal traffic delays are experienced during these peaks since work shifts are staggered, car and vanpooling are practiced, and most deliveries to and shipments from ORNL are timed to avoid the rush hour. Road maintenance and the movement of heavy equipment or escorted shipments typically occur during the workday after traffic flow has subsided.

## 3.9 WASTE MANAGEMENT

In 1999, Bechtel Jacobs Company LLC (BJC) assumed responsibilities for waste storage, transport, and disposal at ORNL. ORNL's wastes are managed in seven categories: conventional, low-level radioactive, transuranic (TRU), hazardous, mixed, toxic, and classified (ORNL 2002b). These categories are briefly described below. Sanitary sewage collection and treatment, which is categorized as a conventional waste, is discussed in Sect. 3.8.1.

### 3.9.1 Sanitary/Industrial Wastes

Sanitary/industrial wastes consist of paper, garbage, wood, metal, glass, plastic, demolition and construction debris, sanitary and food wastes from cafeteria operations, sludge from water and air treatment, and other special wastes. The Y-12 Complex Centralized Sanitary Landfill II is used for disposal of nonhazardous materials such as construction debris and most other sanitary wastes.

### 3.9.2 Process Wastewater

This collection system consists of a series of underground pipes where process wastewater flows from the source facility to a pumping station for transfer to the Process Waste Treatment Complex—either Bldg. 3544 (for radiological treatment) or Bldg. 3608 (for non-radiological treatment). Manholes equipped with alpha and beta-gamma radiation monitors, pH monitors, and flow monitors are located at strategic points throughout the collection system and are continuously monitored at the Waste Operations Control Center to allow personnel to detect any unusual activity within the system. Wastewater goes to either the radiological or non-radiological treatment process based on radiation limits monitored at these manholes. Wastewater requiring radiological treatment is transferred to the storage tanks (two 350,000-gal and one 1,000,000-gal capacity each) at Bldg. 2600. An underground pipe is used to transfer the wastewater to Bldg. 3608 for water softening prior to its transfer to Bldg. 3544 for radiological treatment.

The Bldg. 3544 treatment process consists of three basic operations: precipitation (which actually takes place at Bldg. 3608), filtration, and ion exchange. The first two of these, together called head-end treatment, use conventional water treatment equipment: a sludge recycle tank, a sludge-blanket-type precipitator-clarifier, and pressure filters. The ion-exchange equipment uses a process with strong acid cation exchange resins. The process equipment allows treatment rates of 300 gallons per minute (gpm).

The Bldg. 3608 facility was designed to treat process wastewater from Bldg. 3544, the 4500, 2000, and 1505 Areas, and the HFIR/REDC site to remove particulates, heavy metals, and organics, as well as to adjust the pH of the wastewater before discharge to White Oak Creek. Building 3608 was designed to segregate incoming waste streams into two streams: one containing heavy metals and one not containing heavy metals. At the facility are two 325,000-gal surge tanks: one receives heavy metals wastewater, and the other receives the nonmetals wastewater. The facility consists of the following unit operations: precipitation, filtration, air stripping, treatment through granular-activated carbon columns, and pH adjustment. Building 3608 has the capacity to treat up to 760 gpm (1.1 million gallons per day) of wastewater and is operated 24 h/day, 7 days/week.

### 3.9.3 Liquid Low-Level Waste System

The LLLW system at ORNL collects, neutralizes, concentrates, and stores aqueous radioactive waste solutions from various sources at the Laboratory. The sources of these waste solutions are “hot” sinks and drains in R&D laboratories, radiochemical pilot plants (e.g., Bldg. 3019A), and nuclear reactors located in both Bethel and Melton valleys. The LLLW system/facilities are located throughout ORNL. The LLLW storage tanks are located near the LLLW source buildings, the LLLW Evaporator Facility is located near Third Street, and the Melton Valley Storage Tanks and LLLW Solidification Facility are located in Melton Valley.

Waste is generated from buildings and sent to collection tanks near the facility or directly to the LLLW Evaporator Service Tanks W-21 or W-22. These tanks store evaporator concentrate and dilute radioactive LLLW and are connected directly to the LLLW Evaporator systems. The contents of the tanks are transferred on a batch basis to the evaporator facility for volume reduction. Two 600-gal/h evaporator systems, housed in Bldg. 2531, are used to concentrate the LLLW. Condensate from the evaporator systems receives treatment at the Bldg. 3544 process waste treatment complex for the removal of radiochemicals from the evaporation process. The LLLW concentrate is stored in 50,000-gal evaporator storage tanks until a pipeline transfers it to the Melton Valley Storage Tanks.

LLLW is also transported by surface vehicles to the LLLW collection system for treatment as an alternative to the LLLW collection system, which utilizes a network of underground piping and tanks.

Bulk liquid wastes that are not transferred by pipeline are transported from the generating facility by tank motor vehicle to the collection header in the South Tank Farm for further transport by pipeline to the storage tanks and Bldg. 2531 for treatment. Smaller quantities of liquid waste, such as those produced in some of the research laboratories, are bottled and transferred from the generating facility by motor vehicle directly to Bldg. 2531 for treatment.

### 3.9.4 Stack Ventilation System

The Bldg. 3019 Complex has four multi-zone ventilation systems. The four systems are the Cell Off-Gas, Laboratory Off-Gas, Glove-box Off-Gas, and Vessel Off-Gas. The ventilation systems for the main building (3019A) can exhaust approximately 40,000 cubic feet per minute, which passes through roughing and HEPA filters. The Laboratory and Cell Off-Gas systems also provide ventilation to the out-of-service hot cells in the adjoining 3019B facility. The majority of the process source emissions from the Bldg. 3019 Complex (Cell Off-Gas, Laboratory Off-Gas, and Glove-box Off-Gas) are discharged through the 3020 Stack. However, some emissions (Vessel Off-Gas) are vented through the 3039 Stack Ventilation System. The primary functions of these ventilation systems are to safely and efficiently collect process gaseous waste streams from various ORNL facilities, provide the necessary filtration, monitor the streams for radionuclide and hazardous material contents, and discharge the combined streams to the atmosphere at a central location. The systems are designed to provide continuous, uninterrupted operation by utilizing backup fans, cross-connected systems, redundant capacity, and backup power supplies.

### 3.9.5 Solid Low-Level Radioactive Waste

SLLW is waste that contains radioactivity but is not classified as high-level waste, TRU waste, SNF, or by-product material as defined by DOE Order 435.1, "Radioactive Waste Management." SLLW does not contain hazardous waste as regulated by RCRA and as defined in 40 *CFR* 260–268 (or state of Tennessee equivalent standards) or PCB-contaminated or PCB-detectable waste as regulated by TSCA and as defined in 40 *CFR* 761. DOE Order 435.1 and the Atomic Energy Act of 1954, as amended, provide the primary regulatory guidance and requirements for the management of SLLW. Waste acceptance criteria (WAC) and an implementing procedure are in place to address the storage, treatment, and disposal of SLLW.

SLLW is generated throughout ORNL, and after characterization and waste certification, it is staged at the generating location until it is certified by ORNL and accepted by BJC. BJC determines the most suitable management option for all SLLW generated by ORNL. Based on the characteristics and certification of the waste, BJC may (1) store the waste in one of several storage facilities dedicated to SLLW; (2) utilize treatment options, such as compaction and incineration, offered by commercial facilities or in-house treatment options; or (3) ship the waste to an approved off-site disposal facility such as the Nevada Test Site (NTS) or Envirocare.

### 3.9.6 Transuranic Waste

TRU waste is waste that is contaminated with alpha-emitting transuranium (atomic number greater than 92) with half-lives greater than 20 years and concentrations greater than 100 nanocuries per gram at the time of assay. WAC and an implementing procedure are in place for TRU wastes generated at ORNL.

TRU waste is generated by a limited number of generators and facilities at ORNL. All TRU waste generated is stored in on-site storage facilities operated by BJC. Most of these facilities are RCRA-permitted and store some RCRA-contaminated TRU waste, as well as some RCRA-contaminated SLLW that exceeds the dose limits for BJC's other RCRA-permitted storage facilities. A very small quantity of TRU waste is also PCB contaminated. The entire existing inventory is being shipped to the new Foster Wheeler TRU processing facility in Melton Valley.

### 3.9.7 Hazardous Waste

Hazardous waste is a waste or surplus material with negligible value that may cause or contribute to an increase in mortality or to an increase in serious irreversible illness, or pose a substantial present or potential hazard to human health or the environment when improperly stored, treated, disposed of, or transported. Hazardous wastes are defined in RCRA by specific source lists, nonspecific source lists, characteristic hazards, and discarded commercial chemical product lists. Characteristic wastes are those that exhibit the characteristics of ignitability, corrosivity, reactivity, or toxicity, as defined in 40 *CFR* 261.

