11. DEVELOPMENT OF ALTERNATIVES

This section includes the development of candidate remedial alternatives for radionuclide-contaminated soils, nonradionuclide-contaminated soils, and tank contents. Representative technologies identified in Section 10 are combined to formulate a range of response actions appropriate for Operable Unit (OU) 1-10 contaminant types and site conditions. The candidate alternatives are briefly introduced in this section; specific details of each alternative are given in Section 12, Detailed Analysis of Alternatives. All remedial alternatives would support the achievement of the Remedial Action Objectives within the allotted 40 month time frame.

11.1 Radionuclide-Contaminated Soils

Radionuclide-contaminated soils exceeding risk-based limits have been identified at six sites within OU 1-10. The candidate alternatives developed to address Cs-137 contamination at Technical Support Facility (TSF)-07, TSF-06 (Area B), TSF-09/18, and TSF-26, and Ra-226 contamination at TSF-07 are discussed below.

11.1.1 Alternative 1: No Action/Limited Action

The No Action/Limited Action alternative is presented to comply with requirements of the National Contingency Plan (NCP) [40 Code of Federal Regulations (CFR) 300.430 (e)(6)] and guidance for conducting feasibility studies (FSs) under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (EPA 1988). Limited activities would be included as part of this alternative and consist of ongoing sitewide institutional controls and environmental monitoring. Under this alternative, the implementation of institutional controls and environmental monitoring would be expanded to accommodate site-specific concerns. Institutional controls implemented at OU 1-10 would consist of restricting access to the sites using controls such as fencing. Existing management practices consist of environmental monitoring in accordance with Idaho National Engineering and Environmental Laboratory (INEEL) site-wide requirements. In addition, five-year site reviews would be conducted to evaluate the effectiveness of the institutional controls and the need for further environmental monitoring, or additional control measures, as applicable.

11.1.2 Alternative 2: Containment Alternatives

Two containment alternatives were developed to address Cs-137 and Ra-226 contamination at OU 1-10:

- Native Soil Cover—consisting of a layer of native INEEL soil with surface vegetation, rock armor or other surface cover to control surface exposures to subsurface radionuclides.

- Engineered Barrier—an SL-1 cap consisting of multiple layers of native geologic materials to control surface exposures to subsurface radionuclides, and inhibit biotic intrusion.

The native soil cover and engineered barrier alternatives are discussed in the following subsections.

11.1.2.1 Alternative 2a: Native Soil Cover. The native soil cover consists of 3.05 m (10 ft) of clean INEEL native soils, with surface vegetation, rock armor or other suitable material. This alternative would be implemented at TSF-07 and TSF-09/18 and would consist of clearing and grubbing the site, establishing a compacted soil foundation, and then adding native soil to bring the total thickness above the contaminated soils to a minimum of 3.05 m (10 ft). The cap would have a minimum top slope of 2% and a maximum side slope to existing grade of 4:1. Site-specific considerations would be used to design the optimum configuration for application at specific OU 1-10 sites during the remedial design phase. Alternative 2a would not be appropriate for TSF-06 (Area B) or TSF-26 due to the presence of impacted soils adjacent to, and possibly beneath the segment of Snake Avenue located between these two subsites. The segment of Snake Avenue located in the vicinity of TSF-06 (Area B) and TSF-26 cannot be relocated; therefore, placement of a native soil cover over this area is not a viable option.

This alternative would also include environmental monitoring, cap integrity monitoring and maintenance (e.g., repairing visible degradation including cracks, erosion, biotic intrusion, etc.), and access restrictions (e.g., fencing) conducted on an annual basis. Air monitoring and groundwater monitoring would be performed under INEEL site-wide programs. Five-year site reviews would be conducted to evaluate the effectiveness of the native soil cover and the need for additional environmental monitoring requirements.

11.1.2.2 Alternative 2b: Engineered Barrier. Alternative 2b would consist of the placement of an engineered barrier over the areas of contamination at TSF-07 and TSF-09/18. The engineered barrier would be designed in accordance with specifications developed for the closure cover constructed at the SL-1 site. The SL-1 cover consists of a 0.3-m (12-in.) layer of basalt cobbles underlain and overlain by 0.2-m (8-in.) layers of gravel, covered with a basaltic rip-rap layer. The basaltic rip-rap layer would be a minimum of 0.6-m (24 in.) thick. Alternative 2b would not be appropriate for TSF-06 (Area B) or TSF-26 due to the presence of impacted soils adjacent to, and possibly beneath the segment of Snake Avenue located between these two subsites. The segment of Snake Avenue located in the vicinity of TSF-06 (Area B) and TSF-26 cannot be relocated; therefore, placement of an engineered barrier over this area is not a viable option.

Environmental monitoring, cap integrity monitoring and maintenance (e.g., repairing any observable degradation including cracks, erosion, biotic intrusion, etc.), and access restrictions (e.g., fencing) would be conducted on an annual basis. Air monitoring and groundwater monitoring would be performed under INEEL site-wide programs. Five-year site reviews would be conducted to evaluate the effectiveness of the Engineered Barrier alternative and the need for additional environmental monitoring requirements.

11.1.3 Alternative 3: Excavation and Disposal Alternatives

Removal and disposal alternatives for OU 1-10 radionuclide-contaminated sites consist of using conventional construction equipment to excavate contaminated soil and disposing of the contaminated material on-site at INEEL or at a permitted off-site facility. Under Alternative 3a the excavated soils would be disposed on-site at INEEL, while Alternative 3b considers off-site disposal of the excavated soils. These alternatives are discussed in the following subsections.

11.1.3.1 Alternative 3a: Excavation and On-site Disposal. Implementation of this alternative would involve excavation of soils present above preliminary remediation goals (PRGs) at OU 1-10 and transportation to the proposed Environmental Restoration (ER) INEEL soil repository for disposal. This facility was selected for purposes of evaluation in this FS; however, other INEEL facilities may be considered if deemed appropriate based on factors such as waste acceptance criteria, availability, cost, etc. Conventional excavation and transportation equipment and procedures would be used under this alternative. Verification sampling would be used to ensure that all contamination present at concentrations exceeding PRGs was removed. The excavated areas would be backfilled with clean soil after excavation. Institutional controls would not be required after site excavation and disposal, since all contamination would be removed and all exposure pathways would be eliminated.

