APPENDIX D:

CONCEPTUAL DISPOSAL FACILITY DESIGNS

This appendix presents information on the conceptual facility designs and layouts, modes of transportation, waste packaging, facility resource requirements, and facility emissions associated with the three land disposal methods that the U.S. Department of Energy (DOE) is considering for disposal of greater-than-Class C (GTCC) low-level radioactive waste (LLRW) and GTCC-like waste: (1) borehole disposal, (2) trench disposal, and (3) vault disposal. Each conceptual facility is designed to provide the disposal capacity needed for the entire inventory described in Appendix B. In addition, this appendix provides supporting information for estimating incremental air emissions from waste to be disposed of at the Waste Isolation Pilot Plant (WIPP).

D.1 SCOPE

Two enhanced near-surface methods for disposing of GTCC LLRW and GTCC-like waste were evaluated: a trench and an above-grade vault. One intermediate-depth method — the borehole disposal method — was also evaluated. The level of detail of the proposed designs that is presented in this appendix is sufficient for use in this environmental impact statement (EIS). Further studies, including a site-specific safety analysis report, would be necessary to support further decision-making with regard to implementing any of the three methods.

The disposal facility designs are sized to accommodate the disposal of approximately 12,000 m^3 (420,000 ft^3) of GTCC LLRW and GTCC-like wastes that are expected to be generated through the year 2083. Information on the waste types and their radionuclide activities, volumes, and packaging is provided in Appendix B. The disposal facilities are designed as stand-alone operations. Depending on the final location of such a facility, certain components, such as buildings, equipment, or personnel, could be shared with or obtained from existing facilities, thus lowering anticipated costs.

Section D.2 presents a summary of the assumed disposal packages. Section D.3 provides descriptions of the three land disposal methods considered. Conceptual designs of the proposed facilities are presented in Section D.4. Section D.5 discusses the number of and the cost associated with the personnel required for the construction of and operations at each facility. Estimates of the resource materials and utilities needed to construct and operate the facility are provided in Section D.6. Estimated construction and operation emissions and wastes are discussed in Section D.7, and data on emissions from material deliveries and worker vehicles are provided in Section D.8. Section D.9 provides additional estimates of air emissions related to the expansion and operation of the WIPP facility to accommodate the GTCC LLRW and GTCC-like waste considered in this EIS.

The number of construction workers required at any one time during site preparation and facility construction will vary because of the temporary nature of the work and because certain tasks can be accomplished concurrently while others must occur consecutively. A minimum number of workers are necessary to operate the facility, and that number depends on the waste receipt rate, as discussed further in Section D.5.2. Thus, the estimated resources and emissions from facility operations presented in Sections D.6, D.7, and D.8 are based on the personnel estimates given in Section D.5.2.

D.2 TRANSPORTATION AND PACKAGING

This section provides information on the assumptions about waste transportation and packaging for the borehole, trench, and vault disposal alternatives. Information on the transportation and packaging assumptions for the deep geologic disposal alternative (WIPP) is found in Appendix B. It is assumed that GTCC LLRW and GTCC-like waste would be shipped to the disposal facility in their final disposal containers. Thus, the disposal facilities would be designed to most efficiently accommodate the types of containers that would most likely be used to transport and dispose of this waste. It is assumed that GTCC LLRW and GTCC-like waste would be transported by truck and rail to the disposal facility in Type B shipping packages, as discussed in Section 5. The waste to be disposed of would include sealed sources, contact-handled (CH) Other Waste (Other Waste - CH), remote-handled (RH) Other Waste (Other Waste - RH), and activated metals, as discussed in Appendix B.

D.2.1 Contact-Handled Waste

A common container for the storage of CH and RH GTCC LLRW and GTCC-like waste is the 208-L (55-gal) drum (referred to as drum(s) in the remainder of this appendix). In addition, it is assumed that some stored and projected CH wastes would be packaged for disposal in standard waste boxes (SWBs). As discussed in Appendix B, this EIS explicitly assumes that the disposal of CH waste, except for cesium (Cs) irradiator sources, would be in drums and SWBs. The Cs irradiators are self-contained and would be disposed of in their original shielded container. The size of these irradiators is assumed to be 150 × 65 × 67 cm (59 × 26 × 27 in.) (Sandia 2008a).

Although the use of other shipping and disposal configurations (e.g., 320-L and 380-L [85-gal and 100-gal] drums) might be possible, their use is not explicitly considered; however, the use of other container types could be accommodated in the current disposal facility designs. Also, GTCC LLRW and GTCC-like CH waste might be found in storage in containers larger than SWBs at some sites, but there are currently no viable casks available for transport. Stacking arrangements in the CH disposal cells could be modified accordingly in the future if such packages became available.

D.2.2 Remote-Handled Waste

It is assumed that all RH waste, except for the activated metal waste types, would be packaged for disposal in drums. As discussed in Appendix B, three drums could be packaged in an RH canister (DOE 1995) that is designed for use with the RH-72B shipping cask. As an alternative, RH waste could be loaded directly into the canister for disposal (DOE 2006). The proposed facility designs can accommodate both drums and RH canisters, as discussed further in Sections D.3.1.2.2, D.3.2.2.2, and D.3.3.2.2.

It is assumed that activated metals would be packaged in right circular stainless-steel canisters (activated metal canisters [AMCs]). To facilitate potential shipment by truck as well as rail and to provide flexibility in the facility design, the size and weight of these canisters were selected to be compatible with existing containers and weight limitations of truck casks. Additional discussion on the size of the AMCs is presented in Section B.4.1.2.

D.3 LAND DISPOSAL METHODS

D.3.1 Trench Disposal

D.3.1.1 Conceptual Trench Design

The basic design for the trench disposal facility utilizes trenches that are 3-m (10-ft) wide, 11-m (36-ft) deep, and 100-m (330-ft) long. The trench width and depth were selected to optimize disposal capacity per trench within the limits of excavation equipment that is readily available and shoring equipment that is commercially available. The conceptual drawing of a cross section of the basic trench design (Figure D-1) illustrates the trench design features and dimensions. In addition, the conceptual design for a trench facility is deeper and narrower than it is for conventional near-surface LLRW disposal facilities in order to minimize the potential for inadvertent human intrusion during the post-closure period.

The side walls of the trench would be vertically constructed. A well-compacted material would be placed on top of the native material in the floor of the trench. A layer of sand or gravel (0.3 m [1 ft]) would be placed on top of the compacted material to improve stability. The nature of the compacted material would be selected to be compatible with the surrounding geologic material. The trench sidewalls would be constructed with temporary metal shoring. The metal shoring would be removed when the trench was closed.

The waste packages would be placed into the trench about 5 to 10 m (15 to 30 ft) bgs, and a fine-grained cohesionless fill (sand) would be used to backfill around the waste containers to fill voids. After the trench was filled with the waste containers and backfilled, a reinforced concrete layer would be placed over the waste packages to help mitigate any future inadvertent intrusion. Use of 6-in. (15-cm) on-center steel reinforcement (rebar), in two perpendicular layers, would strengthen the concrete. In addition to adding strength to the concrete layer, the spacing of the rebar would provide protection against inadvertent drilling straight down into the trenches. For this reason, the concrete would have two sets of perpendicular steel reinforcement, one near the top face and the other near the bottom face of the barrier. With a spacing of 6 in. (15 cm), most drill bits would not pass into the trench without encountering the steel reinforcement first (discouraging further penetration), if they had not initially been stopped by the concrete itself.

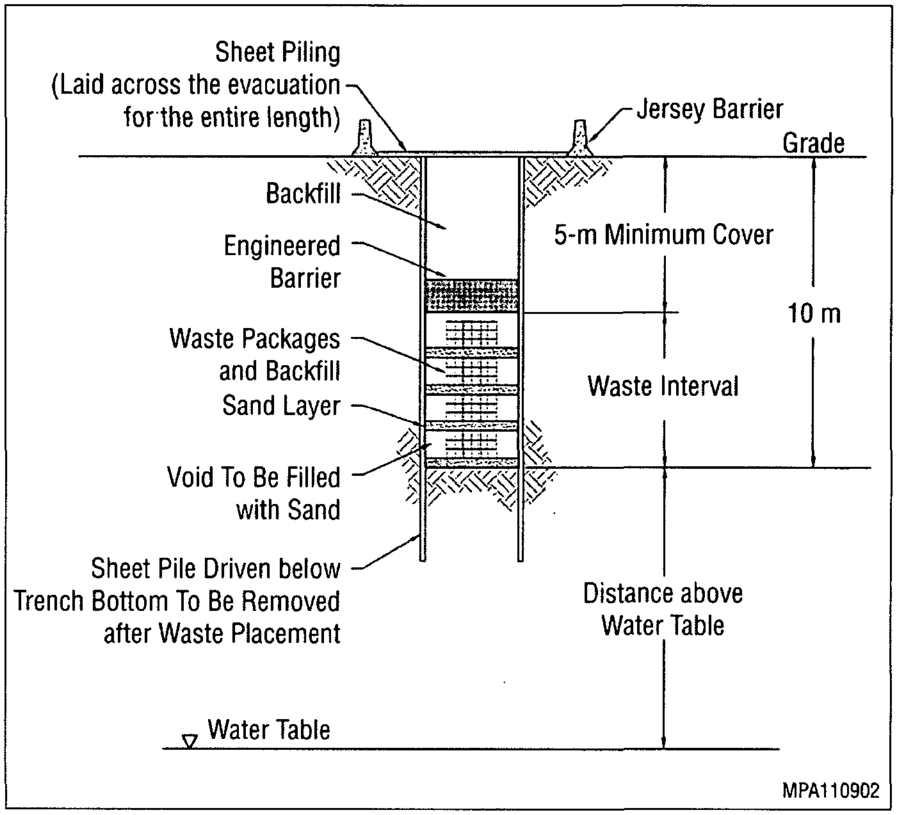

FIGURE D-1 Cross Section of a Conceptual Trench Disposal Unit

It is anticipated that clean fill from construction would be used to backfill the trench above the concrete layer. Each trench could be capped with a cover system consisting of a geotextile membrane overlain by gravel, sand, and topsoil layers (similar to that shown for the vault design final cover system depicted later in Figure D-8). In the case of the trench, the top of the cover system would be flush with or slightly elevated above the surrounding ground surface, depending on the final design.

D.3.1.2 Disposal Package Configurations

D.3.1.2.1 Contact-Handled Waste. The assumed packing arrangement for 208-L (55-gal) drums and SWBs in a 10-m (33-ft) section of trench is shown in Figure D-2. Up to five layers of drums or SWBs could be accommodated with approximately 0.3 m (1 ft) of fill above and below each layer, for a total of 3,000 drums or 500 SWBs per trench. For the larger cesium sources, it is assumed that there would be 560 units per layer (four across the trench width) and three layers, for a total of 1,680 cesium sources per trench. During disposal operations for CH waste, one end of a trench would have a ramp to the surface for entry by a forklift carrying CH waste packages (a pallet of four drums, four cesium sources, or one SWB) for emplacement.

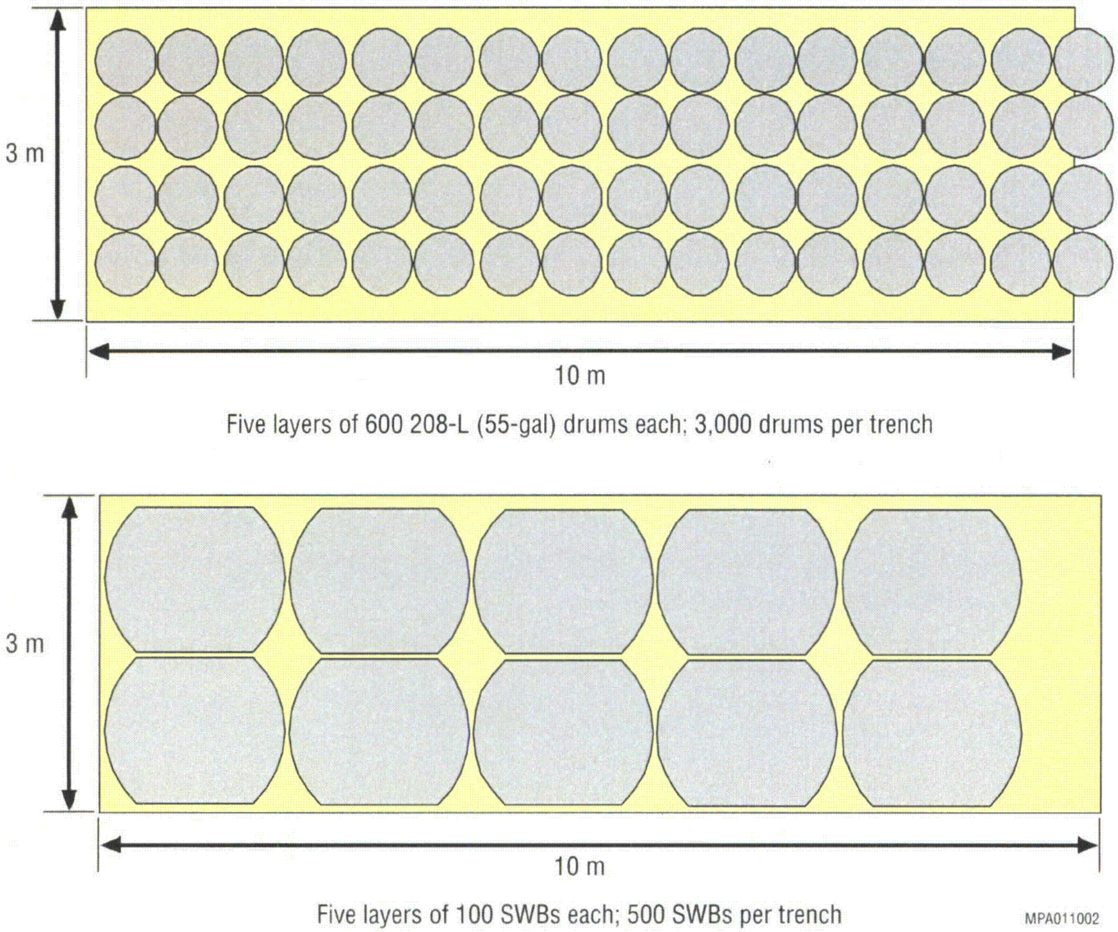

FIGURE D-2 Top View of a 10-m (33-ft) Section of a Trench Packed with Contact-Handled Waste

D.3.1.2.2 Remote-Handled Waste. Additional features are needed in the trenches where RH waste would be buried to provide shielding for the workers once the waste was in place. The RH waste packages (AMCs, drums, and RH canisters) would be disposed of in vertical reinforced concrete cylinders with concrete shield plugs (1.2-m [4-ft] thick) on the top of each cylinder. This design is similar to that proposed for activated metal disposal (Harvego 2007). A mating flange would enable coupling of the bottom-loading transfer cask to a given cylinder for transfer of the waste package into the disposal unit. The transfer cask would be moved off an on-site transport truck into position by an overhead crane. Figure D-3 shows a top view of a 10-m (33-ft) section of an RH waste disposal trench. Each cylinder would be capable of holding up to three AMCs, four individual 208-L (55-gal) drums, or one RH canister. With 302 cylinders per trench, as many as 906 AMCs, 1,208 drums, or 302 RH canisters could be emplaced in one trench.

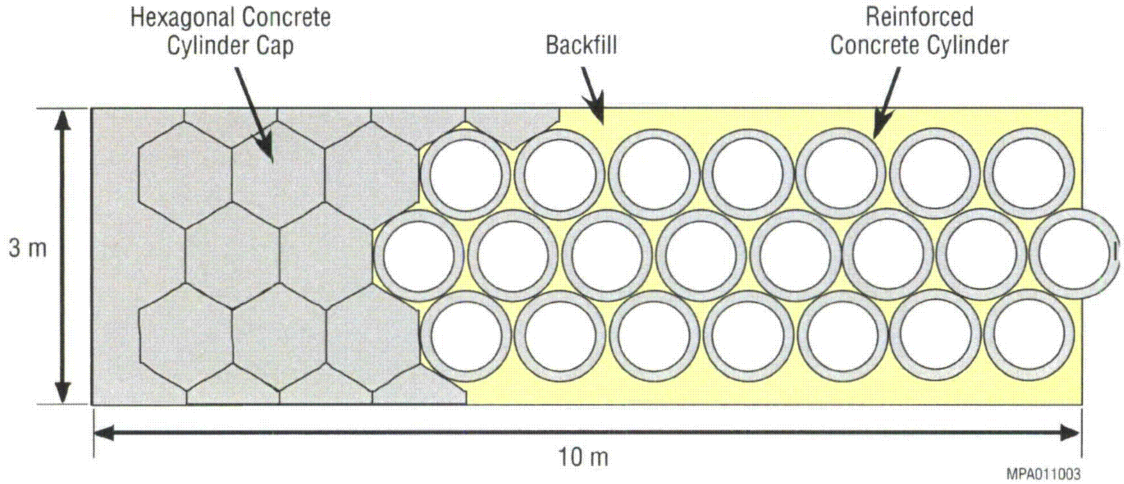

FIGURE D-3 Top View of a 10-m (33-ft) Section of a Trench for Disposal of Remote-Handled Waste

D.3.2 Borehole Disposal

D.3.2.1 Conceptual Borehole Design

Borehole disposal would entail the emplacement of waste in boreholes at depths below 30 m (100 ft) but above 300 m (1,000 ft). Boreholes can vary widely in diameter (from 0.3 to 3.7 m [1 to 12 ft]), and the proximity of one borehole to another can vary depending on the design of the facility. The technology for drilling larger-diameter boreholes is simple and widely available. The current conceptual design employs boreholes that are 2.4 m (8 ft) in diameter and 40-m (130-ft) deep in unconsolidated to semiconsolidated soils, as shown in Figure D-4, with GTCC waste emplacement assumed to be about 30 to 40 m (100 to 130 ft) bgs.

A bucket auger would be used to drill the large-diameter borehole (see Figure D-5), and a smooth steel casing would be advanced to the depth of the borehole during the drilling and construction of the borehole. The casing would provide stability to the borehole walls and ensure that waste packages would not snag and plug the borehole as they were lowered and would not sit in an upright position when they reached the bottom. The upper 30 m (100 ft) of smooth steel casing would be removed upon closure of the borehole. In some cases where consolidated materials might be encountered, a more robust drilling technology would be required. A casing would also be used in this latter case as an aid in placing waste packages.

The waste packages would be placed into the borehole, and a fine-grained cohesionless fill (sand) would be used to backfill around the waste containers to fill voids. After the borehole was filled with the waste containers and backfill, a reinforced concrete layer would be placed over the waste packages to help mitigate any future inadvertent intrusion. Use of 6-in. (15-cm) on-center steel reinforcement (rebar), in two perpendicular layers, would strengthen the concrete. In addition to adding strength to the concrete layer, the spacing of the rebar would provide

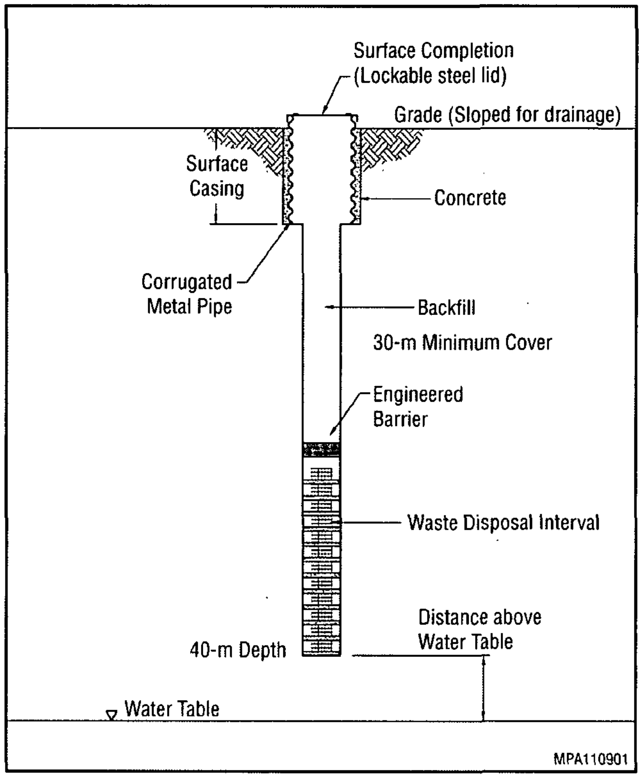

FIGURE D-4 Cross Section of a Conceptual 40-m (130-ft) Borehole

protection against inadvertent drilling straight down into a borehole. For this reason, the concrete would have two sets of perpendicular steel reinforcement, one near the top face and the other near the bottom face of the barrier. With a spacing of 6 in. (15 cm), most drill bits would not pass into the borehole without encountering the steel reinforcement first (discouraging further penetration), if they had not initially been stopped by the concrete itself.

It is anticipated that clean fill from the construction of the facility would be used to backfill the borehole above the concrete layer. Each borehole could be capped with a cover system consisting of a geotextile membrane overlain by gravel, sand, and topsoil layers, similar to that discussed for trench disposal in Section D.3.1.1 and shown for the vault design final cover system depicted later in Figure D-8. In the case of the borehole, the top of the cover system would be flush with or slightly elevated above the surrounding ground surface, depending on the final design.

D.3.2.2 Disposal Package Configurations

D.3.2.2.1 Contact-Handled Waste. CH waste would be taken off the on-site transport vehicle and lowered by crane into a borehole for emplacement. For a borehole, assumed packing

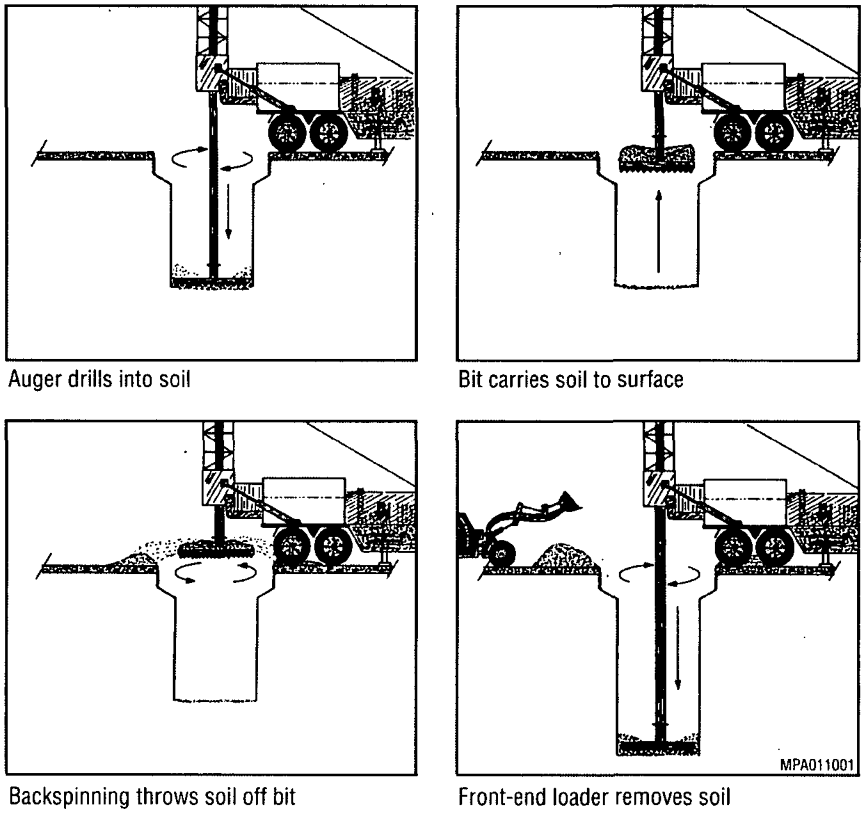

FIGURE D-5 Process Schematic for Drilling a Large-Diameter Borehole by Using a Bucket Auger (Source: Sandia 2007b)

arrangements for CH waste are eight intervals (levels) of 208-L (55-gal) drum 7-packs (56 drums), five intervals of cesium-source 4-packs (20 cesium sources), or eight intervals of one SWB (eight SWBs). Approximately 0.3 m (1 ft) of fill would be used between intervals. Single-interval packing arrangements are shown in Figure D-6.

D.3.2.2.2 Remote-Handled Waste. For RH waste, three intervals of two 3-packs of RH canisters or six intervals of two 3-packs of AMCs are assumed. Thus, 18 RH canisters or 36 AMCs could be emplaced in a borehole. Boreholes for disposal of RH waste would have a shielded cover once the RH waste was emplaced, prior to being full and backfilled. On-site transport of RH waste would occur in shielded bottom-loading transfer casks (e.g., smaller versions of the type used at independent spent fuel storage installations for the movement of spent nuclear fuel [SNF]) that would mate with ports on a borehole cover. Once the transfer cask was mated to the borehole cover, the RH waste would be lowered into place.

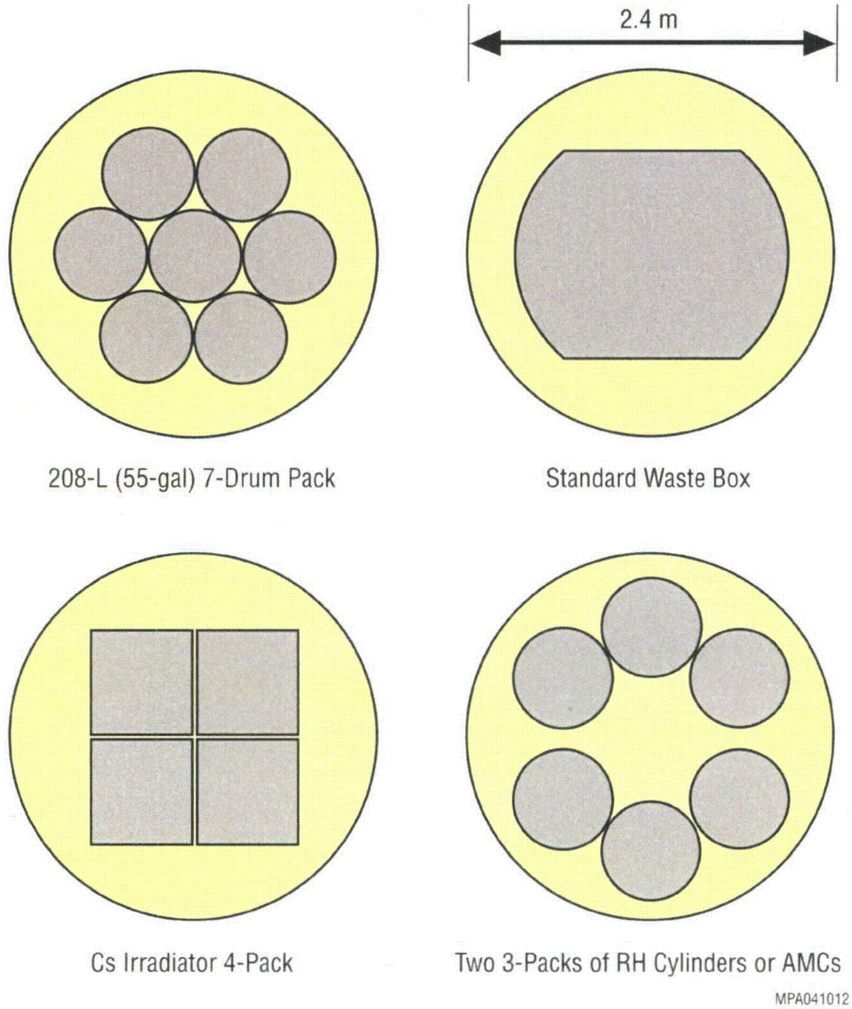

FIGURE D-6 Top View of Single-Interval Packing Arrangements in 2.4-m-Diameter (8-ft-Diameter) Boreholes for Different Container Types

D.3.3 Vault Disposal

D.3.3.1 Conceptual Vault Design

The conceptual design for the vault disposal of GTCC LLRW is a reinforced concrete vault constructed near grade level, with the footings and floors of the vault situated in a slight excavation just below grade. The design is a modification of one disposal concept proposed by Henry (1993) for GTCC LLRW and is similar to a belowground (Denson et al. 1987) vault LLRW disposal method previously investigated by the U.S. Army Corps of Engineers. A similar below-grade concrete vault structure is currently in use for disposal of higher-activity LLRW at the Savannah River Site (SRS) (MMES et al. 1994).

D.3.3.1.1 Vault System. Each vault would be 11-m (35-ft) wide, 94-m (310-ft) long, and 7.9-m (26-ft) tall, with 11 disposal cells situated in a linear array. Interior cell dimensions would be 8.2-m (27-ft) wide, 7.5-m (25-ft) long, and 5.5-m (18-ft) high, with an internal volume of 340 m^3 (12,000 ft^3) per cell. Double interior walls with an expansion joint would be included after every second cell. GTCC waste disposal placement is assumed to be about 4.3 to 5.5 m (14 to 18 ft) above ground surface. Figure D-7 shows a schematic cross section of a vault cell.

The exterior walls and roof would be composed of 1.1-m (3.8-ft)-thick reinforced concrete. In addition to adding strength and durability to the vault, the thick concrete would attenuate the radiation emanating from the RH waste component of the material destined for disposal. The most hazardous of the wastes in this respect would be the activated metals from reactor decommissioning; their external radiation rates, primarily from cobalt-60 (Co-60), could be a few thousand roentgens per hour at the waste package surface (Sandia 2007a). With an attenuation of Co-60 gamma rays of one-half for about every 6.2 cm (2.4 in.) of concrete (Shleien 1992), a reduction in radiation (by a factor of more than 260,000) to near background levels is expected.

Use of 6-in. (15-cm) on-center steel reinforcement (rebar), in two perpendicular layers, would strengthen the concrete in the floor, walls, and vault cap (ceiling). In addition to adding strength to the vault construction, the spacing of the rebar would provide protection against inadvertent drilling into the disposal cells. For this reason, the vault cap would have two sets of perpendicular steel reinforcement, one near the exterior face and the other near the interior face of the cap. With a spacing of 6 in. (15 cm), most drill bits would not pass into the vault without encountering the steel reinforcement first (discouraging further penetration), if they had not initially been stopped by the concrete itself. Steel reinforcement in the walls was included because of the increased prevalence of using directional drilling at deeper depths for utility work, which can expose the walls as well as the top of the vault to drilling.

D.3.3.1.2 Engineered Cover Systems. An engineered cover would be used to aid in the isolation of the waste from the environment over the long term. In addition to the protection afforded by the vault and its internal backfill, the thickness of the cover would assure that external exposure rates remained at background levels. The design would direct surface water away from the waste and help deter intrusion by humans, plants, and animals. Minimum and maximum slope requirements would be incorporated to ensure adequate drainage and to reduce erosion/maintain slope stability, respectively.

Two engineered cover systems are included in the design for the vaults, as shown in Figure D-8. The first would be put in place after a vault was filled with waste and permanently closed, or it could be implemented incrementally as the vault was filled (the interim cover with a rise-to-run of 1:3 from the vault edge to ground level). The second cover system would partially replace the interim cover prior to closure of the disposal facility (the final cover with a rise-to-run of 1:5 from the vault edge to ground level). A graded slope of 3% would be used over the combined cover of all of the vaults. Both covers would have a minimum depth of 5.0 m (17 ft) over any portion of a vault, with a 15-cm (0.5-ft) layer of gravelly sand over a vault followed by a layer of clay 0.9-m (3-ft) thick, as shown in Figure D-8. The next layer in the interim cover would consist of 3.7 m (12.0 ft) of native soil followed by 0.3 m (1 ft) of topsoil. In the final

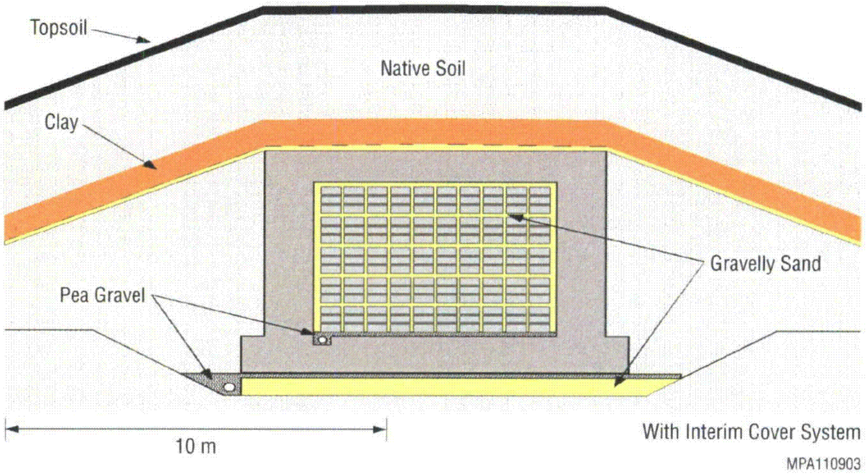

FIGURE D-7 Cross Section of a Conceptual Above-Grade Vault Design (drawn to scale)

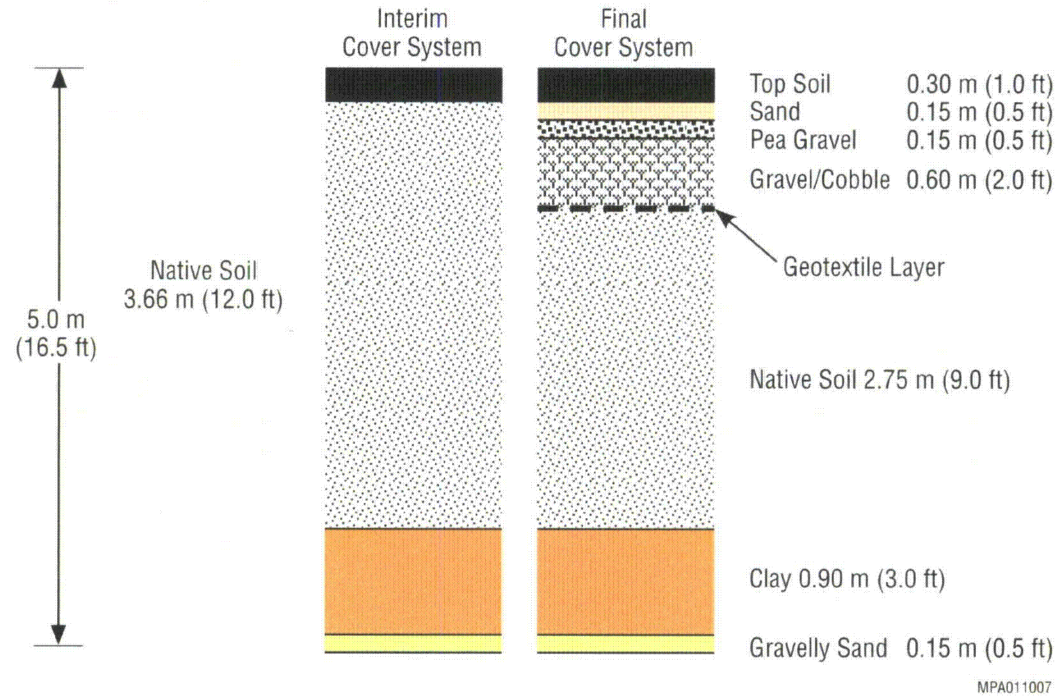

FIGURE D-8 Conceptual Cover Systems for a Vault Disposal Facility (Source: Modified from Henry 1993)

cover, the next layer over the clay layer would have 2.8 m (9.0 ft) of native soil, followed by a geotextile layer, 0.6 m (2 ft) of gravel, 15 cm (0.5 ft) of pea gravel, 15 cm (0.5 ft) of sand, and 0.3 m (1 ft) of topsoil (Henry 1993). If needed, rock armor could also be incorporated into the final cover to further protect against erosion.

D.3.3.2 Disposal Package Configurations

D.3.3.2.1 Contact-Handled Waste. The packing arrangement of CH 208-L (55-gal) drums in a cell assumes placement of 7-drum packs as received at the facility in a Transuranic Package Transporter-II (TRUPACT-II) Type B transportation package. Figure D-9 shows the arrangement for the CH drums, with 18 7-packs used per layer. With five layers, 630 drums could be accommodated in each cell. For SWBs, 20 could be arranged in one layer (see Figure D-10), with five layers for 100 SWBs in one vault cell. In addition, it is estimated that about 300 cesium irradiators (three layers of 10 × 10) would fit in one cell. A layer of fill would be used between layers of disposal containers to minimize void spaces. SWBs, 7-drum packs, and 4-packs of irradiators would be taken off an on-site transport truck and loaded into the vault cell by an overhead crane.

D.3.3.2.2 Remote-Handled Waste. Vault cells for disposal of RH waste would be similar in design to the trench approach as discussed in Section D.3.1.2.2. RH AMCs, 208-L (55-gal) drums, or canisters would be loaded from a bottom-loading transfer cask into vertical reinforced concrete cylinders with thick concrete shield plugs within each cell. Figure D-11 provides a view from the top of a vault cell. The cylinder loading would be the same as that for the trench approach — three AMCs, four 208-L (55-gal) drums, or one RH canister per cylinder. With 72 cylinders per cell, 216 AMCs, 288 drums, or 72 RH canisters could be emplaced in each vault cell.

D.4 CONCEPTUAL FACILITY LAYOUTS

For all methods, an outside fence would maintain a minimum 30-m (100-ft) buffer around the site, with a larger buffer where the stormwater retention pond and site support facilities could be located. A guard house would restrict access to the site. An administration building would provide the base for site operations, with waiting areas, offices, record storage, and personnel support facilities (e.g., meeting rooms, locker rooms). A receipt and storage (waste handling) building would provide space for inspecting newly received waste for disposal, offloading the waste, and temporarily storing the waste before its emplacement in the disposal units. Vehicles, equipment, and supplies necessary to site operations would be maintained, repaired, and stored in a maintenance and storage building. A laboratory building would provide space for analysis of sample monitoring swipes taken from the exterior of waste packages and equipment. A utilities building would house a boiler and refrigeration system, as well as pump equipment for maintaining proper water levels for an on-site water tank to support potable and sanitary water systems, fire protection systems, and dust suppression. A washdown pad would provide an area for cleaning vehicles and equipment.

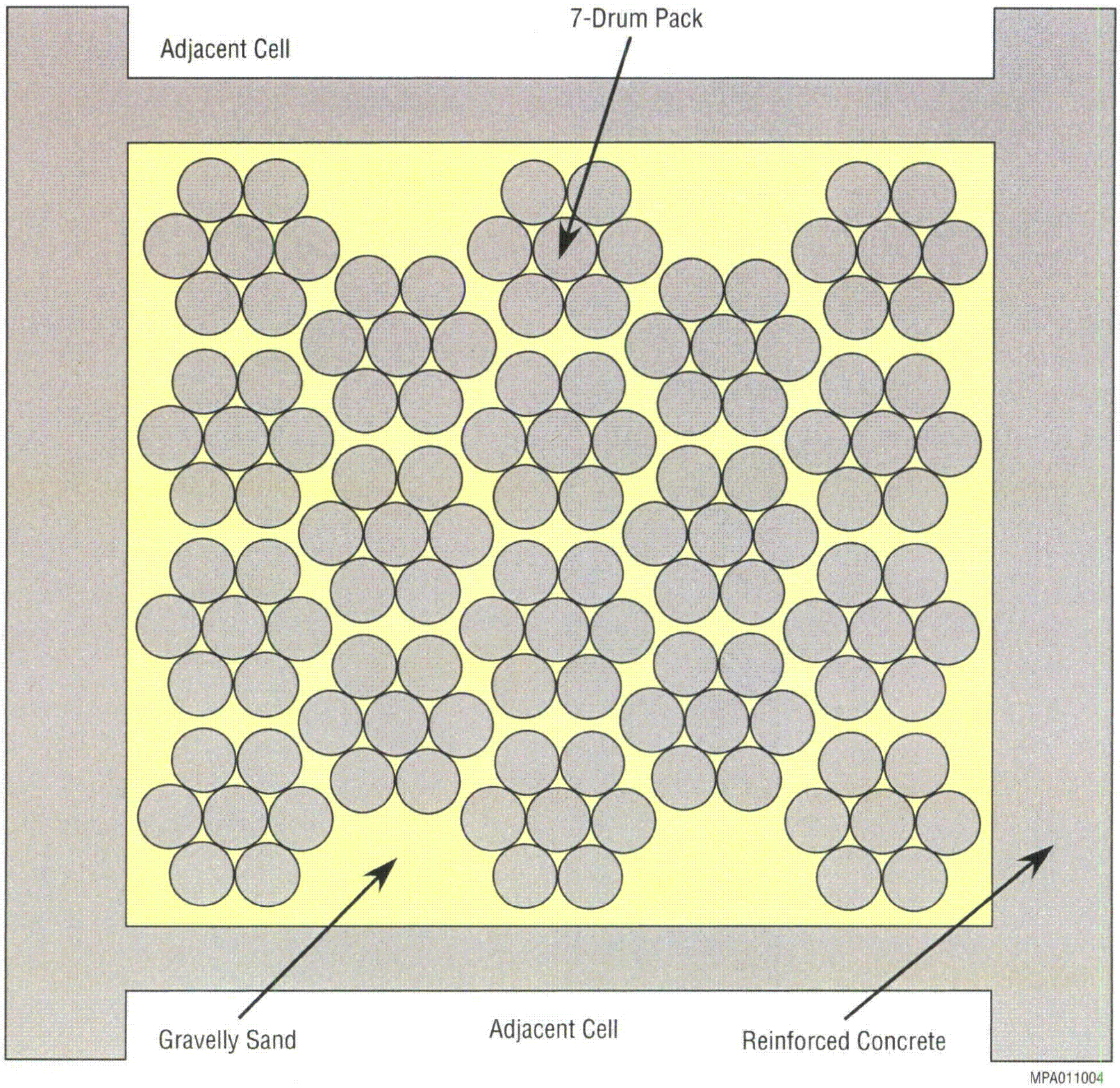

FIGURE D-9 Top View of a Single-Layer Packing Arrangement of Contact-Handled Waste in 208-L (55-gal) 7-Drum Packs in Vault Cells

D.4.1 Trench Disposal

Figure D-12 shows the layout of a conceptual enhanced near-surface trench waste disposal facility. It is estimated that approximately 29 trenches would be required for the disposal of the 12,000 m^3 (420,000 ft^3) of waste currently under consideration. Trenches would be spaced 30 m (100 ft) apart within a facility footprint of about 50 ac (20 ha) with dimensions of 550 × 330 m (1,800 × 1,100 ft) at the fence line.

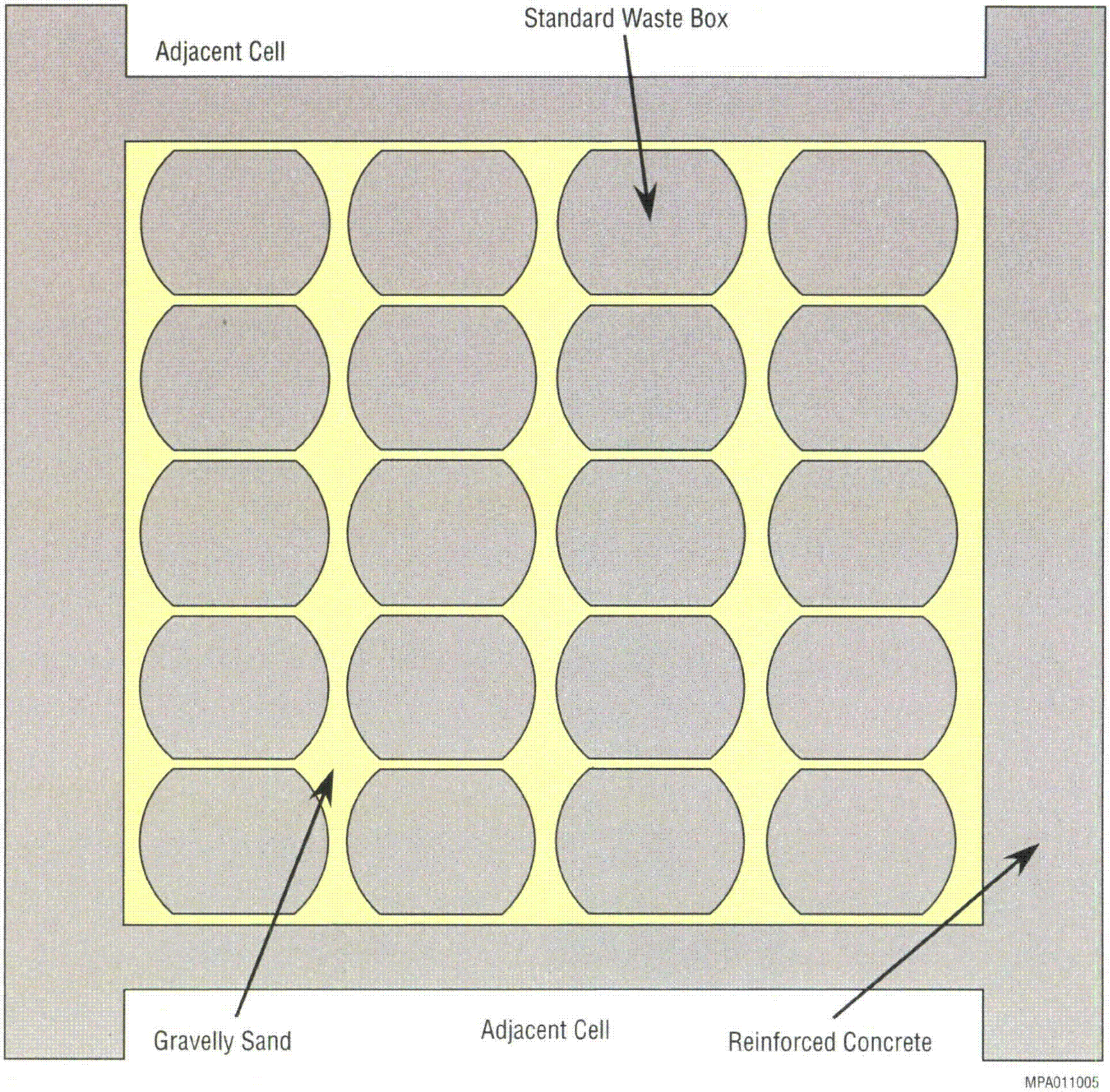

FIGURE D-10 Top View of a Single-Layer Packing Arrangement of Contact-Handled Waste in Standard Waste Boxes in Vault Cells

D.4.2 Borehole Disposal

Figure D-13 shows the layout of a conceptual intermediate-depth borehole waste disposal facility that covers about 110 acres (44 ha). It is estimated that approximately 930 40-m (130-ft) boreholes would be required for the disposal of the 12,000 m^3 (420,000 ft^3) of waste currently under consideration. Boreholes would be spaced 10 m (33 ft) apart on-center with a 30-m (98-ft) space between rows. The facility footprint dimensions would be about 510 × 870 m (1,700 × 2,800 ft) at the fence line.

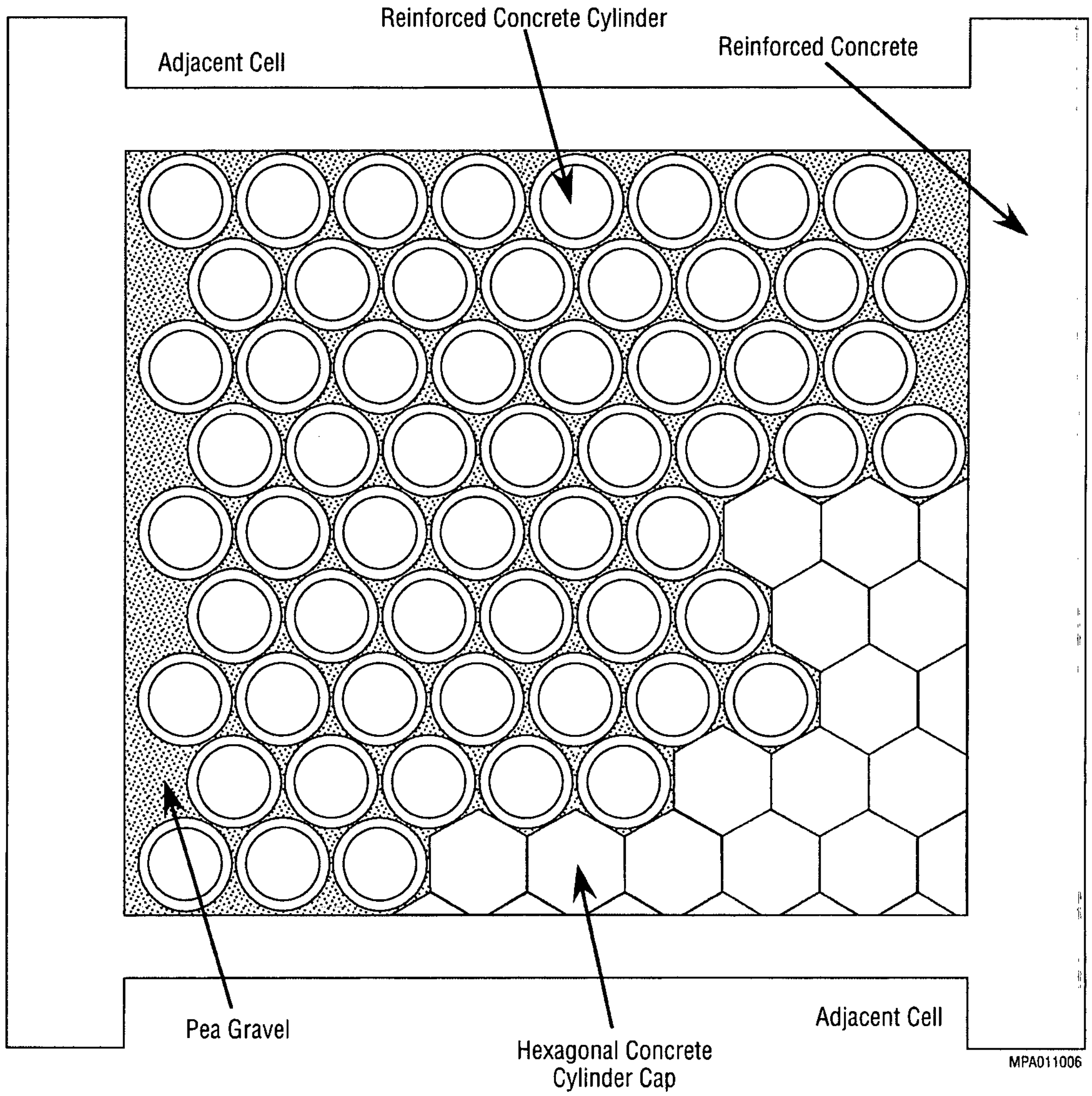

FIGURE D-11 Top View of a Vault Cell for Disposal of Remote-Handled Waste

D.4.3 Vault Disposal

The conceptual above-grade vault system design incorporates 12 vaults with a total land use requirement of about 60 ac (25 ha) within the outer perimeter fence, as shown by the layout of a conceptual facility presented in Figure D-14. Approximately 40 ac (16 ha) would be required for the 12 disposal vaults and their final cover system. The vaults would be spaced to (1) provide adequate room for the interim cover systems (2.1 ac or 0.8 ha each) to be emplaced as each vault was completely filled, (2) protect site workers, and (3) isolate the waste before decommissioning and emplacement of the final cover system prior to facility closure. The facility footprint dimensions would be about 420 × 610 m (1,400 × 2,000 ft) at the fence line.

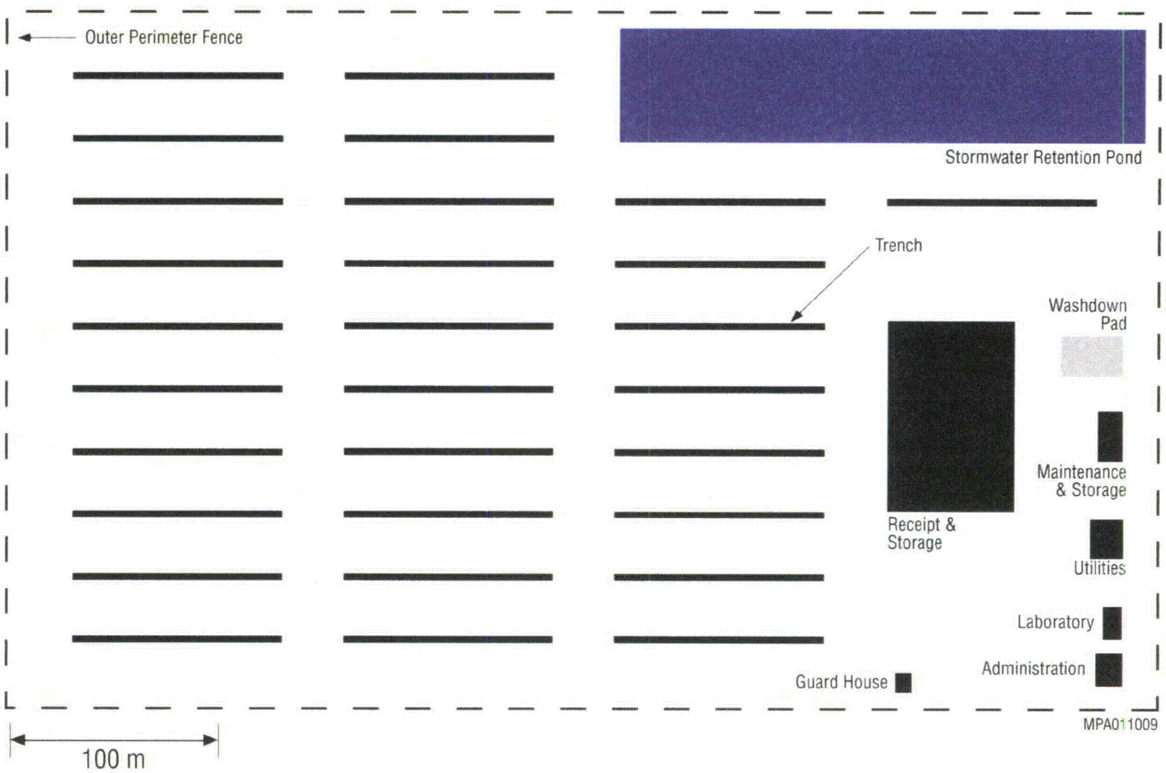

FIGURE D-12 Layout of a Conceptual Trench Disposal Facility

Ditches would separate the vaults with their interim cover systems to minimize standing water and provide site drainage. The conceptual design incorporates a retention pond that is 180 × 110 × 0.30 m (580 × 350 × 1 ft) to manage stormwater runoff. The proposed size of the pond might need to be modified on the basis of site-specific conditions, including precipitation.

D.5 STAFFING AND COST ESTIMATES

D.5.1 Construction

The construction labor force could be organized into five groups:

1. *Management, engineering, design, permitting (Home Office).* This group includes management, planning, engineering, and permitting personnel. Permitting includes licensing activities and National Environmental Policy Act (NEPA) documentation. This group is typically located at the contractors' home or regional office rather than in the field.

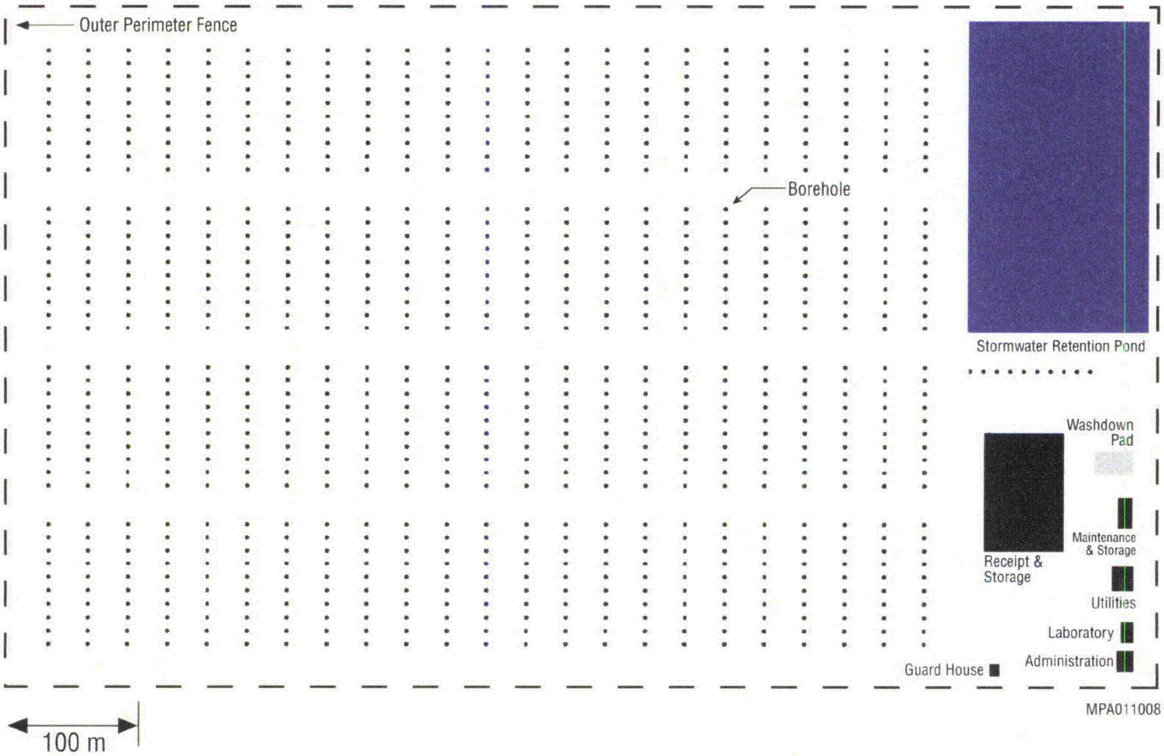

FIGURE D-13 Layout of a Conceptual Borehole Disposal Facility

2. *Management and supervision at the construction site (Field Office).* This group represents overall field management and supervision during actual construction and excavation. Personnel would be stationed in trailers initially. They would relocate to finished buildings (e.g., administration building) upon their completion. This group would remain at one relatively constant level for initial construction of the disposal facility and the initial disposal units. Other levels would be used for intermittent construction of the other disposal units and installation of the final cover system.

3. *Site preparation.* This group includes the surveyors, operating engineers, truck drivers, and laborers who would provide the initial construction entrance, temporary (gravel) roads, stormwater management, initial grubbing, installation of utility services, and associated activities. The level of effort for this group would be greatest during site preparation leading up to construction of the first disposal unit.

4. *Construction.* This group includes those who would be involved in building the trenches, boreholes, or vaults and constructing the support buildings.

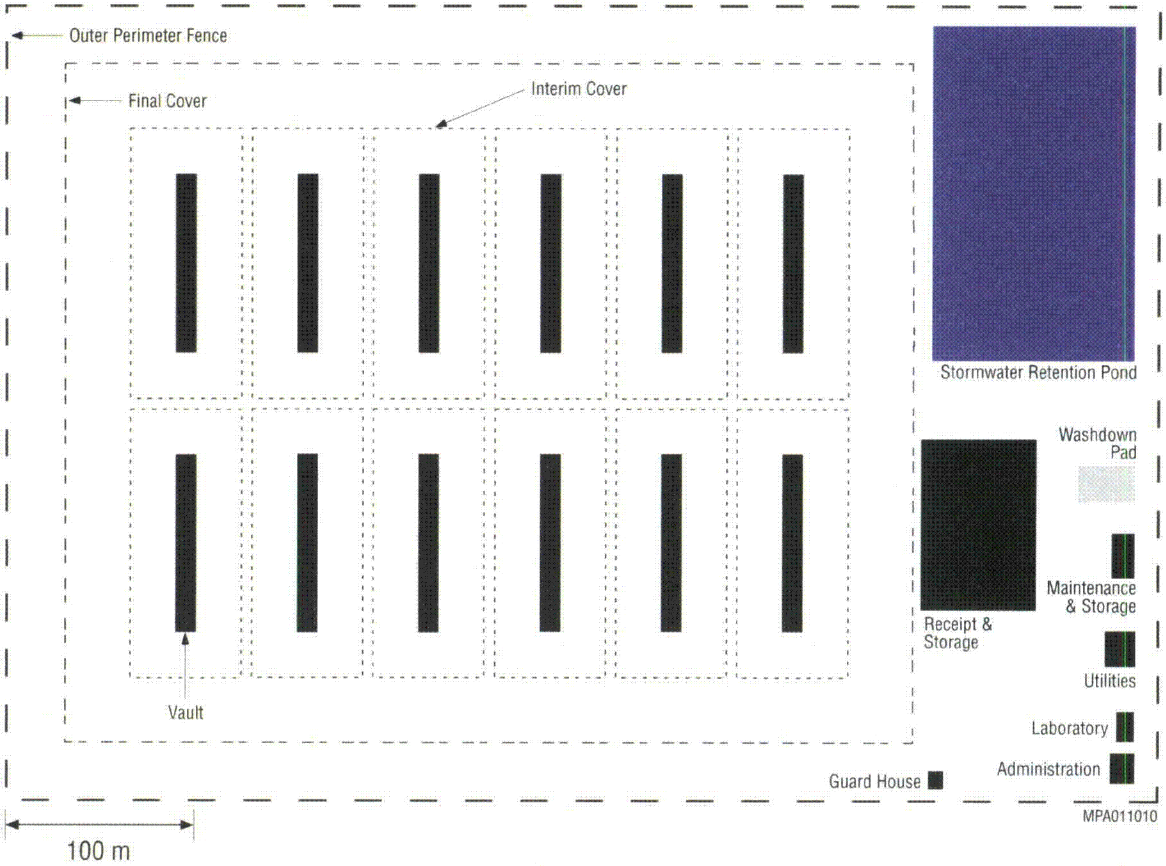

FIGURE D-14 Layout of a Conceptual Vault Disposal Facility

5. *Checkout and startup.* This group includes those involved in readiness assessments, final licensing and permitting activities, and training and certification of the operating staff.

Summaries of labor and cost estimates are provided in Tables D-1 through D-4 for construction of the disposal facility. All cost estimates are based on R.S. Means construction data (R.S. Means 2004, 2006).

D.5.2 Operations

D.5.2.1 Staffing-Level Methodology

To assure that trained personnel would be available at a stand-alone facility, the estimates presented here assume that a disposal facility would remain open on a continuous basis; that is, the facility would not open periodically to receive a short shipping campaign and then close again until a sufficient amount of waste required disposal. This continuous operation would

TABLE D-1 Estimated Person-Hours and Direct Costs Associated with the Construction of the Conceptual Disposal Facilities

Activity	Person-Hours	Material Cost ($)	Labor Cost ($)	S/C[a] Cost ($)	Total Cost ($)
Trench					
Geotechnical investigation	256	16,700	11,600	0	28,300
Shoring placement	1,790	264,000	80,400	0	345,000
Drilling deflector	1,070,000	9,400,000	33,100,000	0	42,500,000
Site prep	44,500	1,020,000	1,210,000	3,360,000	5,600,000
Earthwork grading	1,470	88,800	58,600	0	147,000
RH trenches	155,000	7,680,000	5,730,000	0	13,400,000
Trench closure	20,600	869,000	586,000	0	1,460,000
Support facilities	75,400	4,260,000	2,210,000	1,040,000	7,500,000
Total direct costs	1,370,000	23,600,000	43,000,000	4,400,000	71,000,000
Borehole					
Geotechnical investigation	256	16,700	11,600	0	28,300
Borehole	168,000	103,000,000	13,500,000	0	116,000,000
Drilling deflector	92,000	33,100,000	2,100,000	0	35,200,000
Site prep	81,500	1,620,000	2,220,000	1,320,000	5,170,000
Earthwork grading	3,650	220,000	146,000	0	366,000
Support facilities	88,700	5,120,000	2,530,000	1,090,000	8,740,000
Total direct costs	434,000	143,000,000	20,500,000	2,410,000	166,000,000
Vault					
Vault site preparation	69,800	13,700,000	1,910,000	1,660,000	17,300,000
Vault construction	3,570,000	60,800,000	180,000,000	800,000	241,000,000
Vault cap	307,000	12,700,000	8,650,000	0	21,400,000
Support facilities	114,000	4,870,000	3,330,000	1,480,000	9,690,000
Total direct costs	4,060,000	92,100,000	194,000,000	3,950,000	290,000,000

[a] S/C = subcontract.

TABLE D-2 Estimated Total Construction Full-Time Equivalents

	Staff (FTE-yr)		
Construction Phase	Trench	Borehole	Vault
Direct construction	686	217	2,029
Indirect construction (20% of above)	137	43	406
Total construction	824	260	2,434

TABLE D-3 Project Management Labor Staffing

Project Management Labor	Staff (FTE-yr)		
	Trench	Borehole	Vault
Program manager	1.5	0.5	5.6
Project manager	7.2	2.3	21.1
Program QA/QC manager	0.5	0.1	1.2
Construction manager	43.3	13.7	127.6
Project QA inspector	15.1	4.8	44.6
Health and safety officer	43.3	13.7	127.6
Administrative assistant	22.7	7.2	67.0
Accounting clerk	3.8	1.2	11.1

TABLE D-4 Total Estimated Construction Costs

Cost Summary	Cost ($)		
	Trench	Borehole	Vault
Subcontractor costs	71,000,000	166,000,000	290,000,000
Engineering and design fees	2,840,000	6,630,000	11,600,000
Other direct costs (ODC)	533,000	1,240,000	2,170,000
Subtotal ODC, design, and subcontracts	74,400,000	174,000,000	303,000,000
Markup (15%)	11,200,000	26,000,000	45,500,000
Project management labor costs	1,120,000	2,600,000	4,550,000
Estimated construction costs	86,700,000	202,000,000	354,000,000
Professional services contingency	989,000	2,310,000	4,040,000
Total cost[a]	88,000,000	210,000,000	360,000,000

[a] Total cost is rounded off to two significant figures.

ensure that the same trained personnel would be available to operate the facility and that institutional knowledge would not be lost. In addition, a minimum number of personnel would be necessary for proper operation of the facility, but that number would not scale linearly as the receipt rate increased. Thus, single-value cost estimates or full-time equivalent (FTE) values per shipment or unit volume of waste received are not used.

Coupled with the assumptions on waste receipt rates at the facility, the assumption that the disposal facility would operate on a continuous basis provides for conservative estimates of staffing levels and associated impacts. As discussed below, the number of staff members required to operate the facility is based on potential waste receipt rates in the years following the opening of the facility, which is the time when the majority of the waste would be emplaced. The remaining years of operation would likely require lower staffing levels. Depending on the actual schedules of when the waste could be delivered, the facility could operate on an interim-type basis. In such a case, a pool of trained workers would need to be available when required.

The number of personnel and their functions were estimated on the basis of the functions of the facility, waste volume receipt rates at the facility, and on-site movements of waste packages for final disposal. Details of the time-motion information (unit operations) used to determine the average number of workers required for operations are presented in Argonne (2010). The time period through 2035 was used to estimate the size of the workforce because the majority of the waste under consideration (approximately 75%) would be available for disposal by that time. The annual average receipt rate between 2019 and 2035 is estimated to be 570 truck shipments. As a conservative measure, this receipt rate was used to estimate impacts from operations for the entire period a disposal facility would be open, from 2019 to 2083.

D.5.2.2 Operational Data

Table D-5 provides information on the number and function of personnel required to operate the facility. Annual costs for labor, consumables, and equipment are provided in Tables D-6 through D-8 for trench, borehole, and vault disposal, respectively. More detailed supporting information on operating equipment costs can be found in Argonne (2010).

TABLE D-5 Detailed Worker Breakdown for Disposal Facility Operations[a]

	Number of FTEs		
Labor Category	Trench	Borehole	Vault
Officials and managers	1	1	1
Professionals	1.1	0.6	1.1
Technicians	8	5	8
Security	11	11	11
Craft workers (maintenance)	2	3	2
Office and clerical	6	6	6
Line supervisors	4	4	4
Operators	15	8	18
Total personnel	48	38	51

[a] Values are rounded to appropriate significant figure.

TABLE D-6 Annual Operating and Maintenance Costs for a Conceptual Trench Disposal Facility

Description	Quantity	Unit	Unit Cost ($)	Total Cost ($)
Consumables				
Diesel fuel	210,000	gal/yr	2.49	522,900
Electricity	1,160	MWh/yr	89.00	103,240
Water	1,100,000	gal/yr	0.002	2,498
Natural gas	11,200	Mcf/yr	12.00	134,400
Total consumables cost				763,038
Equipment				
Tractor trailers	3	Each	7,500.00	22,500
Emplacement cranes	1	Each	11,000.00	11,000
Forklift trucks	3	Each	1,500.00	4,500
Vibratory compactor	1	Each	8,500.00	8,500
End-loaders	1	Each	7,950.00	7,950
Pickup trucks	5	Each	1,100.00	5,500
Miscellaneous tools	1	Year	8,805.87	8,806
Maintenance allowance	1	Year	19,000.00	19,000
Total equipment cost				87,756
Labor				
Officials and managers	1.0	FTE	160,000.00	160,000
Professionals	1.1	FTE	130,000.00	142,544
Technicians	7.7	FTE	100,000.00	774,351
Security	10.7	FTE	100,000.00	1,066,611
Craft workers (maintenance)	2.4	FTE	100,000.00	237,500
Office and clerical	6.0	FTE	80,000.00	480,000
Line supervisors	4.0	FTE	100,000.00	400,014
Operators	15.2	FTE	100,000.00	1,523,673
Indirect costs (at 12%)				574,163
Total labor cost				5,358,856

Summary	Subtotal ($)	Contingency (%)	Contingency ($)	Total ($)
Consumables	763,038	40	305,215	1,068,254
Equipment	87,756	30	26,327	114,083
Labor	5,358,856	25	1,339,714	6,698,570
Total	6,209,651		1,671,256	7,880,907[a]

[a] Value rounded to $8 million as annual operating cost. Assuming 20 years of operation, the total cost to operate a trench disposal facility is assumed to be about $160 million.

TABLE D-7 Annual Operating and Maintenance Costs for a Conceptual Borehole Disposal Facility

Description	Quantity	Unit	Unit Cost ($)	Total Cost ($)
Consumables				
Diesel fuel	80,000	gal/yr	2.49	199,200
Electricity	970	MWh/yr	89.00	86,330
Water	410,000	gal/yr	0.002	931
Natural gas	11,200	Mcf/yr	12.00	134,400
Total consumables cost				420,861
Equipment				
Tractor trailers	3	Each	7,500.00	22,500
Emplacement cranes	1	Each	11,000.00	11,000
Fork lift trucks	3	Each	1,500.00	4,500
Vibratory compactor	1	Each	8,500.00	8,500
End-loaders	1	Each	7,950.00	7,950
Pick up trucks	4	Each	1,100.00	4,400
Miscellaneous tools	1	Year	5,133.60	5,134
Maintenance allowance	1	Year	19,000.00	19,000
Total equipment cost				82,984
Labor				
Officials and managers	1.0	FTE	160,000.00	160,000
Professionals	0.6	FTE	130,000.00	78,419
Technicians	5.5	FTE	100,000.00	545,135
Security	10.7	FTE	100,000.00	1,066,611
Craft workers (maintenance)	2.7	FTE	100,000.00	265,000
Office and clerical	6.0	FTE	80,000.00	480,000
Line supervisors	4.0	FTE	100,000.00	400,078
Operators	7.6	FTE	100,000.00	761,721
Indirect costs (at 12%)				450,836
Total labor cost				4,207,799

Summary	Subtotal ($)	Contingency (%)	Contingency ($)	Total ($)
Consumables	420,861	40	168,344	589,206
Equipment	82,984	30	24,895	107,879
Labor	4,207,799	25	1,051,950	5,259,748
Total	4,711,644		1,245,189	5,956,833[a]

[a] Value rounded to $6 million as annual operating cost. Assuming 20 years of operation, the total cost to operate a borehole disposal facility is assumed to be about $120 million.

TABLE D-8 Annual Operating and Maintenance Costs for a Conceptual Above-Grade Vault Facility

Description	Quantity	Unit	Unit Cost ($)	Total Cost ($)
Consumables				
Diesel fuel	210,000	gal/yr	2.49	522,900
Electricity	1,150	MWh/yr	89.00	102,350
Water	1,090,000	gal/yr	0.002	2,476
Natural gas	11,200	Mcf/yr	12.00	134,400
Total consumables cost				762,126
Equipment				
Tractor trailers	3	Each	7,500.00	22,500
Emplacement cranes	1	Each	11,000.00	11,000
Fork lift trucks	3	Each	1,500.00	4,500
Vibratory compactor	1	Each	8,500.00	8,500
End-loaders	1	Each	7,950.00	7,950
Pick up trucks	6	Each	1,100.00	6,600
Miscellaneous tools	1	Year	10,009.12	10,009
Maintenance allowance	1	Year	19,000.00	19,000
Total equipment cost				90,059
Labor				
Officials and managers	1.0	FTE	160,000.00	160,000
Professionals	1.1	FTE	130,000.00	141,606
Technicians	7.7	FTE	100,000.00	770,803
Security	10.7	FTE	100,000.00	1,066,611
Craft workers (maintenance)	2.3	FTE	100,000.00	225,000
Office and Clerical	6.0	FTE	80,000.00	480,000
Line supervisors	4.0	FTE	100,000.00	400,015
Operators	17.8	FTE	100,000.00	1,776,823
Indirect costs (at 12%)				602,503
Total labor cost				5,623,360

Summary	Subtotal ($)	Contingency (%)	Contingency ($)	Total ($)
Consumables	762,126	40	304,850	1,006,976
Equipment	90,059	30	27,018	117,077
Labor	5,623,360	25	1,405,840	7,029,201
Total	6,475,545		1,737,708	8,213,253[a]

[a] Value rounded to $8 million as annual operating cost. Assuming 20 years of operation, the total cost to operate a vault disposal facility is assumed to be about $160 million.

D.6 RESOURCE ESTIMATES

Resources needed for the construction and operations of a GTCC waste disposal facility can be divided into two classes: materials and utilities. Materials are the substances used to construct the disposal trenches, boreholes, or vaults and support buildings, such as sand, clay, gravel, and concrete. This category also includes the excavated materials. Utilities include electricity, natural gas or propane, water, and diesel fuel. Materials would be consumed primarily during construction activities. Utilities would be consumed during both construction and operations.

D.6.1 Construction

Table D-9 summarizes materials and resources consumed during construction of a GTCC waste disposal facility. The large amount of soil required for vault disposal is necessary for the final 5-m (16-ft) cover depth. More detailed supporting information on resources required for construction can be found in Argonne (2010).

D.6.2 Operations

Operational activities would include receiving the packages of waste, inspecting them, possibly storing them temporarily, possibly reconfiguring them for disposal (e.g., bundling RH canisters into 3-packs for borehole disposal), transporting the waste containers to the disposal cells, and emplacing them. To some extent, construction activities and operational activities would be concurrent. For example, one or more trenches, boreholes, or vaults would be being filled while others were being constructed. Once all the GTCC LLRW and GTCC-like waste had been emplaced and the facility had undergone closure, a period of institutional control would follow. An institutional control program would include physical control of access to the site, an environmental monitoring program, periodic surveillance, and custodial care. The use of utilities would be much greater during the operational period than the institutional control period, so utility use during the institutional control period is not considered here.

D.6.2.1 Materials

The only major consumable materials used during operations would be pallets for potential bundling operations, sand for backfill, and chemicals used to treat the water used on-site, as shown in Table D-10.

D.6.2.2 Utilities

The utilities required for operations are summarized in Table D-11 and D-12. Water and sewage usage are based on the staffing requirements discussed in Section D.5.2.1. Gas, oil, and electricity would be consumed primarily to keep the facility buildings operational, with minor

TABLE D-9 Estimates of the Materials and Resources Consumed during Construction of the Conceptual Disposal Facilities

Construction Materials and Resources	Total Consumption		
	Trench	Borehole	Vault
Utilities			
Water (gal)[a]	5,300,000	2,800,000	17,100,000
Electricity (MWh)[b,c]	34,200	10,800	101,000
Solids[c]			
Concrete (yd^3)	25,600	18,600	88,200
Steel (tons)	2,000	1,400	7,960
Gravel (yd^3)	36,100	25,300	156,400
Sand (yd^3)	3,600	27,900	198,300
Clay (yd^3)	12,900	5,180	56,000
Soil (off-site) (yd^3)	–[d]	–	254,000
Liquids			
Diesel fuel (gal)[b]	750,000	2,030,000	3,380,000
Oil and grease (gal)	18,000	48,000	86,000
Gases			
Industrial gases (propane) (gal)[b]	5,400	4,300	13,600

[a] Water requirement estimates are based on DOE (1997), in which each FTE requires 20 gal/d, and cementation requires 26.1 lb of water per 100 lb of cement.

[b] Scaling methodology is based on LLNL (1997).

[c] Peak demand is 1.71, 0.54, or 5.05 MWh for the trench, borehole, and vault disposal facilities, respectively.

[d] Dash means not applicable.

amounts of electricity required to operate the overhead cranes during unloading. More information on utility demand can be found in Argonne (2010).

D.7 FACILITY EMISSIONS AND WASTES

D.7.1 Construction

Wastes generated during construction of the disposal facility would be typical of large construction projects. Wastes would consist primarily of construction debris, including concrete fragments, and sanitary wastes generated by the labor force. Emissions would result primarily from the use of fuels in constructing the facility, removing construction debris, and disturbing the

TABLE D-10 Materials Consumed Annually during Operations[a]

	Quantity (lb/yr)		
Material and Chemical[b]	Trench	Borehole	Vault
Sand	2.59E+05	5.20E+04	9.80E+03
Standard pallet (trench = 48-in. × 48-in. × 7.5-in. tall, borehole = steel pallet)	140	5.84E+05	–
Hydrochloric acid (37% HCl)	277	103	275
Sodium hydroxide (50% NaOH)	227	85	225
Sodium hypochlorite	107	40	106
Copolymers	150	56	149
Phosphates	17	6	17
Phosphonates	16	6	15

[a] See Kemmer (1988) for water treatment.

[b] The chemicals are used to treat the raw water used during waste operations.

[c] Dash means not applicable.

TABLE D-11 Average-Day Utility Consumption during Disposal Operations

	Average-Day Consumption		
Utility[a]	Trench	Borehole	Vault
Potable water (USG/d)	1,300	1,000	1,300
Raw water (USG/d)[b]	4,600	1,700	4,500
Sanitary sewer (USG/d)	1,300	1,000	1,300
Natural gas (Mcf/d)	47	47	47
Diesel fuel (USG/d)	900	300	900
Electricity (MWh)[c]	4.8	4.0	4.8

[a] USG/d = U.S. gallons per day, Mcf = million cubic feet.

[b] Includes potable water and water used in truck washdown. Estimate assumes that on average, 605 gal are used to wash down the truck that transports the GTCC waste. The estimate is based on Table 6-1 in EPA (2001).

[c] Peak-day demand is 0.5, 0.5, and 0.5 MWh for the trench, borehole, and vault disposal facilities, respectively.

TABLE D-12 Annual Utility Consumption during Disposal Operations

	Annual Consumption[b]		
Utility[a]	Trench	Borehole	Vault
Potable water (USG/yr)	310,000	240,000	310,000
Raw water (USG/yr)[b,c]	1,100,000	410,000	1,090,000
Sanitary sewer (USG/yr)	310,000	240,000	320,000
Natural gas (Mcf/yr)	11,200	11,200	11,200
Diesel fuel (USG/yr)	210,000	80,000	210,000
Electricity (MWh)	1,160	970	1,150

[a] USG/yr = U.S. gallons per year, Mcf = million cubic feet.

[b] Based on 240 operations-days per year.

[c] Includes potable water and water used in truck washdown. Estimate assumes that, on average, 605 gal (2,300 L) are used to wash down the truck that transports the GTCC waste. The estimate is based on Table 6-1 in EPA (2001).

land (fugitive dust). The amount of concrete waste was estimated on the basis of the assumption that 0.65% of the concrete usage would be spoilage. The other solid wastes, which would include construction debris and rock cuttings, were taken to be eight times the volume of the concrete spoilage. Steel waste was taken to be 0.5% of the steel requirements. These solid nonhazardous wastes would be disposed of in a municipal solid waste landfill. The amount of sanitary waste was estimated on the basis of the total construction workforce. Liquid (sanitary) nonhazardous wastes would be treated in a portable system or hauled off-site for treatment and disposal. Table D-13 summarizes the amount of waste that would be generated during construction.

Estimates of criteria pollutant emissions generated during construction were based on the estimated amounts of fuel used by the trucks, cranes, and other heavy equipment during construction. Standard U.S. Environmental Protection Agency (EPA) emission factors from the WebFire database (http://cfpub.epa.gov/oarweb/index.cfm?action=fire.main) were used in these calculations. Emissions were calculated from the total quantity of diesel fuel consumed. Dust was estimated from the amount of disturbed land area and the length of time that the disturbed area would be under construction. National Ambient Air Quality Standards (NAAQS) for criteria air pollutants are given in Table D-14. Estimates of construction emissions are given in Table D-15 for the disposal facilities. The initial construction period was assumed to be 3.4 years (824 days for site preparation and construction of support facilities at 240 working days per year). Although disposal unit construction might span more than 60 years because it is assumed that the disposal units would be constructed as the waste became available for disposal, a total of 20 years of actual time for construction operations was assumed, which corresponds to the period when most of the GTCC waste is expected to be received for disposal. Emissions of the following criteria air pollutants were estimated: sulfur oxides (SO_X) as sulfur dioxide (SO_2), nitrogen oxides (NO_X) as nitrogen dioxide (NO_2), carbon monoxide (CO), particulate matter with

TABLE D-13 Total Wastes Generated during Construction

Waste Generation by Category	Trench	Borehole	Vault
Hazardous solids (yd^3)	57	18	168
Hazardous liquids (gal)	23,000	7,300	68,000
Nonhazardous solids (yd^3)[a]	62,000	300,000	5,200
Nonhazardous liquids (gal)[b]	4,800,000	1,500,000	14,000,000

[a] Includes concrete and other excavated materials. Excavated materials (if clean) could be used as backfill during operations and would reduce the volume that could be considered as waste.

[b] Includes sanitary and other nonhazardous liquids.

TABLE D-14 National Ambient Air Quality Standards (NAAQS) for Criteria Air Pollutants

Criteria Air Pollutant	Averaging Time	Primary Standard
CO	1 hour	40 mg/m^3
	8 hours	10 mg/m^3
Hydrocarbons	3 hours	160 $\mu g/m^3$
NO_x (as NO_2)	Annual	100 $\mu g/m^3$
SO_x (as SO_2)	24-hours[a]	365 $\mu g/m^3$
	Annual	80 $\mu g/m^3$
PM_{10}	24 hours	150 $\mu g/m^3$
$PM_{2.5}$	24 hours	35 $\mu g/m^3$
	Annual	15 $\mu g/m^3$

[a] Not to be exceeded more than once a year.

Source: 40 CFR Part 50.0 et seq.

TABLE D-15 Estimated Air Emissions during Construction[a]

	Total Emissions (tons)			Peak-Year Emissions (tons/yr)		
Criteria Pollutant[b]	Trench	Borehole	Vault	Trench	Borehole	Vault
VOCs[b]	13	31	62	0.9	2.7	3.6
NO_x	110	270	540	8.1	26	31
SO_2	12	32	53	0.9	3.0	3.2
CO	39	110	190	3.3	11	11
PM_{10}[c]	25	60	65	5.0	13	8.6
$PM_{2.5}$[d]	12	30	44	1.5	4.1	3.6
CO_2	8,400	29,000	38,000	670	2,200	2,300

[a] Excludes delivery and commuter vehicles.

[b] VOCs = volatile organic compounds.

[c] Assumes construction emission factor for fugitive dust PM_{10} of 0.22 tons/acre-month (average conditions) (URBEMIS2007 2007).

[d] Assumes 21% of fugitive dust PM_{10} is $PM_{2.5}$ and that 89% of combustion PM_{10} is $PM_{2.5}$ (www.aqmd.gov/CEQA/handbook/PM2_5/handout1.doc).

a diameter of less than or equal to 10 micrometers (PM_{10}), and particulate matter with a diameter of less than or equal to 2.5 micrometers ($PM_{2.5}$). The construction equipment fuel use, emission factors, and other supporting information can be found in Argonne (2010).

D.7.2 Operations

Data on annual facility wastes are provided in Table D-16. Data on emissions from fixed facility sources and from mobile sources are provided in Tables D-17 and D-18, respectively. A fixed facility source would be the process steam boiler used for space and water heating and periodic testing of backup diesel generators for electrical power. Mobile emission sources would include tractor trailers, end-loaders, cranes, and forklifts.

D.8 TRANSPORTATION

D.8.1 Construction

Local transportation of workers and materials could lead to significant amounts of vehicle emissions that could affect the local air quality. Large volumes of materials, especially sand and backfill, would be required for the construction of the GTCC waste disposal facility. Approximately 9,200, 36,600, or 74,200 truck shipments for trench, borehole, or vault disposal,

TABLE D-16 Annual Wastes during Operations

Waste Category	Treatability Category	Average Annual Generation Rate: Trench	Borehole	Vault
Radioactive waste				
Liquid LLRW (water from truck washdown[a]) (gal)	Liquid LLRW	790,000	170,000	780,000
Solid LLRW (including HEPA filters[b]) (yd^3)	Combustible and noncombustible solid LLRW	16	10	16
Nonradioactive waste				
Liquid nonhazardous (sanitary) wastes (gal)	NA[c]	310,100	240,000	320,000
Solid nonhazardous wastes[d] (yd^3)	NA	120	95	120

[a] The water used to wash down the truck after it delivered the GTCC waste to the disposal facility could be contaminated (but that is not likely). This analysis conservatively assumes that the washdown water would be considered liquid LLRW until determined otherwise.

[b] HEPA = high-efficiency particulate air.

[c] NA = not applicable.

[d] Solid nonhazardous wastes include domestic trash and office waste.

TABLE D-17 Estimated Annual Emissions of Criteria Pollutants from Fixed Facility Emission Sources

Criteria Pollutant	Mission-Critical Equipment Emissions (tons/yr): Trench	Borehole	Vault	Process Steam Boiler Emissions (tons/yr): Trench	Borehole	Vault
SO_2	3.57E-02	3.57E-02	3.57E-02	3.4E-03	3.4E-03	3.4E-03
NO_x	5.44E-01	5.44E-01	5.44E-01	2.8E-01	2.8E-01	2.8E-01
CO	1.17E-01	1.17E-01	1.17E-01	4.7E-01	4.7E-01	4.7E-01
PM_{10}	1.26E-02	1.26E-02	1.26E-02	4.3E-02	4.3E-02	4.3E-02
$PM_{2.5}$	1.26E-02	1.26E-02	1.26E-02	4.3E-02	4.3E-02	4.3E-02
CO_2	2.03E+01	2.03E+01	2.03E+01	6.7E+02	6.7E+02	6.7E+02

TABLE D-18 Estimated Annual Emissions of Criteria Pollutants from Mobile Sources[a]

Criteria Pollutant	Mobile Equipment Emissions (tons/yr) Trench	Borehole	Vault
SO_2	3.23E+00	1.20E+00	3.27E+00
NO_x	2.58E+01	9.06E+00	2.59E+01
CO	1.25E+01	4.63E+00	1.26E+01
PM_{10}	2.38E+00	8.46E-01	2.39E+00
$PM_{2.5}$	2.12E+00	7.53E-01	2.12E+00
CO_2	2.34E+03	8.73E+02	2.37E+03

[a] Mobile emission sources include forklifts and mobile cranes.

respectively, would be required, as summarized in Table D-19. Estimated emissions from these shipments are provided in Table D-20. The emission factors used in the calculations are given in Table D-21. Additional vehicles required for worker intrasite transportation would also result in some emissions during construction, as shown in Table D-20, which also provides estimates for emissions as a result of worker commuter trips.

D.8.2 Operations

Estimated emissions for local transportation of disposal site workers (i.e., daily commutes) are provided in Table D-22.

D.9 WASTE ISOLATION PILOT PLANT

The primary source of information for estimating the impacts of disposing of the GTCC LLRW and the GTCC-like waste at the Waste Isolation Pilot Plan (WIPP) (Alternative 2) is Sandia (2008b). The following text provides supplemental information for estimating the incremental air emissions during construction of the additional underground rooms required to emplace the waste and during disposal operations.

D.9.1 Construction

Emissions from construction of the underground rooms would result from underground haul trucks taking the mined salt to the waste hoist and surface haul trucks taking the mined salt from the waste hoist to the Salt Storage Area. The miner itself is powered by electricity and thus

TABLE D-19 Rough Order-of-Magnitude Estimate of the Number of Truck Shipments of Construction Materials[a]

		Total Consumption			No. of Truck Shipments		
Resource	Truck Capacity	Trench	Borehole	Vault	Trench	Borehole	Vault
Portland cement (yd^3)[b]	10	2,816	2,046	9,702	282	205	971
Gravel (yd^3)[b]	10	46,596	32,926	192,562	4,660	3,293	19,257
Sand (yd^3)[b]	10	10,256	32,736	221,232	1,026	3,274	22,124
Clay (yd^3)	10	12,900	5,180	56,000	1,290	518	5,600
Steel (tons)[c]	21	2,000	1,400	7,960	96	67	380
Asphalt paving (tons)[d]	20	600	900	700	30	45	35
Backfill (yd^3)[e]	10	–	–	254,000	–	–	25,400
Diesel fuel (gal)[f]	9,000	7.5E+05	2.0E+06	3.4E+06	84	226	376
Excavated materials	10	62,000	294,400	–	6,200	29,440	–
Total (rounded up)					13,700	37,100	74,200

a Calculation neglects truck deliveries of process equipment and related items (which should be low in comparison with other shipments). A dash means not applicable.

b Assumes that concrete is composed of 11% Portland cement, 41% gravel, and 26% sand and is shipped to the site in a standard 10-yd^3 (7.6-m^3) end-dump truck.

c Assumes that the net payload for steel transport to site is 42,000 lb (19,000 kg).

d Assumes hot mix asphalt is loaded into the 20-ton-capacity tri-axle trucks for transport to the paving site.

e Assumes that shipment uses standard 10-yd^3 (7.6-m^3) end-dump trucks.

f Assumes that shipment uses a U.S. Department of Transportation (DOT) 406/MC-306 atmospheric-pressure tank truck with a 9,000-gal (34,000-L) capacity.