Hazardous wastes are generated throughout ORNL and are stored in generator satellite accumulation areas (SAAs) or in (90-day) accumulation areas operated by the generator or Laboratory Waste Services (LWS) pending pickup by BJC. BJC determines the most suitable management option for all hazardous waste generated by ORNL. Based on the characteristics and certification of the waste, BJC may (1) immediately transport the waste to an off-site commercial facility for treatment and/or disposal, (2) store the waste in one of several storage facilities dedicated to hazardous and mixed waste, pending off-site treatment or disposal; (3) detonate the waste in the on-site Chemical Detonation Facility, or (4) utilize other on-site treatment. WAC and an implementing procedure are in place for hazardous wastes generated at ORNL. Hazardous waste storage is consolidated at the BJC accumulation area in the 7650 series buildings on Melton Valley Access Road.

Disposition of newly generated waste is being evaluated for transfer from EM to the DOE Office of Science. UT-Battelle, as the Management and Operating contractor for ORNL, would disposition this waste; however, the same process as described above would be used. Presently, UT-Battelle is responsible for disposition of the majority of hazardous waste generated at ORNL through a pilot project. Most of this waste is being shipped directly from 90-day accumulation areas by UT-Battelle. The remainder is consolidated at the BJC accumulation area.

### 3.9.8 Mixed Waste

Mixed waste is waste that contains both hazardous and radioactive components and must be managed to meet the requirements applicable to both. "Hazardous," in this instance, refers to both those wastes regulated by RCRA and those PCB wastes with concentrations or sources greater than or equal to 50 ppm. Like hazardous wastes, mixed wastes are generated throughout ORNL and are stored in accumulation areas operated by the generator or LWS pending pickup by BJC. BJC determines the most suitable management option for all mixed wastes generated by ORNL. Based on the characteristics of the waste, BJC may store the waste in one of several storage facilities dedicated to hazardous and mixed waste, pending determination of suitable treatment, storage, and disposal options. Many of ORNL's mixed wastes are treated in the TSCA Incinerator located at the East Tennessee Technology Park (ETTP).

### 3.9.9 TSCA Waste

TSCA waste consists of PCB waste and asbestos waste and is regulated by the EPA under TSCA. In accordance with 40 *CFR* 761, Subpart D, TSCA regulates PCB materials (wastes/contaminated equipment) based on PCB concentration. TSCA also regulates PCB/radioactive wastes. The ORR PCB Federal Facilities Compliance Agreement between EPA Region 4 and DOE-ORO addresses PCB compliance issues at ORNL. This agreement specifically addresses the unauthorized use of PCBs, storage and disposal of PCB wastes, spill cleanup and/or decontamination, PCBs mixed with radioactive materials, and records and reporting requirements. The majority of ORNL's PCB/radioactive wastes are treated at the TSCA Incinerator at ETTP, whereas other PCB wastes are sent to commercial facilities within a year of generation.

TSCA also addresses the manufacturing, importing, and processing of asbestos and establishes requirements for asbestos abatement projects not covered by (1) the Asbestos Standard of the Occupational Safety and Health Administration (OSHA), 29 *CFR* 1926.58, (2) an asbestos standard adopted by a state as a part of a plan approved by OSHA under Section 18 of the Occupational Safety and Health Act, or (3) a state asbestos regulation which the EPA has determined to be comparable to, or more stringent than, that established in 40 *CFR* 763.120. Since ORNL does not manufacture, import, or process asbestos, and since asbestos activities are covered by an approved Asbestos Standard, any waste with asbestos-containing material (ACM) is not regulated under TSCA. ACM is either managed as sanitary waste, SLLW, TRU waste, TSCA/RCRA waste, or TSCA/RCRA mixed waste if the ACM has come into contact with such constituents. Accordingly, asbestos is managed as a TSCA (PCB) waste only if it has come into contact with PCBs.

WAC and implementing procedures are in place for TSCA (PCB) and asbestos wastes. Generators initially store these wastes until transfer to BJC for either on-site storage or off-site storage or disposal. PCB wastes received, treated, and disposed are routinely included in the totals for hazardous and mixed wastes.

## 3.10 HUMAN HEALTH

Past activities at ORNL have resulted in releases of radionuclides and chemicals to the environment. Such releases combine with natural sources and can augment the exposure to humans both on- and off-site. Natural background sources include cosmic radiation and uranium and thorium in native soils. Inorganic elements, such as arsenic and manganese, are also found in native soils on the ORR, including ORNL. These naturally existing sources of radiological and chemical exposures become the background exposure to which the effects of the man-made releases would be added. The *Oak Ridge Reservation Annual Site Environmental Report for 2002* (DOE 2003) summarizes releases or environmental contamination levels of chemicals and radiation and resulting exposures for calendar year 2002.

In general, human exposure pathways include direct contact, inhalation, and ingestion. Radiation exposure is commonly categorized as either external (exposure to penetrating radiation) or internal (ingestion and inhalation). Ingestion of radionuclides can be through the intake of water or foodstuffs (e.g., vegetation and fish).

DOE Order 5400.5, *Radiation Protection of the Public and the Environment,* limits the effective dose equivalent (EDE) that an off-site individual may receive from all exposure pathways and all radionuclides released from ORR during one year to no more than 100 mrem. DOE regulations (10 *CFR* 835, *Occupational Radiation Protection)* establish radiation protection standards and program requirements for DOE and DOE contractor operations with respect to the protection of workers from ionizing radiation. DOE's limiting control value for a worker's radiation dose is 5000 mrem/yr total EDE from combined internal and external sources.

### 3.10.1 Radiological Exposure to the Public

The average annual background radiological EDE from natural and man-made sources to an individual residing in the United States is approximately 360 mrem. Approximately 300 mrem of the

360 mrem are from natural sources (e.g., radon, cosmic radiation), about 55 mrem of which are from natural external radiation sources (i.e., cosmic and terrestrial radiation) [NCRP 1987]. External radiation exposure rates from background sources have been measured in Tennessee. The measured rates are equivalent to an average annual EDE of 42 mrem, ranging between 19 and 72 mrem (Myrick et al. 1981). This average is less than the U. S. annual average of 55 mrem.

DOE (2003) provides estimates of radiological doses from ORNL; information from this report is summarized here. The calculated radiation dose to the maximally exposed off-site individual resulting from airborne releases from ORNL was about 0.1 mrem during 2002, which is less than 1% of the natural external radiation background EDE to an average Tennessee resident. The maximally exposed individual for ORNL is assumed to be located about 3.1 miles southwest of the 3039 Stack and 3.2 miles west–southwest of the 7911 Stack. The contribution of ORNL emissions to the collective EDE to the population residing within 50 miles of the ORR was calculated to be about 2.2 person-rem, which is approximately 38% of the collective EDE for the ORR.

### 3.10.2 Radiological Exposure to Workers

Workers at Bldg. 3019A are potentially exposed to radioactive hazards. Most areas of the facility contain out-of-date, service-contaminated equipment remaining from pilot operations and other work involving spent fuel, plutonium, $^{233}$U, thorium, and other radionuclides. An extensive health physics program is used to track any migration of contamination, which is impeded by a combination of engineered physical boundaries (e.g., gloveboxes, cells, etc.) and multi-zoned ventilation control. The chemical explosion that occurred in 1959 distributed plutonium contamination throughout the interior and exterior of the building. Extensive decontamination was conducted, but most interior and exterior surfaces of the building required paint bonding to prevent the spread of the residual alpha contamination. The out-of-service sample conveyor, which crosses the roof from Bldg. 3019A to 3019B, has been a recurring source of contamination to areas of the exterior roof, and the older exterior ventilation ducting requires periodic sealing to prevent leakage of radioactive contaminants.

Storage of $^{233}$U in Bldg. 3019 also presents a radiological risk to workers. High dose rates of penetrating radiation can be encountered when handling or storing $^{233}$U that contains a high concentration of $^{232}$U. The decay of $^{232}$U produces a chain of isotopes, including $^{220}$Rn and $^{208}$Tl, leading to the potential for release of airborne alpha, beta, and gamma-emitting radionuclides. This is the reason for the unique shielding, ventilation, inspection, and remote-handling requirements that protect personnel from the radiation hazards associated with the $^{233}$U storage.

