3.0 DISPOSAL FACILITY CHARACTERISTICS

Section 3.1 provides information regarding site characteristics including detailed information furnished for those characteristics that influence the contaminant transport modeling assumptions provided in Chapter 4.

- Section 3.1.1 provides a general description and layout of the site and the HTF to orient the reader and includes the current (as of 2009) estimated population distribution of the surrounding area as well as future land use planning for information purposes.
- Section 3.1.2 describes meteorological and climatological data collection at SRS. This data collection determines appropriate modeling assumptions related to rainfall and temperature to assess the performance of the HTF closure cap presented in SRNL-ESB-2008-00023 and WSRC-STI-2007-00184. Dose Release Factors (DRFs) are developed from atmospheric dispersion conditions based on the meteorological data collected and are used to model the dispersion of gaseous contaminants emanating to the surface from the closed HTF site described in Section 4.5.
- Section 3.1.3 provides a general description of the ecology of the site for information purposes.
- Section 3.1.4 provides information regarding the geology and seismology of the site that is used to determine appropriate modeling parameters for the PA.
- Section 3.1.5 provides information regarding the hydrogeology of the site that determines the modeling assumptions related to the flow of surface water and groundwater.
- Section 3.1.6 identifies the sources of information available regarding the geochemistry of the soils and cementitious material that determines the modeling assumptions related to the depletion of radionuclides during their migration to potential sites of release to the environment.
- Sections 3.1.7 and 3.1.8 address natural resource management of the site and sources of natural and background radiation exposure, respectively, for information purposes.

Section 3.2 describes in detail the design and construction features of existing HTF waste tanks and ancillary equipment and the proposed design and construction features of HTF waste tank and ancillary equipment grouting system and the HTF closure cap concept.

- Sections 3.2.1 and 3.2.2 provide the details of design and construction of the HTF waste tanks and ancillary equipment, respectively.
- Section 3.2.3 provides the functional performance and design requirements of the grouting system to provide for stabilized contaminant immobilization, intruder deterrence, structural stability, and a chemical environment to retard the mobility of certain radionuclides by increasing their insolubility.
- Section 3.2.4 provides the design performance requirements and constructability requirements for the proposed HTF closure cap concept and the results of the infiltration analysis of the closure cap presented in SRNL-ESB-2008-00023 and

WSRC-STI-2007-00184.

Section 3.3 identifies the stabilized contaminants at the time of the HTF closure.

- Section 3.3.1 provides an initial radionuclide screening process.
- Section 3.3.2 lists the radionuclides that are used in the assessment modeling that have passed through the screening process.
- Section 3.3.3 lists the non-radionuclides that are used in the assessment modeling.
- Section 3.4 presents the inventory methodology used to characterize the radiological and a non-radiological inventories used in the PA analyses.
- Section 3.4.1 provides the estimated radioactive and non-radioactive inventory in the HTF waste tanks based on sample analysis, process history data collected within the Waste Characterization System (WCS), special analyses, and assumed remaining stabilized contaminants volume for waste tanks not yet cleaned.
- Section 3.4.2 provides waste tank inventory adjustments based on operations, inventory developments, and modeling efforts.
- Section 3.4.3 provides the estimated inventory remaining inside ancillary equipment including waste transfer lines (considering diffusion, oxide film layer, and residual material following flushing), pump tanks, and evaporator systems (based on field characterization of the shutdown 242-F evaporator system).

3.1 Site Characteristics

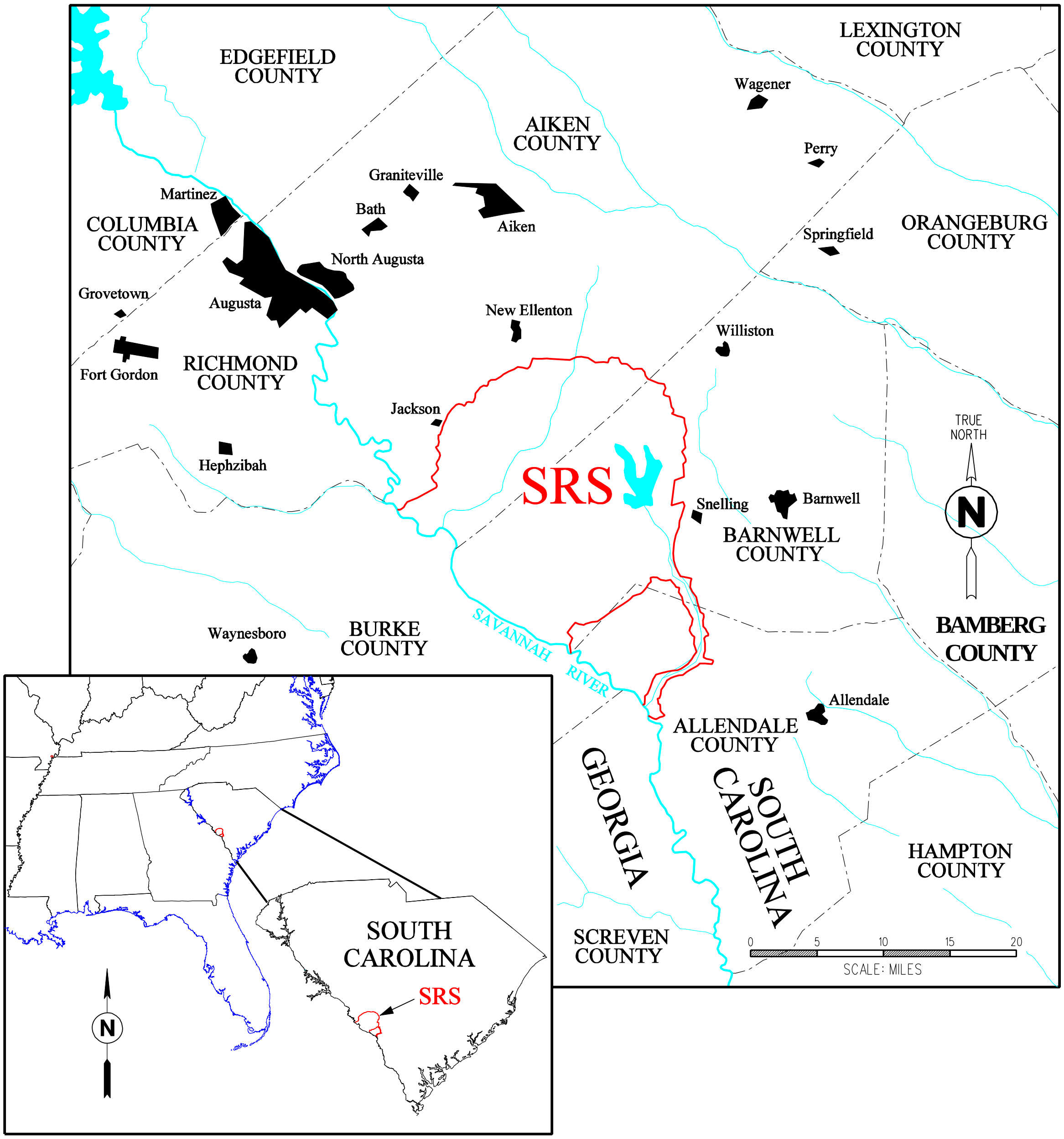
Evaluation of radionuclide transport from the HTF, and of human exposure resulting from release of radionuclides to the environment, requires careful consideration of factors affecting transport processes and exposure potential. Topographic features and hydrogeologic characteristics strongly affect the direction and flow of radionuclides potentially released from the closure site. Projected land use and population distributions affect the estimation of human exposure. In this section, the relevant natural and demographic characteristics of H Area and the surrounding area are discussed.

3.1.1 Geography and Demography

3.1.1.1 SRS Site Description

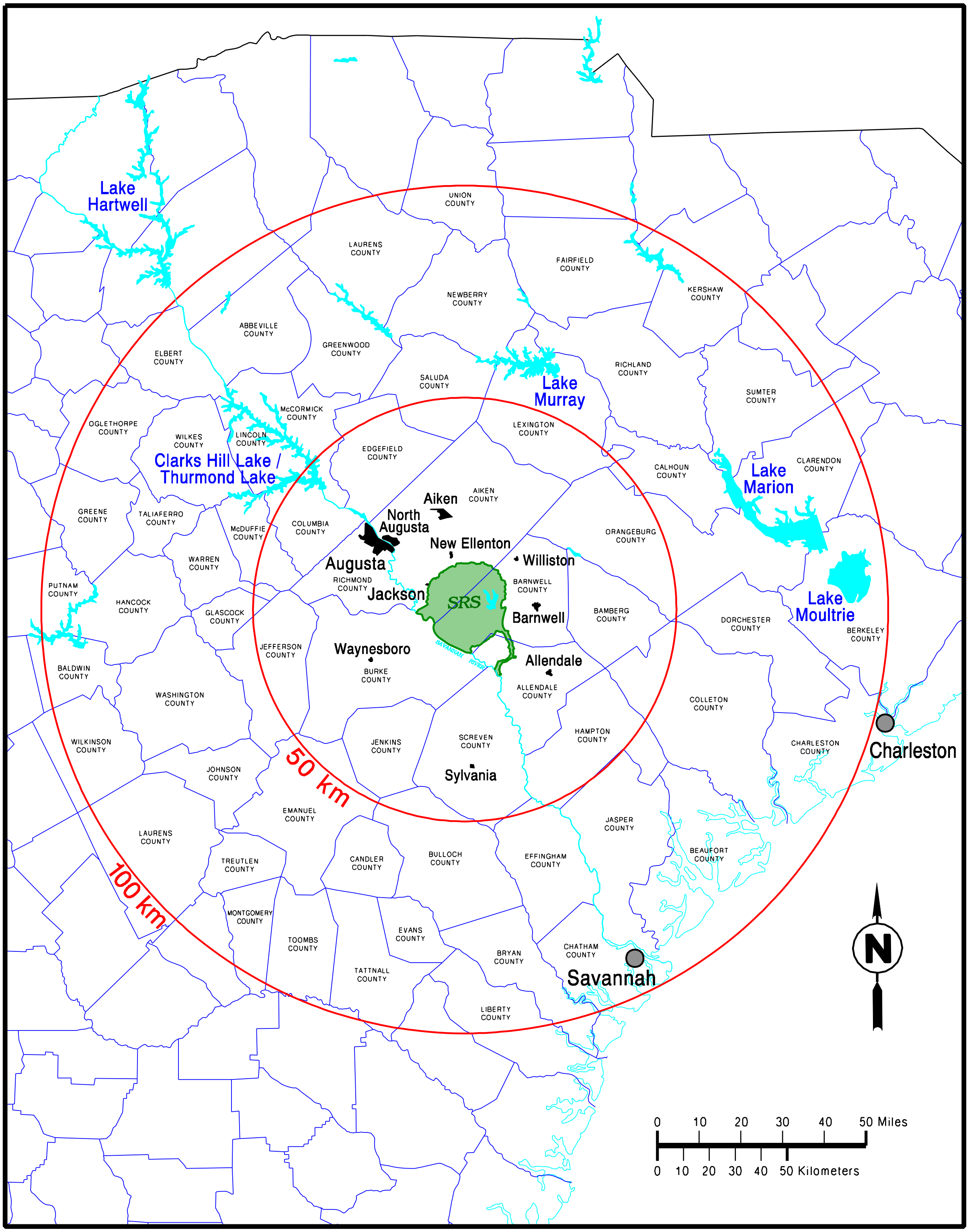
Construction of the SRS (one of the facilities in the DOE complex) started in the early 1950s to produce nuclear materials (such as Pu-239 and tritium). The site covers approximately 310 square miles in South Carolina and borders the Savannah River. The SRS encompasses 198,344 acres in Aiken, Allendale, and Barnwell counties of South Carolina. The site is approximately 12 miles south of Aiken, South Carolina, and 15 miles southeast of Augusta, Georgia, as shown in Figure 3.1-1. [SRNS-STI-2009-00190]

Figure 3.1-1: Physical Location of Savannah River Site



Prominent geographic features within 30 miles of the SRS include the Savannah River and Clarks Hill Lake (also known as Thurmond Lake), shown in Figure 3.1-2. The Savannah River forms the southwest boundary of the SRS. Clarks Hill Lake is the largest nearby public recreational area. This reservoir lies on the Savannah River approximately 40 miles upstream of the center of the SRS.

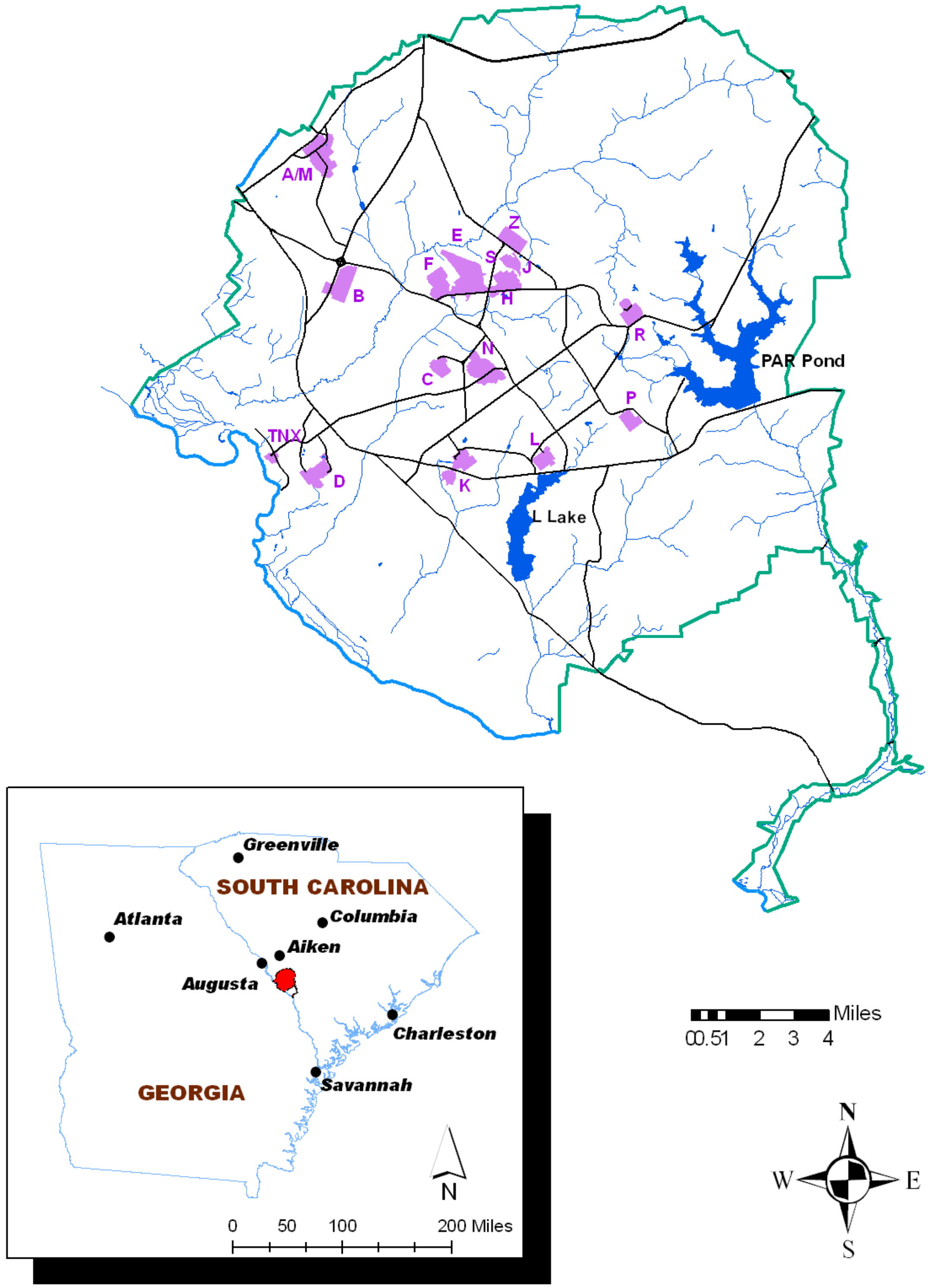
Figure 3.1-2: Location of Savannah River Site and Adjacent Areas



Within the SRS boundary, prominent water features include PAR Pond and L Lake, shown in Figure 3.1-3. PAR Pond, a former reactor cooling water impoundment, covers approximately 2,700 acres and lies in the eastern sector of the SRS. L Lake, another former reactor cooling water impoundment, covers approximately 1,000 acres and lies in the southern sector of the SRS. [WSRC-IM-2004-00008]

Figure 3.1-3 also shows the major operational areas at the SRS. Prominent operational areas, both past and present, include, Separations (F and H Areas), Waste Management Operations (E Area), Liquid Waste Disposition (F, H, J, S, and Z Areas), and the Reactor Areas (C, K, L, P, and R). The Savannah River National Laboratory (SRNL) and Savannah River Ecology Laboratory (SREL) are located in A Area. Administrative and support services are located in B Area and construction administration activities are located in N Area. D Area is the coal-fired powerhouse that provides steam to the SRS. M Area and the Training and Experimental Test Facility (TNX) have undergone Deactivation and Decommissioning (D&D). [SRS-REG-2007-00002]

Figure 3.1-3: Predominant SRS Operational Area Location Map



3.1.1.2 Closure Site Description

The HTF is in H Area, which is located in the central region of the SRS. Figure 3.1-4 presents the area known as the GSA. The GSA is located atop a ridge that runs southwest to northeast forming the drainage divide between UTR to the north and Fourmile Branch to the south. The GSA contains the F-Area and H-Area Separations Facilities, the S-Area Defense Waste Processing Facility (DWPF), the Z-Area Saltstone Facility, and the E-Area LLW Disposal Facilities. The HTF is an active facility consisting of 29 carbon steel waste tanks (Figure 3.1-5) in varying degrees of service or waste removal processes. The waste was generated primarily from the H-Canyon chemical separations processes. The HTF design features (e.g., waste tanks, transfer lines, evaporator systems) are discussed in more detail in Sections 3.2.1 and 3.2.2.

Figure 3.1-4: Layout of the General Separations Area

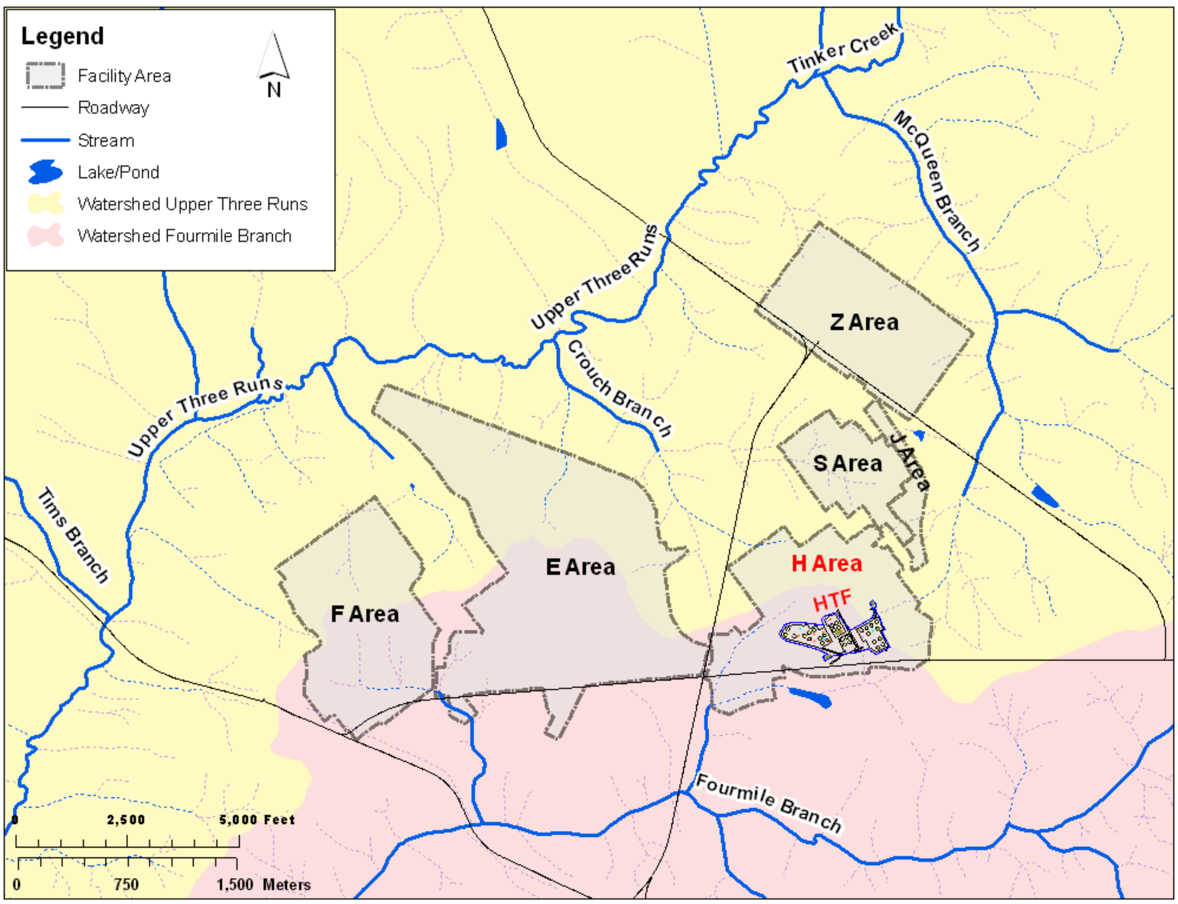


Figure 3.1-5: General Layout of H-Area Tank Farm

3.1.1.3 Population Distribution

According to U.S. Census Bureau data, the estimated 2009 population in the eight-county region of influence (ROI) was 554,482. Four of the counties lie in South Carolina and include Aiken, Allendale, Bamberg, and Barnwell. The other four counties lie in Georgia and include Burke, Columbia, Richmond, and Screven (see Figure 3.1-2). The ROI includes the counties immediately adjacent to SRS and the counties where the majority of SRS workers reside. Approximately 85% of the ROI live in the following three counties, Aiken (28.1%), Richmond (36%), and Columbia (20.4%). Only approximately 15% of the ROI live in the remaining counties as shown in Table 3.1-1. [http://www.factfinder.census.gov/]

Table 3.1-1: Population Distribution and Percent of ROI for Counties and Selected Communities

Jurisdiction	2009 Population Estimate [a]	2009 % Region
SOUTH CAROLINA		
Aiken County	**156,017**	**28.1**
Aiken, City	29,494	5.3
Jackson, Town	1,664	0.3
New Ellenton, Town	2,250	0.4
North Augusta, City	20,880	3.8
Allendale County	**10,195**	**1.8**
Allendale, Town	3,554	0.6
Bamberg County	**15,005**	**2.7**
Bamberg, Town	3,336	0.6
Barnwell County	**22,688**	**4.1**
Barnwell, City	4,733	0.9
GEORGIA		
Burke County	**22,797**	**4.1**
Columbia County	**112,958**	**20.4**
Richmond County	**199,768**	**36.0**
Screven County	**15,054**	**2.7**
Eight-County Total	**554,482**	

(a) 2009 Population estimates based on 2000 population census and provided by the U.S. Census Bureau, Population Estimates Program, http://www.factfinder.census.gov/ data for births, deaths, and domestic and international migration were used by the U.S. Census Bureau to update the 2000 base counts.

From 2000 to 2009, the population in the eight-county region grew an estimated 6.5%. Columbia County had the highest estimated growth at approximately 26.5% followed by Aiken County with an estimated growth of approximately 9.4% and Burke County with an estimated growth of 2.5%. Allendale, Bamberg, Barnwell, and Screven Counties experienced a net population loss. Information obtained from the U.S. Census Bureau website, http://www.factfinder.census.gov/ is the basis for the calculations.

The *High-Level Waste Tank Closure Final Environmental Impact Statement* contains population projections and further information regarding the region around SRS. [DOE-EIS-0303]

3.1.1.4 Land Use Present and Planned

Land within a 5-mile radius of the HTF is entirely within the SRS boundaries and its current use is for industrial purposes or as forested land. The classification of the current land use within the entire GSA is heavy nuclear industrial. Two key planning documents contain the plans for the future of the SRS and are identified below and described in Sections 2.4.2 and 2.4.3.

- The *Savannah River Site End State Vision*, PIT-MISC-0089
- The *Savannah River Site Long Range Comprehensive Plan*, PIT-MISC-0041

3.1.2 Meteorology and Climatology

3.1.2.1 General SRS Climate

The SRS region has a humid subtropical climate characterized by relatively short, mild winters and extended, hot, and humid summers. Summer-like conditions (including mid to late summer heat waves) typically last from May through September when the area is frequently under the influence of a western extension of the semi-permanent subtropical high-pressure system, most commonly known in North America as the Bermuda High. Winds in summer are light and cold fronts generally remain well north of the area. On average, greater than one-half of the days register temperatures in excess of 90°F during the summer months. As this maritime tropical mass comes inland, it rises and forms localized scattered afternoon and evening thunderstorms that are often intense. The influence of the Bermuda High begins to diminish during the fall as continental air masses become more prevalent, resulting in lower humidity and more moderate temperatures.

Average rainfall during the fall is usually the least of the four seasons. In the winter months, mid-latitude low-pressure systems and associated fronts often migrate through the region. As a result, conditions frequently alternate between warm, moist, subtropical air from the Gulf of Mexico region and cool, dry, polar air. The Appalachian Mountains to the north and northwest of the SRS help to moderate the extremely cold temperatures that are associated with occasional outbreaks of Arctic air. Consequently, less than one-third of winter days have minimum temperatures below freezing on average, and days with temperatures below 20°F are infrequent. Measurable snowfall occurs on an average of once every two years. Tornadoes occur more frequently in spring than the other seasons of the year. Although spring weather is somewhat windy, temperatures are usually mild and humidity is relatively low. [WSRC-TR-2007-00118]

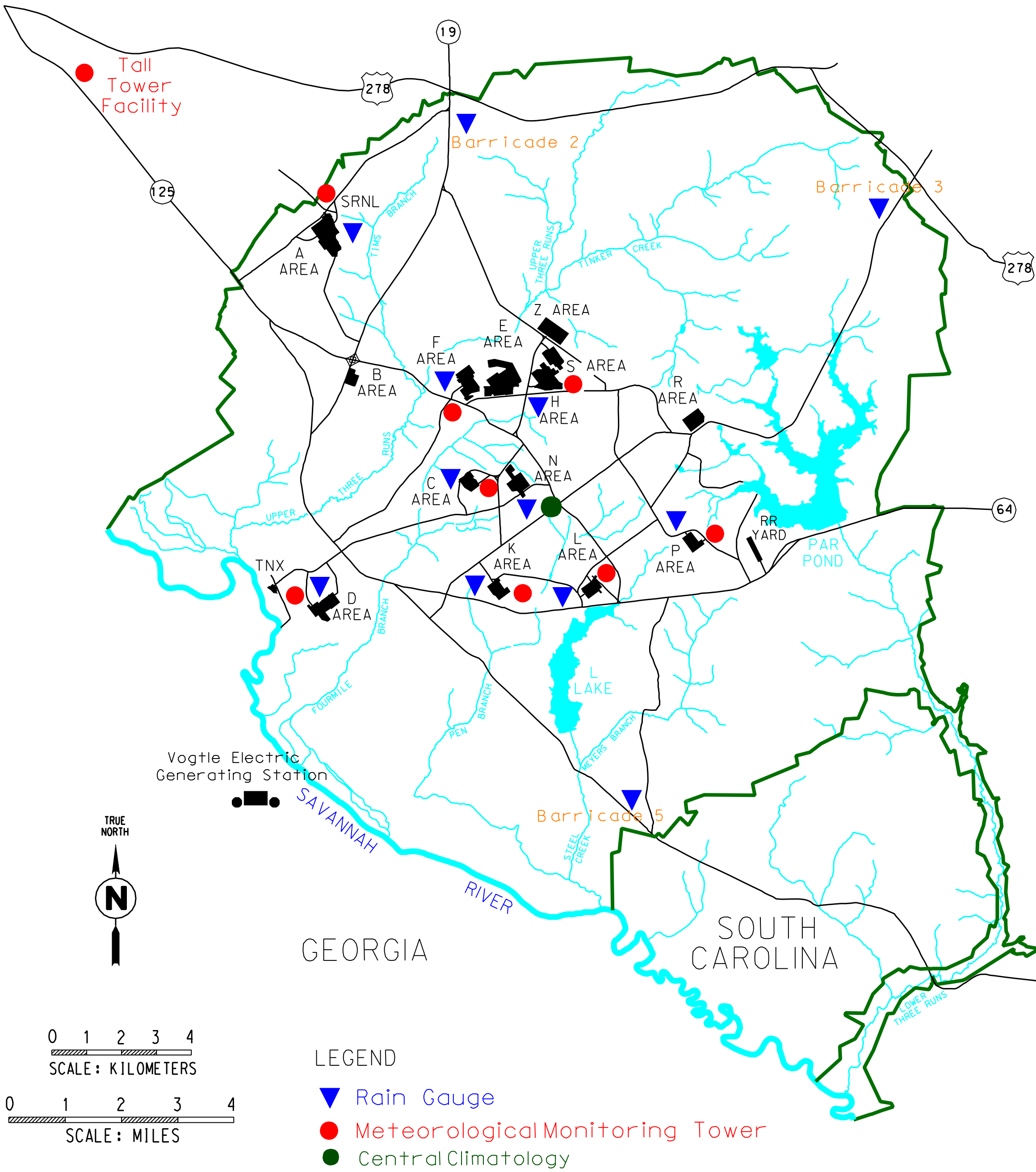
3.1.2.2 Meteorological Data Collection

The collection of SRS meteorological data is from a network of nine primary monitoring stations (Figure 3.1-6). Towers located adjacent to each of eight areas (A, C, D, F, H, K, L, and P Areas) are equipped to measure wind direction and wind speed at 201.3 feet above ground and to measure temperature and dew point at both 6.6 feet (2 meters) and 201.3 feet above ground. A ninth tower near N Area, known as the Central Climatology (CLM) site, is instrumented with wind, temperature, and dew point sensors at four levels: 6.6 feet (13.2 feet for wind), 59.4 feet, 118.8 feet, and 201.3 feet. The CLM site is also equipped with an automated tipping bucket rain gauge, a barometric pressure sensor, and a solar radiometer near the tower at ground level. Data acquisition units at each station record a measurement from each instrument at one-second intervals. Every 15 minutes, 900 data points are processed to generate statistical summaries for each variable, including averages and instantaneous maxima. The results are uploaded to a relational database for permanent archival. [WSRC-TR-2007-00118]

In addition, the Tall Tower facility near Beech Island, South Carolina, provides a set of high quality meteorological measurements that is unique to the Southeastern United States. This facility utilizes fast-response sonic anemometers, water vapor sensors, barometric pressure sensors, slow-response temperature sensors, and relative humidity sensors. The data are collected at 100 feet, 200 feet, and 1,000 feet above ground level. Spread-spectrum modems at each measurement level transmit raw data to a redundant set of personal computers at the SRNL. Data processing software on the personal computers determine mean values and other statistical quantities every 15 minutes and uploads the results to the relational database.

Collection of precipitation measurements are from a network of 13 rain gauges across the SRS (Figure 3.1-6). Twelve of these gauges are read manually by site personnel once daily, usually around 6:00 A.M. The daily data are reported to the SRNL Atmospheric Technologies Center, where it is technically reviewed and manually entered into a permanent electronic database. The other is an automated rain gauge at the CLM site previously addressed above.

Figure 3.1-6: Savannah River Site Meteorological Monitoring Network



[WSRC-TR-2007-00118]

3.1.2.3 Data Pertinent To PA Modeling

Weather data pertinent to the PA modeling are atmospheric dispersion, precipitation, and air temperature. Each is discussed below.

3.1.2.3.1 Atmospheric Dispersion

Since the mid-1970s, a 5-year database of meteorological conditions at the SRS has been updated in order to support dose calculations for accident or routine release scenarios for on-site and off-site populations. The meteorological database includes wind speed, wind direction, temperature, dew point, and horizontal and vertical turbulence intensities. The most recent database is for the time period January 1, 2002 through December 31, 2006, and consists of 1-hour time averages of temperature and dew point; wind speed, direction, and turbulence. [WSRC-STI-2007-00613] These data are for determining DRFs in the evaluation for air pathways dose modeling described in Section 4.5, and was reported in SRNL-STI-2010-00018.

3.1.2.3.2 Precipitation

Compilations of rainfall data obtained from meteorological data collection described above for years 1952 through 2006 for the site and for years 1961 through 2006 from the 200-F weather station are in WSRC-STI-2007-00184. An average precipitation level result of 48.5 in/yr was gathered from the 55-year monitoring period for the site and 49 in/yr from the 200-F weather station. These data are for determining appropriate rainfall assumptions for the performance evaluation of infiltration through the closure cap described in Section 3.2.4 and evaluated in WSRC-STI-2007-00184.

3.1.2.3.3 Air Temperature

A compilation of air temperature data obtained from meteorological data collection (described above) for years 1968 through 2005 is in WSRC-STI-2007-00184. For this 37-year period, the annual average air temperature was approximately 64°F with an average monthly air temperature from a low of approximately 46°F, to a high of approximately 81°F. These data are for determining appropriate assumptions for the performance evaluation of infiltration through the closure cap described in Section 3.2.4 and evaluated in WSRC-STI-2007-00184.

3.1.3 Ecology

Comprehensive descriptions of the SRS ecological resources and wildlife are in *SRS Ecology: Environmental Information Document* and briefly discussed in this section. [WSRC-TR-2005-00201]

The SRS supports abundant terrestrial and semi-aquatic wildlife, as well as a number of species considered threatened or endangered. Since the early 1950s, the site has changed from 67% forest and 33% agriculture to 94% forest, with the remainder in aquatic habitats and developed areas. Wildlife populations correspondingly shifted from forest-farm edge utilizing species to a predominance of forest-dwelling species. The SRS now supports 44 species of amphibians, 60 species of reptiles, 255 species of birds, and 55 species of mammals. These populations include urban wildlife, several commercially and recreationally important species, and a few threatened or endangered species. Protection and restoration of all flora and fauna to a point where their existence is not jeopardized are principal goals of federal and state environmental programs. Those species of plants and animals afforded governmental protection are referred to collectively as "species of concern." [WSRC-TR-2005-00201]

The SRS has extensive, widely distributed wetlands, most of which are associated with floodplains, creeks, or impoundments. In addition, approximately 200 Carolina bays occur on SRS. Carolina bays are unique wetland features of the Southeastern United States. They are isolated wetland habitats dispersed throughout the uplands of SRS. The approximately 200 Carolina bays on SRS exhibit extremely variable hydrogeology and a range of plant communities from herbaceous marsh to forested wetland. [DOE-EIS-0303]

The Savannah River bounds SRS to the southwest for approximately 20 miles. The river floodplain supports an extensive swamp, covering approximately 15 square miles of SRS with a natural levee separating the swamp from the river. Timber was cut in the swamp from the turn of the century until 1951, when the Atomic Energy Commission assumed control of the area. At present, the swamp forest is comprised of two kinds of forested wetland communities. Areas that are slightly elevated and well drained are characterized by a mixture of oak species, as well as red maple, sweet gum, and other hardwood species. Low-lying areas that are continuously flooded are dominated by second-growth bald cypress and water tupelo. [DOE-EIS-0303]

The SRS supports abundant herpetofauna because of its temperate climate and diverse habitats. The species of herpetofauna include 17 salamanders, 27 frogs and toads, 1 crocodilian, 13 turtles, 9 lizards, and 36 snakes. The class Amphibia is represented on-site by 2 orders, 11 families, 16 genera, and 44 species. The Reptilia are represented by 3 orders, 12 families, 41 genera, and 59 species. [WSRC-TR-2005-00201]

More than 255 species of birds can be found at the SRS. Waterfowl and wading birds, as well as many upland species use the SRS aquatic habitats year round. The site's Carolina bays and emergent marshes are used by 67% of these birds. This type of habitat is used by 68% of the upland species. Edge or shoreline areas account for high numbers of upland birds at the Carolina bays and emergent marshes, stream, and small drainage corridors, and river swamp habitats. The aquatic birds are most common in open water habitats. [WSRC-TR-2005-00201]

Large mammals inhabiting the site include white-tailed deer and feral hogs. Raccoon, beaver, and otter are relatively common throughout the wetlands of the SRS. In addition, the gray fox, opossum, bobcat, gray squirrel, fox squirrel, eastern cottontail, mourning dove, northern bobwhite, and eastern wild turkey are common at SRS. Threatened or endangered plant and animal species known to exist or that might be found on the overall site include the smooth purple coneflower, wood stork, red-cockaded woodpecker, and short-nose sturgeon. [WSRC-TR-2005-00201]

The HTF is located within a densely developed, industrialized area of SRS. The immediate area provides habitat for only those animal species typically classified as urban wildlife.

Species commonly encountered in this type of urban landscape include the Southern toad, green anole, rat snake, rock dove, European starling, house mouse, opossum, and feral cats and dogs. Grasses and landscaped areas within the GSA in proximity to the HTF also provide some marginal terrestrial wildlife habitat. A number of ground-foraging bird species (e.g., American robin, killdeer, and mourning dove) and small mammals (e.g., cotton mouse, cotton rat, and Eastern cottontail) that use lawns and landscaped areas around buildings may be present at certain times of the year, depending on the level of human activity (e.g., frequency of mowing). Pine plantations managed for timber production by the U.S. Forest Service (under an interagency agreement with DOE) occupy surrounding areas.

The Fourmile Branch seepline area is located in a bottomland, hardwood forest community. The canopy layer of this bottomland forest is dominated by sweet gum, red maple, and red bay with an occasional sweet bay throughout. The understory consists largely of saplings of these same species, as well as an herbaceous layer of smilax, dog hobble, giant cane, poison ivy, chain fern, and hepatica. At the seepline's upland edge, scattered American holly and white oak occur. Dominant along Fourmile Branch in this area are tag alder, willow, sweet gum, and wax myrtle. The UTR seepline is located in a similar bottomland, hardwood forest community. [DOE-EIS-0303]

No endangered or threatened fish or wildlife species have been recorded near the UTR and Fourmile Branch seeplines. The seeplines and associated bottomland community do not provide habitat favored by endangered or threatened fish and wildlife species known to occur at SRS. The American alligator is the only federally protected species that could potentially occur in the area of the seeplines. Fourmile Branch does support a small population of American alligator in its lower reaches, where the stream enters the Savannah River swamp. [DOE-EIS-0303]

According to summaries of studies on UTR documented in the *SRS Ecology: Environmental Information Document*, the macroinvertebrate communities of UTR drainage are unusual. [WSRC-TR-2005-00201] They include many rare species and species not often found living together in the same freshwater system. Since UTR is a spring-fed stream and is colder and generally clearer than most surface water at its low elevation, species typical of unpolluted streams in northern North America or the southern Appalachian Mountains are found here along with lowland (Atlantic Coastal Plain) species.

The fish community of UTR is typical of third and higher order streams on the SRS that have not been greatly affected by industrial operations, with shiners and sunfish dominating collections. The smaller tributaries of UTR are dominated by shiners and other small-bodied species (i.e., pirate perch, madtoms, and darters) indicative of un-impacted streams in the Atlantic Coastal Plain. In the 1970s, the U.S. Geological Survey (USGS) designated UTR as a National Hydrological Benchmark Stream due to its high water quality and rich fauna. However, this designation was rescinded in 1992 due to increased development of the UTR watershed north of the SRS site boundaries. [DOE-EIS-0303]

3.1.4 Geology, Seismology, and Volcanology

Regional and local information on the geologic and seismic characteristics of the HTF are presented in this section. Because the SRS is not located within a region of active-plate tectonics characterized by volcanism, volcanology is not an issue of concern in this PA, and thus further discussion of this topic is omitted from the following discussion. [WSRC-IM-2004-00008]

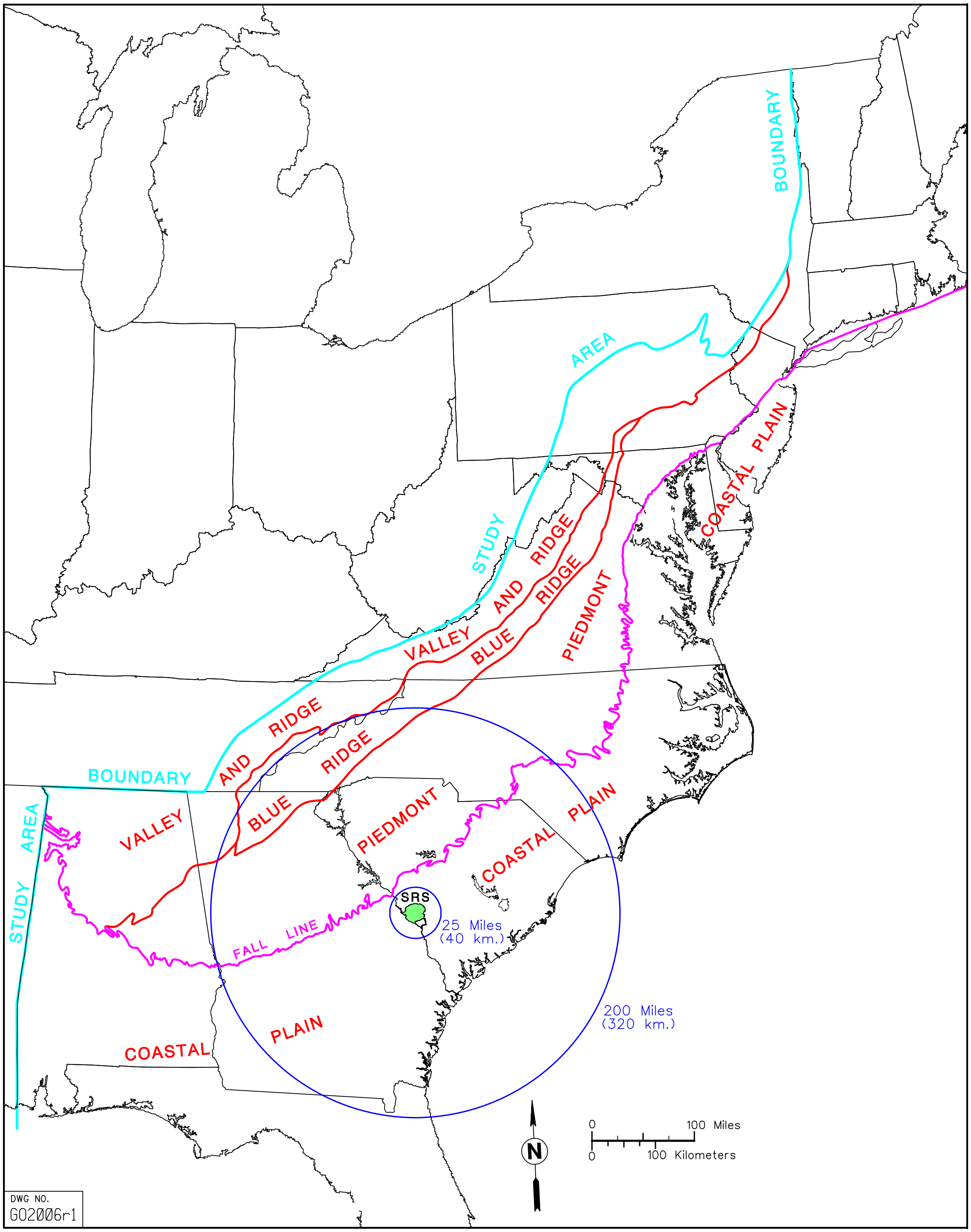
3.1.4.1 Regional and Site-Specific Topography

The SRS is on the Atlantic Coastal Plain Physiographic Province approximately 25 miles southeast of the Fall Line that separates the relatively unconsolidated Coastal Plain sediments from the underlying Piedmont Physiographic Province. Beneath the Coastal Plain, sedimentary sequences reveal two geologic terrains. One is the Dunbarton basin, a Triassic-Jurassic Rift basin filled with lithified terrigenous and lacustrine sediments. The other is a crystalline terrain of metamorphosed sedimentary and igneous rock that may range in age from Precambrian to late Paleozoic derived from the crystalline igneous and metamorphic rocks of possibly late Precambrian to late Paleozoic age in the Piedmont Province. Early to middle Mesozoic (Triassic to Jurassic) rocks occur in isolated fault-bounded valleys either exposed within the crystalline belts or buried beneath the Coastal Plain sediments. The Coastal Plain sediments were derived from erosion of the crystalline rocks during late Mesozoic (Cretaceous) in stream and river valleys, and are represented locally by gravel deposits adjacent to present-day streams and by sediments filling upland depressions (sinks and Carolina Bays). The Cretaceous and younger sediments are not significantly indurated. The total thickness of the sediment package at SRS varies between approximately 700 feet at the northwest boundary and 1,200 feet at the southeast boundary. [WSRC-TR-95-0046]

Figure 3.1-7 shows the relationship of SRS to overall regional geological provinces, and Figure 3.1-8 details the regional physiographic provinces in South Carolina. As can be seen on Figure 3.1-8, much of SRS lies within the Aiken Plateau, and this Plateau slopes to the southeast approximately 5 feet per mile. Savannah and Congaree Rivers bound the plateau, which extends from the Fall Line to the Orangeburg escarpment. The highly dissected surface of the Aiken Plateau is characterized by broad interfluvial areas with narrow, steep-sided valleys. Local relief can be as much as 300 feet. Figure 3.1-9 shows the topography and 20-foot contour lines of the GSA. [WSRC-TR-95-0046]

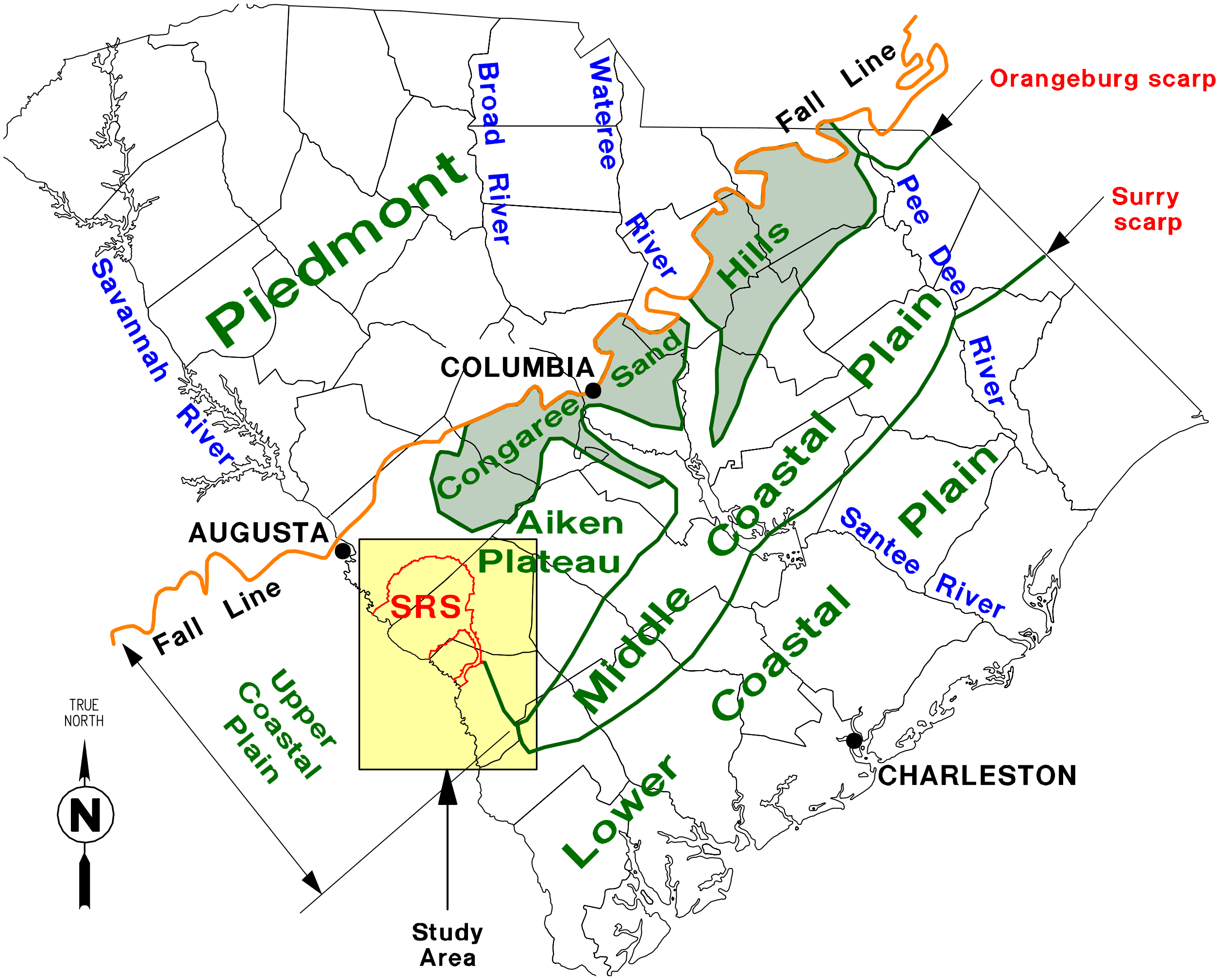
Currently, HTF storm water drainage is directed to an outfall, which will be unaffected by HTF operations and waste tank closure activities. The installation of the HTF closure cap (Section 3.2.4) will necessitate changes to the HTF drainage system, which will be designed later as part of the overall closure of HTF.

Figure 3.1-7: Regional Geological Provinces of Eastern United States



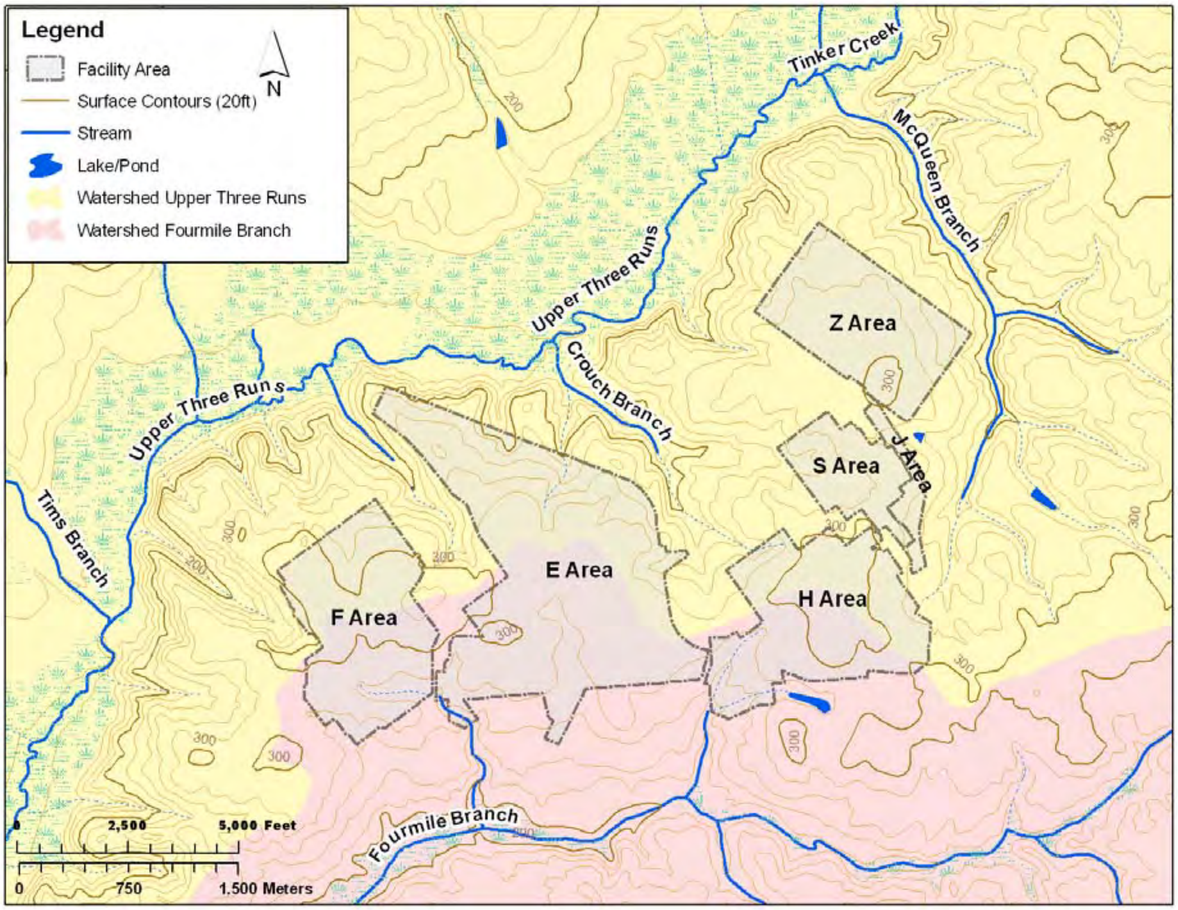
[WSRC-TR-2000-00310, Figure 1]

Figure 3.1-8: Regional Physiographic Provinces of South Carolina



[WSRC-TR-95-0046, Figure 2-3]

Figure 3.1-9: Topography of the GSA



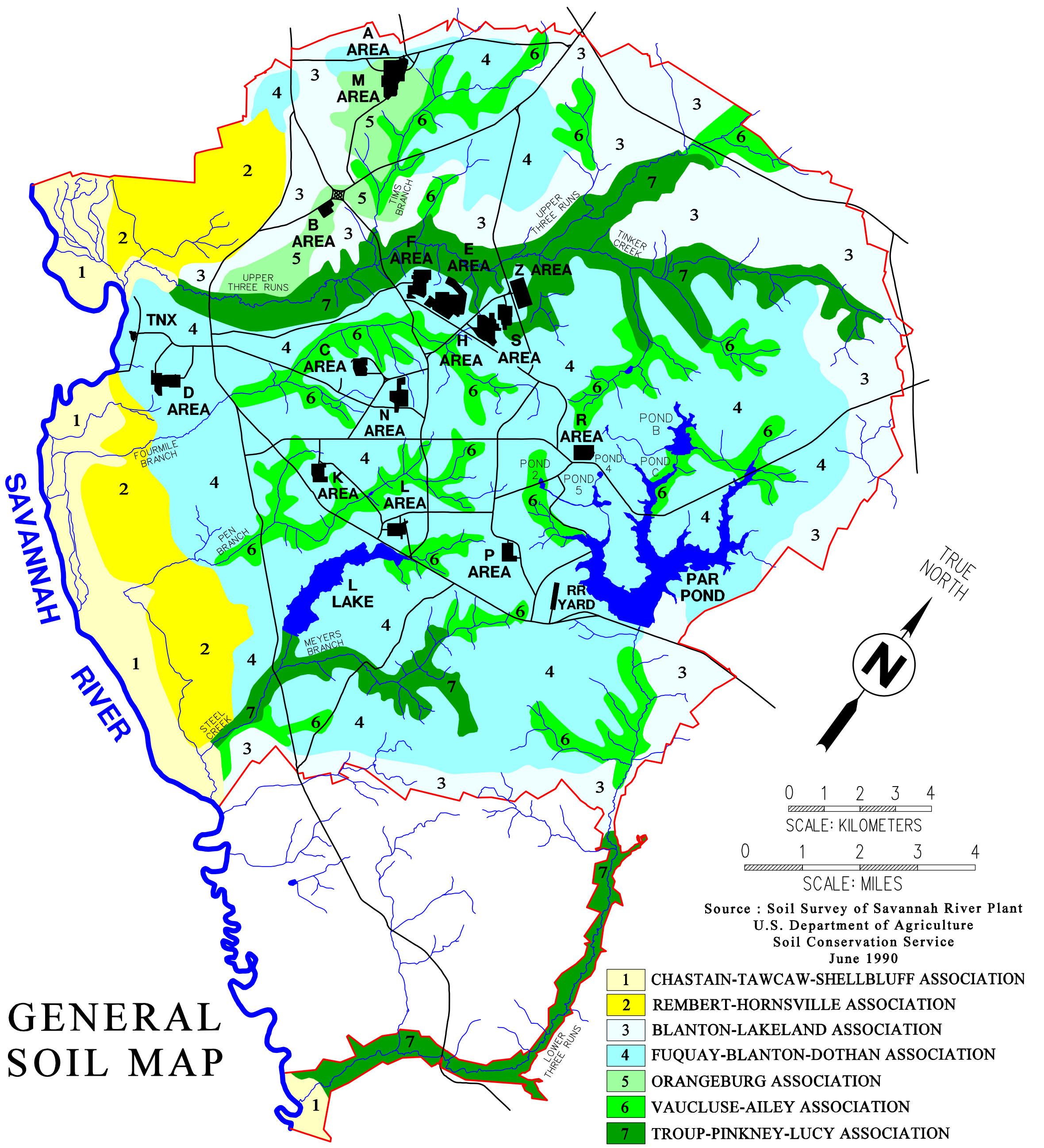
3.1.4.2 Local Geology and Soils

The vadose zone is comprised of the middle to late Miocene-age "Upland Unit," that extends over much of SRS. The term "Upland Unit" is an informal name used to describe sediments at higher elevations located in the Upper Coastal Plain in southwestern South Carolina. This area has also been referred to as the Aiken Plateau. The occurrence of cross-bedded, poorly sorted sands with clay lenses in the Aiken Plateau indicates fluvial deposition (high-energy channel deposits to channel-fill deposits) with occasional transitional marine influence. This depositional environment results in wide differences in lithology and presents a very complex system of transmissive and confining beds or zones. The lower surface of the "Upland Unit" is very irregular due to erosion of the underlying formations.