11.1.3.2 Alternative 3b: Excavation and Off-site Disposal. Implementing this alternative would involve excavation of soils above PRGs at OU 1-10 radionuclide-contaminated sites and transporting them off-site to a low-level radioactive-contaminated soil disposal facility for placement. The most likely off-site disposal location would be the Envirocare Resource Conservation and Recovery Act (RCRA)-permitted low-level radioactive disposal facility, located approximately 480 km (300 mi) south of INEEL. Compliance with appropriate waste characterization, transportation, and possible treatment requirements would be required under this alternative. Conventional excavation and transportation equipment and procedures would be used under this alternative. Verification sampling would be used to ensure that all contamination present at concentrations exceeding PRGs was removed. The excavated areas would be backfilled with clean soil after excavation. Institutional controls would not be required after site excavation and disposal, since all contamination would be removed and all exposure pathways would be eliminated.

11.2 Nonradionuclide-Contaminated Soils

Nonradionuclide-contaminated soils exceeding risk-based limits have been identified at three sites within OU 1-10. The alternatives developed to address lead contamination at Water Reactor Research Test Facility (WRRTF)-01 and TSF-03, and mercury contamination at TSF-08 are discussed in the following subsections.

11.2.1 Alternative 1: No Action/Limited Action

The No Action/Limited Action alternative is presented to comply with requirements of the NCP [40 CFR 300.430 (e)(6)] and guidance for conducting FSs under CERCLA (EPA 1988). Limited activities would be included as part of this alternative and consist of institutional controls and ongoing sitewide environmental monitoring. Existing management practices consist of environmental monitoring in accordance with INEEL site-wide requirements. Institutional controls implemented at OU 1-10 would consist of restricting access to the sites using controls such as fencing. Under this alternative, the environmental monitoring and the implementation of institutional controls would be expanded to accommodate site-specific concerns. In addition, five-year site reviews would be conducted to evaluate the effectiveness of the institutional controls and the need for further environmental monitoring, or additional control measures, as applicable.

11.2.2 Alternative 2: Native Soil Cover

The native soil cover for OU 1-10 nonradionuclide-contaminated sites consists of 3.05 m (10 ft) of clean INEEL native soils, with surface vegetation, rock armor or other suitable material. Implementing this alternative at OU 1-10 nonradionuclide-contaminated sites would consist of adding soil layers above grade to bring the total thickness above the contaminated soils to a minimum of 3.05 m (10 ft). The cap would have a minimum top slope of 2% and a maximum side slope to existing grade of 4:1. Site-specific considerations would be used to design the optimum configuration for application at each site during the remedial design phase.

Environmental monitoring, cap integrity monitoring and maintenance (e.g., repairing any observable degradation including cracks, erosion, biotic intrusion, etc.), and access restrictions (e.g., fencing) would be conducted on an annual basis as part of this alternative. Air monitoring and groundwater monitoring would be performed under INEEL site-wide programs. Five-year site reviews would be conducted to evaluate the effectiveness of the native soil cover and the need for additional environmental monitoring requirements.

11.2.3 Alternative 3: Excavation and Off-site Disposal

This alternative consists of removing contaminated soils at OU 1-10 nonradionuclide-contaminated sites and disposal of the soil off-site. This alternative involves the use of conventional construction equipment to excavate contaminated soils. For purposes of this evaluation, all soils excavated from OU 1-10 nonradionuclide-contaminated sites are assured to require disposal as RCRA-hazardous wastes at a facility in Arlington, Virginia.

If the excavated soils were determined to be nonhazardous according to applicable RCRA regulations, then they may be acceptable for disposal at a permitted solid waste landfill located near (Mud Lake) or at the INEEL. Compliance with appropriate waste characterization, transportation, and treatment requirements imposed by the off-site disposal facility would be required under this alternative.

Verification sampling would be required to ensure that all nonradionuclide contamination present at the subsites exceeding PRGs was removed. Excavated areas would be backfilled with clean INEEL soil after excavation. Institutional controls would not be required after site excavation and disposal, since all contamination would be removed and all exposure pathways would be eliminated.

11.2.4 Alternative 4: Removal and Treatment Alternatives

Alternatives 4a, 4b, and 4c consist of excavation and treatment alternatives for OU 1-10 nonradionuclide-contaminated sites. Each alternative involves the use of conventional construction equipment to excavate contaminated soils. Under Alternative 4a, TSF-08 mercury-contaminated soils would be treated after excavation by thermal retort at an off-site location. Under Alternative 4b, WRRTF-01 and TSF-03 lead-contaminated soils would be treated after excavation on-site using a soil washing technology. Under Alternative 4c, petroleum contaminated soils at WRRTF-13 would be excavated and land farmed at CFA.

11.2.4.1 Alternative 4a: Excavation and Treatment by Thermal Retort Off-Site. This alternative would be implemented only for the soils contaminated with mercury at TSF-08. This alternative would consist of excavating all soil contaminated with mercury at concentrations above the PRG followed by treatment in a mercury retort located at an off-site facility in Bethlehem, Pennsylvania. The metallic mercury would be recovered and used as a recycled material. The remediated soil would be returned to TSF-08 for placement in excavated areas. Conventional excavation equipment would be used during soil removal activities. Verification sampling would be performed to ensure that all contamination present at concentrations exceeding PRGs was removed.

The thermal retort process would consist of heating the mercury-contaminated soil to approximately 1000°F and volatilizing the mercury into the vapor phase. This vapor phase would be passed through a condenser where the liquid mercury would be recovered or processed through activated carbon vessels to adsorb the mercury. No long-term environmental monitoring or institutional controls would be required for TSF-08 after completion of the excavation and treatment activities.

11.2.4.2 Alternative 4b: Excavation and Soil Washing On-Site. This alternative would be implemented only for the lead-contaminated soils at WRRTF-01 and TSF-03. Under this alternative soils contaminated with lead at concentrations above the PRG would be excavated and treated on-site using a soil washing process. A treatability study would be required to assess optimal design parameters and treatment train for the soil washing process. For purposes of FS alternative evaluations, the soil washing process would consist of an initial physical separation of the contaminated soils into fine and coarse-grained fractions followed by an acid leach of the fine-grained fraction. The dissolved lead would be recovered using an ion exchange resin or through a typical chemical precipitation and filtration process. The recovered lead would be recycled appropriately. The acid leach solution would be recycled in a closed loop process on-site as part of the treatment train. Depending on treatability study results, it may be more cost-effective to treat the reduced volume of lead-contaminated soils after the physical separation step using a stabilization technology. The stabilized soils would be disposed of appropriately. The coarse-grained fraction and the treated fines would be replaced in the excavated area if they were below PRGs.