### 3.10.3 Chemical Exposure to the Public

Health effects attributed to chemical exposures can be categorized as carcinogenic or noncarcinogenic. Chemical carcinogenic risks are reported here as a lifetime probability of developing an excess cancer. EPA defines a target cancer risk range of $1 \times 10^{-4}$ (1 in 10,000) to $1 \times 10^{-6}$ (1 in 1,000,000), which defines when cleanup actions are to be considered under CERCLA. Noncarcinogenic hazards are reported as hazard quotients (HQ) where unity (1) or greater represents a potential for adverse health effects. An HQ less than unity indicates an unlikely potential for adverse health effects. The sum of more than one HQ for multiple toxicants and/or multiple exposure pathways is called a hazard index (HI). Pathways of concern for noncarcinogens are defined as those with an HI greater than one.

DOE (2003) estimates the human health risks from chemicals found in the environs of the ORR. The primary exposure pathways considered are ingestion of drinking water and fish. For ingestion of drinking water, HQs were estimated upstream [Clinch River kilometer (CRK) 70] and downstream (CRK 16) of

ORR discharge points. HQs were less than one for detected chemical analytes for which there are reference doses or maximum contaminant levels (i.e., barium, manganese, zinc, etc.).

To evaluate the potential health effects from the fish consumption pathway, HQs were estimated for the consumption of noncarcinogens, and intake/chronic-daily-intake ratios, I/I($10^{-5}$), were estimated for the consumption of carcinogens detected in sunfish and catfish collected both upstream and downstream of the ORR discharge points. For consumption of sunfish and catfish, an HQ greater than one was calculated for Aroclor-1260 at all three locations (CRK 70, CRK 32, and CRK 16). I/I($10^{-5}$) ratios greater than one were calculated for the intake of Aroclor-1260 found in sunfish and catfish collected at all three locations. In catfish, an I/I($10^{-5}$) ratio greater than one was calculated for aldrin at CRK 16.

### 3.10.4 Chemical Exposure to Workers

Chemical hazards to personnel working in Bldg. 3019A include uncoated lead shielding, lead paint, PCBs, asbestos, combustible foam insulation, and perchlorate contamination. RCRA hazardous, TSCA, and PCB wastes are produced in the course of routine operations and maintenance of the facility. Oversight for control of occupational chemical exposures at Bldg. 3019 currently is under the responsibility of the UT-Battelle Environment, Safety, and Health organization who must ensure compliance with the provisions of DOE Order 440.1, *Worker Protection Management for DOE Contract Employees* (DOE 1997b). This Order includes a requirement that contractors comply with Federal OSHA regulations.

# 4. ENVIRONMENTAL EFFECTS

## 4.1 LAND USE

### 4.1.1 No-Action Alternative

Based on a review of the *Oak Ridge National Laboratory Land and Facilities Plan* (ORNL 2002b), there would be no change to the existing land use for the area around the Bldg. 3019 Complex under the no-action alternative. Building 3019A would continue to operate as the storage location for the $^{233}$U inventory at ORNL, and the surrounding area is expected to continue to be used for industrial purposes.

### 4.1.2 Proposed Action

Under the proposed action there would be no impact on land use immediately surrounding Bldg. 3019A since the area is currently used for industrial purposes and is part of the industrialized portion of ORNL. All processing activities would occur within the existing footprint of the Bldg. 3019 Complex. New construction would only include modifications to the interior and exterior of Bldg. 3019A to accommodate various process activities (e.g., new process cells, chemical storage tanks, or small buildings attached to 3019A). All off-site waste treatment and disposal would only occur at existing permitted/licensed facilities. Further processing of the thorium product would be conducted at new or existing permitted/licensed facilities.

The Bldg. 3019 Complex would be placed in safe and stable shutdown for transition to the D&D program after the completion of the processing activities. No timetable has been established for D&D, and the land use in the area is expected to remain industrial.

## 4.2 AIR QUALITY AND NOISE

### 4.2.1 No-Action Alternative

Only negligible air quality impacts would result from the no-action alternative. Ongoing surveillance and maintenance (S&M) activities would continue for the $^{233}$U inventory stored at Bldg. 3019A. Currently, most off-gas emissions from ongoing operations are discharged through Stack 3020, although some are vented through the 3039 Stack Ventilation System. Extended storage of the $^{233}$U in Bldg. 3019A would require additional structural and confinement systems upgrades. These upgrades, if extensive, could result in temporary and localized minor emissions of criteria air pollutants [e.g., $NO_x$, carbon monoxide (CO), and sulfur dioxide ($SO_2$)] that could be generated from the operation of any heavy equipment and transportation vehicles associated with construction activities. Off-gas emissions from ongoing operations would be expected to remain the same as they are currently.

Noise levels at ORNL around the Bldg. 3019 Complex are typical of other industrial areas and are primarily associated with ongoing operations, traffic, and construction activities. Workers associated with the continued storage of $^{233}$U at Bldg. 3019A should not be subjected to excessive noise levels. Workers involved in any future facility upgrades would be expected to wear hearing protection, as appropriate, or as required by OSHA. Sound from the ongoing operation of Bldg. 3019A is generally confined within the building, and since no sensitive noise resources are located in the immediate vicinity of the Bldg. 3019 Complex, no adverse impacts would occur.

### 4.2.2 Proposed Action

Air emissions, under the proposed action would result from two sources. Criteria air pollutants could be generated from operation of any heavy equipment and transportation vehicles during construction activities and air emissions from the process off-gas. Air emissions from process off-gas include entrained nitric acid, $NO_x$, and uranium oxides, and other trace radioactive contaminants.

Air emissions would be regulated through air quality standards and permits. ORNL is located within an attainment area for all NAAQS for criteria pollutants. Although additional criteria pollutants would be generated as a result of project activities, they would be small and are not expected to cause any NAAQS violations. Also, since construction activities would primarily be located within the Bldg. 3019 Complex, only negligible amounts of fugitive dust (particulates) would be expected. The primary means of mitigating process-related emissions would be effective off-gas systems and because the processing operations would primarily be within an enclosed building. Under Title V, compliance with the permit terms and conditions would be verified by Isotek.

In addition to continuing to use the existing ventilation systems that are routed to stacks 3020 and 3039, additional off-gas treatment capabilities would be installed in Bldg. 3019A as part of the proposed action. The proposed process off-gas system would be routed to the appropriate stack (either 3020 or 3039) for discharge. The proposed new process off-gas treatment system for processing would include the following:

- Quench/cooling system – Hot gases from the process furnaces would be cooled before introduction into the scrubbers.

- Scrubbers – $NO_x$ emissions would be controlled by wet scrubbers.

- Heater – An electric heater would heat the off-gas steam to keep the downstream filter and fan dry.

- HEPA filters – HEPA filters would be placed at the duct outlets to reduce particulate and metals buildup in the ducts and in the exhaust gas.

- Fans – The entire off-gas system would be maintained at a negative pressure by standard axial fan(s). Airflow would be from areas of lower potential contamination toward areas of higher contamination.

- On-line analysis – The system would be sampled to allow measurement of chemical and radiological attributes for permit compliance.

- Radon capture and decay – Special features and controls (e.g., radon traps) would be used to mitigate release of radon, as appropriate. The proposed "radon trap" would consist of a hold-up device and a HEPA filter.

All other emission points associated with the Bldg. 3019 Complex are considered general exhaust, such as room ventilation, bathroom vents, etc., and are exempt from permitting. After the processing activities were completed, the Bldg. 3019 Complex would be placed in safe and stable shutdown prior to transfer to the D&D program. This would have the positive effect of reducing potential air emissions from the current storage activities and the proposed processing of the $^{233}$U inventory.

Workers associated with the construction activities required to complete modifications to Bldg. 3019A required for the proposed $^{233}$U disposition and safe shutdown activities would be expected to wear hearing protection, as appropriate, or as required by OSHA. Sound generated from construction and processing activities would generally be confined within Bldg. 3019A, although some additional noise would be generated from deliveries of equipment and supplies and shipping operations. Because the facility is located within an active industrialized area of ORNL and since no sensitive noise resources are located in the immediate vicinity of the Bldg. 3019 Complex, no adverse impacts would occur.

