Enclosure 1

Changes to PSAR Chapters 2 and 3

(Non-Proprietary)

pipelines located within 5 miles (8 km) of the site. These pipelines are evaluated further as hazards in Section 2.2.3 (Reference 2, Reference 3).

2.2.1.2 Description of Waterways

The Clinch River flows southwest from Tazewell, Virginia, through the Great Appalachian Valley to Kingston, Tennessee just west of Knoxville, where it joins the Tennessee River/Watts Bar Reservoir. Significant waterborne transport in the site vicinity is only possible on the Clinch River arm of the Watts Bar Reservoir. Annual waterborne commerce data compiled by the U.S. Army Corps of Engineers (USACE) Waterborne Commerce Statistics Center, for the period of 2001 to 2015, indicates that there were very few shipping cargos on the Clinch River, with no transport of hazardous materials (e.g., chemicals and related products, petroleum, ordnance) that could pose a threat to operations at the site (Reference 4, Reference 5). These shipment cargos were classified as machinery (not electric), fabricated metal products, limestone, and wood in the rough. Therefore, waterborne shipping is not evaluated further with respect to accidents and impacts on waterways, and does not warrant further consideration in determining bounding accident scenarios involving transport of hazardous materials near the site. White Oak Dam is located approximately 5 miles north at the terminus of White Oak Creek into the Clinch River. There are no materials stored at the facility, and therefore the dam has been removed from further evaluation.

2.2.1.3 Description of Highways

The most significant highway near the site is I-40, which runs roughly east-west on the opposite side of the Clinch River arm of the Watts Bar Reservoir. At its closest point, I-40 is approximately 4.9 miles (7.9 km) from the site. According to the Tennessee Department of Transportation, the annual average daily vehicle count just east of the I-40 and TN 58 interchange (approximately 4.5 miles south of the site) was 44,470 vehicles in 2018 (Reference 6).

Other larger roads near the site include TN 58, TN 61, TN 95, and TN 327, the closest of which is TN 327, located approximately 1 mile (0.6 km) east of the site. The intersection of TN 327 and TN 58 lies approximately 2 miles (1.2 km) east of the site. According to the Tennessee Department of Transportation, the annual average daily vehicle count at TN 327 west of the intersection with TN 58 was 2,485 in 2018 (Reference 7), and the annual average daily vehicle count at TN 58 north of the intersection with TN 327~~58~~ was 12,641 in 2018 (Reference 8).

I-40 and TN 58 were identified as those roads within 5 miles (8 km) of the site on which chemicals may be transported. These are considered further in Section 2.2.3.

2.2.1.4 Description of Railroads

The nearest major rail line to the site is operated by Norfolk Southern and runs roughly northeast from Harriman, Tennessee, parallel to TN 61 toward Clinton, Tennessee. At closest approach, this line is approximately 3.3 miles (5.3 km) north-northwest of the site (Figure 2.1-2). A second major rail line operated by Norfolk Southern lies south of the site and runs roughly northeast through Loudon, Tennessee, to Knoxville. At closest approach, this line is approximately 12 miles (19.3 km) from the site. Due to the large distances from these lines to the site and the complex intervening terrain (wooded ridges and valley), accident scenarios on these lines are not evaluated further (Reference 9).

The nearest minor rail line is owned and operated by the Energy*Solutions*, LLC, doing business as Heritage Railroad Corporation for industrial uses. The railroad runs from the Heritage Center Industrial Park to the Blair Interchange on the Norfolk Southern main line north of the site, a distance of approximately 11.5 miles (18.5 km). Within the ETTP, the main line serves the intermodal transfer area operated by Energy*Solutions* and a rail car repair area operated by East Tennessee Rail Car Company.

feeder highway to I-40. Typical hazardous materials transported on I-40 and TN-58 are provided in Table 2.2-4 (Reference 9).

The effects of an explosion along I-40 or TN-58 were evaluated in the Clinch River Nuclear Site ESPA, Part 2, SSAR (Reference 9). ~~The analysis concludes that the safe distance is 3,708 feet (1,130 meters). This is less than the minimum distance from I-40 or TN-58 to the Hermes site.~~ Table 2.2-10 provides the results of the explosion hazard evaluation for materials transported near the Clinch River Nuclear Site as well as explosive chemicals stored at ORNL as provided in the Clinch River Nuclear Site ESPA, Part 2, SSAR (Reference 9) with distances measured to the Hermes site. The table demonstrates that the most limiting explosion, a 11,500-gallon butane tanker, has a minimum safe distance of 3,708 feet from I-40 or TN-58. The shortest distance from the Hermes site to either I-40 or TN-58 is 6,336 feet to TN-58.

There are two railways in proximity to the site. The first railway is run by Norfolk Southern, and transports significant traffic along two main lines located in the vicinity of the Hermes site. The first line is located approximately 3.3 miles (5.3 km) to the west, running from Harriman, Tennessee to Clinton, Tennessee. The second line runs from Loudon, Tennessee, to Knoxville, and is 12 miles (19.3 km) south of the site. Due to the large distances from these lines to the site and the complex intervening terrain (wooded ridges and valley), accident scenarios on these lines are not evaluated further (Reference 9). The other railway is operated by Energy*Solutions*, and is located on the adjacent property. This railway only transports, solid low-level radioactive waste, which by its nature is not explosive.

Nearby Facilities

Three facilities near the site were evaluated in the Clinch River Nuclear Site ESPA, Part 2, SSAR (Reference 9). They were the ORNL-Battelle, located approximately 5 miles (8 km) east of the Hermes reactor site; Tennessee Valley Authority (TVA) Kingston Fossil Plant, located approximately 7 miles (11.2 km) southwest of the Hermes reactor site; and the TVA Bull Run Fossil Plant, located approximately 15 miles (24.1 km) east of the Hermes reactor site. The Clinch River Nuclear Site ESPA, Part 2, SSAR used a conservative TNT equivalency method to determine safe distances for the identified potentially explosive materials. All damaging overpressure safe distances were less than the minimum distance from the storage areas to the Clinch River Nuclear Site. With the exception of the TVA Kingston Fossil Plant, the Hermes site is farther away from the nearby facilities evaluated than the Clinch River Nuclear Site, and all distances between the nearby facilities and the Hermes site are greater than the minimum safe distances reported in the Clinch River Nuclear Site ESPA, Part 2, SSAR.

Based on the proposed Oak Ridge General Aviation Airport EA, a fuel farm is proposed to be constructed operating two 10,000-gallon aboveground tanks for aviation fuels (Reference 11). These tanks would be of double-walled construction (or would employ some other means of secondary containment) and would be equipped with appropriate overfill and spill protection devices. Additionally, spill response equipment, such as absorbent booms and pads, would be made readily available. These tanks may also be required to contain vapor control devices depending on the actual monthly throughput of aviation fuels.

An evaluation of the explosive hazard from a jet fuel tank is provided in the SHINE Medical Technologies PSAR (Reference 18). The SHINE Medical Technologies PSAR evaluated tank of jet fuel containing 500,000 pounds or approximately 75,000 gallons. The tank was modeled using TNT equivalency methodologies to determine minimum separation distance. The model determined that the minimum separation distance from a tank containing 500,000 pounds of jet fuel was 0.22 miles. Combined, the two 10,000-gallon fuel tanks suggested in the Oak Ridge Airport EA (Reference 11) at the proposed Oak Ridge Airport would contain less fuel than the single tank modeled in the SHINE Medical Technologies PSAR, indicating that the minimum separation distance of 0.22 miles would be acceptable for the Oak

Ridge Airport as well. Because the distance from the site to the Oak Ridge Airport would be greater than 0.22 miles, fuel stored at the airport would not present an explosive hazard with a potential of impacting the site.

Although unlikely, a boiling liquid expanding vapor explosion (BLEVE) could occur to one or both of the 10,000-gallon fuel tanks at the proposed Oak Ridge airport as a result of a high-temperature fire. Therefore, BLEVE analysis was conducted for a single 10,000-gallon tank of jet fuel (Jet A) and a single 10,000-gallon tank of aviation gasoline (AvGas) using the methods provided in Regulatory Guide 1.91. These analyses, which were conducted individually for each fuel type, indicated that the impact of the BLEVE would extend 0.40 miles for the jet fuel and 0.38 miles for the aviation fuel. Therefore, a BLEVE accident would not have an impact on the Hermes site approximately 1.1 miles from the proposed airport runway (the location of fuel tanks is not shown on proposed airport figures reviewed). It should be noted that the explosion impact distance is not linear and incorporating BLEVEs from both tanks at the same time would result in a safe distance range increase by approximately 1.23 times (or 0.49 miles for 20,000 gallons of jet fuel).

The locations and quantities of chemical that would be stored onsite at the Clinch River Nuclear Site were not evaluated in the ESPA, Part 2, SSAR (Reference 9). The ESPA, Part 2, SSAR noted that the effects on explosion events from onsite chemical storage would be evaluated in the combined license application for a future reactor project (Reference 9). Chemicals stored at the future reactor site would be maintained and stored in a manner that would be protective of on-site personnel and the on-site reactor(s). Furthermore, due to the distance from the Clinch River Nuclear Site to the Hermes site, a chemical explosion at the Clinch River Nuclear Site would not adversely affect the safe operation of Hermes.

Onsite Chemicals

The location and quantities of chemicals stored at the site have not yet been determined. The effects of explosions from onsite chemical storage will be evaluated in the application for an Operating License.

2.2.3.2 Flammable Vapor Clouds

Flammable materials in the liquid or gaseous state is hypothetically postulated to form an unconfined vapor cloud that could drift toward the plant before ignition occurs. When a flammable chemical is released into the atmosphere and forms a vapor cloud, it disperses as it travels downwind. The parts of the cloud where the concentration is within the flammable range, between the lower and upper flammability limits, could burn if the cloud encounters an ignition source. The speed at which the flame front moves through the cloud determines whether it is a deflagration or a detonation. If the cloud burns fast enough to create a detonation, an explosive force may be generated.

Offsite chemicals evaluated in the Clinch River Nuclear Site ESPA, Part 2, SSAR are shown in Tables 2.2-3 and 2.2-4. No additional significant offsite sources of chemicals were identified. Therefore, due to the proximity of the Clinch River Nuclear Site to the site, the analysis presented in the Clinch River Nuclear Site ESPA, Part 2, SSAR is considered to be directly applicable to the analysis of the site. The chemicals listed in Table 2.2-3 were evaluated in the Clinch River Nuclear Site ESPA, Part 2, SSAR to ascertain which hazardous materials have the potential to form a flammable vapor cloud or vapor cloud explosion. For those chemicals with an identified flammability range, the Areal Locations of Hazardous Atmospheres (ALOHA), an air dispersion model, was used to determine the distances where the vapor cloud may exist between the UEL and the LEL, presenting the possibility of ignition and potential thermal radiation effects.

Table 2.2-8: Near-Airport and Helicopter Crash Frequency Inputs and Calculations

	N, Number of Operations Per Year[a]	x distance mi[b]	y distance mi[b]	f(x,y) value[c]	P, Crash Rate[d]	A, mi^2	Impact Frequency[e]
General Aviation Takeoff	2.41E+04	+0.7	-1.2	1.30E-02	1.10E-05	4.19E-03	1.44E-05
General Aviation Landing	2.41E+04	-0.7	+1.2	1.20E-02	2.00E-05	4.19E-03	2.42E-05

	N, Number of Operations Per Year[a]	P, Crash Rate[d]	A, mi^2	L_H[f]	Helicopter Impact Frequency[g]
Helicopter	1,491	2.50E-5	6.75E-04	37	1.36E-06

[a] Obtained from Table 2.5 in Oak Ridge EA, (Reference 11). Annual helicopter operations (1,491) were subtracted from total annual aircraft operations (49,713) total operations and the remainder was assumed 50% takeoff and 50% landing operations.
[b] Orthonormal distance from the site to the center of each runway at the flight source. Distance values were estimated based on the best current available information. Takeoff is assumed to be to the southwest and landing is assumed to be to the northeast.
[c] Reference 14, Tables B2-B5. Flight direction is currently unknown; therefore, the largest value of f(±x,±y) was selected for conservatism.
[d] Reference 14, Tables B-1 ~~Reference 14~~. Assumed representative fixed wing for General Aviation operations.
[e] Calculated from Equation 5-1 (Reference 14).
[f] Reference 14, Table B-43 ~~(Reference 14)~~.
[g] Calculated from Equation 5-3 (Reference 14).