A notable feature of the "Upland Unit" is its compositional variability. This formation predominantly consists of red-brown to yellow-orange, gray, and tan colored, coarse to fine grained sand, pebbly sand with lenses and beds of sandy clay and clay. Generally vertically upward through the unit, sorting of grains becomes poorer, clay beds become more abundant and thicker, and sands become more argillaceous and indurated. In some areas, small-scale joints and fractures, both of which are commonly filled with sand or silt, traverse the unit. The mineralogy of the sands and pebbles primarily consists of quartz, with some feldspar. In areas to the east-southeast, sediments may become more phosphatic and dolomitic. The soils in the "Upland Unit" may contain as much as 20% to 40% clay. [DOE-EIS-0303]

SRS is comprised of seven major soil associations. They are Chastain-Tawcaw-Shellbluff, Rembert-Hornsville, Blanton-Lakeland, Fuquay-Blanton-Dothan, Orangeburg, Vaucluse-Ailey, and Troup-Pinkney-Lucy. Figure 3.1-10 delineates the general soil associations for SRS. Details regarding these associations may be found in the *Soil Survey of the Savannah River Plant Area, Parts of Aiken, Barnwell, and Allendale Counties, South Carolina.* [http://soildatamart.nrcs.usda.gov/Manuscripts/SC696/0/savannah.pdf]

Figure 3.1-10: General Soil Associations for SRS



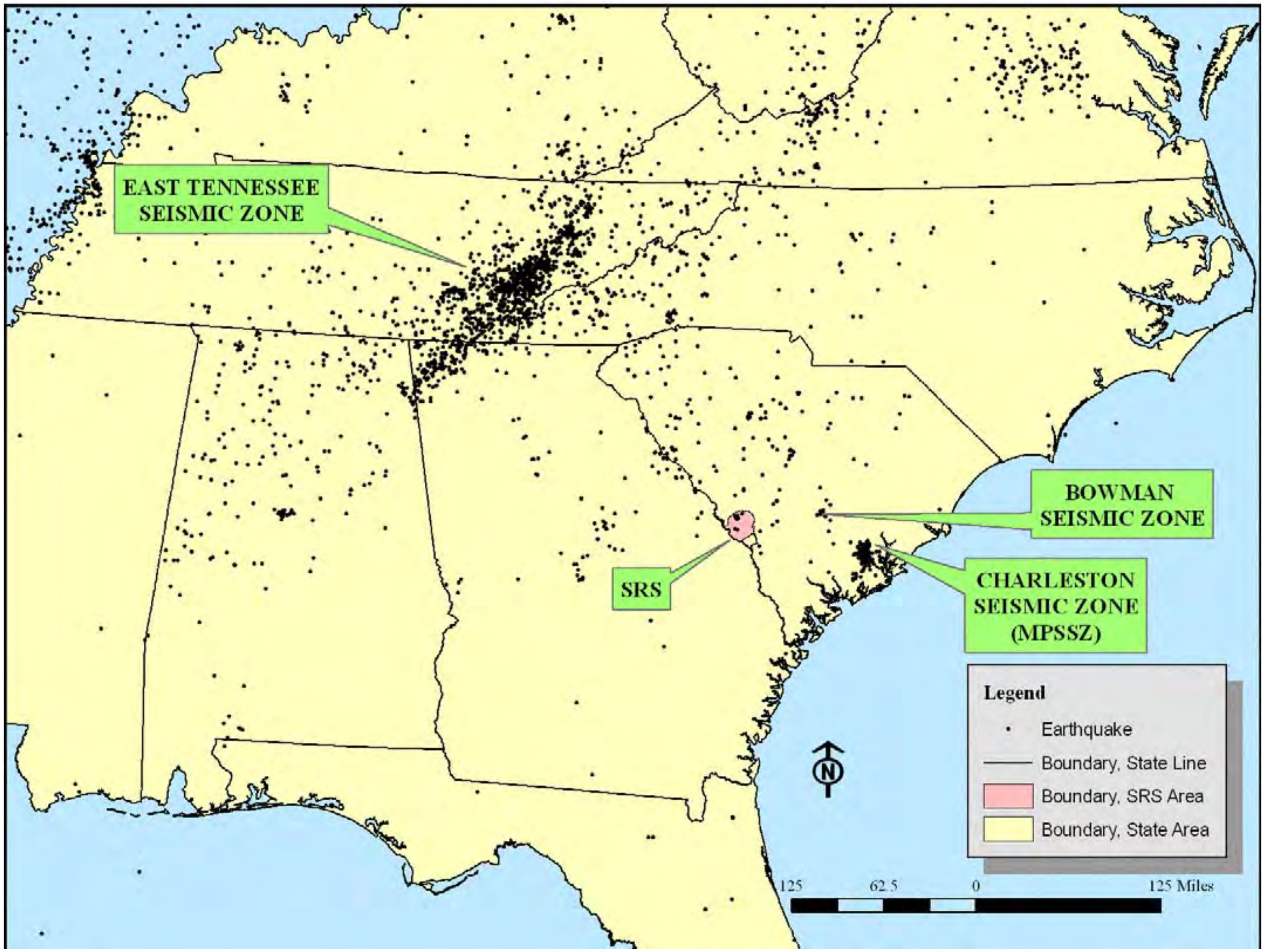
The overall general soil association for H Area is the Fuquay-Blanton-Dothan. The most predominant soil types within H Area are classified as Udorthents. Udorthents consist of well-drained soils that formed in heterogeneous materials, which are the spoil or refuse from excavations and major construction operations. Udorthents range from sandy to clayey, depending upon the source of material or geologic parent material. Udorthents are most commonly associated with well drained to excessively drained upland soils. A few small, poorly drained areas that have spoil are also included. Typical profiles for Udorthents are not shown due to the lack of consolidation within short distances. Clayey soil has demonstrated good retention for most radionuclides. There are also areas that consist of cross-bedded, poorly sorted sand with lenses and layers of silt and clay.

A more detailed description of the geology and soils of the H Area can be found in a report titled *Hydrogeologic Framework of West-Central South Carolina*. [PIT-MISC-0112]

3.1.4.3 Seismology

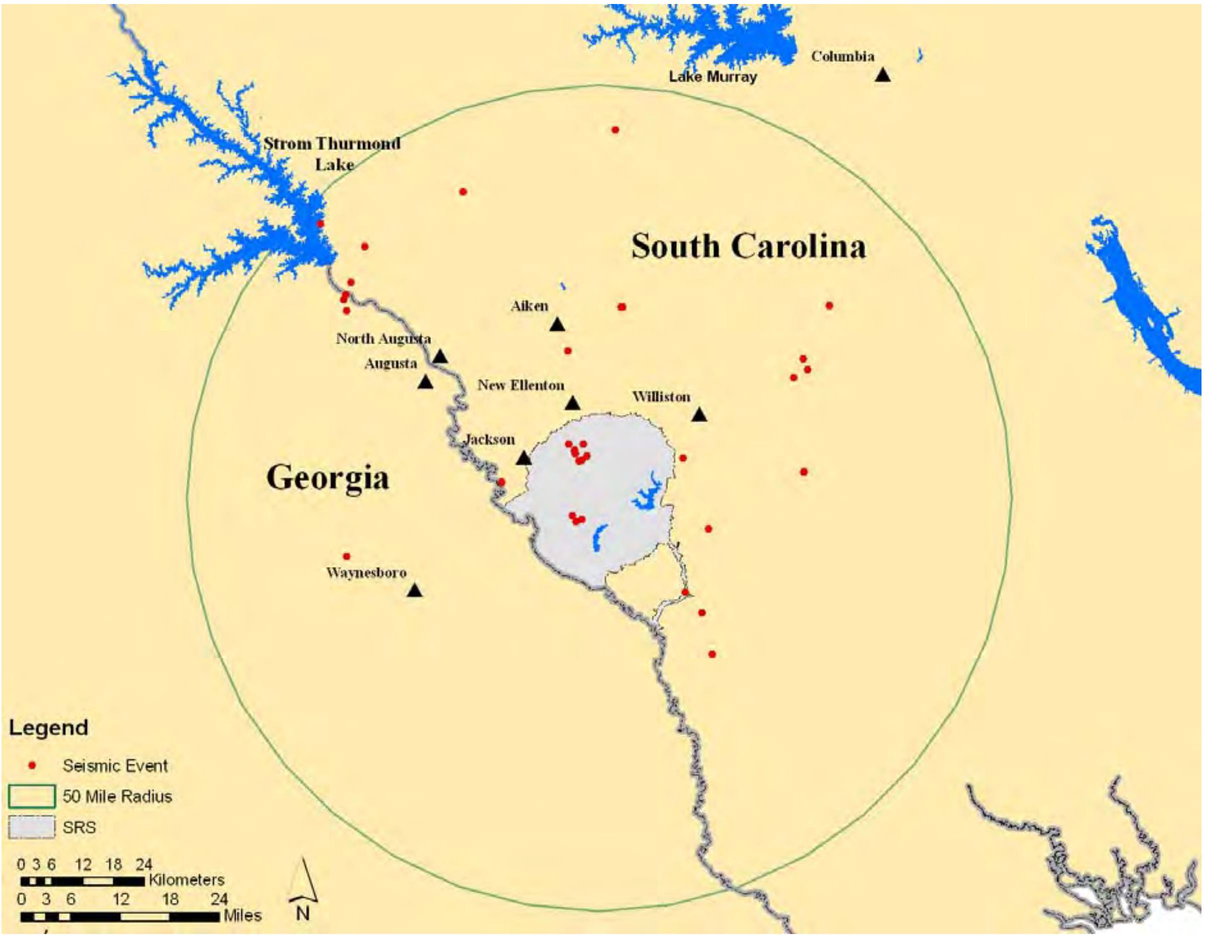
The seismic history of the Southeastern United States (of which SRS is a part) spans a period of nearly three centuries, and is dominated by the Charleston earthquake of August 31, 1886 (estimated magnitude of 7.0). The historical database for the region is essentially composed of two data sets extending back to as early as 1698. The first set is comprised of pre-network, mostly qualitative data (1698-1974), and the second set covers the relatively recent period of instrumentally recorded or post-network seismicity, 1974 through April 2009. Figure 3.1-11 shows the locations of historical seismic events in the Southeast. Figure 3.1-12 denotes the epicenter locations of seismic events within a 50-mile radius of SRS. [WSRC-MS-2003-00617, http://earthquake.usgs.gov/earthquakes/states/last_earthquake.php]

Figure 3.1-11: Historical Seismic Events in the Southeast



[http://earthquake.usgs.gov/earthquakes/states/last_earthquake.php]

Figure 3.1-12: Seismic Events within a 50-Mile Radius of SRS

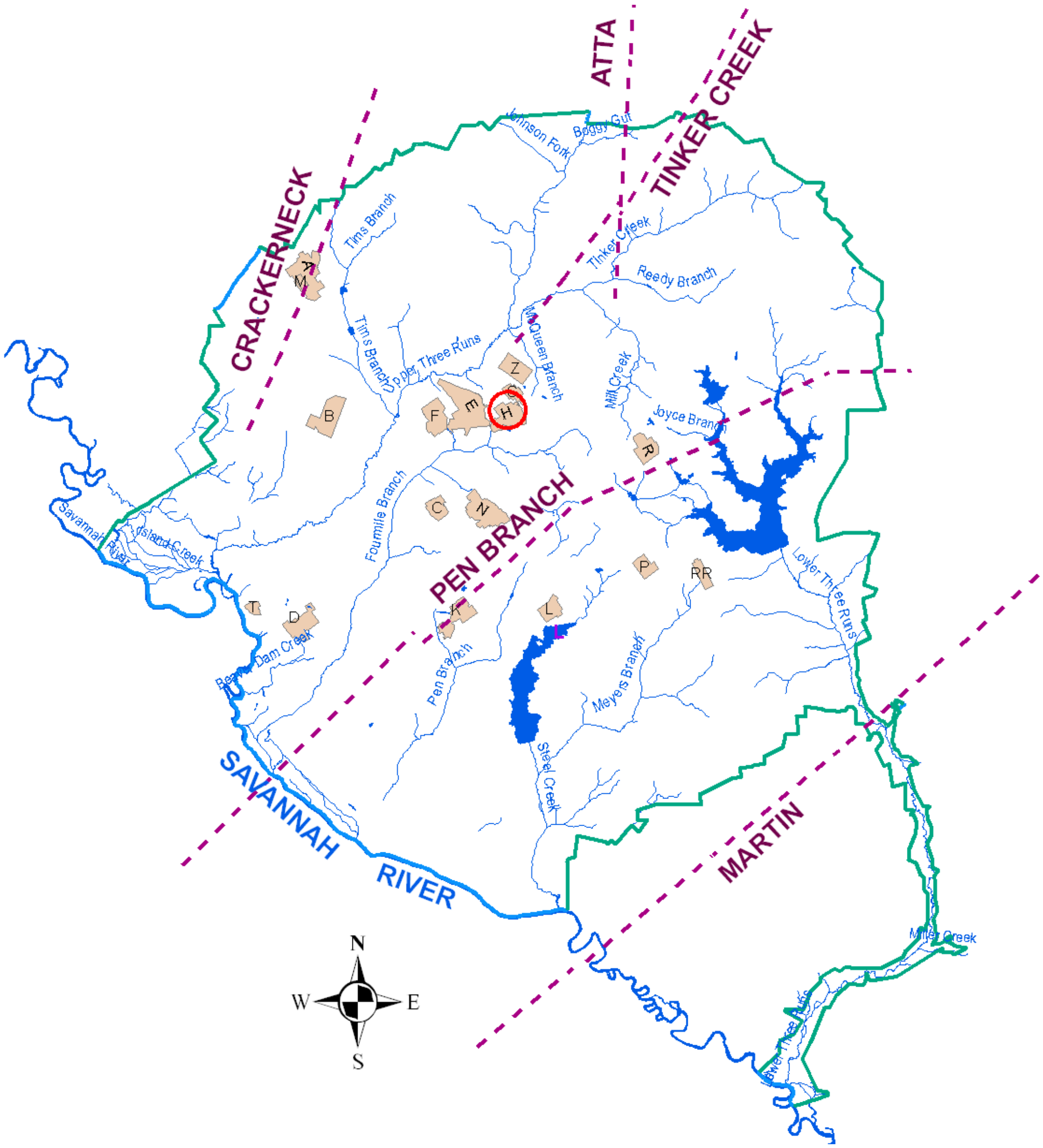


[WSRC-MS-2003-00617, http://earthquake.usgs.gov/earthquakes/states/last_earthquake.php]

The most recent seismic event occurring within a 50-mile radius of SRS was on March 27, 2009, with a magnitude of 2.6. No damage to SRS was recorded. However, there have been four earthquakes with epicenter locations within SRS. They occurred on June 9, 1985 (magnitude of 2.6) August 5, 1988 (magnitude of 2.0) May 17, 1997 (magnitude of 2.3), and October 8, 2001 (magnitude of 2.6). No Strong Motion Accelerometers (SMAs) were triggered because of these earthquakes. Note that additional seismic events with epicenter locations within SRS occurred shortly after the October 2001 earthquake however, these seismic events were attributed to aftershocks and not actual earthquakes. [WSRC-MS-2003-00617]

The regional faults within the SRS and vicinity are shown in Figure 3.1-13. A study entitled *Comparison of Cenozoic Faulting at the Savannah River Site to Fault Characteristics of the Atlantic Coast Fault Province: Implications for Fault Capability* (WSRC-TR-2000-00310) provides additional data. This study concludes that these regional faults exhibit the same general characteristics, are closely associated with the faults of the Atlantic Coastal Fault Province, and thus are part of the Atlantic Coastal Fault Province. Several faults of the Atlantic Coastal Fault Province have been the subject of detailed investigations. In all cases, the conclusion has been reached that these faults have not had a movement within the past 35,000 years and no movement of a recurring nature within the past 500,000 years. Inclusion in the Atlantic Coastal Fault Province means that the historical precedent established by decades of previous studies on the seismic hazard potential for the Atlantic Coastal Fault Province is relevant to faulting at the SRS. [WSRC-TR-2000-00310]

Figure 3.1-13: Regional Scale Faults for SRS and Vicinity



[WSRC-TR-2000-00310, Figure 10]

In 1976, a short-period seismic network was established. In 1999, a 10-station SMA network was installed throughout the complex. Detailed information regarding seismic characteristics at SRS can be found in the Documented Safety Analysis (DSA) document, WSRC-IM-2004-00008.

Seismic considerations are included in the design of the conceptual closure cap to ensure seismic induced degradation mechanisms are addressed. Section 3.2.4 discusses the conceptual closure cap design, which will appropriately consider and handle static loading induced settlement, seismic induced liquefaction and subsequent settlement, and seismic induced slope instability.

3.1.5 Hydrogeology

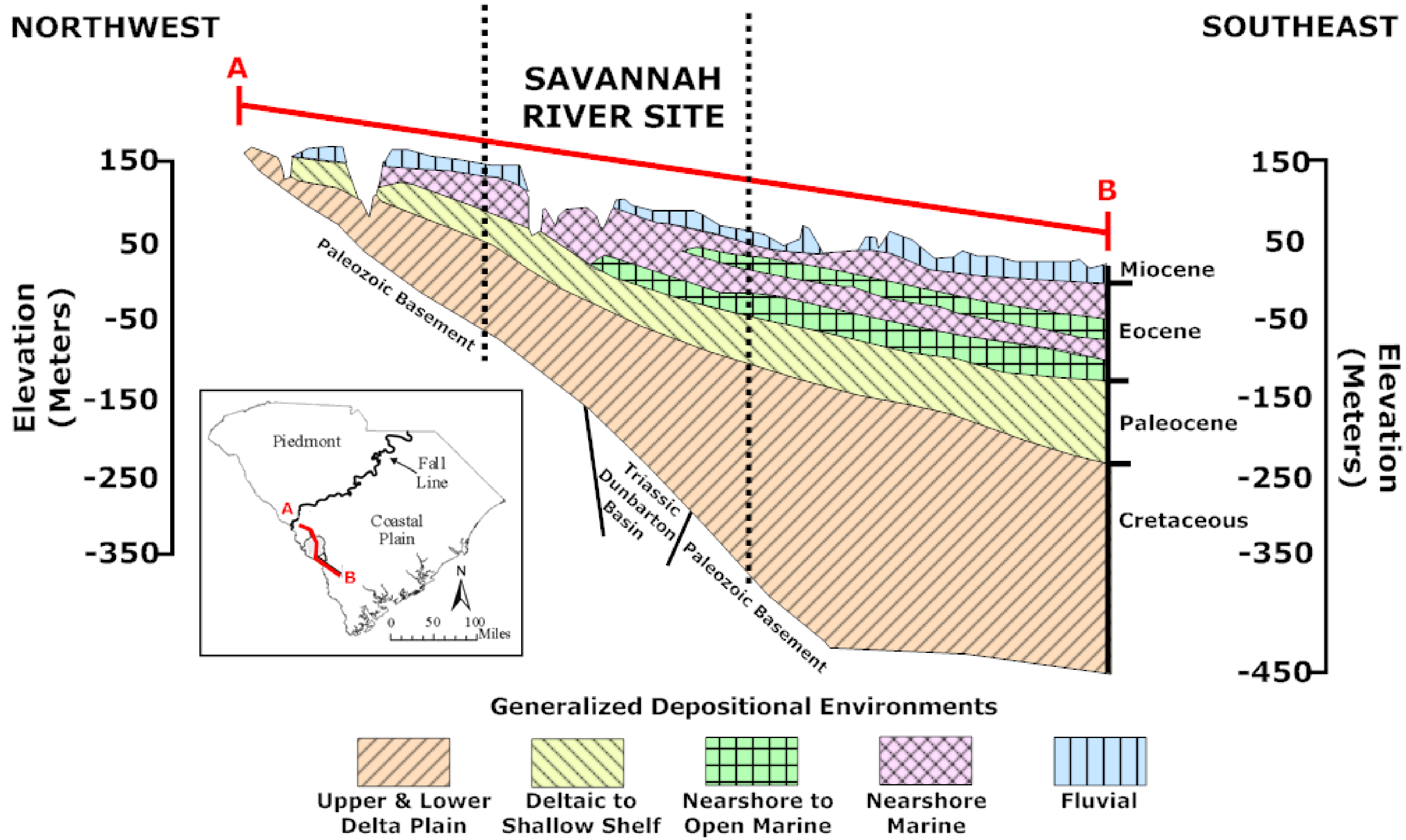
An understanding of the hydrogeology of the HTF is required in order for an estimate of the fate and transport of the residual HTF contaminants to be modeled. Characterization and monitoring data in the SRS GSA is extensive and provides a clear understanding of the hydrogeology containing the HTF, and permitted generation of the General Separations Area Database (GSAD). Additional background information supporting this conclusion is presented in Section 3.1.5.2.

3.1.5.1 Regional Hydrogeology

The SRS lies in the Atlantic Coastal Plain, a southeast-dipping wedge of unconsolidated and semi-consolidated sediment, which extends from its contact with the Piedmont Province at the Fall Line to the continental shelf edge. Sediments range in geologic age from late Cretaceous to recent and include sands, clays, limestones, and gravels. This sedimentary sequence ranges in thickness from essentially zero at the Fall Line to more than 4,000 feet at the Atlantic Coast. At SRS, coastal plain sediments thicken from approximately 700 feet at the northwestern boundary to approximately 1,400 feet at the southeastern boundary of the site and form a series of aquifers and confining or semi-confining units. Aquifer systems include the Floridian, and Dublin-Midville systems. [WSRC-STI-2006-00198]

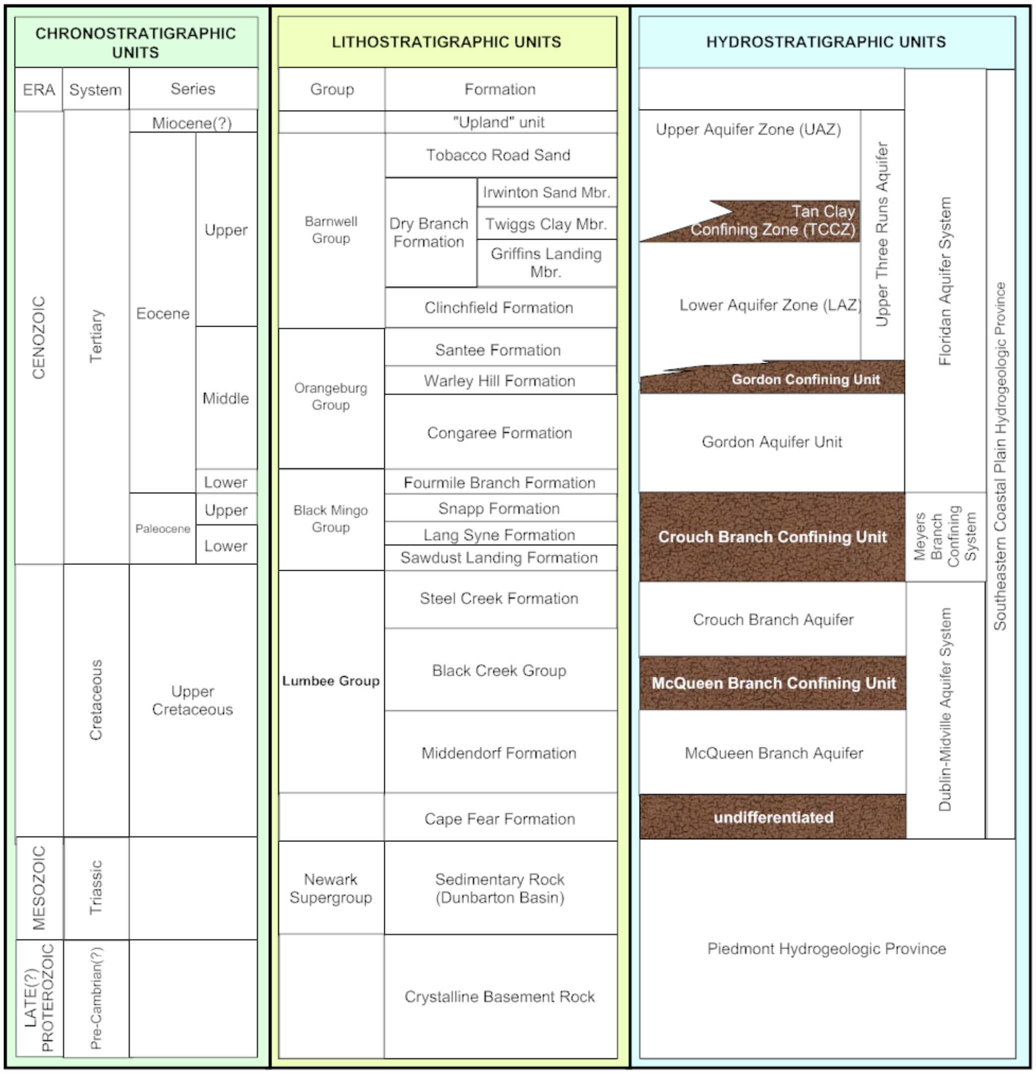
Figure 3.1-14 shows a generalized cross-section of the sedimentary strata and their corresponding depositional environments for the Upper Coastal Plain down-dip through the SRS into the Lower Coastal Plain. Figure 3.1-15 shows the regional lithologic units and their corresponding hydrostratigraphic units at the SRS. This classification system is consistent with the established system and is now widely used as the SRS standard. [SRNL-STI-2010-00148]

Figure 3.1-14: Regional NW to SE Cross Section



[WSRC-STI-2006-00198]

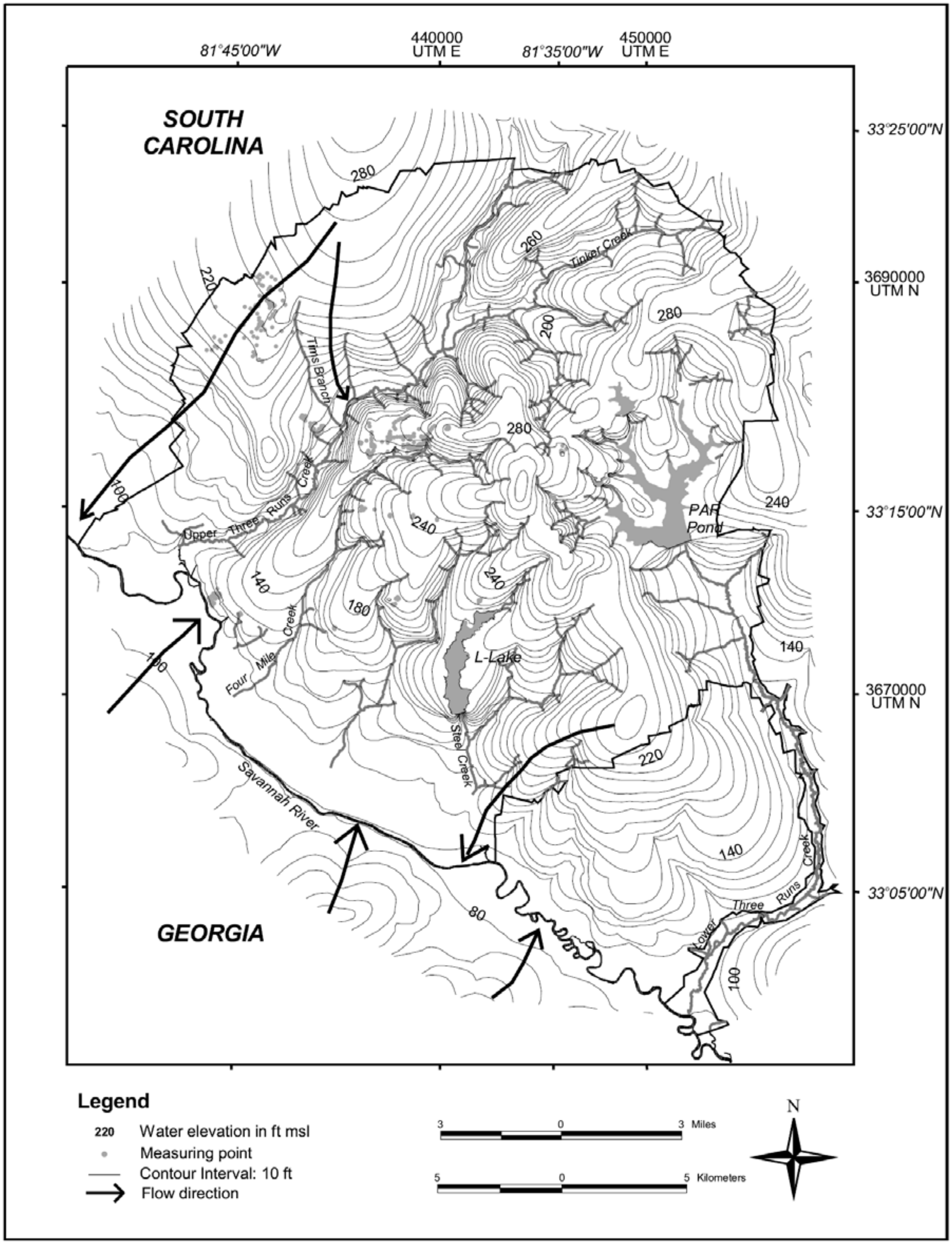
Figure 3.1-15: Comparison of Chronostratigraphic, Lithostratigraphic, and Hydrostratigraphic Units in the SRS Region



[SRNL-STI-2010-00148]

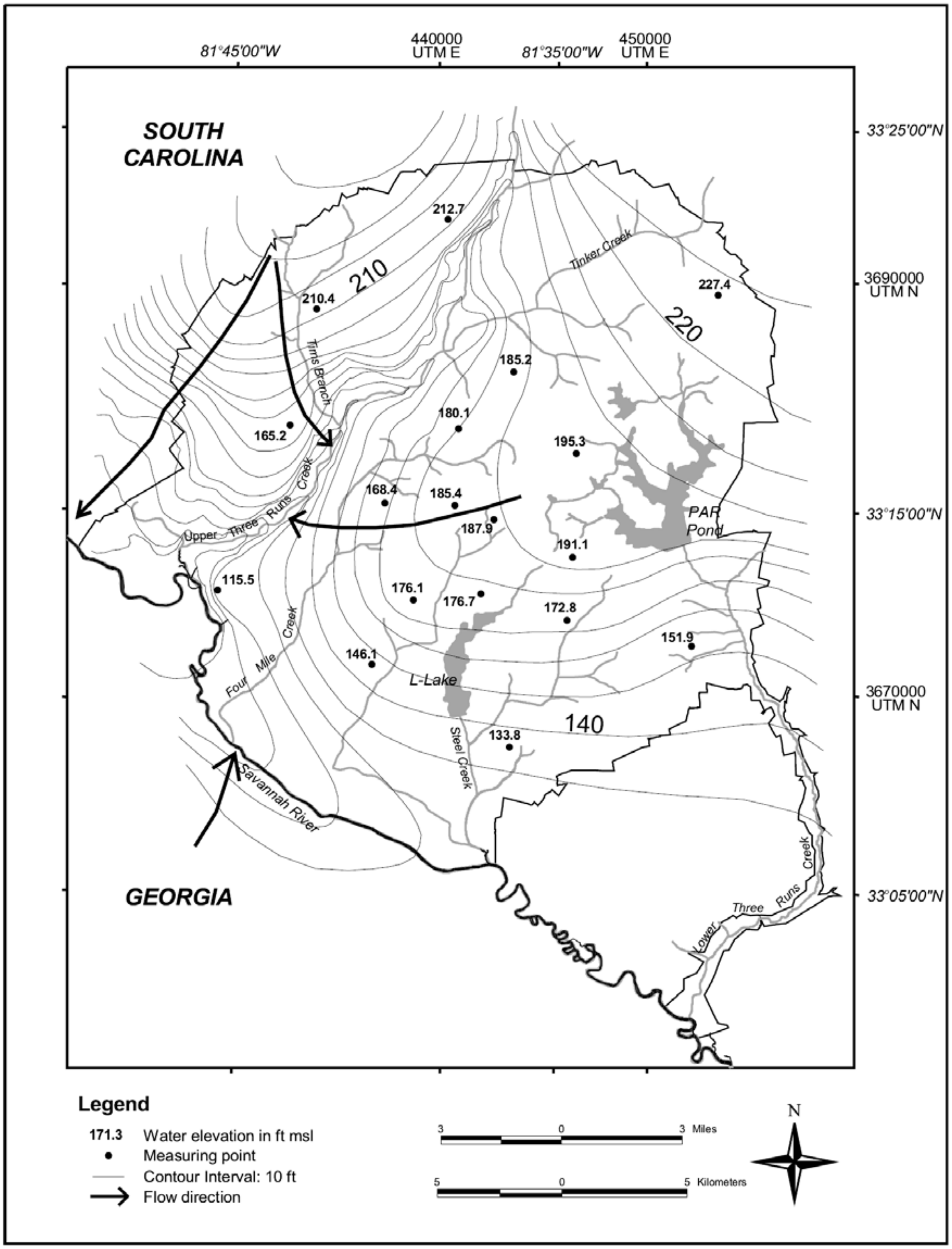
Figures 3.1-16 and 3.1-17 illustrate potentiometric maps of the UTR and The Gordon Aquifers. Groundwater within the Floridian Aquifer system flows toward streams and swamps and into the Savannah River at rates ranging from inches to several hundred feet per year. The depth to which nearby streams cut into sediments, the lithology of the sediments, and the orientation of the sediment formations control the horizontal and vertical movement of the groundwater. The valleys of smaller perennial streams in the GSA, such as Fourmile Branch, McQueen Branch, and Crouch Branch, allow discharge from the shallow saturated geologic formations. The valleys of major tributaries of the Savannah River (e.g., UTR) drain formations of greater depth. With the release of water to the streams, the hydraulic head of the aquifer unit releasing the water can become less than that of the underlying unit. If this occurs, groundwater has the potential to migrate upward from the lower unit to the overlying unit. [DOE-EIS-0303]

Figure 3.1-16: Potentiometric Surface of the UTR Aquifer



[SRNS-STI-2009-00190]

Figure 3.1-17: Potentiometric Surface of the Gordon Aquifer

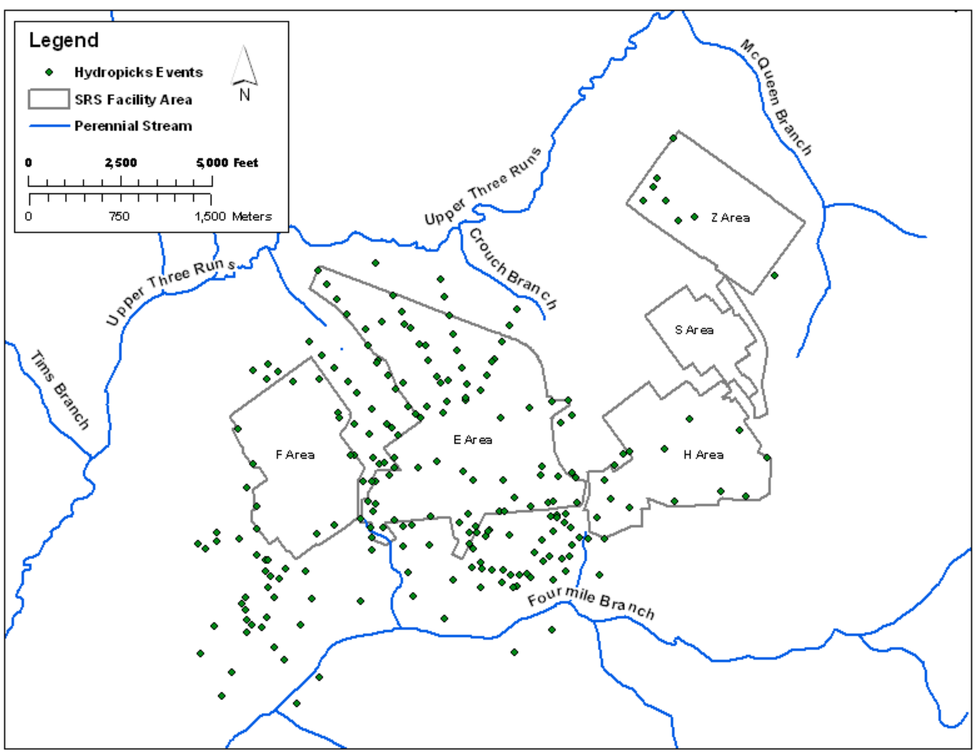


[SRNS-STI-2009-00190]

3.1.5.2 Characterization of Local Hydrogeology

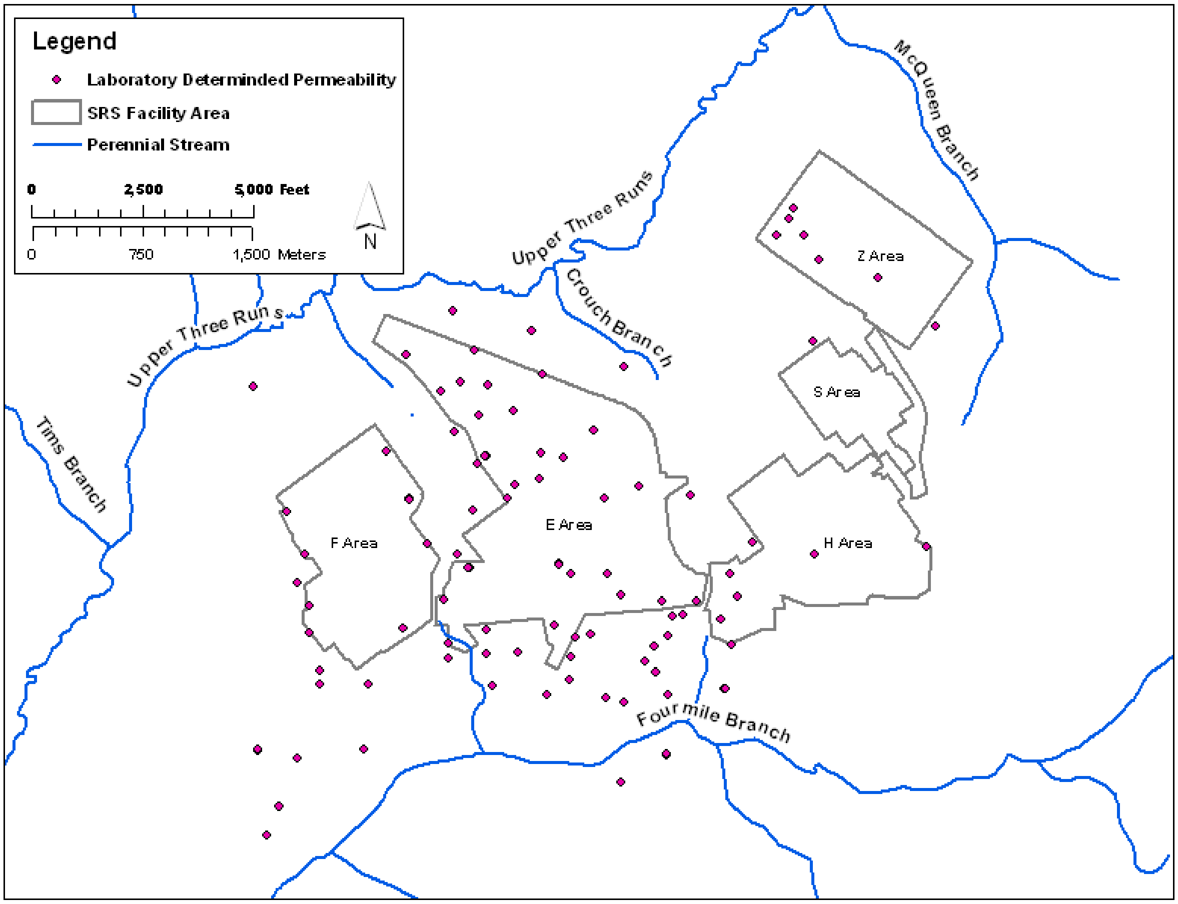
The GSA has been the focus of numerous geological and hydrogeological investigations. Early work included installation of monitoring wells in the 1950's and 1960's. Further characterization and monitoring were conducted in the area during the 1970's through present time, largely to support groundwater monitoring and decommissioning activities. The GSAD was developed using field data and interpretations for the GSA and vicinity through 1996. Although characterization and monitoring have been ongoing, the additional data has not altered fundamental understanding of groundwater flow patterns and gradients in the GSA. The GSAD is a subset of site-wide data sets of soil lithology and groundwater information. Figure 3.1-18 shows the location of all hydrostratigraphic picks used in the GSAD. Picks were made based on a combination of geophysical logs, Cone Penetration Test (CPT) logs, and core descriptions. Figures 3.1-19 through 3.1-22 show the locations of laboratory permeability data, multiple well pump tests, single well pump tests, and slug test data used in the GSAD. Table 3.1-2 presents a summary of the characterization and monitoring data in the GSAD. These data provide detailed understanding of local hydrogeology beneath the HTF. See WSRC-TR-96-0399, Volumes 1 and 2, for a more comprehensive discussion of the data set. The GSAD, comprising the SRS characterization and monitoring data and interpretations, is used as the basis of hydrogeologic input values into the computational model for groundwater flow and contaminant transport as described in Section 4.2.2.1.3.

Figure 3.1-18: Hydrostratigraphic Picks in GSAD



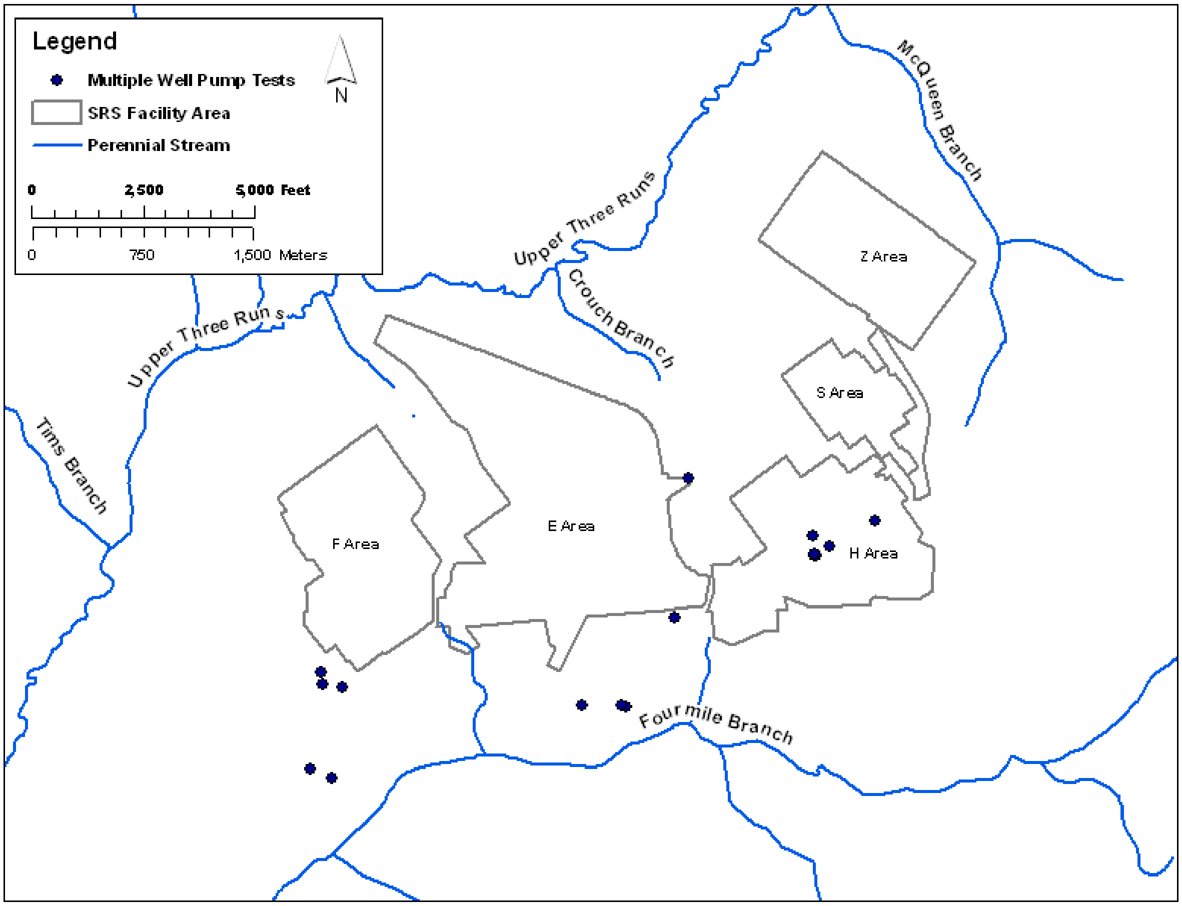
[WSRC-TR-96-0399, Vol. 1]

Figure 3.1-19: Laboratory Determined Permeability Data in GSAD



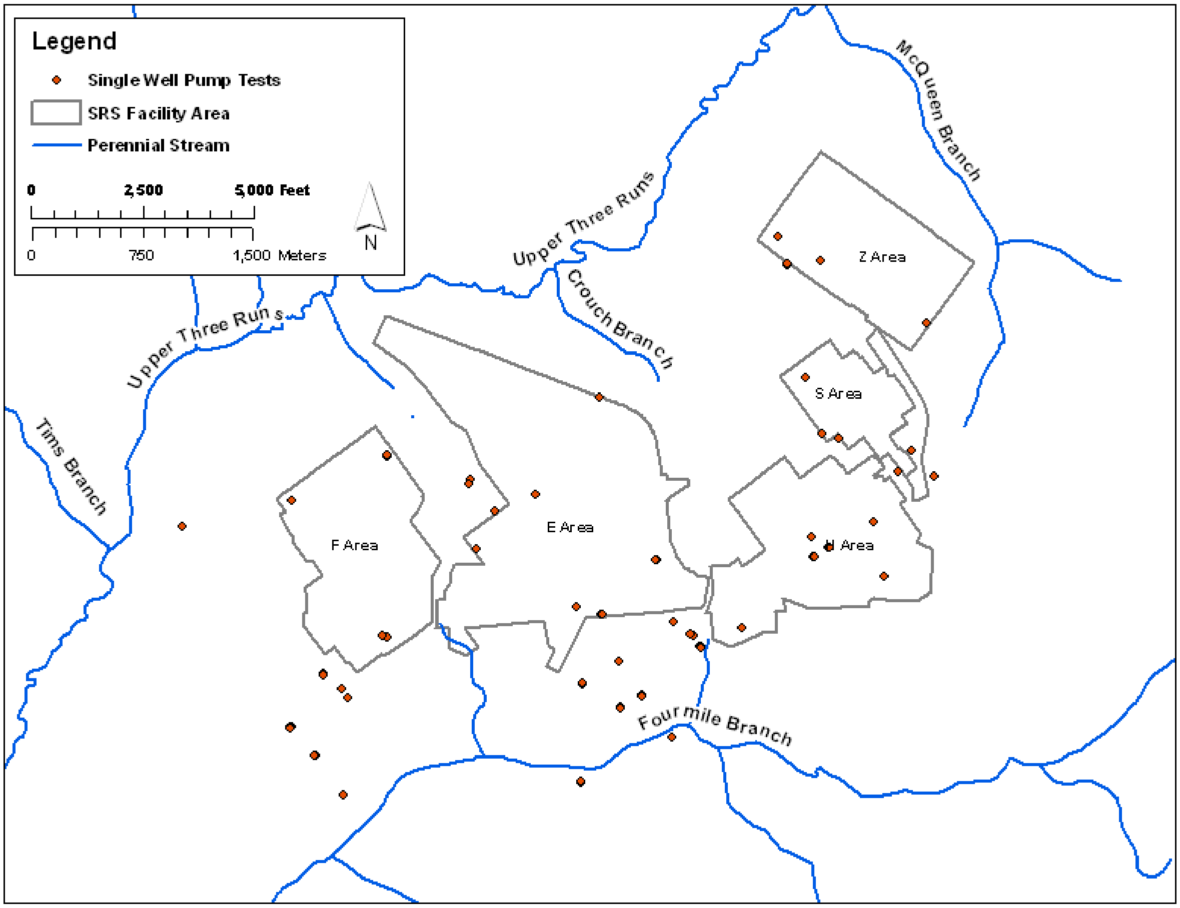
[SRNL-ESB-2007-00035]

Figure 3.1-20: Multiple Well Pump Test Data in GSAD



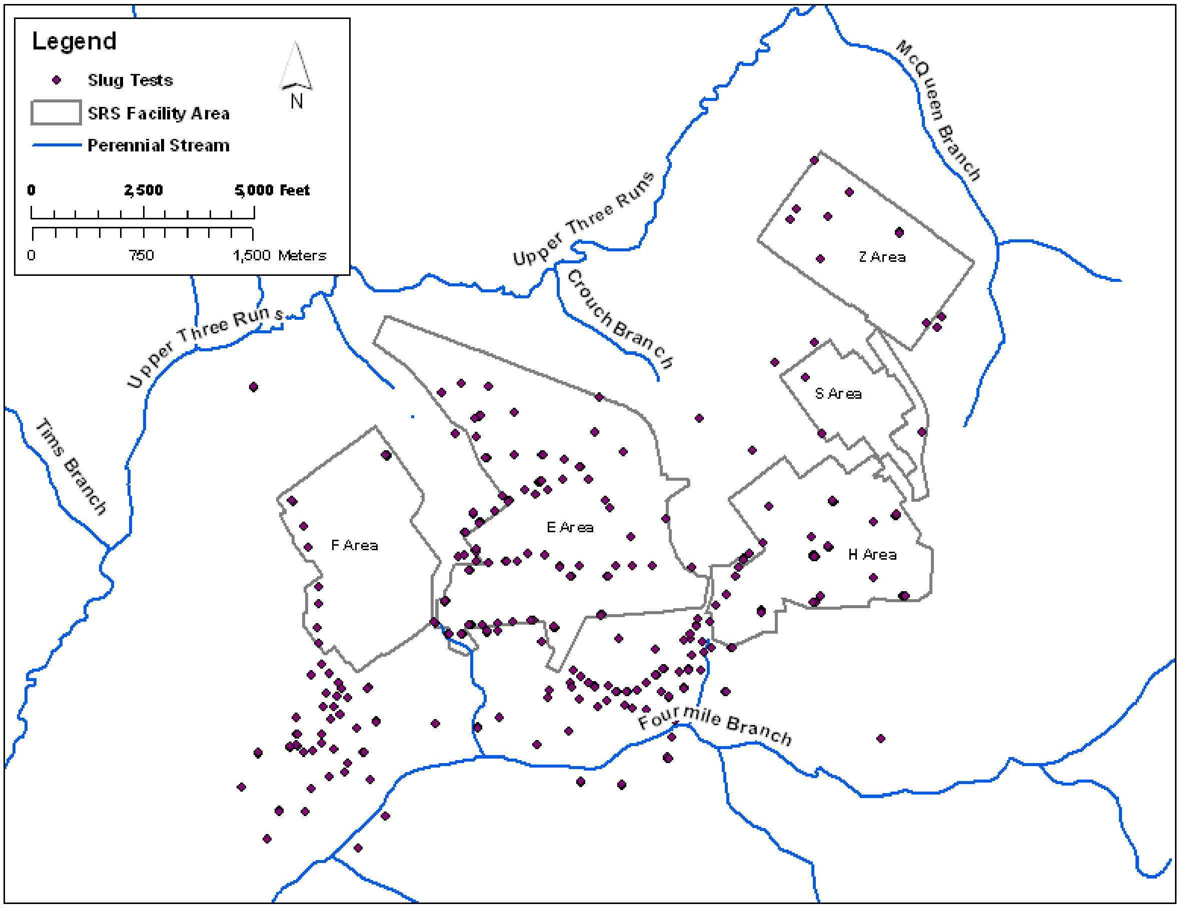
[WSRC-TR-96-0399, Vol. 2]

Figure 3.1-21: Single Well Pump Test Data in GSAD



[WSRC-TR-96-0399, Vol. 2]

Figure 3.1-22: Slug Test Data in GSAD



[WSRC-TR-96-0399, Vol. 2]

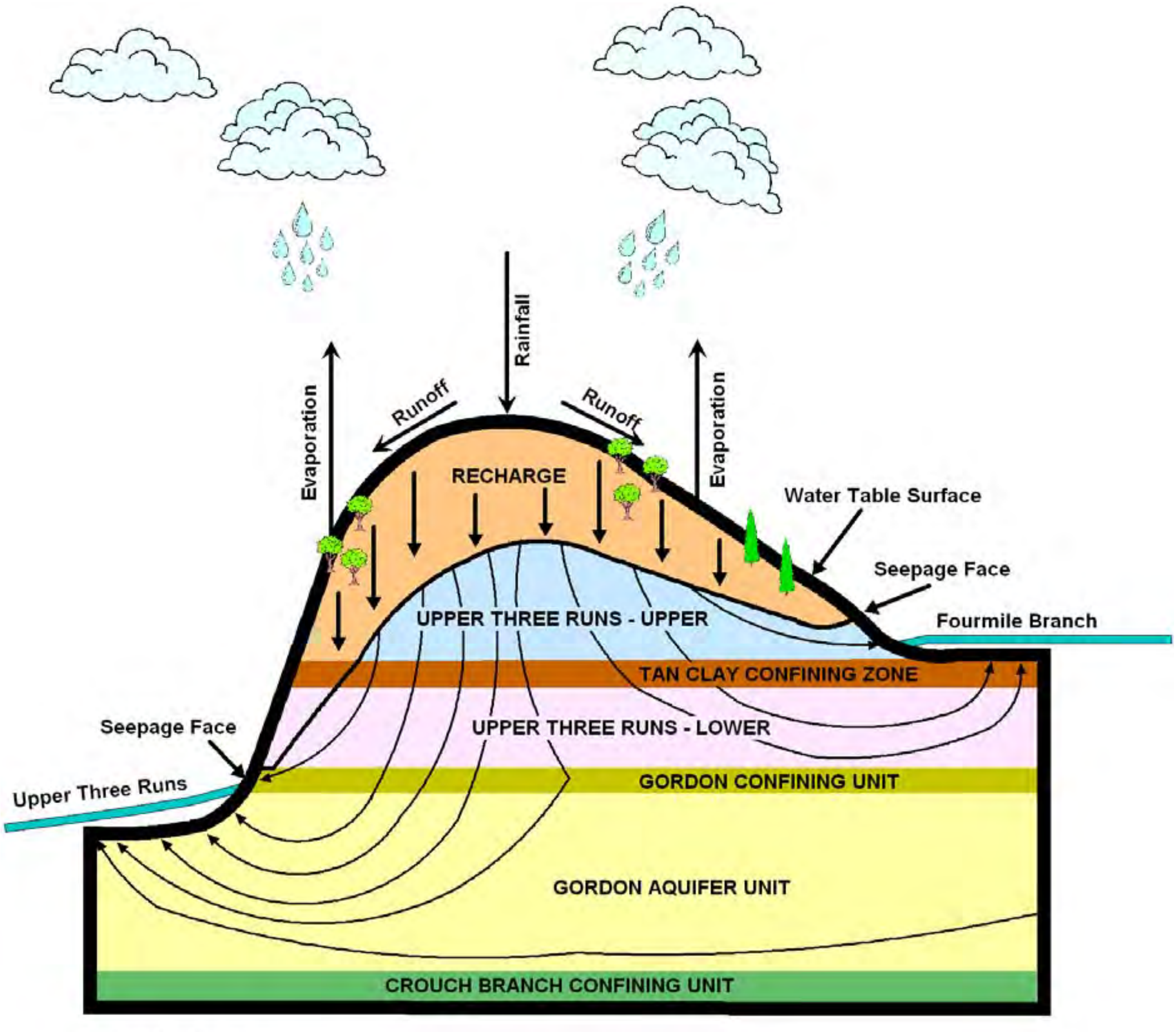
Table 3.1-2: Characterization and Monitoring Data in the GSAD

Data Type	Quantity	Reference
Sediment Core Descriptions	204 Locations; ~37,500 feet	WSRC-TR-96-0399, Vol. 1, App. B
Tops of Hydrostratigraphic Units/Zones		
Crouch Branch Confining Unit	52 Locations	WSRC-TR-96-0399, Vol. 1, App. A-3
Gordon Aquifer Unit	146 Locations	
Gordon Confining Unit	161 Locations	
UTR-Lower Zone (UTR-LZ)	222 Locations	
Tan Clay Confining Zone (TCCZ)	225 Locations	
Permeability Measurements		
Pump Tests	85 Values	WSRC-TR-96-0399, Vol. 2, App. B
Slug Tests	481 Values	
Laboratory Permeability	258 Values	
Water Levels		
Gordon Aquifer Unit	79 Locations	WSRC-TR-96-0399, Vol. 2, App. C
UTR-LZ	173 Locations	
UTR-Upper Zone (UTR-UZ)	387 Locations	

3.1.5.3 Groundwater Flow in the GSA

The aquifers of primary interest for HTF modeling are the UTR and Gordon Aquifers. Plate 17 of the *Hydrogeological Framework of West-Central South Carolina* (PIT-MISC-0112) gives the leakance of the Crouch Branch Confining Unit (of the Meyers Branch Confining System) as roughly 3E-06 per day, which corresponds to 0.13 in/yr for every 10 feet of head difference. The measurement of head difference across the Crouch Branch Confining Unit is zero to 20 feet causing an upward flow averaging 0.13 in/yr. [PIT-MISC-0112] Flow across the unit is therefore a small fraction of total recharge, and is negligible in the HTF modeling. Potential contamination from the HTF is not expected to enter the deeper Crouch Branch Aquifer because an upward gradient exists between the Crouch Branch and Gordon Aquifers near UTR. Figure 3.1-23 is a cross-sectional schematic representation of groundwater flow patterns in the UTR and Gordon Aquifers along a north-south cross-section running through the center of HTF, shown with significant vertical exaggeration. Section 4.2.2.1.3 provides the modeling inputs associated with groundwater flow characteristics obtained from the GSAD.