11.2.4.3 Alternative 4c Excavation and Land Farming. This alternative would only be implemented for the WRRTF-13 petroleum contaminated soil. Under this alternative, soils contaminated with petroleum concentrations that are greater than the TPH PRG would be excavated and moved to the CFA land farm. The soils would be spread on the ground to promote biological remediation of the petroleum contamination. The soils would be sampled periodically to ensure its petroleum contamination is being remediated. The soil would be placed in the CFA landfill, or used as fill material at other INEEL facilities when its average TPH concentration reaches the TPH PRGs.

11.3 TSF-26

Alternatives developed to address tank waste liquids, sludge, and contaminated soils at TSF-26 (PM-2A V-13 and PM-2A V-14) are discussed in the following subsections.

11.3.1 Alternative 1: No Action/Limited Action

Under this alternative, existing management practices currently in place at OU 1-10 would be continued with the addition of expanded institutional controls and environmental monitoring. Institutional controls would consist of restricting access to the sites using controls such as fencing. Existing management practices consist of environmental monitoring in accordance with INEEL site-wide requirements. In addition, five-year site reviews would be conducted to evaluate the effectiveness of the institutional controls and the need for further environmental monitoring, or additional control measures, as applicable.

11.3.2 Alternative 2: Soil Excavation, Tank Removal, Ex Situ Treatment and Disposal

Two alternatives were developed to address tank waste at OU 1-10 through soil excavation, tank removal, ex situ treatment and disposal:

- Excavate contaminated soils, excavate tanks and their contents, treat tank contents on-site, and dispose of the treated material and excavated soils at the proposed on-site ER INEEL repository.

- Excavate contaminated soils, excavate tanks and their contents, treat tank contents on-site, and dispose of the treated material and excavated soils off-site at a commercial mixed/low-level radioactive waste disposal facility.

The soil excavation, tank removal, treatment, and disposal alternatives are discussed in the following subsections:

11.3.2.1 Alternative 2a: Soil Excavation, Tank Removal, and On-site Treatment and Disposal. Alternative 2a would consist of the erection of a temporary containment structure, excavation of the tanks and contaminated soils, removal and stabilization of the dewatered tank contents, and disposal of the excavated soils and treated materials on-site. Soils would be disposed on-site at the proposed ER INEEL soil repository. Treated materials would be disposed at RWMC. A temporary structure equipped with shielding and a negative pressure ventilation system exhausted through high efficiency particulate air (HEPA) filters would be constructed over the tank sites prior to the start of excavation activities. After excavation, tank contents would be removed remotely by jetting and pumping or vacuum removal, and the tanks would be decontaminated prior to disposal.

Tanks and the contaminated soils surrounding the tanks would be excavated using conventional construction equipment. Tank wastes would be dewatered to extract liquids introduced during removal operations, and all wastes determined to have a classification greater than Class A would be treated to create a stable wasteform. Treated waste must conform to the requirements of the INEEL Reusable Property, Recyclable Materials, and Waste Acceptance Criteria (RRWAC) (DOE 1997). Liquid generated during excavation would be characterized and disposed appropriately.

Excavated soils and treated materials would be transported to the proposed ER INEEL soil repository and the Radioactive Waste Management Complex (RWMC) respectively, for disposal. Verification sampling would be conducted to ensure that all contamination present at the subsites with concentrations exceeding PRGs was removed. The excavated areas would be backfilled with clean INEEL soils after excavation. Institutional controls would not be required after site excavation and disposal activities, since all contamination would be removed, and all exposure pathways would be eliminated.

11.3.2.2 Alternative 2b: Soil Excavation, Tank Removal, On-site Treatment, and Off-site Disposal. Alternative 2b would consist of the erection of a temporary containment structure, excavation of the tanks and contaminated soils, removal and stabilization of the dewatered tank contents, and transportation and disposal of the excavated soils and treated materials off-site at the Envirocare low-level radioactive waste disposal facility. A temporary structure equipped with shielding and a negative pressure ventilation system exhausted through HEPA filters would be constructed over the tank site prior to the start of excavation activities. After excavation, tank contents would be removed remotely by jetting and pumping or vacuum removal, and the tanks would be decontaminated prior to disposal.

Tanks and contaminated soils surrounding the tanks would be excavated using conventional construction equipment. Treated waste must conform to the Nuclear Regulatory Commission's (NRC's) Branch Technical Position on Waste Form which specifies limits on the leachability of contaminants and the structural stability of the material. Liquid generated during excavation would be characterized and disposed of appropriately.

Excavated soils and treated materials would be transported to an off-site waste disposal facility such as Envirocare. Compliance with appropriate waste characterization and transportation requirements imposed by the facility would be required under this alternative. Verification sampling would be conducted to ensure that all contamination present at concentrations exceeding PRGs was removed. The excavated areas would be backfilled with clean INEEL soils after excavation. Institutional controls would not be required after site excavation and disposal activities, since all contamination would be removed, and all exposure pathways would be eliminated.

11.3.3 Alternative 3: Soil Excavation, Tank Content Removal, Ex Situ Treatment, and Disposal

Alternative 3 is similar to Alternative 2; however, under Alternative 3 the tank contents would be removed, while the tanks would remain in place. Two alternatives were developed to address tank waste at OU 1-10 through soil excavation, tank content removal, ex situ treatment and disposal:

- Excavate contaminated soils, remove tank contents, treat tank contents on-site, and dispose of the treated material and excavated soils at the proposed ER INEEL soil repository.

- Excavate contaminated soils, remove tank contents, treat tank contents on-site, and dispose of the treated material and excavated soils off-site at a commercial low-level radioactive waste disposal facility.

The soil excavation, tank content removal, ex situ treatment, and disposal alternatives are discussed in the following subsections.

11.3.3.1 Alternative 3a: Soil Excavation, Tank Content Removal, and On-site Treatment and Disposal. Alternative 3a would consist of the erection of a temporary containment structure, excavation of contaminated soils, removal of the tank contents, stabilization of the dewatered tank contents, and disposal of the excavated soils and treated tank contents on-site. Soils would be disposed at the proposed ER INEEL soil repository. Treated tank contents would be disposed at RWMC. A temporary structure equipped with shielding and a negative pressure ventilation system exhausted through HEPA filters would be constructed over the tank site prior to the start of excavation activities. Contaminated soils surrounding the tanks would be excavated using conventional construction equipment. Tank contents would be removed remotely using technologies such as jetting and pumping or vacuum removal.

