APPENDIX C

LONG-TERM CLOSURE MODELING

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APPENDIX C. LONG-TERM CLOSURE MODELING

This appendix provides a discussion of the fate and transport modeling that was performed to determine the long-term impacts from the alternatives described in Chapter 2 of this EIS. This modeling estimates the potential human health and ecological impacts of residual contamination remaining in closed HLW tanks for all alternatives and estimates the concentration and dose levels at the location where the groundwater outcrops into the environment (i.e., the seepline).

In the modeling described in this appendix, the F-Area and H-Area Tank Farms were modeled assuming conditions that would exist after tank closure for four scenarios as follows: (1) No Action Alternative, (2) Clean and Fill with Grout Option, (3) Clean and Fill with Sand Option, and (4) Clean and Fill with Saltstone Option. None of the analyzed scenarios took credit for engineered caps to be placed after completion of closure activities.

DOE intends that the area immediately around the tank farms would remain in commercial/industrial use for the entire 10,000-year period of analysis and would be unavailable for residential use. However, DOE has estimated the impacts if residents have access to the tank farm area.

Potential impacts to the following hypothetical individuals were analyzed:

- *Worker:* An adult who has authorized access to, and works at, the tank farm and surrounding areas but is considered to be a member of the public for compliance purposes. This analysis assumes that the worker remains on the banks of Fourmile Branch or Upper Three Runs during working hours.

- *Intruder:* A teenager who gains unauthorized access to the tank farm and is potentially exposed to contaminants.

- *Nearby adult resident:* An adult who lives in a dwelling across either Fourmile Branch or Upper Three Runs downgradient of the tank farms, near the stream.

- *Nearby child resident:* A child who lives in a dwelling across either Fourmile Branch or Upper Three Runs downgradient of the tank farms, near the stream.

In addition to the hypothetical individuals identified above, concentration and dose levels were calculated at the groundwater seepline point of exposure. For H-Area, the seepline is approximately 1,200 meters downgradient from the center of the tank farm, while for F-Area the seepline is roughly 1,800 meters downgradient from the tank farm. These distances are the linear distances to the seepline; the actual travel distances are somewhat greater due to the curved path of the groundwater. Concentration and dose levels were also calculated at 1-meter and 100-meters downgradient from the edge of the F-Area and H-Area Tank Farms, and an estimate of the dose from all pathways at these locations was performed.

Uncertainty in Analysis

In this EIS, DOE has made assumptions on numerical parameters that affect the calculated impacts. There is some uncertainty associated with the values of these parameter due to unavailable data and current state of knowledge about closure processes and long-term behavior of materials.

The principal parameters that affect modeling results are the following:

- **Inventory:** The amount of material in the tank directly affects the concentrations at any given location, unless the amount of material is so great that the solubility limit is exceeded. Once the solubility limit is exceeded, greater amounts of source material do not necessarily result in increased con-

centrations at receptor locations. In this modeling effort, both plutonium and uranium were assumed to be limited by solubility. Inventory results are based primarily on process knowledge at this time. As each tank is prepared for closure, specific sampling would be conducted to determine the inventory.

- **Hydraulic conductivity:** The actual rate of water movement through the material is ultimately affected by the hydraulic conductivity of the strata underneath the source. Generally, the grout or concrete basemat is the limiting layer with regard to water infiltration. At the time of structural failure, the hydraulic conductivity is increased dramatically, making more water available to carry contaminants to the aquifer. In general, this will result in greater doses/concentrations due to the increased movement of material.

- **Distribution coefficient:** The distribution coefficient (K_d) affects the rate at which contaminates move through strata. Large K_d values provide holdup time for short-lived radionuclides.

- **Vadose zone thickness:** The thickness of the strata between the contaminated region and the aquifer does not necessarily reduce the concentration so much as it slows the progress toward the aquifer. Therefore, for shorter-lived radionuclides, extra time granted by thicker strata can decrease the activity before the contaminants reach the aquifer.

- **Distance downgradient to receptor location:** The distance to a given receptor location affects (a) the time at which contaminants will arrive at the location and (b) how much dispersion occurs. For greater distances, longer travel times will be encountered, resulting in lower activity values for short-lived radioactive constituents and greater dispersion for all constituents.

DOE recognizes that over the period of analysis in this EIS, there is also uncertainty in the structural behavior of materials and the geologic and hydrogeologic setting of the Savannah River Site. DOE realizes that overly conservative assumptions can be used to bound the estimates of impacts; however, DOE believes that this approach could result in masking of differences of impacts among alternatives. Therefore, DOE has attempted to use assumptions in its modeling analysis that are reasonable based on current knowledge so that meaningful comparisons among alternatives can be made.

C.1 Analyzed Scenario

The hydrogeology under various areas of the SRS has been modeled several times in the last few years. Most of the modeling has focused on specific locations (e.g., the Saltstone Manufacturing and Disposal Facility in Z-Area, the seepage basins in H- and F-Areas) and is thus subject to updating as new information becomes available. DOE is continually refining the model for the General Separations Area based on recent hydrogeologic measurements. DOE has prepared this EIS using the methodology and the modeling assumptions as presented in the *Industrial Wastewater Closure Plan for F- and H-Area High-Level Waste-Tank Systems.* DOE recognizes that future refining of the models described in the closure plan may result in slightly different estimates of impacts. However, DOE believes that using the methodology described in the closure plan provides a consistent basis for evaluating the alternatives.

The tank farms were modeled individually to determine the impacts from the respective source. In the analyzed scenario, the mobile contaminants in the tanks are assumed to gradually migrate downward through unsaturated soil to the groundwater aquifer. The aquifers underneath F-Area Tank Farm were assumed to discharge primarily to Fourmile Branch while the aquifers underneath H-Area Tank Farm were assumed to discharge to both Fourmile Branch and Upper Three Runs. Therefore, the contaminants would be transported by the groundwater to the seepline and subsequently to Fourmile Branch or Upper Three Runs. Upon reaching

the surface water, some contaminants would migrate to the sediments at the bottom of the streams and the shoreline. Aquatic organisms in the stream and plants along the shoreline would be exposed to the contaminants. Terrestrial organisms might then ingest the contaminated vegetation and also obtain their drinking water from the contaminated stream. Humans are assumed to be exposed to contaminants through various pathways associated with the surface water.

The following sections describe specific assumptions incorporated into the modeling calculations for the analyzed alternatives.

C.1.1 SCENARIO 1 – NO ACTION ALTERNATIVE

The No Action Alternative assumes that for the 100 years of institutional control, the tanks would contain necessary ballast water that would be treated to minimize corrosion. The tank is assumed to have a constant leak rate (simulated and limited by the hydraulic conductivity of the intact concrete basemat), which causes some passage through the tank bottom. At 100 years, the tanks are filled with water and abandoned but not capped.

At some point in the future, degradation associated with the aging of the tanks would destroy the tanks. The contaminants are then assumed to reside at the bottom of a hole equal to the depth of the tank (generally 30 to 40 feet). Although debris would exist in the hole, it is assumed to play no role in inhibiting infiltration or preventing flow into the soil. Because of the lack of structural support, the tanks and concrete basemat are assumed to fail completely at 100 years, exposing the contaminated media to rainfall with subsequent infiltration to groundwater.

The No Action Alternative is the only alternative that could conceivably expose individuals by the atmospheric pathway from the tank area, because each of the other alternatives would fill the tanks with material that would cover the contaminants and prevent their escape via atmospheric dispersion. The only foreseeable occurrence of an atmospheric release under No Action would be if the tank structures collapsed, causing the suspension of particulates containing contaminants. However, the likelihood of an atmospheric release is considered to be minimal, at best, for the following reasons:

- The amount of rainfall in the area would tend to keep the tank contents damp through the time of failure. After failure, a substantial amount of debris on top of the contaminated material would prevent release even if the contents were to dry during a period of drought.
- The considerable depth of the tanks below grade would tend to discourage resuspension of any of the tanks' contents.

Based on these reasons, no analyses were performed for the atmospheric pathway.

C.1.2 SCENARIO 2 – CLEAN AND FILL WITH GROUT OPTION

Scenario 2 assumes that the tanks would be filled with grout, and engineered structures would not be used to reduce the infiltration of rain water. By analogy with the analysis presented in the *E-Area Vault Radiological Performance Assessment* (WSRC 1994a), the concrete tank structure could enter a period of degraded performance due to cracking at around 1,400 years. Assuming that the approximately 34 feet of grout continue to support the tank roof and provide an additional barrier to infiltration for an indefinite period of time [Z-Area RPA (WSRC 1992)], water infiltration should occur much later than 1,400 years. However, for this scenario, the assumption is made that the tank top, grout, and basemat fail at 1,000 years, with a corresponding increase in their respective hydraulic conductivities.

C.1.3 SCENARIO 3 – CLEAN AND FILL WITH SAND OPTION

Scenario 3 assumes that the tanks would be filled with sand, and engineered structures would not be used to reduce the infiltration of

rain water. Eventually, the sides and roof of the tanks would collapse, allowing water to infiltrate the tank and leach the contaminants down to the aquifers. DOE has assumed that the tank fails at 100 years.

C.1.4 SCENARIO 4 – CLEAN AND FILL WITH SALTSTONE OPTION

Scenario 4 is similar to Scenario 2 in that a cementitious material is used to fill the tanks. However, in this scenario, the fill material is saltstone, a composite material made of cement, flyash, slag, and slightly contaminated media from processing of high-level waste. Currently, saltstone is disposed in Z-Area; under this alternative, saltstone would be used to fill the tanks and (as in Scenario 2) would be assumed to remain intact for 1,000 years following tank closure.

C.2 Methodology

C.2.1 HUMAN HEALTH ASSESSMENT

C.2.1.1 General Methodology

Utilizing the Multimedia Environmental Pollutant Assessment System (MEPAS) computer code (Buck et al. 1995), a multi-pathway risk model developed by Pacific Northwest Laboratory, calculations were performed to assess the impacts of the leaching of contaminants to the groundwater for each of the four tank closure scenarios. To model the four closure scenarios, infiltration rates were selected that represent the vertical moisture flux passing through the tanks for each closure alternative. These infiltration rates are dependent upon the chemical and physical characteristics of the tank fill material for each scenario.

Based on the calculated inventories of chemical and radioactive contaminants remaining in the tanks after bulk waste removal and spray washing, the model was set up to simulate the transport of contaminants from the contaminated zone (residual waste layer), through the concrete basemat (first partially saturated zone), the vadose zone directly beneath the basemat (second partially saturated zone), and into the underlying aquifers (saturated zones). Model runs were completed for both early timeframes (before the assumed failure occurs) and late timeframe (after assumed failure occurs) conditions.

In addition to the four tank closure scenarios, modeling was performed for pollutants remaining in the ancillary equipment and piping above the tanks. In this calculation, the piping and equipment were considered to be the contaminated zone while the partially saturated zone was the layer of soil extending from the surface to the saturated zones.

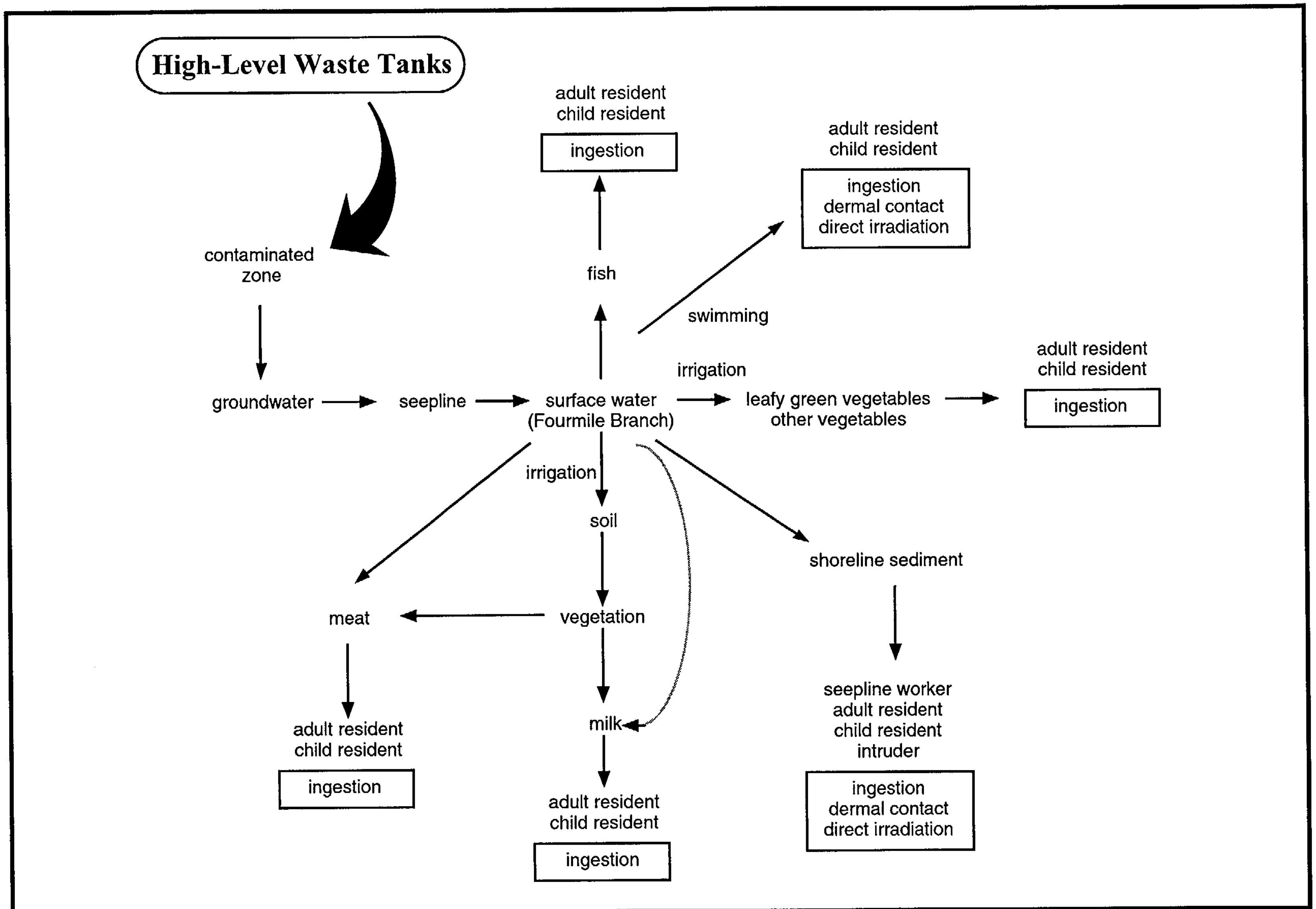
Calculated pollutant concentrations and dose levels are provided at 1 meter and 100 meters downgradient from the edge of the tank farms, at the seepline, and in the surface waters of Fourmile Branch and Upper Three Runs for the hypothetical individuals discussed in Section C.2.1.2. DOE has not calculated groundwater concentrations underneath the tanks because of inherent limitations involved in those calculations. Specifically, the large size of the tank farms and the pattern of groundwater movement make calculations for locations in proximity to the source speculative.

C.2.1.2 Receptors

The potential receptors and exposure pathways are identified in the following sections and illustrated in Figure C-1.

Worker

The worker is assumed to be located in the area including and surrounding either of the tank farms. Because institutional controls are in place, the potential for exposure of the worker to the primary source (residual at the bottom of the tanks) is minimal, owing to the structural integrity of the tank, the lack of any industrial work that would be performed over the tanks, and safety measures that would be taken to further reduce potential exposure. Therefore, this analysis assumes that the worker is located constantly at the nearest place where contaminants



NW TANK/Grfx/C-1 Expo paths.ai

Figure C-1. Potential exposure pathways for human receptors.

would be accessible (i.e., on the bank of Fourmile Branch or Upper Three Runs, as part of his work duties). The assumption is conservative because the worker has a greater potential for exposure to contaminants at the seepline. However, the fact that he is a worker limits, and, hence, eliminates pathways that might be considered if he were considered a resident. The potential exposure pathways for the seepline worker are:

- Direct irradiation from the deposits along the banks of the streams (radioactive contaminants only)
- Incidental ingestion of the soil from the deposits along the banks of the streams
- Dermal contact with dust from the deposits along the banks of the streams

Exposure from inhalation of resuspended soil was not evaluated because the soil conditions at the seepline (i.e., the soil is very damp) are such that the amount of soil resuspended and potentially inhaled would be minimal.

Intruder

Another potential receptor is the intruder, a person who gains unauthorized access to the tank farm site and becomes exposed to the contaminants in some manner. The intruder scenario is analyzed after institutional controls have ceased. Because the intruder is assumed not to have residential habits, he or she would not have exposure pathways like that of a resident (e.g., the intruder does not build a house, grow produce, etc.); instead, the intruder is potentially exposed to the same pathways as the seepline worker but for a shorter duration (4 hours per day, as noted in Section C.3.2.5).

Nearby Adult Resident/Nearby Child Resident

Nearby residents could also potentially be exposed to contaminants from the tank farms. Members of the public are assumed to construct a dwelling near the tank farms on SRS (but outside the tank farm site). The location of the residential dwelling is assumed to be downgradient near one of the two main streams (Fourmile Branch or Upper Three Runs) on the side opposite the tank farms at a point 100 meters downstream of the groundwater outcropping in these streams. The residents of this dwelling include both adults and children. The adult resident was modeled separately from the child resident because of different body weights and consumption rates.

The resident is assumed to use the stream for recreational purposes; to grow and consume produce irrigated with water from the stream; to obtain milk from cows raised on the residential property; and to consume meat that was fed contaminated vegetation from the area. Therefore, potential exposure pathways for both the nearby adult and nearby child resident are the following:

- Incidental ingestion of contaminated soil from deposits along the banks of the streams
- Inhalation of contaminated soil from deposits along the banks of the streams
- Direct irradiation from deposits along the banks of the streams (radioactive contaminants only)
- Direct irradiation from surface water (radioactive contaminants only - recreation)
- Dermal contact with surface water
- Incidental ingestion of surface water
- Ingestion of contaminated meat
- Ingestion of produce grown on contaminated soil irrigated with water from Fourmile Branch
- Ingestion of milk from cows that are fed contaminated vegetation
- Ingestion of aquatic foods (e.g., fish) from Fourmile Branch

Because of the physical circumstances of the fate and transport modeling, the most likely location for soil ingestion is on the shoreline of the streams. Figure C-1 shows this pathway, which is identified as "shoreline sediment" along with the appropriate exposure pathways: ingestion, dermal contact, and direct irradiation. While analyses of some waste sites do show that soil ingestion is a dominant pathway, this usually occurs when the residents have direct access to the highly contaminated soils excavated from the waste site. Because of the depth of the waste tanks so far below grade and the fill material that would be in place, there is n credible situation by which the residents could have direct access to this material in this EIS; therefore, the soil ingestion pathway is not dominant.

Although the basic assumption for the residents is that they are not located at the tank farms, DOE has nevertheless estimated the impact if residents are allowed access to the tank farms.

Atmospheric Pathway Receptors

Based on the reasoning presented in Sections C.1.1 and C.2.1.2, no analyses were performed for the atmospheric pathway.

C.2.1.3 Computational Code

Groundwater and surface water concentrations and human health impacts were calculated using the MEPAS computer code (Buck et al. 1995). MEPAS was developed by Pacific Northwest National Laboratories under DOE contract and integrates source-term, transport, and exposure models for contaminants. In the MEPAS code, contaminants are transported from a contaminated area to potentially exposed humans through various transport pathways (groundwater, surface water, soils, food, etc.). These exposed individuals then receive doses, both chemical and radiation, through exposure or intake routes (ingestion, dermal contact, inhalation, etc.) and numerous exposure pathways (drinking water, leafy vegetables, meat, etc.).

MEPAS includes models to estimate human health impacts from radiation exposure (radionuclides and direct radiation), carcinogenic chemicals, and noncarcinogenic chemicals. Health effects resulting from radiation and radionuclide exposures are calculated as annual dose (millirem per year). Cancer incidence rates are calculated for carcinogens.

The MEPAS code is widely used (PNL 1999) and accepted throughout the DOE complex and has been presented to and accepted by other regulatory agencies such as EPA. Examples of its use by DOE include the EH-Environmental Survey Risk Assessment and the Complex-Wide Programmatic Waste Management EIS Impact Analysis. This code has been used to demonstrate environmental impacts in RCRA-Subpart X permit applications to various EPA regions; these analyses were accepted and permits based on them were issued.

C.2.1.4 Calculational Methodology

The modeling results presented in this appendix are based on the amount of contaminants remaining in the tanks after bulk waste removal and spray washing (except for No Action, which assumes only bulk waste removal with no spray washing). The results can generally be scaled to differing amounts of residual contaminants left in a tank. Although the waste is present as supernate (salt solution), damp saltcake and sludge, the total residual waste volume was assumed to be sludge, based on the assumption that all the residual contaminants reside in the sludge (Newman 1999).

Analyses were performed specifying infiltration rates that relate to the four closure scenarios. An infiltration rate of 40 centimeters per year (average infiltration rate for SRS soils) was used to model time periods after tank failure (WSRC 1994a). This value takes into account the average annual precipitation and the amount of rainfall that evaporates, flows to streams and land surface, etc. and is not available for infiltration into soil. An infiltration rate of 122 centimeters per year was used for the No Action Alternative to simulate infiltration of 100 percent of the average annual precipitation assuming no runoff or evaporation. The latter assumption is consid-

ered to be reasonable given the fact that the tanks are located in a depression that could fill with rainwater if the storm drain system fails.

As discussed in Section C.1.1, tank failure for the No Action Alternative would involve an initial release of the ballast water that would be limited by the hydraulic conductivity.

MEPAS calculations were performed for early (before structural failure) and late (after structural failure) conditions for each closure scenario. As discussed above, a failure time was assumed for each closure scenario based on anticipated performance of the tank fill material and concrete basemat. The tank fill and concrete basemat were assumed to fail simultaneously and completely in terms of retaining waste. Failure was simulated for modeling purposes by increasing the infiltration rate to 40 centimeters per year (except for No Action which remains at 122 centimeters per year) and increasing the hydraulic conductivity of the basemat to that of sand. Because radionuclide and chemical pollutants could leach though the concrete before failure occurs, the original source term was reduced by an amount equal to the quantities released to the aquifer during the prefailure period. In addition, radionuclides continually decay, further changing the source term. Thus, for late runs, in addition to changing the infiltration rates and hydraulic conductivities, the source term concentrations were adjusted to reflect losses and decay occurring before failure.

In the groundwater transport pathway, infiltration causes leaching of pollutants from the tanks through distinct media found below the waste unit down to the groundwater aquifer (saturated zone). To model the movement of the pollutants from the waste unit to the aquifer, MEPAS requires that the distinct strata that the pollutants encounter be identified. For modeling the tank farms, the residual at the bottom of the tanks was considered to be the contaminated zone.

Between the contaminated zone and the saturated zone, two discernible layers were identified: the concrete basemat of the tank and the unsaturated (vadose) zone. Parameters describing the concrete layer were defined for both pre- and postfailure conditions because values for parameters such as porosity, field capacity, and hydraulic conductivity change with degradation state. Analysis of flow through the vadose zone is complicated in that movement varies with soil-moisture content and wetting and drying conditions. Therefore, values for saturated zone soil parameters (e.g., density, porosity) were used to describe the unsaturated zone.

For each of the four layers identified for this site (contaminated zone, concrete basemat, vadose zone, and saturated zone), surface distribution coefficients, K_d values, were selected for each radionuclide and chemical for each modeled layer. Because distribution coefficients are a chemical property, the K_d values were not changed for degraded or failed materials. The identification and derivation of the K_d values is discussed in detail in Section C.3.2.1.

As contaminants are transported from the contaminated zone to the seepline, they are longitudinally (along the streamline of fluid flow), vertically, and transversely (out sideways) dispersed by the transporting medium. MEPAS incorporates longitudinal dispersivity of pollutants moving downward through the partially saturated zone layers (i.e., concrete basemat and vadose zone) in concentration calculations. In the saturated zone, MEPAS incorporates into concentration calculations the three-dimensional dispersion along the length of travel. Dispersion distances were calculated through the concrete basemat, the vadose zone, and the groundwater aquifer. Logically, dispersion generally increases with longer travel distances, and it should be noted that the travel distance is determined by the hydraulic gradients and not by linear distance.

Groundwater concentrations and doses due to ingestion of water are calculated at hypothetical wells at 1 meter and 100 meters downgradient from the edge of the respective tank farms, at the respective seeplines, and in Fourmile Branch and Upper Three Runs.

As discussed earlier, impacts to adult and child residential receptors are evaluated at a point 100 meters downstream of the groundwater outcropping in Fourmile Branch and Upper Three Runs. The concentration of contaminants in the streams was also calculated. Based on the dimensions, flow rate, and stream velocities, MEPAS accounts for mixing of the contaminant-containing water from the aquifer with stream water and other groundwater contributions. For both adult and child residents, ingestion rates were based on site-specific parameters. Parameters and associated assumptions used in calculating human impacts are presented in Section C.3.2.5.

In addition to the four closure scenarios, MEPAS runs were performed to determine the effects of leaving in place the piping, vessels, and other tank-specific systems outside the tanks, all of which contain residual pollutants. It was assumed that an additional 20 percent of the radioactive contaminants remaining in the tanks after bulk cleaning and spray washing would be distributed in the ancillary equipment (d'Entremont 1996). Modeling was performed for two options: (1) leaving the piping and other equipment as they currently exist (assumed for the No Action Alternative and Clean and Fill with Sand Option), and (2) filling, where possible, the piping and other outside equipment with grout (assumed for the Clean and Fill with Grout and Clean and Fill with Saltstone Option). For modeling in MEPAS, the ancillary equipment was considered to be the contaminated zone, and the entire distance between the contaminated zone and the saturated zone was characterized as one layer of typical SRS soil. Therefore, no credit was taken for the additional reduction of leachate afforded by the tanks, thus providing conservative results.

C.2.2 ECOLOGICAL RISK ASSESSMENT

C.2.2.1 <u>General Methodology</u>

Several potential contaminant release mechanisms were considered for assessing ecological risks associated with tank closure. These included contamination of runoff water during rainstorms, soil contamination from air emissions following tank collapse, and contamination of groundwater. Onsite inspection showed that the tanks are well below (4 to 7 meters) the surrounding, original land surface. Therefore, runoff or soil contamination was not a reasonable assumption. Groundwater contamination was determined to be the most likely means of contaminant transport.

Several contaminant migration pathways were evaluated, which for half of H-Area (south of the groundwater divide) include seepage of the groundwater from the Water Table and Barnwell-McBean Aquifers at a downgradient outcrop (seepline) and subsequent mixing in Fourmile Branch and outcrop from the Congaree Aquifer and subsequent mixing in Upper Three Runs. For the other half of H-Area (north of the groundwater divide), all three aquifers outcrop at Upper Three Runs with subsequent mixing with this stream. For F-Area, the analysis included seepage of the groundwater from the Water Table and Barnwell-McBean Aquifers at a downgradient outcrop (seepline) and subsequent mixing in Fourmile Branch, and outcrop from the Congaree Aquifer and subsequent mixing in Upper Three Runs. Each of these migration pathways was evaluated using four methods for tank stabilization, which include the Clean and Fill with Grout Option, the Clean and Fill with Sand Option, the Clean and Fill with Saltstone Option, and the No Action Alternative (no stabilization). The groundwater-to-surface water contaminant migration pathway, together with potential routes of entry into ecological receptors, is shown in the conceptual site model (Figure C-2).

The habitat in the vicinity of the seeplines is bottomland hardwood forest. On the upslope side of the bottomland, the forest becomes a mixture of pine and hardwood.