Table 2.2-10: Evaluation of Chemical Explosion Hazards Near the Hermes Site

Source	Chemical Evaluated[a]	Quantity Analyzed[a]	Heat of Combustion (Btu/lb)[a]	Distance to Hermes Site (ft)	Safe Distance for Explosion to have less than 1 psi of Peak Incident Pressure (ft)[a]
Nearby Offsite Facilities					
ORNL-Battelle	Anhydrous Ammonia	999 lb	7,992	26,400	47.8
	Ethanol (85%)	4,249 lb	11,570		103.3
	Gasoline Blend A (as n-Heptane)	750lb	18,720		63.4
	Gasoline B (as n-Heptane)	999 lb	18,720		75.4
I-40	Butane	11,500 gal	19,152	25,872	3,708
	Gasoline	8,500 gal	18,720		273
	Hydrogen	15,032 ft^3/tube[b]	50,080		520[d]
TN-58[a]	Butane	11,500 gal	19,152	6,336	3,708
	Gasoline	8,500 gal	18,720		273
	Hydrogen	15,032 ft^3/tube[c]	50,080		520[d]

[a] From the Clinch River Nuclear Site ESPA SSAR (Reference 9)

[b] Assumes that any chemicals and quantities transported on I-40 would be the same chemicals and quantities that could be transported on TN-58 because TN-58 feeds into I-40.

(b) Transport quantity for a super jumbo tube (Reference 32).

(c) Minimum safe distance per super jumbo tube determined from Clinch River Nuclear Site ESPA, Part 2, SSAR (Reference 9). An independent evaluation was performed per Regulatory Guide 1.91 using conservative assumptions from a single explosion involving nine super jumbo tubes (I.e., typical trailer capacity). For nine tanks, the minimum standoff distance would correspond to 1,200 ft, well below the distance to the Hermes Site.

2.3.2.7 Fog

Fog data for Knoxville and Oak Ridge are presented in Table 2.3-22. These data indicate that heavy fog (visibility ≤ 1/4 mile) occurs about 30 days per year at Knoxville and 52 days per year at Oak Ridge, with the autumn normally the foggiest season. The site has conditions more similar to Oak Ridge due to proximity.

2.3.2.8 Atmospheric Stability

The frequency of occurrence of Pasquill (classes A-G) atmospheric stability classes based on vertical temperature difference for local ORR meteorological Tower L over a 2-year period (2018-2019) is presented in Table 2.3-23. While the atmosphere at the site for the 2 years analyzed appears to be almost equally stable, neutral, and unstable, the stable lapse conditions (classes E, F, and G - i.e., inversions) occur the majority of the time (42 percent). However, the majority of the stable lapse conditions are only slightly stable (class E), occurring 27 percent of the time. The most stable class (class G) occurs approximately 5.5 percent of the time. Neutral lapse conditions (class D) occur approximately 27 percent of the time. Unstable classes (A, B, and C) occur approximately 31 percent of the time.Inversion Persistence

Table 2.3-24 presents a summary of onsite inversion persistence data, with a breakdown by stability class, at Tower L for 2018-2019. Inversion persistence is defined as two or more consecutive hours of a single stable class (or combination of stable classes). The longest contiguous period of inversion conditions lasted 215 hours.

2.3.2.9 Mixing Heights

Holzworth (Reference 41) provides estimated monthly mean maximum heights for Nashville, Tennessee (the NWS upper air site closest to the site). Seasonal and annual estimates of rural mixing heights for the site are as follows:

- Winter (December, January, February) – 563 meters (morning), 1,123 meters (afternoon)
- Spring (March, April, May) – 606 meters (morning), 1,783 meters (afternoon)
- Summer (June, July, August) – 441 meters (morning), 1,874 meters (afternoon)
- Autumn (September, October, November) – 357 meters (morning), 1,473 meters (afternoon)
- Annual – 492 meters (morning), 1,563 meters (afternoon)

2.3.2.10 Potential Influence of the Plant and Its Facilities on Local Meteorology

Hermes plant systems have a limited potential to noticeably affect local meteorology. The Hermes reactor utilizes air-cooling as the primary heat sink, which limits emission of water droplets or water vapor or aerosol. The decay heat removal system utilizes low-pressure evaporative cooling~~, which removes less than 0.03 percent of the total reactor power through saturated steam, so w~~ (see Section 6.3). While there would be some steam plumes due to heat rejection exhaust, these would be hot exhaust streams that would rapidly evaporate when mixed with ambient air. There would be some minor air quality and visibility impacts on local air quality during construction, although the impacts would be very localized due to near-ground-level releases of non-radioactive particulate related to construction activities.

2.3.2.11 Local Meteorological Conditions for Design and Operating Bases

The meteorological conditions for the design and operational bases are provided in Subsection 2.3.1.

2.3.3 Meteorological Monitoring Program

The Hermes facility uses existing meteorological monitoring and measurements taken within the ORR.

2.4.1 Hydrological Description

The Hermes site is located on the ETTP just west of Poplar Creek, approximately 3 miles upstream of the confluence of Poplar Creek and the Clinch River. Because of the site's location with respect to this confluence, both Poplar Creek and the Clinch River arm of the Watts Bar Reservoir are considered potential flooding sources.

The Hermes reactor location is on the eastern edge of the approximately 40-acre former K-33 building footprint. The approximate grade elevation at the Hermes location is 765 feet above mean sea level (feet msl) in North American Vertical Datum of 1988 (NAVD 88). Flooding elevations from historical reports as well as TVA dam elevations are typically reported in feet msl of the National Geodetic Vertical Datum (NGVD 29). The difference in these two datums at the Hermes site is on the order of several inches. Therefore, comparisons of reported elevations in the NGVD 29 datum to the site grade in the NAVD 88 datum are qualified by the small difference in the datums and do not alter interpretations or conclusions made throughout Section 2.4. ~~for the purposes of comparing previous study flood elevations.~~ The plant grade of 765 feet msl is about 21 feet above a Poplar Creek normal water surface elevation of 744 feet msl and about 24 feet above the Clinch River arm of the Watts Bar Reservoir normal water surface elevation of 741 feet msl. A site location map is provided in Figure 2.4-1.

This section describes the hydrological processes governing the movement and distribution of water in the existing environment at and around the proposed site. Descriptions are limited to only those parts of the hydrosphere that may affect or be affected by building and operation of the non-power reactor at the site and relies on the data and analyses performed for the CRN site (Reference 8).

The Tennessee River (Watts Bar Reservoir) is the principal waterway flowing through the county. Its shoreline is dotted with summer homes and resorts but void of industry. Watts Bar Reservoir, controlled by Watts Bar Dam, is an integral part of the TVA flood control and navigation system. The Tennessee River watershed contains a total of 17,000 square miles as it flows out of Roane County (Reference 5).

The downstream four miles of the Clinch River arm of the Watts Bar Reservoir, the second largest waterway in Roane County, is in backwater from Watts Bar Lake. The Clinch River originates in southwest Virginia and passes through TVA's Norris and Melton Hill Dams before entering Roane County. The Clinch River watershed in Roane County is mainly wooded except for the ETTP and TVA Kingston Steam Plant (Reference 5).

A total of 4,413 square miles of drainage area comprises the Clinch River watershed at its mouth near Kingston, Tennessee. The Emory River, a tributary to the Clinch River, originates on the Cumberland Plateau region northwest of Roane County and flows through rugged undeveloped land before entering Roane County near the City of Harriman. Approximately 780 square miles of drainage area feeds the Emory River at Harriman. The Little Emory River joins the Emory River north of Kingston and flows through mostly forested watershed that contains a total of 42 square miles.

Whites Creek, a tributary of the Tennessee River, is contained in a natural gorge above mile 6. There is a total of 120 square miles of drainage area, 0.3 miles below Black Creek. Black Creek flows through the City of Rockwood before entering the unincorporated areas of Roane County. It flows through pastureland as it parallels U.S. Highway 72. The Black Creek's watershed contains approximately 12 square miles of drainage area at its mouth (Reference 5).

Caney Creek and Pawpaw Creek, tributaries to the Clinch River, flow through undeveloped land before entering the Clinch River and have a total of 3 and 9 square miles of drainage area, respectively. Indian Creek heads along the southern slope of the Cumberland Plateau divide around elevation 790 feet msl NGVD at the northern edge of the Town of Oliver Springs. Indian Creek flows through a restrictive gap just upstream of Mineral Springs Branch (Reference 5). The watershed above the gap is heavily strip mined so flood flows on Indian Creek are heavily laden with silt, which in general contributes to increased flood damage and significant stream channel sedimentation (Reference 5).

Poplar Creek heads out of Walden Ridge northeast of the Town of Oliver Springs and flows south parallel to Tennessee Highway 118 before entering the Town of Oliver Springs. The total drainage area of Poplar Creek at the upstream limits of the study, is 26.6 square miles (Reference 5). On the Oliver Springs side of Poplar Creek, the floodplain is mainly agricultural, with housing well above the 100-year flood, and commercial development inside the floodway at Tennessee Highway 61 and Highway 62 bridges (Reference 5).

East Fork Poplar Creek has its origin on Chestnut Ridge, south of the residential area of Oak Ridge. The creek flows generally northwesterly into Oak Ridge and parallels Tennessee Highway 62 in this reach. Near the intersection of Tennessee Highways 95 and 62, at an elevation of approximately 850 feet msl NGVD, it is joined by a tributary that drains the western portion of the populated section of Oak Ridge. From here, the main stream flows approximately 12.5 miles southwest to enter Poplar Creek approximately 5.5 miles above its mouth in Watts Bar Reservoir backwater (Reference 5).

Historical records of flooding for Poplar Creek and East Fork Poplar Creek have been documented in the FIS (Reference 5):

Poplar Creek – Since 1902, the June 29, 1928 flood is the highest known flood of record. The estimated discharge was 17,000 cubic feet per second (cfs) at mile 13.8 with a recurrence interval of 40 years (Reference 5). On September 29, 1944, a severe flood on Poplar Creek caused extensive damage to crops in the flood plain. The estimated discharge was 13,000 cfs with a recurrence interval of 25 years at the Highway 61 Bridge. During July 5-7, 1967, a total of 9.5 to 11 inches of rain fell on Oliver Springs. Field crops and gardens were heavily damaged and roads were badly washed. At the USGS gaging station at Highway 61 and 62 the flood crest on July 6, 1967 was 3.8 feet below the June 1928 flood. The flood crest on July 12, 1967 was 2.2 feet lower than the July 6, 1967 crest, and the July 29, 1967 crest was 4.4 feet below the July 6, 1967 crest. On November 26-28, 1973, a total of 8.7 inches of rain fell on the Oak Ridge gage, producing the highest gage reading of record (27.1 feet or elevation 770.6 feet msl NGVD) at the USGS stream gage at mile 13.94. At Highway 61 and 62 this flood was about 1.8 feet below the June 1928 and 2 feet higher than the July 1973 floods (Reference 5).