Tank wastes would be dewatered to extract liquids introduced during removal operations, and all wastes determined to have a classification greater then Class A, would be treated to create a stable waste form. The treated waste must conform to the NRC's Branch Technical Position on Waste Form which specifies limits on the leachability of contaminants and the structural stability of the material. Tank contents requiring treatment would be stabilized on-site by mixing with chemical additives such as phosphates or silicates. Liquid generated during the tank content removal would be characterized and disposed of appropriately. The tanks would be decontaminated and filled with an inert material such as sand or grout. This inert material and the tank walls would restrict the movement of contamination that might be left in the tank after it is decontaminated.

Excavated soils and treated tank contents would be transported to the proposed ER INEEL soil repository and RWMC respectively, for disposal. Verification sampling would be conducted to ensure that all contamination present at concentrations exceeding PRGs was removed. The excavated areas would be backfilled with clean INEEL soils after excavation. Institutional controls would not be required after site excavation and disposal, since all contamination would be removed, and all exposure pathways would be eliminated.

11.3.3.2 Alternative 3b: Soil Excavation, Tank Content Removal, On-site Treatment, and Off-site Disposal. Alternative 3b would consist of the erection of a temporary containment structure, excavation of contaminated soils, removal of tank contents, stabilization of the dewatered tank contents, and transportation and disposal of the excavated soils and treated tank contents off-site at an off-site low-level radioactive waste disposal facility. A temporary structure equipped with shielding and a negative pressure ventilation system exhausted through HEPA filters would be constructed over the tank site prior to the start of excavation activities. Contaminated soils would be excavated using conventional construction equipment. Tank contents would be removed remotely using technologies such as jetting and pumping or vacuum removal.

Tank wastes would be dewatered to extract liquids introduced during removal operations, and all wastes determined to have a classification greater than Class A would be treated to create a stable wasteform. Treated waste must conform to the NRC's Branch Technical Position on Waste Form which specifies limits on the leachability of contaminants and the structural stability of the material. Tank contents requiring treatment would be stabilized on-site by mixing with chemical additives such as phosphates or silicates. Liquids generated during tank content removal would be characterized and disposed of appropriately. Tanks would be decontaminated and filled with an inert material such as sand or grout. This inert material and the tank walls would restrict the movement of any contamination that might be left in the tank after it is decontaminated.

Excavated soils and treated materials would be transported to an off-site waste disposal facility, such as Envirocare. Compliance with appropriate waste characterization and transportation requirements imposed by the facility would be required under this alternative. Verification sampling would be conducted to ensure that all contamination present at concentrations exceeding PRGs was removed. The excavated areas would be backfilled with clean INEEL soils after excavation. Institutional controls would not be required after site excavation and disposal activities, since all contamination would be removed, and all exposure pathways would be eliminated.

11.3.4 Alternative 4: Soil Excavation, In Situ Treatment of Tank Contents, and Soil Disposal

Two alternatives were developed to address tank waste at OU 1-10 through soil excavation, in situ treatment of tank contents and disposal of contaminated soils:

- Excavate contaminated soils, grout tank contents in-place, and dispose of the excavated soils at the proposed ER INEEL soil repository.

- Excavate contaminated soils, grout tank contents in-place, and dispose of the excavated soils off-site at a commercial low-level radioactive waste disposal facility.

The soil excavation, in situ treatment of tank contents, and soil disposal alternatives are discussed in the following subsections.

11.3.4.1 Alternative 4a: Soil Excavation, In Situ Treatment of Tank Contents, and On-Site Soil Disposal. Alternative 4a would consist of the erection of a temporary containment structure, excavation of contaminated soils, grouting tank contents in-place, and disposal of the excavated soils on-site at the proposed ER INEEL soil repository. A temporary structure equipped with shielding and a negative pressure ventilation system exhausted through HEPA filters would be constructed over the tank site prior to the start of excavation activities. Contaminated soils would be excavated using conventional construction equipment. Tank contents would be grouted in place remotely by injecting grout into the tanks through existing manholes. A treatability study would be required to assess optimal design parameters for grouting.

Excavated soils would be transported to the proposed ER INEEL soil repository for disposal. Verification sampling would be conducted to ensure that all contamination present at concentrations exceeding PRGs was removed. The excavated areas would be backfilled with clean INEEL soils after excavation. Environmental monitoring to confirm no contaminant migration from the tank area would be conducted following completion of the remedial action. This monitoring may consist of the placement of boreholes and/or monitoring wells through the treated waste form to the underlying soil. In addition, five-year site reviews would be conducted to evaluate the effectiveness of the institutional controls and the need for further environmental monitoring, or additional control measures as applicable. Implementation of this alternative likely prevents return of this site to unrestricted use; however, the treated tank contents will be at depths greater than 10 feet.

11.3.4.2 Alternative 4b: Soil Excavation, In Situ Treatment of Tank Contents, and Off-Site Soil Disposal. Alternative 4b would consist of the erection of a temporary containment structure, excavation of contaminates soils, grouting tank contents in-place and transportation of the excavated soils off-site to a low-level radioactive waste disposal facility. A temporary structure equipped with shielding and a negative pressure ventilation system exhausted through HEPA filters would be constructed over the tank site prior to the start of excavation activities. Contaminated soils would be excavated using conventional construction equipment. Tank contents would be grouted in place by injecting grout into the tanks through existing manholes. A treatability study would be required to assess optimal design parameters for grouting. Excavated soils would be transported to the low-level radioactive waste disposal facility. Compliance with appropriate waste characterization and transportation requirements imposed by the facility would be required under this alternative. Verification sampling would be conducted to ensure that all contamination present at concentrations exceeding PRGs was removed. The excavated areas would be backfilled with clean INEEL soils after excavation. Environmental monitoring to confirm no contaminant migration from the tank area would be conducted following completion of the remedial action. This monitoring may consist of the placement of boreholes and/or monitoring wells through the treated waste form to the underlying soil. In addition, five-year site reviews would be conducted to evaluate the effectiveness of the institutional controls and the need for further environmental monitoring, or additional control measures as applicable. Implementation of this alternative likely prevents return of this site to unrestricted use; however, the treated tank contents will be at depths greater than 10 feet.