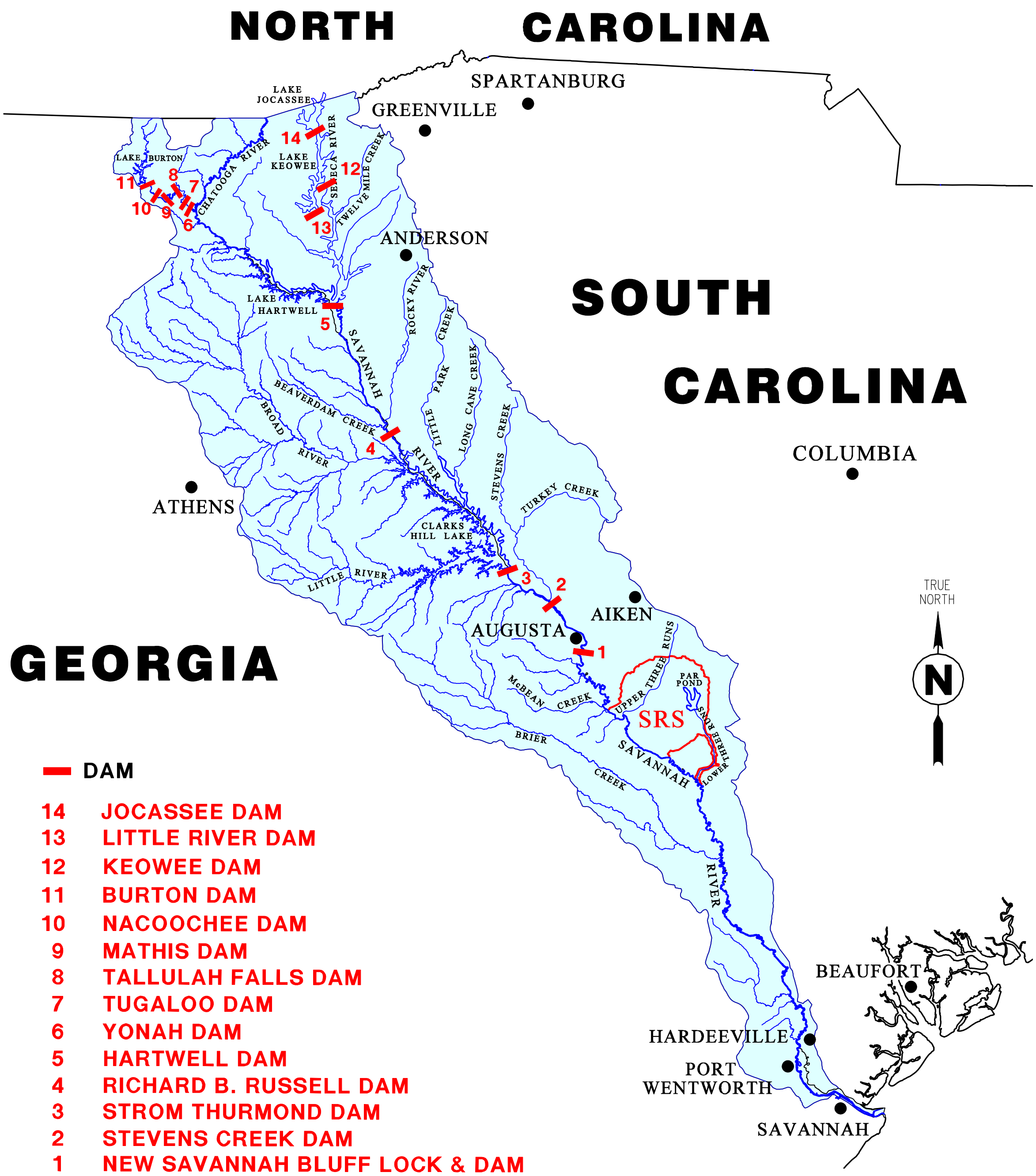
Figure 3.1-23: Conceptual Diagram of Groundwater Flow Beneath the GSA



3.1.5.4 Surface-Water Flow in the GSA

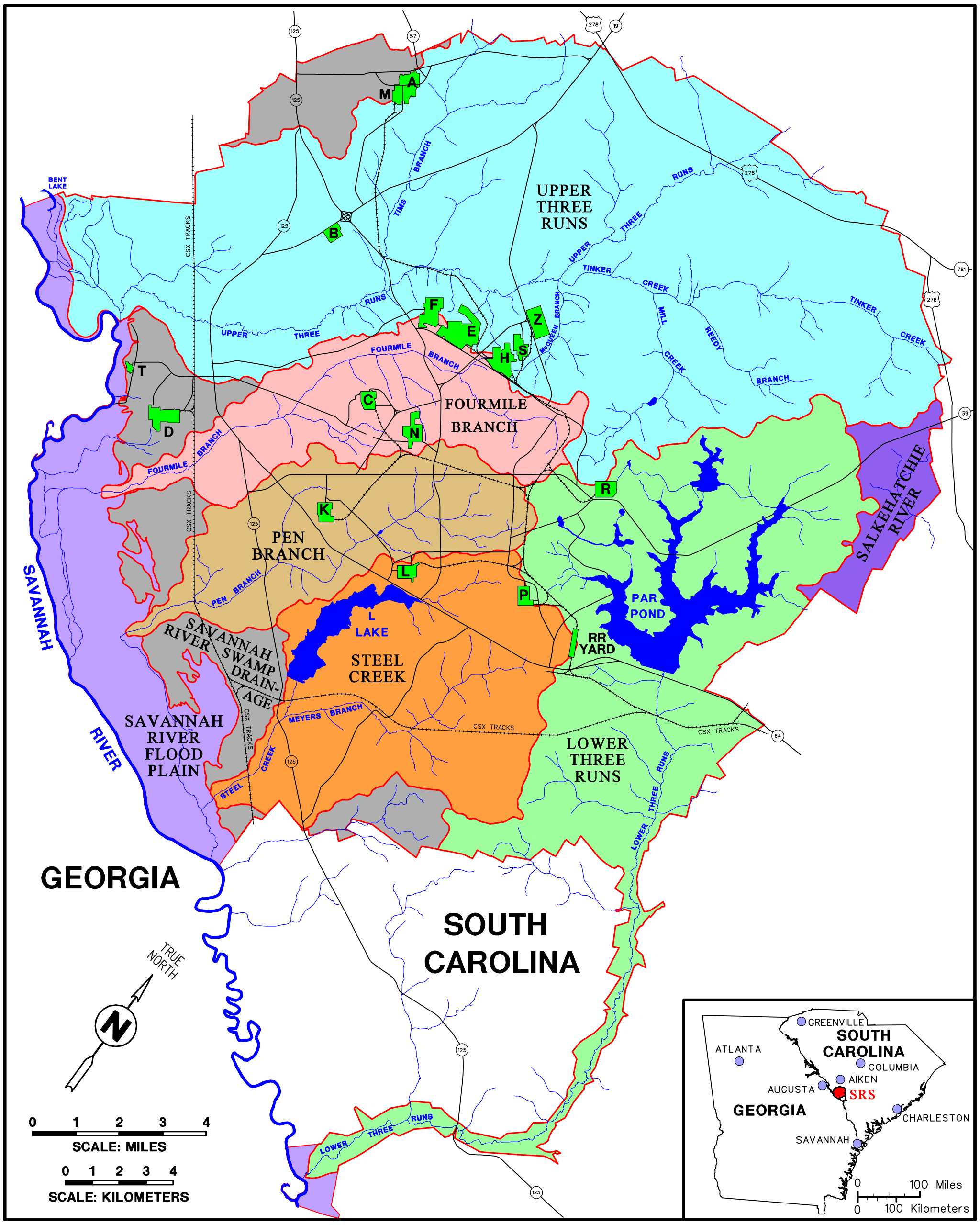
The Savannah River, which forms the boundary between Georgia and South Carolina, is the principal surface-water system near the SRS. The river adjoins the site along its southwestern boundary for a distance of approximately 20 miles and the site is 160 river-miles from the Atlantic Ocean. Five upstream reservoirs Jocassee, Keowee, Hartwell, Richard B. Russell, and Clarks Hill Lake (also known as Thurmond Lake), minimize the effects from droughts and the impacts of low flow on downstream water quality and fish and wildlife resources in the river. Figure 3.1-24 shows the Savannah River Basin dams. The long-term yearly Savannah River flow averages approximately 10,400 cubic feet per second at the SRS. [WSRC-TR-2005-00201, Table 4-24] For 2008, the annual average measured flow rate was 4,830 cubic square feet. [SRNS-STI-2009-00190]

Figure 3.1-24: Savannah River Basin Dams



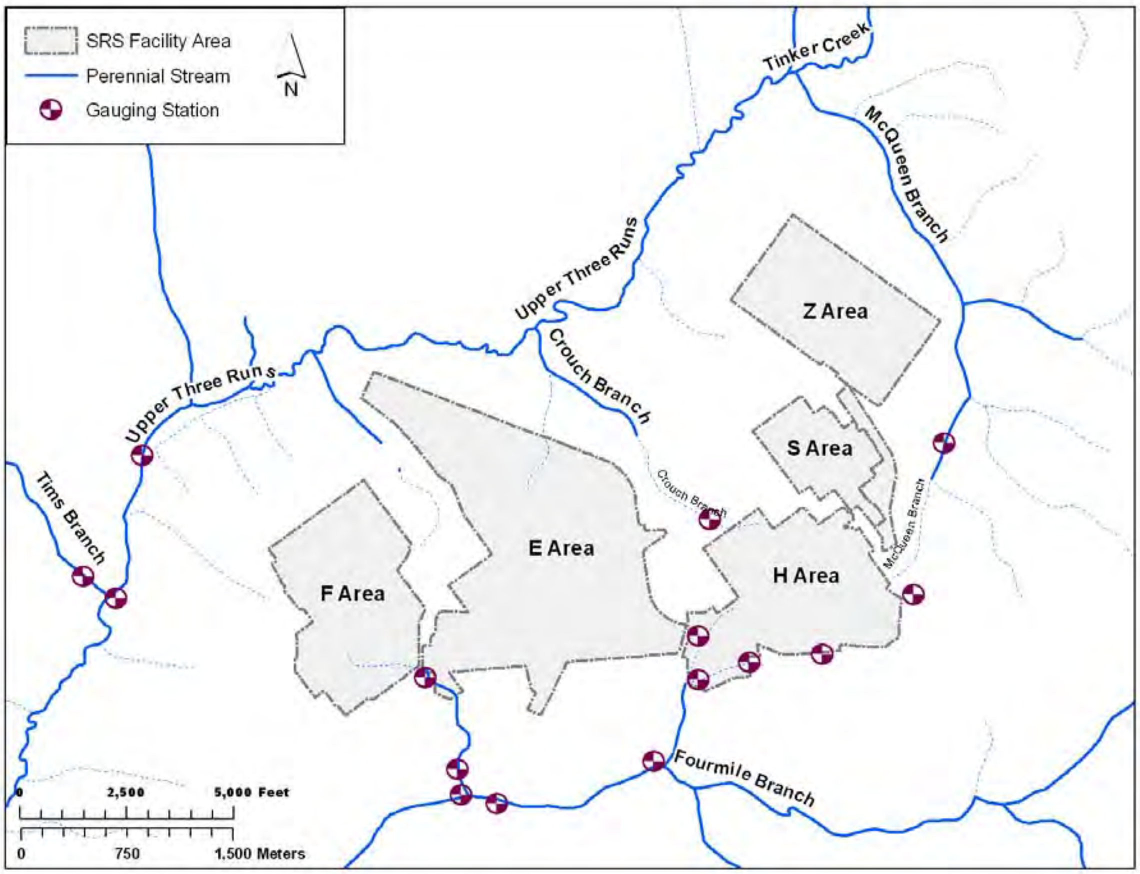
The major tributaries that occur on the SRS are UTR, Fourmile Branch, Pen Branch, Steel Creek, and Lower Three Runs (Figure 3.1-25). These tributaries drain all of SRS with the exception of a small area on the northeast side, which drains to a tributary of the Salkehatchie River. Each of these streams originates on the Aiken Plateau in the Coastal Plain and descends 50 to 200 feet before discharging into the river. The source of most of the surface water on SRS is either natural rainfall (Section 3.1.2), water pumped from the Savannah River and used for cooling site facilities, or groundwater discharging to surface streams. The streams, which historically have received varying amounts of effluent from SRS operations, are not commercial sources of water. Downstream of the SRS, the river supplies domestic water and is used for commercial and sport fishing, boating, and other recreational activities. [DOE-EIS-0303]

Figure 3.1-25: Savannah River Site Watershed Boundaries and Major Tributaries



The natural flow of the SRS streams range from eight cubic square feet in smaller streams to 245 cubic square feet in UTR. [WSRC-IM-2004-00008] Gauging stations located in the GSA (Figure 3.1-26) monitor flows for UTR and Fourmile Branch. Both Fourmile Branch and UTR are measured monthly for water flow, temperature, and quality. The annual *Savannah River Site Environmental Report for 2008* contains detailed information on flow rates and water quality of the Savannah River and the SRS streams. [SRNS-STI-2009-00190]

Figure 3.1-26: GSA Gauging Stations



The SCDHEC regulates the physical properties and concentrations of chemicals and metals in the SRS effluents under the National Pollutant Discharge Elimination System (NPDES) program. Also regulated by SCDHEC, biological Water Quality Standards (WQS) for the SRS waters have classified the Savannah River and SRS streams as "Freshwaters." [DOE-EIS-0303] Freshwaters are described as suitable for primary and secondary contact recreation and as a source for drinking water supply after treatment in accordance with SCDHEC requirements. Freshwaters are suitable for fishing, for the survival and propagation of a balanced indigenous aquatic community of fauna and flora, and for industrial and agricultural uses. [SCDHEC R.61-68]

The longest of SRS streams, UTR, is a large blackwater stream in the northern part of the SRS that discharges to the Savannah River. It drains an area of over 195 square miles and is approximately 25 miles long, with its lower 17 miles within the SRS boundaries. This stream receives more water from underground sources than other SRS streams and is the only stream with headwaters arising outside the site. The UTR is the only major tributary on the SRS that has not received thermal discharges. The UTR valley has meandering channels, especially in the lower reaches, and its floodplain ranges in width from 0.25 to 1 mile. It has a steep southeastern side and gently sloping northwestern sides. [DOE-EIS-0303]

Fourmile Branch is a blackwater stream that originates near the center of the SRS and flows southwest for 15 miles before emptying into the Savannah River. It drains an area of approximately 22 square miles inside the SRS including much of F, H, and C Areas. Fourmile Branch flow is generally perpendicular to the Savannah River behind natural levees and enters the river through a breach downstream from Beaver Dam Creek. In its lower reaches, Fourmile Branch broadens and flows via braided channels through a delta formed by the deposition of sediments eroded from upstream during high flows. Downstream from the delta, the channels rejoin into one main channel. Most of the flow discharges into the Savannah River while a small portion flows west and enters Beaver Dam Creek. The valley is V-shaped, with sides varying from steep to gently sloping. The floodplain is up to 1,000 feet wide. [DOE-EIS-0303]

Flood hazard recurrence frequencies have been calculated for the various SRS site areas. The calculated flood water levels for Fourmile Branch near H Area, for the probability of 100-year, 1,000-year, and 10,000-year returns are about 234.3, 235.2, and 235.8 feet above mean sea level (MSL), respectively. As shown in Section 3.2, the lowest elevation of any waste tank basemat in HTF is 239.9 feet above MSL; thus, the highest flood water level of approximately 236 feet above MSL is below the lowest elevation of residual radioactive material. In addition, the lowest elevation of the lower foundation layer of the proposed closure cap is 280 feet above MSL, which is about 44 feet above the highest flood water level of 236 feet. Therefore, flooding will not affect the HTF and is therefore not considered in this PA. [WSRC-TR-99-00369, SRNL-ESB-2008-00023]

3.1.6 Geochemistry

The migration of radionuclides in the subsurface environment is dependent on physical and chemical parameters or properties of cementitious materials, soils, and groundwater. Studies and analyses have been conducted to determine appropriate distribution coefficient values. The data used in the radionuclide transport model is presented in Sections 4.2.2 and 4.2.3.2 specific to the GSA and is not reproduced in this section.

3.1.7 Natural Resources

Natural resources at SRS are managed under the *Natural Resources Management Plan for the Savannah River Site* (NRMP) prepared for the DOE by the U.S. Department of Agriculture (USDA) Forest Service - Savannah River. [NRMP-2005] The NRMP, which governs the SRS natural resource management was updated in May 2005 and fosters the following principles:

- All work will be done in accordance with integrated safety management components found in DOE Policy 450.4, *Safety Management System Policy*
- Environmental stewardship activities will be compatible with future SRS missions

- The SRS will continue to protect and manage SRS natural resources
- Sustainable resource management will be applied to SRS natural resources
- Close cooperation will be maintained among organizations when managing and protecting the SRS natural resources
- The results of research, monitoring, and operational findings will be used in the management of SRS natural resources
- Restoration of native communities and species will continue
- Employees, customers, stakeholders, state natural resource officials, and regulators will be invited to participate in the natural resource planning process
- The SRS will maintain the area as a National Environmental Research Park (NERP)

3.1.7.1 Water Resources

The SRS monitors non-radioactive liquid discharges to surface waters through the NPDES, as mandated by the Clean Water Act (CWA). As required by EPA and SCDHEC, SRS has NPDES permits in place for discharges to the waters of the United States and South Carolina. These permits establish the specific sites to be monitored, parameters to be tested, and monitoring frequency, as well as analytical, reporting, and collection methods. [SRNS-STI-2009-00190] Continuous surveillance monitoring of site streams occurs downstream of several process areas to detect and quantify levels of radioactivity in effluents transported to the Savannah River. [SRNS-STI-2009-00190]

Table 3.1-3 characterizes Savannah River water quality both upstream and downstream of the SRS. Table 3.1-4 characterizes water quality in UTR and Fourmile Branch downstream of the GSA.

Table 3.1-3: Water Quality in the Savannah River Upstream and Downstream from SRS (Calendar Year 2008)

Parameter	Unit of Measure	Upstream [b]		Downstream [c]	
		Minimum	Maximum [a]	Minimum	Maximum [a]
Aluminum	mg/L	0.035	0.42	0.077	0.49
Cadmium	mg/L	ND	ND	ND	ND
Chromium	mg/L	ND	ND	ND	ND
Copper	mg/L	ND	0.0013	ND	0.0038
Dissolved Oxygen	mg/L	5.5	9.0	2.5	12.6
Gross Alpha Radioactivity	pCi/L	ND	5.68	ND	1.52
Lead	mg/L	ND	0.0016	ND	0.0016
Mercury	mg/L	ND	ND	ND	0.000025
Nickel	mg/L	ND	ND	ND	0.0027
Nitrate (as N)	mg/L	0.16	0.4	0.17	0.39
PH	pH units	6.1	6.9	5.1	7.4
Phosphate	mg/L	0.13	0.31	0.11	0.23
Suspended solids	mg/L	2	7	5	12
Temperature	°F	52.0	79.0	52.3	83.3
Tritium	pCi/L	ND	527	174	2,370
Zinc	mg/L	ND	0.0092	ND	0.017

Notes: Information extracted from SRNS-STI-2009-00190 accompanying data files. Parameters are those the DOE routinely measures as a regulatory requirement or as part of ongoing monitoring programs.
a The maximum listed concentration is the highest single result found during one sampling event
b Data from sampling location RM-160 (SRNS-STI-2009-00190 Figure 2)
c Data from sampling location RM-118.8 (SRNS-STI-2009-00190 Figure 2)
ND = non-detectable

Table 3.1-4: Water Quality in Selected SRS Streams (Calendar Year 2008)

	Temperature (°F)	pH	Dissolved Oxygen (mg/L)	Total Suspended Solids (mg/L)
Sampling Location: Fourmile Branch (Downstream from GSA)[a]				
Mean	63.3	6.8	8.4	2.8
Range	44.4 - 76.5	5.7 - 7.4	6.2 - 10.5	1 - 5
Sampling Location: UTR (Downstream from GSA)[b]				
Mean	63.1	6.4	8.0	6.4
Range	47.1 - 78.6	5.3 - 7.5	6.4 - 11.1	3 - 14

Notes: All data extracted from SRNS-STI-2009-00190 accompanying data files
a Stream sample location FM-6 (SRNS-STI-2009-00190 Figure 2)
b Stream sample location U3R-4 (SRNS-STI-2009-00190 Figure 2)

3.1.7.1.1 Groundwater

The Federal Safe Drinking Water Act (SDWA) was enacted in 1974 to protect public drinking water supplies. The SRS domestic water is supplied by 17 separate systems, all of which utilize groundwater sources. The A-Area, D-Area, and K-Area systems are actively regulated by SCDHEC, while the remaining smaller water systems receive a reduced level of regulatory oversight. [SRNS-STI-2009-00190]

Table 3.1-5 provides the summary of maximum groundwater monitoring results for those areas that most likely discharge to UTR or Fourmile Branch obtained from the *Savannah River Site Environmental Report for 2008*. [SRNS-STI-2009-00190] The groundwater in these areas is not being consumed and active remediation projects are in progress to address the groundwater conditions.

Table 3.1-5: Well Monitoring Results for Major Areas within SRS, 2007-2008

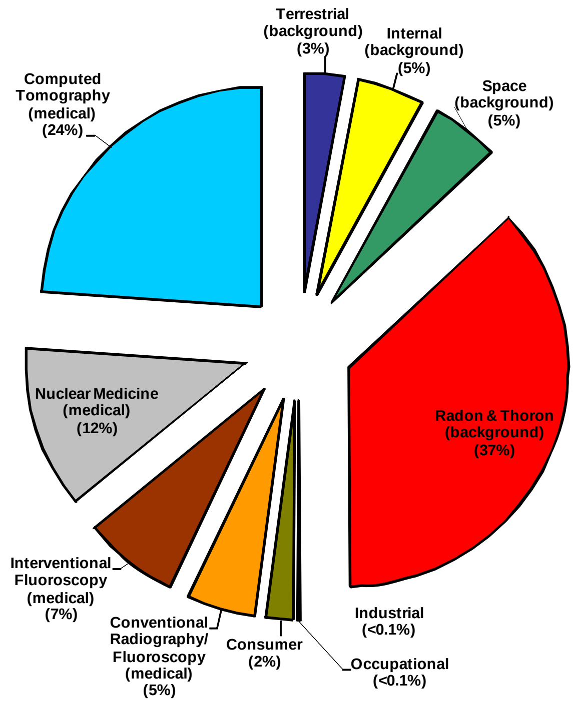
Location	Major Contaminants	Units	2007 Maximum	MCL	2008 Maximum	Likely Outcrop Point
E Area	Tritium TCE	pCi/L ppb	30,800,000 370	20,000 0.5	29,200,000 460	UTR/Crouch Branch in North; Fourmile Branch in South
F Area	TCE Tritium Gross alpha Beta	ppb pCi/L pCi/L pCi/L	52.2 73,000 2,120 380	5.0 20,000 15 4 mrem/yr[a]	60 130,000 1,470 628	UTR/Crouch Branch in North; Fourmile Branch in South
F-Area Seepage Basin	Tritium Gross alpha Beta	pCi/L pCi/L pCi/L	5,710,000 523 1,870	20,000 15 4 mrem/yr[a]	4,810,000 777 2,100	Fourmile Branch
H Area	Tritium Gross alpha Beta	pCi/L pCi/L pCi/L	67,200 25.5 55.6	20,000 15 4 mrem/yr[a]	74,800 14.9 81.9	UTR/Crouch Branch in North; Fourmile Branch in South
H-Area Seepage Basins	Tritium Gross alpha Beta	pCi/L pCi/L pCi/L	3,020,000 88.4 2,970	20,000 15 4 mrem/yr[a]	3,120,000 85 2,050	Fourmile Branch

a The activity (pCi/L) equivalent to 4 mrem/yr varies according to which specific beta emitters are present in the sample. [SRNS-STI-2009-00190]

3.1.8 Natural and Background Radiation

All human beings are exposed to sources of ionizing radiation that include naturally occurring and man-made sources. Individual's average dose contribution estimates from various sources were obtained from the review information presented in National Council on Radiation Protection and Measurements (NCRP) Report 160 and are shown in Figure 3.1-27. On average, a person living in either the United States or the Central Savannah River Area (CSRA) receives approximately the same annual radiation dose of 620 mrem/yr. [NCRP-160] The dose from SRS operations to the maximally exposed offsite individual during calendar year 2008 was estimated to be 0.12 millirem. [SRNS-STI-2009-00190]

Figure 3.1-27: Major Sources of Radiation Exposure Near SRS

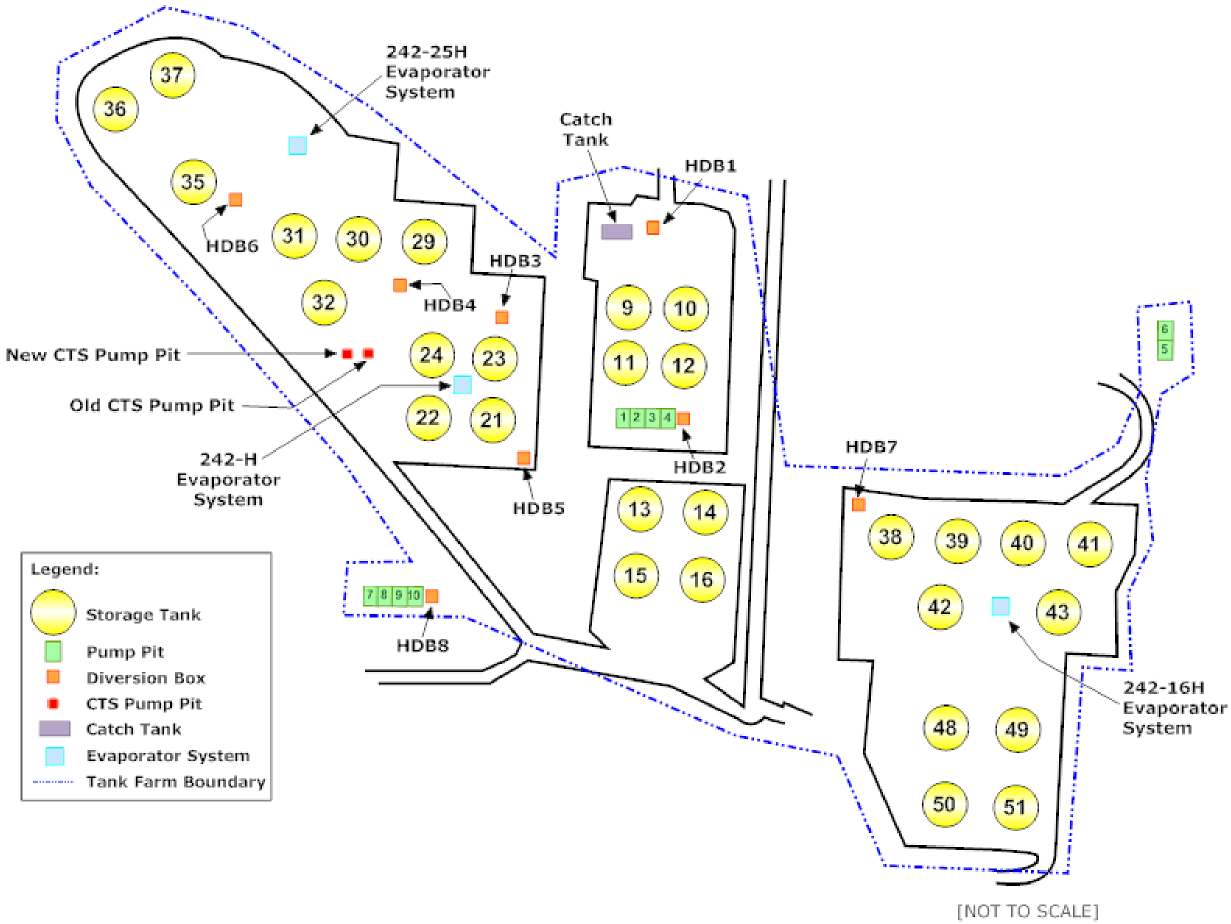


The major source of radiation exposure to an average MOP in the CSRA is attributed to naturally occurring radiation (311 mrem/yr) and medical exposure (300 mrem/yr). This naturally occurring radiation is often referred to as natural background radiation and includes dose from background radon and its decay products (228 mrem/yr), cosmic radiation (33 mrem/yr), internal radionuclides occurring naturally in the body (29 mrem/yr), and natural radioactive material in the ground (21 mrem/yr). The dominant medical sources include dose from computed tomography (147 mrem/yr), nuclear medicine (77 mrem/yr), and radiography/fluoroscopy (77 mrem/yr). The remainder of the dose is from consumer products (13 mrem/yr), industrial/educational/research activities (< 1 mrem/yr), and occupational exposure (< 1 mrem/yr). [NCRP-160]

3.2 Principal Facility Design Features

The HTF occupies a 45-acre site within an area of the SRS commonly referred to as the GSA, which encompasses E, F, H, J, S, and Z Areas (Figure 3.1-9). The HTF consists principally of three control rooms, approximately 74,800 feet of transfer lines, 10 PPs (each has one pump tank except HPP-1 which has none), two concentrate transfer system (CTS) PPs, one catch tank, three evaporators, and 29 waste tanks (Figure 3.2-1).

Figure 3.2-1: Layout of HTF Including Ancillary Equipment



In order to model the potential risk associated with the HTF stabilized contaminant inventory expected to remain after the closure of the HTF, locations with the potential for stabilized contaminant retention and the design features affecting those locations were identified. There are two primary categories of facility design with the potential for stabilized contaminant retention in the HTF 1) waste tanks and 2) ancillary equipment.

Waste tanks refer to the 29 subsurface carbon steel tanks in the HTF designed for storing aqueous liquid wastes. Ancillary equipment refers to the other equipment used in the HTF to transfer waste (e.g., transfer lines, pump tanks) and reduce waste volume through evaporation (e.g., the evaporator systems).

3.2.1 Waste Tanks

There are 29 waste tanks in HTF. The waste tanks are all built of carbon steel and reinforced concrete, but the designs vary. There are four principal types of waste tanks in the HTF, designated as Type I, II, III/IIIA, and IV tanks. The waste tanks were constructed at different times during which design features were improved on. Waste tank design types are covered in Sections 3.2.1.1 through 3.2.1.4

The HTF waste tank numbering along with their design type is as follows:

- Type I: Tanks 9 through 12
- Type II: Tanks 13 through 16
- Type IV: Tanks 21 through 24
- Type III: Tanks 29 through 32
- Type IIIA: Tanks 35 through 43 and 48 through 51

The HTF waste tank locations (North and East coordinates) and working slab top elevations are summarized in Table 3.2-1.

Table 3.2-1: Waste Tank Locations and Elevations for HTF

Tank	North Location	East Location	Working Slab Top (MSL)	References
9	71680.0	62005.0	241.4	W715395
10	71680.0	62109.0	241.4	W715395
11	71580.0	62005.0	239.9	W715395
12	71580.0	62109.0	239.9	W715395
13	71318.0	62043.0	270.33	W163048
14	71318.0	62160.0	270.33	W163048
15	71200.0	62043.0	270.33	W163048
16	71200.0	62160.0	270.33	W163048
21	71463.0	61772.0	281.42 [a]	W230826 W230945
22	71463.0	61660.0	281.42 [a]	W230826 W230945
23	71577.0	61772.0	281.42 [a]	W230826 W230945
24	71577.0	61660.0	281.42 [a]	W230826 W230945
29	71778.5	61636.0	283.5	W236439
30	71778.5	61520.0	282.5	W236439
31	71778.5	61404.0	281.5	W236439
32	71662.5	61462.0	280	W236439
35	71865.0	61220.0	282.7	W449843
36	71990.0	61075.0	283.7	W449843
37	72052.0	61175.0	283.7	W449843
38	71290.0	62490.0	291.09	W449843
39	71290.0	62610.0	292.09	W700834
40	71290.0	62730.0	292.09	W700834
41	71290.0	62850.0	291.09	W700834
42	71170.0	62590.0	293.09	W700834
43	71170.0	62800.0	293.09	W700834
48	70956.0	62610.0	288.14	W706301
49	70956.0	62735.0	288.14	W706301
50	70820.0	62610.0	285.64	W706301
51	70820.0	62735.0	285.64	W706301

a The elevation shown for the Type IV tanks is at the bottom of the floor slab, there is no working slab under the Type IV tanks.

The main component of a waste tank is the primary liner where the liquid waste is contained. The primary liner is cylindrical in shape and made of carbon steel. Each primary liner type differs in size and capacity.

Type I, II, and III/IIIA tanks are enclosed by a secondary liner, which is larger in diameter than the primary liner. The secondary liner, like the primary liner, is constructed of carbon steel. Since the secondary liner is larger in diameter than the primary liner, an area is formed between them called the annulus. The annulus differs in size and capacity for each waste tank type. The annulus serves several purposes for the waste tanks. It provides a collection point for any leakage from the primary liner and provides a method for heating or cooling the primary liner wall in conjunction with the annulus ventilation system. The Type IV tanks do not have a secondary liner.

A reinforced concrete vault surrounds the secondary liner. The vault concrete provides both structural support and radiation shielding. The bottom part of the concrete vault is called the basemat. Underneath the basemat of the Type I, Type II and Type III/IIIA tank is a working slab.

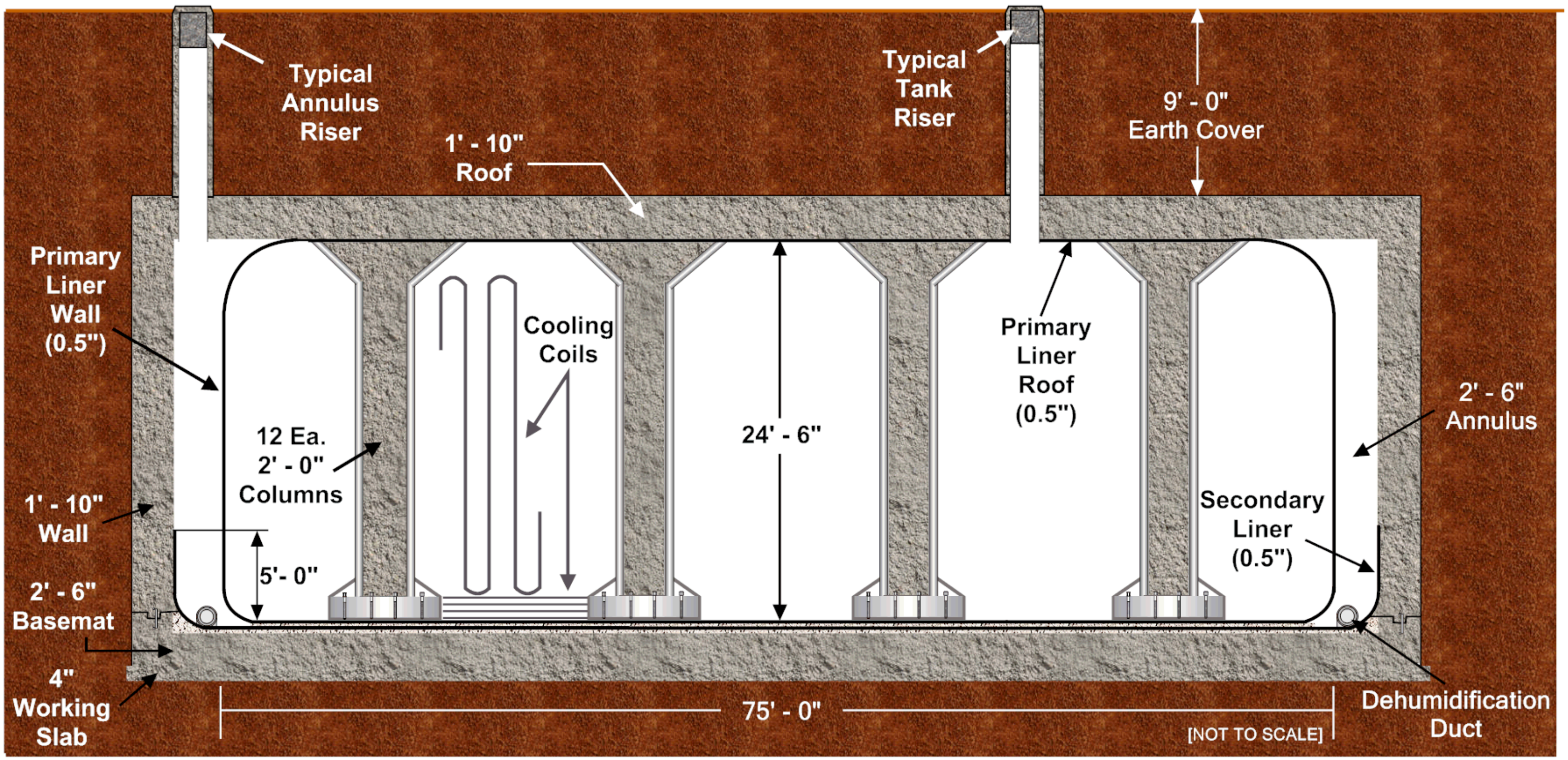
The primary cooling method for the liquid waste is provided from cooling water that is chromate and runs through cooling coils located inside the primary liner. These cooling coils are installed in Type I, II, and III/IIIA tanks and the cooling coil design for each waste tank type varies. Type IV tanks do not have cooling coils.

Risers provide access to the waste tank and annulus interiors. Risers are used primarily for inspections, level detection, dip samples, and the installation of equipment such as annulus jets, dip tubes, thermocouples, conductivity probes, ventilation inlet and outlets, reel tapes, hydrogen monitors, and waste removal equipment. Lead or concrete plugs are inserted in the riser opening if no equipment is installed. The riser structures are made of concrete and lined with carbon steel. Riser layout is dependent on the specific waste tank being discussed. However, waste tanks of a given type have similar equipment installed in the risers. Riser plugs can weigh anywhere from a few pounds to several thousand pounds.

3.2.1.1 Type I Tanks

There are four Type I tanks in the HTF. The HTF Type I tanks were constructed in the early 1950s. These waste tank primary liners are 75 feet in diameter and 24.5 feet high, with a nominal operating capacity of 750,000 gallons. A typical Type I tank is shown in Figure 3.2-2.

Figure 3.2-2: Typical Type I Tank



3.2.1.1.1 Working Slab and Basemat

The working slab for a Type I tank is 4-inches thick, with a radius of 42 feet 5 inches, and has a 2-inch wire mesh layered in the middle. [W145293] The concrete for the working slab was installed with 2,500-psi strength at a 28-day cure time. [W145225] A 1.5-inch thick layer of plaster/waterproofing membrane sits above the working slab. [W145573] A 30-inch reinforced concrete base (basemat) sits on top of the plaster. [W145293] The basemat was also installed with 2,500-psi strength at a 28-day cure time. [W145225] A 3-inch layer of construction grout fill sits on top of the basemat and the secondary liner sits above the grout. In addition, a 3-inch thick layer of grout is placed between the base of the primary liner and the secondary liner. [W145293] Figure 3.2-3 portrays the details of a typical Type I tank floor configuration. Figure 3.2-4 shows the soil preparation and working slab construction for a typical Type I tank. Figure 3.2-5 shows Type I tank basemat construction.

Figure 3.2-3: Typical Type I Tank Floor Configuration

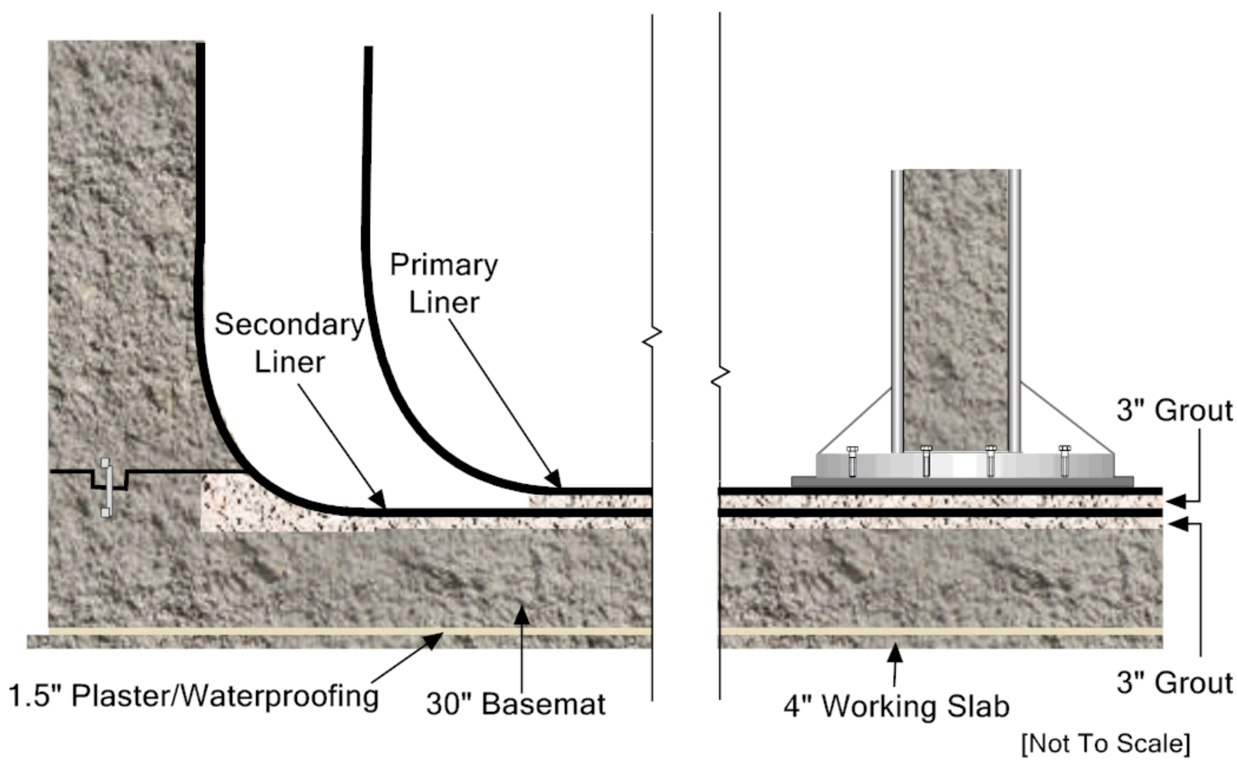


Figure 3.2-4: Typical Working Slab Construction for Type I Tanks

Figure 3.2-5: Typical Basemat Construction for Type I Tanks

3.2.1.1.2 Primary and Secondary Liner

The primary liner for Type I tanks is a cylinder of 0.5-inch thick carbon steel. The inner radius of the primary liner is 37 feet 6 inches and the inner height is 24 feet 6 inches. The walls of the primary liner are welded to the top and bottom of the waste tank by a 0.5-inch thick, curved knuckle plate. The steel specifications, including material and welding information, are provided in W145379. Figure 3.2-6 shows the typical construction of the primary and secondary steel liners for a Type I tank.

Figure 3.2-6: Typical Steel Liner Construction for Type I Tanks

Type I tanks have an annular space with a width of 2.5 feet. The base of the annular space is formed between the 5-foot high secondary liner and primary liner. The upper annular space is formed between the concrete vault and the primary liner. Carbon steel stiffener angles are located at the top of the secondary liner. All the seams in the bottom plates of the secondary liner are full penetration butt-welded using a backup strip on the underside. The steel specifications, including material and welding information, are provided in W145367. The primary liner sits on a 3-inch layer of grout (above the secondary liner). The secondary liner sits on a 3-inch layer of grout on top of the concrete basemat. [W145573] Figure 3.2-7 shows the typical construction of both the primary and secondary liners in the later construction phase; and Figure 3.2-8 presents a close-up, showing the 5-foot high carbon steel secondary liner.

Figure 3.2-7: Typical Steel Liners Construction for Type I Tanks (Late Construction Phase)

Figure 3.2-8: Close-Up of Figure 3.2-7 Showing the Annulus

The primary liner has transfer line penetrations near the top of the tank. There are 3-inch stainless steel inlet waste transfer lines that enter the primary liner through the top knuckle and terminate inside the waste tank. The transfer lines are each enclosed in a 4-inch carbon steel jacket pipe where they bridge across the waste tank annulus. Each jacket pipe is welded to the primary liner; the internal pipe is free to move to accommodate thermal expansion and contraction. [W145573, W148413]

3.2.1.1.3 Tank Concrete Vault

A concrete vault, 80-foot inner diameter, surrounds the Type I tank primary liner. The space between the vault and the primary liner creates a 2 foot 6-inch wide annulus. The vault is formed by 22-inch thick reinforced concrete roof and walls that surround the primary container and connect to the basemat. The vault concrete was installed per construction drawing specifications, with 2,500-psi strength. The walls have horizontal construction joints however; no vertical construction joints were used. [W145225] Figures 3.2-9 and 3.2-10 show the typical construction of the concrete vault and risers (see Section 3.1.2 for description of the waste tank risers) for the Type I tanks.

Figure 3.2-9: Typical Construction of a Type I Tank Concrete Vault

Figure 3.2-10: Typical Riser Construction for Type I Tanks

Because of the presence of the water table around the HTF Type I tanks, the concrete vaults included waterproofing. At the bottom of the concrete vault, a 5-ply layer of bituminous impregnated cotton fabric (waterproofing membrane) was placed between the 4-inch thick concrete working slab and the concrete basemat. An additional 5-ply layer of waterproofing membrane was placed above the 5-ply layer from the bottom of the concrete vault up to the basemat/vault wall construction joint. Between these two layers of waterproofing membrane exists a 0.25-inch thick flashing of metal reinforced fabric. A 5-ply layer of waterproofing membrane was placed on the top of the concrete vault and covered with a 0.25-inch layer of cement plaster or fiberboard, which was covered with 2 inches of shotcrete. An additional 3-ply layer of waterproofing membrane was placed below the 5-ply layer from the top of the concrete vault down to the roof/vault wall construction joint. A 0.25-inch thick flashing separates the two layers of waterproofing membrane. A 5-ply layer of waterproofing membrane was also installed on the concrete vault walls and a 4-inch thick brick wall was constructed 4 inches from the waterproofing membrane on the concrete vault wall. The 4-inch annular space between the brick wall and the waterproofing membrane on the concrete vault wall was filled with bituminous grout (hot sand asphalt mastic). [W158908]

3.2.1.1.4 Support Columns

Twelve concrete and steel columns support the roof of a Type I tank (Figures 3.2-11 and 3.2-12). These columns were made from steel pipes welded to a steel bottom plate. The pipes are 0.5-inch thick carbon steel with a 2-foot outside diameter and are filled with concrete. The columns have flared capitals at the top also filled with concrete. The bottoms of the columns are cylindrical and have eight, 1-inch thick stiffeners on each column. The columns are welded to the top and bottom of the primary liner. The steel specifications, including material and welding information, are provided in W145225 and W145379. Figure 3.2-13 portrays the column layout detail per W145573.

Figure 3.2-11: Support Column - Construction Phase

Figure 3.2-12: Sketch of Typical Support Column Top/Bottom Detail

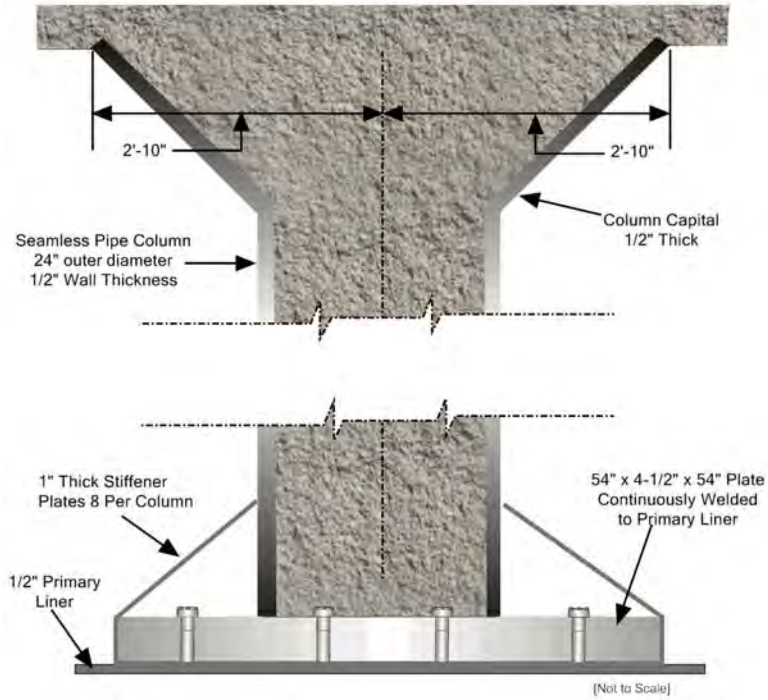
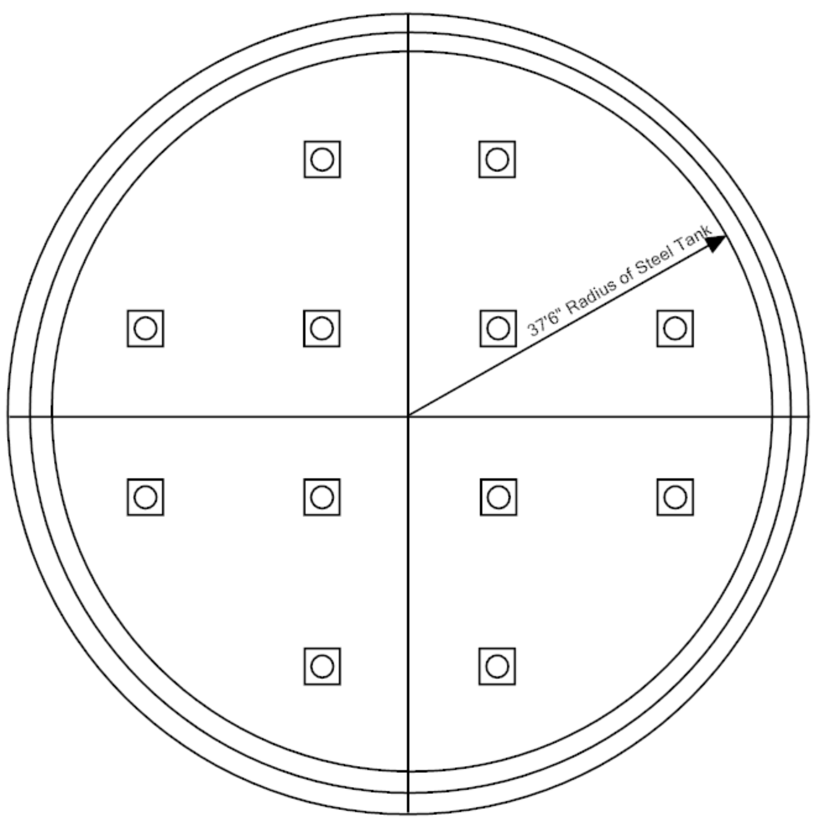


Figure 3.2-13: Column Layout Detail



3.2.1.1.5 Cooling Coils

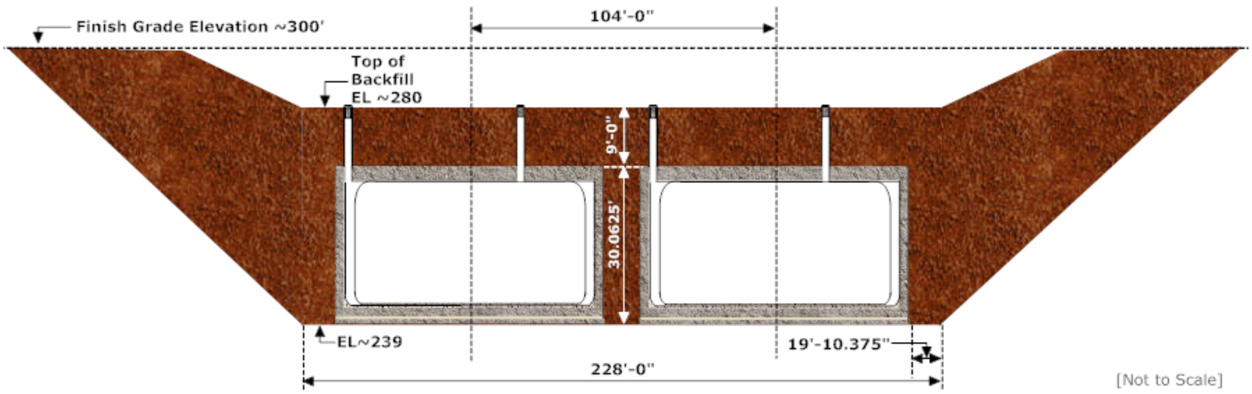
The Type I tanks are equipped with a cooling system. The waste tanks have 34 vertical cooling coils that are supported by hanger and guide rods that are welded to the primary liner. [D116048] Two horizontal cooling coils, which are supported by guide rods that are welded to the primary liner, extend across the bottom of the waste tanks. [D116001] The cooling coils are 2-inch diameter schedule 40 carbon steel seamless pipe. Figure 3.2-14 shows typical Type I tank cooling coils during construction. [D116048, D116001]

Figure 3.2-14: Type I Tank Cooling Coils - Construction Phase

3.2.1.1.6 Soil and Backfill Description

The Type I tank backfill was installed per W145225. The waste tank tops were covered with a minimum of 9 feet of backfill. The backfill around this group of waste tanks extends to a finished grade of approximately 300 feet above MSL. Figure 3.2-15 shows the typical configuration of the waste tanks and emplacement of backfill material. [W146377]

Figure 3.2-15: Type I Tank Backfill



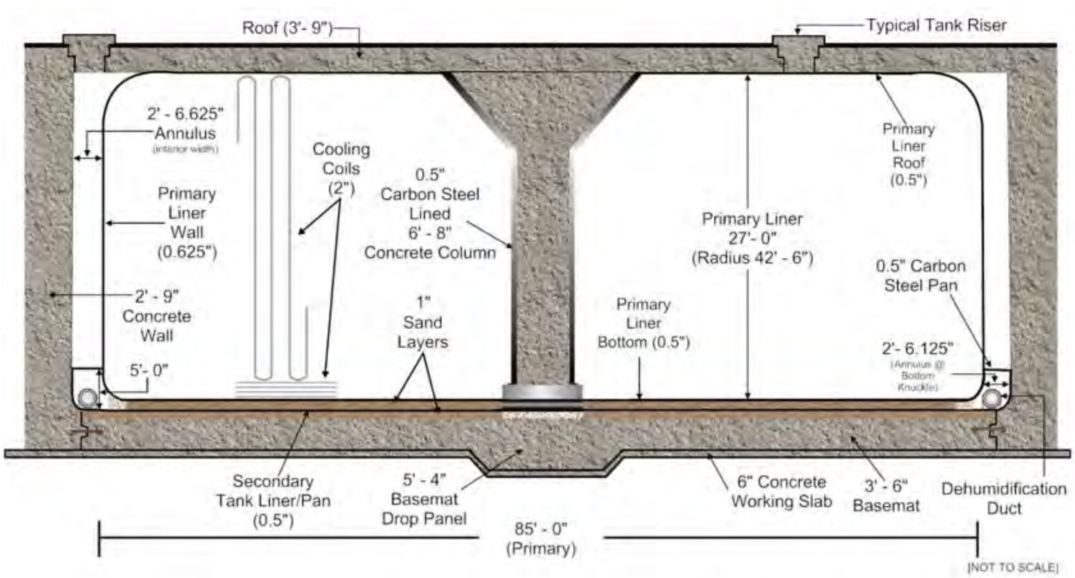
3.2.1.2 Type II Tanks

There are only four Type II tanks at SRS. They are located in the HTF and are Tanks 13 through 16. The HTF Type II tanks were constructed between 1955 and 1956. A typical Type II tank is presented in Figure 3.2-16.

The HTF Type II tank dimensions are as follows:

- Type II primary liner inner radius is 42 feet 6 inches (excluding 0.625-inch liner width). [W162672]
- Type II secondary liner inner radius is 45 feet 1.5 inches (excluding 0.5-inch liner width). [W162688]
- Type II primary liner inner height is 27 feet. [W162672]
- Type II tanks have a nominal operating capacity of 1,030,000 gallons.

Figure 3.2-16: Typical Type II Tank



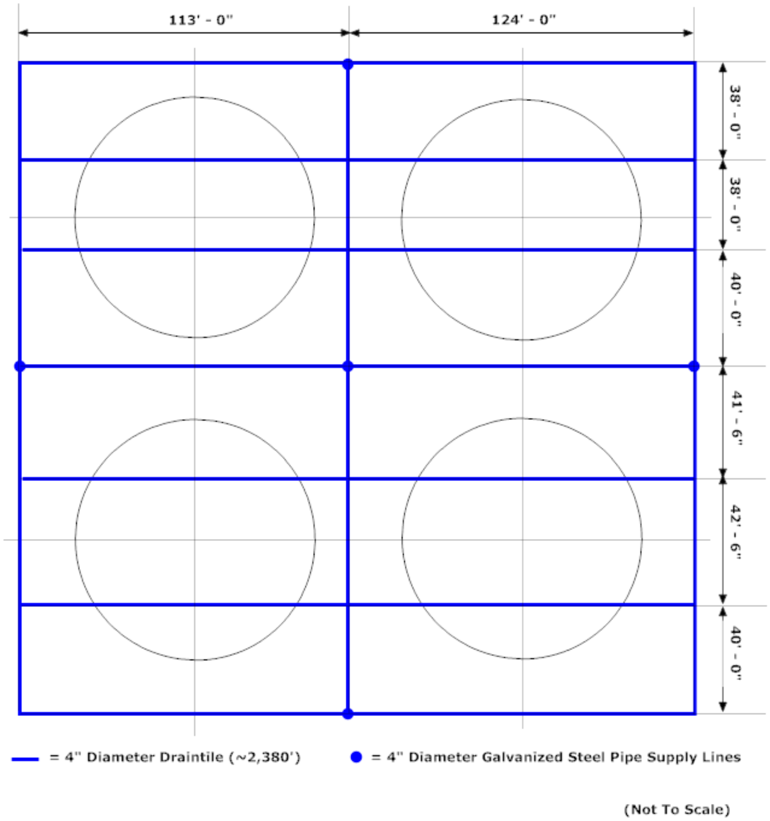
3.2.1.2.1 Working Slab and Basemat

The working slab for the Type II tanks is 6 inches thick with the four waste tanks placed within a 255 foot x 274-foot rectangle. [W163048] Figure 3.2-17 presents the working slab for the four waste tanks. The concrete for the working slab was installed with 3,000-psi strength at a 28-day cure time. A 3 foot 6-inch thick reinforced concrete basemat is located on top of the working slab. The basemat was also installed with 3,000-psi strength at a 28-day cure time. [W162675] There is a 1-inch layer of sand between the top of the basemat and the secondary liner. There is also a 1-inch layer of sand between the secondary liner and primary liner. [W163018] The basemat has reinforcing bars placed throughout. The depth, length, and type of rebar vary depending upon the location within the basemat. [W162675]

Figure 3.2-17: Type II Tank Working Slab and Basemat

A soil hydration system and five feed wells were installed beneath the Type II tanks to address potential issues with soil shrinkage and settlement. The hydration system consists of an interconnecting grid comprised of 4 inch diameter drain tile (perforated piping) located 18 inches below the working slab (Figure 3.2-18). Five supply lines (feed wells) made of 4-inch galvanized steel piping were connected to the grid to allow water to be injected below the working slab. The drain tile was installed inside a 24-inch deep by 18-inch wide trench filled with sand and aggregate. The bottom 6 inches of the trench was filled with sand that half buried the drain tile while the remaining 18 inches of the trench was filled with aggregate. [W163048, W163278] The soil hydration system was never used since the water table under the Type II tanks is higher than anticipated and soil dehydration is not a problem.