East Fork Poplar Creek – Major floods occurred on June 29, 1928, September 29, 1944, November 28, 1973, and April 4, 1977. Elevations, discharges, and recurrence intervals for the 1928 and 1944 floods are not cited because they cannot be compared directly to flooding under current conditions, due to channel changes and watershed urbanization. The November 28, 1973, and April 4, 1977, floods were about equal in magnitude. These floods reached an elevation of 770.2 feet msl NGVD with a recurrence interval of approximately 30 years at 3.3 miles upstream of the confluence with Poplar Creek. Only minor damage occurred as a result of these floods (Reference 5). Based on modeling results for East Fork Poplar Creek and Poplar Creek in Reference 6 for the 100-year return period, a flooding elevation of 771.2 feet msl at East Fork Poplar Creek mile 3.32US projected downstream to Poplar Creek mile 3.17US east of the Hermes site would be approximately 749.6 feet msl, which is more than 15 feet below site grade. Therefore, flooding levels similar to the 1970s floods on East Fork Poplar Creek would have no impact at the Hermes site.

A schematic of the Clinch River and Poplar Creek watersheds is shown in Figure 2.4-2.

2.4.1.1 Surface Water

The Clinch River originates in western Virginia and flows generally to the southwest, joining the Tennessee River near Kingston, Tennessee. Along with its tributaries, the Clinch River drains an area of about 4,416 square miles (mi^2) in the Upper Tennessee River basin. The drainage pattern in the Clinch River watershed is characterized by both long straight river reaches and frequent sharp bends, which are a consequence of the long parallel ridges and valleys of the Valley and Ridge Physiographic Province through which the Clinch River and its tributary streams flow. The Hermes site is bordered on the south, north and east by Poplar Creek, which immediately connects to the Clinch River arm of the Watts Bar Reservoir at the south, at about Clinch River Mile (CRM) 14.5, which is about 14.5 river miles upstream from the confluence with the Tennessee River (Figure 2.4-3). The drainage area of the Clinch River watershed above the location of the Hermes site is 3,370 square miles, about 76% of the total watershed area. Two dams, owned and operated by TVA, are located on the Clinch River upstream of the Hermes site: the Melton Hill Dam is located at about CRM 23 and Norris Dam is located just downstream from the confluence with the Powell River at about CRM 80 (Figure 2.4-4). Releases from each of these dams influence Clinch River flows at the Hermes Site. Norris Dam is operated for flood control and hydroelectric power generation of 110 megawatts electric (MWe). The reservoir provides 1,113,000 ac-ft of flood storage and has a water-surface elevation that varies 29 ft from summer to winter during a year with normal rainfall. Melton Hill Dam does not provide significant flood storage, but it does provide 79 MWe of hydroelectric power generation, and it includes a navigation lock that allows barge traffic 38 miles upstream to Clinton, Tennessee. Both reservoirs provide significant shoreline and in-water recreational opportunities (Reference 3).

Two dams located on the Tennessee River influence flows in the Clinch River at the Hermes Site: Watts Bar Dam and Fort Loudoun Dam, both owned and operated by TVA (Figure 2.4-4). Watts Bar Dam is located at Tennessee River mile 530, about 38 miles downstream from the Clinch River confluence and about 52 river miles downstream from the Hermes Site. The reach of the Clinch River downstream from Melton Hill Dam, which includes the river adjacent to the Hermes Site, is part of the Watts Bar Reservoir and is referred to as the Clinch River arm of the Watts Bar Reservoir. Fort Loudoun Dam is located at Tennessee River mile 602.3, about 35 miles upstream from the Clinch River confluence, and releases water into the Watts Bar Reservoir. Watts Bar and Fort Loudoun Dams are operated for hydroelectric power generation, flood control, and navigation. Both reservoirs provide significant shoreline and in-water recreational opportunities. Some characteristics of the reservoirs that influence flows at the Hermes site are listed in Table 2.4-1. Because the Clinch and Tennessee Rivers near the Hermes site are regulated by releases from reservoirs operated by TVA, relevant information about the flows adjacent to the Site were obtained from TVA. Releases from reservoirs are determined by rainfall, runoff, and management objectives (e.g., flood control). Reservoirs are drawn down in the winter to provide flood storage, and minimum elevations are established to maintain a navigation channel. Reservoir elevations are maintained at higher levels during the summer and fall (generally May through October) (Reference 3).

2.4.1.2 Groundwater, and Groundwater Extraction/Injection

The facility design does not include groundwater withdrawal or injection. No planned future injection or withdrawal of groundwater is expected to have an impact on facility operation or safety. ~~As discussed in Section 2.5, subsurface investigations encountered groundwater at depths from 6.0 to 8.0 feet below the ground surface (El. 765 NAVD 88).~~

2.4.2 Floods

The following paragraphs provide brief descriptions of the previous flood studies and estimated flooding elevations in the vicinity of the ETTP Hermes site.

FEMA Flood Insurance Study for Roane County, Tennessee (Reference 5)

Four Clinch River return period flood profiles were provided in this FIS: 10-year (10% probability of occurring in a given year), 50-year (2% probability of occurring in a given year), 100-year (1% chance of occurring in a given year) and 500-year (0.2% chance of occurring in a given year). Approximate flooding elevations at the confluence of the Clinch River and Poplar Creek and resulting flooding depths at the Hermes site are provided in Table 2.4-2.

Flood Hazard Evaluation for UCOR dated April 2015 (Reference 2)

This study was performed for the purpose of evaluating flooding risk at Department of Energy (DOE) critical facilities including ETTP. The previous NPH was performed by TVA in 1991. The Flood Hazard Evaluation addressed both Poplar Creek and the Clinch River. Flooding events evaluated in this analysis ranged from the 4% (25-year return interval) to a Probable Maximum Flood (PMF) (Reference 2).

The Clinch River flooding event results reported in the 2015 study were taken from different models. TVA developed a Clinch River hydraulic model in 2003 using U.S. Army Corps of Engineers (USACE) Hydrologic Engineering Centers River Analysis System (HEC-RAS) software. The 4% to 0.001% flooding elevations reported in the 2015 study were taken from that model and shown in Table 2.4-3.

For the UCOR 2015 evaluation of Poplar Creek, watershed precipitation and hydraulics were evaluated. A hydraulic model of Poplar Creek developed by TVA in 1991 was converted to HEC-RAS. The model geometry was not revised as it was not part of the scope of work for the 2015 update. The period of record precipitation datasets in the watershed were also reviewed to evaluate changes since 1991.

Based on the 2015 study (Reference 2), flooding elevations at the Hermes site are controlled by Poplar Creek for the 4% to 0.01% flood events and by the Clinch River for the 0.005% to the PMF. Estimated flooding elevations and depths at the Hermes site based on the UCOR study are provided in Table 2.4-3. A ~~site specific~~ PMF study will be discussed with the application for an Operating License.

2.4.2.1 Rainfall Frequency Curve Development

Rainfall frequency curves ~~for the Hermes site~~ were developed for local area rainfall, using estimates of the 5-, 10-, 25-, 50-, and 100-year rainfall and the TVA maximum probable precipitation (TVA Storm) and probable maximum precipitation (PMP). Order-of-magnitude estimates of the probability of the TVA Storm and PMP were made based on extrapolating flood data, watershed rainfall, and extraordinary storm occurrences (Reference 6).

Rainfall-frequency estimates for durations from 5 to 60 minutes, and return periods up to 1000 years, were obtained from National Oceanic and Atmospheric Administration's (NOAA) Atlas 14, Volume 2 Version 3 (Reference 6). TVA Storm and PMP estimates were obtained from Hydrometeorologic Report No. 56 (Reference 6).

To establish the exceedance probability of the TVA Storm, earlier estimates of flood-frequency curves at 36 long-record stream gaging stations, extrapolated to computed TVA maximum probable flood (TVA Flood) estimates, were reviewed. The 36 watersheds were within the Tennessee Valley watershed and ranged from 31.9 square miles to 21,400 square miles. The TVA Flood exceedance probabilities ranged from 1×10^{-3} to 10^{-9} with a median and mode of 1×10^{-5}. The exceedance probability of the TVA Storm was assumed equal to that of the TVA Flood.

Earlier estimates of the exceedance probability of the PMF were reviewed; in particular, estimates based upon two rainfall frequency analyses, which considered (a) rainfall on watersheds within the Tennessee Valley and (b) storms occurring east of the 105th meridian.

The exceedance probability of the PMF can be assumed equal to the exceedance probability of the PMP. This is because the PMP is defined as an event approaching the physical upper limit of precipitation.

To determine the chance of a PMP storm striking a selected area, observed 6- and 24-hour rainfalls for storms covering 10 square miles and for 72-hour rainfalls covering 5,000 square miles east of the 105th meridian greater than or equal to 50 percent of the PMP (Reference 6) were evaluated. Although no PMP storms have occurred, data are available from storms that were from 50 to 90 percent of the PMP storm and struck storm areas of 10 and 5,000 square miles. Extrapolation of these data to the PMP indicate that exceedance probabilities range from 2.4×10^{-7} to 5.6×10^{-8}. Based on this information, an exceedance probability of 1×10^{-8} was assumed for the PMP (Reference 6).

Determination of confidence intervals for the rainfall-frequency curves requires knowledge of the population distribution. The population distribution was assumed to be the Fisher-Tippett Type I distribution with application as described by Gumbel, herein referred to as the Gumbel distribution. This is consistent with NOAA procedures which use the Gumbel frequency distribution. A least-squares regression analysis was used to fit the Gumbel distribution to the sample points for the 5-minute and 1-hour rainfall. A Smirnov-Kolmogorov (S-K) goodness-of-fit test accepted the hypothesis that the sample points were from the Gumbel distribution. However, the S-K goodness-of-fit test is not robust at small exceedance probabilities. Therefore, to be conservative, the upper bound of the 99 percent confidence interval (10^{-6}) was adopted as the exceedance probability of the PMP. ~~This is consistent with the American Nuclear Society's ANSI/ANS 2.8, 1981 guidelines (Reference 1), which state that "an average annual exceedance probability less than 10^{-6} is an acceptable goal for selection of flood design bases for power reactor plants" and accepts precipitation floods resulting from PMP as adequate design flood bases.~~ Extrapolation of the rainfall frequency curves to the PMP with a probability of 1×10^{-6} results in an exceedance probability of 5×10^{-5} for the TVA Storm (Reference 6).

2.4.2.2 Dam Failures Floods

In the 1991 TVA study listed in Section 2.4 (Reference 6), Norris and Melton Hill Dams (separately) were postulated to fail seismically, concurrent with the one-half PMF, and in non-flood conditions. Dam failures were treated as hypotheticals and TVA neither implied or conceded that its dams are inadequate to withstand great floods and/or earthquakes that may be reasonably expected to occur in the region under consideration.

TVA has a program of inspection and maintenance carried out on a regular schedule to keep its dams safe. Instrumentation of the dams to help keep check on their behavior was installed in many of the dams during original construction. Other instrumentation has been added since and is still being added as the need may appear or as new techniques become available.

In short, TVA has confidence that its dams are safe against catastrophic destruction by any natural forces that could be expected to occur.

Failure of Norris and Melton Hill Dams during one-half the PMF was assumed to occur at peak reservoir levels; at Norris, this elevation was 1036.9 and at Melton Hill, 799.3. Reservoir levels for the non-flood failure were assumed at normal maximum pool elevation 1020 for Norris and 795 for Melton Hill. Failure of Norris Dam in both events would overtop and fail the Melton Hill Dam. Unsteady flow techniques were used to route the floods resulting from the dam failures.

The stability of Norris Dam was reanalyzed for various scenarios in 2014 (Reference 2). The analysis concluded that the concrete sections and the earthen embankment were stable under seismic conditions analysis (Reference 2). Therefore, the postulated failure analysis is different than the 1991 study. The controlling seismic event producing the highest elevations on Watts Bar reservoir was used for the seismic postulated failure evaluation. This includes a postulated failure of Melton Hill Dam. A "sunny day" postulated failure scenario was developed for Norris Dam as part of the TVA studies.

2.4.2.3 Landslide Induced Flooding

Flooding may occur as the result of waves generated from of landslides downstream or upstream of the site. The Hermes site is adjacent to Poplar Creek, which is a body of water that is not subject to significant riverbank landslides.