TABLE D-20 Estimated Annual Emissions from Construction Vehicles[a]

Criteria Pollutant	Delivery Vehicle Emissions (tons)[b]			Support Vehicle Emissions (tons)[c]			Worker Commuter Vehicle Emissions (tons)[d]		
	Trench	Borehole	Vault	Trench	Borehole	Vault	Trench	Borehole	Vault
SO_x	1.09E-04	2.96E-04	5.92E-04	1.66E-04	5.35E-05	4.87E-04	2.62E-03	8.26E-04	7.73E-03
NO_x	6.85E-03	1.86E-02	3.71E-02	1.04E-02	3.36E-03	3.06E-02	6.15E-02	1.94E-02	1.82E-01
CO	2.62E-02	7.09E-02	1.42E-01	3.99E-02	1.28E-02	1.17E-01	1.63E+00	5.16E-01	4.82E+00
PM_{10}	1.43E-03	3.88E-03	7.77E-03	2.19E-03	7.02E-04	6.40E-03	1.26E-02	3.99E-03	3.74E-02
$PM_{2.5}$	7.63E-04	2.07E-03	4.13E-03	1.16E-03	3.74E-04	3.41E-03	6.10E-03	1.93E-03	1.80E-02
VOCs	4.28E-03	1.16E-02	2.32E-02	6.52E-03	2.10E-03	1.91E-02	7.85E-02	2.48E-02	2.32E-01
CO_2	1.59E+01	4.29E+01	8.59E+01	2.42E+01	7.77E+00	7.08E+01	1.66E+02	5.23E+01	4.89E+02

[a] Assumes a construction period of 20 years.

[b] Estimates of 13,700, 37,100, and 74,200 auto one-way trips to the construction site are based on the total number of deliveries for trench, borehole, or vault construction, respectively. One-way trip distance of 20 mi (32 km) is based on DOE (1997). Emissions are based on round-trip distances.

[c] Assumes one support vehicle per 30 construction workers (824, 260, or 2,434 FTEs assumed for trench, borehole, or vault construction, respectively), as taken from LLNL (1997) and NRC (1994). Assumes that 10 mi (16 km) are travelled per day per vehicle, as taken from Table 4.5 on page 4-15 of NRC (1994).

[d] Estimates of 9,885, 3,123, and 29,212 auto one-way trips to the construction site are based on the total construction personpower for trench, borehole, or vault facility construction, respectively. Assumes 240 workdays per year. One-way trip distance of 20 mi (32 km) is based on DOE (1997). Emissions are based on round-trip distance.

TABLE D-21 Criteria Pollutant Vehicle Emission Factors

	Emission Factor (g/mi)[a]		
Criteria Pollutant	Delivery Vehicle	Support Vehicle	Commuter Vehicle
SO_x	0.00225	0.00225	0.006
NO_x	0.141	0.141	0.141
CO	0.539	0.539	3.745
PM_{10}	0.0295	0.0295	0.029
$PM_{2.5}$	0.0157	0.0157	0.014
VOCs	0.0880	0.0880	0.18
CO_2	326	326	380

[a] Emission factors were determined by using Argonne GREET 2.8a Version (version date: August 30, 2007) available at http://www.transportation.anl.gov/ software/GREET/greet_2-8a_beta.html.

TABLE D-22 Estimated Annual Emissions from Commuter Vehicles

Criteria Pollutant	Commuter Vehicle Emissions (tons/yr)[a]		
	Trench	Borehole	Vault
SO_x	3.1E-03	2.4E-03	3.2E-03
NO_x	7.2E-02	5.7E-02	7.5E-02
CO	1.9E+00	1.5E+00	2.0E+00
PM_{10}	1.5E-02	1.2E-02	1.5E-02
$PM_{2.5}$	7.1E-03	5.6E-03	7.5E-03
VOCs	9.2E-02	7.2E-02	9.6E-02
CO_2	1.9E+02	1.5E+02	2.0E+02

[a] Estimates of 11,548, 9,117, and 12,116 one-way auto trips to the disposal facility are based on the total operational personpower for trench, borehole, or vault facility construction, respectively. Assumes 240 workdays per year. One-way trip distance of 20 mi (32 km) is based on DOE (1997). Emissions are based on round-trip distance.

would not produce any direct emissions. The assumed construction period for the additional 26 rooms is 20 years. The estimated annual emissions, based on 23,700 tons of salt mined per room (Sandia 2008b), are shown in Table D-23 for the criteria pollutants. Estimates are based on the fuel consumption of the haul trucks given in Table D-24 and the vehicle emission factors provided in Table D-25.

TABLE D-23 Air Emissions during Construction at WIPP

Criteria Pollutant	Total Emissions (tons)	Annual Emissions (tons/yr)
VOCs	2.9	0.14
NO_x	28.7	1.4
SO_2	4.7	0.23
CO	19.4	0.97
PM_{10}[b]	36.5	1.8
$PM_{2.5}$[c]	28.1	1.4
CO_2	3,734	186.7

[a] Calculated by using EPA methodology for coal mining (http://www.epa.gov/ttn/chief/ap42/ch11/final/c11s09.pdf).

[b] Assumes 89% of combustion PM_{10} is $PM_{2.5}$ (www.aqmd.gov/CEQA/handbook/PM2_5/handout1.doc).

D.9.2 Operations

The estimated emissions from operations at WIPP to dispose of the GTCC LLRW and GTCC-like waste would result from the equipment that moves disposal packages underground. For CH waste, a waste transporter moves the package from the waste hoist to a disposal room, where a 20-ton forklift subsequently moves the waste to its emplacement location. For RH waste, it is assumed that a 41-ton forklift would move the disposal package from the hoist to its emplacement location (Sandia 2008b). Table D-26 summarizes the effort involved on an annual basis.

From Table D-26, the average annual hours of operation for each piece of equipment were estimated: 539, 941, and 1,432 hours, respectively, for the 20-ton forklift, the waste transporter, and the 41-ton forklift. The annual average emissions were then estimated by using the emission factors given in Table D-27, as shown in Table D-28.

TABLE D-24 Annual Diesel Fuel Use for Construction of the Additional Disposal Rooms at WIPP

Type of Haul Truck	Diesel Fuel Use per Room (gal)[a]	Duration per Room (h)[a]	No. of Rooms per Year[b]	Duration per Year (h)	Diesel Fuel Use per Year (gal)
185-hp underground	11,440	1,082.2	1.3	1,407	14,872
Surface	3,160	105.3	1.3	137	4,108

[a] Source: Sandia (2008).

[b] Assumes 20-year period to construct the 26 additional rooms required for GTCC LLRW and GTCC-like waste.

TABLE D-25 Construction Equipment Fuel Consumption and Emission Factors

	Consumables (gal/h)		Emission Factor (lb/1,000 gal)					
Type of Haul Truck	Diesel Fuel	Oil and Grease	VOCs	NO_x	SO_2	CO	PM_{10}[a]	CO_2
185-hp underground	10.6	0.2	17.1	171.7	31.2	123.5	16.8	22,600.0
Surface	30.0	0.2	0.2	2.3	0.0	0.8	0.1	272.3

[a] These emission factors are for combustion-derived PM_{10} emissions and do not include the fugitive dust component.

TABLE D-26 Annual Equipment Usage for Disposal of Waste at WIPP

Equipment	Horsepower Rating[a]	Time per Disposal Package (min)[a]	Estimated Diesel Usage (gal)[a]	Average No. of Disposal Packages/yr[b]	Average Diesel Usage (gal/yr)
20-ton forklift (diesel)	94	10	0.9	3,230	2,910
Waste transporter (diesel)	138	20	2.6	2,820	7,340
41-ton forklift (diesel) – RH	231	60	13.2	1,430	18,900
Total					29,200

[a] Source: Sandia (2008b).

[b] Average estimated for operations is based on the assumption that the majority of the waste disposed of annually at WIPP is composed of GTCC LLRW and GTCC-like waste.

TABLE D-27 Equipment Emission Factors

Criteria Air Pollutant	Emission Factor (lb/horsepower per hour) 20-ton Forklift	41-ton Forklift	Waste Transporter
SO_2	1.87E-03	1.87E-03	1.87E-03
NO_x	1.15E-02	9.92E-03	9.92E-03
CO	2.20E-03	2.20E-03	2.20E-03
PM_{10}	1.59E-03	8.82E-04	8.82E-04
$PM_{2.5}$	1.41E-03	7.85E-04	7.85E-04
VOCs	8.82E-04	8.82E-04	8.82E-04
CO_2	1.15E+00	1.15E+00	1.15E+00

Source: www.aqmd.gov/CEQA/documents/2005/nonaqmd/chevron/appB.xls.

TABLE D-28 Estimated Average Annual Emissions of Criteria Pollutants from GTCC LLRW and GTCC-Like Waste Emplacement at WIPP

Criteria Air Pollutant	Annual Average Emissions (tons/yr)
SO_2	4.8E-01
NO_x	2.6E+00
CO	5.6E-01
PM_{10}	2.4E-01
$PM_{2.5}$	2.2E-01
VOCs	2.3E-01
CO_2	2.9E+02

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APPENDIX E:

EVALUATION OF LONG-TERM HUMAN HEALTH IMPACTS FOR THE NO ACTION ALTERNATIVE AND THE LAND DISPOSAL ALTERNATIVES

This appendix presents the approach used to evaluate the long-term impacts on human health that could result from the No Action Alternative in Chapter 3 and the land disposal alternatives (via the borehole, trench, or vault disposal methods) in Chapters 6 through 12 considered in the Greater-Than-Class C (GTCC) Environmental Impact Statement (EIS). The approach used to evaluate long-term impacts on human health from use of the Waste Isolation Pilot Plant (WIPP) deep geologic repository is presented in Chapter 4. The RESRAD-OFFSITE computer code (Yu et al. 2007), with site-specific parameters to the extent that this information was available, was used to perform the analyses for the three land disposal methods at the six federal and four generic commercial sites. This computer code was also used to evaluate the long-term human health impacts for the No Action Alternative. The information given in this appendix summarizes the approach and results described in Argonne (2010). A number of simplifying assumptions are made for the purposes of the comparative analysis in this EIS, especially in terms of the long-term performance of engineered materials assumed for the borehole, trench, and vault disposal facilities. It is expected that detailed, site-specific assessments that would include more specific calculations on the physical and chemical performance of different engineered materials would be made before implementation of any alternative.

For the No Action Alternative, it is assumed that the long-term human health impacts would be limited to members of the general public who might be exposed to GTCC wastes stored in facilities located within the four NRC regions. For the land disposal alternatives, it is assumed that the long-term human health impacts would be limited to members of the general public who might be exposed to radioactive contaminants released from the waste packages after the engineering barriers (including the cover) and waste containers failed. Direct intrusion into the waste disposal units is considered to be a very unlikely event and is not addressed in this appendix; this issue is addressed in Section 5.5. A number of markers and barriers would be placed on, in, and near the closed disposal facility to prevent intrusion into the buried wastes. The impacts from direct intrusion into the disposal facility are therefore addressed qualitatively in the EIS.

There are three release mechanisms considered in RESRAD-OFFSITE that can lead to contamination at off-site locations: airborne releases, surface runoff, and leaching (see Section E.1). However, only two of these mechanisms are considered significant and applicable to storage or disposal of GTCC wastes in the long term: (1) airborne releases and (2) leaching of radioactive contaminants from the waste containers or packages, with transport to groundwater and migration to an accessible location, such as a groundwater well. These two mechanisms are addressed in this EIS to determine the impacts on off-site members of the general public following closure of the storage or disposal facility. Surface runoff is not considered to be a viable pathway, given the depth of the disposal facility cover and use of good engineering practices during closure of the disposal facility, which would include measures to minimize erosion by surface water.

Airborne releases could include gases (e.g., radon, carbon dioxide [CO_2], and water vapor containing tritium [H-3]) and particulates if the disposal facility cover was completely lost through erosion. Particulate radionuclide emissions are not expected to be significant, because it is very unlikely that the thick disposal facility cover would be completely lost through erosion. In addition, any material removed from the facility surface cover by erosion or weathering could be replaced to some extent by nearby soil similarly removed. Potential radiation doses to individuals from gaseous releases are expected to be small because the gases would have to diffuse through the thick covers placed on top of the waste disposal units.

Standard engineering practices and measures would be taken in designing and constructing the disposal facility to ensure long-term stability and to minimize the likelihood of contaminant migration from the wastes to the surrounding environment. The facility would be sited in a location consistent with applicable requirements, which would include the consideration of geologic characteristics, to minimize events that could compromise the containment characteristics of the disposal facilities in the long term. It is expected that the use of engineering controls in concert with the natural features of the selected site would ensure the long-term viability of this facility.

The groundwater pathway is generally the pathway of most concern with regard to addressing the post-closure impacts on the general public from a disposal facility for GTCC LLRW and GTCC-like wastes, and this pathway is the focus of this appendix. Releases to surface water would only occur once the entire engineered cover over the disposed wastes had eroded away. Because of the thick cover layer and the use of very robust engineering techniques to construct it, it was assumed for the analyses in the EIS that the buried GTCC wastes would always be overlain by some cover material through 10,000 years, eliminating surface water runoff as a potential exposure mechanism for the action alternatives.

Even if releases to surface water were to occur, it is not expected that these releases would be significant or result in higher peak annual doses or latent cancer facility (LCF) risks than would releases to groundwater. The disposal facility and waste containers are assumed to maintain their integrity for at least 500 years, and this factor would allow many of the shorter-lived radionuclides to decay to innocuous levels prior to any releases to the environment. In addition, it is expected that releases to surface water would be much more diluted in the environment (such as in a river or lake) before being ingested by the hypothetical receptor than would comparable releases to groundwater (in which case the hypothetical receptor would extract water for use from a well). Because of this smaller amount of dilution, the groundwater pathway would likely be much more significant than the surface water pathway.

Since the travel time to a hypothetical receptor would likely be shorter for any releases to surface water than for releases to groundwater, the time at which the peak annual dose and LCF risk would occur could be sooner for the surface water pathway than the groundwater pathway. However, this is not expected to have a significant impact on the peak annual dose or LCF risk, because the radionuclides that would cause most of the dose have very long half-lives. That is, the additional time to reach a hypothetical receptor through groundwater would not result in any appreciable additional reduction in the radionuclide concentrations causing most of the impacts due to radioactive decay. For these reasons, the groundwater pathway is considered to be the most significant pathway in the long term in this EIS.

An analysis similar to that done for the land disposal alternatives was done for the No Action Alternative (see Chapter 3). Under this alternative, no credit is taken for maintenance of the stored GTCC wastes beyond 100 years. That is, it is assumed for analysis purposes in this EIS that after 100 years, water could contact the radioactive contaminants in the waste packages and leach radionuclides from the wastes, and that these radionuclides could then move toward the underlying groundwater system. While airborne releases from degraded containers could occur, it is expected that the dispersion of any released radionuclides by the wind would greatly decrease the air concentrations. In addition, it is expected that surface runoff would not be a major concern with regard to this alternative in the long term, because the storage sites would probably have berms or other engineered features to minimize water runoff from the site.

The highest doses associated with the No Action Alternative would therefore probably be those associated with the migration of radionuclides to groundwater that would subsequently be used by members of the general public. Focusing on the groundwater pathway for this alternative also allows for a more direct comparison of the long-term impacts from the No Action Alternative with the post-closure impacts given for the action alternatives.

E.1 RESRAD-OFFSITE COMPUTER CODE

The RESRAD-OFFSITE computer code (Yu et al. 2007) is an extension of the original RESRAD code (Yu et al. 2001) developed by Argonne National Laboratory for the U.S. Department of Energy (DOE). The original (on-site) RESRAD code was developed to address exposure pathways relevant to an individual exposed to residual radioactive soil contamination. This focus allowed for the development of soil cleanup criteria for various exposure scenarios, and RESRAD was largely used to develop cleanup criteria for radioactively contaminated soil in support of DOE remedial action projects.

This code was expanded in RESRAD-OFFSITE to address the radiological consequences to a receptor located either on-site or outside the area of primary contamination. The expanded code can be used to calculate the radiological dose and excess lifetime cancer risk to various receptors by using dose coefficients and radionuclide slope factors from the U.S. Environmental Protection Agency (EPA) and International Commission on Radiological Protection (ICRP). Although this code, too, was developed largely to address soil cleanup guidelines corresponding to a specified dose limit, it has a number of features that make it a good choice for use in the analyses done for this EIS.

The following discussion on the use of RESRAD-OFFSITE focuses on the use of this code for the action alternatives. The same general approach that was used for the action alternatives was used for the No Action Alternative. The simulation approach for the action alternatives is described in Section E.2, and the approach used for the No Action Alternative is described in Section E.3.

The RESRAD-OFFSITE computer code allows for the initial radiological contamination to be in environmental settings ranging from those involving surficial contamination to situations in which a clean cover layer overlies a zone of radioactive contamination. This latter situation simulates the closed land disposal facilities for GTCC wastes addressed in this EIS, in which there is an overlying soil cover over the disposed-of wastes (the zone of radioactive contamination). The RESRAD-OFFSITE computer code can incorporate the presence of up to five partially saturated layers below the contaminated zone, a feature that is advantageous for delineating the various sites addressed in this EIS. The RESRAD-OFFSITE code is more flexible than the original RESRAD code in that it has the capability to not only model the radiation exposure of an individual who spends time directly above the primary zone of radioactive contamination (on-site) but also one who spends time away from the primary contamination (off-site), which is the application that is most useful for this EIS.

As noted previously, there are three types of releases that can lead to contamination at off-site locations (Figure E-1) that are addressed by RESRAD-OFFSITE: airborne releases, surface runoff, and leaching. Airborne releases can lead to the off-site releases of either particulates or gases (such as radon). Particulate releases are limited to sites having surficial soil contamination, while gases can be released from buried materials following their upward movement from the radioactive contamination source through any overlying cover materials. For this EIS, particulate releases are expected to be very unlikely given the thick covers overlying the disposed-of wastes. In addition, any such releases would be greatly diluted in the atmosphere, such that potential doses to members of the general public would be very low. The only radionuclides that would be subject to airborne releases are gases, because the surface soil cover

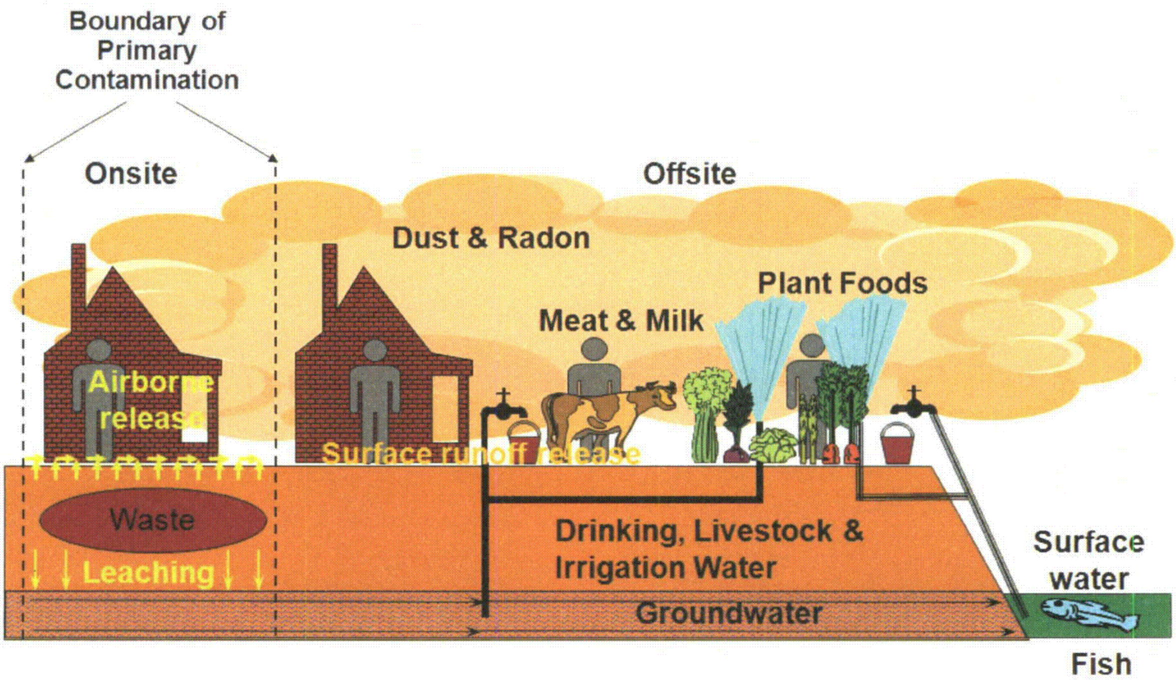

FIGURE E-1 Environmental Release Mechanisms and Exposure Pathways Considered in RESRAD-OFFSITE

is assumed to remain sufficiently intact so as to not expose the buried wastes to the atmosphere. That is, it is assumed in the EIS analyses that the soil cover is not completely removed with regard to all of the sites and disposal methods.

The second release mechanism (surface runoff) is also considered to not be relevant to the analysis conducted for this EIS. This mechanism addresses the loss of surficial contamination by precipitation that flows along the slope of the ground surface to the surrounding area. In the RESRAD-OFFSITE code, any radioactively contaminated material removed by surface runoff is modeled as a release to a nearby surface water body. This exposure pathway is not relevant to this assessment because it is assumed that the disposed-of wastes would always be overlain by some clean soil cover.

The third release mechanism considered by RESRAD-OFFSITE is the leaching of radionuclides by precipitation that percolates through the contaminated waste zone. This is the pathway of most concern in the post-closure assessment of potential human health impacts. For this EIS, it is assumed that once contamination reaches the groundwater, it is removed by a hypothetical individual using a well. Radionuclides in groundwater can also be discharged to a surface water body, but this would result in much lower concentrations of radionuclides due to dilution. For conservatism, groundwater was assumed to be the sole source of potable water for the hypothetical individual for assessing the post-closure impacts.

Since RESRAD-OFFSITE does not contain features to simulate the movement of percolating water over the various layers of an engineered cover or the degradation of waste containers over time, simplifying assumptions were made in this analysis. For example, the engineered barriers and waste containers were assumed to begin to degrade and fail 500 years after closure of the disposal facility. This is a conservative assumption that was used because RESRAD-OFFSITE does not have the capability to calculate a container failure distribution. This adds conservatism to the results presented in this EIS.

However, RESRAD-OFFSITE does have features that allow a reasonable estimate to be made of the release of radioactive contaminants from the GTCC wastes. Specifically, the code uses a rate-controlled release to model the quantity of contaminants that can be removed by leaching from the wastes as water flows down through the primary zone of contamination. The release rate can be specified to vary as a function of time and is used by RESRAD-OFFSITE to simulate the entry of radionuclides into the percolating water with subsequent transport in the unsaturated zone(s) and groundwater aquifer. This is a very useful feature of this code for use in the EIS analyses, because it allows the source term (GTCC waste) to have any physical or chemical form. What needs to be specified is the release rate of the radionuclides from the source.

The RESRAD-OFFSITE groundwater transport model simulates the convection and dispersion of radionuclides in the liquid phase during transport in soils. Some sites have very uniform settings, and parameters can be selected to represent soil properties on the basis of the measurements taken in site soils. Other sites have much more complicated geological settings, and they can include fracture flow. In these cases, it is important to select the parameter values that best represent flow conditions in the local environment so that these conditions can be adequately modeled with the RESRAD-OFFSITE computer code. For example, in the analyses for disposal of GTCC LLRW and GTCC-like waste at Idaho National Laboratory (INL), a distribution coefficient (K_d) value of zero was specified for all radionuclides for the thick-flow basalt layers. This selection was made to simulate the fracture flow condition in which water flows through the basalt layers quickly, leaving little contact time for dissolved radionuclides to be adsorbed to the solid phase.

In evaluating the movement of radionuclides through the environment, the RESRAD-OFFSITE computer code addresses radioactive decay and ingrowth of progeny radionuclide(s). This capability is one of the major reasons RESRAD-OFFSITE was selected for use in this EIS. Many of the radionuclides in the GTCC wastes (in particular, the actinide elements) are present in long decay chains, and it is necessary to accurately account for the decay and ingrowth of all radionuclides that could affect a potential receptor in the long-term future. The RESRAD code has been used in a number of situations addressing radionuclide decay and ingrowth during groundwater transport, and it has been shown to provide good estimates of this effect.

In addition to simply accounting for decay and ingrowth of radioactive progeny as the primary radionuclides move through the environment, RESRAD-OFFSITE uses radionuclide-specific retardation factors to address the effects of sorption and desorption on the transport speed through soil. This feature allows the code to simulate the different rates at which radionuclides in the same decay chain move in the environment. Numerical methods are employed in RESRAD-OFFSITE to evaluate the analytical solutions to the differential equations that characterize the behavior of radionuclides being transported in the unsaturated and saturated zones. To increase the precision of the calculation results in this EIS, the saturated zone was further divided to smaller sublayers.

While other computer models have features that could be used to support this analysis, use of these codes would not significantly improve the results presented in the EIS. The results of most interest were the estimated peak annual dose and peak annual LCF risk in the first 10,000 years. If the peak annual impacts did not occur within 10,000 years, the analysis was extended out to 100,000 years. The radionuclides that would cause most of the dose have long half-lives (C-14, Tc-99, I-129, and isotopes of uranium and plutonium), and the peak annual dose, in many cases, would occur in the distant future. Because of this, it was not necessary to know in great detail the exact mechanisms by which the radionuclides from the site would be released in order to perform this comparative assessment.

A number of the computer codes considered for this analysis require detailed information on the engineering design and the specific materials used to construct the facility, which are generally lacking at this point in the process. Also, although these codes might improve the estimates for the first few hundred years, or even a thousand years, they provide no information to address the conditions of the engineered barriers and waste containers and their performances over the very long time frame necessary for this EIS. After radionuclides would be released from the disposal unit, they would travel through the various layers of soils underneath the disposal facility to reach the groundwater table and then travel in the groundwater aquifer to arrive at the receptor location. The time that the radionuclides would spend traveling in soils could be thousands of years or even longer, and the potential radioactive ingrowth and decay and the different transport speeds between parent and progeny radionuclides could significantly affect the groundwater concentrations.

The RESRAD-OFFSITE code has the ability to simulate the transport of radionuclides in the vadose zone and saturated zone, and this capability has been demonstrated in the past. Although the code does not have the ability to estimate distributed container failure over time, it has provisions that allow users to bypass the release rate calculations and accept the input release rates of radionuclides as a function of time.

There are other computer codes with functions similar to those of RESRAD-OFFSITE. Some neglect the ingrowth of progeny nuclides during transport; some consider ingrowth by assuming progeny nuclides are transported at the same speed as are parent nuclides. Others consider both ingrowth of progeny and different transport speeds of parents and progeny but employ numerical analysis methods that would take very long (unrealistic) computation times for simulations that are run over 10,000 or 100,000 years. The precision of results from a numerical analysis can be greatly affected when the analysis is extended to such a long period of time as that required by this EIS.

Given the complexity of the facility design, the various physical and chemical compositions of waste, the complexity of the actual geologic nature and hydrogeologic nature of the candidate sites, and the unknown behavior of the engineered barriers and waste containers over a very long period of time, estimates of the peak annual radiation doses and LCF risks to human health are very difficult to predict over the time periods considered in the EIS. Assumptions were made to simplify the impact analysis, and these were applied in a uniform manner across the different sites. This allows a comparison to be made of the relative merits of the various disposal alternatives and sites considered in the EIS. These results would not be significantly affected if other computer codes were utilized in the analysis.

RESRAD-OFFSITE also accounts for the accumulation of radionuclides at off-site locations through dust deposition and water irrigation. Water irrigation can lead to the accumulation of radionuclides in soil, which is significant for the hypothetical off-site receptor considered in the EIS (i.e., a resident farmer).

The RESRAD-OFFSITE methodology has been used in two model validation studies: the Biospheric Model Validation Study II (BIOMOV II) program and the Environmental Modeling for Radiation Safety (EMRAS) program (BIOMOVS II 1996; IAEA 1996). Both programs were organized by the International Atomic Energy Agency (IAEA). Currently, the EMRAS Naturally Occurring Radioactive Material Working Group is using RESRAD-OFFSITE for a model comparison study with area source scenarios. This level of validation supports the use of this code in performing the comparative evaluation in this EIS.

E.2 SIMULATION APPROACH FOR THE LAND DISPOSAL ALTERNATIVES

Potential long-term impacts on human health that could result from the disposal of GTCC LLRW and GTCC-like wastes were analyzed in this EIS by using the RESRAD-OFFSITE computer code, as summarized above. Additional details on this computer code are presented in its user manual, which can be reviewed for more information (Yu et al. 2001). This section discusses the exposure scenario and source term assumptions used for the analyses.

E.2.1 Exposure Scenario and Pathways

The assessment of long-term impacts on human health from the closed disposal facility requires the identification of an appropriate exposure scenario. Proper site selection and proper design, closure, and post-closure monitoring and maintenance of the facility would reduce the likelihood, to the extent possible, that anyone would actually be exposed to the radioactive contaminants in the wastes. A hypothetical resident farmer exposure scenario was selected for performing a comparative analysis in this EIS as a conservative approach. This scenario is unlikely to occur at the federal sites evaluated in this EIS, since current land use designations for the reference locations do not include residential use. The results presented here should not be used for regulatory compliance purposes in the future, and they should not be compared with site-specific performance assessments that have been conducted for existing waste disposal facilities. Such assessments are based on site-specific exposure scenarios and conditions. However, the assessment in this EIS does provide useful information to guide the decision-making process for identifying the most appropriate method to manage these GTCC wastes.

For the analysis of long-term impacts on human health after closure of the disposal facility, a hypothetical resident farmer is assumed to move near the site and reside in a house located 100 m (330 ft) from the edge of the disposal facility boundary. This location was selected because it is consistent with the minimum buffer zone distance surrounding a DOE LLRW disposal site identified in DOE Manual 435.1-1 (DOE 1999). This DOE *Radioactive Waste Management Manual* notes that a larger or smaller buffer zone for a DOE LLRW disposal facility may be used if adequate justification is provided. No additional distance beyond this minimum buffer zone of 100 m (330 ft) from the edge of the disposal facility is assumed in this analysis. This assumption is conservative since the federal sites considered in this EIS are very large, and a significant buffer zone of greater than 100 m (330 ft) would likely be employed for this disposal facility. An evaluation of the reduction in the potential radiation dose to this hypothetical receptor at greater distances is given in Section E.6.

For this analysis, a hypothetical individual is assumed to move to this location and develop a farm. This resident farmer is then assumed to develop a groundwater well as the sole source of water (for drinking, household use, irrigation, and feeding livestock) and to obtain much of his/her food (fruits, vegetables, meat, and milk) from the farm. A hypothetical resident farmer was selected for this evaluation because this scenario would involve the most intensive use of the land, and this receptor would thus incur the highest dose of any potential receptor in the future. As mentioned previously, the assumption of a resident farmer presents a potentially conservative bias against sites where such a scenario is less likely. However, the use of the same exposure scenario at all sites provides a common basis for comparison of the results for the sites considered in this EIS. DOE will consider the result of the hypothetical resident farmer scenario and other factors in developing the preferred alternative as discussed in Section 2.9.

The hypothetical resident farmer could be exposed to airborne contaminants, including particulates, radon gas and its short-lived decay products, and gaseous radionuclides such as C-14 (in the form of CO_2) and H-3 (in the form of water vapor). These gases could diffuse out of the waste containers and move through the disposal facility cover and then be transported by the wind to the off-site location where the farmer resides. As noted previously, airborne particulates are not expected to be generated, given the presence of the engineered cover over the GTCC wastes. This individual could also incur a radiation dose through the use of groundwater contaminated as the result of leaching of radionuclides in the waste containers and their transport to the underlying groundwater table.

Secondary soil contamination at off-site locations would be possible if contaminated groundwater was used for irrigation and if this practice was continued for an extended period of time. Potential exposure pathways related to the use of contaminated groundwater include (1) external irradiation; (2) inhalation of dust particulates from irrigated fields, radon gas (and its short-lived decay products), H-3, and C-14; and (3) ingestion of water, soil, plant foods, meat, and milk. Plant foods (fruits and vegetables) could become contaminated through foliar deposition as well as root uptake. Meat and milk could become contaminated if livestock ingested contaminated water (obtained from the well) and fodder contaminated by use of this groundwater. Figure E-2 illustrates the exposure pathways associated with use of contaminated groundwater.

E.2.2 Assumptions Related to Leaching from the Wastes

It is assumed that the only way the hypothetical receptor would be exposed to radiation in the future would be if the radionuclides were released from the waste containers and disposal

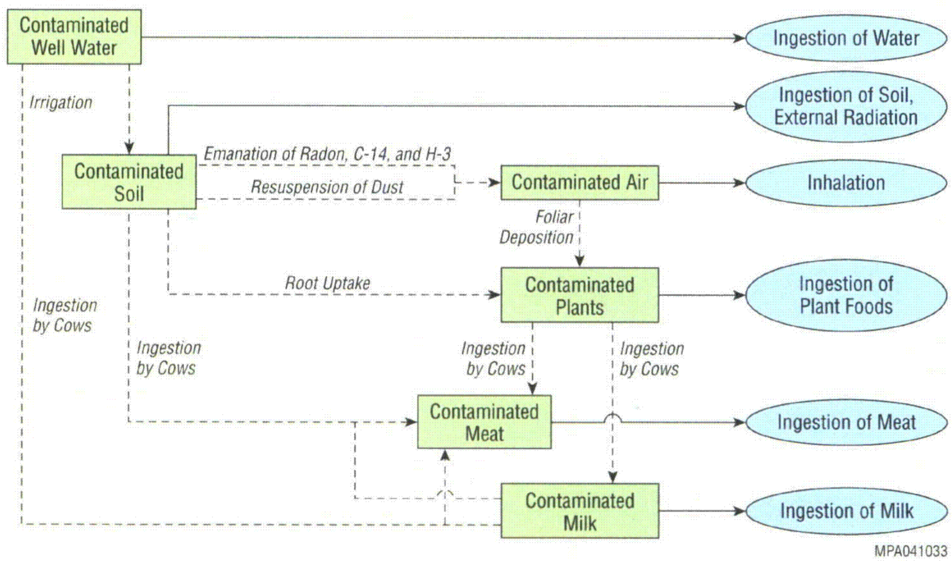

FIGURE E-2 Exposure Pathways Associated with the Use of Contaminated Groundwater

facility. The most likely mechanism for this to occur would be contact with infiltrating water. Precipitation could infiltrate into the disposal area and contact the waste containers. It is assumed that no releases would occur while the waste containers and engineering barriers (including the cover) remained intact. However, it is expected that over time, the waste packages and engineering barriers would lose their integrity. When this condition occurred, water could contact the waste materials within the packages and move downward to the groundwater table. Although water could also enter the contaminated waste zone as a result of the rising groundwater, this scenario is not considered likely because the disposal facility would be sited in accordance with NRC regulations that should preclude this from occurring.

Data on the performance of waste packages and engineering barriers over an extended time period are limited. Even when data are available, using the data to predict the release rates of radionuclides over a very long time period can be difficult to defend. The potential impacts on groundwater are evaluated over a very long time period in this EIS (10,000 years and longer to obtain peak annual doses and LCF risks). Determining how and when the waste packages and engineering barriers would begin to degrade and how this degradation would progress over time is one of the more challenging and site- and design-specific aspects of the analysis. Thus, for a comparative analysis such as this, simplifying assumptions are made regarding the performance of engineering barriers and waste packages.

The radiation doses presented in the post-closure assessment in this EIS are intended to be used for comparing the performance of each land disposal method at each site evaluated. The results indicate that the use of robust engineering designs and redundant measures in the disposal facility could delay the potential release of radionuclides and could reduce the release to very low levels, thereby minimizing the potential groundwater contamination and associated human health impacts in the future.

For purposes of analysis in this EIS, it is assumed that the engineered barriers would begin to degrade and fail 500 years after the closure of the disposal facility. This assumption is considered to be conservative (i.e., yield greater impacts) since the integrity of the engineered barriers is expected to last longer than 500 years. It is assumed that the radionuclides in the disposed-of wastes (listed in Appendix B) would not be available for leaching until the engineering barriers started to degrade. Many of the radionuclides in the GTCC LLRW and GTCC-like wastes have very long half-lives, so this 500-year time period would not result in an appreciable reduction in the total hazard associated with these wastes as a result of radioactive decay. This assumption is more conservative for some sites than others where conditions are more favorable to the long-term performance of waste packages.

In performing these evaluations, the protection provided by a number of engineering measures included in the conceptual facility designs, such as a cover designed to minimize water infiltration, was considered in the analyses. It is assumed that these engineering measures would completely eliminate water infiltration into the waste units for the first 500 years. It is assumed that after that time, the integrity of these engineering measures would begin to degrade and fail, reducing their effectiveness in keeping percolating water out of the waste disposal units. A study at the Savannah River Site (SRS) indicated that after 10,000 years, the closure cap at the F-Area would still shed about 80% of the cumulative precipitation falling on it, with a higher degree of effectiveness occurring before 10,000 years (Phifer et al. 2007). The cover effectiveness would continue to decrease very slowly after 10,000 years. This information was used to estimate the amount of water that could infiltrate into the disposed-of wastes as described in the following text. The assumed effectiveness of a cover system can be a critical factor for distinguishing between facility performance at a humid site and at an arid site.

It is assumed that the water infiltration rate into the top of waste disposal facility would be zero for the first 500 years following closure, and then it would be 20% of the natural rate. This approach is meant to account for the reduction in the integrity of the cover and other engineering barriers as they begin to degrade and fail. This value was used for all future times extending to 10,000 years and longer (to obtain peak annual doses). This reduced water infiltration rate (from the natural rate for the area) is limited to the waste disposal area; at the perimeter of the waste disposal facility, the natural background infiltration rate is used in the EIS analyses.

This is a simplified approach to address the reduction in cover effectiveness over time. The amount of water infiltrating into the disposal facility would increase as the cover effectiveness decreased. It is difficult to model the gradual degradation of the engineered cover; hence, the long-term average effectiveness was simulated in the calculations. A sensitivity analysis was conducted to examine the potential change in off-site doses by using varied values to simulate varying degrees of effectiveness that would yield different water infiltration rates. The results of this sensitivity analysis are given in Section E.6.

This approach of using a reduced water infiltration rate only for the waste disposal area is assumed to be conservative, because with a higher water infiltration rate outside the waste disposal area, the transport time needed for radionuclides to reach the underlying groundwater table after they have been released from the waste disposal area would be shortened. This approach provides less time for radioactive decay to occur during transport, which results in higher groundwater concentrations being estimated at the receptor location.

E.2.3 Assumptions Related to Radionuclide Release Rates

As described in Appendix B, the GTCC LLRW and GTCC-like wastes encompass three waste types for purposes of analysis in this EIS: activated metals, sealed sources, and Other Waste. For activated metal wastes, the release of radionuclides was correlated with the corrosion of metals. The radionuclide release fraction for activated metals was taken to be 1.19×10^{-5}/yr in this analysis. This value is assumed to be reasonable for stainless-steel waste forms for the purpose of this comparative analysis on the basis of rates observed in corrosion experiments on stainless-steel coupons conducted at INL (INL 2006; Adler Flitton et al. 2004). However, if the environmental conditions surrounding a specific waste were not controlled and were more conducive to causing corrosion, or if the metal making up a specific waste was more conducive to corrosion, the release fractions could be higher than those used here.

The release rates of radionuclides in sealed sources were simulated on the basis of the assumption that radionuclides would partition between water and the sealed source matrix when coming in contact with water. It is assumed that the partitioning factor of each radionuclide has the same value as the K_d associated with the surface soil at the various sites. Because there would be backfill soil surrounding the waste containers in the disposal units, radionuclides released from the sealed sources would have to travel through the surrounding soils before leaving the disposal area. By using the soil K_d values to calculate the radionuclide release rates, the binding of radionuclides to the sealed source matrix is assumed to be the same as that in the surrounding soil. This approach is conservative, because it tends to overestimate the release rates of radionuclides from sealed sources.

While activated metals and sealed sources are structurally sound and generally resistant to leaching with water, many of the wastes in the Other Waste type are not. For this analysis, it is assumed that the Other Waste would be solidified (e.g., with grout or another similar material) before being placed in the disposal units. This assumption is reasonable and consistent with current disposal practices for such wastes, which include a wide variety of materials that could compact or quickly degrade without such measures. Use of such a stabilizing agent is not assumed for activated metal and sealed source wastes.

The solidification provided by mixing the Other Waste with a stabilizing agent would also reduce the leaching of radionuclides. However, the reduction in leaching might not last over a long period of time, when the nature of the stabilizing agent would change in the environment or the integrity of the stabilizing agent would deteriorate. In this analysis, the effectiveness of solidification in terms of leaching reduction is assumed to last for 500 years following facility closure; after that, the retention of radionuclides by the stabilizing agent is assumed to be the same as that of the surrounding backfill soils. Hence, the release rates of radionuclides from the Other Waste were simulated with soil K_d values after the effective period of the stabilizing agent. The release rates of radionuclides were simulated with the K_d values for a cementitious system during the effective period, assuming cement would be used as the stabilizing agent.

Cement that contains slag has been shown to reduce the leaching of nickel, technetium, and uranium more effectively than cement that does not contain slag. The presence of slag results in an environment that is more reducing and not oxidizing, as opposed to cement alone. Since technetium and uranium are major radionuclides of concern with respect to the GTCC LLRW and GTCC-like wastes, it is assumed that slag-containing cement would be used to solidify the Other Waste for purposes of analysis in this EIS. Although the cementitious material could eventually convert to an oxidized form over long periods of time, this effect would be offset by the corrosion of the metal drums in the disposal environment, which would consume oxygen and lead to chemically reducing conditions.

Information on the K_d values in cementitious systems is given in Table E-1 for a number of elements from different sources. (All tables appear before the references at the end of this appendix.) Only one set of values was given in Krupka et al. (2004), which was taken to represent a non-slag-containing cementitious system. Kaplan is a co-author of this 2004 report, as well as the author of a separate study published in 2006 (Kaplan 2006). It is assumed that the second report contains additional information that was not available when the first report was published in 2004. Therefore, when selecting the K_d values for cementitious systems, only data from the second report were used for comparison with data from the other sources.

The last two columns of Table E-1 provide the selected K_d values for oxidizing and reducing cement. These values are generally the lowest (or most conservative in that they allow for the most potential leaching into the groundwater) of the reported values, unless multiple sources provided the same higher value. In addition to the reported values, chemical similarity was also considered in determining the values to use in this analysis. The use of the smallest K_d values would result in more conservative (higher) dose estimates.

The K_d values for reducing cement are used in this analysis to estimate the release rates of radionuclides when water infiltrates into the waste disposal units while the effectiveness of the stabilizing agent still holds. As indicated in Table E-1, the selected values for oxidizing and reducing cement are the same except for nickel, technetium, and uranium. Note that these values are based on specific assumptions regarding the type of cement used and would need to be reconsidered on the basis of the actual cements that could be used in a specific situation. Maintaining local reducing conditions can be an important consideration in designing the final system for specific wastes containing significant amounts of nickel, technetium, and uranium isotopes.

For the analyses in this EIS, the grout is assumed to retain its effectiveness for 500 years following facility closure. After this time period, the leachability of the Other Waste would increase as the grout degraded, which would result in higher off-site doses. The amount of the increase would depend on the rate at which the grout failed. While it is difficult to model the gradual degradation of the grout system, a sensitivity analysis was conducted to examine the potential change in off-site doses that would result from a different effective period for the grout stabilization system. The results of this sensitivity analysis are given in Section E.6.

E.3 SIMULATION APPROACH FOR THE NO ACTION ALTERNATIVE

An analysis of the long-term human health impacts associated with the No Action Alternative (in which the wastes are stored indefinitely) was conducted to provide information for comparison of the post-closure human health impacts associated with the action alternatives. As noted previously, the pathway of most concern in the long term is expected to be radionuclide migration to groundwater underlying the storage facilities. The analysis of the No Action Alternative was also done by using the RESRAD-OFFSITE computer code.

Under the No Action Alternative, it is assumed that a generic site located within each of the four NRC regions would be the storage location for all of the GTCC LLRW and DOE GTCC-like wastes within that region. It is assumed that the activated metals and Other Waste would remain within the NRC region in which the facility that generated the wastes was located, and the sealed sources would be divided among the four NRC regions in proportion to the number of NRC-licensed facilities within each region. That is, the potential long-term impacts from the groundwater pathway were analyzed for four different sites with different waste inventories (Table E-2). The characteristics of the generic storage site within each region are assumed to be the same as those of the generic commercial site within the same region for the action alternatives.

It is assumed that the GTCC LLRW and GTCC-like wastes would be placed on the ground surface without any protective covers. They would be stacked randomly and would take up more space than they would in the disposal cells for the action alternatives. Monitoring and surveillance of the waste containers are assumed to last for 100 years but would be discontinued after that period. The waste packages are assumed to be left unattended in this manner for the indefinite future (10,000 years and beyond).

This analysis of the No Action Alternative was performed to provide a baseline against which the action alternatives could be compared. This alternative is not a viable long-term management option for the GTCC wastes, and at some point in the future, a decision would have to be made to dispose of these wastes.

E.3.1 Exposure Scenario and Pathways

The exposure scenario and pathways considered for the No Action Alternative are the same as those considered for the action alternatives described above. That is, a hypothetical resident farmer is assumed to inhabit a site located 100 m (330 ft) from the edge of the storage facility and to obtain water for use at the farm from a groundwater well. The storage area is assumed to cover an area of 90,000 m^2 (970,000 ft^2); that is, 300 × 300 m (1,000 × 1,000 ft).

E.3.2 Assumptions Related to Leaching from the Wastes

The potential long-term human health impacts (peak annual doses and LCF risks) for the No Action Alternative were calculated for each waste type separately. Because there would be no protection against weathering of the waste containers after the monitoring and surveillance period ended (at 100 years), it is assumed that the containers would breach and fail at this time. This would allow precipitation water to enter the containers and contact the waste materials. The precipitation rates assumed for the generic storage sites are 1.07, 1.34, 0.82, and 0.27 m/yr for Regions I, II, III, and IV, respectively (Poe 1998; Toblin 1999). The other assumptions related to leaching of contaminants from the waste packages are generally the same as those given for the action alternatives.

E.3.3 Assumptions Related to Radionuclide Release Rates

The release rates of radionuclides contained in activated metal waste were calculated with an assumed release fraction of 1.19×10^{-5}/yr, which was the same as that assumed for the action alternatives. This release fraction reflects the corrosion rate of metal and was obtained from actual measurements conducted at INL ((INL 2006). For the sealed source and Other Waste types, the release rates of radionuclides were calculated by assuming the partitioning of radionuclides between the waste matrix and the precipitation water would be the same as the partitioning of radionuclides between soil particles and water. This assumption was made because the wastes would not be solidified, and the use of soil K_ds for calculating radionuclide release rates is consistent with the approach used for evaluating the action alternatives.

After radionuclides were released from the waste containers, they would accumulate in the surface soil underneath the containers. This contamination could be released from the storage site by runoff water or be carried to deeper soils by infiltration water. The fraction of released radionuclides removed by runoff water would depend on the amount of runoff water, the slope of the ground surface, the adsorption of radionuclides to the surface soil, and engineered site features such as berms. Unlike the design of a disposal facility that would incorporate engineering measures to facilitate surface water runoff away from the disposal area to prevent water from infiltrating to deeper soils, a preferred feature for a storage area would be the capability to reduce surface water runoff to reduce the spread of contamination to the surrounding area.

For this analysis of the No Action Alternative, it is assumed that all released radionuclides accumulating in the surface soil would be carried by infiltration water to deeper soils. The infiltration rate of water is assumed to be the same as that for the generic commercial disposal facility located in the same region. As shown in Table E-19, the water infiltration rates for the generic disposal facilities in Regions I, II, III, and IV are 0.074, 0.18, 0.05, and 0.001 m/yr, respectively. These values are listed as precipitation rates in the table. Because the irrigation rates, runoff coefficients, and evapotranspiration coefficients are all zero, the infiltration rates would be equivalent to the precipitation rates.

E.4 INPUT PARAMETERS FOR RESRAD-OFFSITE EVALUATIONS

As described previously, the RESRAD-OFFSITE computer code (Yu et al. 2007) was used to calculate the potential impacts on a hypothetical resident farmer located 100 m (330 ft) from the edge of the disposal facility. Two potential release mechanisms (associated with airborne emissions and leaching to groundwater) were considered in the assessment for the action alternatives. For the potential radiation doses resulting from airborne releases coming directly from the disposal area, a Gaussian plume dispersion model (which is incorporated into the RESRAD-OFFSITE code along with the default wind speed and stability class frequency data from the weather station that is nearest the site) was used in this evaluation. The doses from this release mechanism were largely from gaseous emissions (principally radon gas and its short-lived decay products). The results of these analyses are provided in the appropriate sections of the EIS and are not repeated in this appendix.

For the groundwater pathway, site-specific input parameters were used to simulate the movement of contaminants from the wastes contained in the disposal unit to the hypothetical resident farmer located 100 m (330 ft) from the edge of the disposal facility in the downgradient direction. These parameters were obtained from published information given in performance assessments, risk assessments, and environmental modeling studies for the various sites. The input parameters relevant to the groundwater pathway are provided in Tables E-3 through E-14 for the six federal sites. Two tables are provided for each of the six sites. The first table provides the values for all of the input parameters except the K_d values; the K_d values for each of the radionuclides addressed for each site are given in the second table.

For example, Table E-3 provides the values used for the RESRAD-OFFSITE parameters for the evaluation at INL except for the K_d values, which are provided in Table E-4. The same is done for the Hanford Site (Tables E-5 and E-6), Los Alamos National Laboratory (LANL, Tables E-7 and E-8), Nevada National Security Site (NNSS, Tables E-9 and E-10), SRS (Tables E-11 and E-12), and the WIPP Vicinity (Tables E-13 and E-14). Additional details on these values (including the selection rationale and sources used in determining these values) are also provided in the tables.

The input parameters most significant in an evaluation of the groundwater migration pathway are given in a comparative manner for these six sites in Tables E-16 through E-18, in order that differences in site characteristics can be more easily compared. These parameters include the water infiltration rates (Table E-15), characteristics of the unsaturated and saturated zones (Tables E-16 and E-17), and K_d values (Table E-18).

Data for the generic commercial sites located in the four regions were obtained from the same sources (NRC 1981; Poe 1998; Toblin 1999). These values are shown in Tables E-19 and E-20 for comparison. Table E-19 provides the values for all input parameters except the K_d values, and Table E-20 provides the K_d values. These same values were also used for the No Action Alternative.

The calculated concentrations of the various radionuclides in groundwater were used to calculate the radiation dose to the hypothetical resident farmer for the relevant exposure pathways. This individual is assumed to be an adult who spends 75% of his/her time at the site in the vicinity of his/her house (50% indoors and 25% outdoors) and 25% of his/her time away from the area. The farmer is assumed to cultivate an agricultural field encompassing 1,000 m^2 (0.25 ac) for growing fruits and vegetables and a grazing area of 10,000 m^2 (2.5 ac) for raising livestock. It is assumed that the yields of fruits, vegetables, meat, and milk would be sufficient to provide 50% of the needs of the farmer and his family. The remainder of the food would be obtained from sources removed from the farm and be free of any radioactive contamination. These assumptions are taken directly from the RESRAD-OFFSITE code for the default residential farmer scenario.

It is assumed that the farmer would drill a well close to his/her house to supply the potable water needs for drinking, household activities, watering livestock, and irrigating the farm fields. The farmer would draw approximately 2,500 m^3 (660,000 gal) of water from the well each year. For the fruit and vegetable fields, an irrigation rate of 0.1 m/yr (0.33 ft/yr) of water applied to the field is used for SRS and the two generic sites located in Regions I and II; a higher value of 0.2 m/yr (0.66 ft/yr) is used for the other federal sites and the two generic sites located in Regions III and IV. Because SRS and the generic sites located in Regions I and II have higher precipitation rates, less irrigation water would be needed to sustain the growth of crops and vegetables. An irrigation rate of 0.1 m/yr (0.33 ft/yr) is used for the livestock grazing field for all sites. Although irrigation water may not actually be needed at all of these sites (or lesser amounts than those indicated here), this assumption has the effect of increasing the cumulative amount of contamination in the agricultural field that could end up in the resident farmer's food supply.

It is assumed that the resident farmer would ingest 730 L (200 gal) of water; 14 kg (31 lb) of leafy vegetables; 160 kg (350 lb) of fruit, grain, and nonleafy vegetables; 63 kg (140 lb) of meat; and 92 L (24 gal) of milk every year. While working in the fields, the farmer would ingest 36.5 g (0.080 lb) of soil every year (or an average of 0.1 g per day for each day of the year). The inhalation rate of the farmer was taken to be 8,400 m^3/yr (297,000 ft^3/yr). Except for the water ingestion rate, which is about the 90th percentile value for the general public (EPA 2000), these values for the consumption and exposure parameters are the same as the RESRAD-OFFSITE default values.

As noted previously, this assessment is meant to provide a comparative evaluation of the relative merits of each of the disposal sites. While the assumption used (that there would be a complete loss of institutional memory and that residential use of the area in the immediate vicinity of a GTCC waste disposal facility would occur) provides a uniform basis for evaluating potential impacts, its use does not imply that such a situation is expected to occur. Use of standardized assumptions and input parameters (as was done in this analysis) should help to ensure that the best alternative site is selected for disposal of GTCC LLRW and GTCC-like wastes.

While the health effects addressed in this EIS are limited to LCF risks, additional health effects beyond cancer can occur in individuals exposed to radiation, including cardiovascular disease and hereditary effects. However, these additional health effects are not quantified in this EIS. The risk of cardiovascular disease has been shown to increase in persons exposed to high therapeutic doses and also in atomic bomb survivors exposed to more modest doses (NAS 2006). However, there is no direct evidence of increased risk of noncancer diseases at low doses, such as the doses that could potentially occur to members of the general public under the alternatives evaluated in this EIS.

Also, the risk of hereditary effects from radiation exposure is generally attributable to gamma irradiation of the reproductive organs. In contrast, most of the dose to the hypothetical resident farmer in the long term would be a result of long-lived radionuclides having alpha and beta radiation. As noted in NAS (2006), the risk of heritable disease is sufficiently small that it has not been detected in humans, even in thoroughly studied irradiated populations, such as those of Hiroshima and Nagasaki. The risk of cancer fatality was determined to be a reasonable means of comparing alternatives in the EIS.

The assessment of potential human health impacts resulting from groundwater contamination was conducted for a time period of 10,000 years following facility closure. If the maximum impacts (peak annual doses and LCF risks) were not observed in this time period, the assessment time was extended to 100,000 years, which is the maximum time limit for the RESRAD-OFFSITE code. The results of this assessment are provided in Section E.5. A detailed discussion of this evaluation is provided in Argonne (2010).

E.5 RESULTS

The results of the RESRAD-OFFSITE simulations are summarized in Table E-21 for the No Action Alternative. This table presents the estimated peak annual doses when the storage of each individual waste type in each NRC region is considered. As indicated by the results, storage of the GTCC LLRW and GTCC-like wastes in Region I would result in very high radiation exposure to a hypothetical farmer residing 100 m (330 ft) from the edge of the storage facility. The peak annual dose could reach 270,000 mrem/yr for the GTCC-like Other Waste - RH in this region. The peak annual dose for Region II during the first 10,000 years would be much lower, with a maximum value of about 850 mrem/yr for GTCC LLRW Other Waste - RH. However, after 10,000 years, the peak annual dose would increase and could reach as high as 16,000 mrem/yr for GTCC LLRW sealed sources.

A similar tendency was found in the estimated annual doses for Region III. The lowest impacts would occur in Region IV. Within 100,000 years, the estimated peak annual dose would be less than 10 mrem/yr. While the estimated results can largely be explained on the basis of precipitation and infiltration rates as well as the depth to the groundwater table assumed for the storage site at each region, they are also in part due to the different waste inventories assumed to be stored in the different regions.

The results for the action alternatives are summarized in Tables E-22 through E-25. Table E-22 presents the estimated peak annual doses to the hypothetical resident farmer from each individual waste type in the Group 1 stored inventory, and Table E-23 presents the results from each individual waste type in the Group 1 projected inventory. These results are based on the dose conversion factors for an adult in ICRP 72 (ICRP 1996), as discussed in Appendix C. The peak annual doses from each individual waste type in the entire Group 1 waste inventory are given in Table E-24. Table E-25 gives the peak annual doses for the Group 2 inventory (all of which is projected waste). These two groups of wastes are defined in Section 1.4.1 of the EIS. The dose calculations were performed over two time periods — 10,000 years and 100,000 years — following closure of the disposal facility.

The results are provided separately for GTCC LLRW and GTCC-like wastes and address the three separate waste types (activated metals, sealed sources, and Other Waste). The estimated peak annual doses are associated with the disposal of each type of waste material, respectively; therefore, they may occur at different times in the future. The results are provided in this format to allow for an evaluation of the post-closure human health impacts associated with disposing of certain types of wastes at specific locations with specific disposal approaches. For example, it is possible to compare the peak annual projected doses for the stored activated metal GTCC LLRW that could result from using the three disposal methods at the different alternate sites by looking at the appropriate column in Table E-22. As noted previously, these results are intended to be viewed in a comparative manner given the uncertainties associated with this analysis.

The results given in these four tables differ from those given in the site-specific chapters of the EIS. The values given in this appendix are the peak annual doses associated with the disposal of each individual waste type in the Group 1 stored inventory (Table E-22), Group 1 projected inventory (Table E-23), Group 1 total inventory (Table E-24), and Group 2 total inventory (Table E-25). The values given in the main body of the EIS represent the peak annual doses to the hypothetical resident farmer at the time of peak annual dose for the entire GTCC waste inventory. Because of the different radionuclide mixes and activities contained in the different waste types, the maximum doses that could result from each waste type individually generally occur at different times than the peak annual dose from the entire inventory. The results given in the main body of the EIS could be used to support the decision-making process when disposal of the entire inventory at a single separate location is considered, while those in this appendix would support decision-making for the disposal of individual waste types.

The peak annual doses range from zero (meaning that the radioactive contaminants from that particular waste type do not reach the off-site receptor) up to 2,200 mrem/yr for vault disposal of Group 1 GTCC-like Other Waste at INL in 10,000 years. All annual doses calculated as being less than 0.001 mrem/yr are reported as being "<0.001 mrem/yr," since these doses are much too low to be measured or detected. The highest doses calculated for the federal sites are those from disposing of wastes at INL. For the INL site, the high doses are due to the low K_d values for several radionuclides, particularly for iodine-129 (I-129) and uranium isotopes (a value of 0 cm^3/g was used for I-129, and for uranium isotopes, a value of 0 cm^3/g was used for part of the basalt layers and a value of 0.66 cm^3/g was use for the saturated zone in this analysis). A low K_d indicates that the radionuclide has a high potential for partitioning to the liquid phase while moving through soil.

The highest dose for the generic commercial facilities located in the four regions ranges from zero up to 10,000 mrem/yr in 10,000 years. On the basis of the results of the RESRAD-OFFSITE modeling, it is estimated that there would be no groundwater dose within 10,000 years for a generic commercial facility located in Region IV because the radioactive contamination would not reach the groundwater table in 10,000 years as a result of the arid conditions at this location. The highest dose estimated is for a commercial facility located in Region I because of the higher water infiltration rate there, in combination with a shallow depth to groundwater table and low K_d values for C-14 and I-129 (a value of 0 cm^3/g was used in the analysis).

The sites with the lowest estimated annual doses are those located in the arid regions of the country. The analyses indicate that the radionuclides are not expected to reach groundwater for any waste type and disposal method at NNSS in 100,000 years, and generally lower doses are projected to occur at the other sites located in the Western United States (except for INL). No radionuclides are expected to reach groundwater at the WIPP Vicinity in 10,000 years, and the maximum annual doses in 100,000 years at this site are low.

The arid sites result in lower doses because of lower water infiltration rates there (due to lower precipitation) and the longer distance to the groundwater table. Of these two factors, the water infiltration rate appears to be more significant than the depth to the groundwater table. The time period of this analysis is very long (longer than 10,000 years), and many of the radionuclides have very long half-lives. Radionuclides released from the disposed-of wastes would eventually reach the groundwater table within this time period, even if the depth to the groundwater table was increased. Reducing the water infiltration rate would not only reduce the radionuclide release rate but would also increase the transport time to reach the hypothetical exposure location.

E.6 SENSITIVITY ANALYSIS

The peak annual doses and LCF risks to a hypothetical resident farmer located 100 m (330 ft) downgradient of the edge of a disposal facility from using contaminated groundwater are presented in Section E.5. The following assumptions were used in the EIS to perform this evaluation:

1. The engineering barriers incorporated in the disposal facility would keep percolating water out of the waste units for 500 years following closure of the disposal facility.

2. After 500 years, the integrity of the barriers and waste containers would begin to degrade, allowing for water infiltration into the top of the disposal units at 20% of the natural infiltration rate for the area.

3. The water infiltration rate around and beneath the disposal facility would remain at 100% of the natural rate for the area at all times.

4. Once water would begin to affect the disposed-of wastes, radionuclides would be leached out at a rate that would depend on the waste type.

5. A stabilizing agent (grout) would be used to solidify the Other Waste type, and this grout would maintain its effectiveness for 500 years.

6. After 500 years, the effectiveness of the grout would be compromised, allowing for more leaching to occur.

7. The activated metal and sealed source wastes would be disposed of without the use of any additional stabilizing material.

These assumptions were applied across various alternate sites so that the peak annual doses and LCF risks for the different sites could be compared on a uniform basis.

The parameters used in these analyses were generally selected to provide conservative estimates (i.e., to overestimate the peak annual doses and LCF risks that would likely occur in the future should one of these alternatives be implemented). Uncertainties are inherent with these types of analyses, especially given the long periods analyzed in this EIS (10,000 years and longer to obtain peak annual doses and LCF risks). To evaluate the uncertainties associated with key assumptions used for the analysis of the long-term human health impacts, a sensitivity analysis was performed to provide information on the effects that key assumptions have on the results. In this sensitivity analysis, the RESRAD-OFFSITE calculations were repeated while the value of only one parameter was varied and the values of the other parameters were kept at their base values. This approach excluded the influence of the other parameters and provides results that can be analyzed to determine which assumptions have the most impact on these estimates.

Two sites were considered in this sensitivity analysis: SRS and WIPP Vicinity. The first site is representative of sites in the Eastern United States (a humid site), and the second site is representative of sites in the Western United States (an arid site). The analysis was limited to trench disposal of the GTCC-like stored Group 1 Other Waste - CH, and it was conducted for a time period of 10,000 years. It is assumed that this waste would be stabilized with grout, and this waste type has a radionuclide mix that is representative of many of the GTCC wastes. The results of the sensitivity analysis for this waste type and disposal method at these two sites can be used to infer conclusions about different waste streams disposed of at other alternate sites by using the three land disposal methods. This analysis also gives some indication of the level of conservatism in the results, which is useful information for the decision-making process.

Three parameters were addressed in this sensitivity analysis: (1) the water infiltration rate through the disposal facility cover after 500 years following closure of the facility, (2) the effectiveness of the stabilizing agent (grout) used for Other Waste, and (3) the distance to the assumed hypothetical receptor. These three parameters address issues related to disposal facility design, waste form stability, and site selection.

To address the influence of the water infiltration rate on the estimated radiation doses to the hypothetical future farmer, two additional infiltration rates (corresponding to 50% and 100% of the natural infiltration rate for the area) were considered along with the base value of 20%.

The effective period for the stabilizing agent (grout) used for Other Waste is assumed to be 500 years in this EIS. This assumption is considered to be reasonable, but it is likely that the grout could be effective for a longer period of time. To address the significance of this time period assumed for grout, two additional effective periods were addressed for both the SRS and WIPP Vicinity: 2,000 years and 5,000 years.

The exposure distance to the resident farmer is assumed to be 100 m (330 ft) from the edge of the disposal facility. This distance was based on the minimum buffer zone identified for DOE LLRW disposal facilities. This distance would likely be much longer, especially for the federal sites considered in this EIS. To address the significance of the distance to a future hypothetical receptor (which may have a bearing on-site selection and development of a buffer zone), this distance was increased to 300 m (980 ft) and 500 m (1,600 ft).

In addition to the Base Case, two additional values were considered for each of the three parameters at the two sites as discussed above. A total of 10 additional cases were constructed and analyzed by using RESRAD-OFFSITE at SRS and WIPP Vicinity. Table E-26 lists the different cases and the parameter values assumed for those cases.

Tables E-27 and E-28 provide the peak annual doses and the times at which they would occur for the Base Case and the 10 sensitivity analysis cases analyzed for the WIPP Vicinity and SRS, respectively. A time period of 10,000 years was used to perform these analyses with the RESRAD-OFFSITE computer code. Note that the results given here for the Base Case differ from those given in the site-specific chapters in the main body of the EIS. The peak annual doses in this appendix for the Base Case are the peak values when disposal of only the Group 1 stored GTCC-like Other Waste - CH is considered, whereas the values in the main body of the EIS are the peak annual doses when disposal of the entire inventory of GTCC wastes is considered.

For the WIPP Vicinity, groundwater contamination would not occur within 10,000 years for any of the three water infiltration rates used in this analysis (20%, 50%, or 100% of the natural background rate for this area) after failure of the engineering barriers (including the cover) and waste containers. A higher rate than is naturally present at that site is needed for groundwater contamination to occur. A higher infiltration rate to the disposal units would result in higher release rates of radionuclides, yielding higher peak doses. However, the transport time required for radionuclides to move to the groundwater table after leaving the disposal units would be the same, regardless of the water infiltration rate to the disposal units. The times would be the same because in the analysis, it is assumed that the water infiltration rate to areas outside the waste disposal units would be equivalent to the natural background rate. (This assumption was selected to provide more conservative estimates of the potential doses.) Since groundwater contamination would not occur within 10,000 years in the Base Case, the contamination would not be observed in Cases I or II either.

For Cases III to VIII, the effectiveness of grouting was extended from 500 years to either 2,000 years or 5,000 years, which would reduce the leaching of radionuclides for a longer time when compared with the time for the Base Case. Consequently, at the WIPP Vicinity, no groundwater contamination was observed within 10,000 years for these cases. Increasing the exposure distance of the receptor from 100 m (330 ft) to 300 m (980 ft) in Case IX and to 500 m (1,600 ft) in Case X would postpone the onset of radiation exposure. In addition, because of the extra dilution by clean water coming down from the ground surface, the potential radiation dose would also be lower than that in the Base Case. The maximum dose of 0 mrem/yr within 10,000 years as calculated for Cases IX and X at the WIPP Vicinity is consistent with this expectation.

The results for the Base Case and Cases I and II as calculated for SRS (Table E-28) demonstrate the influence of the water infiltration rate on the GTCC wastes in the disposal unit. The results provide information on the influence that the performance of the disposal facility cover has on long-term radiation doses through the groundwater pathway. The peak annual dose would increase as the water infiltration rate increased, because when more water would enter the waste packages, more radionuclides would be leached and released from the disposal area. The increase in the peak annual dose would be roughly proportional to the increase in the water infiltration rate. Similar conclusions can be drawn about the results for Cases III, IV, and V or the results for Cases VI, VII, and VIII. Figure E-3 compares the radiation doses as a function of time among the Base Case, Case I, and Case II. Figure E-4 compares the radiation doses among Cases III, IV, and V. Figure E-5 compares the radiation doses among Cases VI, VII, and VIII.

In Figure E-3, for all the three cases (Base Case, Case I, and Case II), the sharp peak close to time 0 is caused by C-14, which was assumed to be highly soluble in water (a K_d value

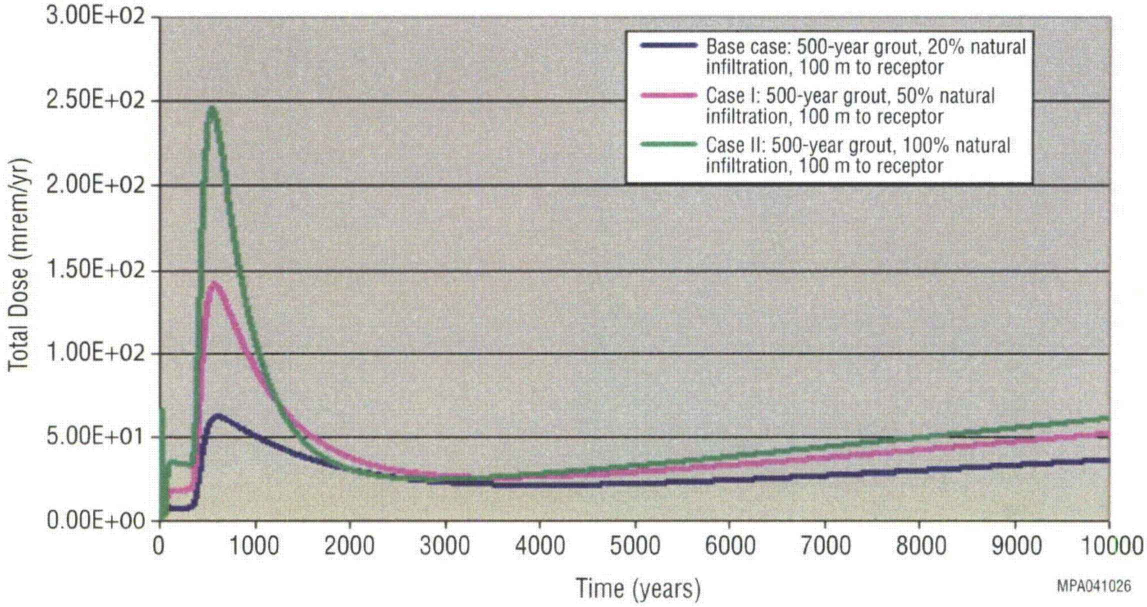

FIGURE E-3 Comparison of Annual Doses for the Base Case and Cases I and II for Trench Disposal of Stored Group 1 GTCC-Like Other Waste - CH at SRS

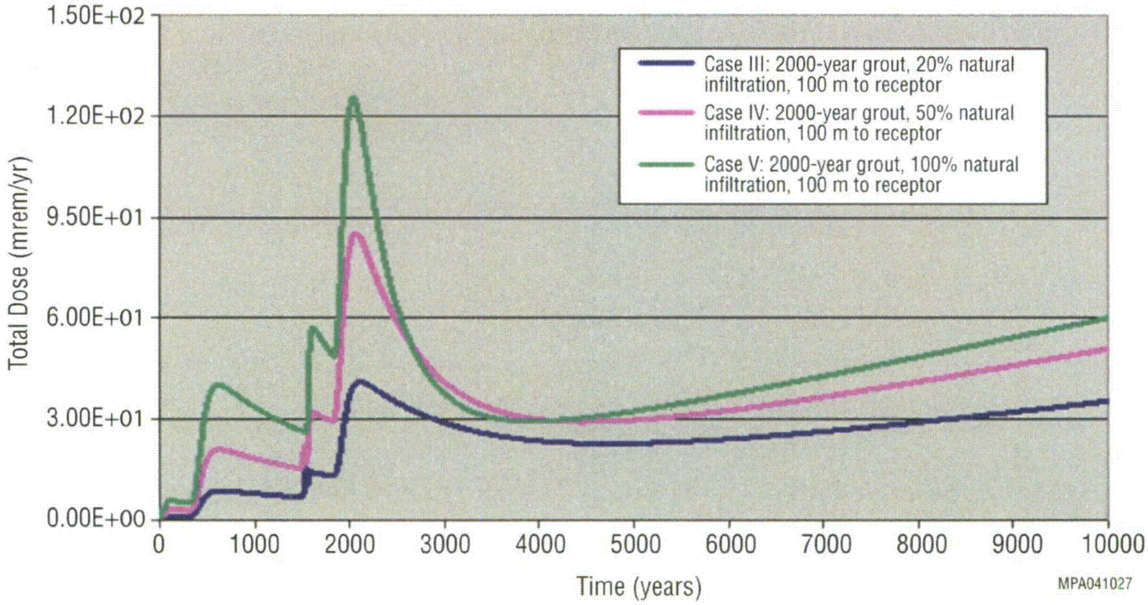

FIGURE E-4 Comparison of Annual Doses for Cases III, IV, and V for Trench Disposal of Stored Group 1 GTCC-Like Other Waste - CH at SRS

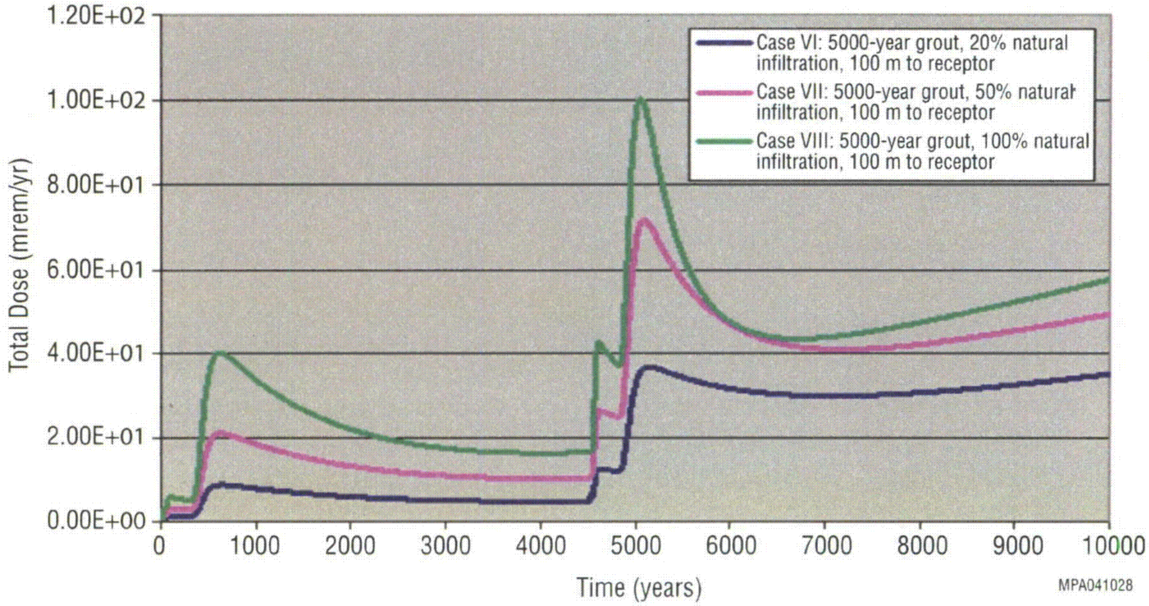

FIGURE E-5 Comparison of Annual Doses for Cases VI, VII, and VIII for Trench Disposal of Stored Group 1 GTCC-Like Other Waste - CH at SRS

of 0 cm^3/g was used in the analyses). After C-14, Np-237 and then Ra-226 would reach the groundwater table. The radiation dose between 100 and 350 years is mainly contributed by Np-237. After 350 years, Ra-226 plays a dominant role in determining the radiation dose. Because of more adsorption to the soil particles during transport to the receptor location, the peaks created by Np-237 and Ra-226 are not as sharp as the peak created by C-14. In addition to the initial inventory in the Group 1 GTCC-like stored Other Waste - CH, Np-237 could be generated by the decay of Am-241, while Ra-226 could be generated by the decay of U-234 and Th-230. The ingrowth of Np-237 and Ra-226 explains the gradual rise of the radiation dose, which continues all the way to 10,000 years after the peak at around 500–600 years. Note that for the RESRAD-OFFSITE analyses, time 0 corresponds to the onset of leaching of radionuclides, which is assumed to occur 500 years after the closure of the disposal facility when the integrity of the barrier materials and waste containers begins to degrade. Therefore, if the reported time is 600 years, it means 1,100 years after the closure of the disposal facility.

The influence of the effectiveness of the stabilizing agent (grout) on the potential radiation doses is demonstrated by comparing the results of the Base Case and Cases III and VI (see Figure E-6). During the effective period, the release rates of radionuclides from the waste disposal area would be reduced, thereby reducing the radiation dose associated with groundwater contamination for the corresponding period. The retention of more radionuclides in the waste containers would allow for more radioactive decay to occur before the release. Hence, the peak annual dose after the effective period would be lower than when there was no waste stabilizing or when the effective period of the stabilizing agent was shorter. The longer the effective period, the more evident the delay and reduction of the peak dose (compare the dose results for Cases I, IV, and VII in Figure E-7 or the results for Cases II, V, and VIII in Figure E-8).

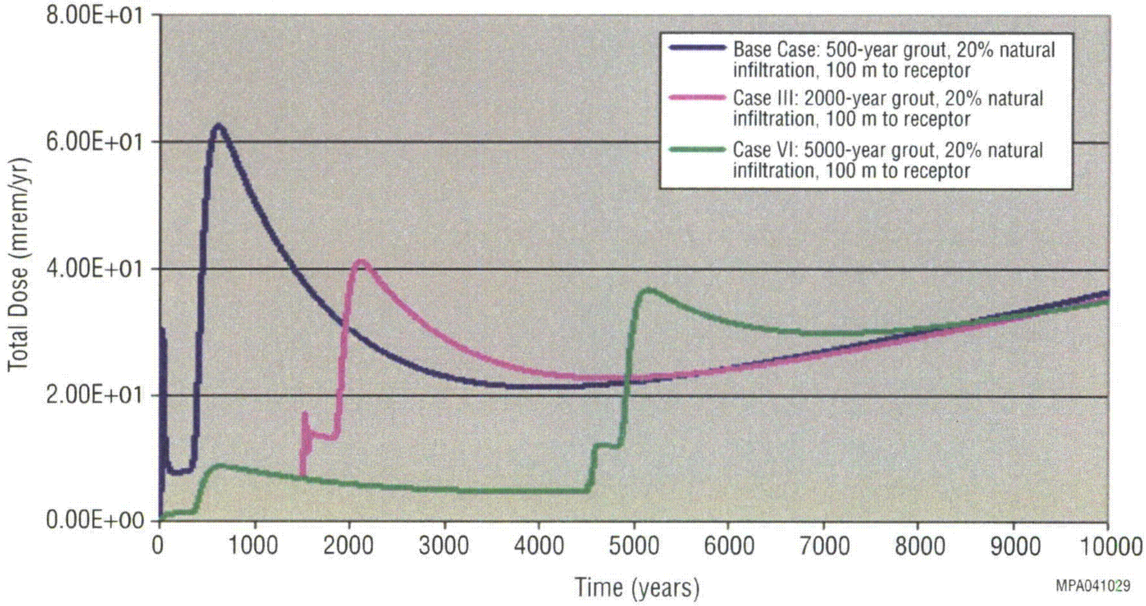

FIGURE E-6 Comparison of Annual Doses for the Base Case and Cases III and VI for Trench Disposal of Stored Group 1 GTCC-Like Other Waste - CH at SRS

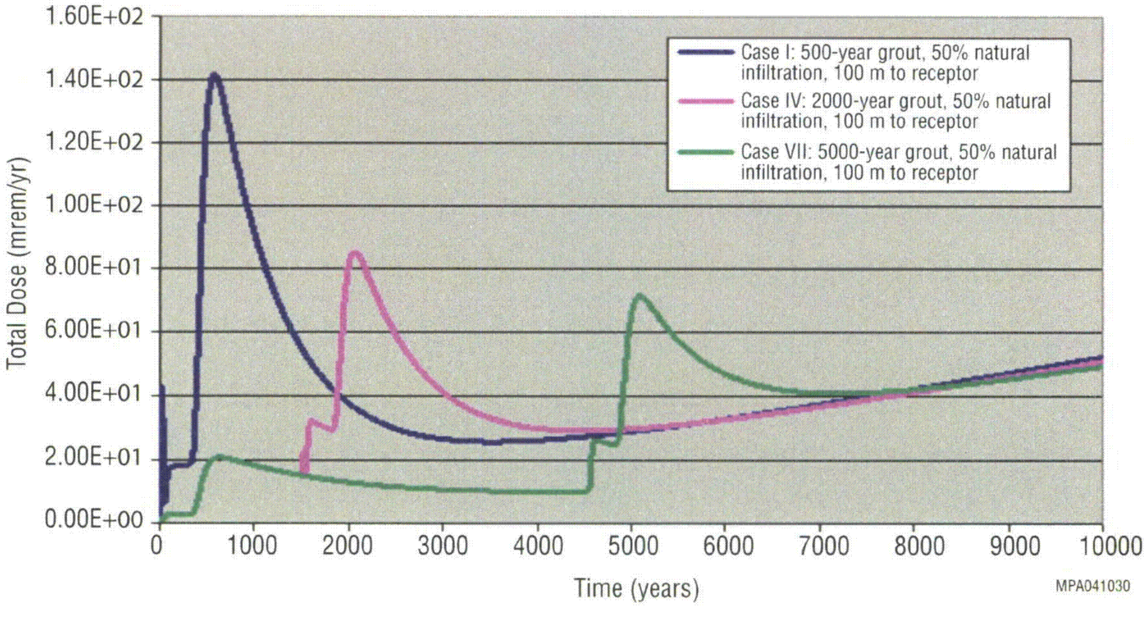

FIGURE E-7 Comparison of Annual Doses for Cases I, IV, and VII for Trench Disposal of Stored Group 1 GTCC-Like Other Waste - CH at SRS

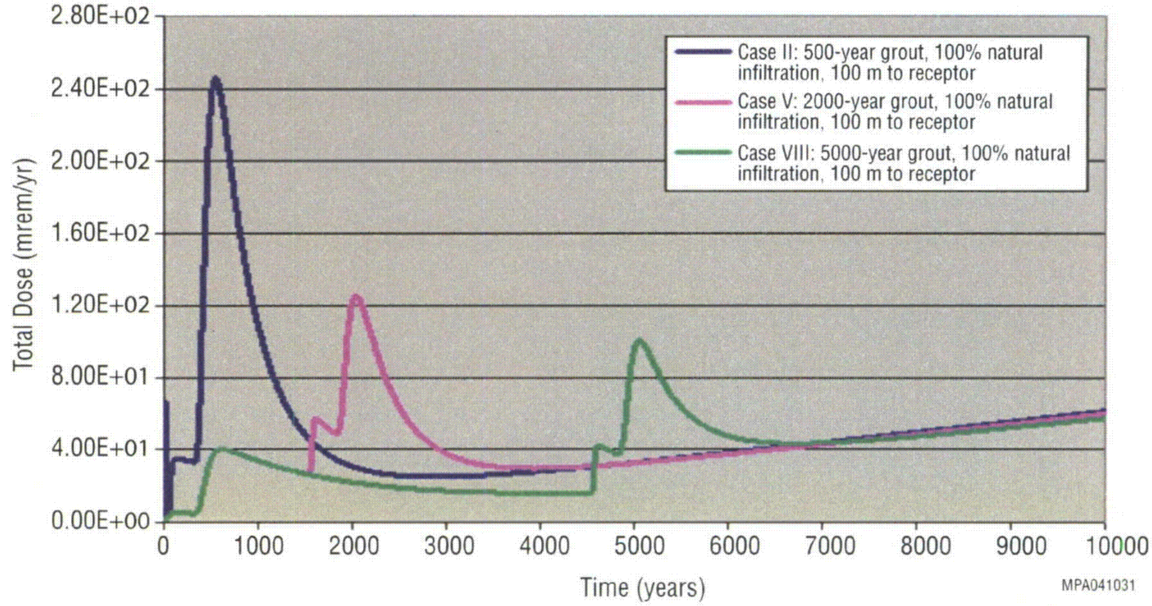

FIGURE E-8 Comparison of Annual Doses for Cases II, V, and VIII for Trench Disposal of Stored Group 1 GTCC-Like Other Waste - CH at SRS

For Case III in Figure E-6 (the first part of the curve overlaps with the curve for Case VI), the dose results were obtained by assuming the effectiveness of grouting would last for 2,000 years (i.e., the grouting would be effective for 1,500 years after water started to infiltrate into the waste containers). The grouting would reduce the releases of radionuclides and allow for more radioactive decay to take place in the containers. By the time the grout was no longer effective, the partitioning of radionuclides to the water phase would increase simultaneously, resulting in a sudden increase of the release rates, and the corresponding increase in radiation dose would be observed at a later time depending on the travel time required for the radionuclides to reach the receptor location. Because the grouting would have more influence on Np-237 than on Ra-226 (K_ds used for Np-237 and Ra-226 were 300 and 100 cm^3/g, respectively, in the analyses), the radiation dose within the effective period (the first 1,500 years in the RESRAD-OFFSITE analyses) would be largely contributed by Ra-226. After the effective period, the release rates of both Np-237 and Ra-226 would increase. However, because Np-237 (with a K_d of 0.6 cm^3/g) would travel faster than Ra-226 (with a K_d of 5 cm^3/g) in the soil column and groundwater aquifer, its influence on the radiation dose would be observed earlier (the first peak after 1,500 years in the dose profile) than that from Ra-226 (the second peak after 1,500 years in the dose profile). The grouting would also reduce the release rate of C-14 (a K_d of 10 cm^3/g was assumed for the grouting system); therefore, a sharp peak before 1,500 years would no longer be observed. The sharp peak (close to 1,500 years in the dose profiles) would occur after the effective period of the grout; however, the radioactivity of C-14 would have decayed some by then, so the sharp peak would become less obvious.

For Case VI in Figure E-6, the dose results were obtained by assuming that the effectiveness of grouting would last for 5,000 years. The dose profiles are similar to that for

Case III and can be explained by the same reasons provided in the previous paragraph, except that more decay and ingrowth of radioactivity would occur in the waste containers prior to the loss of grout effectiveness. The increased radioactive decay explains why magnitudes of the peaks after 4,500 years for Case VI are smaller than magnitudes of the peaks after 1,500 years for Case III. The increased ingrowth of progeny radionuclides explains why the difference in the maximum dose between Cases III and VI is less than the difference in the maximum dose between the Base Case and Case III.

The radiation dose incurred by the hypothetical resident farmer considered for post-closure impact analyses would decrease with increasing exposure distance, as demonstrated by the results for the Base Case and Cases IX and X (see also Figure E-9). As mentioned before, this result would occur because additional dilution of radionuclide concentrations in groundwater would result from the additional transport distance toward the location of the off-site well. As the distance would increase from 100 m (330 ft) to 500 m (1,600 ft), the maximum annual radiation dose would decrease by more than 70%.

Although the sensitivity analysis was not conducted with the entire inventory of GTCC LLRW and DOE GTCC-like waste, the results in this appendix provide a good indication of the dose reduction that would occur with the entire inventory under more favorable conditions than those assumed for the Base Case (i.e., a lower water infiltration rate with better engineering of the cover, a longer effective time for the stabilizing agent [grout], and a longer distance to a hypothetical receptor). It is expected that with more robust designs of engineering barriers and waste containment procedures, the actual human health impacts would be much lower than those presented in this EIS.

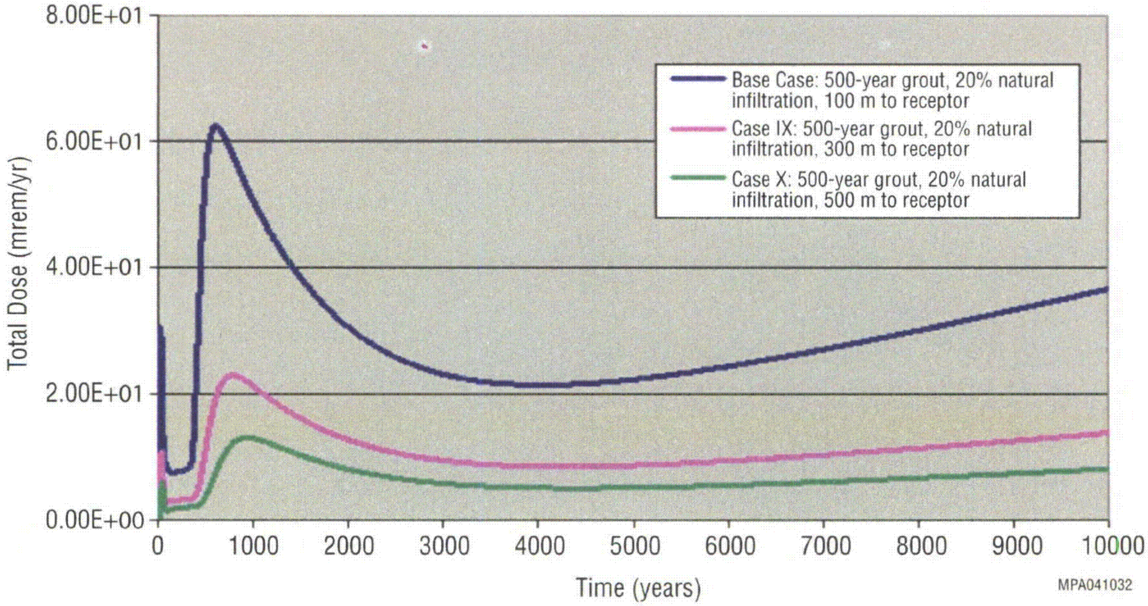

FIGURE E-9 Comparison of Annual Doses for the Base Case and Cases IX and X for Trench Disposal of Stored Group 1 GTCC-Like Other Waste - CH at SRS

TABLE E-1 Distribution Coefficients (cm^3/g) for Cementitious Systems (moderately aged concrete)[a]

Element	PNNL-13037 Rev. 2 (Krupka et al. 2004)	WSRC-TR-2006-0004 Rev. 0 (Kaplan 2006)		SRNL-RPA-2007-00006 (Kaplan 2007)		Mattigod et al. 2002[b]		Mattigod et al. 2002	Selected Value	
		Oxidizing	Reducing	Oxidizing	Reducing	Oxidizing	Reducing	Haddam Neck Samples	Oxidizing	Reducing
Ac	5,000	5,000	5,000	–[c]	–	–	–	–	1,000	1,000
Am	5,000	5,000	5,000	–	–	1,000–5,000	1,000–5,000	>230 – >1,750	1,000	1,000
C	10	10	10	–	–	100	100	–	10	10
Cm	5,000	5,000	5,000	–	–	1,000	1,000	–	1,000	1,000
Co	100	1,000	1,000	–	–	100	100	3,400–32,500, 180–380	100	100
Cs	30	4	4	–	–	20	20	14,800–26,800, 34–240	4	4
Fe	–	–	–	5,000	1,000	100	100	7–18	12	12
Gd	–	5,000	5,000	–	–	–	–	–	1,000	1,000
H	0	0	0	–	–	0	0	–	0	0
I	8	20	20	–	–	–	–	–	20	20
Mn	–	–	–	100	100	–	–	–	100	100
Mo	–	–	–	0.1	0.1	–	–	–	0.1	0.1
Nb	40	1,000	1,000	–	–	1,000	1,000	–	1,000	1,000
Ni	100	1,000	1,000	–	–	100	100	10-61	10	100
Np	2,000	2,000	2,000	–	–	2,000–5,000	5,000	>300 – >510	300	300
Pa	2,000	2,000	2,000	–	–	–	–	–	2,000	2,000
Pb	5,000	500	500	–	–	–	–	–	500	500
Po	–	500	500	–	–	–	–	–	500	500
Pu	5,000	5,000	5,000	–	–	5,000	5,000	>1,300 – >5,600	5,000	5,000
Ra	100	100	100	–	–	–	–	–	100	100
Sm	–	5,000	5,000	–	–	–	–	–	1,000	1,000
Sr	–	1	1	–	–	1–3	1–3	10–11	1	1
Tc	0	0	5,000	–	–	0-1	1,000	6–21	0	1,000
Th	5,000	5,000	5,000	–	–	5,000	5,000	–	5,000	5,000
U	1,000	1,000	5,000	–	–	–	–	–	1,000	5,000

[a] Sources for the K_d values for cementitious systems are Krupka et al. (2004), Kaplan (2006, 2007), and Mattigod et al. (2002).