## 4.3 GEOLOGY, SOILS, AND SEISMICITY

### 4.3.1 No-Action Alternative

No effects to geological resources or soils would occur under the no-action alternative since the activities associated with the continued storage of $^{233}$U at Bldg. 3019A, and any future facility upgrades, would occur within the existing facility in a previously disturbed area used for industrial applications. Based on the subsurface conditions for the Bldg. 3019 Complex and the surrounding area, foundation soils for Bldg. 3019A are predominantly residual clays with fair to hard consistencies. Generally, these types of clays are not susceptible to liquefaction. Therefore, the soil-supported foundation of Bldg. 3019A should remain stable against liquefaction during and after a seismic event (ORNL 2004). The process cells and storage tube vaults within Bldg. 3019A are designated as a Performance Category (PC) 3 structure in accordance with DOE-STD-1021-93. However, the remainder of the facility is designated as a PC-1 structure, with the exception of the Penthouse, which is PC-2. Modifications and upgrades to Bldg. 3019A would be designed and constructed to meet PC-3 criteria for natural events if required. Other modifications and upgrades would be designed to PC-1 or PC-2 criteria, as appropriate. Prior to any process or facility modifications, a design package, including applicable specifications and standards, would be required to be submitted for DOE review and comment.

### 4.3.2 Proposed Action

Under the proposed action, no effects to geological resources or soils would occur since the activities associated with the proposed project would occur within previously disturbed areas used for industrial applications. Potential impacts associated with seismicity would be similar to those described for the no-action alternative.

## 4.4 WATER RESOURCES

### 4.4.1 No-Action Alternative

Under the no-action alternative, surface and groundwater monitoring and appropriate environmental restoration measures would be continued at ORNL. The Bldg. 3019 Complex contains 102 drain sources that send wastewaters, process wastewaters, domestic wastewater, storm water runoff, cooling water, and condensate via piped collection systems to ORNL treatment facilities or outfalls, depending on the nature of the wastewater. The no-action alternative would not result in any changes to these sources, and no additional adverse effects to water resources would occur. Impacts to surface water or groundwater could occur as the result of a spill or leak from ongoing operations. Surface and groundwater protection measures, such as spill prevention and spill response plans, are already in place at ORNL for ongoing operations.

### 4.4.2 Proposed Action

Potential impacts to water resources under the proposed action would be similar to those described for the no-action alternative. Existing surface and groundwater protection measures at the 3019 Complex, such as spill prevention and spill response plans, would be reviewed and modified or continued as appropriate based on the final design for the processing and facility shutdown activities. No change in existing stormwater capacity or handling would be expected. The existing Bldg. 3019 Complex area is a primarily impervious surface that would not be appreciably altered. The existing stormwater collection system would continue to collect runoff from the project area, and no new stormwater-handling facilities would be required. Water discharged into the ORNL stormwater collection system ultimately discharges into White Oak Creek via NPDES-permitted stormwater outfalls. Concentrations of toxic and conventional pollutants and radionuclides would be expected to remain within the existing permit limits.

The safe and secure shutdown of the Bldg. 3019 Complex at the completion of the proposed processing activities would substantially reduce the amount of waste and wastewater generated by the existing operations and the proposed processing of the $^{233}U$. This would also have the positive effect of reducing the potential for a spill or release into the stormwater collection system or groundwater.

## 4.5 ECOLOGICAL RESOURCES

### 4.5.1 No-Action Alternative

Under the no-action alternative, no adverse environmental impacts would occur to any habitat or wildlife. The Bldg. 3019 Complex is located in a highly disturbed area of ORNL used for industrial operations. Habitat in the vicinity of the Bldg. 3019 Complex is limited and mostly maintained by mowing.

### 4.5.2 Proposed Action

No adverse environmental impacts would occur to any habitat or wildlife as a result of implementing the proposed action. All activities associated with $^{233}U$ disposition, medical isotope production, and the shutdown of the Bldg. 3019 Complex would occur within previously disturbed areas used for industrial operations. Habitat in the vicinity of the Bldg. 3019 Complex is highly disturbed and mostly maintained by mowing. This type of habitat precludes the presence of rare, threatened, and endangered plant and animal species. Also, anticipated air emissions and liquid effluent discharges from processing activities are not expected to have any adverse impacts to wildlife or to pose any ecological risk. The U. S. Fish and Wildlife Service, in a letter dated May 17, 2004, stated that available endangered species collection records do not indicate that federally listed or proposed endangered or threatened species occur within the impact area of the project (USFWS 2004).

## 4.6 CULTURAL RESOURCES

### 4.6.1 No-Action Alternative

Ongoing activities at the Bldg. 3019 Complex would have no impact on the historical integrity of Bldg. 3019A. Prior to any facility modification or upgrades, DOE would need to conduct a review of the proposed modifications, make a determination that the undertaking would or would not adversely affect the eligibility for listing Bldg. 3019A on the NRHP, and would consult with the Tennessee State Historic Preservation Office (TN-SHPO).

### 4.6.2 Proposed Action

Although there have been modifications to the structure since it was constructed, much of the original integrity of Bldg. 3019A remains intact. Modifications would be made to the interior and exterior of the building to accommodate various process activities. The exact modifications would not be completely known until the final design was completed. Based on the preliminary design, modifications would be made to Cell 2, Room 201 (Penthouse), Room 147, and Room 22 to support the installation of new processing equipment. Existing equipment in other rooms would be disconnected, packaged, and set aside for later disposition, and the rooms would be refurbished and/or altered, as necessary. The existing building utility systems would be modified, as necessary, to support the project, and piping would be installed at various locations to permit the transfer of material and waste solutions. Chemical storage tanks and hazardous material transfer and storage areas would be constructed outside Bldg. 3019A. Solution transfer equipment and spill containment would be modified and/or installed as necessary. Access to Bldg. 3100 might need to be improved for the storage of drums, and additional construction access might need to be provided at two sides of Bldg. 3019A to allow larger pieces of equipment and material to enter.

Prior to any interior or exterior modification, DOE would need to conduct a review of the proposed modifications, make a determination that the undertaking would or would not adversely affect the eligibility for listing Bldg. 3019A on the NRHP, and would consult with the TN-SHPO. It is expected that prior to any interior or exterior changes and/or modifications, the current building conditions would need to be documented with photographs, and possibly drawings, to ensure that there is a permanent archived record. Initial coordination with the SHPO was conducted during the preparation of the EA.

## 4.7 SOCIOECONOMICS

### 4.7.1 No-Action Alternative

Under the No-Action Alternative, it is assumed that facility upgrade and repackaging activities would occur and that these activities would result in a small, temporary increase in employment. Current operating expenditures are estimated at \$5–6 million per year and account for roughly 31 full-time-equivalent (FTE) jobs. Repackaging activities are expected to cost an additional \$8–10 million per year for 5–6 years, while construction activities to upgrade the facility are estimated to cost about $20 million. It is assumed that continued monitoring and maintenance after these activities are completed would require the same 31 positions that are currently assigned to this task.

The maximum impact would occur if all of the construction occurred in a single year, at the same time as the repackaging activities. The total expenditure of $30 million in one year would represent a negligible change (<0.2%) in the region's income. Moreover, construction activities are more likely to occur over several years, resulting in a smaller annual change in expenditures. Since employment would thereafter return to around current levels, no long-term change in employment or income is expected. No demographic or environmental justice impacts would occur under the no-action alternative.

### 4.7.2 Proposed Action

It is assumed for this analysis that the proposed action would generate up to 127 direct jobs at peak employment (Phase II). Approximately 31 current jobs, required for continued monitoring and maintenance of the $^{233}U$ material stored in Bldg. 3019A, would be eliminated for a temporary net gain of 96 jobs. Since employment during other phases of the project would be considerably lower, this represents an upper bound for the purpose of analysis. Once the proposed action is complete, staffing levels would be reduced to support long-term surveillance and maintenance until D&D begins.

#### 4.7.2.1 Demographics

**Population.** Based on the small number of jobs created, and the pool of qualified local residents available, no impact on population is anticipated.

**Environmental Justice.** Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," requires agencies to identify and address disproportionately high and adverse human health or environmental effects its activities may have on minority and low-income populations. Current information suggests that there would be no high and adverse human health or environmental impacts under normal operations. As discussed in Sect. 3.7.2, of the census tracts in the city of Oak Ridge, only tract 201 includes a higher proportion of minorities in the population than the national average. Other tracts in the city, and tracts closer to ORNL, have low proportions of minorities in their populations. In the event that adverse impacts occur, they are likely to have at least as much effect on these closer populations as on the residents of tract 201.

Similarly, some low-income populations are located within the city and near the ORR. However, these populations are scattered among higher income populations. Any adverse impacts that affect the low-income tracts are also likely to affect the higher income populations. Therefore, any adverse health and environmental impacts that may occur are not expected to have a disproportionate effect on low-income and minority populations.