Flood waves from landslides into upstream reservoirs required no specific analysis. Based on the review of CR-ESPA, Part 2, SSAR, the borders of the Watts Bar and upstream reservoirs indicate the absence of major elevation relief in nearby reservoirs. The volume of material entering the nearby reservoirs from potential landslides is not significant compared to the available detention space in reservoirs. Any waves created from landslides would not result in site flooding due to the large difference in elevation between the maximum normal pool elevation at the Hermes Site.

2.4.3 Credible Hydrological Events and Design Basis

Based on the prior studies discussed above, the credible hydrological events for the siting and design of the Hermes reactor are set according to the site-specific study performed for the ETTP (Reference 2). The credible hydrological event for the Hermes design basis is defined for a probability of $4x10^{-5}$ (25,000 year return period). This return period is appropriate for structures, systems, and components (SSCs) of Flooding Design Category 4 (FDC-4) (Reference 4). For such events, the design basis flooding level elevation at the Hermes site is ~~El.~~ 759.9 feet msl (5.1 feet below plant grade of 765.0 feet msl~~NAVD 88~~). The PMF is not used in the design basis of SSCs, however, a ~~site-specific~~ PMF analysis will be discussed with the application for an Operating License.

2.4.3.1 Design Bases for Flooding in Streams and Rivers

The Hermes Design Basis Flood elevation is 759.9 feet msl.

2.4.3.2 Design Bases for Site Drainage

The Hermes maximum flooding level for site drainage is set at ~~El.~~ 765.0 feet msl (plant grade), 5.1 feet above the $4x10^{-5}$ credible event flooding elevation.

2.4.3.3 Other Site Criteria Design Bases

The Hermes site relies on the existing topography so that runoff water naturally drains to the east, south, and west with flow directed to Poplar Creek ~~the Clinch River arm of the Watts Bar Reservoir~~. The final grading plan of the Hermes site takes full advantage a favorable topography by employing a number of measures, including grading slopes and diversion ditches to divert runoff water to Poplar Creek~~. the Clinch River arm of the Watts Bar Reservoir on three sides of the plant. This results in minimal backwater effects at the safety-related portion of the Hermes reactor building during the local PMP event. Thus, no adverse impacts to the function of safety-related SSCs at the Hermes Site are expected during the design basis extreme flooding event and the local intense precipitation event~~. Detailed design of the site layout and facilities at the Hermes site, including the storm water drainage system will be conducted and the final site grading and site layout designed such that safety-related SSCs are able to function.

2.4.4 Groundwater

~~As discussed in Section 2.5,sS~~ubsurface investigations encountered groundwater starting at depths approximately 10~~from 6.0~~ ~~to 8.0~~ feet below the ground surface. ~~(ground surface at El. 765 NAVD 88).~~ The depth to saturated groundwater will vary with seasonal conditions. These water table level variations will be addressed in the application for an Operating License.

2.4.5 Groundwater Contamination

The primary and intermediate coolants for the Hermes reactor are salt based and not water based. Secondary support systems containing water (i.e., the Decay Heat Removal System and the Component Cooling Water System) could experience small amounts of tritiated water migration. Tritium contamination and the potential for liquid effluent releases from secondary support systems are monitored through periodic sampling and tritium concentration measurements in support system water inventory.

Tritium is controlled in the facility by the Tritium Management System (TMS) as described in Section 9.1.3. Total tritium inventory is monitored to comply with inventory limits set by the maximum hypothetical accident analysis assumptions and dose limits in 10 CFR 100.11. The TMS maintains a level of overall tritium capture capacity to minimize tritium releases from the plant and satisfy PDC 60. Tritium releases in effluents are controlled within the effluent limits in 10 CFR 20.

Additionally, tritium capture is carried out in the environments surrounding the primary heat transport system to collect permeating tritium as well as any tritium released from limited gas leakage out of interfacing systems during normal operations or maintenance activities.

Section 11.1.7 provides additional information regarding the environmental monitoring program.

2.4.6 References

1. Not used ~~American National Standards Institute/American Nuclear Society, *Determining Design Basis Flooding at Power Reactor Sites*, ANSI/ANS 2.8. 1981.~~
2. BARGE, *Flood Hazard Evaluation for Y-12 (Bear Creek) and K-25 (Poplar Creek)*. 2015.
3. U.S. Nuclear Regulatory Commission, Environmental Impact Statement for an Early Site Permit (ESP) at the Clinch River Nuclear Site, Final Report, NUREG-2226, Volume 1, April 2019.
4. Department of Energy, *Natural Phenomena Hazard Analysis and Design Criteria for DOE Facilities*, Standard 1020-2016, DOE. 2016.
5. Federal Emergency Management Agency, *Flood Insurance Study (FIS) for Roane*, FEMA FIS Number 47145CV000B. 2009.
6. Tennessee Valley Authority, *Flood Analysis for Department of Energy Y-12, ORNL, and K-25 Plants*, TVA. 1991.
7. Not used
8. Tennessee Valley Authority, *Clinch River Nuclear Site Early Site Permit Application Part 2 Safety Analysis Report Revision 2*, TVA, ADAMS Accession No. ML19030A358. 2019.
9. Tennessee Valley Authority, *Hydroelectric, Knoxville, Tennessee,* ADAMS Accession No. ML18036A967. TN5241, TVA. 2017.
10. Tennessee Valley Authority, *Lake Levels, Knoxville, Tennessee*. ADAMS Accession No. ML18036A968. TN5242, TVA. 2017.

Table 2.4-1: Reservoirs that Influence Flows at the Confluence of Clinch River and Poplar Creek

Reservoir	Water Body	Purpose	Flood Storage (acre-ft)[1]	Area (Acre)[1]	Operating Elevation (feet msl)[2]	Date[1] Completed
Norris	Clinch & Powell Rivers	Power generation, flood control, recreation	1,113,000	33,840	992-1,020	1936
Melton Hill	Clinch River	Power generation, navigation, recreation, water supply	Negligible	5,470	793-795	1963
Watts Bar	Tennessee, Clinch, & Emory Rivers	Power generation, flood control, navigation, recreation, water supply	379,000	39,090	735-741	1942
Fort Loudoun[3]	Tennessee River	Power generation, flood control, navigation, recreation, water supply	111,000	14,600	807-812.8	1943

NOTES:

[1] Reference 9

[2] Reference 10

[3] Fort Loudoun Reservoir is connected by a canal to Tellico Reservoir on the Little Tennessee River. A regulated spillway on Tellico Dam is used only during extreme flooding

Table 2.4-2: Roane County FEMA FIS Flooding Elevation (Projected to Hermes Site)

Annual Exceedance Probability	Flood Elevation (*) (feet msl)	Estimated Depth at Hermes(**) (feet)
0.1 (10 %)	744.8	-~~19~~20.2
0.02 (2%)	746.0	-19.0
0.01 (1%)	747.0	-18.0
0.002 (0.2%)	749.5	-15.5

(*) Flood elevations from the FIS Study are from Clinch River at the mouth of Poplar Creek in feet msl NGVD 29 datum.

(**) Site Grade is 765 feet msl NAVD 88 datum. Estimated flooding depths shown for the Hermes site do not incorporate a conversion and are qualified due to a small difference in the vertical datums, on the order of several inches. A n~~N~~egative number indicates a dry site.~~ based on plant grade El 765 NAVD 88.~~

Table 2.4-3: UCOR Poplar Creek and Clinch River Flooding Elevations (Projected to Hermes Site)

Annual Exceedance Probability	Flood Elevation (*) (feet msl)	Estimated Depth at Hermes(**) (feet)
0.04 (4%)	747.2	-17.8
0.01 (1%)	749.7	-15.3
0.002 (0.2%)	752.7	-12.3
0.0005 (0.05%)	755.2	-9.8
0.0001 (0.01%)	758.2	-6.8
$5x10^{-5}$ (0.005%)	759.4***	-5.6
$4x10^{-5}$ (0.004%)	759.9***	-5.1
$1x10^{-5}$ (0.001%)	766.6***	1.6

(*) Flood elevations from UCOR Study are feet msl NGVD 29 datum.

(**) Site Grade is 765 feet msl NAVD 88 datum. Estimated flooding depths shown for the Hermes site do not incorporate a conversion and are qualified due to a small difference in the vertical datums, on the order of several inches. A n~~N~~egative number indicates a dry site. ~~based on plant grade El 765 NAVD 88.~~

(***) Flood elevations for higher annual exceedance probabilities up to 0.01% are controlled by Poplar Creek. Flood elevations for lower annual exceedance probabilities at or below 0.005% are controlled by backwater from the Clinch River.

a thick reddish or orangish-brown clay overburden soil. The formations also contain trace silica nodules in the form of chert, that is resistant to weathering and typically scattered throughout the residuum.

A subsurface stratigraphy was developed for the Hermes site from a geotechnical boring program. Details of the boring program, along with subsurface profiles are included in Section 2.5.2.3.

2.5.2.1 Karst

Since the bedrock formations underlying this site contain carbonate rock (e.g., limestone/dolomite), the site could be susceptible to the carbonate hazards of irregular weathering, cave and cavern conditions, and overburden sinkholes. Carbonate rock, while appearing very hard and resistant, is soluble in slightly acidic water. This characteristic, plus differential weathering of the bedrock mass, is responsible for the hazards. Of these hazards, the occurrence of sinkholes is potentially the most damaging to overlying soil-supported structures. Sinkholes primarily occur due to differential weathering of the bedrock and flushing or raveling of overburden soils into the cavities in the bedrock. The loss of solids creates a cavity or dome in the overburden. Growth of the dome over time or excavation over the dome can create a condition in which rapid, local subsidence, or collapse of the roof of the dome, occurs.

The geotechnical investigation at the Hermes site encountered indications of karstic activity. Surface signs of sinkhole activity at the site were not detected. Remnants of the old K-33 building foundations remain undisturbed and fully integrated within the soil matrix. As discussed in 2.5.4.3, it is noted that although zones of soft soils were encountered beginning at a depth of approximately 28 feet in Boring B-1, which may be indicative of the potential for karstic activity, Boring B-1 is located more than 1200 feet away from the proposed location of the Hermes reactor.

The karst investigation will be complemented with a set of tests and surveys. These include site reconnaissance, analysis of LiDAR imaging, inventory of surface depressions in the site area, deeper borings at the reactor location, laboratory analyses of rock cores, and the elaboration of the karst model for Hermes. This information will be provided with the application for an Operating License.

2.5.2.2 Site Subsurface Stratigraphy

Subsurface conditions were explored between March 22 and March 30, 2021, with six soil test borings (designated B-1 through B-6) and six observation trenches. The boring plan is presented in Figure 2.5-1. Location of the borings, existing piezometers, and observation trenches were established with field Global Positioning System (GPS) handheld devices.

2.5.2.3 Soil Borings

The borings were advanced in the overburden soil using hollow stem augers with an inside diameter of 3¼ inches with a Diedrich D-50 drill rig. The drill crew worked in accordance with the American Society for Testing and Materials International (ASTM) D6151 (Reference 5), the Standard Practice for Using Hollow-Stem Augers for Geotechnical Exploration and Soil Sampling. Split-spoon sampling and standard penetration tests (SPTs) were performed in accordance with ASTM D1586, the Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils (Reference 6). Split-spoon samples were obtained and SPT performed with a standard 1.4-inch inside diameter (ID), 2-inch outside diameter (OD) split-spoon sampler at 2½-foot intervals to depths of 10 feet and on 5-foot intervals thereafter. The sampler was first seated 6 inches and then driven an additional foot with blows of the 140-pound hammer falling 30 inches. The number of hammer blows required to drive the sampler the final foot was recorded and is designated as the standard penetration resistance (N-value) with units of blows per foot (bpf). The N-value provides a general indication of in-situ soil conditions and has been correlated with certain engineering properties of soils. An automatic trip drop hammer was used for the standard penetration resistance testing. The automatic hammer has a higher efficiency than a manual hammer and may yield lower N values. The N values reported on boring logs are the field values without any adjustments or corrections. In addition, one thin-walled tube sample was obtained in Boring B-1 at a depth of 30 to 32 feet.