11.3.5 Alternative 5: Soil Excavation, In Situ Vitrification of Tank Contents, and Soil Disposal

Alternative 5 is similar to Alternative 4 with the exception of the proposed treatment of the tank waste. Under Alternative 5, two alternatives were developed to address tank waste at OU 1-10 through soil excavation, in situ treatment of tank contents and disposal of contaminated soils:

- Excavate contaminated soils, vitrify tank contents in-place, and dispose of the excavated soils at the proposed ER INEEL soil repository.

- Excavate contaminated soils, vitrify tank contents in-place, and dispose of the excavated soils off-site at a commercial low-level radioactive waste disposal facility.

The soil excavation, in situ vitrification of tank contents, and soil disposal alternatives are discussed in the following subsections.

Alternative 5a: Soil Excavation, In Situ Vitrification of Tank Contents, and On-Site Soil Disposal. Alternative 5a would consist of the erection of a temporary containment structure, excavation of contaminated soils, vitrification of tank contents in-place, and disposal of the excavated soils on-site at the proposed ER INEEL soil repository. A temporary structure equipped with shielding and a negative pressure ventilation system exhausted through HEPA filters would be constructed over the tank site prior to the start of excavation activities. Contaminated soils would be excavated using conventional construction equipment. Tank contents would be treated in place via in situ vitrification coupled with a vapor control pre-conditioning technique. Pre-conditioning of the tank contents includes mixing with a sufficient amount of absorbent, earthen materials to stabilize free liquids. Void space within the tanks will also be filled with soil. Additionally, a fluxing agent will be added to the fill soil material to lower its melting temperature relative to the surrounding soil. This will have the effect of preferentially directing the melt into the tanks relative to the surrounding soil. To ensure successful processing however, the upper region of the portion of the tank targeted for vitrification will be perforated using the vibratory beam technique. This will increase the effective flow paths for venting during ISV processing. The vibratory beam will require decontamination at the conclusion of the pretreatment process. Additionally, because of their long length, the PM-2A tanks will require processing in two melts. Perforation of the upper region of the tank, as described above, will be performed only on the portion to be processed to prevent any uncontrolled release of vapors from the portion of the tanks not covered by the off-gas hood.

After pretreatment, the works by establishing two, planar shaped ISV melts, on opposites sides of an underground storage tank. These two melts grow together and process the tank and its contents as melting progresses. The melting technique, combined with the structural disruption of the upper regions of the tank during preconditioning, provides a pathway for vapors generated within the tank to be continuously vented during processing. The venting prevents the entrapment of the vapors which could lead to unacceptable operating conditions.

The system involves the use of an array of graphite electrodes to supply electrical energy to the soil/waste to be vitrified. The natural electrical properties of the molten soil permit the flow of current between the electrodes. Gases are generated during processing and are allowed to escape to the surface where they are contained and collected by an off-gas hood. The hood is maintained at a partial vacuum to insure that the off gases are transported through the off-gas treatment system prior to their ultimate release to the environment. The electrotrodes will be installed to near the target treatment depth prior to initiation of melting. Casings using a vibratory insertion method will be used to minimize contamination brought to the surface. Startup of the melts will be accomplished using a proprietary technique.

Gases are generated during processing from the volatilization of water and other volatile species present in the matrix. These gases escape to the surface where they are contained in an off-gas hood. The hood is maintained at a partial vacuum to insure that the off gases are transported through the off-gas treatment system prior to their ultimate release to the environment. The off-gas system consists of a series of quenching scrubbing, filtration, and oxidation stages to insure effluents that the system are well within regulatory limitations on discharge. The off-gases are transported to the off-gas plenum region through a quencher and wet scrubber to cool the gas and perform the initial stages of separating the condensable and particulate matter from the flow stream. The gases are then passed through a mist eliminator to remove aerosols and a preheater to prevent condensation form occurring. Fine particulate filtration occurs as the gases are passed through a series of HEPA filters. The off-gas system also allows provisions to include activated carbon adsorption and or thermal oxidizer subsystems to insure complete and/or destruction of any unprocessed organics. The treated off-gases are then allowed to exit the stack to the environment.

The disposition of the off-gas treatment components will be based on the results of treatability testing of the tank contents, if applicable, and further revised during cold testing.

Excavated soils would be transported to the proposed ER INEEL soil repository for disposal. Verification sampling would be conducted to ensure that all contamination present at concentrations exceeding PRGs was removed. The excavated areas would be backfilled with clean INEEL soils after excavation. Environmental monitoring to confirm no contaminant migration from the tank area would be conducted following completion of the remedial action. This monitoring may consist of the placement of boreholes and/or monitoring wells through the treated waste form to the underlying soil. In addition, five-year site reviews would be conducted to evaluate the effectiveness of the institutional controls and the need for further environmental monitoring, or additional control measures as applicable. Implementation of this alternative likely prevents return of this site to unrestricted use; however, the treated tank contents will be at depths greater than 10 feet.

11.3.5.1 Alternative 5b: Soil Excavation, In Situ Vitrification of Tank Contents, and Off-Site Soil Disposal. Alternative 5b would consist of the erection of a temporary containment structure, excavation of contaminates soils, vitrifying tank contents in-place and transportation of the excavated soils off-site to a low-level radioactive waste disposal facility. A temporary structure equipped with shielding and a negative pressure ventilation system exhausted through HEPA filters would be constructed over the tank site prior to the start of excavation activities. Contaminated soils would be excavated using conventional construction equipment. Tank contents would be vitrified in place as detailed under Alternative 5a.

Excavated soils would be transported to the low-level radioactive waste disposal facility. Compliance with appropriate waste characterization and transportation requirements imposed by the facility would be required under this alternative. Verification sampling would be conducted to ensure that all contamination present at concentrations exceeding PRGs was removed. The excavated areas would be backfilled with clean INEEL soils after excavation. Environmental monitoring to confirm no contaminant migration from the tank area would be conducted following completion of the remedial action. This monitoring may consist of the placement of boreholes and/or monitoring wells through the treated waste form to the underlying soil. In addition, five-year site reviews would be conducted to evaluate the effectiveness of the institutional controls and the need for further environmental monitoring, or additional control measures as applicable. Implementation of this alternative likely prevents return of this site to unrestricted use; however, the treated tank contents will be at depths greater than 10 feet.