[b] Values obtained from Table 5 of Mattigod et al. (2002) for Environment II, which considers moderately aged cement that may last from 100–10,000 years to 1,000–100,000 years. The original sources cited by Mattigod et al. (2002) for the K_d values are Krupka and Serne (1998) and Bradbury and Van Loon (1998).

[c] A dash means no information was available.

TABLE E-2 Inventories of the GTCC LLRW and GTCC-Like Waste in the Four NRC Regions for the No Action Alternative[a]

	Waste Volume (m^3)								
	GTCC LLRW				GTCC-Like Waste				
NRC Region	Activated Metals	Sealed Sources	Other Waste - CH	Other Waste - RH	Activated Metals	Sealed Sources	Other Waste - CH	Other Waste - RH	All Waste Types
I	960	520	1,600	2,000	0	0	930	1,300	7,300
II	420	740	0	390	2.9	0	270	270	2,100
III	220	420	0	0	0	0	0	0	640
IV	390	1200	42	33	9.9	0.83	31	19	1,700

	Waste Activity (Ci)								
	GTCC LLRW				GTCC-Like Waste				
NRC Region	Activated Metals	Sealed Sources	Other Waste - CH	Other Waste - RH	Activated Metals	Sealed Sources	Other Waste - CH	Other Waste - RH	All Waste Types
I	3.3E+07	3.7E+05	2.4E+04	3.1E+04	0.0	0.0	3.3E+04	4.9E+05	3.4E+07
II	5.2E+07	5.3E+05	0.0	9.8E+04	2.3E+05	0.0	2.4E+02	4.2E+04	5.3E+07
III	2.4E+07	3.0E+05	0.0	0.0	0.0	0.0	0.0	0.0	2.4E+07
IV	4.7E+07	8.2E+05	1.1E+01	9.5E+04	5.2+03	7.7E+01	1.3E+03	2.0E+02	4.8E+07

[a] All values are given to two significant figures.

TABLE E-3 RESRAD-OFFSITE Input Parameter Values for Groundwater Analysis for INL

Parameter	Value	Value Selection Rationale	Source
Site properties			
Wind speed (m/s)	3.4	Site-specific data.	WRCC 2007
Precipitation (m/yr)	0.22	Site-specific data.	WRCC 2007
Primary contamination area properties			
Irrigation (m/yr)	0	No agricultural activities.	Yu et al. 2007
Evapotranspiration coefficient	0.52	To obtain an infiltration rate of 4 cm/yr, which is close to the value used for the base-case scenario (4.1 cm/yr) in the performance assessment (PA) for the Tank Farm facility.	DOE 2003
Runoff coefficient	0.6212		
Rainfall and runoff	160	To obtain an erosion rate of 1E-5 m/yr for the cover and contamination zone (i.e., would yield more conservative results).	Yu et al. 2007 (applies to the sum of all four parameters at left)
Slope-length-steepness factor	10		
Cover and management factor	0.045		
Support practice factor	1		
Contaminated zone			
Total porosity	0.4		RESRAD-OFFSITE default
Erosion rate (m/yr)	1.00E-05	Chose a small value so that the contaminated zone would not be eroded away (i.e., would yield more conservative results).	Yu et al. 2007
Dry bulk density (g/cm^3)	1.8	Estimated average for different waste types, based on GTCC inventory data.	Sandia 2008
Soil erodibility factor	0.00112	To obtain an erosion rate of 1E-5 m/yr.	Yu et al. 2007
Field capacity	0.3		RESRAD-OFFSITE default
b-parameter	5.3		RESRAD-OFFSITE default
Hydraulic conductivity (m/yr)	10		RESRAD-OFFSITE default
Cover layer			
Total porosity	0.4		RESRAD-OFFSITE default
Erosion rate (m/yr)	1.00E-05	Chose a small value so that the buried waste would remain covered within the time frame considered (i.e., would yield more conservative groundwater results because there would be no losses through surface runoff and erosion).	Yu et al. 2007
Dry bulk density (g/cm^3)	1.5		RESRAD-OFFSITE default
Soil erodibility factor	0.00093	To obtain an erosion rate of 1E-5 m/yr.	Yu et al. 2007
Unsaturated Zone 1		Alluvium (surficial sediment, a coarse-grain unit consisting of predominantly sand and gravel).	
Thickness (m)	9.14	Based on Well USGS-51 strata information.	DOE 2003, p. 2-46
Density (g/cm^3)	1.643	Density for sandy clay/clay.	Yu et al. 2000, Table 3.1-1
Total porosity	0.5		DOE 2003

TABLE E-3 (Cont.)

Parameter	Value	Value Selection Rationale	Source
Effective porosity	0.5	Set to the same value as total porosity.	DOE 2003
Field capacity	0.1	Coarse grain retains less water.	
Hydraulic conductivity (m/yr)	29,200	Corresponds to 80 m/d used in the PA for the Tank Farm facility.	DOE 2003, p. 3-42
b-parameter	4.339	This b-parameter value, along with the hydraulic conductivity and infiltration rate, gives a moisture content of 0.16.	
Longitudinal dispersivity (m)	0	No dispersivity is assumed for all the sites.	
Unsaturated Zone 2		Thick-flow basalt units.	
Thickness (m)	94.64	Sum of thicknesses of thick-flow basalt layers. According to Well USGS-51 strata profile, thick-flow basalt constitutes roughly 90% of the total thickness of all basalt layers above the groundwater table.	
Density (g/cm^3)	2	Density for basalt.	DOE 2007
Total porosity	0.05	Value assumed for the basalt unit.	DOE 2003
Effective porosity	0.05	Set to the same as total porosity.	DOE 2003
Field capacity	0.001	Set to a value less than moisture content.	
Hydraulic conductivity (m/yr)	3,650	Corresponds to 10 m/d.	DOE 2003, p. 3-43
b-parameter	0.76	Selected to give a moisture content of 0.004, which is provided in INL's comments on RESRAD-OFFSITE input parameters.	Wilcox 2008
Longitudinal dispersivity (m)	0	No dispersivity is assumed for all sites.	
Unsaturated Zone 3		Upper interbed sequence with a low permeability.	
Thickness (m)	7.47	Sum of thicknesses of upper interbeds.	
Density (g/cm^3)	1.46	Value for silt loam.	NUREG/CR-6697 (Yu et al. 2000)
Total porosity	0.57	Porosity used for the C-D interbed in the Radioactive Waste Management Complex (RWMC) PA.	DOE 2006a
Effective porosity	0.57	Set to the same as total porosity.	DOE 2006a
Field capacity	0.3		RESRAD-OFFSITE default
Hydraulic conductivity (m/yr)	1.29	Corresponds to 0.0035 m/d, the geometric mean of 0.005 m/d and 0.0025 m/d assumed for the C-CD and D-DE2 interbeds in the Tank Farm facility PA.	DOE 2003

TABLE E-3 (Cont.)

Parameter	Value	Value Selection Rationale	Source
b-parameter	3.6	Calculated mean for silt loam soil. Distribution is log normal (1.28, 0.334). The b-parameter, along with the assumed infiltration rate and hydraulic conductivity, results in a moisture content of 0.414.	NUREG/CR-6697 (Yu et al. 2000)
Longitudinal dispersivity (m)	0	No dispersivity is assumed for all sites.	
Unsaturated Zone 4		Lower sedimentary interbeds.	
Thickness (m)	15.88	The difference between total thickness of the interbeds (estimated to be about 23.35 m according to the Well USGS-51 profile) and the thickness of the upper interbeds, 7.47 m.	
Density (g/cm^3)	1.643	Set to the value for alluvium sediment since they were assumed to have similar hydraulic characteristics in the Tank Farm facility PA.	DOE 2003
Total porosity	0.5		
Effective porosity	0.5	Set to the same as total porosity.	
Field capacity	0.3		RESRAD-OFFSITE default
Hydraulic conductivity (m/yr)	29,200	Set to the same value as for alluvium.	DOE 2003
b-parameter	10.4	Value for silty clay. This b-parameter value, along with the infiltration rate and hydraulic conductivity, results in a moisture content of 0.286.	
Longitudinal dispersivity (m)	0	No dispersivity is assumed for all sites.	
Unsaturated Zone 5		Thin-flow basalt units.	
Thickness (m)	15.39	Sum of thicknesses of thin-flow basalt layers. According to Well USGS-51 strata profile, thin flows basalt constitutes roughly 10% of the total thickness of all basalt layers above the groundwater table.	
Density (g/cm^3)	2	Density for basalt.	DOE 2007
Total porosity	0.05	Value assumed for the basalt unit.	DOE 2003
Effective porosity	0.05	Set to the same as total porosity.	DOE 2003
Field capacity	0.001	Set to a value less than moisture content.	
Hydraulic conductivity (m/yr)	365,000	Corresponds to 1,000 m/d.	DOE 2003, p. 3-43
b-parameter	1.67	Selected to give a moisture content of 0.004, which is provided in INL's comments on RESRAD-OFFSITE input parameters.	Wilcox 2008

TABLE E-3 (Cont.)

Parameter	Value	Value Selection Rationale	Source
Longitudinal dispersivity (m)	0	No dispersivity is assumed for all sites.	
Saturated zone hydrology			
Thickness (m)	495	Site-specific average (76–914 m).	Anderson and Lewis 1989
Density of saturated zone (g/cm^3)	2	Density for basalt.	DOE 2007
Total porosity	0.05	Value assumed for basalt.	DOE 2003
Effective porosity	0.05	Set to the same as total porosity.	DOE 2003
Hydraulic conductivity (m/yr)	1,979	Corresponds to 5.42 m/d (the geometric mean of the range from 3.0E-3 to 9.8E+3 m/d, reported as the effective hydraulic conductivity of the basalt and interbedded sediments that compose the Snake River Plain Aquifer at and near INL).	DOE 2003
Hydraulic gradient to well	0.00075	Average for the site (0.00019 to 0.0028), close to the average slope of the water table (4 ft/mi) reported in the Tank Farm facility PA.	McCarthy and McElroy 1995; Anderson and Lewis 1989; DOE 2003
Depth of aquifer contributing to well (m), below the water table	10		RESRAD-OFFSITE default
Longitudinal dispersivity (m)	10% of distance traveled	Assumption used for all sites, which is commonly used for groundwater transport modeling.	
Horizontal lateral dispersivity (m)	10% of longitudinal dispersivity		
Disperse vertically (yes/no)	Yes	To consider dispersion.	Yu et al. 2007
Vertical lateral dispersivity (m)	10% of the horizontal lateral dispersivity	Assumption used for all sites.	

TABLE E-4 Soil/Water Distribution Coefficients (K_d values)[a] for Different Radionuclides for INL

	K_d Value (cm^3/g)							
Element	Unsaturated Zone 1 (alluvium, surficial sediment)	Unsaturated Zone 2 (thick flow basalt units)	Unsaturated Zone 3 (upper interbed sequence with a low permeability)	Unsaturated Zone 4 (lower sedimentary interbeds)	Unsaturated Zone 5 (thin flow basalt units)	Saturated Zone	Value Selection Rationale[b]	Source
Ac	225	0	225	225	0	9	Based on comments from INL, the same K_d value was used for alluvium and interbeds. The basalt K_d was set to 0, and the K_d for the saturated zone was set to 1/25 that of alluvium and interbeds.	DOE 2007
Am	225	0	225	225	0	9	Same as for Ac.	DOE 2007
C	0.4	0	0.4	0.4	0	0.016	Same as for Ac.	DOE 2007
Cm	4,000	0	4,000	4,000	0	160	Same as for Ac.	DOE 2007
Co	10	0	10	10	0	0.40	Same as for Ac.	Jenkins 2001
Cs	500	0	500	500	0	20	Same as for Ac.	Jenkins 2001
Fe	220	0	220	220	0	8.8	Same as for Ac.	Jenkins 2001
Gd	240	0	240	240	0	9.6	Same as for Ac.	Jenkins 2001
H	0	0	0	0	0	0	Same as for Ac.	DOE 2007
I	0	0	0	0	0	0	Same as for Ac.	DOE 2007
Mn	50	0	50	50	0	2	Same as for Ac.	Jenkins 2001
Mo	10	0	10	10	0	0.4	Same as for Ac.	DOE 2007
Nb	500	0	500	500	0	20	Same as for Ac.	DOE 2007
Ni	100	0	100	100	0	4	Same as for Ac.	Jenkins 2001
Np	23	0	23	23	0	0.92	Same as for Ac.	DOE 2007
Pa	8	0	8	8	0	0.32	Same as for Ac.	DOE 2007
Pb	270	0	270	270	0	10.80	Same as for Ac.	DOE 2007
Po	150	0	150	150	0	6	Same as for Ac.	Jenkins 2001
Pu	2,500	0	2,500	2,500	0	100	Same as for Ac.	DOE 2007

TABLE E-4 (Cont.)

	K_d Value (cm^3/g)							
Element	Unsaturated Zone 1 (alluvium, surficial sediment)	Unsaturated Zone 2 (thick flow basalt units)	Unsaturated Zone 3 (upper interbed sequence with a low permeability)	Unsaturated Zone 4 (lower sedimentary interbeds)	Unsaturated Zone 5 (thin flow basalt units)	Saturated Zone	Value Selection Rationale[b]	Source
Ra	575	0	575	575	0	23	Same as for Ac.	DOE 2007
Sm	2,500	0	2,500	2,500	0	100	Same as for Ac.	DOE 2007
Sr	12	0	12	12	0	0.48	Same as for Ac.	Jenkins 2001
Tc	0	0	0	0	0	0	Same as for Ac.	DOE 2007
Th	500	0	500	500	0	20	Same as for Ac.	DOE 2007
U	15.4	0	15.4	15.4	0	0.616	Same as for Ac.	DOE 2007

[a] K_d values are listed for the unsaturated zones and the saturated zone. For the contaminated zone, the release fraction of radionuclides is correlated with the metal corrosion rate for the activated metal wastes, the site-specific soil K_d values for sealed sources, and site-specific soil K_d values and cementitious system K_d values for Other Waste.

[b] For INL's review comments on the RESRAD-OFFSITE input parameters, see Wilcox (2008).

TABLE E-5 RESRAD-OFFSITE Input Parameter Values for Groundwater Analysis for Hanford

Parameter	Value	Value Selection Rationale	Source
Site properties			
Wind speed (m/s)	3.4	Site-specific data at Hanford Meteorology Station (HMS), 50 m above ground.	DOE 2004
Precipitation (m/yr)	0.17	Site-specific data (54.39 in./yr), based on HMS measurements. Consistent with values reported by the Western Regional Climate Center (1948–2005).	DOE 2004, p. 4.16
Primary contamination area properties			
Irrigation (m/yr)	0	No agricultural activities.	Yu et al. 2007
Evapotranspiration coefficient	0.97878	In DOE 2005, the infiltration rate suggested for the post-design life for the sitewide surface barrier is 3.5 mm/yr; the post-design life for the Integrated Disposal Facility (IDF) surface barrier is 0.9 mm/yr. However, for the IDF surface barrier, a sensitivity analysis needs to be conducted for an infiltration rate of 5.0 mm/yr as well. Considering the recharge rate at the 200 E Area, which ranges from 1.5 to 4 mm/yr with shrub covering, and to be consistent with the other sites that use a natural infiltration rate for the GTCC analysis, an infiltration rate of 3.5 mm/yr was chosen for the groundwater analysis. To obtain an infiltration rate of 0.0035 m/yr (3.5 mm/yr), the evapotranspiration coefficient was calculated to be 0.97878.	DOE 2005
Runoff coefficient	0.03	Runoff is about 3% of the total precipitation; most of the remaining precipitation is lost through evapotranspiration.	Duncan et al. 2007
Rainfall and runoff	160	To obtain the desired erosion rates for the cover and contamination zone.	Yu et al. 2007 (applies to sum of all four parameters at left)
Slope-length-steepness factor	0.4		
Cover and management factor	0.003		
Support practice factor	1		

TABLE E-5 (Cont.)

Parameter	Value	Value Selection Rationale	Source
Contaminated zone			
Total porosity	0.4		RESRAD-OFFSITE default
Erosion rate (m/yr)	1.00E-05	Chose a small value so that the contaminated zone would not be eroded away. Will yield more conservative results.	Yu et al. 2007
Dry bulk density (g/cm^3)	1.8	Estimated average for different waste streams, based on preliminary GTCC waste inventory data.	Sandia 2008
Soil erodibility factor	0.42	To obtain the desired erosion rate.	Yu et al. 2007
Field capacity	0.3		RESRAD-OFFSITE default
b-parameter	5.3		RESRAD-OFFSITE default
Hydraulic conductivity (m/yr)	10		RESRAD-OFFSITE default
Cover layer			
Total porosity	0.4		RESRAD-OFFSITE default
Erosion rate (m/yr)	1.00E-05	Chose a small value so that the buried waste would remain covered within the time frame considered (i.e., would yield more conservative groundwater results because there would be no losses through surface runoff and erosion).	Yu et al. 2007
Dry bulk density (g/cm^3)	1.5		RESRAD-OFFSITE default
Soil erodibility factor	0.35	To obtain the desired erosion rate.	Yu et al. 2007
Unsaturated Zone 1		Fine sand plus coarse sand-dominated layers in the Hanford Formation. They were considered together because of their similar geological and hydrogeological properties.	
Thickness (m)	58	Average value calculated with the stratigraphic columns data for 200 E area.	Last et al. 2006
Density (g/cm^3)	1.65	For fine sand and coarse sand layers in Hanford Formation.	Last et al. 2006
Total porosity	0.37	Set to the same as effective porosity.	Last et al. 2006
Effective porosity	0.37	For fine sand and coarse sand layers in Hanford Formation.	Last et al. 2006
Field capacity	0.03	Residual moisture content.	Last et al. 2006
Hydraulic conductivity (m/yr)	710	Corresponding to 2.25E-3 cm/s. Selected based on the information presented in Last et al. 2006 for fine and coarse sands in Hanford Formation.	
b-parameter	4.05	Value for sand soil.	Yu et al. 2001
Longitudinal dispersivity (m)	0	No dispersion.	Assumption used for all sites

TABLE E-5 (Cont.)

Parameter	Value	Value Selection Rationale	Source
Unsaturated Zone 2		Gravel-dominated layers in the Hanford Formation plus Ringold Unit E. They were considered together because of their similar geological and hydrogeological properties.	
Thickness (m)	30	Average value calculated with the stratigraphic columns data for 200 E area.	Data presented in Last et al. 2006, Appendix A.
Density (g/cm^3)	1.93	For gravel-dominated layers in Hanford Formation and Ringold Unit E.	Last et al. 2006
Total porosity	0.27	Value for Hanford and Ringold gravel.	DOE 2009
Effective porosity	0.27	Set to the same as total porosity.	DOE 2009
Field capacity	0.024	Residual moisture content.	Last et al. 2006
Hydraulic conductivity (m/yr)	148	Corresponding to 4.68E-4 cm/s. Selected on the basis of information presented in Last et al. 2006 for gravel-dominated layers in Hanford Formation and Ringold Unit E.	Last et al. 2006
b-parameter	7.12	Value for sandy clay loam soil.	Yu et al. 2001, Table E-2
Longitudinal dispersivity (m)	0	No dispersion.	Assumption used for all sites.
Saturated zone hydrology		Consider the combination of the Hanford Formation and Ringold Unit E.	
Thickness (m)	45	Entire aquifer is 45 to 71.7 m thick. Use the lower value.	Horton 2007
Density of saturated zone (g/cm^3)	1.98	Calculated on the basis of a soil particle density of 2.65 g/cm^3 and a total porosity of 0.25.	
Total porosity	0.25	Used for unconfined aquifer.	Page O-91, DOE 2009
Effective porosity	0.25	Set to the same as total porosity.	Page O-91, DOE 2009
Hydraulic conductivity (m/yr)	12,775	Slug tests at five monitoring wells in the IDF location (Reidel 2004) indicate a high-permeability condition, ranging from >25 to >45 m/d. These estimates for the hydraulic conductivity beneath the IDF site are consistent with the unconfined aquifer flow through the gravel-dominated facies of the lower Hanford Formation. Use the average of 35 m/day, which converts to 12,775 m/yr.	Reidel 2004
Hydraulic gradient to well	0.00124	Geometric mean of the range from 0.00073 to 0.00209.	Horton 2007
Depth of aquifer contributing to well (m), below water table	10		RESRAD-OFFSITE default

TABLE E-5 (Cont.)

Parameter	Value	Value Selection Rationale	Source
Longitudinal dispersivity (m)	10% of distance traveled	Assumptions used for all sites. Common practices for groundwater transport modeling.	
Horizontal lateral dispersivity (m)	10% of longitudinal dispersivity		
Disperse vertically (yes/no)	Yes	To consider dispersion.	Yu et al. 2007
Vertical lateral dispersivity (m)	10% of horizontal lateral dispersivity	Assumptions used for all sites.	

TABLE E-6 Soil/Water Distribution Coefficients (K_d values)[a] for Different Radionuclides for Hanford

	K_d Value (cm^3/g)						
Source	Unsaturated Zone 1	Unsaturated Zone 2	Saturated Zone	Value Selection Rationale for Unsaturated Zone 1 and Saturated Zone	Source	Value Selection Rationale for Unsaturated Zone 2	Source
Ac	300	30	300	Best K_d value for far field in sand sequence with natural recharge (no impact from wastes).	Krupka et al. 2004, Table 5.6	Use 10% of the value for sand-dominated soil, an approach used in the groundwater data package.	Thorne et al. 2006
Am	1,900	190	1,900	To be consistent with values used in DOE 2009.	DOE 2009; Beyeler et al. 1999	Same as above.	Thorne et al. 2006
C	4	0.4	4	To be consistent with the values used in DOE 2009.	DOE 2005, 2009	Same as above.	Thorne et al. 2006
Cm	300	30	300	Best K_d value for far field in sand sequence with natural recharge (no impact from wastes).	Table 5.6, Krupka et al. 2004	Same as above.	Thorne et al. 2006
Co	2,000	200	2,000	Best K_d value for far field in sand sequence with natural recharge (no impact from wastes).	Table 5.6, Krupka et al. 2004	Same as above.	Thorne et al. 2006
Cs	80	8	80	To be consistent with the values used in DOE 2009.	DOE 2005, 2009	Same as above.	Thorne et al. 2006
Fe	220	22	220	Generic value for sand soil.	Site-specific value preferred. Sheppard and Thibault 1990; Yu et al. 2000	Same as above.	Thorne et al. 2006

TABLE E-6 (Cont.)

Source	K_d Value (cm^3/g) Unsaturated Zone 1	Unsaturated Zone 2	Saturated Zone	Value Selection Rationale for Unsaturated Zone 1 and Saturated Zone	Source	Value Selection Rationale for Unsaturated Zone 2	Source
Gd	825	82.5	825	Generic value for soil.	Yu et al. 2000	Same as above.	Thorne et al. 2006
H	0	0	0	To be consistent with the values used in DOE 2009.	DOE 2005, 2009	Same as above.	Thorne et al. 2006
I	0	0	0	To be consistent with the values used in DOE 2009.	DOE 2005, 2009	Same as above.	Thorne et al. 2006
Mn	50	5	50	To be consistent with the values used DOE 2009.	Sheppard and Thibault 1990, Yu et al. 2000	Same as above.	Thorne et al. 2006
Mo	10	1	10	To be consistent with the values used DOE 2009.	Sheppard and Thibault (1990); Yu et al. 2000	Same as above.	Thorne et al. 2006
Nb	300	30	300	Best K_d value for far field in sand sequence with natural recharge (no impact from wastes).	Krupka et al. 2004, Table 5.6	Same as above.	Thorne et al. 2006
Ni	400	40	400	To be consistent with the values used in DOE 2009.	DOE 2009; Beyeler et al. 1999	Same as above.	Thorne et al. 2006
Np	2.5	0.25	2.5	To be consistent with the values used in DOE 2009.	DOE 2005, 2009	Same as above.	Thorne et al. 2006
Pa	2.5	0.25	2.5	Set to the same values as Np.	DOE 2005, 2009	Same as above.	Thorne et al. 2006
Pb	80	8	80	To be consistent with the values used in DOE 2009.	DOE 2005, 2009	Same as above.	Thorne et al. 2006

TABLE E-6 (Cont.)

Source	K_d Value (cm^3/g) Unsaturated Zone 1	Unsaturated Zone 2	Saturated Zone	Value Selection Rationale for Unsaturated Zone 1 and Saturated Zone	Source	Value Selection Rationale for Unsaturated Zone 2	Source
Po	150	15	150	Generic value for sand soil.	Sheppard and Thibault 1990; Yu et al. 2000	Same as above.	Thorne et al. 2006
Pu	150	15	150	To be consistent with the values used in DOE 2009.	DOE 2005, 2009	Same as above.	Thorne et al. 2006
Ra	10	1	10	Same as Sr.	DOE 2005	Same as above.	Thorne et al. 2006
Sm	300	30	300	Same as Ac.	Krupka et al. 2004, Table 5.6	Same as above.	Thorne et al. 2006
Sr	10	1	10	To be consistent with the values used in DOE 2009.	DOE 2005, 2009	Same as above.	Thorne et al. 2006
Tc	0	0	0	To be consistent with the values used in DOE 2009.	DOE 2005, 2009	Same as above.	Thorne et al. 2006
Th	3,200	320	3,200	To be consistent with the values used in DOE 2009.	DOE 2009; Beyeler et al. 1999	Same as above.	Thorne et al. 2006
U	0.6	0.06	0.6	To be consistent with the values used in DOE 2009.	DOE 2009; Beyeler et al. 1999	Same as above.	Thorne et al. 2006

[a] K_d values are listed for the unsaturated zones and the saturated zone. For the contaminated zone, the release fraction of radionuclides is correlated with the metal corrosion rate for the activated metal wastes, the site-specific soil K_d values for sealed sources, and the site-specific soil K_d values and cementitious system K_d values for Other Waste.

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TABLE E-7 RESRAD-OFFSITE Input Parameter Values for Groundwater Analysis for LANL

Parameter	Value	Value Selection Rationale	Source
Site properties			
Wind speed (m/s)	2.65	Geometric mean of the distribution log normal (2.65, 1.35).	Distribution information from Henckel 2008. The distribution function is based on wind speed data collected at the meteorological tower at TA-54 from January 1992 through April 2005 (http://weather.lanl.gov)
Precipitation (m/yr)	0.356	Site-specific data.	Bowen 1990
Primary contamination area properties			
Irrigation (m/yr)	0	No agricultural activities.	Yu et al. 2007
Evapotranspiration coefficient	0.9	To obtain an infiltration rate of 5 mm/yr, which was determined for use in the analysis on the basis of the histogram shown on p. 23 of Stauffer et al. 2005.	Stauffer et al. 2005
Runoff coefficient	0.8596		
Rainfall and runoff	160	To obtain the erosion rates used as the input values for the cover and contamination zone.	Yu et al. 2007 (applies to the sum of all four parameters at left)
Slope-length-steepness factor	10		
Cover and management factor	0.045		
Support practice factor	1		
Contaminated zone			
Total porosity	0.4		RESRAD-OFFSITE default
Erosion rate (m/yr)	1.00E-05	Chose a small value so that the buried waste would remain covered within the time frame considered (i.e., would yield more conservative groundwater results because there would be no losses through surface runoff and erosion).	Yu et al. 2007
Dry bulk density (g/cm^3)	1.8	Estimated average for different waste streams, on the basis of preliminary GTCC waste inventory data.	Sandia 2008
Soil erodibility factor	0.00112	To obtain the erosion rate used for the input value.	Yu et al. 2007
Field capacity	0.3		RESRAD-OFFSITE default
b-parameter	5.3		RESRAD-OFFSITE default
Hydraulic conductivity (m/yr)	10		RESRAD-OFFSITE default
Cover layer			
Total porosity	0.4		RESRAD-OFFSITE default
Erosion rate (m/yr)	1.00E-05	Chose a small value so that the cover material would not be eroded away completely within the time frame considered.	Yu et al. 2007
Dry bulk density (g/cm^3)	1.5		RESRAD-OFFSITE default
Soil erodibility factor	0.00093	To obtain the erosion rate used for the input value.	Yu et al. 2007

TABLE E-7 (Cont.)

Parameter	Value	Value Selection Rationale	Source
Unsaturated Zone 1		Tshirege Member Unit 2.	
Thickness (m)	13	Determined on the basis of as-drilled data for Well R-22.	Stauffer et al. 2005, Table 2
Density (g/cm^3)	1.4	Value for Tshirege Member Unit 2.	Stauffer et al. 2005, Table 4
Total porosity	0.41	Value for Tshirege Member Unit 2.	Stauffer et al. 2005, Table 4
Effective porosity	0.41	Set to the same value as total porosity.	
Field capacity	0.02	Set to a smaller value than 0.024, the moisture content for a saturation of 0.06.	
Hydraulic conductivity (m/yr)	61.81	Corresponds to a permeability of 2.0E-13 m^2 for the Tshirege Member Unit 2.	Stauffer et al. 2005, Table 4
b-parameter	0.175	Selected to give a saturation of 0.06, an approximated value based on the range of site data for Unit 2 presented in Figure 2.1-2 of Birdsell et al. 1999.	Birdsell et al. 1999
Longitudinal dispersivity (m)	0	No dispersion for vadose zone, an assumption applied to all sites.	
Unsaturated Zone 2		Tshirege Units 1v, 1g, and Cerro Toledo interval.	
Thickness (m)	26	Determined based on as-drilled data for Well R-22.	Stauffer et al. 2005, Table 2
Density (g/cm^3)	1.2	Average value for Tshirege Member Unit 5.	Stauffer et al. 2005, Table 4
Total porosity	0.47	Average value for Tshirege Units 1f, 1g, and Cerro Toledo interval.	Stauffer et al. 2005, Table 4
Effective porosity	0.47	Set to the same value as total porosity.	
Field capacity	0.02	Set to a smaller value than 0.094, the moisture content for a saturation of 0.2.	
Hydraulic conductivity (m/yr)	46.36	Corresponds to a permeability of 1.5E-13 m^2, the average for Tshirege Member Units 1v, 1g, and Cerro Toledo interval.	Stauffer et al. 2005, Table 4
b-parameter	1.339	Selected to give a saturation of 0.2, an approximated value based on the range of site data for Unit 2 presented in Figure 2.1-2 of Birdsell et al. 1999.	Birdsell et al. 1999
Longitudinal dispersivity (m)	0	No dispersion for vadose zone, an assumption applied to all sites.	

TABLE E-7 (Cont.)

Parameter	Value	Value Selection Rationale	Source
Unsaturated Zone 3		Otowi Member above Guaje Pumice.	
Thickness (m)	16	Determined based on as-drilled data for Well R-22.	Stauffer et al. 2005, Table 2
Density (g/cm^3)	1.2	Value for Otowi Member above Guaje Pumice.	Stauffer et al. 2005, Table 4
Total porosity	0.44	Value for Otowi Member above Guaje Pumice.	Stauffer et al. 2005, Table 4
Effective porosity	0.44	Set to the same value as total porosity.	
Field capacity	0.04	Set to a smaller value than 0.12; the moisture content corresponds to a saturation of 0.27.	
Hydraulic conductivity (m/yr)	71.08	Corresponds to a permeability of 2.3E-13 m^2 for Otowi Member above Guaje Pumice.	Stauffer et al. 2005, Table 4
b-parameter	2.152	Selected to give a saturation of 0.27, an approximated value based on a range of site data in Figure 2.1-2 of Birdsell et al. 1999.	Birdsell et al. 1999
Longitudinal dispersivity (m)	0	No dispersion for vadose zone, an assumption applied to all sites.	
Unsaturated Zone 4		Otowi Member Guaje Pumice.	
Thickness (m)	3	Determined based on as-drilled data for Well R-22.	Stauffer et al. 2005, Table 2
Density (g/cm^3)	0.8	Value for Otowi Member Guaje Pumice.	Stauffer et al. 2005, Table 4
Total porosity	0.67	Value for Otowi Member Guaje Pumice.	Stauffer et al. 2005, Table 4
Effective porosity	0.67	Set to the same value as total porosity.	
Field capacity	0.00001	Set to a small value so that it is not used to reset the saturation ratio calculated.	
Hydraulic conductivity (m/yr)	46.36	Corresponds to a permeability of 1.5E-13 m^2 for the Otowi Member Guaje Pumice.	Stauffer et al. 2005, Table 4
b-parameter	1.891	Selected to give a saturation of 0.26, an approximated value based on a range of site data presented in Figure 2.1-2 of Birdsell et al. 1999.	Birdsell et al. 1999
Longitudinal dispersivity (m)	0	No dispersion for vadose zone, an assumption applied to all sites.	
Unsaturated Zone 5		Cerros del Rio basalts vadose zone.	
Thickness (m)	211	Determined on the basis of as-drilled data for Well R-22.	Stauffer et al. 2005, Table 2
Density (g/cm^3)	2.7	Value for the basalts.	Stauffer et al. 2005, Table 4

TABLE E-7 (Cont.)

Parameter	Value	Value Selection Rationale	Source
Total porosity	0.001	Value for basalts vadose zone.	Stauffer et al. 2005, Table 4
Effective porosity	0.001	Set to the same value as total porosity.	
Field capacity	0.00001	Set to a small value so that it is not used to reset the saturation ratio calculated.	
Hydraulic conductivity (m/yr)	309.05	Corresponds to a permeability of 1.0E-12 m^2 for the basalts vadose zone.	Stauffer et al. 2005, Table 4
b-parameter	2.713	Selected to give a saturation of 0.27, an approximated value based on the range of site data presented in Figure 2.1-2 of Birdsell et al. 1999.	Birdsell et al. 1999
Longitudinal dispersivity (m)	0	No dispersion for vadose zone, an assumption applied to all sites.	
Saturated zone hydrology		Cerro del Rio basalts saturated zone.	
Thickness (m)	37.5	Used for groundwater modeling.	Stauffer et al. 2005
Density of saturated zone (g/cm^3)	2.7	Value for the basalts.	Stauffer et al. 2005, Table 4
Total porosity	0.05	Value for basalts saturated zone.	Stauffer et al. 2005, Table 4
Effective porosity	0.05	Set to the same value as total porosity.	
Hydraulic conductivity (m/yr)	309.05	Corresponds to a permeability of 1.0E-12 m^2 for the basalts vadose zone.	Stauffer et al. 2005, Table 4
Hydraulic gradient to well	0.013		Stauffer et al. 2005, Section 3.1.4.3
Depth of aquifer contributing to well (m), below water table	10		RESRAD-OFFSITE default
Longitudinal dispersivity (m)	10% of distance traveled	Assumption applied to all sites considered. A common practice used in groundwater modeling.	
Horizontal lateral dispersivity (m)	10% of the longitudinal dispersivity		
Disperse vertically (yes/no)	Yes	To consider dispersion.	Yu et al. 2007
Vertical lateral dispersivity (m)	10% of the horizontal lateral dispersivity	Assumption applied to all sites considered.	

TABLE E-8 Soil/Water Distribution Coefficients (K_d values)[a] for Different Radionuclides for LANL

	K_d Value (cm^3/g)			
Element	Unsaturated Zone	Saturated Zone	Value Selection Rationale	Source
Ac	130	130	Value suggested by French of LANL for use in RESRAD-OFFSITE modeling to develop a GTCC waste disposal facility.	French 2008; Wolsberg 1980
Am	2,400	2,400	Most likely value based on the distribution, T (2.0E+02, 2.4E+3, 2.7E+04).	French 2008; Longmire et al. 1996
C	0	0	For volcanic tuff.	Birdsell et al. 1999; Krier et al. 1997; Brookins 1984; French 2008
Cm	50	50	For devitrified volcanic tuff.	Birdsell et al. 1999; Krier et al. 1997; Brookins 1984; French 2008
Co	0.45	0.45	For volcanic tuff.	Birdsell et al. 1999; Krier et al. 1997; Brookins 1984; French 2008
Cs	7.5	7.5	Mean of distribution, U(1.0E+0, 1.5E+01, 7.5E+0).	French 2008; Bechtel/SAIC 2004
Fe	209	209	Value for generic soil.	Yu et al. 2000
Gd	50	50	Value for generic soil.	Krier et al. 1997
H	0	0	Assumed no adsorption.	Krier et al. 1997
I	0	0	For volcanic tuff.	Birdsell et al. 1999; Krier et al. 1997
Mn	158	158	Value for generic soil.	Yu et al. 2000
Mo	4	4	For volcanic tuff.	Birdsell et al. 1999; Krier et al. 1997; Brookins 1984
Nb	100	100	For volcanic tuff.	Birdsell et al. 1999; Krier et al. 1997; Brookins 1984
Ni	50	50	For volcanic tuff.	Birdsell et al. 1999; Krier et al. 1997; Brookins 1984
Np	2.2	2.2	Most likely value based on the distribution, T(1.7E-01, 2.2E+0, 3.1E+0).	French 2008; Longmire et al. 1996
Pa	5,500	5,500	Mean of the distribution, TN(5.5E+03, 1.5E+03, 1.0E+03, 1.0E+04).	French 2008; Bechtel/SAIC 2004
Pb	25	25	For volcanic tuff.	Birdsell et al. 1999; Krier et al. 1997; Brookins 1984
Po	10	10	Value for generic soil.	Yu et al. 2000
Pu	4.10	4.10	Geometric mean for volcanic tuff (4.1-110).	Birdsell et al. 1999, Krier et al. 1997
Ra	500	500	Mean of the distribution, U(1.0E+2, 1.0E+03, 5.0E+02).	French 2008; Bechtel/SAIC 2004
Sm	50	50	Set to the same value as Gd.	Krier et al. 1997; Baes et al. 1984
Sr	40	40	Mean of the distribution, U(1.0E+0, 7.0E+01, 4.0E+01).	French 2008; Bechtel/SAIC 2004
Tc	0	0	Assumed no adsorption.	Birdsell et al. 1999; Krier et al. 1997; French 2008; Longmire et al. 1996
Th	5,000	5,000	Mean of the distribution, U(1.0E+3, 1.0E+04, 5.0E+03).	French 2008; Bechtel/SAIC 2004
U	2.4	2.4	Most likely value based on the distribution, T(1.4E+0, 2.4E+0, 3.5E+0).	French 2008; Longmire et al. 1996

[a] K_d values are listed for the unsaturated zones and the saturated zone. For the contaminated zone, the release fraction of radionuclides is correlated with the metal corrosion rate for the activated metal wastes, the site-specific soil K_d values for sealed sources, and site-specific soil K_d values and cementitious system K_d values for Other Waste.

TABLE E-9 RESRAD-OFFSITE Input Parameter Values for Groundwater Analysis for NNSS

Parameter	Value	Value Selection Rationale	Source
Site properties			
Wind speed (m/s)	2.6	Site-specific data.	Bechtel Nevada 2006
Precipitation (m/yr)	0.13	Site-specific data.	National Security Technologies, LLC 2008
Primary contamination area properties			
Irrigation (m/yr)	0	No agricultural activities.	Yu et al. 2007
Evapotranspiration coefficient	0.99	Selected to give an infiltration rate of 0.00003 m/yr, which is the site-specific hydraulic conductivity for the vadose zone.	Shott et al. 1998
Runoff coefficient	0.977		
Rainfall and runoff	160	To obtain the erosion rates used as the input values for the cover and contamination zone.	Yu et al. 2007 (applies to sum of all four parameters at left)
Slope-length-steepness factor	0.4		
Cover and management factor	0.003		
Support practice factor	1		
Contaminated zone			
Total porosity	0.4		RESRAD-OFFSITE default
Erosion rate (m/yr)	1.00E-05	Chose a small value so that the buried waste would remain covered within the time frame considered (i.e., would yield more conservative groundwater results because there would be no losses through surface runoff and erosion).	Yu et al. 2007
Dry bulk density (g/cm^3)	1.8	Estimated average for different waste streams, based on preliminary GTCC waste inventory data.	Sandia 2008
Soil erodibility factor	0.42	To obtain the erosion rate used as the input value.	Yu et al. 2007
Field capacity	0.3		RESRAD-OFFSITE default
b-parameter	5.3		RESRAD-OFFSITE default
Hydraulic conductivity (m/yr)	10		RESRAD-OFFSITE default
Cover layer			
Total porosity	0.4		RESRAD-OFFSITE default
Erosion rate (m/yr)	1.00E-05	Chose a small value so that the cover material would not be eroded away completely within the time frame considered. Would yield more conservative results.	Yu et al. 2007
Dry bulk density (g/cm^3)	1.5		RESRAD-OFFSITE default
Soil erodibility factor	0.35	To obtain the erosion rate used as the input value.	Yu et al. 2007
Unsaturated Zone 1			
Thickness (m)	246	Average of the range from 235.3 to 256.6 m.	Bechtel Nevada 2001, 2002

TABLE E-9 (Cont.)

Parameter	Value	Value Selection Rationale	Source
Density (g/cm^3)	1.65	Site-specific data.	Shott et al. 1998
Total porosity	0.36	Site-specific data.	Shott et al. 1998
Effective porosity	0.36	Site-specific data.	Shott et al. 1998
Field capacity	0.3		RESRAD-OFFSITE default
Hydraulic conductivity (m/yr)	0.00003	Site-specific data.	Shott et al. 1998
b-parameter	5.3		RESRAD-OFFSITE default
Longitudinal dispersivity (m)	0	No dispersivity was assumed for the unsaturated zone.	Assumption used for all sites.
Saturated zone hydrology			
Thickness (m)	220	Average value from well monitoring data.	Reynolds Electrical & Engineering Company, Inc. 1994
Density of saturated zone (g/cm^3)	1.6	Site-specific data.	Shott et al. 1998
Total porosity	0.36	Site-specific data.	Shott et al. 1998
Effective porosity	0.36	Site-specific data.	Shott et al. 1998
Hydraulic conductivity (m/yr)	439	Site-specific data.	Shott et al. 1998
Hydraulic gradient to well	9.70E-05	Site-specific data.	National Security Technologies, LLC 2008
Depth of aquifer contributing to well (m), below water table	10		RESRAD-OFFSITE default
Longitudinal dispersivity (m)	10% of the distance traveled	Assumption used for all sites. Common practice for groundwater modeling.	
Horizontal lateral dispersivity (m)	10% of the longitudinal dispersivity	Assumption used for all sites. Common practice for groundwater modeling.	
Disperse vertically (yes/no)	Yes	To consider dispersion.	Yu et al. 2007
Vertical lateral dispersivity (m)	10% of the horizontal lateral dispersivity	Assumption used for all sites.	

TABLE E-10 Soil/Water Distribution Coefficients for Different Radionuclides for NNSS[a]

	K_d Value (cm^3/g)			
Element	Unsaturated Zone	Saturated Zone	Value Selection Rationale	Source
Ac	7,000	7,000	Mean value of the distribution used in the Area 5 Radioactive Waste Management Site (RWMS) performance assessment (PA) model.	Bechtel Nevada 2006
Am	7,000	7,000	Same as Ac.	Bechtel Nevada 2006
C	0	0	Same as Ac.	Bechtel Nevada 2006
Cm	4,000	4,000	Suggested value for sandy soil.	Yu et al. 2000
Co	60	60	Suggested value for sandy soil.	Yu et al. 2000
Cs	280	280	Suggested value for sandy soil.	Yu et al. 2000
Fe	209	209	Suggested value for generic soil.	Yu et al. 2000
Gd	825	825	Suggested value for generic soil.	Yu et al. 2000
H	0	0	Value used in the Area 5 RWMS PA model.	Bechtel Nevada 2006
I	0	0	Value used in the Area 5 RWMS PA model.	Bechtel Nevada 2006
Mn	50	50	Suggested value for sandy soil.	Yu et al. 2000
Mo	10	10	Suggested value for sandy soil.	Yu et al. 2000
Nb	7,000	7,000	Mean value of the distribution used in the Area 5 RWMS PA model.	Bechtel Nevada 2006
Ni	100	100	Same as Nb.	Bechtel Nevada 2006
Np	5	5	Same as Nb.	Bechtel Nevada 2006
Pa	5	5	Same as Nb.	Bechtel Nevada 2006
Pb	300	300	Same as Nb.	Bechtel Nevada 2006
Po	300	300	Set to the same value as Pb.	Bechtel Nevada 2006
Pu	7.5	7.5	Same as Nb.	Bechtel Nevada 2006
Ra	185	185	Same as Nb.	Bechtel Nevada 2006
Sm	245	245	Set to the same value as Eu used in the Area 5 RWMS PA model.	Bechtel Nevada 2006
Sr	420	420	Same as Nb.	Bechtel Nevada 2006
Tc	0	0	Same as Nb.	Bechtel Nevada 2006
Th	7,000	7,000	Same as Nb.	Bechtel Nevada 2006
U	0.8	0.8	Same as Nb.	Bechtel Nevada 2006

[a] K_d values are listed for the unsaturated zones and the saturated zone. For the contaminated zone, the release fraction of radionuclides is correlated with the metal corrosion rate for the activated metal wastes, the site-specific soil K_d values for sealed sources, and site-specific soil K_d values and cementitious system K_d values for Other Waste.

TABLE E-11 RESRAD-OFFSITE Input Parameter Values for Groundwater Analysis for SRS

Parameter	Value	Value Selection Rationale	Source
Site properties			
Wind speed (m/s)	3	Site-specific data.	SRCC 2007a
Precipitation (m/yr)	1.2	Site-specific data.	SRCC 2007b; Cook et al. 2004
Primary contamination area properties			
Irrigation (m/yr)	0	No agricultural activities.	Yu et al. 2007
Evapotranspiration coefficient	0.598	On the basis of both coefficients, an infiltration rate of 0.376 m/yr (14.8 in./yr) was derived. The Flach et al. 2005 estimate for trenches covered with a 4-ft operational soil cover and topsoil is 14.8 in./yr. The Young and Pohlmann 2003 study shows an infiltration rate ranging from 9 to 16 in./yr with a median value of 14.8 in./yr, or 1/3 of the yearly rainfall of approximately 48 in. The above information is cited in WSRC 2008, Part C, pp. 68 and 69.	WSRC 2008 (applies to both parameters at left)
Runoff coefficient	0.221		
Rainfall and runoff	160	To obtain the desired erosion rates for the cover and contamination zone.	Yu et al. 2007 (applies to sum of all four parameters at left)
Slope-length-steepness factor	10		
Cover and management factor	0.045		
Support practice factor	1		
Contaminated zone			
Total porosity	0.4		RESRAD-OFFSITE default
Erosion rate (m/yr)	1.01E-05	Chose a small value so that the contaminated zone would not be eroded away. Will yield more conservative results.	Yu et al. 2007
Dry bulk density (g/cm^3)	1.8	Estimated average for different waste streams, based on preliminary GTCC waste inventory data.	Sandia 2008
Soil erodibility factor	0.00112	To obtain the desired erosion rate.	Yu et al. 2007
Field capacity	0.3		RESRAD-OFFSITE default
b-parameter	5.3		RESRAD-OFFSITE default
Hydraulic conductivity (m/yr)	10		RESRAD-OFFSITE default

TABLE E-11 (Cont.)

Parameter	Value	Value Selection Rationale	Source
Cover layer			
Total porosity	0.4		RESRAD-OFFSITE default
Erosion rate (m/yr)	1.00E-05	Chose a small value so that the buried waste would remain covered within the time frame considered (i.e., would yield more conservative groundwater results because there would be no losses through surface runoff and erosion).	Yu et al. 2007
Dry bulk density (g/cm^3)	1.5		RESRAD-OFFSITE default
Soil erodibility factor	0.00093	To obtain the desired erosion rate.	Yu et al. 2007
Unsaturated Zone 1			
Thickness (m)	6.1	According to Part B, Figure 1-6, of WSRC 2008, the thickness of the upper vadose zone can be calculated as the sum of the thicknesses of the soil fill (4 ft), upper waste zone (2.5 ft), and lower waste zone (13.5 ft). The total is 20 ft, (i.e., 6.1 m).	WSRC 2008, Figure 1-6
Density (g/cm^3)	1.65	Calculated with a soil particle density of 2.70 g/cm^3 and an effective porosity of 0.39.	WSRC 2008, Part B, Table 1-14
Total porosity	0.39		WSRC 2008, Part B, Table 1-14, p. 1-55
Effective porosity	0.39	Set to the same value as total porosity.	
Field capacity	0.3		RESRAD-OFFSITE default
Hydraulic conductivity (m/yr)	2.7	For upper vadose zone.	WSRC 2008, Part B, Table 1-14, Appendix G, Table G-2
b-parameter	6.62	Mean of distribution, log normal (LN) (1.89, 0.260) for sandy clay soil.	Yu et al. 2000
Longitudinal dispersivity (m)	0		WSRC 2008, p. 2-43
Unsaturated Zone 2			
Thickness (m)	16.9	The water table in the E-Area and Z-Area is approximately 20 to 25 m below the ground surface.	Kaplan 2006
Density (g/cm^3)	1.62	Calculated with a soil particle density of 2.66 g/cm^3 and an effective porosity of 0.39.	WSRC 2008, Table 1-14
Total porosity	0.39	Used for PORFLOW transport analysis for lower vadose zone.	WSRC 2008, p. 2043
Effective porosity	0.39	For lower vadose zone.	WSRC 2008, Table 1-14
Field capacity	0.3		RESRAD-OFFSITE default
Hydraulic conductivity (m/yr)	29	For lower vadose zone.	WSRC 2008, Tables 1-14, G-2
b-parameter	4.1	Mean of distribution, LN (1.41, 0.275), for sandy clay loam.	Yu et al. 2000
Longitudinal dispersivity (m)	0		WSRC 2008, p. 2-43

TABLE E-11 (Cont.)

Parameter	Value	Value Selection Rationale	Source
Saturated zone hydrology			
Thickness (m)	27.85	Mean of the range of site-specific data (15.5–40.2 m), including thicknesses from the upper and lower aquifer zones and the tan clay confining zone.	For E Area, Cook et al. 2004
Density of saturated zone (g/cm^3)	1.39	Considering the distribution of local clayey sediments throughout the sandy aquifer.	WSRC 2008, p. 1-67
Total porosity	0.38	For sandy material associated with aquifers.	WSRC 2008, p. 1-57
Effective porosity	0.25	Considering the distribution of local clayey sediments throughout the sandy aquifer.	WSRC 2008, p. 1-67
Hydraulic conductivity (m/yr)	1,265	Geometric mean of the values for Upper Three Runs aquifer and Lower Three Runs aquifers.	WSRC 2008, p. 1-57 and Table G-1
Hydraulic gradient to well	0.0079	Geometric mean of the site-specific range for Aquifer Unit IIB, 0.0035–0.018.	MMES et al.1994
Depth of aquifer contributing to well (m), below water table	10		RESRAD-OFFSITE default
Longitudinal dispersivity (m)	10% of the distance traveled	Assumption used for all sites. Common practice for groundwater modeling.	
Horizontal lateral dispersivity (m)	1% of distance traveled	Assumption used for all sites. Common practice for groundwater modeling.	
Disperse vertically (yes/no)	Yes	To consider dispersion.	Yu et al. 2007
Vertical lateral dispersivity (m)	0.1% of distance traveled	Assumption used for all sites.	

TABLE E-12 Soil/Water Distribution Coefficients for Different Radionuclides for SRS[a]

	K_d Value (cm^3/g)				
Element	Unsaturated Zone 1	Unsaturated Zone 2	Saturated Zone	Value Selection Rationale	Source
Ac	8,500	1,100	1,100	Clay/sand material best estimated K_d. Clay material K_d for unsaturated Zone 1. Sand material K_d for unsaturated Zone 2 and saturated zone.	WSRC 2008, Table 2-33; Kaplan 2006
Am	8,500	1,100	1,100	Same as above.	Same as above
C	0	0	0	Same as above.	Same as above
Cm	8,500	1,100	1,100	Same as above.	Same as above
Co	30	7	7	Best value for clayey/sandy sediment.	Kaplan 2006, Table 10
Cs	250	50	50	Best value for sandy/clayey sediment.	Kaplan 2006, Table 10
Fe	400	200	200	Best value for clayey/sandy soil.	Kaplan 2007
Gd	8,500	1,100	1,100	Best value for clayey/sandy sediment.	Kaplan 2006, Table 10
H	0	0	0	Clay/sand material best estimated K_d. Clay material K_d for unsaturated Zone 1. Sand material K_d for unsaturated Zone 2 and saturated zone.	WSRC 2008, Table 2-33; the values listed were obtained from Kaplan 2006
I	0.6	0	0	Same as above.	Same as above
Mn	200	15	15	Best value for clayey/sandy soil.	Kaplan 2007
Mo	120	6	6	Best value for clayey/sandy soil.	Kaplan 2007
Nb	0	0	0	Same as above.	WSRC 2008, Table 2-33; the values listed were obtained from Kaplan 2006
Ni	30	7	7	Same as above.	Same as above
Np	35	0.6	0.6	Same as above.	Same as above
Pa	35	0.6	0.6	Same as above.	Same as above
Pb	5,000	2,000	2,000	Same as above.	Same as above
Po	5,000	2,000	2,000	Best value for clayey/sandy soil.	Kaplan 2006
Pu	5,900	270	270	Clay/sand material best estimated K_d. Clay material K_d for unsaturated Zone 1. Sand material K_d for unsaturated Zone 2 and saturated zone.	WSRC 2008, Table 2-33; the values listed were obtained from Kaplan 2006
Ra	17	5	5	Same as above.	Same as above
Sr	17	5	5	Same as above.	Same as above
Sm	8,500	1,100	1,100	Same as above.	Same as above
Tc	0.2	0.1	0.1	Same as above.	Same as above
Th	2,000	900	900	Same as above.	Best value for sandy soil, Kaplan 2006
U	300	200	200	Same as above.	Same as above

[a] K_d values are listed for the unsaturated zones and the saturated zone. For the contaminated zone, the release fraction of radionuclides is correlated with the metal corrosion rate for the activated metal wastes, the site-specific soil K_d values for sealed sources, and site-specific soil K_d values and cementitious system K_d values for Other Waste.

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TABLE E-13 RESRAD-OFFSITE Input Parameter Values for Groundwater Analysis for WIPP Vicinity

Parameter	Value	Value Selection Rationale	Source
Site properties			
Wind speed (m/s)	3.71	Site-specific data, low end of the most prevalent range.	DOE 2006b
Precipitation (m/yr)	0.3048	Site-specific data (about 12 in.).	DOE 2006b
Primary contamination area properties			
Irrigation (m/yr)	0	No agricultural activities.	Yu et al. 2007
Evapotranspiration coefficient	0.9934	To obtain an infiltration rate of 0.002 m/yr, which is indicated in the source suggested by WIPP staff for reference.	Campbell et al. 1996
Runoff coefficient	0.0125	Because of the flat ground surface, the annual runoff is typically 0.1 to 0.2 in. The average value of 0.15 in. converts to a runoff coefficient of 0.0125.	For annual runoff — DOE 2006b
Rainfall and runoff	160	To obtain the erosion rates used as input values for the cover and contamination zone.	Yu et al. 2007 (applies to sum of all four parameters at left)
Slope-length-steepness factor	0.4		
Cover and management factor	0.003		
Support practice factor	1		
Contaminated zone			
Total porosity	0.4		RESRAD-OFFSITE default
Erosion rate (m/yr)	1.00E-05	Chose a small value so that the contaminated zone would not be eroded away. Will yield more conservative results.	Yu et al. 2007
Dry bulk density (g/cm^3)	1.8	Estimated average for different waste streams, based on GTCC waste inventory data.	Sandia 2008
Soil erodibility factor	0.42	To obtain the erosion rate used as the input value.	Yu et al. 2007
Field capacity	0.3		RESRAD-OFFSITE default
b-parameter	5.3		RESRAD-OFFSITE default
Hydraulic conductivity (m/yr)	10		RESRAD-OFFSITE default
Cover layer			
Total porosity	0.4		RESRAD-OFFSITE default
Erosion rate (m/yr)	1.00E-05	Chose a small value so that the buried waste would remain covered within the time frame considered (i.e., would yield more conservative groundwater results because there would be no losses through surface runoff and erosion).	Yu et al. 2007
Dry bulk density (g/cm^3)	1.5		RESRAD-OFFSITE default
Soil erodibility factor	0.35	To obtain the erosion rate used as the input value.	Yu et al. 2007

2

TABLE E-13 (Cont.)

Parameter	Value	Value Selection Rationale	Source
Unsaturated Zone 1		The perched aquifer located in the Dewey Lake Formation was selected as the groundwater of concern in the modeling. Among the subsurface and deep groundwater aquifers, it has the best water quality and was classified as a U.S. Environmental Protection Agency (EPA) Class II aquifer. The depth to the groundwater table (153 m) specified in Table 4.4-1 of Sandia 2007 (Task 3.4 report) also corresponds to this aquifer in Dewey Lake Formation.	
Thickness (m)	153	Comparable to the groundwater level measurement data.	DOE 2006b; Sandia 2007
Density (g/cm^3)	1.47	Average of sandy and silty soils. According to the description in DOE 2006b, the Dewey Lake Redbeds Formation consists of alternating thin beds of siltstone and fine-grained sandstone.	Yu et al. 2000
Total porosity	0.445	Average of silty and sandy soil.	Distribution information for silt and sand soils from Yu et al. 2000
Effective porosity	0.404	Average of silty and sandy soil.	Distribution information for silt and sand soils from Yu et al. 2000
Field capacity	0.1	Used a smaller value because the moisture content is expected to be low because of the small infiltration rate.	
Hydraulic conductivity (m/yr)	107.31	Geometric mean for sandy and silty soils. Geometric mean for sandy soil was calculated as 803.5 m/yr. Geometric mean for silty soil was calculated as 14.33 m/yr.	Distribution information for silt and sand soils from Yu et al. 2000
b-parameter	1.76	Geometric mean for sandy and silty soils. Geometric mean for sandy soil was calculated as 0.975. Geometric mean for silty soil was calculated as 3.1899.	Distribution information for sand and silt soils from Yu et al. 2000
Longitudinal dispersivity (m)	0	No dispersivity was assumed for the unsaturated zone.	Assumption used for all sites.

TABLE E-13 (Cont.)

Parameter	Value	Value Selection Rationale	Source
Saturated zone hydrology			
Thickness (m)	5.1	Saturated thickness for the natural water table identified in middle Dewey Lake.	DOE 2006b
Density of saturated zone (g/cm^3)	1.47	Average of sandy and silty soils.	Distribution information for silt and sand soils from Yu et al. 2000
Total porosity	0.445	Average of silt and sand soil.	Distribution information for silt and sand soils from Yu et al. 2000
Effective porosity	0.404	Average of silt and sand soil.	Distribution information for silt and sand soils from Yu et al. 2000
Hydraulic conductivity (m/yr)	107.31	Geometric mean for sandy and silty soils. Geometric mean for sandy soil was calculated as 803.5 m/yr. Geometric mean for silty soil was calculated as 14.33 m/yr.	Distribution information for silt and sand soils from Yu et al. 2000
Hydraulic gradient to well	0.017	The gradient in Dewey Lake is 20–40 ft/mi in the east. It is up to 150 ft/mi to the west. Average is 90 ft/mi.	Powers et al. 1978
Depth of aquifer contributing to well (m), below water table	5.1	Set to the depth of aquifer.	Yu et al. 2007
Longitudinal dispersivity (m)	10% of the distance traveled	Assumption used for all sites. Common practice for groundwater modeling.	
Horizontal lateral dispersivity (m)	10% of the longitudinal dispersivity	Assumption used for all sites. Common practice for groundwater modeling.	
Disperse vertically (yes/no)	Yes	To consider dispersion.	Yu et al. 2007
Vertical lateral dispersivity (m)	10% of the horizontal lateral dispersivity	Assumption used for all sites.	

TABLE E-14 Soil/Water Distribution Coefficients for Different Radionuclides for WIPP Vicinity[a]

	K_d Value (cm^3/g)			
Element	Unsaturated Zone	Saturated Zone	Value Selection Rationale[b]	Source
Ac	450	450	Value for sandy soil	Sheppard and Thibault 1990
Am	1,445	1,445	Value for generic soil	Yu et al. 2000
C	5	5	Value for sandy soil	Sheppard and Thibault 1990
Cm	4,000	4,000	Value for sandy soil	Sheppard and Thibault 1990
Co	60	60	Value for sandy soil	Sheppard and Thibault 1990
Cs	280	280	Value for sandy soil	Sheppard and Thibault 1990
Fe	209	209	Value for generic soil	Yu et al. 2000
Gd	825	825	Value for generic soil	Yu et al. 2000
H	0.06	0.06	Value for generic soil	Yu et al. 2000
I	1	1	Value for sandy soil	Sheppard and Thibault 1990
Mn	50	50	Value for sandy soil	Sheppard and Thibault 1990
Mo	10	10	Value for sandy soil	Sheppard and Thibault 1990
Nb	160	160	Value for sandy soil	Sheppard and Thibault 1990
Ni	400	400	Value for sandy soil	Sheppard and Thibault 1990
Np	5	5	Value for sandy soil	Sheppard and Thibault 1990
Pa	380	380	Value for generic soil	Yu et al. 2000
Pb	270	270	Value for sandy soil	Sheppard and Thibault 1990
Po	150	150	Value for sandy soil	Sheppard and Thibault 1990
Pu	550	550	Value for sandy soil	Sheppard and Thibault 1990
Ra	500	500	Value for sandy soil	Sheppard and Thibault 1990
Sr	15	15	Value for sandy soil	Sheppard and Thibault 1990
Sm	245	245	Value of sandy soil	Sheppard and Thibault 1990
Tc	0.1	0.1	Value for sandy soil	Sheppard and Thibault 1990
Th	3,200	3,200	Value for sandy soil	Sheppard and Thibault 1990
U	35	35	Value for sandy soil	Sheppard and Thibault 1990

a K_d values are listed for the unsaturated zones and the saturated zone. For the contaminated zone, the release fraction of radionuclides is correlated with the metal corrosion rate for the activated metal wastes, the site-specific soil K_d values for sealed sources, and site-specific soil K_d values and cementitious system K_d values for Other Waste.

b The K_d value selected was the smaller one of either the value for sandy soil given in Sheppard and Thibault (1990) or the value for generic soil recommended in NUREG/CR-6697 (Yu et al. 2000).

TABLE E-15 Water Infiltration Rates Used in the RESRAD-OFFSITE Analyses for the Six DOE Sites[a]

	Evaluated Sites					
Parameter	Hanford	INL	LANL	NNSS	SRS	WIPP Vicinity
Precipitation rate (m/yr)	0.17	0.22	0.36	0.13	1.2	0.3
Irrigation rate[b] (m/yr)	0	0	0	0	0	0
Infiltration rate used in the analyses (m/yr)	0.0035	0.05	0.005	0.00003	0.376	0.002

[a] Values were obtained from site reports.

[b] No agricultural activity over the disposal areas was assumed for this analysis

1 **TABLE E-16 Unsaturated Zone Characteristics Used as Input Parameters in the RESRAD-OFFSITE Analyses for the Six DOE Sites[a]**

	Disposal Site Considered					
Parameter	Hanford	INL	LANL	NNSS	SRS	WIPP Vicinity
Unsaturated Zone 1						
Thickness (m)	58	9.14	13	246	6.1	153
Density (g/cm^3)	1.65	1.64	1.4	1.65	1.65	1.47
Total porosity	0.37	0.5	0.41	0.36	0.39	0.445
Effective porosity	0.37	0.5	0.41	0.36	0.39	0.404
Field capacity	0.03	0.1	0.02	0.3	0.3	0.1
Hydraulic conductivity (m/yr)	710	29,200	61.81	0.00003	2.7	107.31
Soil b-parameter	4.05	4.34	0.175	5.3	6.62	1.76
Unsaturated Zone 2						
Thickness (m)	30	94.6	26	–[b]	16.9	–
Density (g/cm^3)	1.93	2.0	1.2	–	1.62	–
Total porosity	0.27	0.05	0.47	–	0.39	–
Effective porosity	0.27	0.05	0.47	–	0.39	–
Field capacity	0.024	0.001	0.02	–	0.3	–
Hydraulic conductivity (m/yr)	148	3650	46.36	–	29	–
Soil b-parameter	7.12	0.76	1.339	–	4.1	–
Unsaturated Zone 3						
Thickness (m)	–	7.47	16	–	–	–
Density (g/cm^3)	–	1.46	1.2	–	–	–
Total porosity	–	0.57	0.44	–	–	–
Effective porosity	–	0.57	0.44	–	–	–
Field capacity	–	0.3	0.04	–	–	–
Hydraulic conductivity (m/yr)	–	1.29	71.08	–	–	–
Soil b-parameter	–	3.6	2.152	–	–	–
Unsaturated Zone 4						
Thickness (m)	–	15.88	3	–	–	–
Density (g/cm^3)	–	1.64	0.8	–	–	–
Total porosity	–	0.5	0.67	–	–	–
Effective porosity	–	0.5	0.67	–	–	–
Field capacity	–	0.3	0.00001	–	–	–
Hydraulic conductivity (m/yr)	–	29,200	46.36	–	–	–
Soil b-parameter	–	10.4	1.891	–	–	–
Unsaturated Zone 5						
Thickness (m)	–	15.39	211	–	–	–
Density (g/cm^3)	–	2.0	2.7	–	–	–
Total porosity	–	0.05	0.001	–	–	–
Effective porosity	–	0.05	0.001	–	–	–
Field capacity	–	0.001	0.00001	–	–	–
Hydraulic conductivity (m/yr)	–	365,000	309.05	–	–	–
Soil b-parameter	–	1.67	2.71	–	–	–

[a] The values given here were used in the RESRAD-OFFSITE evaluations for post-closure performance of the vault method. A smaller value for thickness (of the effective unsaturated zone) was used as the input value for evaluating post-closure performance of the trench and borehole methods to simulate placement of the waste in the unsaturated zone for these two methods.

2 [b] A dash means not applicable.

TABLE E-17 Saturated Zone Characteristics Used as Input Parameters in the RESRAD-OFFSITE Analyses for the Six DOE Sites[a]

	Site Included for Evaluation					
Parameter	Hanford	INL	LANL	NNSS	SRS	WIPP Vicinity
Thickness (m)	45	495	37.5	220	27.85	5.1
Density of saturated zone (g/cm^3)	1.98	2.0	2.7	1.6	1.39	1.47
Total porosity	0.25	0.05	0.05	0.36	0.38	0.445
Effective porosity	0.25	0.05	0.05	0.36	0.25	0.404
Hydraulic conductivity (m/yr)	12,775	1,979	309.1	439	1,265	107.31
Hydraulic gradient to well	0.00124	0.00075	0.013	0.000097	0.0079	0.017
Depth of aquifer contributing to well (m)	10	10	10	10	10	5.1

[a] Parameter values were obtained from site reports when available.

TABLE E-18 Soil/Water Distribution Coefficient (K_d) Values (cm^3/g) Used in RESRAD-OFFSITE Analyses for the Six DOE Sites[a]

		Site					
Element[b]	Soil Layer[c]	Hanford	INL	LANL[d]	NNSS	SRS	WIPP Vicinity
Ac	UZ	300, 30	225, 0, 225, 225, 0	130	7,000	8,500; 1,100	450
	SZ	300	9	130	7,000	1,100	450
Am	UZ	1,900; 190	225, 0, 225, 225, 0	2,400	7,000	8,500; 1,100	1,445
	SZ	1,900	9	2,400	7,000	1,100	1,445
C	UZ	4, 0.4	0.4, 0, 0.4, 0.4, 0	0	0	0, 0	5
	SZ	4	0.016	0	0	0	5
Cm	UZ	300, 30	4,000; 0; 4,000; 4,000; 0	50	4,000	8,500; 1,100	4,000
	SZ	300	160	50	4,000	1,100	4,000
Co	UZ	2,000; 200	10, 0, 10, 10, 0	0.45	60	30, 7	60
	SZ	2,000	0.4	0.45	60	7	60
Cs	UZ	80, 8	500, 0, 500, 500, 0	7.5	280	250, 50	280
	SZ	80	20	7.5	280	50	280
Fe	UZ	220, 22	220, 0, 220, 220, 0	209	209	400, 200	209
	SZ	220	8.8	209	209	200	209
Gd	UZ	825, 82.5	240, 0, 240, 240, 0	50	825	8,500; 1,100	825
	SZ	825	9.6	50	825	1,100	825

TABLE E-18 (Cont.)

		Site					
Element[b]	Soil Layer[c]	Hanford	INL	LANL[d]	NNSS	SRS	WIPP Vicinity
H	UZ	0, 0	0, 0, 0, 0, 0	0	0	0, 0	0.06
	SZ	0	0	0	0	0	0.06
I	UZ	0, 0	0, 0, 0, 0, 0	0	0	0.6, 0	1
	SZ	0	0	0	0	0	1
Mn	UZ	50, 5	50, 0, 50, 50, 0	158	50	200, 15	50
	SZ	50	2	158	50	15	50
Mo	UZ	10, 1	10, 0, 10, 10, 0	4	10	120, 6	10
	SZ	10	0.4	4	10	6	10
Nb	UZ	300, 30	500, 0, 500, 500, 0	100	7,000	0, 0	160
	SZ	300	20	100	7,000	0	160
Ni	UZ	400, 40	100, 0, 100, 100, 0	50	100	30, 7	400
	SZ	400	4	50	100	7	400
Np	UZ	2.5, 0.25	23, 0, 23, 23, 0	2.2	5	35, 0.60	5
	SZ	2.5	0.92	2.2	5	0.6	5
Pa	UZ	2.5, 0.25	8, 0, 8, 8, 0	5,500	5	35, 0.6	380
	SZ	2.5	0.32	5,500	5	0.6	380
Pb	UZ	80, 8	270, 0, 270, 270, 0	25	300	5,000; 2,000	270
	SZ	80	10.8	25	300	2,000	270
Po	UZ	150, 15	150, 0, 150, 150, 0	10	300	5,000; 2,000	150
	SZ	150	6	10	300	2,000	150

TABLE E-18 (Cont.)

		Site					
Element[b]	Soil Layer[c]	Hanford	INL	LANL[d]	NNSS	SRS	WIPP Vicinity
Pu	UZ	150, 15	2,500; 0; 2,500; 2,500; 0	4.1	7.5	5,900; 270	550
	SZ	150	100	4.1	7.5	270	550
Ra	UZ	10, 1	575, 0, 575, 575, 0	500	185	17, 5	500
	SZ	10	23	500	185	5	500
Sm	UZ	300, 30	2,500; 0; 2,500; 2,500; 0	50	245	8,500; 1,100	245
	SZ	300	100	50	245	1,100	245
Sr	UZ	10, 1	12, 0, 12, 12, 0	40	420	17, 5	15
	SZ	10	0.48	40	420	5	15
Tc	UZ	0, 0	0, 0, 0, 0, 0	0	0	0.2, 0.1	0.1
	SZ	0	0	0	0	0.1	0.1
Th	UZ	3,200; 320	500, 0, 500, 500, 0	5,000	7,000	2,000; 900	3,200
	SZ	3,200	20	5,000	7,000	900	3,200
U	UZ	0.6, 0.06	15.4, 0, 15.4, 15.4, 0	2.4	0.8	300, 200	35
	SZ	0.6	0.616	2.4	0.8	200	35

a K_d values were obtained from site reports and other site sources, as identified in Tables E-3, E-5, E-7, E-9, E-11, and E-13.

b The K_d values for different isotopes of the same element were assumed to be the same in the analysis.

c For purposes of this analysis, the transport of radionuclides leached from the disposal area was assumed to occur in vadose zones and the saturated zone at all potential disposal sites. The physical properties of these zones are site dependent. Abbreviations for vadose zones (which are unsaturated) and the saturated zone are UZ and SZ, respectively.

d For the LANL site, all the vadose zones were assumed to have the same K_d value.

TABLE E-19 RESRAD-OFFSITE Input Parameter Values for Groundwater Analysis for Generic Commercial Sites in the Four Regions

Parameter Name	Region I	Region II	Region III	Region IV
Site properties				
Precipitation (m/yr)[a]	0.074	0.18	0.05	0.001
Primary contamination area properties[b]				
Irrigation (m/yr)	0	0	0	0
Evapotranspiration coefficient	0	0	0	0
Runoff coefficient[c]	0	0	0	0
Rainfall and runoff[c]	160	160	160	160
Slope-length-steepness factor	0.4	0.4	0.4	0.4
Cover and management factor	0.03	0.03	0.03	0.03
Support practice factor	1	1	1	1
Contaminated zone[b]				
Total porosity	0.4	0.4	0.4	0.4
Erosion rate (m/yr)	1.00E-05	1.00E-05	1.00E-05	1.00E-05
Dry bulk density (g/cm^3)	1.8	1.8	1.8	1.8
Soil erodibility factor	0.42	0.42	0.42	0.42
Field capacity	0.3	0.3	0.3	0.3
b-parameter	5.3	5.3	5.3	5.3
Hydraulic conductivity (m/yr)	10	10	10	10
Cover layer[b]				
Total porosity	0.4	0.4	0.4	0.4
Erosion rate (m/yr)	1.00E-05	1.00E-05	1.00E-05	1.00E-05
Dry bulk density (g/cm^3)	1.5	1.5	1.5	1.5
Soil erodibility factor	0.35	0.35	0.35	0.35
Unsaturated zone 1[d]				
Thickness (m)	3.353	13.41	2.16	54.86
Density (g/cm^3)	1.6	1.5	1.5	1.6
Total porosity	0.38	0.42	0.44	0.41
Effective porosity	0.38	0.42	0.44	0.41
Field capacity	0.093	0.15	0.23	0.12
Hydraulic conductivity (m/yr)	1981	201	518	1798
b parameter[b]	5.3	5.3	5.3	5.3
Longitudinal dispersivity (m)[b]	0	0	0	0
Saturated zone hydrology[d]				
Thickness (m)	13.72	15.24	11.28	64
Density of saturated zone (g/cm^3)	1.6	1.8	1.6	1.7
Total porosity	0.38	0.4	0.38	0.3
Effective porosity	0.22	0.23	0.22	0.17
Hydraulic conductivity (m/yr)[e]	103.6	18.9	21.03	91
Hydraulic gradient to well[e]	1	1	1	1
Depth of aquifer contributing to well (m), below water table	10	10	10	10
Longitudinal dispersivity (m)	10% of distance traveled	10% of distance traveled	10% of distance traveled	10% of distance traveled

TABLE E-19 (Cont.)

Parameter Name	Region I	Region II	Region III	Region IV
Horizontal lateral dispersivity (m)	10% of longitudinal dispersivity	10% of longitudinal dispersivity	10% of longitudinal dispersivity	10% of longitudinal dispersivity
Disperse vertically (yes/no)	Yes	Yes	Yes	Yes
Vertical lateral dispersivity (m)	10% of horizontal lateral dispersivity	10% of horizontal lateral dispersivity	10% of horizontal lateral dispersivity	10% of horizontal lateral dispersivity

[a] The input value for the precipitation rate was set to match the infiltration rate used in NUREG-0782, Vol. 4 (NRC 1981). In order to obtain the same infiltration rate to the vadose zone as that used in NUREG-0782, the irrigation rate, evapotranspiration rate, and runoff coefficient were all set to 0.

[b] Input parameters for the primary contamination area, contaminated zone, and cover layers were kept the same as those used for the DOE alternate sites, unless specifically noted.

[c] The evapotranspiration rate and runoff coefficient were set to zero in order to obtain the desired water infiltration rate. See also note footnote a.

[d] Input parameters for the unsaturated and saturated zones were obtained from Toblin (1998, 1999), and Poe (1998), unless specifically noted.

[e] To obtain the same Darcy's velocity as used in Toblin (1999), the hydraulic conductivity was set to the Darcy velocity value, while the hydraulic gradient was set to 0.

TABLE E-20 Soil/Water Distribution Coefficients (cm^3/g) for Different Radionuclides[a] for Commercial Facilities in the Four Regions

	Region I		Region II		Region III		Region IV	
Element	Unsaturated Zone	Saturated Zone	Unsaturated Zone	Saturated Zone	Unsaturated Zone	Saturated Zone	Unsaturated Zone	Saturated Zone
Ac	228	228	538	228	538	228	228	228
Am	82	82	200	82	200	82	82	82
C	0	0	0	0	0	0	0	0
Cm	82	82	200	82	200	82	82	82
Co	2	2	9	2	9	2	2	2
Cs	51	51	249	51	249	51	51	51
Fe[b]	209	209	209	209	209	209	209	209
Gd[b]	50	50	50	50	50	50	50	50
H	0	0	0	0	0	0	0	0
I	0	0	0	0	0	0	0	0
Mn[b]	50	50	50	50	50	50	50	50
Mo[b]	4	4	4	4	4	4	4	4
Nb	50	50	100	50	100	50	50	50
Ni	12	12	59	12	59	12	12	12
Np	3	3	3	3	3	3	3	3
Pa	0	0	50	0	50	0	0	0
Pb	234	234	597	234	597	234	234	234
Po[c]	234	234	597	234	597	234	234	234
Pu	10	10	100	10	100	10	10	10
Ra	24	24	100	24	100	24	24	24
Sm	228	228	538	228	538	228	228	228
Sr	24	24	100	24	100	24	24	24
Tc	3	3	3	3	3	3	3	3
Th	100	100	100	100	100	100	100	100
U	0	0	50	0	50	0	0	0

a K_d values were obtained from Toblin (1999) unless specifically noted.

b Selected K_d values for Fe, Gd, Mn, Mo, respectively, were the smallest values among those used for the six federal sites.

c The value of the K_d for Po was set to be same as the value of the K_d for Pb.

TABLE E-21 Estimated Peak Annual Doses (in mrem/yr) from the Use of Contaminated Groundwater for the No Action Alternative[a,b]

		Peak Annual Dose (mrem/yr) within 10,000 and 100,000 Years							
		GTCC LLRW				GTCC-Like Waste			
NRC Region	Time Period of Analysis (yr)	Activated Metals	Sealed Sources	Other Waste - CH	Other Waste - RH	Activated Metals	Sealed Sources	Other Waste - CH	Other Waste - RH
I	10,000	130	73,000	3,800	26,000	–	–	97,000	270,000
	100,000	130	73,000	3,800	26,000	–	–	97,000	270,000
II	10,000	10	210	–	850	0.14	–	0.14	0
	100,000	170	16,000	–	3,200	0.14	–	180	14,000
III	10,000	6.2	120	–	–	–	–	–	–
	100,000	190	13,000	–	–	–	–	–	–
IV	10,000	0	0	0	0	0	0	0	0
	100,000	0	9.3	0	0.023	0	0	0.89	9.8

[a] CH = contact-handled, GTCC = greater-than-Class C, RH = remote-handled, Region I–IV = a generic storage site located within each of the four NRC regions.

[b] These annual doses are associated with the use of contaminated groundwater by a hypothetical resident farmer located 100 m (330 ft) from the edge of the storage facility. All values are given to two significant figures, and a dash means there is no inventory for that waste type. The values given in this table represent the peak annual doses from each waste type. Because of the different radionuclide mixes and activities contained in the different waste types, the peak annual doses that could result from each waste type individually generally occur at different times than the peak annual dose from the entire inventory. The peak annual doses from the entire GTCC waste inventory are given in Chapter 3 of the EIS.

TABLE E-22 Estimated Peak Annual Doses (in mrem/yr) from the Use of Contaminated Groundwater at the Various Sites for the Stored Group 1 Inventory[a,b]

			Peak Annual Dose (mrem/yr) within 10,000 and 100,000 Years							
			GTCC LLRW				GTCC-Like Waste			
Site	Method	Time Period of Analysis (yr)	Activated Metals	Sealed Sources	Other Waste - CH	Other Waste - RH	Activated Metals	Sealed Sources	Other Waste - CH	Other Waste - RH
Hanford	Vault	10,000	0.26	–[b]	0	0.044	0	0	0.012	40
		100,000	0.26	–	< 0.001	0.36	0	< 0.001	20	40
	Trench	10,000	0.33	–	0	0.042	0	0	0.014	39
		100,000	0.33	–	< 0.001	0.35	0	< 0.001	24	39
	Borehole	10,000	0.17	–	0	0.013	0	0	< 0.0042	0.11
		100,000	0.17	–	0	0.11	< 0.001	< 0.001	7.5	0.63
INL	Vault	10,000	7.7	–	0	2.3	0.86	0	5.5	2,200
		100,000	7.7	–	0.0029	2.3	0.86	0	70	2,200
	Trench	10,000	8.9	–	0	2.0	0.99	0	6.4	1,900
		100,000	8.9	–	0	2.0	0.99	0	78	1,900
	Borehole	10,000	6.2	–	0	0.79	0.68	0	48	750
		100,000	6.2	–	0	0.79	0.68	0	53	750
LANL	Vault	10,000	60	–	0	0.22	0.45	0	1.8	230
		100,000	60	–	0	0.22	0.45	0	1.8	230
	Trench	10,000	5.2	–	0	0.21	0.55	0	2.2	210
		100,000	5.2	–	0	0.21	0.55	0	2.2	210
	Borehole	10,000	3.0	–	0	0.065	0.33	0	0.74	67
		100,000	3.0	–	0	0.065	0.33	0	0.74	67
NNSS	Vault	10,000	0	–	0	0	0	0	0	0
		100,000	0	–	0	0	0	0	0	0
	Trench	10,000	0	–	0	0	0	0	0	0
		100,000	0	–	0	0	0	0	0	0
	Borehole	10,000	0	–	0	0	0	0	0	0
		100,000	0	–	0	0	0	0	0	0

TABLE E-22 (Cont.)

			Peak Annual Dose (mrem/yr) within 10,000 and 100,000 Years							
			GTCC LLRW				GTCC-Like Waste			
Site	Method	Time Period of Analysis (yr)	Activated Metals	Sealed Sources	Other Waste - CH	Other Waste - RH	Activated Metals	Sealed Sources	Other Waste - CH	Other Waste - RH
SRS[c]	Vault	10,000	2.9	–	0.0051	1.3	0.21	< 0.001	40	1,000
		100,000	2.9	–	0.0051	1.3	0.21	< 0.001	120	1,000
	Trench	10,000	4.0	–	0.0059	1.4	0.27	< 0.001	62	1,100
		100,000	8.0	–	0.0059	1.4	0.27	< 0.001	130	1,100
WIPP Vicinity	Vault	10,000	0	–	0	0	0	0	0	0
		100,000	2.9	–	0	0.16	0	0	0.039	36
	Trench	10,000	0	–	0	0	0	0	0	0
		100,000	2.9	–	0	0.12	0	0	0.039	28
	Borehole	10,000	0	–	0	0	0	0	0	0
		100,000	2.9	–	0	0.068	0	0	0.022	16
Region I[c]	Vault	10,000	14	–	0	24	0.027	0.0075	700	3,200
		100,000	14	–	0	24	0.027	0.0075	700	3,200
Region II[c]	Vault	10,000	0.98	–	0.013	0.056	0.13	0	18	940
		100,000	16	–	0.013	5.4	0.13	0	130	940
	Trench	10,000	1.7	–	0	0.25	0.16	0	20	950
		100,000	62	–	0	18	0.16	0	590	2,100
Region III[c]	Vault	10,000	1.1	–	0	0.077	0.16	0	6.3	410
		100,000	32	–	0	3.7	0.16	0	90	410
Region IV	Vault	10,000	0	–	0	0	0	0	0	0
		100,000	0.0041	–	0	0.11	0	0	5.8	5.7
	Trench	10,000	0	–	0	0	0	0	0	0
		100,000	0.0072	–	0	0.10	0	0	7.1	5.4
	Borehole	10,000	0	–	0	0	0	0	0	0
		100,000	0.028	–	0	0.034	0.0039	0	2.3	1.7

Footnotes appear on next page.

TABLE E-22 (Cont.)

[a] CH = contact-handled, GTCC = greater-than-Class C, INL = Idaho National Laboratory, LANL = Los Alamos National Laboratory, NNSS = Nevada National Security Site, RH = remote-handled, SRS = Savannah River Site, WIPP = Waste Isolation Pilot Plant, Region I–IV = a generic commercial site located within each of the four major regions of the country.

[b] These annual doses are associated with the use of contaminated groundwater by a hypothetical resident farmer located 100 m (330 ft) from the edge of the disposal facility. All values are given to two significant figures, and a dash means there is no inventory for that waste type. Annual doses of less than 0.001 mrem/yr are reported as <0.001. The values given in this table represent the peak annual doses from each waste type. Because of the different radionuclide mixes and activities contained in the different waste types, the peak annual doses that could result from each waste type individually generally occur at different times than the peak annual dose from the entire inventory. The peak annual doses from the entire GTCC waste inventory are given in the site-specific chapters of the EIS.

[c] The above-grade vault is the only method evaluated for Region I and Region III because of the shallow groundwater depth. The borehole method is not considered suitable for SRS and Regions I, II, and III.

TABLE E-23 Estimated Peak Annual Doses (in mrem/yr) from the Use of Contaminated Groundwater at the Various Sites for the Projected Group 1 Inventory[a,b]

			Peak Annual Dose (in mrem/yr) within 10,000 and 100,000 Years							
			GTCC LLRW				GTCC-Like Waste			
Site	Method	Time Period of Analysis (yr)	Activated Metals	Sealed Sources	Other Waste - CH	Other Waste - RH	Activated Metals	Sealed Sources	Other Waste - CH	Other Waste - RH
Hanford	Vault	10,000	4.0	0	–[b]	0.0013	0	0	0.0045	0.12
		100,000	4.0	21	–	0.011	0	0.0012	5.6	480
	Trench	10,000	5.0	0	–	0.0013	0	0	0.0055	0.12
		100,000	5.0	25	–	0.011	0	0.0015	6.9	460
	Borehole	10,000	2.6	0	–	< 0.001	0	0	0.0016	0.036
		100,000	2.6	11	–	0.0033	< 0.001	< 0.001	2.1	140
INL	Vault	10,000	120	0.028	–	0.069	2.1	0	1.6	6.4
		100,000	120	150	–	0.069	2.1	0.0058	19	1,700
	Trench	10,000	140	0	–	0	2.5	0	1.8	5.7
		100,000	140	170	–	0	2.5	0	22	1,500
	Borehole	10,000	93	32	–	0.024	1.7	0	8.4	580
		100,000	93	74	–	0.024	1.7	0	8.6	580
LANL	Vault	10,000	64	0	–	0	1.1	0	0.52	0.62
		100,000	64	0	–	0	1.1	0	0.52	0.62
	Trench	10,000	78	0	–	0	1.4	0	0.63	0.58
		100,000	78	0	–	0	1.4	0	0.63	0.58
	Borehole	10,000	46	0	–	0	0.81	0	0.21	0.18
		100,000	46	0	–	0	0.81	0	0.21	0.18
NNSS	Vault	10,000	0	0	–	0	0	0	0	0
		100,000	0	0	–	0	0	0	0	0
	Trench	10,000	0	0	–	0	0	0	0	0
		100,000	0	0	–	0	0	0	0	0
	Borehole	10,000	0	0	–	0	0	0	0	0
		100,000	0	0	–	0	0	0	0	0

TABLE E-23 (Cont.)

			Peak Annual Dose (mrem/yr) within 10,000 and 100,000 Years							
			GTCC LLRW				GTCC-Like Waste			
Site	Method	Time Period of Analysis (yr)	Activated Metals	Sealed Sources	Other Waste - CH	Other Waste - RH	Activated Metals	Sealed Sources	Other Waste - CH	Other Waste - RH
SRS[c]	Vault	10,000	45	150	–	0.039	0.53	< 0.001	10	3.6
		100,000	45	150	–	0.039	0.53	< 0.001	33	400
	Trench	10,000	60	170	–	0.043	0.66	< 0.001	16	3.9
		100,000	120	330	–	0.043	0.66	0.073	38	430
WIPP Vicinity	Vault	10,000	0	0	–	0	0	0	0	0
		100,000	44	0	–	0.0047	0	0	0.014	0.44
	Trench	10,000	0	0	–	0	0	0	0	0
		100,000	44	0	–	0.0037	0	0	0.014	0.34
	Borehole	10,000	0	0	–	0	0	0	0	0
		100,000	44	0	–	0.0021	0	0	< 0.001	0.19
Region I[c]	Vault	10,000	220	5,300	–	0.73	0.067	10	200	9,700
		100,000	220	5,300	–	0.73	0.067	10	200	9,700
Region II[c]	Vault	10,000	15	220	–	0.0059	0.33	0	3.2	0.55
		100,000	250	1,400	–	0.16	0.33	0.049	37	330
	Trench	10,000	26	250	–	0	0.39	0	4.7	320
		100,000	940	5,400	–	0.54	0.39	4.6	170	430
Region III[c]	Vault	10,000	18	95	–	0	0.40	0	1.4	0.2
		100,000	490	940	–	0.11	0.40	0.19	26	170
Region IV	Vault	10,000	0	0	–	0	0	0	0	0
		100,000	0.062	5.7	–	0.0032	0	0	1.6	130
	Trench	10,000	0	0	–	0	0	0	0	0
		100,000	0.11	6.9	–	0.0031	0.0013	0	1.9	130
	Borehole	10,000	0	0	–	0	0	0	0	0
		100,000	0.45	2.3	–	< 0.001	< 0.001	0	0.64	44

Footnotes appear on next page.