#### 4.7.2.2 Employment and income

This analysis assumes that the proposed action would create a net gain of 96 direct, FTE jobs during peak operations. This figure represents a negligible increase (<0.1%) from the 2001 total employment shown in Table 3.1. As an upper bound, if it is assumed that each of the newly generated direct jobs pays the 2001 average annual wage of $47,349 for DOE-related employment (Murray and Dowell 2002), the direct impact on ROI income would be an increase of $4.5 million, or <0.1% of the 2001 ROI income. Once the project is complete, the 31 net jobs lost would also have a negligible impact on ROI employment and income.

## 4.8 UTILITIES

### 4.8.1 No-Action Alternative

Under the no-action alternative, normal operations of the Bldg. 3019 Complex and any future upgrades or modifications of Bldg. 3019A would not increase utility usage, and current building space allocation would not be affected. Changes to utilities would be limited to normal maintenance activities.

### 4.8.2 Proposed Action

All equipment to be used during the project would be electrically powered but would not increase electrical demand beyond the capacity of the current infrastructure. Equipment would be laboratory-scale with moderate power requirements. Existing diesel generators within the Bldg. 3019 Complex would provide backup electrical power. Since the project would occur within an existing facility within an industrial complex, it is expected that the current electrical power supply and transmission system would be adequate to supply the needed electricity without major modifications or upgrades.

Data on estimated water usage (potable and process) ranged from 1000 to 3000 gpd depending on the various stages of the project. It is expected that this estimated usage could be readily accommodated by the existing ORNL water supply system.

It is estimated that project operations would generate approximately 3000 gpd of sanitary wastewater that would be discharged to the ORNL Sewage Treatment Plant for subsequent treatment. The ORNL Sewage Treatment Plant has enough existing capacity to handle the additional discharge of the sanitary wastewater that would be generated from this project. LLLW generated from process activities is addressed in Sect. 4.10.2. After the Bldg. 3019 Complex is placed in safe and stable shutdown, the major utility systems serving the facility (i.e., electrical, process, potable, and fire protection water, compressed air, steam, and standby diesel generators) would remain operational until D&D occurs.

## 4.9 TRANSPORTATION

### 4.9.1 No-Action Alternative

Under the no-action alternative, the $^{233}U$ inventory would continue to be stored at Bldg. 3019A at ORNL; therefore, there would be no transportation or transportation risk. Traffic would likely continue to remain close to current levels and no impacts would occur.

### 4.9.2 Proposed Action

Transportation associated with the proposed action is grouped into five general categories: (1) transport of construction materials and equipment, (2) transport of $DUO_3$, (3) transport of downblended $U_3O_8$, (4) shipments of waste materials, and (5) shipment of the $^{229}Th$ material. Each of these transportation categories is discussed in more detail below. Transportation of waste materials to off-site treatment and/or disposal locations is discussed in Sect. 4.10.

The transport of materials and equipment associated with the limited construction and modification activities that would take place at Bldg. 3019A would be over regional and local roadways to the site. Construction traffic for the proposed action would begin after traffic reductions from completing major construction at the SNS site. No adverse transportation impacts would result.

$DUO_3$ for the project would be shipped via truck from SRS to the NFS facility in Erwin, Tennessee, for further processing. To minimize transportation and handling, the $DUO_3$ blendstock would be shipped from SRS in truckload quantities on an as-needed basis. The preferred route would use Interstates 26 and 40 passing through Columbia, South Carolina, and Asheville, North Carolina. From Asheville the preferred route would use Interstate 26 to Erwin.

It is estimated that about 14 truck shipments would be required to transport the required amount of $DUO_3$ from SRS to the uranium-processing facility, a distance of approximately 251 miles. Each shipment would consist of about 30 drums of material inside of a Sea-Land-type container. The first shipment would be scheduled to arrive at NFS approximately 3 months prior to the start of Bldg. 3019A processing operations. Thereafter, shipments of blendstock to Erwin would be scheduled about every 11 weeks. At the NFS facility, the $DUO_3$ would be converted to a depleted uranyl nitrate solution that would be transported to Bldg. 3019A in tanker trailers owned and operated by NFS and approved by the NRC. These tankers have been used for routine commercial transfer of low enriched uranyl nitrate to General Electric (Wilmington, North Carolina) and Westinghouse (Columbia, South Carolina), and are currently being used to ship natural uranium blendstock to SRS for the TVA HEU downblend program. DOE is currently listed as a registered user of these tanker trailers and has concluded that there are no major risks associated with transporting uranyl nitrate solutions (DOE 1996). The distance from the facility to ORNL is about 144 miles. An estimated one to three tanker shipments per month would be required over the duration of the processing phase.

Downblended $U_3O_8$ would be packaged into approved containers and placed into government-furnished overpacks for transport by truck from Bldg. 3019A to a storage location in Melton Valley. It is estimated that around 1100 containers would need to be transported. The weight of the packaged blended product could limit the number of containers per shipment. Shielded vans would be used for high dose rate containers. The on-site transportation of the downblended $U_3O_8$ to the Melton Valley storage location would comply with DOE Order 460.1A, 10 *CFR* 830, and the Oak Ridge Transportation Safety Report. If the $U_3O_8$ were to be shipped over public highways, applicable transportation requirements, including the use of DOT-approved Type B packaging, would be complied with.

The extracted $^{229}Th$ would be shipped to new or existing commercial facilities for further processing and distribution in shielded product packages using DOT-approved Type B packaging and a common carrier.

## 4.10 WASTE MANAGEMENT

### 4.10.1 No-Action Alternative

Under the no-action alternative, waste storage, transport, and disposal activities associated with the Bldg. 3019 Complex would continue to be handled under ORNL's Waste Management Program, which is described in Sect. 3.8.3. No additional impacts would occur.

### 4.10.2 Proposed Action

It is expected that none of the activities associated with the proposed action would result in unacceptable adverse impacts related to waste generation or disposal. All waste generated would be characterized to allow proper segregation, treatment, storage, and disposal. Characterization activities would meet all applicable quality assurance and other waste management requirements. Characterization activities would include the measurement of the physical, chemical, and radiological properties of the waste streams, and analytical parameters selected would be based on the WAC profile requirements for each waste stream and disposal site. Only existing permitted and licensed disposal facilities would be used, and those facilities are expected to have enough existing capacity for the quantities of waste to be generated assuming all the applicable WAC are met.

Waste minimization measures would also be used to the extent practicable in order to reduce the amount of process and secondary wastes generated and to minimize the overall volume of waste sent to disposal. A waste management plan would be developed to ensure that all waste streams would meet the required DOE/NRC/DOT waste-packaging requirements and the disposal site WAC. Qualified transportation subcontractors would be used for the shipment of waste to off-site treatment and disposal facilities in full compliance with NRC and DOT.

Solid waste anticipated to be generated from the project consists of seven general categories:

- sanitary waste from heterogeneous debris generated during construction, operations, and safe shutdown activities;

- low-level (radioactive) waste (LLW) and mixed waste made up of homogeneous solids (i.e., spent ion/cation exchange resins and P-24 Tank disposition waste) and heterogeneous debris (i.e., $^{233}U$ packaging waste, empty $DUO_3$ drums, process cell waste off-gas filtration media, personal protective equipment (PPE), other dry active waste, construction/facility modification waste, and maintenance waste);

- RCRA hazardous waste primarily from analytical laboratory waste;

- TSCA waste (i.e., asbestos, paint waste, and light ballast/debris generated during construction/facility modifications, maintenance activities, and safe shutdown);

- radioactive TSCA (same as other TSCA waste sources but with radioactive contamination); and

- TRU waste.

Liquid wastes would also be generated, including LLW from the process, RCRA (non-radioactive and mixed) from analytical laboratory waste and maintenance waste, and TSCA (non-radioactive and mixed) due to polychlorinated biphenyls that are present in Bldg. 3019A. Isotek estimates that approximately 21,000 gal of LLLW would be generated during the project through the use of laboratory drains and cleaning systems and about 300,000-gal would be generated from process liquids. A large portion of the process wastewater would be generated from the de-nitration of the downblended uranyl nitrate solution. All LLLW generated would be sampled and analyzed and, if it met the WAC, would be discharged to an appropriate collection system (see Sect. 3.9.3). Storage and treatment capacities of the existing ORR liquid waste treatment systems are adequate for the estimated amounts of liquid effluent that would be generated. Other liquid wastes would be characterized, recycled as much as possible, and most likely would be stabilized through some form of treatment prior to disposal.

PPE, concrete, and structural debris from in-plant modifications during construction of new process facilities would be minimized by reducing the modification area and packaging in large-size containers. LLW construction debris would be disposed of at permitted/licensed disposal facilities, and non-radioactive construction debris would be sent to a local construction/demolition landfill for disposal. Other sanitary waste would be disposed of in a local sanitary landfill.