Figure 3.2-18: Soil Hydration System below Type II Tanks



[W163278]

3.2.1.2.2 Primary and Secondary Liner

The primary liner for Type II tanks is a cylinder made of carbon steel per W162672. The primary liner walls and bottom are connected via a curved knuckle plate that is welded to both the liner walls and bottom. The steel specifications, including material and welding information are provided in W162672. The primary liner thicknesses within the waste tank are identified in Table 3.2-2. [W162672]

Table 3.2-2: Type II Tank Primary Liner Thicknesses

Location	Thickness
Top and bottom	0.5 inch
Upper knuckle	0.562 inch
Wall	0.625 inch
Lower knuckle	0.875 inch

The Type II tank primary liner was constructed above a 1-inch sand pad placed on top of the secondary liner. An additional 1-inch sand pad is located beneath the secondary liner (Figure 3.2-19). [W163018] In accordance with the requirements of W163018, both sand pad layers consists of clean, hard, durable, siliceous particles free from foreign material (i.e., procured and washed sand free of silt or clay), and uniformly graded from standard sieves #16 and #100. The size of the sand grain ranges from 0.15 millimeter (#100 sieve) to 1 millimeter (#16 sieve), and is classified as fine to medium sand per the Unified Soil Classification System and fine to coarse per USDA classification.

Figure 3.2-19: Lower Sand Pad Installation over the Basemat

The secondary liner for the Type II tank forms an annulus space 30.625 inches wide between the primary liner and concrete wall. The upper portion is formed by the concrete wall while the bottom is formed by the 5-foot high carbon steel annulus pan (secondary liner). Type II tank primary and secondary liners are shown in Figure 3.2-20.

Figure 3.2-20: Type II Tank Early Construction of Primary and Secondary Liner

The secondary liner material is 0.5-inch carbon steel. [W162688] A carbon steel stiffener angle is located at the top of the secondary liner. All the seams in the bottom plates of the secondary liner are full penetration butt-welded using a backup strip on the underside. Drawings W163018 and W162672 provide the steel specifications, including material and welding information.

Type II tank tops are equipped with risers which provide access into the primary and secondary liner interiors. A 3-inch stainless steel waste transfer line penetrates the primary liner through the upper knuckle by way of a 4-inch schedule 40 pipe that is welded to the primary liner. The annular space between the 3-inch pipe and the 4-inch pipe is packed with asbestos wicking. [W162672]

3.2.1.2.3 Concrete Vault

The Type II tanks are completely enclosed in a concrete vault. A 95 foot 8.5-inch outer diameter concrete vault surrounds the Type II tank primary liner creating a 2 foot 6.625-inch wide annulus.

The vault is formed by 2 foot 9-inch thick reinforced concrete walls and a 3 foot 9-inch thick reinforced concrete roof that surrounds the primary liner and connects to the basemat. [W163018] The concrete vault height is approximately 34 feet 6 inches. The vault concrete was installed with 2,500-psi strength at a 28-day cure time. The sidewalls have horizontal construction joints however; no vertical construction joints were used. There are copper water stops at the bottom of the concrete vault wall. [W163018]

Figures 3.2-21 and 3.2-22 show both early and late stage Type II tank concrete vault construction. Figure 3.2-23 portrays the details of a typical Type II tank floor/annulus space configuration.

Figure 3.2-21: Type II Tank - Early Stage of Vault Construction

Figure 3.2-22: Type II Tank - Late Stage of Vault Construction

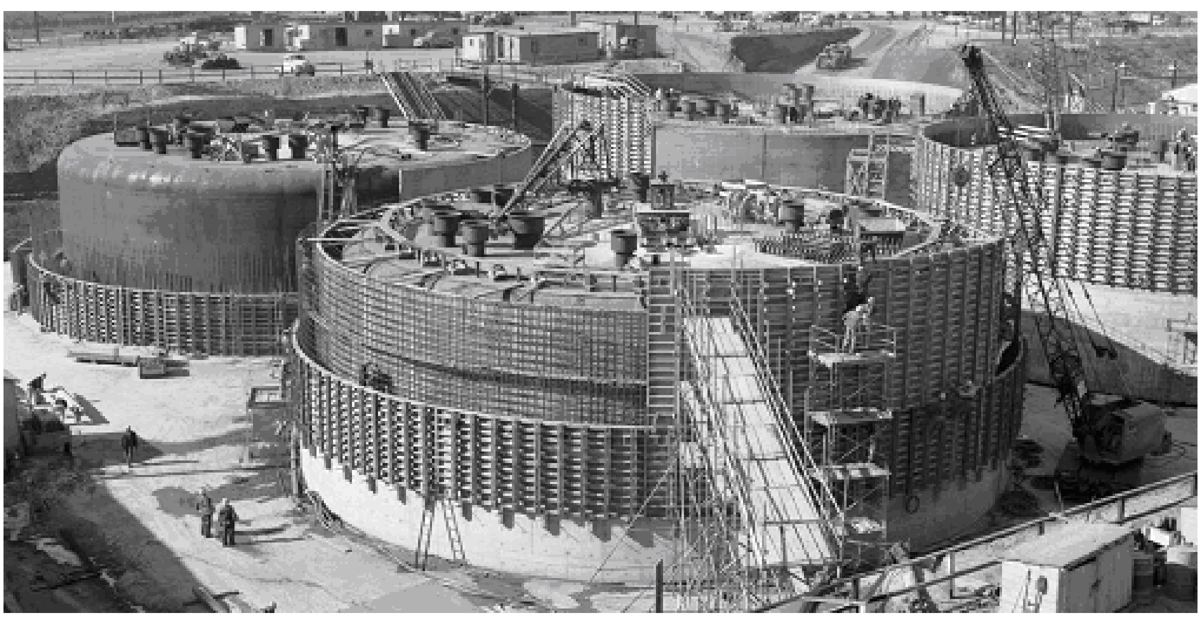
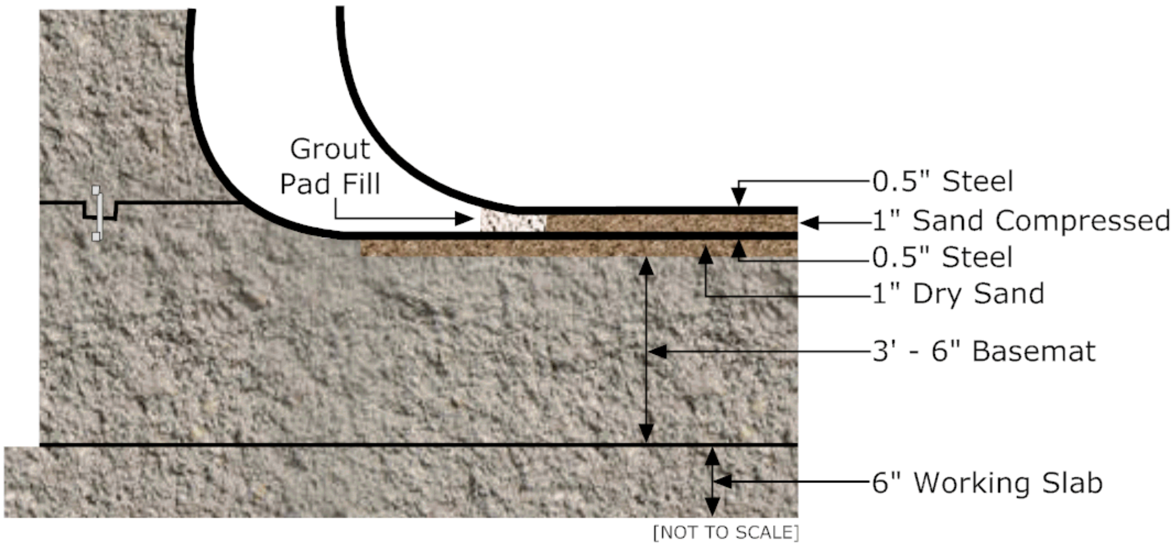


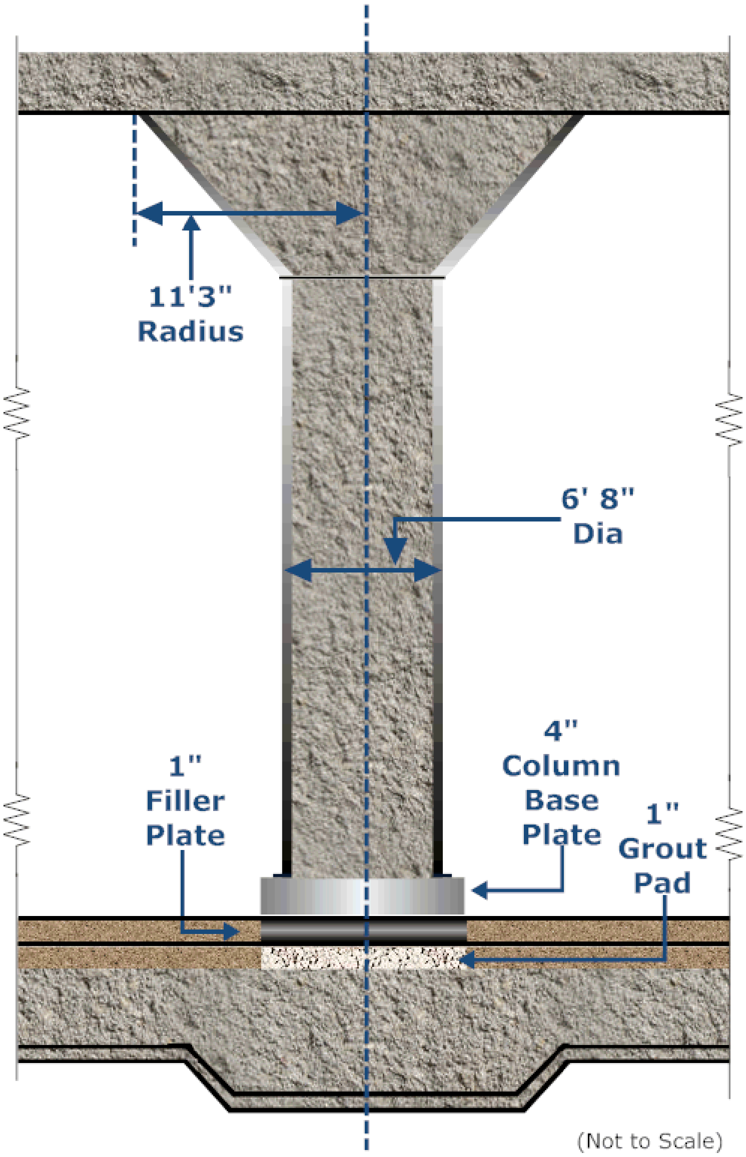
Figure 3.2-23: Type II Tank Annulus Corner Detail



3.2.1.2.4 Support Columns

One central reinforced concrete and steel column supports the roof of a Type II tank (Figure 3.2-24). The carbon steel column has a thickness of 0.5 inch and an inside diameter of 6 feet 8 inches. The steel column was welded to a steel bottom plate and filled with concrete. The column has a reinforced, concrete filled, flared capital at the top. The concrete for the steel column was installed with 3,000-psi minimum compressive strength at a 28-day cure time. [W163018] The steel specifications, including material and welding information, are provided in W162672. The support column concrete is reinforced with varying length and types of rebar. [W162676]

Figure 3.2-24: Support Column Dimension Details



3.2.1.2.5 Cooling Coils

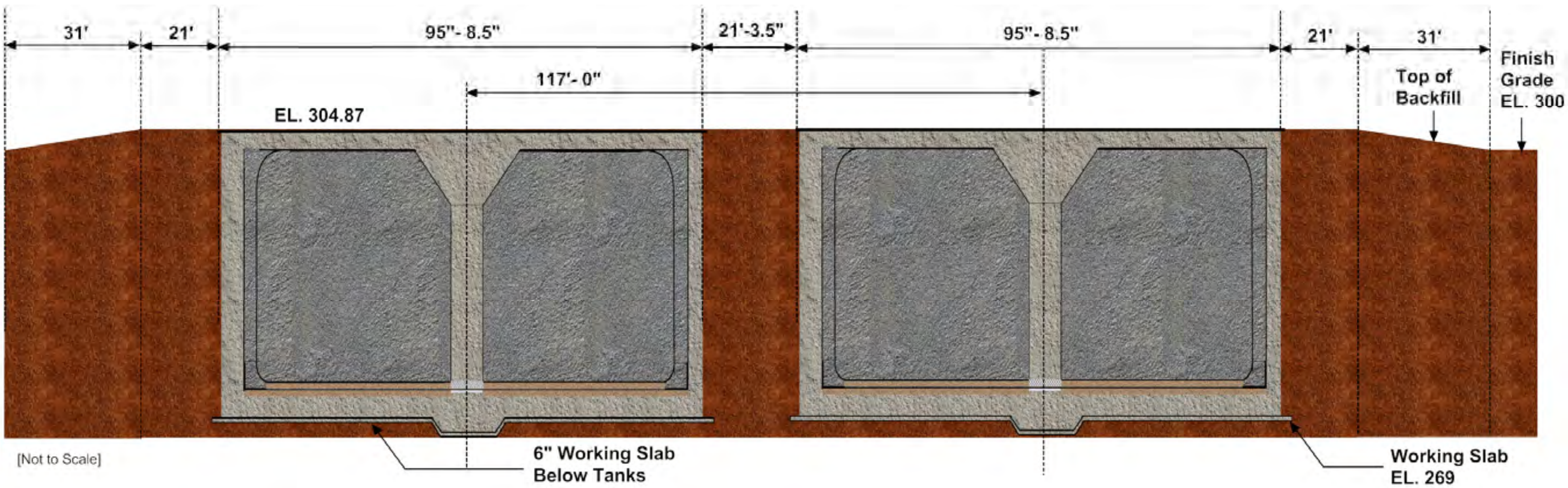
The Type II tanks are equipped with 44 cooling coils (Figure 3.2-25). The waste tanks have 40 vertical cooling coils (20 operating and 20 auxiliary) that are supported by hanger and guide rods that are welded to the top and bottom of the primary liner. [W163593] The four bottom cooling coils (two operating and two auxiliary coils) extend across the bottom of the waste tanks, and are supported by guide rods and steel angles welded to the bottom of the primary liner. [W163658] The cooling coils are 2-inch diameter schedule 40 carbon steel seamless pipes. The total coil length is 14,700 feet for operating coils and 14,700 feet for auxiliary coils. [W163593]

Figure 3.2-25: Type II Tank Cooling Coils

3.2.1.2.6 Soil and Backfill

The Type II tank backfill was installed per drawing W163048 specifications. The backfill below the working slab is test controlled compacted backfill not to contain more than 7% material passing through a #200 sieve. Excavated backfill soil around the waste tanks consisted of suitable approved soil to allow satisfactory consolidation. The backfill around the waste tanks was placed in successive, uniform layers with a compacted thickness no more than 12 inches. The backfill layers around the tanks were rolled with earthwork equipment until uniformly compacted to specification. In areas inaccessible to such equipment, the backfill was compacted with approved hand or mechanical tampers. The backfill around the waste tanks was brought to an elevation level with the top of the waste tanks (approximately 395 feet above MSL) and extended laterally for a minimum of 21 feet. The backfill was then sloped down at an angle less than 1:1 for a lateral distance of 31 feet, reaching final grade at an elevation of 300 feet above MSL. Figure 3.2-26 shows the backfill configuration. [W163048]

Figure 3.2-26: Type II Tank Backfill Detail



3.2.1.3 Type III/IIIA Tanks

There are four, Type III tanks (Tanks 29-32) and 13, Type IIIA tanks (Tanks 35 through 37, 38 through 43, and 48 through 51) in the HTF. The Type III tanks were constructed between 1966 and 1970. The Type IIIA tanks were constructed between 1974 and 1981. The primary liners are 85 feet in diameter and 33 feet high with a nominal operating capacity of 1,300,000 gallons. [W236519] Typical HTF Type III and Type IIIA tanks are shown in Figures 3.2-27 and 3.2-28, respectively. Note that Tanks 35, 36, and 37 have been designated as Type IIIA tanks but they differ from Figure 3.2-28 in that these waste tanks have a flat roof with a uniform 4-foot concrete thickness, similar to the Type III tanks. Additionally, Tank 35 has insertable cooling coils rather than permanently installed cooling coils.

Figure 3.2-27: Typical HTF Type III Tank

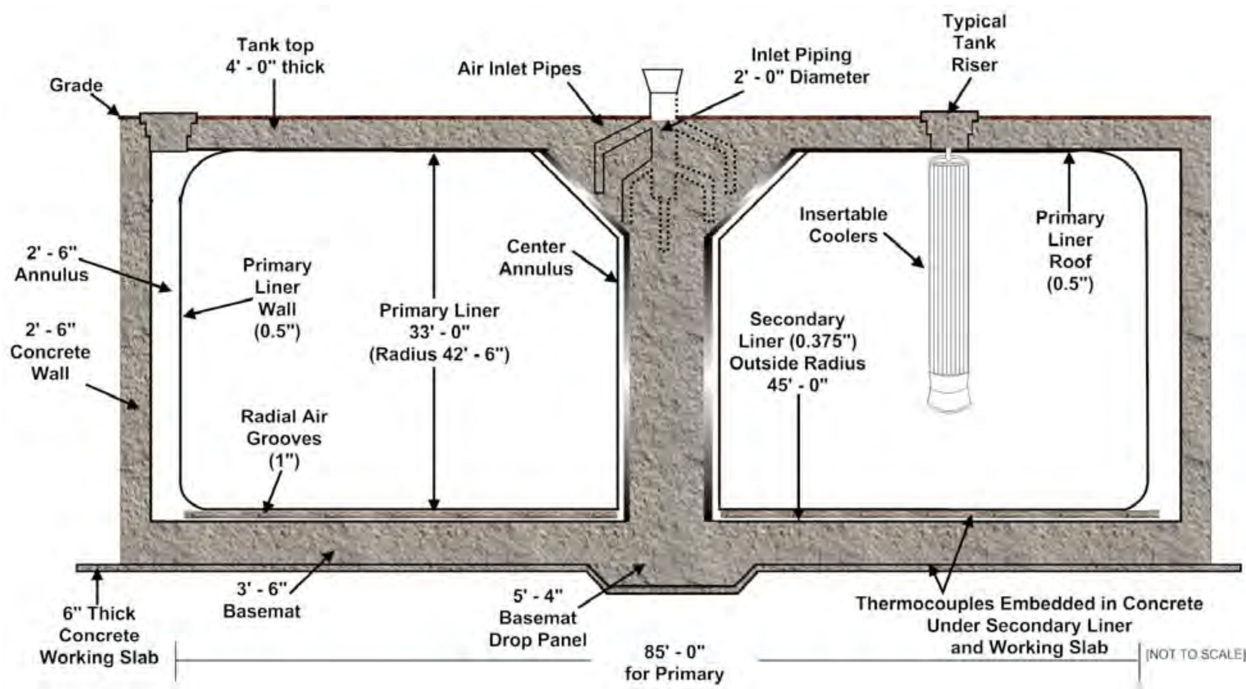
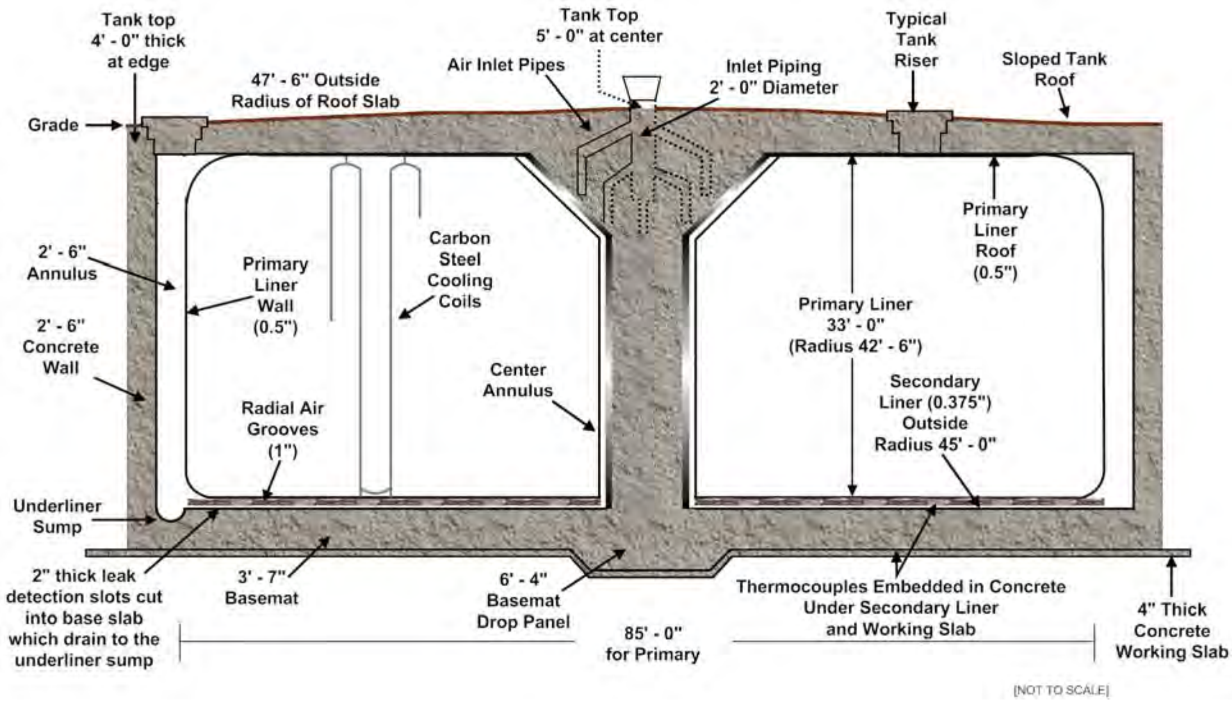


Figure 3.2-28: Typical HTF Type IIIA Tank



3.2.1.3.1 Type III Working Slab and Basemat

The concrete basemat rests on a 6-inch thick (minimum) construction-working slab that slopes away as it extends 30 feet beyond the edge of the waste tank. The working slab is under all four Type III tanks (Tanks 29 through 32). [W236495] The basemat is 3-foot 6-inches thick (5 feet 4 inches at the drop panel in the waste tank center) with a radius of 45 feet (not including the wall radius of 2 foot 6 inches). [W236562] Figure 3.2-29 shows the early construction of a typical Type III/IIIA basemat.

Figure 3.2-29: Early Construction of a Type III/IIIA Tank Basemat

The basemat concrete was installed with reinforcing bars placed throughout, with the length and type of bar varying depending upon the location. The basemat also includes a water stop embedded in the circumference. [W236495, W236562]

3.2.1.3.2 Type IIIA Working Slab and Basemat

The working slab rests on undisturbed soil. [W448847, W700855, W707138] Tanks 35 through 37, 38 through 43, and 48 through 51 were built on a single working slab that extends out at least 25 feet beyond the edge of the waste tanks. [W449843, W700834, W706301] Prior to the placement of backfill, the working slab was broken up or perforated with 4-inch diameter holes spaced 18 inches apart, center-to-center between the waste tanks to prevent perched water (Figure 3.2-30).

The basemat rests on the 4-inch (minimum) thick working slab. The basemat thickness is 3 feet 7 inches (6 feet 4 inches at the drop panel in the waste tank center) and a radius of 45 feet (not including the wall radius of 2 foot 6 inches). The basemat has reinforcing bars placed throughout, with the length and type of bar varying depending upon the location. A water stop is provided at the basemat-to-vault wall joint. [W448847, W700505, W707138]

Figure 3.2-30: Drilled Working Slab of a Type IIIA Tank

Tanks 38 through 43 and 48 through 51 have an underliner sump located between the secondary liner and basemat. A grid of interconnected radial channels that are 2 inches deep by 4 inches wide is grooved into the basemat. The secondary liner rests on top of the concrete basemat. Figure 3.2-31 shows the leak-detection channel grid in a typical Type IIIA basemat. The channels are sloped to drain through a center collection pipe to a sump located inside the concrete vault wall. A 1.5-inch stainless steel access pipe rises to grade from the sump to allow for liquid measurement, sampling, and the pumping out of collected liquid. [W701336, W707253]

Figure 3.2-31: Typical Leak-Detection Channel Grid in Type IIIA Tank Basemat

If both the primary liner and the secondary liner develop a leak, liquid will collect in the channels of the leak detection grid and then drain to the sump. The sump can be monitored by conductivity probes that alarm when liquid contacts the probes.

Tanks 35 through 37 each had 56 thermocouples installed on the outside of the primary liner. [W449815] Tank 38 has 34 thermocouples that were installed on the outside of the primary liner. [W700715] Each of the remaining Type IIIA tanks (39 through 43 and 48 through 51) have 22 thermocouples that were installed on the outside of the primary liner. [W707031] All Type IIIA tanks have a thermocouple located on the top of the basemat and another thermocouple located just below the working slab. [W702019] Tanks 35 through 37 have an additional thermocouple that was installed approximately 10 feet below the working slab. [W449931]

3.2.1.3.3 Primary and Secondary Liners

The Type III/IIIA tank primary liner has a radius of 42 feet 6 inches (inside) and a height of 33 feet. The Type III/IIIA liners are made of two concentric cylinders joined by curved knuckle plates to washer shaped top and bottom plates. The minimum thickness of each plate is provided in Table 3.2-3. Drawing W236562 identifies the primary liner steel plate specifications including material and welding information for Tanks 29 through 32, drawing W448849 for Tanks 35 through 37, drawing W700856 for Tanks 38 through 43, and drawing W707114 for Tanks 48 through 51.

Table 3.2-3: Minimum Primary Liner Plate Thicknesses for Type III/IIIA Tanks

Location	Tanks 29-32 Thickness (in) [W236519]	Tanks 35-37 Thickness (in) [W448842]	Tanks 38-43 Thickness (in) [W700856]	Tanks 48-51 Thickness (in) [W707114]
Top and floor	0.5	0.5	0.5	0.5
Upper knuckle	0.5	0.5	0.5	0.5
Outer liner				
Upper band	0.5	0.5	0.5	0.5
Middle band	0.5	0.625	0.625	0.625
Lower band	0.5	0.5	0.875	0.875
Column liner				
Upper band	0.5	0.625	0.5	0.5
Lower band	0.5	0.875	0.625	0.625
Lower Knuckle				
Outer	1.0	0.875	0.875	0.875
Inner (at column)	0.625	0.625	0.625	0.625

The primary liner sits on a bed of insulating material grooved to channel airflow to the secondary annulus liner. [W236993, W702700] The insulating bed has radial grooves so that ventilating air can flow through the slots, and any leakage from the primary liner bottom or center annulus flows to the outer annulus. The Type III tanks have a 6-inch thick layer of insulating material with 1-inch deep x 2-inch wide slots. [W236993] The Type IIIA tanks have an 8-inch thick layer of insulating material with 2-inch deep x 5-inch wide slots. [W702700] Figure 3.2-32 shows the grooved radial air slots for a typical Type IIIA tank and Figure 3.2-33 shows the grooved radial air slots emerging from below the primary liner.

Figure 3.2-32: Radial Air Grooves for a Typical Type IIIA Tank

Figure 3.2-33: Typical Type IIIA Tank Primary and Secondary Liner - Early Construction

The secondary liner for the Type III/IIIA tanks is 0.375-inch thick carbon steel. [W236562] The secondary liner is the full height of the primary liner and has a 90-foot outside diameter forming a 2-foot 6-inch annular space between the primary and secondary liners. Figures 3.2-33 and 3.2-34, show the primary and secondary liners for a typical Type IIIA tank during construction.

Figure 3.2-34: Typical Type IIIA Tank Primary and Secondary Liner - Partial Construction

Type III tanks (Tanks 29 through 32) have a number of penetrations through the primary and/or secondary liner at the waste tank top ranging in size from approximately 9 inches to 36 inches in diameter. Two pairs of stainless steel lines penetrate the primary liner at the upper knuckle. One pair is the main waste inlet lines that are 3 inches in diameter and enter the waste tank through a 10-inch diameter carbon steel sleeve that is welded to the primary liner. The 10-inch sleeve traverses the annular space and mates into a 12-inch carbon steel sleeve that is welded to the secondary liner and penetrating through the concrete vault wall. The second pair is the spare waste inlet lines that are 2 inches in diameter and enter the waste tank through a 6-inch diameter steel sleeve that is welded to the primary liner. The 6-inch sleeve traverses the annular space and mates into an 8-inch carbon steel sleeve that is welded to the secondary liner and penetrating through the concrete vault wall. Both pairs of inlet lines have asbestos wicking packed within the annular space between the larger and smaller sleeves. [W236519]

Similar to the Type III tanks, the Type IIIA tanks have a number of penetrations through the primary and/or secondary liner at the waste tank top ranging in size from approximately 9 inches to 52 inches in diameter. In addition, the Type IIIA tanks (except Tank 35) have multiple penetrations to accommodate the valve house on the waste tank top for the permanently installed cooling coils. Penetrations exist on the side of the Type IIIA tanks at various locations along the upper knuckle, similar in design to the side penetrations described above for the Type III tanks. [W449795, W449796, W449797]

3.2.1.3.4 Type III Tank Center Column

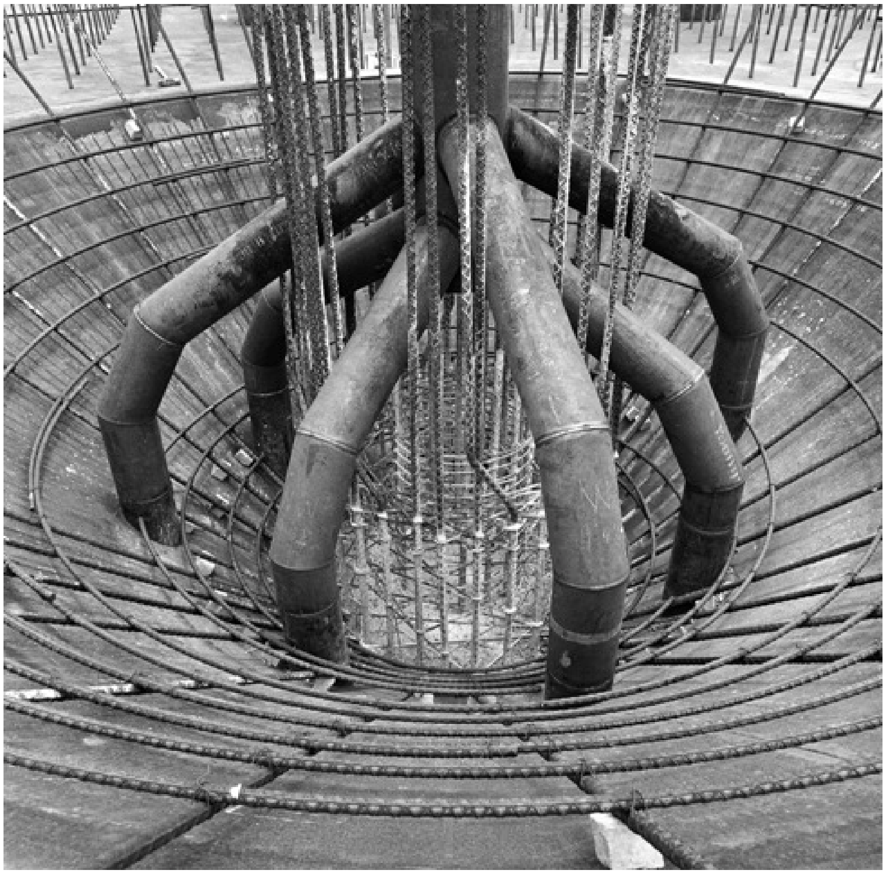
The Type III primary liner roof is supported by a steel-lined concrete center support column that was made as an integral part of the basemat. This design does not require the waste tank bottom to support the weight of the roof support column, as it does in the Type I and II tanks, thereby reducing stress on the primary waste tank bottom (Figure 3.2-35). At the center column, the secondary liner diameter is 6 feet 6 inches and the primary liner diameter is 6 feet 9 inches. [W236562]

Type III Tanks have air ventilation/cooling system supply ducts to the radial air grooves embedded in the center support column (Figure 3.2-36). [W236499]

The column concrete in each waste tank was installed with a 3,000-psi compressive strength at 28-day cure time. [W236562] Reinforcing bars are placed throughout the center support column with variation in length and type depending upon the location. [W236499]

Figure 3.2-35: Typical Center Column Roof Support in a Type III/IIIA Tank

Figure 3.2-36: Type III/IIIA Tank Vent Duct Work



3.2.1.3.5 Type IIIA Tank Center Column

The Type IIIA tank roof support for the primary liner is provided by a steel-lined concrete center support column with a diameter of 6 feet 2 inches. The center support column is made as an integral part of the concrete basemat; therefore, the waste tank bottom does not support the weight of the roof support column, as does the Type I and II tanks, thus reducing stress on the primary liner bottom (Figure 3.2-35). At the center column, the secondary liner is 6 foot 2-inches in diameter (6-foot 1-inch for Tanks 48 through 51) and the primary liner is 6 foot 9-inches in diameter. [W448842, W700856, W707114]

Type IIIA tanks have air ventilation/cooling system supply ducts to the radial air grooves embedded in the center support column (Figure 3.2-36). [W448844, W704339, W707111]

The column concrete was installed with a 3,000-psi compressive strength at 28 days. [W448847, W700855, W707138] Reinforcing bars were placed throughout the center support column with the length and type varying depending upon the location. [W448844, W704340, W707138]

3.2.1.3.6 Type III/IIIA Tank Concrete Vaults

The Type III/IIIA tanks are completely enclosed in a concrete vault. The concrete vault roof is 48 inches thick and the walls are 30 inches thick. The thick vault concrete enclosure eliminates the need for an earthen cover for shielding on the top of the Type III/IIIA tanks. All Type III tanks and the Type IIIA Tanks 35 through 37 have a flat roof. The roof on each of the Type IIIA Tanks 38 through 43 and 48 through 51 is sloped with the roof being 5-foot thick at the waste tank center and 4-foot thick at the waste tank edge. The concrete vault wall and the roof have reinforcing bars placed throughout, with the length and type varying depending upon the location (Figure 3.2-37). All Type III/IIIA tanks have a 24-ounce water stop at the basemat-wall joint with all seams brazed watertight. [W236562, W448847, W704339, W707138] The concrete and reinforcing bar, walls, basemat, and top roof slab were installed per construction drawing specifications. [W236577, W706690, W236499, W448844]

Figure 3.2-37: Typical Type III/IIIA Tank Side Wall Rebar

The Type III/IIIA tanks have both a center and outer annulus. The center annulus is formed between the primary liner and the roof support column. The center annulus allows for ventilation airflow to the waste tank bottom, then out to the outer annulus through the radial air grooves. Figure 3.2-38 shows placement of the waste tank top reinforcing bars and center annulus supply ventilation ductwork in preparation for concrete pouring. The Type IIIA tanks have conductivity probes that cross through the waste tank top concrete into the center annulus. [W448849, W700856, W707114] Multiple conductivity probes are also installed in the outer annulus to provide redundant leak detection capability. No primary waste tank leakage has been detected in the Type III/IIIA tanks. A completed Type IIIA tank (prior to receiving backfill) is shown in Figure 3.2-39.

Figure 3.2-38: Typical Type III/IIIA Tank Top Preparation for Concrete Pour

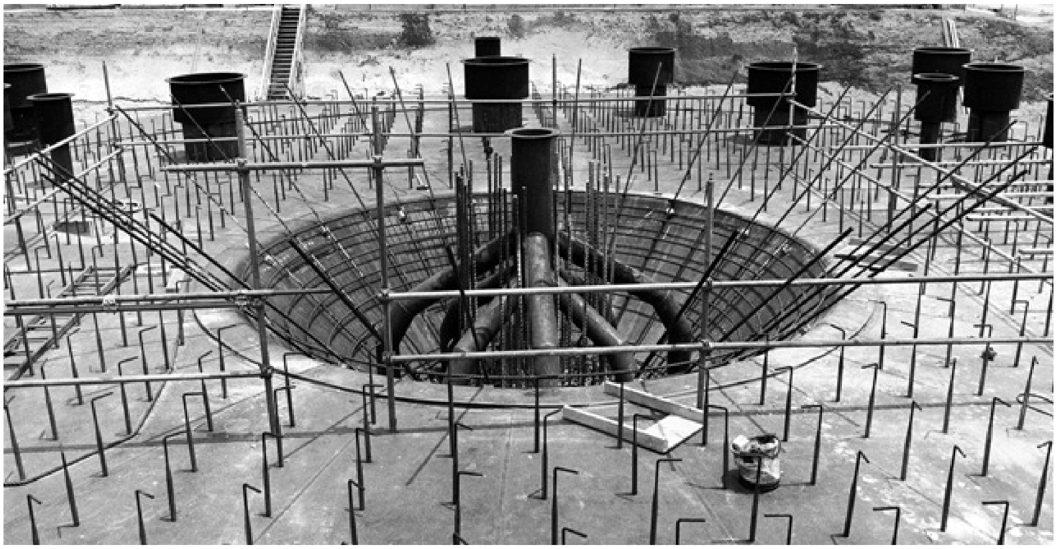


Figure 3.2-39: Final Construction of a Typical Type III/IIIA Tank

3.2.1.3.7 Type III Cooling Coils

Type III Tanks 29 through 32 each have deployable cooling coils that were installed after the waste tank was completed. The deployable coils are installed through the waste tank risers and supported by the waste tank roof. Figure 3.2-40 depicts the various designs used for the deployable coolers in Tanks 29 through 32. Tank 29 has nine deployable coils, Tank 31 has seven deployable coils, and Tanks 30, 32, and 35 each have five deployable coils. Type III tanks do not have horizontal cooling coils along the waste tank bottom. Type III tank bottoms are cooled by forced air that passes through grooved channels in the concrete insulating slab between the primary liner and secondary liner. [W236993]

Figure 3.2-40: Insertable Coolers Used in Type III Tanks

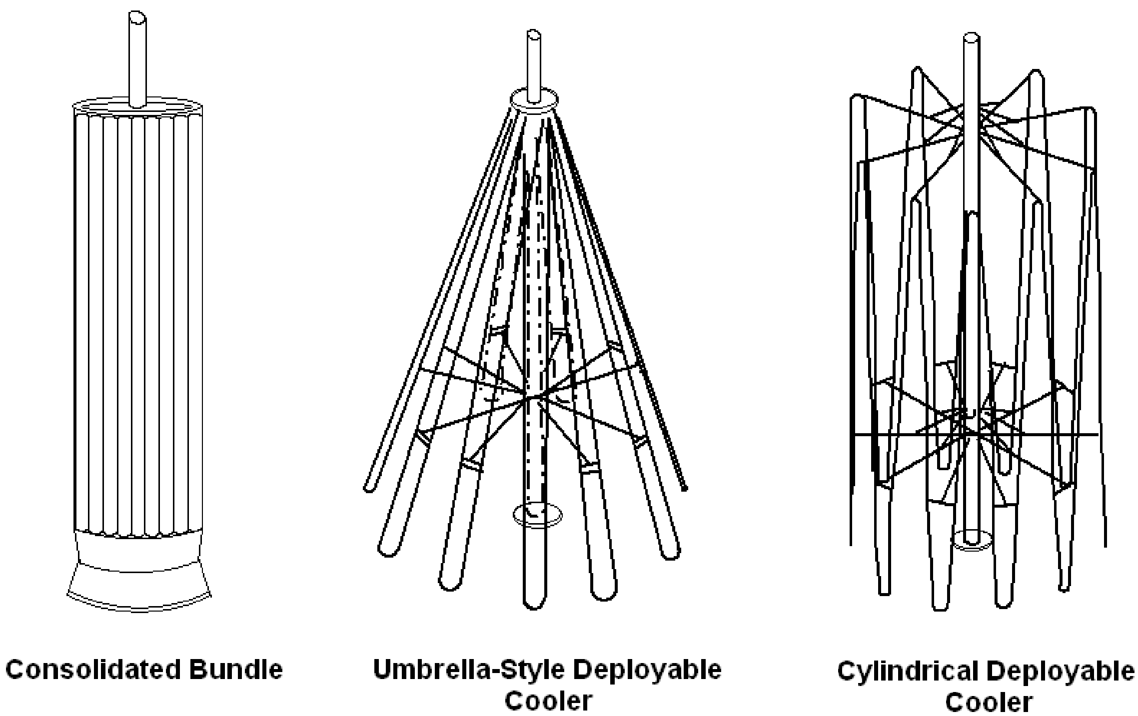


Figure 3.2-41: Insertable Cooling Coil Installed in a Type III Tank

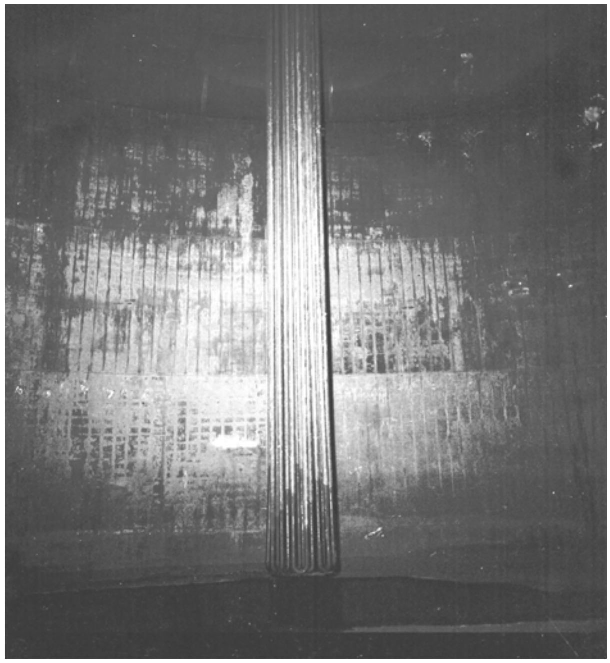


Figure 3.2-42: Typical Conical (Umbrella) Type of Deployable Cooling Coil

3.2.1.3.8 Type IIIA Cooling Coils

All Type IIIA tanks, except Tank 35, have permanently installed cooling coils similar to those in the Type I and II tanks. Like the Type III tanks, Tank 35 had deployable cooling coils installed after construction. With the exception of Tank 35, Type IIIA tanks have top and bottom supported vertical coils on 3-foot triangular centers. The cooling coils supports are welded to the bottom of the primary liner. There are 246 vertical coils mounted 9 inches off the bottom of the waste tank and spaced on 3-foot centers. The coils are made of 2-inch carbon steel pipe. [W449710, W700286, W701130, W708852]

All Type IIIA tank bottoms are cooled by forced air that passes through grooved channels in the concrete insulating slab between the primary liner and secondary liner to supplement the vertical cooling coils. [W448840, W449824, W702700, W707288] Figure 3.2-43 shows a typical cooling coil arrangement.

Figure 3.2-43: Cooling Coils in a Type IIIA Tank

3.2.1.3.9 Type III/IIIA Soil and Backfill

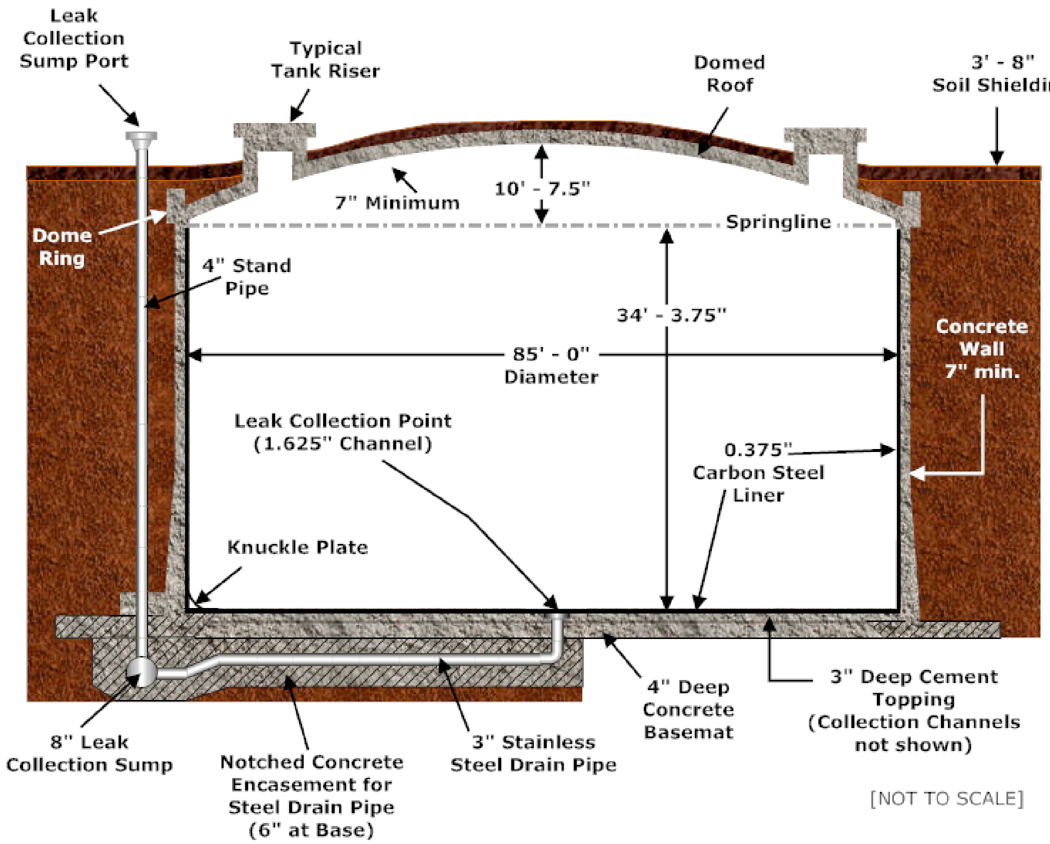
All areas receiving backfill (including sloped areas) were prepared per W700834. Prior to placing backfill, either the working slab was broken up or 4-inch diameter holes, 18 inches on center were punched in the slab. In other areas receiving backfill, the soil cover (e.g., vegetation, top soil, soil-erosion protection layer) was removed and the ground scarified to a depth of 4 inches. Backfill with the amount (percent) of water most favorable to achieve not less than 95% of the maximum dry density was used. [W701036]. Backfill was placed to within 1 foot of the elevation of the top of the Type III/IIIA tanks. [W231220, W700242, W701036, W704700] Figure 3.2-44 shows a typical Type III/IIIA tank after completion of backfill placement.

Figure 3.2-44: Typical Type III/IIIA Tank - Backfill Complete

3.2.1.4 Type IV Tanks

There are four Type IV tanks in HTF (Tanks 21 through 24). The Type IV tanks were constructed between 1958 and 1962. A typical HTF Type IV tank configuration is shown in Figure 3.2-45. These waste tanks have a single liner with a spherical, reinforced concrete, domed roof that supports itself. Type IV tanks are 85 feet in diameter and approximately 34 feet high at the side wall, with a nominal operating capacity of 1,300,000 gallons. [DP-478]

Figure 3.2-45: Typical HTF Type IV Tank



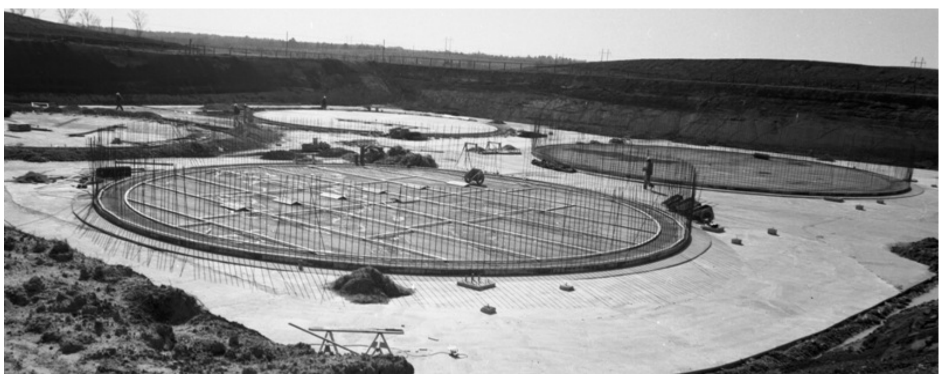
3.2.1.4.1 Basemat and Cement Topping

A Type IV tank bottom layer is a reinforced basemat that is 4 inches thick. The basemat was installed with a thickness tolerance of plus 0.5 inch and minus 0.25 inch. [W230945] The testing of concrete and concrete materials was in accordance with W230945.

The basemat is covered with a wire mesh covered by a 3-inch cement topping with a float and trowel finish giving a maximum tolerance of ± 0.125 inch from true level. Figure 3.2-46 shows the placement of the basemat. Drainage channels (1.625 inch deep and approximately 3.5 inches wide) used for leak detection were formed in the cement topping (Figure 3.2-47). The channels coincide with the locations of welds and backup strips. [W230945]

Figure 3.2-46: Type IV Tank Basemat Placement

Figure 3.2-47: Type IV Tank Basemat Showing Geometry of Drainage Channels



A 3-inch stainless steel drainpipe to collect any leakage is located at the center of the basemat. The drainpipe was placed below the 4-inch basemat and runs to an 8-inch long collection chamber (8 inches in diameter) below the footing at the edge of the waste tank wall. A 4-inch diameter pipe connects the leak collection chamber to the surface so that a leak collection probe might be placed in the chamber. [W230945]

3.2.1.4.2 Primary Liner

The Type IV tank primary liner is a cylinder (open at the top) made of 0.375-inch carbon steel plates and 0.4375-inch knuckle plates. [W230907] The primary waste tank liner is reinforced internally with three circumferential 4-inch carbon steel stiffener angles and is anchored externally to the concrete wall. The primary carbon steel liner material is identified and installed per specifications listed in W230907. Figure 3.2-48 shows the primary liner during Type IV tank construction.

Figure 3.2-48: Type IV Tank Primary Liner Construction

Penetrations through the primary liner and the side concrete (vault) wall exist to accommodate processing needs. The process lines penetrate the waste tank liner and concrete (vault) wall through sleeved penetrations. The size and material type for the process lines and the penetration sleeves are identified in Table 3.2-4.

Table 3.2-4: Type IV Tank Side Penetrations in Primary Liner

Tank No.	Process Line	Sleeve Welded to Primary Liner	Reference Drawings
21 - 24	3-inch schedule 40 stainless steel core pipe with 6-inch schedule 20 stainless steel jacket	10-inch schedule 40 carbon steel	W231244 W234134
21 - 24	3-inch schedule 40 stainless steel (two per waste tank)	10-inch schedule 40 carbon steel	W231244
21	4-inch stainless steel	6-inch schedule 40 carbon steel	W231210 W231244

3.2.1.4.3 Waste Tank Concrete Vault

The Type IV tank is completely enclosed in a concrete vault. After the wall foundation and basemat had been set and cured, the annular space between them was filled with metallic non-shrink grout with a compressive strength at least equal to that of the basemat. [W230976] The wall footing total width is 4 feet 10 inches, with 2 feet of the wall footing extending underneath the primary liner. The wall and wall footing contain vertical and horizontal reinforcing steel bars as detailed in drawings W230945 and W230976.

The waste tank roof consists of a spherical reinforced concrete dome made of concrete 7 to 10 inches thick (the dome concrete is thicker near the risers). The concrete dome is reinforced throughout with steel bars. Figure 3.2-49 shows the reinforced steel bars prior to the placement of the concrete. The dome has an internal curvature radius of 90 feet 4 inches and a rise of 10 feet 7.5 inches above the springline. The dome shape of the roof provides its own structural support; therefore, the concrete roof is not lined with carbon steel on the inside. The dome was constructed of Class A concrete that developed 5,000-psi at a 28-day cure time. [W231023] Each waste tank has six peripheral risers, each providing a 2-foot diameter opening into the waste tank interior. The riser locations are detailed in drawing W231206. Figure 3.2-50 shows the concrete vault for a Type IV tanks and the peripheral risers on the waste tank dome.

Figure 3.2-49: Type IV Tank Dome Construction

Figure 3.2-50: Type IV Tank Concrete Vault Construction

There is no secondary steel liner for the Type IV tanks. The concrete vault for the Type IV tank was built around the primary steel liner with the wall and the dome ring formed by shotcrete and reinforcing bars. [W230976] The walls were shot in vertical strips to avoid any horizontal joints around the waste tank and vertical joints were staggered in subsequent layers. The shotcrete was applied in successive layers from 0.75 inches to a maximum of 2 inches to provide the buildup thickness required per specification in W230976. Figure 3.2-51 shows the application of shotcrete on the wall of the Type IV tank.

Figure 3.2-51: Type IV Tank Vault Wall Shotcrete Application

The walls (concrete and liner) form a cylinder with an inner diameter of 85 feet and a height of 34 feet 3.75 inches at the springline surmounted by the dome ring. The core wall is 7 inches thick at the top and 11 inches at the bottom. The dome ring and wall were made monolithic by shooting the layers continually from the bottom to the top of the wall. The vertical reinforcing in the wall was also carried up into the dome ring. The dome ring and wall act as a unit with a joint between dome ring and dome slab and a joint between the wall and floor. [W230976]

The dome ring and the wall were prestressed by round bands to provide compression of the wall during operating conditions. [W230976]

3.2.1.4.4 Soil and Backfill

Earth was excavated from the area surrounding Tanks 21 through 24 to a depth of 17 feet below existing grade. [W230826] Since no annulus exists for these waste tanks, a three-layer backfilling system is used to surround the sidewalls of the concrete vault. [W231221] The backfill consists of a vermiculite fill layer, a special manually compacted fill of soil, and a test controlled compacted fill of soil. The vermiculite fill, (minimum 8 inches thick) added in bags, provides a cushion layer for expansion of the primary liner with temperature variations of the waste tank and waste tank contents from the foundation to the underside of the dome ring. As each bag layer was placed, voids behind and between bags were filled with earth backfill. When the fill came up to the top of a course of vermiculite bags, additional bags were placed against the waste tank. [DP-478, Section 8] Standard compaction of excavated soil (sandy clay) was performed around and over waste tanks. [W230976, W231023, W231221] The final test-controlled compacted fill was packed and rolled with heavy equipment. Figure 3.2-52 shows the placement of the vermiculite bags along the waste tank wall with backfilling operations approximately 50% complete. The waste tanks were finally covered with a minimum of 3 feet 8 inches of compacted soil (Figure 3.2-53). [W231023]

Figure 3.2-52: Type IV Tanks with Backfill - Vermiculite Bags Showing

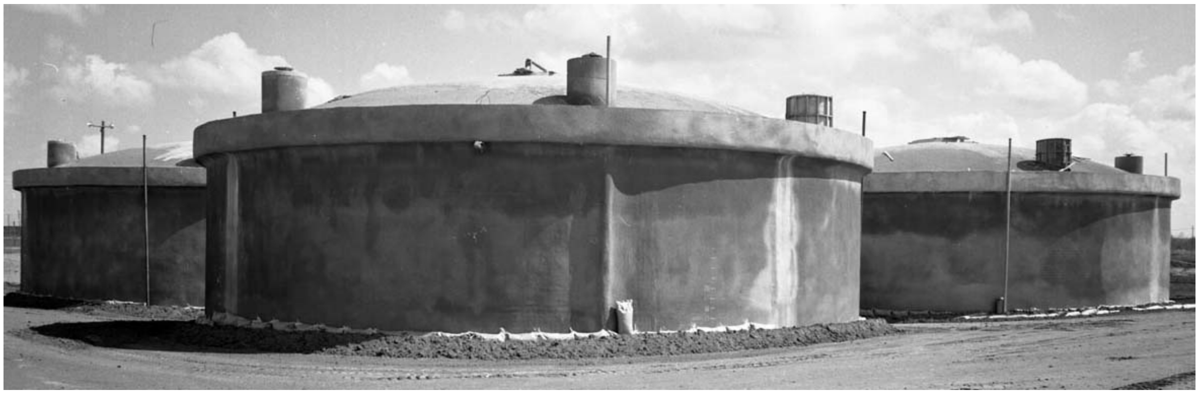


Figure 3.2-53: Type IV Tanks Backfill Complete

3.2.1.5 Water Infiltration through Waste Tank Design Features

Multiple waste tank design elements serve to minimize water infiltration. The concrete vaults and steel liners serve to retard water flow through the waste tanks. The design features assumed in the HTF modeling are described in detail in Section 4. In addition, the waste tank tops are covered by the HTF closure cap (Section 3.2.4), and the waste tank liners are filled with cementitious material (Section 3.2.3), which will further limit the amount of water infiltration into the waste tank CZ.

3.2.1.6 Waste Tank Design Features Structural Stability/Degradation

Waste tank carbon steel primary liner and concrete vault structural stability is provided by the closure concept of grouting voids. The EIS considered several alternatives for the HTF waste tanks, including filling them with low-level contaminated grout or leaving a remaining void above the first grout lift with grout fill being the preferred alternative. [DOE-EIS-0303 ROD] In this PA, it is assumed that the entire waste tank is filled with grout therefore structural failure (i.e., collapse) is not considered. The HTF modeling included the impact of waste tank degradation (e.g., cracking or corrosion leading to increased hydraulic conductivity), and is described in detail in Section 4.2.2.2.