11.4 TSF-09/18

Alternatives developed to address tank waste liquids, sludge, and contaminated soils at TSF-09/18 (V1, V2, V3, and V9) are discussed in the following subsection

11.4.1 Alternative 1: No Action/Limited Action

Under this alternative, existing management practices currently in place at OU 1-10 would be continued with the addition of expanded institutional controls and environmental monitoring. Institutional controls would consist of restricting access to the sites using controls such as fencing. Existing management practices consist of environmental monitoring in accordance with INEEL site-wide requirements. In addition, five-year site reviews would be conducted to evaluate the effectiveness of the institutional controls and the need for further environmental monitoring, or additional control measures, as applicable.

11.4.2 Alternative 2: Soil Excavation, Tank Removal, Ex Situ Treatment and Disposal

Two alternatives were developed to address tank waste at OU 1-10 through soil excavation, tank removal, ex situ treatment and disposal:

- Excavate contaminated soils, excavate tanks and their contents, treat tank contents on-site (5 options), and dispose of the treated material at RWMC and excavated soils at the proposed ER INEEL soil repository.

- Excavate contaminated soils, excavate tanks and their contents, treat tank contents off-site, stabilize residues and dispose of the residues at RWMC and excavated soils at the proposed ER INEEL soil repository.

The soil excavation, tank removal, treatment, and disposal alternatives are discussed in the following subsections:

11.4.2.1 Alternative 2a: Soil Excavation, Tank Removal, and On-site Treatment and Disposal. Alternative 2a would consist of the erection of a temporary containment structure, excavation of the tanks and contaminated soils, removal of the tank contents, and disposal of the excavated soils and treated materials on-site. Soils would be disposed on-site at the proposed ER INEEL soil repository. Treated materials would be disposed at RWMC. A temporary structure equipped with shielding and a negative pressure ventilation system exhausted through HEPA filters would be constructed over the tank sites prior to the start of excavation activities. After excavation, tank contents would be removed remotely by jetting and pumping or vacuum removal, and the tanks would be decontaminated prior to disposal.

Tanks and the contaminated soils surrounding the tanks would be excavated using conventional construction equipment. Treated waste must conform to the NRC's Branch Technical Position on Waste Form which specifies limits on the leachability of contaminants and the structural stability of the material.

Excavated soils and treated materials would be transported to the proposed ER INEEL soil repository and the RWMC respectively, for disposal. Verification sampling would be conducted to ensure that all contamination present at the subsites with concentrations exceeding PRGs was removed. The excavated areas would be backfilled with clean INEEL soils after excavation. Institutional controls would not be required after site excavation and disposal activities, since all contamination would be removed, and all exposure pathways would be eliminated.

An overview of the treatment options considered for on-site treatment of tank contents are presented below and detailed in the following paragraphs:

1. Option 2a1—Solidify/Stabilize tank contents without solid/liquid separation.

2. Option 2a2—Solidify/Stabilize tank contents with solid/liquid separation prior to solidification/stabilization

3. Option 2a3—Storage of tank waste at RWMC in HICs followed by thermal treatment and ultimate disposal at RWMC.

4. Option 2a4—Solid/liquid separation followed by treatment of liquids using reverse osmosis (RO) and treatment of solids by solidification/stabilization.

5. Option 2a5—Solid/liquid separation followed by treatment of liquids using evaporation/carbon adsorption and treatment of solids by solidification/stabilization.

Figure 11-1 is a simple block flow diagram for ex-situ solidification/stabilization of the V-Tank waste and illustrates Options 2a1 and 2a2. Option 2a1 is for treating the waste without first separating the solids and liquids. This is the simplest treatment option considered. Option 2a2 includes a solid/liquid separation using a filter or centrifuge so that each phase can be treated separately in the solidification/stabilization process. Since the Cs-137 activity is much greater in the solids than the liquid, this process allows some of the treated product to be disposed as a contact-handled waste. Whereas, all the waste product for Option 2a1 is considered remote-handled.

Option 2a3 consists of an on-site thermal treatment option (i.e., vitrification or incineration) under consideration and is illustrated in Figure 11-2. Option 2a3 treats the waste at the INEEL when Pit-9 or the Advanced Mixed Waste Treatment Facility (AMWTF) becomes available. Since these facilities will not be on-line for several years, it was assumed that the waste could be temporarily stored at the RWMC in HICs until it could be treated.

Options 2a4 and 2a5 consist of a combination of physical and chemical operations which are illustrated in Figure 11-3. This strategy includes using transportable, skid-mounted equipment to treat the V-Tank waste on-site. In each option, the solids are removed from the liquids and stabilized for disposal. In option 2a4, the liquids are processed through a RO unit assuming it can reduce the amount of water requiring solidification by 70 %. The clean water would be discharged. Option 2a5 uses an evaporator to concentrate the nonvolatile soluble contaminants which are stabilized. The water vapor is treated with carbon adsorption to remove VOCs and HEPA filtered for radionuclide capture prior to atmospheric discharge.

11.4.2.2 Alternative 2b: Soil Excavation, Tank Removal, and Off-site Treatment and On-site Disposal of Treated Residuals. Alternative 2b would consist of the erection of a temporary containment structure, excavation of the tanks and contaminated soils, disposal of soils on-site at the proposed INEEL ER soil repository, removal of the tank contents, transportation of the tank contents to Oak Ridge National Laboratory (ORNL) for treatment, treatment of the residuals, and disposal of treated residuals at RWMC. A temporary structure equipped with shielding and a negative pressure ventilation system exhausted through HEPA filters would be constructed over the tank site prior to the start of excavation activities. After excavation, tank contents would be removed remotely by jetting and pumping or vacuum removal, and the tanks would be decontaminated prior to on-site disposal.

Tanks and contaminated soils surrounding the tanks would be excavated using conventional construction equipment. Tank wastes would be placed in high integrity containers (HICs) and transported to the ORNL for treatment and the treatment residuals would be stabilized and returned to INEEL for disposal at RWMC. Liquids generated during excavation would be characterized and disposed of appropriately.