Potential impacts to terrestrial receptors at the seepline and aquatic receptors in Fourmile Branch and Upper Three Runs were evaluated. For the assessment of risk due to toxicants, the aquatic receptors are treated as a group because

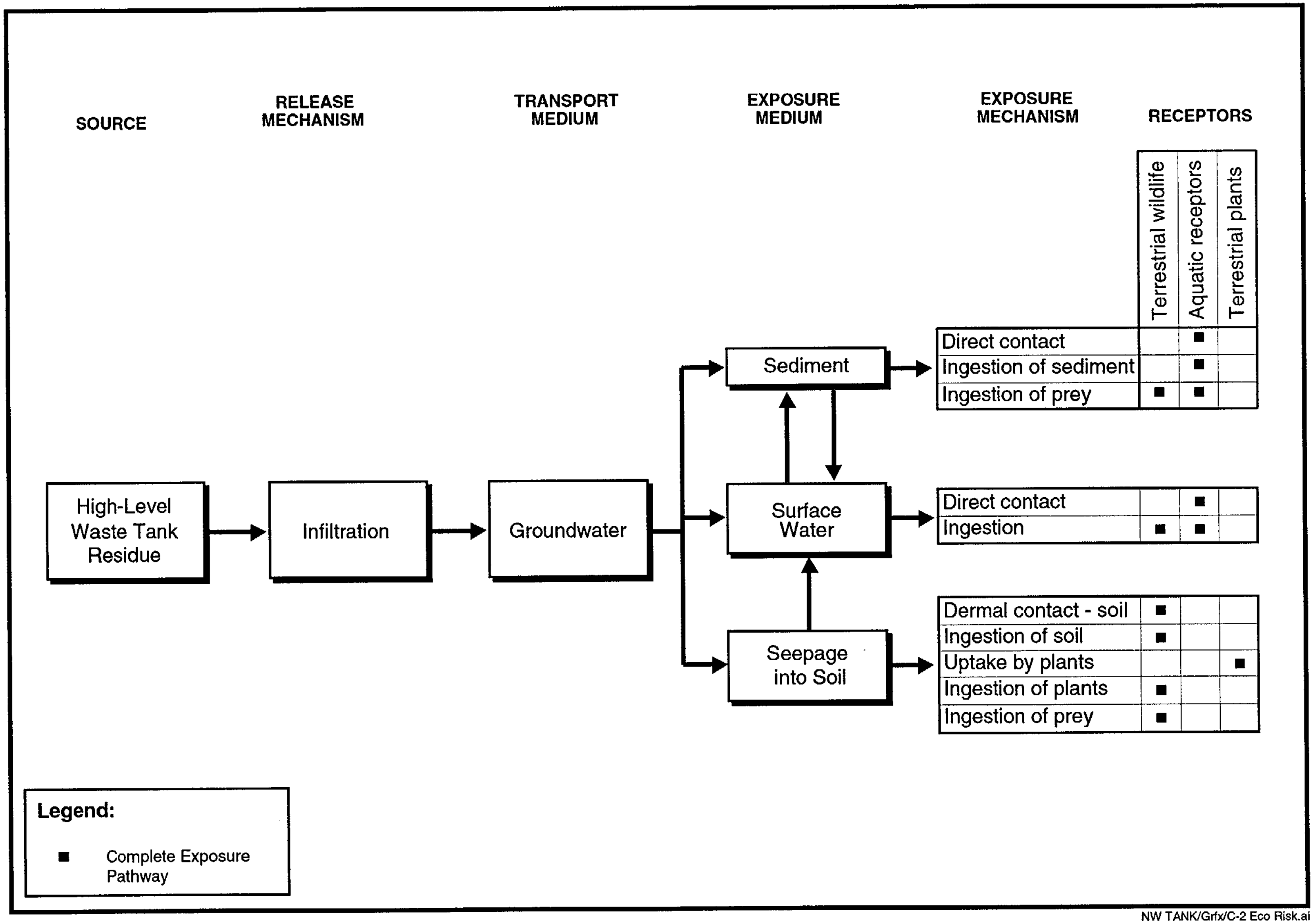


Figure C-2. Ecological Risk Assessment Conceptual Site Model.

water quality criteria have been derived for protection of aquatic life in general. These criteria, or equivalent values, are used as threshold concentrations. For the radiological risk assessment, the redbreast sunfish was selected as an indicator species due to its abundance in Fourmile Branch and Upper Three Runs (Halverson et al. 1997).

There are no established criteria for the protection of terrestrial organisms from toxicants. Receptor indicator species are usually selected for risk analysis and the results extrapolated to the populations, communities, or feeding groups (e.g., herbivores, predators) they represent. Two terrestrial animal receptors, the southern short-tailed shrew and the mink, were selected in accordance with EPA Region IV guidance, which calls for investigation of small animals with small home ranges. The guidance also calls for investigation of predators when biomagnifying contaminants (such as mercury) are being studied. The southern short-tailed shrew is small and one of the most common mammals on the SRS; the mink is a small-bodied predator associated with waterways and is found on SRS (Cothran et al. 1991). Species that are more abundant on SRS than the mink with similar eclogues were considered for use in this assessment, including the raccoon. However, the mink has a small body size relative to similar species, which results in a more conservative estimate of exposure. Also, the mink is considered to be a highly contaminant-sensitive species, and is almost exclusively carnivorous (which maximizes toxicant exposure). The short-tailed shrew and mink are also used in the radiological assessment.

The seepage areas are estimated to be small, about 0.5 hectare (DOE 1997), so risk to plant populations would be negligible even if individual plants were harmed. The only case in which harm to individual plants might be a concern in such a small area would be if protected plant species are present. Because no protected plant species are known to occur in these areas, risks to terrestrial plants are not treated further in the risk assessment.

The following exposure routes were chosen for calculating absorbed radiation dose to the terrestrial mammals of interest (shrew and mink) located on or near the seeplines: ingestion of food (earthworms, slugs, insects and similar organisms for the shrew, and shrews for the mink); ingestion of soil; and ingestion of water. The following exposure routes were chosen for calculating absorbed dose to aquatic animals of interest (sunfish) living in Fourmile Branch and Upper Three Runs: uptake of contaminants from water and direct irradiation from submersion in water. Standard values for parameter such as mass, food ingestion rate, water ingestion rate, soil ingestion rate, and bioaccumulation factors were used (see Section C.3.3).

C.2.2.2 Exposure and Toxicity Assessment

Exposure to Chemical Toxicants

Exposure for aquatic receptors is simply expressed as the concentration of contaminants in the water surrounding them. This is the surface-water exposure medium shown in the conceptual site model (Figure C-2). The conceptual model also includes sediment as an exposure medium; sediment can become contaminated from the influence of the surface water or from seepage that enters sediment directly. However, this exposure medium was not evaluated because estimating sediment contamination from surface water inputs would be highly speculative and seepage into sediment is not considered in the groundwater model; all of the transported material is assumed to come out at the seepline.

Exposure for terrestrial receptors is based on dose, expressed as milligrams of contaminant ingested per kilogram of body mass per day. The routes of entry (exposure routes) used for estimating dose were ingestion of food and water. Dermal absorption is a possibility, but the fur of shrews and minks was considered to be an effective barrier against this route. The food of shrews is mainly soil invertebrates, and the mink eats small mammals, fish, and a variety of other small animals. Contaminants in seepage water were considered to be directly ingested as drinking water (shrew), ingested as drinking

water after dilution in Fourmile Branch (mink), ingested in aquatic prey (mink), and transferred to soil, soil invertebrates, shrews, and mink through a simple terrestrial food chain.

Chemical Toxicity Assessment

The goal of the toxicity assessment is to derive threshold exposure levels which are protective of the receptors (Table C.2.2-1). For aquatic receptors, most of the threshold values are ambient water quality criteria for chronic exposures. Others include the concentration for silver, which is an acute value (no chronic level was available).

For terrestrial receptors, toxicity thresholds are based on the lowest oral doses found in the literature that are no-observed-adverse-effect-levels (NOAELs) or lowest-observed-adverse-effect-levels (LOAELs) for chronic endpoints that could affect population viability or fitness (Table C.2.2-2). Usually the endpoints are adverse effects on reproduction or development. Uncertainty factors are applied to these doses to extrapolate from LOAELs to NOAELs and from subchronic or acute-to-chronic study durations. The derivation of these values is listed in Table C.2.2-3. Adjustments for differences in metabolic rates between experimental animals, usually rats or mice, and indicator species are made by applying a factor based on relative differences in estimated body surface area to mass ratios.

C.2.2.3 Calculational Design

Chemical Contaminants

For terrestrial receptors, the exposure calculation is a ratio of total contaminant intake to body mass, on a daily basis. This dose is divided by the toxicity threshold value to obtain a hazard quotient. Modeled surface water concentrations in Fourmile Branch and Upper Three Runs were divided by aquatic threshold levels to obtain a hazard quotient.

Radioactive Contaminants

Animal ingestion dose conversion factors (DCFs) for both terrestrial animals (shrew and mink) were estimated, for purposes of these calculations, by assuming that the animals possess similar metabolic processes as humans with regard to retention and excretion of radioisotopes; the chemistry of radioisotopes in the animals' bodies is assumed to be similar to that of humans. This assumption is appropriate because much of the data used to determine the chemistry of radioisotopes in the humans' bodies was derived from studies of small mammals. Equations from International Commission on Radiological Protection (ICRP) Publication 2 (ICRP 1959) were used to predict the uptake rate and body burden of radioactive material over the life span of the animals. All isotopes were assumed to be uniformly distributed throughout the body of the animal. Dose conversion factors for the aquatic animal, sunfish, were calculated by assuming a steady-state concentration of radioactive material within the tissues of the animal and a uniform concentration of radioactive material in the water surrounding the sunfish.

The quantity of radioactivity ingested by the organisms of interest was estimated by assuming that the organisms live their entire lives in the contaminated region (the seepline area for the terrestrial organisms and Fourmile Branch and Upper Three Runs near the seepline for the sunfish). The shrews are assumed to drink seepline water at the maximum calculated concentrations of radioactivity and to eat food that lives in the soil/sediments near the seepline. The concentrations of radioactivity in these media were derived from the calculated seepline and Fourmile Branch or Upper Three Runs concentrations. The mink is assumed to drink Fourmile Branch or Upper Three Runs water and eat only shrews that live near the seepline.

The estimated amount of radioactivity that the terrestrial organisms would ingest, through all postulated pathways, was then multiplied by the

Table C.2.2-1. Threshold toxicity values.

Contaminant	Aquatic receptors (milligrams per liter)	Terrestrial receptors (milligrams per kilograms per day)	
		Shrew	Mink
Aluminum	0.087	27.7	6.4
Barium	0.0059	1.78	0.41
Chromium	0.011	11.6	2.7
Copper	0.0014[a]	52.2	12
Fluoride	NA[b]	8.3	2.5
Iron	1.0	NA	NA
Lead	0.00013[a]	0.012	0.003
Manganese	NA	52.9	12.1
Mercury	0.000012	0.082	0.019
Nickel	0.019[a]	29.7	6.8
Nitrate (as N)	NA	(c)	–
Silver	0.000055[a]	0.33	0.077
Uranium	0.00187	4.48	1.01
Zinc[a]	0.0127	14.0	3.17

a. Based on a hardness of 8.2 mg $CaCO_3$/L.
b. Screening for MCL (10 mg/L) in seep water considered protective for nitrate.
NA: Not applicable (normally not a toxin for this type of receptor).

DCFs to calculate an annual radiation dose to the organism. For the sunfish, the concentration of radioactivity in the surface water was multiplied by the submersion and uptake dose conversion factors to calculate an annual radiation dose. These radiation doses are compared to the limit of 1,000 millirad per day (365,000 millirad per year).

C.3 Assumptions and Inputs

C.3.1 SOURCE TERM

C.3.1.1 Radionuclides

Radioactive material source terms for the tank farms and ancillary piping residuum used for the modeling are listed in Table C.3.1-1. These source terms relate to quantities remaining after bulk waste removal and spray washing. The ancillary piping and evaporator residual was conservatively estimated to be equal to 20 percent of the tank inventories.

The No Action Alternative analyzed in this EIS assumes that only bulk waste removal is performed. Based on experience in removing waste from Tanks 16, 17, and 20, DOE has assumed that the amount of radionuclides remaining after only bulk waste removal would be five times higher than that reported in Table C.3.1-1. Also, the Clean and Fill with Saltstone Option would introduce additional radioactive material into the HLW tanks. DOE used inventory estimates from the *Final Supplemental Environmental Impact Statement for the Defense Waste Processing Facility* (DOE 1994) for saltstone content to account for this additional radioactivity.

C.3.1.2 Chemicals

Chemical material source terms used in this modeling are listed in Table C.3.1-2. As with the radioactive source term, the ancillary piping and evaporator residual was conservatively estimated to be equal to 20 percent of the tank inventories. In addition, the lead in the tank top risers (500 pounds per riser, 6 risers per tank) was modeled.

Table C.2.2-2. Toxicological basis of NOAELs for indicator species.

Analyte	Surrogate species	LOAEL (milligrams per kilograms per day)	Duration	Effect	NOAEL (milligrams per kilograms per day)	Reference	Notes
Inorganics							
Aluminum	Mouse	–	13 mo	Reproductive system	19	Ondreicka et al. (1966) in ATSDR (1992)	
Barium	Rat	5.4	16 mo	Systemic	0.54	Perry et al. (1983) in Opresko et al. (1995)	
Chromium VI	Rat	–	1 y	Systemic	3.5	Mackenzie et al. (1958) in ATSDR (1993)	
Copper	Mink	15	50 w	Reproductive	12	Aulerich et al. (1982) in Opresko et al. (1995)	
Fluoride	Rat	5	60 d	Reproductive	–	Araibi et al. (1989) in ATSDR (1993)	
	Mink	5	382 d	Systemic	–	Aulerich et al. (1987) in ATSDR (1993)	Systemic LOAEL < reproductive
Iron							Data inadequate; essential nutrient
Lead	Rat	0.28	30 d	Reproductive	0.014	Hilderbrand et al. (1973)	
Manganese	Rat	–	100-224 d	Reproductive	16	Laskey et al. (1982)	
Mercury	Mink	0.25	3 mo	Death; devel.	0.15	Wobeser et al. (1976) in Opresko et al. (1995)	
Nickel	Rat	18	3 gens	Reproductive	–	Ambrose et al. (1976)	Based on first-generation effects
Nitrate (as N)							MCL of 10 mg/L at seepline is protective
Silver	Mouse	23	125 d	Behavioral	–	Rungby & Danscher (1984)	
Uranium	Mouse	–	~102 d	Reproductive	3.07	Paternain et al. (1989) in Opresko et al. (1995)	
Zinc	Mouse	96	9-12 mo	Systemic	–	Aughey et al. (1977)	Small data base

Table C.2.2-3. Derivation of NOAELs for indicator species.

Contaminant of concern	Surrogate species	NOAEL or LOAEL in surrogate species (milligrams per kilograms per day)	UF[a]	Body surface area conversion factor	Indicator species	Indicator species NOAEL (milligrams per kilograms per day)	Notes
Inorganics							
Aluminum	Mouse	19	1	0.33	Mink	6.4	
	Mouse	19	1	1.46	Shrew	27.7	
Barium	Rat	0.54	1	0.76	Mink	0.41	
	Rat	0.54	1	3.30	Shrew	1.78	
Chromium VI	Rat	3.5	1	0.76	Mink	2.7	
	Rat	3.5	1	3.30	Shrew	11.6	
Copper	Mink	12	1	1.00	Mink	12.0	
	Mink	12	1	4.35	Shrew	52.2	
Fluoride	Mink	5	2	1.00	Mink	2.5	UF from less serious LOAEL
	Rat	5	2	3.30	Shrew	8.3	UF from less serious LOAEL
Iron							Data inadequate; essential nutrient
Lead	Rat	0.014	4	0.76	Mink	0.003	UF for study duration
	Rat	0.014	4	3.30	Shrew	0.012	UF for study duration
Manganese	Rat	16	1	0.76	Mink	12.1	
	Rat	16	1	3.30	Shrew	52.9	
Mercury	Mink	0.15	8	1.00	Mink	0.019	UF for study duration
	Mink	0.15	8	4.35	Shrew	0.082	UF for study duration
Nickel	Rat	18	2	0.76	Mink	6.8	UF from LOAEL: NOAEL in 2nd and 3rd generations
	Rat	18	2	3.30	Shrew	29.7	UF from LOAEL: NOAEL in 2nd and 3rd generations
Nitrate (as N)							MCL of 10 mg/L at seepline is protective
Silver	Mouse	23	100	0.33	Mink	0.077	UF for LOAEL and nature of study
	Mouse	23	100	1.46	Shrew	0.33	UF for LOAEL and nature of study
Uranium	Mouse	3.07	1	0.33	Mink	1.01	
	Mouse	3.07	1	1.46	Shrew	4.48	
Zinc	Mouse	96	10	0.33	Mink	3.17	UF: LOAEL to NOAEL
	Mouse	96	10	1.46	Shrew	14.0	UF: LOAEL to NOAEL

a. UF = Uncertainty factor.

Table C.3.1-1. Tank farm residual after bulk waste removal and spray washing (curies).[a]

Radionuclide	F-Area Tank Farm	H-Area Tank Farm
Se-79	1.2	1.7
Sr-90	6.2×10^4	9.5×10^4
Tc-99	20	29
Sn-126	2.2	2.2
Cs-135	0.013	0.02
Cs-137	4,300	5,600
Eu-154	350	1,200
Np-237	0.06	0.12
Pu-238	0[b]	1,680
Pu-239	130	22

a. Derived from Newman (1999) and Hester (1999). Ancillary equipment is assumed to constitute an additional 20 percent of contaminants.
b. Only trace amounts of Pu-238 are present in F-Area Tank Farm.

Table C.3.1-2. Tank farm residual after bulk waste removal and spray washing (kilograms).[a]

Constituent	F-Area Tank Farm	H-Area Tank Farm
Iron	2,300	1,000
Manganese	240	140
Nickel	55	26
Aluminum	820	250
Chromium VI	20[b]	6.7[b]
Mercury	6.3	89
Silver	27	0.9
Copper	14	1.7
Uranium	450	4.3
Nitrate	150	62
Zinc	27	8.6
Fluoride	14.2	2
Lead [c]	24	12

a. Derived from Newman (1999) and Hester (1999). Ancillary equipment is assumed to constitute an additional 20 percent of contaminants.
b. All chromium was modeled as Chromium VI.
c. Additional lead from risers are not included in this value.

The No Action Alternative analyzed in this EIS assumes that only bulk waste removal is performed. Consequently, DOE has assumed that the amount of chemical constituents remaining after only bulk waste removal would be five times higher than that reported in Table C.3.1-2. Also, the Clean and Fill with Saltstone Option would introduce additional material into the HLW tanks. DOE used inventory estimates from the *Final Supplemental Environmental Impact Statement for the Defense Waste Processing Facility* (DOE 1994) for saltstone content to account for this additional material.

C.3.2 CALCULATIONAL PARAMETERS

The modeling described in this appendix was designed to be specific to the tank farms. This was accomplished by utilizing site-specific data where available. For the hundreds of MEPAS input parameters, default values were used only for the distribution coefficients for chemical constituents.

For the four closure scenarios modeled, the majority of the MEPAS input parameters remain constant. Examples of constant parameters include contaminants of concern (radionuclide and chemical) and their respective initial source terms, spatial dimensions and elevation of the contaminated zone, strata thicknesses, chemical and physical properties (hydraulic conductivity and gradient, distribution coefficients) of SRS soil, exposure pathways, dose conversion factors and downgradient distances to compliance points.

Input parameters that changed for the various closure scenarios and were shown by sensitivity analyses to markedly affect the breakthrough times and peak concentrations include constituent and strata specific distribution factors, rainwater infiltration factors, and concrete basemat hydraulic conductivities. These and other important parameters are discussed in the following sections.

C.3.2.1 Distribution Coefficients

The distribution coefficient, K_d, is defined for two-phased systems as the ratio of the constituent concentration in the solid (soil) to the concentration of the constituent in the interstitial liquid (leachate). For a given element, this parameter may vary over several orders of magnitude depending on such conditions as soil pH and clay content. Experiments have been performed (Bradbury and Sarott 1995) that have demonstrated that strong oxidizing or reducing environments tend to affect the K_d values markedly. Because this parameter is highly sensitive in relation to breakthrough and peak times (but not necessarily peak concentration), careful selection is imperative to achieve reasonable results. For this reason, several literature sources were used to assure the most current and appropriate K_d values were selected for the example calculation.

For modeling purposes, four distinct strata were used for groundwater contaminant transport for all four closure scenarios (except for ancillary equipment and piping, which used only three, see below). These four strata are identified as (1) contaminated zone (CZ), (2) first partially saturated zone or concrete basemat, (3) second partially saturated zone or vadose zone, and (4) saturated zone. Distribution coefficients for each of these zones differ depending on the closure scenario-specific chemical and physical characteristics.

The models for ancillary equipment/piping and tanks were similar, except the piping model was assumed to have only one partially saturated zone. For this model, the concrete basemat was conservatively assumed to have no effect on reducing the transport rate of contaminants to the saturated zone. The thickness of the vadose zone was increased to 45 feet to reflect the higher elevation of the piping in relation to the saturated zone.

Distribution coefficients for each strata under various conditions are listed in Table C.3.2-1. A detailed discussion of the selection process is provided for each closure scenario.

Scenario 1 – No Action Alternative

For this scenario, K_d values for the CZ were assumed to behave similarly to that of clay found in the vicinity of the SRS tank farms. For the radionuclides and chemicals of interest, these K_d values are listed in Column V of Table C.3.2-1.

For the first partially saturated zone (concrete basemat), K_d values were selected for concrete in a non-reducing environment and are listed in Column II of Table C.3.2-1. K_d values for the second partially saturated zone (vadose zone) and the saturated zone are the same and were selected to reflect characteristics of SRS soil. These values are listed in Column I of Table C.3.2-1. For the ancillary equipment and piping, K_d values for the CZ are presented in Column V, partially saturated and saturated zones are listed in Column I of Table C.3.2-1.

Scenario 2 – Clean and Fill With Grout Option

This scenario assumes that the tanks and ancillary piping would be filled with a strongly reducing grout. Therefore, for the tank model, K_d values for the CZ, first and second partially saturated zones, and the saturated zone are listed in Columns IV, III, I, and I of Table C.3.2-1, respectively.

Similarly, for the piping model, K_d values for the CZ, partially saturated zone, and the saturated zone are listed in Columns IV, I, and I of Table C.3.2-1, respectively.

Scenario 3 – Clean and Fill With Sand Option

This scenario uses the same K_d values as for scenario 1.

Scenario 4 – Clean and Fill With Saltstone Option

This scenario assumes that the tanks and ancillary piping would be filled with saltstone with composition like that in the Z-Area Saltstone Manufacturing and Disposal Facility. There-

Table C.3.2-1. Radionuclide and chemical groundwater distribution coefficients, cubic centimeters per gram.

	I		II		III		IV		V		VI	
	SRS Soil	Ref.	Non-Reducing Concrete[l]	Ref.	Reducing[j] Concrete	Ref.	Reducing[j] CZ	Ref.	Non-Reducing CZ	Ref.	Saltstone	Ref.
Se-79[a]	5	b	0	b	0.1	i	0.1	i	740[m]	b	7	s
Sr-90	10	b	10	b	1	i	1	i	110[m]	b	10	s
Tc-99	0.36	b	700	b	1,000	i	1,000	i	1[m]	b	700	s
Sn-126	130	b	200	b	1,000	i	1,000	i	670[m]	b	t	
Cs-135, 137	100	b	20	b	2	i	2	i	1,900[m]	b	t	s
Eu-154[p]	800[d]	c	1,300	e	5,000[q]	i	5,000[q]	i	1,300	e	t	
Np-237	10	b	5,000	b	5,000	b	5,000	i	55	b	t	
Pu-238, 239	100	b	5,000	b	NA	f	NA	f	5,100[m]	b	t	
Iron	15	g	15	n	1.5	o	1.5	o	15	n	t	
Manganese	16.5	g	36.9	n	100	i	100	i	36.9	n	t	
Nickel	300	b	650	n	100	i	100	i	650	n	t	
Aluminum	35,300	g	35,300	n	353	o	353	o	35,300	n	t	
Chromium VI[h]	16.8	g	360	n	7.9	o	7.9	o	360	n	t	
Mercury	322	g	5,280	n	5,280	o	5,280	o	5,280	n	t	
Silver	0.4	g	40	n	1	i	1	i	40	n	t	
Copper	41.9	g	336	n	33.6	o	33.6	o	336	n	t	
Uranium	50	b	1,000	n	NA	u	NA	u	1,600	b	t	
Nitrate	0	g	0	n	0	o	0	o	0	n	0	s
Zinc	12.7	g	50	n	5	o	5	o	50	n	t	
Fluoride	0	g	0	n	0	o	0	o	0	n	t	
Lead	234	g	NA	r	NA	r	NA	r	NA	r	NA	r

a. Values also used for chemical contaminants.
b. E-Area RPA (WSRC 1994a), Table 3.3-2, page 3-69.
c. Yu et al. (1993), Table 32.1, page 105.
d. Value used for loam from c.
e. Value used for clay from c.
f. Solubility limit of 4.4×10^{-13} mols/liter used, WSRC (1994a), page C-32.
g. MEPAS default for soil <10% clay and pH from 5-9.
h. For conservatism, all chromium modeled as VI valence.
i. Bradbury and Sarott (1995), Table 4, Region 1, page 42.
j. Reducing environment assumed for grout fill.
k. Non-reducing environments assumed for No Action and sand fill option.
l. Values used for basemat concrete for No Action and sand fill option.
m. Value used for clay from WSRC (1994a).
n. MEPAS default used for soil >30% clay and pH from 5-9.
o. MEPAS default used for soil >30% clay and pH >9.
p. Characteristics similar to Sm per Table 3, page 16 of Bradbury and Scott (1995).
q. Characteristics similar to Am per Table 3, page 16 of Bradbury and Scott (1995).
r Lead is outside of reducing environments for all cases. Therefore, value from Column I is used for all cases.
s Z-Area Saltstone Radiological Performance Assessment (WSRC 1992), page A-13.
t Values of K_d for these contaminants were based on non-reducing concrete.
u Solubility limit of 3.0×10^{-10} μ/liter used to determine K_d, E-Area (WSRC 1994a) p. D-34.

fore, for the tank model, K_d values for the CZ, first and second partially saturated zones, and the saturated zone are listed in Columns VI, III, I, and I of Table C.3.2-1, respectively.

C.3.2.2 MEPAS Groundwater Input Parameters

Table C.3.2-2 lists input parameters used for the partially saturated zones for the various closure scenarios, and Table C.3.2-3 lists input parameters for the saturated zone. The values used for the concrete basemat and vadose layer for the partially saturated zone were constant for all tank groups within both tank farms with the exception of the vadose zone thickness. Because there are significant differences in the bottom elevation between the various tank groups, the thickness of the vadose zone was modeled specifically for each tank group. Some tank groups in the H-Area were modeled without a vadose zone because the tanks are situated in the Water Table Aquifer. When horizontal flow was modeled in each of the aquifer layers all of the overlying layers were treated as part of the partially saturated zone (i.e., vertical transport only) for that simulation.

The values for the remaining partially saturated zone layers and for all of the saturated zone layers are constant for all tank groups within either the F- or H-Area that have groundwater flow to the same point of discharge (i.e., to Fourmile Branch or Upper Three Runs). The parameters do vary, however, among the different layers and along different groundwater flow paths. For this reason, Tables C.3.2-2 and C.3.2-3 contain three sets of input parameters: flow from the F-Area Tank Farm toward Fourmile Branch (all tank groups); flow from the H-Area Tank Farm toward Fourmile Branch (four tank groups); and flow from the H-Area Tank Farm toward Upper Three Runs (three tank groups). Because only one-dimensional vertical flow was considered for the Tan Clay and Green Clay layers in both the partially saturated and saturated conditions, the input parameters were the same for these layers for each of the groupings shown in the tables.

C.3.2.3 Hydraulic Conductivities

Because leach rate is ultimately limited by the lowest hydraulic conductivity of the strata and structures above and below the contaminated zone, this parameter is highly sensitive in its effect on breakthrough times and peak concentrations at the receptor locations. For modeling purposes, it was assumed that excess water has a place to run off (over the sides of the basemat) and that ponding above the contaminated zone does not occur.

C.3.2.4 Human Health Exposure Parameters and Assumed Values

Because the impact on a given receptor depends in large part on the physical characteristics and habits of the receptor, it is necessary to stipulate certain values to obtain meaningful results. Certain of these values are included as default values in MEPAS; however, others must be specified so the receptors are modeled appropriately for the scenario being described.