TABLE E-23 (Cont.)

[a] CH = contact-handled, GTCC = greater-than-Class C, INL = Idaho National Laboratory, LANL = Los Alamos National Laboratory, NNSS = Nevada National Security Site, RH = remote-handled, SRS = Savannah River Site, WIPP = Waste Isolation Pilot Plant, Region I–IV = a generic commercial site located within each of the four major regions of the country.

[b] These annual doses are associated with the use of contaminated groundwater by a hypothetical resident farmer located 100 m (330 ft) from the edge of the disposal facility. All values are given to two significant figures, and a dash means there is no inventory for that waste type. Annual doses of less than 0.001 mrem/yr are reported as <0.001. The values given in this table represent the peak annual doses from each waste type. Because of the different radionuclide mixes and activities contained in the different waste types, the peak annual doses that could result from each waste type individually generally occur at different times than the peak annual dose from the entire inventory. The peak annual doses from the entire GTCC waste inventory are given in the site-specific chapters of the EIS.

[c] The above-grade vault is the only method evaluated for Region I and Region III because of the shallow groundwater depth. The borehole method is not considered suitable for SRS and Regions I, II, and III.

TABLE E-24 Estimated Peak Annual Doses (in mrem/yr) from the Use of Contaminated Groundwater at the Various Sites for the Total Group 1 Inventory[a,b]

			Peak Annual Dose (mrem/yr) within 10,000 and 100,000 Years							
			GTCC LLRW				GTCC-Like Waste			
Site	Method	Time Period of Analysis (yr)	Activated Metals	Sealed Sources	Other Waste - CH	Other Waste - RH	Activated Metals	Sealed Sources	Other Waste - CH	Other Waste - RH
Hanford	Vault	10,000	4.2	0	0	0.045	0	0	0.016	41
		100,000	4.2	21	< 0.001	0.38	0	0.0012	26	490
	Trench	10,000	5.3	0	0	0.043	0	0	0.02	39
		100,000	5.3	25	< 0.001	0.36	0	0.0015	31	480
	Borehole	10,000	2.8	0	0	0.013	0	0	0.0058	0.14
		100,000	2.8	11	0	0.11	< 0.001	< 0.001	9.6	140
INL	Vault	10,000	130	0.028	0	2.3	3.0	0	7.1	2,200
		100,000	130	150	0.0029	2.3	3.0	0.0058	89	2,200
	Trench	10,000	150	0	0	2.0	3.4	0	8.2	1,900
		100,000	150	170	0	2.0	3.4	0	100	1,900
	Borehole	10,000	99	32	0	0.81	2.4	0	56	750
		100,000	99	74	0	0.81	2.4	0	61	750
LANL	Vault	10,000	120	0	0	0.22	1.6	0	2.3	230
		100,000	120	0	0	0.22	1.6	0	2.3	230
	Trench	10,000	84	0	0	0.21	1.9	0	2.8	210
		100,000	84	0	0	0.21	1.9	0	2.8	210
	Borehole	10,000	49	0	0	0.065	1.1	0	0.95	67
		100,000	49	0	0	0.065	1.1	0	0.95	67
NNSS	Vault	10,000	0	0	0	0	0	0	0	0
		100,000	0	0	0	0	0	0	0	0
	Trench	10,000	0	0	0	0	0	0	0	0
		100,000	0	0	0	0	0	0	0	0
	Borehole	10,000	0	0	0	0	0	0	0	0
		100,000	0	0	0	0	0	0	0	0

TABLE E-24 (Cont.)

			Peak Annual Dose (mrem/yr) within 10,000 and 100,000 Years							
			GTCC LLRW				GTCC-Like Waste			
Site	Method	Time Period of Analysis (yr)	Activated Metals	Sealed Sources	Other Waste - CH	Other Waste - RH	Activated Metals	Sealed Sources	Other Waste - CH	Other Waste - RH
SRS[c]	Vault	10,000	48	150	0.0051	1.3	0.74	< 0.001	50	1,000
		100,000	48	150	0.0051	1.3	0.74	< 0.001	150	1,000
	Trench	10,000	64	170	0.0059	1.4	0.93	< 0.001	79	1,100
		100,000	130	330	0.0059	1.4	0.93	0.073	170	1,100
WIPP Vicinity	Vault	10,000	0	0	0	0	0	0	0	0
		100,000	47	0	0	0.16	0	0	0.054	36
	Trench	10,000	0	0	0	0	0	0	0	0
		100,000	47	0	0	0.13	0	0	0.053	28
	Borehole	10,000	0	0	0	0	0	0	0	0
		100,000	47	0	0	0.070	0	0	0.030	16
Region I[c]	Vault	10,000	230	5,300	0	25	0.093	10	900	10,000
		100,000	230	5,300	0	25	0.093	10	900	10,000
Region II[c]	Vault	10,000	16	220	0.013	0.060	0.46	0	19	940
		100,000	260	1,400	0.013	5.5	0.46	0.049	170	940
	Trench	10,000	27	250	0	0.25	0.55	0	22	950
		100,000	1,000	5,400	0	18	0.55	4.6	760	2,600
Region III[c]	Vault	10,000	19	95	0	0.077	0.55	0	6.8	410
		100,000	520	940	0	3.8	0.55	0.19	120	580
Region IV	Vault	10,000	0	0	0	0	0	0	0	0
		100,000	0.066	5.7	0	0.11	0	0	7.3	140
	Trench	10,000	0	0	0	0	0	0	0	0
		100,000	0.12	6.9	0	0.11	0.0013	0	9	130
	Borehole	10,000	0	0	0	0	0	0	0	0
		100,000	0.48	2.3	0	0.035	0.013	0	3	45

Footnotes appear on next page.

TABLE E-24 (Cont.)

[a] CH = contact-handled, GTCC = greater-than-Class C, INL = Idaho National Laboratory, LANL = Los Alamos National Laboratory, NNSS = Nevada National Security Site, RH = remote-handled, SRS = Savannah River Site, WIPP = Waste Isolation Pilot Plant, Region I– IV = a generic commercial site located within each of the four major regions of the country.

[b] These annual doses are associated with the use of contaminated groundwater by a hypothetical resident farmer located 100 m (330 ft) from the edge of the disposal facility. All values are given to two significant figures. Annual doses of less than 0.001 mrem/yr are reported as <0.001. The values given in this table represent the peak annual doses from each waste type. Because of the different radionuclide mixes and activities contained in the different waste types, the peak annual doses that could result from each waste type individually generally occur at different times than the peak annual dose from the entire inventory. The peak annual doses from the entire GTCC waste inventory are given in the site-specific chapters of the EIS.

[c] The above-grade vault is the only method evaluated for Region I and Region III because of the shallow groundwater depth. The borehole method is not considered suitable for SRS and Regions I, II, and III.

TABLE E-25 Estimated Peak Annual Doses (in mrem/yr) from the Use of Contaminated Groundwater at the Various Sites for the Total Group 2 Inventory[a,b]

			Peak Annual Dose (rem/yr) within 10,000 and 100,000 Years							
			GTCC LLRW				GTCC-Like Waste			
Site	Method	Time Period of Analysis (yr)	Activated Metals	Sealed Sources	Other Waste - CH	Other Waste - RH	Activated Metals	Sealed Sources	Other Waste - CH	Other Waste - RH
Hanford	Vault	10,000	2.0	0	0.025	1.6	–[b]	–	0.0062	0.23
		100,000	2.0	0	3.7	9.4	–	–	11	22
	Trench	10,000	2.5	0	0.031	1.5	–	–	0.0076	0.22
		100,000	2.5	0	4.5	8.9	–	–	14	21
	Borehole	10,000	1.3	0	0.0091	0.47	–	–	0.0023	0.066
		100,000	1.3	0	1.4	2.8	–	–	4.2	6.5
INL	Vault	10,000	57	0	2.4	100	–	–	3.1	12
		100,000	57	0	13	100	–	–	38	76
	Trench	10,000	65	0	2.9	100	–	–	3.6	11
		100,000	65	0	14	100	–	–	43	69
	Borehole	10,000	45	0	5.6	50	–	–	17	26
		100,000	45	0	5.9	50	–	–	18	30
LANL	Vault	10,000	30	0	0.87	40	–	–	1.0	3.1
		100,000	30	0	0.87	40	–	–	1.0	3.1
	Trench	10,000	37	0	1.0	38	–	–	1.2	2.9
		100,000	37	0	1.0	38	–	–	1.2	2.9
	Borehole	10,000	22	0	0.35	13	–	–	0.42	0.96
		100,000	22	0	0.35	13	–	–	0.42	0.96
NNSS	Vault	10,000	0	0	0	0	–	–	0	0
		100,000	0	0	0	0	–	–	0	0
	Trench	10,000	0	0	0	0	–	–	0	0
		100,000	0	0	0	0	–	–	0	0
	Borehole	10,000	0	0	0	0	–	–	0	0
		100,000	0	0	0	0	–	–	0	0

TABLE E-25 (Cont.)

			Peak Annual Dose (mrem/yr) within 10,000 and 100,000 Years							
			GTCC LLRW				GTCC-Like Waste			
Site	Method	Time Period of Analysis (yr)	Activated Metals	Sealed Sources	Other Waste - CH	Other Waste - RH	Activated Metals	Sealed Sources	Other Waste - CH	Other Waste - RH
SRS[c]	Vault	10,000	21	0	10	390	–	–	20	50
		100,000	21	0	26	390	–	–	66	110
	Trench	10,000	28	0	13	460	–	–	32	59
		100,000	62	0	27	460	–	–	76	59
WIPP Vicinity	Vault	10,000	0	0	0	0	–	–	0	0
		100,000	20	0	0.017	3.6	–	–	0.022	0.67
	Trench	10,000	0	0	0	0	–	–	0	0
		100,000	20	0	0.016	2.8	–	–	0.022	0.52
	Borehole	10,000	0	0	0	0	–	–	0	0
		100,000	19	0	0.0091	1.6	–	–	0.012	0.29
Region I[c]	Vault	10,000	110	0	71	490	–	–	410	820
		100,000	110	0	71	490	–	–	410	820
Region II[c]	Vault	10,000	7.1	0	5.4	210	–	–	6.3	39
		100,000	120	0	10	210	–	–	76	150
	Trench	10,000	12	0	6.6	210	–	–	9.5	35
		100,000	480	0	43	330	–	–	340	530
Region III[c]	Vault	10,000	7.8	0	2.1	83	–	–	2.5	15
		100,000	240	0	7.1	74	–	–	56	110
Region IV	Vault	10,000	0	0	0	0	–	–	0	0
		100,000	0.11	0	1.0	8.4	–	–	3.1	6.2
	Trench	10,000	0	0	0	0	–	–	0	0
		100,000	0.14	0	1.2	6.9	–	–	3.9	5.8
	Borehole	10,000	0	0	0	0	–	–	0	0
		100,000	0.26	0	0.41	1.5	–	–	1.3	2.0

Footnotes appear on next page.

TABLE E-25 (Cont.)

[a] CH = contact-handled, GTCC = greater-than-Class C, INL = Idaho National Laboratory, LANL = Los Alamos National Laboratory, NNSS = Nevada National Security Site, RH = remote-handled, SRS = Savannah River Site, WIPP = Waste Isolation Pilot Plant, Region I–IV = a generic commercial site located within each of the four major regions of the country.

[b] These annual doses are associated with the use of contaminated groundwater by a hypothetical resident farmer located 100 m (330 ft) from the edge of the disposal facility. All values are given to two significant figures, and a dash means there is no inventory for that waste type. Annual doses of less than 0.001 mrem/yr are reported as <0.001. The values given in this table represent the peak annual doses from each waste type. Because of the different radionuclide mixes and activities contained in the different waste types, the peak annual doses that could result from each waste type individually generally occur at different times than the peak annual dose from the entire inventory. The peak annual doses from the entire GTCC waste inventory are given in the site-specific chapters of the EIS.

[c] The above-grade vault is the only method evaluated for Region I and Region III because of the shallow groundwater depth. The borehole method is not considered suitable for SRS and Regions I, II, and III.

TABLE E-26 Sensitivity Analysis Cases Addressed in the EIS

Parameter	Base Case	Case I	Case II	Case III	Case IV	Case V	Case VI	Case VII	Case VIII	Case IX	Case X
Effective period of grout (yr)	500	500	500	2,000	2,000	2,000	5,000	5,000	5,000	500	500
Percentage of natural infiltration rate into the waste units after 500 years (%)	20	50	100	20	50	100	20	50	100	20	20
Distance to the hypothetical receptor (m)	100	100	100	100	100	100	100	100	100	300	500

TABLE E-27 Peak Annual Doses within 10,000 Years and the Occurrence Times at the WIPP Vicinity for the Different Sensitivity Analysis Cases[a]

Result	Base Case	Case I	Case II	Case III	Case IV	Case V	Case VI	Case VII	Case VIII	Case IX	Case X
Peak annual dose (mrem/yr)	0	0	0	0	0	0	0	0	0	0	0
Time (yr)	0	0	0	0	0	0	0	0	0	0	0

[a] The sensitivity analysis considered the disposal of stored Group 1 GTCC-like Other Waste - CH by using the trench method.

TABLE E-28 Peak Annual Doses within 10,000 Years and the Occurrence Times at SRS for the Different Sensitivity Analysis Cases[a]

Result	Base Case	Case I	Case II	Case III	Case IV	Case V	Case VI	Case VII	Case VIII	Case IX	Case X
Peak annual dose (mrem/yr)	62	140	250	41	85	130	37	72	100	23	13
Time (yr)	610	580	550	2,100	2,100	2,000	5,100	5,100	5,100	780	940

[a] The sensitivity analysis considered the disposal of stored Group 1 GTCC-like Other Waste - CH by using the trench method. All values are given to two significant figures. The times for the peak annual doses represent the time after failure of the cover and engineered barriers (which is assumed to begin 500 years after closure of the disposal facility).

E.7 REFERENCES

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APPENDIX F:

CONSULTATION CORRESPONDENCE FOR THE DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR THE DISPOSAL OF GREATER-THAN-CLASS C (GTCC) LOW-LEVEL RADIOACTIVE WASTE AND GTCC-LIKE WASTE

Table F-1 lists the consultation correspondence related to the GTCC reference locations evaluated in this EIS. (Note that in the letters, the Nevada National Security Site was still referred to as the Nevada Test Site or NTS, and this was not changed.) Copies of the correspondence follow this table. Background information on the project, which was included as an attachment to each letter from A.M. Edelman of the U.S. Department of Energy, Office of Disposal Operations, is provided at the end of this appendix, after the letters.

TABLE F-1 Consultation Correspondence

Page	Source	Recipient	Date of Letter
F-3	U.S. Department of Energy (A.M. Edelman)	U.S. Fish and Wildlife Service, Wenatchee, Wash. (J. Gonzales)	December 10, 2009
F-4	U.S. Fish and Wildlife Service, Wenatchee, Wash. (K.S. Berg)	U.S. Department of Energy (A.M. Edelman)	January 27, 2010
F-8	U.S. Department of Energy (A.M. Edelman)	U.S. Fish and Wildlife Service, Boise, Id. (J. Foss)	December 10, 2009
F-9	U.S. Fish and Wildlife Service, Chubbock, Id. (D. Miller)	U.S. Department of Energy (A.M. Edelman)	January 4, 2010
F-10	U.S. Department of Energy (A.M. Edelman)	U.S. Fish and Wildlife Service, Albuquerque, N.M. (W. Murphy)	December 10, 2009
F-11	U.S. Fish and Wildlife Service, Albuquerque, N.M. (W. Murphy)	U.S. Department of Energy (A.M. Edelman)	February 2, 2010
F-13	U.S. Department of Energy (A.M. Edelman)	U.S. Fish and Wildlife Service, Reno, Nev. (R. Williams)	December 10, 2009
F-14	U.S. Fish and Wildlife Service, Reno, Nev. (R.D. Williams)	U.S. Department of Energy (A.M. Edelman)	January 21, 2010
F-19	U.S. Department of Energy (A.M. Edelman)	U.S. Fish and Wildlife Service, Charleston, S.C. (M. Tobin)	December 10, 2009
F-20	U.S. Fish and Wildlife Service, Charleston, S.C. (D.L. Lynch)	U.S. Department of Energy (A.M. Edelman)	January 6, 2010
F-23	U.S. Department of Energy (A.M. Edelman)	Washington State Department of Fish and Wildlife Service, Yakima, Wash. (J. Tayer)	January 19, 2010

TABLE F-1 (Cont.)

Page	Source	Recipient	Date of Letter
F-25	U.S. Department of Energy (A.M. Edelman)	Idaho Department of Fish and Game, Idaho Falls, Id. (S. Schmidt)	January 19, 2010
F-27	U.S. Department of Energy (A.M. Edelman)	Ecological Services, Albuquerque, N.M. (W. Murphy)	January 19, 2010
F-29	U.S. Department of Energy (A.M. Edelman)	Nevada Natural Heritage Program, Carson City, Nev. (J.E. Newmark)	January 19, 2010
F-31	Nevada Natural Heritage Program, Carson City, Nev. (E.S. Miskow)	U.S. Department of Energy (A.M. Edelman)	February 10, 2010
F-35	U.S. Department of Energy (A.M. Edelman)	South Carolina Department of Natural Resources, Columbia, S.C. (J. Holling)	January 19, 2010
F-37	South Carolina Department of Natural Resources, Columbia, S.C. (J. Holling)	U.S. Department of Energy (A.M. Edelman)	January 27, 2010
F-40	U.S. Department of Energy (A.M. Edelman)	Los Alamos Site Office (J. Griego)	January 19, 2010
F-41	U.S. Department of Energy (A.M. Edelman)	Department of Archeology and Historic Preservation, Olympia, Wash. (A. Brooks)	January 19, 2010
F-43	U.S. Department of Energy (A.M. Edelman)	State Historic Preservation Office, Boise, Id. (K. Reid)	January 19, 2010
F-45	U.S. Department of Energy (A.M. Edelman)	State of New Mexico Department of Cultural Affairs, Santa Fe, N.M. (J. Biella)	January 19, 2010
F-47	U.S. Department of Energy (A.M. Edelman)	Nevada State Historic Preservation Office, Carson City, Nev. (R. James)	January 19, 2010
F-49	Nevada State Historic Preservation Office, Carson City, Nev. (A.M. Baldrica)	U.S. Department of Energy (A.M. Edelman)	February 26, 2010
F-50	U.S. Department of Energy (A.M. Edelman)	Department of Archives and History, Columbia, S.C. (E. Emerson)	January 19, 2010

Department of Energy
Washington, DC 20585

December 10, 2009

Ms. Jessica Gonzales
Assistant Project Leader
Wenatchee Field Office
U.S. Fish and Wildlife Service
215 Melody Lane, Suite 119
Wenatchee, Washington 98801

Dear Ms. Gonzalez:

The Department of Energy, Office of Environmental Management is preparing an Environmental Impact Statement (EIS) under the National Environmental Policy Act for the disposal of Greater-Than-Class-C Low-Level-Radioactive Waste (GTCC LLRW). In compliance with the Endangered Species Act, the EIS will contain an analysis of the proposed action and potential impacts to listed and proposed threatened and endangered species. We request that you provide us with any information regarding the occurrence of federally listed and proposed threatened and endangered species that may occur on or in the vicinity of the proposed GTCC LLRW disposal location immediately south of the Integrated Disposal Facility site in the 200 East Area in the central portion of the Hanford Site, Benton County that should be considered in preparing the EIS.

I have enclosed a brief background of the project, including information on the potential Hanford GTCC location, and a copy of the Notice of Intent. I wish to thank you in advance for the information that you will be providing to us. If you have any questions, please contact me at (301) 903-5145 or at arnold.edelman@em.doe.gov.

Sincerely,

Arnold M Edelman

Arnold M. Edelman
EIS Document Manager
Office of Disposal Operations

Enclosures

cc: Woody Russell, ORP

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United States Department of the Interior

FISH AND WILDLIFE SERVICE

Washington Fish and Wildlife Office
Central Washington Field Office
215 Melody Lane, Suite 119
Wenatchee, WA 98801

January 27, 2010

In Reply Refer To:
USFWS Reference: 13260-2010-SL-0019

Arnold M. Edelman
EIS Document Manager, Office of Disposal Operations
Department of Energy
1000 Independence Ave., SW
Washington, DC 20585

Dear Mr. Edelman:

We have received your request for information on endangered and threatened species and their critical habitats that may be present near your potential disposal location of Greater-Than-Class-C Low-Level Radioactive Waste (GTCC LLRW) in Benton County, Washington. For your convenience, updated countywide species and habitat listings are now available on our website at http://www.fws.gov/easternwashington. To view the listings in your area of concern, select "county species lists" within the ESA programs page, and then select the county of interest. The lists available on our website are compliant with Section 7(c) of the Endangered Species Act of 1973, as amended (Act), and are the most current available listings of endangered, threatened and proposed species and critical habitats in a given area. For optional consideration, the lists also contain updated species of concern and candidate species. Please be aware that the U.S. Fish and Wildlife Service is in the process of proposing bull trout critical habitat.

Species of anadromous fish that have been listed under the Act by the National Marine Fisheries Service (NMFS) may also occur in your project area. Please contact NMFS in Ellensburg, Washington, at (509) 962-8911 to request information on listed species within NMFS's jurisdiction.

If you would like information concerning state listed species or species of concern, you may contact the Washington Department of Fish and Wildlife, at (360) 902-2543, for fish and wildlife species; or the Washington Department of Natural Resources, at (360) 902-1667, for plant species.

When you submit a request for Section 7 consultation, we request that you include your downloaded species list and the date it was downloaded, as an attachment. If applicable,

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Arnold M. Edelman 2

please also include the USFWS reference number on your consultation request. This will document your compliance with 50 CFR 402.12 (c).

Should your project plans change significantly, or if the project is delayed more than 90 days, you should update your species lists through our website and through the above listed agencies.

Thank you for your efforts to protect our nation's species and their habitats. If you have any questions concerning the above information, please contact Jeff Krupka at (509) 665-3508, extension 18, or via e-mail at Jeff_Krupka@fws.gov.

Sincerely,

Jessica L. Gonzales

Ken S. Berg, Manager
Washington Fish and Wildlife Office

cc: Joe Bartoszek, Mid-Columbia River NWR Complex, USFWS, Burbank, WA

Enclosure A

LISTED AND PROPOSED ENDANGERED AND THREATENED SPECIES,
CRITICAL HABITAT, CANDIDATE SPECIES, AND SPECIES OF CONCERN
THAT MAY OCCUR IN THE COUNTIES OF EASTERN WASHINGTON
AS LISTED BY THE U.S. FISH AND WILDLIFE SERVICE

January 27, 2010

FWS Reference: 13260-2010-SL-0019

COMMENTS

Major concerns that should be addressed in your biological assessment of project impacts to listed threatened, endangered, or proposed animal species are:

1. Level of use of the project area by listed species.
2. Effect of the project on listed species' primary food stocks and foraging areas in all areas influenced by the project.
3. Impacts from project construction and implementation (e.g. increased noise levels, increased human activity and/or access, loss or degradation of habitat) which may result in disturbance to listed species and/or their avoidance of the project area.

Major concerns that should be addressed for listed or proposed plant species are:

1. Distribution of taxon in project vicinity.
2. Disturbance (trampling, uprooting, collecting, etc.) of individual plants and loss of habitat.
3. Changes in hydrology where taxon is found.

Candidate species are those species for which the U.S. Fish and Wildlife Service has sufficient information to propose for listing as threatened or endangered under the Act. Species of concern (some of which are former Category 1 and Category 2 candidates) are those species whose conservation standing is of concern to the Service, but for which status information is still needed. Conservation measures for species of concern and candidate species are voluntary but recommended. Protection provided to these species now may preclude possible listing in the future.

For information regarding species listed by NOAA Fisheries, please visit the following website http://www.nwr.noaa.gov/lsalmon/salmesa/index.hhn or call (509) 962-8911 in Ellensburg, Washington.

BENTON COUNTY

Updated 4/15/2008

Listed

Endangered

Pygmy rabbit (*Brachylagus idahoensis*) – Columbia Basin distinct population segment

Threatened

Bull trout (*Salvelinus confluentus*) – Columbia River distinct population segment
Spiranthes diluvialis (Ute ladies'-tresses), plant

Candidate

Yellow-billed cuckoo (*Coccyzus americanus*)
Eriogonum codium (Umtanum desert buckwheat), plant

Species of Concern

Animals

Bald eagle (*Haliaeetus leucocephalus*) (delisted, monitor status)
Burrowing owl (*Athene cunicularia*)
California floater (*Anodonta californiensis*), mussel
Columbia clubtail (*Gomphus lynnae*), dragonfly
Ferruginous hawk (*Buteo regalis*)
Giant Columbia spire snail (*Fluminicola columbiana*)
Loggerhead shrike (*Lanius ludovicianus*)
Long-eared myotis (*Myotis evotis*)
Margined sculpin (*Cottus marginatus*)
Pacific lamprey (*Lampetra tridentata*)
Pallid Townsend's big-eared bat (*Corynorhinus townsendii pallescens*)
Redband trout (*Oncorhynchus mykiss*)
River lamprey (*Lampetra ayresi*)
Sagebrush lizard (*Sceloporus graciosus*)
Townsend's ground squirrel (*Spermophilus townsendii*)
Western brook lamprey (*Lampetra richardsoni*)

Vascular Plants

Astragalus columbianus (Columbia milk-vetch)
Cryptantha leucophaea (Gray cryptantha)
Haplopappus liatriformis (Palouse goldenweed)
Lomatium tuberosum (Hoover's desert-parsley)
Mimulus jungermannioides (Liverwort monkey-flower)
Rorippa columbiae (Persistent sepal yellowcress)

Department of Energy
Washington, DC 20585

December 10, 2009

Mr. Jeffery Foss, Field Supervisor
U.S. Fish and Wildlife Service
Idaho Fish and Wildlife Office
1387 South Vinnell Way, Suite 368
Boise, Idaho 83709-1657

Dear Mr. Foss:

The Department of Energy, Office of Environmental Management is preparing an Environmental Impact Statement (EIS) under the National Environmental Policy Act for the disposal of Greater-Than-Class-C Low-Level-Radioactive Waste (GTCC LLRW). In compliance with the Endangered Species Act, the EIS will contain an analysis of the proposed action and potential impacts to listed and proposed threatened and endangered species. We request that you provide us with any information regarding the occurrence of federally listed and proposed threatened and endangered species that may occur on or in the vicinity of the proposed GTCC LLRW disposal location at the Idaho National Laboratory (INL), southwest of the Reactor Technology Complex in the south central portion of INL, Butte County that should be considered in preparing the EIS.

I have enclosed a brief background of the project, including information on the potential INL GTCC location, and a copy of the Notice of Intent. I wish to thank you in advance for the information that you will be providing to us. If you have any questions, please contact me at (301) 903-5145 or at arnold.edelman@em.doe.gov.

Sincerely,

Arnold M. Edelman
EIS Document Manager
Office of Disposal Operations

Enclosures

cc: Richard Kauffman, ID

Printed with soy ink on recycled paper

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JAN 04 2010

Arnold M. Edelman
EIS Document Manager
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Department of Energy
Washington, DC 20585

Subject: Proposed Disposal of Greater-Than-Class-C Low-Level-Radioactive Waste at the INL in Southeast Idaho. SL #10-0116

Dear Mr. Edelman:

The U.S. Fish and Wildlife Service (Service) is writing in response to your request for information about the potential impacts to endangered, threatened, proposed, and/or candidate species from the proposed disposal of greater-than-C low-level-radioactive waste at the INL in Southeast Idaho. The Service has not identified any issues that indicate that consultation under section 7 of the Endangered Species Act of 1973, as amended, is needed for this project. This finding is based on our understanding of the nature of the project, local conditions, and/or current information indicating that no listed species are present. If you determine otherwise or require further assistance, please contact Sandi Arena of this office at (208)237-6975 ext 102.

Thank you for your interest in endangered species conservation.

Sincerely,

Damien Miller
Supervisor, Eastern Idaho Field Office

Department of Energy
Washington, DC 20585

December 10, 2009

Mr. Wally Murphy, Field Supervisor
U.S. Fish and Wildlife Service
New Mexico Ecological Services Field Office
2105 Osuna NE
Albuquerque, New Mexico 87113

Dear Mr. Murphy:

The Department of Energy, Office of Environmental Management is preparing an Environmental Impact Statement (EIS) under the National Environmental Policy Act for the disposal of Greater-Than-Class-C Low-Level-Radioactive Waste (GTCC LLRW). In compliance with the Endangered Species Act, the EIS will contain an analysis of the proposed action and potential impacts to listed and proposed threatened and endangered species. We request that you provide us with any information regarding the occurrence of federally listed and proposed threatened and endangered species that may occur on or in the vicinity of the three proposed GTCC LLRW disposal locations in your State: 1. Los Alamos National Laboratory within TA-54, on Mesita del Buey, Zone 6, North Site, and North Site Expanded, Los Alamos County; 2. the Waste Isolation Pilot Plant (WIPP) in Eddy County; and 3. Sections 27 and 35 in and around WIPP.

I have enclosed a brief background of the project, including information on the potential GTCC locations within the State, and a copy of the Notice of Intent. I wish to thank you in advance for the information that you will be providing to us. If you have any questions, please contact me at (301) 903-5145 or at arnold.edelman@em.doe.gov.

Sincerely,

Arnold M Edelman

Arnold M. Edelman
EIS Document Manager
Office of Disposal Operations

Enclosures

cc: George Rael, LASO
Nancy Werdel, DOE AL
Susan McCauslin, CBSO

FEB-02-2010 09:27AM FROM-US.FISH AND WILDLIFE +5053462542 T-237 P.001/004 F-406

United States Department of the Interior

FISH AND WILDLIFE SERVICE
New Mexico Ecological Services Field Office
2105 Osuna NE
Albuquerque, New Mexico 87113
Phone: (505) 346-2525 Fax: (505) 346-2542

FEB -2 2010

Thank you for your recent request for information on threatened or endangered species or important wildlife habitats that may occur in your project area. The New Mexico Ecological Services Field Office has posted lists of the endangered, threatened, proposed, candidate and species of concern occurring in all New Mexico Counties on the Internet. Please refer to the following web page for species information in the county where your project occurs: http://www.fws.gov/southwest/es/NewMexico/SBC_intro.cfm. If you do not have access to the Internet or have difficulty obtaining a list, please contact our office and we will mail or fax you a list as soon as possible.

After opening the web page, find New Mexico Listed and Sensitive Species Lists on the main page and click on the county of interest. Your project area may not necessarily include all or any of these species. This information should assist you in determining which species may or may not occur within your project area.

Under the Endangered Species Act of 1973, as amended (Act), it is the responsibility of the Federal action agency or its designated representative to determine if a proposed action "may affect" endangered, threatened, or proposed species, or designated critical habitat, and if so, to consult with us further. Similarly, it is their responsibility to determine if a proposed action has no effect to endangered, threatened, or proposed species, or designated critical habitat. On December 16, 2008, we published a final rule concerning clarifications to section 7 consultations under the Act (73 FR 76272). One of the clarifications is that section 7 consultation is not required in those instances when the direct and indirect effects of an action pose no effect to listed species or critical habitat. As a result, we do not provide concurrence with project proponent's "no effect" determinations.

If your action area has suitable habitat for any of these species, we recommend that species-specific surveys be conducted during the flowering season for plants and at the appropriate time for wildlife to evaluate any possible project-related impacts. Please keep in mind that the scope of federally listed species compliance also includes any interrelated or interdependent project activities (e.g., equipment staging areas, offsite borrow material areas, or utility relocations) and any indirect or cumulative effects.

FEB-02-2010 09:27AM FROM-US FISH AND WILDLIFE +5053462542 T-237 P.002/004 F-406

Candidates and species of concern have no legal protection under the Act and are included on the web site for planning purposes only. We monitor the status of these species. If significant declines are detected, these species could potentially be listed as endangered or threatened. Therefore, actions that may contribute to their decline should be avoided. We recommend that candidates and species of concern be included in your surveys.

Also on the web site, we have included additional wildlife-related information that should be considered if your project is a specific type. These include communication towers, power line safety for raptors, road and highway improvements and/or construction, spring developments and livestock watering facilities, wastewater facilities, and trenching operations.

Under Executive Orders 11988 and 11990, Federal agencies are required to minimize the destruction, loss, or degradation of wetlands and floodplains, and preserve and enhance their natural and beneficial values. We recommend you contact the U.S. Army Corps of Engineers for permitting requirements under section 404 of the Clean Water Act if your proposed action could impact floodplains or wetlands. These habitats should be conserved through avoidance, or mitigated to ensure no net loss of wetlands function and value.

The Migratory Bird Treaty Act (MBTA) prohibits the taking of migratory birds, nests, and eggs, except as permitted by the U.S. Fish and Wildlife Service. To minimize the likelihood of adverse impacts to all birds protected under the MBTA, we recommend construction activities occur outside the general migratory bird nesting season of March through August, or that areas proposed for construction during the nesting season be surveyed, and when occupied, avoided until nesting is complete.

We suggest you contact the New Mexico Department of Game and Fish, and the New Mexico Energy, Minerals, and Natural Resources Department, Forestry Division for information regarding fish, wildlife, and plants of State concern.

Thank you for your concern for endangered and threatened species and New Mexico's wildlife habitats. We appreciate your efforts to identify and avoid impacts to listed and sensitive species in your project area.

Sincerely,

Wally Murphy
Field Supervisor

Department of Energy
Washington, DC 20585

December 10, 2009

Mr. Robert Williams, State Supervisor
U.S. Fish and Wildlife Service
Nevada Fish and Wildlife Office
1340 Financial Boulevard, Suite 234
Reno, Nevada 89502-7147

Dear Mr. Williams:

The Department of Energy, Office of Environmental Management is preparing an Environmental Impact Statement (EIS) under the National Environmental Policy Act for the disposal of Greater-Than-Class-C Low-Level-Radioactive Waste (GTCC LLRW). In compliance with the Endangered Species Act, the EIS will contain an analysis of the proposed action and potential impacts to listed and proposed threatened and endangered species. We request that you provide us with any information regarding the occurrence of federally listed and proposed threatened and endangered species that may occur on or in the vicinity of the proposed GTCC LLRW disposal location at the Nevada Test Site (NTS), in the vicinity north of Frenchman Flat, either southeast or west of the existing Radioactive Waste Management Facility, Nye County that should be considered in preparing the EIS.

I have enclosed a brief background of the project, including information on the potential NTS GTCC location, and a copy of the Notice of Intent. I wish to thank you in advance for the information that you will be providing to us. If you have any questions, please contact me at (301) 903-5145 or at arnold.edelman@em.doe.gov.

Sincerely,

Arnold M. Edelman

Arnold M. Edelman
EIS Document Manager
Office of Disposal Operations

Enclosures

cc: Linda Cohn, NSO

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United States Department of the Interior

FISH AND WILDLIFE SERVICE
Nevada Fish and Wildlife Office
4701 North Torrey Pines Drive
Las Vegas, Nevada 89130
Ph: (702) 515-5230 ~ Fax: (702) 515-5231

January 21, 2010
File No. 84320-2010-SL-0133

Mr. Arnold Edelman
Office of Disposal Operations
U.S. Department of Energy
Cloverleaf Building (EM-43)
1000 Independence Avenue, SW
Washington, DC. 20585

Dear Mr. Edelman:

Subject: Request for Information on Federally Listed and Proposed Threatened or Endangered Species or Designated Critical Habitats that May Occur Near the Proposed Low-level Radioactive Waste Disposal Project Area on the Nevada Test Site in Nyc County, Nevada

This responds to your letter dated December 10, 2009, requesting information on federally listed and proposed threatened or endangered species or designated critical habitat that may occur near the proposed project area on the Nevada Test Site in Nye County, Nevada. We have determined that there is no critical habitat in/near the action area, but that the following federally listed species may occur in/near the action area:

- Desert tortoise (*Gopherus agassizii*) (Mojave population), threatened

This response fulfills the requirement of the Fish and Wildlife Service (Service) to provide information on potential presence of federally listed species pursuant to section 7(c) of the Endangered Species Act of 1973 (Act), as amended (16 U.S.C. 1531 *et seq.*), for projects that are authorized, funded, or carried out by a Federal agency.

To minimize the potential effects to this species from the implementation of this proposed action, we recommend the Department of Energy (DOE) propose minimization measures in accordance with the terms of the *Incidental Take Statement* in our Final Programmatic Biological Opinion for Implementation of Actions Proposed on the Nevada Test Site, Nye County, Nevada dated February 12, 2009 (Service File No. 84320-2008-F-0416).

TAKE PRIDE IN AMERICA

Mr. Arnold M. Edelman File No. 84320-2010-SL-0133

As a reminder, pursuant to the Act if the action agency determines that the proposed action may affect listed species or designated critical habitat the action agency would request that the proposed action be appended under the programmatic consultation and provide project-specific information that: (1) describes each proposed action and the specific areas to be affected; (2) identifies the species and critical habitat that may be affected; (3) describes the manner in which the proposed action may affect listed species; (4) describes the anticipated effects; (5) specifies, if appropriate, that the *anticipated effects from the proposed project are consistent with those anticipated in the programmatic biological opinion*; (6) describes proposed measures to minimize potential effects of the action; (7) describes any additional effects, if any, not considered in the programmatic consultation. The project information and effects analysis should be accompanied by a cover letter that specifies that the action agency has determined the proposed project is consistent with the programmatic biological opinion.

The Nevada Fish and Wildlife Office no longer provides species-of-concern lists. Most of these species for which we have concern are on the at-risk or watch-list species lists for Nevada maintained by the State of Nevada's Natural Heritage Program (Heritage). Instead of maintaining our own list, we have adopted Heritage's lists and partnered with them to provide distribution data and information on the conservation needs for sensitive species to agencies or project proponents. The mission of Heritage is to continually evaluate the conservation priorities of native plants, animals, and their habitats, particularly those most vulnerable to extinction or those that are in serious decline. Consideration of these sensitive species and exploring management alternatives early in the planning process can provide long-term conservation benefits and avoid future conflicts.

For a comprehensive list of at-risk or watch-list species that may occur in the project area, you can obtain a data request form from http://heritage.nv.gov/forms.htm or by contacting the Administrator of Heritage at 901 South Stewart Street, Suite 5002, Carson City, Nevada, 89701, 775-684-2900. Please indicate on the form that your request is being obtained as part of your coordination with the Service under the Act. During your project analysis, if you obtain new information or data for any Nevada sensitive species, we request that you provide the information to Heritage at the above address.

We are concerned that the project may impact the Gila monster (*Heloderma suspectum cinctum*), a species listed as sensitive under the Heritage Program and as a protected species under Nevada State law. The banded Gila monster resides primarily in the Mojave desert scrub and salt desert scrub ecosystems in southern Nevada, southeastern California, southwestern Utah, and western Arizona. The Gila monster is one of only two venomous lizard species in the world. Gila monsters are difficult to locate as they spend the majority of the year in underground burrows; however, illegal collection, construction of roads, and loss of habitat continue to threaten this sensitive. Given that the Gila monster may occur within the project area, we encourage you to minimize project impacts to any existing populations and suitable habitat for this species.

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Mr. Arnold M. Edelman File No. 84320-2010-SL-0133

Furthermore, certain species of fish and wildlife are protected by the State of Nevada (see http://www.leg.state.nv.us/NAC/NAC-503.html). You must first obtain the appropriate license, permit, or written authorization from the Nevada Department of Wildlife to take or possess any parts of protected wildlife species. Please visit http://www.ndow.org or contact Supervisory Biologist - Habitat, Nevada Department of Wildlife at 4747 Vegas Drive, Las Vegas, Nevada 89108, 702-486-5127.

The Service also has conservation responsibilities and management authority for migratory birds under the Migratory Bird Treaty Act (MBTA) of 1918, as amended (16 U.S.C. 703 *et seq.*). Under the MBTA, nests (nests with eggs or young) of migratory birds may not be harmed, nor may migratory birds be killed. Such destruction may be in violation of the MBTA. Therefore, we recommend land clearing, or other surface disturbance associated with the proposed project, be conducted outside the avian breeding season to avoid potential destruction of bird nests or young, or birds that breed in the area. If this is not feasible, we recommend a qualified biologist survey the area prior to land clearing. If nests are located, or if other evidence of nesting (*i.e.*, mated pairs, territorial defense, carrying nesting material, transporting food) is observed, a protective buffer (the size depending on the habitat requirements of the species) should be delineated and the entire area avoided to prevent destruction or disturbance to nests until they are no longer active.

In particular, we are concerned about the State-protected western burrowing owl (*Athene cunicularia hypugea*) and potential project impacts to this species from your project. The reduction of habitat in southern Nevada is a major threat to this species. Therefore, we recommend that the project avoid disturbing burrows that are used by burrowing owls. If this is not possible, we ask that the project incorporate the recommendations in our pamphlet, "Protecting Burrowing Owls at Construction Sites in Nevada's Mojave Desert Region" (Enclosure).

Please reference File No. 84320-2010-SL-0133 in future correspondence concerning this species list. If you have questions regarding this correspondence or require additional information, please contact Brian A. Novosak in the Nevada Fish and Wildlife Office in Las Vegas at 702-515-5230.

Sincerely,

for Robert D. Williams
State Supervisor

Enclosure

3

U.S. Fish and Wildlife Service
Nevada Fish and Wildlife Office
4701 N. Torrey Pines Drive
Las Vegas, NV 89130
Phone: 702-515-5230
Fax: 702-515-5231

http://www.fws.gov/nevada

U. S. Fish and Wildlife Service

Nevada Fish and Wildlife Office
Conserving the Biological Diversity of Great Basin, Eastern Sierra & Mojave Desert

PROTECTING BURROWING OWLS AT CONSTRUCTION SITES IN NEVADA'S MOJAVE DESERT REGION

(June 2007)

Burrowing owl numbers are declining despite protection under the Migratory Bird Treaty Act. Killing or possessing these birds or destruction of their eggs or nest is prohibited.

Be part of the solution; help these owls!

Though burrowing owls are capable of digging their own burrows, they often will use burrows of other animals for shelter and nesting. They will even adopt pipes or culverts 6" to 8" in diameter.

Tips for Protecting Burrowing Owls, Their Eggs and Young at Construction Sites:

Even though burrowing owls are often active during the day, always check burrows, cracks, and crevices for owls before beginning construction. Use of a fiber-optic scope or remote mini-camera to look into a burrow can help determine the presence of owls or nests. Ensure owls and eggs are not present in burrows when grading begins, to avoid burying them.

In southern Nevada, owls breed from about mid-March through August. If a burrow has an active nest, the site must be avoided until the chicks have fledged. To ensure that birds will not abandon the nest, a buffer of at least a 250-foot radius should be placed around the burrow, within which no construction should occur. It takes a minimum of 74 days from when eggs are laid until chicks are able to fly (fledge). After the young have fledged, check the nest burrow for any owlets before resuming construction.

<u>The following owl behaviors may help determine breeding or the presence of an active nest:</u>

- **A pair of owls is initially observed at a site, then only one owl is observed.** This may indicate that the pair has chosen a nest burrow, and the female has gone down into the burrow to lay and incubate eggs. Once incubation begins the female rarely leaves the burrow.
- **An owl is frequently observed carrying food to the burrow.** The male provides food for the female while she is incubating eggs. The best time of day to observe owls is dawn and dusk, but they may be active throughout the day. The male will most likely leave the food in front of the burrow and the female will come to the entrance to take the food. This is probably the best indication that the owls have an active nest.
- **Only one owl has been seen for a period of time; then, two owls are observed.** This may indicate that either the nest has failed, or the eggs have hatched, and the female has emerged from the burrow to assist the male in hunting for food to feed the chicks. The chicks will appear at the burrow entrance when they are about 10 days old.

If you are unsure of breeding status, seek the assistance of a professional biologist or other knowledgeable person. Should breeding behavior be observed, presence of an active nest should be assumed and the area avoided until the chicks have fledged or the nest is no longer occupied.

IMPORTANT! **In the Mojave Desert portions of Clark, southern Lincoln and Nye counties, owls may use desert tortoise burrows for nesting and shelter. Desert tortoises are protected under the Endangered Species Act. Killing, harming, or harassing desert tortoises, including destruction of their nests with eggs, without prior authorization is prohibited by Federal law.***

* IF YOUR PROJECT IS IN CLARK COUNTY, PLEASE READ ON:

Clark County holds a permit from the U.S. Fish & Wildlife Service authorizing "take" of desert tortoises during the course of otherwise legal activities on non-federal lands. **In Clark County only**, discouraging burrowing owls from breeding in the construction site on private property is allowed by collapsing tortoise burrow's during the owl's non-breeding season (September through February). This may help avoid construction delays. Prior to collapsing a burrow, always check for owls or other protected wildlife occupying the burrow for the winter. Call the Nevada Department of Wildlife at 702-486-5127 if a Gila monster is found as this is a State protected species.

Thank you for your assistance in protecting migratory birds and Nevada's endangered and threatened species!

Department of Energy
Washington, DC 20585

December 10, 2009

Mr. Melvin Tobin, Field Supervisor
U.S. Fish and Wildlife Service
Charleston Ecological Services Field Office
176 Croghan Spur Road, Suite 200
Charleston, South Carolina 29407-7558

Dear Mr. Tobin:

The Department of Energy, Office of Environmental Management is preparing an Environmental Impact Statement (EIS) under the National Environmental Policy Act for the disposal of Greater-Than-Class-C Low-Level-Radioactive Waste (GTCC LLRW).. In compliance with the Endangered Species Act, the EIS will contain an analysis of the proposed action and potential impacts to listed and proposed threatened and endangered species. We request that you provide us with any information regarding the occurrence of federally listed and proposed threatened and endangered species that may occur on or in the vicinity of the proposed GTCC LLRW disposal location at the Savannah River Site (SRS) at the upland ridge overlooking Tinker Creek, northeast of Area Z in the north-central portion of SRS, Aiken County, that should be considered in preparing the EIS.

I have enclosed a brief background of the project, including information on the potential SRS GTCC location, and a copy of the Notice of Intent. I wish to thank you in advance for the information that you will be providing to us. If you have any questions, please contact me at (301) 903-5145 or at arnold.edelman@em.doe.gov

Sincerely,

Arnold M. Edelman
EIS Document Manager
Office of Disposal Operations

Enclosure

cc: Drew Grainger, SR

United States Department of the Interior

FISH AND WILDLIFE SERVICE
176 Croghan Spur Road, Suite 200
Charleston, South Carolina 29407

January 6, 2010

Mr. Arnold M. Edelman
EIS Document Manager
Office of Disposal Operations
Department of Energy
Washington, DC 20585

Re: Radioactive Waste Disposal, Savannah River Site, Aiken County, SC
FWS Log No. 42410-2010-SL-0118

Dear Mr. Edelman:

The U.S. Fish and Wildlife Service (Service) has received your request for information regarding threatened and endangered species in the vicinity of the proposed low level radioactive waste disposal site at the Savannah River Site in Aiken County, SC. The Department of Energy (DOE) is developing an Environmental Impact Statement (EIS) to consider alternative disposal sites for low level radioactive waste. The Savannah River Station is one of the sites under consideration. Information requested by the DOE is pursuant to the requirements of the National Environmental Policy Act (NEPA) of 1969, as amended.

Please find attached a list of T&E species that are known to or may occur in Aiken County. This list includes species of state and federal concern. Reconnaissance efforts for the project must include a search for the federally listed T&E species. We also recommend the DOE include all state listed species in its biological/ecological review. Please contact the S.C. Department of Natural Resources for further information on these species and their habitat requirements.

The Service appreciates the opportunity to provide comments and reserves the right to provide additional comments throughout the development of this project. If you have any questions concerning the submitted comments please contact the Service's project manager Mr. Mark Caldwell at (843) 727-4707 ext. 215.

Sincerely,

Diane L. Lynch

Diane L. Lynch
Acting Field Supervisor

DLL/MAC

TAKE PRIDE IN AMERICA

South Carolina Distribution Records of
Endangered, Threatened, Candidate and Species of Concern
March 2009

E	Federally endangered
T	Federally threatened
P	Proposed in the Federal Register
CH	Critical Habitat
BGEPA	Federally protected under the Bald and Golden Eagle Protection Act
C	The U.S. Fish and Wildlife Service or the National Marine Fisheries Service has on file sufficient information on biological vulnerability and threat(s) to support proposals to list these species
S/A	Federally protected due to similarity of appearance to a listed species
SC	Federal Species of concern. These species are rare or limited in distribution but are not currently legally protected under the Endangered Species Act.
*	Contact the National Marine Fisheries Service for more information on this species

These lists should be used only as a guideline, not as the final authority. The lists include known occurrences and areas where the species has a high possibility of occurring. Records are updated continually and may be different from the following.

AIKEN COUNTY

Bald eagle	Haliaeetus leucocephalus	BGEPA	Known
Wood stork	Mycteria americana	E	Known
Red-cockaded woodpecker	Picoides borealis	E	Known
Shortnose sturgeon	Acipenser brevirostrum*	E	Known
Relict trillium	Trillium reliquum	E	Known
Piedmont bishop-weed	Ptilimnium nodosum	E	Known
Smooth coneflower	Echinacea laevigata	E	Known
Southern Dusky Salamander	Desmognathus auriculatus	SC	Possible
Gopher frog	Rana capito	SC	Known
Small-flowered buckeye	Aesculus parviflora	SC	Known
Sandhills milk-vetch	Astragalus michauxii	SC	Known
Elliott's croton	Croton elliottii	SC	Known
Dwarf burhead	Echinodorus parvulus	SC	Known
Shoals spider-lily	Hymenocallis coronaria	SC	Known
White-wicky	Kalmia cuneata	SC	Known
Bog spicebush	Lindera subcoriacea	SC	Known
Boykin's lobelia	Lobelia boykinii	SC	Known
Carolina bogmint	Macbridea caroliniana	SC	Known
Awned-meadowbeauty	Rhexia aristosa	SC	Known
Pickering's morning-glory	Stylisma pickeringii var. pickeringii	SC	Known

AIKEN COUNTY (cont)

Reclined meadow-rue	Thalictrum subrotundum	SC	Known
Bachman's sparrow	Aimophila aestivalis	SC	Possible
Henslow's sparrow	Ammodramus henslowii	SC	Known
American kestrel	Falco sparverius	SC	Possible
Loggerhead shrike	Lanius ludovicianus	SC	Possible
Painted bunting	Passerina ciris ciris	SC	Possible
Redhorse, Robust	Moxostoma robustum	SC	Known
Arogos skipper	Atrytone arogos arogos	SC	Known
Rafinesque's big-eared bat	Corynorhinus rafinesquii	SC	Known
Gopher tortoise	Gopherus polyphemus	SC	Known
Southern hognose snake	Heterodon simus	SC	Known
Pine or Gopher snake	Pituophis melanoleucus melanoleucus	SC	Known

Department of Energy
Washington, DC 20585

JAN 1 9 2010

Mr. Jeff Tayer
Regional Program Director
Washington State Department of Fish and Wildlife
1701 South 24th Avenue
Yakima, Washington 98902

Dear Mr. Tayer:

The Department of Energy, Office (DOE) of Environmental Management is preparing an Environmental Impact Statement (EIS) under the National Environmental Policy Act for the disposal of Greater-Than-Class-C Low-Level-Radioactive Waste (GTCC LLRW). The development of this EIS is mandated under Section 631 of the Energy Policy Act (EPAct) of 2005 and Section 3(b)(1)(D) of the Low-Level Radioactive Waste Policy Amendments Act (LLRWPAA) of 1985. The LLRWPAA assigned the Federal Government responsibility for the disposal of GTCC LLRW that result from Nuclear Regulatory Commission (NRC) licensed activities. The LLRWPAA also directed that such waste be disposed of in a facility licensed by NRC. DOE is the Federal agency responsible for the disposal of GTCC LLRW. This Draft EIS will be issued for public comment in late spring 2010.

Pursuant to Section 631 of EPAct, before making a final decision on the disposal alternative(s) to be implemented, DOE is required to submit to Congress a report that describes all alternatives considered in the EIS and await Congressional action. DOE will issue a report to Congress once the Final EIS is published; anticipated in summer 2011.

The Department is in the process of analyzing the proposed action and potential impacts to listed and proposed threatened and endangered species both at the Federal and State level. We request that you provide us with any information regarding the occurrence of state listed and proposed threatened and endangered species and state sensitive species that may occur on or in the vicinity of the proposed GTCC LLRW disposal location immediately south of the Integrated Disposal Facility site in the 200 East Area in the central portion of the Hanford Site, Benton County that should be considered in preparing the EIS.

I have enclosed a brief background of the project, including information on the potential GTCC locations within the State, and a copy of the Notice of Intent. I wish to thank you in advance for the information that you will be providing to us. If you have any questions, please contact me at (301) 903-5145 or at arnold.edelman@em.doe.gov.

Printed with soy ink on recycled paper

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Please send the requested information to:

Arnold Edelman
Office of Disposal Operations
Department of Energy, Cloverleaf Building (EM-43)
1000 Independence Avenue, SW
Washington, DC 20585

Sincerely,

Arnold M. Edelman
EIS Document Manager
Office of Disposal Operations

Enclosures

cc: Woody Russell, ORP

Department of Energy
Washington, DC 20585

JAN 19 2010

Mr. Steve Schmidt
Idaho Department of Fish and Game
4279 Commerce Circle
Idaho Falls, Idaho 83401

Dear Mr. Schmidt:

The Department of Energy, Office (DOE) of Environmental Management is preparing an Environmental Impact Statement (EIS) under the National Environmental Policy Act for the disposal of Greater-Than-Class-C Low-Level-Radioactive Waste (GTCC LLRW). The development of this EIS is mandated under Section 631 of the Energy Policy Act (EPAct) of 2005 and Section 3(b)(1)(D) of the Low-Level Radioactive Waste Policy Amendments Act (LLRWPAA) of 1985. The LLRWPAA assigned the Federal Government responsibility for the disposal of GTCC LLRW that result from Nuclear Regulatory Commission (NRC) licensed activities. The LLRWPAA also directed that such waste be disposed of in a facility licensed by NRC. DOE is the Federal agency responsible for the disposal of GTCC LLRW. This Draft EIS will be issued for public comment in late spring 2010.

Pursuant to Section 631 of EPAct, before making a final decision on the disposal alternative(s) to be implemented, DOE is required to submit to Congress a report that describes all alternatives considered in the EIS and await Congressional action. DOE will issue a report to Congress once the Final EIS is published; anticipated in summer 2011.

The Department is in the process of analyzing the proposed action and potential impacts to listed and proposed threatened and endangered species both at the Federal and State level. We request that you provide us with any information regarding the occurrence of State listed and proposed threatened and endangered species and any state sensitive species that may occur on or in the vicinity of the proposed GTCC LLRW disposal location at the Idaho National Laboratory (INL), southwest of the Reactor Technology Complex in the south central portion of INL, Butte County that should be considered in preparing the EIS.

I have enclosed a brief background of the project, including information on the potential GTCC locations within the State, and a copy of the Notice of Intent. I wish to thank you in advance for the information that you will be providing to us. If you have any questions, please contact me at (301) 903-5145 or at arnold.edelman@em.doe.gov.

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2

Please send the requested information to:

Arnold Edelman
Office of Disposal Operations
Department of Energy, Cloverleaf Building (EM-43)
1000 Independence Avenue, SW
Washington, DC 20585

Sincerely,

Arnold M. Edelman
EIS Document Manager
Office of Disposal Operations

Enclosures

cc: Jack Depperschmidt, IDSO

Department of Energy
Washington, DC 20585

JAN 19 2010

Mr. Wally Murphy, Field Office Supervisor
Ecological Services
2105 Osuna Road, NE
Albuquerque, New Mexico 87113

Dear Mr. Murphy:

The Department of Energy, Office (DOE) of Environmental Management is preparing an Environmental Impact Statement (EIS) under the National Environmental Policy Act for the disposal of Greater-Than-Class-C Low-Level-Radioactive Waste (GTCC LLRW). The development of this EIS is mandated under Section 631 of the Energy Policy Act (EPAct) of 2005 and Section 3(b)(1)(D) of the Low-Level Radioactive Waste Policy Amendments Act (LLRWPAA) of 1985. The LLRWPAA assigned the Federal Government responsibility for the disposal of GTCC LLRW that result from Nuclear Regulatory Commission (NRC) licensed activities. The LLRWPAA also directed that such waste be disposed of in a facility licensed by NRC. DOE is the Federal agency responsible for the disposal of GTCC LLRW. This Draft EIS will be issued for public comment in late spring 2010.

Pursuant to Section 631 of EPAct, before making a final decision on the disposal alternative(s) to be implemented, DOE is required to submit to Congress a report that describes all alternatives considered in the EIS and await Congressional action. DOE will issue a report to Congress once the Final EIS is published; anticipated in summer 2011.

The Department is in the process of analyzing the proposed action and potential impacts to listed and proposed threatened and endangered species both at the Federal and State level. We request that you provide us with any information regarding the occurrence of state listed and proposed threatened and endangered species and any State sensitive species that may occur on or in the vicinity of the three proposed GTCC LLRW disposal locations in your State: 1. Los Alamos National Laboratory within TA-54, on Mesita del Buey, Zone 6, North Site, and North Site Expanded, Los Alamos County; and 2. the Waste Isolation Pilot Plant (WIPP) in Eddy County; and 3. Sections 27 and 35 in and around WIPP.

I have enclosed a brief background of the project, including information on the potential GTCC locations within the State, and a copy of the Notice of Intent. I wish to thank you in advance for the information that you will be providing to us. If you have any questions, please contact me at (301) 903-5145 or at arnold.edelman@em.doe.gov.

2

Please send the requested information to:

Arnold Edelman
Office of Disposal Operations
Department of Energy, Cloverleaf Building (EM-43)
1000 Independence Avenue, SW
Washington, DC 20585

Sincerely,

Arnold M. Edelman
EIS Document Manager
Office of Disposal Operations

Enclosures

cc: George Rael, LASO
Nancy Werdel, DOE AL
Susan McCauslin, CBFO

Department of Energy
Washington, DC 20585

JAN 19 2010

Ms. Jennifer E. Newmark, Administrator
Nevada Natural Heritage Program
Richard H. Bryan Building
901 South Stewart Street, Suite 5002
Carson City, Nevada 89701-5245,

Dear Ms. Newmark:

The Department of Energy, Office (DOE) of Environmental Management is preparing an Environmental Impact Statement (EIS) under the National Environmental Policy Act for the disposal of Greater-Than-Class-C Low-Level-Radioactive Waste (GTCC LLRW). The development of this EIS is mandated under Section 631 of the Energy Policy Act (EPAct) of 2005 and Section 3(b)(1)(D) of the Low-Level Radioactive Waste Policy Amendments Act (LLRWPAA) of 1985. The LLRWPAA assigned the Federal Government responsibility for the disposal of GTCC LLRW that result from Nuclear Regulatory Commission (NRC) licensed activities. The LLRWPAA also directed that such waste be disposed of in a facility licensed by NRC. DOE is the Federal agency responsible for the disposal of GTCC LLRW. This Draft EIS will be issued for public comment in late spring 2010.

Pursuant to Section 631 of EPAct, before making a final decision on the disposal alternative(s) to be implemented, DOE is required to submit to Congress a report that describes all alternatives considered in the EIS and await Congressional action. DOE will issue a report to Congress once the Final EIS is published; anticipated in summer 2011.

The Department is in the process of analyzing the proposed action and potential impacts to listed and proposed threatened and endangered species both at the Federal and State level. We request that you provide us with any information regarding the occurrence of State listed and proposed threatened and endangered species and any state sensitive species that may occur on or in the vicinity of the proposed GTCC LLRW disposal location at the Nevada Test Site (NTS), in the vicinity north of Frenchman Flat, either southeast or west of the existing Radioactive Waste Management Facility, Nye County that should be considered in preparing the EIS.

I have enclosed a brief background of the project, including information on the potential GTCC locations within the State, and a copy of the Notice of Intent. I wish to thank you in advance for the information that you will be providing to us. If you have any questions, please contact me at (301) 903-5145 or at arnold.edelman@em.doe.gov.

Printed with soy ink on recycled paper

Please send the requested information to:

Arnold Edelman
Office of Disposal Operations
Department of Energy, Cloverleaf Building (EM-43)
1000 Independence Avenue, SW
Washington, DC 20585

Sincerely,

Arnold M Edelman

Arnold M. Edelman
EIS Document Manager
Office of Disposal Operations

Enclosures

cc: Linda Cohn, NSO
Lori Plummer, NSO

ALLEN BIAGGI
Director

Department of Conservation
and Natural Resources

JENNIFER E. NEWMARK
Administrator

JIM GIBBONS
Governor

Nevada Natural Heritage Program
Richard H. Bryan Building
901 S. Stewart Street, Suite 5002
Carson City, Nevada 89701-5245
U.S.A.

tel: (775) 684-2900
fax: (775) 684-2909

Nevada Natural Heritage Program

STATE OF NEVADA
DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES

Nevada Natural Heritage Program

http://heritage.nv.gov

10 February 2010

Arnold Edelman
Office of Disposal Operations
Department of Energy, Cloverleaf Building (EM-43)
1000 Independence Ave., SW
Washington, DC 20585

RE: Data request received 25 January 2010

Dear Mr. Edelman:

We are pleased to provide the information you requested on endangered, threatened, candidate, and/or at risk plant and animal taxa recorded within or near the Proposed Greater-Than-Class-C Low Level Radioactive Waste disposal project area on the Nevada Test Site. We searched our database and maps for the following, a three kilometer radius around the location provided in your request including:

Township	12S	Range	54E	Sections	All
Township	12S	Range	55E	Sections	All
Township	13S	Range	53E	Sections	All
Township	13S	Range	54E	Sections	All
Township	13S	Range	55E	Sections	All

The enclosed printout lists the taxa recorded within the given area. Please be aware that habitat may also be available for: the Clokey pincushion, *Coryphantha vivipara* var. *rosea*, a Taxon determined to be Vulnerable by the Nevada Natural Heritage Program as well as a protected cactus under NRS 527.060-120); the Clarke phacelia, *Phacelia filiae*, a Nevada Bureau of Land Management (BLM) Sensitive Species; the western small-footed myotis, *Myotis ciliolabrum*, a Nevada BLM Sensitive Species; and the pallid bat, *Antrozous pallidus*, a Nevada BLM Sensitive Species. We do not have complete data on various raptors that may also occur in the area; for more information contact Chet VanDellen, Nevada Division of Wildlife at (775) 688-1565. Note that all cacti, yuccas, and Christmas trees are protected by Nevada state law (NRS 527.060-.120), including taxa not tracked by this office.

Please note that our data are dependent on the research and observations of many individuals and organizations, and in most cases are not the result of comprehensive or site-specific field surveys. Natural Heritage reports should never be regarded as

(NSPO 8-08)

DOE GTCC NTS
10 February 2010

page 2 of 2

final statements on the taxa or areas being considered, nor should they be substituted for on-site surveys required for environmental assessments.

Thank you for checking with our program. Please contact us for additional information or further assistance.

Sincerely,

Eric S. Miskow
Biologist/Data Manager

At Risk Taxa Recorded Near the GTCC Reference Location on the NTS Project Area

Compiled by the Nevada Natural Heritage Program for the U.S. Department of Energy
10 February 2010

Scientific name	Common name	Usfws	Blm	Usfs	State	Srank	Grank	UTM E	UTM N	Prec	Last observed
Plants											
Arctomecon merriamii	white bearpoppy		N	S		S3	G3	597410.49	4064718.51	G	1971-06-04
Astragalus funereus	black woollypod		N;C	S		S2	G2	596692.17	4086468.33	S	1979-05-10
Astragalus funereus	black woollypod		N;C	S		S2	G2	593788.82	4084956.51	S	1992-05-04
Astragalus funereus	black woollypod		N;C	S		S2	G2	593421.31	4084613.41	S	1992-05-05
Camissonia megalantha	Cane Spring suncup		N			S3	G3Q	594939.94	4081610.01	M	1978-09-26
Camissonia megalantha	Cane Spring suncup		N			S3	G3Q	593595.51	4086772.70	M	1992-08-17
Camissonia megalantha	Cane Spring suncup		N			S3	G3Q	594251.35	4083420.67	S	1992-08-04
Camissonia megalantha	Cane Spring suncup		N			S3	G3Q	593834.18	4085326.80	S	1992-08-04
Cymopterus ripleyi var. *saniculoides*	sanicle biscuitroot		N;C			S3	G3G4T3Q	590467.43	4073764.28	G	1965-05-19
Cymopterus ripleyi var. *saniculoides*	sanicle biscuitroot		N;C			S3	G3G4T3Q	589218.92	4088821.27	G	1965-05-20
Cymopterus ripleyi var. *saniculoides*	sanicle biscuitroot		N;C			S3	G3G4T3Q	595068.38	4070085.31	G	1941-05-13
Phacelia beatleyae	Beatley scorpionflower		N			S3	G3	595818.80	4087105.60	M	1976-06-21
Phacelia beatleyae	Beatley scorpionflower		N			S3	G3	594839.83	4083920.27	S	1992-06-11
Phacelia beatleyae	Beatley scorpionflower		N			S3	G3	597347.06	4083301.44	M	1979-05-10
Phacelia beatleyae	Beatley scorpionflower		N			S3	G3	596294.14	4086648.76	S	1977-PRE
Phacelia beatleyae	Beatley scorpionflower		N			S3	G3	597773.31	4089285.29	M	1979-05-10
Reptiles											
Gopherus agassizii	desert tortoise (Mojave Desert pop.)	LT	S	T	YES	S2S3	G4	599229.05	4079008.49	M	1994-PRE
Gopherus agassizii	desert tortoise (Mojave Desert pop.)	LT	S	T	YES	S2S3	G4	599850.80	4076673.52	M	1994-PRE
Gopherus agassizii	desert tortoise (Mojave Desert pop.)	LT	S	T	YES	S2S3	G4	587377.81	4072961.68	M	1994-PRE
Gopherus agassizii	desert tortoise (Mojave Desert pop.)	LT	S	T	YES	S2S3	G4	593997.43	4081753.65	S	1993-05-05
Gopherus agassizii	desert tortoise (Mojave Desert pop.)	LT	S	T	YES	S2S3	G4	587532.46	4079619.89	M	1994-PRE
Mammals											
Notiosorex crawfordi	Crawford's desert shrew					S3	G5	595367.85	4067684.80	G	1961-10-11

U. S. Fish and Wildlife Service (Usfws) Categories for Listing under the Endangered Species Act:

LT	Listed Threatened - likely to be classified as Endangered in the foreseeable future if present trends continue

Bureau of Land Management (Blm) Species Classification:

S	Nevada Special Status Species - USFWS listed, proposed or candidate for listing, or protected by Nevada state law
N	Nevada Special Status Species - designated Sensitive by State Office
C	California Special Status Species (see definition S and N)

United States Forest Service (Usfs) Species Classification:

S	Region 4 (Humboldt-Toiyabe NF) sensitive species
T	Region 4 and/or Region 5 Threatened species

Nevada State Protected (State) Species Classification:

Fauna:

YES	Species protected under NRS 501.

Precision (Prec) of Mapped Occurrence:

Precision, or radius of uncertainty around latitude/longitude coordinates:

S	Seconds: within a three-second radius
M	Minutes: within a one-minute radius, approximately 2 km or 1.5 miles
G	General: within about 8 km or 5 miles, or to map quadrangle or place name

Nevada Natural Heritage Program Global (**Grank**) and State (**Srank**) Ranks for Threats and/or Vulnerability:

- G Global rank indicator, based on worldwide distribution at the species level
- T Global trinomial rank indicator, based on worldwide distribution at the infraspecific level
- S State rank indicator, based on distribution within Nevada at the lowest taxonomic level
  - 1 Critically imperiled and especially vulnerable to extinction or extirpation due to extreme rarity, imminent threats, or other factors
  - 2 Imperiled due to rarity or other demonstrable factors
  - 3 Vulnerable to decline because rare and local throughout its range, or with very restricted range
  - 4 Long-term concern, though now apparently secure; usually rare in parts of its range, especially at its periphery
  - 5 Demonstrably secure, widespread, and abundant
    - A Accidental within Nevada
    - B Breeding status within Nevada (excludes resident taxa)
    - H Historical; could be rediscovered
    - N Non-breeding status within Nevada (excludes resident taxa)
    - Q Taxonomic status uncertain
    - U Unrankable
    - Z Enduring occurrences cannot be defined (usually given to migrant or accidental birds)
    - ? Assigned rank uncertain

Department of Energy
Washington, DC 20585

JAN 19 2010

Ms. Julie Holling
Department of Natural Resources
Wildlife and Freshwater Fisheries Division
P.O. Box 167
Columbia, South Carolina 29202-0167

Dear Ms. Holling:

The Department of Energy, Office (DOE) of Environmental Management is preparing an Environmental Impact Statement (EIS) under the National Environmental Policy Act for the disposal of Greater-Than-Class-C Low-Level-Radioactive Waste (GTCC LLRW). The development of this EIS is mandated under Section 631 of the Energy Policy Act (EPAct) of 2005 and Section 3(b)(1)(D) of the Low-Level Radioactive Waste Policy Amendments Act (LLRWPAA) of 1985. The LLRWPAA assigned the Federal Government responsibility for the disposal of GTCC LLRW that result from Nuclear Regulatory Commission (NRC) licensed activities. The LLRWPAA also directed that such waste be disposed of in a facility licensed by NRC. DOE is the Federal agency responsible for the disposal of GTCC LLRW. This Draft EIS will be issued for public comment in late spring 2010.

Pursuant to Section 631 of EPAct, before making a final decision on the disposal alternative(s) to be implemented, DOE is required to submit to Congress a report that describes all alternatives considered in the EIS and await Congressional action. DOE will issue a report to Congress once the Final EIS is published; anticipated in summer 2011.

The Department is in the process of analyzing the proposed action and potential impacts to listed and proposed threatened and endangered species both at the Federal and State level. We request that you provide us with any information regarding the occurrence of State listed and proposed threatened and endangered species and any state sensitive species that may occur on or in the vicinity of the proposed GTCC LLRW disposal location at the Savannah River Site (SRS) at the upland ridge overlooking Tinker Creek, northeast of Area Z in the north-central portion of SRS, Aiken County, that should be considered in preparing the EIS.

I have enclosed a brief background of the project, including information on the potential GTCC locations within the State, and a copy of the Notice of Intent. I wish to thank you in advance for the information that you will be providing to us. If you have any questions, please contact me at (301) 903-5145 or at arnold.edelman@em.doe.gov.

2

Please send the requested information to:

Arnold Edelman
Office of Disposal Operations
Department of Energy, Cloverleaf Building (EM-43)
1000 Independence Avenue, SW
Washington, DC 20585

Sincerely,

Arnold M. Edelman
EIS Document Manager
Office of Disposal Operations

Enclosures

cc: Drew Grainger, SR

South Carolina Department of
Natural Resources

DNR

John E. Frampton
Director

Ken Rentiers
Deputy Director for
Land, Water and Conservation Division

January 27, 2010

Mr. Arnold M. Edelman, EIS Document Manager
Office of Disposal Operations
Department of Energy, Cloverleaf Building (EM-43)
1000 Independence Avenue, SW
Washington, DC 20585

RE: Threatened and Endangered Species and GTCC LLRW waste disposal at Savannah River Site, South Carolina

Dear Mr. Johnson,

Because our database does not represent a comprehensive biological inventory of the state, I can only verify the known occurrences in the vicinity of your project. There may be occurrences of species in the vicinity of your project area that have not been reported to us. Fieldwork remains the responsibility of the investigator.

Since this is a preliminary report and only a rough idea given for the location, I have reviewed our database a little more broadly than usual. There are no known occurrences or any federally or state listed threatened or endangered within the expected drainage of the project area. However, there are a number of rare plant records for the drainage area, including: *Carex folliculata* (Long Sedge, G4G5, S1), *Ilex amelanchier* (Sarvis Holly, G4, S3), *Lindera subcoriacea* (Bog Spicebush, G2G3, S3), *Nestronia umbellula* (Nestronia, G4, S3), *Nolina georgiana* (Georgia Bear-grass, G3G5, S3), *Platanthera lacera* (Green-fringe Orchis, G5, S2), and *Rhododendron flammeum* (Piedmont azalea, G3, S3). Although these species do not have any legal protection, we ask that you consider protecting them during your work. As further indication of other species that may occur in the project area, I have also enclosed the list of rare, threatened, and endangered species and communities that occur within roughly 5 miles of the project site.

Rembert C. Dennis Building • 1000 Assembly Street • PO Box 167 • Columbia, SC 29202 • Telephone: 803-734-9100 • Fax: 803-734-9200

As a professional courtesy, we ask that you acknowledge S.C. Heritage Trust as a source of information whenever you use this data in reports.

If you need additional assistance, please contact me by phone at 803-734-3917 or by e-mail at HollingJ@dnr.sc.gov.

Sincerely,

Julie Holling, Data Manager
SC Department of Natural Resources
Heritage Trust Program

Encl.

Rare, Threatened, and Endangered Species and Communities Known to Occur within 5 miles of SRS GTCC LLRW Disposal Site
January 26, 2010

Scientific Name	Common Name	USESA Designation	State Protection	Global Rank	State Rank
Vertebrate Animals					
Condylura cristata	Star-nosed Mole			G5	S3?
Corynorhinus rafinesquii	Rafinesque's Big-eared Bat		SE-Endangered	G3G4	S2?
Egretta caerulea	Little Blue Heron			G5	SNRB,SNRN
Heterodon simus	Southern Hognose Snake			G2	SNR
Neotoma floridana	Eastern Woodrat			G5	S3S4
Pituophis melanoleucus	Pine or Gopher Snake			G4	S3S4
Rana capito	Gopher Frog		SE-Endangered	G3	S1
Vascular Plants					
Allium cuthbertii	Striped Garlic			G4	S2
Baptisia lanceolata	Lance-leaf Wild-indigo			G4	S3
Carex folliculata	Long Sedge			G4G5	S1
Coreopsis rosea	Rose Coreopsis			G3	S2
Croton elliottii	Elliott's Croton			G2G3	S2S3
Echinacea laevigata	Smooth Coneflower	LE: Listed endangered		G2G3	S3
Echinodorus tenellus	Dwarf Burhead			G5?	S2
Eleocharis robbinsii	Robbins Spikerush			G4G5	S2
Ilex amelanchier	Sarvis Holly			G4	S3
Lindera subcoriacea	Bog Spicebush			G2G3	S3
Ludwigia spathulata	Spatulate Seedbox			G2G3	S3
Nestronia umbellula	Nestronia			G4	S3
Nolina georgiana	Georgia Beargrass			G3G5	S3
Paronychia americana	American Nailwort			G3G4	SNR
Platanthera lacera	Green-fringe Orchis			G5	S2
Rhododendron flammeum	Piedmont Azalea			G3	S3
Sagittaria isoetiformis	Slender Arrow-head			G4?	S3
Utricularia floridana	Florida Bladderwort			G3G5	S2
Utricularia olivacea	Piedmont Bladderwort			G4	S2
Communities					
Fagus grandifolia - (*Liquidambar styraciflua*) / *Oxydendrum arboreum* / *Kalmia latifolia* forest	Piedmont/coastal Plain Beech - Mountain Laurel Slope Forest			G3?	SNR

Page 1 of 2

Department of Energy
Washington, DC 20585

JAN 19 2010

MEMORANDUM FOR JUAN GRIEGO
ASSISTANT MANAGER FOR
NATIONAL SECURITY MISSION
LOS ALAMOS SITE OFFICE

FROM: CHRISTINE GELLES
DIRECTOR
OFFICE OF DISPOSAL OPERATIONS

SUBJECT: Cultural and Paleontological Resources Consultation for the *Disposal of Greater-Than-Class C (GTCC) Low Level Radioactive Waste and GTCC-Like Waste Environmental Impact Statement (DOE/EIS-0375D)*

The Department of Energy, Office of Environmental Management is preparing an Environmental Impact Statement (EIS) under the National Environmental Policy Act for the disposal of Greater-Than-Class-C Low-Level-Radioactive Waste (GTCC LLRW). In compliance with the National Historic Preservation Act of 1966 (PL-89-665), the EIS will contain an analysis of the proposed action and potential impacts to cultural resources. We request that you provide us with any information regarding cultural resources that may be affected by the location of the proposed GTCC LLRW disposal locations within TA-54, on Mesita del Buey, Zone 6, North Site, and North Site Expanded, Los Alamos County.

I have attached a brief background of the project, including information on the potential GTCC location, and a copy of the Notice of Intent. I wish to thank you in advance for the information that you will be providing to us. If you have any questions, please contact Arnie Edelman at (301) 903-5145 or at arnold.edelman@em.doe.gov.

Please send the requested information to:

Arnold Edelman
Office of Disposal Operations
Department of Energy, Cloverleaf Building (EM-43)
1000 Independence Avenue, SW
Washington, DC 20585

Attachment

cc: Vicki Loucks, LASO

Department of Energy
Washington, DC 20585

JAN 19 2010

Dr. Allyson Brooks
State Historic Preservation Officer
Department of Archeology and Historic Preservation
Washington Department of Community, Trade and Economic Development
P.O. Box 48343
Olympia, Washington 98504-8343

Dear Dr. Brooks:

The Department of Energy, Office (DOE) of Environmental Management is preparing an Environmental Impact Statement (EIS) under the National Environmental Policy Act for the disposal of Greater-Than-Class-C Low-Level-Radioactive Waste (GTCC LLRW). The development of this EIS is mandated under Section 631 of the Energy Policy Act (EPAct) of 2005 and Section 3(b)(1)(D) of the Low-Level Radioactive Waste Policy Amendments Act (LLRWPAA) of 1985. The LLRWPAA assigned the Federal Government responsibility for the disposal of GTCC LLRW that result from Nuclear Regulatory Commission (NRC) licensed activities. The LLRWPAA also directed that such waste be disposed of in a facility licensed by NRC. DOE is the Federal agency responsible for the disposal of GTCC LLRW. This Draft EIS will be issued for public comment in late spring 2010.

Pursuant to Section 631 of EPAct, before making a final decision on the disposal alternative(s) to be implemented, DOE is required to submit to Congress a report that describes all alternatives considered in the EIS and await Congressional action. DOE will issue a report to Congress once the Final EIS is published; anticipated in summer 2011.

In compliance with the National Historic Preservation Act of 1966 (PL-89-665), the EIS will contain an analysis of the proposed action, and potential impacts to cultural and paleontological resources. The Department is in the process of analyzing information regarding cultural and paleontological resources in the 200-West Area. This information will be presented in the Draft EIS chapter on Hanford.

Should the EIS Record of Decision, expected to be issued in 2011, select a site near the Hanford Site Central Waste Complex for disposal of GTCC waste, a formal Cultural Resources Review would be conducted in accordance with Section 106 of the National Historic Preservation Act, and Advisory Council on Historic Preservation regulations for Protection of Historic Properties (36 CFR Part 800).

In support of the preparation of this EIS, DOE is soliciting any specific concerns you may have regarding cultural resources that may be affected by the proposed project.

I have enclosed a brief background of the project, including information on the location of the potential GTCC location within the State, and a copy of the Notice of Intent. I wish to thank you in advance for the information that you will be providing to us. If you have any questions, please contact me at (301) 903-5145 or at arnold.edelman@em.doe.gov.

Please send the requested information to:

Arnold Edelman
Office of Disposal Operations
Department of Energy, Cloverleaf Building (EM-43)
1000 Independence Avenue, SW
Washington, DC 20585

Sincerely,

Arnold M Edelman

Arnold M. Edelman
NEPA Document Manager
Office of Disposal Operations

Enclosure

cc: Woody Russell, ORP
A. Rodriguez, DOE-RL
R. Corey, DOE-RL

Department of Energy
Washington, DC 20585

JAN 19 2010

Mr. Ken Reid, Deputy SHPO
State Historic Preservation Office
210 Main Street (The Assay Office)
Boise, Idaho 83702

Dear Mr. Reid:

The Department of Energy, Office (DOE) of Environmental Management is preparing an Environmental Impact Statement (EIS) under the National Environmental Policy Act for the disposal of Greater-Than-Class-C Low-Level-Radioactive Waste (GTCC LLRW). The development of this EIS is mandated under Section 631 of the Energy Policy Act (EPAct) of 2005 and Section 3(b)(1)(D) of the Low-Level Radioactive Waste Policy Amendments Act (LLRWPAA) of 1985. The LLRWPAA assigned the Federal Government responsibility for the disposal of GTCC LLRW that result from Nuclear Regulatory Commission (NRC) licensed activities. The LLRWPAA also directed that such waste be disposed of in a facility licensed by NRC. DOE is the Federal agency responsible for the disposal of GTCC LLRW. This Draft EIS will be issued for public comment in late spring 2010.

Pursuant to Section 631 of EPAct, before making a final decision on the disposal alternative(s) to be implemented, DOE is required to submit to Congress a report that describes all alternatives considered in the EIS and await Congressional action. DOE will issue a report to Congress once the Final EIS is published; anticipated in summer 2011.

In compliance with the National Historic Preservation Act of 1966 (PL-89-665), the EIS will contain an analysis of the proposed action, and potential impacts to cultural and paleontological resources. The Department is in the process of analyzing the proposed action and their potential impacts. We request that you provide us with any information regarding cultural and paleontological resources that may be affected by the proposed GTCC LLRW disposal location at the Idaho National Laboratory (INL), southwest of the Reactor Technology Complex in the south central portion of INL, Butte County that should be considered in preparing the EIS.

I have enclosed a brief background of the project, including information on the location of the potential GTCC location within the State, and a copy of the Notice of Intent. I wish to thank you in advance for the information that you will be providing to us. If you have any questions, please contact me at (301) 903-5145 or at arnold.edelman@em.doe.gov.

Please send the requested information to:

Arnold Edelman
Office of Disposal Operations
Department of Energy, Cloverleaf Building (EM-43)
1000 Independence Avenue, SW
Washington, DC 20585

Sincerely,

Arnold M Edelman

Arnold M. Edelman
NEPA Document Manager
Office of Disposal Operations

Enclosure

cc: Jack Depperschmidt, IDSO

Department of Energy
Washington, DC 20585

JAN 19 2010

Ms. Jan Biella
State of New Mexico Department of Cultural Affairs
Bataan Memorial Building
407 Galisteo Street
Suite 236
Santa Fe, New Mexico 87501

Dear Ms. Biella:

The Department of Energy, Office (DOE) of Environmental Management is preparing an Environmental Impact Statement (EIS) under the National Environmental Policy Act for the disposal of Greater-Than-Class-C Low-Level-Radioactive Waste (GTCC LLRW). The development of this EIS is mandated under Section 631 of the Energy Policy Act (EPAct) of 2005 and Section 3(b)(1)(D) of the Low-Level Radioactive Waste Policy Amendments Act (LLRWPAA) of 1985. The LLRWPAA assigned the Federal Government responsibility for the disposal of GTCC LLRW that result from Nuclear Regulatory Commission (NRC) licensed activities. The LLRWPAA also directed that such waste be disposed of in a facility licensed by NRC. DOE is the Federal agency responsible for the disposal of GTCC LLRW. This Draft EIS will be issued for public comment in late spring 2010.

Pursuant to Section 631 of EPAct, before making a final decision on the disposal alternative(s) to be implemented, DOE is required to submit to Congress a report that describes all alternatives considered in the EIS and await Congressional action. DOE will issue a report to Congress once the Final EIS is published; anticipated in summer 2011.

In compliance with the National Historic Preservation Act of 1966 (PL-89-665), the EIS will contain an analysis of the proposed action and potential impacts to cultural and paleontological resources The Department is in the process of analyzing the proposed action and their potential impacts. We therefore request that you provide us with any information regarding cultural and paleontological resources that may be affected by the location of the proposed GTCC LLRW disposal locations in your State, the Waste Isolation Pilot Plant (WIPP) in Eddy County; and Sections 27 and 35 in and around WIPP. Please note that we are working with our DOE offices on development of the EIS and that Consultation with the State, if needed for LANL, will occur through the Los Alamos Site Office.

I have enclosed a brief background of the project, including information on the potential New Mexico GTCC locations, and a copy of the Notice of Intent. I wish to thank you in advance for the information that you will be providing to us. If you have any questions, please contact me at (301) 903-5145 or at arnold.edelman@em.doe.gov.

Printed with soy ink on recycled paper

Please send the requested information to:

Arnold Edelman
Office of Disposal Operations
Department of Energy, Cloverleaf Building (EM-43)
1000 Independence Avenue, SW
Washington, DC 20585

Sincerely,

Arnold M. Edelman
NEPA Document Manager
Office of Disposal Operations

Enclosure

cc: Susan McCauslin, CBFO
Vicki Loucks, LASO
Elizabeth Withers, DOE-AL

Department of Energy
Washington, DC 20585

JAN 19 2010

Mr. Ronald James
Historic Preservation Office
100 North Stewart Street
Capitol Complex
Carson City, Nevada 89701-4285

Dear Mr. James:

The Department of Energy, Office (DOE) of Environmental Management is preparing an Environmental Impact Statement (EIS) under the National Environmental Policy Act for the disposal of Greater-Than-Class-C Low-Level-Radioactive Waste (GTCC LLRW). The development of this EIS is mandated under Section 631 of the Energy Policy Act (EPAct) of 2005 and Section 3(b)(1)(D) of the Low-Level Radioactive Waste Policy Amendments Act (LLRWPAA) of 1985. The LLRWPAA assigned the Federal Government responsibility for the disposal of GTCC LLRW that result from Nuclear Regulatory Commission (NRC) licensed activities. The LLRWPAA also directed that such waste be disposed of in a facility licensed by NRC. DOE is the Federal agency responsible for the disposal of GTCC LLRW. This Draft EIS will be issued for public comment in late spring 2010.

Pursuant to Section 631 of EPAct, before making a final decision on the disposal alternative(s) to be implemented, DOE is required to submit to Congress a report that describes all alternatives considered in the EIS and await Congressional action. DOE will issue a report to Congress once the Final EIS is published; anticipated in summer 2011.

In compliance with the National Historic Preservation Act of 1966 (PL-89-665), the EIS will contain an analysis of the proposed action, and potential impacts to cultural and paleontological resources. The Department is in the process of analyzing the proposed action and their potential impacts. We request that you provide us with any information regarding cultural and paleontological resources that may be affected by the proposed GTCC LLRW disposal location at the Nevada Test Site (NTS), in the vicinity north of Frenchman Flat, either southeast or west of the existing Radioactive Waste Management Facility, Nye County that should be considered in preparing the EIS.

I have enclosed a brief background of the project, including information on the location of the potential GTCC location within the State, and a copy of the Notice of Intent. I wish to thank you in advance for the information that you will be providing to us. If you have any questions, please contact me at (301) 903-5145 or at arnold.edelman@em.doe.gov.

2

Please send the requested information to:

Arnold Edelman
Office of Disposal Operations
Department of Energy, Cloverleaf Building (EM-43)
1000 Independence Avenue, SW
Washington, DC 20585

If you have any questions, please contact me at (301) 903-5145.

Sincerely,

Arnold M. Edelman
NEPA Document Manager
Office of Disposal Operations

Enclosure

cc: Linda Cohn, NSO

From: Alice Baldrica [mailto:ABaldrica@nevadaculture.org]
Sent: Wednesday, March 24, 2010 5:39 PM
To: Edelman, Arnold
Subject: RE: your request for information

Dear Mr. Edelman:

I checked the Nevada Cultural Resources Information System (NVCRIS), the State's electronic database for archaeological resources. A handful of very small lithic scatters are located within the alternative project area but none of them are eligible for inclusion in the National Register of Historic Places.

Historic properties resulting from nuclear testing activities have been recorded at Frenchman Flat that are associated with the Cold War. At the present time, the effect of a project on such historic properties is unknown.

If you have any questions let me know.

Alice M. Baldrica
State Historic Preservation Office
100 N. Stewart St.
Carson City, NV 89701
Telephone: 775-684-3444
FAX: 775-684-3442
abaldrica@nevadaculture.org

Department of Energy
Washington, DC 20585

JAN 19 2010

Mr. Eric Emerson
Department of Archives and History
8301 Parklane Road
Columbia, South Carolina 29223-4905

Dear Mr. Emerson:

The Department of Energy, Office (DOE) of Environmental Management is preparing an Environmental Impact Statement (EIS) under the National Environmental Policy Act for the disposal of Greater-Than-Class-C Low-Level-Radioactive Waste (GTCC LLRW). The development of this EIS is mandated under Section 631 of the Energy Policy Act (EPAct) of 2005 and Section 3(b)(1)(D) of the Low-Level Radioactive Waste Policy Amendments Act (LLRWPAA) of 1985. The LLRWPAA assigned the Federal Government responsibility for the disposal of GTCC LLRW that result from Nuclear Regulatory Commission (NRC) licensed activities. The LLRWPAA also directed that such waste be disposed of in a facility licensed by NRC. DOE is the Federal agency responsible for the disposal of GTCC LLRW. This Draft EIS will be issued for public comment in late spring 2010.

Pursuant to Section 631 of EPAct, before making a final decision on the disposal alternative(s) to be implemented, DOE is required to submit to Congress a report that describes all alternatives considered in the EIS and await Congressional action. DOE will issue a report to Congress once the Final EIS is published; anticipated in summer 2011.

In compliance with the National Historic Preservation Act of 1966 (PL-89-665), the EIS will contain an analysis of the proposed action, and potential impacts to cultural and paleontological resources. The Department is currently in the process of analyzing the proposed action and their potential impacts. We request that you provide us with any information regarding cultural and paleontological resources that may be affected by the proposed GTCC LLRW disposal location at the Savannah River Site (SRS) at the upland ridge overlooking Tinker Creek, northeast of Area Z in the north-central portion of SRS, Aiken County, which should be considered in preparing the EIS.