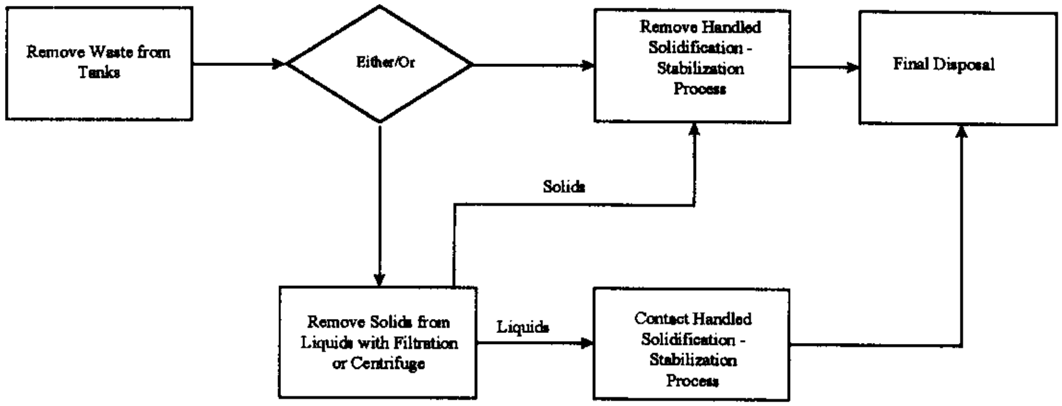

Figure 11-1. Ex-situ solidification/stabilization of the V-Tank waste and illustration of Options 2a1 and 2a2.

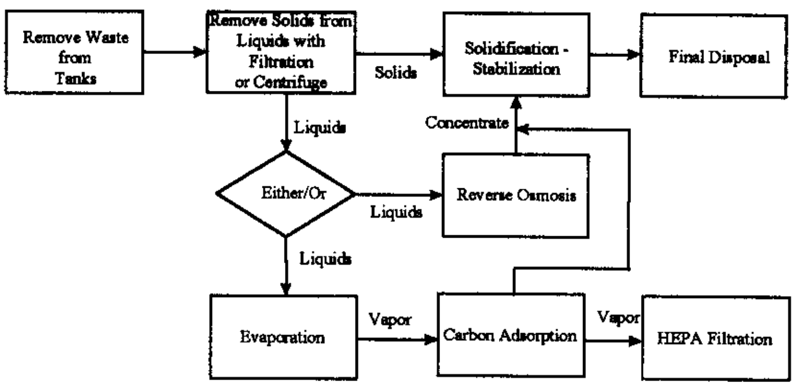

Figure 11-2. Diagram for on-site combined technologies.

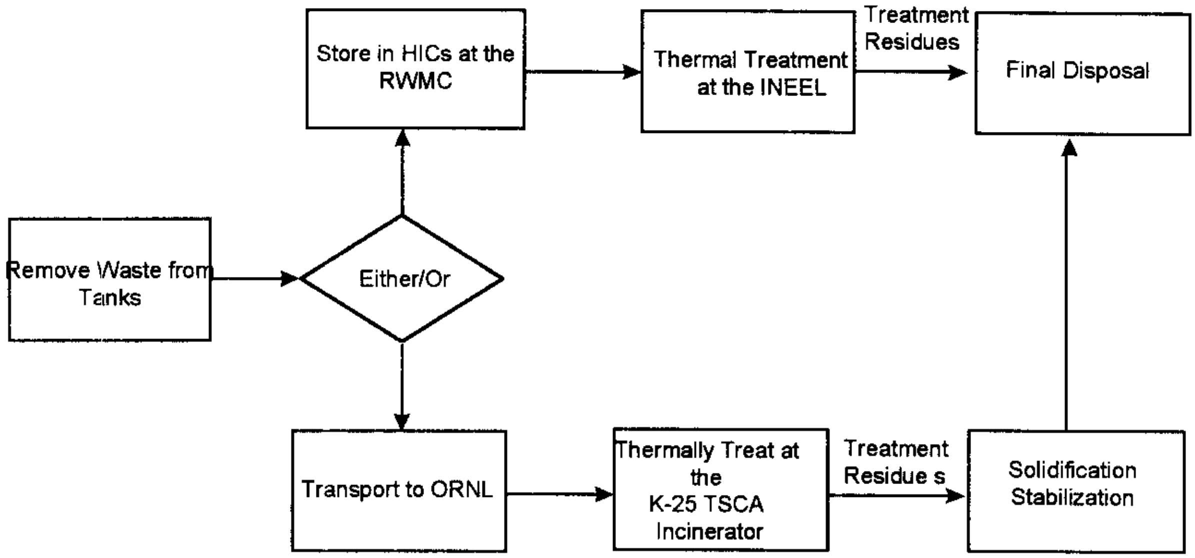

Figure 11-3. Diagram for thermal treatment.

Compliance with appropriate waste characterization and transportation requirements imposed by ORNL would be required under this alternative. Verification sampling would be conducted to ensure that all contamination present at concentrations exceeding PRGs was removed. The excavated areas would be backfilled with clean INEEL soils after excavation. Institutional controls would not be required after site excavation and disposal activities, since all contamination would be removed, and all exposure pathways would be eliminated. Alternative 2b includes transporting the waste in HICs to the Toxic Substances Control Act (TSCA) incinerator at the ORNL for treatment. Figure 11-3 illustrates this treatment scheme. This option includes stabilizing the residues for disposal since the treatment units planned for the INEEL will produce stable waste forms amenable for disposal.

11.4.3 Alternative 3: Soil Excavation, In Situ Treatment of Tank Contents, and Soil Disposal

Two alternatives were developed to address tank waste at OU 1-10 through soil excavation, in situ treatment of tank contents and disposal of contaminated soils:

- Excavate contaminated soils, grout tank contents in-place, and dispose of the excavated soils at the proposed ER INEEL soil repository.
- Excavate contaminated soils, grout tank contents in-place, and dispose of the excavated soils off-site at a commercial low-level radioactive waste disposal facility.

The soil excavation, in situ treatment of tank contents, and soil disposal alternatives are discussed in the following subsections.

11.4.3.1 Alternative 3a: Soil Excavation, In Situ Treatment of Tank Contents, and On-Site Soil Disposal. Alternative 3a would consist of the erection of a temporary containment structure, excavation of contaminated soils, grouting tank contents in-place, and disposal of the excavated soils on-site at the proposed ER INEEL soil repository. In order to effectively grout the tank contents it maybe necessary to add a chemical oxidant to the tank contents to prevent the organics from inhibiting the ability of the grout to solidify into a stable waste form. If the use of chemical oxidants is determined to be necessary, air pollution control may be required to capture any volatilized liquids resulting from the addition of the oxidants. A temporary structure equipped with shielding and a negative pressure ventilation system exhausted through HEPA filters would be constructed over the tank site prior to the start of excavation activities. Contaminated soils would be excavated using conventional construction equipment. Tank contents would be thoroughly mixed and then grouted in place remotely by injecting grout into the tanks through existing manholes. A treatability study would be required to assess optimal design parameters for grouting.