For this modeling effort, site-specific values were used as much as possible; that is, values that had been used in other modeling efforts for the SRS were incorporated when available and appropriate. Table C.3.2-4 lists the major parameters that were used in assigning characteristics to the receptors used in the calculations.

C.3.3 ECOLOGICAL RISK ASSESSMENT

The exposure factors used in calculating doses to the shrew and mink are listed in Table C.3.3-1. An important assumption of the exposure calculation is that no feeding or drinking takes place outside the influence of the seepage, even though the home ranges of the shrew and the mink typically are larger than the seep areas. EPA (1993) presents a range of literature-based home ranges for the short-tailed shrew that vary from 0.03 to 1.8 ha. Home ranges for the mink also vary widely in the literature from 7.8 to 770 ha (EPA 1993). The bioaccumulation factor for soil and soil invertebrates is 1 for all metals, as is the factor

Table C.3.2-2. Partially saturated zone MEPAS input parameters.

	Concrete basemat		Vadose Zone layer	Water Table layer	Tan clay layer	Barnwell-McBean layer	Green clay layer
	Intact	Failed					
F-Area Tank Farm, flow toward Fourmile Branch							
Thickness (centimeters)	18[a]	18[a]	Varies[b]	1,200[c]	91[c]	1,800[c]	150[c]
Bulk density (grams per cubic centimeters)	2.21[d]	1.64[e]	1.59[d]	1.59[d]	1.36[e]	1.59[d]	1.39[e]
Total porosity	15%[d]	38%[e]	35%[f]	35%[f]	40%[f]	35%[f]	40%[f]
Field Capacity	15%[d]	9%[e]	12%[e]	35%[e]	33.4%[e]	35%[e]	32.5%[e]
Longitudinal dispersion (centimeters)[g]	0.18	0.18	Varies	12	0.91	18	1.5
Vertical hydraulic conductivity (centimeters per second)	9.6×10^{-9}[d]	6.6×10^{-3}[e]	7.1×10^{-4}[h]	7.1×10^{-4}[h]	1.6×10^{-6}[h]	5.6×10^{-4}[h]	4.4×10^{-9}[h]
H-Area Tank Farm, flow toward Fourmile Branch							
Thickness (centimeters)	18[a]	18[a]	Varies[b]	1,900[i]	300[i]	2,000[i]	300[i]
Bulk density (grams per cubic centimeters)	2.21[d]	1.64[e]	1.59[d]	1.59[d]	1.36[e]	1.59[d]	1.39[e]
Total porosity	15%[d]	38%[e]	35%[f]	35%[f]	40%[f]	35%[f]	40%[f]
Field capacity	15%[d]	9%[e]	12%[e]	35%[j]	33.4%[j]	35%[j]	32.5%[j]
Longitudinal dispersion (centimeters)[g]	0.18	0.18	Varies	19	3.0	20	3.0
Vertical hydraulic conductivity (centimeters per second)	$9.\times10^{-9}$[d]	6.6×10^{-3}[e]	1.6×10^{-4}[i]	1.6×10^{-4}[i]	3.2×10^{-7}[i]	1.6×10^{-4}[i]	3.5×10^{-8}[i]
H-Area Tank Farm, flow toward Upper Three Runs							
Thickness (centimeters)	18[a]	18[a]	Varies[b]	1,900[i]	300[i]	1,800[i]	300[i]
Bulk density (grams per cubic centimeters)	2.21[d]	1.64[e]	1.59[d]	1.59[d]	1.36[e]	1.59[d]	1.39[e]
Total porosity	15%[d]	38%[e]	35%[f]	35%[f]	40%[f]	35%[f]	40%[f]
Field capacity	15%[d]	9%[e]	12%[e]	35%[j]	33.4%[j]	35%[j]	32.5%[j]
Longitudinal dispersion (centimeters)[g]	0.18	0.18	Varies	19	3.0	18	3.0
Vertical hydraulic conductivity (centimeters per second)	9.6×10^{-9}[d]	6.6×10^{-3}[e]	1.3×10^{-4}[i]	1.3×10^{-4}[i]	3.0×10^{-7}[i]	1.3×10^{-4}[i]	3.5×10^{-8}[i]

a. Type IV tank shown; Type I = 3.54, Type III = 2.74.
b. Distance between tank bottom elevation (see a. above) and historic groundwater elevation.
c. GeoTrans (1987).
d. WSRC (1994a). Radiological Performance Assessment for the E-Area Vaults Disposal Facility (U), WSRC-RP-94-218.
e. Buck et al. (1995), MEPAS Table 2.1.
f. Aadland (1995).
g. Buck et al. (1995); calculated using MEPAS formula for longitudinal dispersivity, based on total travel distance.
h. GeoTrans (1993); where Kz = 0.1 Kx for aquifer layers.
i. WSRC (1994b). WSRC E-7 Procedure Document Q-CLC-H-00005, Revision 0.
j. Buck et al. (1995), MEPAS Table 2.1; assumes aquifer layers are saturated and clay layers nearly saturated.

Table C.3.2-3. MEPAS input parameters for the saturated zone.

	Water Table Aquifer	Barnwell-McBean Aquifer	Congaree Aquifer
F-Area Tank Farm, flow toward Fourmile Branch			
Thickness (centimeters) [a]	1,200	1,800	3,000
Bulk density (grams per cubic centimeter) [b]	1.59	1.59	1.64
Total porosity [c]	35%	35%	34%
Effective porosity [d]	20%	20%	25%
Longitudinal dispersion (centimeters)		1/20 th of the flow distance	
Hydraulic conductivity (centimeters per second)	7.1×10^{-3}	5.6×10^{-3}	0.013
Hydraulic gradient [a]	0.006	0.004	0.006
H-Area Tank Farm, flow toward Fourmile Branch			
Thickness (centimeters) [a]	1,900	2,000	3,000
Bulk density (grams per cubic centimeter) [b]	1.59	1.59	1.64
Total porosity [c]	35%	35%	34%
Effective porosity [d]	20%	20%	25%
Longitudinal dispersion (centimeters)		1/20 th of the flow distance	
Hydraulic conductivity (centimeters per second)	1.6×10^{-3}	1.6×10^{-3}	1.4×10^{-3}
Hydraulic gradient [a]	0.014	0.011	0.004
H-Area Tank Farm, flow toward Upper Three Runs			
Thickness (centimeters) [a]	1,900	1,800	3,000
Bulk density (grams per cubic centimeter) [b]	1.59	1.59	1.64
Total porosity [c]	35%	35%	34%
Effective porosity [d]	20%	20%	25%
Longitudinal dispersion (centimeters)		1/20 th of the flow distance	
Hydraulic conductivity (centimeters per second)	1.3×10^{-3}	1.3×10^{-3}	1.4×10^{-3}
Hydraulic gradient [a]	0.015	0.009	0.003

a. GeoTrans (1987 and 1993).
b. Buck et al. (1995), MEPAS Table 2.1.
c. Aadland (1995)
d. EPA (1989) and WSRC (1994b) WSRC E-7 Procedure Document Q-CLC-H-00005, Revision 0.

Table C.3.2-4. Assumed human health exposure parameters.

Parameter	Applicable receptor	Value	Comments
Body mass	Adult	70 kg	This value is taken directly from ICRP (1975). In radiological dose calculations, this is the standard value in the industry.
	Child	30 kg	This value was obtained from ICRP (1975). Both a male and female child of age 9 have an average mass of 30 kg.
Exposure period	All	1 year	This value is necessary so that MEPAS will calculate an annual radiation dose. Lifetime doses can be calculated by multiplying the annual dose by the assumed life of the individual.
Leafy vegetable ingestion rate	Adult	21 kg/yr	This value was taken from Hamby (1993), which was used previously in other modeling work at SRS.
	Child	8.53 kg/yr	This value was calculated based on the adult ingestion rate from Hamby (1993) and the ratio of child to adult ingestion rates for maximum individuals in NRC (1977).
Other vegetables ingestion rate	Adult	163 kg/yr	This value was taken from Hamby (1993), which was used previously in other modeling work at SRS.
	Child	163 kg/yr	This value was calculated based on the adult ingestion rate from Hamby (1993) and the ratio of child to adult ingestion rates for maximum individuals in NRC (1977).
Meat ingestion rate	Adult	43 kg/yr	This value was taken from Hamby (1993), which was used previously in other modeling work at SRS.
	Child	16 kg/yr	This value was calculated based on the adult ingestion rate from Hamby (1993) and the ratio of child to adult ingestion rates for maximum individuals in NRC (1977).
Milk ingestion rate	Adult	120 L/yr	This value was taken from Hamby (1993), which was used previously in other modeling work at SRS.
	Child	128 L/yr	This value was calculated based on the adult ingestion rate from Hamby (1993) and the ratio of child to adult ingestion rates for maximum individuals in NRC (1977).
Water ingestion rate	All	2 L/day	This value is standard in MEPAS and is consistent with maximum drinking water rates in NRC (1977).
Finfish ingestion rate	Adult	9 kg/yr	This value was taken from Hamby (1993), which was used previously in other modeling work at SRS.
	Child	2.96 kg/yr	This value was calculated based on the adult ingestion rate from Hamby (1993) and the ratio of child to adult ingestion rates for maximum individuals in NRC (1977).
Time spent at shoreline	Adult resident	12 hrs/yr	This is a default value from MEPAS and is consistent with NRC (1977).
	Child resident	12 hrs/yr	This is a default value from MEPAS and is consistent with NRC (1977).
	Seepline worker	2080 hrs/yr	This value is based on the assumption of continuous exposure of the seepline worker during each working day.
	Intruder	1040 hrs/yr	This value is based on the conservative assumption of half-time exposure during each working day.
Time spent swimming	Adult resident	12 hrs/yr	This is a default value from MEPAS and is consistent with NRC (1977).
	Child resident	12 hrs/yr	This is a default value from MEPAS and is consistent with NRC (1977).

Table C.3.3-1. Parameters for foodchain model ecological receptors.

Receptor	Feeding group	Parameter	Value	Notes; Reference
Southern short-tailed shrew (*Blarina carolinensis*)	Insectivore	Body weight	9.7 grams	Mean of 423 adults collected on SRS; Cothran et al. (1991)
		Water ingestion	2.2 grams/day	0.223 g/g/day X 9.7g; EPA (1993)
		Food ingestion	5.2 grams/day	0.541 g/g/day X 9.7g; Richardson (1973) cited in Cothran et al. (1991)
		Soil ingestion	10% of diet	Between vole (2.4%) and armadillo (17%); Beyer et al. (1994)
		Home range	0.96 ha	Mean value on SRS; Faust et al. (1971) cited in Cothran et al. (1991)
Mink (*Mustela vison*)	Carnivore	Body weight	800 grams	"Body weight averages 0.6 to 1.0 kg"; Cothran et al. (1991)
		Water ingestion	22.4 grams/day	0.028 g/g/day X 800g; EPA (1993)
		Food ingestion	110 grams/day	Mean of male and female estimates; EPA (1993)
		Soil ingestion	5% of diet	Between red fox (2.8%) and raccoon (9.4%); Beyer et al. (1994)
		Home range	variable	7.8-20.4 ha (Montana);
				259-380 ha (North Dakota; EPA 1993)
				Females: 6-15 ha, males: 18-24 ha (Kansas; Bee et al. 1981)

for soil invertebrates and shrews. K_d values for estimating-contaminant concentrations in soil due to the influence of seepage are from Baes et al. (1984). Bioconcentration factors for estimating contaminant concentrations in aquatic prey items are from the EPA Region IV water quality criteria table. For contaminants with no listing in the Region IV table for a bioconcentration factor, a factor of 1 is used. The mink was modeled as obtaining half of its diet from shrews at the seep area and the other half from aquatic prey downstream of the seepline.

C.4 Results

C.4.1 HUMAN HEALTH ASSESSMENT

For each scenario, the maximum concentration or dose was identified for each receptor and for each contaminant along with the time period during which the maximum occurred within a 10,000-year performance period. In addition, for radiological constituents, the total dose was calculated to allow evaluation of the impact of all radiological constituents. Because the maximum doses for each radionuclide do not necessarily occur simultaneously, it is not appropriate to add the maximum doses for each radionuclide. Rather, it is more appropriate to assess the doses as a function of time, sum the doses from all radionuclides for each time increment, and then select the maximum total dose from this compilation. Therefore, the total dose reported in the following tables for radiological constituents may not necessarily correlate to the maximum dose or time period for any individual radionuclide because of the contributions from all radionuclides at a given time. In addition to total dose, the gross alpha concentration was calculated to enable comparison among the alternatives

Non-radiological constituent concentrations in the various water bodies were calculated to allow direct comparison among the alternatives. For each constituent, the maximum concentration was calculated along with the time period during which the maximum concentration occurred. None of the non-radiological constituents are known ingestion carcinogens; therefore cancer risk was not calculated for these contaminants.

Tables C.4.1-1 through C.4.1-26 list impact estimates for the four scenarios described in Section C.2. For those tables describing radiological impacts, doses are presented for postulated individuals (i.e., Adult Resident, Child Resident, Seepline Worker, and Intruder) and at the seepline. Additional calculations were performed at groundwater locations close to the tank farm and are reported as drinking water does to allow comparison to the appropriate maximum contaminant level. DOE estimates that the total dose at the locations would not exceed the drinking water doses by more than 20%. For nonradiological constituents, the maximum concentration of each contaminant is reported for each water location.

For the case of No Action, the reported doses are those arising strictly from the water pathways; impacts from air pathways, in principle, would increase the total dose to a given receptor. It is expected, however, that atmospheric release of the tanks' contents would not be appreciable because:

- The amount of rainfall in the area would tend to keep the tank contents damp through the time of failure. After failure, a substantial amount of debris on top of the contaminated material would prevent release even if the contents were to dry during a period of drought.

- The considerable depth of the tanks below grade would tend to discourage resuspension of any of the tanks' contents.

As discussed in Chapters 3 and 4 of this EIS, DOE performed groundwater modeling calculations for the three uppermost aquifers underneath the tank farms: the Water Table Aquifer, the Barnwell-McBean Aquifer, and the Congaree Aquifer. Tables C.4.1-1 through C.4.1-26 present results for each tank farm and by aquifer. Although more than one aquifer may outcrop to the same point on the seepline, the

Table C.4.1-1. Radiological results for F-Area Tank Farm in the Water Table Aquifer (millirem per year).

		Maximum concentration			
		Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative
Adult resident (total dose)	Maximum value	1.9×10^{-2}	2.9×10^{-2}	1.7×10^{-1}	3.3
	Time of maximum (yrs)	385	175	7035	1155
Child resident (total dose)	Maximum value	1.7×10^{-2}	2.7×10^{-2}	1.6×10^{-1}	3.1
	Time of maximum (yrs)	385	175	7035	1155
Seepline worker (total dose)	Maximum value	(a)	(a)	(a)	9.6×10^{-3}
	Time of maximum (yrs)	(a)	(a)	(a)	105
Intruder (total dose)	Maximum value	(a)	(a)	(a)	4.8×10^{-3}
	Time of maximum (yrs)	(a)	(a)	(a)	105
1-meter well (drinking water dose)	Maximum value	4.3×10^{1}	1.3×10^{2}	3.0×10^{2}	3.6×10^{5}
	Time of maximum (yrs)	385	35	5705	245
100-meter well (drinking water dose)	Maximum value	1.6×10^{1}	5.1×10^{1}	1.4×10^{2}	6.0×10^{3}
	Time of maximum (yrs)	315	35	7035	315
Seepline (drinking water dose)	Maximum value	1.0	1.4	9.5	1.8×10^{2}
	Time of maximum (yrs)	385	175	7455	1155
Surface water (drinking water dose)	Maximum value	6.9×10^{-3}	1.1×10^{-2}	6.3×10^{-2}	1.2
	Time of maximum (yrs)	385	175	7035	1155

a. Radiation dose for this alternative is less than 1×10^{-3} millirem.

Table C.4.1-2. Radiological results for F-Area Tank Farm in the Barnwell-McBean Aquifer (millirem per year).

		Maximum concentration			
		Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean with water, fill with saltstone	No Action Alternative
Adult resident (total dose)	Maximum value	2.7×10^{-2}	5.1×10^{-2}	3.7×10^{-1}	6.2
	Time of maximum (yrs)	875	245	7525	1225
Child resident (total dose)	Maximum value	2.4×10^{-2}	4.7×10^{-2}	3.4×10^{-1}	5.7
	Time of maximum (yrs)	875	245	7525	1225
Seepline worker (total dose)	Maximum value	(a)	(a)	1.0×10^{-3}	1.8×10^{-2}
	Time of maximum (yrs)	(a)	(a)	7525	1225
Intruder (total dose)	Maximum value	(a)	(a)	(a)	9.0×10^{-3}
	Time of maximum (yrs)	(a)	(a)	(a)	1225
1-meter well (drinking water dose)	Maximum value	1.3×10^{2}	4.2×10^{2}	7.9×10^{2}	3.5×10^{4}
	Time of maximum (yrs)	665	105	6965	35
100-meter well (drinking water dose)	Maximum value	5.1×10^{1}	1.9×10^{2}	5.1×10^{2}	1.4×10^{4}
	Time of maximum (yrs)	665	105	6685	35
Seepline (drinking water dose)	Maximum value	1.9	3.5	2.5×10^{1}	4.3×10^{2}
	Time of maximum (yrs)	875	245	6475	1225
Surface water (drinking water dose)	Maximum value	9.8×10^{-3}	1.9×10^{-2}	1.3×10^{-1}	2.3
	Time of maximum (yrs)	875	245	7525	1225

a. Radiation dose for this alternative is less than 1×10^{-3} millirem.

Table C.4.1-3. Radiological results dose for F-Area Tank Farm in the Congaree Aquifer (millirem per year).

		Maximum concentration			
		Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative
Adult resident (total dose)	Maximum value Time of maximum (yrs)	(a) (a)	(a) (a)	1.4×10^{-2} 8855	1.1×10^{-1} 1365
Child resident (total dose)	Maximum value Time of maximum (yrs)	(a) (a)	(a) (a)	1.3×10^{-2} 8855	1.0×10^{-1} 1365
Seepline worker (total dose)	Maximum value Time of maximum (yrs)	(a) (a)	(a) (a)	(a) (a)	(a) (a)
Intruder (total dose)	Maximum value Time of maximum (yrs)	(a) (a)	(a) (a)	(a) (a)	(a) (a)
1-meter well (drinking water dose)	Maximum value Time of maximum (yrs)	9.1×10^{-1} 4935	1.2 2905	3.0×10^{1} 6615	1.7×10^{2} 1155
100-meter well (drinking water dose)	Maximum value Time of maximum (yrs)	2.2×10^{-1} 1225	2.5×10^{-1} 3115	6.4 8435	4.2×10^{1} 1295
Seepline (drinking water dose)	Maximum value Time of maximum (yrs)	6.5×10^{-3} 5495	8.7×10^{-3} 3325	1.9×10^{-1} 7805	1.6 1295
Surface water (drinking water dose)	Maximum value Time of maximum (yrs)	(a) (a)	(a) (a)	5.0×10^{-3} 8855	4.2×10^{-2} 1365

a. Radiation dose for this alternative is less than 1×10^{-3} millirem.

Table C.4.1-4. Radiological results dose for H-Area Tank Farm in the Water Table Aquifer (millirem per year).

			Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative
Adult resident (total dose)	North of Groundwater Divide	Maximum value (mrem/yr)	1.4×10^{-3}	1.2×10^{-2}	2.6×10^{-2}	1.2
		Time of maximum (years)	455	105	6125	105
	South of Groundwater Divide	Maximum value (mrem/yr)	1.0×10^{-2}	1.6×10^{-2}	1.9×10^{-1}	2.4
		Time of maximum (years)	455	175	6125	1015
Child resident (total dose)	North of Groundwater Divide	Maximum value (mrem/yr)	1.3×10^{-3}	1.1×10^{-2}	2.4×10^{-2}	1.1
		Time of maximum (years)	455	105	6125	105
	South of Groundwater Divide	Maximum value (mrem/yr)	9.3×10^{-3}	1.5×10^{-2}	1.8×10^{-1}	2.2
		Time of maximum (years)	455	175	6125	1015
Seepline worker (total dose)	North of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	(a)	3.5×10^{-3}
		Time of maximum (years)	(a)	(a)	(a)	105
	South of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	(a)	7.0×10^{-3}
		Time of maximum (years)	(a)	(a)	(a)	1015
Intruder (total dose)	North of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	(a)	1.7×10^{-3}
		Time of maximum (years)	(a)	(a)	(a)	105
	South of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	(a)	3.5×10^{-3}
		Time of maximum (years)	(a)	(a)	(a)	1015
1-meter well (drinking water dose)	North of Groundwater Divide	Maximum value (mrem/yr)	1.0×10^{5}	1.3×10^{5}	1.0×10^{5}	9.3×10^{6}
		Time of maximum (years)	175	175	175	105
	South of Groundwater Divide	Maximum value (mrem/yr)	1.2×10^{2}	2.5×10^{2}	5.5×10^{2}	8.3×10^{5}
		Time of maximum (years)	315	385	4725	245
100-meter well (drinking water dose)	North of Groundwater Divide	Maximum value (mrem/yr)	3.0×10^{2}	9.2×10^{2}	8.7×10^{2}	9.0×10^{4}
		Time of maximum (years)	245	35	5915	35
	South of Groundwater Divide	Maximum value (mrem/yr)	2.9×10^{1}	6.1×10^{1}	2.9×10^{2}	6.1×10^{3}
		Time of maximum (years)	315	35	5635	35
Seepline (drinking water dose)	North of Groundwater Divide	Maximum value (mrem/yr)	2.5	2.5×10^{1}	4.6×10^{1}	2.5×10^{3}
		Time of maximum (years)	455	105	5635	105
	South of Groundwater Divide	Maximum value (mrem/yr)	9.5×10^{-1}	1.4	1.6×10^{1}	2.0×10^{2}
		Time of maximum (years)	455	175	5425	1015
Surface water (drinking water dose)	North of Groundwater Divide	Maximum value (mrem/yr)	(a)	4.3×10^{-3}	9.6×10^{-3}	4.5×10^{-1}
		Time of maximum (years)	(a)	105	6125	105
	South of Groundwater Divide	Maximum value (mrem/yr)	3.7×10^{-3}	6.0×10^{-3}	7.1×10^{-2}	9.0×10^{-1}
		Time of maximum (years)	455	175	6125	1015

a. Radiation dose for this alternative is less than 1×10^{-3} millirem.

Table C.4.1-5. Radiological results for H-Area Tank Farm in the Barnwell-McBean Aquifer (millirem per year).

			Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative
Adult resident (total dose)	North of Groundwater Divide	Maximum value (mrem/yr)	(a)	2.1×10^{-3}	1.1×10^{-2}	2.4×10^{-1}
		Time of maximum (years)	(a)	455	6195	385
	South of Groundwater Divide	Maximum value (mrem/yr)	3.4×10^{-3}	7.8×10^{-3}	1.2×10^{-1}	1.4
		Time of maximum (years)	4515	385	6335	1155
Child resident (total dose)	North of Groundwater Divide	Maximum value (mrem/yr)	(a)	2.0×10^{-3}	1.0×10^{-2}	2.2×10^{-1}
		Time of maximum (years)	(a)	455	6195	385
	South of Groundwater Divide	Maximum value (mrem/yr)	3.1×10^{-3}	7.2×10^{-3}	1.1×10^{-1}	1.3
		Time of maximum (years)	4515	385	6335	1155
Seepline worker (total dose)	North of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	(a)	(a)
		Time of maximum (years)	(a)	(a)	(a)	(a)
	South of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	(a)	4.2×10^{-3}
		Time of maximum (years)	(a)	(a)	(a)	1155
Intruder (total dose)	North of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	(a)	(a)
		Time of maximum (years)	(a)	(a)	(a)	(a)
	South of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	(a)	2.1×10^{-3}
		Time of maximum (years)	(a)	(a)	(a)	1155
1-meter well (drinking water)	North of Groundwater Divide	Maximum value (mrem/yr)	9.7×10^{1}	1.9×10^{3}	1.7×10^{3}	1.7×10^{5}
		Time of maximum (years)	1155	105	4165	105
	South of Groundwater Divide	Maximum value (mrem/yr)	5.3×10^{1}	1.4×10^{2}	4.3×10^{2}	2.5×10^{4}
		Time of maximum (years)	4445	245	5005	945
100-meter well (drinking water)	North of Groundwater Divide	Maximum value (mrem/yr)	3.2×10^{1}	4.6×10^{2}	6.4×10^{2}	5.8×10^{4}
		Time of maximum (years)	1155	105	5845	105
	South of Groundwater Divide	Maximum value (mrem/yr)	1.6×10^{1}	5.1×10^{1}	2.7×10^{2}	4.9×10^{3}
		Time of maximum (years)	1155	245	6405	105
Seepline (drinking water)	North of Groundwater Divide	Maximum value (mrem/yr)	7.5×10^{-1}	4.5	2.3×10^{1}	4.9×10^{2}
		Time of maximum (years)	4515	385	6125	385
	South of Groundwater Divide	Maximum value (mrem/yr)	3.5×10^{-1}	8.4×10^{-1}	1.3×10^{1}	1.6×10^{2}
		Time of maximum (years)	4445	385	6895	1155
Surface water (drinking water)	North of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	4.2×10^{-3}	8.8×10^{-2}
		Time of maximum (years)	(a)	(a)	6195	385
	South of Groundwater Divide	Maximum value (mrem/yr)	1.2×10^{-3}	2.9×10^{-3}	4.6×10^{-2}	5.3×10^{-1}
		Time of maximum (years)	4515	385	6265	1155

a. Radiation dose for this alternative is less than 1×10^{-3} millirem.

Table C.4.1-6. Total radiation dose for H-Area Tank Farm in the Congaree Aquifer (millirem per year).

			Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative
Adult resident (total dose)	North of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	1.1×10^{-2}	8.6×10^{-2}
		Time of maximum (years)	(a)	(a)	6825	805
	South of Groundwater Divide	Maximum value (mrem/yr)	1.6×10^{-3}	2.0×10^{-3}	6.6×10^{-2}	4.3×10^{-1}
		Time of maximum (years)	5285	3395	6755	1645
Child resident (total dose)	North of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	1.0×10^{-2}	7.9×10^{-2}
		Time of maximum (years)	(a)	(a)	6825	805
	South of Groundwater Divide	Maximum value (mrem/yr)	1.4×10^{-3}	1.8×10^{-3}	6.1×10^{-2}	4.0×10^{-1}
		Time of maximum (years)	5285	3395	6755	1645
Seepline worker (total dose)	North of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	(a)	(a)
		Time of maximum (years)	(a)	(a)	(a)	(a)
	South of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	(a)	1.2×10^{-3}
		Time of maximum (years)	(a)	(a)	(a)	1645
Intruder (total dose)	North of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	(a)	(a)
		Time of maximum (years)	(a)	(a)	(a)	(a)
	South of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	(a)	(a)
		Time of maximum (years)	(a)	(a)	(a)	(a)
1-meter well (drinking water)	North of Groundwater Divide	Maximum value (mrem/yr)	3.2×10^{1}	9.8×10^{1}	7.7×10^{2}	9.7×10^{3}
		Time of maximum (years)	5005	595	5145	595
	South of Groundwater Divide	Maximum value (mrem/yr)	1.2×10^{1}	1.6×10^{1}	2.0×10^{2}	3.2×10^{3}
		Time of maximum (years)	5215	3115	5355	1505
100-meter well (drinking water)	North of Groundwater Divide	Maximum value (mrem/yr)	5.6	2.5×10^{1}	2.5×10^{2}	2.5×10^{3}
		Time of maximum (years)	4935	665	6475	595
	South of Groundwater Divide	Maximum value (mrem/yr)	1.7	2.3	6.4×10^{1}	4.6×10^{2}
		Time of maximum (years)	4935	3185	7105	1435
Seepline (drinking water)	North of Groundwater Divide	Maximum value (mrem/yr)	9.8×10^{-2}	2.7×10^{-1}	3.2	2.5×10^{1}
		Time of maximum (years)	5005	805	6755	805
	South of Groundwater Divide	Maximum value (mrem/yr)	1.9×10^{-2}	2.3×10^{-2}	7.7×10^{-1}	4.8
		Time of maximum (years)	5285	3325	7665	1645
Surface water (drinking water)	North of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	4.0×10^{-3}	3.2×10^{-2}
		Time of maximum (years)	(a)	(a)	6825	805
	South of Groundwater Divide	Maximum value (mrem/yr)	(a)	(a)	2.4×10^{-2}	1.6×10^{-1}
		Time of maximum (years)	(a)	(a)	6755	1645

a. Radiation dose for this alternative is less than 1×10^{-3} millirem.