A structural evaluation was performed on Type IV Tanks 18 and 19 in the FTF to demonstrate that the waste tanks would maintain structural integrity during grouting activities. [T-CLC-F-00373] An additional analysis was performed to show that there would be minimal settlement (approximately 2 inches maximum) of the waste tanks even after they are grouted and a closure cap installed. [K-CLC-F-00073]

The long-term structural behavior/integrity of a grout filled waste tanks was evaluated. Mechanisms that could lead to cracking, such as material degradation, seismic loads, and settlement were analyzed. The analyses concluded that these mechanisms would not cause the grout filled waste tank to crack. [T-CLC-F-00421]

3.2.1.7 Waste Tank Design Features as Inadvertent Intruder Barrier

Multiple elements of the waste tank design serve as inadvertent intruder barriers. The HTF closure cap, waste tank concrete roof, and waste tank grout fill are considered sufficient to prevent drilling into the waste form given well drilling practices in the region and the presence of nearby land without underground concrete obstructions. The presence of the earthen cover and the intruder barrier will prevent the worker from coming in contact with the waste form during construction of a basement for a residence as an inadvertent intruder. Section 4.2.3 contains a detailed discussion of the inadvertent intruder and exposure scenarios that are considered credible based on the waste tank design.

3.2.2 Ancillary Equipment

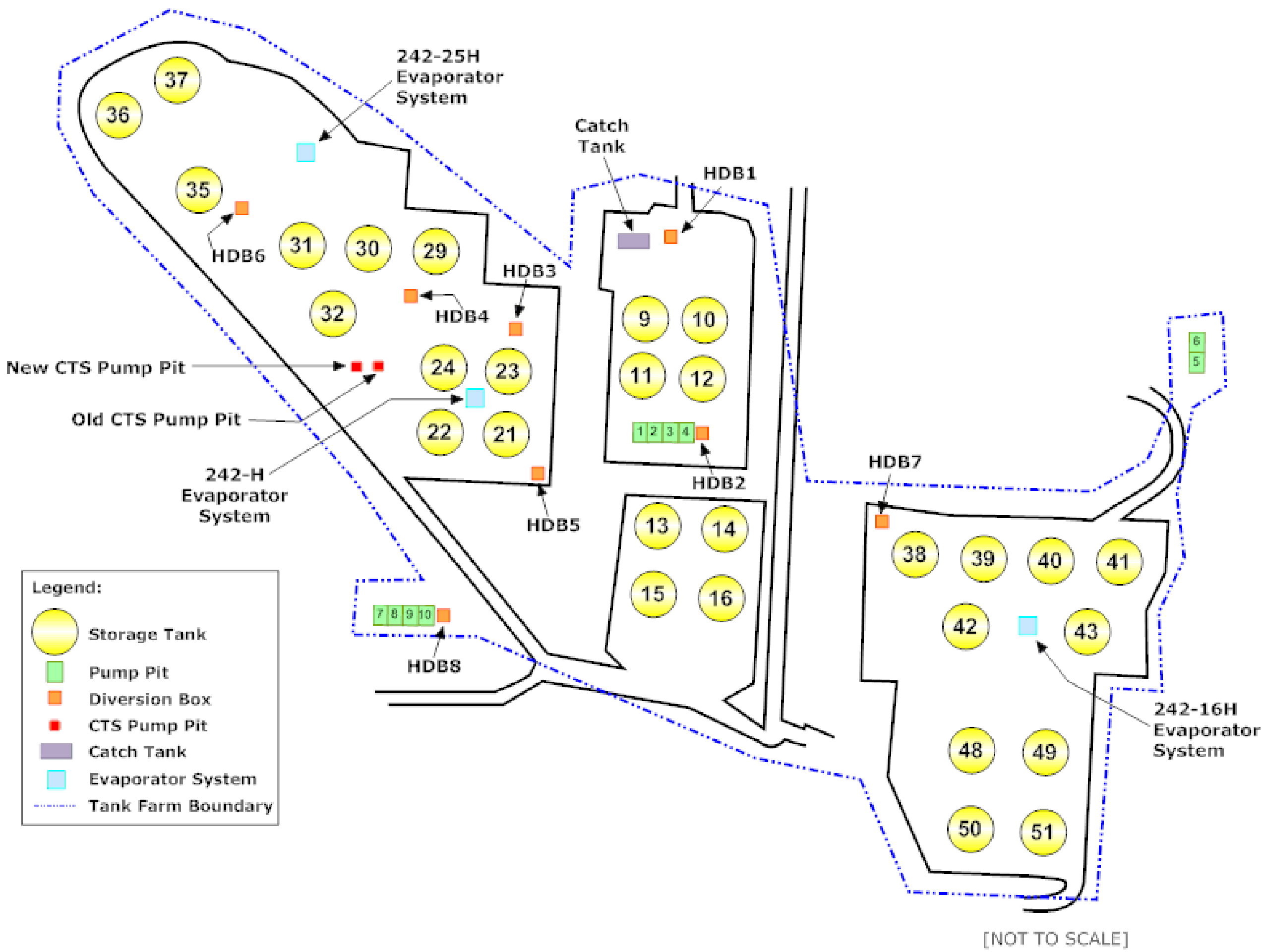
The HTF contains ancillary equipment with a residual radiological inventory that must be accounted for as a part of facility closure. This ancillary equipment includes buried pipe (transfer lines), pump tanks, and evaporators, all of which have been in contact with liquid waste over the operating life of the facility. The ancillary equipment was used in the HTF to transfer waste (e.g., transfer lines, pump tanks) and reduce waste volume though evaporation (e.g., the evaporator systems), or treat wastes (e.g., Actinide Removal Process (ARP), Modular Caustic Side Solvent Extraction Unit (MCU). The amount of contamination on these components depends on such factors as the service life of the component, its materials of construction, and the contaminating medium in contact with the component.

Figure 3.2-54 identifies locations of specific ancillary equipment relative to the HTF waste tanks and relative to other components. The following HTF locations were considered in the PA waste modeling (discussed further in Section 4.4.2).

- The HTF transfer line system (74,800 linear feet), including transfer line jackets, leak detection boxes (LDBs), cleanout ports, and other transfer line secondary containment systems (e.g., the Type I tank transfer line encasements)
- The HTF pump tanks (i.e., HPT 2-10, CTS PT-242-3H, and CTS PT 242-18H)
- The HTF PPs (i.e., HPP 1-10, CTS PP-242-3H, and CTS PP-242-18H)
- The 242-H evaporator system, including the evaporator cell and system support tanks (e.g., mercury collection tank, cesium removal column (CRC) pump tank, and overheads tanks)

- The 242-16H evaporator system, including the evaporator cell and system support tanks (e.g., mercury collection tank, CRC pump tank, and overheads tanks)
- The 242-25H evaporator system, including the evaporator cell and system support tanks (e.g., condenser, mercury collection tank, and overheads pumps and tanks)

Figure 3.2-54: HTF Ancillary Equipment Locations



The initial conceptual design and approach used in the HTF PA modeling is an aphysical simplification of the actual infrastructure of HTF ancillary equipment design. This approach is required for analytical modeling. Certain equipment features and design elements have been omitted in the conceptual model.

Transfer line inventory is modeled by distributing the assumed inventory uniformly throughout the HTF modeling cells. The pump tanks, evaporator pots, and CTS tanks are modeled as uniform inventories spread throughout a single modeling cell at the location of the applicable ancillary source. Other HTF ancillary equipment (i.e., DBs, valve boxes, catch tank, evaporator cells, and overheads tanks) are not modeled. This approach is because these locations did not serve as primary waste containment, and therefore will not contain significant radiological inventory at closure. Additionally, ancillary equipment in the ARP/MCU facilities is not modeled, as these facilities will be extensively cleaned or decontaminated, and/or removed to support closure activities.

3.2.2.1 Transfer Line System

The HTF transfer line details are provided in Table 3.2-5 and based on reference drawings and data obtained from the Structural Integrity Database (M-ML-G-0005), an engineering database developed to help control and maintain the technical baseline of the SRS facilities including the HTF.

Table 3.2-5: HTF Transfer Line Segment Listing

Line No.	From (a)	To	Core Material (b)	Core Diameter (inches)	Jacket Diameter (inches)	Line Length (ft)	Cross-Sectional Area (ft^2)
1	HDB-1(24)	HPP-1(2)	SS	3	Encasement	342	100
2	HDB-1(15)	HPP-1(3)	SS	3	Encasement	339	99
3	HDB-1(27)	HPP-2(2)	SS	3	Encasement	325	95
4	HDB-1(18)	HPP-2(3)	SS	3	Encasement	322	94
5	HDB-1(22)	HPP-3(2)	SS	3	Encasement	308	90
6	HDB-1(13)	HPP-3(3)	SS	3	Encasement	305	89
7	HDB-1(25)	HPP-4(2)	SS	3	Encasement	304	89
8	HDB-4(3)	HPP-1(16)	SS	3	Encasement	304	89
9	HDB-2(6)	HPP-3(23)	SS	3	Encasement	70	20
10	HPP-1(5)	HDB-2(5)	SS	3	Encasement	60	18
11	HPP-2(4)	HDB-2(4)	SS	3	Encasement	50	15
12	HPP-2(5)	HDB-2(3)	SS	3	Encasement	63	18
13	HPP-3(4)	HDB-2(8)	SS	3	Encasement	56	16
14	HPP-3(5)	HDB-2(7)	SS	3	Encasement	60	18
15	HPP-4(4)	HDB-2(2)	SS	3	Encasement	30	9
17	HDB-2(16)	Tank 13	SS	3	Encasement	173	50
18	HDB-2(15)	cut & capped	SS	3	Encasement	0	0
19	HDB-2(14)	Tank 15	SS	3	Encasement	293	85
20	HDB-2(13)	Tank 15	SS	3	Encasement	293	85
21	Tank 15 & Tank 16 Valve Box	HDB-2(12)	SS	3	Encasement	289	84
22	HDB-2(11)	Tank 16	SS	3	Encasement	293	85
23	HDB-2(10)	Tank 14	SS	3	Encasement	173	50
24	HDB-2(9)	Tank 14	SS	3	Encasement	173	50
27	Tank 13(7)	HDB-2(22)	SS	3	4	256	50

Table 3.2-5: HTF Transfer Line Segment Listing (Continued)

Line No.	From (a)	To	Core Material (b)	Core Diameter (inches)	Jacket Diameter (inches)	Line Length (ft)	Cross-Sectional Area (ft^2)
29	HDB-5(11)	HDB-2(20)	SS	3	4	282	82
30	HDB-5(10)	HDB-2(19)	SS	3	4	290	85
31/107	HDB-2(18)	HDB-4(13)	SS	3	10	700	204
32/106	HDB-2(17)	HDB-4(15)	SS	3	10	700	204
33E	HDB-1(11)	Tank 9	SS	3	Encasement	81	24
34E	HDB-1(12)	Tank 10	SS	3	Encasement	81	24
36E	HDB-1(14)	Tank 12	SS	3	Encasement	181	53
39E	HDB-1(17)	Tank 11	SS	3	Encasement	181	53
41E	#91	HDB-1(19)	SS	3	Encasement	50	15
42E	HDB-1(20)	Tank 9	SS	3	Encasement	81	24
43E	HDB-1(21)	Tank 10	SS	3	Encasement	81	24
45E	HDB-1(23)	Tank 12	SS	3	Encasement	181	53
48E	HDB-1(26)	Tank 11	SS	3	Encasement	181	53
100	HDB-3(3)	Tank 23 (NW)	SS	3	6	25	7
100(EVAP)	Tank 32(TP)	242-25H Evaporator (P8)	SS	2	8	423	84
101(DB3)	HDB-3(2)	Tank 21(NE)	SS	3	6	160	47
101(DB4)	HDB-4(11)	Tank 29	SS	2	3	81	16
101E	Tank 23(N)	HDB-5(7)	SS	3	10	280	82
102(DB4)	Tank 29(TJ)	HDB-4(9)	SS	3	8	103	30
102(DB6)	HDB-6(8)	Tank 35(C1)	SS	3	10	83	24
102/RCZ74	HDB-6(2)	HDB-8(21)	SS	3	6	1,176	343
103	Tank 14(2)	Tank 13(7)	SS	3	4	370	108
103(DB4)	HDB-4(6)	Tank 31(C1)	SS	3	10	190	55
103(DB6)	HDB-6(9)	Tank 36(C1)	SS	3	10	463	135

Table 3.2-5: HTF Transfer Line Segment Listing (Continued)

Line No.	From (a)	To	Core Material (b)	Core Diameter (inches)	Jacket Diameter (inches)	Line Length (ft)	Cross-Sectional Area (ft^2)
104(DB4)	HDB-4(4)	Tank 32(TJ)	SS	3	8	110	32
104 (DB6)	HDB-6(10)	Tank 37(C1)	SS	3	10	575	168
105(DB4)	HDB-4(8)	Tank 30(C1)	SS	3	10	84	25
105/HHP14	HDB-8(20)	HDB-6(1)	SS	3	6	1,176	343
108	HDB-4(12)	HDB-5(9)	SS	3	10	460	134
109	HDB-4(10)	Tank 29(C1)	SS	3	8	103	30
110	Tank 31(TJ)	HDB-4(5)	SS	3	8	190	55
111	Tank 32(C1)	HDB-4(3)	SS	3	8	110	32
112	Tank 30(TJ)	HDB-4(7)	SS	3	8	84	25
140	244-H (RBOF)	HDB-3 (1)	SS	3	6	852	249
151	Tank 35(TJ)	HDB-6(5)	SS	3	10	81	24
201	Tank 36(TJ)	HDB-6(6)	SS	3	10	463	135
251	Tank 37(TJ)	HDB-6(7)	SS	3	10	575	168
451	Tank 13(TP)	242-H Evaporator	SS	3	6	427	125
452	242-H Evaporator vent	Tank 13	SS	3	6	427	125
475	242-25H Evaporator (P4)	Tank 29(C2)	SS	3	8	239	70
476	242-25H Evaporator (P5)	Tank 30(C2)	SS	3	8	188	55
477	242-25H Evaporator (P6)	capped/not installed	SS	3	8	116	34
479	242-25H Evaporator (P18)	Tank 37(C2)	SS	3	8	251	73
501	242-H Evaporator	HCTS(2)	SS	3	8	282	82
504	HCTS (27)	Tank 29	SS	3	4	90	26
505	HCTS (21)	Tank 32 cut & capped	SS	2	3	90	18
506	Tank 31(C2)	Tank 32 cut & capped	SS	2	3	289	57
507	Tank 31(C2)	Tank 30 cut & capped	SS	2	3	165	33

Table 3.2-5: HTF Transfer Line Segment Listing (Continued)

Line No.	From (a)	To	Core Material (b)	Core Diameter (inches)	Jacket Diameter (inches)	Line Length (ft)	Cross-Sectional Area (ft^2)
508	Tank 30 cut & capped	Tank 29(C2)	SS	2	3	73	14
509	Tank 29 cut & capped	HCTS (24)	SS	2	8	253	50
535	242-25H Cell(P12)	Tank 32(C2)	SS	2	8	456	90
552	242-25H Hg Tank overheads	Tank 32	SS	2	8	463	92
665	Tank 12(7) TJ	Line 930 at HDB-2	CS	3	4	80	23
671	Tank 11(6)	Tank 11(7)	SS	3	4	16	5
703A	ITP filter cell #1	#1554A	SS	3	6	34	10
705A	ITP filter cell #1	Tank 48(E2)	SS	6	10	57	31
910	#2225	#911	SS	3	4	130	38
911	Tank 10(2) TJ	#41E to HDB-1(19)	CS	3	8	212	62
930	Tank 11(7)	HDB-2(29)	CS	3	4	140	41
1051	HDB-4(2)	HDB-6(13)	SS	3	6	641	187
1052	HDB-6(11) sump	Tank 35(C2)	SS	2	4	58	11
1100	221H HHW HDR#1	HPP-6(1)	SS	3	10	750	219
1101	221H LHW HDR#4	HPP-5(1)	SS	3	10	771	225
1102	221H LHW HDR#3	HPP-5(2)	SS	3	10	760	222
1103	221H HHW HDR#2	HPP-6(2)	SS	3	10	760	222
1103A	ITP filter cell #2	#703A	SS	3	6	31	9
1104	221H LDB#4	#1000 at HPP-6	CS	1.5	N/A	752	119
1105A	ITP filter cell #2	Tank 48(E2)	SS	6	10	72	40
1151A	Tank 48(G)	ITP filter cell #2	SS	6	10	135	75
1152A	Tank 48(H)	ITP filter cell #1	SS	6	10	165	91
1251A	Tank 49 transfer valve box drain	#8318 to #8415 to drain cell	CS	3	Encasement	108	32

Table 3.2-5: HTF Transfer Line Segment Listing (Continued)

Line No.	From (a)	To	Core Material (b)	Core Diameter (inches)	Jacket Diameter (inches)	Line Length (ft)	Cross-Sectional Area (ft^2)
1252A	Tank 49 transfer valve box	#1660	SS	3	6	10	3
1253A	Tank 49 transfer valve box	Late Wash facility	SS	3	6	893	260
1451A	#1661	Tank 49	SS	3	6	13	4
1501	Tank 39(TJ)	Tank 43(C1)	SS	3	6	350	102
1501A	Tank 22 valve box	Tank 22 side port	SS	3	4	53	15
1502A	Tank 22 valve box	#5811	SS	3	4	17	5
1503A	HDB-5(3)	Tank 22 valve box	SS	3	4	205	60
1528	Tank 38(TJ)	Tank 43(R)	SS	3	6	586	171
1552A	ITP building	cut & capped	SS	3	6	22	6
1554A	ITP hold tanks	Tank 48	SS	3	6	78	23
1555A	#1552A	#1566A	SS	3	6	16	5
1555A (cut)	ITP building	cut & capped	SS	3	6	19	6
1566A	ITP wash valve	Tank 48(B3)	SS	3	6	65	19
1576	Tank 41(TJ)	Tank 43	SS	3	6	314	92
1596	#16102	Tank 43	SS	3	6	338	99
1626	Tank 43(TJ)	HDB-7(10)	SS	3	10	815	238
1628	Tank 43 (R) pump	242-16H Evaporator (N12)	SS	1	6	104	11
1651	242-16H Evaporator (N10)	Tank 43(C3)	SS	2	6	79	16
1653	242-16H Evaporator (N9)	Tank 41(C3)	SS	2	6	164	32
1654	242-16H Evaporator (N8)	Tank 40(C3)	SS	2	6	92	18
1660	#1252A	#3056	SS	3	10	404	118
1661	#1701A	#1451A	SS	3	6	292	85
1662	#16053 at Tank 51	Tank 43	SS	3	10	451	132
1663	Tank 50(TJ)	Tank 43 cut & capped	SS	3	10	620	181

Table 3.2-5: HTF Transfer Line Segment Listing (Continued)

Line No.	From (a)	To	Core Material (b)	Core Diameter (inches)	Jacket Diameter (inches)	Line Length (ft)	Cross-Sectional Area (ft^2)
1701A	Tank 48(B5) TTP	#1661	SS	3	6	58	17
1825	Tank 24(TJ)	HDB-5(8)	SS	3	10	396	116
1905A/SSP2	Tank 50 (B5) TTP	Low point drain tank	SS	4	6	3,371	1264
2225	Tank 9(3) TJ	#910	SS	3	4	5	1
2701	242-16H Evaporator (N4)	Tank 39(C3)	SS	2	6	114	23
2702	242-16H Evaporator (N3)	Tank 38(C3)	SS	2	6	206	41
2703	242-16H Evaporator bottom line clean out drain	Tank 38	SS	1.5	3	93	15
2708	242-16H Evaporator (N2)	Tank 42(C3)	SS	2	6	77	15
2722	Tank 42(C1) valve box	Tank 43	SS	3	8	381	111
3051	HDB-7(11)	Tank 43(C1)	SS	3	10	815	238
3052	HDB-7(12)	Tank 41(C1)	SS	3	10	515	150
3053	HDB-7(13)	Tank 40 valve box	SS	3	10	377	110
3054	HDB-7(14)	Tank 39(C1)	SS	3	6	238	69
3055	HDB-7(15) drain	Tank 38	SS	1.5	4	51	8
3056	#1660	HDB-7(20)	SS	3	12	394	115
3057	HDB-7(19)	Tank 48(C1)	SS	3	12	404	118
3059	Tank 50(C1) TJ	HDB-7(21)	SS	3	12	855	249
3060	#16052	HDB-7(22)	SS	3	12	975	284
3062	HDB-8(3)	HDB-7(23)	SS	3	6	1,152	336
3063	HDB-8(2)	HDB-7(24)	SS	3	6	1,154	337
3068	HDB-2(31)	HDB-7(5)	SS	3	10	472	138
3069	HDB-2(30)	HDB-7(6)	SS	3	10	472	138
3070	HDB-7(3)	HDB-8(1)	SS	3	10	1,173	342

Table 3.2-5: HTF Transfer Line Segment Listing (Continued)

Line No.	From (a)	To	Core Material (b)	Core Diameter (inches)	Jacket Diameter (inches)	Line Length (ft)	Cross-Sectional Area (ft^2)
3071	HDB-8(4)	HDB-7(4)	SS	3	10	1,173	342
3083	HDB-7(17)	Tank 38(C1)	SS	3	6	64	19
3084	Tank 42(C1) valve box	HDB-7(18)	SS	3	8	285	83
3094	HPP-6(6)	HDB-7(1)	SS	3	10	857	250
3095	HPP-6(7)	HDB-7(2)	SS	3	10	857	250
3096/RCZ73	HDB-8(15)	HDB-7(9)	SS	3	8	1,206	352
3097	HPP-5(6)	HDB-7(7)	SS	3	10	816	238
3098	HPP-5(7)	HDB-7(8)	SS	3	10	816	238
3102	HDB-7(25)	HDB-8(16)	SS	3	8	1,180	344
3378	242-16H Evaporator overheads drain	Tank 43	SS	2	4	100	20
3934	242-16H (N6)	Tank 50	SS	2	6	342	68
3958	242-16H CRC feed pumps	Tank 42(M)	SS	1.5	6	86	14
3964	Tank 42(M)	242-16H OH receiver	SS	1.5	6	86	14
5811	#1502A	Tank 22(S)	SS	3	4	5	1
6386	ETF WC Tk2	Tank 50 VB	SS	2	6	1,286	255
8352	LDB drain cell (2)	Tank 48	SS	2	4	46	9
12261	Tank 15(7) TJ	916 valve box at Tank 16	SS	3	4	119	35
13568	916 valve box Tank 16	#21 to HDB-2(12)	SS	3	4	296	86
14101	#3084 at Tank 42 valve box	#2722 at Tank 42 valve box	SS	3	4	5	1
15912	#16053	Tank 51 drain valve box	SS	3	4	27	8
15913	#3060	Tank 51 drain valve box	SS	3	4	4	1
15914	Tank 51 drain valve box	#16055	SS	3	4	2	1
15961	Tank 51(B5) TTP	Tank 51 transfer valve box	SS	3	4	25	7

Table 3.2-5: HTF Transfer Line Segment Listing (Continued)

Line No.	From (a)	To	Core Material (b)	Core Diameter (inches)	Jacket Diameter (inches)	Line Length (ft)	Cross-Sectional Area (ft^2)
16051	Tank 51 transfer valve box	Tank 51(C1) jet	SS	3	4	45	13
16052	Tank 51 transfer valve box	#3060	SS	3	4	43	13
16054	Tank 51 transfer valve box	DWPF LPPP sludge tank	SS	3	10	1,131	330
16055	Tank 51 transfer valve box	Tank 51(C1) jet	SS	3	6	35	10
16101	Tank 40 transfer valve box	Tank 40(C1)	SS	3	4	28	8
16102	Tank 40 transfer valve box	#1596	SS	3	6	54	16
16103	Tank 40 transfer valve box	Tank 40(C1)	SS	3	6	62	18
16104	Tank 40 transfer valve box	DWPF LPPP sludge tank	SS	3	10	1,360	397
16262	Tank 40(V2)	Tank 40 transfer valve box	SS	3	4	41	12
16312	Tank 40(B5)	Tank 40 transfer valve box	SS	3	4	22	6
16460	Tank 40(C1)	Tank 40 transfer valve box	SS	3	4	36	11
16462	#16102	Tank 40 drain valve box	SS	3	4	11	3
16463	Tank 40 drain valve box	#16101	SS	3	4	25	7
210001	Tank 21(S)	Tank 21 valve box	SS	3	4	22	6
210002	Tank 21 valve box	Tank 21(SW) spare inlet	SS	3	4	71	21
210003	Tank 21 valve box	HDB-5(6)	SS	3	4	89	26
HHP16	HPP-9(5)	HDB-8(13)	SS	3	Encasement	30	9
HHP17	HDB-8(4)	HPP-9(3)	SS	3	Encasement	30	9
PSP11	HPP-7(5)	HDB-8(3)	SS	3	Encasement	50	15
PSP12	HDB-8(16)	HPP-7(4)	SS	3	Encasement	50	15
RCZ20	Auxiliary pump pit	HDB-8(8)	SS	3	6	2,350	685
RCZ36	LW hold tank	HDB-8(7)	SS	3	6	2,350	685
RCZ75	HDB-5(1)	HDB-8(17)	SS	3	6	311	91
RCZ76	HDB-8(18)	HDB-5(2)	SS	3	6	311	91

Table 3.2.5: HTF Transfer Line Segment Listing (Continued)

Line No.	From (a)	To	Core Material (b)	Core Diameter (inches)	Jacket Diameter (inches)	Line Length (ft)	Cross-Sectional Area (ft^2)
RCZ92	ETF valve pit	HDB-8(6)	SS	3	8	1,260	386
RCZ94	ETF conc DB	HDB-8(5)	SS	4	10	150	56
RCZ117	HDB-8(1)	HPP-7(3)	SS	3	Encasement	50	15
RCZ120	HPP-8(5)	HDB-8(14)	SS	3	Encasement	50	15
RCZ121	HDB-8(6)	HPP-8(2)	SS	3	Encasement	40	12
RCZ122	HDB-8(2)	HPP-8(3)	SS	3	Encasement	40	12
RCZ123	HDB-8(11)	HPP-8(4)	SS	3	Encasement	40	12
RCZ125	HPP-9(2)	HDB-8(7)	SS	3	Encasement	30	9
RCZ126	HPP-9(4)	HDB-8(10)	SS	3	Encasement	30	9
RCZ128	HDB-8(8)	HPP-10(3)	SS	3	Encasement	20	6
RCZ129	HPP-10(5)	HDB-8(9)	SS	3	Encasement	20	6
RCZ130	HDB-8(5)	HPP-10(4)	SS	3	Encasement	20	6
RCZ131	HDB-8(12)	HPP-10(2)	SS	3	Encasement	20	6
RCZ135	HPP-7(2)	HDB-8(15)	SS	3	Encasement	50	15
HB-241942-WTS-L-13052	Tank 42 riser B3 WTS-P-5	Tank 42 transfer valve box	SS	3	4	41	12
HB-241951-WTS-L-15910	Tank 51 riser C1	Transfer valve box WTS-V-78	SS	3	4	26	8
HB-241951-WTS-L-16011	Tank 51 riser V1	Valve box WTS-V-8 line used for flushing	SS	3	4	35	10
HB-241951-WTS-L-16053	Tank 51 valve box WTS-V-76 tie-in	#15912	SS	3	4	23	7
HI-241278-WTS-L-1459	ARP Filtrate line at tie-in to S-512000-RCZ37	Line WTE-L-1459 (at MCU wall/seal plate)	SS	3	4	42	12
HI-241278-WTS-L-1657	Line from seal plate at line WTE-L-1657	tie-in at RCZ38 alias 1253A	SS	3	4	42	12

Table 3.2-5: HTF Transfer Line Segment Listing (Continued)

Line No.	From (a)	To	Core Material (b)	Core Diameter (inches)	Jacket Diameter (inches)	Line Length (ft)	Cross-Sectional Area (ft^2)
HI-241278-WTS-L-1755	Line from seal plate at line WTE-L-1755	Tie-in at SDP1	SS	3	4	40	12
HI-241949-WTS-L-651A	Tank 49 riser B5 WTS-P-3	Tank 49 VBX (above ground)	SS	3	6	56	16
HI-241949-WTS-L-656A	Tank 49 riser B3 WTS-P-4	Tank 49 VBX (above ground)	SS	3	6	47	14
HI-241950-LD-L-8424	Drain line from Tank 50 valve box	Tank 50	CS	3	N/A	21	6
HL-241000-WTS-L-3	Tie-in line HL-241000-WTS-L-49E	HPP-2(2) via encasement	SS	3	N/A	43	13
HL-241000-WTS-L-33E	HDB-1(11)	Tank 9	SS	3	N/A	142	41
HL-241000-WTS-L-34E	HDB-1(12)	Tank 10	SS	3	N/A	132	39
HL-241000-WTS-L-35E	HDB-1(13)	HPP-3(3)	SS	3	N/A	356	104
HL-241000-WTS-L-36E	HDB-1(14)	Tank 12	SS	3	N/A	230	67
HL-241000-WTS-L-41E	#911	HDB-1(19)	SS	3	N/A	69	20
HL-241000-WTS-L-42E	HDB-1(20)	Tank 9	SS	3	N/A	124	36
HL-241000-WTS-L-43E	HDB-1(21)	Tank 10	SS	3	N/A	116	34
HL-241000-WTS-L-44E	HDB-1(22)	Tie-in with HL-241035-WTS-L-5	SS	3	N/A	318	93

Table 3.2-5: HTF Transfer Line Segment Listing (Continued)

Line No.	From (a)	To	Core Material (b)	Core Diameter (inches)	Jacket Diameter (inches)	Line Length (ft)	Cross-Sectional Area (ft^2)
HL-241000-WTS-L-45E	HDB-1(23)	Tank 12	SS	3	N/A	215	63
HL-241000-WTS-L-48E	HDB-1(26)	Tank 11	SS	3	N/A	215	63
HL-241000-WTS-L-49E	HDB-1(27)	Tie-in with HL-241000-WTS-L-3	SS	3	N/A	319	93
HL-241-035-WTS-L-16	HDB-2(1)	HPP-4(5)	SS	3	N/A	18	5
HL-241-035-WTS-L-17	HDB-2(16)	Tank 13	SS	3	N/A	177	52
HL-241-035-WTS-L-18-102	HDB-2(15)	Line #102 at Tank 13 cut & capped at HDB-5	SS	3	N/A	171	50
HL-241-035-WTS-L-19	HDB-2(14)	Tank 15	SS	3	N/A	351	102
HL-241-035-WTS-L-2	HDB-1(15)	HPP-1(3)	SS	3	N/A	388	113
HL-241-035-WTS-L-20	HDB-2(13)	Tank 15	SS	3	N/A	355	104
HL-241-035-WTS-L-22	HDB-2(11)	Tank16	SS	3	N/A	359	105
HL-241-035-WTS-L-23	HDB-2(10)	Tank 14	SS	3	N/A	185	54
HL-241-035-WTS-L-24	HDB-2(9)	Tank 14	SS	3	N/A	187	55
HL-241035-WTS-L-3071	HDB-2(28)	cut & capped at HDB-2	SS	3	10	8	2

Table 3.2-5: HTF Transfer Line Segment Listing (Continued)

Line No.	From (a)	To	Core Material (b)	Core Diameter (inches)	Jacket Diameter (inches)	Line Length (ft)	Cross-Sectional Area (ft^2)
HL-241035-WTS-L-33	HDB-2 overflow to encasement	Tie-in with #68E	SS	3	N/A	140	41
HL-241035-WTS-L-4	HDB-1(18)	HPP-2(3)	SS	3	N/A	367	107
HL-241035-WTS-L-5	Tie-in line HL-241000-WTS-L-44E	HPP-3(2) via encasement	SS	3	N/A	29	8
HL-241035-WTS-L-6	HDB-1(13)	HPP-3(3)	SS	3	N/A	358	104
HL-241035-WTS-L-7	HDB-1(25)	HPP-4(2)	SS	3	N/A	329	96
HL-241035-WTS-L-8	HDB-1(16)	HPP-4(3)	SS	3	N/A	340	99
HL-241035-WTS-L-8E	HDB-1 Encasement drain	Catch tank	SS	3	N/A	399	116
HL-241035-WTS-L-9-HPP1	HPP-1(4)	HDB-2(6) cut & capped	SS	3	N/A	87	25
HL-241035-WTS-L-HP68E	Encasement line #33	Line #8E tie-in	SS	3	N/A	60	18
HL-241035-WTS-L-IAL-25	HDB-2(24)	cut & capped near HDB-8	SS	3	4	660	193
HL-241035-WTS-L-IAL-26	HDB-2(23)	cut & capped near HDB-8	SS	3	4	660	193
HL-241052-WTS-L-21	HDB-5(4)	Tank 21 south riser	SS	1.5	3	94	15
HL-241911-WTS-PSP-5362	Tank 11 annulus transfer line south riser, including new spool piece	Tank 11 Riser 6	SS	3	4	25	7

Table 3.2-5: HTF Transfer Line Segment Listing (Continued)

Line No.	From (a)	To	Core Material (b)	Core Diameter (inches)	Jacket Diameter (inches)	Line Length (ft)	Cross-Sectional Area (ft^2)
HL-241916-WTS-L-20E	Tank 16(TJ)	Tank 13(5)	SS	3	4	200	58
HM-242016-WEE-L-3932	Evaporator (N5)	Tank 48	SS	2	4	200	40
HM-242016-WEE-L-3933	Evaporator (N11)	Tank 49	SS	2	4	185	37
HM-242016-WEE-L-3935	Evaporator (N7)	Tank 51	SS	2	3	359	71
Total (Carbon Steel)						1,313	283
Total (Stainless Steel)						73,487	21,240
Grand Total (Carbon Steel and Stainless Steel)						74,800	21,523

a. Number in "( )" is riser or nozzle identifier
b. SS = Stainless Steel, CS = Carbon Steel.

The HTF has 74,800 linear feet of transfer line with line segments ranging from a few feet in length to almost 3,400 feet. The HTF waste transfer lines are typically constructed of a stainless steel primary core pipe and are normally located below ground. Those lines that are above or near the surface are shielded to minimize radiation exposure to personnel. Figure 3.2-55 shows typical construction for transfer lines. All of the primary transfer lines have secondary containments of some type. The majority of primary transfer lines are surrounded by another pipe (jacket) constructed of carbon steel, stainless steel, or cement-asbestos. These jackets typically drain to LDBs, Modified LDBs (MLDBs), or to another primary or secondary containment (e.g., a waste tank). The balance of the primary transfer lines are located inside covered, concrete encasements, which perform the same secondary containment functions as the jacketed type previously described. Multiple (core) waste transfer lines may be contained in a single secondary containment jacket or concrete encasement. [W236508, W148228]

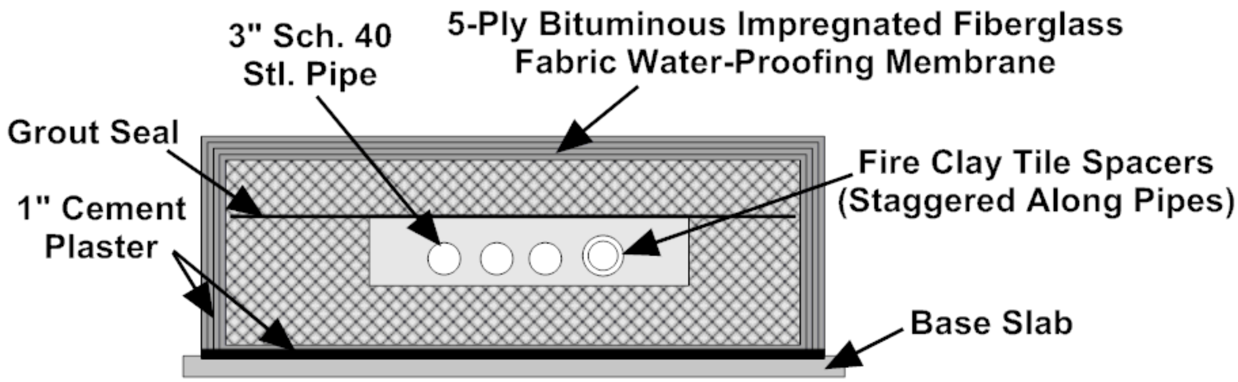
Figure 3.2-55: HTF Transfer Line Construction at Tank 30H

Waste transfer lines are typically sloped to be self-draining and where a pipe transitions from one size to another, the bottom of the pipe is generally aligned to prevent a situation that would prevent waste from draining to the intended tank. The line segments are supported using rod or disk-type core pipe spacers, core pipe supports, jacket supports, jacket guides, or other approved methods. Typically, core pipe spacers and supports are of stainless steel welded to the core pipe and jacket, while jacket supports and guides are of stainless steel with a concrete support. [C-CH-H-8096]

The following types of transfer lines exist in the HTF (it should be noted that designation of transfer line type and waste tank type are not related):

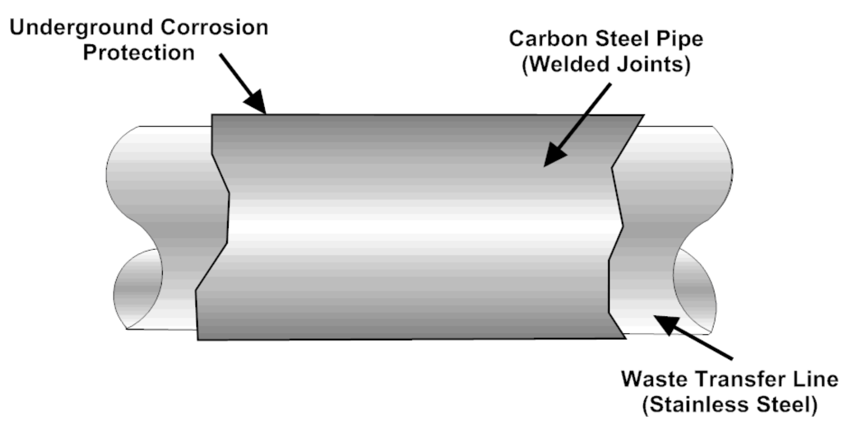
Type I transfer line - The core pipe is enclosed in a covered reinforced concrete encasement below ground and constructed of stainless steel (e.g., transfer lines from HDB-1 to Tanks 9 through 12) as shown in Figure 3.2-56. Core pipe leakage into the encasement and in-leakage of groundwater into the encasement will gravity drain to the catch tank. The catch tank is described later.

Figure 3.2-56: Type I Line Encasement (Sealed Concrete Trench)



Type II Transfer Line - The core pipe is stainless steel inside a carbon steel jacket (Figure 3.2-57). Pipe joints are typically welded and leak tested. Most jackets are encased in insulation. The portion of the carbon steel pipe in contact with the soil is protected against corrosion with polyethylene film wrap or bituminous coating. Type II transfer lines are the most common type of transfer lines in use.

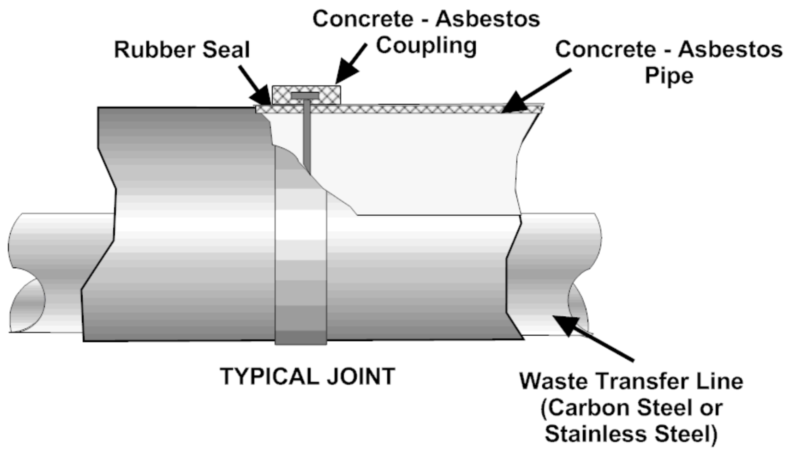
Figure 3.2-57: Type II Line Carbon Steel Jacket



Type IIA Transfer Line - Type IIA lines are similar to Type II except that both core pipe and jacket are of carbon steel. In HTF, there are very few lines of this type, and they are all associated with Tanks 10 through 12 only.

Type III Transfer Line - The core pipe is stainless steel within a cement-asbestos secondary containment that has rubber seals in the joints between the sections of cement-asbestos (Figure 3.2-58). Very few of these lines exist in the HTF and the few that do are associated with HDB-3.

Figure 3.2-58: Type III Line Concrete Asbestos Jacket



Type IV Transfer Line - Type IV lines are similar to Type II except that both the core pipe and jacket are stainless steel. This type of line in HTF is commonly found in use in conjunction with the evaporator systems, especially within the confines of the evaporator cells.

Type VI Transfer Line - Type VI transfer lines are designed to transfer evaporator overheads to and from the CRC. These lines do not have secondary containment. There are a few of these lines in HTF associated with the CRCs in the evaporator systems.

3.2.2.2 Pump Pits and Pump Tanks

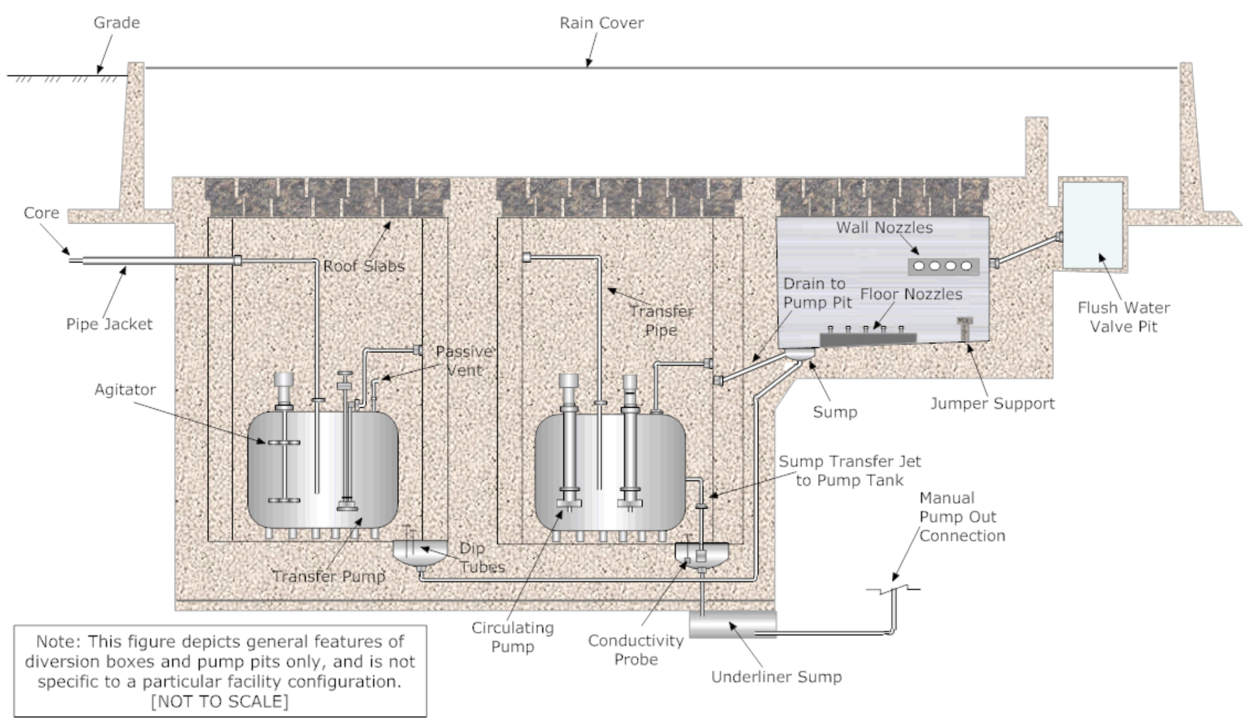
The HTF has 12 PPs (HPP-1 through HPP-10) and the CTSs, old and new. Table 3.2-6 provides a summary of the size and location of the PPs. The PPs are reinforced concrete structures (usually lined with stainless steel) and located below grade at the low points of the transfer lines. The PPs typically have walls that are 2 to 3 feet thick with sloped floors that are approximately 3 feet thick and concrete cell covers that are 2 to 4 feet thick. All PPs house a pump tank (with the exception of HPP-1) and provide secondary containment for the pump tanks. The CTS was used to facilitate transfers of the concentrate from the 1H Evaporator to selected waste tanks. A second CTS pit was needed to replace the original CTS pit to accommodate additional waste tanks. See Figure 3.2-54 for locations of PPs and CTS pits relative to other tank farm components. HPP-1 through HPP-4 and HPP-7 through HPP-10 are co-located with a DB. See Figure 3.2-59 for a typical DB and PP layout. [W163386, W163527]

Table 3.2-6: HTF Pump Pit Sizes and Elevations

Pump Pit	Interior Dimension of Floor Area (ft)	Northern Location [a]	Eastern Location [a]	Minimum Elevation of PP Bottom (ft above MSL)	Minimum Elevation of PP Top (ft above MSL)	References
HPP-1	15 X 15	71477	62007.5	246.9 [b]	282.33	W163386 W163527
HPP-2	15 X 15	71477	62025.5			
HPP-3	15 X 15	71477	62043.5			
HPP-4	15 X 15	71477	62061.5			
HPP-5	18 X 15	71659.5	62950	272.88 [b]	306.5	W714951 W714352
HPP-6	18 X 15	71680.5	62950			
HPP-7	18 X 18	71141.5	61579.5	250 [c]	294	W778702 W778815
HPP-8	18 X 18	71141.5	61601.0			
HPP-9	18 X 18	71141.5	61622.5			
HPP-10	18 X 18	71141.5	61644.0			
CTS (OLD) (242-3H)	14 X 14	71585.8	61549.5	297.18	323	W238758 W238746
CTS (NEW) (242-18H)	14 X 14	71585.83	61506.5	295.625	325	W702909 W702913

a Approximate to centerline of PP
b Bottom of structural slab
c Bottom of concrete below sump

Figure 3.2-59: Typical Diversion Box and Pump Pit Layout



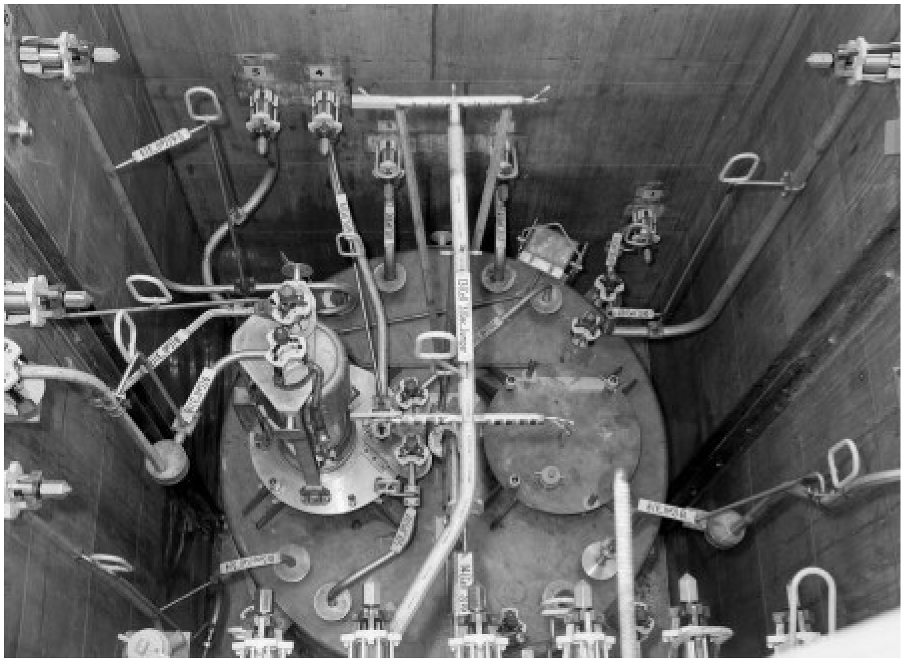
HPP-1 through HPP-4/HPT-2 through HPT-4 - The walls of HPP-1 through HPP-4 are 2 feet 6 inches to 3 feet 9 inches thick with sloped floors that are approximately 3 feet thick (2 feet 9 inches minimum). The cells are 15 feet square. [W163386] The cell covers consist of 12 concrete slabs that are approximately 1 foot 4 inches thick (four across and three high for each PP). [W163613]. Sheets of 16-gage stainless steel cover the walls and 11-gage stainless steel sheets cover the floor and sump of the individual cells. [W163510] Figure 3.2-60 is a photograph of a typical PP during construction.

Figure 3.2-60: Construction of Typical HTF PP

All the PPs (except for HPP-1) contain a stainless steel pump tank. The PP tank vessels are 12 feet in diameter and 8 feet 6 inches high. [D116850] The PP provides secondary containment for the pump tank. The PPs have sumps have a conductivity probe, dip tube, and a transfer pump/jet for level detection and content transfer. Most PP locations have a flush water connection for flushing lines and vessels within the PP. The pump tanks have an approximately 7,200-gallon capacity equipped with dip-tubes for monitoring pump tank level. [PV179667]

There is not a pump tank in HPP-1 and it is used only for storage of old jumpers (rainwater that collects in the sump is pumped to HPT-3). A pump tank is within HPP-2, HPP-3, and HPP-4 (HPT-2, HPT-3, and HPT-4, respectively). Figure 3.2-61 shows the interior of HPP-3.

Figure 3.2-61: Interior View of HPP-3



HPP-5 and HPP-6/HPT-5 and HPT-6 - The walls of HPP-5 and HPP-6 are 2 feet 6 inches to 3 feet thick with sloped floors that are approximately 3 feet thick (2 feet 9 inches minimum). The cells are 18 feet x 15 feet and cell covers are concrete slabs 4 feet 3 inches thick. [W714951] Sheets of 11-gage stainless steel cover the walls and 0.375-inch thick sheets of stainless steel cover the floor and sump. [W714953] The PP tank vessels have sloped bottoms and are 12 feet in diameter, each with a capacity of 7,200 gallons. [PV179667]

HPP-7 through HPP-10/HPT-7 Through HPT-10 - HPP-7 through HPP-10 are 18 feet square, a height of 38 feet 8 inches, walls 3 feet to 3 feet 6 inches thick, and sloped floors approximately 3 feet thick. The cell covers are concrete slabs that are 4 feet 3 inches thick. [W778815] Sheets of 0.25-inch thick stainless steel cover the walls and 0.375-inch thick stainless steel sheets cover the floor and sump. [W778850] The tank vessels have sloped bottoms and are 12 feet in diameter, each with an approximate operating capacity of 6,000 gallons. [W752789]

CTS PP Building 242-3H (OLD) - 242-3H PP (Figure 3.2-62) is a 14 foot square cell with walls of reinforced concrete 1 foot 8 inches to 2 feet thick and sloped floors that are approximately 2 feet thick. The cell covers are reinforced concrete slabs with minimum thickness of 3 feet. [W238758] Sheets of stainless steel cover the walls, floor, and sump. [W238862] The PP tank vessel has a sloped bottom and is 8 feet in diameter with a capacity of approximately 3,000 gallons. [D139006] This PP was retired from service in 1979 and replaced with a new CTS PP to accommodate additional waste tanks.

Figure 3.2-62: Construction of HTF CTS PP Building 242-3H (Old)

CTS PP Building 242-18H (NEW) - 242-18H PP (Figure 3.2-63) is a 14-foot square cell with walls of reinforced concrete that are minimum 2 feet thick and sloped floors approximately 2 feet thick. [W702913] The cell covers are reinforced concrete slabs approximately 3 feet thick. [W702914] Sheets of 11-gage stainless steel cover the walls and 0.375-inch thick stainless steel sheets cover the floor and sump. [W702915] The PP tank vessel has a sloped bottom and is 8 feet in diameter with a capacity of approximately 3,000 gallons. [D139006]

Figure 3.2-63: Concentrate Transfer System PP and Pump Tank

3.2.2.3 Catch Tank

There is a single catch tank in HTF designed to collect drainage from HDB-1 and the Type I tank transfer line encasements. These transfer lines run primarily from Tanks 9 through 16 to HDB-1 and HDB-2. The transfer line encasement slopes towards the catch tank to collect leakage from the transfer line core pipe and in-leakage from ground water. The catch tank is located west of HDB-1. No significant contamination has been collected in this waste tank and it was not modeled as a source for contamination in the HTF PA; however, its description is provided for completeness.

The catch tank is a dished head stainless steel tank with a straight shell length of 30 feet and a diameter of 8 feet with a capacity of approximately 11,700 gallons. [D129961] It is located in an underground reinforced concrete cell with walls that are 2 feet 8 inches thick, a cover that is 2 feet 11 inches thick, and a floor that is 3 feet 10 inches thick. The floor of the catch tank is sloped to drain liquid into a sump and the bottom elevation of the floor, which is approximately at 241 feet above MSL, rests on a 4-inch thick base slab. [W149426]

3.2.2.4 Evaporator Systems

There are three evaporator systems in the HTF, the 242-H evaporator system (1H Evaporator), the 242-16H evaporator system (2H Evaporator), and the 242-25H evaporator system (3H Evaporator). The evaporators are used to reduce the amount of liquid volume of material resulting from nuclear processes. The evaporator systems are principally comprised of the evaporator, the overheads system, and the condenser. The 242-H evaporator system also includes the CTS, which was used to distribute evaporator bottoms throughout HTF (see Figure 3.2-54 for evaporator system locations within HTF). Table 3.2-7 provides evaporator system locations and elevations.

Table 3.2-7: Evaporator System Locations and Elevations

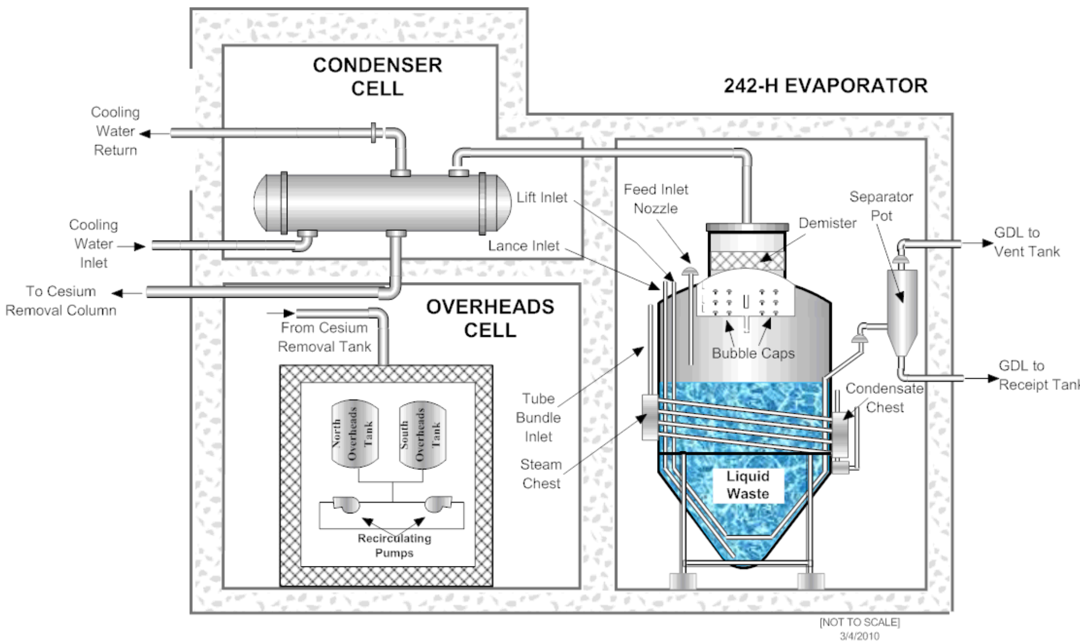
Evaporator System	North Location	East Location	Reference	Elevation of Cell Bottom (ft above MSL)	Top Elevation (ft above MSL)	Reference
242-H	71521	61716	W231132	314.5	348.5	W231299
242-16H	71173	62695	W702194	333.72 [a]	374.78 [b]	W702199
242-25H	71913	61398	W835332	295	345 [c]	SE5-2-2004313

Note Location is centerline of evaporator.
a Top of evaporator sump floor
b Top of cell covers over condenser (N71191, E62691)
c. Top of cell covers - does not include enclosure building.

3.2.2.4.1 242-H Evaporator System

The 242-H evaporator cell is a cuboid with a 16 foot x 15-foot base and a height of 25 feet. The cell includes a 2 foot x 2-foot floor sump with a depth of 2 foot 6 inches. The cell covers are 1-foot thick reinforced concrete. The cell provided containment for the evaporator and served as shielding for personnel protection. [W231299] Figure 3.2-64 is a sketch of the 242-H evaporator system.

Figure 3.2-64: 242-H Evaporator System Schematic



242-H Evaporator Vessel/Pot - The evaporator pot, located inside the 242-H evaporator cell, is a stainless steel cylindrical vessel with a conical bottom. The cylindrical portion is 8 feet in diameter and the overall height of the vessel is 15 feet. The evaporator was used to concentrate liquid in order to reduce liquid volumes. [W703006] Figure 3.2-65 is a view of the top of the evaporator.