Excavated soils would be transported to the proposed ER INEEL soil repository for disposal. Verification sampling would be conducted to ensure that all contamination present at concentrations exceeding PRGs was removed. The excavated areas would be backfilled with clean INEEL soils after excavation. Environmental monitoring to confirm no contaminant migration from the tank area would be conducted following completion of the remedial action. This monitoring may consist of the placement of boreholes and/or monitoring wells through the treated waste form to the underlying soil. In addition, five-year site reviews would be conducted to evaluate the effectiveness of the institutional controls and the need for further environmental monitoring, or additional control measures as applicable. Implementation of this alternative likely prevents return of this site to unrestricted use; however, the treated tank contents will be at depths greater than 10 feet.

11.4.3.2 Alternative 3b: Soil Excavation, In Situ Treatment of Tank Contents, and Off-Site Soil Disposal. Alternative 3b would consist of the erection of a temporary containment structure, excavation of contaminates soils, grouting tank contents in-place and transportation of the excavated soils off-site to a low-level radioactive waste disposal facility. In order to effectively grout the tank contents it maybe necessary to add a chemical oxidant to the tank contents to prevent the organics from inhibiting the ability of the grout to solidify into a stable waste form. If the use of chemical oxidants is determined to be necessary, air pollution control may be required to capture any volatilized liquids resulting from the addition of the oxidants. A temporary structure equipped with shielding and a negative pressure ventilation system exhausted through HEPA filters would be constructed over the tank site prior to the start of excavation activities. Contaminated soils would be excavated using conventional construction equipment. Tank contents would be thoroughly mixed and then grouted in place by injecting grout into the tanks through existing manholes. A treatability study would be required to assess optimal design parameters for grouting. Excavated soils would be transported to the low-level radioactive waste disposal facility. Compliance with appropriate waste characterization and transportation requirements imposed by the facility would be required under this alternative. Verification sampling would be conducted to ensure that all contamination present at concentrations exceeding PRGs was removed. The excavated areas would be backfilled with clean INEEL soils after excavation. Environmental monitoring to confirm no contaminant migration from the tank area would be conducted following completion of the remedial action. This monitoring may consist of the placement of boreholes and/or monitoring wells through the treated waste form to the underlying soil. In addition, five-year site reviews would be conducted to evaluate the effectiveness of the institutional controls and the need for further environmental monitoring, or additional control measures as applicable. Implementation of this alternative likely prevents return of this site to unrestricted use; however, the treated tank contents will be at depths greater than 10 feet.

11.4.4 Alternative 4: In Situ Vitrification of Tank Contents and Soil Within the Treatment Area

Alternative 4 would consist of the in situ vitrification of the tank contents for the TSF-09/18 tanks (V-1, V-2, V-3, and V-9) and contaminated soil above those tanks. Pre-conditioning of the tank contents includes mixing with a sufficient amount of absorbent, earthen materials to stabilize free liquids. Void space within the tanks will also be filled with soil. Additionally, a fluxing agent will be added to the fill soil material to lower its melting temperature relative to the surrounding soil. This will have the effect of preferentially directing the melt into the tanks relative to the surrounding soil. To ensure successful processing however, the upper region of the portion of the tank targeted for vitrification will be perforated using the vibratory beam technique. This will increase the effective flow paths for venting during ISV processing. The vibratory beam will require decontamination at the conclusion of the pretreatment process. Tank V-9 will be subjected to a cold test followed by individual processing. The V-1, V-2, and V-3 tanks will be perforated along their entire lengths and processed by individual melts. Perforation of the upper region of the tank, as described above, will be performed only on the portion to be processed to prevent any uncontrolled release of vapors from the portion of the tanks not covered by the off-gas hood. The proposed process works by establishing two, planar shaped ISV melts, on opposite sides of an underground storage tank. These two melts grow together and process the tank and its contents as melting progresses. The melting technique, combined with the structural disruption of the upper regions of the tank during pre-conditioning, provides a pathway for vapors generated within the tank to be continuously vented during processing. The venting prevents the entrapment of the vapors which could lead to unacceptable operating conditions.

The system involves the use of an array of graphite electrodes to supply electrical energy to the soil/waste to be vitrified. The natural electrical properties of the molten soil permit the flow of current between the electrodes. Gases are generated during processing and are allowed to escape to the surface where they are contained and collected by an off-gas hood. The hood is maintained at a partial vacuum to insure that the off gases are transported through the off-gas treatment system prior to their ultimate release to the environment. The electrotrodes will be installed to near the target treatment depth prior to initiation of melting. Casings using a vibratory insertion method will be used to minimize contamination brought to the surface. Startup of the melts will be accomplished using a proprietary technique.

Gases are generated during processing from the volatilization of water and other volatile species present in the matrix. These gases escape to the surface where they are contained in an off-gas hood. The hood is maintained at a partial vacuum to insure that the off gases are transported through the off-gas treatment system prior to their ultimate release to the environment. The off-gas system consists of a series of quenching scrubbing, filtration, and oxidation stages to insure effluents that the system are well within regulatory limitations on discharge. The off-gases are transported to the off-gas plenum region through a quencher and wet scrubber to cool the gas and perform the initial stages of separating the condensable and particulate matter from the flow stream. The gases are then passed through a mist eliminator to remove aerosols and a preheater to prevent condensation form occurring. Fine particulate filtration occurs as the gases are passed through a series of HEPA filters. The off-gas system also allows provisions to include activated carbon adsorption and or thermal oxidizer subsystems to insure complete and/or destruction of any unprocessed organics. The treated off-gases are then allowed to exit the stack to the environment.

The disposition of the off-gas treatment components will be based on the results of treatability testing of the tank contents, if applicable, and further revised during cold testing.

Environmental monitoring to confirm no contaminant migration from the tank area would be conducted following completion of the remedial action. This monitoring may consists of the placement of boreholes and/or monitoring wells through the treated waste forms to the underlying soil. In addition, five-year site reviews would be conducted to evaluate the effectiveness of the institutional controls and the need for further environmental monitoring, or additional control measures as applicable. Implementation of this alternative likely prevents return of this site to unrestricted use; however, the treated tank contents will be at depths greater than 10 feet.

11.5 Reference

DOE, 1997, *Idaho National Engineering and Environmental Laboratory Reusable Property, Recyclable Materials, and Waste Acceptance Criteria (RRWAC)*, DOE/ID-10381, Rev. 6, February.

EPA, 1988, *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*, EPA/540/G-89/004, Interim Final, U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, October.