Table C.4.1-7. Alpha concentration for F-Area Tank Farm in the Water Table Aquifer (picocuries per liter).

		Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action
1-meter well	Maximum value	5.2	5.3	5.2	7.6×10^{2}
	Time of maximum (yrs)	1855	945	1855	455
100-meter well	Maximum value	1.9	1.9	1.9	2.4×10^{2}
	Time of maximum (yrs)	1995	1085	1995	595
Seepline	Maximum value	2.6×10^{-2}	2.6×10^{-2}	2.6×10^{-2}	5.6
	Time of maximum (yrs)	3885	2905	3885	9555
Surface water	Maximum value	1.8×10^{-4}	1.8×10^{-4}	1.8×10^{-4}	4.1×10^{-2}
	Time of maximum (yrs)	3885	2975	3885	9555

Table C.4.1-8. Alpha concentration for F-Area Tank Farm in the Barnwell-McBean Aquifer (picocuries per liter).

		Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action
1-meter well	Maximum value	1.3×10^{1}	1.3×10^{1}	1.3×10^{1}	1.7×10^{3}
	Time of maximum (yrs)	2695	1785	2695	875
100-meter well	Maximum value	4.7	4.6	4.7	5.3×10^{2}
	Time of maximum (yrs)	2905	1995	2905	1085
Seepline	Maximum value	3.9×10^{-2}	3.9×10^{-2}	3.9×10^{-2}	9.2
	Time of maximum (yrs)	6405	5495	6405	9975
Surface water	Maximum value	2.2×10^{-4}	2.2×10^{-4}	2.2×10^{-4}	4.8×10^{-2}
	Time of maximum (yrs)	6265	5355	6265	9975

Table C.4.1-9. Alpha concentration for F-Area Tank Farm in the Congaree Aquifer (picocuries per liter).

		Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action
1-meter well	Maximum value	3.1×10^{-3}	3.1×10^{-3}	3.1×10^{-3}	1.7
	Time of maximum (yrs)	8295	7315	8295	9975
100-meter well	Maximum value	1.3×10^{-3}	1.2×10^{-3}	1.3×10^{-3}	3.6×10^{-1}
	Time of maximum (yrs)	8225	8225	8225	9975
Seepline	Maximum value	3.7×10^{-5}	3.7×10^{-5}	3.7×10^{-5}	9.4×10^{-3}
	Time of maximum (yrs)	9345	8435	9345	9975
Surface water	Maximum value	1.0×10^{-6}	1.0×10^{-6}	1.0×10^{-6}	2.6×10^{-4}
	Time of maximum (yrs)	8365	7455	8365	9975

Table C.4.1-10. Alpha concentration for H-Area Tank Farm in the Water Table Aquifer (picocuries per liter).

			Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative
1-meter well	North of Groundwater Divide	Maximum value	2.4×10^{1}	2.9×10^{2}	2.4×10^{1}	1.3×10^{4}
		Time of maximum (years)	1925	175	1925	1715
	South of Groundwater Divide	Maximum value	8.6-	8.6	8.6	1.1×10^{3}
		Time of maximum (years)	1855	945	1855	455
100-meter well	North of Groundwater Divide	Maximum value	7.0	3.8×10^{1}	7.0	3.8×10^{3}
		Time of maximum (years)	2205	455	2205	455
	South of Groundwater Divide	Maximum value	2.0	2.0	2.0	2.0×10^{2}
		Time of maximum (years)	2065	1155	2065	665
Seepline	North of Groundwater Divide	Maximum value	1.5×10^{-1}	3.3×10^{-1}	1.5×10^{-1}	3.4×10^{1}
		Time of maximum (years)	4655	2695	4655	2345
	South of Groundwater Divide	Maximum value	1.9×10^{-2}	1.9×10^{-2}	1.9×10^{-2}	4.9
		Time of maximum (years)	4585	3675	4585	8925
Surface water	North of Groundwater Divide	Maximum value	3.1×10^{-5}	6.1×10^{-5}	3.1×10^{-5}	6.2×10^{-3}
		Time of maximum (years)	4585	2765	4585	2695
	South of Groundwater Divide	Maximum value	7.9×10^{-5}	7.9×10^{-5}	7.9×10^{-5}	2.2×10^{-2}
		Time of maximum (years)	4655	3745	4655	8855

Table C.4.1-11. Alpha concentration for H-Area Tank Farm in the Barnwell-McBean Aquifer (picocuries per liter).

			Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative
1-meter well	North of Groundwater Divide	Maximum value	3.8	2.1×10^{1}	3.8	2.2×10^{3}
		Time of maximum (years)	5355	3185	5355	2975
	South of Groundwater Divide	Maximum value	1.9	1.9	1.9	6.6×10^{2}
		Time of maximum (years)	5005	4095	5005	8435
100-meter well	North of Groundwater Divide	Maximum value	1.2	5.7	1.2	6.0×10^{2}
		Time of maximum (years)	5845	3605	5845	3325
	South of Groundwater Divide	Maximum value	5.2×10^{-1}	5.2×10^{-1}	5.2×10^{-1}	1.2×10^{2}
		Time of maximum (years)	5355	4445	5355	8785
Seepline	North of Groundwater Divide	Maximum value	1.0×10^{-2}	6.4×10^{-2}	1.0×10^{-2}	6.0
		Time of maximum (years)	9975	9975	9975	9625
	South of Groundwater Divide	Maximum value	1.0×10^{-2}	1.0×10^{-2}	1.0×10^{-2}	1.7
		Time of maximum (years)	9205	8295	9205	7875
Surface water	North of Groundwater Divide	Maximum value	2.0×10^{-6}	1.2×10^{-5}	2.0×10^{-6}	1.1×10^{-3}
		Time of maximum (years)	9975	9975	9975	9765
	South of Groundwater Divide	Maximum value	3.8×10^{-5}	3.8×10^{-5}	3.8×10^{-5}	6.4×10^{-3}
		Time of maximum (years)	9555	8645	9555	7735

Table C.4.1-12. Alpha concentration for H-Area Tank Farm in the Congaree Aquifer (picocuries per liter).

			Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative
1-meter well	North of Groundwater Divide	Maximum value	7.3×10^{-4}	7.2×10^{-2}	7.3×10^{-4}	9.5
		Time of maximum (years)	9975	9975	9975	9975
	South of Groundwater Divide	Maximum value	2.5×10^{-4}	1.2×10^{-3}	2.5×10^{-4}	4.0×10^{-1}
		Time of maximum (years)	9975	9975	9975	9975
100-meter well	North of Groundwater Divide	Maximum value	1.9×10^{-4}	1.6×10^{-2}	1.9×10^{-4}	2.1
		Time of maximum (years)	9975	9975	9975	9975
	South of Groundwater Divide	Maximum value	5.2×10^{-5}	2.8×10^{-4}	5.2×10^{-5}	1.0×10^{-1}
		Time of maximum (years)	9975	9975	9975	9975
Seepline	North of Groundwater Divide	Maximum value	6.7×10^{-9}	4.4×10^{-6}	6.7×10^{-9}	7.8×10^{-4}
		Time of maximum (years)	9975	9975	9975	9975
	South of Groundwater Divide	Maximum value	7.8×10^{-10}	1.6×10^{-8}	7.8×10^{-10}	1.8×10^{-5}
		Time of maximum (years)	9975	9975	9975	9975
Surface water	North of Groundwater Divide	Maximum value	2.6×10^{-11}	6.4×10^{-9}	2.6×10^{-11}	1.1×10^{-6}
		Time of maximum (years)	9975	9975	9975	9975
	South of Groundwater Divide	Maximum value	8.0×10^{-11}	9.3×10^{-10}	8.0×10^{-11}	8.8×10^{-7}
		Time of maximum (years)	9975	9975	9975	9975

Table C.4.1-13. Concentration in groundwater and surface water of silver (milligrams per liter).

		F-Area				H-Area							
						North of Groundwater Divide				South of Groundwater Divide			
Location	Aquifer	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative
1-meter well	Water Table	1.2×10^{-1}	7.9×10^{-2}	1.2×10^{-1}	8.2×10^{-1}	8.6×10^{-3}	6.3×10^{-3}	8.6×10^{-3}	5.3×10^{-1}	9.7×10^{-4}	7.2×10^{-4}	9.7×10^{-4}	4.9×10^{-2}
	Time (yr)	1015	245	1015	105	1015	245	1015	105	1015	245	1015	105
	Barnwell-McBean	3.2×10^{-1}	2.0×10^{-1}	3.2×10^{-1}	3.4	7.1×10^{-4}	9.4×10^{-4}	7.1×10^{-4}	9.3×10^{-2}	8.8×10^{-5}	8.9×10^{-5}	8.8×10^{-5}	9.0×10^{-3}
	Time (yr)	1155	385	1155	245	2695	1855	2695	1785	2765	1715	2765	1645
	Congaree	3.1×10^{-5}	3.1×10^{-5}	3.1×10^{-5}	3.3×10^{-4}	2.0×10^{-5}	2.4×10^{-5}	2.0×10^{-5}	2.3×10^{-3}	1.2×10^{-6}	1.2×10^{-6}	1.2×10^{-6}	1.2×10^{-4}
	Time (yr)	4165	3325	4165	3115	9975	9765	9975	9555	9975	9205	9975	9205
100-meter well	Water Table	2.3×10^{-2}	1.4×10^{-2}	2.3×10^{-2}	1.8×10^{-1}	1.5×10^{-3}	1.9×10^{-3}	1.5×10^{-3}	1.5×10^{-1}	2.0×10^{-4}	1.7×10^{-4}	2.0×10^{-4}	1.1×10^{-2}
	Time (yr)	1015	245	1015	105	1015	35	1015	35	1015	245	1015	175
	Barnwell-McBean	6.5×10^{-2}	3.9×10^{-2}	6.5×10^{-2}	9.0×10^{-1}	1.2×10^{-4}	1.9×10^{-4}	1.2×10^{-4}	1.8×10^{-2}	1.7×10^{-5}	1.6×10^{-5}	1.7×10^{-5}	1.7×10^{-3}
	Time (yr)	1155	385	1155	245	2625	1785	2625	1785	2765	1645	2765	1645
	Congaree	5.7×10^{-6}	5.7×10^{-6}	5.7×10^{-6}	6.7×10^{-5}	3.1×10^{-6}	4.0×10^{-6}	3.1×10^{-6}	3.7×10^{-4}	(a)	(a)	(a)	2.0×10^{-5}
	Time (yr)	4235	3325	4235	3115	9905	9695	9905	9835	(a)	(a)	(a)	9415
Seepline	Water Table	7.1×10^{-4}	5.8×10^{-4}	7.1×10^{-4}	1.1×10^{-2}	4.5×10^{-5}	5.8×10^{-5}	4.5×10^{-5}	6.0×10^{-3}	5.2×10^{-6}	5.1×10^{-6}	5.2×10^{-6}	5.5×10^{-4}
	Time (yr)	1085	315	1085	245	1155	175	1155	175	1155	385	1155	245
	Barnwell-McBean	1.7×10^{-3}	1.2×10^{-3}	1.7×10^{-3}	2.1×10^{-2}	3.9×10^{-6}	5.7×10^{-6}	3.9×10^{-6}	4.8×10^{-4}	(a)	(a)	(a)	6.7×10^{-5}
	Time (yr)	1365	525	1365	455	3115	2275	3115	2065	(a)	(a)	(a)	1925
	Congaree	(a)	(a)	(a)	1.9×10^{-6}	(a)	(a)	(a)	4.0×10^{-6}	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	3185	(a)	(a)	(a)	9835	(a)	(a)	(a)	(a)
Surface Water	Water Table	4.5×10^{-6}	3.8×10^{-6}	4.5×10^{-6}	7.8×10^{-5}	(a)	(a)	(a)	1.2×10^{-6}	(a)	(a)	(a)	2.4×10^{-6}
	Time (yr)	1085	315	1085	245	(a)	(a)	(a)	245	(a)	(a)	(a)	245
	Barnwell-McBean	8.8×10^{-6}	6.5×10^{-6}	8.8×10^{-6}	1.1×10^{-4}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	1365	595	1365	455	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)

a. Concentration is less than 1×10^{-6} mg/L.

Table C.4.1-14. Concentrations in groundwater and surface water of aluminum (milligrams per liter).

		F-Area				H-Area							
						North of Groundwater Divide				South of Groundwater Divide			
Location	Aquifer	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative
1-meter well	Water Table	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
100-meter well	Water Table	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Seepline	Water Table	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Surface Water	Water Table	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)

a. Concentration is less than 1×10^{-6} mg/L.

Table C.4.1-15. Concentrations in groundwater and surface water of barium (milligrams per liter).

		F-Area				H-Area North of Groundwater Divide				H-Area South of Groundwater Divide			
Location	Aquifer	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative
1-meter well	Water Table	6.3×10^{-5}	(a)	6.3×10^{-5}	2.9×10^{-4}	1.9×10^{-4}	2.2×10^{-5}	1.9×10^{-4}	7.2×10^{-4}	(a)	(a)	(a)	(a)
	Time (yr)	9975	(a)	9975	9975	7945	8435	7945	6475	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
100-meter well	Water Table	(a)	(a)	(a)	2.6×10^{-6}	(a)	(a)	(a)	4.0×10^{-6}	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	9975	(a)	(a)	(a)	9975	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Seepline	Water Table	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Surface Water	Water Table	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)

a. Concentration is less than 1×10^{-6} mg/L.

Table C.4.1-16. Concentrations in groundwater and surface water of fluoride (milligrams per liter).

		F-Area				H-Area							
						North of Groundwater Divide				South of Groundwater Divide			
Location	Aquifer	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative
1-meter well	Water Table	1.1×10^{-2}	6.5×10^{-2}	1.1×10^{-2}	4.2×10^{-1}	1.2×10^{-2}	1.3×10^{-2}	1.2×10^{-2}	7.4×10^{-1}	2.6×10^{-3}	9.1×10^{-3}	2.6×10^{-3}	5.1×10^{-1}
	Time (yr)	105	105	105	105	35	35	35	35	105	105	105	105
	Barnwell-McBean	2.0×10^{-1}	2.1×10^{-1}	2.0×10^{-1}	1.9	1.2×10^{-2}	1.2×10^{-2}	1.2×10^{-2}	9.5×10^{-1}	1.0×10^{-2}	1.0×10^{-2}	1.0×10^{-2}	1.0
	Time (yr)	1015	105	1015	105	1015	105	1015	105	1015	105	1015	105
	Congaree	1.1×10^{-3}	1.2×10^{-3}	1.1×10^{-3}	1.0×10^{-2}	2.2×10^{-3}	3.1×10^{-3}	2.2×10^{-3}	2.7×10^{-1}	1.2×10^{-3}	1.3×10^{-3}	1.2×10^{-3}	1.4×10^{-1}
	Time (yr)	1085	175	1085	105	1155	245	1155	245	1155	245	1155	245
100-meter well	Water Table	3.8×10^{-3}	1.2×10^{-2}	3.8×10^{-3}	1.1×10^{-1}	3.2×10^{-3}	3.6×10^{-3}	3.2×10^{-3}	3.3×10^{-1}	6.0×10^{-4}	1.8×10^{-3}	6.0×10^{-4}	1.3×10^{-1}
	Time (yr)	105	105	105	105	35	35	35	35	105	105	105	105
	Barnwell-McBean	4.5×10^{-2}	4.7×10^{-2}	4.5×10^{-2}	5.0×10^{-1}	2.3×10^{-3}	2.4×10^{-3}	2.3×10^{-3}	2.2×10^{-1}	1.7×10^{-3}	1.7×10^{-3}	1.7×10^{-3}	1.7×10^{-1}
	Time (yr)	1015	105	1015	105	1015	35	1015	35	1015	105	1015	105
	Congaree	2.0×10^{-4}	2.2×10^{-4}	2.0×10^{-4}	2.1×10^{-3}	3.5×10^{-4}	6.0×10^{-4}	3.5×10^{-4}	4.8×10^{-2}	1.7×10^{-4}	2.0×10^{-4}	1.7×10^{-4}	2.1×10^{-2}
	Time (yr)	1085	175	1085	105	1155	245	1155	245	1155	245	1155	245
Seepline	Water Table	1.8×10^{-4}	7.0×10^{-4}	1.8×10^{-4}	8.4×10^{-3}	1.5×10^{-4}	1.7×10^{-4}	1.5×10^{-4}	1.6×10^{-2}	1.9×10^{-5}	8.4×10^{-5}	1.9×10^{-5}	7.8×10^{-3}
	Time (yr)	105	105	105	105	35	35	35	35	105	105	105	105
	Barnwell-McBean	1.1×10^{-3}	1.4×10^{-3}	1.1×10^{-3}	2.0×10^{-2}	6.3×10^{-5}	8.0×10^{-5}	6.3×10^{-5}	5.9×10^{-3}	5.5×10^{-5}	5.5×10^{-5}	5.5×10^{-5}	4.1×10^{-3}
	Time (yr)	1015	105	1015	105	1085	175	1085	175	1085	175	1085	105
	Congaree	5.8×10^{-6}	6.3×10^{-6}	5.8×10^{-6}	6.8×10^{-5}	5.6×10^{-6}	8.1×10^{-6}	5.6×10^{-6}	5.5×10^{-4}	1.6×10^{-6}	1.9×10^{-6}	1.6×10^{-6}	1.8×10^{-4}
	Time (yr)	1085	175	1085	175	1225	315	1225	315	1225	315	1225	315
Surface Water	Water Table	1.2×10^{-6}	4.8×10^{-6}	1.2×10^{-6}	6.1×10^{-5}	(a)	(a)	(a)	3.0×10^{-6}	(a)	(a)	(a)	3.5×10^{-5}
	Time (yr)	105	105	105	105	(a)	(a)	(a)	35	(a)	(a)	(a)	105
	Barnwell-McBean	5.7×10^{-6}	7.3×10^{-6}	5.7×10^{-6}	1.1×10^{-4}	(a)	(a)	(a)	1.1×10^{-6}	(a)	(a)	(a)	1.4×10^{-5}
	Time (yr)	1015	105	1015	105	(a)	(a)	(a)	175	(a)	(a)	(a)	105
	Congaree	(a)	(a)	(a)	1.8×10^{-6}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	5.8×10^{-6}
	Time (yr)	(a)	(a)	(a)	175	(a)	(a)	(a)	(a)	(a)	(a)	(a)	315

a. Concentration is less than 1×10^{-6} mg/L.

Table C.4.1-17. Concentrations in groundwater and surface water of chromium (milligrams per liter).

		F-Area				H-Area							
						North of Groundwater Divide				South of Groundwater Divide			
Location	Aquifer	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative
1-meter well	Water Table	2.1×10^{-2}	8.5×10^{-3}	2.1×10^{-2}	1.9×10^{-1}	5.4×10^{-3}	2.7×10^{-3}	5.4×10^{-3}	3.2×10^{-1}	3.6×10^{-3}	1.8×10^{-3}	3.6×10^{-3}	2.1×10^{-1}
	Time (yr)	1715	1925	1715	805	1645	1855	1645	805	1575	1785	1575	805
	Barnwell-McBean	2.3×10^{-2}	1.9×10^{-2}	2.3×10^{-2}	3.8×10^{-1}	2.9×10^{-6}	1.1×10^{-5}	2.9×10^{-6}	3.8×10^{-3}	1.4×10^{-6}	1.4×10^{-5}	1.4×10^{-6}	3.7×10^{-3}
	Time (yr)	3745	4025	3745	2065	9975	9975	9975	9975	9975	9975	9975	9975
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
100-meter well	Water Table	2.7×10^{-3}	1.5×10^{-3}	2.7×10^{-3}	3.5×10^{-2}	7.6×10^{-4}	5.4×10^{-4}	7.6×10^{-4}	7.4×10^{-2}	5.2×10^{-4}	4.1×10^{-4}	5.2×10^{-4}	3.4×10^{-2}
	Time (yr)	1855	2065	1855	945	1995	2415	1995	1155	2065	2065	2065	1155
	Barnwell-McBean	4.4×10^{-3}	3.7×10^{-3}	4.4×10^{-3}	8.1×10^{-2}	(a)	1.2×10^{-6}	(a)	3.8×10^{-4}	(a)	1.4×10^{-6}	(a)	4.3×10^{-4}
	Time (yr)	4165	4305	4165	2485	(a)	9975	(a)	9975	(a)	9975	(a)	9975
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Seepline	Water Table	3.1×10^{-5}	2.9×10^{-5}	3.1×10^{-5}	5.2×10^{-4}	1.5×10^{-5}	1.3×10^{-5}	1.5×10^{-5}	1.0×10^{-3}	9.2×10^{-6}	9.2×10^{-6}	9.2×10^{-6}	4.4×10^{-4}
	Time (yr)	4865	4865	4865	3955	5495	5565	5495	4235	6265	5775	6265	4935
	Barnwell-McBean	4.6×10^{-5}	4.5×10^{-5}	4.6×10^{-5}	8.0×10^{-4}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	9625	9625	9625	8015	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Surface Water	Water Table	(a)	(a)	(a)	3.7×10^{-6}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	2.0×10^{-6}
	Time (yr)	(a)	(a)	(a)	4095	(a)	(a)	(a)	(a)	(a)	(a)	(a)	4935
	Barnwell-McBean	(a)	(a)	(a)	4.2×10^{-6}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	7945	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)

a. Concentration is less than 1×10^{-6} mg/L.

Table C.4.1-18. Concentrations in groundwater and surface water of copper (milligrams per liter).

		F-Area				H-Area North of Groundwater Divide				H-Area South of Groundwater Divide			
Location	Aquifer	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative
1-meter well	Water Table	6.0×10^{-3}	4.6×10^{-3}	6.0×10^{-3}	6.2×10^{-2}	9.0×10^{-4}	7.1×10^{-4}	9.0×10^{-4}	6.6×10^{-2}	4.5×10^{-4}	3.4×10^{-4}	4.5×10^{-4}	2.9×10^{-2}
	Time (yr)	2765	2905	2765	1295	2695	2835	2695	1295	2555	2695	2555	1295
	Barnwell-McBean	9.4×10^{-3}	8.8×10^{-3}	9.4×10^{-3}	1.5×10^{-1}	(a)	(a)	(a)	8.0×10^{-4}	(a)	(a)	(a)	6.5×10^{-4}
	Time (yr)	6195	6405	6195	3115	(a)	(a)	(a)	9975	(a)	(a)	(a)	9975
	Congaree	(a)	(a)	(a)	5.2×10^{-6}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	9835	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
100-meter well	Water Table	7.6×10^{-4}	6.8×10^{-4}	7.6×10^{-4}	1.1×10^{-2}	1.2×10^{-4}	1.1×10^{-4}	1.2×10^{-4}	1.4×10^{-2}	4.5×10^{-5}	4.7×10^{-5}	4.5×10^{-5}	4.2×10^{-3}
	Time (yr)	3255	3465	3255	1785	3465	4025	3465	2135	3465	3745	3465	2345
	Barnwell-McBean	1.5×10^{-3}	1.6×10^{-3}	1.5×10^{-3}	2.7×10^{-2}	(a)	(a)	(a)	2.0×10^{-5}	(a)	(a)	(a)	2.4×10^{-5}
	Time (yr)	6895	7385	6895	4095	(a)	(a)	(a)	9975	(a)	(a)	(a)	9975
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Seepline	Water Table	7.9×10^{-6}	8.1×10^{-6}	7.9×10^{-6}	1.2×10^{-4}	1.5×10^{-6}	1.6×10^{-6}	1.5×10^{-6}	1.6×10^{-4}	(a)	(a)	(a)	4.0×10^{-5}
	Time (yr)	9975	9975	9975	8505	9835	9975	9835	9835	(a)	(a)	(a)	9975
	Barnwell-McBean	(a)	(a)	(a)	1.1×10^{-5}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	9905	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Surface Water	Water Table	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)

a. Concentration is less than 1×10^{-6} mg/L.

Table C.4.1-19. Concentrations in groundwater and surface water of iron (milligrams per liter).

		F-Area				H-Area							
						North of Groundwater Divide				South of Groundwater Divide			
Location	Aquifer	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative
1-meter well	Water Table	2.6	2.7	2.6	3.0×10^{1}	1.1	1.1	1.1	8.2×10^{1}	4.8×10^{-1}	4.8×10^{-1}	4.8×10^{-1}	2.9×10^{1}
	Time (yr)	1575	735	1575	385	1575	665	1575	385	1505	665	1505	385
	Barnwell-McBean	4.7	4.7	4.7	7.4×10^{1}	4.5×10^{-1}	4.5×10^{-1}	4.5×10^{-1}	6.2×10^{1}	2.2×10^{-1}	2.1×10^{-1}	2.2×10^{-1}	2.6×10^{1}
	Time (yr)	2485	1645	2485	805	3605	2695	3605	1575	3465	2485	3465	1435
	Congaree	5.9×10^{-3}	6.0×10^{-3}	5.9×10^{-3}	7.6×10^{-2}	1.5×10^{-2}	2.5×10^{-2}	1.5×10^{-2}	2.6	4.1×10^{-3}	6.2×10^{-3}	4.1×10^{-3}	6.1×10^{-1}
	Time (yr)	4795	4095	4795	2695	9975	9905	9975	9345	9975	9975	9975	9835
100-meter well	Water Table	3.4×10^{-1}	3.3×10^{-1}	3.4×10^{-1}	4.7	1.3×10^{-1}	1.4×10^{-1}	1.3×10^{-1}	1.1×10^{1}	7.4×10^{-2}	7.6×10^{-2}	7.4×10^{-2}	4.6
	Time (yr)	1785	875	1785	595	1995	1085	1995	735	1925	1085	1925	875
	Barnwell-McBean	7.4×10^{-1}	7.2×10^{-1}	7.4×10^{-1}	1.3×10^{1}	6.2×10^{-2}	6.4×10^{-2}	6.2×10^{-2}	7.1	4.7×10^{-2}	4.5×10^{-2}	4.7×10^{-2}	3.7
	Time (yr)	2835	1925	2835	1225	4445	3535	4445	2275	4095	3185	4095	1995
	Congaree	1.1×10^{-3}	1.1×10^{-3}	1.1×10^{-3}	1.6×10^{-2}	2.1×10^{-3}	4.2×10^{-3}	2.1×10^{-3}	3.9×10^{-1}	9.2×10^{-4}	1.5×10^{-3}	9.2×10^{-4}	1.2×10^{-1}
	Time (yr)	4865	3955	4865	2695	9975	9975	9975	9695	9975	9905	9975	9345
Seepline	Water Table	3.9×10^{-3}	3.9×10^{-3}	3.9×10^{-3}	6.0×10^{-2}	2.3×10^{-3}	2.4×10^{-3}	2.3×10^{-3}	1.6×10^{-1}	1.4×10^{-3}	1.4×10^{-3}	1.4×10^{-3}	7.7×10^{-2}
	Time (yr)	4585	3605	4585	3255	5145	4165	5145	3675	5425	4585	5425	4305
	Barnwell-McBean	5.8×10^{-3}	5.8×10^{-3}	5.8×10^{-3}	9.2×10^{-2}	1.7×10^{-4}	3.3×10^{-4}	1.7×10^{-4}	3.1×10^{-2}	7.9×10^{-4}	7.9×10^{-4}	7.9×10^{-4}	4.6×10^{-2}
	Time (yr)	7665	6825	7665	6055	9975	9975	9975	9975	9065	8225	9065	6895
	Congaree	2.5×10^{-5}	2.5×10^{-5}	2.5×10^{-5}	4.1×10^{-4}	(a)	(a)	(a)	2.8×10^{-4}	(a)	(a)	(a)	7.3×10^{-5}
	Time (yr)	6405	5495	6405	4445	(a)	(a)	(a)	9975	(a)	(a)	(a)	9975
Surface Water	Water Table	2.5×10^{-5}	2.5×10^{-5}	2.5×10^{-5}	4.2×10^{-4}	(a)	(a)	(a)	3.7×10^{-5}	6.2×10^{-6}	6.2×10^{-6}	6.2×10^{-6}	3.5×10^{-4}
	Time (yr)	4445	3535	4445	3255	(a)	(a)	(a)	3815	5635	4725	5635	4235
	Barnwell-McBean	3.0×10^{-5}	3.0×10^{-5}	3.0×10^{-5}	4.9×10^{-4}	(a)	(a)	(a)	5.6×10^{-6}	3.0×10^{-6}	3.0×10^{-6}	3.0×10^{-6}	1.7×10^{-4}
	Time (yr)	7665	6825	7665	6195	(a)	(a)	(a)	9905	8785	7945	8785	6615
	Congaree	(a)	(a)	(a)	1.1×10^{-5}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	2.6×10^{-6}
	Time (yr)	(a)	(a)	(a)	4585	(a)	(a)	(a)	(a)	(a)	(a)	(a)	9975

(a. Concentration is less than 1×10^{-6} mg/L.