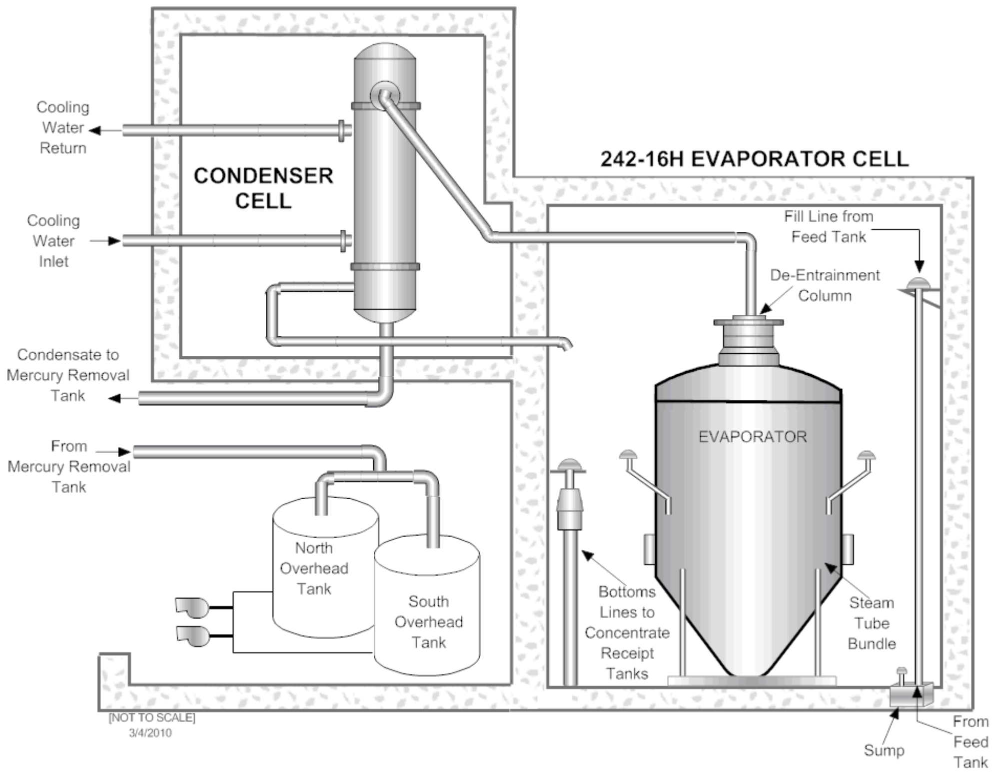
Figure 3.2-65: 242-H Evaporator Vessel Top View

242-H Evaporator Overheads System - The receiver cell is a cuboid with a base 15 feet x 8 feet 10 inches and a height of 16 feet 6 inches. The receiver cell includes a floor sump, with the sump base 1 foot 6 inches square and a depth of 1 foot 6 inches. The receiver cell provided containment for the two overheads vessels. The overheads vessels functioned as receipt tanks for liquids condensed from evaporator vapors via the 242-H Condenser. [W231299]

3.2.2.4.2 242-16H Evaporator System

The 242-16H evaporator system is contained in three cells and a gang valve house. The evaporator cell contains the evaporator; the condenser cell contains the condenser; and an overheads cell contains overheads system components other than the condenser as shown in Figure 3.2-66.

Figure 3.2-66: 242-16H Evaporator System Schematic



242-16H Evaporator Cells - The evaporator cell is 16 feet x 16 feet and approximately 25 feet high. The walls are constructed of concrete that is 3 feet 6 inches thick and lined with 11-gage stainless steel. The floor is lined with 0.375-inch stainless steel plate. The roof consists of 1-foot thick concrete slab sections covered with a sloped galvanized steel rain cover with access ports. The evaporator cell collects leakage from equipment inside the evaporator or condenser cells, leakage from the lift/lance/evaporator cell sump-gang valve vent header, and liquid from cell spray operations. An evaporator underliner sump collects any leakage through the stainless steel liner. [W702199, W702678]

The condenser cell is 10 feet 6 inches x 9 feet 8 inches and 15 feet 6 inches high. The walls are 2-foot thick concrete. The roof is composed of 1-foot thick concrete slab sections and a sloped, galvanized steel rain cover with access ports. The condenser cell contains a 1-foot high stainless steel liner pan on a sloped floor. The condenser cell has an opening to the evaporator cell for the de-entrainment column piping and permits airflow to the evaporator cell. [W702199, W702678, W702679]

The overheads cell is 15 feet x 21 feet and is 21 feet high. The walls are constructed of concrete and the cell contains the following primary equipment: two overheads tanks, mercury removal tank, CRC feed tank, two CRC pumps, and two overheads pumps. This cell has a 14-inch high concrete curb and a sloped floor that are lined with 11-gage stainless steel. [W702199, W702678, W702679]

242-16H Evaporator Vessel/Pot - The 242-16H evaporator vessel is 8 feet in diameter and has a height of 19 feet from the top of the demister to the bottom of the conical shaped lower section. The vessel is constructed of 0.5-inch stainless steel. There are multiple evaporator vessel service/equipment lines installed in, or penetrating the vessel, including the feed inlet nozzle, steam tube bundle, warming coil, lift lines, de-entrainment column, lance lines, and the seal pot. Figure 3.2-67 provides a top view of the 242-16H evaporator vessel. [W449644]

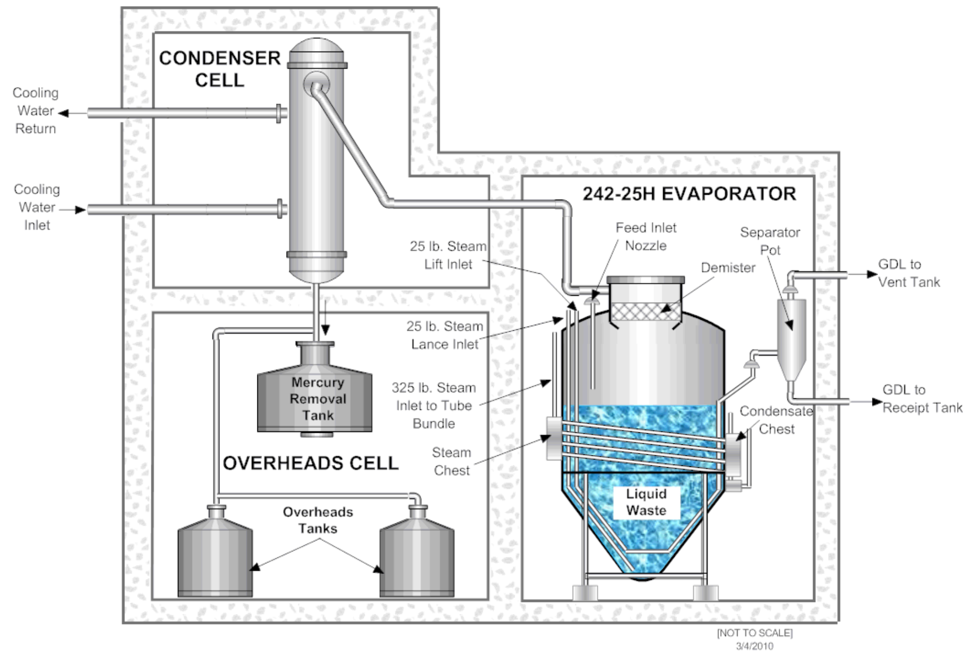
Figure 3.2-67: 242-16H Evaporator Vessel Top View

242-16H Evaporator Overheads System - The 242-16H overheads system includes the condenser, mercury removal tank; CRC feed tank, two CRC pumps, two overheads tanks, and two overheads pumps. The condenser is a vertical, single-pass, counter-flow tube, and shell type heat exchanger located in the condenser cell. The mercury removal tank receives condensed overheads from the condenser. When full, the stainless steel tank overflows to the CRC feed tank, permitting the heavier mercury to settle out and remain in the tank. The tank vents to the condenser cell, which vents and drains to the evaporator cell. The path from the evaporator vessel to the stainless steel overheads tanks travels through a stainless steel CRC feed tank. [W702199]

3.2.2.4.3 242-25H Evaporator System

The 242-25H evaporator facility includes the evaporator cell, which houses the evaporator vessel (pot), the condenser cell and condenser, and an overheads cell, which contains the overheads system (that includes the mercury removal tank, mercury removal station, two overheads tanks, and two overheads pumps). Figure 3.2-68 shows the (3H) 242-25H evaporator system configuration. [SE5-2-2004260, W835332, W2010385]

Figure 3.2-68: 242-25H Evaporator System Schematic



242-25H Evaporator Building - The evaporator cell is 27 feet 6 inches x 20 feet with a height of 32 feet 9 inches. The concrete walls are 3 feet 6 inch thick and the roof is 3-foot 6-inch thick concrete slabs. The evaporator cell floor and sump are lined with 0.375-inch thick stainless steel and the walls are lined with 11-gage stainless steel. [W835332, W835333, W838269] Figure 3.2-69 provides a top view of the evaporator vessel and the evaporator cell.

Figure 3.2-69: 242-25H Evaporator Vessel and Cell Top View

The condenser cell is 10 feet 9 inches x 19 feet and 18 feet high. The concrete walls are a minimum of 2 feet thick and the roof is 2-foot thick concrete slabs. The condenser cell contains a 0.25-inch thick stainless steel liner pan on a sloped floor and 11-gage stainless steel wall liner 6 inches high. The condenser cell has an opening to the evaporator cell for de-entrainment column piping and airflow to the evaporator cell. [W835332, W835333, W838269]

The overheads cell is below grade and is 25 feet x 24 feet and 23 feet high. This cell contains a mercury removal tank, two overheads tanks, an overheads tank sample system, and two overheads pumps. The overheads cell contains a 0.25-inch thick stainless steel liner pan on a sloped floor and 14 inches high, 11-gage stainless steel wall liner. [SE5-2-2004260, W835335, W838269]

242-25H Evaporator Vessel/Pot - The 242-25H evaporator vessel has a capacity of approximately 19,000 gallons. The insulated vessel is 14 feet in diameter and 26 feet 6.375 inches in height from the top of the demister to the conical shaped bottom. The vessel shell is constructed of 0.5625-inch thick stainless steel and the cone is comprised of 0.4038-inch thick stainless steel. There are multiple evaporator vessel service/equipment lines installed in, or penetrating, the vessel, including the feed inlet nozzle, steam tube bundle, warming coil, lift lines, de-entrainment column, lance lines, and the seal pot. [AA98142C Sheets 31 and 40] Figure 3.2-70 provides a view of the bottom of the 242-25H evaporator vessel.

Figure 3.2-70: View of the Bottom of the 242-25H Evaporator Vessel

242-25H Evaporator Overheads System - The 242-25H overheads system includes the condenser, mercury removal tank, two overheads tanks, and two overheads pumps. The condenser is a vertical, single-pass, counter-flow tube, and shell type heat exchanger located in the condenser cell. The mercury removal tank receives condensed overheads from the condenser. A drain valve leads from the bottom of the removal tank to the mercury collection station located in the overheads receiver cell. The overheads are pumped to the Effluent Treatment Facility (ETF) by one of the two-recirculation pumps. The removal tank vents to the condenser cell, which vents and drains to the evaporator cell. Figure 3.2-71 provides a view of the overheads system condenser. [W835333]

Figure 3.2-71: 242-25H Evaporator Overheads System Condenser

3.2.2.5 Diversion Boxes and Valve Boxes

The HTF contains eight DBs (see Figure 3.2-54 for DB locations). Two of the DBs are incorporated with the design and construction of multiple PPs. Incorporated with HPP-1 through HPP-4 is HDB-2 and HDB-8 is incorporated with HPP-7 through HPP-10. [W163527, W778815]

The DBs are reinforced concrete structures that provide a central location for waste transfer lines. The DBs contain transfer line nozzles to which jumpers are connected in order to direct waste transfers to desired waste tanks and pump tanks. This reduces the number of transfer lines necessary to perform diverse transfers amongst tanks and other facilities. Each of the DBs are associated with, and provide connections to, a group of waste tanks that are categorized as shown in Table 3.2-8 (see Figure 3.2-54 for locations). Figure 3.2-72 shows the interior of HDB-1 and Figure 3.2-73 shows HDB-3 during the concrete cell and transfer pipe construction phase. [W147544, S5-2-1341]

Table 3.2-8: Diversion Boxes and Associated Service

Diversion Box	Associated Service
HDB-1	Type I Tanks 9 - 12
HDB-2	Type I Tanks 9 - 12, Type II Tanks 13 - 16
HDB-3	Type IV Tanks 21 - 24
HDB-4	Type III Tanks 29 - 32
HDB-5	Type IV Tanks 21 - 24
HDB-6	Type IIIA Tanks 35 - 37
HDB-7	Type IIIA Tanks 38 - 43, Tanks 48 - 51
HDB-8	Transfers to/from HDB-5, HDB-6, HDB-7 or transfers from FTF and the DWPF.

Figure 3.2-72: Interior of HDB-1

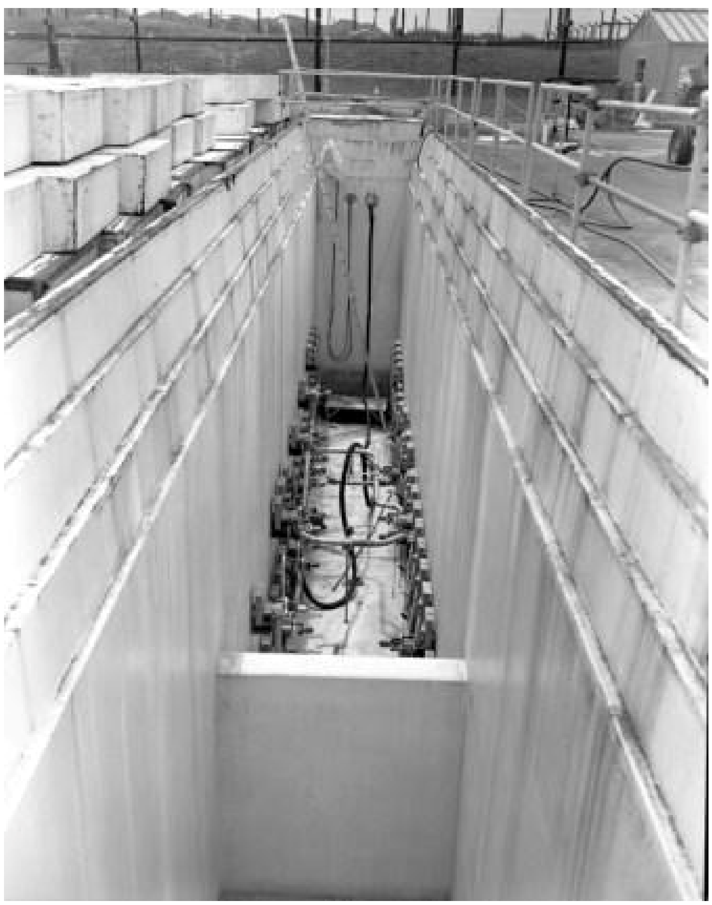


Figure 3.2-73: HDB-3 During Construction Phase

HDB-1 is 78 feet long x 7 feet wide and 21 feet high. The walls are reinforced concrete and are a minimum of 1 foot 6 inches thick and taper to accommodate the two layers of concrete slabs that form a roof approximately 2 feet 8 inches thick. The sloped, reinforced concrete floor is a minimum of 2 feet 6 inches thick. [W158080]

HDB-2 is 26 feet long x 15 feet wide that is incorporated with HPP-1 through HPP-4. The walls are reinforced concrete a minimum of 3 feet thick with a sloped floor of reinforced concrete approximately 4 feet 6 inches thick. The DB covers are concrete slabs and the walls and floor are lined with stainless steel. [W163386]

HDB-3 is a square with outside dimensions of 6 feet 8 inches. The concrete walls and floor are 10 inches thick and the concrete slabs that comprise the roof are 8 inches thick. [S5-2-1341]

HDB-4 is an octagon with an outer dimension of 10 feet and inside diameter of 7 feet. It is comprised of reinforced concrete walls a minimum of 18 inches thick and a sloped, reinforced concrete floor that is approximately 2 feet 6 inches thick. The cover is a reinforced concrete plug 7 feet 8 inches inside diameter and 3 feet thick. Stainless steel plate covers the walls, floor, and sump. [W236630]

HDB-5 is an octagon with an outer dimension of 10 feet and an inside diameter of 7 feet. It is comprised of reinforced concrete walls that are a minimum of 18 inches thick and a sloped, reinforced concrete floor that is approximately 2 feet 4 inches thick. The cover is a reinforced concrete plug with an inside diameter of 7 feet 8 inches and a thickness of 3 feet. Stainless steel plate covers the walls, floor, and sump. [S5-2-4262]

HDB-6 is a 15 foot square with walls and floor that are comprised of reinforced concrete. The walls are minimum 18 inches thick and the sloped floor is approximately 2 feet 11 inches thick. The cover for the DB is comprised of reinforced concrete slabs that are 3 feet thick. Stainless steel sheets cover the wall, floor, and sump. [W700547]

HDB-7 is a 25-foot long x 19-foot wide rectangle with walls and floor that are comprised of reinforced concrete. The walls are minimum 2 feet 6 inches thick and the sloped floor is approximately 3 feet 4 inches thick. The cover for the DB is comprised of reinforced concrete slabs that are 3 feet thick. Stainless steel covers the walls, floor, and sump. [W703874]

HDB-8 is a 20-foot long x 24-foot wide rectangle that is incorporated with HPP-7 through HPP-10. The HDB-8 walls are reinforced concrete with a minimum thickness of 3 feet. The floor is reinforced concrete that is 3 feet thick. The DB cover is comprised of reinforced concrete slabs approximately 4 feet 3 inches thick. The walls, floor, and sump are lined with stainless steel. [W778815, W778818]

3.2.2.5.1 Transfer Valve Boxes

Valve boxes provide passive containment for valve manifolds that allow waste to be transferred to one of several different locations using common transfer lines. Valve boxes house permanently installed valve manifolds within a heavily shielded box. The valves are manual ball valves installed within removable jumpers with flush water connections. The valve boxes serve specific transfers that are conducted as needed to support facility operations. Valve boxes are generally located adjacent to the tanks they provide transfer isolation capability for depending on the type of transfer being performed. [W2017867]

The valve boxes are constructed of stainless steel providing secondary containment for the valve manifolds they house. All valve boxes contain conductivity probes that actuate control room alarms if leakage is detected. Leakage that collects in the valve box will generally drain to the associated waste tank, DB or LDB. The valve boxes associated with HTF are further described below. [W2017867]

Valve Box 15/16 - Valve box for Tanks 15 and 16 contains a transfer line connection to HDB-2. Valve Box 15/16 design is shown on drawing S5-2-11980.

Tanks 21 and 22 Valve Boxes - Valve box design details for Tanks 21 and 22 are shown on drawings P-PM-H-7723 and P-PM-H-7726, respectively.

Tank 40 Valve Box and Tank 40 Drain Valve Box - Valve box and drain valve box design details for Tank 40 are shown on drawings W802781 and D199324, respectively.

Tank 42 Valve Box - Valve box design for Tank 42 is shown on drawing W740180.

Tank 49 Valve Box - Valve box design for Tank 49 is shown on drawing D189542.

Tank 50 Valve Box - Valve box design for Tank 50 is shown on drawing P-PJ-H-7973.

Tank 51 Valve Box and Tank 51 Drain Valve Box - The valve box for Tank 51 is used for transfers in and out of the waste tank. The design of the Tank 51 valve box and the Tank 51 drain valve box are shown on drawings W800445 and W807558, respectively.

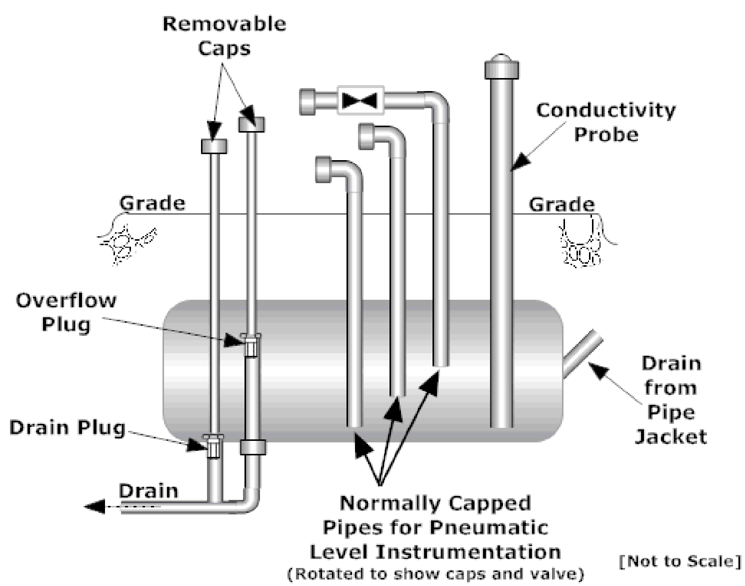
241-96H Valve Box - The 241-96H valve box allows transfers in and out of the Building 241- 96H MST strike tanks. This valve box design is shown on drawing C-CM-H-7026.

3.2.2.6 Other Ancillary Equipment

The LDBs are the primary means of detecting leaks from the waste transfer piping. The LDBs are situated at the low point of a transfer line, near a waste tank or DB where a transfer pipe penetrates the containment wall.

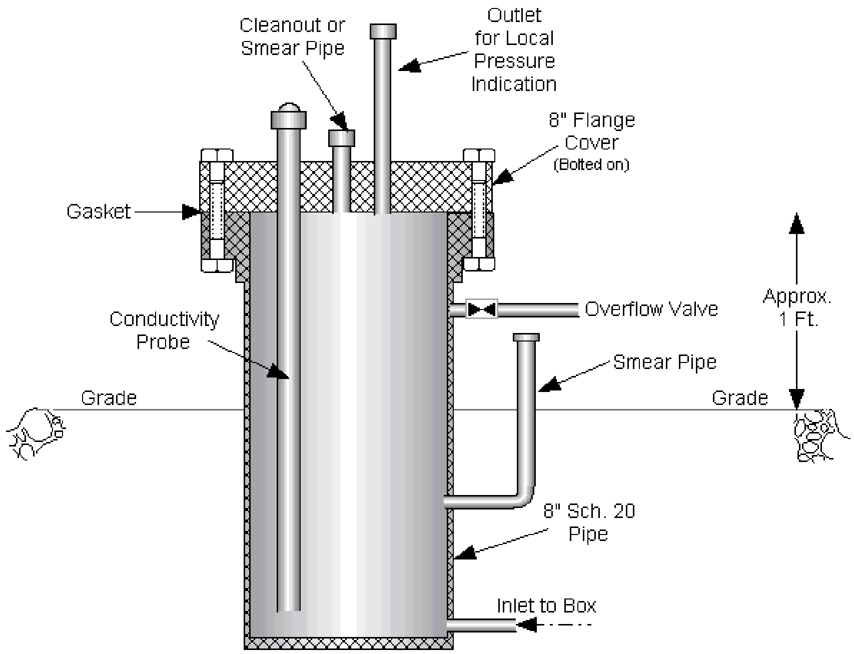
The LDBs are horizontal, carbon steel cylinders, with capped ends. They are located below grade level in proximity to a waste tank or DB that transfer lines penetrate. Each LDB is coated with protective coatings to protect it from corrosion. The components of a typical LDB include a conductivity probe, a set of dip tubes, an overflow line, and a drain line. The overflow plug is normally removed but is installed during pressure testing to ensure a pressure seal is maintained within the transfer piping and LDB. To support LDB conductivity probe operability, the drain plug is installed and to prevent waste from draining past the probe undetected. The conductivity probe will annunciate a control room alarm if liquid is detected. Figure 3.2-74 shows a typical LDB. [W715343]

Figure 3.2-74: Typical Leak Detection Box



The MLDBs are used in place of LDBs in areas where the LDB cannot be gravity drained. Part of the MLDB extends above the ground. Each MLDB is coated with protective coating to protect it from corrosion. The MLDB consists of a vertical pipe flanged at the top with three 1 inch to 1.5-inch pipes extending out of the top flange. Level conductivity probe are located near the bottom of the MLDB. In addition to a conductivity probe, MLDBs also include an overflow line that is routed to a DB or PP, and an above ground pressure gauge to monitor for potential over-pressurization. A cleanout/smear pipe provides a means to sample, smear, or measure the contamination level of the MLDB. The cleanout/smear pipe also can be used to empty the MLDB, using a portable pump. Figure 3.2-75 shows a typical MLDB. [W702976]

Figure 3.2-75: Typical Modified Leak Detection Box



[Not to Scale]

3.2.2.7 Water Infiltration through Ancillary Equipment

Multiple elements of the HTF design serve to minimize water infiltration through ancillary equipment. The steel wall liners will serve significantly to retard water flow into ancillary equipment. The design features assumed in HTF modeling are described in detail in Section 4.2.2.2. In addition, the ancillary equipment will be covered by the HTF closure cap (Section 3.2.4) which will further serve to limit the amount of water infiltration into any residual contamination remaining in the ancillary equipment.

3.2.2.7.1 Ancillary Equipment Structural Stability/Degradation

The structural stability of the ancillary equipment is provided by the steel wall liners and surrounding concrete vaults, (as applicable to the particular piece of ancillary equipment described previously). The impact of ancillary equipment degradation (e.g., corrosion leading to failure of the stainless steel liner) was considered in HTF modeling and is described in detail in Section 4.2.2.

3.2.2.7.2 Ancillary Equipment as Inadvertent Intruder Barrier

The HTF closure cap, which covers all of the ancillary equipment, will serve as a deterrent to the inadvertent intruder, as will the concrete structures that house the ancillary equipment vessels (i.e., evaporator cells, PPs, catch tank cell) and the steel walls of the structures themselves. Section 4.2.3 contains a more detailed discussion of the inadvertent intruder and which exposure scenarios are considered credible based on the HTF ancillary equipment design.

3.2.3 Waste Tank Grouting

In May 2002, DOE issued an EIS on waste tank cleaning and stabilization alternatives. [DOE-EIS-0303] DOE studied five alternatives:

1. Empty, clean, and fill waste tank with grout
2. Empty, clean, and fill waste tank with sand
3. Empty, clean, and fill waste tank with saltstone
4. Clean and remove waste tanks
5. No action

The EIS concluded the "empty, clean, and fill with grout" option under the Stabilize Tanks Alternative was preferred. The DOE also issued an EIS ROD selecting the "empty, clean, and fill with grout" alternative for SRS waste tank closure. [DOE-EIS-0303 ROD]

Evaluations described in the EIS showed the "empty, clean, and fill with grout" alternative to be the best approach to minimize human health and safety risks associated with closure of the tanks. [DOE-EIS-0303] This alternative offers several advantages over the other alternatives evaluated such as:

- Provides greater long-term stability of the tanks and their stabilized contaminants than the sand-fill approach
- Provides for retaining radionuclides within the tanks by use of reducing agents in a fashion that the sand-fill would not
- Avoids the technical complexities and additional worker radiation exposure that the fill-with-saltstone approach would entail
- Produces smaller impacts due to radiological contaminant transport than the sand- and saltstone-fill alternatives
- Avoids the excessive personnel radiation exposure and greater occupational safety impact that would be associated with the clean and remove alternative (DOE-EIS-0303)

Cementitious materials are often used to stabilize radioactive wastes. The purpose of this stabilization is to maintain waste tank structure and minimize water infiltration over an extended period, thereby impeding release of stabilized contaminants into the environment. Grout is a mixture of primarily cement and water proportioned to produce a pourable consistency. Grout studies focus on improving grout production and batching, grout flow, measurement of the effective diffusion coefficients in grout and measurement of hydraulic properties. [WSRC-STI-2007-00369]

Filling a cleaned waste tank with grout prevents the walls and ceiling from possibly collapsing. The grout fill also helps to reduce water intrusion into the waste tank over time. Reducing the amount of water allowed to enter a closed waste tank retards the migration of residual radioactivity from the waste tank to the environment. Testing has demonstrated the chemical and physical characteristics of the grout formula used at SRS retards the movement of radioactivity. [WSRC-TR-97-0102]

The fill grout is grout, which has low oxidation potential, minimizes the mobility of radionuclides after closure. All grout formulas are alkaline because grout is a cement-based material that naturally has a high pH to be compatible with the carbon steel of the waste tank. Grout has a high compressive strength and low permeability, which enhances its ability to limit the migration of contaminants after closure. The grout formulas must be flowable to allow a near level placement.

F-Area Tanks 17 and 20 were closed using three different types of grout in a three-layer configuration. A combination of admixtures was required to achieve the desired properties in the grout layer. The grout mixes contain ample reducing and alkaline properties to meet the chemistry requirement for stabilizing contaminant waste. The compressive strength of the intruder or strong grout is sufficient to provide a physical barrier to discourage intruders and to meet the placement requirements for filling the domes of Type IV tanks only. Additionally, selected equipment already in the waste tank is to be grouted in place.

3.2.3.1 Waste Tank Grouting Plan

Grout will be used to fill the entire volume of the Type I, II, III/IIIA, and IV tanks. Figures 3.2-76 through 3.2-80 illustrate the typical grouted configurations for Type I, II, III, IIIA, and IV tanks. For Type IV tanks, the grout formulation from WSRC-STI-2007-00369 meets the requirements of strong grout such that it will prevent an intruder from drilling into the waste tank because of the thin roof. For waste tank types with cooling coils and annulus, the cooling coils and annulus are grouted to minimize void spaces and for stability. The closure and capping of the cooling coil penetrations in the valve-house will be similar to the risers above the primary liner that will be detailed in the future closure modules. Equipment (jets, dip tubes, etc.) voids inside the annulus will be filled with grout as possible. Annulus risers and ductwork will be filled with grout up to grade level, closed, and capped in the same manner as risers. Ancillary equipment such as DBs, PPs, and pump tanks will be grouted to prevent subsidence.

Figure 3.2-76: Typical Type I Tank Grouting Configuration

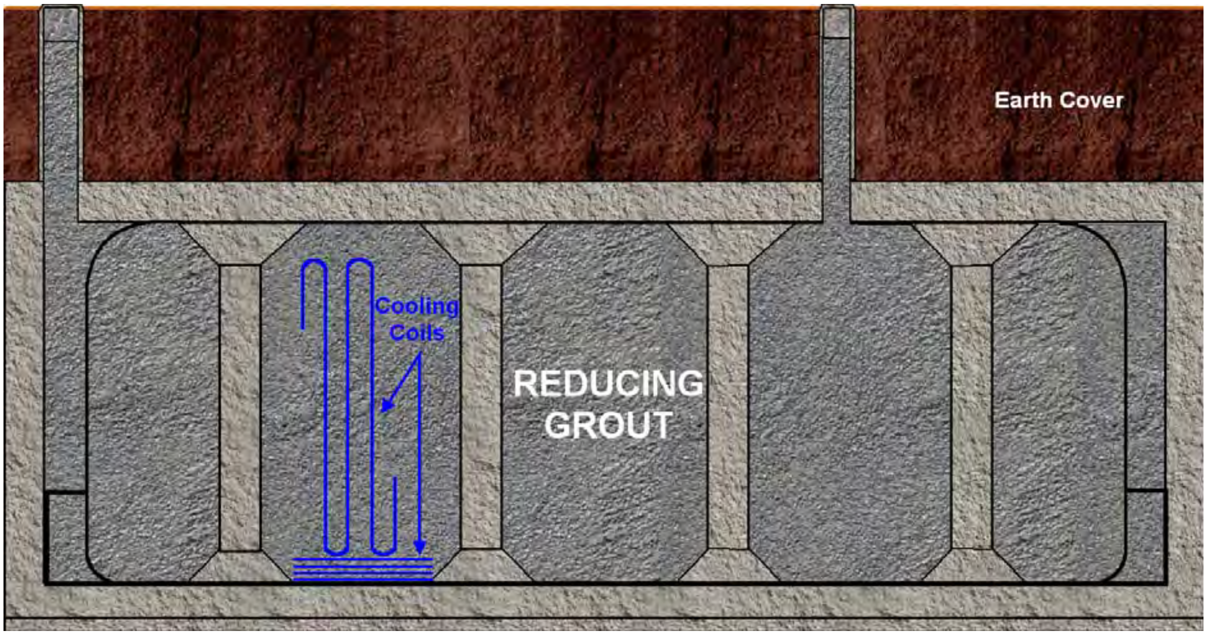


Figure 3.2-77: Typical Type II Tank Grouting Configuration

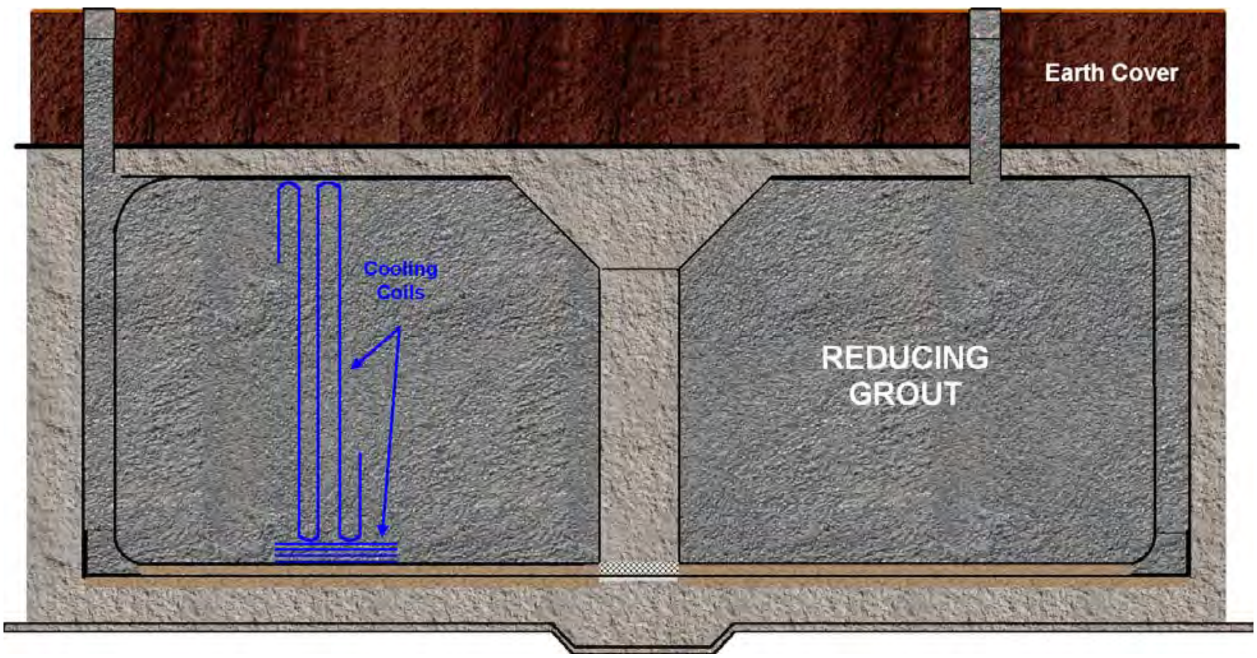


Figure 3.2-78: Typical Type III Tank Grouting Configuration

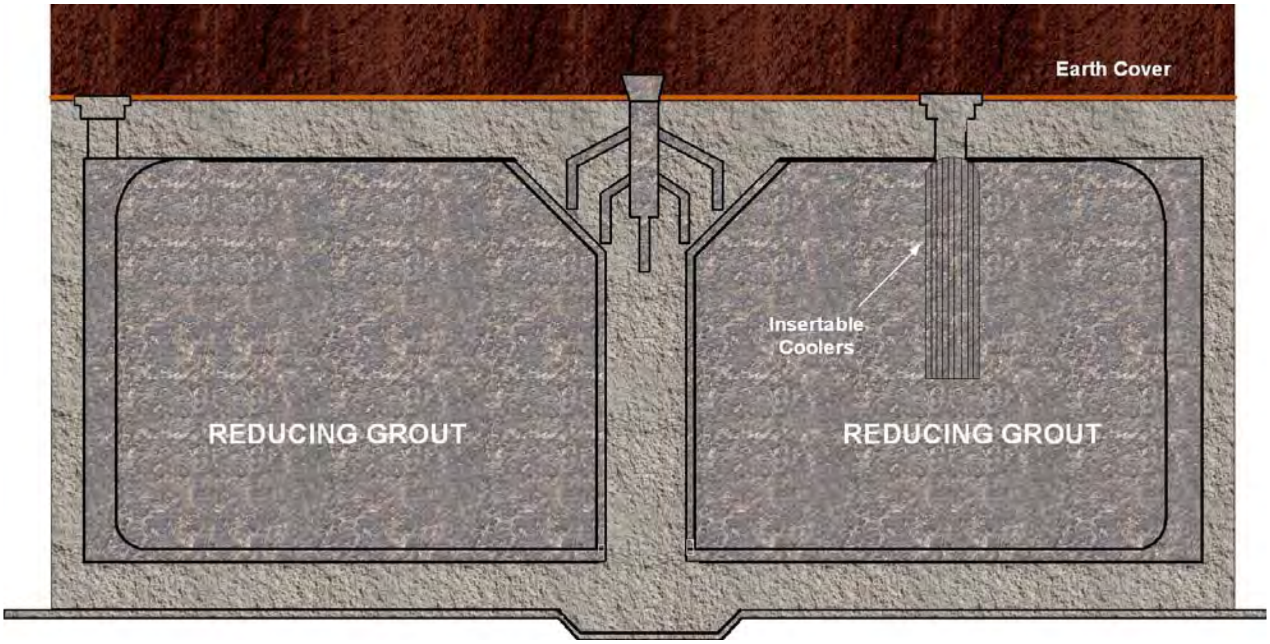


Figure 3.2-79: Typical Type IIIA Tank Grouting Configuration

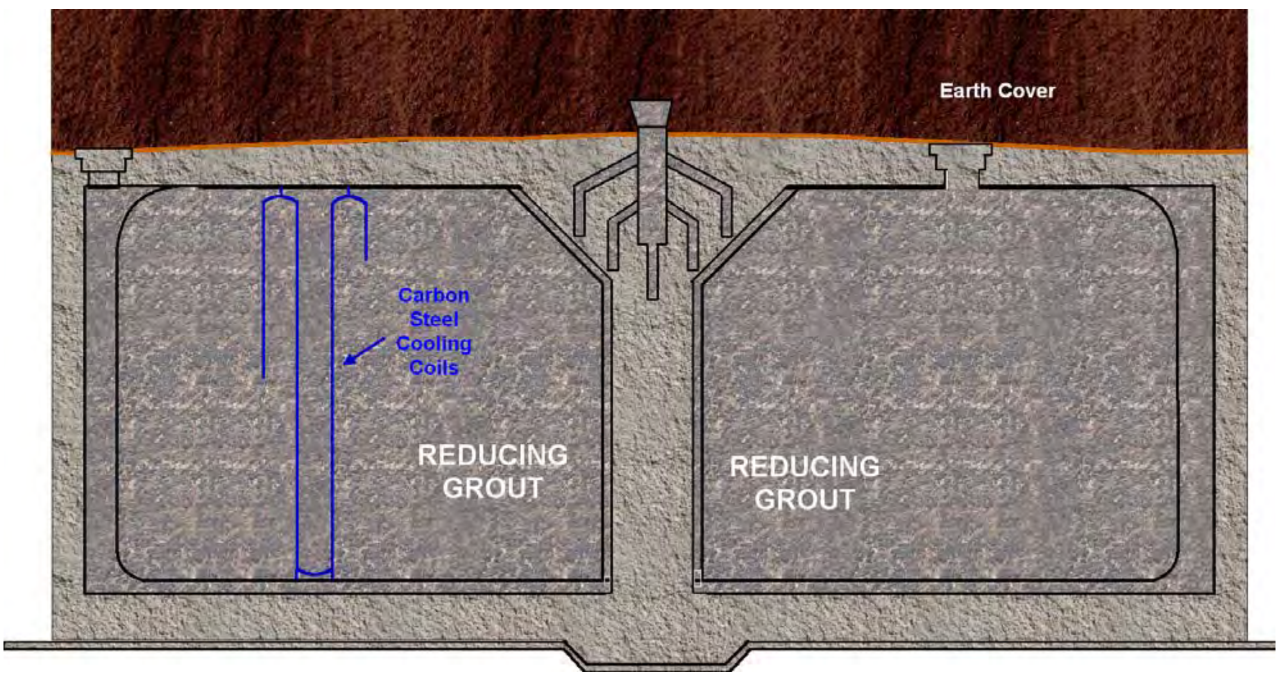
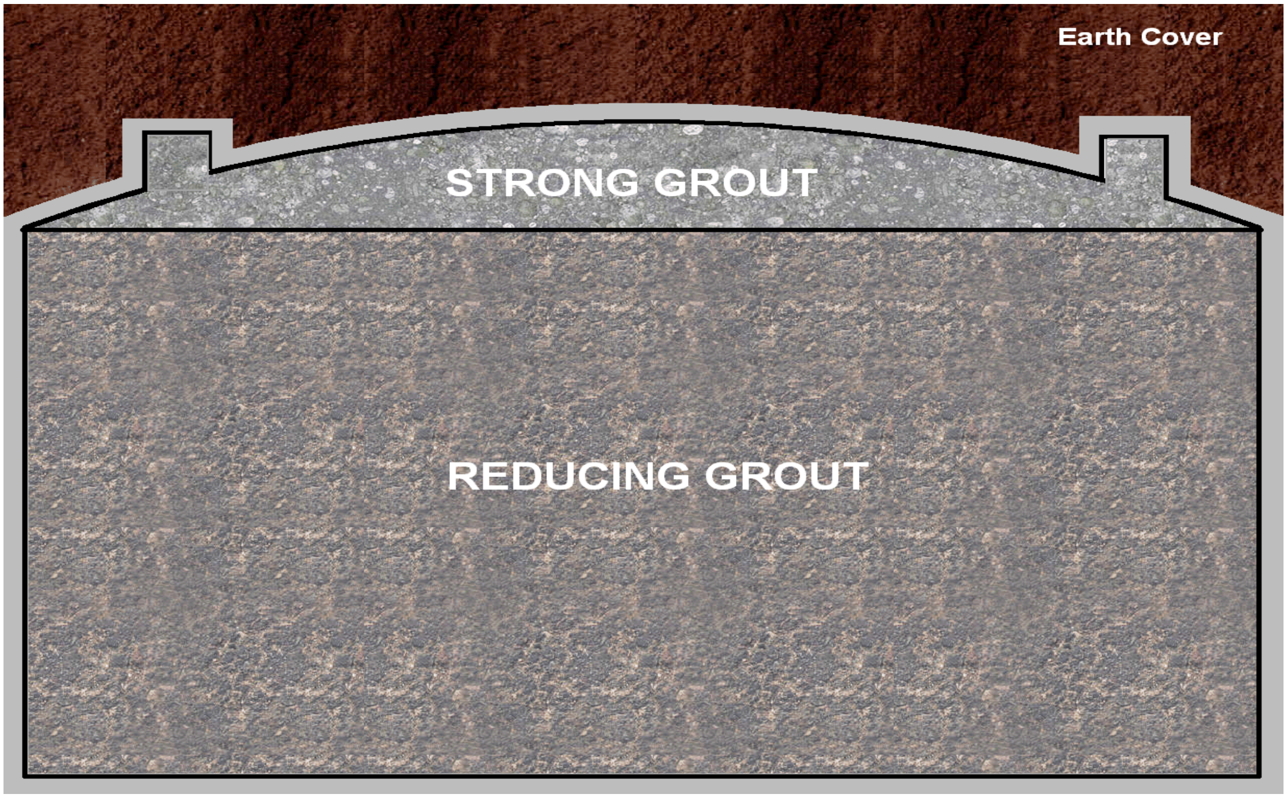


Figure 3.2-80: Typical Type IV Tank Grouting Configuration



The grout attributes important to waste tank closure are:

- Low hydraulic conductivity
- High pH
- Low oxidation potential
- High degradation resistance
- Highly flowable
- Self-leveling
- Low bleed water

Grout studies performed evaluated the chemical and mechanical properties of grout for waste tank closure. [WSRC-STI-2007-00369]

Grout is composed primarily of cement, sand, water, fly ash, slag, silica fume, viscosity modifier (Kelco-Crete or similar), and high range water reducer (ADVAFLOW or similar). The grout mix must be flowable, pumpable, and self-leveling. For grout formulations, future changes will be evaluated and used during final closure if further testing indicates the properties of the alternative mixes are superior to the current grout formula. While the admixtures have significant benefit in the early stages of grout placement, they are not expected to have any appreciable effect on the degradation analysis conducted in support of the HTF PA based on the short effective life and the small quantity of the material added to the grout.

Most of the grout types studied consists of two major states, cured and fresh. [WSRC-STI-2007-00369] The major requirements for cured properties of grout include compressive strength, effective diffusion coefficient, hydraulic conductivity, porosity, dry bulk density, and Young's Modulus. The fresh grout properties include flow, bleed water, set time, air content, and wet unit weight (density). [WSRC-STI-2007-00641] The quality control of the grout production will be included as part of the grout procurement specification.

Grout requirements consist of both mechanical and chemical properties. The mechanical requirements of the grout consist of adequate compressive strength to withstand the overburden load and provide a physical barrier to discourage intruders. The chemical requirements of grout include high pH and a low oxidation potential. Table 3.2-9 outlines some of the key requirements.

Table 3.2-9: Mechanical and Chemical Requirements for Grout Material

Requirement / Properties	Attribute	
	Reducing Waste Tank Grout	**Strong Grout**
Mechanical Requirements		
Rheology	ASTM D 6103 - 04	ASTM D 6103 - 04
Cure time	< 72 hours	< 72 hours
Compressive Strength at 28 days (nominal)	500 psi	2,000 psi
Leveling Quality	Self	Self
Segregation	Minimal	No requirement
Heat of Hydration	Low Heat Mass Pour	Low Heat Mass Pour
Chemical Requirements		
Initial Oxidation Potential	< 0 mV	No requirement
Initial PH	> 12.5	No requirement

[WSRC-TR-97-0102, WSRC-TR-98-00271, ASTM D 6103 - 04]

3.2.3.2 Grout Structural Stability/Degradation

During the grout degradation period, the permeability (hydraulic conductivity) increases from its initial permeability. Conceptually, the increasing permeability reflects an increase in the pathways available for water flow.

The permeability of degraded grout has not been measured but for modeling purposes in this PA, it is assumed to increase as much as 100 times. [SRNL-STI-2010-00035]

The most extensive attack comes from carbonation. The impact of carbonation on the permeability of cementitious barriers in the HTF closure concept depends on whether the barrier contains steel. The annulus and Type IV tanks do not contain rebar or steel, thus the overall effect of carbonation should be minimal regardless of the depth of the penetration.

Sulfate attack represents a complex set of chemical and physical processes that cannot be characterized by a single mechanism. Such type of degradation typically affects structures in contact with acidic flowing or percolating acidic water for long periods. [SRNL-STI-2010-00035]

The alkali-aggregate reactions take place in the concrete when alkalis in the pore solution or an alkali-rich external source react with carbonate or certain types of alkali to form hygroscopic gels that can imbibe water and expand.

The corrosion of steel reinforcement is the most common cause of degradation. Metal rebar oxidation in the presence of water results in the formation of iron hydroxide (rust). Progressive oxidations of steel rebar results in volumetric expansion as corrosion products are formed. This expansion causes de-bonding between the concrete and steel, and is responsible for micro cracking and a loss in tensile strength of the structural element. As the process progresses, continued expansion results in more cracking and spalling of the concrete cover, which exposes more steel rebar and accelerates corrosion and loss of mechanical properties.

Acid attack or decalcification of the calcium containing phases in the hydrated Portland cement paste plays a role in most of the chemical degradation processes affecting pastes and composite cementitious material. Decalcification also includes leaching of alkali ions from the cementitious material. Decalcification is a coupled dissolution/diffusion process. The simplest approach for simulating acid leaching is to assume a diffusion controlled process. The description of ionic transport phenomena at the pore scale has advanced considerably over the last 10 years. Most simulate acid attack as leaching of calcium hydroxide from the matrix. Some of these models also take into account the evolution of the porosity as the solid phases dissolve. [SRNL-STI-2010-00035]

A detailed explanation of degradation mechanisms is presented in SRNL-STI-2010-00035. Table 3.2-10 presents factors known to affect the physical stability of cementitious materials.

Table 3.2-10: Physical and Chemical Factors Related to Grout Stability

PHYSICAL FACTORS	CHEMICAL FACTORS
Loss of Mass - Erosion • Water • Wind **Mechanical Cracking** - Overload - Bio-intrusion - Freeze Thaw - Thermal Stress - Geological Stress • Earthquakes • Subsidence	**Loss of Mass** - Desiccation (Early water loss) - Cracking - Dissolution/Leaching - Increased Porosity • Water • Acids • Microbial degradation **Addition of Mass (Expansion) - Cracking** - Sulfate (Ettringite) - Alkali (ASR hygroscopic gel) - Iron (rebar) + Oxygen, Carbonate, Chloride **Addition of Mass - Fill/Seal Cracks & Pores** - Carbonate (Calcium Carbonate Precipitation)

[WSRC-RP-2005-01675]

Mechanical cracking can be caused by overloading the waste tank and grout due to poor design or to geological events such as earthquakes or subsidence. Structural overload of the grout in the waste tank top is unlikely because the load requirement is the same as that of compacted soil. However, seismic events will not remove material on top of the waste tank, and the load bearing capacity of the unit is not expected to reduce to less than that of the surrounding soil. [WSRC-RP-2005-01675]

The grout is designed to minimize the chemical factors that can lead to cracking caused by shrinkage or expansion. In most cases, desiccation being the exception, cracking is due to the addition of mass rather than removal of mass. The reaction of carbon dioxide gas with the hydrated phases of the Portland cement in the grout is called carbonation. The products of carbonation block the pores in the grout. As the result of aging, carbonation will transform the grout from a man-made sandstone-like rock with a calcium silicate hydrate (CSH) matrix to a sandstone-like rock with a calcite-silicate (aged hydrated Portland cement) matrix. For the grout, the specification requires Type I/II un-hydrated Portland cement, which has a low to moderate (< 5%) tricalcium aluminate concentration. [WSRC-TR-98-00271] With this relatively low percentage of reactive aluminum in the un-hydrated Portland cement, gypsum in the cement converts all the reactive alumina to ettringite. Ettringite is thermodynamically stable in a sulfate environment minimizing the potential for sulfate attack and sulfate degradation of the grout. [SRNL-STI-2010-00035]

If cracking does occur, the hydraulic conductivity of the grout will be affected, but even in a cracked state, the structural requirements are met because of the contained system. This is in contrast to structural concrete in which cracking will accelerate corrosion of rebar and the transmission of load to the rebar. For free standing reinforced structural concrete members and supported reinforced concrete slabs, transmission of load per the design requirements is critical because performance in tension, flexion and shear are typically required in addition to performance in compression. [SRNL-STI-2010-00035]

Finally, models/methodologies have been developed for predicting changes in physical properties of material in response to chemical and physical factors as a function of time. Empirical, theoretical, mechanistic, and probabilistic models are sometimes used in addition to analogies with geologic and ancient man-made materials. To date simpler models have been applied to the waste tank closure grouts to describe the consequences of bounding (worst) cases. Initial mechanistic evaluations indicated that the grout would only be exposed to infiltrating rainwater and geologic forces. [SRNL-STI-2010-00035]

3.2.4 Closure Cap

An engineered closure cap will be installed over the HTF following the closure of the waste tanks and ancillary equipment. The HTF conceptual closure cap design is presented in SRNL-ESB-2008-00023. Because of the similar characteristics of the HTF design to the FTF design presented in the WSRC-STI-2007-00184, the FTF infiltration rates are considerd applicable. The design information being provided is for planning purposes sufficient to support evaluation of the closure cap as part of the ICM being evaluated in this PA and is taken from the detailed FTF closure cap report WSRC-STI-2007-00184 for HTF. The closure cap design will be finalized closer to the time of HTF closure, to take advantage of possible advances in materials and closure cap technology that could be used to improve the design.

3.2.4.1 Closure Cap Background

An HTF engineered closure cap is anticipated to be necessary for several reasons. One, to provide physical stabilization of the closed site. Two, to minimize infiltration of surface water. Note that surface water that reaches stabilized contaminant wastes in the underground waste tanks and ancillary equipment could eventually lead to the contaminants reaching the underlying aquifer system. The third reason is to serve as an intruder deterrent to prevent a person who might inadvertently enter the area after active institutional controls preventing contact to buried residual radioactive material have ended. Intruder deterrence is provided by at least 10 feet of material above the waste tanks and significant ancillary equipment and the erosion barrier layer. Significant ancillary equipment is defined as equipment that requires intruder protection in association with the closure cap due to the anticipated residual radionuclide inventory. Significant ancillary equipment includes the evaporator facilities, PPs, and waste transfer lines.

3.2.4.1.1 HTF Layout Beneath the Closure Cap

The HTF encompasses approximately 45 acres. Within this area are the 29 underground waste tanks and ancillary equipment, including three evaporators housed in concrete buildings, an underground catch tank, PPs, DBs, and various underground transfer lines.

The design of the closure cap is obviously influenced by HTF topography and equipment location that is evident by the aerial views of the HTF shown in Figures 3.2-81 through 3.2-83. The size and topography of the HTF influence the envisioned conceptual design of the closure cap concept to consist of three distinct areas, 1) known as the "West Hill" area (shown in Figure 3.2-82) will have its own closure cap, 2) known as the "East Hill" area (shown in Figure 3.2-83) will have its own closure cap, and 3) only encompasses HPP-5 and HPP-6 (shown in Figure 3.2-83) and warrants its own closure cap because of the topography of the area. [SRNL-ESB-2008-00023]

Figure 3.2-81: Aerial View of HTF

Figure 3.2-82: "West Hill" Area Aerial View

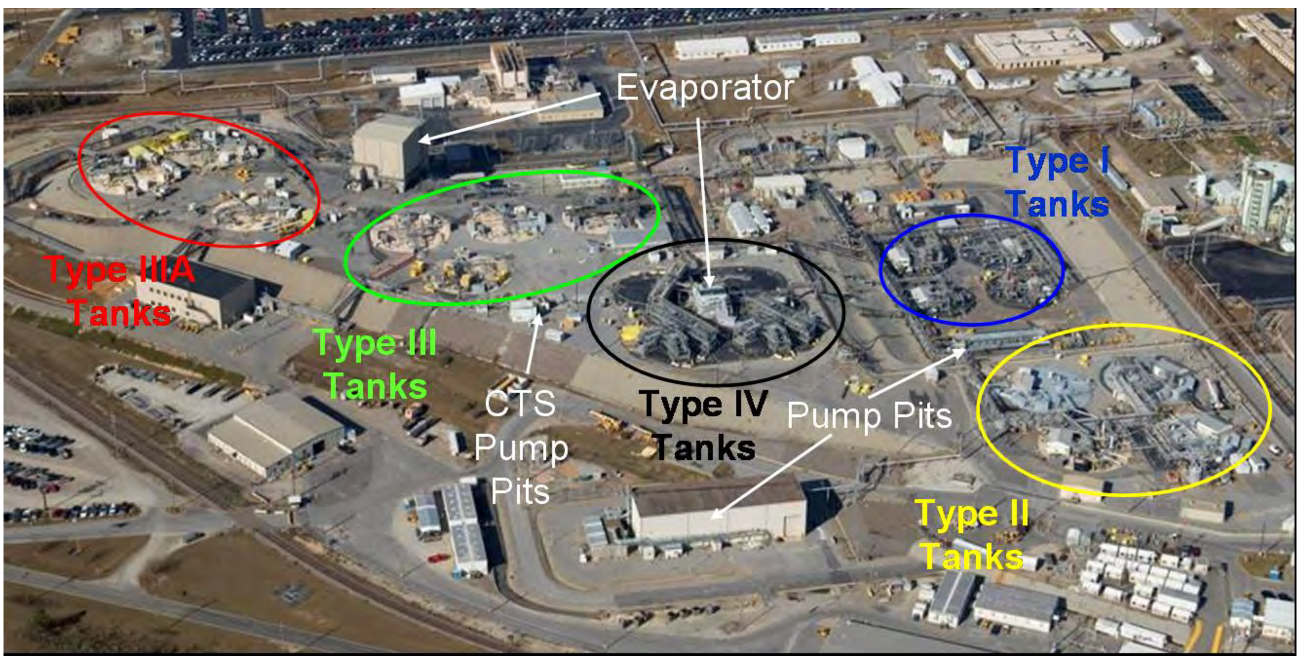


Figure 3.2-83: "East Hill" Area and HPP-5 and HPP-6 Aerial View

3.2.4.1.2 Key Time Period Assumptions

During the operational period (period during which waste is stored, processed, and removed from the waste tanks and then they are grouted), it is assumed that active HTF facility maintenance will be performed sufficient to prevent infiltration of rainwater into the waste tanks and subsurface discharge out of the waste tanks. After installation of the closure caps, a 100-year institutional control period will begin, during which time active HTF facility maintenance will be conducted sufficient to prevent pine forest succession and to repair any significant erosion. After the institutional control period ends, it is assumed that no active HTF facility maintenance will be conducted.

Currently no site-specific cap performance studies have been completed; therefore, conservative degradation assumptions have been made (e.g., pine tree root penetrations through the Geosynthetic Clay Liner (GCL)). The closure caps are substantially degraded by approximately 2,600 years after closure.

3.2.4.1.3 Layouts Evaluated and Water Balances Analyzed

The current plan for HTF is to place a closure cap over all of HTF after operational period. The HTF conceptual closure cap design has a 2% maximum surface slope that is less than 585 feet in length. Therefore, the calculations for the FTF conceptual closure cap design documented in WSRC-STI-2007-00184 are applicable for the HTF.

Using the 585 feet maximum slope length and 2% maximum slope, initial infiltration estimates through the conceptual closure cap case were made utilizing the Hydrologic Evaluation of Landfill Performance (HELP) Model. Based upon the initial estimates, detailed water balances were produced. Table 3.2-11 presents the pertinent closure cap case for HTF modeling and the resulting average initial infiltration rate.

Table 3.2-11: Closure Cap Initial Configurations Evaluated and Condition Results

Parameter	**Configuration**
Layer (depth)	Topsoil (6 inches)
Layer (depth)	Upper Backfill (30 inches)
Layer (depth)	Erosion Barrier (12 inches) [soil infill]
Layer (depth)	Middle Backfill (12 inches)
Layer (depth)	Lateral Drainage Layer (12 inches) [soil infill]
Layer (depth)	High Density Polyethylene (HDPE) (0.06 inch)
Layer (depth)	GCL (0.2 inch)
Layer (depth)	Foundation Layer - Upper/Lower (84 inches)
Average infiltration rate	0.00088 in/yr (through the GCL)
Average change in water storage	0.06 in/yr

[WSRC-STI-2007-00184]

Note While the geotextile fabric layers are part of the cap design, they are not explicitly modeled in HELP.