Most solid LLW and high-activity process wastes would be shipped off-site for disposal (e.g., NTS or Envirocare in Utah). Some small amounts of mixed waste (i.e., analytical residues and used oils) would likely be managed by commercial mixed-waste facilities. Non-radioactive RCRA and TSCA waste would be managed for treatment and disposal through a hazardous waste broker. P-24 Tank liquids would be addressed in a detailed P-24 Tank Content Disposition Plan that would be prepared during Phase II of the project. The plan would include collection of additional characterization data, identification of environmental requirements, and evaluation of specific treatment and disposition approaches. The P-24 Tank liquids would likely be transported to a commercial waste treatment facility for stabilization then dispositioned at an appropriately permitted facility.

Based on the characteristics of the stored $^{233}$U material and the facility, there is the possibility of TRU waste being generated from facility modifications, process activities, and cleanup. It is estimated that approximately ten 55-gal drums of remote-handled TRU waste would be generated. This waste could be transferred to the Oak Ridge TRU waste facility or to another site for treatment and disposal.

## 4.11 HUMAN HEALTH

The following sections look at the human health effects for the no-action alternative and the proposed action under both routine operations and for various accident scenarios. The potential effects are evaluated for the three populations: the facility worker, the co-located worker, and the public. The types of hazards that are present include radiological exposure, chemical exposure, and energetic hazards (explosions, fire, electrical, and structural collapse). Initiating events for the accidents analyzed include natural phenomena events, mechanical failure, and human error.

### 4.11.1 No-Action Alternative

Human health effects for the no-action alternative are analyzed in the current Bldg. 3019 Complex Safety Analysis Report (SAR) [ORNL 2004] and an addendum, the *System Safety Analysis for the Placement of Sodium Fluoride (NaF) Traps in Cell 3*. The hazards involve principally the containers of material in the storage tube vaults. The duration of the hazard is indefinite, given that the no-action alternative is to continue long-term S&M of the facility. It should be noted that the facility was constructed over 50 years ago and that the cost of maintaining the facility in a safe condition will continue to rise due to aging of the structure and components, and the risk that a failure could result in an environmental release will increase.

The hazards associated with routine operations are predominantly radiation exposure to the facility worker, particularly during retrieval of cans from the tube vaults. This exposure is controlled by the ORNL health physics program and is well below the DOE guidelines for radiation workers. The physical structure of the building shields on-site workers and the public from any exposure. Another hazard during routine operations, particularly maintenance activities, is the disturbance of fixed radioactive contamination, creating an airborne, respirable particulate. From decades of reprocessing and radioactive material-handling operations, and particularly from a chemical explosion in 1959, there is fixed contamination that may be encountered.

The SAR concluded that normal RDF operations will have minimal impact on operating personnel and members of the public. Several controls are being implemented to protect on-site personnel and maintain off-site consequences below the evaluation guideline during accident conditions.

The accidents analyzed for the no-action alternative identified several “families” of potential events, including (1) natural phenomena, (2) fires, (3) material handling accidents and can failures, (4) process accidents, (5) can failure while in a storage tube vault, and (6) external man-made events. The accident analysis credited the ability of the storage tube vaults and the process cells to withstand facility fire events and the evaluation-basis earthquake event with no structural failure that results in significant damages to the stored materials. The process cell structures for Cells 1, 2, and 3 were credited with providing a confinement function for accidental releases that occur when ventilation systems are not operational. The Penthouse is credited with providing a confinement function for non-fire events, such as container breech while retrieving a can, to protect on-site personnel.

The most credible accident that would potentially have an impact on the public is a fire. For small fires in the process cells and outside, the material is assumed to be released at ground level, not resulting in a large plume. Also, based on the fire hazard analysis [*Fire Hazard Analysis for the Radiochemical Development Facility, Building 3019 Complex, at Oak Ridge National Laboratory, Oak Ridge, Tennessee* (UT-B 2003)], a large fire in Cells 1, 2, and 3 is not credible due to the lack of sufficient combustible material in the cell. The cell structure prevents spread of fire from outside the cell into the cell. For large Penthouse fires and fires involving the whole facility, a heated plume rise was assumed. Still a natural phenomena event (e.g., earthquake or tornado) involving a pressurized can failure produces the highest quantity of respirable airborne material. The consequences were determined assuming the off-site receptors are at the Graphite Reactor Visitor's Center and at Bethel Valley Road. The maximum amount of oxide powder or its equivalent permitted in the Penthouse (can removed from a tube vault) is 180 g Pu-EID (equivalent inhalation dose). With these controls in place, the maximum consequences to the public of the bounding scenario (natural phenomena event dispersing material in the Penthouse) were determined to be a dose of 13.1 rem, which is below the DOE guideline of 25 rem. For the majority of the accidents analyzed, the dose was well below 1 rem, and for many the dose was negligible.

The material also has a criticality hazard, which is addressed by the criticality safety program. There are no operational drivers that would lead to a scenario wherein criticality could be achieved, and there are minimal opportunities for spilled or otherwise released fissionable material to accumulate and be effectively moderated in an unsafe geometry. Due to the extremely unlikely physical conditions required to achieve criticality without intentional human intervention, occurrence of a criticality accident is not considered credible.

There were no externally generated explosions or blast waves identified that could cause significant structural damage to the facility. The most likely event that could cause material release is a missile generated by an explosion breaching a wall of the facility and impacting a container stored or in process. Materials in the process cells and tube vaults would not be damaged by external missiles. Only materials present in the labs and Penthouse are "at risk" to externally generated missiles, and the quantities of materials in these areas are controlled to a minimum for radiation protection purposes. A similar analysis was done for material release due to an aircraft crash. The only credible scenario was one involving small, general-aviation-type aircraft. A crash involving this type of aircraft was not expected to damage the tube vaults or process cells, and materials outside of these areas are controlled to a minimum.

Other hazards evaluated in the SAR and determined either not to pose a significant risk or not to be present include: toxic materials (including combustion products), carcinogens, biohazards, asphyxiants, flammable materials, reactive materials, explosive materials, incompatible chemical reaction products, electrical energy sources, kinetic energy sources, thermal energy sources, high-pressure energy sources, potential energy sources, lasers, accelerators, and X-ray machines.

No accidents, which would cause widespread major environmental damage, were identified in the SAR. Numerous controls that act to protect the human receptor will also protect the environment from nonstandard industrial hazards. These features help ensure that facility operations will not adversely impact the environment and that consequences to the environment from accidents are minimized to the extent reasonably achievable.

No unusual, non-nuclear hazards are associated with the RDF. All non-nuclear hazards were determined to be insignificant, routine, or standard industrial hazards.

### 4.11.2 Proposed Action

Human health effects for the proposed action alternative are analyzed in the Isotek proposal, the Bldg. 3019 Complex SAR (ORNL 2004), and the Draft Preliminary Documented Safety Analysis (PDSA) [Isotek 2004]. The proposed action can be broken into four project phases with regard to accident analysis. Each phase is listed below, along with its anticipated duration, based on the proposed schedule:

| Phase | Duration |
|---|---|
| (1) Ongoing S&M | Over life of project, diminishing as material is removed and downblended |
| (2) Construction and building modifications | Early in project (Nov. 2004 to June 2007) |
| (3) Material processing and downblending | Beginning after modifications are made and continuing over life of project (July 2007 to Dec. 2010) |
| (4) Facility stabilization | Beginning after material processing is complete (Jan. 2011 to March 2012) |

Ongoing S&M entails the same operations as the no-action alternative, except that it will diminish over the life of the project. Therefore, the hazards will be the same as those discussed in the previous section.

Hazards associated with the construction and building modification phase are similar to those encountered conducting maintenance activities, except that the activities are more extensive and have greater potential for an accident. For routine construction activities, the greatest health effect potential would be from disturbing the fixed contamination in the facility. Isotek's proposed Health and Safety program will characterize the areas prior to undertaking any activities and ensure that if contamination is present, workers are wearing the proper PPE. Localized ventilation and filtration would ensure that the contamination does not spread to other parts of the facility, or beyond the facility, where it could affect on-site workers. Isotek plans to implement an Integrated Safety Management Program to evaluate the risks of each activity in order to prevent accidents.

Material processing and downblending includes the processes described in Sect. 2.1 and, for the purposes of this analysis, thorium extraction, Tank P-24 thorium disposition, and NaF trap disposition. Hazards introduced during the material processing and downblending phase of the project include predominantly the radioactive solutions, chemical reagent storage, and ovens (thermal energy) that are not currently present in Bldg. 3019A. During routine operations, health effects will be limited to the facility worker and will again be exposure to radiation, as well as exposure to chemical fumes. Isotek will have an Industrial Safety program and a Radiation Protection program in place to limit worker exposure to hazardous chemicals to below OSHA guidelines and to radiation to as low as reasonably achievable below DOE guidelines.