Table C.4.1-20. Concentrations in groundwater and surface water of mercury (milligrams per liter).

		F-Area				H-Area							
						North of Groundwater Divide				South of Groundwater Divide			
Location	Aquifer	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative
1-meter well	Water Table	2.6×10^{-5}	3.6×10^{-5}	2.6×10^{-5}	1.6×10^{-3}	1.4×10^{-3}	7.4×10^{-4}	1.4×10^{-3}	1.2×10^{-1}	(a)	(a)	(a)	1.2×10^{-1}
	Time (yr)	9975	9975	9975	9975	9835	5285	9835	9975	(a)	(a)	(a)	9975
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
100-meter well	Water Table	(a)	2.7×10^{-6}	(a)	1.3×10^{-4}	3.0×10^{-5}	5.3×10^{-5}	3.0×10^{-5}	5.3×10^{-3}	(a)	(a)	(a)	2.8×10^{-5}
	Time (yr)	(a)	9975	(a)	9905	9975	9975	9975	9975	(a)	(a)	(a)	9975
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Seepline	Water Table	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Surface Water	Water Table	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)

a. Concentration is less than 1×10^{-6} mg/L.

Table C.4.1-21. Concentrations in groundwater and surface water of nitrate (milligrams per liter).

		F-Area				H-Area							
						North of Groundwater Divide				South of Groundwater Divide			
Location	Aquifer	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative
1-meter well	Water Table	1.2×10^{-1}	6.7×10^{-1}	4.2×10^{3}	4.8	2.3×10^{-1}	2.7×10^{-1}	2.4×10^{4}	1.5×10^{1}	7.5×10^{-2}	2.5×10^{-1}	8.7×10^{3}	1.3×10^{1}
	Time (yr)	105	105	385	105	35	35	35	35	105	105	245	105
	Barnwell-McBean	2.1	2.2	4.4×10^{4}	2.2×10^{1}	2.8×10^{-1}	2.8×10^{-1}	3.5×10^{4}	2.3×10^{1}	2.9×10^{-1}	2.9×10^{-1}	3.4×10^{4}	2.7×10^{1}
	Time (yr)	1015	105	1015	105	1015	105	1015	105	1015	105	1015	105
	Congaree	1.2×10^{-2}	1.2×10^{-2}	4.2×10^{2}	1.2×10^{-1}	5.2×10^{-2}	7.2×10^{-2}	1.6×10^{4}	6.2	3.2×10^{-2}	3.7×10^{-2}	5.3×10^{3}	3.4
	Time (yr)	1085	175	1085	105	1155	245	1155	245	1155	245	1155	245
100-meter well	Water Table	3.9×10^{-2}	1.3×10^{-1}	1.0×10^{3}	1.3	6.5×10^{-2}	7.6×10^{-2}	6.8×10^{3}	6.9	2.1×10^{-2}	6.0×10^{-2}	2.3×10^{3}	3.6
	Time (yr)	105	105	1015	105	35	35	35	35	105	105	1015	105
	Barnwell-McBean	4.7×10^{-1}	4.9×10^{-1}	1.8×10^{4}	5.8	6.1×10^{-2}	6.1×10^{-2}	1.4×10^{4}	4.6	5.9×10^{-2}	5.9×10^{-2}	9.9×10^{3}	4.6
	Time (yr)	1015	105	1015	105	1015	105	1015	35	1015	105	1015	105
	Congaree	2.0×10^{-3}	2.3×10^{-3}	7.1×10^{1}	2.4×10^{-2}	8.9×10^{-3}	1.4×10^{-2}	2.1×10^{3}	1.1	5.6×10^{-3}	6.9×10^{-3}	9.3×10^{2}	5.6×10^{-1}
	Time (yr)	1085	175	1085	105	1155	245	1155	245	1155	245	1155	245
Seepline	Water Table	1.8×10^{-3}	7.4×10^{-3}	5.8×10^{1}	1.0×10^{-1}	3.1×10^{-3}	4.2×10^{-3}	3.0×10^{2}	3.4×10^{-1}	9.8×10^{-4}	3.5×10^{-3}	1.5×10^{2}	2.2×10^{-1}
	Time (yr)	105	105	1015	105	35	105	35	35	1015	105	1015	105
	Barnwell-McBean	1.2×10^{-2}	1.5×10^{-2}	4.2×10^{2}	2.4×10^{-1}	1.7×10^{-3}	2.1×10^{-3}	3.3×10^{2}	1.5×10^{-1}	2.5×10^{-3}	2.5×10^{-3}	4.2×10^{2}	1.1×10^{-1}
	Time (yr)	1015	105	1085	105	1085	175	1085	175	1085	175	1085	105
	Congaree	6.1×10^{-5}	6.5×10^{-5}	2.3	8.1×10^{-4}	1.5×10^{-4}	2.0×10^{-4}	3.0×10^{1}	1.3×10^{-2}	7.0×10^{-5}	8.5×10^{-5}	1.2×10^{1}	5.1×10^{-3}
	Time (yr)	1085	175	1085	175	1225	315	1225	315	1225	315	1225	315
Surface Water	Water Table	1.2×10^{-5}	5.0×10^{-5}	3.9×10^{-1}	7.3×10^{-4}	(a)	(a)	5.5×10^{-2}	6.5×10^{-5}	4.4×10^{-6}	1.5×10^{-5}	6.6×10^{-1}	9.9×10^{-4}
	Time (yr)	105	105	1015	105	(a)	(a)	35	35	1015	105	1015	105
	Barnwell-McBean	5.9×10^{-5}	7.7×10^{-5}	2.3	1.3×10^{-3}	(a)	(a)	6.0×10^{-2}	2.7×10^{-5}	9.3×10^{-6}	9.4×10^{-6}	1.6	4.1×10^{-4}
	Time (yr)	1015	105	1085	105	(a)	(a)	1085	175	1085	175	1085	105
	Congaree	1.6×10^{-6}	1.7×10^{-6}	5.9×10^{-2}	2.2×10^{-5}	(a)	(a)	3.8×10^{-2}	1.7×10^{-5}	2.3×10^{-6}	2.8×10^{-6}	3.8×10^{-1}	1.7×10^{-4}
	Time (yr)	1085	175	1085	175	(a)	(a)	1225	315	1225	315	1225	315

a. Concentration is less than 1×10^{-6} mg/L.

Table C.4.1-22. Concentrations in groundwater and surface water of manganese (milligrams per liter).

		F-Area				H-Area: North of Groundwater Divide				H-Area: South of Groundwater Divide			
Location	Aquifer	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative
1-meter well	Water Table	1.9×10^{-1}	2.2×10^{-1}	1.9×10^{-1}	2.2	2.9×10^{-1}	3.5×10^{-1}	2.9×10^{-1}	2.5×10^{1}	5.5×10^{-2}	6.2×10^{-2}	5.5×10^{-2}	4.0
	Time (yr)	1995	875	1995	455	1295	245	1295	245	1925	805	1925	455
	Barnwell-McBean	3.6×10^{-1}	3.8×10^{-1}	3.6×10^{-1}	5.5	2.2×10^{-2}	4.5×10^{-2}	2.2×10^{-2}	6.0	1.8×10^{-2}	2.0×10^{-2}	1.8×10^{-2}	2.2
	Time (yr)	3115	1925	3115	945	5145	2765	5145	2415	4445	3885	4445	2415
	Congaree	2.4×10^{-4}	2.4×10^{-4}	2.4×10^{-4}	3.6×10^{-3}	1.3×10^{-6}	1.6×10^{-4}	1.3×10^{-6}	3.1×10^{-2}	(a)	8.7×10^{-6}	(a)	4.9×10^{-3}
	Time (yr)	6405	5425	6405	4795	9975	9975	9975	9975	(a)	9975	(a)	9975
100-meter well	Water Table	2.8×10^{-2}	3.1×10^{-2}	2.8×10^{-2}	7.0×10^{-1}	4.3×10^{-2}	3.9×10^{-2}	4.3×10^{-2}	4.1	6.4×10^{-3}	6.5×10^{-3}	6.4×10^{-3}	5.6×10^{-1}
	Time (yr)	2205	1085	2205	805	1715	665	1715	665	2345	1155	2345	875
	Barnwell-McBean	6.2×10^{-2}	6.1×10^{-2}	6.2×10^{-2}	1.6	6.2×10^{-3}	1.1×10^{-2}	6.2×10^{-3}	1.3	2.8×10^{-3}	3.2×10^{-3}	2.8×10^{-3}	3.5×10^{-1}
	Time (yr)	3535	2345	3535	1505	6125	3675	6125	3045	5215	4445	5215	3115
	Congaree	4.6×10^{-5}	4.6×10^{-5}	4.6×10^{-5}	1.1×10^{-3}	(a)	3.0×10^{-5}	(a)	6.0×10^{-3}	(a)	(a)	(a)	6.3×10^{-4}
	Time (yr)	6755	5705	6755	4585	(a)	9975	(a)	9975	(a)	(a)	(a)	9975
Seepline	Water Table	3.8×10^{-4}	3.8×10^{-4}	3.8×10^{-4}	1.2×10^{-2}	5.4×10^{-4}	5.5×10^{-4}	5.4×10^{-4}	4.7×10^{-2}	6.8×10^{-5}	6.7×10^{-5}	6.8×10^{-5}	6.4×10^{-3}
	Time (yr)	5215	4165	5215	3535	5215	4305	5215	3815	6195	5005	6195	4585
	Barnwell-McBean	5.6×10^{-4}	5.6×10^{-4}	5.6×10^{-4}	1.8×10^{-2}	4.0×10^{-6}	4.2×10^{-5}	4.0×10^{-6}	5.4×10^{-3}	3.4×10^{-5}	3.7×10^{-5}	3.4×10^{-5}	3.7×10^{-3}
	Time (yr)	8855	7805	8855	6545	9975	9975	9975	9975	9905	9485	9905	8155
	Congaree	1.2×10^{-6}	1.2×10^{-6}	1.2×10^{-6}	4.1×10^{-5}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	8225	7175	8225	6335	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Surface Water	Water Table	2.5×10^{-6}	2.5×10^{-6}	2.5×10^{-6}	8.5×10^{-5}	(a)	(a)	(a)	9.5×10^{-6}	(a)	(a)	(a)	2.8×10^{-5}
	Time (yr)	5215	4165	5215	3745	(a)	(a)	(a)	4025	(a)	(a)	(a)	4515
	Barnwell-McBean	2.9×10^{-6}	2.9×10^{-6}	2.9×10^{-6}	9.8×10^{-5}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	1.3×10^{-5}
	Time (yr)	8785	7735	8785	7035	(a)	(a)	(a)	(a)	(a)	(a)	(a)	7875
	Congaree	(a)	(a)	(a)	1.1×10^{-6}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	6335	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)

a. Concentration is less than 1×10^{-6} mg/L

Table C.4.1-23. Concentrations in groundwater and surface water of nickel (milligrams per liter).

		F-Area				H-Area: North of Groundwater Divide				H-Area: South of Groundwater Divide			
Location	Aquifer	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative
1-meter well	Water Table	1.0×10^{-4}	2.2×10^{-5}	1.0×10^{-4}	1.1×10^{-1}	4.8×10^{-3}	4.7×10^{-3}	4.8×10^{-3}	2.9×10^{-1}	5.8×10^{-4}	2.4×10^{-4}	5.8×10^{-4}	5.9×10^{-2}
	Time (yr)	9975	9975	9975	6335	5495	4725	5495	5285	9975	9975	9975	6335
	Barnwell-McBean	(a)	(a)	(a)	6.7×10^{-4}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	9975	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
100-meter well	Water Table	(a)	(a)	(a)	1.9×10^{-2}	2.9×10^{-4}	3.4×10^{-4}	2.9×10^{-4}	3.4×10^{-2}	(a)	(a)	(a)	3.4×10^{-3}
	Time (yr)	(a)	(a)	(a)	9905	9975	9975	9975	9905	(a)	(a)	(a)	9975
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Seepline	Water Table	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Surface Water	Water Table	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)

a. Concentration is less than 1×10^{-6} mg/L.

Table C.4.1-24. Concentrations in groundwater and surface water of lead (milligrams per liter).

		F-Area				H-Area							
						North of Groundwater Divide				South of Groundwater Divide			
Location	Aquifer	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative
1-meter well	Water Table	5.2×10^{-4}	2.9×10^{-4}	5.2×10^{-4}	2.3×10^{-2}	7.3×10^{-4}	2.0×10^{-4}	7.3×10^{-4}	8.5×10^{-2}	3.9×10^{-4}	1.4×10^{-5}	3.9×10^{-4}	3.0×10^{-2}
	Time (yr)	9975	6055	9975	6475	9975	3745	9975	6965	9975	9975	9975	6545
	Barnwell-McBean	(a)	(a)	(a)	1.3×10^{-5}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	9975	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
100-meter well	Water Table	8.3×10^{-5}	8.0×10^{-5}	8.3×10^{-5}	4.2×10^{-3}	3.7×10^{-5}	3.4×10^{-5}	3.7×10^{-5}	8.1×10^{-3}	(a)	(a)	(a)	2.9×10^{-3}
	Time (yr)	8575	8505	8575	9765	9975	9765	9975	9975	(a)	(a)	(a)	9975
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Seepline	Water Table	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Surface Water	Water Table	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)

a. Concentration is less than 1×10^{-6} mg/L.

Table C.4.1-25. Concentrations in groundwater and surface water of uranium (milligrams per liter).

		F-Area				H-Area							
						North of Groundwater Divide				South of Groundwater Divide			
Location	Aquifer	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative
1-meter well	Water Table	1.7×10^{-5}	1.7×10^{-5}	1.7×10^{-5}	7.6×10^{-5}	4.0×10^{-5}	4.0×10^{-5}	4.0×10^{-5}	1.7×10^{-4}	3.7×10^{-5}	3.7×10^{-5}	3.7×10^{-5}	2.2×10^{-4}
	Time (yr)	8365	7035	8365	9975	9975	8925	9975	9695	9695	8785	9695	9345
	Barnwell-McBean	(a)	1.4×10^{-6}	(a)	1.5×10^{-4}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	9975	(a)	9975	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
100-meter well	Water Table	6.4×10^{-6}	6.5×10^{-6}	6.4×10^{-6}	4.5×10^{-5}	1.3×10^{-5}	1.3×10^{-5}	1.3×10^{-5}	1.0×10^{-4}	1.3×10^{-5}	1.3×10^{-5}	1.3×10^{-5}	1.3×10^{-4}
	Time (yr)	8995	8435	8995	9695	9485	8505	9485	9485	9975	9065	9975	9135
	Barnwell-McBean	(a)	(a)	(a)	6.1×10^{-5}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	9975	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Seepline	Water Table	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Surface Water	Water Table	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Barnwell-McBean	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)

a. Concentration is less than 1×10^{-6} mg/L.

Table C.4.1-26. Concentrations in groundwater and surface water of zinc (milligrams per liter).

						H-Area							
		F-Area				North of Groundwater Divide				South of Groundwater Divide			
Location	Aquifer	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative
1-meter well	Water Table	4.4×10^{-3}	4.4×10^{-3}	4.4×10^{-3}	8.7×10^{-2}	6.7×10^{-4}	4.8×10^{-4}	6.7×10^{-4}	5.4×10^{-2}	1.5×10^{-3}	1.5×10^{-3}	1.5×10^{-3}	2.4×10^{-2}
	Time (yr)	2135	1155	2135	595	2135	1225	2135	1925	2555	1645	2555	1015
	Barnwell-McBean	3.3×10^{-3}	5.7×10^{-3}	3.3×10^{-3}	1.3×10^{-1}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	9975	9975	9975	5425	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
100-meter well	Water Table	1.5×10^{-3}	1.5×10^{-3}	1.5×10^{-3}	2.8×10^{-2}	1.6×10^{-4}	1.6×10^{-4}	1.6×10^{-4}	1.5×10^{-2}	7.4×10^{-4}	7.4×10^{-4}	7.4×10^{-4}	1.1×10^{-2}
	Time (yr)	2205	1295	2205	735	2345	1435	2345	2205	2975	2065	2975	1295
	Barnwell-McBean	1.2×10^{-3}	1.2×10^{-3}	1.2×10^{-3}	3.2×10^{-2}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	7315	6335	7315	5845	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Seepline	Water Table	2.3×10^{-5}	2.3×10^{-5}	2.3×10^{-5}	5.5×10^{-4}	3.7×10^{-6}	3.7×10^{-6}	3.7×10^{-6}	5.3×10^{-4}	2.3×10^{-5}	2.3×10^{-5}	2.3×10^{-5}	3.1×10^{-4}
	Time (yr)	8855	7875	8855	4375	5005	4165	5005	4375	5775	4865	5775	4515
	Barnwell-McBean	9.3×10^{-6}	1.8×10^{-5}	9.3×10^{-6}	9.0×10^{-4}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	9975	9975	9975	9975	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Surface Water	Water Table	(a)	(a)	(a)	3.9×10^{-6}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	1.4×10^{-6}
	Time (yr)	(a)	(a)	(a)	4375	(a)	(a)	(a)	(a)	(a)	(a)	(a)	4165
	Barnwell-McBean	(a)	(a)	(a)	4.7×10^{-6}	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	9975	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Congaree	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
	Time (yr)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)

a. Concentration is less than 1×10^{-6} mg/L.

concentration values at the seepline are not additive. Therefore, DOE used only the maximum seepline concentration for Fourmile Branch and Upper Three Runs from the alternatives in its comparison of impacts among the alternatives.

C.4.2 ECOLOGICAL RISK ASSESSMENT

C.4.2.1 Nonradiological Analysis

H-Area: Upper Three Runs – Barnwell McBean, Water Table, and Congaree Aquifers

Aquatic Hazard Quotients (HQs) for each contaminant were summed to obtain an aquatic Hazard Index (HI). All HIs were less than 1.0 for all four alternatives. All terrestrial HQs for the shrew and the mink were less than 1.0 for all four scenarios: (Tables C.4.2-1 through C.4.2-4). Thus potential risks to ecological receptors at and downgradient of the Upper Three Runs seeps (from all aquifers under H-Area) are negligible.

H-Area: Fourmile Branch – Barnwell McBean and Water Table Aquifers, Upper Three Runs – Congaree Aquifers

Aquatic HQs for each contaminant were summed to obtain an aquatic Hazard Index (HI). All HIs were less than 1.0 for the four scenarios. All terrestrial HQs for the shrew and the mink were less than 1.0 for these alternatives and options (Tables C.4.2-5 through C.4.2-8). Thus potential H risks to ecological receptors at and downgradient of the Fourmile Branch seep (from the Barnwell McBean and Water Table Aquifers and under H-Area) are negligible, as are those for the Congaree at Upper Three Runs.

F-Area: Fourmile Branch – Barnwell McBean and Water Table Aquifers; Upper Three Runs – Congaree Aquifer

Aquatic HQs for each contaminant were summed to obtain an aquatic Hazard Index (HI). All aquatic HIs were less than 1.0 for the Clean and Fill with Sand and Clean and Fill with Saltstone Options. The maximum HI for the Clean and Fill with Grout Option with the Water Table Aquifer was 1.42. In addition, HIs for the No Action Alternative with the Barnwell McBean and Water Table Aquifers were greater than 1.0: 2.0 and 1.42, respectively. This suggests some potential risks, although the relatively low HI values suggest that these risks are generally low. HQs for the shrew and the mink were less than 1.0 for all four scenarios (Tables C.4.2-9 through C.4.2-12). The exception was a silver HQ of 1.55 for the shrew under the No Action Alternative (Barnwell-McBean Aquifer). Although this indicates that risks are possible at the Fourmile Branch seep (via groundwater under F-Area), the relatively low HQ suggests that these risks are somewhat low.

C.4.2.2 Radiological Analysis

Calculated absorbed doses to the referenced organisms are presented in Tables C.4-2-13 through C.4.2-21. All calculated doses are below the regulatory limit of 365,000 mrad per year (365 rad per year).

C.5 Ecological Risk Assessment Uncertainties

Most of the data and assumptions used in the exposure calculations (exclusive of the exposure concentrations, which were calculated by the groundwater model) are average or midpoint values. Uncertainty for these values is largely a question of precision in measurement or variability about these points. However, two assumptions are conservative, meaning that they are likely to overestimate risk.

The relationship between seep area and home range has already been mentioned; the lack of correction for home range is likely to overestimate risk to an individual shrew by a factor of two and to an individual mink by a factor greater than ten. The other assumption is that when contaminants in seepage adsorb to the soil, they are not removed from the water. In other words, the seepage concentration is used to predict soil concentrations and downstream water concentrations without adjustment for losses.

Table C.4.2-1. Results of terrestrial risk assessment for H-Area/Upper Three Runs (Barnwell-McBean, Water Table, and Congaree Aquifers), Clean and Fill with Grout Option.

	Barnwell-McBean Aquifer			Congaree Aquifer			Water Table Aquifer		
	Maximum HQ		Time of	Maximum HQ		Time of	Maximum HQ		Time of
Analyte	Mink	Shrew	maximum HQ[a]	Mink	Shrew	maximum HQ	Mink	Shrew	maximum HQ
Aluminum	b	b	NA	b	b	NA	b	b	NA
Barium	b	b	NA	b	b	NA	b	b	NA
Chromium	b	b	NA	b	b	NA	b	b	NA
Copper	b	b	NA	b	b	NA	b	b	NA
Fluoride	b	b	NA	b	b	NA	b	b	NA
Lead	b	b	NA	b	b	NA	b	b	NA
Manganese	b	b	NA	b	b	NA	b	b	NA
Mercury	b	b	NA	b	b	NA	b	b	NA
Nickel	b	b	NA	b	b	NA	b	b	NA
Silver	b	b	NA	b	b	NA	b	b	NA
Uranium	b	b	NA	b	b	NA	b	b	NA
Zinc	b	b	NA	b	b	NA	b	b	NA

a. Years after closure.
b. HQ is less than ~ 1×10^{-2}.
NA = Not applicable.

Table C.4.2-2. Results of terrestrial risk assessment for H-Area/Upper Three Runs (Barnwell-McBean, Water Table, and Congaree Aquifers), Clean and Fill with Sand Option.

	Barnwell-McBean Aquifer			Congaree Aquifer			Water Table Aquifer		
	Maximum HQ		Time of maximum HQ[a]	Maximum HQ		Time of maximum HQ	Maximum HQ		Time of maximum HQ
Analyte	Mink	Shrew		Mink	Shrew		Mink	Shrew	
Aluminum	b	b	NA	b	b	NA	b	b	NA
Barium	b	b	NA	b	b	NA	b	b	NA
Chromium	b	b	NA	b	b	NA	b	b	NA
Copper	b	b	NA	b	b	NA	b	b	NA
Fluoride	b	b	NA	b	b	NA	b	b	NA
Lead	b	b	NA	b	b	NA	b	b	NA
Manganese	b	b	NA	b	b	NA	b	b	NA
Mercury	b	b	NA	b	b	NA	b	b	NA
Nickel	b	b	NA	b	b	NA	b	b	NA
Silver	b	b	NA	b	b	NA	b	b	NA
Uranium	b	b	NA	b	b	NA	b	b	NA
Zinc	b	b	NA	b	b	NA	b	b	NA

a. Years after closure.
b. HQ is less than ~ 1×10^{-2}.
NA = Not applicable.

Table C.4.2-3. Results of terrestrial risk assessment for H-Area/Upper Three Runs (Barnwell-McBean, Water Table, and Congaree Aquifers), Clean and Fill with Saltstone Option.

	Barnwell-McBean Aquifer			Congaree Aquifer			Water Table Aquifer		
	Maximum HQ		Time of	Maximum HQ		Time of	Maximum HQ		Time of
Analyte	Mink	Shrew	maximum HQ[a]	Mink	Shrew	maximum HQ	Mink	Shrew	maximum HQ
Aluminum	b	b	NA	b	b	NA	b	b	NA
Barium	b	b	NA	b	b	NA	b	b	NA
Chromium	b	b	NA	b	b	NA	b	b	NA
Copper	b	b	NA	b	b	NA	b	b	NA
Fluoride	b	b	NA	b	b	NA	b	b	NA
Lead	b	b	NA	b	b	NA	b	b	NA
Manganese	b	b	NA	b	b	NA	b	b	NA
Mercury	b	b	NA	b	b	NA	b	b	NA
Nickel	b	b	NA	b	b	NA	b	b	NA
Silver	b	b	NA	b	b	NA	b	b	NA
Uranium	b	b	NA	b	b	NA	b	b	NA
Zinc	b	b	NA	b	b	NA	b	b	NA

a. Years after closure.
b. HQ is less than ~ 1×10^{-2}.
NA = Not applicable.

Table C.4.2-4. Results of terrestrial risk assessment for H-Area/Upper Three Runs (Barnwell-McBean, Water Table, and Congaree Aquifers), No Action Alternative.

	Barnwell-McBean Aquifer			Congaree Aquifer			Water Table Aquifer		
	Maximum HQ		Time of	Maximum HQ		Time of	Maximum HQ		Time of
Analyte	Mink	Shrew	maximum HQ[a]	Mink	Shrew	maximum HQ	Mink	Shrew	maximum HQ
Aluminum	b	b	NA	b	b	NA	b	b	NA
Barium	b	b	NA	b	b	NA	b	b	NA
Chromium	b	b	NA	b	b	NA	2.19×10^{-2}	3.94×10^{-2}	4,235
Copper	b	b	NA	b	b	NA	b	b	NA
Fluoride	2.43×10^{-2}	5.76×10^{-2}	175	b	b	NA	6.6×10^{-2}	1.56×10^{-1}	35
Lead	b	b	NA	b	b	NA	b	b	NA
Manganese	b	b	NA	b	b	NA	b	b	NA
Mercury	b	b	NA	b	b	NA	b	b	NA
Nickel	b	b	NA	b	b	NA	b	b	NA
Silver	1.93×10^{-2}	3.54×10^{-2}	2,065	b	b	NA	2.41×10^{-1}	4.43×10^{-1}	175
Uranium	b	b	NA	b	b	NA	b	b	NA
Zinc	b	b	NA	b	b	NA	b	b	NA

a. Years after closure.
b. HQ is less than ~ 1×10^{-2}.
NA = Not applicable.

Table C.4.2-5. Results of terrestrial risk assessment for H-Area/Fourmile Branch (Barnwell-McBean, Water Table, and Congaree Aquifers), Clean and Fill with Grout Option.