Figure 2.5-23 and Figure 2.5-24 provide profile sections of the soil borings and observation trenches with collected boring data summary. Section 2.5.2.3.2 describes the stratigraphic column based on the boring findings.

The soil samples obtained during the field activities were visually classified by members of the field engineering staff in accordance with ASTM D2488, the Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) (Reference 7). Laboratory testing was performed to classify soils. The extent of the laboratory testing was limited to basic index testing for site characterization. A more comprehensive evaluation will be provided with the application for an Operating License.

A description of the overburden soils is provided in Section 2.5.2.3.2.

2.5.2.3.1 Observation Trenches

The observation trenches were advanced using a CASE CX210D tracked excavator. All trenches except OT-3 were excavated in one direction adjacent to a remnant foundation and in a direction perpendicular to the foundation. OT-3 was excavated as one long trench approximately 120 feet long. Soils were logged in accordance with ASTM D2488 (Reference 7). The foundations were cleaned, observed, and photographed. Depths of soil strata, foundations, and ground water were recorded.

2.5.2.3.2 Subsurface Stratigraphy

Table 2.5-1 summarizes the subsurface stratigraphy at the Hermes site. Each of the borings and trenches encountered topsoil at the ground surface with thickness ranging from 4 to 12 inches thick.

Fill soil was encountered beneath the surface cover in each of the borings and trenches. The fill ranged in depth from about 12 to 21 feet. In trenches OT-2, OT-4, OT-6A, and OT-6B the entire interval of fill soil was not penetrated. Typically, the fill consisted of red to yellow, red fat clay (CH) with limestone and rock fragments. Strata of crushed stone were encountered in several of the observation trenches in thin layers of about 6 to 8 inches thick throughout the fill, and occasionally in layers of 3 to 5 feet thick closer to the ground surface. Concrete foundations were also encountered as deep as about 12 feet. Additional discussions related to the old foundations and site history are presented in Section 2.5.5.1. The SPT N-values for the fine-grained fill ranged from 6 to 100 bpf indicating soil consistencies of medium firm to very hard, although SPT N-values of 100 were likely amplified by rock fragments in the samples. The SPT value for the coarse-grained fill was 26 bpf indicating a medium dense relative density.

Alluvial soils were encountered beneath the fill in Borings B-1 and B-4 to depths of 22 to 31 feet, respectively. Alluvial soils are soils transported to their present location by flowing water. The SPT N-values for the fine-grained alluvium ranged from 8 to 11 bpf indicating soil consistencies of medium firm to firm. The SPT values for the coarse-grained alluvium was 15 bpf indicating a medium dense relative density.

Residual soils were encountered beneath the alluvial soil in Borings B-1 and B-4. Residual soil was encountered beneath the fill in each of the observation trenches, except for trenches OT-01, OT-02, OT-04, OT-05A, OT-06A and OT-06B. Residual soils are soils weathered from the underlying parent bedrock. Residual soils extended to auger refusal at depths ranging from 14.1 to 54.4 feet in the borings and about 13 to 19.5 feet in the observation trenches. The residual soils consisted of red brown, yellow brown, light gray, to dark brown fat clays with varying amounts of chert, fine sand, and weathered rock. The SPT N-values of the residual soils ranged from 2 bpf to 100 bpf, indicating soil consistencies of very soft to very hard. Based on observations of the cutting, the soil consistencies ranged from very soft to firm. Samples with higher blow counts were typically amplified by refusal material within the samples. Residual soils were encountered to depths ranging from 11 feet to 54.4 feet. Trenches OT-05B and OT-05C were terminated in residual soil.

Moisture content of the boring samples was determined to range from 4.5 to 50.9 percent.

Bedrock at the Hermes site consists of dolomitic limestones of different nature. The north portion of the site is underlain by the Mascot formation, a gray, medium to thickly bedded, fresh, hard rock. The bedrock is directly underneath the residuum and presented a Rock Quality Designation (RQD) of 70% to 100%. At the north end of the site, around Boring B-1, the Mascot bedrock was encountered at a depth of about 55 feet.

The midsection of the site, near the area of Boring B-2, is underlain by the Pond Springs formation, which is described as a limestone, light gray, medium bedded, medium jointed. It presented an approximately 5 feet thick weathered layer and quickly transitions to fresh hard rock with RQD of 70%. The Pond Springs bedrock was encountered at a depth of about 35 feet below the ground surface.

The south end of the Hermes site is underlain by the Murfreesboro dolomitic limestone. Encountered at depths of about 20 feet near Boring B-5, this formation is light gray, medium, close jointed, with an approximately 3 feet weathered layer. Below the weathered zone, RQD is greater than 80%.

Figure 2.5-2 and Figure 2.5-3 provide the subsurface profiles that are mapped in Figure 2.5-1.

2.5.3 Vibratory Ground Motion

The CRN site is only 3.5 miles away from Hermes. The seismic hazard study for CRN is documented in the CR-ESP application, Part 2, SSAR. The study evaluated new data, methods, and models developed since publication of the 2012 Central and Eastern United States (CEUS) Seismic Source Characterization model (Reference 8). Relevant updates to the CEUS Seismic Source Characterization were incorporated into the site-specific evaluation of the seismic hazard at CRN. The update team performed interviews of experts who have developed data and/or interpretations of seismic sources in the site region, reviewed an updated seismicity catalog developed for CRN, and performed site-specific studies, as needed, to assess the quality of data and uncertainty associated with recently published studies. The updates include geologic/paleoseismic studies within the Eastern Tennessee Seismic Zone (ETSZ); (2) investigations of the Mineral, Virginia earthquake that occurred in or near the Central Virginia Seismic Zone (CVSZ); and (3) revisions to the maximum magnitude distributions for seismic zones in the CEUS Seismic Source Characterization model. The PSHA for CRN incorporates the post CEUS-Seismic Source Characterization updates. Since the Hermes site is only separated from CRN by less than 3.5 miles, CEUS Seismic Source Characterization updates performed for CRN are applicable to Hermes.

The goal of the Senior Seismic Hazard Analysis Committee (SSHAC) process (for the SSHAC or PSHA Levels) is to provide a methodology for developing Seismic Source Characterization and Ground Motion Characterization (GMC) models that capture the center, body, and range of technically defensible interpretations of available data, methods, and models. The terminology “center, body, and range” refers to the complete characterization of epistemic uncertainty. By following the structured methodology of the SSHAC process, reasonable regulatory assurance is provided that the goal of representing the center, body, and range of the characterizations has been met, and thus provides the basis for developing seismic hazard estimates that are reproducible, defensible, transparent, and stable.

2.5.3.4.1 Uniform Hazard Response Spectra

The UHRS for hard rock conditions reported in the CR-ESPA, Part 2, SSAR is applicable at Hermes. The PSHA resulting hard rock hazard curves are plotted in Figure 2.5-9. The UHRS for hard rock conditions is derived from the hazard curves and plotted Figure 2.5-10. The four (4) annual probabilities of exceedance are presented in the plots.

2.5.3.4.2 Soil Columns at Hermes and CRN

The Hermes reactor is located at the southeast corner of the original K-33 footprint (See Figure 2.5-11). Section 2.5.2.2 details the foundation interface for Hermes. The ~~basemat~~ foundation mat of the SDC-3 structures is deployed at a depth of about 20 feet below grade. The ~~facilities~~ safety-related structures are founded ~~into the~~ on concrete fill on competent bedrock of Murfreesboro dolomitic limestone. Shear wave velocity values for limestone like the one encountered at Hermes are in the range of 2,500 to 3,000 meters per second (m/s) (Reference 10 and Reference 11). This range is equivalent to the reported values in the CR-ESPA, Part 2, SSAR, which originate from site-specific velocity measurements. Figure 2.5-12 provides a comparison between the CRN Location A (Reference 1) and assumed Hermes site velocity profiles. Since the Hermes reactor is deployed over the Murfreesboro limestone, it is possible to define the Hermes site ground motion control point as an outcropping ground motion at the elevation of the bedrock horizon. Therefore, the UHRS at the Hermes site is considered equivalent to the UHRS at CRN Location A. As discussed in Section 2.5.3.4.5 and Section 2.5.3.4.6, additional margin is incorporated into the DRS to account for the uncertainty associated with the lack of site-specific shear wave velocity measurements.

2.5.3.4.3 UHRS at Hermes

ASCE 43-19 guidelines for development of SDC-3 and SDC-2 DRS require UHRS at the hazard levels specified in Step 1 of 2.5.3.4.

The 1×10^{-4} UHRS is directly obtained from the CR-ESPA, Part 2, SSAR. The other three annual probability of exceedance levels are developed by scaling the 1×10^{-4} UHRS times a spectral amplification ratio calculated for each frequency (Figure 2.5-13). The resulting UHRS at Hermes are plotted in Figure 2.5-14.

2.5.3.4.4 Hermes ASCE 4-19 DRS

The SF to establish the DRS at Hermes is computed using Spectral Accelerations (SA) in the UHRS, as follows (Reference 3):

$$SF = max[SF_1, SF_2, SF_3] \qquad \text{(Equation 2.5-1)}$$

Where: $SF_1 = A_R^{-1.0}$; $SF_2 = 0.6 \cdot A_R^{-1.0}$; $SF_3 = 0.45$

For SDC-3:

$$A_R = \frac{SA_{1\times10^{-4}}}{SA_{1\times10^{-3}}}$$

For SDC-2:

$$A_R = \frac{SA_{4\times10^{-4}}}{SA_{4\times10^{-3}}}$$

2.5.3.4.5 USGS NSHMP and Hermes

Figure 2.5-15 compares the hazard levels reported in the USGS NSHMP for rock sites (Site Category A) at 4×10^{-4} to the Hermes Location A at 4×10^{-4} (Conterminous U.S. 2014 Update) (Reference 12). This comparison establishes an upper bound of the hazard at the Hermes site by using the risk levels of

USGS. The USGS accelerations are higher than the site-specific study counterpart. The following section utilizes the difference between the USGS and the SDC-3 curves to add margin for the Hermes spectra. The margin accounts for the uncertainty associated with the pending shear wave velocity measurements.

2.5.3.4.6 Enveloping Design Response Spectrum

The NGA-East report (PEER Report 2018/08) (Reference 13) indicates that the use of NGA-East (instead of EPRI, 2013, which was the GMPE used at the CRN site) at the Chattanooga, Tennessee, test site results in a factor of 1.5 to 1.7 increase in the 1E-4 UHRS at 1 Hz. This increase is accommodated by introducing additional margin to the DRS at low frequencies.

The final Hermes DRS is established by:

a) Increasing the DRS obtained in the previous step by factor of one (1) plus 40% of the relative difference between the USGS NSHMP and Hermes SDC-3 curves. The factor increases the spectral acceleration levels to define an enveloping DRS that addresses uncertainties associated with the ongoing shear wave velocity measurements,

b) Further increasing the DRS in the low frequency range below 6 Hz by a factor of up to 1.6 at 1.0 Hz to account for the findings of the new 2018 NGA East report, and

c) Multiplying the horizontal DRS by the Vertical to Horizontal (V/H) ratio recommended in the CR-ESPA, Part 2, SSAR.

The resulting DRS for SDC-3 and SDC-2 are plotted in Figure 2.5-16 and the spectral values listed in Table 2.5-3.

2.5.4 Potential for Subsurface Deformation

Potential causes for subsurface deformation are surface faults or discontinuities in the foundation bedrocks, liquefaction of saturated sand deposits, or voids in the bedrock formations resulting from karstic limestone dissolution. The following paragraphs describe these hazards.