I have enclosed a brief background of the project, including information on the location of the potential GTCC location within the State, and a copy of the Notice of Intent. I wish to thank you in advance for the information that you will be providing to us. If you have any questions, please contact me at (301) 903-5145 or at arnold.edelman@em.doe.gov.

Please send the requested information to:

Arnold Edelman
Office of Disposal Operations
Department of Energy, Cloverleaf Building (EM-43)
1000 Independence Avenue, SW
Washington, DC 20585

Sincerely,

Arnold M Edelman

Arnold M. Edelman
NEPA Document Manager
Office of Disposal Operations

Enclosure

cc: Drew Grainger, SRSO

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PROJECT BACKGROUND INFORMATION

This is a copy of the information attached as an enclosure to the letter sent out by A.M. Edelman of DOE.

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Enclosure

Project Background Information

The following provides a brief background of the project and an overview of the alternative disposal sites.

The Department of Energy (DOE) published its Notice of Intent (NOI) to prepare an Environmental Impact Statement (EIS) for disposal of Greater-Than-Class-C Low-Level-Radioactive Waste (GTCC LLRW) in the Federal Register (Vol. 72, No.140) on July 23, 2007. (A copy of the NOI is attached).[1] DOE proposes to construct and operate a new facility or facilities, or use an existing facility or facilities, for the disposal of GTCC LLRW and GTCC-like waste. DOE would then close the facility or facilities at the end of each facility's operational life. Institutional controls, including monitoring, would be employed for a period of time determined during the implementation phase. A combination of disposal methods and locations may be appropriate, depending on the characteristics of the waste and other factors.

The Waste Isolation Pilot Plant (WIPP) in Eddy County, New Mexico is evaluated for deep geologic disposal. Land disposal methods (i.e., boreholes, trench and above-grade vault methods) are evaluated at seven federally owned sites: (1) Hanford Site in Benton County, Washington; (2) Idaho National Laboratory (INL) in Butte County, Idaho; (3) Los Alamos National Laboratory (LANL) in Los Alamos County, New Mexico; (4) Nevada Test Site (NTS) in Nye County, Nevada; (5) Oak Ridge Reservation (ORR) in Roane and Anderson Counties, Tennessee; (6) Savannah River Site (SRS) in Aiken County, South Carolina; and (7) WIPP Vicinity in Eddy County, New Mexico. The WIPP Vicinity location is situated just outside the boundary of the WIPP facility. A map of these sites being considered for waste disposal is provided in Figure 1.

The DOE sites evaluated for the land disposal methods were chosen on the basis of mission compatibility (i.e., only DOE sites that currently have radioactive waste disposal as part of their ongoing mission were considered). Since these sites are currently being used for disposal of LLRW, it is expected that they may contain areas within them that are suitable for disposal of similar but generally higher-activity LLRW (i.e., the GTCC LLRW and GTCC-like waste inventory that will be discussed in the EIS). These DOE sites would also have supporting infrastructure already in place that might be useful for future potential GTCC waste disposal activities. The WIPP Vicinity was chosen because of its proximity to ongoing waste disposal operations at WIPP and the potential to use its supporting infrastructure.

Aside from mission compatibility, site factors that were considered in identifying an acceptable area for developing a GTCC LLRW disposal facility were as follows: have sufficient depth to avoid groundwater; not to be located within the 100-year floodplain or in or near wetlands; be consistent with current land use plans; have low probability for erosion, mass wasting, faulting, folding, and seismic activity; and have site data available for modeling or evaluation purposes.

[1] The proposed Yucca Mountain repository mentioned in the NOI is no longer being considered for a disposal site for GTCC LLRW.

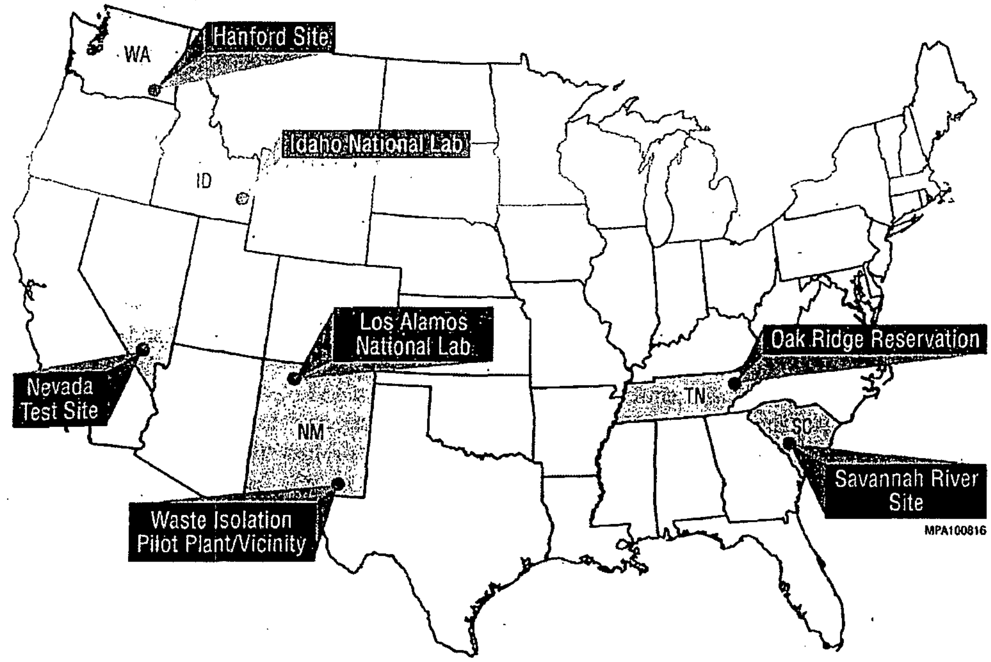

FIGURE 1 Map of Sites Being Considered for Disposal of GTCC LLRW and GTCC-Like Waste

WIPP

WIPP is a DOE facility that is the world's first underground repository permitted by the U.S. Environmental Protection Agency (EPA) and the state of New Mexico to safely and permanently dispose of defense-related TRU radioactive waste associated with the research and production of nuclear weapons. WIPP is located 26 mi east of Carlsbad, New Mexico, in the Chihuahuan Desert in the southeast corner of the state (Figure 2). Project facilities include disposal rooms that are mined 2,150 ft under the ground in a salt formation (the Salado Formation) that is 2,000-ft thick and has been stable for more than 200 million years. The WIPP facility sits in the approximate center of a 16-mi^2 area that was withdrawn from public domain and transferred to DOE (Figure 3). The facility footprint itself encompasses 35 fenced acres of surface space and about 7.5 mi of underground excavations in the Salado Formation.

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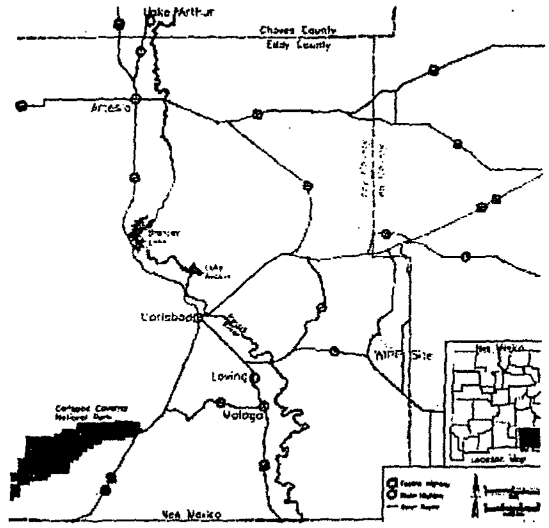

FIGURE 2 General Location of WIPP in Eddy County, New Mexico

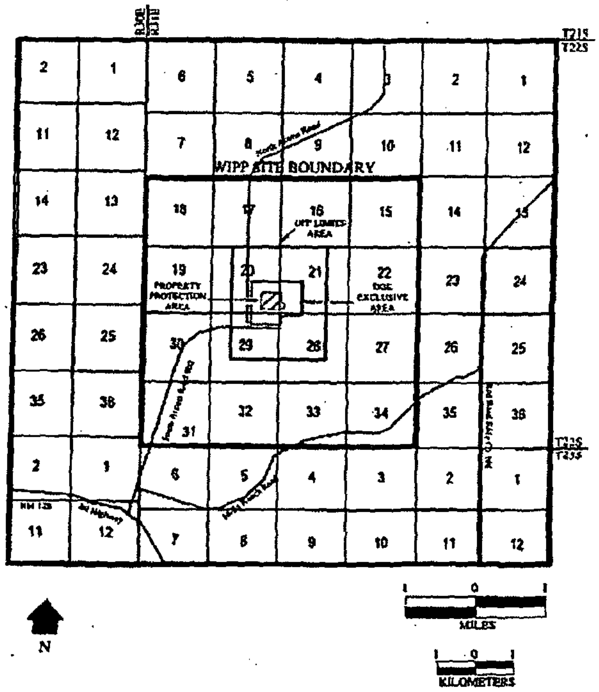

FIGURE 3 Land Withdrawal Area Boundary at WIPP

3

Hanford Site

The Hanford Site is located in south-central Washington State on 586 mi^2 of land between the Cascade Range and the Rocky Mountains (Figure 4). The Columbia River flows through the northern portion of the site and forms part of its eastern boundary. Hanford has been operated by DOE and its predecessors (the Manhattan Engineer District, U.S. Atomic Energy Commission [AEC], and U.S. Energy Research and Development Administration) since it was created in 1943. Its primary mission was to produce nuclear materials in support of national defense, research, and biomedical programs. Operations associated with those programs used facilities for the fabrication of nuclear reactor fuel, reactors for nuclear materials production, chemical separation plants, nuclear material processing facilities, research laboratories, and waste management facilities. Current activities include research, environmental restoration, and waste management. The U.S. Fish and Wildlife Service (Service) and DOE co-manage the 195,000-acre Hanford Reach National Monument, which was established by Presidential proclamation in 2000.

The GTCC reference location is immediately south of the Integrated Disposal Facility (IDF) site in the 200 East Area in the central portion of the Hanford Site (Figure 4). The 200 East and West Areas are located on a plateau about 7 and 5 miles, respectively, south of the Columbia River. Historically, these areas have been dedicated to fuel reprocessing and to waste management and disposal activities.

Current waste management activities at the Hanford Site include the treatment and disposal of LLRW on site, the processing and certification of TRU waste pending its disposal at WIPP, and the storage of high-level radioactive waste on site pending its disposal in a geologic repository. The main areas where waste management activities occur are the 200 West Area and the 200 East Area, which are south of the Columbia River. These 200 Areas cover about 6 mi^2. Activities at the 200 Areas include the operation of lined trenches for the disposal of LLRW and mixed LLRW and the operation of the Environmental Restoration Disposal Facility for the disposal of LLRW generated by environmental restoration activities that are being conducted at Hanford Site to comply with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). U.S. Ecology, Inc., operates a commercial LLRW disposal facility on a 40-ha (100-ac) site leased by the State of Washington near the 200 East Area. The facility is licensed by the NRC and the State of Washington.

INL

INL is located in southeastern Idaho on 890 mi^2 of relatively undisturbed DOE land in the upper Snake River Plain (Figure 5). Basalt flows cover most of the plain, producing a rolling topography. INL is bordered by mountain ranges on the north and by volcanic buttes and open plain on the south. Lands immediately adjacent to the INL site consist of open rangeland, foothills, and agricultural fields. About 60 percent of the site is open to livestock grazing. Key facilities at INL consist of clusters of buildings and structures that are typically less than a few square miles each, separated from each other by miles of gently rolling sagebrush-covered semi-arid desert. The GTCC reference location is southwest of the Reactor Technology Complex

(RTC) in the south central portion of INL (Figure 5). The RTC is dedicated to research supporting DOE missions, including nuclear technology research.

Current waste management activities at INL include the treatment and storage of mixed LLRW (waste containing hazardous constituents in addition to radionuclides) on site, the treatment and disposal of LLRW on site, the storage of TRU waste on site, and the storage of high-level radioactive waste and Spent Nuclear Fuel (SNF) on site pending the disposal of these last two materials in a geologic repository. These wastes originate from DOE activities and from the on-site Naval Reactors Program. LLRW from INL site operations is disposed of at the Subsurface Disposal Area at the Radioactive Waste Management Complex (RWMC). TRU waste is also stored and treated at the RWMC to prepare it for disposal at WIPP.

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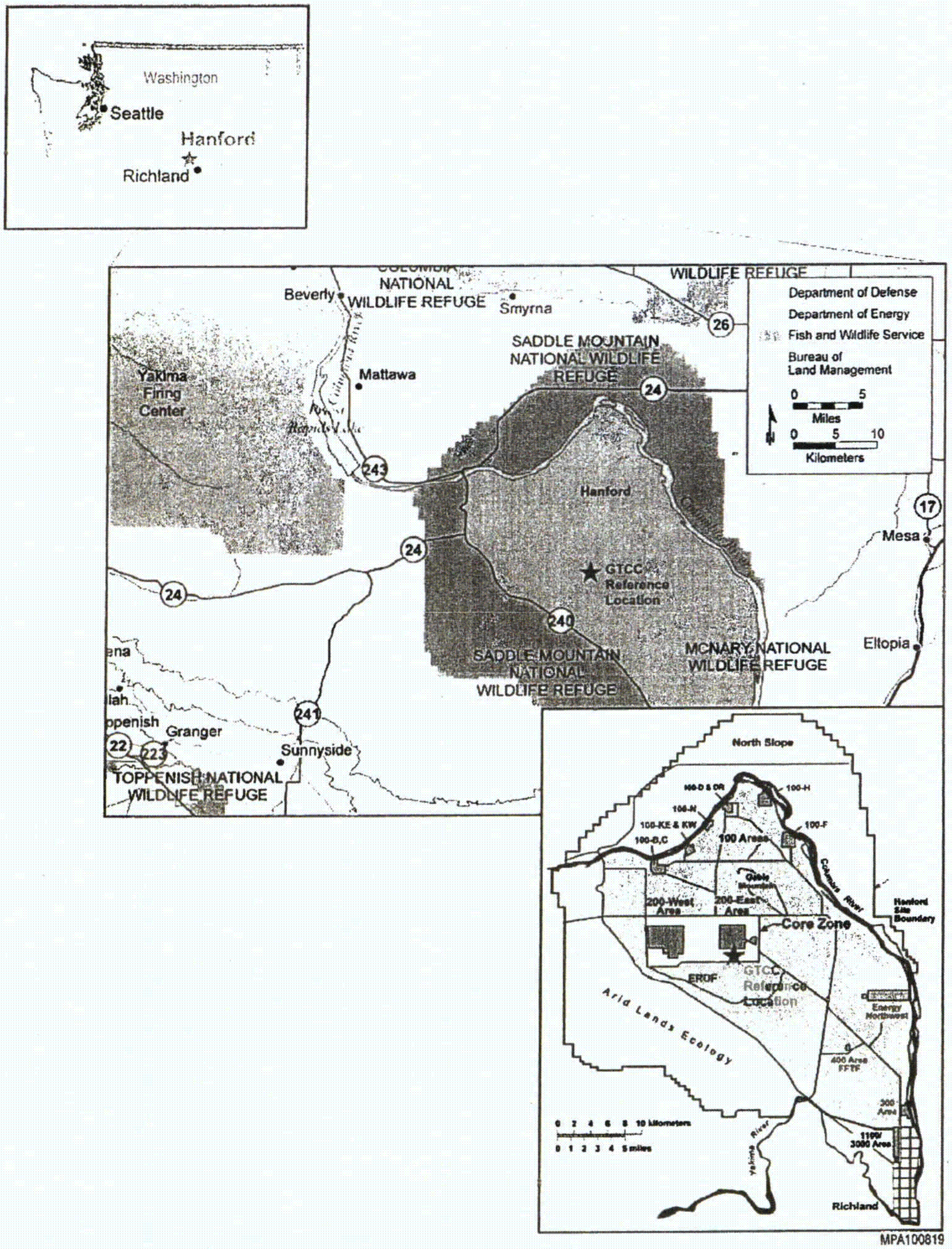

FIGURE 4 GTCC Reference Location at the Hanford Site

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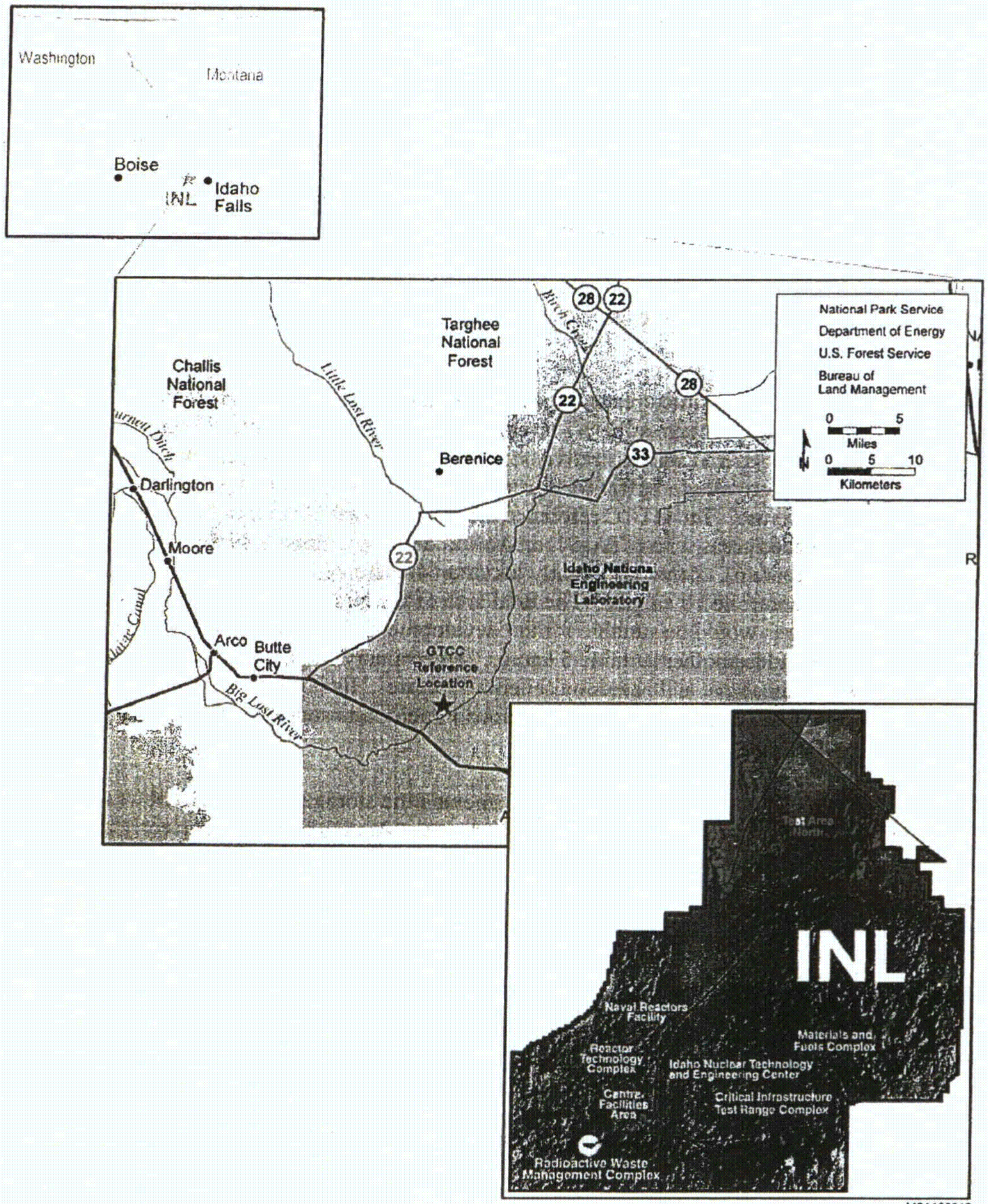

FIGURE 5 GTCC Reference Location at INL

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LANL

LANL is located in northern New Mexico, within Los Alamos County, on 40 mi^2 or 25,600 acres of land owned by the U.S. Government. The laboratory is administered by DOE and the National Nuclear Security Administration (NNSA) (Figure 6). The site is situated on the eastern flank of the Jemez Mountains along an area known as the Pajarito Plateau. The terrain in the LANL area consists of mesa tops and canyon bottoms that trend in a west-to-east direction, with the canyons intersecting the Rio Grande River to the east of LANL. Laboratory operations are conducted in numerous facilities located in 48 designated technical areas (TAs) and at other leased properties located nearby. The laboratory's core mission has been to maintain the effectiveness of the nation's nuclear deterrent. As one of the world's leading research institutions, it is also involved in hydrogen fuel cell development, supercomputing, and applied environmental research.

There are more than 2,000 structures on the site, providing about 8.6 million ft^2 of covered space. About half of the square footage at LANL is considered laboratory or production space; the remaining area is considered administrative, storage, service, or other space. Most of the site is undeveloped, which provides a buffer for security and safety and offers the possibility of expansion for future use. The GTCC reference location is situated in two undeveloped and relatively undisturbed areas within TA-54, on Mesita del Buey: Zone 6, North Site, and North Site Expanded (Figure 6). Zone 6 is slightly less than 40 acres in area. It is not fenced, but access by road is controlled by a gate. The total area of the North Site is about 63 acres, of which about 50 acres would be suitable for the development of disposal cells. The North Site Expanded section adds another suitable 57 acres. The primary function of TA-54 is the management of radioactive and hazardous chemical wastes. Its northern border coincides with the boundary between LANL and the San Ildefonso Pueblo; its southeastern boundary borders the town of White Rock.

Current waste management activities at LANL include the storage of mixed LLRW, the disposal of LLRW on site, and the storage of TRU waste on site. Area G at TA-54 currently accepts on-site LLRW for disposal, and in special cases, off-site waste has also been accepted from other DOE sites for disposal. Engineered shafts are actively used to dispose of remote handled LLRW.

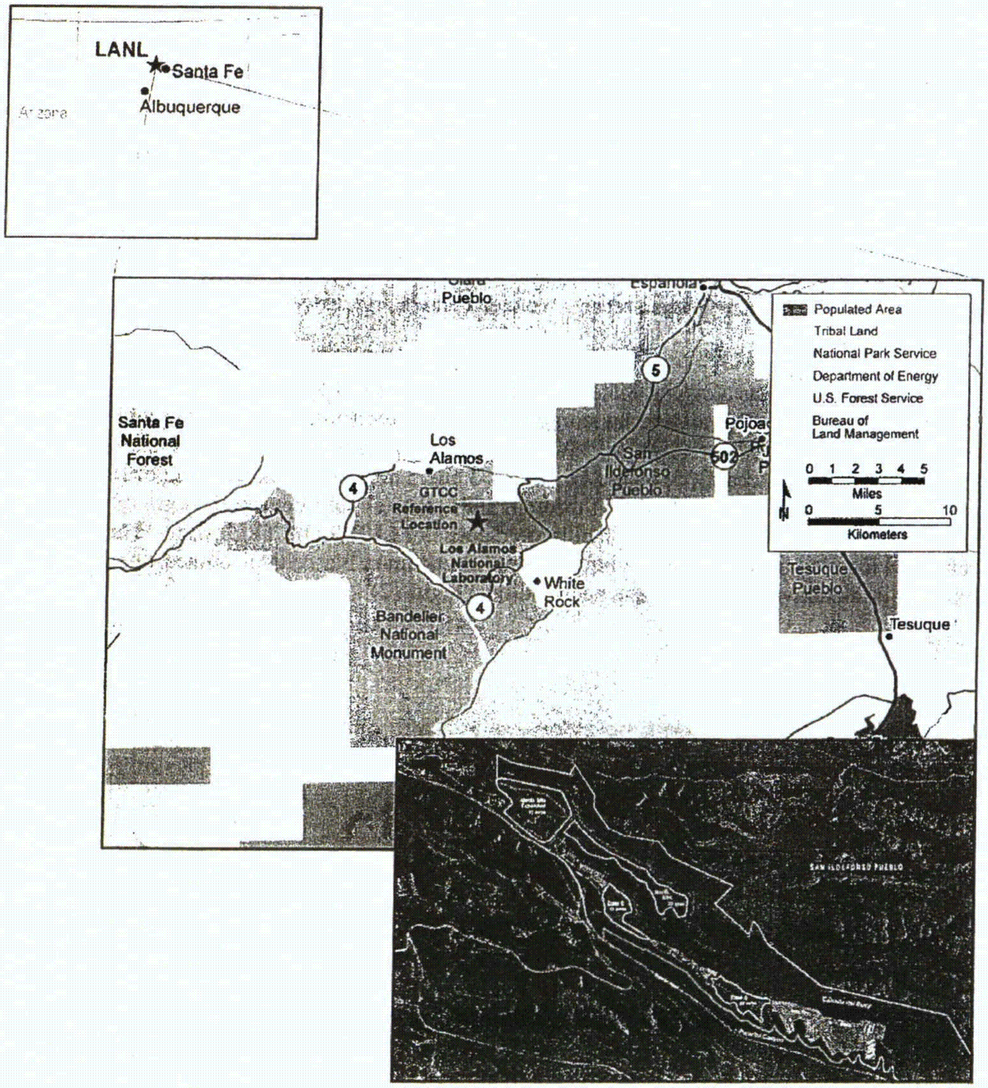

FIGURE 6 GTCC Reference Location at LANL

NTS

NTS is located about 65 miles northwest of Las Vegas in southern Nevada on 1,350 mi^2 of land managed by DOE (Figure 7). Its terrain is characterized by high relief, with elevations ranging from about 3,000 ft at Frenchman Flat in the southeastern portion of the site to about 7,400 ft on Rainier Mesa. Historically, the primary mission of NTS was to conduct nuclear weapons tests. The tests have altered the natural topography of NTS, creating craters in Yucca Flat and Frenchman Flat basins and on the Pahute and Rainier Mesas. Since the moratorium on nuclear testing that began in October 1992, the mission of NTS has changed to one of maintaining readiness to conduct nuclear tests in the future. The site also supports DOE's waste management program, as well as other national-security related research and development and testing programs.

NTS presently serves as a disposal site for LLRW and mixed LLRW generated by DOE defense-related facilities. It is also an interim storage site for a limited amount of TRU mixed wastes pending transfer to WIPP for disposal. Waste management activities are conducted in four primary NTS areas: Areas 3, 5, 6, and 11. Areas 3 and 5 are the two existing radioactive waste management sites at NTS. From 1984 through 1989, greater confinement disposal (at depths of 70 to 120 ft) was used at the Area 5 facility to dispose of LLRW and TRU waste. The GTCC reference location at NTS in the vicinity north of Frenchman Flat, either southeast or west of the existing Radioactive Waste Management Facility (Figure 7).

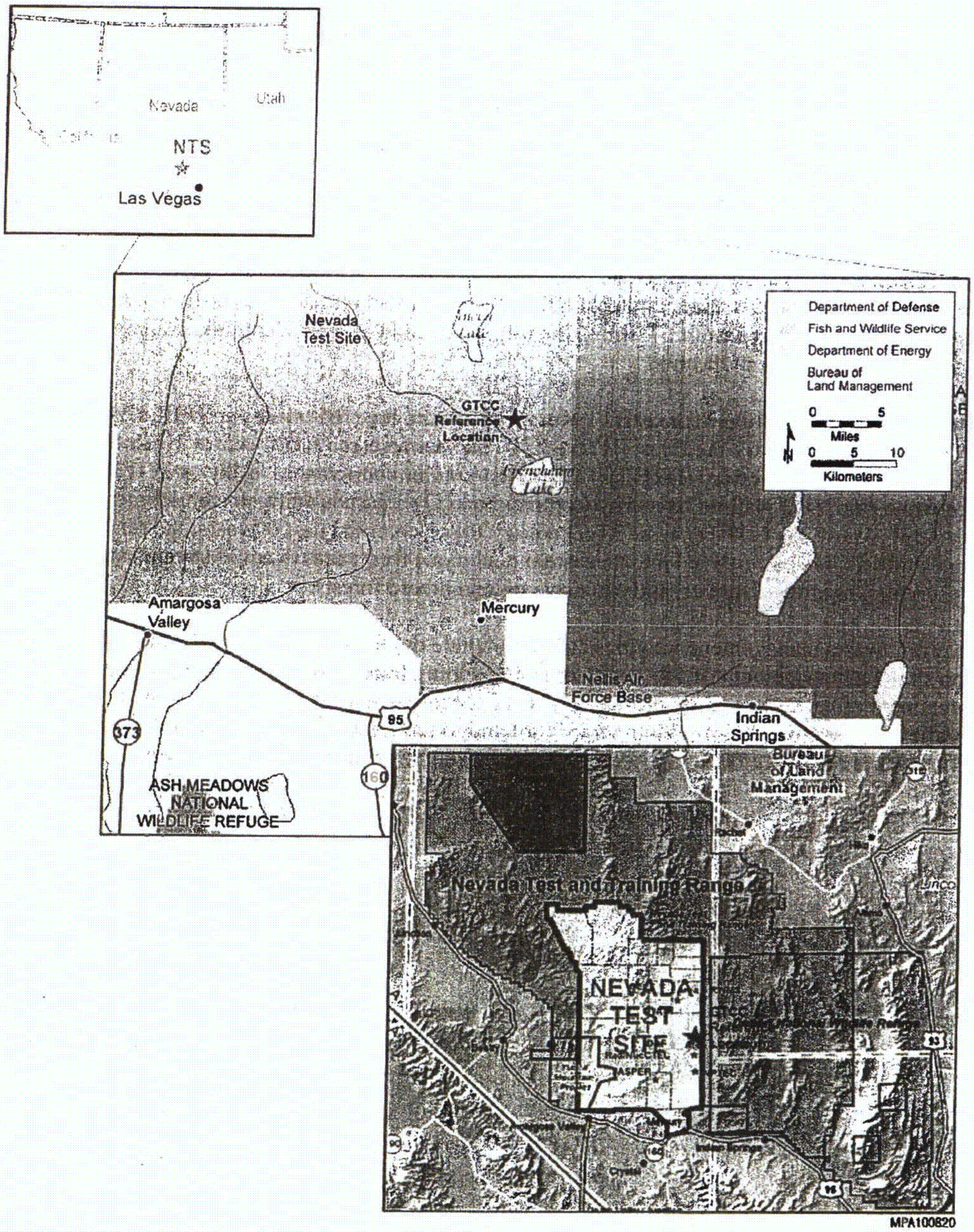

FIGURE 7 GTCC Reference Location at NTS

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ORR

ORR is located in eastern Tennessee, in Roane and Anderson Counties, on 34,241 acres of mostly contiguous land owned by DOE (Figure 8). The terrain is characterized by a series of parallel valleys and ridges with a northeast-southwest trend caused by the differential weathering of interstratified formations exposed at the surface. The topographic relief between valley floors and ridge crests is generally about 300 to 350 ft. The majority of ORR lies within the corporate limits of the city of Oak Ridge. The residential section of Oak Ridge forms ORR's northern and eastern boundaries; the Tennessee Valley Authority's Melton Hill and Watts Bar Reservoirs on the Clinch and Tennessee Rivers form the southern and western boundaries. Except for the city of Oak Ridge, the land within 5 miles of ORR is semirural and is used primarily for residences, small farms, and cattle pasture. Fishing, boating, water skiing, and swimming are popular recreational activities in the area.

Following its acquisition in the early 1940s, much of the land that makes up ORR served as a buffer for three primary facilities: (1) the X-10 nuclear research facility currently known as Oak Ridge National Laboratory (ORNL); (2) the first uranium enrichment facility or Y-12, currently known as the Y-12 National Security Complex; and (3) a gaseous diffusion enrichment facility currently known as East Tennessee Technology Park. Over the past 60 years, the relatively undisturbed area has evolved into an eastern deciduous forest ecosystem of streams and reservoirs, hardwood forests, and extensive upland mixed forests.

Current waste management activities at ORR include the treatment and storage of mixed LLRW on site, the management of TRU waste on site pending transfer off site for disposal, and the treatment of hazardous waste on site. The GTCC reference location is in Western Bear Creek Valley, just south of White Wing Scrap Yard and to the west of the Y-12 Complex (Figure 8). The area is relatively flat and bisected by a creek running perpendicular to the valley's trend.

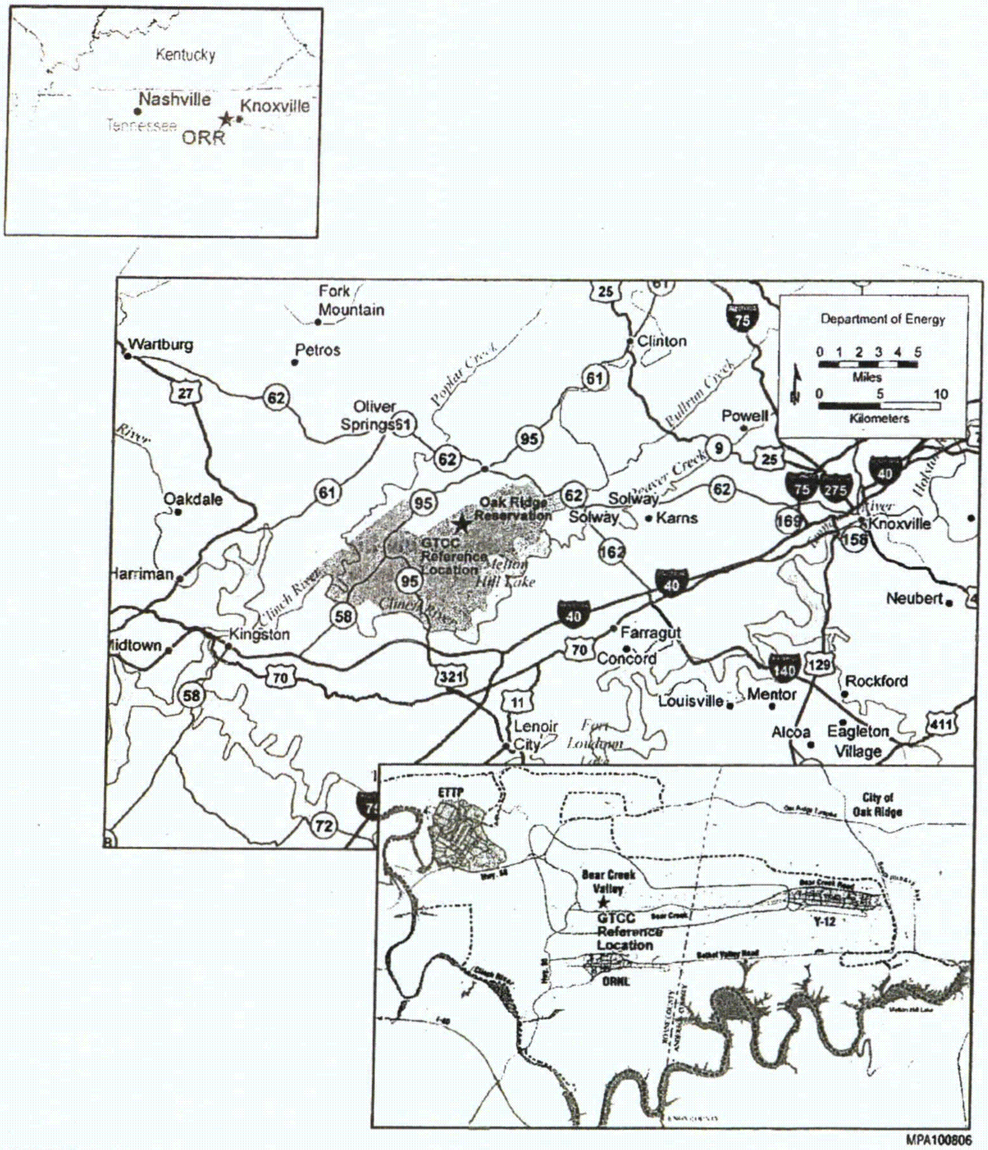


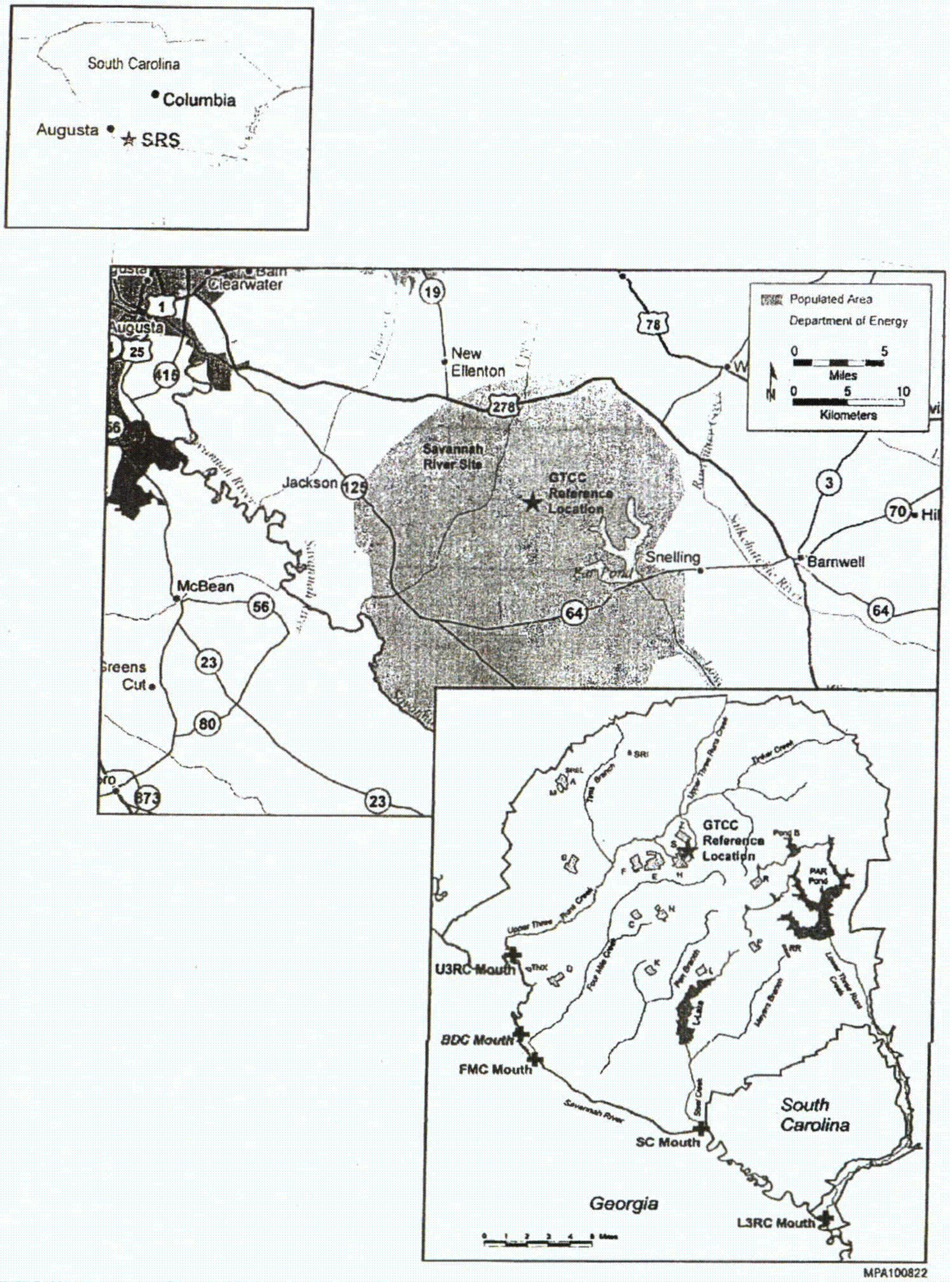
FIGURE 8 GTCC Reference Location at ORR

SRS

SRS is located on 310 mi^2 of DOE land along the Savannah River, about 12 miles south of Aiken, South Carolina, and 15 miles southeast of Augusta, Georgia, in southwestern South Carolina (Figure 9). Until the early 1990s, SRS primary mission was the production of special radioactive isotopes to support national defense programs. Currently, the site's mission emphasizes waste management, environmental restoration, and decontamination and decommissioning of facilities that are no longer needed for its traditional defense activities.

Current waste management activities at SRS include shipping hazardous waste, mixed LLRW, and TRU waste off site for treatment and disposal. High-level radioactive waste is stored on site pending disposal in a geologic repository. LLRW is treated and disposed of on site as well as at other DOE or commercial facilities. In addition, mixed LLRW may be treated and stored on site before being shipped off site. Other on-site activities include the treatment of LLRW prior to disposal and the preparation of TRU waste for shipment to WIPP for disposal. On-site disposal facilities at SRS include engineered trenches and vaults for the permanent disposal of solid LLRW.

The GTCC reference location is on an upland ridge overlooking Tinker Creek, to the northeast of Area Z in the north-central portion of SRS (Figure 9). The area is not currently being used for waste management.



GTCC Reference Location at SRS

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WIPP Vicinity

The WIPP Vicinity reference locations are within Section 27, within the WIPP Land Withdrawal Boundary (LWB) and Section 35, outside of and immediately adjacent to the south eastern boundary of the WIPP LWB. WIPP is located in Eddy County in southeastern New Mexico, about 30 miles east of the city of Carlsbad (Figure 10). The land is a relatively flat area. It is primarily used for grazing, potash mining, and oil and gas exploration. There are currently no waste management activities being conducted within either of these locations.

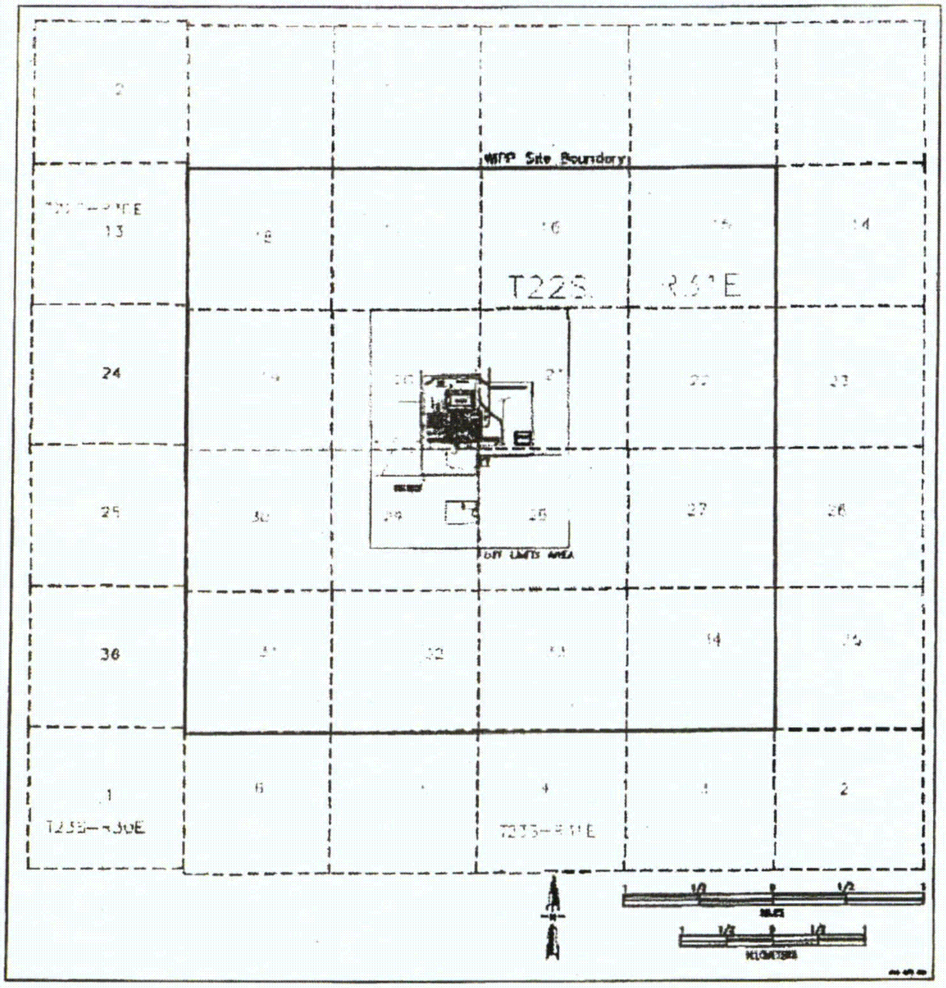

FIGURE 10 GTCC Reference Locations (Section 27 and 35) at the WIPP Vicinity

Attachment

Federal Register /Vol. 72, No. 140 /Monday,

DEPARTMENT OF ENERGY

Notice of Intent To Prepare an Environmental Impact Statement for the Disposal of Greater-Than-Class-C Low-Level Radioactive Waste

AGENCY: Department of Energy.

ACTION: Notice of Intent To Prepare an Environmental Impact Statement.

SUMMARY: The Department of Energy (DOE) announces its intent to prepare an environmental impact statement (EIS) under the National Environmental Policy Act (NEPA) for the disposal of Greater-Than-Class-C low-level radioactive waste (GTCC LLW). GTCC LLW is defined by the Nuclear Regulatory Commission (NRC) in 10 CFR 72.3 as "low-level radioactive waste that exceeds the concentration limits of radionuclides established for Class C waste in [10 CFR 61.55]." GTCC LLW is generated by NRC or Agreement State-licensed activities (hereafter referred to as NRC-licensed activities). DOE proposes to evaluate alternatives for GTCC LLW disposal: in a geologic repository; in intermediate depth boreholes; and in enhanced near surface facilities. Candidate locations for these disposal facilities would be: the Idaho National Laboratory (INL) in Idaho; the Los Alamos National Laboratory (LANL) and Waste Isolation Pilot Plant (WIPP) in New Mexico; the Nevada Test Site (NTS) and the proposed Yucca Mountain repository in Nevada; the Savannah River Site (SRS) in South Carolina; the Oak Ridge Reservation (ORR) in Tennessee; and the Hanford Site (Hanford) in Washington. DOE will also evaluate disposal at generic commercial facilities in arid and humid locations.

In addition, DOE proposes to include DOE LLW and transuranic waste having characteristics similar to GTCC LLW and which may not have an identified path to disposal (hereafter referred to as GTCC-like waste) in the scope of this EIS. DOE's GTCC-like waste is owned or generated by DOE. The use of the term "GTCC-like" does not have the intent or effect of creating a new classification of radioactive waste.

DOE invites public comment on the scope of this EIS during a 60-day public scoping period. During this period, DOE will hold public scoping meetings to provide the public with an opportunity to comment on the scope of the EIS and to learn more about the proposed action from DOE officials.

DOE issued an Advance Notice of Intent (ANOI), 70 FR 24775 (May 11, 2005), inviting the public to provide preliminary comments on the potential scope of the EIS. This Notice of Intent (NOI) includes a summary of the public comments received on the ANOI.

DATES: The public scoping period starts with the date of publication of this NOI in the **Federal Register** and will continue until September 21, 2007. DOE will consider all comments received or postmarked by September 21, 2007 in defining the scope of this EIS. Comments received or postmarked after that date will be considered to the extent practicable.

Public scoping meetings will be held to provide the public with an opportunity to present comments on the scope of the EIS and to learn more about the proposed action from DOE officials. The locations, dates, and times for the public scoping meetings are listed in the "Public Scoping" section under SUPPLEMENTARY INFORMATION.

ADDRESSES: Written comments on the scope of the GTCC LLW EIS or requests to speak at one of the public scoping meetings should be sent to: James L. Joyce, Document Manager, Office of Regulatory Compliance (EM–10), U.S. Department of Energy, 1000 Independence Avenue, SW., Washington, DC 20585–0119. Telephone: (301) 903–2151. Fax: 301–903–4303. E-mail: *gtcceis@anl.gov*. Written comments on the scope of the GTCC LLW EIS and requests to speak at one of the public scoping meetings can also be submitted through the Web site at *http://www.gtcceis.anl.gov*.

FOR FURTHER INFORMATION CONTACT: To request further information about the EIS, the public scoping meetings, or to be placed on the EIS distribution list, use any of the methods (fax, telephone, e-mail, or Web site) listed under ADDRESSES above. For general information concerning the DOE NEPA process, contact: Carol Borgstrom, Director, Office of NEPA Policy and Compliance (GC–20), U.S. Department of Energy, 1000 Independence Avenue, SW., Washington, DC 20585–0119.

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Telephone: 202–586–4600, or leave a message at 1–800–472–2756.
Fax: 202–586–7031.

This NOI will be available on the internet at *http://www.eh.doe.gov/nepa.* Additional information on the GTCC LLW EIS can be found at *http://www.gtcceis.anl.gov.*

SUPPLEMENTARY INFORMATION:

Background

GTCC LLW is defined by NRC in 10 CFR 72.3 as "low-level radioactive waste that exceeds the concentration limits of radionuclides established for Class C waste in 10 CFR 61.55." In 10 CFR 61.55, the NRC defines classes of LLW as A, B and C by the concentration of specific short- and long-lived radionuclides, with Class C LLW having the highest radionuclide concentration limits. Consistent with NRC's and DOE's authorities under the Atomic Energy Act of 1954 (as amended), the NRC LLW radioactive waste classification system does not apply to radioactive wastes generated or owned by DOE and disposed of at DOE facilities. However, DOE owns and generates LLW and transuranic radioactive waste with characteristics similar to GTCC LLW and that may not have a path to disposal. For the purposes of this EIS, DOE is referring to this DOE waste as GTCC-like waste (the use of the term "GTCC-like" does not have the intent or effect of creating a new classification of radioactive waste). DOE proposes to evaluate alternatives for the disposal of both GTCC LLW and DOE GTCC-like waste in this EIS.

Section 3(b)(1)(D) of the Low-Level Radioactive Waste Policy Amendments Act of 1985 (LLRWPAA) assigns the responsibility for the disposal of GTCC LLW to the Federal Government. The LLRWPAA specifies that the GTCC LLW covered under Section 3(b)(1)(D) is to be disposed of in a facility licensed and determined to be adequate by the NRC. DOE is the federal agency responsible for the disposal of GTCC LLW. This responsibility was described in a 1987 report to Congress, *Recommendations for Management of Greater-Than-Class-C Low-Level Waste* (DOE/NE–0077), U.S. Department of Energy, February 1987. The report can be obtained by contacting the Document Manager listed under ADDRESSES above or from the Web site at *http://www.gtcceis.anl.gov.*

The September 11, 2001, attacks and subsequent threats have heightened concerns that terrorists could gain possession of radiological sealed sources, including GTCC LLW sealed sources, and use them for malevolent purposes. Since 2003, the Government Accountability Office (GAO) has issued three reports on matters related to the security of uncontrolled sealed sources, including the Department's progress in developing a GTCC LLW disposal facility.[1] In addition, the Energy Policy Act of 2005 contains several provisions (e.g., sections 631, 651, and 957) directed at improving the control of sealed sources, including disposal availability.

Because of its technical expertise in radiation protection, the U.S. Environmental Protection Agency (EPA) will participate as a cooperating agency in the preparation of this EIS. NRC will be a commenting agency.

Energy Policy Act of 2005 Reporting Requirements

Section 631 of the Energy Policy Act of 2005 requires the Secretary of Energy to: provide Congress with notification of the DOE office with responsibility for completing activities needed to provide for safe disposal of GTCC LLW; submit a report to Congress containing an estimate of the cost and schedule to complete an EIS and record of decision (ROD) for a permanent disposal facility for GTCC LLW; and prior to making a final decision on the disposal alternative or alternatives to be implemented, submit to Congress a report that describes all alternatives considered in the EIS. In meeting these requirements thus far, DOE has named the Office of Environmental Management as the lead organization having responsibility to develop GTCC LLW disposal capability and has submitted a report to Congress dated July 2006 on the estimated cost and proposed schedule to complete the EIS.

Types and Estimated Quantities of GTCC LLW and DOE GTCC-like Waste

GTCC LLW may generally be categorized into the following three types: sealed sources, activated metals, and other miscellaneous waste (e.g., contaminated equipment). Sealed sources are typically small, high-activity radioactive materials encapsulated in closed metal containers. They are used for a variety of purposes including irradiating food and medical products for sterilization, detecting flaws and failures in pipelines and metal welds,

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calculating moisture content in soil and other materials, and assisting in the diagnosis and treatment of illnesses.

Activated metal wastes are primarily generated in nuclear reactors during facility modifications and decommissioning. There are 104 operating commercial reactors in the United States and an additional 18 that have been closed or decommissioned. The activated metals consist of internal nuclear components that have become radioactive from neutron absorption. These components include portions of the reactor vessel and other stainless steel components near the fuel assemblies.

Other miscellaneous waste includes all GTCC LLW that is not activated metals or sealed sources. This waste includes contaminated equipment, debris, trash, scrap metal and decontamination and decommissioning waste from miscellaneous industrial activities, such as the manufacture of sealed sources and laboratory research.

DOE GTCC-like waste includes some sealed sources owned or generated by DOE activities; activated metals including reflector materials from research reactors as well as other miscellaneous waste owned by DOE or generated by DOE activities that has characteristics similar to GTCC LLW and may not have a path to disposal. Most of the DOE GTCC-like waste consists of transuranic waste[2] (a DOE waste category) that may have originated from non-defense activities and therefore may not be authorized for disposal at WIPP under the Waste Isolation Pilot Plant Land Withdrawal Act of 1992 and has no other currently identified path to disposal.

DOE estimates a total inventory (existing and projected to be generated) of approximately 2,600 cubic meters of GTCC LLW and approximately 3,000 cubic meters of GTCC-like waste. A small percentage of this waste is mixed waste (i.e., radioactive waste that contains a hazardous component subject to the Resource Conservation and Recovery Act). Table 1 shows estimated quantities of GTCC LLW and GTCC-like waste that DOE proposes to analyze and is based on the report entitled *Greater-Than-Class C Low-Level Radioactive Waste Inventory Estimates*, (DOE, July 2007). This report updates the 1993 inventory estimates contained in the report entitled *Greater-Than-Class C Low-Level Radioactive Waste Characterization: Estimated Volumes, Radionuclides, Activities, and Other Characteristics*, DOE/LLW–114, Revision 1 (Sept. 1994), which served as the basis for inventories in the ANOI. Copies of both reports are available by contacting the Document Manager listed under **ADDRESSES** above or at *http://www.gtcceis.anl.gov*.

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[2] Transuranic waste is radioactive waste containing more than 100 nanocuries of alphaemitting transuranic isotopes per gram of waste, with half-lives greater than 20 years, except for: (1) High-level waste; (2) waste that the Secretary of Energy has determined, with the concurrence of the Administrator of EPA, does not need the degree of isolation required by the 40 CFR Part 191 disposal regulations; or (3) waste that the NRC has approved for disposal on a case-by-case basis in accordance with 10 CFR Part 61.

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TABLE 1.—INVENTORY SUMMARY OF ESTIMATED QUANTITIES OF GTCC LLW AND DOE GTCC-LIKE WASTE[a]

Waste type	In storage	Projected	Total stored and projected			
			Volume in cubic meters (m³)	Activity[b] MCi	Volume m³	Activity[b] MCi
GTCC LLW:						
Activated metal	58	3.5	810	110	870	110
Sealed sources	([c])	([c])	1,700	2.4	1,700	2.4
Other[d]	76	0.0076	1.0	0.00023	77	0.0078
Total GTCC LLW	130	3.5	2,500	110	2,600	110
DOE GTCC-like waste:						
Activated metal	5.0	0.11	29	0.82	34	0.93
Sealed sources	8.7	0.013	25	0.030	34	0.043
Other[d]	860	11	2,000	19	2,900	30
Total DOE GTCC-like waste	870	11	2,100	20	3,000	31
Total GTCC and GTCC-like waste	1,000	15	4,600	130	5,600	140

[a] Values have been rounded to two significant figures.
[b] Radioactivity values are in millions of curies (MCi).
[c] There are sealed sources currently possessed by NRC licensees that may become GTCC LLW when no longer needed by the licensee. The estimated volume and activity of those sources are included in the projected inventory, notwithstanding the lack of information on the current status of the sources (e.g., in use, waste, etc.).
[d] Other GTCC LLW and DOE GTCC-like waste includes contaminated equipment, debris, trash, scrap metal and decontamination and decommissioning waste.

Purpose and Need for Action

As shown in Table 1, NRC and Agreement State licensees have generated and continue to generate GTCC LLW for which there is no permitted disposal facility. DOE is responsible for the safe and secure disposal of GTCC LLW covered under Section 3(b)(1)(D) of the LLRWPAA, including determining how and where to dispose of these wastes. In addition, DOE owns or generates certain LLW and transuranic wastes with characteristics similar to GTCC LLW that also may not have an identified path to disposal.

Proposed Action

DOE proposes to construct and operate a new facility or facilities, or use an existing facility, for the disposal of GTCC LLW and GTCC-like waste. DOE would then close the facility or facilities at the end of each facility's operational life. Based on the EIS analysis, DOE expects to make a decision on the method(s) and location(s) for disposing of GTCC LLW and DOE GTCC-like waste. A combination of disposal methods and locations may be appropriate based on the characteristics of the waste and other factors.

Alternatives Proposed for Evaluation

The GTCC EIS will evaluate the range of reasonable alternatives for the disposal of GTCC LLW and GTCC-like waste, together with a no action alternative. The NRC regulations at 10 CFR 61.55(a)(2)(iv) define GTCC LLW as that waste which would require disposal in a geologic repository as defined in 10 CFR Part 60 or 63, unless proposals for an alternative method of disposal are approved by NRC under 10 CFR 61.55(a)(2)(iv). Although NRC regulations state that GTCC LLW is generally not acceptable for near surface-disposal, the NRC recognizes in 10 CFR 61.7(b)(5) that "there may be some instances where waste with concentrations greater than permitted for Class C waste would be acceptable for near-surface disposal with special processing or design." Therefore, the disposal methods DOE proposes to evaluate in the EIS include deep geologic repository disposal, intermediate depth borehole disposal, and enhanced near-surface disposal. For deep geologic disposal, DOE intends to analyze disposal at Yucca Mountain in Nevada, a proposed geologic repository to be licensed under 10 CFR Part 63. DOE will also evaluate deep geologic repository disposal at WIPP in New Mexico. Identification of the proposed Yucca Mountain repository for analysis in the EIS is based on the 10 CFR 61.55 regulations, which identify disposal in a geologic repository licensed under 10 CFR Part 60 or 63 as an acceptable method for the disposal of GTCC LLW. Identification of WIPP is based on its characteristics as

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a geologic repository, although not subject to NRC licensing as a geologic repository under 10 CFR Parts 60 or 63. DOE does not plan to evaluate an additional deep geologic repository facility because siting of another deep geologic repository facility for GTCC LLW and GTCC-like waste is impractical due to the cost, time, and the relatively small volume of GTCC LLW and GTCC-like waste.

DOE also intends to evaluate disposal of GTCC LLW and GTCC-like waste in a new intermediate depth borehole facility and enhanced-near surface facility at existing DOE sites and generic commercial locations. The DOE sites considered for analysis include INL in Idaho, LANL in New Mexico, WIPP vicinity (either within the WIPP Land Withdrawal perimeter that is under the jurisdiction of DOE, or on government property in the vicinity of WIPP), NTS in Nevada, SRS in South Carolina, ORR in Tennessee, and Hanford in Washington. Identification of these sites for potential analysis is based on mission compatibility (these DOE sites currently have waste disposal operations as part of their mission) and physical characteristics of the sites such as hydrogeology and topography.

In addition, DOE intends to evaluate a generic enhanced near surface and intermediate depth borehole commercial disposal facility under both arid and humid conditions in the EIS.

In a Request for Information in the *FedBizOpps* on July 1, 2005, DOE solicited technical capability statements from commercial vendors that may be interested in constructing and operating a GTCC waste disposal facility. Although several commercial vendors expressed an interest, no vendors have provided specific information on disposal locations and methods for analysis in the EIS. Including a generic commercial facility in the EIS would allow DOE to make a programmatic determination regarding disposal of GTCC LLW and GTCC-like waste in such a facility. Should one or more commercial facilities be identified at a later time, DOE would conduct further NEPA review, as appropriate.

DOE intends to evaluate each of the GTCC waste types (*i.e.*, sealed sources, activated metals, and other waste) individually and in combination for each of the disposal alternatives, taking into account the characteristics of the waste types and other considerations (e.g., waste volumes, physical and radiological characteristics, and generation rates). For example, GTCC LLW containing transuranic radionuclides with longer half-lives may require greater isolation or other special measures to protect against potential inadvertent human intrusion, whereas GTCC LLW containing radionuclides with shorter half-lives may require less extensive measures. DOE will also consider volumes and time periods when wastes would be generated and require disposal.

In the GTCC LLW EIS, DOE will describe the statutory and regulatory requirements for each disposal alternative and whether legislation or regulatory modifications may be needed to implement the alternative under consideration. In summary, DOE proposes to evaluate the alternatives listed below:

Alternative 1: No Action—under this alternative, current and future GTCC LLW and GTCC-like waste would be stored at designated locations consistent with ongoing practices, such as storage of GTCC LLW activated metals at nuclear utilities;

Alternative 2: Disposal in a Geologic Repository at WIPP—under this alternative, DOE would dispose of GTCC LLW and GTCC-like waste at WIPP;

Alternative 3: Disposal in a Geologic Repository at Yucca Mountain—under this alternative, DOE would dispose of GTCC LLW and GTCC-like waste at the proposed Yucca Mountain Repository;

Alternative 4: Disposal at a New Enhanced Near-Surface Facility—under this alternative, DOE would dispose of GTCC LLW or GTCC-like waste at a new enhanced near-surface facility at INL, LANL, WIPP vicinity, NTS, SRS, ORR, and Hanford, or a commercial facility should such a facility be identified in the future;

Alternative 5: Disposal at a New Intermediate Depth Borehole Facility—under this alternative, DOE would dispose of GTCC LLW or GTCC-like waste at a new intermediate depth borehole facility at INL, LANL, WIPP vicinity, NTS, SRS, ORR and Hanford, or a commercial facility should such a facility be identified in the future.

Identification of Environmental Issues

DOE proposes to evaluate disposal

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technologies at various DOE and generic commercial locations for the construction, operation, and closure of a facility or facilities for the disposal of GTCC LLW and GTCC-like waste. DOE proposes to address the issues listed below in the process of considering the potential impacts of the proposed disposal alternatives.

□ Potential impacts on air, noise, surface water and groundwater.
□ Potential impacts from the shipment of GTCC LLW and GTCC-like waste to the disposal site(s).
□ Potential impacts from postulated accidents.
□ Potential impacts on human health, including impacts to involved and noninvolved site workers and members of the public.
□ Potential impacts to historical and cultural artifacts or sites of historical and cultural significance.
□ Potential disproportionately high and adverse effects on low income and minority populations (environmental justice).
□ Potential Native American concerns.
□ Short-term and long-term land use impacts.
□ Long-term site suitability, including erosion and seismicity.
□ Potential impacts to endangered species.
□ Intentional destructive acts.
□ Compliance with applicable federal, state, and local requirements.
□ Irretrievable and irreversible commitment of resources.
□ Cumulative impacts from past, present and reasonably foreseeable actions.

This list is not intended to be inclusive, and we invite interested parties to suggest other issues to be considered, including aspects of the waste inventories presented in Table 1.

Summary of Public Comments on the Advance Notice of Intent

In 2005, DOE issued an ANOI, 70 Fed. Reg. 24775 (May 11, 2005), inviting the public to provide preliminary comments on the potential scope of the EIS. DOE received comments on the ANOI from: the states of Nevada, Oregon and Washington; the Sacramento Municipal Utility District; the New England Coalition; the Sierra Club; the Nuclear Energy Institute; and the Savannah River Site Citizens Advisory Board. The major scoping issues identified in the comments are summarized below, along with DOE's response.

□ *EIS General Scope:* Commenters questioned the need for the EIS, assuming that GTCC LLW would be disposed of in the proposed Yucca Mountain repository for spent nuclear fuel and high-level waste. Some commenters favored the inclusion of DOE's GTCC-like waste along with GTCC LLW generated from NRClicensed activities in the EIS, while other commenters recommended restricting the scope of the EIS to GTCC LLW analyzed in the Yucca Mountain EIS (DOE/EIS–0250, February 2002) or to waste generated from NRC-licensed activities. Still other commenters questioned the basis for projecting the GTCC LLW volume to 2035 and 2055.

Response: GTCC waste is LLW, not high-level waste or spent nuclear fuel; nevertheless, DOE has identified the proposed Yucca Mountain repository as one of the sites to be analyzed in the EIS for GTCC LLW as a disposal alternative, as well as other appropriate sites, in accordance with 10 CFR Part 61. Under the LLRWPAA, DOE is responsible for disposing of this waste, and because such disposal would be a major federal action, DOE is required by the Council on Environmental Quality regulations that implement NEPA to complete an EIS analyzing the range of reasonable alternatives for this action. The Energy Policy Act of 2005 also requires DOE to take actions related to the preparation of an EIS for GTCC LLW. DOE plans to include its GTCC-like waste that may have no path to disposal, as well as waste generated from NRC or Agreement State licensed activities, and to identify where economies of scale may be achieved in using the same disposal methods and locations.

DOE has identified the estimated GTCC LLW and GTCC-like waste volumes based on the best available data. DOE has changed the projections to 2035 and 2062 to include the 20-year license renewal that commercial reactors may receive plus an additional 6-year "cooling period" before commencing reactor decommissioning activities. Thus GTCC LLW and GTCClike waste estimates are projected through 2035, except for GTCC LLW activated metals estimates, which are projected through 2062, based on anticipated nuclear reactor

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decommissioning schedules.

☐ *Waste Disposal Alternatives:* Commenters stated that DOE should identify its criteria for including sites considered in the EIS as potential disposal locations and criteria for selecting the technologies and disposal methods to be evaluated.

Response: DOE has identified its basis for the disposal locations and disposal methods proposed for analysis in the EIS under "Alternatives Proposed for Evaluation" in this Notice.

☐ *Waste Inventories:* Commenters stated that the inventory data provided in the ANOI should be updated.

Response: DOE has updated the inventory data as shown in Table 1. DOE will incorporate other appropriate inventory data that may become available during preparation of the EIS.

☐ *Resource Areas Proposed for Analysis:* Commenters suggested a number of subjects that DOE should include in the EIS impact analyses.

Response: DOE's list of subjects proposed for evaluation in the EIS under "Identification of Environmental Issues" in this NOI responds to those comments.

☐ *Concentration Averaging:* Commenters raised questions about DOE's potential use of "concentration averaging" in which, for example, the activity of one component is averaged over the volume or mass of waste to identify applicable waste classification standards.

Response: For the purposes of analysis in the EIS, DOE would use guidance in the *Branch Technical Position on Concentration Averaging and Encapsulation*, U.S. Nuclear Regulatory Commission, Washington DC, January 1995, to determine when LLW is greater than Class C as defined at according to 10 CFR Part 61.

☐ *Regulatory Requirements:* A number of commenters discussed the need to address compliance with regulatory and other legal requirements in the EIS.

Response: The EIS would describe applicable regulatory and other legal requirements and consider the extent to which the alternatives analyzed meet those requirements.

Public Scoping

Interested parties are invited to participate in the public scoping process to provide their comments on the proposed disposal alternatives for analysis in the EIS and the environmental issues to be analyzed. The scoping process is intended to involve all interested agencies (federal, state, county, and local), public interest groups, Native American tribes, businesses, and members of the public. Public scoping meetings will be held at the following locations and times:

☐ *Carlsbad, New Mexico:* Pecos River Village Conference Center, Carousel House, 711 Muscatel Avenue, Carlsbad, New Mexico, Monday, August 13, 2007, 6 p.m.–9 p.m.

☐ *Los Alamos, New Mexico:* Hilltop House Best Western, La Vista Room, 400 Trinity Drive, Los Alamos, New Mexico, Tuesday, August 14, 2007, 6 p.m.–9 p.m.

☐ *Oak Ridge, Tennessee:* DOE Oak Ridge Information Center, 475 Oak Ridge Turnpike, Oak Ridge, Tennessee, Wednesday, August 22, 6 p.m.—9 p.m.

☐ *North Augusta, South Carolina:* North Augusta Community Center, 495 Brookside Avenue, North Augusta, South Carolina, Thursday, August 23, 6 p.m.–9 p.m.

☐ *Troutdale, Oregon:* Comfort Inn & Suites-Columbia Gorge West, 477 NW Phoenix Drive, Troutdale, Oregon, Monday, August 27, 2007, 6 p.m.–9 p.m.

☐ *Pasco, Washington:* Red Lion Hotel, Gold Room, 2525 N 20th Avenue, Pasco, Washington, Tuesday, August 28, 2007, 6 p.m.–9 p.m.

☐ *Idaho Falls, Idaho:* Red Lion Hotel On The Falls, Yellowstone/Teton Rooms, 475 River Parkway, Idaho Falls, Idaho, Thursday, August 30, 2007, 6 p.m.–9 p.m.

☐ *Las Vegas, Nevada:* Atomic Testing Museum, 755 E. Flamingo Road (Just East of Paradise Road), Las Vegas, Nevada, Tuesday, September 4, 2007, 6 p.m.–9 p.m.

☐ *Washington DC:* Hotel Washington, Washington Room, 15th and Pennsylvania Avenue, NW., Washington, DC, Monday, September 10, 1 p.m.–5 p.m.

During the first hour of each scoping meeting, DOE officials will be available for informal discussions with attendees. During the formal part of the meeting, the public will have the opportunity to provide comments orally or in writing. The presiding officer will establish procedures to ensure that everyone who wishes to speak has a chance to do so. Both oral and written comments will be considered and given equal weight.

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Issued in Washington, DC on July 17, 2007.

James A. Rispoli,

Assistant Secretary for Environmental Management.

[FR Doc. E7-14139 Filed 7-20-07; 8:45 am]

BILLING CODE 6450-01-P

DEPARTMENT OF ENERGY

Office of Civilian Radioactive Waste Management; Safe Routine Transportation and Emergency Response Training; Technical Assistance and Funding

AGENCY: Department of Energy.

ACTION: Notice of revised proposed policy and request for comments.

SUMMARY: The Department of Energy (DOE) is publishing this notice of revised proposed policy to set forth its revised plans for implementing Section 180(c) of the Nuclear Waste Policy Act of 1982 (the NWPA). Under Section 180(c) of the NWPA, DOE shall provide technical and financial assistance for training of local public safety officials to States and Indian Tribes through whose jurisdictions the DOE plans to transport spent nuclear fuel or high-level

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APPENDIX G:

TRIBAL NARRATIVES

[a] In the tribal narratives, the Nevada National Security Site was still referred to as the Nevada Test Site or NTS, and this was not changed.

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American Indian Writers Committee
of the
Consolidated Group of Tribes and Organizations

Tribal Narrative for the Nevada Test Site

May 11-15, 2009

American Indian Writers Committee
Richard Arnold
Jerry Charles
Betty Cornelius
Maurice Frank-Churchill
Danelle Gutierrez
Gerald Kane
Lalovi Miller

Facilitated By
Richard W. Stoffle, University of Arizona

Document Approved by
Consolidated Group of Tribes and Organizations
Meeting August 31 – September 2, 2009
Mercury, Nevada

Date Submitted to DOE/EM Division

September 2009

Tribal Views on Nevada Test Site: Affected Environment and Consequences

1.0 Affected Environment

1.1 Climate

CGTO knows that the climate of the region has changed over the thousands of years that the Indian people have lived in this region (See Indian Appendix for more). The NTS has only occupied this area since the early 1940s. It is important to recognize that major climatic changes have taken place since the end of the Pleistocene and shorter term climate changes such as the wet period in the 1980s and 1990s contrast with the current 10-year drought. It is important for the GTCC EIS to assess the impacts of short term and long term climatic changes because the DOE expects to safely manage these GTCC wastes for up to 10K years during which similar climate changes can be expected.

The current climate description in the GTCC EIS is specific to the present decade-long period of extended drought (a similar one occurred between 1896 and 1906) so this type of drought and the wet period between 1980s and 1990s may be a factor in siting the GTCC facility. An analysis of long term impacts based on current conditions will neither be representative of climate conditions viewed over much longer periods nor applicable to a short climate shift to much wetter conditions.

1.2 Groundwater

The CGTO knows that most dry lakes are not known to be completely dry. An example is Soda Lake near Barstow, California. The Mohave River flows into this dry lake and most of the year it looks dry but it actually flows underground. Building berms on dry lake beds to offset water and runoff doesn't sound like a good idea to the Indian way of thinking. As one CGTO member added, to Indian people "water is life. Our water has healing powers" (NRC 2009a). So why build a GTCC site on and use this playa when the odds of radiation seem feasible? The Indian people who visited this site recommend not to bother Frenchmen Playa. It is only one of two in the immediate region and has special meanings. There should be a more descriptive study to fully understand the impacts. More time is needed, also for Indians to revisit this site. Although some people continue to view Frenchman playa as a wasteland, the CGTO knows it is not. Further ethnographic studies are needed.

1.3 Ecology

The CGTO knows that this site (in Area 5) is an ancient playa, surrounded by mountain ranges (See Indian Appendix for more). The runoff from these ranges serves to maintain the healthy desert floor. Animals frequent this area, there are numerous animals' trails, and these play a significant part in the history of the locality and of the Indian lifestyles. Our ancestors knew that the Creator always provided for them and this site is one of their favorite places to hunt and trap rabbits. We have special leaders that organized large rabbit hunts. Many people participated so this place would be occupied at times by all kinds of our people. Rabbits provided good eating, bones for tool-making, warm blankets, and even games. Indian people refrained from eating coyote, wolves, and birds but these contribute to our stories which tell us how to behave and why we are here. We have many stories and songs that include animals and birds who have human-like antics. From these antics Indian people learn the life lessons to build character to become better persons. So animals and the places where they live contribute to our history and culture.

This culturally central place was used by and important to Indian people from our agricultural and horticultural communities located to the north – near Reese River Valley and Duckwater, to the south – near Ash Meadows, to the southeast – near Indian Springs and Corn Creek, to the east – near the Pahranagat-Muddy River, and west – near the Oasis Valley. It was also used by people from our agricultural and horticultural communities to the far west in Owens Valley, to the far south near Cottonwood Island and Palo Verde Valley on the Colorado River, to the far southwest at Twenty Nine Palms, to the far east along the Virgin River, Santa Clara River, and Kanab Creeks, to the far north along the Humbolt River and Ruby Valley.

Plants

The CGTO knows based on previous DOE-sponsored ethnobotany studies that there are at least 364 Indian use plants on the NTS (see Appendix G). Indian people visiting the proposed location of the GTCC facility identified the following traditional use plants: (1) Indian Tea, (2) White Sage or Winter Fat, (3) Indian Rice Grass, (4) Creosote, (5) Wolfberries, (6) Four O'clock, (7) Spiny Hop Sage, (8) Joshua Tree, (9) Daises, (10) Desert Trumpet, (11) Cholla, (12) Globe Mallow, (13) Fuzzy Sage, (14) Tortoise Food plant, (15) Sacred Datura, (16) Wheat Grass, and (17) Lichen. Other plants were present but not identified due to the late season and the dry condition of the plants.

Plants are still used for medicine, food, basketry, tools, homes, clothing, fire, and ceremony -- both social and healing. The characteristics of the plants at the proposed GTCC area are smaller and thinner than in other desert areas where it is wetter. Indian people from elsewhere traveled to this area to gather specific plants because they have stronger characteristics when they grow in dry places. The sage is used for spiritual ceremonies, smudging, and medicine. The Indian rice grass and wheat grass are used for breads and puddings. Joshua trees and Yucca plants are important for hair dye, basketry, foot ware, and rope. Datura is used for hallucinogenic effects during which alternative places can be visited by medicine men. Datura also goes itself to disturbed areas and heals them. The globe mallow had traditional medicine uses, but in recent times is also used for curing European contagious diseases.

Animals/Insects

The CGTO knows based on previous DOE-sponsored ethnofauna studies that there are at least 170 Indian use animals on the NTS (see Appendix G). Indian people visiting the proposed location of the GTCC facility identified the following traditional use animals: (1) Jack Rabbits, (2) Whiptail Lizards, (3) Antelope, (4) Tortoise, (5) Kangaroo Rats, (6) Horned Toad, (7) Rock Wrens, (8) Ravens, (9) Grasshoppers, and (10) Stink Bugs. Other animals (such as snakes, bats, and owls) were perceived to be present but not observed because they primarily emerge at night.

All animals and insects were and are culturally important and the relationships between them, the Earth, and Indian people are represented by the respectful roles they play in the stories of our life then and now. The GRCC valley is where a spiritual journey occurred. It involved Wolf (*Tavats* in Southern Paiute, *Bia esha* in Western Shoshone, *Wi gi no ki* in Owens Valley Paiute) and Coyote (*Sinav* in Southern Paiute, *Duhvo esha* in Western Shoshone, *Esha* in Owens Valley Paiute) and is considered a Creation Story. Only parts of this can be presented here. When Wolf and Coyote had a battle over who was more powerful, Coyote killed Wolf and felt glorious. Everyone asked Coyote what happened to his brother Wolf. Coyote felt extremely guilty and tried to run and hide but to no avail. Meanwhile, the Creator took Wolf and made him into a beautiful Rainbow (*Paro wa tsu wu nutuvi* in Southern Paiute, *Oh ah podo* in Western Shoshone, *Paduguna* in Owens Valley Paiute). When Coyote saw this special privilege he cried to the Creator in remorse and he too wanted to be a Rainbow. Because Coyote was bad, the Creator put Coyote as a fine white mist at the bottom of the Rainbow's arch. This story and the spiritual trails discussed in the full version are connected to the Spring Mountains and the large sacred cave in the Pintwater Mountains as well as to lands now called the Nevada Test Site. This area is the home place of Wolf who is still present and watches over the area and us.

Minerals

The CGTO knows based on previous DOE-sponsored cultural studies that there are many minerals on the NTS (no complete list available). Indian people visiting the proposed GTCC site identified the following traditional use minerals: (1) Obsidian, (2) chalcedony, (3) Yellow Chert or Jasper, (4) Black Chert, (5) Pumice, (6) Quartz Crystal, and (7) Rhyolite Tuff. Other minerals were perceived to be present but not observed because of the limited time and search area.

All minerals are culturally important and have significant roles in many aspects of Indian life. For example, the Chalcedony on the proposed GTCC site would have made an attractive offering which would be acquired here by a ceremonial traveler and then left at the vision quest or medicine site located to the north on top of a volcano like Scrugham Peak. Returning ceremonial travelers would also bring offerings back to where they had acquired offerings, thus the Yellow Chert or Jasper (observed on the GTCC site) which outcrops about 70 miles to the north would be gathered there and returned to the Chalcedony site as an offering.

Playas

The CGTO knows, based on cultural studies funded by the DOE on the NTS and playa-specific studies funded by Nellis Air Force Test and Training Range (Henderson 2008), that playas occupy a special place in Indian culture. Playas are often viewed as empty and meaningless places by western scientists, but to Indian people playas have a role and often contain special resources that occur no where else. The following text was prepared by the Indian people who visited the proposed GTCC site.

Is a playa a wasteland? According to Indian elders playas were used in traveling or moving to places where work, hunting, pine cutting or gathering of other important foods and medicine could be done. One elder remembers crossing over dry lake beds and traveling around but near the edges and they discussed how provisions were left there and at nearby springs by previous travelers at camping spots. Indian people left caches in playa areas for people who crossed valleys when water and food was scarce. Frenchmen Playa is such a place. Indian people took advantage of traveling through this playa as mountains completely surround this area. The CGTO knows that most dry lakes are not known to be completely dry. An example is Soda Lake near Barstow, California. The Mohave River flows into this dry lake and most of the year it looks dry but it actually flows underground. Building berms on dry lake beds to offset water and runoff doesn't sound like a good idea to the Indian way of thinking. As one CGTO member added, to Indian people "water is life. Our water has healing powers" (NRC 2009a). So why build a GTCC site on and use this playa when the odds of radiation seem feasible? The Indian people who visited this site recommend not to bother Frenchmen Playa. It is only one of two in the immediate region and has special meanings. There should be a more descriptive study to fully understand the impacts. More time is needed, also for Indians to revisit this site. Although some people continue to view Frenchman playa as a wasteland, the CGTO knows it is not. Further ethnographic studies are needed.

1.4 Environmental Justice

DOE has recognized the need to address environmental justice concerns of the CGTO based on disproportionately high and adverse impacts to their member tribes from DOE NTS activities. In 1996, the CGTO expressed concerns relating to environmental justice that included (1) damage to Holy Lands, (2) negative health impacts, and (3) lack of access to traditional places that contributes to breakdowns in cultural transmission. In the 2002 NTS SA, NNSA/NSO concluded that with the selection of the Preferred Alternative, the CGTO would be impacted at a disproportionately high and adverse level consequently creating an environmental justice issue. Since 2002, NNSA/NSO has supported a few ethnographic studies involving the CGTO and culturally important places including in 2004, when NNSA/NSO arranged for tribal representatives to conduct evening ceremonies at Water Bottle Canyon. While the opportunity for the evening ceremony was a significant accommodation, disproportionately high and adverse impacts from DOE NTS activities continue to affect American Indians. The three environmental justice issues noted by the CGTO need to be addressed.

1.5 Radiation

The CGTO knows that radiation can be and is viewed from both a western science and a Native American perspective (See Indian Appendix for more). These alternative and competing perspectives are key for understanding the cultural foundations of American Indian responses to the mining, processing, use, transportation, and disposal of radioactive materials. At some level of analysis from and Indian perspective, all radioactive waste is basically the same problem to Indian people. Subtle differences in classification from a western science perspective of radioactive waste only mask and do not significantly modify the basic cultural problems of radioactive waste for Indian people and their traditional lands.

The Angry Rock is a concept used by Indian people, involved in DOE funded radioactive waste transportation and disposal studies, to quickly summarize the complex cultural problems associated with what happened to this known mineral when it was improperly taken and used by non-Indians. The notion of an Angry Rock is premised on the belief that all of the earth is alive, sentient, speaks Indian, and has agency. When the elements of the earth are approached with respect and asked for the permission before being used they share their power with humans. The reverse occurs when they are taken without permission – they become angry withhold their power and often using it against humans. Thus uranium is an Angry Rock. Uranium has been known and carefully used by spiritual specialists and medicine persons for thousands of years (Lindsay et al. 1968). The following American Indian elder quote from a DOE funded report (Austin 1998) begins to explain this perspective:

We are the only ones who can talk to these things. If we do not make sure that we talk to those things, then they are going to give us more bad harm, because it is already happening throughout the country. Those are the reasons why the Indian people say ... like uranium, for one, uranium was here since the beginning of this Earth, when it was here we knew uranium at one time. And still it is used, but then they got a hold of it and made something else out of it. Now it is a man made thing, and today it accumulates waste from nuclear power plants, it accumulates more, it has its own life. Radiation has said to us at one time "If you use me make sure you tell me before you use me why you are going to use me and what for. " And we never said anything to that uranium at all, and we put something else in there with it, which shouldn't belong with it. It gives it more power to eliminate the life, of all living things on this planet of ours. Those are the reasons, why the Indian people always say, and I know because I have been there. The rocks have a voice...

Although from a Western science perspective radiation can be isolated and contained by conventional techniques, the Angry Rock has the power to move and cannot be contained by barriers. Indian people who have dealt with the Angry Rock for thousands of years note that there are traditional ways to deal with uranium, the natural rock, if used by trained Indian specialists, but these may or may not work with the Angry Rock of modern radiation waste.

Songs ... we are the ones who should be talking to those things. Radiation is going to take all of our lives; it is continuously moving over the land. The land don't want it, nobody wants it. And today, we are doing a bad thing by using radiation on each other. Radiation is something that should not be used to kill animal life...

Another elder noted:

And can it be contained? As it's transformed it can be, I think it can be contained physically but not spiritually, and again I think spiritually as it's been altered because it's in that energy field because it's been altered. The spirit, that's where it can do its harm in an altered form. It doesn't do any good to anybody. And there you're just in the wrong place in the wrong time, it does influence plants and animals, minerals and air, the spirit of any area it passes through. The reason somebody is sick. I don't think it's necessary to talk about how each one of these is influenced, it just is.

Another elder noted:

As far as the transportation of waste there's a lot of unknowns and we don't know what the consequences are. We know there are many sicknesses that come out from people that have been contaminated by nuclear waste and as far as Indian people go, we show respect to the land, show respect to other people, for the animals, the plants, the rocks. The power of the rock – Just looking at Chemehuevi Mountain, it's a very spiritual mountain from this perspective right here. When I look out towards the mountains and I don't just see a mountain, I see a place *of power, I see a place where I can go and meditate and speak with the Creator directly and ask for prayers and blessings for people directly. Just like anything else, you have to give prayers all the time because the creator is here to watch and protect over us. I feel that we wouldn't have come this far if he wasn't here to watch over us and we are here to pray and we are here to protect the other resources.*

Another elder said:
I can envision the animals standing back once it goes through for the first time and they recognize that there's a danger that they would move away because of fear. That they would no longer be there and that there's something bad coming down the road and they disperse and move away into different corridors. Kind of like a dust storm, they disperse and move further and further away. I see it from the animals' standpoint, they're a lot smarter than us and they've been doing this for longer than us and their senses are more keen and I think the animals would get back and it would create dead zones throughout the country. Through these corridors or transportation routes of course at the site there will be those that are curious who want to go see.

Another elder said:
I don't know what you would do with this rock if it's angry and this is its way of rebelling, getting back. I think as a Native American I would backstep and ask for forgiveness. Sometimes forgiving is not very easy because there's sacrifices we have to make and there's consequences ... I don't think it can be done as a group, it's an individual thing and each one of us has to go back and ... ask for forgiveness for what has taken place. It's not just only that I think it's going to be more complicated than going out into the mountains and saying, "hey, I'm sorry, I won't do this, I won't do that and I won't bother you anymore. There's a lot of other things that need to be forgiven. The rock is the most precious and it's the largest and it's the one that needs to be forgiven the most. There's a lot of small forgiveness that have to be given before the large rock. I think it's a stepping stone ... the rocks are angry, yes, they're striking out saying "don't do this to me, don't touch me; don't let this happen. " In a sense you look at it from a spirituality standpoint, it's the spirits of Mother Earth telling us don't mess with Mother Earth. It remains a matter of debate as to whether traditional means of placating powerful rock-based forces can be used to control or placate radioactive waste. Western scientists have created a problem for Indian people that, despite being very critical to their future, is not easily resolved.

1.6 Cultural Resources

The CGTO knows that American Indian cultural resources include all physical, artifactual, and spiritual aspects of the NTS. The CGTO has established that formal studies of these aspects of the land should be conducted to identify, assess, mitigate, and manage these resources. These resources should be studied with members of the CGTO recommended for the study. Such studies are termed: (1) Ethnoarchaeology, (2) Ethnobotany, (3) Ethnozoology, (4) Storied Rocks, (5) Traditional Cultural Properties, (6) Ethnogeography, and (7) Cultural Landscapes (see Appendix G).

The CGTO knows that many of these cultural resources are directly present on the GTCC proposed site, in the Indian Defined Area of Potential Effect, and immediate region surrounding the GTCC site. The Indian people who visited the GTCC site note that their time on site was insufficient to fully identify, analyze, and evaluate resource that may be present. They recommend one or more of the kinds of resource studies identified above be conducted. Based on their site visit they do know that the area contains important cultural resources including plants, animals, minerals, trails, and portions of cultural landscapes (see Indian Appendix of this EIS).

Cultural Artifacts and Features

The CGTO knows based on previous DOE-sponsored cultural studies that there are many cultural artifacts and features on the NTS (American Indian Transportation Committee, Stoffle, and Toupal 1998; American Indian Transportation Committee, et al. 1999; American Indian Writers Subgroup, CGTO 1996; Arnold et al. 1997; Arnold et al.1998; Arnold et al. 1999; Austin 1998; Stoffle et al. 2001a; Stoffle et al. 2001b; Stoffle, Evans, Harshbarger 1989; Stoffle, Evans, Halmo 1988; Stoffle et al. 1989; Stofle, Halmo, and Dufort 1994; Stoffle, Olmsted, and Evans 1988; Stoffle, Zedeño, and Carroll 2000; United States Department of Energy (USDOE) 1996; USDOE, National Nuclear Security Administration 2002; USDOE, National Nuclear Security Administration 2008; Henderson 2008). Indian people visiting the proposed GTCC site identified the following traditional cultural artifacts and features: (1) Chert Flakes, (2) Rock Alignments, (3) Boulder Grinding Indentation or metate (*Mata* in Owens Valley, *Doso* in Western Shoshone, *Mada* in Southern Paiute), (4) Hand Grinding Stone or mano (*Paha* or *Tusu* in Owens Valley, *Botoh* in Western Shoshone, *Mohum* in Southern Paiute), (5) Volcanoes, (6) Trails, and (7) Chalcedony, and (8) Yellow Jasper.

Artifacts are the evident signs of our ancestors on this land. They are proof that we were here for thousands of years. We were told by our elders never to move artifacts or take them from their place. This is their home because they were left there for us to see and understand the past. We never remove them because they still belong to the ancestors who put them there for us and still watch over them today. Artifacts come from parts of the living earth and are still alive with a right to remain where they were placed. Whether or not there is evidence of being modified, the volcanoes, stones, rocks and trails that we incorporated into our lives are artifacts. These were visited for ceremony, chosen and moved as offerings, and traveled on our journeys and thus were a part of our life, are artifacts of our ancestors that we respect, and are there for future generations.

1.7 Visual Resources

Views are important cultural resources that contribute to the location and performance of American Indian ceremonialism. Views combine with other cultural resources to produce special places where power is sought for medicine and other types of ceremonies. Views can be of any landscape, but more central viewscapes are experienced from high places, which are often the tops of mountains and the edges of mesas. Indian viewscapes tend to be panoramic and are special when they contain highly diverse topography. The viewscape panorama is further enhanced by the presence of volcanic cones and lava flows. Viewscapes are tied with songscapes and storyscapes, especially when the vantage point has a panorama composed of multiple locations from either song or story. Key to the Indian experience of viewscapes is isolation. Successful performance of ceremonies (whether by individuals or groups) is often commemorated by the building of rock cairns and by storied rocks and paintings. The CGTO tribes recognize the cultural significance of viewscapes and have identified a number of these on the NTS. The Timber Mountain Caldera contains a number of significant points with different panoramas, including Scrugham Peak-Buckboard Mesa and the Shoshone Mountain massif.