	Barnwell-McBean Aquifer			Congaree Aquifer[c]			Water Table Aquifer		
	Maximum HQ		Time of maximum HQ[a]	Maximum HQ		Time of maximum HQ	Maximum HQ		Time of maximum HQ
Analyte	Mink	Shrew		Mink	Shrew		Mink	Shrew	
Aluminum	b	b	NA	b	b	NA	b	b	NA
Barium	b	b	NA	b	b	NA	b	b	NA
Chromium	b	b	NA	b	b	NA	b	b	NA
Copper	b	b	NA	b	b	NA	b	b	NA
Fluoride	b	b	NA	b	b	NA	b	b	NA
Lead	b	b	NA	b	b	NA	b	b	NA
Manganese	b	b	NA	b	b	NA	b	b	NA
Mercury	b	b	NA	b	b	NA	b	b	NA
Nickel	b	b	NA	b	b	NA	b	b	NA
Silver	b	b	NA	b	b	NA	b	b	NA
Uranium	b	b	NA	b	b	NA	b	b	NA
Zinc	b	b	NA	b	b	NA	b	b	NA

a. Years after closure.
b. HQ is less than ~ 1×10^{-2}.
c. Congaree Aquifer discharges to Upper Three Runs for this scenario.
NA = Not applicable.

Table C.4.2-6. Results of terrestrial risk assessment for H-Area/Fourmile Branch (Barnwell-McBean, Water Table, and Congaree Aquifers), Clean and Fill with Sand Option.

	Barnwell-McBean Aquifer			Congaree Aquifer[c]			Water Table Aquifer		
	Maximum HQ		Time of	Maximum HQ		Time of	Maximum HQ		Time of
Analyte	Mink	Shrew	maximum HQ[a]	Mink	Shrew	maximum HQ	Mink	Shrew	maximum HQ
Aluminum	b	b	NA	b	b	NA	b	b	NA
Barium	b	b	NA	b	b	NA	b	b	NA
Chromium	b	b	NA	b	b	NA	b	b	NA
Copper	b	b	NA	b	b	NA	b	b	NA
Fluoride	b	b	NA	b	b	NA	b	b	NA
Lead	b	b	NA	b	b	NA	b	b	NA
Manganese	b	b	NA	b	b	NA	b	b	NA
Mercury	b	b	NA	b	b	NA	b	b	NA
Nickel	b	b	NA	b	b	NA	b	b	NA
Silver	b	b	NA	b	b	NA	b	b	NA
Uranium	b	b	NA	b	b	NA	b	b	NA
Zinc	b	b	NA	b	b	NA	b	b	NA

a. Years after closure.
b. HQ is less than ~ 1×10^{-2}.
c. Congaree Aquifer discharges to Upper Three Runs for this scenario.
NA = Not applicable.

Table C.4.2-7. Results of terrestrial risk assessment for H-Area/Fourmile Branch (Barnwell-McBean, Water Table, and Congaree Aquifers), Clean and Fill with Saltstone Option.

	Barnwell-McBean Aquifer			Congaree Aquifer[c]			Water Table Aquifer		
	Maximum HQ		Time of	Maximum HQ		Time of	Maximum HQ		Time of
Analyte	Mink	Shrew	maximum HQ[a]	Mink	Shrew	maximum HQ	Mink	Shrew	maximum HQ
Aluminum	b	b	NA	b	b	NA	b	b	NA
Barium	b	b	NA	b	b	NA	b	b	NA
Chromium	b	b	NA	b	b	NA	b	b	NA
Copper	b	b	NA	b	b	NA	b	b	NA
Fluoride	b	b	NA	b	b	NA	b	b	NA
Lead	b	b	NA	b	b	NA	b	b	NA
Manganese	b	b	NA	b	b	NA	b	b	NA
Mercury	b	b	NA	b	b	NA	b	b	NA
Nickel	b	b	NA	b	b	NA	b	b	NA
Silver	b	b	NA	b	b	NA	b	b	NA
Uranium	b	b	NA	b	b	NA	b	b	NA
Zinc	b	b	NA	b	b	NA	b	b	NA

a. Years after closure.
b. HQ is less than ~ 1×10^{-2}.
c. Congaree Aquifer discharges to Upper Three Runs for this scenario.
NA = Not applicable.

Table C.4.2-8. Results of terrestrial risk assessment for H-Area/Fourmile Branch (Barnwell-McBean, Water Table, and Congaree Aquifers), No Action Alternative.

	Barnwell-McBean Aquifer			Congaree Aquifer[c]			Water Table Aquifer		
	Maximum HQ		Time of	Maximum HQ		Time of	Maximum HQ		Time of
Analyte	Mink	Shrew	maximum HQ[a]	Mink	Shrew	maximum HQ	Mink	Shrew	maximum HQ
Aluminum	b	b	NA	b	b	NA	b	b	NA
Barium	b	b	NA	b	b	NA	b	b	NA
Chromium	b	b	NA	b	b	NA	b	b	NA
Copper	b	b	NA	b	b	NA	b	b	NA
Fluoride	1.69×10^{-2}	4.0×10^{-2}	105	b	b	NA	3.22×10^{-2}	7.61×10^{-2}	105
Lead	b	b	NA	b	b	NA	b	b	NA
Manganese	b	b	NA	b	b	NA	b	b	NA
Mercury	b	b	NA	b	b	NA	b	b	NA
Nickel	b	b	NA	b	b	NA	b	b	NA
Silver	b	b	NA	b	b	NA	2.21×10^{-2}	4.06×10^{-2}	245
Uranium	b	b	NA	b	b	NA	b	b	NA
Zinc	b	b	NA	b	b	NA	b	b	NA

a. Years after closure.
b. HQ is less than ~ 1×10^{-2}.
c. Congaree Aquifer discharges to Upper Three Runs for this scenario.
NA = Not applicable.

Table C.4.2-9. Results of terrestrial risk assessment for F-Area/Fourmile Branch (Barnwell-McBean, Water Table, and Congaree Aquifers), Clean and Fill with Grout Option.

	Barnwell-McBean Aquifer			Congaree Aquifer[c]			Water Table Aquifer		
	Maximum HQ		Time of	Maximum HQ		Time of	Maximum HQ		Time of
Analyte	Mink	Shrew	maximum HQ[a]	Mink	Shrew	maximum HQ	Mink	Shrew	maximum HQ
Aluminum	b	b	NA	b	b	NA	b	b	NA
Barium	b	b	NA	b	b	NA	b	b	NA
Chromium	b	b	NA	b	b	NA	1.14×10^{-2}	2.05×10-2	3,955
Copper	b	b	NA	b	b	NA	b	b	NA
Fluoride	b	1.07×10^{-2}	1,015	b	b	NA	3.47×10^{-2}	8.2×10^{-2}	105
Lead	b	b	NA	b	b	NA	b	b	NA
Manganese	b	b	NA	b	b	NA	b	b	NA
Mercury	b	b	NA	b	b	NA	b	b	NA
Nickel	b	b	NA	b	b	NA	b	b	NA
Silver	6.83×10^{-2}	1.25×10^{-1}	1,365	b	b	NA	4.42×10^{-1}	8.12×0^{-1}	245
Uranium	b	b	NA	b	b	NA	b	b	NA
Zinc	b	b	NA	b	b	NA	b	b	NA

a. Years after closure.
b. HQ is less than ~ 1×10^{-2}.
c. Congaree Aquifer discharges to Upper Three Runs for this scenario.
NA = Not applicable.

Table C.4.2-10. Results of terrestrial risk assessment for F-Area/Fourmile Branch (Barnwell-McBean, Water Table, and Congaree Aquifers), Clean and Fill with Sand Option.

Analyte	Barnwell-McBean Aquifer			Congaree Aquifer[c]			Water Table Aquifer		
	Maximum HQ		Time of	Maximum HQ		Time of	Maximum HQ		Time of
	Mink	Shrew	maximum HQ[a]	Mink	Shrew	maximum HQ	Mink	Shrew	maximum HQ
Aluminum	b	b	NA	b	b	NA	b	b	NA
Barium	b	b	NA	b	b	NA	b	b	NA
Chromium	b	b	NA	b	b	NA	b	b	NA
Copper	b	b	NA	b	b	NA	b	b	NA
Fluoride	b	1.37×10^{-2}	105	b	b	NA	b	b	NA
Lead	b	b	NA	b	b	NA	b	b	NA
Manganese	b	b	NA	b	b	NA	b	b	NA
Mercury	b	b	NA	b	b	NA	b	b	NA
Nickel	b	b	NA	b	b	NA	b	b	NA
Silver	4.82×10^{-2}	8.85×10^{-2}	525	b	b	NA	2.33×10^{-2}	4.28×10^{-2}	315
Uranium	b	b	NA	b	b	NA	b	b	NA
Zinc	b	b	NA	b	b	NA	b	b	NA

a. Years after closure.
b. HQ is less than ~ 1×10^{-2}.
c. Congaree Aquifer discharges to Upper Three Runs for this scenario.
NA = Not applicable.

Table C.4.2-11. Results of terrestrial risk assessment for F-Area/Fourmile Branch (Barnwell-McBean, Water Table, and Congaree Aquifers), Clean and Fill with Saltstone Option.

Analyte	Barnwell-McBean Aquifer			Congaree Aquifer[c]			Water Table Aquifer		
	Maximum HQ		Time of maximum HQ[a]	Maximum HQ		Time of maximum HQ	Maximum HQ		Time of maximum HQ
	Mink	Shrew		Mink	Shrew		Mink	Shrew	
Aluminum	b	b	NA	b	b	NA	b	b	NA
Barium	b	b	NA	b	b	NA	b	b	NA
Chromium	b	b	NA	b	b	NA	b	b	NA
Copper	b	b	NA	b	b	NA	b	b	NA
Fluoride	b	1.07×10^{-2}	1,105	b	b	NA	b	b	NA
Lead	b	b	NA	b	b	NA	b	b	NA
Manganese	b	b	NA	b	b	NA	b	b	NA
Mercury	b	b	NA	b	b	NA	b	b	NA
Nickel	b	b	NA	b	b	NA	b	b	NA
Silver	6.83×10^{-2}	1.25×10^{-1}	1,365	b	b	NA	2.85×10^{-2}	5.24×10^{-2}	1,085
Uranium	b	b	NA	b	b	NA	b	b	NA
Zinc	b	b	NA	b	b	NA	b	b	NA

a. Years after closure.
b. HQ is less than ~ 1×10^{-2}.
c. Congaree Aquifer discharges to Upper Three Runs for this scenario.
NA = Not applicable.

Table C.4.2-12. Results of terrestrial risk assessment for F-Area/Fourmile Branch (Barnwell-McBean, Water Table, and Congaree Aquifers), No Action Alternative

	Barnwell-McBean Aquifer			Congaree Aquifer[c]			Water Table Aquifer		
	Maximum HQ		Time of	Maximum HQ		Time of	Maximum HQ		Time of
Analyte	Mink	Shrew	maximum HQ[a]	Mink	Shrew	maximum HQ	Mink	Shrew	maximum HQ
Aluminum	b	b	NA	b	b	NA	b	b	NA
Barium	b	b	NA	b	b	NA	b	b	NA
Chromium	1.76×10^{-2}	3.15×10^{-2}	8,015	b	b	NA	1.14×10^{-2}	2.05×10^{-2}	3,955
Copper	b	b	NA	b	b	NA	b	b	NA
Fluoride	8.25×10^{-2}	1.95×10^{-1}	105	b	b	NA	3.47×10^{-2}	8.2×10^{-2}	105
Lead	b	b	NA	b	b	NA	b	b	NA
Manganese	b	b	NA	b	b	NA	b	b	NA
Mercury	b	b	NA	b	b	NA	b	b	NA
Nickel	b	b	NA	b	b	NA	b	b	NA
Silver	8.44×10^{-1}	1.55	455	b	b	NA	4.42×10^{-1}	8.12×10^{-1}	245
Uranium	b	b	NA	b	b	NA	b	b	NA
Zinc	b	b	NA	b	b	NA	b	b	NA

a. Years after closure.
b. HQ is less than ~ 1×10^{-2}.
c. Congaree Aquifer discharges to Upper Three Runs for this scenario.
NA = Not applicable.

Table C.4.2-13. Calculated absorbed radiation dose (millirad per year) to aquatic and terrestrial organisms for F-Area Tank Farm – Water Table Aquifer.

	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative
Sunfish dose	0.0027	0.0016	0.025	0.49
Shrew dose	10.1	6.3	94.9	2,530
Mink dose	1.1	0.9	9.9	1,690

Table C.4.2-14. Calculated absorbed radiation dose (millirad per year) to aquatic and terrestrial organisms for F-Area Area Tank Farm – Barnwell-McBean Aquifer.

	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative
Sunfish dose	0.0038	0.0072	0.053	0.89
Shrew dose	18.7	34.5	372	4,320
Mink dose	2.0	3.6	265	452

Table C.4.2-15. Calculated absorbed radiation dose (millirad per year) to aquatic and terrestrial organisms for F-Area Tank Farm – Congaree Aquifer.

	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative
Sunfish dose	6.7×10^{-5}	8.9×10^{-5}	0.002	0.016
Shrew dose	0.1	0.1	1.9	15.8
Mink dose	0	0	0.2	1.7

Table C.4.2-16. Calculated absorbed radiation dose (millirad per year) to aquatic and terrestrial organisms for H-Area Tank Farm to Four Mile Branch – Water Table Aquifer.

	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative
Sunfish dose	0.0014	0.0023	0.027	0.35
Shrew dose	9.5	14.4	158.9	2,260
Mink dose	1.0	1.5	17.8	669.1

Table C.4.2-17. Calculated absorbed radiation dose (millirad per year) to aquatic and terrestrial organisms for H-Area Tank Farm to Four Mile Branch – Barnwell-McBean Aquifer.

	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative
Sunfish dose	2.2×10^{-4}	0.0011	0.018	0.21
Shrew dose	0.2	8.3	126.6	1,580
Mink dose	0	0.9	13.3	165.7

Table C.4.2-18. Calculated absorbed radiation dose (millirad per year) to aquatic and terrestrial organisms for H-Area Tank Farm to Four Mile Branch – Congaree Aquifer.

	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative
Sunfish dose	4.8×10^{-4}	2.8×10^{-4}	0.0095	0.061
Shrew dose	3.5	0.2	7.6	47.5
Mink dose	0.4	0	0.8	5.0

Table C.4.2-19. Calculated absorbed radiation dose (millirad per year) to aquatic and terrestrial organisms for H-Area Tank Farm to Upper Three Runs – Water Table Aquifer.

	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative
Sunfish dose	2.1×10^{-4}	0.0017	0.0037	0.039
Shrew dose	24.8	244.5	460.5	24,450
Mink dose	3.3	25.6	48.7	2,560

Table C.4.2-20. Calculated absorbed radiation dose (millirad per year) to aquatic and terrestrial organisms for H-Area Tank Farm to Upper Three Runs – Barnwell-McBean Aquifer.

	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative
Sunfish dose	5.4×10^{-5}	3.1×10^{-4}	0.0016	0.014
Shrew dose	7.5	44.6	230.1	4,890
Mink dose	0.8	4.7	24.1	512

Table C.4.2-21. Calculated absorbed radiation dose (millirad per year) to aquatic and terrestrial organisms for H-Area Tank Farm to Upper Three Runs – Congaree Aquifer.

	Clean and Fill with Grout Option	Clean and Fill with Sand Option	Clean and Fill with Saltstone Option	No Action Alternative
Sunfish dose	4.8×10^{-5}	1.3×10^{-4}	0.0016	0.012
Shrew dose	1.0	2.7	31.6	244.5
Mink dose	0.1	0.3	3.3	25.6

Uncertainty in the toxicity assessment includes the selection of a particular dose and the factors applied to ensure that it is protective. The fluoride dose selected as a threshold, a LOAEL of 5 milligram per kilogram per day associated with relatively less serious effects in rats and minks, could have been a higher dose based on effects more likely to cause decreased fitness. The data base available for silver toxicity is not good, and this is reflected in the high uncertainty factor (100X) used to lower the selected dose.

Because toxicity data is mostly limited to individual responses, a risk assessment is usually limited to the probability of risk to an individual. This makes the evaluation of risk to populations, communities, and ecosystems a speculative and uncertain undertaking, even though characterization of risks to populations is the typical goal of an ecological risk assessment. In the case of the seep, it is reasonable to assume that terrestrial effects will be limited to this area because the contaminants have not been shown to bioaccumulate in terrestrial systems. Surface water is the only likely pathway for contaminants to exit the seep area. [Mercury is known to accumulate in aquatic food chains, but only a minimal amount of mercury is transported to the seepline during the 10,000 year modeled time period.]

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APPENDIX D

PUBLIC SCOPING SUMMARY

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APPENDIX D. PUBLIC SCOPING SUMMARY

This Appendix describes how DOE defined the scope of the *Savannah River Site High-Level Waste Tank Systems Closure Program Environmental Impact Statement.* It also describes the comments received from the stakeholders of SRS on this planned environmental impact statement (EIS), the issues raised during the scoping process, and the DOE responses to these comments.

D.1 Scoping Process

On December 29, 1998, DOE announced its intent to prepare an EIS to assess the environmental impacts of closing the HLW tanks at the SRS in accordance with the *Industrial Wastewater Closure Plan for F-and H-Area High Level Waste Tank Systems.* The Notice of Intent began a scoping period, which extended until February 12, 1999, and announced that DOE would hold scoping meetings in Columbia and North Augusta, South Carolina during the scoping period. The scoping meetings were subsequently announced in newspapers in the vicinity of the meeting locations.

DOE encouraged SRS stakeholders and other interested parties to submit comments for consideration in the preparation of the EIS and established several methods for such submittals:

- By letter to the Savannah River Operations Office
- By voice mail using a toll-free telephone number
- By facsimile transmission (fax) using a toll-free telephone number
- By electronic mail to an address at the Savannah River Site
- Orally or in writing at public scoping meetings

DOE held scoping meetings on the planned EIS in North Augusta, South Carolina on January 14, 1999 and in Columbia, South Carolina on January 19, 1999. DOE held an afternoon and an evening session at each meeting. Each session included an introduction to the NEPA process in relation to the tank closure proposal, a description of the HLW tanks and alternatives for closure, and a video showing some aspects of the closure of Tank 17 at the SRS. Each session also included opportunities to ask questions of DOE officials and opportunities to offer comments on the scope of the EIS for the record. Transcripts of the question and answer and comment portions of the meetings are available for inspection at the DOE Public Reading Room, Gregg-Graniteville Library, University of South Carolina at Aiken, University Parkway, Aiken, South Carolina.

D.2 Summary of Scoping Comments and Issues

During the scoping period DOE received the following:

- Three comment letters
- One comment E-mail
- One recommendation from the Savannah River Site Citizens Advisory Board
- Seven verbal comments given at the scoping meetings

In these submittals and presentations, DOE identified thirty-six separate comments. The Department reviewed and categorized these comments. The following paragraphs discuss the comments and provide DOE's responses to them.

Comments Relative to the Alternatives: Six comments recommended changes or additions to the alternatives. Comments included the following:

- The scope of this EIS should be expanded to include identification of an alternative, such as ion exchange, to the In-Tank Precipitation process.

DOE Response: DOE has chosen to prepare a separate Supplemental EIS on the construction and operation of a new salt disposition technology to replace In-Tank Precipitation. The selection of a new technology is independent of tank closure, from both technical and regulatory viewpoints. The two EISs are being prepared on similar schedules, and overlap of DOE staff assigned to support the two programs ensures consistent treatment of common issues.

- The EIS should include an alternative of completely emptying the tanks and thoroughly washing them. This alternative would provide the greatest long-term protection of the environment around and down gradient of the tanks as well as the most protection to future generations.

DOE Response: This suggested alternative is essentially what would happen for both the Clean and Stabilize Tanks Alternative and the Clean and Remove Tanks Alternative.

- Any alternative for tank closure that is premised on the re-classification of residual high-level waste as "incidental waste," violates the 1982 Nuclear Waste Policy Act ("NWPA"), §§ 10101 et seq., and therefore cannot be considered as a viable alternative in the proposed EIS.

DOE Response: DOE has evaluated the characteristics of the expected residual waste relative to the DOE Order 435.1 process for incidental waste, and has concluded that the Order requirements will be met for waste left in the tanks.

- Add an alternative "Delayed Tank Closure" pending research and development activities. Delay subsequent tank closures (but not tank emptying and cleaning activities) beyond 2003; perform technology development to enable removal of residual tank waste.

DOE Response: DOE finds the "Delayed Closure" proposed alternative to be no different than no action. DOE has ongoing research and development efforts underway aimed at improving closure techniques.

- Add an alternative to have separate actions: tank removal and grouting taking place in different tanks, as needed.

DOE Response: This Draft EIS examines the impacts of both tank removal and grouting. Depending on the ability of cleaning to meet the performance requirements for a given tank, the decisionmaker may elect to remove a tank if it is not possible to meet the performance requirements by another method. This Draft EIS examines the alternative of cleaning the tanks and removing them for appropriate disposal.

- Add the alternative "complete tank removal," with point of compliance for groundwater contamination located within F- and H-Area Tank Farms, and no reliance on long-term institutional controls for intruder scenario exposures evaluated for the impact assessment.

DOE Response: DOE has evaluated in the draft EIS potential contamination at 1 meter and 100 meters from the tank farm for each alternative. Intruder scenarios are evaluated without consideration of institutional controls after 100 years. DOE intends however, to maintain long-term institutional control, consistent with applicable regulations.

Comments Related to Data Needs: Three comments suggested data to be included. Comments included the following:

- DOE should include the total volume of waste and the total amount of each radionuclide and chemical expected to remain in the tanks.

- DOE should include a description of the grout or other material proposed to fill the tanks.

- DOE should include potential release of contaminants from closed tanks.

DOE Response: A list of radionuclides and their half-lives that may remain in the tanks is provided in the Draft EIS. See Appendix C, Table C.3.1-1. DOE has described the types of grout used to fill the tanks and provided reference to the research and development methods and results. See Appendix A, Section A.4.3. The potential for release of contaminants from closed tanks to the soil is described in the Draft EIS. Section Chapter 4, Section 4.2.1.

Comments Related to Evaluations and Analyses: Eleven comments suggested evaluations to be used or concerns about analyses. Comments included the following:

- DOE should remove one tank to see what the ground is like underneath.

DOE Response: The cost and risk to workers to remove one tank would make the suggested procedure difficult to perform. As part of the overall closure process conditions around and under the tanks would be assessed using monitoring and sampling data, and the results used as part of the closure module modeling.

- DOE should use an evaluation technique cited in a 1995 article from the Harvard School of Public Health.

DOE Response: This approach applies to setting priorities, not deciding on a particular action and, therefore, does not apply. For example, even if the evaluation recommended by this comment showed that more lives would be saved by funding public health and safety instead of closing the tanks, DOE could not do so.

- The interaction of all contamination from the tanks with all other sources at the SRS should be considered.

DOE Response: The Closure Plan requires that the process of establishing performance requirements for closure modules for individual tanks explicitly examine the sources of contamination that could interact with residual waste in the tank.

- The effects of contamination as they impact subsistence sportsmen should be included.

DOE Response: In the Draft EIS, DOE has estimated the potential health effects to a hypothetical maximally exposed individual, who drinks water, eats food (including fish), and breathes air exposed to SRS releases. In addition, the SRS Annual Environmental Monitoring report estimates the exposure of a recreational sportsman resulting from SRS releases via all pathways.

- Intergenerational concerns and long-term hazards to local ecosystems should be discussed.

DOE Response: DOE calculates adverse health effects to workers and the general public in terms of an estimated number of total fatal cancers. The calculated numbers of excess cancers reported in the Draft EIS are less than one for all alternatives. The risk of genetic effects is smaller than the latent cancer risk (on a per person-rem basis); therefore DOE does not expect any cross-generational effects from implementation of any of the alternatives.

In the Draft EIS DOE has addressed the issue of the potential for long-term hazards to ecosystems. See Chapter 4, section 4.2.3.

- Analyses should use using the data obtained from the closure of Tanks 17 and 20, including (1) data from emptying and cleaning work; (2) analyses of residual waste (predictions from process records and actual measurements); (3) worker dosimetry; (4) regulatory and legal issues; and (5) costs.

- Dosimetric records of workers performing closure of Tanks 17 and 20 must be included in the EIS, and contrasted with the EA-1164 estimates for worker exposure.

DOE Response: One of the primary purposes of the EIS is to incorporate lessons learned from closure of tanks 17 and 20 into actions for closure of the remainder of the tanks. DOE has used (1) data from emptying and cleaning work; (2) analyses of residual waste (predictions from process records and actual measurements); (3) worker dosimetry; and (4) cost. DOE has made the dosimetric comparisons and contrasts for workers to the extent possible given the availability of the required information.

- DOE cannot rely on the current groundwater transport modeling (MEPAS) to support the EIS conclusions.

DOE Response: DOE does not find the MEPAS model inadequate for representing contaminant fate and transport. The South Carolina Department of Health and Environmental Control and the Environmental Protection Agency – Region IV have concurred with DOE's use of the MEPAS code for fate and transport modeling.

- New data from recent measurements at the Nevada Test Site have shown that more rapid groundwater transport of actinides can occur via the mechanism of actinide binding with colloids, should be used in the EIS analysis.

DOE Response: DOE has reviewed the Nevada data. DOE finds that the data represent phenomena specific to conditions at the Nevada Test Site. The modeling for this Draft EIS represents site specific conditions wherever possible.

- Horizontal groundwater flow and tank failure due to this horizontal flow must be modeled.

DOE Response: DOE has performed the necessary calculations to account for the differences in groundwater flows. The results are represented in the fate and transport modeling in the Draft EIS. See Appendix C.

Comments Related to Criteria and Regulations: Six comments dealt with concerns about criteria used or regulatory compliance. Comments included the following:

- The EIS should clearly define the criteria for assessing technical and economic feasibility, solicit public comment on the criteria, and then should use the criteria in assessing alternatives.

DOE Response: The criteria for assessing technical and economic feasibility are given in the "waste incidental to reprocessing" process in DOE Order 435.1. Public input to this Order was solicited when this Order went through the standards review / development process which all DOE Orders must have.

- Ensure that the EIS data and conclusions feed into the CERCLA process to save time and costs.

DOE Response: DOE will ensure that the EIS data gathering and analysis supports the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) process for the ultimate closure of the Tank Farms. See Chapter 7, Section 7.3.2.

- DOE should include in the EIS a full discussion of applicable requirements of the Resource Conservation and Recovery Act, Comprehensive Emergency Response, compensation, and Liability Act, and the Nuclear Regulatory Commission (NRC) criteria.

DOE Response: The Draft EIS has a full discussion of applicable laws and regulations in Chapter 7.

- The choice of the seepline as the point-of-compliance for evaluation provides a highly misleading measure of the significant environmental contamination resulting from tank closure.

DOE Response: In addition to the point of compliance information, the Draft EIS presents estimated groundwater contamination at distances of 1 meter and 100 meters from the tank farm. See Section 4.2.

- Activities that result in residual High-Level Waste cannot be conducted with the approval of the SCDHEC if the NRC does not classify residual waste as "incidental."

- This reclassification of the residual High-Level Waste as "incidental" violates the 1982 NWPA and, accepting arguendo its legitimacy, is inconsistent with the narrow scope of the exemption for incidental waste.

DOE Response: The Draft EIS discusses the bases for determining that residual waste remaining after tank cleaning is "waste incidental to reprocessing."

Comments Related to Schedule and Process: Two comments dealt with schedule or EIS process. Comments include the following:

- Sweeping the SRS tank closure into a national program has or will slow down the process of closing the tanks at SRS.

- The EIS should be cancelled unless there are significant worker safety, public health and environmental protection issues that need to be addressed. But if the EIS proceeds, it should be done in a minimum amount of time with a minimum expenditure of funds.

DOE Response: Preparing an EIS at this time will not slow down the tank closure process. SRS is committed to closing additional tanks in 2003 in accordance with the Federal Facility Agreement. Bulk waste removal will proceed as scheduled while the EIS is being prepared. DOE will continue the EIS process. While DOE knows of no new issues, the EIS process involves a more thorough look at worker and public safety and health issues, and environmental protection issues, than was accomplished with the 1996 environmental assessment. DOE will devote the amount of funds and time necessary to complete the EIS.

Comments Covering Miscellaneous Topics: Four comments dealt with a variety of topics that do not fit in any of the areas given above. Comments include the following:

- Tanks that are being considered for closure are the same tanks that have been reported to have leaked in the past.