2.5.4.1 Surface Faulting

This information will be provided in the application for the Operating License.

2.5.4.2 Liquefaction Potential

The Hermes safety-related reactor foundation ~~base~~mat is deployed ~~at~~ over a concrete fill placed directly on competent bedrock. Surrounding structures rest either over bedrock or engineered soils after excavation and backfill operations. Section 2.5.5.2 describes the foundation interface conditions for the Hermes reactor foundation. Liquefaction at the Hermes site is accordingly not an issue for the safety-related reactor foundation. This conclusion and the effects of liquefaction on the surrounding nonsafety-related structure foundations will be addressed in the application for an Operating License.

2.5.4.3 Karst

The geotechnical subsurface investigation encountered limited evidence of voids or karstic dissolution at or near the reactor building location. Boring B-5 encountered an open void between 21-22.5 feet. As discussed in Section 2.5.2.1, signs of karstic activity at the bedrock/overburden interface were encountered in the area of Boring B-1, located at the Northwest corner of the site, more than 1,200 feet away from the reactor foundation. Residuum clays were not encountered south of Boring B-5. The location for the Hermes reactor is approximately 100 feet north of Boring B-5 and has been selected in part based on the findings of the geotechnical investigation. The foundation rock for the Hermes reactor will be at depths at which no evidence of karstic dissolution is encountered. Over-excavation will be performed at areas at which the compromised bedrock/overburden interface is encountered.

2.5.5 Foundation Interface

This section presents the foundation interface for the Hermes reactor and its auxiliary facilities. The foundation layout has been established based on knowledge of the site subsurface conditions gathered from both historical documentation and the subsurface boring exploration campaign. Subsurface profiles are provided in Section 2.5.2.3.

2.5.5.1 Site History

Site preparations for the construction of the original K-33 building involved significant amounts of earth movement and fill placement. Figure 2.5-17 shows topographic maps developed at the site (a) prior to construction of some the Oak Ridge Gaseous Diffusion Plant (ORGDP) facilities (1949), and (b) during construction of the ORGDP and prior to the erection of K-33 (1951) (Reference 14). For the construction of K-33, the site was releveled and graded to foundation footprint elevation. Currently, the site grade is El. 765 feet North American Vertical Datum of 1988 (NAVD 88) (Figure 2.5-1). The historic maps point out an area at which rock was encountered at higher elevations. This observation coincides with the findings of the geotechnical investigation, which encountered rock at the highest near Boring B-3 (Figure 2.5-1). It appears that, in this zone, the excavation for the construction of K-33 reached the top of bedrock horizon. The area was then backfilled with a rock/soil fill material of crushed limestone and reddish clay soil (Reference 15). This observation is also consistent with the findings of the geotechnical investigation at Boring B-3.

Building K-33 was a two-story, 25 meter tall structure with approximately 260,000 square meters of floor space (Figure 2.5-18). Subsequent to its demolition, there is no sign of the above ground remnants of the K-33 building and decontamination has been completed. Figure 2.5-19 shows a present day above ground image of the site.

The K-33 building consisted of a steel braced frame two-story structure resting on isolated spread footing reinforced concrete foundations. The foundations were not removed during demolition and remain underneath the ground surface. There are more than 3,000 isolated spread footing foundations. These range in depths of approximately 4’ to 18’ below the ground surface. Footing footprints are square with dimensions ranging from 4’4” to over 14’ (Reference 16). The width of the columns over the footings varies, on average, between 24” and 42”. The thickness of the footings varies from 14” to 40” and spacing between footings ranges 10’ to 15’. Figure 2.5-20 is an image extract of the original foundation plan showing the north portion of the site (Reference 16). The figure indicates the nature of the density of foundation remnants throughout the subsurface. The geotechnical investigation included observation trenches.

Figure 2.5-21 shows a photograph of footings encountered at OT-2 and OT-6. The OT-6 case shows the column rising from the footing.

2.5.5.2 Plant Layout and Foundation Interface

Plant grade is set at El. 765 NAVD 88. The location for the Hermes reactor is the southeast corner of the Hermes site, approximately 100 feet north of Boring- B-5 (see Figure 2.5-11). From geotechnical stability and constructability perspectives, at this location, the bedrock interface is just above the depth of the foundation. This condition provides an adequate bearing stratum while reducing the amounts of excavation of hard rock. The foundation surface is to be carefully examined and subjected to inspection after excavation. Weathered zones are to be over-excavated and backfilled with adequate sub-base.

Figure 2.5-22 presents a cross section of the Hermes reactor foundation interface. The Hermes safety-related structure and the non-safety related structures do not fully share the same foundation system. The bearing system for the safety-related structure is a foundation mat resting on concrete fill over the Murfreesboro rock. Engineered fill supports the lighter portions of the surrounding non-safety related facility. Foundation and structural design aspects are described in Section 3.5. ~~The total foundation depth is 20 feet below grade.~~

2.5.5.2.1 Bearing Capacity

Because Hermes is supported in bedrock, ample bearing capacity for mat foundations is available. Foundation settlement is expected to be minimal and limited to immediate elastic response of the supporting rock.

Settlement of the non-safety related structure can be controlled because the supporting media is engineered fill. Response is expected to be elastic, and settlement limited to immediate displacement.

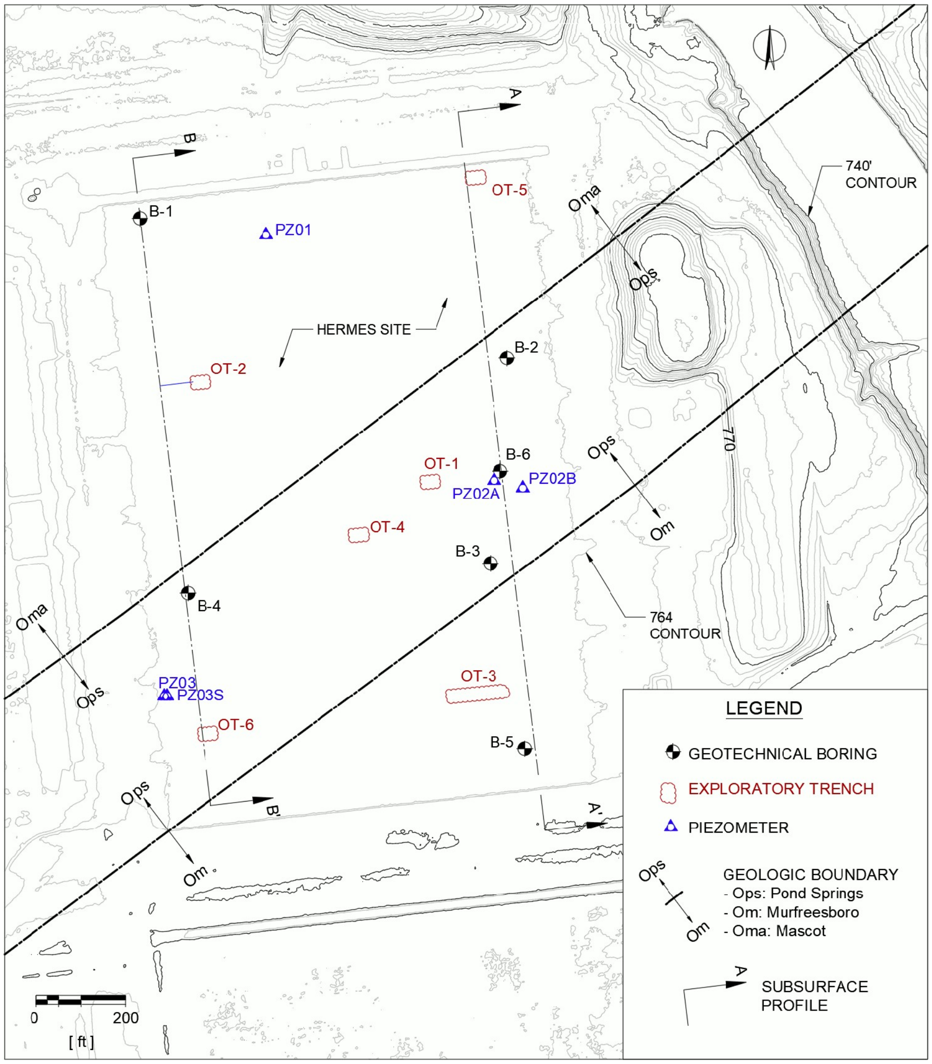
Additional details on bearing capacity, settlement and lateral pressure will be provided in the application for an Operating License.

In conclusion, both failure and settlement-controlled bearing capacities are sufficient to safely support Hermes at the repurposed site.

2.5.6 References

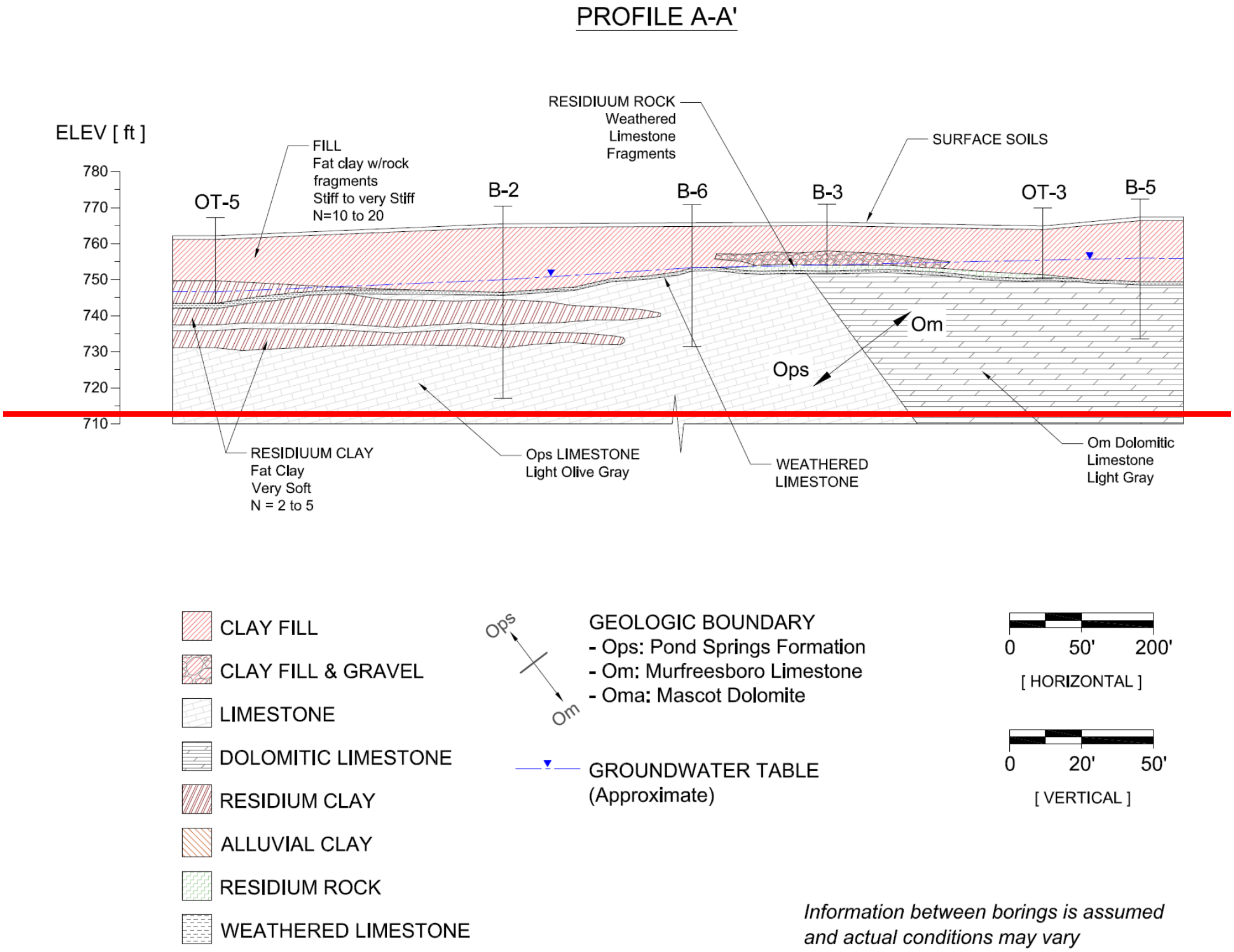
1. Tennessee Valley Authority, Clinch River Nuclear Site Early Site Permit Application Part 2 Safety Analysis Report Revision 2, ML19030A358, TVA. 2019.
2. American National Standards Institute/American Nuclear Society, “Probabilistic Seismic Hazard Analysis, ANSI/ ANS 2.29. 2020.
3. American Society of Civil Engineers, "Seismic Design Criteria for Structures, Systems, and Components in Nuclear Facilities," ASCE 43-19. 2019.
4. Limiszki, P., "Geologic Map of the Elverton Quadrangle, Tennessee," Tennessee Geologic Survey. 2015.
5. American Society for Testing and Materials, "Standard Practice for Using Hollow-Stem Augers for Geotechnical Exploration and Soil Sampling," D6151, ASTM. 2015.
6. American Society for Testing and Materials, "Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils," D1586, ASTM. 2018.
7. American Society for Testing and Materials, "Standard Practice for Description and Identification of Soils (Visual-Manual Procedure ASTM)," D2488, ASTM. 2017.
8. Electric Power Research Institute, "Technical Report: Central and Eastern United States Seismic Source Characterization for Nuclear Facilities, DOE, NRC," NUREG 2115, EPRI Report 1021097. 2012.
9. Giffells and Vallet, I., Foundation Plan, Project K Oak Ridge Area. 1954.
10. Earle, S., Physical Geology, s.l.: University of British Columbia. 2019.
11. United States Geologic Survey, "Petrologic and Mineral Physics Database for Use with the U.S. Geological Survey National Crustal Model," USGS, Open-File Report. 2019-1035.
12. United States Geologic Survey, National Seismic Hazard Mapping Project, Web access: https://earthquake.usgs.gov/hazards/interactive/, USGS. 2014.