1.8 Waste Management

The CGTO requests an analysis of the hydrological and ecological impacts of the existing water diversion dike of the current Radioactive Waste Management Complex in Area 5. The DOE recognizes that this is a very flood prone area, with major flooding episodes occurring about every 23 years. Indian people visiting this site observed that even though the current dike has been built recently and thus not experienced a 23-year flood, it has diverted and consolidated sufficient runoff that a small arroyo has been established. The Indian people visiting this site believe that the existing dike has unnaturally stressed down-slope plants and animals who now do not receive normal sheet runoff. The Indian people visiting the site believe that by concentrating the runoff, the dike has reduced the amount of water absorbed during normal sheet runoff because the consolidated runoff moves more quickly and only flows in the new and developing eroded arroyo. It is believed by the Indian people visiting the site that were a GTCC facility to be established east of the current RWMC then the dike would necessarily have to be extended causing an even greater runoff shadow and an even greater developing arroyo. The desert tortoise in the area will have to move out of this larger runoff shadow and may be concentrated in the area of Frenchmen Playa. Moving their living areas towards the playa will expose them to higher levels of radioactivity. The Indian people visiting the site believe that these current and potential impacts should be analyzed, monitored by Indian people, and reported back to the CGTO at the next annual meeting.

1.9 Site Description

The CGTO knows that the southern bajada (alluvial fan) of French Peak and associated hills to the east combine to periodically cause massive runoffs which flow rapidly towards Frenchman Playa making it a seasonal shallow lake. Frenchman Playa has a 140 square-mile watershed that could impact the GTCC site as it potentially does the current RWMS (Raytheon Services 1993). Especially considered in these Indian comments are runoffs from the north of the proposed GTCC storage area. This watershed involves 13.6 square miles and directly impacts the current RWMS. This runoff from this area is normally sheetflow, but every 23 years or so a major flood occurs. This threat has resulted in the RWMS building a large diversion dike and trench to protect the current Radioactive Waste Management Complex. The Raytheon study indicates that the southwest corner of the RWMS is located in the 100-year flood hazard zone, but the entire northern alluvial fan brings runoff directly into the immediate area.

1.10 Climate and Air Quality

One performance objective in selecting a preferred site is to protect individuals and communities who might occupy the disposal site after active and passive controls are no longer present. These individuals are to be protected from exposure to GTCC radiation while they engage in normal activities such as agriculture, dwelling construction, food acquisition, and ceremony. The CGTO believes that a wetter climate will raise the water table up to or over the GTCC waste site. Nearby wetland plants and animals would absorb radiation and then expose local people. Drinking water from these wetlands will also result in exposure. Indian people visiting the site believe their descendants will live near and use these wetlands as their ancestors did thousands of years ago.

The climatic effects of both wet and dry periods should be analyzed and incorporated in the GTCC site assessment.

2.0 Environmental Consequences

2.1 Radiation

Indian people have raised in past radioactive waste disposal and transportation studies a range of questions regarding how to protect themselves and their natural resources from exposure to what they call the Angry Rock (See Indian Appendix for more). The analysis of GTCC waste should address directly these potential impacts and suggest ways to either avoid or mitigate them. The potential impacts to Indian people and their life are significant including potentially blocking the path to the afterlife (Stoffle and Arnold 2003).

2.2 Cultural Resources

The CGTO knows that there are physical, spiritual, and archaeological elements associated with the entire Frenchman Flat valley. Impacts to any of these elements are considered important and need to be considered during GTCC siting considerations. There are direct impacts to Indian cultural resources that have been observed by the Indian people who visited the current RWMS. Especially obvious is the construction of a water diversion dike and subsequent arroyo cutting and dewatering of areas down slope of the dike. Surface disturbance will remove medicine and food plants, impact animal habitat and concentrate certain species of animals. The Chalcedony deposits and chert offerings will be totally removed thus causing a disconnect between the Indian ancestors who used these and contemporary and future generations of Indian people. This is an act of disrespect.

2.3 Waste Management

The CGTO requests an analysis of the hydrological and ecological impacts of the existing water diversion dike of the current Radioactive Waste Management Complex in Area 5. The DOE recognizes that this is a very flood prone area, with major flooding episodes occurring about every 23 years. Indian people visiting this site observed that even though the current dike has been built recently and thus not experienced a 23-year flood, it has diverted and consolidated sufficient runoff that a small arroyo has been established. The Indian people visiting this site believe that the existing dike has unnaturally stressed down-slope plants and animals who now do not receive normal sheet runoff. The Indian people visiting the site believe that by concentrating the runoff, the dike has reduced the amount of water absorbed during normal sheet runoff because the consolidated runoff moves more quickly and only flows in the new and developing eroded arroyo. It is believed by the Indian people visiting the site that were a GTCC facility to be established east of the current RWMS then the dike would necessarily have to be extended causing an even greater runoff shadow and an even greater developing arroyo. The desert tortoise in the area will have to move out of this larger runoff shadow and may be concentrated in the area of Frenchmen Playa. Moving their living areas towards the playa will expose them to higher levels of radioactivity. The Indian people visiting the site believe that these current and potential impacts should be analyzed, monitored by Indian people, and reported back to the CGTO at the next annual meeting.

2.4 Cumulative Impacts from the GTCC Action at NTS

According to the CGTO tribes, increased land disturbances associated with all forms of activities and development on the NTS could result in a decrease in access to these areas for American Indians. Limiting access could reduce the traditional use of the NTS and other areas and affect their sacred nature. Increased development at the NTS could increase the potential for greater disturbance and vandalism of American Indian cultural resources. The CGTO tribes believe (See Final Environmental Impact Statement for the NevadaTest Site and Off-Site Locations in the State of Nevada 1996: Appendix G) that cumulative impacts in the following areas may occur:

- *Holy land violations.* Further destruction of traditional cultural sites, making the water disappear, general treatment of the land without proper respect.

- *Cultural survival.* Decreased ability and access to perform ceremonies.

- *Environmental restoration.* Revegetation of restored lands with native species.

- *Empowerment process.* Over the past 17 years of regular consultation between the NNSA/NV and the CGTO tribes, there has been a growing co-management role for the tribes. Their recommendations have been heard and, for the most part, responded to by the NNSA/NV. Indian access to places on the NTS has increased, after an early period of access loss. Unfortunately, each new program that is added to the NTS decreases the amount of space that is available for the practice of Indian religions, ceremonies, and cultural persistence. However, having no programs also can have an impact. For example, even though the mesas are now accessible to Indians for ceremonies, the roads are not maintained because there are no projects on the mesas. This makes access to the ceremonially important areas difficult.

- *Radiation risks.* These risks began with nuclear testing. Today, the CGTO tribes perceive that the radioactive risks continue in known and unknown ways underground.

There are still ongoing risks to Indian people from storage and disposal of waste and these will continue. Finally, transportation of radioactive materials is continuing and increasing. It is not clear to the CGTO tribes that, after two American Indian studies of radioactive waste transportation, there has been a meaningful consideration of their concerns. It is not clear to what extent further radioactive waste disposal at the proposed GTCC facility will do to increase radiation risks to the physical and spiritual dimensions of Frenchman Playa area but some assessment is possible by Indian religious leaders.

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Appendix A: Native American Responses to The GTCC Proposal on the NTS

This Greater Than Class C EIS study was funded by the Waste Management Office of the DOE and NNSA/NSO. Text was provided by the American Indian Subgroup who represents the seventeen tribes and Indian organizations that are in consultation with the NNSA/NSO regarding the Nevada Test Site (NTS) and related locations. The consulting Indian tribes and organizations are known as the Consolidated Group of Tribes and Organizations (CGTO), within which there are numerous subgroups who act in different roles such as the American Indian Writers Subgroup (AIWS). The recognized role of the AIWS and other CGTO subcommittees is to follow closely specific issues and report to the CGTO. The CGTO members then report back to their respective tribal governments or Indian organization governing boards. It is important to note that official responses to issues only come from tribal governments and governing boards.

The role of the AIWS is to review all manuscripts that involve Indian people on the NTS and to review fieldwork proposals. The AIWS is composed of a coordinator, three officially appointed members, and three alternates who were selected by the subgroup members. The members of this subcommittee are (1) Southern Paiutes – Betty Cornelius and Lalovi Miller, (2) Western Shoshones – Maurice Frank-Churchill and Jerry Charles, and (3) Owens Valley Paiutes – Gerald Kane and Danelle Gutierrez. Richard Arnold is the appointed AIWS coordinator.

AIWS Responses

The AIWS believes that the Native American responses for the current GTCC EIS should be presented together with some responses also repeated in relevant sections of the main body of the EIS. Their responses, however, are directed at different sections of this EIS and vary in terms of structure and purpose. The current American Indian text builds upon already established ideas presented in Appendix G (American Indian Writers Subgroup, CGTO 1996), the *2002 Nevada Test Site Supplement Analysis* (United States Department of Energy, National Nuclear Security Administration 2002) and the *2008 Draft Nevada Test Site Supplement Analysis* (United States Department of Energy, National Nuclear Security Administration 2008). This writing procedure reflects the ongoing interest of the CGTO in the activities and potential environmental impacts of NNSA/NSO, and emphasizes the continuity of issues established in the previous documents and again in this SA.

The following text is provided as an appendix of this GTCC EIS. This integrated essay represents the responses of the consulting tribes who have participated for almost 23 years in the NNSA/NSO American Indian Program and who refer to themselves in this consultation as the CGTO. Some portions of the following text are repeated in other sections of this report. The full analysis and text are held together in this section so that the consulting tribes and organizations who will review this document will have a holistic view of the American Indian responses. This report reflects the assessments of the AIWS, but it was technically finalized by the Bureau of Applied Research in Anthropology (BARA) team at the University of Arizona.

LAND USE (DaMiDovia "Our Land", Ia-vooTuvipum "Our Land")

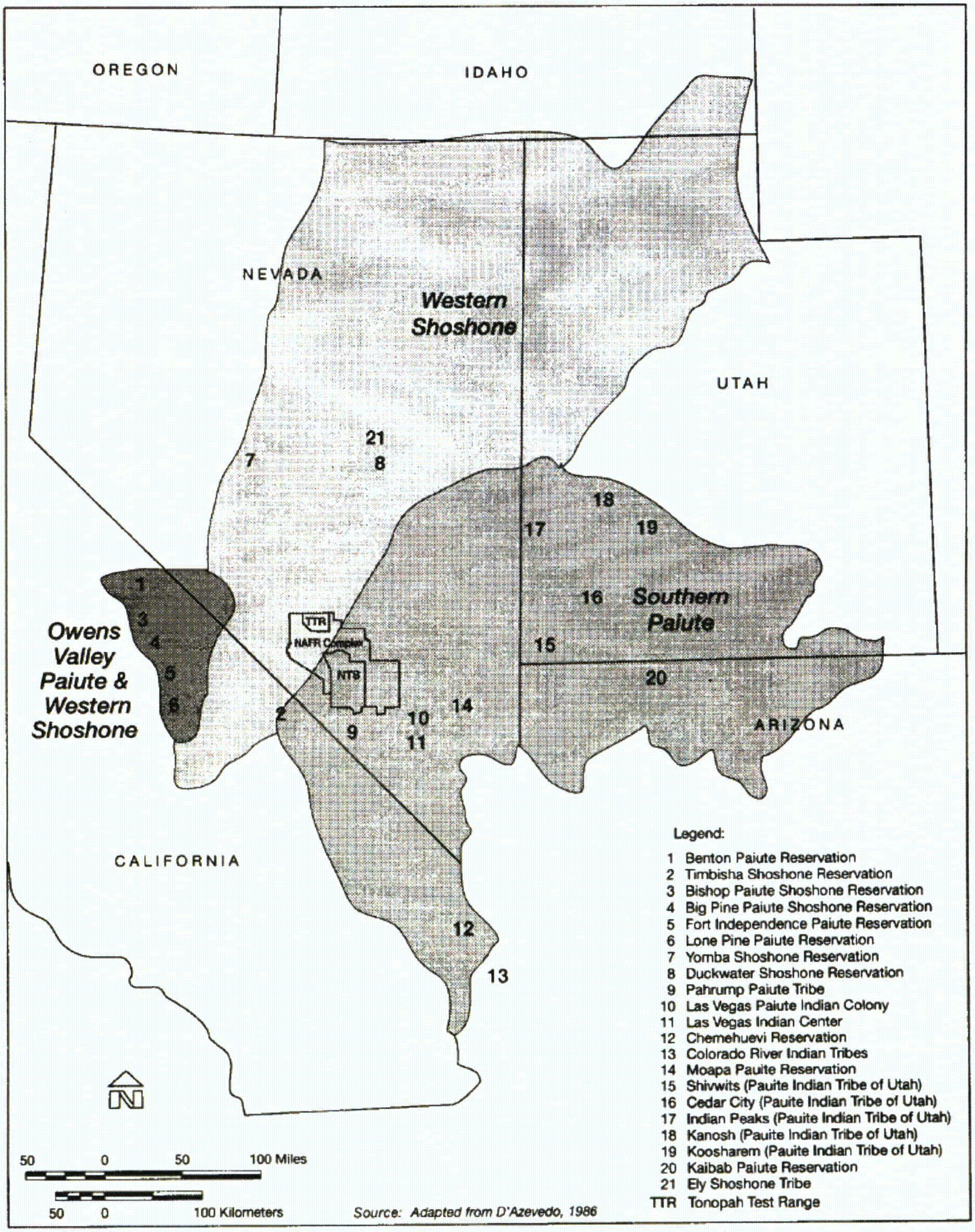

Figure A-1 American Indian Region of Influence for NTS GTCC EIS

The CGTO maintains that members of the consulting tribes have Creation based rights to protect, use, and access lands (Divia, 1 Tuvip, 2) of the NTS and immediate area. These rights were established at Creation and persist forever. During the past decade representatives of the consulting tribes have visited portions of the NTS and have identified places, Puha Paths, and cultural landscapes of traditional and contemporary cultural significance. The managers of the NTS have responded to CGTO requests that portions of these identified areas be set aside for traditional and contemporary ceremonial use. Because this is a public document the exact locations of these areas will not be revealed, however they do include a burial cave, a Native American Graves Protection and Repatriation Act (NAGPRA) reburial area, and a local Puha Path and ceremonial landscape near a large water tank (Stoffle, Evans, and Harshbarger1989; Stoffle et al. 2001a; Stoffle et al. 2001b; Stoffle, Zedeño, and Halmo 2001; Stoffle et al. 2006). These actions by the agency are in keeping with the persistent recommendations of the CGTO that portions of their holy lands be placed under co-stewardship arrangements. In order to fulfill the holy land use expectations, the members of the consulting tribes of the CGTO recommend continuing to identify special places, Puha Paths, and landscapes and setting aside these places for unique co-stewardship and ceremonial access. For example, currently studies have begun and portions are completed regarding the identification of places, Puha Paths and cultural landscapes in the Timber Mountain Caldera (Stoffle et al. 1994a; Stoffle, Halmo, and Dufort 1994; Stoffle et al. 2001a; Stoffle et al. 2001b; Stoffle, Zedeño, and Halmo 2001; Stoffle et al. 2006). These studies are planned to continue and when completed will add a Native American cultural sensitivity component which will contribute to the currently recognized importance of this National Natural Landmark and Area of Critical Environmental concern.

Climate

CGTO knows that the climate of the region has changed over the thousands of years that the Indian people have lived in this region. The NTS has only occupied this area since the early 1940s. It is important to recognize that major climatic changes have taken place since the end of the Pleistocene and shorter term climate changes such as the wet period in the 1980s and 1990s contrast with the current 10-year meteorological drought. It is important for the GTCC EIS to assess the impacts of short term and long term climatic changes because the DOE expects to safely manage these GTCC wastes for up to 10K years during which similar climate changes can be expected.

The current climate description in the GTCC EIS is specific to the present decade-long period of extended drought (a similar one occurred between 1896 and 1906), so this type of drought and the wet period between 1980s and 1990s may be factors in siting the GTCC facility. An analysis of long term impacts based on current conditions will neither be representative of climate conditions viewed over much longer periods nor applicable to short climate shift to much wetter conditions.

The CGTO maintains that during the last decade the NTS and surrounding region has experienced a meteorological drought. Current meteorological analysis suggests that this is a 10-year duration type drought and even could be the beginning of a longer drought episode. The region has not experienced a drought with these characteristics since a decade spanning the beginning of the 20th century. Therefore, this meteorological episode can be termed a 100-year drought. The early 20th century drought becomes an analog against which to discuss the environmental implications of the current episode (see Figure A–4).

The 100-Year Drought (Uh-na-hp dumime sogobe basa-type "A long time our Mother Earth has been dry", Minga- na-vas-so-quip "very dry land")

Nevada is "much below normal" to date in 2007. As of June 2007, the Palmer Z Index, which measures short term drought on a monthly scale, indicated that central Nevada, including the NTS, was in a "severe drought" condition. Data from the National Climatic Data Center shows that Nevada was ranked the driest state in the U.S. for the period of August 2006 to June 2007. This period reflects the drought trend in Nevada that has characterized the past decade (Figures A–1, A–2) (http://www.ncdc.noaa.gov/oa/climate/research/2007/jun/st026dv00pcp200706.html).

On a broad scale, the two previous decades (1980s and 1990s) were unusually wet with short periods of extensive droughts. The 1930s and 1950s showed the opposite trend with prolonged periods of extensive droughts and few wet periods http://www.ncdc.noaa.gov/oa/climate/research/2007/jun/us-drought.html).

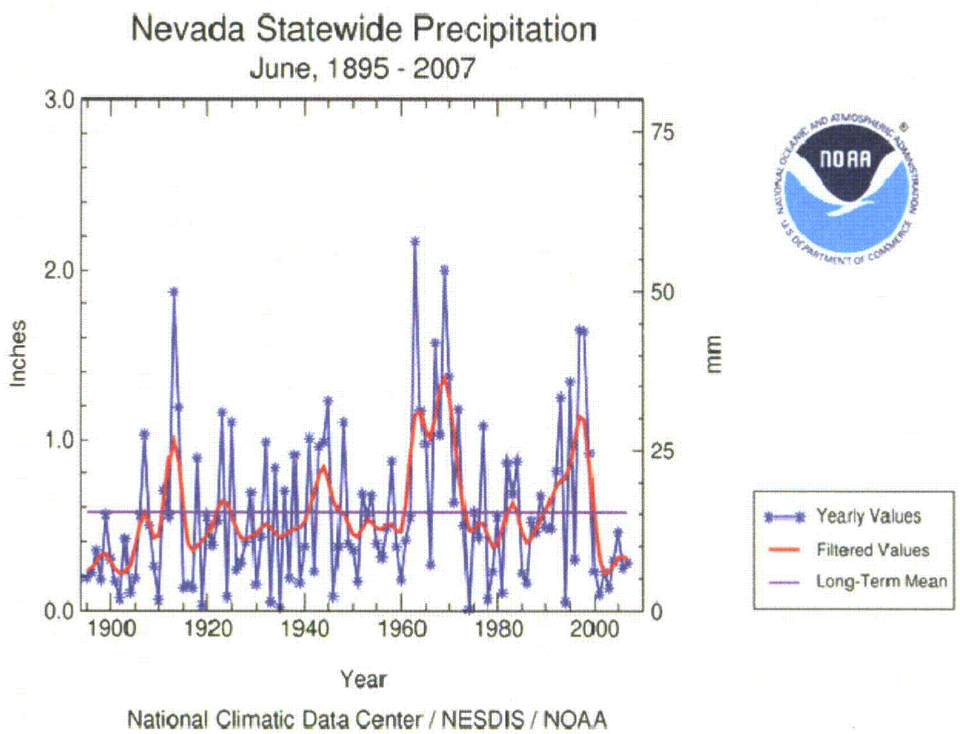

Figure A–2 One hundred and twelve years of Nevada precipitation averages

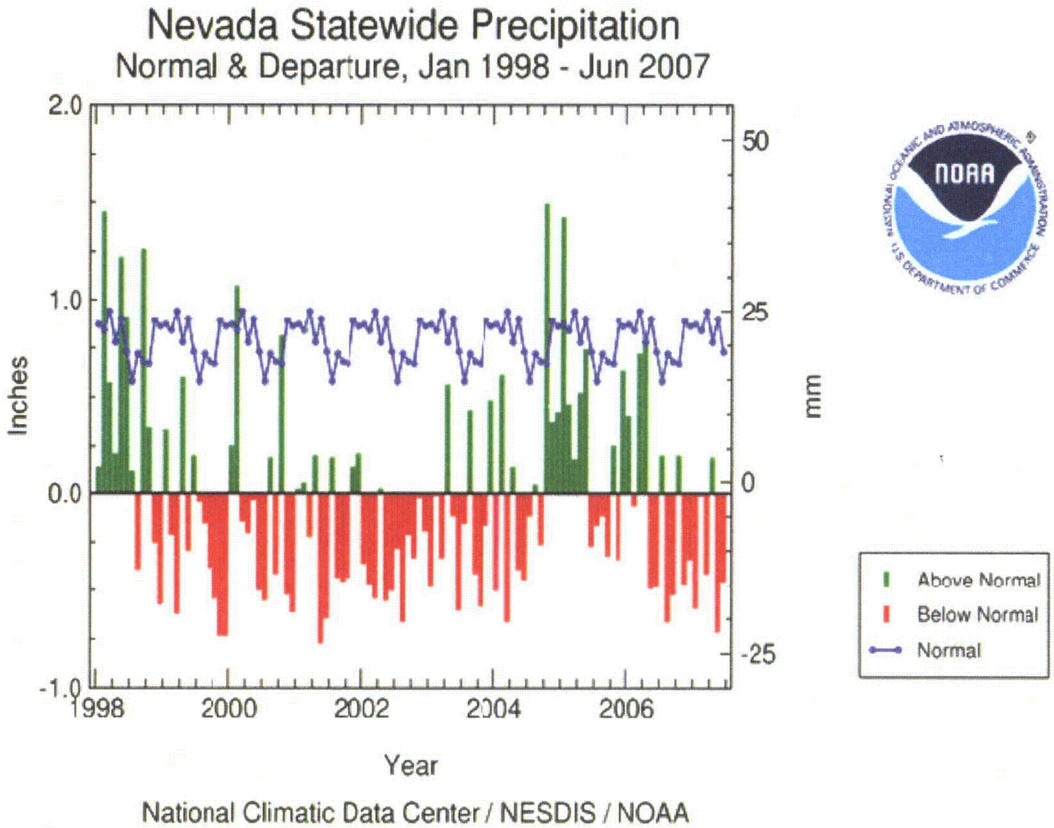

Figure A–3 Fluxuations in Nevada statewide precipitation since 1998

Hughes and Graumlich (1996) reconstructed 7979 years of annual precipitation from bristlecone pine in the White Mountains of eastern California to document the occurrence of eight multi-decadal droughts, with the two most recent centered on 924 AD and 1299 AD (Figure A–3).

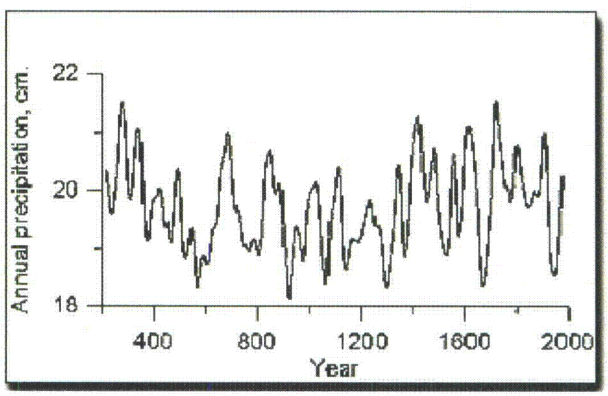

Figure A–4 7979 Years of annual precipitation reconstructed from bristlecone pine

Areas specific to the NTS and southern Nevada are in a 100-year drought cycle; Figure A–4 shows that major drought conditions have occurred in multiyear waves since 1895. The current drought that is affecting the NTS and its neighboring lands has persisted since 1996 (Goodrich 2007). Researchers think that the rise in greenhouse gases in the atmosphere may lead to a return of multi-decadal megadrought conditions that existed prior to 1600 AD. The most severe megadrought occurred between 900 AD and 1300 AD (Cook et al. 2004, Goodrich 2007).

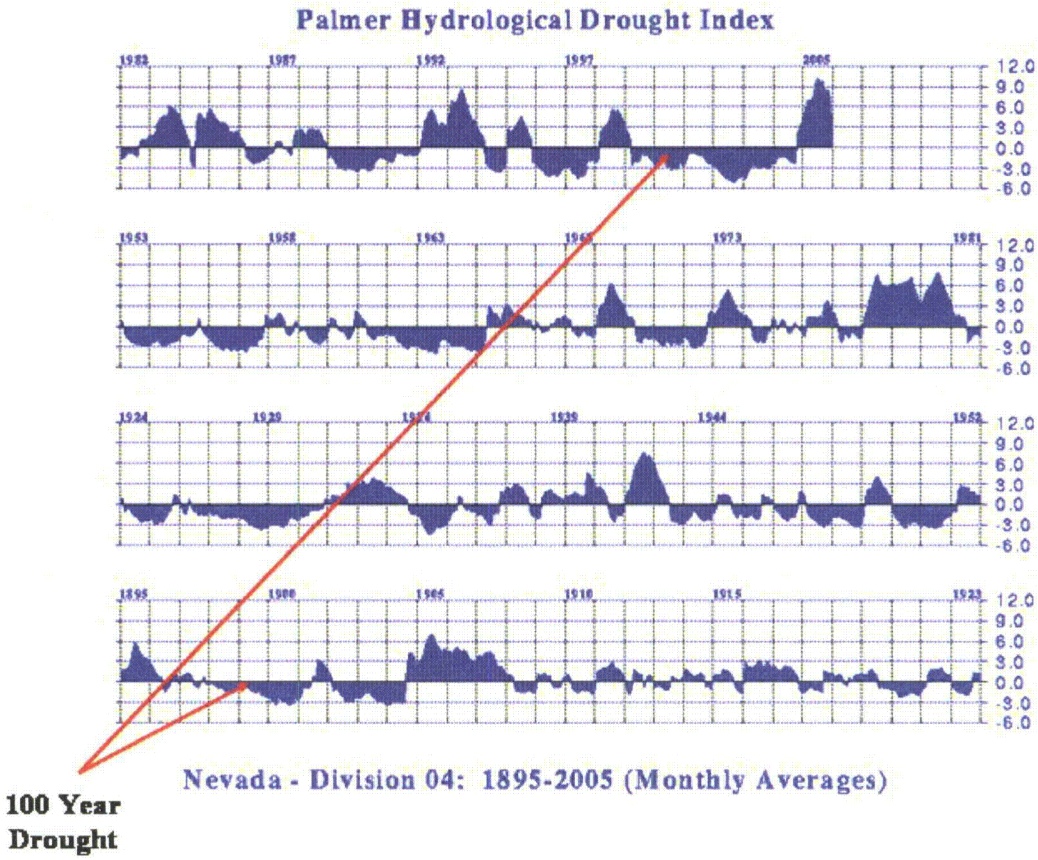

Figure A–5 Palmer hydrological drought index from 1895-2005 in Nevada – Division 04

The CGTO recommends that action be taken to lessen the impacts of this drought cycle through meaningful research and management applications because there is the potential for irreversible environmental degradation and biodiversity loss. This type of action is a concept found in social impact assessment and environmental studies known as the precautionary principle. This principle implies that there must be a willingness to take action in the advance of scientific proof or evidence of the need for proposed action. If there is a delay in action, it will be devastating to both society and nature (Cooney and Dickson 2005). The precautionary principle stresses that there must be ethical responsibilities towards maintaining the integrity of natural systems, and the fallibility of human understanding. The CGTO requests that traditional environmental management practices occur in order to help restore and maintain the ecology of the NTS.

HYDROLOGY

One inevitable implication of the current 100-year drought is that the surface water on the NTS and immediate areas has diminished and become more sporadic. Surface water is here defined as water available for shallow rooted plants during rainfall, water available during post-rain ponding, runoff, and absorption, and water recharged into near-surface aquifers. The modification and availability of surface water has the ability to affect all plants, animals, and associated trophic levels on the NTS.

Calling the Rain (Pahwwanipagee "calling the rain", Oo-wap-pi "calling the rain")

One type of interaction was in the form of calling the rain. Rain calling is a basic aspect of American Indian life and culture. Traditionally there were rain callers (rain shamans, rain doctors), rain ceremonies, and helpers from the spiritual world which would help facilitate rain production. Most traditional communities had a rain maker. When the special rain shaman called upon the rain, he sang songs and was aided by his spirit helper, which was usually in the form of a mountain sheep, to call upon the rain. The mountains had important roles in this activity. They interacted with the clouds and the sky to call down the rain.

Winter Ceremonies-Snow Making Ceremonies: Western Shoshone

The Winter Ceremony was performed in the fall to ensure that a good winter with heavy snow fall will happen. The spiritual leader (weather doctor) would call the people together and meet at a special place in the mountains, sometimes near a Pine Nut gathering area. Prayers and songs were done by the spiritual leader. Usually this ceremony lasted a day. If too much rain was falling certain precautions would be taken, for example, the children were not allowed to shake willows that would be used for weaving or to kill frogs as this would bring more rain.
Hummingbirds
were not killed for many reasons, but if they were killed, there would be flooding and lighting storms, with lightning killing the person who killed the hummingbird.

Stinkbug (Bee-voos, Wu-who-koo-wechuts)

Even today, individual traditional native people can bring rain. This is done by turning a stinkbug on his back. The rain will come provided the stinkbug allows a person to tickle his belly with a small stick. As the person prays for rain, he tells the stinkbug why he is asking for rain.

Snow Fleas

Snow Fleas represent a special category of Native American environmental knowledge because they are almost invisible and live at the highest elevations on mountains. According to Indian beliefs during the late fall when it is cold there is a snow ceremony. A part of this ceremony involves calling on the snow fleas. The snow fleas are the ones that make the snow wet and absorb into the mountain. Without the snow fleas, the snow is dry and evaporates quickly. Without ceremonies and the water making fleas, there is less water for the mountains and the valleys below. The snow ceremony is conducted in relationship with ceremony of the seeds where young girls dance with seeds in winnowing trays and a spiritual person sings songs to bring whirlwinds which envelope the dancers and scatter the seeds as a gesture of fertilizing the earth. Thus, water is brought to the fertile and dispersed seeds.

Ecology Indian Comments

The CGTO knows that this site is an ancient playa, surrounded by mountain ranges. The runoff from these ranges serves to maintain the healthy desert floor. Animals frequent this area, there are numerous animals' trails, and these play a significant part in the history of the locality and of the Indian lifestyles. Our ancestors knew that the Creator always provided for them and this site is one of their favorite places to hunt and trap rabbits. We have special leaders that organized large rabbit hunts. Many people participated so this place would be occupied at times by all kinds of our people. Rabbits provided good eating, bones for tool-making, warm blankets, and even games. Indian people refrained from eating coyote, wolves, and birds but these contribute to our stories which tell us how to behave and why we are here. We have many stories and songs that include animals and birds who have human-like antics. From these antics Indian people learn the life lessons to build character to become better persons. So animals and the places where they live contribute to our history and culture.

This culturally central place was used by and important to Indian people from our agricultural and horticultural communities located to the north – near Reese River Valley and Duckwater, to the south – near Ash Meadows, to the southeast – near Indian Springs and Corn Creek, to the east – near the Pahranagat-Muddy River, and west – near the Oasis Valley. It was also used by people from our agricultural and horticultural communities to the far west in Owens Valley, to the far south near Cottonwood Island and Palo Verde Valley on the Colorado River, to the far southwest at Twenty Nine Palms, to the far east along the Virgin River, Santa Clara River, and Kanab Creeks, to the far north along the Humbolt River and Ruby Valley.

Plants

The CGTO knows based on previous DOE-sponsored ethnobotany studies that there are at least 364 Indian use plants on the NTS (see Appendix G). Indian people visiting the proposed location of the GTCC facility identified the following traditional use plants: (1) Indian Tea, (2) White Sage or Winter Fat, (3) Indian Rice Grass, (4) Creosote, (5) Wolfberries, (6) Four O'clock, (7) Spiny Hop Sage, (8) Joshua Tree, (9) Daises, (10) Desert Trumpet, (11) Cholla, (12) Globe Mallow, (13) Fuzzy Sage, (14) Tortoise Food Plant, (15) Sacred Datura, (16) Wheat Grass, and (17) Lichen. Other plants were present but not identified due to the late season and the dry condition of the plants.

Plants are still used for medicine, food, basketry, tools, homes, clothing, fire, and ceremony – both social and healing. The characteristics of the plants at the proposed GTCC area are smaller and thinner than in other desert areas where it is wetter. Indian people from elsewhere traveled to this area to gather specific plants because they have stronger characteristics when they grow in dry places. The sage is used for spiritual ceremonies, smudging, and medicine. The Indian rice grass and wheat grass are used for breads and puddings. Joshua tree is important for hair dye, basketry, foot ware, and rope. Datura is used for hallucinogenic effects during which alternative places can be visited by medicine men. Datura also goes itself to disturbed areas and heals them. The globe mallow had traditional medicine uses, but in recent times is also used for curing European contagious diseases.

Animals/Insects

The CGTO knows based on previous DOE-sponsored ethnofauna studies that there are at least 170 Indian use animal on the NTS (see Appendix G). Indian people visiting the proposed location of the GTCC facility identified the following traditional use animals: (1) Jack Rabbits, (2) Whiptail Lizards, (3) Antelope, (4) Tortoise, (5) Kangaroo Rats, (6) Horned Toad, (7) Rock Wrens, (8) Ravens, (9) Grasshoppers, and (10) Stink Bugs. Other animals (such as snakes, bats, and owls) were perceived to be present but not observed because they primarily emerge at night.

All animals and insects were and are culturally important and the relationships between them, the Earth, and Indian people are represented by the respectful roles they play in the stories of our life then and now. The GRCC valley is where a spiritual journey occurred. It involved Wolf (*Tavats* in Southern Paiute, *Bia esha* in Western Shoshone, *Wi gi no ki* in Owens Valley Paiute) and Coyote (*Sinav* in Southern Paiute, *Duhvo esha* in Western Shoshone, *Esha* in Owens Valley Paiute) and is considered a Creation Story. Only parts of this can be presented here. When Wolf and Coyote had a battle over who was more powerful, Coyote killed Wolf and felt glorious. Everyone asked Coyote what happened to his brother Wolf. Coyote felt extremely guilty and tried to run and hide but to no avail. Meanwhile, the Creator took Wolf and made him into a beautiful Rainbow (*Paro wa tsu wu nutuvi* in Southern Paiute, *Oh ah podo* in Western Shoshone, *Paduguna* in Owens Valley Paiute). When Coyote saw this special privilege he cried to the Creator in remorse and he too wanted to be a Rainbow. Because Coyote was bad, the Creator put Coyote as a fine white mist at the bottom of the Rainbow's arch. This story and the spiritual trails discussed in the full version are connected to the Spring Mountains and the large sacred cave in the Pintwater Mountains as well as to lands now called the Nevada Test Site. This area is the home place of Wolf who is still present and watches over the area and us.

Minerals

The CGTO knows based on previous DOE-sponsored cultural studies that there are many minerals on the NTS (no complete list available). Indian people visiting the proposed GTCC site identified the following traditional use minerals: (1) Obsidian, (2) Chalcedony, (3) Yellow Chert or Jasper, (4) Black Chert, (5) Pumice, (6) Quartz Crystal, and (7) Rhyolite Tuff. Other minerals were perceived to be present but not observed because of the limited time and search area.

All minerals are culturally important and have significant roles in many aspects of Indian life. For example, the Chalcedony on the proposed GTCC site would have made an attractive offering which would be acquired here by a ceremonial traveler and then left at the vision quest or medicine site located to the north on top of a volcano like Scrugham Peak. Returning ceremonial travelers would also bring offerings back to where they had acquired offering, thus the Yellow Chert or Jasper (observed on the GTCC site) which outcrops about 70 miles to the north would be gathered there and returned to the Chalcedony site as an offering.

Playas

The CGTO knows, based on cultural studies funded by the DOE on the NTS and playa-specific studies funded by Nellis Air Force Test and Training Range (Henderson 2008), that playas occupy a special place in Indian culture. Playas are often viewed as empty and meaningless places by Western scientists, but to Indian people playas have a role and often contain special resources that occur nowhere else. The following text was prepared by the Indian people who visited the proposed GTCC site.

Is a playa a wasteland? According to Indian elders playas were used in traveling or moving to places where work, hunting, pine cutting or gathering of other important foods and medicine could be done. One elder remembers crossing over dry lake beds and traveling around but near the edges and they discussed how provisions were left there and at nearby springs (See NRC 2009b for additional information about the cultural importance of springs) by previous travelers at camping spots. Indian people left caches in playa areas for people who crossed valleys when water and food was scarce. Frenchmen playa is such a place. Indian people took advantage of traveling through this playa as mountains completely surround this area. The CGTO knows that most dry lakes are not known to be completely dry. An example is Soda Lake near Barstow, California. The Mohave River flows into this dry lake and most of the year it looks dry but it actually flows underground. Building berms on dry lakes beds to offset water and runoff doesn't sound like a good idea to the Indian way of thinking. So why build a GTCC site on and use this playa when the odds of radiation seem feasible? The Indian people who visited this site recommend not to bother Frenchmen Playa. It is only one of two in the immediate region and has special meanings. There should be a more descriptive study to fully understand the impacts. More time is needed, also for Indians to revisit this site. Although some people continue to view Frenchman playa as a wasteland, the CGTO knows it is not. Further ethnographic studies are needed.

BIOLOGICAL RESOURCES (Dá Me Na-Nu-Wu-Tsi "Our Relations All of Mother Earth")

It is nearly impossible to observe and monitor the changes on cultural resources on the NTS study lands. Some changes occur quickly and certain changes happen slowly. For an example, an earthquake could cause serve damage instantly and the onslaught of impending drought and famine can become a great heavy burden on mankind and his environment.

The current 100-year drought has increasingly stressed all of the plants and animals on the NTS. Because this is a unique, albeit, perhaps a cyclical event, its environmental impacts are unprecedented in the history of the operation and management of the lands of the NTS. It is expected that the 100-year drought has modified the abundance and distribution of all animals and plants. The quality, quantity, and distribution of indigenous plants necessary to sustain a healthy environment to maintain a productive animal habitat is clearly affected.

Because Native Americans view the NTS lands as holy lands there is deep concern for it. Certain springs have dried up, which makes animals travel into other districts, makes food foraging difficult, and dries up the land (See NRC 2009b for additional information about the cultural importance of springs). The remaining stressed animals and plants have lower fecundity and nutritional value in the food chain. The CGTO recognizes the nation-wide need to identify and protect threatened and endangered plants and animals.

The members of the consulting tribes who have lived on these lands since Creation value all plants and animals, yet some of these occupy a more culturally central position in their lives. The main characteristic of a healthy landscape is healthy plants, animals, and visual beauty. The role of land managers is to help care for the land and its ecosystems. Therefore, the CGTO applauds the efforts being designed to minimize the severe impacts of the ongoing drought. Conservation and preservation should become high priority. In order to convey the Native American meaning of these plants, a series of studies were conducted and the findings were negotiated into a set of criteria for assessing the cultural importance of each plant and of places where plant communities exist. The CGTO provided these cultural guidelines so that NEPA analysis and other agency decisions could be assessed from a Native American perspective.

Because of these stresses, the animals and plants of the NTS require management interventions unforeseen during the 1996 *NTS EIS*. American Indian people have faced such drought episodes in the past and have the capacity to suggest and carry out adaptive responses. Adaptive responses to extreme climatic fluctuations involve both physical and spiritual interventions designed to restore balance and well-being to the area. All tribes involved in the CGTO recognize a range of these interventions, which have been successful in the past. The following are a series of cases that demonstrate how Native American people have interacted with the land and natural elements to help all aspects of life.

What is Out There?

The CGTO has identified as fundamental in their cultural concern a list of 364 plants and 170 animals which were traditionally used and are currently culturally central. Concerns exist that this larger list has been reduced to an official list of 107 plants and 26 animals (see American Indian Writers Subgroup, CGTO 1996: Table G-1, G-2, pp G-14 – G-17, G-18). The CGTO argues that the full list should be used to assess impacts because both plants and animals appear and disappear on the NTS at various seasons and during various climatic episodes. Thus the working list of potentially impacted plants and animals needs to be expanded to the full list of Indian plants and animals. These species have been identified as indicators of the health of NTS ecosystems.

Native Americans have always been concerned that the native species of vegetation on the NTS may be in danger of being lost. To native people, plants provided most of the food resources as well as the raw materials for medicines, tools, shelter, and even ceremonial objects. Take the tobacco, considered highly sacred, the tobacco plant was carefully cultivated to ensure its posterity. Religious leaders and traditionalists would guard the location for their own use. The plant used properly would bloom and blossom for the user, because it was being utilized appropriately. Other sacred plants were the sage, sweet-grass and cedar. These are considered as gifts from the earth and are to be applied in traditional ceremonies and not for so-called "recreational" purposes. There is much evidence that regaining and reclaiming Indian plant

knowledge could benefit humans in many ways. The CGTO would like the land managers of the NTS to implement measures with the goal of restoring lands with native species.
Ecosystem health includes the people with whom the natural environment developed, specifically, the member tribes of the CGTO. By involving the CGTO in the design, implementation, and analysis of the biological surveys, NNSA/NSO can obtain more comprehensive reports of ecosystem health and potential impacts, as well as further facilitate government-to-government consultation with the CGTO.

Environmental Justice

The CGTO would like to have their DOE approved definition of Environmental Justice added to the current Environmental Justice description.

DOE has recognized the need to address environmental justice concerns of the CGTO based on disproportionately high and adverse impacts to their member tribes from DOE NTS activities. In 1996, the CGTO expressed concerns relating to environmental justice that included 1) damage to Holy Lands, 2) negative health impacts, and 3) lack of access to traditional places that contributes to breakdowns in cultural transmission. In the 2002 NTS SA, NNSA/NSO concluded that with the selection of the Preferred Alternative, the CGTO would be impacted at a disproportionately high and adverse level consequently creating an environmental justice issue. Since 2002, NNSA/NSO has supported a few ethnographic studies involving the CGTO and culturally important places including in 2004, when NNSA/NSO arranged for tribal representatives to conduct evening ceremonies at Water Bottle Canyon. While the opportunity for the evening ceremony was a significant accommodation, disproportionately high and adverse impacts from DOE NTS activities continue to affect American Indians. The three environmental justice issues noted by the CGTO need to be addressed.

The CGTO is the voice for acclaiming the responsibility of maintaining stewardship with the land for all Native American Indian Tribes. The bonding is a privilege to be faceted above all else and must be carried and held by enabling principles. The CGTO believes this right was given to them at Creation and must be followed. Otherwise, the networking of the other spirit world will be severed. The CGTO knows there are places on the NTS landscape that needs traditional ceremonies and blessings to offset the tensions of severe land disturbances done to it. An example is Shoshone Mountain. Shoshone Mountain is large and long. Roads are limited to its crest making it inaccessible for religious and traditional people to go there to conduct ceremonies. The CGTO recommends that special privileges be allowed for ceremonial journeys to take place and to provide funding for transporting traditional leaders to inaccessible places such as Shoshone Mountain by helicopter to perform ceremonies.

Environmental Justice and the Ruby Valley Treaty of 1863

The CGTO supports the efforts of the Western Shoshone to have the Ruby Valley Treaty of 1863 be fully recognized as originally intended. Previously, DOE/ NNSA has relied on the Supreme Court Decision of U.S. v. Dann as a means of abrogating their trust responsibilities. The focus of this case dealt with trespass violations associated with grazing cattle on government land. In the opinion of the Western Shoshone people, this treaty of peace and friendship is still in full force and affect. Subsequent, to this court decision, the Western Shoshone Nation brought the matter before the United Nations and the Organization of Human Rights in Geneva, Switzerland. On January 9, 2003, the Inter-American Commission on Human Rights rendered its final decision in the case of Western Shoshone land rights in favor of Mary and Carrie Dann. This international body found the actions of the U.S. Government to be in violation of Western Shoshone rights with regard to property, due process, and equality under the law.

In 2004, the United States attempted to bring closure to the Western Shoshone claims by offering compensation. This highly controversial action has not affected nor diminished the aboriginal claims of the Western Shoshone to the land. It is maintained in previous EIS documents that the United States has failed to uphold its trust responsibility and negotiate further with the Western Shoshone Nation. No nation to nation discussions as promulgated under federal law have occurred. In this regard, the Western Shoshone Nation should receive equal treatment as afforded to other countries.

In March 2005, the Western Shoshone Nation filed a lawsuit against the DOE for the siting of a High-Level Nuclear Waste and Spent Nuclear Fuel Underground Geologic Repository at Yucca Mountain. It is the position of the Western Shoshone that such action being proposed by the DOE violates the terms and conditions of the Ruby Valley Treaty of 1863. At this current time, all activities at Yucca Mountain have been suspended as ordered by President Obama. Despite this freeze, the CGTO recommends that the DOE abide by the treaty as originally intended.

Transportation

The transportation of low level radioactive waste (LLRW) was a major issue originally addressed in Appendix G of the 1996 EIS. The AIWS addressed serious flaws in the then draft transportation study by noting that neither the CGTO nor the tribes were consulted formally. The tribes were only informed of the matter through a series of public meetings, which the AIWS viewed as a violation of federal legislation requiring government to government consultation. The AIWS also detected limited and faulty assessments of new railroads and other activities on cultural and Native American resources. The study documents revealed missing or misnamed Indian tribes and reservations therefore, the AIWS recommended a systematic comprehensive study of American Indian transportation issues to complete the general study that incorporated concerns of "stakeholders."

Native Americans Respond to the Transportation of Low Level Radioactive Waste to the Nevada Test Site (Austin 1998)

On July 25, 1996, the DOE/NV sent a letter announcing a comprehensive Native American LLRW study and requested tribal participation. The five members of the AIWS who recommended the study participated in a planning team and formed the core of the American Indian Transportation Committee (AITC). The planning team began by meeting with DOE/NV officials to determine which proposed transportation routes were under consideration. A study proposal was developed and three criteria were determined that needed to be met by each tribe invited to participate in the study. The criteria were aboriginal and/or historic cultural affiliation to the lands along any of the three proposed routes, location near any of the three proposed routes in the vicinity of Nevada, and frequent use of the proposed routes by tribal members.

In addition to the regular CGTO members, the AITC planning team identified six additional Western Shoshone tribes, bands, communities, and organizations, as well as Mohave, Hopi, Navajo, and Goshute peoples all of whom met the criteria for participation in the study. A total of 29 tribes, subgroups, bands, communities, and organizations were potentially affected by the transportation of LLRW.

This study addressed perceived risks by American Indians that derive from the transportation of LLRW. It focused on three truck haul routes as these pass through in a four-state area that generally reflects the administrative responsibility of the DOE/NV. The study involved a series of unique methods including both quantitative and qualitative data collection. The study documented that radiation is perceived as an Angry Rock by many Indian people. It exists and acts according to epistemological guidelines that do not reflect those perceived as existing in Western science. This is an extremely important finding because American Indian responses to radioactivity reflect its spiritual as well as its physical dimensions (Austin 1998).

U.S. DOE Nevada Operations Office, Intermodal Transportation of LLRW to the Nevada Test Site, Summary of Meeting with Native Americans, November 18 to 20, 1998, Tonopah, NV (American Indian Transportation Committee 1998)

While the initial Native American LLRW study was being completed, the DOE decided to conduct an Environmental Assessment of the Intermodal Transportation of Low Level Radioactive Waste (IM EA). Intermodal refers to the use of both railroad and trucks to haul LLRW from its producers to the NTS. The intermodal study introduced the concept of an entrepot (a trans-shipment facility) where LLRW would be taken from railroads, perhaps stored for a period of time, and then reshipped via truck to the NTS. The DOE asked the members of the AITC to take the findings from the Austin report and any pertinent previous studies and apply them directly to the IM EA. This task was accomplished at a meeting held in Tonopah, Nevada and resulted in a report entitled *U.S. DOE Nevada Operations Office, Intermodal Transportation of LLRW to the Nevada Test Site, Summary of Meeting with Native Americans, November 18 to 20, 1998, Tonopah NV (American Indian Transportation Committee 1998).*

American Indian Transportation Committee Field Assessment of Cultural Sites Regarding the U.S. Department of Energy Pre-approval Draft Environmental Assessment of Intermodal Transportation of Low-Level Radioactive Waste to the Nevada Test Site (American Indian Transportation Committee 1999)

The AITC concluded that the Austin study (1) was not designed to assess specific locations along its study-area highways, (2) the IM EA was considering some highway routes that had not been considered in the Austin study, and (3) the IM EA raised the issue of potential LLRW impacts along railroad routes. The AITC thus recommended to the DOE/NV that they support the AITC to conduct on-site studies along the new highway routes. This request was resulted in a formal research proposal submitted to the DOE on December 22, 1998. The proposal was funded on January 4, 1999. The AITC went into the field on January 11, 1999 and worked continuously until January 21, 1999. The direct field observations of the AITC during this period of study were the foundation for their summary of findings.

The study was guided by a series of agreed to methods for collecting data. Given the great distances and the time needed to assess each place visited along the proposed routes, it was agreed by the AITC that two kinds of site evaluations would be conducted. The first is a complete site evaluation and the second was called a mini-site evaluation. Each had his/her own forms and each AITC member filled out one or the other form at each site that was identified along the proposed routes. At the end of three days of site visits, the AITC spent one day writing the results of their evaluations. These site descriptions and evaluations were fully discussed by the AITC; therefore, the text provided in this summary of findings has been agreed to by the entire AITC.

A total of 25 sites were evaluated by the AITC. The sites were dispersed across an extensive area within the previously established region of influence, from Moapa and Caliente, Nevada in the east, to Barstow, California in the west. This vast stretch of land contained a large variety of culturally significant Indian places. Cultural resources and cultural landscape features were identified and evaluated; these included mountains, valleys, springs, trails, a variety of plants and animals, archaeological remains, storied rocks, rivers, and urban communities considered important to Numic and Yuman speaking peoples.

Comments and concerns made for the places visited and the associated resources, as well as Indian socioeconomics and environmental justice were edited and integrated into the existing pre-approval draft IM EA text sections. Also recommendations pertaining to further Native American input and assessments as part of the EA process were made to the DOE (Arnold et al. 1999).

Confronting the Angry Rock: American Indians' Situated Risks from Radioactivity (Stoffle and Arnold 2003)

This article synthesized the key findings from the previous transportation studies by discussing Numic-speaking peoples' epistemological views towards radioactive materials and how it could impact places and resources on traditional lands. The article framed the discussion in terms of perceived risks from the transportation of radioactive waste. As mentioned earlier, Numic-speaking people view radioactive material as an angry rock and they have possessed this knowledge and have used this rock for thousands of years. The angry rock is a powerful spiritual being that is a threat that cannot be controlled nor contained through conventional means. It has the power to pollute places, food, and medicines thus they cannot be used afterwards by Indian people. The angry rock also has the ability to cause serious spiritual impacts. The transportation of the angry rock along the highways poses threats to areas like Animal Creation places (the Red Tail Hawk Origin Site), access to spiritual beings (Potato Woman), human souls that have not been sung to the afterlife (Hiko Massacre Site), and ceremonial areas (Black Canyon, Pahranagat Valley).

The findings presented in this article demonstrate that American Indian risk perceptions are real and need to be understood as calculated risks. Also the shared cognitions of risk among people who share a common culture raise questions of alternative epistemologies which are not normally addressed in risk assessments. The article concluded with thoughts on the "logical step" towards addressing risk. There is a need to afford special protection for Indian people and their connected environment and allow the reestablishment of this relationship (Stoffle and Arnold 2003). The AIWS addresses this issue directly in the Biological Resources and Environmental Justice sections of this essay.

The Angry Rock

The CGTO knows that radiation can be and is viewed from both a western science and a Native American perspective. These alternative and competing perspectives are key for understanding the cultural foundations of American Indian responses to the mining, processing, use, transportation, and disposal of radioactive materials. At some level of analysis from an Indian perspective, all radioactive waste is basically the same problem to Indian people. Subtle differences in classification from a Western science perspective of radioactive waste only mask and do not significantly modify the basic cultural problems of radioactive waste for Indian people and their traditional lands.

The Angry Rock is a concept used by Indian people, involved in DOE funded radioactive waste transportation and disposal studies, to quickly summarize the complex cultural problems associated with what happened to this known mineral when it was improperly taken and used by non-Indians. The notion of an Angry Rock is premised on the belief that all of the earth is alive, sentient, speaks Indian, and has agency. When the elements of the earth are approached with respect and asked for the permission before being used they share their power with humans. The reverse occurs when they are taken without permission – they become angry withhold their power and often using it against humans. Thus, uranium is an Angry Rock. Uranium has been known and carefully used by spiritual specialists and medicine persons for thousands of years (Lindsay et al. 1968). The following American Indian elder quote from a DOE funded report (Austin 1998) begins to explain this perspective:

We are the only ones who can talk to these things. If we do not make sure that we talk to those things, then they are going to give us more bad harm, because it is already happening throughout the country. Those are the reasons why the Indian people say ... like uranium for one, uranium was here since the beginning of this Earth, when it was here we knew uranium at one time. And still it is used, but then they got a hold of it and made something else out of it. Now it is a man made thing, and today it accumulates waste from nuclear power plants, it accumulates more, it has its own life. Radiation has said to us at one time "If you use me make sure you tell me before you use me why you are going to use me and what for. " And we never said anything to that uranium at all, and we put something else in there with it, which shouldn't belong with it. It gives it more power to eliminate the life, of all living things on this planet of ours. Those are the reasons, why the Indian people always say, and I know because I have been there. The rocks have a voice...

Although from a Western science perspective radiation can be isolated and contained by conventional techniques, the Angry Rock has the power to move and cannot be contained by barriers. Indian people who have dealt with the Angry Rock for thousands of years note that there are traditional ways to deal with the uranium the natural rock if used by trained Indian specialists, but these may or may not work with the Angry Rock of modern radiation waste.

Another elder noted:

Songs ... we are the ones who should be talking to those things. Radiation is going to take all of our lives, it is continuously moving over the land. The land don't want it, nobody wants it. And today, we are doing a bad thing by using radiation on each other. Radiation is something that should not be used to kill animal life...

Another elder noted:

And can it be contained? As it's transformed it can be, I think it can be contained physically but not spiritually, and again I think spiritually as it's been altered because it's in that energy field because it's been altered. The spirit, that's where it can do its harm in an altered form. It doesn't do any good to anybody. And there you're just in the wrong place in the wrong time, it does influence plants and animals, minerals and air, the spirit of any area it passes through. The reason somebody is sick. I don't think it's necessary to talk about how each one of these is influenced, it just is.

Another elder noted:

As far as the transportation of waste there's a lot of unknowns and we don't know what the consequences are. We know there are many sicknesses that come out from people that have been contaminated by nuclear waste and as far as Indian people go, we show respect to the land, show respect to other people, for the animals, the plants, the rocks. The power of the rock – Just looking at Chemehuevi Mountain, it's a very spiritual mountain from this perspective right here. When I look out towards the mountains and I don't just see a mountain, I see a place of power, I see a place where I can go and meditate and speak with the Creator directly and ask for prayers and blessings for people directly. Just like anything else, you have to give prayers all the time because the creator is here to watch and protect over us. I feel that we wouldn't have come this far if he wasn't here to watch over us and we are here to pray and we are here to protect the other resources.

Another elder said:

I can envision the animals standing back once it goes through for the first time and they recognize that there's a danger that they would move away because of fear. That they would no longer be there and that there's something bad coming down the road and they disperse and move away into different corridors. Kind of like a dust storm, they disperse and move further and further away. I see it from the animals' standpoint, they're a lot smarter than us and they've been doing this for longer than us and their senses are more keen and I think the animals would get back and it would create dead zones throughout the country. Through these corridors or transportation routes of course at the site there will be those that are curious who want to go see.

Another elder said:

I don't know what you would do with this rock if it's angry and this is its way of rebelling, getting *back. I think as a Native American I would backstep and ask for forgiveness. Sometimes forgiving is not very easy because there's sacrifices we have to make and there's consequences ... I don't think it can be done as a. group, it's an individual thing and each one of us has to go back and ... ask for forgiveness for what has taken place. It's not just only that I think it's going to be more complicated than going out into the mountains and saying, "hey, I'm sorry, I won't do this, I won't do that and I won't bother you anymore. There's a lot of other things that need to be forgiven. The rock is the most precious and it's the largest and it's the one that needs to be forgiven the most. There's a lot of small forgiveness that have to be given before the large rock. I think it's a stepping stone...*

... the rocks are angry, yes, they're striking out saying "don't do this to me, don't touch me, don't let this happen. " In a sense you look at it from a spirituality standpoint, it's the spirits of Mother Earth telling us don't mess with Mother Earth.

It remains a mater of debate as to whether traditional means of placating powerful rock-based forces can be used to control or placate radioactive waste. Western scientists have created a problem for Indian people that, despite being very critical to their future, is not easily resolved.

Cultural Resources

The CGTO affirms a commitment to assisting the archaeology program by providing CGTO appointed tribal monitors. These monitors are provided approved guidance and training by the CGTO as well as extensive project orientation by the professional archaeologists. Monitors are trained so they know certain appropriate cultural responses to materials identified during archaeological survey, but they recognize that certain kinds of cultural resources require spiritual specialists who are then called in to evaluate and respond to newly identified cultural resources. In cases where NAGPRA relevant resources are identified then the CGTO is contacted and will set into motion NAGPRA inadvertent discovery protocols (NAGPRA 1990; Stoffle, Halmo, and Dufort 1994; Stoffle, Zedeño, and Carroll 2000). At the end of the monitoring experience, each monitor provides his or her own personal notes and experiences for a summary report that is prepared and submitted to the CGTO.

The CGTO knows the distribution and density of known archaeology sites has not significantly changed since the 1996 NTS EIS. They know the largest number of recorded cultural resources is in the northwest part of the NTS, on and around Jackass Flats, Yucca Mountain and Shoshone Mountain. The reason for this is because numerous activities were conducted on those portions of the NTS within the last 10 years, less attention has been directed to these regions and adverse impacts has been minimized. While this lapse is occurring, NTS decision-makers may consider conducting new projects and investigations. The CGTO recommends that prior to land disturbances of projects a timely American Indian Assessment be completed.

Types of American Indian Resources

The CGTO knows, based upon its collective knowledge of Indian culture and past American Indian studies, that American Indian people view cultural resources as being integrated. Thus certain systematic studies of a variety of American Indian cultural resources must be conducted before the cultural significance of a place, area, or region can be fully assessed. Although some of these studies have been conducted, in other areas studies have not begun. A number of studies are currently planned. Indian people can fully assess the cultural significance of a place and its associated natural and cultural resources when all studies have been completed and our governments and tribal organizations have reviewed the recorded thoughts of our elders and have officially supported these conclusions. American Indian studies focus on one topic at a time so that tribes and organizations can send experts in the subject being assessed. The following is a list of studies for a complete American Indian assessment:

- Ethnoarchaeology – the interpretation of the physical artifacts produced by our Indian ancestors.

- Ethnobotany – the identification and interpretation of the plants used by Indian people.

- Ethnozoology – the identification and interpretation of the animals used by Indian people.

- Storied Rocks – the identification and interpretation of traditional Indian paintings and rock peckings.

- Traditional Cultural Properties – the identification and interpretation of places of central cultural importance to a people, called Traditional Cultural Properties; often Indian people refer to these as "power places." Native American Indian properties and interpretations shall be determined by Native American spiritual person when:
    - Cleansing (removing negatives)
    - Purifications/preparations (repatriations and related issues).

- Ethnogeography – the identification and interpretation of soils, rocks, water, and air.

- Cultural Landscapes – the identification and interpretation of special units that are culturally and geographically unique areas for American Indian people.

When all of these subjects have been studied, then it will be possible for American Indian people to assess three critical issues: (1) What is the natural condition of this portion of our traditional lands? (2) What has changed due to DOE activities? And (3) What impacts will proposed alternatives have on either furthering existing changes in the natural environment or restoring our traditional lands to their natural condition? Indian people believe that the natural state of their traditional lands was what existed before 1492, when Indian people were fully responsible for the continued use and management of these lands. The NTS and nearby lands were central to the Western Shoshone, Owens Valley Paiute, and Southern Paiute people. The lands were central in the lives of these people and so were mutually shared for religious ceremony, resource use, and social events (Stoffle et al. 1990a and b). When Europeans encroached on these lands, the numbers of Indian people, their relations with one another, and the condition of their traditional lands began to change. European diseases killed many Indian people; European animals replaced Indian animals and disrupted fields of natural plants; Europeans were guided to and then assumed control over Indian minerals; and Europeans took Indian agricultural areas. Despite the pollution and destruction of some cultural resources and the physical separation from the NTS and neighboring lands, Indian people continue to value and recognize the central role of these lands in their continued survival.

Recognizing this continuity in traditional ties between the NTS and Indian people, the DOE in 1985 began long-term research involving the inventory and evaluation of American Indian cultural resources in the area. This research was designed to comply with the American Indian Religious Freedom Act (AIRFA), which specifically reaffirms the First Amendment of the U.S. Constitution rights of American Indian people to have access to lands and resources essential in the conduct of their traditional religion. These rights are exercised not only in tribal lands, but also beyond the boundaries of a reservation (AIRFA 1978; Stoffle et al. 1994; Stoffle, Halmo, and Dufort1994). To reinforce their cultural affiliation rights to prevent the loss of ancestral ties to the NTS, 17 tribes and organizations have aligned themselves to form the CGTO. This group is formed by officially appointed representatives who are responsible for representing their respective tribal concerns and perspectives. The CGTO has established a long standing relationship with the DOE. The primary focus of the group has been the protection of cultural resources.

The DOE and the CGTO have participated in cultural resource management, including the Yucca Mountain Project (Stoffle 1987; Stoffle, Evans, and Halmo 1988; Stoffle, Olmsted, and Evans 1988; Stoffle, Evans, and Harsbarger 1989; Stoffle et al. 1989; Stoffle, Halmo, and Olmsted 1990; Stoffle et al. 1990a; Stoffle et al. 1990b; Stoffle and Evans 1988; Stoffle and Evans 1990; Stoffle and Evans 1992), the Underground Weapons Testing Project (Stoffle et al. 1994), the Rock Art Study (Zedeño et al. 1999), the Water Bottle Canyon Interpretation and Traditional Cultural Property Study (Arnold et al. 1998; Stoffle, Van Vlack, and Arnold 2005) and the Timber Mountain Caldera Study (Stoffle et al. 2006). These studies are used in this GTCC EIS, along with the collective knowledge of the CGTO, as the basis of the comments in the 1996 NTS EIS, 2002 NTS SA, and the current SA. The cultural resource management projects sponsored by the DOE have been extremely useful for expanding the inventory of American Indian cultural resources beyond the identification of archaeological remains and historic properties.

Visual Resources

Views are important cultural resources that contribute to the location and performance of American Indian ceremonialism. Views combine with other cultural resources to produce special places where power is sought for medicine and other types of ceremonies. Views can be of any landscape, but more central viewscapes are experienced from high places, which are often the tops of mountains and the edges of mesas. Indian viewscapes tend to be panoramic and are special when they contain highly diverse topography. The viewscape panorama is further enhanced by the presence of volcanic cones and lava flows. Viewscapes are tied with songscapes and storyscapes, especially when the vantage point has a panorama composed of multiple locations from either song or story. Key to the Indian experience of viewscapes is isolation. Successful performance of ceremonies (whether by individuals or groups) is often commemorated by the building of rock cairns and by storied rocks and paintings. The CGTO tribes recognize the cultural significance of viewscapes and have identified a number of these on the NTS. The Timber Mountain Caldera contains a number of significant points with different panoramas, including Scrugham Peak-Buckboard Mesa and the Shoshone Mountain massif.

Waste Management

The CGTO requests an analysis of the hydrological and ecological impacts of the existing water diversion dike of the current Radioactive Waste Management Complex in Area 5. The DOE recognizes that this is a very flood prone area, with major flooding episodes occurring about every 23 years. Indian people visiting this site observed that even though the current dike has been built recently and thus not experienced a 23-year flood, it has diverted and consolidated sufficient runoff that a small arroyo has been established. The Indian people visiting this site believe that the existing dike has unnaturally stressed down-slope plants and animals who now do not receive normal sheet runoff. The Indian people visiting the site believe that by concentrating the runoff, the dike has reduced the amount of water absorbed during normal sheet runoff because the consolidated runoff moves more quickly and only flows in the new and developing eroded arroyo. It is believed by the Indian people visiting the site that were a GTCC facility to be established east of the current RWMC then the dike would necessarily have to be extended causing an even greater runoff shadow and an even greater developing arroyo. The desert tortoise in the area will have to move out of this larger runoff shadow and may be concentrated in the area of Frenchmen Playa. Moving their living areas towards the playa will expose them to higher levels of radioactivity. The Indian people visiting the site believe that these current and potential impacts should be analyzed, monitored by Indian people, and reported back to the CGTO at the next annual meeting.

NTS Waste Management in Perspective

After 11 years of formal transportation studies the CGTO continues to have reservations in regards to the storage of low-level and other hazardous wastes at the NTS and the transportation of low-level waste to the NTS for storage. The CGTO still maintains that what was suggested 11 years ago still exists and affects cultural resources. Disposal diminishes the potential for visitation by members of the CGTO representatives and other Indian people.

The CGTO still believes that the waste should be disposed of in a culturally appropriate manner and that the transportation of low-level radioactive waste poses risks to the people and the environment. Previous reports on this issue document the extent and depth of our concerns for these issues (American Indian Transportation Committee 1998; Arnold et al.1997; Austin 1998; Stoffle and Arnold 2003). Waste disposal activity on the NTS is still ongoing in regards to non-Nevada low-level radioactive waste. The NTS presently uses the Disposal Crater Complex, which is expected to close by 2010. Although the NTS has future low-level radioactive waste disposal pits on standby, there is a possibility that additional craters would need to be developed. Disposal of the following materials is performed at the NTS: Nevada-generated low-level radioactive waste, mixed low-level radioactive waste, greater confinement disposal waste, asbestiform low level radioactive waste, Nevada-generated mixed waste and transuranic waste, mixed transuranic waste. These materials are stored on-site until shipped elsewhere. The CGTO remains on record as opposed to this type of practice as it potentially will limit cultural activities involving the Indian tribes.

Cumulative Impacts

Cumulative Impacts are key to the various Indian peoples connected to the NTS and specifically the proposed GTCC waste facility in Frenchman Flats. These issues have been discussed for more than 13 years with the DOE (See American Indian Writers Subgroup, CGTO 1996) but it remains unclear the extent that the process of negative impacts to Indian people and culture has been mitigated by DOE actions. Still some progress has occurred through appropriate consultation with the CGTO and their subsequent involvement in the identification and management of cultural resources (see earlier discussion of what Indian people define as cultural resources).

According to the CGTO tribes, increased land disturbances associated with all forms of activities and development on the NTS could result in a decrease in access to these areas for American Indians. Limiting access could reduce the traditional use of the NTS and other areas and affect their sacred nature. Increased development at the NTS could increase the potential for greater disturbance and vandalism of American Indian cultural resources. The CGTO tribes believe (See Appendix G – AIWS 1996) that cumulative impacts in the following areas may occur:

- *Holy land violations*. Further destruction of traditional cultural sites, making the water disappear, general treatment of the land without proper respect.

- *Cultural survival*. Decreased ability and access to perform ceremonies.

- *Environmental restoration*. Revegetation of restored lands with native species.

- *Empowerment process*.

- *Radiation risks*. These risks began with nuclear testing. Today, the CGTO tribes perceive that the radioactive risks continue in known and unknown ways underground.

Over the past 17 years of regular consultation between the NNSA/NV and the CGTO tribes, there has been a growing co-management role for the tribes. Their recommendations have been heard and, for the most part, responded to by the NNSA/NV. Indian access to places on the NTS has increased, after an early period of access loss. Unfortunately, each new program that is added to the NTS decreases the amount of space that is available for the practice of Indian religions, ceremonies, and cultural persistence. However, having no programs also can have an impact. For example, even though the mesas are now accessible to Indians for ceremonies, the roads are not maintained because there are no projects on the mesas. This makes access to the ceremonially important areas difficult.

There are still ongoing risks to Indian people from storage and disposal of waste and these will continue. Finally, transportation of radioactive materials is continuing and increasing. It is not clear to the CGTO tribes that, after two American Indian studies of radioactive waste transportation, there has been a meaningful consideration of their concerns. It is not clear to what extent further radioactive waste disposal at the proposed GTCC facility will do to increase radiation risks to the physical and spiritual dimensions of Frenchman Playa area but some assessment is possible by Indian religious leaders.

GTCC Waste Repository

Nez Perce Tribe Narrative for EIS

Department of Energy, Hanford Site

2009

INTRODUCTION

Nez Perce History and Perspective

Preparing for the Nez Perce

Tribal memory can still recall the origins of the Nimiipuu or Nez Perce. The oral traditions bind the Nez Perce to the landscape. They also explain how to perceive and value the landscape and its many resources. The oral traditions described hereafter are formative in the Nez Perce relationship with the land and its resources. The first story describes how the animal people stepped forth in council to offer assistance and guidance to the new people to help them survive. It is one of the earliest oral traditions explaining the arrival of the Nimiipuu. The synopsis of this oral tradition is as follows:

> *At one time only the animal people lived on the land and all of them spoke the same language. Each animal could communicate with the others. A council was called and the animal people began to gather around. It was announced that the land would change with the arrival of a new creature that walked on two legs and this new creature will need help to survive. It would need to learn what to eat and how to keep warm. The animal people were asked to make an offering to help this creature survive. A great commotion arose as the animal people engaged in discussion about what was going to be offered. First among them was Nacox the Salmon. It said that it would give its entire body as food to help the new people survive. It said that it would travel to far away places and give gifts to the people upon its return. Nacox said that its sacrifice must be remembered by allowing it to die in the place in which it was born.*

> *All were impressed by the generosity of the Salmon and followed its example by making an offering of food. One group of animals was discussing how they were going to look. They were trying to settle their size, color of fur and horns as well as which direction their horns or antlers were going to face. At last they stepped forth and declared that they give their bodies to be foods for the new people just as salmon had proclaimed, adding that their skins could be made into clothing for the new people to keep warm. They also announced that their bones, horns and antlers could be made into tools to process hides into clothing and shelter. The were recognized with names and they are Bison, Moose, Elk, Mountain Sheep, Mountain Goat, Antelope and various kinds of deer. The birds were next and they went through the same process and were recognized as the various birds. Some of them are Prairie Chicken, Raven, Crow, Meadowlark, Owl, Hawk, Eagle, Condor and the many other types of birds found in Nez Perce Country. In a similar manner, the rest of the animal people stepped forth and proclaimed their gifts in front of the council; stating how they would assist the new people in their efforts to survive.*

> *There was one animal that was late to the council and when it asked what was going on, everything had to be retold. It was announced that there would be a new creature to walk the land and that each animal was making an offering to help the creature to live. Each gift was described again and upon hearing the news, the late one wanted to be like Grizzly Bear. It was asked to display how it would be a convincing Grizzly. It promptly showed its small teeth, slightly growled and passed its little claws through the air. All the*

animal people laughed because, although this late one was furry, it was nowhere near as fierce as Grizzly Bear. So then the late one said it wanted to be like Eagle and it backed up and ran toward the center of the council and jumped into the air landing only a short distance away. All the people laughed again because it failed to capture the grace of an eagle in the air. Then it wanted to be a salmon so it was sent to the river to demonstrate its agility in the water. It promptly dived in the water and slowly paddled around in the fashion of a dog and all the animal people laughed as it crawled from the river and shook the water from its fur. All the positions were taken so a special task was given to this creature. It would be the one to create the new two-legged creatures and its name would be 'Iceyeeye or Coyote. 'Iceyeeye was cautioned that all the qualities he possessed would be carried on by the creatures he went on to create: 'Iceyeeye was known to be good, helpful, very intelligent, curious to a fault and, at times, fool hardy. He was also very forgetful. Some of the animal people chose to remain in the area in which the council occurred; pulling their robes up over their shoulders and heads. They became stone in order to serve as a reminder of the great council that occurred wherein the animal people gave tremendous gifts for the survival of the coming new people.

The place of the council can still be seen in the Nez Perce homeland along the valley of the Clearwater River in North Central Idaho (Landeen and Pinkham 1999 p.4-8).

'Iceyeeye went on to numerous adventures; frequently proclaiming his preparations for the new people. 'Iceyeeye turned many animal people to stone to serve as a reminder of both proper and improper conduct. He carved rivers into the ground, turned giants into mountains and turned some animal people into constellations in the night sky so the new people could travel to far away places.

Seasonal Round

The seasonal round is best described as a *return to a specific area* for the purpose of gathering resources: food, medicinal or otherwise. The seasonal round advanced in area and elevation simultaneously. It is not the act of following resources wherever they occur but rather a return to an area to gather resources based on prior knowledge or experience. It is also marked by the availability as warming seasonal temperatures foster development of the resource. Examples are the return to root digging areas as spring or summer temperatures have warmed plants to the point of opening the opportunity to harvest, or a return to a hunting area in the fall before temperatures drop to low. The map below shows how the Hanford area fits into the area used by the Nez Perce over time.

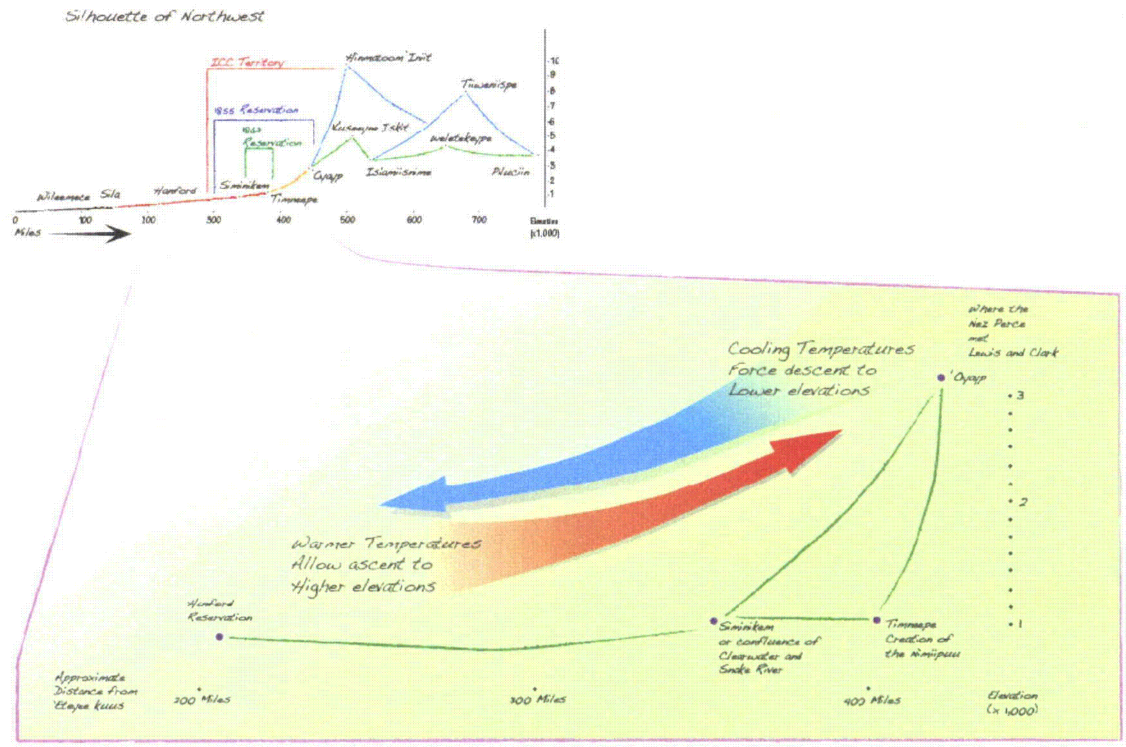

Diagram 1

The time for gathering resources is marked by lunar changes. Since there were more foods than there were moons during the year some resource gathering times were simultaneous. The diagram below shows how the seasons for gathering various foods correspond to the commonly used twelve-month calendar and four seasons. The Nez Perce changed elevations depending on the warming weather and this is shown through another diagram showing the names of the gathering seasons and the elevations.

It also covered an elevation from sea level up to ten thousand feet. The map titled "Silhouette of the Northwest" shows the elevation difference in the usual and accustomed areas used by the Nez Perce. The beginning of the seasonal round is marked with a Ke'uyit or first foods ceremony in the spring. Ke'uyit translates to "first bite" and is an annual ritual of prayer immersed in song for the first foods of the year. Traditional foods are laid out on the floor in the order in which they are gathered throughout the year beginning with Salmon. This annual ritual is an expression of gratitude to the foods for their return and for those gathered during the seasonal round. Other tribes have more than one feast such as a root feast and a huckleberry feast but the Nez Perce only have one and it is held toward the latter part of the spring.

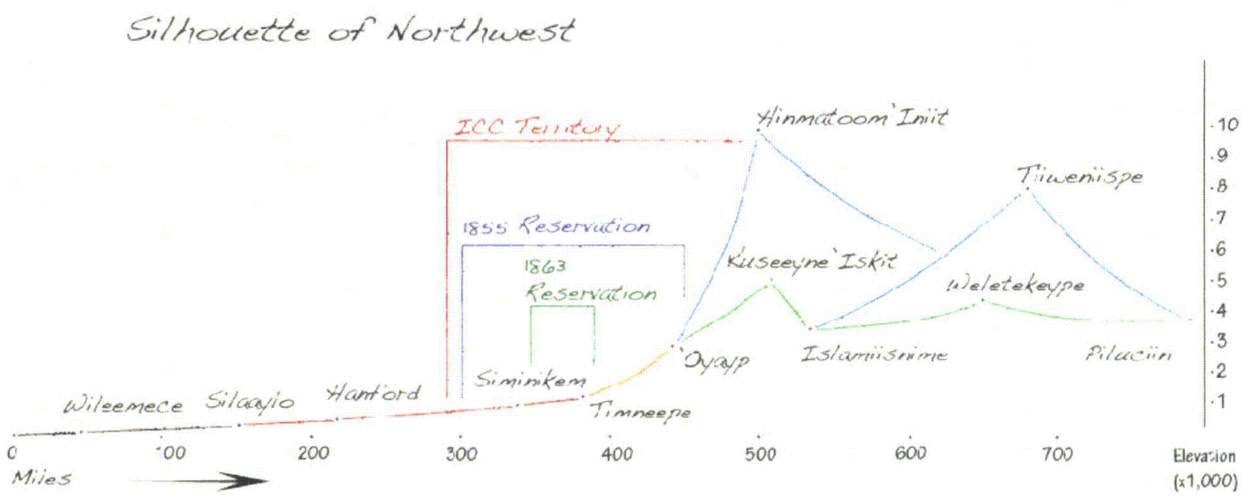

Diagram 2

Gathering Times

Examples of resource gathering times is shown in diagram 3:

Wiluupup: Time when cold air travels. Often corresponds to the month of January.

'Alatam'aal: Time between winter and spring or the time for fires (often corresponds to the month of February) 'Ala=fire

Miseemi latiit’al: Time of false blossoms roughly corresponding to early March. Miseemi=to lie or speak falsely, Latii=to bloom or blossom.

Latiit’al or Latiit’aal: Time when flowers bloom. Roughly corresponds to the month of March. Latii=to bloom or blossom.

Qeqiit’aal or qaqiit’aal: Time of gathering qeqiit roots. Roughly corresponds to April.

‘Apa’aal: Time for digging roots and making them into small cakes called ‘Apa. Roughly corresponds to the month of May or June.

Tustimasaatal: Ascend to higher mountain areas. Roughly corresponds to the month of June. Tusti=higher/above

’Il’aal: The time of the first run of Salmon. Roughly corresponds to the month of June.

Haso’al’: The time to gather eels or Pacific Lamprey. Roughly corresponds to the month of June. Heesu=eel.

Qama’aal: Time for digging and roasting qem’es bulbs. Often corresponds to the month of July. Qem’es=camas bulbs.

Q’oyxc’aal: Time of gathering Blueback Salmon. Often around the month of July. Q’oyxc=Blueback Salmon

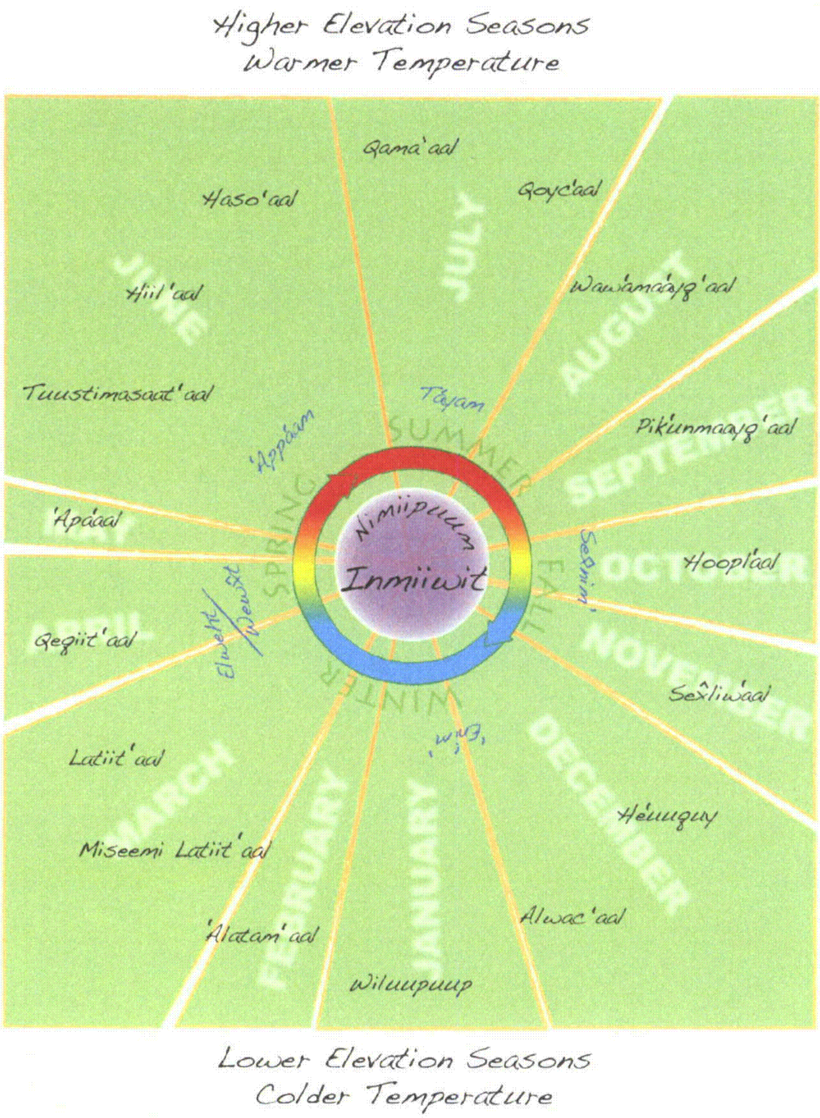

Diagram 3

Waw'ama'aq'aal: Season when salmon swim to the headwaters of streams (often corresponds to August) Waaw'am=headwaters

Pik'unma'ayq'al or pik'onma'ayq'aal: Time when Chinook Salmon return to the main river and steelhead begin their ascent. Roughly corresponds to September. Piik'un=river

Hoopl'al: Time when Tamarack needles begin to fall. Huup=to fall (as Pine needles do). Roughly corresponds to October.

Sexliw'aal: Autumn or the time roughly corresponding to November.

He'uquy: Time of calf elk or foaling roughly corresponding to December.

'Alwac'aal: Time of Bison Yearling roughly corresponding to December. 'Alawa=bison yearling.

Oral History

Oral histories impart basic beliefs, taught moral values, and explained the creation of the world, the origin of rituals and customs, the location of food, and the meaning of natural phenomena. The oral tradition provides accounts and descriptions of the region's flora, fauna, and geology. Fish and other animals are characters in many of these stories. Coyote, is the main character in many of the stories because he exhibits all the good and bad of traits of human beings. Although some of the characters and themes may differ slightly, many of these same stories are held in common by Columbia Basin tribes.

Tribal Values

Tribal values lie imbedded within the rich cultural context of oral tradition and are conveyed to the next generation by the depth of the Nez Perce language. The numerous landmarks that season the precious landscape are reminders to the events, stories, and cultural practices of our people. How to properly perceive life and land are among the core tenets of which the stories speak. The values are what must endure and they can only be properly conveyed by the oral traditions and language. Overall the values are intent on protection, preservation and perpetuation of resources for the sake of survival. The Nez Perce still maintain those same values for our children just as they were for those that carry them today. The most appropriate way to convey the values of the Nez Perce is to discuss some of the cultural practices still conducted on our landscape. They reflect a complex tradition of high regard for the land by utilizing the resources, but not using so much that the resource cannot propagate to preserve their continued existence.

Land was managed by cultural practices so that resources would not be jeopardized by the actions of one generation. The Nez Perce Tribe utilized resource areas with several other tribes that carried similar resource values. The Nez Perce value the landscape for the rich resources it offers our children for their survival. The landscape is full of powerful reminders that were placed in their respective areas in the form of rock features associated with oral traditions relating the exploits of the animal people. The Nez Perce elders recall hunting and fishing areas taught to them when they were young. These are the same places they learned about in the same way from their elder kinsmen. The women dig roots and harvest berries in the same places that they learned about from their grandmothers. Each place utilized for the resources was maintained with balance to sustain children and future generations.

Each plant had a window of harvest in which it could be gathered. The window of harvest was always honored because gathering at another time would either affect its strength or viability. When women were gathering *qem'es* bulbs, they would evaluate the field to ensure that others had not already gathered past the threshold of the resource's stability. If the field looked as though others had already been there and the resource needed to be left so it could continue on, then they would simply go to another place. When a place was found which could be used for harvest, the digging would begin with prayer songs and it was common for many of the women to sing as they continued to dig. When the work was finished for the day it was closed with a prayer song just as it had began. They were cautious about the way in which they gathered the roots as well. Arguing and fighting didn't occur while gathering foods, even among the young, because they were strictly forbidden. Root diggers were reminded by the elderly to be prayerful and concentrate on good thoughts as they conducted their work avoiding negative feelings that might be carried by the foods to those that would consume them. Peelings from the roots always were to be returned to the original grounds from which they came or buried in the earth. They are never to be simply thrown in the garbage. There are traditional stories that communicate values that regardless of where the oral tradition originated, it applies during times that native tribes are on site and practicing usual and accustomed rights. These are teachings tied to the landscape and the land ethic that is our culture.

Fishing and hunting were conducted in the same way. Young boys were raised with the guidance of elder kinsmen. A group of hunters or fishermen would depart for areas that were, on occasion, previously scouted for the presence of fish and/or game. Young hunters and fishermen would observe the actions of those that were responsible for imparting knowledge of how to conduct oneself appropriately as game was stalked or fish were caught. Expectations were similar to those of the young women; concentrate on good thoughts and feelings, prohibited acts included fighting and arguing. Excessive pride and boasting were frowned upon by elder kinfolk since the hunt was to be conducted with the utmost humility. Hunters and fisherman learned to avoid catching the largest fish or killing the largest animal they could find because it preserved the gene pool that replaced that size animal. Upon return, the hunters were not questioned as to the number each hunter killed and it was never announced because it was deemed as a group activity. One exception was when a young hunter killed an animal for the first time or caught his first fish. At this time the family recognized the young hunter or fisherman as a provider with a ceremonial feast. The elder fisherman and hunters sat around the meat which was to be boiled, baked or prepared in some traditional fashion as stories were told conveying more teachings and proper conduct. As the elder hunters and fishermen consumed the meat the newly recognized hunter or fisherman was not allowed to partake of even a morsel of the meal. Everyone else was to eat before the hunter or fisherman could consume a meal. This reinforced their role as a provider rather than someone that merely killed game or caught fish for recreational purposes.

Young hunters were taught proper shot placement, as it was crucial to the hunting experience. Young hunters were taught to shoot an animal so that it would be killed as quickly and limit the animal's suffering as much as possible. Shooting an animal or catching a fish was only part of the overall commitment to the animal's sacrifice. It had to be cleaned and taken care of with the same regard as the roots and berries. The utmost gratitude and respect was offered to the animal's spirit for imparting a tremendous gift of life to the people.

Spiritual or religious aspects of natural resources are the heart of Indian culture. There is a connection to the daily activities of a traditional lifestyle communicated through the oral traditions that tell how to take care of the land. Even landmarks have oral traditions associated with them. These landmarks are tangible cultural reminders.

Value of uncontaminated resources- For natural resources to be uncontaminated as part of Niimiipuu physical and spiritual well-being, then land and waters and air from which they come should be uncontaminated otherwise the risk to human health increases the potential for illness and other ailments.

For tribal use of natural resources to be fully utilized, the example of manufacturing and using a *wistiitam'o* or sweat lodge is presented. One purpose of a sweat lodge is for purification. It is for cleansing and a time for meditation, spiritual reflection, healing, sharing oral history and teaching. The *wistiitam'o* is often a place where the Nez Perce return to have spiritual well-being restored after family losses. It is a place of contemplation and an opportunity to relieve stress and anxiety built up from the day's activities. It is a place for centering your soul through prayer and meditation. It is also a place where many socialize with family and friends and learn what is happening in the community.

For these reasons, it is imperative that the materials used in making a sweat lodge come from the natural environment. The structure is to be made of willows gathered from the immediate vicinity of where the sweat lodge will stand. The covering is to be of animal hides, or other natural materials. The water for the bathing after sweating is to be from a natural spring or stream. Herbs are collected in their proper season with prayers and gratitude offered for their service.

Sitting in a sweat bath is a rigorous activity. While outwardly relaxed, your inner organs are as active as though you were exercising. The skin is the largest organ of the body and through the pores it plays a major role in the detoxifying process along with the lungs, kidneys, bowels, liver and the lymphatic and immune systems. Capillaries dilate permitting increased flow of blood to the skin in an attempt to draw heat from the surface and disperse it inside the body. The heart is accelerated to keep up with the additional demands for circulation. Impurities in the liver, stomach, muscles, brain, and most other organs are flushed from the body. It is in this way that purification occurs.