Details on the input development required for the HELP modeling are provided in WSRC-STI-2007-00184. For the purposes of this modeling, synthetic daily weather data for precipitation, temperature, and solar radiation over 100 years was generated based upon the HELP data for Augusta, Georgia, and modified with SRS-specific average monthly precipitation and temperature data reported in WSRC-STI-2007-00184. Section 3.1.2 describes the collection process of weather data at SRS.

3.2.4.2 Ancillary Equipment Strategy

Underground piping will remain in place with a closure strategy consistent with other underground piping at a site that has been closed under CERCLA. Large diameter piping (greater than six inches in diameter) will be filled with a grout formulation or other materials, as appropriate, to prevent subsidence issues. The criterion for selecting piping size is based upon grouting practicality and elimination of subsidence potential. Ancillary equipment including the evaporator buildings, the catch tank, PPs, and DBs, to the extent practical, will remain in place and be filled with grout or other materials, as appropriate to eliminate subsidence potential. An exception to leaving ancillary equipment in place will be made for equipment that is significantly higher in elevation than the adjacent waste tanks, and would therefore result in a significant increase in the closure cap elevation. An example of structures needing elevation reduction would be the 242-16H Evaporator. Such ancillary equipment would undergo D&D to reduce to an appropriate elevation for closure cap construction. Above grade structures, utilities, equipment, etc., (other than substantial above grade concrete associated with the waste tanks and ancillary equipment) that could interfere with closure cap construction will be removed from the HTF area prior to installation of the closure cap.

3.2.4.3 Closure Cap Installation Sequence

Design and installation of the final HTF closure cap will be coordinated with CERCLA closure activities in the area, and occur at a similar time as overall CERCLA closures as reported in Appendix E of the SRS FFA. [WSRC-OS-94-42] The final HTF closure cap will be designed with an appropriate interface with adjacent CERCLA closure systems.

3.2.4.4 Stability Analysis

Calculations to evaluate the physical stability of the closure cap design in relation to the erosion potential associated with a SRS-specific Probable Maximum Precipitation (PMP) event have been made using standard methodologies for a riprap design with a maximum 585 feet slope length. [NUREG-1623] While the methodology presented in NUREG-1623 specifically addresses a 1,000-year timeframe, the use of site-specific PMP event data (e.g., low frequency of occurrence and a bounding event of greater than 70 inches of rain in 1 hour) provides assurance of physical stability of the closure cap design for the 10,000-year compliance period. A summary of this analysis is provided below, however details are presented in WSRC-STI-2007-00184.

- A 2% slope over a length of 585 feet for the vegetative soil cover is considered physically stable (i.e., it would prevent the initiation of gully erosion during a PMP event). Maximum acceptable slopes for portions of the closure cap with slope lengths less than 585 feet may be greater than 2%, if it were determined that they would be physically stable during the actual closure cap design process.
- An erosion barrier consisting of 12-inch thick riprap with a D_{50} (median size) of 2.5 inches on a 585-foot long, 2% slope is considered physically stable (i.e., it would prevent any riprap movement during a PMP event). Based upon the D_{50} of 2.5 inch, rock consistent with Type B riprap from Table F-3 of NUREG-1623 or Size R-20 riprap from Table 1 of ASTM D 6092 - 97 is suitable for use in the erosion barrier.
- Side slope riprap that is 24 inches thick with a D_{50} of 9.1 inches on a 120-foot long, 33.3% slope receiving drainage from a 585-foot long, 2% slope is considered physically stable (i.e., it would prevent any riprap movement during a PMP event). Based upon the D_{50} of 9.1 inches, rock consistent with Type D riprap from Table F-3 of NUREG-1623 or Size R-150 riprap from Table 1 of ASTM D 6092 - 97 is suitable for use on the side slopes.
- The toe of side slope riprap that is 42 inches thick, extends out 20 feet from the side slope, and has a D_{50} of 11.6 inches is considered physically stable (i.e., it would prevent any riprap movement due to receiving runoff from the 2%, 585 feet top slope and 33.3%, 120-foot side slope during a PMP event). Based upon the D_{50} of 11.6 inches, rock consistent with Type D riprap from Table F-3 of NUREG-1623 or Size R-300 riprap from Table 1 of ASTM D 6092 - 97 is suitable for use on the toe.

Erosion barrier, side slope, and toe riprap size may be smaller for portions of the closure cap with shorter slope lengths than those used to determine these requirements if it is determined that the smaller sized riprap would be stable during a PMP event, during the actual closure cap design process.

3.2.4.5 Closure Cap General Design Features

As noted previously, it is anticipated that the closure caps will be installed over all 29 waste tanks and associated ancillary equipment at the end of the operational period. The closure cap design and installation will take into account the waste tank and ancillary equipment characteristics and location, disposition of non-disposal structures and utilities, site topography and hydrogeology, potential exposure scenarios, and lessons learned implementing other closure systems, including those for other SRS facilities, uranium mill tailings sites and other DOE sites.

Figure 3.2-84 presents the general design of the closure cap above a closed waste tank. Figure 3.2-85 presents the closure cap footprint. Figures 3.2-86 to 3.2-89 present cross sections of the closure cap conceptual design. [SRNL-ESB-2008-00023] These figures represent the configuration identified in Table 3.2-11 with the inclusion of a geotextile fabric layer on top of the erosion barrier layer, a geotextile filter fabric layer on top of the lateral drainage layer, and a geotextile fabric layer on top of the HDPE geomembrane layer.

3.2.4.5.1 Function of Closure Cap Layers

It is anticipated that the HTF closure cap will consist of the layers illustrated in Figure 3.2-84. Table 3.2-12 summarizes the function of each of these layers. Detailed discussion of each layer in the closure cap design is provided in WSRC-STI-2007-00184. The concepts for the side slopes and toes of the closure cap based upon the results of physical stability calculations referred to above are also detailed in WSRC-STI-2007-00184.

Figure 3.2-84: The HTF Closure Cap General Concept

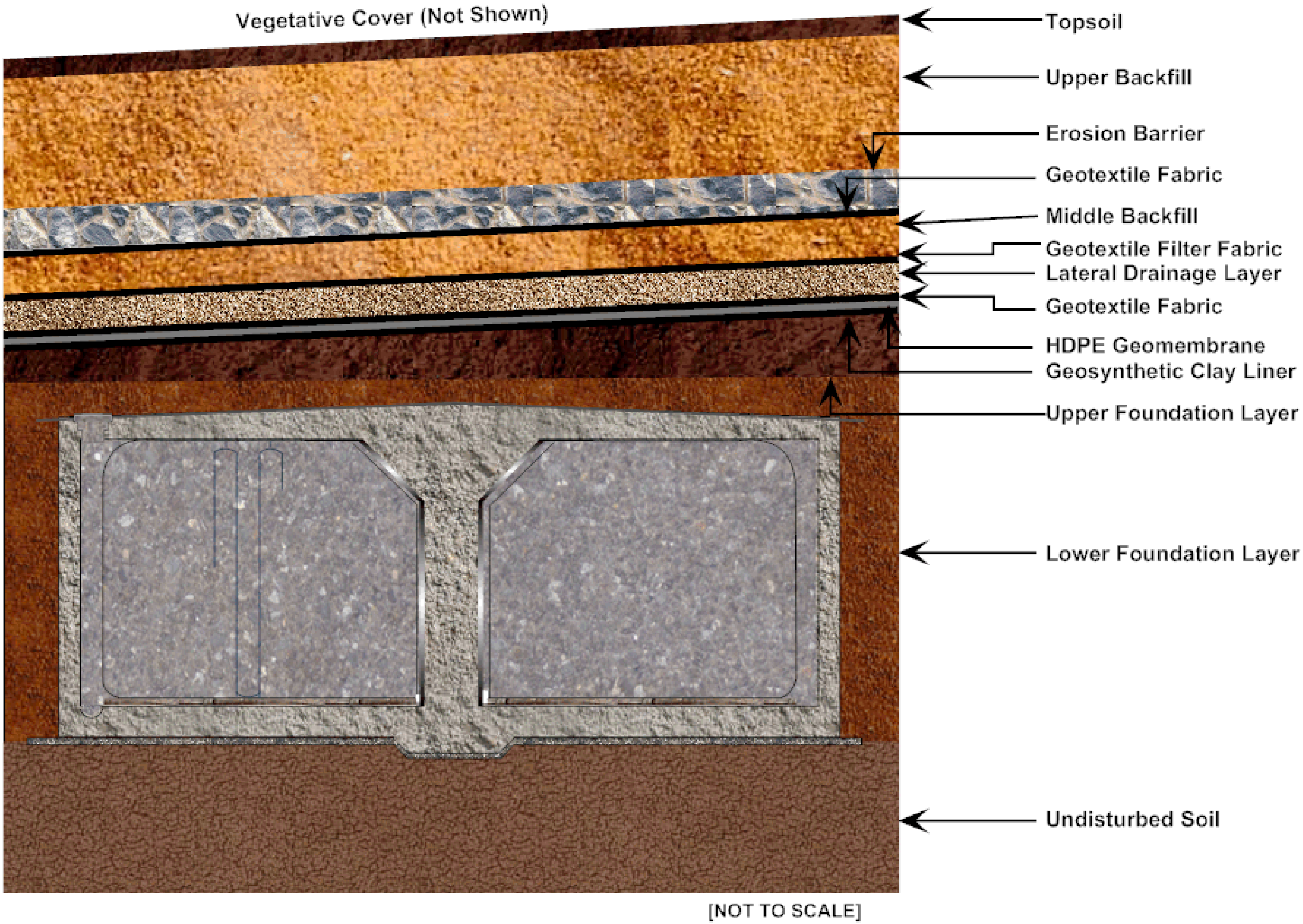
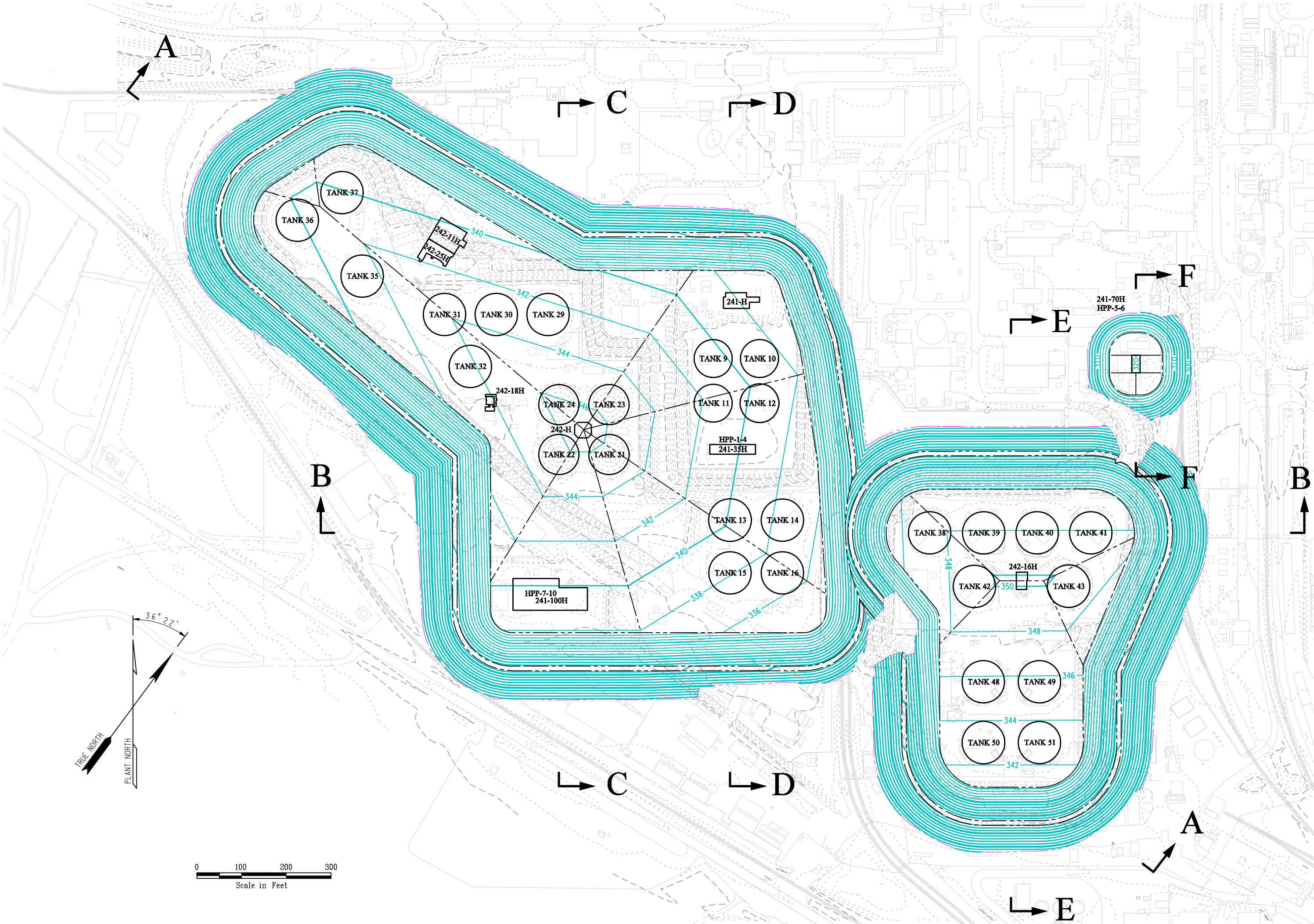
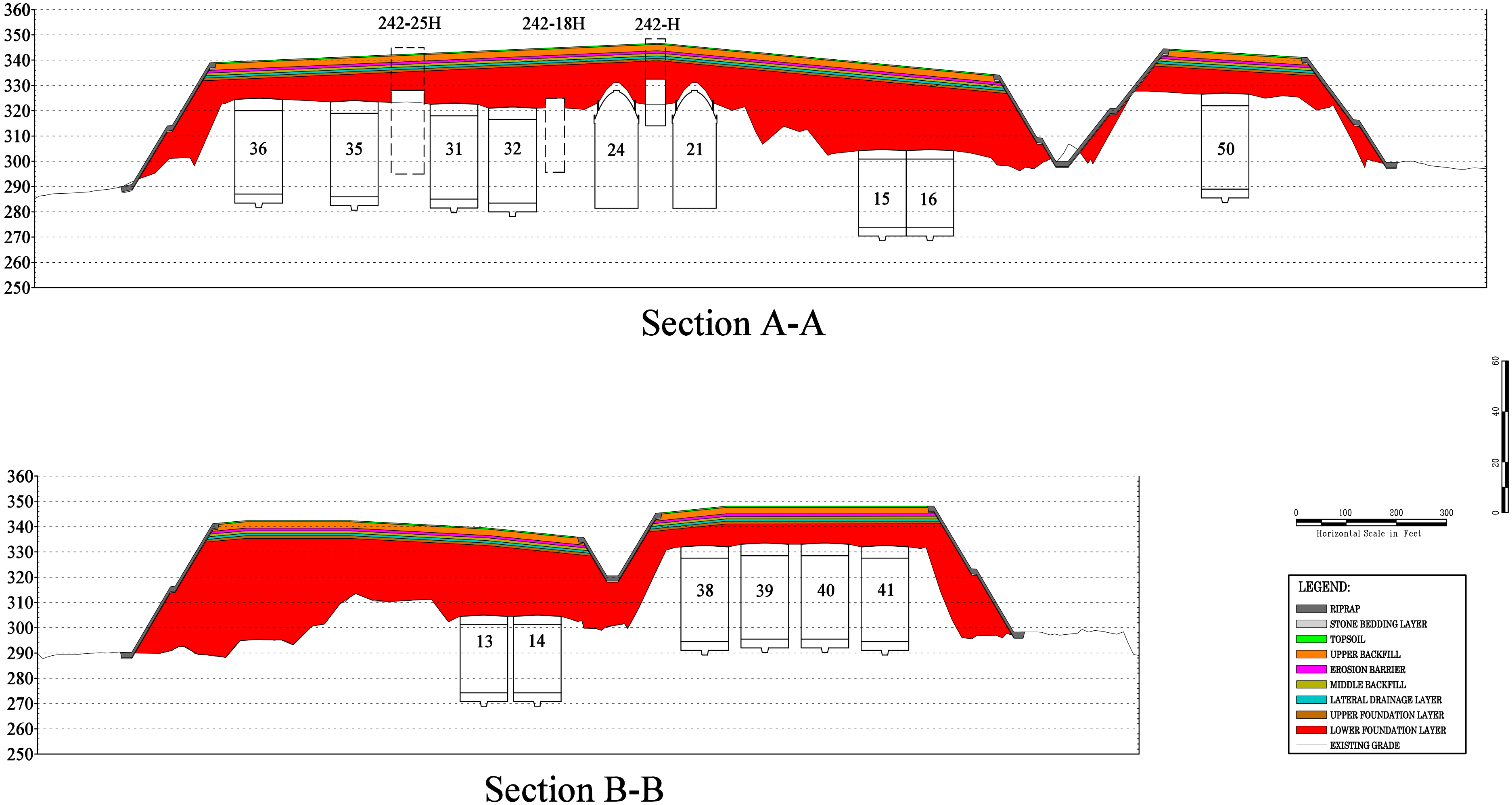


Figure 3.2-85: The H-Area Tank Farm Closure Cap Conceptual Design Footprint



[SRNL-ESB-2008-00023 Figure 1]

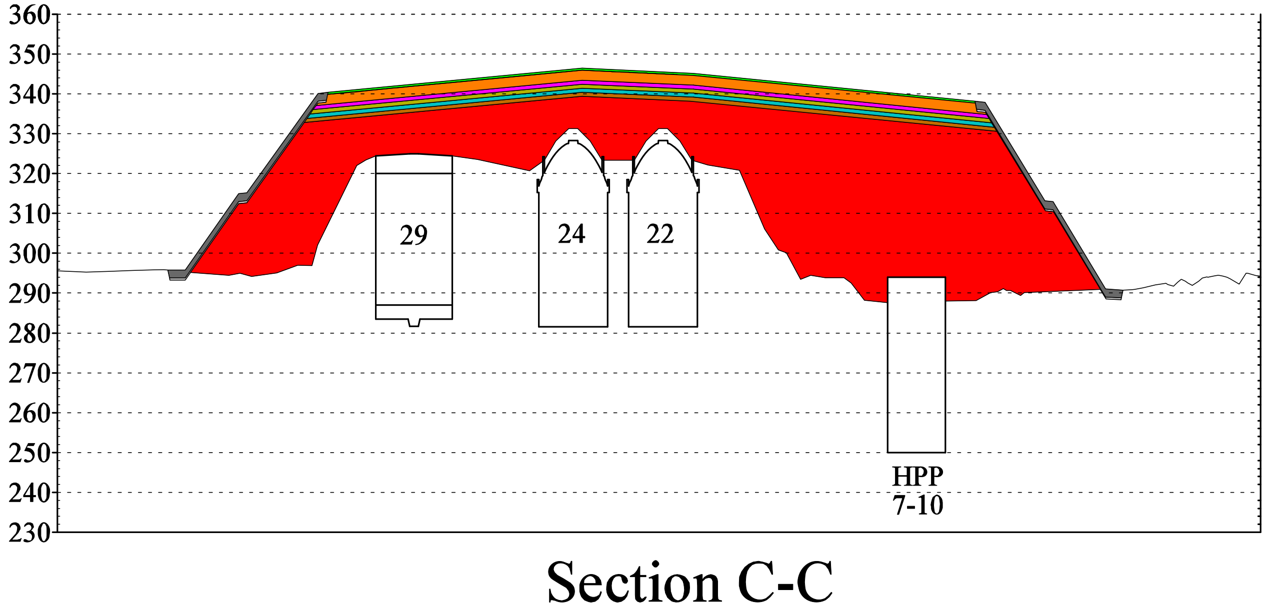
Figure 3.2-86: Closure Cap Conceptual Design, Sections A-A and B-B

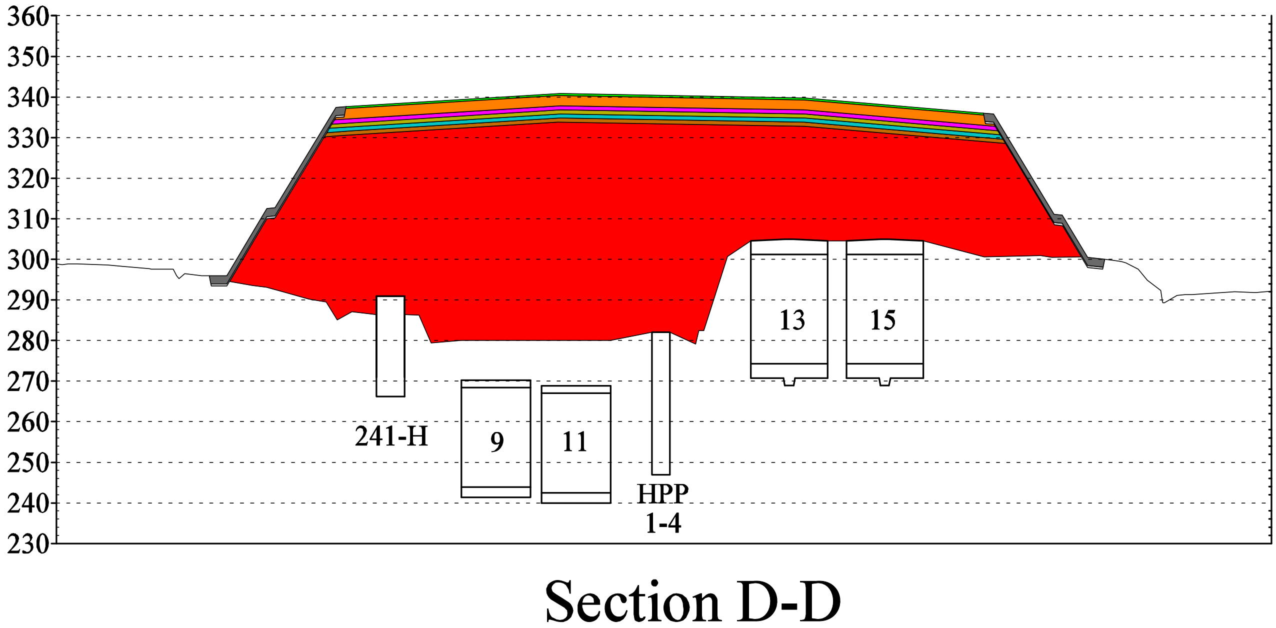


[SRNL-ESB-2008-00023 Figure 2]

NOTE Vertical scale of sections has been exaggerated five times in order to show all closure cap layers.

Figure 3.2-87: Closure Cap Conceptual Design, Sections C-C and D-D



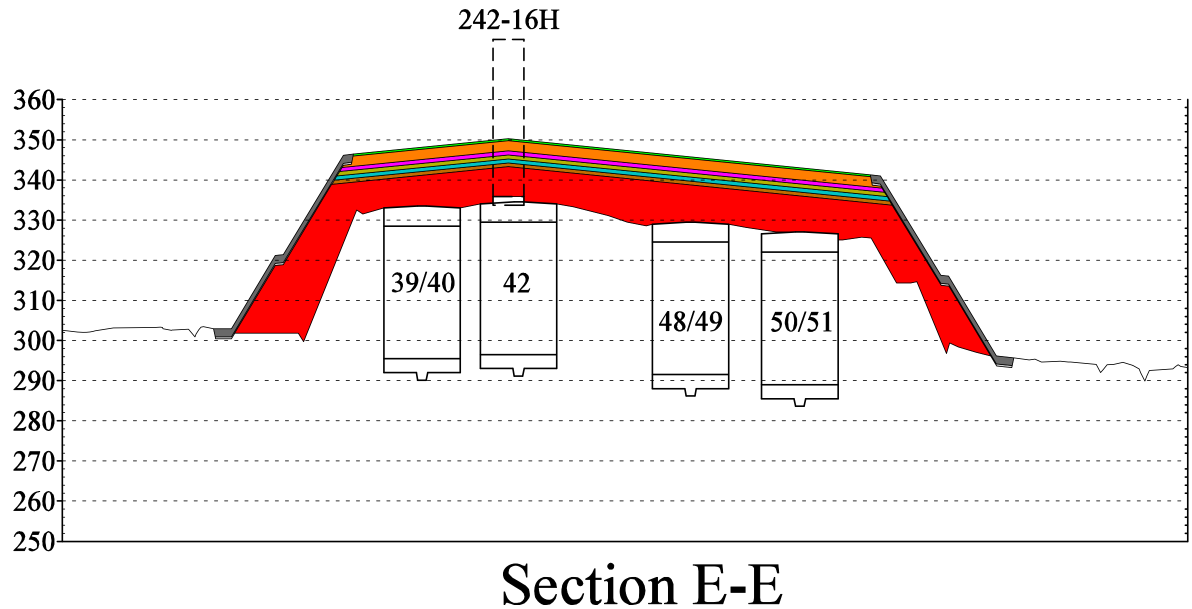


Legend on Figure 3.2-86

[SRNL-ESB-2008-00023 Figure 3]

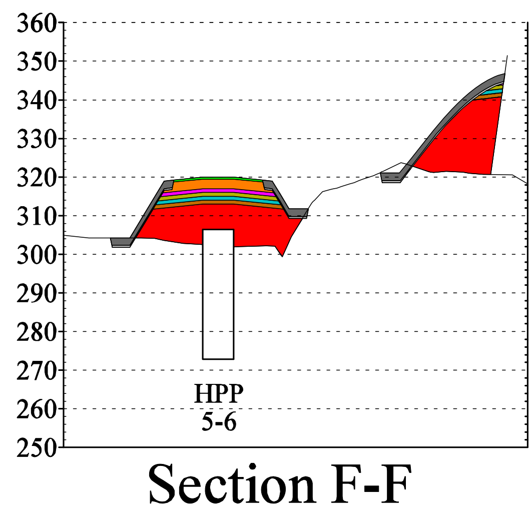
Note Vertical scale of sections has been exaggerated five times in order to show all closure cap layers.

Figure 3.2-88: Closure Cap Conceptual Design, Section E-E



Legend on Figure 3.2-86

Figure 3.2-89: Closure Cap Conceptual Design, Section F-F



[SRNL-ESB-2008-00023 Figure 3]

NOTE Vertical scale of sections has been exaggerated five times in order to show all closure cap layers. See legend on Figure 3.2-86

Table 3.2-12: Function of the Conceptual Closure Cap Layers

Layer	Function
Vegetative Cover	The vegetative cover will promote runoff, minimize erosion, and promote evapotranspiration. The initial vegetative cover will be a persistent grass such as Bahia. If it is determined, that bamboo is a climax species that prevents or greatly slows the intrusion of pine trees, bamboo will be planted as the final vegetative cover at the end of the 100-year institutional control period. Bamboo is not assumed in present design calculations and modeling.
Topsoil	The topsoil is designed to support a vegetative cover, promote runoff, prevent the initiation of gully erosion, and provide water storage for the promotion of evapotranspiration.
Upper Backfill	The upper backfill is designed to increase the elevation of the closure cap to that necessary for placement of the topsoil and to provide water storage for the promotion of evapotranspiration.
Erosion Barrier	The erosion barrier is designed to prevent riprap movement during a PMP event and therefore form a barrier to further erosion and gully formation (i.e., provide closure cap physical stability). It is used to maintain a minimum 10 feet of clean material above the waste tanks and significant ancillary equipment to act as an intruder deterrent. It also provides minimal water storage for the promotion of evapotranspiration.
Geotextile Fabric	This geotextile fabric is designed to prevent the penetration of erosion barrier stone into the underlying middle backfill and to prevent piping of the middle backfill through the erosion barrier voids.
Middle Backfill	The middle backfill provides water storage for the promotion of evapotranspiration in the event that the topsoil and upper backfill are eroded away since the overlying erosion barrier provides only minimal water storage.
Geotextile Filter Fabric	This geotextile fabric is designed to provide filtration between the overlying middle backfill layer and the underlying lateral drainage layer. This filtration allows water to freely flow from the middle backfill to the lateral drainage layer while preventing the migration of soil from the middle backfill to the lateral drainage layer.
Lateral Drainage Layer	The lateral drainage layer is a coarse sand pad designed to divert infiltrating water away from the underlying waste tanks and ancillary equipment and transport the water to the perimeter drainage system, in conjunction with the underlying composite hydraulic barrier (i.e., HDPE geomembrane and GCL), and to provide the necessary confining pressures to allow the underlying GCL to hydrate properly.
Geotextile Fabric	This geotextile fabric is a non-woven geotextile fabric designed to protect the underlying HDPE geomembrane from puncture or tear during placement of the overlying lateral drainage layer.
HDPE Geomembrane	The HDPE geomembrane forms a composite hydraulic barrier in conjunction with the GCL. The composite hydraulic barrier is designed to promote lateral drainage through the overlying lateral drainage layer and minimize infiltration to the waste tanks and ancillary equipment.
GCL	The GCL forms a composite hydraulic barrier described above in conjunction with the HDPE geomembrane. As part of the composite hydraulic barrier, the GCL is designed to hydraulically-plug any holes that may develop in the HDPE geomembrane.
Upper Foundation Layer Lower Foundation Layer	The foundation layers are designed to provide structural support for the rest of the overlying closure cap, produce the required contours and a slope of 2% for the overlying layers, produce the maximum 3:1 side slopes of the closure cap, provide a suitable surface for installation of the GCL (i.e., a soil with a moderately low permeability and a smooth surface, free from deleterious materials), promote drainage of infiltrating water away from and around the waste tanks and ancillary equipment, and contain utilities, equipment, facilities, etc., that are not removed from above current grade prior to installation of the closure cap.

[WSRC-STI-2007-00184, Table 12]

3.2.4.5.2 Site Preparation

The existing surfaces (i.e., soils, asphalt, riprap, concrete waste tank tops, and significant ancillary equipment) over which the closure cap will be constructed must be prepared prior to closure cap construction. It is anticipated that existing soil surfaces will have 3 to 6 inches of soil removed to eliminate any topsoil and vegetation present, will be rough graded to establish a base elevation, and will be compacted with a vibratory roller. Existing asphalt surfaces directly over waste tanks and significant ancillary equipment will likely be left in place; however such surfaces between waste tanks and significant ancillary equipment may need to be broken up or removed in order to prevent the asphalt from acting as a perched water zone within the closure cap and to promote downward infiltration around the waste tanks and significant ancillary equipment. It is anticipated that existing riprap will be removed or that the voids within the existing riprap surfaces will be filled to eliminate subsidence potential. It is anticipated that no preparatory actions will be required for the waste tank tops themselves other than that necessary to provide appropriate protection during closure cap construction. It is anticipated that the PPs, DBs, and catch tanks will require grouting in order to eliminate subsidence potential.

Detailed information regarding the purpose, design, and constructability of each of the closure cap layers is provided in WSRC-STI-2007-00184.

3.2.4.5.3 Vegetative Cover

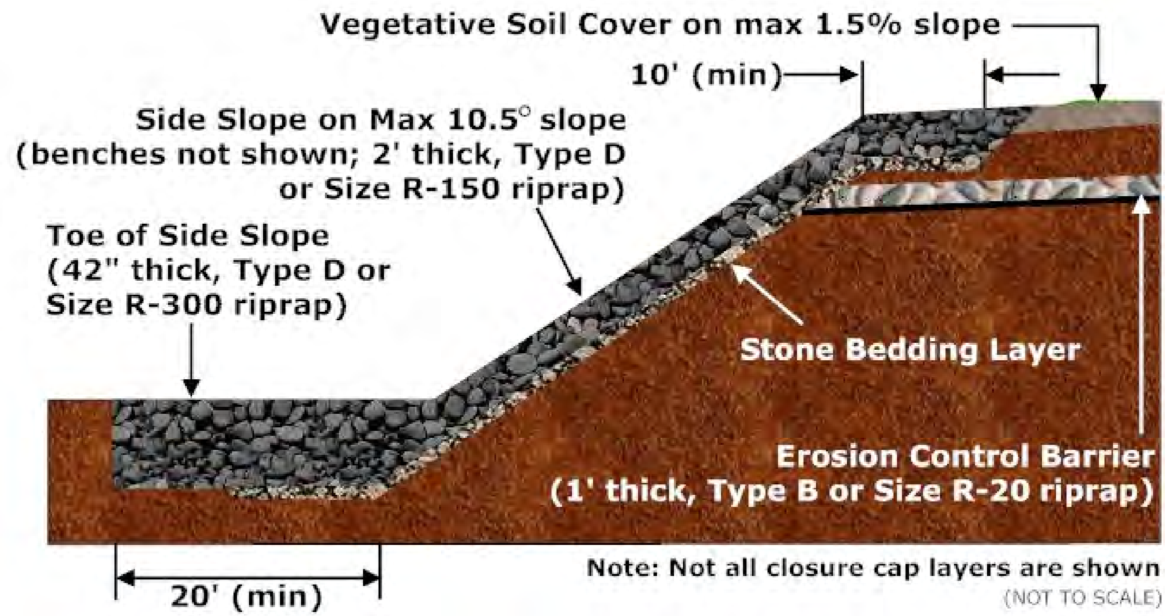
In addition to the modeled closure cap layers, a vegetative cover will promote runoff, minimize erosion, and promote evapotranspiration. The topsoil will be fertilized, seeded, and mulched to provide a vegetative cover. The initial vegetative cover shall be a persistent grass such as Bahia. During seeding and establishment of the initial grass, appropriate mulch, erosion control fabric, or similar substances will be used to protect the surface.

The area will be repaired through transplanting or replanting to ensure that a self maintaining cover is developed. If it is determined that bamboo is a climax species that prevents or greatly slows the intrusion of pine trees, it will be planted as the final vegetative cover at the end of the 100-year institutional control period. Pine trees are typically assumed to be the most deeply rooted naturally occurring climax plant species at SRS, which will degrade the GCL through root penetration. In contrast, bamboo is a shallow-rooted species, which will not degrade the GCL. Additionally, bamboo evapotranspirates year-round in the SRS climate, minimizes erosion, and can sustain growth with minimal maintenance. A study conducted by USDA Soil Conservation Service (SCS) has shown that two species of bamboo will quickly establish a dense ground cover. [WSRC-MS-92-513] All work in association with the vegetative cover shall be performed in accordance with approved drawings, plans, and specifications of the final design, which will be produced near the end of the operational period.

3.2.4.5.4 Conceptual Closure Cap Slopes

The toe of the closure cap side slope will consist of a riprap layer to stabilize the side slope riprap, provide erosion protection at the toe, transition flow from the side slope to adjacent areas, and provide gully intrusion protection to the embankment. The toe riprap will extend from the toe of the side slope a minimum of 20 feet, as shown in Figure 3.2-90. Since the HTF maximum slope height is greater than FTF, the riprap size will have to be re-evaluated prior to final cap design but will not impact the infiltration rates. [SRNL-ESB-2008-00023]

Figure 3.2-90: Closure Cap Toe and Side Slope Configuration Concept



Note Not shown in the above figure is the bench for the side slopes of the caps covering the "West Hill" and "East Hill" areas.

The closure cap side slopes will be placed at a maximum three horizontal to one vertical (3H:1V, 33.3%, or 19.5°) and have a riprap surface with an underlying gravel bedding layer to prevent gully formation on the side slopes and to provide long-term slope stability. The side slope riprap and underlying gravel bedding layer will extend from the toe of the side slope up the side slope to a minimum 10 feet onto the top slope, as shown in Figure 3.2-90. Details of the cap side slope design and construction is provided in WSRC-STI-2007-00184.

An integrated drainage system will be designed and built to handle the runoff from the closure caps and drainage from the closure cap lateral drainage layers. The runoff and lateral drainage will be directed to a system of riprap lined ditches, which will be designed in accordance with NUREG-1623. The riprap lined ditches will direct the water away from the closure cap as a whole and will be constructed around the perimeter of the closure caps. The ditches will discharge into sedimentation basins as necessary for sediment control. The riprap for the ditches has not been sized yet since the HTF is currently in the operational period. Due to the early phase and lack of a detailed closure cap layout, a detailed drainage system can not yet be designed. Therefore drainage areas and flows cannot be currently assigned in order to size the riprap for various sized ditches.

3.2.4.6 Conceptual Closure Cap Case

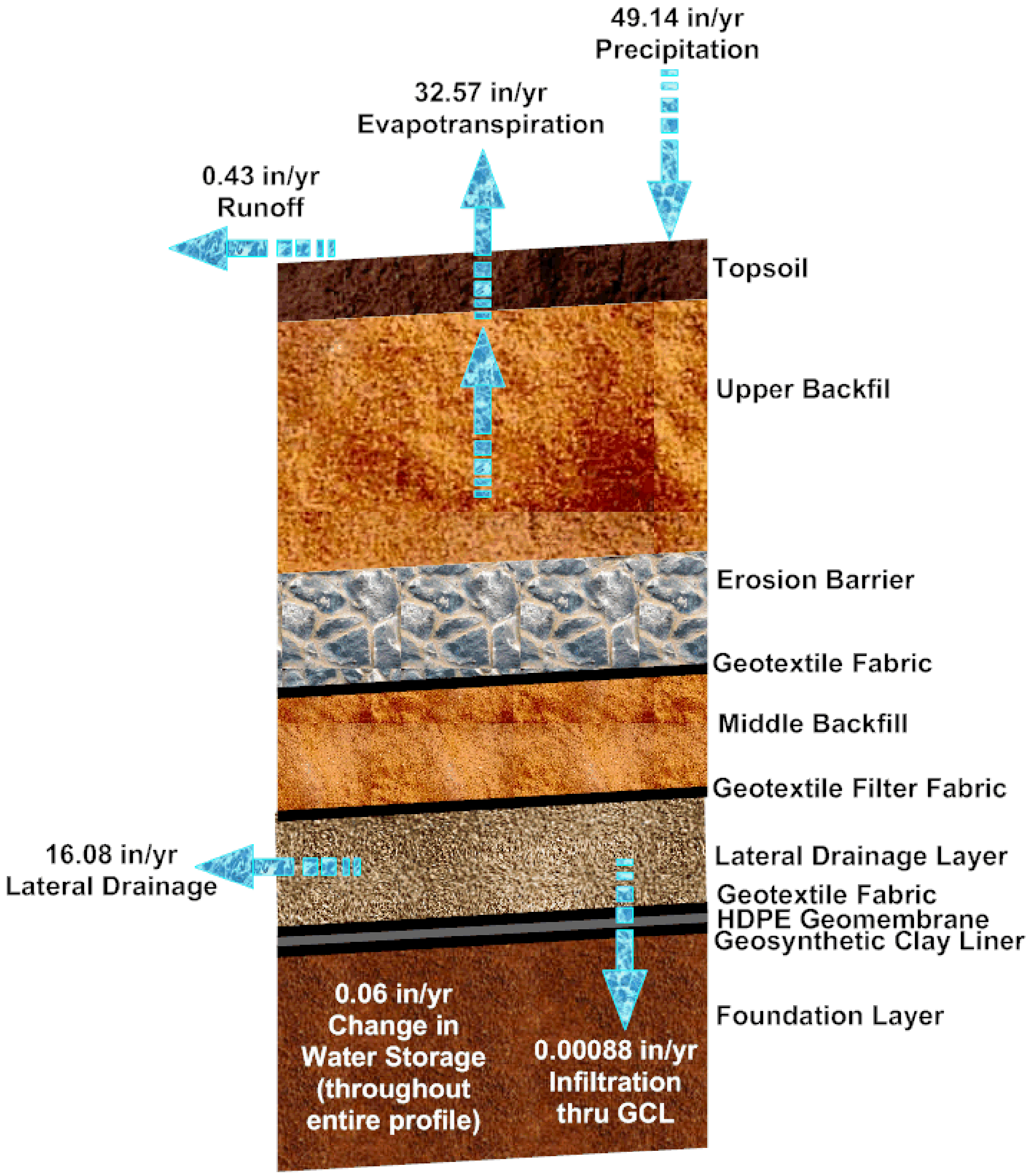
Based on the results from WSRC-STI-2007-00184, closure cap Configuration # 1a which consists of a composite hydraulic layer with an overlaying lateral drainage layer and an erosion barrier is the recommended closure cap configuration for FTF and is the proposed configuration for HTF. This configuration has the following advantages:

- Results in the least infiltration to the waste tanks
- The use of a composite hydraulic barrier (i.e., HDPE geomembrane underlain by a GCL) provides defense-in-depth by the providing a HDPE geomembrane with a significantly lower saturated hydraulic conductivity underlain by the GCL to plug any holes that may develop in the HDPE geomembrane
- The use of an erosion barrier provides long-term physical stability for the closure cap

(Note: Configuration # 1 in WSRC-STI-2007-00184, results in the lowest infiltration rate however, the selection of the material to infill the erosion barrier has not been determined and the use of soil as the infill material, used in Configuration # 1a results in a more conservative infiltration rate.)

Figure 3.2-91 depicts the HELP model scenario and results for the recommended closure cap design. The material properties utilized in this assessment of the closure cap configuration are provided in WSRC-STI-2007-00184.

Figure 3.2-91: The HELP Model Scenario and Results for Closure Cap Design Initial Conditions



[WSRC-STI-2007-00184]

3.2.4.7 Conceptual Closure Cap Degradation Mechanisms

Potential HTF closure cap degradation mechanisms are the same as presented and discussed in detail in WSRC-STI-2007-00184. This scenario assumes a 100-year institutional control period following closure cap construction during which the closure cap is maintained. At the end of institutional control, it is assumed that a pine forest succeeds the closure cap's original vegetative cover. A summary of the degradation mechanisms and proposed course of action to address each mechanism is provided in Table 3.2-13.

Table 3.2-13: Closure Cap Potential Degradation Mechanisms and Course of Action

Affected Layer	Potential Degradation Mechanism	Proposed Course of Action
All Layers	-Static loading induced settlement -Seismic induced liquefaction and subsequent settlement -Seismic induced slope instability	Final design will appropriately consider and handle these mechanisms and thus are not considered for performance modeling purposes
	-Seismic induced lateral spread	Location of closure cap not conducive to lateral spreading - no action
	-Seismic induced direct rupture due to faulting	Surface faulting is non-existent in Southeastern United States - no action
	-Stabilized Contaminant Layer Subsidence	Not applicable - waste tanks and subsurface items containing significant void space will be filled with grout
Vegetative cover	-Succession -Stressors (droughts, disease, fire, and biological)	Penetration of pine tree roots and the rate of pine tree succession from stressors are included in the performance modeling
Soil above the erosion barrier	-Erosion	Included in the performance modeling
	-Desiccation (wet-dry cycles)	Mineralogy and composition of topsoil and backfill and the controlled compaction of the backfill is expected to preclude significant cracking upon drying and thus is not considered for performance modeling purposes
Erosion barrier	-Weathering (dissolution)	Weathering will be appropriately considered in the final design and thus is not considered for performance modeling purposes
	-Biological (root penetration)	The hydraulic properties of the erosion barrier are not expected to be appreciably impacted by pine root penetration and thus root penetration is not considered for performance modeling purposes
	-Biological (burrowing animals)	Design precludes the intrusion of burrowing animals and thus this mechanism is not considered for performance modeling purposes
	-Chemical (stabilized contaminant leachate)	Not applicable - potential sources are located below this layer
Lateral drainage layer	-Silting-in	Performance model includes the migration of colloidal clay from the middle backfill layer to this layer - affecting hydraulic properties
	-Biological (root penetration)	The presence of pine tree roots within this layer is included in the performance modeling

Table 3.2-13: Closure Cap Potential Degradation Mechanisms and Course of Action (Continued)

Affected Layer	Potential Degradation Mechanism	Proposed Course of Action
HDPE Geomembrane	-Ultraviolet radiation	During construction, timely coverage of the geomembrane limits potential degradation from ultraviolet radiation thus not considered for performance modeling purposes
	-Antioxidant depletion	Included in the performance modeling in conjunction with tensile stress cracking (below)
	-Thermal oxidation	Included in the performance modeling in conjunction with tensile stress cracking (below)
	-High energy irradiation	Estimated dose rate and the 10,000 year integrated dose are not sufficient to cause degradation and are not considered for performance modeling purposes
	-Tensile stress cracking	Included in the performance modeling
	-Biological (microbial)	HDPE geomembrane insensitive to microbial biodegradation and is not considered for performance modeling purposes
	-Biological (root penetration)	Root penetration through existing holes caused by other degradation mechanisms is included in the performance modeling
	-Biological (burrowing animals)	Existence of erosion barrier above this layer precludes this mechanism and is not considered for performance modeling purposes
	-Chemical (stabilized contaminant leachate)	Not applicable - potential sources are located below this layer
GCL	-Slope stability	Placement is only on 2% slope thus is not considered for performance modeling purposes
	-Freeze-thaw cycles	Depth of the layer precludes this degradation thus is not considered for performance modeling purposes
	-Dissolution	Degradation via this mechanism is not considered credible thus is not considered for performance modeling purposes
	-Divalent cations (Ca^{+2}, Mg^{+2}, etc.)	Included in the performance modeling
	-Desiccation (wet-dry cycles)	Selection of materials and 6 feet of soil materials preclude this damage thus is not considered for performance modeling purposes
	-Biological (root penetration)	Root penetration through existing holes in the HDPE geomembrane is included in the performance modeling
	-Biological (burrowing animals)	Existence of erosion barrier above this layer precludes this mechanism and is not considered for performance modeling purposes
	-Chemical (stabilized contaminant leachate)	Not applicable - potential sources are located below this layer

Based on the identified degradation mechanisms, Table 3.2-14 presents the estimated infiltration rate change over the compliance period.

Table 3.2-14: Conceptual Closure Cap Estimated Infiltration over Time

Time Interval (yr)	Average Annual Infiltration through the GCL (in/yr)
0	0.00088
100	0.010
180	0.17
290	0.37
300	0.50
340	1.00
380	1.46
560	3.23
1,000	7.01
1,800	10.65
2,623	11.47
3,200	11.53
5,600	11.63
10,000	11.67

[SRNL-ESB-2008-00023, Table 2]

3.2.4.8 Open Issues for Further Design

Listed below are open issues related to the HTF closure cap concept which will be addressed as the design concept matures.

- Is bamboo a climax species that prevents or greatly slows the intrusion of pine trees?
- What are the requirements for the foundation layer particularly in terms of its ability to drain water away from and around the waste tanks and ancillary equipment?
- What is the estimated weathering rate of the erosion barrier stone (assumed granite) based upon natural or archaeological analogs and available literature?
- What material should be used to fill the stone voids of the erosion barrier to prevent loss of overlying material into the erosion barrier?
- Should a sodium bentonite or calcium bentonite GCL be utilized?
- The definition of a significant void requiring grouting in order to eliminate subsidence needs to be determined.
- Sizing of the side slope and toe riprap.

The current design concept makes conservative assumptions about these open issues, and is acceptable for use for PA modeling.

3.3 Evaluation of Inventory Constituents

3.3.1 Evaluation of Radionuclides in Principal Decay Chains

An initial radionuclide screening process, developed to support characterization efforts applicable for HTF PA modeling, evaluated 849 isotopes. Of the original 849 isotopes, 690 were excluded from further consideration using the following information as described in Appendix A of SRR-CWDA-2010-00023 and detailed in CBU-PIT-2005-00228:

- Physical properties of each radioisotope (e.g., half-life and decay mechanism)
- Potential isotope production mechanisms and age of the waste
- Screening factors for ground disposal of radionuclides developed in NCRP-123, which convert a quantity of each radionuclide to a dose (CBU-PIT-2005-00228)

3.3.2 Evaluation of Remaining Radionuclides

Many of the remaining 159 isotopes from the initial screening were not created in SRS reactors and therefore further evaluation determined which isotopes could be screened from analyses as described in Appendix B of SRR-CWDA-2010-00023. The isotopes to be used in further analyses are identified in Table 3.3-1 and will have initial inventory estimates developed.

Table 3.3-1: Radionuclides of Concern

Ac-227	Cl-36	Eu-152	Pa-231	Ra-226	Th-232
Al-26	Cm-243	Eu-154	Pd-107	Ra-228	U-232
Am-241	Cm-244	H-3	Pt-193	Se-79	U-233
Am-242m	Cm-245	I-129	Pu-238	Sm-151	U-234
Am-243	Cm-247	K-40	Pu-239	Sn-126	U-235
Ba-137m	Cm-248	Nb-94	Pu-240	Sr-90	U-236
C-14	Co-60	Ni-59	Pu-241	Tc-99	U-238
Cf-249	Cs-135	Ni-63	Pu-242	Th-229	Y-90
Cf-251	Cs-137	Np-237	Pu-244	Th-230	Zr-93

3.3.3 Evaluation of Non-Radionuclides

The list of non-radiological constituents that were included in the PA modeling was derived from the *State Primary Drinking Water Regulations* (SCDHEC R.61-58) for inorganic contaminants. Asbestos, beryllium, cyanide, and thallium were removed from the list due to lack of inventory in the waste tanks. The resulting list was compared to the list of inorganic characteristic hazards specified in 40 CFR 261 and silver and lead were added to the list. Secondary contaminants copper, manganese, iron, and zinc were also included due to the process knowledge that they were potentially present in the waste. Specific controls exist precluding the introduction of organic constituents to the waste tank systems therefore they were not considered while establishing inventory or for the PA modeling. The chemicals (non-radiological inventory) of concern are listed in Table 3.3-2. These chemicals will be characterized during final closure for each tank.

Table 3.3-2: Non-Radiological Inventory of Concern

Ag	Cd	F	Mn	NO_3	Se
As	Cr	Fe	Ni	Pb	U
Ba	Cu	Hg	NO_2	Sb	Zn

Further information can be found on evaluation of the radiological and non-radiological constituents in the HTF closure inventory document. [SRR-CWDA-2010-00023]

3.4 Inventory Methodology

The following general approach was used for estimating radiological and non-radiological inventories for use in the HTF PA modeling.

- The contaminant screening process discussed in Section 3.3 consisted of several steps to arrive at an appropriate list of isotopes to be included in the HTF waste tank closure inventory estimates.
- Both residual material concentrations and volumes were estimated to develop initial inventory estimates.
- Adjustments were made to the initial inventory estimates to develop the final inventory estimates. These adjustments included grouping the waste tanks according to use and design; inventory adjustment as applicable within that group; increasing initial individual waste tank inventories by one order of magnitude for the Type I, Type II, and Type IV waste tanks; and assigning the maximum concentration of each radiological or non-radiological constituent from each individual waste tank within a grouping.
- The HTF non-radiological (chemical) inventory was estimated using the same methodology.

Specific details of the methodology can be found in SRR-CWDA-2010-00023.

At the time of waste tank closure, sampling and analyses will be performed. A statistically based sampling plan will be developed specifically for each waste tank. The plan will ensure samples are collected in a manner that provides the basis for the final waste tank residual characterization. The samples will be analyzed in accordance with the sample plan and the results used in the final waste tank residual inventory determination. Constituents listed in Tables 3.3-1 and 3.3-2 will be included in the basis for the final inventory determination. Although not all constituents will be included in the sampling analyses, those constituents not included in the sampling analyses will be justified (e.g., lack of risk significance, not detectable, below detection limits). These constituents will be determined via special methods (e.g., ratios to other radionuclides or fission yields) in order to conduct an appropriate comparison to the PA modeled residual inventory. Appendix B of SRNL-STI-2010-00439 contains a description of the various methodologies employed during final closure characterization.

3.4.1 Initial Waste Tank Inventory Estimates

The initial waste tank inventory estimates were based on WCS concentrations and volume estimates from waste tank cleaning history.

3.4.1.1 Initial Waste Tank Inventory Concentration Estimates

The majority of the radionuclide concentrations and the entire inventory of non-radiological constituents (chemicals) in the residual material are estimated using data from WCS.

3.4.1.1.1 The Waste Characterization System

The WCS is an electronic information system that tracks waste tank data, including projected radiological and non-radiological inventories, based on sample analyses, process histories, composition studies, and theoretical relationships. The system (initially developed in 1995) tracks the dry sludge concentrations of 40 radiological and of 37 non-radiological waste compounds in each of the SRS waste tanks. The 40 radionuclides tracked in the WCS were selected primarily based on their impact on waste tank safety basis source term, inhalation dose potential, or on the E-Area Vault Waste Acceptance Criteria (WAC). Further information concerning the use of the WCS and its maintenance is provided in SRR-CWDA-2010-00023.

3.4.1.1.2 Other Constituents Not Addressed in the WCS

In the WCS, a subset of the 29 HTF waste tanks required additional estimating where no input was available for a particular radiological or non-radiological constituent. In addition, updated special analysis methods provided estimates for additional isotopes generated as activation products. Affected constituents and the methods used to estimate their inventories are detailed in SRR-CWDA-2010-00023.

3.4.1.1.3 Accounting for Zeolite

Certain waste tanks contain zeolite in addition to the sludge material. Liquid overheads from the evaporator systems were treated in the past using CRCs containing zeolite, which functioned as a molecular sieve. In HTF, these columns were located in Tanks 24, 32, and 42. The estimated radiological concentrations in Tanks 24, 32, 38, 40, 42, and 51 have been adjusted to account for the zeolite and corresponding captured cesium.

The solids (sludge and zeolite) concentrations assume that zeolite remains unchanged during the waste removal processes. Experience with Tanks 18 and 19 demonstrated that the only element that accumulated on zeolite under actual in-tank conditions was cesium. The zeolite volume percents were calculated with the assumption that zeolite weight and volume percents are the same in residual material.

3.4.1.2 Initial Waste Tank Inventory Volume Estimates

The initial inventory estimates were based on residual solids volume using an average height of 0.0625 inch on the waste tank floor. This height was based on plans to use Oxalic Acid (OA) for waste tank cleaning because of prior experience with OA cleaning of Tank 16. This assumption was necessary to develop an estimated residual solids volume, which was used to calculate an initial value for the residual radiological and non-radiological inventories. This initial value was then adjusted as discussed Section 3.4.3. However, it is important to note that it is the radiological inventories (curies (Ci)) and non-radiological inventories (kilograms) that are important to the PA analysis, and not the specific estimated height of the residual solids.

The assumption is that inventories of radiological and non-radiological constituents in residual liquid were included in the final closure solids inventory, as the residual liquid has typically evaporated by the time samples are taken from the waste tanks. The assumption is that inventories inside failed cooling coils, on the surface of waste tank walls, cooling coils, and columns are encompassed by the total estimated waste tank inventory. The surfaces of internal waste tank walls, cooling coils, and support columns are expected to contain negligible deposits because they will be rinsed with OA (effectively cleaning these surfaces).

3.4.2 Type II Tank Sand Pad and Annulus Inventory Estimates

All Type II tanks have both a primary and secondary sand pad. All the Type II tank primary liners have formed leak sites during their operational history. This has resulted in material accumulating on the annulus floor for each of these waste tanks. Therefore, it is assumed for this inventory estimate that this layer was saturated with supernate material for all Type II tanks.

Tank 16 experienced the largest quantity of material leaving the waste tank and gathering in the annulus. In 1960, enough material filled the annulus that tens of gallons overflowed the annulus pan (secondary liner). [DPSPU-77-11-17_REDACTED] For the purpose of this inventory evaluation, it is conservatively assumed that all of the material that overflowed the annulus pan (secondary liner) entered the secondary sand pad below Tank 16. For Tanks 13 through 15, no material has leaked beyond the secondary liner; therefore, it is assumed that the secondary sand pads below these waste tanks contain no inventory. For all Type II tanks, residual inventory is assumed to remain on the annulus floor. Additional information can be found in SRR-CWDA-2010-00023.

Table 3.4-1 provides the estimated radionuclide inventories within the Type II sand pads and annulus. Table 3.4-2 provides the estimate non-radiological inventories within Type II sand pads and annulus.