DOE Response: Some of the high-level waste tanks at SRS have leaked in the past. The HLW tanks are of four different designs (identified as Type I, II, III, or IV), all constructed of carbon-steel inside reinforced concrete containment vaults. The major design features and dimensions of each tank design are shown in Figure 1-5.

There are 12 Type I tanks (4 in H-Area and 8 in F-Area) that were built in 1952 and 1953. These tanks have partial-height secondary containment and active cooling. The tank tops are 9.5 feet below grade, and the bottoms of Tanks 1 through 8 in F-Area are above the seasonal high water table. The bottoms of Tanks 9 through 12 in H-Area are in the water table. Tanks 1 and 9 through 12 are known to have leak sites where waste has leaked from the primary to the secondary containment. There is no evidence that the waste has leaked from the secondary containment.

Four Type II tanks, Tanks 13 through 16, were built in 1956 in H-Area. These tanks have partial-height secondary containment and active cooling. These tanks are above the water table. All four tanks have known leak sites where waste has leaked from the primary to the secondary containment. In Tank 16, waste overflowed the annulus pan (secondary containment) and migrated into the surrounding soil. Waste removal from the Tank 16 primary vessel was completed in 1980, but waste that leaked into the annulus has not been removed.

Eight Type IV tanks, Tanks 17 through 24, were built between 1958 and 1962. These tanks have single steel walls and do not have active cooling. Tanks 17 through 20 in the F-Area Tank Farm are slightly above the water table. Tanks 19 and 20 have known cracks that are believed to have been caused by groundwater corrosion of the tank walls in the past. Small amounts of groundwater have leaked into these tanks, but there is no evidence that waste ever leaked out. Tanks 17 and 20 have been closed in the manner

described in the Clean and Fill with Grout Option of the Clean and Stabilize Tanks Alternative evaluated in the EIS. Tanks 21 through 24 in the H-Area Tank Farm are above the groundwater table, but are in a perched water table, caused by the original construction of the tank area.

The newest design, Type III tanks, have a full-height secondary tank and active cooling. These 27 tanks were placed in service between 1969 and 1986, with 10 in the F-Area and 17 in the H-Area Tank Farms. All Type III tanks are above the water table.

- There is a problem in getting the solidified material from the bottom of the tanks.

DOE Response: The Draft EIS discusses the difficulty of removing sludge from the bottom of the tanks, and it describes and evaluates the options for removing such materials and stabilizing the residue that remains after cleaning.

- New SRS missions will add to the amount of high-level waste and prolong the closure.

DOE Response: DOE has recently selected SRS as the site for several new missions. The Pit Disassembly and Conversion Facility, Mixed Oxide Fuel Facility, Immobilization Facility, and the Tritium Extraction Facility will not add HLW to the current SRS inventory. Stabilizing plutonium residues from the Rocky Flats Environmental Technology Site at SRS is expected to result in the equivalent of five DWPF canisters. The melt and dilute facility for management of spent nuclear fuel would add the equivalent of 17 DWPF canisters. These canisters are in addition to the approximately 6,000 canisters DOE expects to produce absent the new missions.

- It is not reasonable for the EIS to assume that groundwater remediation could compensate for radionuclide release to the environment.

DOE Response: DOE has not assumed in the Draft EIS that groundwater remediation could compensate for long-term releases of contamination to the groundwater after tank closure. The *Industrial Waste Water Closure Plan for F- and H-Area High-Level Waste Tank Systems* also does not make this assumption.

LIST OF PREPARERS

This section lists the individuals who contributed to the technical content of this environmental impact statement (EIS). The preparation of the EIS was directed by J. N. Knox and L. T. Ling of the U.S. Department of Energy (DOE) and P. L. Young of Tetra Tech NUS, Inc.

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NAME:	**PAT BURKE**
AFFILIATION:	U. S. Department of Energy
EDUCATION:	B.S., Civil Engineering, 1980
TECHNICAL EXPERIENCE:	Five years reviewing NEPA documents; 15 years in civil engineering and 5 years in utility management.
EIS RESPONSIBILITY:	Reviewed Chapters 3 and 6.

NAME:	**STEVE CONNOR**
AFFILIATION:	Tetra Tech NUS, Inc.
EDUCATION:	M.S. Physics, 1974 B.S., Physics, 1973
TECHNICAL EXPERIENCE:	Twenty-three years experience in environmental management systems, radiological effluent monitoring, analytical laboratory quality assurance, gamma spectrometry, radiological transportation risk assessments, environmental transport, dose assessments, human health risk assessments, and NEPA document preparation.
EIS RESPONSIBILITY:	Deputy Project Manager; prepared Appendix A.

NAME:	**WILLIAM J. CRAIG**
AFFILIATION:	Tetra Tech NUS, Inc.
EDUCATION:	M.S., Planning, 1977 B.S., Forestry, 1972
TECHNICAL EXPERIENCE:	Twenty years experience in utility fuel planning, and nuclear powerplant siting.
EIS RESPONSIBILITY:	Prepared Socioeconomics and Land Use sections of Chapters 3 and 4.

NAME:	**KENT T. CUBBAGE**
AFFILIATION:	Tetra Tech NUS, Inc.
EDUCATION:	M.S., Ecotoxicology, 1993 B.S., Biology, 1991
TECHNICAL EXPERIENCE:	Five years experience as an ecotoxicologist.
EIS RESPONSIBILITY:	Prepared Long-Term Ecological Resources sections of Chapter 4 and Appendix C.

NAME:	**PHILIP C. FULMER, CHP**
AFFILIATION:	Tetra Tech NUS, Inc.
EDUCATION:	Ph.D., Nuclear Engineering, 1993 M.S., Health Physics, 1990 B.S., Health Physics, 1989
TECHNICAL EXPERIENCE:	Ten years experience in radiation protection, internal radiation dosimetry, and external radiation dosimetry.
EIS RESPONSIBILITY:	Prepared Long-Term Human Health sections of Chapter 4 and prepared Appendix C.

NAME:	**ANDREW R. GRAINGER**
AFFILIATION:	U. S. Department of Energy
EDUCATION:	M.S., Wildlife Ecology, 1978 B.S., Natural Resources, 1975
TECHNICAL EXPERIENCE:	Twelve years preparing NEPA documents; 18 years in terrestrial ecology, facility siting, wetlands ecology, endangered species management.
EIS RESPONSIBILITY:	NEPA Compliance Officer; NEPA Specialist for the EIS; DOE-SR reviewer for Draft EIS; contributed to Chapters 1, 2, and 3; prepared the Summary and Appendix D.

NAME:	**GARY L. GUNTER**
AFFILIATION:	Tetra Tech NUS, Inc.
EDUCATION:	B.S., Geology, 1984
TECHNICAL EXPERIENCE:	Ten years experience in geology and hydrogeology projects specializing in groundwater assessment and remediation.
EIS RESPONSIBILITY:	Prepared Geologic Resources sections of Chapters 3 and 4; prepared Short-Term Groundwater Resources sections of Chapter 4.

NAME:	**KATHRYN B. HAUER**
AFFILIATION:	Tetra Tech NUS, Inc.
EDUCATION:	M.A., English, 1985 B.A., English, 1983
TECHNICAL EXPERIENCE:	Eleven years experience in technical writing, editing, and teaching in both government and business disciplines.
EIS RESPONSIBILITY:	Technical Editor.

NAME:	**BRENDA HAYS**
AFFILIATION:	U. S. Department of Energy
EDUCATION:	J.D., 1986
TECHNICAL EXPERIENCE:	Six years preparing NEPA documents; 11 years experience as attorney.
EIS RESPONSIBILITY:	Contributed to Chapter 7; reviewed Draft EIS.

NAME:	**ALLAN JENKINS**
AFFILIATION:	Tetra Tech NUS, Inc.
EDUCATION:	B.S., Geology, 1975 A.S., General Studies, 1972
TECHNICAL EXPERIENCE:	Seventeen years experience in engineering geology, hydrogeology, environmental investigations, and remediation of petroleum-contaminated soil and groundwater.
EIS RESPONSIBILITY:	Prepared Long-Term Groundwater Resources section of Chapter 4; contributed to Appendix C.

NAME:	**RONALD JERNIGAN**
AFFILIATION:	U. S. Department of Energy
EDUCATION:	B.S., Geography, 1973
TECHNICAL EXPERIENCE:	Fourteen years reviewing NEPA documents; 25 years in real estate management.
EIS RESPONSIBILITY:	Reviewed Chapters 3 and 6.

NAME:	**DOUGLAS E. KENNEMORE**
AFFILIATION:	Tetra Tech NUS, Inc.
EDUCATION:	M.S., Biology, 1995 B.S., Biology, 1991
TECHNICAL EXPERIENCE:	Seven years in botany and plant community investigations.
EIS RESPONSIBILITY:	Prepared Cultural Resources section of Chapter 3.

NAME:	**JOHN KNOX**
AFFILIATION:	U. S. Department of Energy
EDUCATION:	M.S., Botany, 1974 B.S., Biology, 1972
TECHNICAL EXPERIENCE:	Four years preparing or reviewing NEPA documents; 24 years in environmental analysis and environmental management.
EIS RESPONSIBILITY:	Prepared Chapter 1; principal DOE reviewer of Draft EIS; contributed to Chapter 3.

NAME:	**LARRY T. LING**
AFFILIATION:	U. S. Department of Energy
EDUCATION:	B.S., Chemical Engineering, 1982
TECHNICAL EXPERIENCE:	Three years preparing or reviewing NEPA documents; over 17 years experience in nuclear facilities and systems.
EIS RESPONSIBILITY:	Document Manager; DOE reviewer of Draft EIS; contributed to Chapters 1, 2, and 6, and Appendix A.

NAME:	**LISA A. MATIS**
AFFILIATION:	Tetra Tech NUS, Inc.
EDUCATION:	M.S., Mechanical Engineering, 1989 B.S., Chemical Engineering, 1984
TECHNICAL EXPERIENCE:	Fourteen years experience in chemical-environmental engineering.
EIS RESPONSIBILITY:	Prepared Waste and Materials sections of Chapters 3 and 4; prepared Utilities and Energy section of Chapter 4; prepared Chapter 7.

NAME:	**PHILIP R. MOORE**
AFFILIATION:	Tetra Tech NUS, Inc.
EDUCATION:	M.S., Wildlife and Fisheries Biology, 1983 B.A., English, 1975
TECHNICAL EXPERIENCE:	Seventeen years experience as fishery biologist and aquatic ecologist.
EIS RESPONSIBILITY:	Prepared Surface Water and Ecological sections of Chapters 3 and 4.

NAME:	**APARAJITA S. MORRISON**
AFFILIATION:	Tetra Tech NUS, Inc.
EDUCATION:	B.S., Health Physics, 1985
TECHNICAL EXPERIENCE:	Eleven years experience in environmental and occupational radiological programs including management of an environmental monitoring laboratory, startup testing of nuclear instrumentation, training, and technical assessments of environmental and radiation protection programs.
EIS RESPONSIBILITY:	Prepared Health and Safety sections of Chapters 3 and 4; prepared Chapter 5.

NAME:	**JAMES L. OLIVER**
AFFILIATION:	Tetra Tech NUS, Inc.
EDUCATION:	B.S., Biology (Fisheries), 1971
TECHNICAL EXPERIENCE:	Twenty-three years experience in research and impact assessment projects for the U.S. Department of Interior and DOE. Reviews environmental and natural resource management issues and performs strategic planning for National Environmental Policy Act documentation for DOE.
EIS RESPONSIBILITY:	Prepared Chapter 6. Management Reviewer.

NAME:	**JOSEPH W. RIVERS**
AFFILIATION:	Jason Associates Corporation
EDUCATION:	B.S., Mechanical Engineering, 1982
TECHNICAL EXPERIENCE:	Three years experience in preparing NEPA documents; 16 years in commercial and DOE nuclear projects; design, systems engineering, safety and accident analysis, and regulatory compliance.
EIS RESPONSIBILITY:	Prepared Accident Analysis section of Chapter 4; prepared Appendix B.

NAME:	**DIANE S. SINKOWSKI**
AFFILIATION:	Tetra Tech NUS, Inc.
EDUCATION:	M.E., Nuclear Engineering, 1994 B.S., Nuclear Engineering Sciences, 1990
TECHNICAL EXPERIENCE:	Six years in air permitting, fate and transport modeling, human health impacts, environmental compliance, and health physics.
EIS RESPONSIBILITY:	Prepared Air Resources sections of Chapters 3 and 4; contributed to Appendix C.

NAME:	**THOMAS TEMPLES**
AFFILIATION:	U. S. Department of Energy
EDUCATION:	Ph.D., Geology, 1996 M.S, Geology, 1978 B.S., Geology, 1976
TECHNICAL EXPERIENCE:	Four years preparing NEPA documents; 18 years as a geophysicist.
EIS RESPONSIBILITY:	Contributed to Chapter 3.

NAME:	**ALAN L. TOBLIN**
AFFILIATION:	Tetra Tech NUS, Inc.
EDUCATION:	M.S., Chemical Engineering, 1970 B.E., Chemical Engineering, 1968
TECHNICAL EXPERIENCE:	Twenty-three years experience in analyzing radiological and chemical contaminant transport in water resources.
EIS RESPONSIBILITY:	Contributed to Appendix C.

NAME:	**PHILIP L. YOUNG, CHP**
AFFILIATION:	Tetra Tech NUS, Inc.
EDUCATION:	M.S., Health Physics, 1989 B.S., Radiation Health (Health Physics), 1988
TECHNICAL EXPERIENCE:	Ten years experience in environmental health physics and environmental impact assessment, with emphasis on radiological effluent monitoring, environmental surveillance, environmental dosimetry, radiological risk assessment, and radioactive waste management.
EIS RESPONSIBILITY:	Project Manager; technical reviewer; contributed to Appendix C.

NEPA DISCLOSURE STATEMENT FOR PREPARATION OF THE ENVIRONMENTAL IMPACT STATEMENT FOR CLOSURE OF HIGH-LEVEL WASTE TANKS AT THE SAVANNAH RIVER SITE, SOUTH CAROLINA

CEQ Regulations at 40 CFR 1506.5c, which have been adopted by the DOE (10 CFR 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 purposes of this disclosure is defined in the March 23, 1981, guidance "Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations," 46 FR 18026-18038 at Question 17a and b.

"Financial or other interest in the outcome of the project" includes "any financial benefit such as a promise of future construction or design work in the project, as well as indirect benefits the contractor is aware of (e.g., if the project would aid proposals sponsored by the firm's other clients)." See 46 FR 18026-18031.

In accordance with these requirements, the offeror and the proposed subcontractors hereby certify as follows: (check either (a) or (b) and list financial or other interest if (b) is checked).

(a) ☑ Contractor has no financial or other interest in the outcome of the project.

(b) ☐ Offeror and any proposed subcontractor have the following financial or other interest in the outcome of the project and hereby agree to divest themselves of such interest prior to award of this contract.

Financial or Other Interest

1.

2.

3.

Certified by:

[signature]
Signature

Daniel M. Evans
Name (Printed)

General Manager
Title

Tetra Tech NUS, Inc.
Company

June 10, 1999
Date

DISTRIBUTION LIST

DOE provided copies of the *Savannah River Site, High-Level Waste Tank Closure Draft Environmental Impact Statement* EIS to Federal, state, and local elected and appointed officials and agencies of government; Native American groups; Federal, state, and local environmental and public interest groups; and other organizations and individuals listed below. Copies will be provided to other interested parties upon request as identified in the cover sheet of this EIS.

CONTENT

A. UNITED STATES CONGRESS

A.1 SENATORS FROM AFFECTED AND ADJOINING STATES

The Honorable Max Cleland
United States Senate

The Honorable Zell Miller
United States Senate

The Honorable Ernest F. Hollings
United States Senate

The Honorable Strom Thurmond
United States Senate

A.2 UNITED STATES SENATE COMMITTEES

The Honorable Mary Landrieu
Ranking Minority Member
Subcommittee on Strategic Forces
Committee on Armed Services

The Honorable Robert C. Byrd
Ranking Minority Member
Committee on Appropriations

The Honorable Pete V. Domenici
Chairman
Subcommittee on Energy and Water Development
Committee on Appropriations

The Honorable Carl Levin
Ranking Minority Member
Committee on Armed Services

The Honorable Harry Reid
Ranking Minority Member
Subcommittee on Energy and Water Development
Committee on Appropriations

The Honorable Robert Smith
Chairman
Subcommittee on Strategic Forces
Committee on Armed Services

The Honorable Ted Stevens
Chairman
Committee on Appropriations

The Honorable John Warner
Chairman
Committee on Armed Services

A.3 UNITED STATES HOUSE OF REPRESENTATIVES FROM AFFECTED AND ADJOINING STATES

The Honorable James E. Clyburn
U.S. House of Representatives

The Honorable Nathan Deal
U.S. House of Representatives

The Honorable Lindsey Graham
U.S. House of Representatives

The Honorable Jack Kingston
U.S. House of Representatives

The Honorable Cynthia McKinney
U.S. House of Representatives

The Honorable Charlie Norwood
U.S. House of Representatives

The Honorable Mark Sanford
U.S. House of Representatives

The Honorable Floyd Spence
U.S. House of Representatives

The Honorable John M. Spratt, Jr.
U.S. House of Representatives

A.4 UNITED STATES HOUSE OF REPRESENTATIVES COMMITTEES

The Honorable Peter Visclosky
Ranking Minority Member
Subcommittee on Energy and Water Development
Committee on Appropriations

The Honorable Duncan L. Hunter
Chairman
Subcommittee on Military Procurement
Committee on National Security

The Honorable C. W. Bill Young
Chairman
Committee on Appropriations

The Honorable Ron Packard
Chairman
Subcommittee on Energy and Water Development
Committee on Appropriations

The Honorable David Obey
Ranking Minority Member
Committee on Appropriations
U.S. House of Representatives

The Honorable Norman Sisisky
Ranking Minority Member
Subcommittee on Military Procurement
Committee on National Security

The Honorable Ike Skelton
Ranking Minority Member
Committee on National Security

The Honorable Floyd Spence
Chairman
Committee on National Security

B. FEDERAL AGENCIES

Mr. Roger L. Banks
U.S. Fish and Wildlife Service

Mr. John Bellinger
NEPA Coordinator
Office of Environmental Policy
U.S. Army Corps of Engineers

Major General R. M. Bunker
Division Engineer, South Atlantic Division
U.S. Army Corps of Engineers

Mr. Bill Champion
West Valley Nuclear Services
U.S. Department of Energy

Mr. Douglas H. Chapin
Richland Operations Office
U.S. Department of Energy

Mr. Ken Clark
Region II Public Affairs Officer
U.S. Nuclear Regulatory Commission

Commander, Savannah District
Attn: Planning Division
U.S. Army Corps of Engineers

Mr. Brian Costner
Senior Policy Advisor
Office of the Secretary of Energy

Ms. Marjorie S. Davenport
District Chief
Water Resources Division
U.S. Geological Survey
U.S. Department of Interior

Mr. Paul F. X. Dunigan, Jr.
Richland Operations Office
U.S. Department of Energy

Mr. Robert Fairweather
Chief, Environmental Branch
Office of Management and Budget

Dr. Haus Mark
Assistant Secretary for Nuclear, Chemical and Biological Defense Programs

Mr. Joseph R. Franzmathes
Assistant Regional Administrator, Office of Policy and Management
U.S. Environmental Protection Agency, Region IV

Mr. Don Fontozzi
U.S. Department of State

Mr. Mark Frei (EM-40)
Office of the Deputy Assistant Secretary for Project Completion

Mr. Kenneth W. Holt
Centers for Disease Control and Prevention
National Center for Environmental Health
U.S. Department of Health and Human Services

Mr. Dave Huizenga (EM-20)
Office of Deputy Assistant Secretary for Integration and Disposition
U.S. Department of Energy

Mr. Michael Jansky
WM Hanford
U.S. Department of Energy

Mr. Don L. Klima
Director, Office of Planning & Review
Advisory Council on Historic Prevention

Mr. Andreas Mager, Jr.
Habitat Conservation Division
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
U.S. Department of Commerce

Mr. Jim Melillo
Executive Director
Environmental Management Advisory Board
U.S. Department of Energy

Mr. Heinz Mueller
Office of Environmental Policy & Compliance
U.S. Environmental Protection Agency

Mr. Charles Oravetz
Chief
Protected Species Management Branch
Southeast Regional Office
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
U.S. Department of Commerce

Ms. Cynthia Carpenter
Director
Nuclear Material Safety Safeguards
U.S. Nuclear Regulatory Commission

Mr. Bob Peralta
Chief Council
Argonne National Laboratory
U.S. Department of Energy Laboratory

Mr. Jon Richards
Region IV
U.S. Environmental Protection Agency

Dr. Libby Stull
Argonne National Laboratory
U.S. Department of Energy Laboratory

Mr. Willie R. Taylor
Director
Office of Environmental Policy & Compliance
U.S. Department of Interior

Mr. Andrew Thibadeau
Information Officer
Defense Nuclear Facilities Safety Board

Mr. Greer C. Tidwell
Administrator, US EPA-IV

Mr. Barry Zalcman
Office of Nuclear Reactor Regulation
Nuclear Regulatory Commission

C. STATE OF SOUTH CAROLINA

C.1 STATEWIDE OFFICES AND LEGISLATURE

The Honorable Jim Hodges
Governor of South Carolina

The Honorable Bob Peeler
Lieutenant Governor of South Carolina

The Honorable Charles Condon
Attorney General

The Honorable James E. Smith, Jr.
South Carolina House of Representatives

Ms. Omeaga Burgess
Office of the State Budget

C.2 STATE AND LOCAL AGENCIES AND OFFICIALS

The Honorable Jackie Holman
Mayor of Blackville

Coordinator
Aiken County Civil Defense
Aiken County Emergency Services
Attn: Freddie M. Bell

Mr. Russell Berry
South Carolina Department of Health and Environmental Control

Mr. Frank Brafman
Hilton Head Town Council

Mr. Donnie Cason
South Carolina Department of Highways and Public Transportation

Mr. Keith Collinsworth
Federal Facility Liaison
Environmental Quality Control
South Carolina Department of Health and Environmental Control

Mr. Phil England
Director
Aiken County Planning & Development Department

Mr. G. Kendall Taylor
Division of Hydrogeology
Bureau of Land and Hazardous Waste Management
South Carolina Department of Health and Environmental Control

Mr. David Wilson
Division of Hydrogeology
Bureau of Land and Hazardous Waste Management
South Carolina Department of Health and Environmental Control

D. STATE OF GEORGIA

D.1 STATEWIDE OFFICES AND LEGISLATURE

The Honorable Roy Barnes
Governor of Georgia

The Honorable Mark Taylor
Lieutenant Governor of Georgia

The Honorable Charles W. Walker
Georgia Senate

The Honorable Thurbert Baker
Attorney General

The Honorable Ben L. Harbin
Georgia House of Representatives

E. NATURAL RESOURCE TRUSTEES, SAVANNAH RIVER SITE

Mr. Douglas E. Bryant
Commissioner, SCDHEC
Natural Resource Trustee

Mr. A. B. Gould
Director
Natural Resource Trustee
DOE-SR Environmental Quality Management

Mr. Clarence Ham
SRS Natural Resource Trustee
US Army Corps of Engineers
Charleston District
Department of the Army

Mr. David Holroyd
SRS Natural Resource Trustee
US Environmental Protection Agency Region IV

Mr. Ronald W. Kinney
SRS Natural Resource Trustee
SCDHEC Waste Assessment and Emergency Response

Ms. Denise Klimas
SRS Natural Resource Trustee
National Oceanic and Atmospheric Administration
US EPA Waste Division

Mr. James H. Lee
Regional Environmental Officer
SRS Natural Resource Trustee
US Department of the Interior

Mr. Douglas L. Novak
SRS Natural Resource Trustee
South Carolina Office of the Governor

Mr. James Setser
Chief, Program Coordinator Branch
SRS Natural Resource Trustee
Department of Natural Resources

Dr. Paul A. Sandifer
Director
SC Department of Natural Resources
SRS Natural Resource Trustee

F. NATIVE AMERICAN GROUPS

The Honorable Gilbert Blue
Chairman
Catawba Indian Nation

The Honorable Bill Fife
Principal Chief
Muscogee (Creek) Nation

G. ENVIRONMENTAL AND PUBLIC INTEREST GROUPS

Mr. Joel Yudiken
Economist
Department of Public Policy
AFL-CIO

Ms. Susan Gordon
Program Director
Alliance for Nuclear Accountability

Ms. Kethy Crandell
Alliance for Nuclear Accountability

Ms. Karen Patterson
SRS Citizens Advisory Board

Mr. Alan Kuperman
Brookings Institute

Dr. Arjun Makhijani
President
Institute for Energy and Environmental Research

Dr. Mildred McClain
Citizens for Environmental Justice, Inc.

Mr. Paul Schwartz
National Campaigns Director
Clean Water Action

Mr. Gawain Kripke
Director Economics Program
Friends of the Earth

Mr. Tom Clements
Executive Director
Nuclear Control Institute

Mr. Damon Moglen
Greenpeace
Washington, D.C.

Dr. David Bradley
National Community Action Foundation

Mr. Robert Holden
Executive Director
National Congress of American Indians

Mr. Alex Echols
Deputy Director
National Fish and Wildlife Foundation

Ms. Betsy Merritt
Associate General Counsel
Department of Law & Public Policy
National Trust for Historic Preservation

Mr. Thomas F. Donnelly
Executive Vice President
National Water Resources Association

Mr. Steven Shimberg
Vice-President
National Wildlife Foundation

Dr. Thomas B. Cochran
Director, Nuclear Programs
Natural Resources Defense Council

Dr. Ed Lyman
Scientific Director
Nuclear Control Institute

Mr. Robert Musil, Ph.D.
Director of Security Programs
Physicians for Social Responsibility

Ms. Joy Oakes
Regional Staff Director
Appalachian Office
The Sierra Club

Mr. David Becker
The Sierra Club

Mr. Alden Meyer
Director of Arms Control Project
Union of Concerned Scientists

Ms. Diane Jackson
Administrative Assistant
Ecology and Economics Research Department
The Wilderness Society

H. OTHER GROUPS AND INDIVIDUALS

Mr. Peter Allan

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SAIC

Mr. Tom Anderson
Battelle

Ms. Jila Banaee
Lockheed-Martin Idaho Technologies Company

Mr. Sy Baron
MUSC

Ms. Sonya Barnette

Mr. James R. Barrett
B&W Services, Inc.

Colonel Mary Barton

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Mr. Sam Booher

Mr. Edmund D. Boothe
Aiken Technical College

R. P. Borsody

Mr. Carlos W. Bowen

Ms. Sara Jo Braid

Mr. Dannion Brinkley
Mr. Bill Brizes

Ms. Elizabeth R. Brown
Charleston Deanery
South Carolina Council of Catholic Women

Mr. Ethan Brown

Mr. Ken Bulmahn

Ms. Donna Campbell
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Mr. Fred Campbell

Mr. Rich Campbell
Chem-Nuclear Systems

Mr. Roy Carter

Mr. George R. Caskey

Dr. Kailash Chandra

Mr. Ernie Chaput

Ms. Rebecca Charles
Tennessee Department of Environment and Conservation

Mr. Vladimir Y. Chechik
Shaw, Pitman, Potts, & Trowbridge

Mr. Carl E. Cliche

Mr. Leonard Collard

Ms. Marlena Conde
Edlow International Company

Mr. Steve Connor

Mr. John Cook

Mr. S. W. Corbett

Mr. Stephen Crump

Dr. Tim Devol
Clemson University
Environmental Systems Engineering Department

Mr. Sal Dimaria

Mr. John Dimarzio

Mr. John F. Doherty, J.D.

Mr. Dave Ecklund

Mr. Richard Engelmann
Waste Management Hanford

Ms. Lynne Fairobent

Ms. Rita Fellers
Department of Geography
University of North Carolina at Chapel Hill

Mr. Leverne P. Fernandez

Mr. Ken Fitch

Ms. Bonnie Fogdall
SAIC

Professor H. Paul Friesema
Institute for Policy and Research
Northwestern University

Mrs. Nadia Friloux
COGIMA Inc.