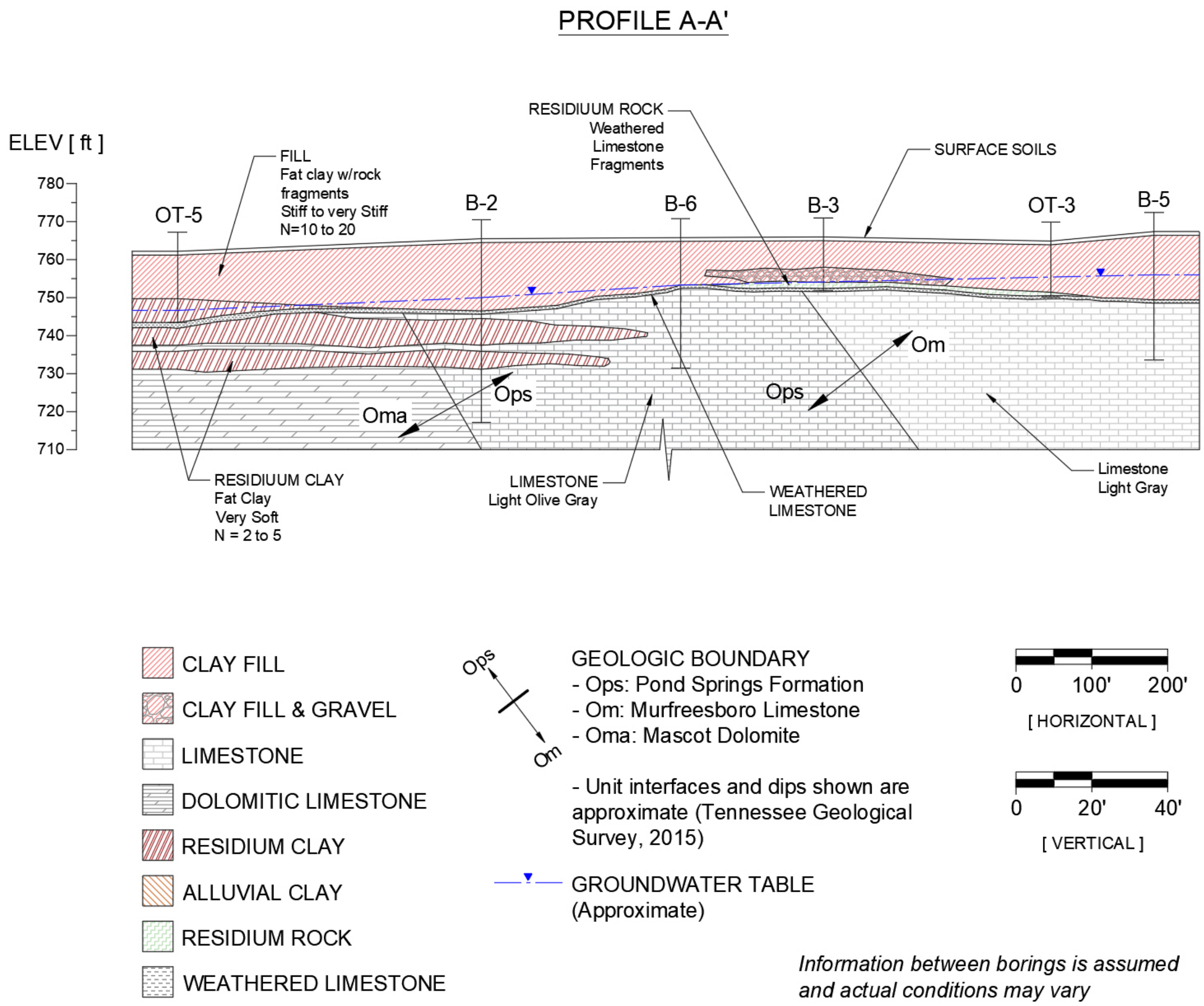
Figure 2.5-1: Boring Layout



Note - Sectional Views A-A’ and B-B’ are provided in Figures 2.5-23 and 2.5-24.

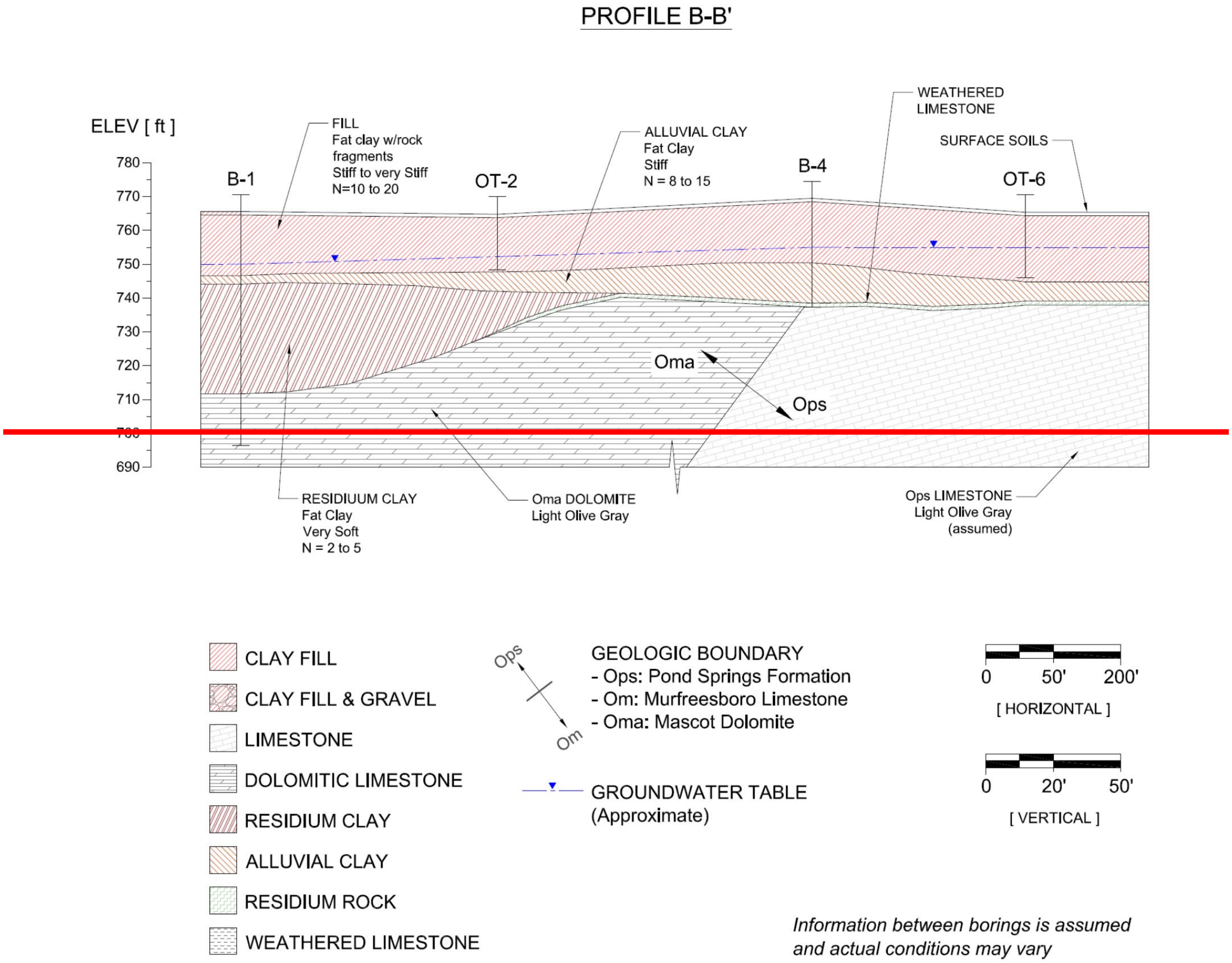
Figure 2.5-2: Subsurface Profile A-A'





PROFILE A-A'
ELEV [ft]
780
770
760
750
740
730
720
710
OT-5
B-2
B-6
B-3
OT-3
B-5
FILL
Fat clay w/rock fragments
Stiff to very Stiff
N=10 to 20
RESIDIUUM ROCK
Weathered Limestone Fragments
SURFACE SOILS
Om
Ops
Ops
Oma
RESIDIUUM CLAY
Fat Clay
Very Soft
N = 2 to 5
LIMESTONE
Light Olive Gray
WEATHERED LIMESTONE
Limestone
Light Gray
CLAY FILL
CLAY FILL & GRAVEL
LIMESTONE
DOLOMITIC LIMESTONE
RESIDIUM CLAY
ALLUVIAL CLAY
RESIDIUM ROCK
WEATHERED LIMESTONE
Ops
Om
GEOLOGIC BOUNDARY
- Ops: Pond Springs Formation
- Om: Murfreesboro Limestone
- Oma: Mascot Dolomite
- Unit interfaces and dips shown are approximate (Tennessee Geological Survey, 2015)
GROUNDWATER TABLE
(Approximate)
0 100' 200'
[HORIZONTAL]
0 20' 40'
[VERTICAL]
Information between borings is assumed and actual conditions may vary

Figure 2.5-3: Subsurface Profile B-B'



PROFILE B-B'