Affected Environment

NEPA approaches the environment with a certain defined boundary. This fragmentation of the natural and human environment does not adequately describe different resource values that a particular part of society may have, like a formally recognized tribe and its federally protected rights. A tribal environmental ethic, which maintains a cultural and spiritual connection to the natural environment and a holistic approach, is difficult to communicate in a NEPA document. There needs to be a placeholder in this document to accept these important yet different values that tribes bring to evaluating environmental and human impacts.

The Nez Perce Tribe recommends that the draft EIS include the following analysis or issues for the GTCC Programmatic EIS evaluation. We have summarized the issues/concerns by EIS sections for ease of DOE's organization and inclusion. This *Tribal Narrative* is for DOE to consider for inclusion into the EIS.

Climate, Air Quality, and Noise

Climate

Climate is one of the dominate issues of our time. Indian people have experience with volcanic periods when it seemed our world was on fire and times when our world was much colder. Distinct climatic periods have occurred during which Tribal life adapted to environmental changes and our oral history reflects these climate changes and adaptations. Scientific and historic knowledge validates tribal oral history for many thousands of years.

Columbia Plateau Tribes have stories about the world being transformed from a time considered prehistoric to what is known today. The Nez Perce remember volcanoes, great floods, and animals now extinct. Mammoth and bison harvest sites are found throughout the Columbia Plateau. They have memories of their world being destroyed by fire and water and believe it will happen again.

The Nez Perce know and remember about the weather and its changes because it was so important to forming their lives. Oral histories indicate that the climate was much wetter and supported vast forests in the region. Oral histories also recall a time when Gable Mountain or *Nookshia* (Relander1986: 305), a major landscape feature on the Hanford Reservation, rose out of the Missoula floods. There is a story about Indian people who fought severe winds that were common a long time ago. One story tells of how a family trained their son by having him fight with the ice in the river until he became strong enough to fight the wind. He then beat the very strong winds of the past and now we do not have such winds.

Holocene (Roberts 1998) is the term used to describe the climate since the last glaciers (11,700 years ago), covering much of the northwestern North America. This archaeological record confirms the prehistory that includes arctic foxes found with Marmes Rock Shelter (Browman and Munsell 1969; Hicks 2004). The Palynological data would be a good source for recreating climates that supported ecosystems of the past 10,000 years.

Air Quality

The Nez Perce believe that radioactivity is brought into the air by high winds – commonly blowing 40-45 miles per hour and intermittently much stronger (http://www.bces.wa.gov/windstorms.pdf). High winds over 150 mile per hour were recorded in 1972 on Rattlesnake Mountain and in 1990 winds on the mountain were recorded at 90 miles per hour. Dust devils can be massive in size, spin up to 60 miles per hour, and frequently occur at the site. Tornadoes have been observed in Benton County which is regionally famous for receiving strong winds.

It gets so windy that the site managers at Environmental Restoration Disposal Facility (ERDF) occasionally sends all workers home and close down the facility due to the degree of blowing dust making it unsafe to work. Air quality monitoring results, including radioactive dust, should be presented for ERDF, various plant operations, emission stacks, venting systems, and power generation sites. Also, fugitive dust can affect Viewshed and contribute to health affects during inversions.

Noise

Native people understand that non-natural noise can be offensive while traditional ceremonies are being held. Traditional ceremonies have been held at the Hanford site in recent years. Some of the cultural use of the Hanford site by Tribes is being lost. Not all ceremonial sites are known to non-Indians. The noise generated by the Hanford facility may presently create noise interference for ceremonies held at sites like Gable Mountain and Rattlesnake Mountain. Noise generating projects, such as the GTCC proposed site, can interrupt the thoughts and focus and thus the spiritual balance and harmony of the community participants of a ceremony (Greider 1993). The Nez Perce Tribe recommends that quiet zones and time periods should be identified for known Native American ceremonial locations on and near the Hanford Reservation. The general values or attributes provide solitude, quietness, darkness and wilderness-like or undegraded environments. These attributes provide unquantifiable value and are fragile. These types of values are also discussed in the Viewshed section.

Light pollution

Artificial light can be a "pollutant" when it creates measurable harm to the environment. Light can affect nocturnal and diurnal animals. It can affect reproduction, migration, feeding and other aspects of survival. Artificial light can also reduce the quality of experience during tribal cultural and ceremonial activities.

Geology and Soils

Geology

Physiography- The Yakima Fold Belt and the Palouse Slope play potentially very significant roles at Hanford both culturally and geologically. Rattlesnake and Gable Mountains are examples of folded basalt structures within the Yakima Fold Belt. These geological features have direct bearing on the ground water and groundwater flow direction. There are oral history accounts of these basalt features above the floodwaters of Lake Missoula. Many other topography features have oral history explanations such as the Mooli Mooli (flood ripples along the river terrace) and the sand dunes.

Site Geology and Stratigraphy - The GTCC referenced vadose zone location is similar to that of the 200 West area. A primary similarity between the GTCC location and the 200 West is that the underlying sediments are the Hanford Formation and possibly the Cold Creek formation. Like the 200 west area there is uncertainly about the geology and hydraulic conductivity in this area.

The vadose zone needs to be discussed as part of the Stratigraphy Section of the GTCC EIS and is probably one of the most important elements to discuss for a potential Hanford GTCC repository. It should be noted that within those sediments, a major subsurface trough feature exists (an eroded channel at the surface of the Ringold Formation) that can be traced in the stratigraphy from Gable Gap across the eastern part of 200 East and on to the southeast. This trough contains the Cold Creek sedimentary unit. Geologists are still trying to determine the effects this subsurface feature in the vadose zone has on contaminant transport.

Clastic dikes are networks of features in the near surface wherein cracks were developed in the vadose zone from sediments either upwelling from a deeper layer, or by filling in from a feature open at the surface, or a combination of both. These features are thought to be related to seismic activity. What affect these have directly on contaminant transport needs to be understood, and thus far they have not. There is a question as to whether or not the DOE has looked for them at the site. They were noted to be present in the 200 Areas during the tank farm construction.

Regional Seismicity –The Pacific Northwest has been historically geologically active and this needs to be discussed if there is to be analysis of putting more contaminants in the ground at Hanford. The 1936 earthquake and the 1973 earthquakes at Hanford need to be discussed in terms of the GTCC.

Geologic structure of the Pacific Northwest includes a feature called the Olympic-Wallowa Lineament (the OWL). Surface and depth data have identified a structural "line" within the earth's crust that can be traced roughly from southeast of the Wallowa Mountains, under Hanford, through the Cascades and under Seattle and the Sound. Such lineaments are signals of crustal structure that are not yet well identified. Emerging research being reported through the USGS is highlighting the importance of Seattle area faults connecting under the Cascades into the Yakima Fold Belt and on along the OWL. The geologic stress on the surface of the earth in the local region have a north-south compressional force direction that has caused the surface to wrinkle in folds that trend approximately east-west, thus creating the Yakima Fold Belt. Fault movement along these folds occurs all the time, and studies have shown these to be considered active fault zones (Repasky, TR, et.al., 1998; Campbell, N.P., et.al., 1995).

Soils

Native Peoples understand the importance of soils and minerals. Oral history has suggested that soils have a medicinal purpose for healing wounds as well as used for building structures, creating mud baths, and filtering water. Material from the White bluffs was used for cleaning hides, making paints, and whitewashing villages.

Soil characteristics: soil chemistry (ph, ion activity, micronutrients, microorganisms, lack of this knowledge is a data gap such as the influence of past tank leaks on soil chemistry and characteristics/properties. Sandy soils have high transmissivity. Soil integrity is important to tribes since the soils support plant life, which supports many other life forms, which are all important to tribes.

Minerals and Energy Resources

Tribal Comments: Barrow material site and waste material site: Alternatives selection will have varying degrees of impact and footprint. For example, a vault alternative will need significant capping material from barrow area C that has its own set of ramifications.

Questions to be answered: What will the energy use be for a fully functioning GTCC waste site? What is the size and location of the footprint?

Water Resources

Groundwater

Purity of water is very important to the Nez Perce, and thus DOE should be managing for an optimum condition considering Tribal cultural connection and direct use of water, rather than managing for a minimum water quality threshold.

From the perspective of the Nez Perce Tribe, the greatest long-term threat at the Hanford site lies in the contaminated groundwater. There is insufficient characterization of the vadose zone and groundwater. There is a tremendous volume of radioactive and chemical contamination in the groundwater. The mechanisms of flow and transport of contaminants through the soil to the groundwater are still largely unknown. The volumes of contamination within the groundwater and direction of flow are still only speculative. Due to lack of knowledge and limited technical ability to remediate the vadose zone and groundwater puts the Columbia River at continual risk.

Water Use

The Columbia River is the lifeblood of the Nez Perce people. It supports the salmon and every food or material that they rely on for subsistence. It is an essential human right to have clean water.

If water is contaminated it then contaminates all living things. Tribal members that exercise a traditional lifestyle would also become contaminated. A perfect example is making a sweat lodge and sweating. It is a process of cleansing and purification. If water is contaminated then the sweat lodge materials and process of cleansing would actually contaminate the individual.

Tribal people are well known for adopting technology if it were instituted wisely and did not sacrifice or threaten the survival of the group as a whole. This approach applies to tribal use of groundwater. Even though groundwater was not used except at springs, tribes would have potentially used technology for developing wells and would have used groundwater if seen to be an appropriate action. The existing contamination is considered an impact to tribal rights to utilize this valuable resource.

The hyporheic zone in the Columbia River needs to be more fully characterized to understand the location and potential of groundwater contaminants discharging to the Columbia River.

Contaminated groundwater plumes at Hanford are moving towards the Columbia River and some contaminants are already recharging to the river. It is the philosophy of the Columbia River Tribes that groundwater restoration and protection be paramount to DOE's management of Hanford. Institutional controls, such as preventing use of groundwater, should only be a temporary measure for the safety of people and animals. It will be questioned when DOE views institutional controls as a viable long-term management option to allow natural attenuation. The timeline of natural attenuation may not best represent a Tribal preference of a proactive corrective cleanup measure(s). for contamination plumes. Cleanup should be a priority before considering placement of additional waste like GTCC in the 200 area.

Human Health

Nez Perce health involves access to traditional foods and places. Both of these are located on the Hanford facility and can be impacted by placement of the GTCC waste in the 200 area.

Definition of Tribal health- Native American ties to the environment are much more complex and intense than is generally understood by risk assessors (Harris 1998, Oren Lyons[1]). All of the foods and implements gathered and manufactured by the traditional American Indian are

[1] http://www.ratical.org/many_worlds/6Nations/OLatUNin92.html; http://www.youtube.com/watch?v=hDF7ia23hVg.

interconnected in at least one way, but more often in many ways. Therefore, if the link between a person and his/her environment is severed through the introduction of contamination or physical or administrative disruption, the person's health suffers, and the well being of the entire community is affected.

To many American Indians, individual and collective well being is derived from membership in a healthy community that has access to, and utilization of, ancestral lands and traditional resources. This wellness stems from and is enhanced by having the opportunity and ability to live within traditional community activities and values. If the links between a tribal person and his or her environment were severed through contamination or DOE administrative controls, the well being of the entire community is affected.

Risk Assessments

Risk assessments should take a public health approach to defining community and individual health. Public health naturally integrates human, ecological, and cultural health into an overall definition of community health and well-being. This broader approach used with risk assessments is adaptable to indigenous communities that, unlike westernized communities, turn to the local ecology for food, medicine, education, religion, occupation, income, and all aspects of a good life (Harris, 1998, 2000; Harper and Harris, 2000).

"Subsistence" in the narrow sense refers to the hunting, fishing, and gathering activities that are fundamental to the way of life and health of many indigenous peoples.

The more concrete aspects of a subsistence lifestyle are important to understanding the degree of environmental contact and how subsistence is performed in contemporary times. Also, traditional knowledge can be learned directly from nature. Through observation this knowledge is recognized and a spiritual connection is often attained as a result. Subsistence utilizes traditional and modern technologies for harvesting and preserving foods as well as for distributing the produce through communal networks of sharing and bartering. The following is a useful explanation of "subsistence," slightly modified from the National Park Service:

> *"While non-native people tend to define subsistence in terms of poverty or the minimum amount of food necessary to support life, native people equate subsistence with their culture. It defines who they are as a people. Among many tribes, maintaining a subsistence lifestyle has become the symbol of their survival in the face of mounting political and economic pressures. To Native Americans who continue to depend on natural resources, subsistence is more than eking out a living. The subsistence lifestyle is a communal activity that is the basis of cultural existence and survival. It unifies communities as cohesive functioning units through collective production and distribution of the harvest. Some groups have formalized patterns of sharing, while others do so in more informal ways. Entire families participate, including elders, who assist with less physically*

demanding tasks. Parents teach the young to hunt, fish, and farm. Food and goods are also distributed through native cultural institutions. Nez Perce young hunters and fisherman are required to distribute their first catch throughout the community at a first feast (first bite) ceremony. It is a ceremony that illustrates the young hunter is now a man and a provider for his community. Subsistence embodies cultural values that recognize both the social obligation to share as well as the special spiritual relationship to the land and resources."[2]

The following four categories of an undisturbed environment contribute to individual and community health. Impacts to any of these functions can adversely affect health. Metrics associated with impacts within each of these categories are presented in Harper and Harris (1999).

Human Health-Related Goods and Services: This category includes the provision of water, air, food, and native medicines. In a tribal subsistence situation, the land provided all the food and medicine that was necessary to enjoy long and healthy lives. From a risk perspective, those goods and services can also be exposure pathways.

Environmental Functions and Services: This category includes environmental functions such as soil stabilization and the human services that this provides, such as erosion control or dust reduction. Dust control in turn would provide a human health service related to asthma reduction.

Environmental functions such as nutrient production and plant cover would provide wildlife services such as shelter, nesting areas, and food, which in turn might contribute to the health of a species important to ecotourism. Ecological risk assessment includes narrow examination of exposure pathways to biota as well as examination of impacts to the quality of ecosystems and the services provided by individual biota, ecosystems, and ecology.

Social and Cultural Goods, Functions, Services, and Uses: This category includes many things valued by suburban and tribal communities about Introduction particular places or resources associated with intact ecosystems and landscapes. Some values are common to all communities, such as the aesthetics of undeveloped area s, intrinsic existence value, environmental education, and so on.

Economic Goods and Services: This category includes conventional dollar-based items such as jobs, education, health care, housing, and so on. There is also a parallel non-dollar indigenous economy that provides the same types of services, including employment (i.e., the functional role of individuals in maintaining the functional community and ensuring its survival), shelter (house sites, construction materials), education (intergenerational knowledge required to ensure sustainable survival throughout time and maintain personal and community identity), commerce (barter items and stability of extended trade networks), hospitality, energy (fuel), transportation

[2] National Park Service: http://www.cr.nps.gov/aad/cg/fa_1999/Subsist.htm

(land and water travel, waystops, navigational guides), recreation (scenic visitation areas), and economic support for specialized roles such as religious leaders and teachers.

Ecology

The Nez Perce people have lived in these lands for a very long time and thus have learned about the resources and their ecological interrelationships. They knew about environmental indicators that foretold seasons and conditions that guided them. When Cliff Swallows first appear in the spring, their arrival is an indicator that the fish are coming up the river. Doves are the fish counters, telling how many fish are coming. Many natural phenomena foretell when the earth is coming alive again in the spring, even if things are dormant underground. The Nez Perce has traditional ecological knowledge of this environment and tribal people have ceremonies that acknowledge the arrival of Spring. The winds bring information about what will happen. It provides guidance about how to bring balance back to the land.

Biodiversity on the National Monument

The Monument encompasses a biologically diverse landscape containing an irreplaceable natural and historic legacy. Limited development over approximately 70 years has allowed for the Monument to become a haven for important and increasingly scarce plants and animals of scientific, historic and cultural interest. It supports a broad array of newly discovered or increasingly uncommon native plants and animals. Migrating salmon, birds and hundreds of other native plant and animal species, some found nowhere else in the world, rely on its natural ecosystems. The Monument also includes 46.5 miles of the last free-flowing, non-tidal stretch of the Columbia River, known as the "Hanford Reach."

Salmon

Columbia River salmon runs, once the largest in the world, have declined over 90% during the last century. The 7.4 – 12.5 million average annual number of fish above Bonneville Dam have dropped to 600,000. Of these, approximately 350,000 are produced in hatcheries. Many salmon stocks have been removed from major portions of their historic range (Columbia Basin Fish and Wildlife Authority, 2009).

Multiple salmon runs reach the Hanford Nuclear Reservation. These runs include Spring Chinook, Fall Chinook, Sockeye, Silver and Steelhead. The runs tend to begin in April and end in November.

Salmon runs have been decimated as a result of loss and change to habitat. The changes include non-tribal commercial fisheries, agriculture interests, and especially construction of hydro-projects on the Columbia River. Protection and preservation of anadromous fisheries were not a priority when the 227 Columbia River dams were constructed. Some dams were constructed without fish ladders and ultimately eliminated approximately half of the spawning habit available in the Columbia System.

The Hanford Reach is approximately 51 miles long and is the only place on the upper main stem of the Columbia River where Chinook salmon still spawn naturally. This reach is the last free flowing section of the Columbia River above Bonneville Dam. It produces about eighty to ninety percent of the fall Chinook salmon run on the Columbia River.

Tribal elders say that the last runs of big salmon (Chinook) that came through the Hanford Reach occurred in 1905. Non-Tribal Commercial fisheries on the lower Columbia are largely responsible for the loss of the large Chinook salmon.

The Columbia River Tribes, out of a deep commitment to the fisheries and in spite of the odds, plan to restore stocks of Chinook, Coho, Sockeye, Steelhead, Chum, Sturgeon and Pacific Lamprey. This effort was united in 1995 under a recovery plan called the Wy-Kan-Ush-Mi Wa-Kish-Wit (Spirit of the Salmon). Member tribes are the Nez Perce Umatilla, Warm Springs and Yakama.

The Columbia River tribes see themselves as the keepers of ancient truths and laws of nature. Respect and reverence for the perfection of Creation are the foundation of their culture. Salmon are part of our spiritual and cultural identity. Tribal values are transferred from generation to generation with the salmon returns. Without salmon, tribes would loose the foundation of their spiritual and cultural identity.

All tribes affected by the Hanford site are co-managers of Columbia River fisheries including assisting in tagging fry and counting redds along the Hanford Reach for the purposes of estimating fish returns. This information is essential in the negotiation of fish harvest between the USA and Canada as well as between Indian and non-Indian fishermen.

In many ways, the loss of salmon mirrors the plight of native people. Elders remind us that the fate of humans and salmon are linked. The circle of life has been broken with the loss of traditional fishing sites and salmon runs on the Columbia River.

Socioeconomics

Modern tribal economy

A subsistence economy is one in which currency is limited because many goods and services are produced and consumed within families or bands, and currency is based as much on obligation and respect as on tangible symbols of wealth and immediate barter. It is well-recognized in anthropology that indigenous cultures include networks of materials interlinked with networks of obligation. Together these networks determine how materials and information flow within the community and between the environment and the community. Today, there is an integrated interdependence between formal (cash-based) and informal (barter and subsistence-based) economic sectors that exists and must be considered when thinking of economics and employment of tribal people.[3]

Indian people engage in a complex web of exchanges that often involves traditional plants, minerals, and other natural resources. These exchanges are a foundation of community and intertribal relationships. Thus there are natural resource issues, some of which are located on Hanford, that involve direct production that permeate Indian life. Indian people, catch salmon that become gifts to others living near and far. Sharing self-gathered food or self-made items is a part of establishing and maintaining reciprocal relationships. People have similar relationships between places and elements of nature, which are based on mutual respect for the rights of animals, plants, places and people.

Use of the Hanford site and surrounding areas by tribes was tied primarily to the robust Columbia River fishery. Past social activities of native people include gatherings for such activities like marriages, trading, feasts, harvesting, fishing, and mineral collection. Tribal families and bands lived along the Columbia either year round or seasonally for catching, drying and smoking salmon. The reduction of salmon runs, loss of fishing sites due to dam impoundments and Hanford land use restrictions have contributed to the degradation of the supplies necessary for this gifting and barter system of our tribal culture.

The future of salmon and treaty-reserved fisheries will likely be determined during the life of the GTCC waste. With the tremendous efforts to recover salmon (and other fish species) by tribes, government agencies, and conservation organizations, Tribal expectations are that these species will be recovered to healthy populations.

If aquatic species were to recover, the regional economy and tribal barter economy would likely greatly increase in the Hanford area. These fish returns and the associated social and economic potential should be considered within the lifecycle of a GTCC waste repository.

Direct Production

Direct production by tribes is part of the economy that needs to be represented, especially considering the Tribe's emphasis on salmon recovery. This type of individual commerce in modern economics is termed and calculated as "direct production". The increase in direct production would be relational to the region's salmon recovery, yet there is no economic measure (within the NEPA process) to account for this robust element of a traditional economy.

In a traditional sense, direct production is a term of self and community reliance on the environment for existence as opposed to employment or modern economies. Direct production is use of salmon and raw plant materials for foods, ceremonial, and medicinal needs and the associated trading or gifting of these foods and materials. Direct production needs to be

[3] http://arcticcircle.uconn.edu/NatResources/subsistglobal.html

understood, and should include elements like: use of plant foods, ceremonial plants, medicinal plants, beadwork, hide work, tule mats and dried salmon.

An example of this economy would be the documented number of Native Americans that fished at Celilo Falls; as many as 1500 fisherman assembled at the site not far from Hanford during the peak fishing seasons. Trading between and among tribes include but are not limited to items like dentalia shells, mountain sheep horns, bows, horses, baskets, tule mats, art, bead work, leather and raw hide, and buffalo robes.

Environmental Justice

President Clinton signed Executive Order 12898 to address Environmental Justice issues and to commit each federal department and agency to "make achieving Environmental Justice part of its mission." (Environmental Biosciences Program 2001). According to the Executive Order, no single community should host disproportionate health and social burdens of society's polluting facilities. Many American Indians are concerned about the interpretation of "Environmental Justice" by the U.S. Federal Government in relation to tribes. By this definition, tribes are included as a minority group. However, the definition as a minority group fails to recognize tribes' sovereign nation-state status, the federal trust responsibility, or protection of treaty and statutory rights of American Indians. Because of a lack of the these details, tribal governments and federal agencies have not been able to develop a clear definition of Environmental Justice in Indian Country, and thus it is difficult to determine appropriate actions.

American Indian and Alaskan Natives use and manage the environment holistically; everything is viewed as living and having a spirit. Thus, many federal and state environmental laws and regulations designed to protect the environment do not fully address the needs and concerns of American Indian and Alaskan Natives. Land based resources are the most important assets to tribes spiritually, culturally and economically.

Land Use

The Nez Perce Tribe recommends that DOE continue efforts to identify special places and landscapes with spiritual significance. Newly identified sites would be added to those already requiring American Indian ceremonial access and needing long-term stewardship.

Native people maintain that aboriginal and treaty rights allow for the protection, access to, and use of resources. These rights were established at the origin of the Native People and persist forever. There are sites or locations within the existing Hanford reservation boundary with tribal significance that are presently restricted through DOE's institutional controls and should be considered for special protections or set aside for traditional and contemporary ceremonial uses. Sites like the White Bluffs, Gable Mountain, Rattlesnake Mountain, Gable Butte, and the islands on the river are known to have special meaning to Tribes and should be part of the discussion for special access and protection. These locations should be placed in co-management with DOE, FWS and the Tribes for long-term management and protection.

Tribal Access

In the Regulatory Section there are several federal regulations, policies, and executive orders that define tribal access that override institutional controls of the CLUP or the CCP when risk levels are acceptable for access. The following is a brief summary of those legal references:

According to the *American Indian Religious Freedom Act*, tribal members have a protected right to conduct religious ceremonies at locations on public lands where they are known to have occurred before. There has been an incomplete effort to research the full extent of tribal ceremonial use of the Hanford site.

Executive Order 13007 supports the American Religions Freedom Act by stating that Tribal members have the right to access ceremonial sites. This includes agencies to maintain existing trails or roads that provide access to the sites.

DOE managers that are considering the placement of GTCC waste at Hanford must evaluate any potential impact to ceremonial access as part of their trust responsibility to Tribes.

There are locations that have specific protections due to culturally significant findings, burial sites, artifact clusters, etc. These types of areas are further described under the Cultural Resources Sections. As decommissioning and reclamation occurs across the Hanford site, any culturally significant findings will continue to expand the list of sites and their locations with special protections that override existing land use designation as outlined in the CLUP or other documents.

Comprehensive Land Use Plan (CLUP):

The present DOE land use document for Hanford, called the Comprehensive Land Use Plan (CLUP), has institutional controls that limit present and future use by Native Americans. DOE plans to remove some institutional controls over time as the contamination footprint is reduced as a result of instituting the 2015 vision along the river and also the proposed cleanup of the 200 area. With removal of institutional controls, the affected tribes assume they can resume access to usual and accustomed areas.

Future decisions about land transfer must consider the implications for Usual and Accustomed uses (aboriginal and treaty reserved rights) in the long-term management of resource areas.

The 50-year management time horizon of the CLUP does create permanent land use designations. On the contrary, land use designations or their boundaries can be changed in the interim at the discretion of DOE and/or Hanford stakeholders. The CLUP is often misused by assuming designations are permanent. Also, it is important to not that the interim land use designations in the CLUP cannot abrogate treaty rights. That requires an act of Congress.

Hanford National Monument

A Presidential Proclamation established the Hanford Reach National Monument (Monument) (Presidential Proclamation 7319) and it directed the DOE and the U.S. Fish and Wildlife Service

(FWS) jointly manage the monument. The Monument covers an area of 196,000 acres on the Department of Energy's (DOE) Hanford Reservation. DOE permits and agreements delegates authorities to FWS for 165,000 acres. The DOE directly manages approximately 29,000 acres, and the Washington Department of Fish and Wildlife currently manages the remainder (approximately 800 acres) through a separate DOE permit.

The Monument is co-managed by the FWS and the DOE; each agency has several missions they fulfill at the Hanford Site. The FWS is responsible for the protection and management of Monument resources and people's access to Monument lands under FWS control. The FWS also has the responsibility to protect and recover threatened and endangered species; administer the Migratory Bird Treaty Act; and protect fish, wildlife and Native American and other trust resources within and beyond the boundaries of the Monument.

The FWS developed a comprehensive conservation plan (CCP) for management of the Monument as part of the National Wildlife Refuge System as required under the National Wildlife Refuge System Improvement Act. The CCP is a guide to managing the Monument lands (165,000 acres). It should be understood that FWS management of the Monument is through permits or agreements with the DOE.

Tribes participated in the development of the CCP with regard to protection of natural and cultural resources and tribal access. Based on the Presidential Proclamation that established the Hanford Reach National Monument, Affected tribes assume that all of Hanford will be restored and protected:[4]

Operable Units (OUs)

Hanford has delineated contamination areas called operable units (OUs) both subsurface contamination OUs and surface contamination OUs. When describing the affected environment for land use it is essential to reference this information that should be presented in the soils and groundwater sections. By understanding the types and extent of surface and subsurface contamination will give better understanding of the CLUP landuse designations. For example, the proposed GTCC site at Hanford lies somewhere in or near the 200 ZP-1 groundwater OU. This OU has contamination from uranium, technetium, iodine 129 and other radioactive and chemical constituents.

[4] FR Volume 36--Number 23: 1271-1329; Monday, June 12, 2000

Transportation

Traditional transportation:

Indian people have been traveling this homeland to usual and accustomed areas for a very long time. Early modes of transportation began with foot travel. Domesticated dogs were utilized to carry burdens. Dugout canoes were manufactured and used to traverse the waterways when the waters were amiable. Otherwise, trails along the waterways were used. The arrival of the horse changed how people traveled. Numerous historians note its arrival to the Columbia Plateau in the late 1700's but they are mistaken. The arrival of the horse was actually a full century earlier in the late 1600's. Its acquisition merely quickened movement on an already extant and heavily used travel network. This travel network was utilized by many tribal groups on the Columbia Plateau and was paved by thousands of years of foot travel. Early explorers and surveyors utilized and referenced this extensive trail network. Some of the trails have become major highways and the Columbia and Snake Rivers are still a crucial part of the modern transportation network.

The Middle Columbia Plateau of the Hanford area is the crossroads of the Columbia Plateau located half way between the Great Plains and the Pacific Northwest Coast. In this area major Columbia River tributaries the Walla Walla, Snake, and Yakima Rivers flow into this section of the main stem Columbia River. These rivers formed a critical part of a complex transportation network north, south, east, and west through the region including the Columbia River through the Hanford site. The slow water at the Wallula Gap was one of the few places where horses could traverse the river year round. The river crossing at Wallula provided access to a vast web of trails that crossed the region. Portions of these trails are known to cross the Hanford site.

Present Transportation:

There are two interstate highways that near the site [Interstate 90 (I-90) and Interstate 84 (I-84)]. There are estimates of as many as 12,000 shipments of GTCC waste that would need to be delivered to Hanford by rail, barge or highway. The Nez Perce Tribe believes that decision-making criteria need to be presented in the EIS to clarify how rail, barge or highway routing will be determined. Treaty resources and environmental protections are important criteria in determining a preferred repository location. The public needs to be assured that the public health and high valued resources like salmon and watersheds are going to be protected.

Northwest river systems have received significant federal and state resources over recent decades in an attempt to recover salmon and rehabilitate damaged watersheds. DOE needs to describe how public safety, salmon and watersheds "fit" into the criteria selection process for determining a GTCC waste site and multiple shipping options. The protection and enhancement of existing river systems are critical to sustaining tribal cultures along the Columbia River.

The interstate highway system is a primary transportation corridor for shipping nuclear waste through the states of Oregon, Washington, and Idaho. Waste moving across these states will cross many major salmon bearing rivers that are important to the Tribes. Major rail lines also cross multiple treaty resource areas.

Cultural Resources

From a tribal perspective, all things of the natural environment are recognized as a cultural resource. This is a different perspective from those who think of cultural resources as artifacts or historic structures. The natural environment provides resources for a subsistence lifestyle for tribal people. This daily connection to the land is crucial to Nez Perce culture and has been throughout time. All elements of nature therefore are the connection to tribal religious beliefs. Oral histories confirm this cultural and religious connection.

> "According to our religion, everything is based on nature. Anything that grows or lives, like plants and animals, is part of our religion..." *Horace Axtell (Nez Perce Tribal Elder).*

Landscape and Ethno-Habitat

For thousands of years American Indians have utilized the lands in and around the Hanford Site. Historically, groups such as the Yakama, the Walla Walla, the Wanapum, the Palouse, the Nez Perce, the Columbia, and others had ties to the Hanford area. "The Hanford Reach and the greater Hanford Site, a geographic center for regional American Indian religious activities, is central to the practice of the Indian religion of the region and many believe the Creator made the first people here (DOI 1994). Indian religious leaders such as Smoholla, a prophet of Priest Rapids who brought the Washani religion to the Wanapum and others during the late 19th century, began their teachings here (Relander 1986). Prominent landforms such as Rattlesnake Mountain, Gable Mountain, and Gable Butte, as well as various sites along and including the Columbia River, remain sacred. American Indian traditional cultural places within the Hanford Site include, but are not limited to, a wide variety of places and landscapes: archaeological sites, cemeteries, trails and pathways, campsites and villages, fisheries, hunting grounds, plant gathering areas, holy lands, landmarks, important places in Indian history and culture, places of persistence and resistance, and landscapes of the heart (Bard 1997). Because affected tribal members consider these places sacred, many traditional cultural sites remain unidentified." NEPA 18 4.6.1.2 (p. 4.120).

Viewshed

The Nez Perce Tribe utilizes vantage points to maintain a spiritual connection to the land. Viewsheds must remain in their natural state, they tend to be panoramic and are made special when they contain prominent uncontaminated topography. The viewshed panorama is further enhanced by abrupt changes in topography and or habitats.

Nighttime viewsheds are also significant to indigenous people who still use the Hanford Reach. Each tribe has stories about the night sky and why stars lie in their respective places. The patterns convey spiritual lessons via oral traditions. Often, light pollution from neighboring developments diminishes the view of the constellations. It is getting difficult to find places to simultaneously relate the oral traditions and view the corresponding constellations.

There are several culturally significant viewsheds located on the Hanford site. The continued use of these sites brings spiritual renewal. Special considerations should be given to tribal elders and youth to accommodate traditional ceremonies.

Salmon

Salmon remain a core part of the oral traditions of the tribes of the Columbia Plateau and still maintains a presence in native peoples' diet just as it has for generations. Salmon are recognized as the first food at tribal ceremonies and feasts. One example is the *ke'uyit*, which translates to "first bite." It is a ceremonial feast that is held in spring to recognize the foods that return to take care of the people. It is a long-standing tradition among the people and it is immersed in prayer songs and dancing. Salmon is the first food that is eaten by the attendants. Extending gratitude to the foods for sustaining the life of the people is among the tenets of plateau lifestyle. Nez Perce life is perceived as being intertwined with the life of the Salmon. A parallel can be seen between the dwindling numbers of the Salmon runs and the struggle of native people (Landeen and Pinkham 1999).

Waste Management

The Nez Perce Tribe will continue to work with DOE via its cooperative agreement on cleanup issues to ensure that treaty rights and cultural and natural resources are being protected and that interim cleanup decisions are protective of human health and the environment.

Cumulative Impacts

Within this EIS process, a cumulative risk assessment needs to be developed for the Hanford option. This risk assessment needs to utilize the existing Hanford Tribal risk scenarios (CTUIR, Yakama Indian Nation, DOE default), and include existing Hanford risk values to determine cumulative impacts.

Institutional control boundaries need to be clearly displayed in a map, showing the GTCC proposed repository and the extent it will add to the size, scope, and timeframe of limiting access. For tribal people, a 10,000-year repository extends institutional controls without reasonable compensation or mitigation.

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Appendix A

Legal Framework

TREATY RIGHTS AND OBLIGATIONS

The Nez Perce Tribe is a sovereign government whose territory comprises over 13 million acres of what are today northeast Oregon, southeast Washington, and north-central Idaho. In 1855 the Nez Perce Tribe entered into a treaty with the United States, securing, among other guarantees a permanent homeland, as well as fishing, hunting, gathering, and pasturing rights. (Treaty with the Nez Perces, June 11, 1855; 12 Stat. 957).

Since 1855, many federal and state actions have recognized and reaffirmed the Tribe's treaty-reserved rights. The Tribe's treaty-reserved interests in the Hanford Reach area inform its legal relationship with the United States. Aboriginal rights provided in the 1855 Treaty extend to areas of land in Idaho and surrounding states, including the Columbia, Snake, and Salmon River regions, which may be impacted by DOE activities. Because these rights are of enormous importance to the Tribe 's subsistence and cultural fabric, the ecosystems that support fish and wildlife (including both flora and fauna) must remain undamaged and productive. DOE recognizes the existence of reserved treaty rights and is committed to identifying and assessing impacts of all DOE activities to both on and off-reservation lands.

The Nez Perce Tribe has the responsibility to protect the health, welfare, and safety of its members, and the environment and cultural resources of the Tribe. Therefore, activities (such as any release of hazardous/radioactive substances to the air, water, or soil column) related to the Hanford operations and cleanup should avoid endangering the Tribe 's environment and culture, or impairing their ability to protect the health and welfare of Tribal members.

The Nez Perce Tribe Treaty of 1855

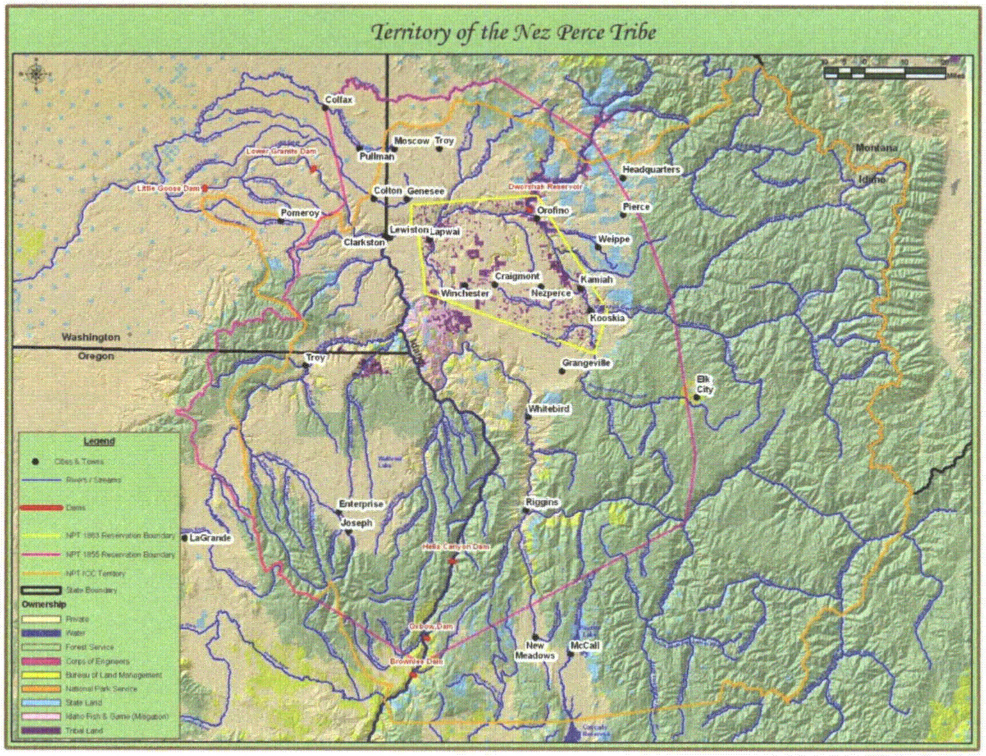
The Nez Perce Tribe Treaty of 1855 promulgated articles of agreement between the United States and the Tribe. The Treaty is superior to any conflicting state laws or state constitutional provisions under the Supremacy Clause of the U.S. Constitution (Art. VI. cl. 2).

Under the Treaty of 1855, the Tribe ceded certain areas of its aboriginal lands to the United States and reserved for its exclusive use and occupation certain lands, rights, and privileges; and the United States assumed fiduciary responsibilities to the Tribe.

> Rights reserved under the Treaty of 1855 include those found in Article 3 of the Treaty, "*The exclusive right of taking fish in all the streams where running through or bordering said reservation is further secured to said Indians; as also the right of taking fish at all usual and accustomed places in common with citizens of the Territory; and of erecting temporary buildings for curing, together*

with the privilege of hunting, gathering roots and berries, and pasturing their horses and cattle upon open and unclaimed land."

The reserved rights to the aforementioned areas are a fundamental concern to the Nez Perce Tribe. The fish, roots, wild game, religious sites, and ancestral burial and living sites remain integral to the Nez Perce culture. The Tribe expects, accordingly, to be the primary consulting party in all federal actions related to Hanford that stand to affect or implicate the Tribe's treaty-reserved or cultural interests.



Treaty Reserved Resources

Treaty reserved resources situated on and off the Reservation (hereinafter referred to as "Tribal Resources") include but are not limited to:

Tribal water resources located within the Columbia, Snake, and Clearwater River Basins including those water resources associated with the Tribe's usual and accustomed fishing areas and Tribal springs and fountains described in Article 8 of the Nez Perce Tribe Treaty of 1863;

Fishery resources situated within the Reservation, as well as those resources associated with the Tribe's usual and accustomed fishing areas in the Columbia, Snake, and Clearwater River Basins;

Areas used for the gathering of roots and berries, hunting, and other cultural activities within open and unclaimed lands including lands along the Columbia, Clearwater, and Snake River Basins;

Open and unclaimed lands which are or may be suitable for domestic livestock grazing;

Forest resources situated on the Reservation and within the ceded areas of the Tribe;

Land holdings held in trust or otherwise located on and off the Nez Perce Reservation in the States of Idaho, Oregon; and Washington;

Culturally sensitive areas, including, but not limited to, areas of archaeological, religious, and historic significance, located both on and off the Reservation.

FEDERAL RECOGNITION OF TRIBAL SOVEREIGNTY

A unique political relationship exists between the United States and Indian Tribes, as defined by treaties, the United States Constitution, statutes, federal policies, executive orders, court decisions, , which recognize Tribes as separate sovereign governments. As a fiduciary, the United States and all its agencies owe a trust duty to the Nez Perce Tribe and other federally-recognized tribes. *See United States v. Cherokee Nation of Oklahoma,* 480 U.S. 700, 707 (1987); *United States v. Mitchell,* 463 U.S. 206, 225 (1983); *Seminole Nation v. United States,* 316 U.S. 286, 296-97 (1942). This trust relationship has been described as "one of the primary cornerstones of Indian law," Felix Cohen, Handbook of Federal Indian Law 221 (1982), and has been compared to one existing under the common law of trusts, with the United States as trustee, the tribes as beneficiaries, and the property and natural resources managed by the United States as the trust corpus. *See, e.g. Mitchell,* 463 U.S. at 225.

The United States' trust obligation includes a substantive duty to consult with a tribe in decision-making to avoid adverse impacts on treaty resources and a duty to protect tribal treaty-reserved rights "and the resources on which those rights depend." *Klamath Tribes v. U.S.,* 24 Ind. Law Rep. 3017, 3020 (D.Or. 1996). The duty ensures that the United States conduct meaningful consultation "in advance with the decision maker or with intermediaries with clear authority to present tribal views to the ... decision maker." *Lower Brule Sioux Tribe v. Deer,* 911 F. Supp 395, 401 (D. S.D. 1995).

Consistent with the United States' trust obligation to Tribes, Congress has enacted numerous laws to protect Tribal resources and cultural interests, including, but not limited to the National Historic Preservation Act (NHPA) of 1966; the Archaeological Resources Protection Act of 1979; the Native American Graves Protection and Repatriation Act (NAPRA) of 1990; and the American Indian Religious Freedom Act (AIRFA) of 1978.

Executive Orders

Executive order, 13007, May 24, 1996. Updated April 30, 2002.

Section 1. Accommodation of Sacred Sites. (a) In managing Federal lands, each executive branch agency with statutory or administrative responsibility for the management of Federal lands shall, to the extent practicable, permitted by law, and not clearly inconsistent with essential agency functions, (1) accommodate access to and ceremonial use of Indian sacred sites by Indian religious practitioners and (2) avoid adversely affecting the physical integrity of such sacred sites. Where appropriate, agencies shall maintain the confidentiality of sacred sites.

This Executive Order directs Federal land-managing agencies to accommodate Native Americans' use of sacred sites for religious purposes and to avoid adversely affecting the physical integrity of sacred sites. {267} Some sacred sites may be considered traditional cultural properties and, if older than 50 years, may be eligible for the National Register of Historic Places. Thus, compliance with the Executive Order may overlap with Section 106 and Section 110 of NHPA. Under the Executive Order, Federal agencies managing lands must implement procedures to carry out the directive's intent. Procedures must provide for reasonable notice where an agency's action may restrict ceremonial use of a sacred site or adversely affect its physical integrity. {268} Federal agencies with land-managing responsibilities must provide the President with a report on implementation of Executive Order No. 13007 one year from its issuance.

Executive Order No. 13007 builds upon a 1994 Presidential Memorandum concerning government-to-government relations with Native American tribal governments. The Memorandum outlined principles Federal agencies must follow in interacting with federally recognized Native American tribes in deference to Native Americans' rights to self-governance. {269} Specifically, Federal agencies are directed to consult with tribal governments prior to taking actions that affect federally recognized tribes and to ensure that Native American concerns receive consideration during the development of Federal projects and programs. The 1994 Memorandum amplified provisions in the 1992 amendments to NHPA enhancing the rights of Native Americans with regard to historic properties.

Executive Order 11593

Section 1. Policy. The Federal Government shall provide leadership in preserving, restoring and maintaining the historic and cultural environment of the Nation. Agencies of the executive branch of the Government (hereinafter referred to as "Federal agencies") shall (1) administer the cultural properties under their control in a spirit of stewardship and trusteeship for future generations, (2) initiate measures necessary to direct their policies, plans and programs in such a way that federally owned sites, structures, and objects of historical, architectural or archaeological significance are preserved, restored and maintained for the inspiration and benefit of the people, and (3), in consultation with the Advisory Council on Historic Preservation (16 U.S.C. 4701), institute procedures to assure that Federal plans and programs contribute to the preservation and enhancement of non-federally owned sites, structures and objects of historical, architectural or archaeological significance.

The Executive Order requires Federal agencies to administer cultural properties under their control and direct their policies, plans, and programs in such a way that federally owned sites, structures, and objects of historical, architectural, or archeological significance were preserved, restored, and maintained. {250} To achieve this goal, Federal agencies are required to locate, inventory, and nominate to the National Register of Historic Places all properties under their jurisdiction or control that appear to qualify for listing in the National Register. {251} The courts have held that Executive Order No. 11593 obligates agencies to conduct adequate surveys to locate "any" and "all" sites of historic value, {252} although this requirement applies only to federally owned or federally controlled properties. {253} Moreover, the Executive Order directs agencies to reconsider any plans to transfer, sell, demolish, or substantially alter any property determined to be eligible for the National Register and to afford the Council an opportunity to comment on any such proposal. {254} Again, the requirement applies only to properties within Federal control or ownership. {255} Finally, the Executive Order requires agencies to record any listed property that may be substantially altered or demolished as a result of Federal action or assistance and to take necessary measures to provide for maintenance of and future planning for historic properties. {256}

Executive Order 13175, November 6, 2000

Executive Order 13175 establishes regular and meaningful consultation and collaboration with tribal officials in the development of Federal policies that have tribal implications, to strengthen the United States government-to-government relationships with Indian tribes, and to reduce the imposition of unfunded mandates upon Indian tribes. The executive Order applies to all federal programs, projects, regulations and policies that have Tribal Implications.

E.O. further provides that each "agency shall have an accountable process to ensure meaningful and timely input by tribal officials in the development of regulatory policies that have tribal implications." According to the President' April 29, 1994 memorandum regarding Government-to-Government Relations with Native American Tribal Governments, federal agencies "shall assess the impacts of Federal Government plans, projects, programs, and activities on tribal trust resources and assure that Tribal government rights and concerns are considered during the development of such plans, projects, programs, and activities." As a result, Federal agencies must proactively protect tribal interest, including those associated with tribal culture, religion, subsistence, and commerce. Meaningful consultation with the Nez Perce Tribe is a vital component of this process.

On November 5, 2009 President Obama issued a Presidential Memorandum for the Heads of Executive Departments and Agencies. That Memorandum affirms the United States' government-to-government relationship with Tribes, and directs each agency to submit to the Office of Management and Budget (OMB), within 90 days and following consultation with tribal governments, "a detailed plan of actions the agency will take to implement the policies and directives of Executive Order 13175."

U.S. Department of Energy American Indian Policy

On November 29, 1991, DOE announced a seven-point American Indian Policy, which formalizes the government-to-government relationship between DOE and federally recognized Indian Tribes. A key policy element pledges prior consultation with Tribes where their interests or reserved treaty rights might be affected by DOE activities. The DOE American Indian Policy provides another basis for the Cooperative Agreement. The Cooperative Agreement will also serve as an Office of Environmental Management Implementation Plan for the DOE American Indian Policy regarding interactions with the Nez Perce Tribe.

THE ROLES OF THE NEZ PERCE TRIBE AT HANFORD

The Tribe has a duty to protect its reserved treaty rights and privileges, environment, culture, and welfare as well as to educate its members and neighboring public to its activities. The Tribe assumes many different roles. It is a governmental entity with powers and authorities derived from its inherent sovereignty, from its status as the owner of land, and from legislative delegations from the Federal government. The Tribe exercises its powers and authority to serve its members and to regulate activities occurring within the reservation. The Tribe is also a cultural entity and is accordingly charged with the responsibility of protecting and transmitting that culture which is uniquely Nez Perce. The Tribe is also a beneficiary within the context of federal trust relationship with, and obligations to Indian Tribes. The Tribe is a trustee responsible for the protection and betterment of its members and the protection of its and their rights and privileges. The Tribe is also party to treaties between itself and the United States government.

Nez Perce and DOE Relationship

The relationship between the Tribe and DOE is defined by the trust relationship that exists between the Federal government and the Tribe, by treaty, federal statute, executive orders, administrative rules, caselaw, DOE's American Indian Policy, and by the mutual and generally convergent interests of the parties in the efficient and expeditious cleanup of the DOE weapons complex, and by the Cooperative Agreement. The structured relationship embodied by the Cooperative Agreement can best be described as a partnership grounded in the site-specific cleanup of Hanford, and extends to all trust-related activities of the Department.

The Tribe sees itself not only as an advisor to DOE, but also as an technical resource available to assist DOE. The Tribe sees its members and employees as a source of technically trained and certified labor for environmental restoration and decontamination and decommissioning work.

The continuation of the Cooperative Agreement contemplates an approach that will integrate these and other roles into a comprehensive Nez Perce-DOE program.

The Tribe is asked to review and comment on documents and activities by DOE implicates our Treaty reserved rights and DOE's acknowledgement of other federal statutes, laws, regulations, executive orders and memoranda governing the United States' relationship with Native Americans and the Nez Perce people. Several tribal departments lend their respective technical expertise to DOE Hanford issues and present recommendations to the Nez Perce Tribal Executive Committee (NPTEC), for consideration and guidance. The NPTEC also may requests formal consultation with the federal agency to discus a proposal or issue further.

Consultation with Native Americans

DOE's consultation responsibilities to the Tribe are enumerated generally in the document entitled, Consultation with Native Americans. This policy defines consultation in relevant part:

> "Consultation includes, but is not limited to: prior to taking any action with potential impacts upon American Indian ands Alaska Native nations, providing for mutually agreed protocols for timely communication, coordination, cooperation, and collaboration to determine the impact on traditional and cultural lifeways, natural resources, treaty and other federally reserved rights involving appropriate tribal officials and representatives through the decision making process."

In regard to security clearance, none of the various provisions of the continuation of the Cooperative Agreement shall be construed as providing for the release of reports or other classified information designated as "classified" or "Unclassified Controlled Nuclear Information" to the Nez Perce Tribe, or as waiving any other security requirements. Classified information includes National Security Information (10 CFR Part 1045) and Restricted Data (10 CFR Part 1016). Unclassified Controlled Nuclear Information is described in 10 CFR Ch. X, Part 1017.

In the event that reports or information requested under the provisions of the continuation of the Cooperative Agreement, while not "classified" or "Unclassified Controlled Nuclear Information," are determined by DOE-RL to be subject to the provisions of the Privacy Act, or the exemptions provided under the Freedom of Information Act, DOE-RL may, to the extent authorized by law, provide such reports or information to the Tribes upon receipt of the Tribe's written assurance that the Nez Perce Tribe will maintain the confidentiality of such data.

Greater Than Class C Radioactive Waste Environmental Impact Statement

Pueblo Views on Environmental Resource Areas

Los Alamos Meeting of Pueblo EIS Writers

June 7 – 12, 2009

Pueblo Writers Representatives

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John W. Yates, Nambe Pueblo

Facilitated By

Richard W. Arnold, Pahrump Paiute Tribe
Richard W. Stoffle, University of Arizona

1.1 Climate

The Pueblo people, having lived since the beginning of time in the region of the proposed GTCC waste disposal site, are concerned about meteorological climate shifts occurring over hundreds of years and longer term climate changes occurring over thousands of years. Such shifts impact vegetation. During dryer periods vegetation burns increase and post-burn erosion is accelerated. The Cerro Grande fire (Grieggs, Ramos, and Percy 2001) increased post-fire storms' runoff flows in some drainages more than 1,000 times the pre-fire levels (United States Department of Energy [DOE] 2008: 4-59). These higher runoff flows increased erosion and moved radioactive and hazardous materials downstream towards the Pueblo people.

During warmer periods, more intense rainfall episodes occur and less snow falls in winter, thus increasing erosion. Tree ring data document shifts in annual rainfall between 1523 and today, with a rainfall high in 1597 of 40 inches to a low in 1685 of 2.4 inches (Sean Rev 4.0: 2008 2-12).

During the Holocene, major shifts occurred in this region, and the GTCC disposal is to be evaluated for a duration of 10,000 years. These climate shifts are both culturally important to the Pueblo people who conduct ceremonies to balance climate and pertinent to the consideration of GTCC proposal.

1.2 Existing Air Emissions

Contaminated air emissions either from fugitive dust, violent storms, dust devils, emission stacks, bomb testing, burn pits, or from the Cerro Grande fire have spread to surrounding Pueblo lands and communities. A Santa Clara Pueblo wind monitor meteorological station recorded a wind of 70 miles per hour. Dust devils have been recorded by LANL at 73 miles per hour. Santa Clara, Pueblo de San Ildefonso, Pueblo de Cochiti, and Jemez perceive that they have received contaminated ash and air from the Cerro Grande fire, from more than 110 historic and active LANL emission stacks, and bomb testing detonations. Nambe, Pojoaque, and the surrounding Pueblos perceive that they too received contaminated ash from the Cerro Grande fire. The contaminations from these events exposed natural resource users ranging from hunters of animals to gatherers of clay for pots. Even normal Pueblo residents were exposed in many ways from farming to outdoor activities to everyday life.

The Pueblo de Cochiti is situated within Sandoval County, and emissions rates here were not compared in the GTCC to emission rates of LANL. The Pueblo de Cochiti is located south of LANL and adjacent to the PSD [Prevention of Significant Deterioration] Class I Bandelier National Monument. The Pueblo de Cochiti could thus be considered a PSD Class I area as well and all emissions pose a threat to this classification.

All the Accord Pueblos (Pueblo de San Ildefonso, Pueblo de Cochiti, Santa Clara, and Jemez Pueblo) are currently conducting independent studies of air emissions from LANL.

These studies have been ongoing for about ten years. Some Pueblos have their findings evaluated by independent laboratories. These studies are monitoring tritium, plutonium, uranium, americium, and other radionuclides and metals. Some of the studies have documented contaminated air emissions on Pueblo lands.

1.3 Existing Noise Environment

The Sacred Area is currently monitored for noise by Pueblo de San Ildefonso. Noise, which from a Pueblo perspective is an unnatural sound, does disturb ceremony and the place itself. Currently non-Indian voices, machinery, and processing equipment have been recorded by Pueblo de San Ildefonso monitors as coming from Area G to the Sacred Area.

1.4 Geology

The Pueblo people are aware of the occurrence of major earthquakes in the GTCC study area (up to 2000 have been recorded in recent times). These cause vertical displacements, large fissures, and small fractures. Water seeps into these fissures and plant roots follow them to great depths (up to 66 feet). Pueblo people believe that plant roots will eventually penetrate the GTCC facility.

1.5 Minerals and Energy Resources

The Pueblo people who visited the proposed GTCC disposal site note the likelihood of traditionally used minerals occurring there. They assess that this is a medium to high probability. There is a need for a cultural mineral assessment and study to identify the existence of minerals of cultural significance and use.

Although there is no current Pueblo ethnogeology studies for the LANL, one was recently developed for Bandelier National Monument (Stoffle et al. 2007). That study, which was approved by the participating pueblos, documented that 96 geological resources were found to have specific uses by Pueblo people, which is estimated to be the bulk of the occurring minerals in Bandelier NM. The following are the ten most frequently cited mineral resources, presented in order of frequency of reference. Included also is the number of pueblos that were documented to have used the named resource (1) Clay 17 times mentioned for 7 pueblos; (2) Turquoise 15 times mentioned for 7 pueblos; (3) Basalt 15 times mentioned for 5 pueblos; (4) Obsidian 9 times mentioned for 4 pueblos; (5) Gypsum 8 times mentioned for 5 pueblos; (6) Rock Crystal 8 times mentioned for 5 pueblos; (7) Salt 7 times mentioned for 4 pueblos; (8) Mica 6 times mentioned for 5 pueblos; (9) Sandstone 6 times mentioned for 5 pueblos; and (10) Hematite 6 times mentioned for 4 pueblos. Just as there are certain minerals that are more frequently documented, certain pueblos were more often the subject of observations and ethnographies (Stoffle et al. 2007: 33).

1.6 Surface Water

Pueblo people know that drainages in LANL flow during major runoff and storm events. These flows, though at times low in volume, have a potential to reach the Rio Grande and lower water bodies. In 1996, the Pueblo of Cochiti conducted a cooperative sediment study with LANL and the USGS in which Pre-1960s Legacy Waste was identified using the Thermal Ionization Mass Spectroscopy (TIMS) method. This Pre-1960s Legacy Waste has been recorded on the up-river portion of the Cochiti Reservoir, which is on the Rio Grande as it passes through the Cochiti Reservation.

There exists high potential for continuing pollution flows as indicated in the GTCC text above, and now the Cerro Grande fire has increased the potential for constituent movement as indicated in the Site-Wide EIS (DOE 2008: 4-59, 4-60). Evidence of radioactivity and hazardous waste (PCBs) movement from LANL has led to fish consumption warnings on eating fish from the Rio Grande.

1.7 Groundwater

Pueblo people know that extensive work has been completed to map and determine flow rates, direction, and quality of groundwater systems. There are independent studies published which challenge these findings. These other studies maintain that monitoring at sites is inadequate and that the drilling practices influence the results (see Bob Gilkeson Reports).

Santa Clara Pueblo is concerned that their groundwater is being contaminated by LANL – especially from TA 54 waste deposits. Even though Santa Clara Pueblo is upstream when only surface water is considered, known faults between LANL and SCP are suspected to connect reservation groundwater and TA 54 wastes in LANL groundwater. Current investigations by Santa Clara Pueblo science teams and funded by the Pueblo are on-going to determine if Santa Clara Pueblo groundwater is connected through water bearing faults.

1.8 Human Health

Standard calculations of human heath exposure as used for the General Public are not applicable to Pueblo populations. The concept General Public is an EPA term that is a generalization that derives from studies of average adult males. Residency time for the General Public tends to be a short period of an individual's lifetime and exposure is voluntary. Pueblo people live here in their Sacred Home Lands for their entire lives and will continue to reside here forever.

Pueblo people use their resources differently than average US citizens so standard dosing rates do not apply. For ceremonial purposes, for example, water is consumed directly from surface water sources and natural springs. Potters, for example, have direct and intimate contact with stream and surface clay deposits. Natural pigment paints, for example, are placed on people's bodies and kept there through long periods of time during which strenuous physical activities opens the pores.

1.9 Ecology

Pueblo People know that they have many traditional plants and animals located on and near to the GTCC proposal area. During a brief visit to the proposed GTCC site, Pueblo EIS writers identified traditional use plants, which include medicinal, ceremonial, and domestic use plants. These plants were identified in a brief period and it was noted that many plants could be identified were a full ethnobotany of the site to be conducted. During this site visit the Pueblo EIS writers identified the presence of traditional animals, but noted that more could easily be identified during a full ethnozoological study.

While a full list of the traditional use plants was not available at the time of this analysis, a recent study conducted on the adjacent Bandelier National Monument identified 205 Pueblo use plants there (Stoffle et al. 2007). These use plants represent 59% of the known plants on the official plant inventory of Bandelier.

A Pueblo Writers' GTCC site visit and a draft LANL LLRW study for Area G documented the presence of the following plants:

Plants From LLRW Areas	Listed in Area G LLRW Study	Observed by Pueblo Writer's Group
Blue Grama (*Bouteloua gracilis*)	X	P
Indian Rice Grass (*Oryzopsis hymenoides*)		P
Cutleaf evening primrose (*Oenothera caespitosa*	X	
Mullein Amaranth (*Verbascum thapsus*)	X	P
Indian Paintbrush (*Castilleja sp.*)		P
4-O'clock (*Mirabilis jalapa*)		P
Narrowleaf Yucca (*Yucca angustissima*)	X	P
Penstemon spp.		P
Prickly Pear (*Opuntia polyacantha*)	X	P
Small Barrel (*Sclerocactus*)		P
Sunflower (*Helianthus petiolaris*)	X	P
Apache Plume (*Fallugia paradoxa*)	X	P
Big Sage (*Artemisia tridentate*)	X	P
Chamisa (*Chrysothamnus nauseosus*)	X	P

Four-wing Saltbush (*Atriplex canescens*)	X	P
Mountain Mahogany (*Cercocarpus montanus*)	X	
New Mexico Locust (*Robinia neomexicana*)	X	
Oak (*Quercus spp.*)	X	
Snakeweed (*Gutierresia sarthrae*)	X	
Squawberry (*Rhus trilobata*)	X	
Wax Currant (*Ribes cereum*)	X	
Wolfberry (*Lycium barbarum*)		P
One-seed Juniper(*Juniperus monosperma*)	X	P
Pinon Pine (*Pinus edulis*)	X	P
Ponderosa Pine (*Pinus ponderosa*)	X	P

While a full list of the traditional use animals was not available at the time of this analysis, a recent study conducted on the adjacent Bandelier National Monument identified 76 Pueblo use animals there (Stoffle et al. 2007). The use animals represent 76% of the animals on the official animal inventory.

A Pueblo GTCC site visit and a LANL LLRW study for Area G documented the presence of the following animals:

Deer
Elk
Lizards
Harvester Ants
Rattlesnake
Cicadas
Mocking Bird
Pocket Mice and Kangaroo Rats
Pocket Gophers
Chipmunks and Ground Squirrels

Pueblo people note that LANL intends to use cover plants such as grasses on disposal pits at closure. These reseeding efforts have caused the intrusion of non-Native plants as well as the intended stabilization grasses. This is a cultural violation because the artificial intrusion of plant seed not normally found in an area is inappropriate. In addition, while grasses are the initial reseeding plants, other plants, trees and woody plants will soon establish in the soft pit closure soils putting deep roots into the disturbed subsoil.

1.10 Environnemental Justice

As Indian peoples culturally affiliated with land currently occupied by LANL, the Pueblo people would like to expand the definition of Environmental Justice so that it reflects the unique burdens borne by them. This definition is defined more fully below.

Pueblo people and their lands have been encroached upon by Europeans since the 1500s. During this time they have experienced loss of control over many aspects of their lives including (1) loss of traditional lands, (2) damage to Sacred Home Lands, (3) negative health effects due to European diseases and shifting diet, and (4) lack of access to traditional places. Negative encroachments that occurred during the Spanish period were continued after 1849 under the United States of America's federal government. The removal of lands for the creation of LANL in 1942 were a major event causing great damage to Pueblo peoples. Resulting pollution to the natural environment and ground disturbances from LANL activities constitute a base-line of negative Environmental Justice impacts. The GTCC proposal needs to be assessed in terms how it would continue these Environmental Justice impacts and thus further increase the differential emotional, health, and cultural burdens borne by the Pueblo peoples.

The Congress of the United States recognized this violation of their human, cultural, and national rights when the American Indian Religious Freedom Act (AIRFA) was passed in 1978. In the AIRFA legislation Congress told all Federal agencies to submit plans which would assure they would no longer violate the religious freedom of American Indian peoples (Stoffle et al. 1990). Subsequent legislation like the Native American Graves Protection and Repatriation Act (NAGPRA) (1990) and Executive Order 13007 – Sacred Sites Access (1996) have further defined their rights to Sacred Home Lands and traditional resources. The Federal Government also has a Trust Responsibility to American Indian peoples which is recognized in the DOE American and Alaska Native policy (http://www.em.doe.gov/pages/emhome.aspx). Environmental Justice is one point of analysis where these concerns can be expressed by Pueblo peoples and the obligations addressed by Federal Agencies during the NEPA EIS process.

Pueblo people believe that their health has been adversely affected by LANL operations including different types of cancers. These concerns were publicly recorded in videos produced with Closing the Circle grants provided by the National Park Service and the DOE (Pueblo de San Ildefonso 2000; Santa Clara 2001). Documentation of these adverse health affects is difficult because post-mortem analysis is not normal due to cultural rules regarding the treatment of the deceased and burial practices.

1.11 Land Use

There are two major power transmission lines, the Norton and Reeves Power lines, which exist on both mesas that are considered by the proposed GTCC (see DOE 2008: 4-136, 4-137). One line goes through GTCC Zone 6 and the other through GTCC North Side and North Side Expanded. These major district power lines occupy the centers of both mesas and greatly reduce the potential areas of the GTCC. Along both lines are a series of

Pueblo archaeology sites, which are currently signed as restricted access areas protected under the National Historic Protection Act.

1.12 Transportation

Pueblo people note that all waste shipments move by highway. There are no local railroads. Pueblo people believe that GTCC waste shipments will adversely impact natural resources, reservation communities, tribal administration activities, public schools, day schools, and businesses located along Highway 502 and Highway 84/285.

The Pueblo of Nambe is located on Highway 84/285 between the Pueblos of Pojoaque and Tesuque. The Pueblo of Nambe is located on the Rio Nambe, which joins the Rio Grande a few miles downstream. The Rio Nambe is the major water source for the Pueblo. Nambe Falls is on the reservation is an eco-tourism destination. Also on the reservation is Nambe Lake, which is used for irrigation of fields (crops) and recreation. Nambe has established several businesses on Highway 84/285, such as the Nambe Pueblo Development Corporation, Nambe Falls Travel Center, Hi-Tech, and many more businesses are planned for this location. New businesses include a water bottling factory, a housing complex, and solar and wind energy projects.

The Pueblo of Nambe raises the issue of security. The Pueblo government wants to know when radioactive waste is being transported past the reservation lands. We have a "need to know" and this information should be provided to appropriate tribal authorities such as First Responders and Emergency Managers. The tribes with Indian Land on transportation routes should be funded by the DOE to train their own radiation monitor teams, to maintain capability for their own safety and to protect sovereign immunity of Native American Tribes as independent Nations within the United States. This would enable tribes to be effective participants in handling hazards and threats as mandated by US. Department of Homeland Security in the "Metrics for Tribes" to be compliant with NIMS. Tribes should be able to participate in the preparations of waste materials for transportation at DOE sites. This participation/observation would give Tribes confidence that proper packing techniques and guidelines are adhered to. Currently Tribes are expected to "trust" that State and Federal authorities are doing this phase properly. The Indian people will feel more comfortable if we have some role in observing the process/procedures particularly if our observers are properly trained to understand the scientific reasons associated with packaging methodology.

The Pueblo of Nambe wants to monitor the transportation of GTCC materials in the same way that transuranic waste is monitored on its route from LANL to WIPP site at Carlsbad.

The Pueblo of Santa Clara is traversed by NM 30. Near this road are tribal residential areas, tribal businesses, schools, and economic developments. This highway is not an alternate route for radioactive waste hauling. A violation of this rule occurred in 2006 when three semi-trailer trucks loaded with radioactive soils from LANL were seen using NM30 as a short-cut route (they should have remained on NM 502) Drivers had disregarded tribal regulations. A tribal representative caught up with them nearby and recorded the violation.

Other Pueblo people have business and tribal resources along potential transportation routes. The Pueblo de San Ildefonso, for example, is concerned about radioactive waste transportation along Highway 502. The Totavi Business Plaza, is an area that was traditionally occupied, and is now a restaurant and gas station and may be a location for new tribal housing. The Pueblo de San Ildefonso youth attend a Day School, a District High School, Middle School, and Elementary Schools along 502. Pojoaque has a business park and two gas stations along 502 and 84/285 as well as their youth attend these schools.

1.13 Cultural Resources

Pueblo oral histories document that they have lived in and used the entire area of LANL including the GTCC proposed site since the beginning of time. Because of this Pueblo people are the descendants of the people who have lived here throughout time and included time periods referred by LANL archaeologists by the terms (1) Paleo-Indian, (2) Archaic, (3) Ancestral Pueblo, (4) American Indian, and (5) Federal Scientific Laboratory (See DOE 2008). Pueblo people lived in the area before the Ancestral Pueblo period, which is dated at 1600AD. Pueblo people continue to know about and value lands, natural resources, and archaeological materials located on LANL. Pueblo people continue to desire and have a culturally important role and responsibilities in the management of all of these traditional lands.

Recent cultural resource surveys have been conducted on LANL, which have identified some sites that were not identified when LANL was established after 1943. Pueblo people believe that these sites are connected with other much larger sites that were destroyed when the LANL facility was built and operated. The Pueblo people express concern that many early LANL developments destroyed culturally significant sites and that no effort has been made to conduct ceremonies that may alleviate the violations association with site destruction.

A known Sacred Area, primarily identified with Pueblo de San Ildefonso, is located on the next mesa to the north of the proposed GTCC waste site. It is spiritually connected to the surrounding area and is not bounded any federal boundaries. It is recognized as a Sacred Area on old USGS quads. The Sacred Area is continually monitored by Pueblo de San Ildefonso to constantly check on its cultural integrity. It has visual, auditory, and spiritual dimensions. Pueblo de San Ildefonso air quality program consistently monitors for tritium releases, which derive from nearby area G on TA 54 on LANL. Winds blow across this area from the Southwest from LANL on to the Sacred Area. The Cerro Grande fire brought ash debris which contained radionuclides to the Sacred Area. The Sacred Area is thus believed to have been contaminated by the ash from Cerro Grande fire. Dust contaminated from ongoing operations from area G has blown into the Sacred Area.

Although four American Indian pueblos, called by LANL the Accord Tribes: Santa Clara Pueblo, Pueblo de San Ildefonso, Jemez Pueblo, and Pueblo de Cochiti have been singled out during the GTCC consultation process as being both nearby and culturally connected with LANL, there is a widely recognized undestanding that other American Indian tribes are also culturally connected with LANL. These include but are not limited to (1) all 8 northern pueblos including San Juan O'Hkayowingee, Nambe O-weenge, Pojoaque, Picuris; (2) Jicarilla Apache; (3) southern Pueblos like Santo Domingo; and (4) western pueblos like Zuni and Hopi. Important LANL actions like the GTCC EIS undergoing a major analysis should include all the culturally connected (affiliated) American Indian tribes.

The LANL NAGPRA consultation report includes the following statement "It is noted that since around 1994, LANL has consistently consulted with five tribes on issues relating to cultural resources management, or at least have informed them of proposed construction projects and other issues surrounding cultural resources management at LANL." These include the "Accord Pueblos" of San Ildefonso, Santa Clara, Cochiti, and Jemez, each of which has signed agreements with LANL, along with the Mescalero Apache Tribe. In addition, the Pueblo of Acoma and the Jicarilla Apache Nation have been recognized as having an active interest in cultural resources management at LANL. A draft version of that NAGPRA report was subsequently also sent in January 2002 to all New Mexico Pueblos and to the Pueblos of Hopi in Arizona and Ysleta del Sur in Texas, as well as to the Jicarilla Apache Nation, the Mescalero Apache Tribe, the Navajo Nation, and the Ute Mountain and Southern Ute Tribes. The pueblo writers find the patterns of consultation by LANL to be confusing and not clearly grounded in a formal policy based on an agreed to Cultural Affiliation study.

Meaning of Artifacts, Places, and Resources – There is a general pueblo concern for pre-agricultural period Indian artifacts and the places where they were left. These include the role of ceremony itself as an act of sanctifying places, such as has been conducted and occurred near Sacred Area over the past thousands of years. Pueblo people believe they have been in the area since the beginning of time. This connection back in time thus connects them to all places, artifacts, and resources in the area.

1.14 Waste Management

The Pueblo people would like to point out a direct conflict in current LANL policy and the GTCC proposal. Today LANL is officially remediating contaminated areas. These actions result in the waste being moved to new sites such as WIPP. Some of this may be transported past Pueblo communities and economic business along transportation routes. LANL has already agreed to remove radioactive waste from Area G to WIPP. Currently LANL is shipping most kinds of radioactive and TRU waste off-site (DOE 2008: 4-160). This current LANL policy is in conflict with the GTCC proposal, which would place radioactive waste and TRU waste on LANL and near Area G. In addition, the Pueblos along the transportation routes will now be exposed twice – once to current LANL waste leaving for elsewhere like the WIPP site, and secondly to new GTCC waste shipments that are arriving from elsewhere.

The Pueblo people note that one of the potential GTCC sites, indicated as Zone 4, that is being considered in the EIS appears to have been withdrawn (June 2009) from consideration for GTCC waste because LANL is continuing to dispose of LLRW waste there (DOE 2008: 4-151). This is LLRW that has been or will be produced by LANL. These additional LANL wastes add to perceived contamination risks by the Pueblo people.

The Pueblo people note that the potential site for the GTCC waste disposal is already leaking radioactive contaminants around the perimeter of Area G and DARHT (DOE 2008: 4-32). GTCC waste could only increase the contamination of this area and add to the off-site flow of contaminants.

There is a known Sacred Area on the next ridge next to the existing LANL Area G radioactive waste isolation facility and also across from the proposed GTCC site. This Sacred Area is spiritually connected to the surrounding area and is not bounded any federal boundaries (it is even recognized as a sacred area on old USGS quads). Area is constantly monitored by Pueblo de San Ildefonso to check on its integrity. The Sacred Area has visual, auditory dimension, which are consistently monitoring for tritium from nearby areas. Winds blow across this area. The Cerro Grande fire brought ash debris, which contained radionuclides to the Sacred Area, thus the area is believed to have been contaminated by the ash from Cerro Grande fire. Radioactive Dust has blown away from Area G and has been recorded near Sacred Area. The Pueblo de San Ildefonso and other pueblo people believe that locating a GTCC facility in this area will further diminish the spiritual integrity of the Sacred Area.

Radioactivity studies using the TIMS (Thermo Ionization Mass Spectrometry) method have been fingerprinted and thus identified the source (1996) of radioactivity found in the sediments of Cochiti Reservoir as coming from LANL. This is a major concern for the Cochiti people. Storm and snow run off bring LANL radioactivity downstream to places where clay is deposited. There has even been a 100-year runoff event since the Cerro Grande fire. Automated recorders have documented radioactivity being recently brought down as far as the Pueblo de San Ildefonso. Jemez Pueblo potters also express concerns they these radioactive movement will impact them when they dig through these deposits while collecting clay for pottery and minerals for other uses.

1.15 Cumulative Impacts from the GTCC Proposed Action at LANL

Pueblo people express a concern that negative *stigmas* have been attached and will continue to be attached to their Sacred Home Lands, the natural resources from these lands, their businesses, and even themselves. The concept of having something, some place, or some people stigmatized is well documented in the NEPA-based literature (Grieggs, Ramos, and Pearcy 2001; Gregory, Flynn, and Slovic 1995; Messer et al. 2006; Metz 1994; Slovic, Flynn, and Gregory 1994). Projects having a significant potential for causing harm are recognizing as having the potential of attaching negative evaluations to the places, people, and resources near where they are located. This has been especially true of hazardous and radioactivity related projects.

The Pueblo people believe that the presence and activities of LANL has caused a variety of negative stigmas, which Pueblo people constantly attempt to address. All of the Accord Pueblos received Federal Closing the Circle grants to both document and address tribal concerns about what LANL has caused. Both NPS and DOE funds were provided to the Accord Pueblos to videotape oral histories regarding what impacts Indian people perceive that the establishment and operation of LANL have had on traditional environmental uses, cultural activities, and spiritual life (http://www.nps.gov/history/hps/HPG/Tribal/index.htm). One set of these impacts can be termed *stigmas*.

Since 1943, when LANL was established, these former pristine Pueblo lands have been disturbed and polluted. This process began immediately during the development of the atomic bomb when sub-critical explosions and radioactive materials processing released radioactivity and mixed wastes. During this period waste disposal was weakly regulated with many disposal sites being poorly documented and contained. The Center for Disease Control is currently reconstructing waste releases during this early period of LANL operations in order to determine whether or not a Dose Reconstruction Study should be formally conducted for LANL (http://www.lahdra.org). Public perceptions of the LANL area as being polluted have grown through time. Recently studies have added to rather than reduced this perception.

Pueblo people document existing and potential kinds of stigmas. Some Pueblos sponsor elk hunting for fundraisers. Recent newspaper discussions of radioactivity being present in area plants, water, and animals have caused, according to Pueblo accounts, reduced participation in such hunts. One tribal fishing lake was identified in a newspaper account as having radioactive fish, which greatly reduced fishing at that lake. Food pollution fears are widely documented. Tribal members also express concerns about using animals. Many Pueblos are moving towards commercial sales of garden products, which are marketed as local Indian-produced organic products. Concerns were expressed that were contaminated clay to be used by a Pueblo potter and the pot subsequently found to be contaminated that this event could greatly reduce all area pottery sales. Other Pueblo people with commercial businesses along highways are concerned that radioactive waste transportation accidents could reduce customer's willingness to stop at tribal businesses. Even Pueblo people themselves believe that there are polluted areas which they currently not do not visit because of their concern for contamination.

Pueblo people believe that the existing background of awareness of contamination would be increased were the public to become aware that GTCC wastes were being transported to and deposited at LANL.

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Umatilla Input from NEPA Analysis for CTUIR at Hanford

<u>Note to EIS preparers.</u> The following information is intended to supplement the Hanford NEPA boilerplate[1] by adding tribal perspectives. This material evolved significantly from the materials submitted by the GTCC Tribal Writers group, but has not been reviewed by them. For questions, please call Stuart Harris (541-966-2400) or Barbara Harper (541-966-2804).

A. CTUIR Introduction to Affected Resources

A.1 History and Standing

For at least 12,000 years, the Columbia River Plateau has supported the survival and thriving for many indigenous peoples. The Columbia River flows through what was a cultural and economic center for the Plateau communities. The indigenous communities were part of the land and its cycles, and it was part of them. The land and its many entities and attributes provided for all their needs: hunting and fishing, food gathering, and endless acres of grass on which to graze their horses, commerce and economy, art, education, health care, and social systems. All of these services flowed among the natural resources, including humans, in continuous interlocking cycles. These relationships form the basis for the unwritten laws or *Tamanwit* that were taught by those who came before, and are passed on through generations by oral tradition in order to protect those yet to arrive. The ancient responsibility to respect and uphold these teachings is directly connected to the culture, the religion, and the landscape along the Columbia Plateau. The cultural identity, survival, and sovereignty of the native nations along the Columbia River and its tributaries are maintained by adhering to, respecting, and obeying these ancient unwritten laws here in this place along the N'Chi Wana, or Big River.

In contemporary times, Indian life along the Columbia River and its tributaries continues to be based on the responsibility to manage modern daily affairs and environmental management practices in a manner consistent with the ancient teachings. This responsibility is to protect, preserve, and enhance this earth including the air, water, and ground, and all that grows and lives here. In order to fulfill this responsibility, the native sovereign nations need cold, clean, uncontaminated water; clean, clear uncontaminated air; uncontaminated soil; clean, vibrant, and uncontaminated biological resources; clean, uncontaminated, and wholesome foods; and clean, uncontaminated, and healthful medicines.

[1] Duncan, J.P. (ed.)(2007) Hanford Site National Environmental Policy Act (NEPA) Characterization. PNNL-6415 Rev. 18.

A.1.1 Treaties of 1855

In 1855, representatives of the U.S. Government signed treaties with representatives from many of the different Indian groups in the southern Plateau. The Indian groups ceded ownership of huge tracts of land to the federal government in return for promises food, education, health care, and other services, and retained the perpetual right to fish, hunt, erect fish-curing structures, gather food, and graze stock throughout the region, including the area in and around Hanford. Through the Treaties, the native nations sought to protect their homeland and food gathering rights within the traditional use areas necessary to sustain their citizens, preserve their cultural, subsistence, and ceremonial practices, and ensure the survival of future generations. The Treaties are legal contracts binding the native sovereign nations and the United States of America, and bring forth Federal fiduciary and trusteeship responsibilities to protect these interests.

A.1.2 Nuclear Waste Policy Act of 1982 and Tri-Party Agreement of 1989

The Nuclear Waste Policy Act of 1982 recognized the three native nations (the Confederated Tribes of the Umatilla Indian Reservation, the Yakama Nation, and the Nez Perce Tribe) as "affected Indian Tribes" at Hanford because they have "federally defined possessory or usage rights to other lands outside of the reservation's boundaries arising out of congressionally ratified treaties" and could be "substantially and adversely affected by the locating of such a facility." (Title 42, Chapter 108).

In 1989, the cleanup of the Site began with the Hanford Federal Facility and Consent Order, also known as the Tri-Party Agreement, which is the legal framework for cleanup of the Site. Through the original NWPA designation, these three native sovereign nations were recognized as having vital interests in the cleanup process. In 1992, cooperative agreements between the U.S. DOE-Headquarters and the three affected tribes were agreed upon to enable tribal participation in Hanford cleanup issues and decisions, protection of cultural resources, and (more recently) to engage in natural resource injury assessment and restoration activities as Natural Resource Trustees.

A.1.3 Policy on American Indian and Alaskan Native Tribal Government (2000) and DOE Order 1230.2 (1992).

In this policy DOE formalized its commitment to meeting its government-to-government relationships. The most important doctrine derived from this relationship is the trust responsibility of the United States to protect tribal sovereignty and self-determination, tribal lands, assets, resources, and treaty and other federally recognized and reserved rights. These aspects carry through the evaluation of affected resources.

A.1.4 Framework to Provide Guidance for Implementation of US DOE's Policy (2007) and DOE Oder 144.1

This framework enhances DOE's government-to-government working relationship with Indian Nations. DOE offices of EM, NE, SC, and NNSA will work to foster the government-to-government relationship with Indian Nations impacted by its activities and to maintain DOE'S trust responsibilities including: (a) protecting tribal people and tribal resources from EM, NE, SC, or NNSA actions that could harm their health, safety, or sustainability; and (b) protecting cultural and religious artifacts and sites on lands managed by DOE. DOE will endeavor to protect natural resources which include plants, animals, minerals, and natural features that have religious significance to Indian tribes and/or are held in trust by the Federal Government. The aspects of health and resource protection carry through the evaluation of affected resources.

A.2 The Fiduciary Trust Relationship

"The Federal Government has enacted numerous statutes and promulgated numerous regulations that establish and define a trust relationship with Indian tribes. The United States continues to work with Indian tribes on a government-to-government basis to address issues concerning Indian tribal self-government, tribal trust resources, and Indian tribal treaty and other rights" (Executive Order 13175, 65 Fed. Reg. 67249 (November 9, 2000)).

The Ninth Circuit has underscored the importance of trust responsibility for all agencies:

> "We have noted, with great frequency, that the federal government is the trustee of the Indian tribes' rights, including fishing rights. *See,* e.g., Joint Bd. of Control v. United States, 862 F.2d 195, 198 (9th Cir. 1988). This trust responsibility extends not just to the Interior Department, but attaches to the federal government as a whole."

Tribal trust law is most well developed in the arena of trust property and money[2]. Indian Trust assets include, but are not limited to money, lands, rights, and water. The federal Indian trust doctrine is considered the "cornerstone" of federal Indian law.

> *See* Dep't of the Interior v. Klamath Water Users Protective Ass'n, 532 U.S. 1, 11 (2001) ("The fiduciary relationship has been described as 'one of the primary cornerstones of Indian law,' and has been compared to one existing under a common law trust, with the United States as trustee, the Indian tribes or individuals as beneficiaries, and the property and natural resources managed by the United States as the trust corpus.").

The courts have made it clear that certain kinds of Indian property and monies are held by the United States in trust. In such cases, the government must assume the obligations of a fiduciary or trustee. The courts have imposed trust duties with respect to tribal funds. Additionally, as the Indian Claims Commission noted, "the fiduciary obligations of the United States toward restricted Indian reservation land, including minerals and timber, are established by law and require no proof." *Blackfeet and Gros Ventre Tribes of*

[2] **http://www.msaj.com/papers/43099.htm**

Indians, 32 Ind. Cl. Comm. 65, 77 (1973). As a general matter, the United States must properly manage and, protect such resources as: tribal land, *United States v. Shoshone Tribe of Indians*, 304 U.S. 111 (1938); *Lane v. Pueblo of Santa Rosa*, 249 U.S. 110 (1919); tribal minerals, *Navajo Tribe of Indians v. United States*, 9 Cl. Ct. 227 (1985); oil and gas, *Navajo Tribe of Indians v. United States*, 610 F.2d 766 (Ct. Cl. 1979); grazing lands, *White Mountain Apache Tribe v. United States*, 8 Cl. Ct. 677 (1985); water, *Id.*, and timber, *United States v. Mitchell*, (*Mitchell II*), *supra.*

> "An Indian Trust Asset (ITA) is defined by the Bureau of Reclamation (Reclamation) as a legal interest in an asset that is held in trust by the U.S. Government for Indian Tribes or individual Tribal members. Examples of ITA's include water rights, lands, minerals, hunting and fishing rights, money, and claims."[3]

Fiduciary trustee must always act in the interests of the beneficiaries (*Covelo Indian Community v. FERC*, 895 F.2d 581 (9th Cir. 1990 at 586). A trustee is obligated to not waste the trust asset. The Trust responsibility means that the federal government needs to be on the side of the Tribes. The federal government must act on behalf of the tribe, and is not supposed to treat tribes as stakeholders to be considered.

The Supreme Court, in defining the trust responsibility, has held that:

> [The federal government] has charged itself with moral obligations of the highest responsibility and trust. Its conduct, as disclosed in the acts of those who represent it in dealing with the Indians, should therefore be judged by the most exacting fiduciary standards. *Seminole Nation v. United States*, 316 U.S. 286, 296-97 (1941).

United States v. White Mountain Apache Tribe, 537 U.S. 465, 475 (2003) recognizes that the fundamental common law duty of a trustee is to maintain trust assets. Fort Mojave Indian Tribe v. United States, 23 Cl. Ct. 417, 426 (Cl. Ct. 1991) found the federal trust duty to protect Indian water rights because "the title to plaintiffs' water rights constitutes the trust property which the government, as trustee, has a duty to preserve."

The same trust principles that govern private fiduciaries also define the scope of the federal government's obligations to the Tribe. *See Covelo Indian Community v. F.E.R.C.*, 895 F.2d 581, 586 (9th cir. 1990). These include: 1) preserving and protecting the trust property; 2) informing the beneficiary about the condition of the trust resource; and 3) acting fairly, justly and honestly in the utmost good faith and with sound judgment and prudence. *See Assiniboine and Sioux Tribes v. Board of Oil and Gas Conservation*, 792 F.2d 782, 794 (9th Cir. 1986); *Trust*, 89 C.J.S. §§ 246-62. Additionally, a long line of cases imposes a trust duty of protection on agencies when their off-reservation actions threaten the use and enjoyment of Indian land. *See, e.g., Northern Cheyenne Tribe v. Hodel*, 851 F.2d 1152 (9th Cir. 1988); *Joint Tribal Council of Passomoquaddy Tribe v. Morton*, 528 F.2d 370, 379 (1st Cir. 1975).

[3] http://www.ose.state.nm.us/water-info/AamodtSettlement/Appendix21.pdf

In addition to the fiduciary trust obligations of the federal government to the Hanford tribes, the Confederated Tribes of the Umatilla Indian Reservation, Yakama Nation, and the Nez Perce Tribe are recognized by the federal government as trustees of the natural resources at Hanford.[4]

> "The concept of natural resource trustees is derived from the public trust doctrine. This ancient principal of law provides that governments hold certain property and natural resources in trust for the benefit of the public. Furthermore, the governments have the duty and authority to protect and preserve such property and resources for public uses."

Both CERCLA and OPA define "natural resources" broadly to include "land, fish, wildlife, biota, air, water, ground water, drinking water supplies, and other such resources..." Both statutes limit "natural resources" to those resources held in trust for the public, termed Trust Resources. While there are slight variations in their definitions, both CERCLA and OPA state that a "natural resource" is a resource "belonging to, managed by, held in trust by, appertaining to, or otherwise controlled by" the United States, any State, an Indian Tribe, a local government, or a foreign government [CERCLA §101(16); OPA §1001(20)].[5]

In summary, it is the opinion of the CTUIR and the Indian Writer's Group that the "reference location" for the GTCC disposal at Hanford involves a Trust Resource under natural resource trusteeship rules, and has associated obligations of the federal fiduciary trustee (the federal government) to the Tribes, and of the natural resource trustees (Tribes, states, and federal government) to each other and their constituencies.

A.3 Regional and Sitewide Tribal Context

The natural law, or Tamanwit, teaches that American Indian people are not separate from the environment. A tremendous amount of tribal knowledge is contained and taught through oral traditions. Some stories and oral histories contain factual information, while others contain social principles and cultural values. Traditional environmental knowledge reflects tribal science and keen observation, sometimes expressed as accurate explanations of environmental processes, and sometimes expressed in symbolic terms. These teachings have been built over thousands of years, and teach each generation how to live and behave to sustain themselves and the community. This lifestyle is resilient, having persisted through floods, droughts, cataclysms, upheavals, and warfare.

[4] http://www.hanford.gov/?page=292&parent=291
[5] http://www.epa.gov/superfund/programs/nrd/primer.htm

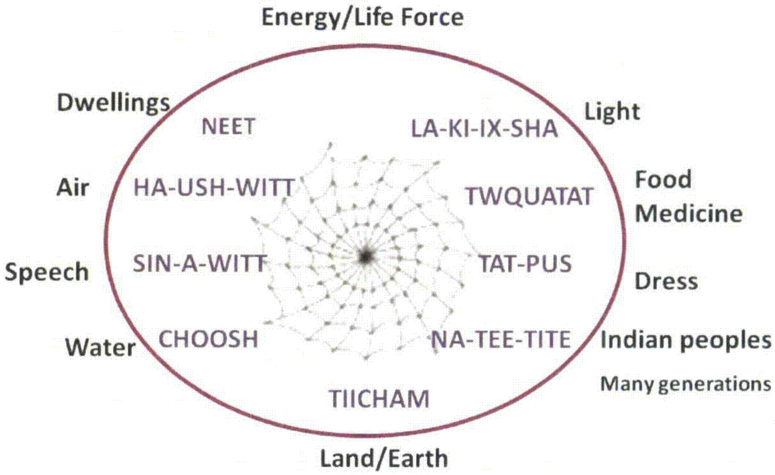

Figure. Depiction of CTUIR Tamanwit, the Natural Law.

Native American ties to the environment are much more complex and intense than is generally understood by risk assessors (Harris 1998). All of the foods and implements gathered and manufactured by the traditional American Indian are interconnected in at least one way, but more often in many ways. Everything is woven together in a web that extends across space-time. To many American Indians, individual and collective well-being is derived from membership in a healthy community that has access to, and utilization of, ancestral lands and traditional resources, so that they may fulfill their part of the natural cycles and their responsibility to uphold the natural law. Adverse impacts to one resource ripple through the entire web and through interconnected biological and human communities. Therefore, if the link between a person and his/her environment is severed through the introduction of contamination or physical or administrative disruption, natural resource service flows may be interrupted, the person's health suffers, and the well being of the entire community is affected.