Accidents postulated in the Isotek proposal and analyzed in the PDSA are provided in Table 4.1, along with potential consequences and the affected population. The PDSA is the mechanism for early agreement between DOE and its contractor regarding what safety systems and design features are needed in the modified nuclear facility. It includes analysis of design basis accidents and any recommended safety design features or administrative controls. When construction is completed and approved, Isotek will execute the project under a further updated version of the existing approved safety basis documentation that will include the information in the approved version of the PDSA. Most of the accidents listed in Table 4.1 were screened from further analysis in the PDSA because they did not meet the criteria for design basis accidents. However, they were included in the EA because they help to provide a more complete list of reasonably foreseeable accidents associated with the proposed action.

The PDSA found that the principal difference between hazards associated with the proposed action and those analyzed in the SAR for the current activities in Bldg. 3019 is the increased unmitigated frequency of a nuclear criticality accident for fissionable material and the increased potential of the project activities for dispersion of radioactive material without the appropriate preventive and mitigative measures (ISO-PDSA-001; Isotek 2004). The hazard exposure to off-site receptors was evaluated, and the unmitigated total effective dose equivalent (TEDE) for the worst-case accident (an earthquake involving dispersing thorium in storage) was found to be 51.9 rem, which exceeds the DOE evaluation guideline of 25 rem. The design features recommended in the PDSA are expected to reduce the unmitigated dose by one or more orders of magnitude. No other accident analyzed exceeded the evaluation guideline; however, if the estimated TEDE exceeded 1 rem, additional design features or controls were recommended.

The initiating event frequency was estimated to fall into one of four annual frequency ranges: $< 10^{-6}$, $10^{-4} > p \geq 10^{-6}$, $10^{-2} > p \geq 10^{-4}$, $10^{-1} > p \geq 10^{-2}$. The frequency estimate is determined using operating experience, industry failure data, standard human error probabilities, natural phenomena frequency data, or engineer judgment, as appropriate.

**Qualitative Likelihood Classification Table**

| Range | Estimate annual frequency of occurrence | Description |
|---|---|---|
| Anticipated | $10^{-1} > p \geq 10^{-2}$ | Incidents that may occur several times during the lifetime of the facility (i.e., incidents that commonly occur) |
| Unlikely | $10^{-2} > p \geq 10^{-4}$ | Accidents that are not anticipated to occur during the lifetime of the facility |
| Extremely unlikely | $10^{-4} > p \geq 10^{-6}$ | Accidents that will probably not occur during the lifetime of the facility |
| Beyond extremely unlikely | $p > 10^{-6}$ | Accidents that will probably not occur during the lifetime of the facility |

**Table 4.1. Summary of potential accidents and consequences**

| Potential accidents | Consequences | Estimated frequency | Affected population |
|---|---|---|---|
| **Processes Inside Facility** | | | |
| Minor radionuclide release to atmosphere due to fire | Inhalation of radionuclides resulting in internal estimated dose of less than 1 rem | $10^{-3}$ | Facility worker, co-located worker |
| Failure of a $^{233}U$ storage canister | Potential personnel exposure to uranium-bearing powder and potential alpha uptake | $10^{-3}$ | Facility worker, co-located worker |
| Failure of uranium oxide containers in storage-puncture by handling equipment | Minor uranium oxide spill resulting in dust exposure, dermal irritation, and alpha contamination in personnel cleaning up the spill; no impact to the general public | $10^{-3}$ | Facility worker, co-located worker |
| Failure of uranium oxide containers in storage-container spill during handling | Potential large uranium oxide spill resulting in dust exposure, dermal irritation, and alpha contamination in personnel cleaning up the spill; no impact to the general public | $10^{-3}$ | Facility worker, co-located worker |
| Nitric acid release inside facility due to process leak | Exposure may result in severe chemical burns and/or respiratory irritation | $10^{-5}$ | Facility worker |
| Sodium hydroxide release inside facility due to process leak | Exposure may result in severe chemical burns and/or respiratory irritation | $10^{-5}$ | Facility worker |
| Uranium oxides release inside facility due to process leak | Exposure may result in respirable dust hazard, dermal irritation, and alpha contamination | $10^{-5}$ | Facility worker |
| Inert gases released inside facility due to process leak | Exposure may result in asphyxiation in confined areas | $10^{-5}$ | Facility worker |
| Uranyl or thorium nitrate solution released inside facility due to process leak | Exposure may result in severe chemical burns and/or respiratory irritation, dermal irritation, and alpha contamination | $10^{-5}$ | Facility worker |
| Mechanical damage to tank from bumping or other collision | Potential major release of uranyl or thorium nitrate solution | $10^{-5}$ | Facility worker |
| Chemical corrosion or erosion of uncontained piping | Possible personnel contamination, exposure, and environmental release | $10^{-5}$ | Facility worker |
| Power outage in Bldg. 3019 Complex (due to equipment, operator, or maintenance failure) | Process shutdown resulting in potential exposure to uranium materials and acids | $10^{-3}$ | Facility worker |
| Loss of ventilation (due to system failure, filter plugging, or malfunction) | Potential positive pressures inside the hot cells, resulting in gas vapors and radionuclides leaking into the work spaces or atmosphere<br>Potential uranium-bearing powder within the hood/equipment; leakage from piping and ductwork into the building work spaces | $10^{-3}$ | Facility worker |
| Process off-gas failure (due to blower failure, filter plugging, or operator error) | Potential personnel contamination with uranium-bearing powder<br>Potential personnel exposure to gas vapors | $10^{-3}$ | Facility worker |

**Table 4.1. Summary of potential accidents and consequences (continued)**

| Potential accidents | Consequences | Estimated frequency | Affected population |
|---|---|---|---|
| Fan failure (due to filter plugging or operator error) | Potential personnel contamination with uranium-bearing powder | $10^{-3}$ | Facility worker |
| Catastrophic failure of uranyl nitrate, nitric acid, or NaOH tank | Potential exposure to both personnel co-located and possible exposure to the general public | $10^{-4}$ | Facility worker, co-located worker |
| Loss of containment during downloading of tanks | Potential exposure of personnel to uranyl nitrate, nitric acid, or NaOH | $10^{-4}$ | Facility worker, co-located worker |
| Transfer pump inadvertently turned on at the control room while personnel are hooking up the download line to the truck | Potential exposure of personnel to uranyl nitrate, nitric acid, or NaOH | $10^{-5}$ | Facility worker, co-located worker |
| Failure of the gasket at the truck hookup of the transfer line | Loss of containment and personnel exposure to uranyl nitrate, nitric acid, or NaOH | $10^{-5}$ | Facility worker, co-located worker |
| Power loss during pumped download of thorium nitrate to truck | Possibility of siphon action from the holding tank into the truck | $10^{-3}$ | Facility worker, co-located worker |
| Blockage of the vent line for the truck to the tank while pumping to the truck | Potential for pressurization of the truck tank | $10^{-5}$ | Facility worker, co-located worker |
| **Nitric Acid Leak-Receiving Tank** | | | |
| Catastrophic failure of the nitric acid tank<br>Loss of containment during downloading of tanks<br>Transfer pump inadvertently turned on at the control room while personnel are hooking up the download line to the tank truck<br>Failure of the gasket at the truck hookup of the transfer line | Potential exposure to both personnel on-site and possible environmental release<br>Potential personnel exposure to nitric acid<br>Potential personnel exposure to nitric acid<br>Loss of containment and personnel exposure to nitric acid | $10^{-4}$ | Facility worker, co-located worker |
| **Sodium Hydroxide-Receiving Tank** | | | |
| Catastrophic failure of the sodium hydroxide tank<br>Loss of containment during downloading of tanks<br>Transfer pump inadvertently turned on at the control room while personnel are hooking up the download line to the tank truck<br>Failure of the gasket at the truck hookup of the transfer line | Potential exposure to both personnel on-site and possible environmental release<br>Potential personnel exposure to sodium hydroxide<br>Potential personnel exposure to sodium hydroxide<br>Loss of containment and personnel exposure to sodium hydroxide | $10^{-4}$ | Facility worker, co-located worker |