Mr. Richard Fry
Director, Division of Radiation Protection

Mr. Melvyn P. Galin

Mr. Ben Gannon

Mr. John Geddie

Colonel George A. Gibson
Mr. Robert Godfrey
Counselor (Nuclear)
Embassy of Australia

Mr. Anthony P. Gouge

Dr. Randall Guensler
School of Civil & Environmental Engineering
Georgia Institute of Technology

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Mr. Brandon Haddock
Augusta Chronicle

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Mr. David Haines

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Ms. Shelley Hawkins
Jacobs Engineering Group, Inc.

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Laborers Local 1137
AFL-CIO

Mr. C. C. Holcomb

Mr. Tom Houston

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Mr. Leonard Huesties

Mr. Charles E. Irvin

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Mr. Keith Johnson

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Mr. Dan Kaplan

Mr. Roy Karimi

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Mr. Richard Kimmel

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Waste Management Services

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Dynamic Corporation

Miss Cynthia E. Lake

Mr. Dewey E. Large
Molten Metal Technology Inc. of TN

Mr. Bill Lawless

Mr. David Lechel

Mr. Thomas L. Lippert

Dr. William A. Lochstet
University of Pittsburgh at Johnstown Physics

Mr. Alastair J. MacDonald
UKAEA

Mr. Robert Maher

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ES&H Program Control Manager
Argonne Medical Laboratory-West

Mr. Joseph A. Martillotti
Texas Department of Health
Bureau of Radiation Control

Mr. Bob Matthews

Ms. Elizabeth McBride

Ms. Trish McCracken

Dr. William R. McDonell

Mr. Michael F. McGowan
Geological Environmental Consultant

Ms. Dana McIntyre
WJBF-TV
Channel 6

Mr. Frank Metz

Ms. Louise M. Montgomery

Mr. Emment Moore
Washington State University

Mr. Kenneth J. Newcomer

Ms. Kim Newell
Public Information Director
SCDHEC

Mr. R. I. Newman

Mr. Matthew J. O'Connor
Mr. James L. Oliver

Mr. J. F. Ortaldo

Mr. Robert F. Overman

Mr. Aris Papadopoulous

Ms. Jean Pasquale

Dr. Ruth Patrick
Division of Limnology and Ecology
Academy of Natural Sciences of Philadelphia

Mr. Mark A. Petermann
Hydrogeologist
RMT, Inc.

Mr. Jeff Petraglia

Mr. George Piper

Mr. David Pittman

Mr. W. Lee Poe

Mr. Ron Pound
Environmental Projects
Newsletter

Mr. Richard H. Powell

Ms. Essie M. Richards
Carver Heights Community Org.

Ms. Dorene L. Richardson

Mr. Wayne Rickman
Sonalysts, Inc.

Mr. F. A. Riemann

Mr. Jacob Charles Robertson

Mr. Paul Robinson
Southwest Research & Information Center

Ms. Linda Rodgers

Ms. Connie Rogers

Mr. Edward Scalsky

Mr. Glenn R. Schlafer

Mr. Guy R. Selph

Dr. R. F. Shangraw, Jr.
Project Performance Corporation

Ms. Margaret Shekell
Ultra Systems Environmental

Mr. John O. Shipman

Ms. Kimberly Sizemore

Mr. Jim Skinner

Mr. Donald J. Skinner

Mr. Arthur H. Smith, Jr.

Mr. Don Solki
Carpenter's Local 283

Mr. Paul Stansbury
PNL

Mr. Jim Steinke
Newport News Shipbuilding Co.
Mr. Ed Stevens

Mr. Bill Stokes
Advanced Nuclear and Medical Systems

The Reverend Thomas A. Summers

Mr. Arthur Sutherland
Rogers & Associates Engineering Corporation

Ms. Lucy Swartz

Mr. Edward S. Syrjala

Dr. D. William Tedder
Associate Professor
School of Chemical Engineering
Georgia Institute of Technology

Mr. James W. Terry
Oak Ridge National Laboratory

Mr. Vincent Van Brunt
University of South Carolina
Chemical Engineering Department

Ms. Kathleen Gore
Exploration Resources

Mr. Alan Vaughan
Nuclear Fuel Services

Mr. Martin Vorum
Commodore Advanced Sciences, Inc.

Ms. Melissa Vrana
Project Performance Corporation

Mr. Jim Wanzeck

Mr. Payton H. Ward, Jr.
Ironworkers Local Union #709

Mr. Edgar West
Ironworkers Local Union #709

Mr. Frank S. Watters

Mr. Kim Welsch

Dr. F. Ward Whicker
Radiological Health Services
Colorado State University

Ms. Reba White
Teledyne Brown Engineering, Inc.

Ms. Pam Whitson
Oak Ridge Associated Universities

Mr. Patrick L. Whitworth

Mrs. Debbie Wilcox

Mr. Don J. Wilkes
Jacob Engineering Group

Mr. Jermetia L. Williams

Mr. Michael Witunski

Mr. Mel Woods

Dr. Abe Zeitoun
ATL

Mr. Francis P. Zera
The Georgia Guardian

I. READING ROOMS AND LIBRARIES

Freedom of Information Public Document Room
University of South Carolina at Aiken SC
Gregg-Graniteville Library
Aiken, SC

Freedom of Information Reading Room
U.S. Department of Energy
Washington, D.C.

Battelle-Pacific Northwest Laboratories
Attn: Technical Library
Richland, WA

Librarian
Chatham-Effingham-Liberty Regional Library
Savannah, GA

Librarian
Los Alamos Technical Association
Los Alamos, NM

Head, Document Department
The Libraries
Colorado State University
Fort Collins, CO

Librarian
Erskine College
McCain Library
Due West, SC

Parsons Brinckerhoff Library
Denver, CO

Public Reading Room
Chicago Operations Office
Argonne, IL

Mr. Michael Simpson
Library of Congress
Washington, D.C.

Ms. Judy Smith
Monographs Acquisition Services
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Idaho Falls, ID

GLOSSARY

Terms in this glossary are defined based on the context in which they are to be used in this EIS.

accident
: An unplanned sequence of events that results in undesirable consequences.

alpha-emitter
: A radioactive substance that decays by releasing an alpha particle.

alpha particle
: A positively charged particle consisting of two protons and two neutrons, that is emitted during radioactive decay from the nucleus of certain nuclides. It is the least penetrating of the three common types of radiation (alpha, beta, and gamma).

alpha waste
: Waste containing alpha-emitting transuranic radionuclides with activities between 10 and 100 nanocuries per gram.

alternative
: A major choice or strategy to address the EIS "Purpose and Need" statement, as opposed to the engineering options available to achieve the goal of an alternative.

annulus
: The space between the two walls of a double-wall tank.

applicable or relevant and appropriate requirements (ARARs)
: Requirements, including cleanup standards, standards of control, and other substantive environmental protection requirements and criteria for hazardous substances as specified under Federal and State law and regulations, that must be met when complying with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA).

aquifer
: A body of permeable rock, rock fragments, or soil through which groundwater moves.

as low as reasonably achievable (ALARA)
: A process by which a graded approach is applied to maintaining dose levels to workers and the public, and releases of radioactive materials to the environment at a rate that is as far below applicable limits as reasonably achievable.

atomic number
: The number of positively charged protons in the nucleus of an atom and the number of electrons on an electrically neutral atom.

background radiation
: Radiation from cosmic sources; naturally occurring radioactive materials, including radon (except as a decay product of source or special nuclear material), and global fallout as it exists in the environment from the testing of nuclear explosive devices.

backfill

Material such as soil or sand used in refilling an excavation.

basemat

The concrete and steel portion of the tank below the residual material and above the vadose zone.

beta-emitter

A radioactive substance that decays by releasing a beta particle.

beta particle

A charged particle emitted from a nucleus during radioactive decay, with a mass equal to 1/1837 that of a proton. A negatively charged beta particle is identical to an electron. A positively charged beta particle is called a positron.

beyond design basis accident (BDBA)

An accident with an annual frequency of occurring between 1 in 1,000,000 and 1 in 10,000,000 ($1.0\times^{-6}$ and 1.0×10^{-7}).

biodiversity

Pertains to the variety of life (e.g., plants, animals and other organisms) that inhabits a particular area or region.

blackwater stream

Water in coastal plains, creeks, swamp, and/or rivers that has been imparted a dark or black coloration due to dissolution of naturally occurring organic matter from soils and decaying vegetation.

borosilicate

A form of glass with silica sand, boric oxide, and soda ash.

borrow material

Material such as soil or sand that is removed from one location and used as fill material in another location.

bounding accident

A postulated accident that is defines to encompass the range of anticipated accidents and used to evaluate the consequences of accidents at facilities. The most conservative parameters (e.g., source terms, and meteorology) applied to a conservative accident resulting in a bounding accident analysis.

cancer

The name given to a group of diseases characterized by uncontrolled cellular growth.

canister

A container (generally stainless steel) into which immobilized radioactive waste is placed and sealed.

capable fault

In part, a capable fault is one that may have had movement at or near the ground surface at least once within the past 35,000 years, or has had recurring movement within the past 500,000 years. Further definition can be found in 10 CFR 100, Appendix A.

carcinogen
: A radionuclide or nonradiological chemical that has been proven or suspected to be either a promoter or initiator of cancer in humans or animals.

characterization
: The determination of waste composition and properties, whether by review of process knowledge, nondestructive examination or assay, or sampling and analysis, generally done for the purpose of determining appropriate storage, treatment, handling, transport, and disposal requirements.

chronic exposure
: The absorption of hazardous material (or intake of hazardous materials) over a long period of time (for example, over a lifetime).

Code of Federal Regulations (CFR)
: A document containing the regulations of Federal executive departments and agencies.

collective effective dose equivalent
: Sum of the effective dose equivalents for individuals composing a defined population. The units for this are person-rem or person-sievert.

committed dose equivalent
: Total dose equivalent accumulated in an organ or tissue in the 50 years following a single intake of radioactive materials into the body.

committed effective dose equivalent
: The sum of committed radiological dose equivalents to various tissues in the body, each multiplied by the appropriate weighing factor and expressed units of rem.

condensate
: Liquid that results from condensing a gas by cooling below its saturation temperature.

confining (unit)
: A rock layer (or stratum) having very low hydraulic conductivity (or permeability) that restricts the movement of groundwater either into or out of adjacent aquifers.

contaminant
: Any gaseous, chemical or organic material that contaminates (pollutes) air, soil, or water. This term also refers to any hazardous substance that does not occur naturally or that occurs at levels greater than those naturally occurring in the surrounding environment (background).

contamination
: The deposition of unwanted radioactive material on the surfaces of structures, areas, objects, or personnel.

critical
: A condition where in uranium, plutonium or tritium is capable of sustaining a nuclear chain reaction.

criticality
: State of being critical. Refers to a self-sustaining nuclear chain reaction in which there is an exact balance between the production of neutrons and the losses on neutrons in the absence of extraneous neutron sources.

curie (CI)
The basic unit used to describe the intensity of radioactivity in a sample of material. he curie is equal to 37 billion disintegrations per second, which is approximately the rate of decay of 1 gram of radium. A curie is also a quantity of any radionuclide that decays at a rate of 37 billion disintegrations per second.

decay, radioactive
The decrease in the amount of any radioactive material with the passage of time, due to the spontaneous emission from the atomic nuclei of either alpha or beta particles, often accompanied by gamma radiation (see half-life, radioactive).

decommissioning
The process of removing a facility from operation followed by decontamination, entombment, dismantlement, or conversion to another use.

decontamination
The actions taken to reduce or remove substances that pose a substantial present or potential hazard to human health or the environment, such as radioactive contamination from facilities, soil, or equipment by washing, chemical action, mechanical cleaning, or other techniques.

design basis accident (DBA)
For nuclear facilities, a postulated abnormal event that is used to establish the performance requirements of structures, systems, and components that are necessary to maintain them in a safe shutdown condition indefinitely or to prevent or mitigate the consequences so that the general public and operating staff are not exposed to radiation in excess of appropriate guideline values.

design basis earthquake
The maximum intensity earthquake that might occur along the nearest fault to a structure. Structures are built to withstand a design basis earthquake.

DOE Orders
Requirements internal to the U.S. Department of Energy (DOE) that establish DOE policy and procedures, including those for compliance with applicable laws.

dosage
The concentration-time profile for exposure to toxicological hazards.

dose (or radiation dose)
A generic term that means absorbed dose, dose equivalent, effective dose equivalent, committed dose equivalent, committed effective dose equivalent, or total effective dose equivalent, as defined elsewhere in this glossary.

dose equivalent
Product of the absorbed dose, the quality factor, and any other modifying factors. The dose equivalent is a quantity for comparing the biological effectiveness of different kinds of radiation on a common scale. The unit of dose equivalent is the rem. A millirem is one one-thousandth of a rem.

effective dose equivalent (EDE)
: The sum of the products of the dose equivalent to the organ or tissue and the weighting factors applicable to each of the body organs or tissues that are irradiated. It includes the dose from radiation sources internal and/or external to the body and is expressed in units of rem. The International Commission on Radiation Protection defines this as the effective dose.

effluent
: Liquid or gaseous waste streams released from a facility.

effluent monitoring
: Sampling or measuring specific liquid or gaseous effluent streams for the presence of pollutants.

endemic
: Native to a particular area or region.

environmental restoration
: Cleanup and restoration of sites and decontamination and decommissioning of facilities contaminated with radioactive and/or hazardous substances during past production, accidental releases, or disposal activities.

environmental restoration program
: A DOE subprogram concerned with all aspects of assessment and cleanup of both contaminated facilities in use and of sites that are no longer a part of active operations. Remedial actions, most often concerned with contaminated soil and groundwater, and decontamination and decommissioning are responsibilities of this program.

evaporator
: A facility that mechanically reduces the water contents in tank waste to concentrate the waste and reduce storage space needs.

exposure pathways
: The course a chemical or physical agent takes from the source to the exposed organism. An exposure pathway describes a unique mechanism by which an individual or population is exposed to chemicals or physical agents at or originating from a release site. Each exposure pathway includes a source or release from a source, an exposure point, and an exposure route. If the exposure point differs from the source, a transport/exposure medium such as air or water is also included.

external accident (or initiator)
: An accident that is initiated by manmade energy sources not associated with operation of a given facility. Examples include airplane crashes, induced fires, transportation accidents adjacent to a facility, and so forth.

facility basemat
: For this purposes of this EIS, basemat is defined as the concrete pad beneath the HLW tank.

fissile material
: Any material fissionable by thermal (slow) neutrons. The three primary fissile materials are uranium-233, uranium-235, and plutonium-239.

floodplain
: The level area adjoining a river or stream that is sometimes covered by flood water.

gamma-emitter

A radioactive substance that decays by releasing gamma radiation.

gamma ray (gamma radiation)

High-energy, short wavelength electromagnetic radiation (a packet of energy) emitted from the nucleus. Gamma radiation frequently accompanies alpha and beta emissions and always accompanies fission. Gamma rays are very penetrating and are best stopped or shielded against by dense materials, such as lead or uranium. Gamma rays are similar to x-rays, but are usually more energetic.

geologic repository

A deep (on the order of 600 meter [1,928 feet] or more) underground mined array of tunnels used for permanent disposal of radioactive waste.

groundwater

Water occurring beneath the earth's surface in the intervals between soil grains, in fractures, and in porous formations.

grout

A fluid mixture of cement-like materials and liquid waste that sets up as a solid mass and is used for waste fixation, immobilization, and stabilization purposes.

habitat

The sum of environmental conditions in a specific place occupied by animals, plants, and other organisms.

half-life

The time in which half the atoms of a particular radioactive substance disintegrate to another nuclear form. Measured half-lives vary from millionths of a second to billions of years. Also called physical half-life.

hazard index

The sum of several hazard quotients for multiple chemicals and/or multiple exposure pathways. A hazard index of greater than 1.0 is indicative of potential adverse health effects. Health effect could be minor temporary effects or fatal, depending on the chemical and amount of exposure.

hazard quotient

The ratio of an exposure level to a substance to a toxicity reference value selected for risk assessment purposes.

hazardous chemical

A term defined under the Occupational Safety and Health Act and the Emergency Planning and Community Right-to-Know Act as any chemical that is a physical hazard or a health hazard.

hazardous material

A substance or material, including a hazardous substance, which has been determined by the U.S. Secretary of Transportation to be capable of posing an unreasonable risk to health, safety, and property when transported in commerce.

hazardous substance
: Any substance that when released to the environment in an uncontrolled or unpermitted fashion becomes subject to the reporting and possible response provisions of the Clean Water Act and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

hazardous waste
: Under the Resource Conservation and Recovery Act, a solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may (a) cause, or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness; or (b) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed. Source, special nuclear material, and by-product material, as defined by the Atomic Energy Act, are specifically excluded from the definition of solid waste.

heavy metals
: Metallic elements with high atomic weights (for example, mercury, chromium, cadmium, arsenic, and lead) that can damage living things at low concentrations and tend to accumulate in the food chain.

high-efficiency particulate air (HEPA) Filter
: A filter with an efficiency of at least 99.95 percent used to separate particles from air exhaust streams prior to releasing that air into the atmosphere.

high-level waste
: As defined by the Nuclear Waste Policy Act [42 U.S. C. 10101], High Level Waste means (a) the highly radioactive waste material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid material derived from such liquid that contains [a combination of transuranic and] fission products [nuclides] in sufficient concentrations; and (b) other highly radioactive material that the [U.S. Nuclear Regulatory] Commission, consistent with existing law, determines by rule requires permanent isolation.

hydrology
: The study of water, including groundwater, surface water, and rainfall.

immobilization
: A process (e.g., grouting or vitrification) used to stabilized waste. Stabilizing the waste inhibits the release of waste to the environment.

inadvertent intrusion
: The inadvertent disturbance of a disposal facility or its immediate environment by a potential future occupant that could result in loss of containment of the waste or exposure of personnel. Inadvertent intrusion is a significant consideration that shall be included either in the design requirements or waste acceptance criteria of a waste disposal facility.

incidental waste
: Wastes that are not defined as high-level waste (i.e., originating from nuclear fuel processing).

inhibited water
: Water to which sodium hydroxide has been added to inhibit corrosion.

in situ
: A Latin term meaning "in place."

institutional control

The control of waste disposal sites or other contaminated sites by human institutions in order to prevent or limit exposures to hazardous materials. Institutional control may be accomplished by (1) active control measures, such as employing security guards and maintaining security fences to restrict site access, and (2) passive control measures, such as using physical markers, deed restrictions, government regulations, and public records and archives to preserve knowledge of the site and prevent inappropriate uses.

internal accidents

Accidents that are initiated by man-made energy sources associated with the operation of a given facility. Examples include process explosions, fires, spills, criticalities, and so forth.

involved worker

Workers that would be involved in a proposed action as opposed to workers that would be on the site of a proposed action but not involved in the action.

isotope

One of two or more atoms with the same number of protons, but different numbers of neutrons, in their nuclei. Thus, carbon-12, carbon-13, and carbon-14 are isotopes of the element carbon, the numbers denoting the approximate atomic weights. Isotopes have very nearly the same chemical properties, but often different physical properties (for example, carbon-12 and -13 are stable, carbon-14 is radioactive).

latent cancer fatality

A fatality resulting from cancer caused by an exposure to a known or suspected radionuclide or carcinogenic chemical.

low-level waste (LLW)

Waste that contains radioactivity and is not classified as high-level waste, transuranic waste, or spent nuclear fuel, or byproduct tailings containing uranium or thorium from processed ore (as defined in Section II e(2) of the Atomic Energy Act).

low-level mixed waste (LLMW)

Waste that contains both hazardous waste under the Resource Conservation and Recovery Act and source, special nuclear, or by-product material subject to the Atomic energy Act of 1954 (42 USC 2011, *et seq.*).

macroinvertebrate

Small animal, such as a larval aquatic insect, that is visible to the naked eye and has no vertebral column.

maximally exposed individual (MEI)

A hypothetical individual defined to allow dose or dosage comparison with numerical criteria for the public. This individual is located at the point on the DOE site boundary nearest to the facility in question.

millirad

One thousandth of a rad (see rad).

millirem

One thousandth of a rem (see rem).

mixed waste
: Waste that contains both hazardous wastes under the Resource Conservation and Recovery Act and source, special nuclear, or by-product material subject to the Atomic Energy Act of 1954.

nanocurie
: One billionth of a curie (see curie).

natural phenomena accidents
: Accidents that are initiated by phenomena such as earthquakes, tornadoes, floods, and so forth.

noninvolved workers
: Workers in a fixed population outside the day-to-day process safety management controls of a given facility area. In practice, this fixed population is normally the workers at an independent facility area located a specific distance (often 100 meters) from the reference facility area.

nuclear criticality
: A self-sustaining nuclear chain reaction.

nuclide
: A general term referring to all known isotopes, both stable (279) and unstable (about 5,000), of the chemical elements.

offsite
: Away from the SRS site.

offsite population
: For facility accident analyses, the collective sum of individuals located within an 80-kilometer (50-mile) radius of a facility and within the path of the plume with the wind blowing in the most populous direction.

oxalic acid
: A water soluble organic acid, $H_2C_2O_4$, being considered as a cleaning agent to use in spray-washing tanks because it dissolves sludge and is only moderately aggressive against carbon steel, the material used in the construction of the waste tanks.

particulate
: Pertains to minute, separate particles. An example of dry particulate is dust.

performance objectives
: Parameters within which a facility must perform to be considered acceptable.

permanent disposal
: For high level waste the term means emplacement in a repository for high-level radioactive waste, spent nuclear fuel, or other highly radioactive material with no foreseeable intent of recovery, whether or not such emplacement permits the recovery of such waste.

permeability
: The degree of ease with which water can pass through a rock or soil.

person-rem
A unit used to measure the radiation exposure to an entire group and to compare the effects of different amounts of radiation on groups of people. It is obtained by multiplying the average dose equivalent (measured in rems) to a given organ or tissue by the number of persons in the population of interest.

pH
A measure of the relative acidity or alkalinity of a solution. A neutral solution has a pH of 7, acids have a pH of less than 7, and bases have a pH of greater than 7.

picocurie
One trillionth of a curie (see curie).

pollutant migration
The movement of a contaminant away from its initial source.

population
For risk assessment purposes, population consists of the total potential members of the public or workforce who could be exposed to a possible radiation or chemical dose from an exposure to radionuclides or carcinogenic chemicals.

population dose
The overall dose to the offsite population.

rad
The special unit of absorbed dose. One rad is equal to an absorbed dose of 100 ergs/gram.

radiation (ionizing radiation)
Alpha particles, beta particles, gamma rays, x-rays, neutrons, high-speed electrons, high-speed protons, and other particles capable of producing ions. Radiation, as it is used here, does not include nonionizing radiation such as radio- or microwaves, or visible, infrared, or ultraviolet light.

radiation worker
A worker who is occupationally exposed to ionizing radiation and receives specialized training and radiation monitoring devices to work in such circumstances.

radioactive waste
Waste that is managed for its radioactive content.

radioactivity
The property or characteristic of material to spontaneously "disintegrate" with the emission of energy in the form of radiation. The unit of radioactivity is the curie (or becquerel).

radioisotope
An unstable isotope of an element that decays or disintegrates spontaneously, emitting radiation. approximately 5,000 natural and artificial radioisotopes have been identified.

radionuclide

The radioisotopes that together comprise 95 percent of the total curie content of a waste package by volume and have a half-life of at least 1 week. Radionuclides that are important to a facility's radiological performance assessment and/or a safety analysis and are listed in the facility's waste acceptance criteria are considered major radionuclides.

Record of Decision (ROD)

A public document that records the final decision(s) concerning a proposed action.

reducing grout

A grout formulated to behave as a chemical reducing agent. A chemical reducing agent is a substance that reduces other substances (i.e., decreases their positive charge or valence) by supplying electrons. The purpose of a reducing grout in closure of the high-level waste tanks would be to provide long-term chemical durability against leaching of the residual waste by water. Reducing grout would be com

posed primarily of cement, blast furnace slag, masonry sand, and silica fume.

rem

A unit of radiation dose that reflects the ability of different types of radiation to damage human tissues and the susceptibility of different tissues to the damage. Rems are a measure of effective dose equivalent.

risk

Quantitative expression of possible loss that considers both the probability that a hazard causes harm and the consequences of that event.

Safety Analysis Report (SAR)

A report, prepared in accordance with DOE Orders 5481.1B and 5480.23, that summarize the hazards associated with the operation of a particular facility and defines minimum safety requirements.

saltcake

Salt compounds that have crystallized as a result of concentrating the liquid.

saltstone

Concrete-like substance formed when the low-activity fraction of high-level waste is mixed with cement, flyash, and slag.

seepline

An area where subsurface water or groundwater emerges from the earth and slowly flows overland.

segregation

The process of separating (or keeping separate) individual waste types and/or forms in order to facilitate their cost-effective treatment and storage or disposal.

seismicity

The phenomenon of earth movements; seismic activity. Seismicity is related to the location, size, and rate of occurrence of earthquakes.

sludge

Solid material that precipitates or settles to the bottom of a tank.

solvent
Substance (usually liquid) capable of dissolving one or more other substances.

source material
(a) Uranium, thorium, or any other material that is determined by the U.S. Nuclear Regulatory Commission pursuant to the provisions of the Atomic Energy Act of 1954, Section 61, to be source material; or (b) ores containing one or more of the foregoing materials, in such concentration as the U.S. Nuclear Regulatory Commission may by regulation determine from time-to-time [Atomic Energy Act 11(z)]. Source material is exempt from regulation under to Resource Conservation and Recovery Act.

source term (Q)
the quantity of radioactive material released by an accident or operation that causes exposure after transmission or deposition. Specifically, it is that fraction of respirable material at risk (MAR) that is released to the atmosphere from a specific location. The source term defines the initial condition for subsequent dispersion and consequence evaluations. Q = material at risk (MAR) damage ration (DR) x airborne release fraction (ARF) x respirable fraction (RF) x leak path factor (LPF). The units of Q are quantity at risk averaged over the specified time duration.

spent nuclear fuel
Fuel that has been withdrawn from a nuclear reactor following irradiation, the constituent elements of which have not been separated.

stabilization
Treatment of waste to protect the environment from contamination. This includes rendering a waste immobile or safe for handling and disposal.

subsurface
The area below the land surface (including the vadose zone and aquifers).

tank farm
An installation of multiple adjacent tanks, usually interconnected for storage of liquid radioactive waste.

total effective dose equivalent
The sum of the external dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures).

transuranic waste
Waste containing more than 100 nanocuries of alpha-emitting transuranic isotopes, with half-lives greater than 20 years, per gram of waste, except for (a) high-level radioactive waste; (b) waste that the U.S. Department of Energy has determined, with the concurrence of the Administrator of the U.S. Environmental Protection Agency, does not need the degree of isolation required by 40 CFR 191; or (c) waste that the U.S. Nuclear Regulatory Commission has approved for disposal on a case-by-case basis in accordance with 10 CFR 61.

treatment
Any activity that alters the chemical or physical nature of a hazardous waste to reduce its toxicity, volume, mobility or to render it amenable for transport, storage or disposal.

vadose zone

The zone between the land surface and the water table. Saturated bodies, such as perched groundwater, may exist in the vadose zone. Also called the zone of aeration and the unsaturated zone.

vitrification

A method of immobilizing waste (e.g., radioactive, hazardous, and mixed). This involves adding frit and waste to a joule-heated vessel and melting the mixture into a glass. The purpose of this process is to permanently immobilize the waste and to isolate it from the environment.

volatile organic compound (VOC)

Compounds that readily evaporate and vaporize at normal temperatures and pressures.

waste minimization

An action that economically avoids or reduces the generation of waste by source reduction, reducing the toxicity of hazardous waste, improving energy usage, or recycling. These actions will be consistent with the general goal of minimizing present and future threats to human health, safety, and the environment.

waste stream

A waste or group of wastes with similar physical form, radiological properties, U. S. Environmental Protection Agency waste codes, or associated land disposal restriction treatment standards. It may be the result of one or more processes or operations.

wetlands

Area that are inundated or saturated by surface water or groundwater and that typically support vegetation adapted for life in saturated soils. Wetlands generally include swamps, marshes, bogs, and similar areas.

wind rose

A star-shaped diagram showing how often winds of various speeds blow from different directions. This is usually based on yearly average.