B. CTUIR Affected Resources – Features, Attributes, Goods, and Services

B.1 Climate and Ethnohistory

People have inhabited the Columbia Basin throughout the entire Younger Dryas era (from 10,000 years ago to the present). Several even earlier archaeological sites are known. Mammoth and bison harvest sites are found throughout the Columbia Plateau. As the temperatures rose throughout this period, the Pleistocene lakes began to shrink and wither away into alkali basins. The post-glacial grasslands of the Great Basin and Columbia Basin were replaced by desert grasses, juniper, and sage, and megafauna likewise decreased through ecological and hunting pressure. The glaciers in the Cascades, Wallowa and Steens mountains rapidly disappeared.[6]

After about 5400 B.P. increasing precipitation and rising water tables were apparent again on both sides of the Cascades. Pollen history indicates continual short, sharp climatic shifts that, directly (e.g., soil moisture) or indirectly (e.g., fire and disease), produced rapid changes in the Northwest's vegetation. The plants and animals were now modern in form. Hunters switched to deer, elk, antelope and small game such as rabbits and birds. Fishing also became important along the coastal streams and in the Columbia River system, with an increasing emphasis on the annual runs of the salmon even though salmon runs date considerably farther back. [6]

The human ethnohistory in the Columbia Basin is divided into cultural periods that parallel the climatic periods and represent cultural adaptations to changing environmental conditions. Throughout this entire period the oral history continually added information needed for survival and resiliency as the climate fluctuated. The oral history of local native people is consistent with contemporary scientific and historic knowledge of the region and validates the extreme climate changes that have occurred in the region over thousands of years. Cameron (2008)[7] examined archaeological, ethnographic, paleo-environmental, and oral historical studies from the Interior Plateau of British Columbia, Canada, from the Late Holocene period, and found correlations among all four sources of information.

Tribal stories tell of eruptions, volcanoes, great floods, and animals now extinct. Indian people on the Columbia Plateau have stories about the world being destroyed by fire and water. Some of these were directly experienced, for example, the Mazama eruption

[6] http://www.oregon-archaeology.com/archaeology/oregon/;
http://www.wac6.org/livesite/precirculated/1803_precirculated.pdf;
Mehringer, P.J. (1996) "Columbia River Basin EcosystemsL Late Quaternary.
http://www.icbemp.gov/science/mehringe.pdf.

[7] Camerion, I (2008) "Late Holocene environmental change on the Interior Plateau of Western Canada as seen through the archaeological and oral historical records." World Archaeological Congress 6, Dublin, Ireland.

6,800 years ago, and the last of the Missoula floods 13,000 years ago. A major landscape feature at Hanford, Gable Mountain or Nookshia (Relander1986: 305), is remembered when it rose out of the flood waters. Older events were accurately inferred from geologic features and then taught, either as literal explanations of the physiography or in symbolic terms as stories or fables (i.e., taking the opportunity to teach a beneficial eco-behavioral lesson).

Large scale manipulation of plants and animals through fire as a tool to reduce plants tied up in climax vegetation and to increase valued plant (and animals that depended on them) started perhaps 3500-3000 years ago, particularly in moister areas where burning out climax vegetation reduced the biomass tied up in cellulose (trees), and increased the diversity of the natural habitat. Important species such as elk, camas (a root food), tarweed (a seed food) and oak were enhanced with periodic burning. Other plants used for food, medicine, and fiber also increase in relative abundance with the use of fire.

Climate change that will occur over the next 10,000 years will inevitably draw on knowledge from the past, whether the climate becomes wetter or drier. Evaluation of future climate scenarios will need to include as much variation as occurred in the last 10,000 years.

B.2 Air Quality

The importance of clean fresh air is often overlooked in NEPA analysis. For example, while wind and fire are part of the natural regime, and an intact soil surface with a cryptogam crust in the desert reduces dust resuspension during wind events.

While chemical and radioactive air emissions are relatively low at Hanford presently, the extensive cleanup and construction activities on Hanford contribute to blowing dust, increased traffic, diesel emissions, deposition or re-deposition of radionuclides, and generation of ozone, particulate matter, and other air pollutants with unknown human and environmental health effects. Viewshed and haze are also affected.

B.3 Physical Resources

It is well known that environmental attributes or qualities such as wilderness, solitude, peace, calm, quiet, and darkness are important to individual species that need large undisturbed habitat as well as to humans who value those experiential qualities[8]. These qualities are very fragile, and once lost are hard to recover. A single light at night breaks the quality of darkness, just as the first drop of contamination changes the quality of water from pure to impure. CTUIR recommends that more attention be paid to the value of unfragmented and undisturbed shrub steppe habitat and natural resources.

[8] http://findarticles.com/p/articles/mi_m1145/is_n8_v29/ai_15769900/; http://findarticles.com/p/articles/mi_m1145/is_n8_v29/ai_15769900/

B.3 .1 Quiet

Noise can affect living organisms in the ecosystem through interruption of reproductive cycles and migration patterns, and driving away species that are sensitive to human presence. Non-natural noise can be offensive while traditional ceremonies are being held. The noise generated by the Hanford facility may presently create noise interference for ceremonies held at sites like Gable Mountain and Rattlesnake Mountain by interrupting the thoughts and focus and thus the spiritual balance and harmony of the community participants of a ceremony (Greider 1993)[9].

B.3.2 Darkness

Light at night affects nocturnal animals such as bats, owls, night crawlers and other species. Night light also has known affects on diurnal creatures and plants by interrupting their natural patterns. Light can affect reproduction, migration, feeding and other aspects of a living organism's survival. Light at night also disrupts the quality of human experience, including star gazing and cultural activities. Extensive light pollution is already being produced from by the Hanford site.

B.4 Geological Resources

Geological resources include soils, sediments, minerals, geological landscapes and associated features, borrow materials, gas, and petroleum.

B.4.1 Soils, Minerals

Native Peoples understand the importance of soils and minerals. Many uses of soils are included in the attached material on exposure pathways. At Hanford, material from the White Bluffs was used for cleaning hides, making paints, and whitewashing villages. Borrow material for caps, barriers, and clean fill is a particular concern, and needs to be part of each NEPA analysis.

B.4.2 Landscapes

The human aspects of Hanford landscapes are discussed briefly here. The CTUIR recommend that DOE pay more attention to landscape features and visual and aesthetic services that flow from the geologic formations at Hanford. Cultural and sacred landscapes may be invisible unless they are disclosed by the peoples to whom they are important. Tribal values lie embedded within the rich cultural landscape and are conveyed to the next generation through oral tradition by the depth of the Indian languages. Numerous landmarks are mnemonics to the events, stories, and cultural practices of native peoples. Oral histories impart basic beliefs, taught moral values and the land ethic, and helped explained the creation of the world, the origin of rituals and customs, the location of food, and the meaning of natural phenomena. The oral tradition

[9] Greider, T (1993) Aircraft Noise and the Practice of Indian Medicine: The Symbolic Transformation of the Environment. Human Organization 52(1): 76-82.

provides accounts and descriptions of the region's flora, fauna, and geology. Within this landscape are songs associated with specific places; when access is denied a song may be lost.

"At Hanford there are three overlapping cultural landscapes that overlie the natural landscape. These are not displacements of a previous landscape by a new landscape, but a coexistence of all three simultaneously even if one landscape is more visible in a particular area. The first represents the American Indians, who have created a rich archeological and ethnographic record spanning more than 10,000 years. This is the only stretch of the Columbia River that is still free-flowing, and one of the few areas in the Mid-Columbia Valley without modern agricultural development. As a result, this is one of the few places where native villages and campsites can still be found. Still today, local American Indian tribes revere the area for its spiritual and cultural importance, as they continue the traditions practiced by their ancestors." The second landscape was created by early settlers, and the third by the Manhattan Project. Today, DOE is removing much of the visible portion of the Manhattan landscape, returning the surface of the site to a more natural state (restoration and conservation) and thus revealing the cultural landscape that remains underneath.[10]

The Hanford Reach and the greater Hanford Site, a geographic center for regional American Indian religious activities, is central to the practice of the Indian religion of the region and many believe the Creator made the first people here. Indian religious leaders such as Smoholla, a prophet of Priest Rapids who brought the Washani religion to the Wanapum and others during the late 19th century, began their teachings here. Prominent landforms such as Rattlesnake Mountain, Gable Mountain, and Gable Butte, as well as various sites along and including the Columbia River, remain sacred. American Indian traditional cultural places within the Hanford Site include, but are not limited to, a wide variety of places and landscapes: archaeological sites, cemeteries, trails and pathways, campsites and villages, fisheries, hunting grounds, plant gathering areas, holy lands, landmarks, important places in Indian history and culture, places of persistence and resistance, and landscapes of the heart. Because affected tribal members consider these places sacred, many traditional cultural sites remain unidentified.

More generally, cultural landscapes have been defined by the World Heritage Committee as distinct geographical areas or properties uniquely representing the combined work of nature and of man. They identified and adopted three categories of landscape: the purely natural landscape, the human-created landscape, and an associative cultural landscape which may be valued because of the religious, artistic or cultural associations of the natural and/or human elements.

Sacred natural sites are natural places recognized by indigenous and traditional peoples as having spiritual or religious significance. They can be mountains, rivers, lakes, caves, forest groves, coastal waters, and entire islands. The reasons for their sacredness are diverse. They may be perceived as abodes of deities and ancestral spirits; as sources of healing water and plants; places of contact with the spiritual, or communication with the

[10] http://www.hanford.gov/doe/history/?history=archaeology.

'beyond-human' reality; and sites of revelation and transformation. As a result of access restrictions, many sacred places are now important reservoirs of biological diversity. Sacred natural sites such as forest groves, mountains and rivers, are often visible in the landscape as vegetation-rich ecosystems, contrasting dramatically from adjoining, non-sacred, degraded environments.[11]

B.4.3 Viewsheds

Viewscapes tend to be panoramic and are made special when they contain prominent topography. Viewscapes are tied with songscapes and storyscapes, especially when the vantage point has a panorama composed of multiple locations from either song or story. Viewscapes are critical to the performance of some Indian ceremonies. As told by a Wanapum elder, within the Hanford viewshed (at an undisclosed location) is at least one calendar wheel that guided native residents in their movements and activities. The wheel had spokes which were duplicated at villages. At each village a white stone was placed in the ground and atop this stood a high post. The post would cast a shadow which was read. When it reached a certain angle, like the spoke in the wheel, the people would respond with the proper action. The wheel was a reference point that held time schedules. Gable Mountain is a central area which is also a point of reference for many ceremonies. Many of the reference points that were set on the ground are organized like the stars – they are related in important ways that are described in detailed songs and stories. Interruption of the vista by large facilities or bright lights impairs the cultural services associated with the viewshed.

A viewshed map is included in the Hanford NEPA boilerplate document (Duncan 2007).

B.5 Water

Water sustains all life. As with all resources, there is both a practical and a spiritual aspect to water. Water is sacred to the Indian people, and without it nothing would live. When having a feast, a sip of water is taken either first or after a bite of salmon, then a bit of salmon, then small bites of the four legged animals, then bites of roots and berries, and then all the other foods.

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[11] Oviedo, G. (2002). member of the Task Force of Non-Material Values of Protected Areas of the World Commission on Protected Areas (WCPA), at the Panel on Religion, Spirituality and the Environment of the World Civil Society Forum, Geneva, 17 July 2002.
Stoffle, R.W., Halmo, D.B., Austin, D.E. (1998). Cultural Landscapes and Traditional Cultural Properties: a Southern Paiute View of the Grand Canyon and Colorado River. American Indian Quarterly, Vol. 21: 229-250.
Walker, D.E., 1991. "Protection of American Indian Sacred Geography," in: *Handbook of American Indian Religious Freedom,* Vecsey, C., Ed., Crossroad, New York, NY, pp. 100-115.

The quality of purity is very important for ceremonial use of water. For example, making a sweat lodge and sweating is a process of cleansing and purification. The sweat lodge should be made with clean natural materials and the water used for sweat-bathing should also be uncontaminated. The concept of sacred water or holy water is global, and often connects people, places, and religion; religions that are not land-connected may lose this concept.[12] Additionally, concepts related to the flow of services from groundwater and the valuation of groundwater are receiving increased attention.[13]

Although DOE's threshold for groundwater injury may be regulatory standards based on human or biological health, perhaps the most important criterion for contamination from a tribal perspective is the first drop of contamination, which moves the water from a condition of purity to a condition of degraded. This concept sets a threshold of injury at background or the detection limit.

From the CTUIR's perspective, contamination in the groundwater at the Hanford site is the greatest long-term threat to the Columbia River. There is a tremendous volume of radioactive and chemical contamination in the vadose zone and the groundwater. The mechanics of transport of contaminants through the soil to the ground water is still largely unknown. The actual volumes of contamination within the ground water and the direction of ground water flow are not fully characterized. The uncertainly due to this lack of knowledge and the limited technical ability to remediate the vadose zone and ground water puts the Columbia River and its biota at continual risk. The tremendous importance of groundwater means that the uncertainty about present and future contamination must play a key role in the risk assessment – the severity of the consequences if groundwater and the river become more contaminated is high (risk = probability x severity).

[12] Altman, N. (2002) Sacred Water: the Spiritual Source of Life. Mahwah, NJ: Hidden Spring Publ.; Marks, W.E. (2001) The Holy Order of Water. Vancouver BC: Steiner Books Inc.;
Burmil, S., Daniel, T.C., and Hetherington, J.D. (1999). Human values and perceptions of water in arid landscapes. *Landscape and Urban Planning,* 44: 99-109;
Mazumdar, S. and Mazumdar, S. (2004). Religion and place attachment: A study of sacred places. Journal of Environmental Psychology, 24: 385-397.
[13] National Research Council (1997) Valuing Ground Water: Economic Concepts and Approaches. Washington D.C.: National Academy Press.

B.6 Biological Resources

B.6.1 Ethno-Habitat

Natural resources are integral to many traditional practices and celebrations throughout the year, many of which honor the traditional foods or First Foods. Based on the importance and many uses of the natural resources, an exposure scenario reflecting the underlying **ethnohabitat or eco-cultural system** was developed for use in dose and risk assessments at Hanford (Harper and Harris 1997; Harris and Harper 2000; CTUIR 2004)[14]. Ethno-habitats can be defined as the set of cultural, religious, nutritional, educational, psychological, and other services provided by intact, functioning ecosystems and landscapes. Although the concept of ethnohabitat or ethnoecology has been used various forms in anthropological disciplines for many years, it had never been used in risk assessment.

A healthy ethno-habitat or eco-cultural system is one that supports its natural plant and animal communities and also sustains the biophysical and spiritual health of its native peoples. Ethno-habitats are places clearly defined and well understood by groups of people within the context of their culture. These are living systems that serve to help sustain modern Native American peoples' way of life, cultural integrity, social cohesion, and socio-economic well-being. The lands, which embody these systems, encompass traditional Native American homelands, places, ecological habitats, resources, ancestral remains, cultural landmarks, and cultural heritage. Larger ethno-habitats can include multiple interconnected watersheds, discrete geographies, seasonal use areas, and access corridors.[15] A depiction of the eco-cultural system for the CTUIR is shown as a seasonal round that includes both terrestrial and aquatic resources.

Figure. Umatilla Seasonal Round

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[14] Harris, S.G. and Harper, B.L. "A Native American Exposure Scenario." Risk Analysis, 17(6): 789-795, 1997; S Harris and B Harper. "Using Eco-Cultural Dependency Webs in Risk Assessment and Characterization." Environmental Science and Pollution Research, 7(Special 2): 91-100, 2000; http://www.hhs.oregonstate.edu/ph/tribal-grant-main-page.

[15] Modified from the East-Side EIS of the Interior Columbia Environmental Management Plan (ICBEMP).

B.6.2 Terrestrial Resources of the Plateau Culture Area

An ethnoecological approach to describing terrestrial resources begins with a description of the potential natural vegetation within the Columbia Basin ecozones, and then describes the natural resource usage patterns of the Plateau Culture Area.[16]

All natural resources are significant to tribal culture as part of functioning ecosystems, and many are individually important as useful for food, medicines, materials, or other uses. A comprehensive list of potentially injured biota was compiled for the tribal natural resource trustees, including 13 algae species, 56 fish species, 269 bird species, 52 mammal species, 21 amphibian and reptile species, over 800 aquatic and terrestrial plant species, and dozens of orders, families, and genera of aquatic and terrestrial insects.

The Hanford shrub steppe is a Washington State priority habitat[17] due to its large and largely unfragmented nature, which is now rare. In the 1970s, the National Environmental Research Park (NERP) program created seven NERPs to set aside land for ecosystem preservation and study. The Hanford NERP, managed by the Department of Energy, includes the Fitzner/Eberhardt Arid Lands Ecology Reserve, which is the only remaining sizable remnant (312 square kilometers, 120 square miles) of the Washington shrub-steppe landscape that is still in a relatively pristine condition, the industrial zone of the Hanford Site, which contains nuclear production facilities in various stages of cleanup and closure, and buffer zones on the opposite shore of the Columbia River: the US Department of the Interior's Saddle Mountain Wildlife Reserve and the Washington State wildlife management area.[18] Ecological functions that require this degree of intactness is make Hanford very valuable, and make contiguity, biodiversity, and attributes of a similar scale very important to preserve and enhance.

Based on the Presidential Proclamation that established the Hanford Reach National Monument, the CTUIR policy seeks to ensure that all of Hanford will be restored and protected:[19]

> "The area being designated as the **Hanford Reach** National Monument forms an arc surrounding much of what is known as the central **Hanford** area. While a portion of the central area is needed for Department of Energy missions, much of the area contains the same shrub-steppe habitat and other objects of scientific and historic interest that I am today permanently protecting in the monument. Therefore, I am directing you to manage the central area to protect these important values where practical. I further direct you to consult with the Secretary of the Interior on how best to permanently protect these objects, including the possibility of adding lands to the monument as they are remediated."

[16] http://www.fs.fed.us/land/pubs/ecoregions/ch48.html#342I
[17] http://www.fws.gov/hanfordreach/natural-resources.html
[18] http://www.pnl.gov/nerp/
[19] FR Volume 36--Number 23: 1271-1329; Monday, June 12, 2000

In addition to biological resources and natural resource goods, ecological functions and services that flow to people may be injured by contamination or physical disturbance. For tribal members, human use services that natural resources provide include both direct use of resources (e.g., hunting, fishing, and gathering of edible plants) and nonuse services (e.g., spiritual identity). Because Tribal identity is so strongly defined by their relationship to their natural environment, natural resources provide more services (on average) to Tribal members than to other members of the general public.

An overview of the resources that can serve as conduits of exposure to native peoples is presented in the CTUIR and Yakama Nation exposure scenarios. The CTUIR exposure factors based on natural resources is presented in the "Reference Indian" section.

B.6.3 Aquatic Resources of the Plateau Culture Area

The Columbia River, which cuts through the Hanford site, is the life blood of the region, with rich diverse fisheries delicately balanced on thriving aquatic ecosystems. The Hanford Reach is the last free-flowing segment of the Columbia River and is home of the last remaining naturally spawning fall Chinook. Ancestral CTUIR fisheries sites are located throughout the Hanford Reach. The health of the Hanford Reach is the keystone essential to the survival of Columbia Basin fisheries and CTUIR Treaty rights and resources.

Use of the Hanford site and surrounding areas by tribes was tied primarily to the robust Columbia River fishery. Past social activities of native people include gatherings for such activities like marriages, trading, feasts, harvesting, fishing, and mineral collection. Tribal families and bands lived along the Columbia either year round or seasonally for catching, drying and smoking salmon. The reduction of salmon runs, loss of fishing sites due to dam impoundments and 70 years of DOE institutional controls at Hanford have contributed to the degradation of the supplies necessary for this gifting and barter system of CTUIRculture.

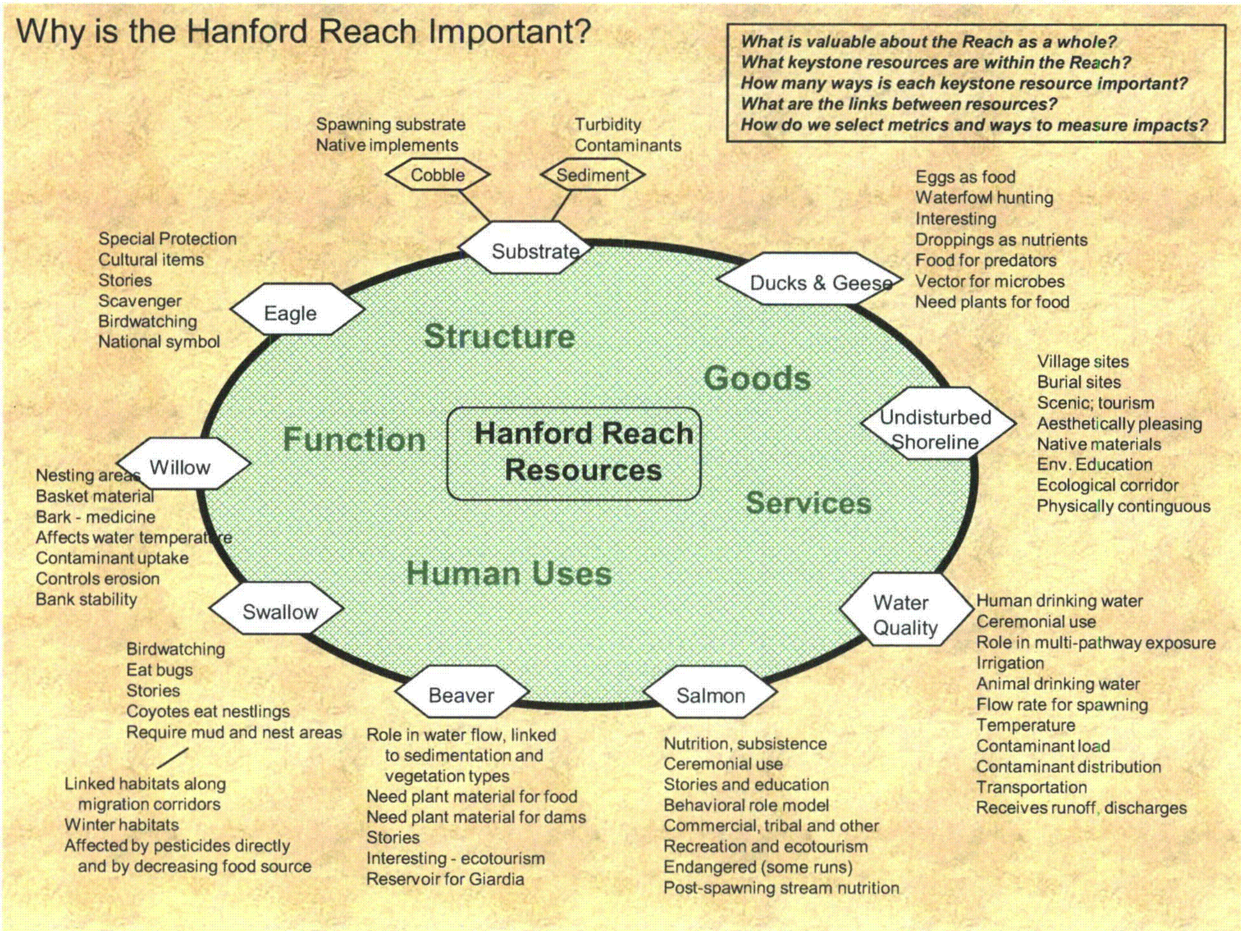
Salmon remains a core part of the oral traditions of the tribes of the Columbia Plateau and it still maintains a presence in native peoples' diet just as it has for thousands of generations. Salmon is among those foods regularly recognized ceremonially. One example is the *ke'uyit* which translates to "first bite." It is a ceremonial feast that is held in spring to recognize the foods that return to take care of the people. It is a long standing tradition among the people and it is immersed in prayer songs and dancing. Salmon is the first food that is eaten by the attendants. Extending gratitude to the foods for sustaining the life of the people is among the tenets of plateau lifestyle. Life is perceived as intertwined with the life of the Salmon. A parallel can be seen between the dwindling numbers of the Salmon runs and the struggle of native people. *from Salmon and His People*[20]

[20] Landeen, D. (1999) Salmon and His People: Fish and Fishing in Nez Perce Culture. Lewiston, ID: Lewis and Clark State College Press.

The people of the Columbia River tribes have always shared a common understanding -- that their very existence depends on the respectful enjoyment of the Columbia River Basin's vast land and water resources. Indeed, their very souls and spirits were and are inextricably tied to the natural world and its myriad inhabitants. Among those inhabitants, none were more important than the teeming millions of anadromous fish enriching the basin's rivers and streams. Despite some differences in language and cultural practices, the people of these tribes shared the foundation of a regional economy based on salmon. The Treaties of 1855 between the Tribes and the federal government explicitly reserved the right to continue fishing forever. Over the next century, settlers encroached on most tribal fishing grounds, blocked access, stole nets, destroyed boats, arrested Indians, over-fished, destroyed habitat, and built dams. In 1974 Judge George Boldt decided in *United States v. Washington* (384 F. Supp. 312) that the "fair and equitable share" of fish for tribes was, in fact, 50 percent of all the harvestable fish destined for the tribes' traditional fishing places. The following year, Judge Belloni applied the 50/50 standard to *U.S. v. Oregon* and the Columbia River. Judge Boldt's decision also affirmed tribal rights to self-regulation when in compliance with specific standards. In 1988, Public Law 10- 581, Title IV Columbia River Treaty Fishing Access Sites, was enacted. The primary purpose of the legislation is to provide an equitable satisfaction of the United States' commitment to provide lands for Indian treaty fishing activities in lieu of those inundated by construction of Bonneville Dam (www.critfc.org).

Salmon will always be important and necessary for physical health and for spiritual well-being. Tribal people continue to fish for ceremonial, subsistence and commercial purposes employing, as they always have, a variety of technologies. Tribal people fish from wooden scaffolds and boats, and use set nets, spears, dip nets and poles and lines. Tribal people still maintain a dietary preference for salmon, and its role in ceremonial life remains preeminent.

Aquatic resources in the Hanford Reach (the area of the river flowing through the Hanford site) include many species, including people. An illustration of resource interconnections and services is shown in figure X.


Why is the Hanford Reach Important?
What is valuable about the Reach as a whole?
What keystone resources are within the Reach?
How many ways is each keystone resource important?
What are the links between resources?
How do we select metrics and ways to measure impacts?
Hanford Reach Resources
Structure
Goods
Function
Services
Human Uses
Spawning substrate
Native implements
Cobble
Turbidity
Contaminants
Sediment
Substrate
Ducks & Geese
Eggs as food
Waterfowl hunting
Interesting
Droppings as nutrients
Food for predators
Vector for microbes
Need plants for food
Eagle
Special Protection
Cultural items
Stories
Scavenger
Birdwatching
National symbol
Undisturbed Shoreline
Village sites
Burial sites
Scenic; tourism
Aesthetically pleasing
Native materials
Env. Education
Ecological corridor
Physically continguous
Willow
Nesting areas
Basket material
Bark - medicine
Affects water temperature
Contaminant uptake
Controls erosion
Bank stability
Water Quality
Human drinking water
Ceremonial use
Role in multi-pathway exposure
Irrigation
Animal drinking water
Flow rate for spawning
Temperature
Contaminant load
Contaminant distribution
Transportation
Receives runoff, discharges
Swallow
Birdwatching
Eat bugs
Stories
Coyotes eat nestlings
Require mud and nest areas
Linked habitats along migration corridors
Winter habitats
Affected by pesticides directly and by decreasing food source
Beaver
Role in water flow, linked to sedimentation and vegetation types
Need plant material for food
Need plant material for dams
Stories
Interesting - ecotourism
Reservoir for Giardia
Salmon
Nutrition, subsistence
Ceremonial use
Stories and education
Behavioral role model
Commercial, tribal and other
Recreation and ecotourism
Endangered (some runs)
Post-spawning stream nutrition

TRANSPORTATION

The Middle Columbia Plateau of the Hanford area is the crossroads of the Columbia Plateau, being located half way between the Great Plains and the Pacific Northwest Coast. In the Hanford area major Columbia River tributaries (the Walla Walla, Snake, and Yakima Rivers) flow into this section of the main stem Columbia River. The slow water at the Wallula Gap was one of the few places where the river could be traversed by horses year round including during the spring melt. The river crossing at Wallula provided access to a vast web of trails that crossed the region.

This travel network was utilized by many tribal groups on the Columbia Plateau for thousands of years of foot travel. Early explorers and surveyors utilized and referenced this extensive trail network. Some of the trails have become major highways and rail lines. Part of the ancient trail system, at one time called the Oregon Trail, now Interstate 84 (I-84) is a primary transportation corridor for nuclear waste enters the State of Oregon at Ontario, Oregon. I-84 and a Union Pacific rail line also cross the Umatilla Indian Reservation, including some steep and hazardous grades that are notorious nationally for fog and freezing fog, freezing rain and snow.

Any waste traveling to Hanford will cross many major rivers that are important salmon bearing watersheds including the Snake River, the Burnt River, the Grande Ronde River (Tributaries of the Snake River), the Umatilla River and Columbia River main stem. All of these river systems have threatened and endangered species issues.

Consequence Evaluation

Recommendations for features and measures are presented in a format similar to the Features-Events-Processes (FEPs) method, but reflecting the tribally-important or eco-cultural attributes of each resource. More detail is contained in the text of various other sections.

Resource or Topic	Features, Attributes, Functions, Goods, Services	Measures of loss or benefit (positive or negative movement; degree of movement)
Sitewide Whole	Support services for traditional lifeways; Intact webs of resources, goods, service flows.	Degree of impact (or enhancement) of traditional lifeways by cultural QALY measure (under development); Loss or recovery of individual traditional activities (hunting, gathering, fishing); Loss or recovery of access to areas or media such as groundwater; Security of protection from development or other loss of acreage, resources, or rights.
Landscape	Intact scape for places, names, songs, calendar, other services. Undisturbed physiographic profile.	Loss or preservation of future land use options. Loss or enhancement of conservation potential; Impact on physiographic profile; Loss or recovery of native scapes.
Light, Noise, other aesthetic attributes.	Quiet needed for ceremonies, experiential quality; Darkness needed for same; Buffer of solitude, isolation, safety from intrusion	Degradation or improvement in quiet during transportation and storage; Degradation or improvement in darkness at night during transport and storage; Duration of impacts (lifecycle of operation); Quality of recovery plan after operation is over.
Viewshed	Uninterrupted viewshed	Degrees in visual field without impact x volume of space with natural features; Significance of direction or features of interruption (line of sight).
Air quality, dust	Clean fresh air for life support and quality of life, without toxics, haze, or dust.	More or fewer emissions during construction, transport, operations, closure. Potential for dust resuspension during each phase. Indirect impacts from energy production, ozone emissions, diesel use. Contribution or benefit to PSD area or attainment status. Greenhouse gas emissions.
Soil,	Clean shallow and deep soil; special materials (White Bluffs);	Mass of contaminated soil x degree of exceedance of human health standards x duration of contamination; Undisturbed soil profile; Intactness of cryptogam crust. Access to special materials.
Minerals, gravel, fill, barrier material		Volume and area of clean fill; Quality of resource mitigation actions;

		Minimization of linked resource impacts.
Sediments	Clean sediment	Present or future exceedance of a standard, including tribal health standard; Function in aquatic ecosystems.
Water	Clean, clear, cold water for drinking, ceremonies	Comparison to tribal standards; Gallon-years above detection limit or background.
Terrestrial Ecosystems	Large-scale ecoregion preservation; Support for tribal lifeways components;	Evaluation of NRDA impacts; Preservation of biodiversity; Reduction in ecological stressors; Loss or benefit in contiguity (fragmentation); Formal process for stressor identification; Identification of valued ecological components.
Terrestrial habitats and species	Provision of goods for food, clothing, shelter, ceremonies, mental health, peace of mind, and so on.	Selection of habitat suitability index; Number of impacted ecological acre-years; Consideration of tribally-important species; Number of impacted cultural acre-years; Time to full recovery.
Aquatic Ecosystems	Large-scale ecoregion preservation; Support for tribal lifeways components;	Proximity of action to river; Evaluation of NRDA impacts; Formal process for stressor identification; Identification of valued ecological components.
Aquatic habitats and species, shorelines	Provision of goods for food, clothing, shelter, ceremonies, mental health, peace of mind, and so on.	Impacted number of river-miles Consideration of tribally-important species; Number of impacted cultural acre-years Time to full recovery
Transportation	Features and events related to safety and vulnerability of adjacent areas.	General transportation risks; Routes through tribal lands; Routes near critical habitats, rivers.
Hazardous substances; safety aspects	Baseline (target) is lack of contamination but current condition is tremendous contamination.	Amount of hazardous material imported, generated, stored, or disposed. Amount of hazardous material already on site, both permitted and contaminated.
Human Health	Target is both lack of excessive exposure and active multi-dimensional health promotion.	Individual and community doses and risks using Tribal scenarios, Multigenerational exposures and risk, Consideration of broader health context.
Env Justice	Tribally-appropriate EJ analysis needed to understand disproportionate impacts.	Compliance with Treaty and Trust; Presence of disadvantaged or disproportionally affected groups-Tribes; Eco-spatial basis for tribal EJ analysis.
Economic	Recognition of subsistence economy methods.	Convention analysis for general pop; Impacts to subsistence for tribes.
Cultural Resources	Need evaluation of likelihood of adverse or beneficial impacts to sites, zones, districts.	Amount of activity in TCP, archaeological zone, sacred sites, and NHPA sites.
Energy and Infrastructure	Need lifecycle energy and infrastructure evaluation, including adequacy of closure plans.	Energy requirement Infrastructure footprint Replacement-mitigation of resources Road needs, water and sewer needs. Intensity of security needs
Climate-Energy Values	Targets of energy efficiency, net zero, sustainability, planning for	Net-zero operations Carbon footprint

	climate change.	
Cumulative	Lifeways support	Impacts to health, ecology, cultural, socio-economic, other analyses. Space-time mapping of impacts. Lifecycle impacts and costs. Sitewide totals of hazardous materials, footprints; Impact on the ability to reach a fully restored endstate.

PLATEAU SUBSISTENCE ECONOMY

The eco-cultural system described in other sections includes human, biological, and physical components, and supports the flow of nutritional, religious, spiritual, educational, sociological, and economic services. No component or service is separable from any other. It is well-recognized in anthropology that indigenous cultures include networks of materials interlinked with networks of obligation and trust. Indian people engage in a complex web of exchanges that are the foundation of community and intertribal relationships. Together these networks determine how materials, services, and information flow within the community and between the environment and the community.

In economic terms, this system is called a subsistence economy. An explanation of "subsistence" developed by the EPA Tribal Science Council is as follows.[21]

> "Subsistence is about relationships between people and their surrounding environment, a way of living. Subsistence involves an intrinsic spiritual connection to the earth, and includes an understanding that the earth's resources will provide everything necessary for human survival. People who subsist from the earth's basic resources remain connected to those resources, living within the circle of life. Subsistence is about living in a way that will ensure the integrity of the earth's resources for the beneficial uses of generations to come.

As the National Park Service explains,

> "While non-native people tend to define subsistence in terms of poverty or the minimum amount of food necessary to support life, native people equate subsistence with their culture. It defines who they are as a people. Among many tribes, maintaining a subsistence lifestyle has become the symbol of their survival in the face of mounting political and economic pressures. To Native Americans who continue to depend on natural resources, subsistence is more than eking out a living. The subsistence lifestyle is a communal activity that is the basis of cultural existence and survival. It unifies communities as cohesive functioning units through collective production and distribution of the harvest. Some groups have formalized patterns of sharing, while others do so in more informal ways. Entire families participate, including elders, who assist with less physically demanding tasks. Parents teach the young to hunt, fish, and farm. Food and goods are also distributed through native cultural institutions. Young hunters, gatherers, and fisherman are required to distribute their first catch or harvest throughout the community at a first feast ceremony. It is a ceremony that illustrates the young person is now a provider for his community. Subsistence embodies cultural values that recognize both the social obligation to share as well as the special spiritual

[21] Tribal Science Council (2002). "Subsistence: A Scientific Collaboration between Tribal Governments and the USEPA." Provided by John Persell (jpersell@lldrm.org).

relationship to the land and resources. This relationship is portrayed in native art and in many ceremonies held throughout the year."[22]

The terms "fish, hunt or gather" are shorthand labels that identify some of the most visible activities within this personally self-sufficient or subsistence economy, but they also include a wide range of associated activities such as preparation, processing, using or consuming, and various traditional and cultural activities. A subsistence economy includes people with a wide range of 'jobs' such as food procurement, processing, and distribution; transportation (pasturing and veterinary); botany/apothecary services; administration and coordination (chiefs); education (elders, linguists); governance (citizenship activities, conclaves); finance (trade, accumulation and discharge of obligations); spiritual health care; social gathering organization; and so on. The categories of 'fish, hunt, and gather' each include a full cross section of these activities. This is why 'hunting' is not just the act of shooting and eating an animal, but includes a full cross-section of all the activities that a hunter-specialist does within their community.

The natural resources that are located on Hanford are essential to this system of relationships. When access and resources needed for personal enterprise associated with salmon or any other resource are blocked, there are psychological, nutritional, monetary, social, welfare, self-esteem, and many other impacts that ripple through the entire community. This includes collection and preparation of animals, plants or other raw materials for foods, ceremonial, medicinal, beadwork, hide work, tule mats and many other items along with the associated trading or gifting. The number of individuals that participate in these personal enterprises would greatly increase if access to Hanford is regained and resources restored.

The more concrete aspects of a subsistence lifestyle are important to understanding the degree of environmental contact and how subsistence is performed in contemporary times. Today, there is an integrated interdependence between formal (cash-based) and informal (barter and subsistence-based) economic sectors that exists and must be considered when thinking of economics and employment of tribal people.[23] Today's subsistence family generates may include members engaged in both monetary and subsistent activities as wage-laborers, part-time workers, professional business people, traditional craft makers, seasonal workers, hunters, fishers, artisans, and so on. Today's subsistence utilizes traditional and modern technologies for harvesting and preserving foods as well as for distributing the produce through communal networks of sharing and bartering. This information is used when describing the lifestyle and developing the dietary and direct exposure factors in the "reference Indian" scenario.

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[22] National Park Service: http://www.cr.nps.gov/aad/cg/fa_1999/Subsist.htm
[23] http://arcticcircle.uconn.edu/NatResources/subsistglobal.html

Environmental Justice Analysis

DOE analysis of Environmental Justice is uniformly inadequate to address Native American rights, resources, and concerns. At Hanford, Tribal rights, health, and resources are always more impacted than those of the general population due to the traditional lifeways, close connections to the natural and cultural resources, and natural resource trusteeship. Thus, Hanford EJ analyses generally find that beneficial impacts of new missions, such as new jobs or more taxes, accrue to the local non-native community, yet fail to recognize that the majority of negative impacts accrue to Native Americans, such as higher health risk, continuation of restricted access, lack of natural resource improvement, and so on.

President Clinton signed Executive Order 12898 to address Environmental Justice issues and to commit each federal department and agency to "make achieving Environmental Justice part of its mission." According to the Executive Order, no single community should host disproportionate health and social burdens of society's polluting facilities. Many American Indians and Alaskan Natives are concerned about the interpretation of "environmental justice communities" by the U.S. Federal Government in relation to tribes. By this definition, tribes are included as a minority group. However, the definition as a minority group fails to recognize tribes' sovereign nation-state status, identify the federal trust responsibility to tribes, promote economic and social development, or protect the treaty and statutory rights of American Indians and Alaskan Natives.

The identification of rural EJ populations, particularly Native Americans, is not always obvious if an impacted area is not directly on a reservation. If natural resources appertaining to tribes are present, or if cultural resources or traditional sites within a ceded or usual and accustomed are affected, then an "EJ Community" is present. Further, Native American communities face environmental exposures that are greater than those faced by other EJ communities because of their greater contact with the environment that occurs during traditional practices and resource uses.

Thus, the EJ analysis begins with an identification of resources and who uses them, not with county demographics. The first step in evaluating EJ for Native Americans at Hanford is to answer the following questions:

- Do tribal members live in (now or in the past), visit, or use resources from the impacted zone?
- Is the affected area within a tribal historic area, a traditional cultural property, or a tribally important landscape?
- Is the affected area linked ecologically, culturally, visually, or hydrologically to tribal or other EJ population resources or uses?
- Is a tribe a Natural Resource Trustee of the affected resource or lands?

If the answer to any of these questions is positive (the answers are all 'yes' at Hanford), the EJ analysis may proceed with more detailed evaluation.

- *Resource identification and quantification.* Likelihood that cultural resources are present within an impact zone or that the site or resource has tribal or community significance, including sacred sites, historical/ archaeological sites, burial sites, and sites containing important traditional foods, medicines, or cultural materials or with associated cultural uses or history, or general community importance (values recreational areas, physical features by which the community identifies itself, etc.). The quantity of goods and services, or acreage, is quantified in this step.

- *Damage Potential.* The probability and severity of the damage in terms of physical disturbance, existing stressors, contamination, desecration, or degradation. Predicted peak concentrations, time to impact, and resiliency of the affected system are also estimated. This is a vulnerability index that includes aspects of imminence, severity, and resiliency or reversibility. Are tribal exposure factors higher than for a rural residential population?

- *Consequence Potential.* The consequences of the damage on cultural activities, resources or values. This parameter represents the combination of the first two parameters (the probability of a resource being present and the probability of damage). Consequence might be restricted access or loss of future use options, and associated impacts such as loss of place names or a cultural skill associated with loss of access, or interruption of other goods and services. It may also include how much the Trust is fulfilled or not, and the potential for multiple generations to be inequitably affected. [24]

Economic Analysis. Conventional EJ evaluates impacts to local economy and jobs. When Native American resources are impacted, the economic analysis of the subsistence economy is appropriate (see section on Subsistence Economy).

Equity analysis. Evaluating disproportionate impacts to Native Americans involves the following:

- Are the exposures different when the tribal subsistence scenario is used as compared to the rural residential or other non-native scenario? Whose risks are highest?
- Are the natural resources of tribal interest more impacted than those identified by the general population? How important are those resources or places? How many ways are those resources or places important? How large is the impacted area from a tribal perspective?
- Do disparities in impact accumulate over many generations, and do they accumulate at a higher rate in the EJ communities? Have the next seven or more generations been taken into consideration?

[24] Harper, B. and Harris, S. (2001) An Integrated Framework for Characterizing Cumulative Tribal Risks. Posted at www.iiirm.org.; Harper, B.L. and Harris, S.G., "Measuring Risks to Tribal Community Health and Culture," *Environmental Toxicology and Risk Assessment: Recent Achievements in Environmental Fate and Transport, Ninth Volume, ASTM STP 1381,* F. T. Price, K. V. Brix, and N. K. Lane, Eds., American Society for Testing and Materials, West Conshohocken, PA, 1999.

- Is the tribe already vulnerable (at risk) due to existing health disparities, economic disadvantages, higher exposure to other toxics, or existence of several dozen co-risk factors (e.g., poor housing, high unemployment, etc – contact authors for more details)?
- What proportion of tribal members is affected (rather than absolute numbers of people)?
- Is the federal fiduciary Trust obligation being met?
- Is cultural awareness and respect shown equitably to the affected tribes as to the local civic entities?[25]

[25] From: AMERIC&AN INDIAN ALASKAN NATIVE ENVIRONMENTAL JUSTICE ROUNDTABLE Albuquerque, New Mexico August 3-4, 2000; Final Report, January 31, 2001. Edited by the Environmental Biosciences Program, Medical University of South Carolina Press.

Cumulative Tribal Impacts

There is a growing recognition that conventional risk assessment methods do not address all of the things that are “at risk” in communities facing the prospect of contaminated waste sites, permitted chemical or radioactive releases, or other environmentally harmful situations. Conventional risk assessments do not provide enough information to "tell the story" or answer the questions that people ask about risks to their community, health, resource base, and way of life. As a result, cumulative risks, as defined by the community, are often not described, and therefore the remedial decisions may not be accepted. The full span of risks and impacts needs to be evaluated within the risk assessment framework in order for cumulative risks to be adequately characterized. This is in contrast to a more typical process of evaluating risks to human health and ecological resources within the risk assessment phase and deferring the evaluation of risks to socio-cultural and socioeconomic resources until the risk management phase (National Research Council, 1994, 1996; President's Commission, 1997).

Because many communities need more information than simply risk and dose results, the Environmental Protection Agency developed a Comparative Risk method over a decade ago for adding a community welfare or quality of life component (EPA, 1993). The Comparative Risk field has been developing methods for community Quality of Life (QOL) that combine cultural, social, and economic measures along with aesthetics and any other factor the community identifies as important. The original Manual (EPA 1993) and many Comparative Risk Projects across the country were developed for situations where environmental planning and prioritization was needed. Several of the Comparative Risk Projects have been done by or for tribes such as the Coeur d'Alene Tribe. The QOL metrics identified in that report included the categories of Localized Effects, Economy/ Subsistence, Aesthetics, Fairness and Equity, Trends (annual and multi-year), Degree of Uncertainty, Personal Well-Being, and Spiritual/Moral factors.

We have modified this concept to reflect traditional tribal cultural values as well as secular or social community aspects that apply to suburban as well as to tribal communities (Harper et al., 1995; Harper and Harris, 2000). We envisioned three or four components to the risk assessment process: human health (using appropriate exposure scenarios), ecological health, and socio-cultural/socio-economic health, all of which are elements of the overall eco-cultural system (Figure).

One of the premises of cumulative impact analysis is that risks to the entire tribal community, not just to a maximally exposed individual, must be evaluated. It is not necessarily true that protecting a MEI protects the entire community, or that protecting threatened and endangered species protects an entire ecosystem. Thus, we need to define tribal community health. John M. Last defines individual human health as “a state characterized by anatomic integrity, ability to perform personal, family, work, and community roles; ability to deal with physical, biological, and social stress; a feeling of well-being; and freedom from the risk of disease and untimely death” (Last 1998). This definition is broader than the regulatory approach which tends to equate good health with lack of excessive exposure. Definitions of health and functionality from the public health literature include a variety of medical and functional measures, but may not specifically call out the fact that the survival and well-being of every individual and culture depends on a healthy environment.

When risk assessments take a public health approach to defining community and individual health, they integrate human, ecological, and cultural health into an overall definition of community health and well-being. This broader approach used with risk assessments is adaptable to indigenous communities that, unlike westernized communities, turn to the local ecology for food, medicine, education, religion, occupation, income, and all aspects of a good life (Harris, 1998, 2000; Harper and Harris, 2000). The attributes of the eco-cultural system that support these services are described in affected resources as clean fresh air, clean cold water, unimpacted landscapes, clean wholesome foods, clean healthful medicines, and robust thriving habitats and ecosystems.

Human Health-Related Goods and Services: This category includes the provision of water, air, food, and native medicines. In a tribal subsistence situation, the land provided all the food and medicine that was necessary to enjoy long and healthy lives. From a risk perspective, those goods and services can also be exposure pathways.

Environmental Functions and Services: Ecological risk assessment includes narrow examination of exposure pathways to biota as well as examination of impacts to the quality of ecosystems and the services provided by individual biota, ecosystems, and ecology. Broader than this, intact ecosystems provide many functions such as soil stabilization and the human services that result from them. For example, the function of erosion control or dust reduction would provide a human health service related to asthma reduction. Other environmental functions such as nutrient production and plant cover would provide wildlife services such as shelter, nesting areas, and food for people and animals, which in turn might contribute to the health of a species important to ecotourism.

Social and Cultural Goods, Functions, Services, and Uses: This category includes many things valued by suburban and tribal communities about Introduction particular places or resources associated with intact ecosystems and landscapes. Some values are common to all communities, such as the aesthetics of undeveloped area s, intrinsic existence value, environmental education, and so on. Because social impact assessment and other aspects of community health are unfamiliar to risk assessors, several measure are suggested as follows:

- Impact on societal structure and cohesion (hours per year unavailable for social interaction through loss or reduced value of the resource or area)
- Educational opportunity (lost study areas associated with traditional stories or place names or family history or traditional practices; lost R&D opportunity)
- Integrity of cultural resources: number of sites with any disturbance or contamination, weighted by type and years of history associated with the site.
- Access to traditional lands: degree of restricted access (full restriction to any area or resource evidenced by institutional controls or barriers or reduced visits), fraction of ceremonial resources available relative to original quantity and quality
- Cultural landscape quality: proxy scale (1-10?) with elicited judgment based on original condition; total remaining landscape size without encroachments
- Degree of compliance with Treaty rights (proxy scale based on access, safety, natural and cultural resource integrity and quality, freedom from encroachments, hassle-free exercise of rights)
- Degree of Compliance with Trusteeship obligations (basis for NRDA injury, restoration costs, human use of natural resources
- Preservation of future land use and remedial options (acres of permanent losses including plumes, number of uses no longer viable, number of curies x half-life in irretrievable waste forms)
- Degree of sustainability of the resource, its degree of permanent administrative protection, and associated exercise of Treaty rights of access and use.

Economic Goods and Services: This category includes conventional dollar-based items such as jobs, education, health care, housing, and so on. There is also a parallel non-dollar indigenous economy that provides the same types of services, including employment (i.e., the functional role of individuals in maintaining the functional community and ensuring its survival), shelter (house sites, construction materials), education (intergenerational knowledge required to ensure sustainable survival throughout time and maintain personal and community identity), commerce (barter items and stability of extended trade networks), hospitality, energy (fuel), transportation (land and water travel, waystops, navigational guides), recreation (scenic visitation areas), and economic support for specialized roles such as religious leaders and teachers.

Cumulative Space-Time evaluation often leads to impacts expressed as service-acre-years. This is the most common unit of quantification for habitat-scale natural resource injury. In our experience, it is most logical to use cultural service-acre-years as the ecological dimension of tribal impacts. The environmental perspective held by indigenous communities mean that eco-spatial characteristics should be identified and evaluated for the extent, magnitude and duration of eco-cultural impairment of each service. In a cultural evaluation, specific cultural services associated with a site or resource can be identified by tribal elders or other community leaders according to general importance (thus avoiding trespass on intellectual property and proprietary information). As a simple surrogate for many of these services, the areal extent and duration of contamination (i.e., outer boundary at the detection limit) can be measured and graded accorded to the size of the area degraded or the percent of degradation, and the duration for which each gradation of impact persists can be estimated.

The functions and services provided by an intact and functioning habitat have been receiving increased attention recently (Costanza and Folke 1997, Scott et al. 1998, Daly 1996, Daily 1997). Many of the metrics used in natural resource valuation require spatial and temporal descriptors in addition to concentrations at individual points of compliance because they deal with ecosystems. Many of the concerns raised as cultural risk issues are parallel and also related to areas, ecosystems, or landscapes as well as to the duration of the contamination or the effect. Many of the concepts used in natural resource valuation are applicable to the evaluation of cultural risk and the culturally-related goods and cultural services provided by a healthy environment.

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Title: A "Reference Indian" for use in radiological and chemical risk assessment.

Authors: B. Harper and S. Harris (CTUIR)

Two tribal exposure scenarios have been developed for use at Hanford by the Confederated Tribes of the Umatilla Indian Reservation (CTUIR 2004) and the Yakama Nation (Ridolfi 2007) in Hanford risk assessments.[26] Both of these scenarios reflect traditional tribal uses of the lands and resources on the Hanford Site, including hunting, fishing, gathering, and use of the sweat lodge. They are multimedia (air, dust, surface soil, vadose soil, surface water, groundwater, plants, and animals) and are full-time residential scenarios. These scenarios should be used to evaluate risks to tribal members at the location of the proposed federal and any impacted areas, i.e., 'Reference Indian' scenarios. These scenarios can also be considered baseline and inadvertent intruder scenarios, as required by DOE Order 435.1.

EPA is required to identify populations who are more highly exposed; for example, subsistence populations and subsistence consumption of natural resources (Executive Order 12898[27]). EPA is also required to protect sensitive populations.[28] Some of the factors known to increase sensitivity include developmental stage, age (very young and very old), gender, genetics, and health status[29], and this is part of EPA's human health research strategy.[30]

> "The Superfund law requires cleanup of the site to levels which are protective of human health and the environment, which will serve to minimize any disproportionately high and adverse environmental burdens impacting the EJ community"[31].

This scenario reflects an active, outdoor lifestyle with a subsistence economic base. Subsistence food sources include gathering, gardening, hunting, pasturing livestock, and fishing. The forager relies all or in part on native foods and medicines, while the residential farmer relies on domesticated but self-produced foods. Thus, the CTUIR scenario is at the foraging end of the subsistence spectrum, while the residential farmer is at the domesticated end of the subsistence spectrum. Both are active, outdoor lifestyles,

[26] CTUIR (2004) Exposure Scenario for CTUIR Traditional Subsistence Lifeways. Report prepared by the CTUIR Department of Science & Engineering, October. http://www.hhs.oregonstate.edu/ph/tribal-grant/index.html.
Ridolfi Inc. (2007) Yakama Nation Exposure Scenario for Hanford Site Risk Assessment, Richland, Washington. Prepared for the Yakama National ERWM Program. September.

[27] White House, 1994. Federal Actions To Address Environmental Justice In Minority Populations And Low income Populations: Feb. 11, 1994; 59 FR 7629, Feb. 16, 1994.
[28] *Superfund Exposure Assessment Manual.* EPA/540/1-88/001 OSWER directive 9285.5-1. U.S. Environmental Protection Agency Office of Remedial Response, U.S. Environmental Protection Agency, Washington, D.C. 1988.
[29] http://www.epa.gov/nheerl/research/childrens_health.html
[30] EPA/600/R-02/050, September 2003 (posted at http://www.epa.gov/nheerl/publications/).
[31] http://www.epa.gov/region02/community/ej/superfund.htm

and are consistent with the reasonable maximum exposure (RME) approach to baseline risk assessment. Traditional or subsistence scenarios are similar in format to existing residential recreational, or occupational exposure scenarios, but reflect and are inclusive of tribal cultural and lifestyle activities. They are comprised of:

1. standard exposure pathways and exposure factors (such as inhalation or soil ingestion but with increased environmental contact rates),
2. traditional diets composed of native plants and animals possibly supplemented with a home garden, and
3. unique pathways such as the sweatlodge.

Tribal exposure scenarios pose a unique problem in that much of the specific cultural information about the uses of plants and animals for food, medicine, ceremonial, and religious purposes is proprietary. However, major activities in the generally-recognized activity categories can be described in enough detail to understand the basic frequency, duration, and intensity of environmental contact within each category and habitat.

Table 1. Major Activity Categories

Activity Type	*General Description*
Hunting	Hunting includes a variety of preparation activities of low to moderate intensity. Hunting occurs in terrain ranging from flat and open to very steep and rugged. It may also include setting traplines, waiting in blinds, digging, climbing, etc. After the capture or kill, field dressing, packing or hauling, and other very strenuous activities occur, depending on the species. Subsequent activities include cutting, storing (e.g., smoking or drying), etc.
Fishing	Fishing includes building weirs and platforms, hauling in lines and nets, gaffing or gigging, wading (for shellfish), followed by cleaning the fish and carrying them to the place of use. Activities associated with smoking and constructing drying racks may be involved.
Gathering	A variety of activities is involved in gathering, such as hiking, bending, stooping, wading (marsh and water plants), digging, and carrying.
Sweatlodge Use	Sweatlodge building and repairing is intermittent, but collecting firewood is a constant activity.
Materials and Food Use	Many activities of varying intensity are involved in preparing materials for use or food storage. Some are quite vigorous such as pounding or grinding seeds and nuts into flour, preparing meat, and tanning hides, Many others are semi-active, such as basket making, flintknapping, construction of storage containers, cleaning village sites, sanitation activities, home repairs, and so on.

Once the activities comprising a particular subsistence lifestyle are known, they are translated into a format that is used for risk assessment. This translation captures the degree of environmental contact that occurs through activities and diet, expressed as numerical "exposure factors." Direct exposure pathways include exposure to abiotic media (air, water, and soil), which can result in inhalation, soil ingestion, water ingestion, and dermal exposure. Indirect pathways refer to contaminants that are incorporated into biota and subsequently expose people who ingest or use them. There are also unique exposure pathways that are not accounted for in scenarios for the general public, but may be significant to people with certain traditional specialties such as pottery or basket making, flint knapping, or using natural medicines, smoke, smudges, paints and dyes.

These activities may result in increased dust inhalation, soil ingestion, soil loading onto the skin for dermal exposure, or exposure via wounds, to give a few examples. While the portals of entry into the body are the same (primarily via the lungs, skin, mouth), the amount of contaminants may be increased, and the relative importance of some activities (e.g., basketmaking, wetlands gathering), pathways (e.g., steam immersion or medicinal infusions) or portals of entry (e.g., dermal wounding) may be different than for the general population.

Together, this information is then used to calculate the direct and indirect exposure factors. This process follows the general sequence:

1. Environmental setting – identify what resources are available;
2. Lifestyle description – activities and their frequency, duration and intensity, and uses of natural resources;
3. Diet (indirect exposure factors);
4. Pathways and media;
5. Exposure factors - Crosswalk between pathways and direct exposure factors; cumulative soil, water and air exposures.

The basic components of the exposure scenario are given below. A great deal of peer-reviewed documentation has been provided to DOE, and the CTUIR and YN scenarios are being used at Hanford.

- Soil ingestion = 400 mg/d for all age groups
- Inhalation rate = 25 m^3/d for adults, with children scaled from the adult value
- Drinking water = 3L/d for adults, with children scaled from the adult value; an additional 1L is ingested during each use of the sweat lodge.
- Based on the ecological resources and on the anthropological literature, the CTUIR developed two relevant diets, one for the Columbia River regions where salmon forms a large percentage of the protein source, and one for upland and mountain areas with resident fish and spawning areas for anadromous species.

CTUIR Columbia River Diet					CTUIR Blue Mountain Diet				
Food Category	***gpd***	**kcal/ 100g**	**kcal/d**	**Percent of calories**	***Food Category***	***gpd***	**kcal/1 00g**	**kcal/d**	**Percent of calories**
Fish	620	175	1085	49%	Fish	142	175	249	11%
Game, large and small	125	175	219	10%	Game, large and small	600	175	1050	48%
Fowl & Eggs	62	200	124	6%	Fowl & Eggs	62	200	124	6%
Bulbs (onions, other)	40	30	12	1%	Bulbs (onions, other)	40	30	12	1%
Berries, Fruits	125	100	125	6%	Berries, Fruits	125	100	125	6%
Other vegetation (lichen, pith, cambium)	40	100	40	2%	Other vegetation (lichen, pith, cambium)	40	100	40	2%
Greens, Tea, Medicines, Spices	133	30	40	2%	Greens, Tea, Medicines, Spices	133	30	40	2%
Honey, Sweete	15	275	41	2%	Honey, Sweete	15	275	41	2%
Seeds, Nuts, Grain	24	500	120	5%	Seeds, Nuts, Grain	24	500	120	5%
Roots, Tubers	400	100	400	18%	Roots, Tubers	400	100	400	18%
TOTALS	***1584***		***2206***		***TOTALS***	***1584***		***2201***	

Human Health Reference Indian ADDENDUM – SOIL INGESTION

Ingestion of soil, sediment, or dust is the result of hand-to-mouth contact, swallowing inhaled dust, mouthing of objects, and ingestion of dirt or dust on food. The recommended subsistence soil ingestion rate of 400 mg/d is based on a review of EPA guidance, soil ingestion studies in suburban and indigenous populations, military, construction and utility worker studies, and local climatic, habitat, and geologic conditions. Components of the traditional lifestyle that contribute to soil ingestion include hunting, gathering, digging roots, processing and eating wild foods, preparing and using natural materials such as basket materials, tending livestock, building and repairing sweat lodges, tending cemeteries, and social gatherings. It also considers occupational activities such as wildlife field work, construction or road work, sample collection, and cultural resource field work.

1.0 EPA Guidance

EPA reviewed studies relevant to suburban populations and published summaries in its Exposure Factors Handbook (1989, 1991, and 1997). In the current iteration of the Exposure Factors Handbook[32], EPA recommends100 mg/d as a mean value for children in suburban settings, 200 mg/day as a conservative estimate of the mean, and a value of 400 mg/day as an "upper bound" value (exact percentile not specified). Most state and federal guidance uses 200 mg/d for children and 100 mg/d for adults in residential or agricultural settings.

A value for an ingestion rate for adult outdoor activities is no longer given in the 1997 Exposure Factors Handbook for adults as "too speculative." However, EPA's soil screening guidance recommends 330 mg/d for a construction or other outdoor worker. Risk assessments for construction workers typically use a rate of 480 mg/d. Some states recommend the use of 1 gram per acute soil ingestion event[33] to approximate a non-average day for children, such as an outdoor day.

2.0 Military Guidance

The US military assumes 480 mg per exposure event[34] or per field day (Technical Guide 230).[35] Department Of Defense (2002)[36] recommendations for certain activities such as construction, landscaping, or other field activities is 480 mg/day. During deployment, DOD assumes that half

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[32] Environmental Protection Agency. 1997. Exposure Factors Handbook. Volumes I, II, III. U.S. Environmental Protection Agency, Office of Research and Development. EPA/600/P-95/002Fa.

[33] MADEP (1992). Background Documentation For The Development Of An "Available Cyanide" Benchmark Concentration. http://www.mass.gov/dep/ors/files/cn_soil.htm

[34] http://www.gulflink.osd.mil/pesto/pest_s22.htm, citing US Environmental Protection Agency, Office of Research and Development, Exposure Factors Handbook, Volume I, EPA/600/P-95/002a, August 1997 as the basis for the 480 mg/d.

[35] USACPPM TG 230A (1999). Short-Term Chemical Exposure Guidelines for Deployed Military Personnel. U.S. Army Center for Health Promotion and Preventive Medicine. Website: http://www.grid.unep.ch/btf/missions/september/dufinal.pdf

[36] Reference Document (RD) 230, "Exposure Guidelines for Deployed Military" A Companion Document to USACHPPM Technical Guide (TG) 230, "Chemical Exposure Guidelines for Deployed Military Personnel", January 2002. Website: http://chppm-www.apgea.army.mil/desp/; and http://books.nap.edu/books/0309092213/html/83.html#pagetop.

of a soldier's time is spent in thes higher-contact activities. The UN Balkans Task Force assumes that 1 gram of soil can be ingested per military field day[37].

3.0 Studies in suburban or urban populations

Written knowledge that humans often ingest soil dates back to the classical Greek era. Soil ingestion has been widely studied from a perspective of exposure to soil parasite eggs and other infections. More recently, soil ingestion was recognized to be a potentially significant pathway of exposure to contaminants. Several early studies estimated intakes by children. Estimates based on observation of 'sticky sweets' (Day et al., 1975), outdoor activities (Hawley, 1985), or camping (Van Wijnen et al., 1990). Other studies used tracer elements (Binder, et al., 1986; Clausing et al., 1987; Thompson and Burmaster, 1991; Calabrese et al., 1989; Stanek and Calabrese (1995a, 1997). These studies estimated a wide range of soil ingestion rates.

Pica (ingestion of more than 5000 mg/d) is generally thought of as a pediatric condition. ATSDR estimates that between 10 and 50% of children may exhibit pica behavior at some point. Regulatory guidance recommends using a soil ingestion rate of 5 or 10g/d for pica children. Some examples are:

(1) EPA (1997) recommends a value of 10g/d for a pica child.
(2) Florida recommends 10g per event for acute toxicity evaluation[38].
(3) ATSDR uses 5 g/day for a pica child[39].

4.0 Studies in Indigenous Populations

Studies of soil ingestion in indigenous populations have largely centered on estimates of past exposure (or dose reconstruction) of populations affected by atomic bomb tests. Haywood and Smith (1992) estimated potential doses to aboriginal inhabitants of the Maralinga and Emu areas of South Australia by considering the number of hours per week spent in sleeping, sitting, hunting or driving, cooking or butchering, and other activities. They noted that virtually all food, whether of local origin or purchased, has some dust content by the time of consumption due to methods of preparation and the nature of the environment. They recommend a soil intake of 1 to 10 gpd. Other authors have used estimates of 0.5 or 1 gpd in other indigenous populations such as the Marshall Islanders (Sun and Meinhold, 1997; LaGoy, 1987). Simon (1998) recommended using a soil ingestion rate for indigenous people in hunters/food gathering/nomadic societies of 1g/d in wet climates and 2 g/d in dry climates, and 3 g/d for all indigenous children, and 5 g/d if geophagia is common.

These estimates are supported by studies of human coprolites from archaeological sites. For instance, Nelson (1999) noted that human coprolites from a desert spring-fed aquatic system included obsidian chips (possibly from sharpening points with the teeth), grit (pumice and quartzite grains from grinding seeds and roots), and sand (from mussel and roots consumption). Her conclusions are based on finding grit in the same coprolites as seeds, and sand in the same

[37] UNEP/UNCHS Balkans Task Force (BTF) (1999). The potential effects on human health and the environment arising from possible use of depleted uranium during the 1999 Kosovo conflict. www.grid.unep.ch/btf/missions/september/dufinal.pdf

[38] Proposed Modifications To Identified Acute Toxicity-Based Soil Cleanup Target Level, December 1999, www.dep.state.fl.us/waste/quick_topics/ publications/wc/csf/focus/csf.pdf.

[39] For Example: El Paso Metals Survey, Appendix B, www.atsdr.cdc.gov/HAC/PHA/elpaso/epc_toc.html.

coprolites as mussels and roots. She concludes that "the presence of sand in coprolites containing aquatic root fibers suggests that the roots were not well-cleaned prior to consumption.

5.0 Geophagia

Despite the limited awareness of geophagia in western countries, the deliberate consumption of dirt, usually clay, has been recorded in every region of the world both as idiosyncratic behavior of isolated individuals and as culturally prescribed behavior (Abrahams, 1997; Callahan, 2003; Johns and Duquette, 1991; Reid, 1992). It also routinely occurs in primates (Krishnamani and Mahaney (2000). Indigenous peoples have routinely used montmorillonite clays in food preparation to remove toxins (e.g., in acorn breads), as condiments or spices, or to aid digestion (e.g., kaolin clay in Kaopectate) (Reid, 1992; Krishnamani and Mahaney, 2000). Callahan (2003) also suggests that certain soils may reduce parasite loads (demonstrated in monkeys) through immune enhancement, and clays with aluminum salts may have an adjuvant effect as they do in commercial vaccines.

Pregnancy is the most common occasion for eating dirt in many societies, especially kaolin and montmorillonite clays in amounts of 30g to 50g a day. In some cultures, well-established trade routes and clay traders make rural clays available for geophagy even in urban settings. Clays from termite mounds are especially popular among traded clays, perhaps because they are rich in calcium (Callahan, 2003; Johns and Duquette, 1991). In countries such as Uganda where modern pharmaceuticals are either unobtainable or prohibitively expensive, ingested soils may be very important as a mineral supplement, particularly iron and calcium (Abrahams, 1997; Krishnamani and Mahaney, 2000; Johns and Duquette, 1991).

7.0 Data from dermal adherence

Dermal adherence of soil is generally studied in relation to dermal absorption of contaminants, but soil on the hands and face can be ingested, as well. Kissel, et al. (1996) included reed gatherers in tide flats. "Kids in mud" at a lakeshore had by far the highest skin loadings. Reed gatherers were next highest, followed by farmers and rugby players and irrigation installers. Holmes et al. (1999) studied a variety of occupations. Farmers, reed gatherers and kids in mud had the highest overall skin loadings, followed by equipment operators, gardeners, construction, and utility workers. Archaeologists and several other occupations had somewhat lower skin loadings.

Grain size affects adherence and tactile responses to ingested soil. Particles below the sand-silt size division (0.075 mm) adhering more than smaller sizes (see EPA, 1992[40] for more details). Sieving is recommended, and data for particle size <0.044 cm (RAGSe, App. C, Table C-4).

8.0 Data from washed or unwashed vegetables.

Direct soil ingestion also occurs via food, for example from dust blowing onto food (Hinton, 1992), residual soil on garden produce or gathered native plants, particles on cooking utensils, and so on. Beresford and Howard (1991) found that soil adhesion to vegetation was highly

[40] EPA (1992). Interim Report: Dermal Exposure Assessment: Principles And Applications. Office of Health and Environmental Assessment, Exposure Assessment Group. /600/8-91/011B

seasonal, being highest in autumn and winter, and is important source of deposited radionuclides to grazing animals.

9.0 Subsistence lifestyles and rationale for soil ingestion rate

The derivation of the soil ingestion rate is based on the following points:

- The foraging-subsistence lifestyle is lived in close contact with the environment.
- Plateau winds and dust storms are fairly frequent. Incorporated into overall rate, rather than trying to segregate ingestion rates according to number of high-wind days per year because low-wind days are also spent in foraging activities.
- The original Plateau lifestyle – pit houses, caches, gathering tules and roots - includes processing and using foods, medicines, and materials. This is considered but not as today's living conditions.
- The house is assumed to have little landscaping other than the natural conditions or xeriscaping, some naturally bare soil, a gravel driveway, no air conditioning (more open windows), and a wood burning stove in the winter for heat.
- All persons participate in day-long outdoor group cultural activities at least once a month, such as pow-wows, horse races, and seasonal ceremonial as well as private family cultural activities. These activities tend to be large gatherings with a greater rate of dust resuspension and particulate inhalation. These are considered to be 1-gram events or greater.
- 400 mg/d is based on the following:
    1. 400 mg/d is the upper bound for suburban children (EPA); traditional or subsistence activities are not suburban in environs or activities
    2. This rate is within the range of outdoor activity rates for adults (between 330 and 480); subsistence activities are more like the construction, utility worker or military soil contact levels. However, it is lower than 480 to allow for some low-contact days.
    3. The low soil-contact days are balanced with many 1-gram days and events (as suggested by Boyd et al., 1999) such as root gathering days, tule and wapato gathering days, pow wows, rodeos, horse training and riding days, sweat lodge building or repair days, grave digging, and similar activities. There are also likely to be many high or intermediate-contact days, depending on the occupation (e.g., wildlife field work, construction or road work, cultural resource field work).
    4. This rate does not account for pica or geophagy
    5. Primary data is supported by dermal adherence data in gatherers and 'kids in mud'. Tule and wapato gathering are kid-in-mud activities
    6. This rate includes a consideration of residual soil on roots (a major food category) through observation and anecdote, but there is no quantitative data.

Human Health Reference Indian ADDENDUM - INHALATION RATE

Many risk assessments use the EPA default value of $20m^3/d$ (EPA 1997), which reflects contemporary lifestyles of the general population. However, EPA recognizes that inhalation rates may be higher in certain populations, such as athletes or outdoor workers, because levels of activity outdoors may be higher over long time periods. "If site-specific data are available to show that subsistence farmers and fishers have higher respiration rates due to rigorous physical activities than other receptors, that data may be appropriate."[41] Such subpopulation groups are considered 'high risk' subgroups.[42]

In order to develop inhalation rates more appropriate to traditional lifestyles, we evaluated the approach that uses specific activity levels to estimate short-term and long-term inhalation rates. Several examples of this approach are:

- EPA's National Air Toxics Assessment (homepage: http://www.epa.gov/ttn/atw/nata/natsa3.html) uses the CHAD database to estimate national average air toxics exposures by selecting a series of single day's patterns to represent an individual's annual activity pattern.
- The California Air Resources Board (CARB, 2000) reviewed ventilation rates for many activities in the CHAD database and concluded that 20 m^3/d represents an 85th percentile of typical adult activity lifestyles reflecting 8 hours sleeping and 16 hours of light activity with little moderate or heavy activity.
- In their technical guidance document, "Long-term Chemical Exposure Guidelines for Deployed Military Personnel," the US Army Center for Health Promotion and Preventive Medicine (USACHPPM) recommended an inhalation rate of 29.2 m^3/d for US Armed Service members that includes 8 hours of moderate duties.[43]
- EPA used 30 m^3/day for a year-long exposure estimate for the general public at the Hanford Superfund site in Washington state, based on a person doing 4 hours of heavy work, 8 hours of light activity, and 12 hours resting.[44]
- The DOE's Lawrence Berkeley Laboratory also used 30 m^3/d: "the working breathing rate is for 8 hours of work and, when combined with 8 hours of breathing at the active rate and 8 hours at the resting rate, gives a daily equivalent intake of 30 m^3 for an adult."[45]
- The Rocky Flats Oversight Panel recommended using 30 m^3/d.[46]

Using EPA guidance on hourly inhalation rates for different activity levels, a reasonable inhalation rate for an average tribal member's active lifestyle is an average rate of 26.2 m^3/d, based on 8 hours sleeping at 0.4 m^3/hr, 2 hours sedentary at 0.5 m^3/hr, 6 hours light activity at 1 m^3/hr, 6 hours moderate activity at 1.6 m^3/hr, and 2 hours heavy activity at 3.2 m^3/hr. Unlike most other exposure factors, which are upper bounds, the inhalation rate is an average rate, so to be consistent with national methodology, we have rounded the rate down to 25 m^3/day.

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[41] EPA (OSWER) "Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities, Support Materials Volume 1: Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities" page 6-4, at (http://www.epa.gov/earth1r6/6pd/rcra_c/protocol/volume_1/chpt6-hh.pdf)

[42] Exposure Factors Handbook, 1997, Volume 1. page 5-24

[43] http://www.gulflink.osd.mil/particulate_final/ particulate_final_s06.htm and http://www.gulflink.osd.mil/pm/pm_en.htm.

[44] "Report of Radiochemical Analyses for Air Filters from Hanford Area" Memorandum from Edwin L. Sensintaffar, Director of the National Air and Radiation Environmental Laboratory to Jerrold Leitch, Region 10 Radiation Profram Manager (http://yosemite.epa.gov/R10/AIRPAGE.NSF/webpage/Hanford+Environmental+Perspective)

[45] (www.lbl.gov/ehs/epg/tritium/TritAppB.html)

[46] RAC (Risk Assessment Corporation). 1999. *Task 1: Cleanup Levels at Other Sites. Rocky Flats Citizens Advisory Board, Rocky Flats Soil Action Level Oversight Panel.* RAC Report No. 3-RFCAB-RFSAL-1999' http://www.itrcweb.org/Documents/RAD-2.pdf

The estimate of the activity levels associated with traditional lifestyles is based on anthropological studies, ethnographic literature on foraging theory and hunting-gathering lifestyles, and confirmatory interviews with Tribal members. The inhalation rate reflects a wide range of traditional indoor and outdoor activities, including (a) youth who are learning traditional subsistence skills, (b) adults who hunt, gather, fish, and work in environmental management occupations, and (c) elders who gather plants and medicines, prepare and use them, and teach traditional activities. At present, it is not possible to extrapolate directly from the CHAD database from window washing, for example, to hide scraping; research is underway to fill this data gap using heart rate monitors keyed to respiration rate during specific traditional activities.

Finally, there may be some ethnic specificity in the link between metabolic and inhalation rates such as thrifty genotype(s) and oxidation adiposity patterns (Goran, 2000; Fox et al., 1998; Muzzin et al., 1999; Rush et al., 1997; Saad et al., 1991; Kue Young et al., 2002), as well as ethnic differences in spirometry (Crapo et al., 1988; Lanese et al., 1978; Mapel et al., 1997; Aidaraliyev et al., 1993; Berman et al., 1994). There are several stress response genes that enable indigenous populations to respond to environmental stresses and to the rapid transition between extremes, including feast and famine, heat and cold, disruption in circadian rhythms, dehydration, seasonality, and explosive energy output or rapid transitions between minimum and maximum exercise and $VO2_{max}$ (Kimm et al., 2002; Snitker et al., 1998). This may affect inhalation rate, but at present this remains a testable hypothesis.

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Wanapum Overview and Perspectives

Developed During Tribal Narrative Workshop (June 15-19, 2009)

Hanford, WA

January 2010

Wanapum Introduction

Before the Columbia, there was Chiwana. Wanapum, which means the River People, are part of the river and the land through which it flows. They are a part of the people who lived there and those who continue to live along the river's shores. Coyote created the river in his efforts to care for the Wanapum. The Columbia is the river of life and myth. The Wanapum people have been supported by the river's bounty for thousands of years – honor the spirit of the river. Teachings of the Wanapum tell all who will listen to be responsible to the land, to the creatures that live within the water and on the land, to the ancestors that are buried in the land, and to those who have not yet been born. The Wanapum are the caretakers responsible for the land and passing on the teachings of the natural world to the next generation.

The Wanapum live on the Columbia River; it has been their home from time immemorial. As Indian people, they were put there to protect and preserve the land and river for themselves, their children, and those not yet born. As spiritual people the Wanapum continue to practice their religion. Friendly, understanding, and respectful of all people and things, the Wanapum only wish to live in peace. Through strenuous and prudent efforts the Wanapum have successfully built relationships with federal, state, and local agencies. The respect, trust, and mutual understanding that results from these relationships allow the Wanapum to actively participate in decision-making processes that affect their responsibilities to care for all things put here by the Creator.

Wanapum Background

The Wanapum made their homes along the Columbia River in an area known as the Columbia Plateau. They traditionally lived in small villages. The villages included mat lodges made from tules for housing and a longhouse for spiritual ceremonies.

Priest Rapids became a central location for the Wanapum because the location offered optimal fishing conditions. The Wanapum traveled regularly up and down the coast of the Columbia River for food and other resources. Their proximity to the river allowed the Wanapum to catch plentiful salmon. The Wanapum learned the ways of the land and discovered hundreds of ways to create medicines and other remedies from plants.

In 1870, an outbreak of smallpox left the Wanapum with just 300 living members. Within 30 years many of the Wanapum people became members of nearby reservations because of health, family connections, or employment opportunities. In 1930, the Wanapum population reached an all-time low with just 30 to 50 members. The Wanapum managed to preserve their traditions throughout the 1940s.

In the decades that followed, the Wanapum experienced various impositions on their land. The construction of the Hanford Plutonium Plant and the U.S. Army Training Center took nearly 1,000 square miles of Wanapum land. The Priest Rapid Dam and the Wanapum Dam forever changed their fishing and living routines.

The self-sufficient Wanapum chose to remain an unrecognized tribe, meaning they do not have obligations to nor receive support from the U.S. government. The Wanapum frequently join forces with other recognized tribes to further common causes. They work within their own group to preserve their own culture and traditions. The survival of the Wanapum culture is evidence of the determination and strength of the people.

Tribal Values

In essence, tribal values are intent on protecting, preserving and perpetuating resources for the sake of traditional and cultural existence. Each resource had a time or a season on when to gather, store, and properly use. This harmony and connection to the land is our culture and is captured and passed down in our oral history. It is imperative that materials available for use in from Hanford for a substance lifestyle be uncontaminated. Once resources become contaminated or lost then part of our connection to the land and part of our culture is lost.

General Comments

- We assume that all of Hanford will be eventually restored and protected[1].

- Any new proposals at Hanford should at a minimum utilize the "Hanford Site NEPA Guidance Document" as a primary reference for creating any NEPA document, especially the Affected Environment section.

- We expect to be proactively engaged by DOE during the scoping and alternatives development for Hanford proposals. Tribes are part trustees of Hanford and should be informed and have opportunity to be engaged beyond the NEPA public involvement process.

- NEPA documents at Hanford need to include sections describing Viewscapes and Soundscapes that are important to our tribal culture.

- Socioeconomic Section of a NEPA EIS should be separated into sections *Social* and *Economics*.

- A GTCC repository at Hanford is a conflicting mission with present DOE cleanup efforts.

[1] FR Volume 36--Number 23: 1271-1329; Monday, June 12, 2000

- Salmon and water are important cultural resource that are intertwined with the subsistence lifestyle of affected tribes.

- Affected Tribes and the trust responsibilities of DOE and other federal agencies (NEPA 18, section 6) need to be clearly described in the GTCC EIS. It needs to include tribal aboriginal rights, treaty rights and Executive Orders 12898, 13007, and 13175.

- Climate is simply not a snapshot in time. Archeological evidence supports tribal oral history that speaks of a time when the region had extreme climate and weather changes. We have stories of volcanic activity, glacial periods, times of great floods, and what we know today. A GTCC repository should consider climate change and extreme weather changes expected over 10,000 year period.

- We recommend that quiet zones and time periods should be identified for known Native American ceremonial locations on and near the Hanford Reservation.

- Not all ceremonial sites at Hanford have been shared with DOE beyond Gable Mountain and Rattlesnake Mountain.

- Hanford in general is composed of sandy soils that do not retain water very well and consideration must be made for the potential long-term moisture percolation affecting any underground structure.

- Some soils have medicinal purposes for healing like the White Bluffs area. Care should be taken to recognize those with such properties.

- Proposal of any new risk of further contamination of the Columbia River system will receive high priority review.

- The affected environment needs to fully describe and graphically illustrate known groundwater plumes surrounding the Area of Potential Effect (APE). Contamination in the ground water is the greatest long-term threat at the Hanford site. The groundwater section needs to also identify where groundwater and its contaminant are not fully characterized. This uncertainly and limited technical ability to remediate the vadose zone and ground water puts the Columbia River at increased risk.

- Indian health is sustained through a balanced traditional lifestyle. Any contamination or restriction is a negative affect on tribal health. We are against adding any waste to the Hanford site that adds risk to tribal health.

- "Reference Indian" scenarios should be considered in any risk assessment development. These scenarios can also be considered inadvertent intruder scenarios, as required by DOE Order 435.1.

- Biodiversity within National Monument include rare plant and wildlife species.

- We expect DOE to comply with Comprehensive Conservation Plan (CCP).

- Columbia River Tribes have created a salmon recovery plan called the Wy-Kan-Ush-Mi Wa-Kish-Wit (Spirit of the Salmon). We expect that DOE's potential placement of a repository to not conflict with elements of this Plan.

- A tribal subsistence economy needs to be described in terms of long-term "personal" enterprise. ("Personal enterprise" is the term for self and community reliance on the environment for existence as opposed to employment or modern economies.)

- The potential for large returning salmon runs should be considered part of potential changes to the economy. A goal of tribes, federal and state governments, is to dramatically improve salmon returns in the Columbia River.

- Tribal employment at Hanford and surrounding area should be part of the employment description.

- Environmental justice (EJ) in Indian country needs to be better defined to clarify sovereign nation-state status, federal trust responsibility to tribes, and include treaty and aboriginal rights.

- We maintain that aboriginal rights allow for the protection, access to, and use of open and unclaimed lands of the Hanford Reservation when human health and safety are not in jeopardy.

- There are sites or locations within the existing Hanford reservation boundary that should be considered for special protections or set aside for tribal ceremonial uses.

- We propose that ceremonial sites be placed in co-stewardship with DOE, USFWS and affected tribes for long-term management and protection.

- The Comprehensive Land Use Plan (CLUP) has institutional controls (ICs) that limit present and future use by Native Americans. These ICs should be described as part of the affected environment. Any new proposals that extend, expand, or create new IC should be considered cumulative impacts to native people.

- The 50-year management time horizon of the CLUP and its land use designations are often incorrectly assumed to be permanent designations. CLUP landuse designations and their boundaries can be changed at the discretion of DOE with recommendations by Hanford stakeholders, including affected tribes.

- According to the *American Indian Religious Freedom Act*, tribal members have a protected right to conduct religious ceremonies at locations on public lands where they are known to have occurred.

- *Executive Order 13007* states that Tribal members have the right to access ceremonial sites.

- DOE and USFWS must maintain trails or roads that are presently providing access to known ceremonial sites.

- New culturally significant findings are required to be added to the list of sites and locations with special cultural protections that override any land use designation of the CLUP or other documents.

- Shipment routes need to be described for proposed Hanford site. Travel routes will cross many major rivers and salmon-bearing watersheds that are important to Tribes.

- All things of the natural environment we recognize as cultural resources. Nature provides for a subsistence live style, and thus, the daily interaction with the land is our culture, and our foundation of our religious beliefs.

- *Cultural Landscapes* have been defined by the World Heritage Committee as distinct geographical areas or properties uniquely representing the combined work of nature and of man.

- There are three overlapping cultural landscapes that overlie the natural landscape at Hanford. The first is the tribal archeological and ethnographic record spanning more than 10,000 years. The second was created by early settlers, and the third by the Manhattan Project. DOE is presently removing much of the Manhattan landscape to a more *natural* state (restoration and conservation).

- We recognize culturally significant viewscapes as described in the Hanford Cultural Resources Management Plan. Special protections and visit considerations should be given to tribal elders and youth to maintain and accommodate educational opportunities of tribal cultural and ceremonial activities.

- A proposed Repository must consider local DOE strategies of Hanford recovery, including the 200 Area 7th ROD and the 2015 Vision for the River Corridor. These long-term recovery strategies must be part of the NEPA evaluation for a repository.

- The APE for the cultural landscape should include areas across the lower Columbia Plateau from the Wallula Gap to the Sentinel Gap.

- There are many cemeteries, ceremonial sites, and areas of spiritual significance within the Hanford Boundary. Not all sites are known to DOE.

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APPENDIX H:

PUBLIC DISTRIBUTION FOR THE DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR THE DISPOSAL OF GREATER-THAN-CLASS C (GTCC) LOW-LEVEL RADIOACTIVE WASTE AND GTCC-LIKE WASTE

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APPENDIX I:

LIST OF PREPARERS

Name	Education/Expertise	Contribution
U.S. Department of Energy		
George Dixon	M.S., Environmental Health Science; 33 years of experience in environmental assessment and waste management	DOE Senior Technical Advisor
Arnold Edelman	M.A., Physical Geography/ Geomorphology; 37 years of experience in multimedia environmental regulation, pollution prevention, waste management, environmental management, safety and health	DOE Document Manager
Christine Gelles	B.A., Literature, Philosophy, Communications; 17 years of experience in environmental management policy and oversight; 6 years of experience in radioactive waste management strategy and policy development	DOE Senior Manager
James Joyce	B.S., Geological Engineering; 22 years of experience in environmental remediation, waste management, and program and project management	DOE Project Manager
Argonne National Laboratory		
Timothy Allison	M.S., Mineral and Energy Resource Economics; M.A., Geography; 26 years of experience in regional analysis and economic impact analysis	Socioeconomics, environmental justice
Georgia Anast	B.A., Mathematics/Biology; 20 years of experience in environmental assessment	Quality assurance coordinator
Bruce Biwer	Ph.D., Chemistry; 19 years of experience in environmental assessment and transportation risk analysis	Transportation, accidents, facility design, inventory database

Name	Education/Expertise	Contribution
Brian Cantwell	B.S., Forestry, 26 years of experience in cartography and GIS	Environmental justice maps and tables
Young-Soo Chang	Ph.D., Chemical Engineering; 21 years of experience in air quality and noise impact analysis	Climate, air quality, noise
Shih-Yew Chen	Ph.D., Nuclear Engineering; 24 years of experience in environmental assessment, waste and risk analysis	Senior technical advisor
Jing-Jy Cheng	Ph.D., Polymer Science and Engineering; 19 years of experience in computer model development and applications for human health and ecological risk assessments	RESRAD model, human health impacts
Deborah Elcock	B.A., Mathematics; M.B.A.; 21 years of experience in regulatory analysis	Applicable laws, regulations, and other requirements
Stephen Folga	Ph.D., Gas Engineering; 13 years of experience in technology assessment and waste management	Technology assessment, accident assessment, resource materials
Elizabeth Hocking	J.D.; 18 years of experience in environmental and energy policy analysis	Applicable laws, regulations, and other requirements
Timothy Klett	M.S., Computer Science; 9 years of experience in software development and data management	Inventory database
Mary Moniger	B.A., English; 30 years of experience in editing and writing	Lead technical editor
Michele Nelson	Certificate of Design; 32 years of experience in graphic design	Graphics
Daniel O'Rourke	M.S., Industrial Archaeology; 16 years of experience in cultural resource management, 10 years in historical property issues	Cultural resources
Terri Patton	M.S., Geology; 19 years of experience in environmental research and assessment	Geology, water resources; cumulative impacts

Name	Education/Expertise	Contribution
John Peterson	M.S., Nuclear Engineering; Certified Health Physicist (CHP); 31 years of experience in nuclear engineering and health physics	Technical coordinator, waste inventory, human health impacts
Mary Picel	M.S., Environmental Health Sciences; 23 years of experience in environmental assessment, risk assessment, and waste management	Project manager, document manager, human health impacts, waste management, cumulative impacts
Albert Smith	Ph.D., Physics; 34 years of experience in environmental assessment	Climate, air quality, noise
David Tomasko	Ph.D., Civil Engineering; 28 years of experience in hydrogeology and fluid mechanics	Water resources
William Vinikour	M.S. and B.S., Biology with environmental emphasis; 34 years of experience in ecological research and environmental assessment	Ecology, land use

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APPENDIX J:

CONTRACTOR DISCLOSURE STATEMENT

Argonne National Laboratory is the contractor assisting the U.S. Department of Energy (DOE) in preparing the environmental impact statement (EIS) for the disposal of greater-than-Class C (GTCC) low-level radioactive waste and GTCC-like waste. DOE is responsible for reviewing and evaluating the information and determining the appropriateness and adequacy of incorporating any data, analyses, or results in the EIS. DOE determines the scope and content of the EIS and supporting documents and will furnish direction to Argonne, as appropriate, in preparing these documents.

The Council on Environmental Quality's regulations (40 CFR 1506.5(c)), which have been adopted by DOE (10 CFR Part 1021), require contractors who will prepare an EIS to execute a disclosure specifying that they have no financial or other interest in the outcome of the project. The term "financial interest or other interest in the outcome of the project" for the purposes of this disclosure is defined in the March 23, 1981, "Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations," 46 *Federal Register* 18026–18028 at Questions 17a and 17b. Financial or other interest in the outcome of the project includes "any financial benefit such as promise of future construction or design work on the project, as well as indirect benefits the consultant is aware of (e.g., if the project would aid proposals sponsored by the firm's other clients)," 46 *Federal Register* 18026–18038.

In accordance with these regulations, Argonne National Laboratory hereby certifies that it has no financial or other interest in the outcome of the project.

Certified by:

John D. Ditmars
Signature

John D. Ditmars
Name

Interim Director, Environmental Science Division
Title

Jan. 18, 2011
Date

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