**Table 4.1. Summary of potential accidents and consequences (continued)**

| Potential accidents | Consequences | Estimated frequency | Affected population |
|---|---|---|---|
| **Uranyl Nitrate-Receiving Tank** | | | |
| Catastrophic failure of the uranyl nitrate tank<br>Loss of containment during downloading of tanks<br>Transfer pump inadvertently turned on at the control room while personnel are hooking up the download line to the tank truck<br>Failure of the gasket at the truck hookup of the transfer line | Potential exposure to both personnel on site and possible environmental release<br>Potential personnel exposure to uranyl nitrate<br>Potential personnel exposure to uranyl nitrate<br><br><br>Loss of containment and personnel exposure to uranyl nitrate | $10^{-4}$ | Facility worker, co-located worker |
| **Design Basis Accidents** | | | |
| Energetic release (primarily due to seismic forces) involving stored radioactive material | Inhalation of radionuclides resulting in <u>unmitigated</u> internal estimated dose of 51.9 rem | $10^{-6}$ | Facility worker, co-located worker, public |
| Major radionuclide release to atmosphere due to fire | Inhalation of radionuclides resulting in <u>unmitigated</u> internal estimated dose of less than 5.2 rem | $10^{-6}$ | Facility worker, co-located worker, public |
| Criticality event with U-233 | Criticality event with exposure to both personnel on-site as well as possible release to the environment and exposure to the general public | $10^{-6}$ | Facility worker, Co-located worker |

Other than the determination of whether or not an event is credible (i.e., frequency > $10^{-6}$/year), the frequency is only used for the relative likelihood of the accidents (DOE 2002b).

The health effects associated with facility stabilization are similar to those of maintenance and facility modification: facility worker exposure to airborne contamination created by disturbing fixed contamination. Also, there would be a hazard due to radioactive and hazardous liquids remaining in process vessels that need to be drained.

## 4.12 PERMITS

There are pending Title V air permits that would apply to air emissions from Bldg. 3019A. In addition, the existing ORNL sitewide NPDES permit (TN0002941), which was issued on December 6, 1996, covers 102 wastewater effluent sources in the Bldg. 3019 Complex. Compliance requirements include sampling and analysis to confirm that total activity, fissile isotopes, and other parameters are within the WAC of the receiving wastewater treatment facility.

The majority of process source emissions from the Bldg. 3019 Complex are discharged through Stack 3020, and some emissions are vented through Stack 3039. 40 *CFR* 61, Subpart H, monitoring and reporting requirements are applicable to these Bldg. 3019 Complex emission points. Stack 3039 is currently permitted by the TDEC (permit number 739974P) and will also be permitted as a Title V source through the BJC permit application. The air-operating permit covers the process off-gas hot cell ventilation system, Stack 3039, and HEPA filter and wet scrubber (stand-by) control. Compliance requirements include limits on particulate matter and visible emissions and no operation of source without control device(s) listed in application unless otherwise specified in Rule 1200-3. Stack 3020 is presently not permitted as a major source. However, this stack will be permitted as a Title V source due to potential radionuclide emissions greater than 0.1 mrem/yr.

The Bldg. 3019 Complex has no RCRA permits, but has RCRA and TSCA-regulated generator areas. The Bldg. 3019 Complex has several SAAs and Used Oil Collection Points. Generation of RCRA and TSCA-regulated waste would be minimized, and appropriate accumulation areas would be established and maintained to accommodate project wastes.

# 5. CUMULATIVE IMPACTS

This chapter considers the impacts from other actions that could, along with the potential effects from the proposed action, result in cumulative impacts to the environment. Cumulative impacts are defined as "...the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions" (40 *CFR* 1508.7). Impacts are considered on a cumulative basis because significant effects are often the result of individually minor direct and indirect effects of multiple actions that occur over time. Cumulative impacts should be considered over the "lifetime" of the impacts, rather than only the duration of the action.

Impacts were evaluated in Chap. 4 using the no action alternative as a baseline for comparison against the proposed action. Other actions with similar potential effects to the proposed action could act synergistically or additively with the effects discussed in Chap. 4, thereby increasing the potential adverse or beneficial impacts on a cumulative basis. If a resource area would not be affected as a result of taking an action, there would, of course, be no cumulative impact potentially resulting from the action either.

Identification of other actions that could result in cumulative impacts when combined with the proposed action is based on actions likely to have similar potential impacts within the same geographic area and over the same timeframe. Several projects that involve similar activities resulting in similar impacts have been, or would be, initiated very near the proposed project. These include ORR environmental restoration and D&D actions, continued revitalization of ORNL, operation of the SNS facility in Bethel Valley, and the operation and decommissioning of the Oak Ridge TRU waste treatment facility in Melton Valley.

**Cumulative Impacts by Resource Area**

**Land Use.** No major land use changes are anticipated for the area surrounding the Bldg. 3019 Complex. Most of the new construction associated with the revitalization of ORNL is occurring in other portions of the lab, and the land use of the Bldg. 3019 Complex area is assumed to remain industrialized. No cumulative impact to land use would occur.

**Air Quality and Noise.** Additional air emissions or changes to air quality, as a result of implementation of the proposed action, would be within permit conditions. However, after the completion of the proposed processing activities, the contribution of air emissions from the Bldg. 3019 Complex would be reduced when the facility is put into safe and stable shutdown. This could result in a slight, positive cumulative effect on air quality in the vicinity of ORNL. No cumulative noise impacts were identified.

**Geology and Soils.** Implementation of the proposed action would not contribute to cumulative impacts on the geology or soils of ORNL or the surrounding area since the proposed activities would occur within a previously disturbed area of the lab.

**Water Resources.** The impact on water resources from the proposed action would be negligible and would not have a cumulative impact. Placing the facility in safe and stable shutdown at the completion of processing activities would have a positive impact.

**Ecological Resources.** Because the area of the proposed action is a highly disturbed industrial area with limited habitat, impacts on ecological resources would be negligible and would not contribute to cumulative impacts.

**Cultural Resources.** Building 3019A is a contributing property to the ORNL Historic District. Per agreement with the SHPO, consultation and possibly mitigation would be completed prior to taking any direct action (e.g., building modifications). Cumulative impacts to historic properties could result from other actions in combination with the proposed action. Therefore, the implementation of the proposed action could contribute to cumulative effects on historic cultural resources of the ORR.

**Socioeconomics and Environmental Justice.** Environmental effects from the proposed action on the economy and community infrastructure of the ROI would be negligible. Since most of the construction and operations employment would be filled by the existing area labor force and the short-term nature of the activities, there would be no cumulative impact or change to regional income, housing markets, or the demand for community services. No potential effects to environmental justice were identified from the proposed action or for other projects with a potential to contribute to cumulative effects. Therefore, there would be no cumulative effects on environmental justice.

**Utilities.** Incremental increases in utilities by addition of identified reasonably foreseeable projects (e.g., new ORNL facilities and the SNS) could have minor cumulative impacts to ORNL and ORR utility infrastructures. However, the proposed action would not contribute to any cumulative impacts.

**Transportation.** Implementation of the proposed action would not result in appreciable changes to traffic. Likewise, the transport of materials to ORNL for the proposed action and the anticipated transport of waste off-site would not increase substantially from routine operations. No cumulative impacts would be expected.

**Waste Management.** The incremental contribution of the proposed action to waste generation would be off-set over time by an anticipated reduction in waste generated once the processing activities were completed and the facility was placed in safe and stable shutdown. Because ample capacity for waste is available, no cumulative effects would be anticipated.

**Human Health.** No operations included under the proposed action would increase chemical or radiological emissions for ORNL because operations would be similar to the historical operations of the Bldg. 3019 Complex. However, completion of the project would have many positive impacts, including the elimination of need for safeguards, security, and nuclear criticality controls for the existing $^{233}U$ material and resulting beneficial use for medical research and treatment. Placing the facility into safe and stable shutdown for D&D would also have a positive cumulative impact on human health for workers and the public.

# 6. LIST OF AGENCIES AND PERSONS CONTACTED

The following agencies and persons were contacted for information and data used in the preparation of this EA.

| Name | Affiliation | Location | Topic |
|---|---|---|---|
| Lee Barclay | U. S. Fish and Wildlife Service | Cookeville, TN | Endangered Species Act, Section 7 – Informal Consultation |
| Joseph Garrison | Tennessee Historical Commission | Nashville, TN | National Historic Preservation Act, Section 106 - Compliance |
| Dale Gergely | Isotek Systems, LLC | Oak Ridge, TN | Environment, Safety, and Health |
| Cheryl LaBorde | Isotek Systems, LLC | Oak Ridge, TN | Permits |
| Joe Wolfe | ORNL | Oak Ridge, TN | Air Quality |
| Greg Byrd | ORNL | Oak Ridge, TN | Ecological Resources |

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