Table 3.4-1: Type II Tank Annulus Estimated Radiological Inventory at Closure

Rad	Primary Sand Pad (Ci)	Annulus Floor (Ci)	Secondary Sand Pad (Ci)	Rad	Primary Sand Pad (Ci)	Annulus Floor (Ci)	Secondary Sand Pad (Ci)
Ac-227	6.1E-04	1.3E-05	1.2E-05	Pa-231	6.1E-04	1.3E-05	1.2E-05
Al-26	1.0E+00	1.0E+00	1.0E+00	Pd-107	6.1E-04	1.3E-05	1.2E-05
Am-241	8.3E+00	1.8E-01	1.7E-01	Pt-193	6.1E-04	1.3E-05	1.2E-05
Am-242m	1.0E+00	1.0E+00	1.0E+00	Pu-238	2.9E+01	6.2E-01	5.8E-01
Am-243	1.0E+00	1.0E+00	1.0E+00	Pu-239	5.1E+00	1.1E-01	1.0E-01
Ba-137m	4.4E+02	9.5E+00	8.9E+00	Pu-240	4.5E+00	9.7E-02	9.1E-02
C-14	1.0E+00	1.0E+00	1.0E+00	Pu-241	5.2E+00	1.1E-01	1.0E-01
Cf-249	6.1E-04	1.3E-05	1.2E-05	Pu-242	1.0E+00	1.0E+00	1.0E+00
Cf-251	6.1E-04	1.3E-05	1.2E-05	Pu-244	6.1E-04	1.3E-05	1.2E-05
Cl-36	6.1E-04	1.3E-05	1.2E-05	Ra-226	6.1E-04	1.3E-05	1.2E-05
Cm-243	1.0E+00	1.0E+00	1.0E+00	Ra-228	6.1E-04	1.3E-05	1.2E-05
Cm-244	5.2E-02	1.1E-03	1.0E-03	Se-79	1.0E+00	1.0E+00	1.0E+00
Cm-245	6.1E-04	1.3E-05	1.2E-05	Sm-151	1.5E+02	3.2E+00	3.1E+00
Cm-247	6.1E-04	1.3E-05	1.2E-05	Sn-126	1.0E+00	1.0E+00	1.0E+00
Cm-248	6.1E-04	1.3E-05	1.2E-05	Sr-90	3.6E+03	7.6E+01	7.2E+01
Co-60	6.1E-04	1.3E-05	1.2E-05	Tc-99	3.6E+00	7.6E-02	7.1E-02
Cs-135	3.7E-03	7.9E-05	7.4E-05	Th-229	6.1E-04	1.3E-05	1.2E-05
Cs-137	4.7E+02	1.0E+01	9.4E+00	Th-230	6.1E-04	1.3E-05	1.2E-05
Eu-152	1.0E+00	1.0E+00	1.0E+00	Th-232	7.4E-04	1.6E-05	1.5E-05
Eu-154	3.4E+00	7.2E-02	6.8E-02	U-232	6.1E-04	1.3E-05	1.2E-05
H-3	1.0E+00	1.0E+00	1.0E+00	U-233	4.1E-02	8.8E-04	8.2E-04
I-129	6.1E-04	1.3E-05	1.2E-05	U-234	2.1E-02	4.6E-04	4.3E-04
K-40	6.1E-04	1.3E-05	1.2E-05	U-235	2.4E-04	5.2E-06	4.9E-06
Nb-94	6.1E-04	1.3E-05	1.2E-05	U-236	8.3E-04	1.8E-05	1.7E-05
Ni-59	1.0E+00	1.0E+00	1.0E+00	U-238	1.1E-03	2.2E-05	2.1E-05
Ni-63	1.1E+01	2.4E-01	2.3E-01	Y-90	3.6E+03	7.6E+01	7.2E+01
Np-237	3.1E-02	6.5E-04	6.2E-04	Zr-93	7.0E-03	1.5E-04	1.4E-04

Table 3.4-2: Type II Tank Annulus Estimated Non-Radiological Inventory at Closure

Chemical	Primary Sand Pad (kg)	Annulus Floor (kg)	Secondary Sand Pad (kg)
Ag	6.1E+00	1.3E-01	9.2E-02
As	1.7E-02	3.7E-04	2.6E-04
Ba	2.8E+00	6.0E-02	4.2E-02
Cd	5.3E-01	1.1E-02	7.9E-03
Cr	2.7E+00	5.7E-02	4.0E-02
Cu	1.5E+00	3.1E-02	2.2E-02
F	1.3E+00	2.8E-02	2.0E-02
Fe	1.2E+02	2.5E+00	1.8E+00
Hg	4.0E+01	8.4E-01	6.0E-01
Mn	1.9E+00	4.0E-02	2.9E-02
Ni	3.9E+00	8.3E-02	5.8E-02
NO_2	5.1E+02	1.1E+01	7.6E+00
NO_3	9.9E+02	2.1E+01	1.5E+01
Pb	3.4E+01	7.1E-01	5.0E-01
Sb	1.2E+01	2.5E-01	1.8E-01
Se	1.4E-02	3.0E-04	2.1E-04
U	1.9E-02	4.1E-04	2.9E-04
Zn	4.7E+00	9.9E-02	7.0E-02

3.4.3 Waste Tank Inventory Adjustments

Following the initial estimate of residual waste tank inventories, adjustments were performed based on experience with tank farm operations, previous inventory developments, and modeling efforts. Independent steps were developed to adjust systematically the HTF waste tank inventories, with each step adjusting the inventory either by waste tank or by radionuclide. The steps used in the inventory adjustment were as follows:

1. The inventory adjustment used the initial inventory estimates as the starting point
2. The waste tanks were grouped according to waste tank use and design
3. Within each waste tank grouping, the inventories were adjusted as applicable within that group
4. Due to future waste removal uncertainties (e.g., unknowns regarding the effectiveness of waste tank cleaning technologies), the initial individual waste tank inventories were increased one order of magnitude for the Type I, Type II, and Type IV tanks
5. Within the Type IV tank grouping, the Tank 24 inventories were revised to account for an increased level of uncertainty surrounding the residual inventories remaining after waste removal impacted by the presence of zeolite
6. To account for uncertainty surrounding future operations and movement of material within the HTF, the maximum concentration of each radionuclide or non-radionuclide from any waste tank within a group was applied to the other waste tanks within the grouping

The adjustments summarized in this section are explained in further detail in SRR-CWDA-2010-00023.

3.4.3.1 Waste Tank Grouping

The waste tank type generally had an effect on the type of waste received and therefore guided the group selection. Since a group of waste tanks generally had similar waste, any adjustment made to the inventory of one waste tank would be applicable to the others within that group. In addition, the waste tanks generally contain one of two waste types, metal hydroxides (commonly referred to as sludge) and sodium nitrate/nitrite salt (commonly referred to as salt). For the waste tanks categorized as either salt or sludge, the predominant use was considered. This was established as the use (past and future) for the majority of the waste tank life. The waste tanks were grouped based on use and design as presented in Table 3.4-3.

Table 3.4-3: Waste Tank Groupings

Types I and II		**Type III/IIIA**				**Type IV**
Salt	**Sludge**	**Salt (West)**	**Salt (East)**	**Sludge (West)**	**Sludge (East)**	**N/A***
Tanks 9 and 10	Tanks 11, 12, 13, 14, and 15	Tanks 29, 30, 31, 35, 36, and 37	Tanks 38, 41, 48, 49, and 50	Tank 32	Tanks 39, 40, 42, 43, and 51	Tanks 21, 22, 23, and 24

Note Tank 16 is a special case with its own grouping
* No additional criteria can be attributed to this waste tank type group

The Type I and II tanks were grouped together. Within this grouping, the waste tanks were split into two groups based on the waste type (i.e., salt or sludge). For the Type IV tanks, the waste type is similar for all the waste tanks, so there was no need to form subgroups.

The last grouping was for the Type III and IIIA tanks. These waste tanks also contained the two different waste types, in addition to two groupings based on waste tank location within HTF (East and West Hills).

Tank 16 was not grouped with any other waste tanks. Tank 16 has been cleaned with OA and the bases for portions of its inventory are a result of residual material sampling analyses already completed. Using Tank 15 as a surrogate provided the remaining inventory estimates. No further adjustments were made to the inventory estimates of Tank 16.

3.4.3.2 Residual Inventory Uncertainty

An adjustment to the inventory estimates was made to provide for greater uncertainties in the residual inventories from the planned waste removal operation. Based on recent waste removal activities in Tanks 5 and 6, there is uncertainty around the projected residual inventories for the waste tanks remaining to be cleaned. To account for this uncertainty and ensure that the PA would provide a reasonably bounding inventory projection, the existing inventories were multiplied by a factor of 10. This adjustment was made to radionuclides and chemicals inventories for all Type I, II, and IV tanks with the exception of Tank 16. Type III and IIIA tanks were not adjusted because these waste tanks will be the last waste tanks cleaned and will incorporate all waste tank waste removal lessons learned to date. In addition, Type III and IIIA tanks do not have the same cooling coil arrangments as Type I and Type II tanks, which should support improved waste removal.

3.4.3.3 Nominal Activity (Radionuclides)

Allowing for more efficient and cost effective means of confirming radionuclide concentrations with a limited potential impact to dose, the inventories for a group of radionuclides were adjusted to either 1 curie, or used an analytical detection limit that resulted in an inventory of 1.0E-04 curie. If the radionuclide inventory estimated was less than 1.0E-04 curie, then it was adjusted up to 1.0E-04 curie. However, if the radionuclide inventory estimated was at least 1.0E-04 curie, then it was adjusted up to 1 curie. For I-129, the detection limit used resulted in an inventory estimate of 1.0E-05 curie because the analytical laboratory was able to achieve lower analytical detection limits during analysis of Tanks 18 and 19 samples. [SRNL-STI-2010-00386, SRNL-STI-2010-00439] The adjustments to either 1.0E-04 curie or to 1 curie exclusively increased residual inventories estimates. Inventory estimates were not adjusted lower, only higher.

For those radionuclides that have been observed (through previous analyses or scoping studies) to have greater potential impact on the overall dose, the inventory was adjusted to the analytical detection limit.

Note that those radionuclides with estimated inventories greater than 1 curie were not adjusted in this step. In addition, this adjustment only applied to the radiological inventories and not to the non-radiological inventories.

3.4.3.4 Future Operations

Within the waste tank group, the maximum inventory for any one waste tank was used to estimate the inventory for the other waste tanks within the grouping due to the uncertain order of waste removal and closure activities. While a waste tank is in the closure process, material will be removed and transferred to another waste tank. This will cause the concentrations of the two waste tanks to become more similar. Since the order of waste tank closure and the transfer sequences are uncertain, all the radiological and non-radiological waste tank inventory within each group were adjusted to match the maximum waste tank inventory within that group.

3.4.3.5 Chemical Cleaning

Based on the differences in concentrations observed during the chemical cleaning of Tank 5, decreases in concentrations are anticipated for cesium, strontium, technetium, and uranium. Therefore, the inventories for these elements were adjusted one order of magnitude lower to reflect the chemical cleaning efficiency. However, the chemical cleaning process is not planned for Tank 24 because the acid effect on zeolite hampers future waste removal efforts. Therefore, this adjustment was not applied to Tank 24.

3.4.4 Final Waste Tank Inventory Estimates

The system plan calls for the last waste tank to be grouted at the end of fiscal year 2032. Therefore, all the radiological inventories have been decay corrected to 2032. After all waste inventory adjustments, the final radionuclide estimates are provided in Table 3.4-4. The estimated non-radiological constituent inventories are provided in Table 3.4-5.

In using the estimates of Tables 3.4-4 and 3.4-5 in the PA, it should be kept in mind that the curies of residual radiological and the mass of residual non-radiological waste constituents are important to the analyses, not the estimated residual waste volume. While the estimated solids volume was used to calculate the residual radiological and non-radiological waste constituent inventories, the volume estimate was not significant in its own right.

Estimate conservatism and uncertainty are addressed in Section 5.6.3.1. In addition, further details can be found in SRR-CWDA-2010-00023.

Table 3.4-4: Estimated Radiological Inventory (Ci) at Closure

Tank	Ac-227	Al-26	Am-241	Am-242m	Am-243	Ba-137m	C-14	Cf-249	Cf-251	Cl-36	Cm-243	Cm-244	Cm-245
9	1.0E-03	1.0E+00	1.9E+02	1.0E+00	1.0E+00	1.7E+02	1.0E+00	1.0E-03	1.0E-03	1.0E-03	1.0E+00	1.1E-02	1.0E-03
10	1.0E-03	1.0E+00	1.9E+02	1.0E+00	1.0E+00	1.7E+02	1.0E+00	1.0E-03	1.0E-03	1.0E-03	1.0E+00	1.1E-02	1.0E-03
11	1.0E-03	1.0E+00	2.1E+02	1.0E+00	1.0E+00	2.8E+02	1.0E+00	1.0E-03	1.0E-03	1.0E-03	1.0E+00	2.3E+00	1.0E-03
12	1.0E-03	1.0E+00	2.1E+02	1.0E+00	1.0E+00	2.8E+02	1.0E+00	1.0E-03	1.0E-03	1.0E-03	1.0E+00	2.3E+00	1.0E-03
13	1.0E-03	1.0E+00	2.1E+02	1.0E+00	1.0E+00	2.8E+02	1.0E+00	1.0E-03	1.0E-03	1.0E-03	1.0E+00	2.3E+00	1.0E-03
14	1.0E-03	1.0E+00	2.1E+02	1.0E+00	1.0E+00	2.8E+02	1.0E+00	1.0E-03	1.0E-03	1.0E-03	1.0E+00	2.3E+00	1.0E-03
15	1.0E-03	1.0E+00	2.1E+02	1.0E+00	1.0E+00	2.8E+02	1.0E+00	1.0E-03	1.0E-03	1.0E-03	1.0E+00	2.3E+00	1.0E-03
16	1.0E-04	1.0E+00	1.9E+01	1.0E+00	1.0E+00	2.8E+01	1.0E+00	1.0E-04	1.0E-04	1.0E-04	1.0E+00	1.2E-01	1.0E-04
21	1.0E-03	1.0E+00	2.7E+01	1.0E+00	1.0E+00	1.3E+03	1.0E+00	1.0E-03	1.0E-03	1.0E-03	1.0E+00	3.5E+00	1.0E+00
22	1.0E-03	1.0E+00	2.7E+01	1.0E+00	1.0E+00	1.3E+03	1.0E+00	1.0E-03	1.0E-03	1.0E-03	1.0E+00	3.5E+00	1.0E+00
23	1.0E-03	1.0E+00	2.7E+01	1.0E+00	1.0E+00	1.3E+03	1.0E+00	1.0E-03	1.0E-03	1.0E-03	1.0E+00	3.5E+00	1.0E+00
24	1.0E-03	1.0E+00	2.7E+01	1.0E+00	1.0E+00	1.3E+04	1.0E+00	1.0E-03	1.0E-03	1.0E-03	1.0E+00	3.5E+00	1.0E+00
29	1.0E-04	1.0E+00	5.7E+01	1.0E+00	1.0E+00	5.6E+01	1.0E+00	1.0E-04	1.0E-04	1.0E-04	1.0E+00	1.9E-01	1.0E-04
30	1.0E-04	1.0E+00	5.7E+01	1.0E+00	1.0E+00	5.6E+01	1.0E+00	1.0E-04	1.0E-04	1.0E-04	1.0E+00	1.9E-01	1.0E-04
31	1.0E-04	1.0E+00	5.7E+01	1.0E+00	1.0E+00	5.6E+01	1.0E+00	1.0E-04	1.0E-04	1.0E-04	1.0E+00	1.9E-01	1.0E-04
32	1.0E-04	1.0E+00	8.6E+01	1.0E+00	1.0E+00	8.1E+01	1.0E+00	1.0E-04	1.0E-04	1.0E-04	1.0E+00	1.0E-01	1.0E-04
35	1.0E-04	1.0E+00	5.7E+01	1.0E+00	1.0E+00	5.6E+01	1.0E+00	1.0E-04	1.0E-04	1.0E-04	1.0E+00	1.9E-01	1.0E-04
36	1.0E-04	1.0E+00	5.7E+01	1.0E+00	1.0E+00	5.6E+01	1.0E+00	1.0E-04	1.0E-04	1.0E-04	1.0E+00	1.9E-01	1.0E-04
37	1.0E-04	1.0E+00	5.7E+01	1.0E+00	1.0E+00	5.6E+01	1.0E+00	1.0E-04	1.0E-04	1.0E-04	1.0E+00	1.9E-01	1.0E-04
38	1.0E-04	1.0E+00	1.8E+01	1.0E+00	1.0E+00	2.2E+01	1.0E+00	1.0E-04	1.0E-04	1.0E-04	1.0E+00	8.5E+00	1.0E+00
39	1.0E-04	1.0E+00	4.2E+01	1.0E+00	1.0E+00	3.9E+01	1.0E+00	1.0E-04	1.0E-04	1.0E-04	1.0E+00	7.8E+01	1.0E+00
40	1.0E-04	1.0E+00	4.2E+01	1.0E+00	1.0E+00	3.9E+01	1.0E+00	1.0E-04	1.0E-04	1.0E-04	1.0E+00	7.8E+01	1.0E+00
41	1.0E-04	1.0E+00	1.8E+01	1.0E+00	1.0E+00	2.2E+01	1.0E+00	1.0E-04	1.0E-04	1.0E-04	1.0E+00	8.5E+00	1.0E+00
42	1.0E-04	1.0E+00	4.2E+01	1.0E+00	1.0E+00	3.9E+01	1.0E+00	1.0E-04	1.0E-04	1.0E-04	1.0E+00	7.8E+01	1.0E+00
43	1.0E-04	1.0E+00	4.2E+01	1.0E+00	1.0E+00	3.9E+01	1.0E+00	1.0E-04	1.0E-04	1.0E-04	1.0E+00	7.8E+01	1.0E+00
48	1.0E-04	1.0E+00	1.8E+01	1.0E+00	1.0E+00	2.2E+01	1.0E+00	1.0E-04	1.0E-04	1.0E-04	1.0E+00	8.5E+00	1.0E+00
49	1.0E-04	1.0E+00	1.8E+01	1.0E+00	1.0E+00	2.2E+01	1.0E+00	1.0E-04	1.0E-04	1.0E-04	1.0E+00	8.5E+00	1.0E+00
50	1.0E-04	1.0E+00	1.8E+01	1.0E+00	1.0E+00	2.2E+01	1.0E+00	1.0E-04	1.0E-04	1.0E-04	1.0E+00	8.5E+00	1.0E+00
51	1.0E-04	1.0E+00	4.2E+01	1.0E+00	1.0E+00	3.9E+01	1.0E+00	1.0E-04	1.0E-04	1.0E-04	1.0E+00	7.8E+01	1.0E+00

Table 3.4-4: Estimated Radiological Inventory (Ci) at Closure (Continued)

Tank	Cm-247	Cm-248	Co-60	Cs-135	Cs-137	Eu-152	Eu-154	H-3	I-129	K-40	Nb-94	Ni-59	Ni-63	Np-237
9	1.0E-03	1.0E-03	1.0E-03	1.8E-03	1.8E+02	3.8E+00	6.6E+00	1.0E+00	1.0E-04	1.0E-03	1.2E-03	2.3E+00	1.5E+02	1.3E-01
10	1.0E-03	1.0E-03	1.0E-03	1.8E-03	1.8E+02	3.8E+00	6.6E+00	1.0E+00	1.0E-04	1.0E-03	1.2E-03	2.3E+00	1.5E+02	1.3E-01
11	1.0E-03	1.0E-03	1.0E-03	2.3E-03	2.9E+02	6.2E+00	7.8E+01	1.0E+00	1.0E-04	1.0E-03	1.0E-03	3.7E+00	2.6E+02	1.3E-01
12	1.0E-03	1.0E-03	1.0E-03	2.3E-03	2.9E+02	6.2E+00	7.8E+01	1.0E+00	1.0E-04	1.0E-03	1.0E-03	3.7E+00	2.6E+02	1.3E-01
13	1.0E-03	1.0E-03	1.0E-03	2.3E-03	2.9E+02	6.2E+00	7.8E+01	1.0E+00	1.0E-04	1.0E-03	1.0E-03	3.7E+00	2.6E+02	1.3E-01
14	1.0E-03	1.0E-03	1.0E-03	2.3E-03	2.9E+02	6.2E+00	7.8E+01	1.0E+00	1.0E-04	1.0E-03	1.0E-03	3.7E+00	2.6E+02	1.3E-01
15	1.0E-03	1.0E-03	1.0E-03	2.3E-03	2.9E+02	6.2E+00	7.8E+01	1.0E+00	1.0E-04	1.0E-03	1.0E-03	3.7E+00	2.6E+02	1.3E-01
16	1.0E-04	1.0E-04	1.0E-04	2.3E-04	2.9E+01	1.0E+00	7.8E+00	1.0E+00	1.0E-05	1.0E-04	1.0E-04	1.0E+00	2.6E+01	5.2E-03
21	1.0E-03	1.0E-03	1.0E-03	7.0E-03	1.4E+03	1.0E+00	4.5E+01	1.0E+00	1.0E-04	1.0E-03	1.0E-03	1.0E+00	2.6E+01	3.4E-02
22	1.0E-03	1.0E-03	1.0E-03	7.0E-03	1.4E+03	1.0E+00	4.5E+01	1.0E+00	1.0E-04	1.0E-03	1.0E-03	1.0E+00	2.6E+01	3.4E-02
23	1.0E-03	1.0E-03	1.0E-03	7.0E-03	1.4E+03	1.0E+00	4.5E+01	1.0E+00	1.0E-04	1.0E-03	1.0E-03	1.0E+00	2.6E+01	3.4E-02
24	1.0E-03	1.0E-03	1.0E-03	7.0E-02	1.4E+04	1.0E+00	4.5E+01	1.0E+00	1.0E-04	1.0E-03	1.0E-03	1.0E+00	2.6E+01	3.4E-02
29	1.0E-04	1.0E-04	1.0E-04	3.6E-04	5.9E+01	1.2E+00	2.9E+01	1.0E+00	1.0E-05	1.0E-04	1.0E-04	1.0E+00	4.4E+01	1.3E-02
30	1.0E-04	1.0E-04	1.0E-04	3.6E-04	5.9E+01	1.2E+00	2.9E+01	1.0E+00	1.0E-05	1.0E-04	1.0E-04	1.0E+00	4.4E+01	1.3E-02
31	1.0E-04	1.0E-04	1.0E-04	3.6E-04	5.9E+01	1.2E+00	2.9E+01	1.0E+00	1.0E-05	1.0E-04	1.0E-04	1.0E+00	4.4E+01	1.3E-02
32	1.0E-04	1.0E-04	1.0E-04	4.8E-04	8.6E+01	1.8E+00	5.0E+01	1.0E+00	1.0E-05	1.0E-04	1.1E-04	1.0E+00	6.0E+01	3.4E-03
35	1.0E-04	1.0E-04	1.0E-04	3.6E-04	5.9E+01	1.2E+00	2.9E+01	1.0E+00	1.0E-05	1.0E-04	1.0E-04	1.0E+00	4.4E+01	1.3E-02
36	1.0E-04	1.0E-04	1.0E-04	3.6E-04	5.9E+01	1.2E+00	2.9E+01	1.0E+00	1.0E-05	1.0E-04	1.0E-04	1.0E+00	4.4E+01	1.3E-02
37	1.0E-04	1.0E-04	1.0E-04	3.6E-04	5.9E+01	1.2E+00	2.9E+01	1.0E+00	1.0E-05	1.0E-04	1.0E-04	1.0E+00	4.4E+01	1.3E-02
38	1.0E-04	1.0E-04	1.0E-04	1.3E-04	2.3E+01	1.0E+00	9.8E+00	1.0E+00	1.0E-05	1.0E-04	1.0E-04	1.0E+00	1.5E+01	6.5E-03
39	1.0E-04	1.0E-04	1.0E-04	2.0E-04	4.1E+01	1.0E+00	3.6E+01	1.0E+00	1.0E-05	1.0E-04	1.0E-04	1.0E+00	2.6E+01	1.6E-02
40	1.0E-04	1.0E-04	1.0E-04	2.0E-04	4.1E+01	1.0E+00	3.6E+01	1.0E+00	1.0E-05	1.0E-04	1.0E-04	1.0E+00	2.6E+01	1.6E-02
41	1.0E-04	1.0E-04	1.0E-04	1.3E-04	2.3E+01	1.0E+00	9.8E+00	1.0E+00	1.0E-05	1.0E-04	1.0E-04	1.0E+00	1.5E+01	6.5E-03
42	1.0E-04	1.0E-04	1.0E-04	2.0E-04	4.1E+01	1.0E+00	3.6E+01	1.0E+00	1.0E-05	1.0E-04	1.0E-04	1.0E+00	2.6E+01	1.6E-02
43	1.0E-04	1.0E-04	1.0E-04	2.0E-04	4.1E+01	1.0E+00	3.6E+01	1.0E+00	1.0E-05	1.0E-04	1.0E-04	1.0E+00	2.6E+01	1.6E-02
48	1.0E-04	1.0E-04	1.0E-04	1.3E-04	2.3E+01	1.0E+00	9.8E+00	1.0E+00	1.0E-05	1.0E-04	1.0E-04	1.0E+00	1.5E+01	6.5E-03
49	1.0E-04	1.0E-04	1.0E-04	1.3E-04	2.3E+01	1.0E+00	9.8E+00	1.0E+00	1.0E-05	1.0E-04	1.0E-04	1.0E+00	1.5E+01	6.5E-03
50	1.0E-04	1.0E-04	1.0E-04	1.3E-04	2.3E+01	1.0E+00	9.8E+00	1.0E+00	1.0E-05	1.0E-04	1.0E-04	1.0E+00	1.5E+01	6.5E-03
51	1.0E-04	1.0E-04	1.0E-04	2.0E-04	4.1E+01	1.0E+00	3.6E+01	1.0E+00	1.0E-05	1.0E-04	1.0E-04	1.0E+00	2.6E+01	1.6E-02

Table 3.4-4: Estimated Radiological Inventory (Ci) at Closure (Continued)

Tank	Pa-231	Pd-107	Pt-193	Pu-238	Pu-239	Pu-240	Pu-241	Pu-242	Pu-244	Ra-226	Ra-228	Se-79	Sm-151	Sn-126
9	1.0E-03	1.0E-03	1.0E-03	2.3E+01	3.9E+00	8.7E-01	1.0E+00	1.0E+00	1.0E-03	1.0E-03	1.0E-03	1.6E+00	2.2E+03	2.9E+00
10	1.0E-03	1.0E-03	1.0E-03	2.3E+01	3.9E+00	8.7E-01	1.0E+00	1.0E+00	1.0E-03	1.0E-03	1.0E-03	1.6E+00	2.2E+03	2.9E+00
11	1.0E-03	1.0E-03	1.0E-03	1.4E+03	2.8E+01	1.5E+01	1.7E+02	1.0E+00	1.0E-03	1.0E-03	1.0E-03	2.0E+00	3.5E+03	1.9E+00
12	1.0E-03	1.0E-03	1.0E-03	1.4E+03	2.8E+01	1.5E+01	1.7E+02	1.0E+00	1.0E-03	1.0E-03	1.0E-03	2.0E+00	3.5E+03	1.9E+00
13	1.0E-03	1.0E-03	1.0E-03	1.4E+03	2.8E+01	1.5E+01	1.7E+02	1.0E+00	1.0E-03	1.0E-03	1.0E-03	2.0E+00	3.5E+03	1.9E+00
14	1.0E-03	1.0E-03	1.0E-03	1.4E+03	2.8E+01	1.5E+01	1.7E+02	1.0E+00	1.0E-03	1.0E-03	1.0E-03	2.0E+00	3.5E+03	1.9E+00
15	1.0E-03	1.0E-03	1.0E-03	1.4E+03	2.8E+01	1.5E+01	1.7E+02	1.0E+00	1.0E-03	1.0E-03	1.0E-03	2.0E+00	3.5E+03	1.9E+00
16	1.0E-04	1.0E-04	1.0E-04	6.7E+01	1.8E+00	8.6E-01	4.8E+00	1.0E+00	1.0E-04	1.0E-04	1.0E-04	1.0E+00	3.5E+02	1.0E+00
21	1.0E-03	1.0E-03	1.0E-03	6.2E+02	3.1E+00	2.6E+00	1.8E+02	1.0E+00	1.0E-03	1.0E-03	1.0E-03	1.0E+00	5.9E+02	1.0E+00
22	1.0E-03	1.0E-03	1.0E-03	6.2E+02	3.1E+00	2.6E+00	1.8E+02	1.0E+00	1.0E-03	1.0E-03	1.0E-03	1.0E+00	5.9E+02	1.0E+00
23	1.0E-03	1.0E-03	1.0E-03	6.2E+02	3.1E+00	2.6E+00	1.8E+02	1.0E+00	1.0E-03	1.0E-03	1.0E-03	1.0E+00	5.9E+02	1.0E+00
24	1.0E-03	1.0E-03	1.0E-03	6.2E+02	3.1E+00	2.6E+00	1.8E+02	1.0E+00	1.0E-03	1.0E-03	1.0E-03	1.0E+00	5.9E+02	1.0E+00
29	1.0E-04	1.0E-04	1.0E-04	3.7E+01	7.5E+00	5.5E+00	1.0E+02	1.0E+00	1.0E-04	1.0E-04	1.0E-04	1.0E+00	7.0E+02	1.0E+00
30	1.0E-04	1.0E-04	1.0E-04	6.9E+02	7.5E+00	5.5E+00	1.0E+02	1.0E+00	1.0E-04	1.0E-04	1.0E-04	1.0E+00	7.0E+02	1.0E+00
31	1.0E-04	1.0E-04	1.0E-04	3.7E+01	7.5E+00	5.5E+00	1.0E+02	1.0E+00	1.0E-04	1.0E-04	1.0E-04	1.0E+00	7.0E+02	1.0E+00
32	1.0E-04	1.0E-04	1.0E-04	1.1E+03	1.1E+01	8.7E+00	1.8E+02	1.0E+00	1.0E-04	1.0E-04	1.0E-04	1.0E+00	1.0E+03	1.0E+00
35	1.0E-04	1.0E-04	1.0E-04	6.9E+02	7.5E+00	5.5E+00	1.0E+02	1.0E+00	1.0E-04	1.0E-04	1.0E-04	1.0E+00	7.0E+02	1.0E+00
36	1.0E-04	1.0E-04	1.0E-04	3.7E+01	7.5E+00	5.5E+00	1.0E+02	1.0E+00	1.0E-04	1.0E-04	1.0E-04	1.0E+00	7.0E+02	1.0E+00
37	1.0E-04	1.0E-04	1.0E-04	6.9E+02	7.5E+00	5.5E+00	1.0E+02	1.0E+00	1.0E-04	1.0E-04	1.0E-04	1.0E+00	7.0E+02	1.0E+00
38	1.0E-04	1.0E-04	1.0E-04	1.8E+02	3.3E+00	1.8E+00	3.6E+01	1.0E+00	1.0E-04	1.0E-04	1.0E-04	1.0E+00	2.8E+02	1.0E+00
39	1.0E-04	1.0E-04	1.0E-04	6.1E+02	9.4E+00	5.8E+00	1.8E+02	1.0E+00	1.0E-04	1.0E-04	1.0E-04	1.0E+00	4.9E+02	1.0E+00
40	1.0E-04	1.0E-04	1.0E-04	6.1E+02	9.4E+00	5.8E+00	1.8E+02	1.0E+00	1.0E-04	1.0E-04	1.0E-04	1.0E+00	4.9E+02	1.0E+00
41	1.0E-04	1.0E-04	1.0E-04	1.8E+02	3.3E+00	1.8E+00	3.6E+01	1.0E+00	1.0E-04	1.0E-04	1.0E-04	1.0E+00	2.8E+02	1.0E+00
42	1.0E-04	1.0E-04	1.0E-04	6.1E+02	9.4E+00	5.8E+00	1.8E+02	1.0E+00	1.0E-04	1.0E-04	1.0E-04	1.0E+00	4.9E+02	1.0E+00
43	1.0E-04	1.0E-04	1.0E-04	6.1E+02	9.4E+00	5.8E+00	1.8E+02	1.0E+00	1.0E-04	1.0E-04	1.0E-04	1.0E+00	4.9E+02	1.0E+00
48	1.0E-04	1.0E-04	1.0E-04	1.8E+02	3.3E+00	1.8E+00	3.6E+01	1.0E+00	1.0E-04	1.0E-04	1.0E-04	1.0E+00	2.8E+02	1.0E+00
49	1.0E-04	1.0E-04	1.0E-04	1.8E+02	3.3E+00	1.8E+00	3.6E+01	1.0E+00	1.0E-04	1.0E-04	1.0E-04	1.0E+00	2.8E+02	1.0E+00
50	1.0E-04	1.0E-04	1.0E-04	1.8E+02	3.3E+00	1.8E+00	3.6E+01	1.0E+00	1.0E-04	1.0E-04	1.0E-04	1.0E+00	2.8E+02	1.0E+00
51	1.0E-04	1.0E-04	1.0E-04	6.1E+02	9.4E+00	5.8E+00	1.8E+02	1.0E+00	1.0E-04	1.0E-04	1.0E-04	1.0E+00	4.9E+02	1.0E+00

Table 3.4-4: Estimated Radiological Inventory (Ci) at Closure (Continued)

Tank	Sr-90	Tc-99	Th-229	Th-230	Th-232	U-232	U-233	U-234	U-235	U-236	U-238	Y-90	Zr-93
9	2.5E+03	2.7E+00	1.0E-03	1.0E-03	1.0E-03	1.0E-03	1.3E-02	1.8E-03	1.0E-03	1.0E+00	1.8E-03	2.5E+03	7.5E-02
10	2.5E+03	2.7E+00	1.0E-03	1.0E-03	1.0E-03	1.0E-03	1.3E-02	1.8E-03	1.0E-03	1.0E+00	1.8E-03	2.5E+03	7.5E-02
11	5.2E+03	3.4E+00	1.3E-03	1.0E-03	1.7E-02	1.0E-03	4.5E-02	5.6E-03	1.3E-03	1.0E+00	1.6E-03	5.2E+03	1.6E-01
12	5.2E+03	3.4E+00	1.3E-03	1.0E-03	1.7E-02	1.0E-03	4.5E-02	5.6E-03	1.3E-03	1.0E+00	1.6E-03	5.2E+03	1.6E-01
13	5.2E+03	3.4E+00	1.3E-03	1.0E-03	1.7E-02	1.0E-03	4.5E-02	5.6E-03	1.3E-03	1.0E+00	1.6E-03	5.2E+03	1.6E-01
14	5.2E+03	3.4E+00	1.3E-03	1.0E-03	1.7E-02	1.0E-03	4.5E-02	5.6E-03	1.3E-03	1.0E+00	1.6E-03	5.2E+03	1.6E-01
15	5.2E+03	3.4E+00	1.3E-03	1.0E-03	1.7E-02	1.0E-03	4.5E-02	5.6E-03	1.3E-03	1.0E+00	1.6E-03	5.2E+03	1.6E-01
16	5.2E+02	3.4E-01	1.0E-04	1.0E-04	1.7E-03	1.0E-04	2.0E-03	5.6E-04	1.0E-04	1.0E+00	1.0E-04	5.2E+02	1.6E-02
21	8.9E+02	3.5E-01	1.0E-03	1.0E-03	1.0E-03	1.0E-03	4.1E-03	3.2E-03	1.0E-03	1.0E+00	1.0E-03	8.9E+02	2.7E-02
22	8.9E+02	3.5E-01	1.0E-03	1.0E-03	1.0E-03	1.0E-03	4.1E-03	3.2E-03	1.0E-03	1.0E+00	1.0E-03	8.9E+02	2.7E-02
23	8.9E+02	3.5E-01	1.0E-03	1.0E-03	1.0E-03	1.0E-03	4.1E-03	3.2E-03	1.0E-03	1.0E+00	1.0E-03	8.9E+02	2.7E-02
24	8.9E+03	3.5E+00	1.0E-03	1.0E-03	1.0E-03	1.0E-03	4.1E-02	3.2E-02	1.0E-03	1.0E+00	5.0E-03	8.9E+03	2.7E-02
29	1.0E+03	5.4E-01	1.0E-04	1.0E-04	1.7E-04	1.0E-04	3.5E-03	5.9E-04	1.3E-04	1.0E+00	1.6E-04	1.0E+03	3.2E-02
30	1.0E+03	5.4E-01	1.0E-04	1.0E-04	1.7E-04	1.0E-04	3.5E-03	5.9E-04	1.3E-04	1.0E+00	1.6E-04	1.0E+03	3.2E-02
31	1.0E+03	5.4E-01	1.0E-04	1.0E-04	1.7E-04	1.0E-04	3.5E-03	5.9E-04	1.3E-04	1.0E+00	1.6E-04	1.0E+03	3.2E-02
32	1.5E+03	7.2E-01	1.0E-04	1.0E-04	1.0E-04	1.0E-04	1.0E-03	9.5E-04	1.6E-04	1.0E+00	1.0E-04	1.5E+03	4.6E-02
35	1.0E+03	5.4E-01	1.0E-04	1.0E-04	1.7E-04	1.0E-04	3.5E-03	5.9E-04	1.3E-04	1.0E+00	1.6E-04	1.0E+03	3.2E-02
36	1.0E+03	5.4E-01	1.0E-04	1.0E-04	1.7E-04	1.0E-04	3.5E-03	5.9E-04	1.3E-04	1.0E+00	1.6E-04	1.0E+03	3.2E-02
37	1.0E+03	5.4E-01	1.0E-04	1.0E-04	1.7E-04	1.0E-04	3.5E-03	5.9E-04	1.3E-04	1.0E+00	1.6E-04	1.0E+03	3.2E-02
38	3.8E+02	2.0E-01	1.0E-04	1.0E-04	3.6E-04	1.0E-04	1.5E-03	7.8E-04	1.2E-04	1.0E+00	1.1E-04	3.8E+02	1.2E-02
39	7.5E+02	3.0E-01	1.0E-04	1.0E-04	5.5E-04	1.0E-04	1.6E-03	2.6E-03	4.1E-04	1.0E+00	1.2E-04	7.5E+02	2.3E-02
40	7.5E+02	3.0E-01	1.0E-04	1.0E-04	5.5E-04	1.0E-04	1.6E-03	2.6E-03	4.1E-04	1.0E+00	1.2E-04	7.5E+02	2.3E-02
41	3.8E+02	2.0E-01	1.0E-04	1.0E-04	3.6E-04	1.0E-04	1.5E-03	7.8E-04	1.2E-04	1.0E+00	1.1E-04	3.8E+02	1.2E-02
42	7.5E+02	3.0E-01	1.0E-04	1.0E-04	5.5E-04	1.0E-04	1.6E-03	2.6E-03	4.1E-04	1.0E+00	1.2E-04	7.5E+02	2.3E-02
43	7.5E+02	3.0E-01	1.0E-04	1.0E-04	5.5E-04	1.0E-04	1.6E-03	2.6E-03	4.1E-04	1.0E+00	1.2E-04	7.5E+02	2.3E-02
48	3.8E+02	2.0E-01	1.0E-04	1.0E-04	3.6E-04	1.0E-04	1.5E-03	7.8E-04	1.2E-04	1.0E+00	1.1E-04	3.8E+02	1.2E-02
49	3.8E+02	2.0E-01	1.0E-04	1.0E-04	3.6E-04	1.0E-04	1.5E-03	7.8E-04	1.2E-04	1.0E+00	1.1E-04	3.8E+02	1.2E-02
50	3.8E+02	2.0E-01	1.0E-04	1.0E-04	3.6E-04	1.0E-04	1.5E-03	7.8E-04	1.2E-04	1.0E+00	1.1E-04	3.8E+02	1.2E-02
51	7.5E+02	3.0E-01	1.0E-04	1.0E-04	5.5E-04	1.0E-04	1.6E-03	2.6E-03	4.1E-04	1.0E+00	1.2E-04	7.5E+02	2.3E-02

Table 3.4-5: Estimated Non-Radiological Inventory (kg) at Closure

Tank	Ag	As	Ba	Cd	Cr	Cu	F	Fe	Hg
9	3.3E+00	2.0E-02	4.1E+00	2.1E+00	3.9E+00	2.0E+00	4.6E+00	3.7E+02	1.7E+00
10	3.3E+00	2.0E-02	4.1E+00	2.1E+00	3.9E+00	2.0E+00	4.6E+00	3.7E+02	1.7E+00
11	1.3E+00	7.2E-02	1.2E+01	7.6E+00	8.7E+00	3.0E+00	4.5E+00	1.8E+03	1.7E+02
12	1.3E+00	7.2E-02	1.2E+01	7.6E+00	8.7E+00	3.0E+00	4.5E+00	1.8E+03	1.7E+02
13	1.3E+00	7.2E-02	1.2E+01	7.6E+00	8.7E+00	3.0E+00	4.5E+00	1.8E+03	1.7E+02
14	1.3E+00	7.2E-02	1.2E+01	7.6E+00	8.7E+00	3.0E+00	4.5E+00	1.8E+03	1.7E+02
15	1.3E+00	7.2E-02	1.2E+01	7.6E+00	8.7E+00	3.0E+00	4.5E+00	1.8E+03	1.7E+02
16	1.3E-01	5.2E-03	3.9E-01	5.5E-01	4.8E-01	1.4E-01	4.0E-01	3.6E+01	1.2E+01
21	1.3E+00	1.4E-02	2.1E+00	1.5E+00	3.5E+00	4.1E-01	4.4E+00	4.2E+02	3.1E+01
22	1.3E+00	1.4E-02	2.1E+00	1.5E+00	3.5E+00	4.1E-01	4.4E+00	4.2E+02	3.1E+01
23	1.3E+00	1.4E-02	2.1E+00	1.5E+00	3.5E+00	4.1E-01	4.4E+00	4.2E+02	3.1E+01
24	1.3E+00	1.4E-02	1.8E-03	1.5E+00	3.5E+00	4.1E-01	4.4E+00	4.2E+02	3.1E+01
29	1.3E-01	8.3E-03	1.2E+00	8.8E-01	1.6E+00	4.4E-01	1.4E+00	1.8E+02	3.8E+01
30	1.3E-01	8.3E-03	1.2E+00	8.8E-01	1.6E+00	4.4E-01	1.4E+00	1.8E+02	3.8E+01
31	1.3E-01	8.3E-03	1.2E+00	8.8E-01	1.6E+00	4.4E-01	1.4E+00	1.8E+02	3.8E+01
32	1.3E-01	9.4E-03	1.1E+00	9.9E-01	1.6E+00	4.4E-01	1.4E+00	8.3E+01	3.8E+01
35	1.3E-01	8.3E-03	1.2E+00	8.8E-01	1.6E+00	4.4E-01	1.4E+00	1.8E+02	3.8E+01
36	1.3E-01	8.3E-03	1.2E+00	8.8E-01	1.6E+00	4.4E-01	1.4E+00	1.8E+02	3.8E+01
37	1.3E-01	8.3E-03	1.2E+00	8.8E-01	1.6E+00	4.4E-01	1.4E+00	1.8E+02	3.8E+01
38	1.3E-01	9.4E-03	5.3E-01	9.9E-01	5.6E-01	1.8E-01	3.5E-01	6.2E+01	1.1E+01
39	3.6E-01	9.4E-03	5.3E-01	9.9E-01	5.6E-01	2.5E-01	3.7E-01	6.8E+01	1.2E+01
40	3.6E-01	9.4E-03	5.3E-01	9.9E-01	5.6E-01	2.5E-01	3.7E-01	6.8E+01	1.2E+01
41	1.3E-01	9.4E-03	5.3E-01	9.9E-01	5.6E-01	1.8E-01	3.5E-01	6.2E+01	1.1E+01
42	3.6E-01	9.4E-03	5.3E-01	9.9E-01	5.6E-01	2.5E-01	3.7E-01	6.8E+01	1.2E+01
43	3.6E-01	9.4E-03	5.3E-01	9.9E-01	5.6E-01	2.5E-01	3.7E-01	6.8E+01	1.2E+01
48	1.3E-01	9.4E-03	5.3E-01	9.9E-01	5.6E-01	1.8E-01	3.5E-01	6.2E+01	1.1E+01
49	1.3E-01	9.4E-03	5.3E-01	9.9E-01	5.6E-01	1.8E-01	3.5E-01	6.2E+01	1.1E+01
50	1.3E-01	9.4E-03	5.3E-01	9.9E-01	5.6E-01	1.8E-01	3.5E-01	6.2E+01	1.1E+01
51	3.6E-01	9.4E-03	5.3E-01	9.9E-01	5.6E-01	2.5E-01	3.7E-01	6.8E+01	1.2E+01

Table 3.4-5: Estimated Non-Radiological Inventory (kg) at Closure (Continued)

Tank	Mn	Ni	NO_2	NO_3	Pb	Sb	Se	U	Zn
9	3.6E+02	4.0E+01	6.6E+02	2.2E+01	4.8E+00	8.4E-01	1.6E-02	5.5E+00	3.8E+00
10	3.6E+02	4.0E+01	6.6E+02	2.2E+01	4.8E+00	8.4E-01	1.6E-02	5.5E+00	3.8E+00
11	3.0E+02	3.1E+01	1.5E+03	9.8E+01	3.0E+01	3.1E+00	5.8E-02	4.7E+00	2.5E+00
12	3.0E+02	3.1E+01	1.5E+03	9.8E+01	3.0E+01	3.1E+00	5.8E-02	4.7E+00	2.5E+00
13	3.0E+02	3.1E+01	1.5E+03	9.8E+01	3.0E+01	3.1E+00	5.8E-02	4.7E+00	2.5E+00
14	3.0E+02	3.1E+01	1.5E+03	9.8E+01	3.0E+01	3.1E+00	5.8E-02	4.7E+00	2.5E+00
15	3.0E+02	3.1E+01	1.5E+03	9.8E+01	3.0E+01	3.1E+00	5.8E-02	4.7E+00	2.5E+00
16	6.2E+00	2.5E-02	2.6E+00	9.5E+00	3.3E-01	2.2E-01	4.2E-03	5.9E-03	1.2E-01
21	1.4E+02	1.8E+01	3.0E+02	1.9E+01	6.9E+00	6.1E-01	1.2E-02	1.5E+00	1.2E+01
22	1.4E+02	1.8E+01	3.0E+02	1.9E+01	6.9E+00	6.1E-01	1.2E-02	1.5E+00	1.2E+01
23	1.4E+02	1.8E+01	3.0E+02	1.9E+01	6.9E+00	6.1E-01	1.2E-02	1.5E+00	1.2E+01
24	1.4E+02	1.8E+01	3.0E+02	1.9E+01	6.9E+00	6.1E-01	1.2E-02	1.5E+00	1.2E+01
29	2.6E+01	2.5E+00	6.7E+01	3.3E+01	3.0E+00	1.4E+00	2.7E+00	4.7E-01	4.2E-01
30	2.6E+01	2.5E+00	6.7E+01	3.3E+01	3.0E+00	1.4E+00	2.7E+00	4.7E-01	4.2E-01
31	2.6E+01	2.5E+00	6.7E+01	3.3E+01	3.0E+00	1.4E+00	2.7E+00	4.7E-01	4.2E-01
32	1.2E+01	1.9E+00	4.1E+01	3.3E+01	7.7E-01	4.0E-01	7.5E-03	2.9E-01	4.2E-01
35	2.6E+01	2.5E+00	6.7E+01	3.3E+01	3.0E+00	1.4E+00	2.7E+00	4.7E-01	4.2E-01
36	2.6E+01	2.5E+00	6.7E+01	3.3E+01	3.0E+00	1.4E+00	2.7E+00	4.7E-01	4.2E-01
37	2.6E+01	2.5E+00	6.7E+01	3.3E+01	3.0E+00	1.4E+00	2.7E+00	4.7E-01	4.2E-01
38	1.4E+01	1.8E+00	3.7E+01	8.3E+00	7.7E-01	4.0E-01	7.5E-03	2.9E-01	2.5E-01
39	1.4E+01	1.8E+00	5.5E+01	9.2E+00	9.1E-01	4.0E-01	7.5E-03	3.5E-01	3.9E-01
40	1.4E+01	1.8E+00	5.5E+01	9.2E+00	9.1E-01	4.0E-01	7.5E-03	3.5E-01	3.9E-01
41	1.4E+01	1.8E+00	3.7E+01	8.3E+00	7.7E-01	4.0E-01	7.5E-03	2.9E-01	2.5E-01
42	1.4E+01	1.8E+00	5.5E+01	9.2E+00	9.1E-01	4.0E-01	7.5E-03	3.5E-01	3.9E-01
43	1.4E+01	1.8E+00	5.5E+01	9.2E+00	9.1E-01	4.0E-01	7.5E-03	3.5E-01	3.9E-01
48	1.4E+01	1.8E+00	3.7E+01	8.3E+00	7.7E-01	4.0E-01	7.5E-03	2.9E-01	2.5E-01
49	1.4E+01	1.8E+00	3.7E+01	8.3E+00	7.7E-01	4.0E-01	7.5E-03	2.9E-01	2.5E-01
50	1.4E+01	1.8E+00	3.7E+01	8.3E+00	7.7E-01	4.0E-01	7.5E-03	2.9E-01	2.5E-01
51	1.4E+01	1.8E+00	5.5E+01	9.2E+00	9.1E-01	4.0E-01	7.5E-03	3.5E-01	3.9E-01

3.4.5 Ancillary Equipment Inventory Estimates

Ancillary equipment includes transfer lines, transfer line secondary containment, pump tanks, PPs, a catch tank, DBs, valve boxes, and the evaporator systems. Over the operating life of the facility, radioactive waste comes in physical contact with some of these components, leaving behind varying degrees of contamination depending on the service life of the component, the material of construction, and the type of waste that contacts the component. Components that directly contacted waste material have an estimated modeling inventory and are transfer lines, pump tanks, CTS tanks, and evaporator vessels.

The ancillary equipment estimates summarized in this section are explained in further detail in SRR-CWDA-2010-00023. All estimates are at 2032 date of closure.

3.4.5.1 Transfer Line Inventory Estimate

The amount of residual material in the piping systems was determined analytically. [CBU-PIT-2005-00120] The inventory of residue in the transfer lines is the sum of the following:

- Residue by diffusion into metal
- Residue in the oxide film formed on the carbon steel and the stainless steel
- Residue of particles remaining after the transfer lines are flushed

The total radiological inventory in the transfer lines is presented in Table 3.4-6. The total non-radiological (chemical) inventory in the transfer lines is presented in Table 3.4-7.

The majority of the contribution for the transfer line inventory was from the residue after flushing. To illustrate, Table 3.4-8 presents examples of the contribution from the significant inventory contributors.

Table 3.4-6: Estimated Radiological Inventory (Ci) in Transfer Lines at Closure

Radionuclide	Remaining	Radionuclide	Remaining	Radionuclide	Remaining
Ac-227	7.2E-09	Eu-152	1.6E-01	Ra-226	1.5E-08
Al-26	5.1E-04	Eu-154	1.4E+00	Ra-228	6.9E-07
Am-241	2.0E+01	H-3	2.7E-02	Se-79	1.6E-01
Am-242m	1.5E-02	I-129	1.3E-05	Sm-151	2.5E+02
Am-243	8.3E-02	K-40	1.7E-04	Sn-126	1.9E-01
Ba-137m	1.6E+02	Nb-94	6.1E-05	Sr-90	2.5E+03
C-14	2.2E-04	Ni-59	2.7E-01	Tc-99	2.5E+00
Cf-249	3.4E-12	Ni-63	1.6E+01	Th-229	5.9E-05
Cf-251	1.2E-13	Np-237	1.1E-02	Th-230	1.8E-06
Cl-36	1.7E-04	Pa-231	8.8E-08	Th-232	1.9E-04
Cm-243	1.1E-03	Pd-107	1.7E-04	U-232	1.8E-05
Cm-244	7.1E-01	Pt-193	1.3E-04	U-233	2.4E-02
Cm-245	6.8E-04	Pu-238	1.3E+02	U-234	6.7E-03
Cm-247	6.5E-13	Pu-239	2.4E+00	U-235	1.4E-04
Cm-248	6.8E-13	Pu-240	1.4E+00	U-236	9.3E-04
Co-60	3.2E-06	Pu-241	8.5E+00	U-238	1.2E-03
Cs-135	2.7E-03	Pu-242	3.7E-03	Y-90	2.5E+03
Cs-137	1.7E+02	Pu-244	1.7E-05	Zr-93	1.3E-01

Table 3.4-7: Estimated Chemical Inventory (kg) in Transfer Lines at Closure

Chemical	Remaining	Chemical	Remaining
Ag	2.2E-01	Mn	2.6E+01
As	6.8E-03	Ni	3.2E+00
Ba	1.0E+00	NO_2	6.4E+01
Cd	6.7E-01	NO_3	9.9E+00
Cr	8.9E-01	Pb	2.3E+00
Cu	2.9E-01	Sb	3.7E-01
F	4.5E-01	Se	2.0E-01
Fe	1.5E+02	U	3.6E+00
Hg	1.8E+01	Zn	3.6E-01

Table 3.4-8: Distribution of Estimate Contributions

	Diffusion into Metal (Ci/ft^2)	% of Total	Residue in Oxide (Ci/ft^2)	% of Total	Particle Residues (Ci/ft^2)	% of Total
Cs-137	2.3E-21	4.7E-17	3.8E-05	0.77	4.9E-03	99
Np-237	3.4E-27	1.8E-18	1.5E-09	0.77	1.9E-07	99
Pu-238	4.6E-23	1.7E-18	2.1E-05	0.77	2.7E-03	99
Ra-226	5.8E-33	2.3E-18	1.9E-15	0.77	2.5E-13	99
Tc-99	1.6E-22	3.4E-16	3.6E-07	0.77	4.6E-05	99
U-234	2.1E-27	1.9E-18	8.7E-10	0.77	1.1E-07	99
U-238	3.8E-28	1.9E-18	1.6E-10	0.77	2.0E-08	99

3.4.5.2 Pump Tank and CTS Inventory

Pump tanks differ from piping systems with respect to such features as geometry and usage. Only residue left behind after rinsing and flushing was considered for these components. All of these pump tanks are accessible for waste removal and cleaning resulting in a very low residual inventory. The HTF has two CTS tanks. The CTS tanks are comparable in capacity to the pump tanks, thus a similar residual inventory is expected. Therefore, the source term and residual volumes are assumed the same for each pump tank and CTS tank resulting in the same estimated inventory for each. The non-radiological (chemical) inventory is presented in Table 3.4-9. The pump tank radiological inventory is presented in Table 3.4-10.

3.4.5.3 Evaporator System Inventory

Field characterization data for the FTF 242-F Evaporator was used to estimate the residual material in each evaporator in HTF. Further details on the estimated inventories for the evaporator systems are in the HTF closure inventory document. [SRR-CWDA-2010-00023] The inventories are presented in Tables 3.4-11 and 3.4-12.

Table 3.4-9: Estimated Chemical Inventory (kg) in Pump Tanks and CTS Tank at Closure

Chemical	HPT and CTS	Chemical	HPT and CTS
Ag	5.2E-04	Mn	6.1E-02
As	1.6E-05	Ni	7.6E-03
Ba	2.4E-03	NO_2	1.5E-01
Cd	1.6E-03	NO_3	2.3E-02
Cr	2.1E-03	Pb	5.5E-03
Cu	6.8E-04	Sb	8.7E-04
F	1.1E-03	Se	4.8E-04
Fe	3.5E-01	U	8.4E-03
Hg	4.2E-02	Zn	8.5E-04

Table 3.4-10: Estimated Radiological Inventory (Ci) in Pump Tanks and CTS Tank at Closure

Radionuclide	HPT and CTS	Radionuclide	HPT and CTS
Ac-227	1.7E-11	Pa-231	2.1E-10
Al-26	1.2E-06	Pd-107	9.8E-05
Am-241	4.7E-02	Pt-193	1.4E-02
Am-242m	3.6E-05	Pu-238	3.1E-01
Am-243	2.0E-04	Pu-239	5.5E-03
Ba-137m	3.8E-01	Pu-240	3.2E-03
C-14	5.1E-07	Pu-241	2.0E-02
Cf-249	8.1E-15	Pu-242	8.7E-06
Cf-251	2.9E-16	Pu-244	4.0E-08
Cl-36	2.0E-04	Ra-226	3.4E-11
Cm-243	2.6E-06	Ra-228	1.6E-09
Cm-244	1.7E-03	Se-79	3.8E-04
Cm-245	1.6E-06	Sm-151	5.9E-01
Cm-247	1.5E-15	Sn-126	4.4E-04
Cm-248	1.6E-15	Sr-90	5.8E+00
Co-60	7.6E-09	Tc-99	6.4E-03
Cs-135	6.4E-06	Th-229	1.4E-07
Cs-137	4.0E-01	Th-230	4.3E-09
Eu-152	3.7E-04	Th-232	4.4E-07
Eu-154	3.4E-03	U-232	4.2E-08
H-3	1.4E-05	U-233	5.6E-05
I-129	3.2E-08	U-234	1.6E-05
K-40	1.8E-05	U-235	3.3E-07
Nb-94	1.4E-07	U-236	2.2E-06
Ni-59	6.3E-04	U-238	2.8E-06
Ni-63	3.8E-02	Y-90	5.8E+00
Np-237	2.6E-05	Zr-93	3.0E-04

Table 3.4-11: Estimated Radiological Inventory (Ci) in Evaporator Vessels at Closure

Radionuclide	Inventory in Evaporator Vessels	Radionuclide	Inventory in Evaporator Vessels
Am-241	3.9E-03	Pu-242	4.5E-06
Ba-137m	4.7E-01	Se-79	7.7E-09
Co-60	3.0E-05	Sr-90	2.8E-02
Cs-137	5.0E-01	Tc-99	1.3E-03
H-3	3.0E-06	U-233	1.1E-05
Np-237	3.6E-06	U-234	7.1E-06
Pu-238	4.3E-03	U-235	8.1E-08
Pu-239	1.4E-02	U-236	1.4E-07
Pu-240	3.1E-03	U-238	7.5E-06
Pu-241	1.1E-02	Y-90	2.8E-02

Table 3.4-12: Estimated Chemical Inventory (kg) in Evaporator Vessels at Closure

Chemical	Inventory in Evaporator Vessel (kg)
Ag	2.2E-04
As	2.1E-05
Ba	7.4E-04
Cd	3.0E-04
Cr	2.5E-03
Cu	8.3E-04
Fe	2.2E-01
Hg	1.0E-03
Mn	8.7E-03
Ni	3.0E-03
Pb	1.6E-03
Sb	8.2E-04
Se	2.1E-05
U	2.2E-02
V	5.0E-05
Zn	2.8E-03

3.4.5.4 Other Ancillary Equipment

The PPs are stainless steel lined reinforced concrete structures located below grade at the low points of transfer lines. These structures are secondary containments that house the pump tanks and are accessible for cleaning at the time of closure. No inventory was assigned to these structures.

There is a single catch tank in HTF designed to collect drainage from HDB-1 and the Type I tank transfer line encasements. No significant contamination has been collected in this catch tank. Therefore, no inventory was assigned to this catch tank.

The DBs are shielded reinforced concrete structures containing transfer line nozzles to which jumpers are connected in order to direct waste transfers to the desired location. The majority of DBs are located below ground and are either stainless steel lined or sealed with water proofing compounds to prevent ground contamination. These structures are accessible for cleaning at the time of closure. No inventory was assigned to these structures.

Transfer valve boxes facilitate specific waste transfers that are conducted frequently. The valves are generally manual ball valves in removable jumpers with flush water connections on the transfer lines. The valve boxes provide secondary containment. These structures are accessible for cleaning at the time of closure. No inventory was assigned to these structures.

Various ancillary equipment serves as transfer line secondary containment (e.g., transfer line jackets, LDB, encasements). No leakage of waste from primary core pipe into secondary containment has been identified. The core transfer line inner surface area is 99% stainless steel and is not expected to corrode significantly prior to end of operations. Therefore, no inventory will be assigned to the jackets.

It is expected that ARP/MCU facilities will be completely cleaned so that no inventory remains or any contaminated components will be removed prior to the placement of the closure cap. No inventory has been assigned to these facilities.