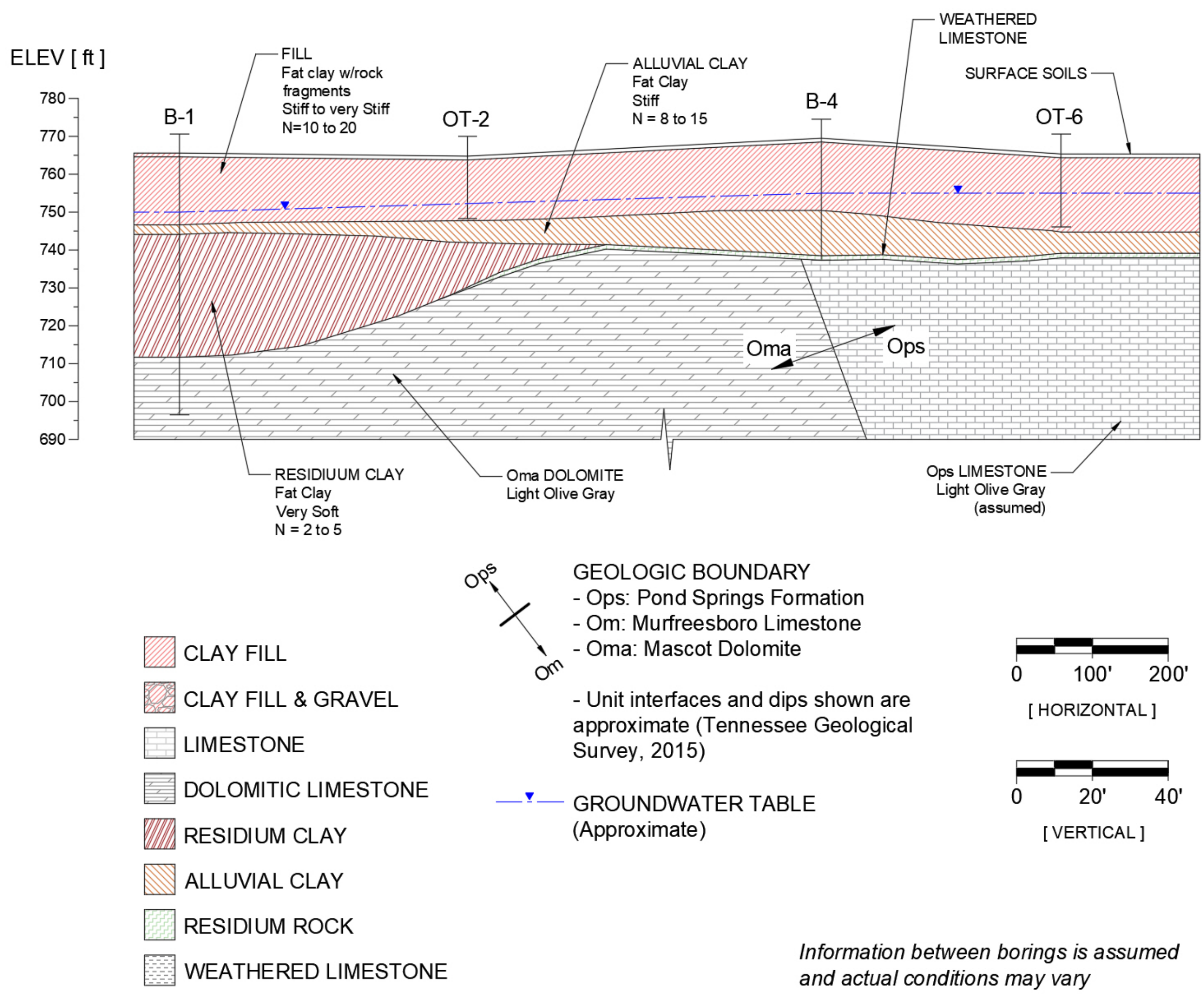
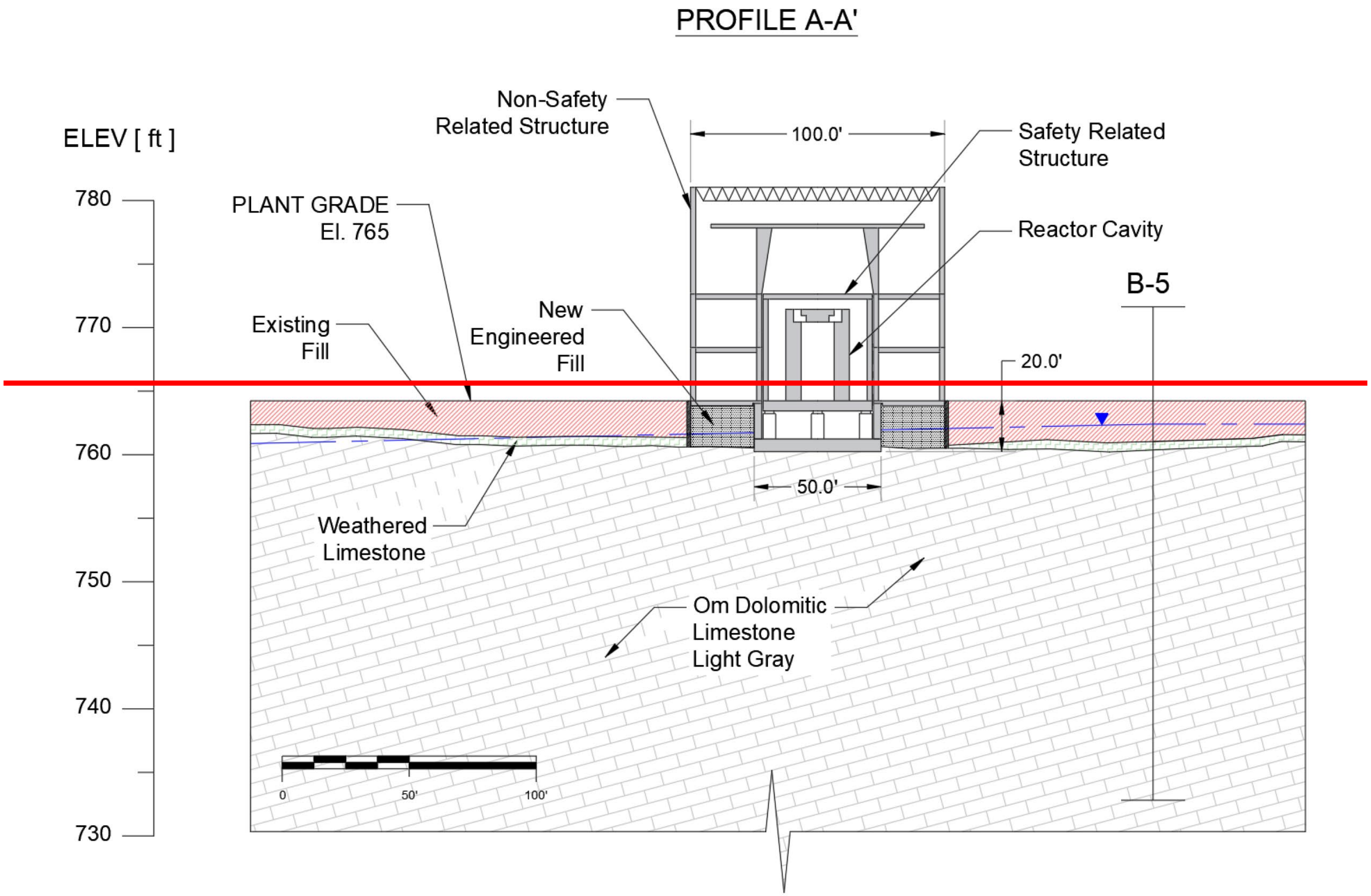
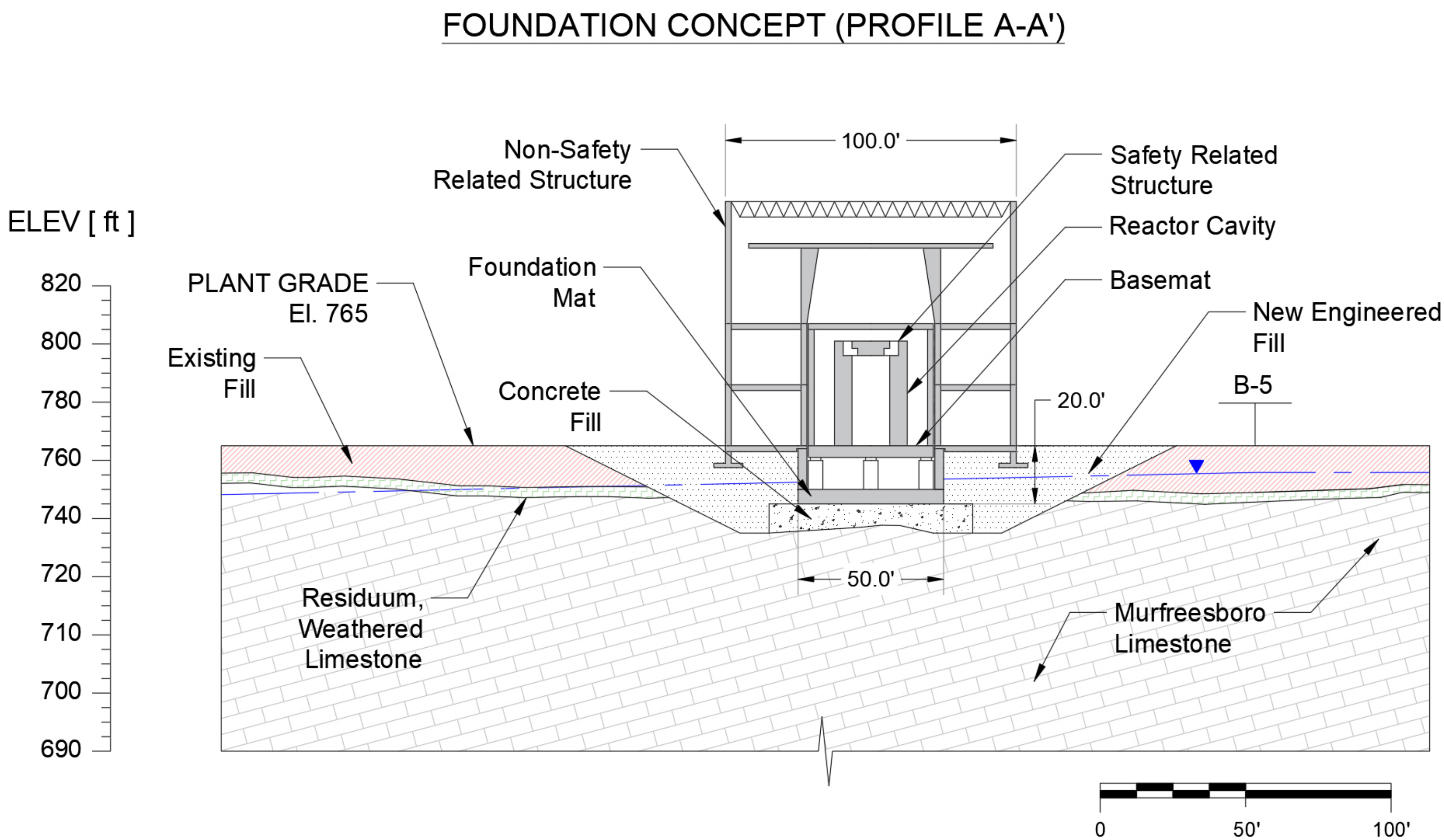

ELEV [ft]
780
770
760
750
740
730
720
710
700
690
B-1
OT-2
B-4
OT-6
FILL
Fat clay w/rock fragments
Stiff to very Stiff
N=10 to 20
ALLUVIAL CLAY
Fat Clay
Stiff
N = 8 to 15
WEATHERED LIMESTONE
SURFACE SOILS
Oma
Ops
RESIDIUUM CLAY
Fat Clay
Very Soft
N = 2 to 5
Oma DOLOMITE
Light Olive Gray
Ops LIMESTONE
Light Olive Gray
(assumed)
Ops
Om
GEOLOGIC BOUNDARY
- Ops: Pond Springs Formation
- Om: Murfreesboro Limestone
- Oma: Mascot Dolomite
- Unit interfaces and dips shown are approximate (Tennessee Geological Survey, 2015)
GROUNDWATER TABLE
(Approximate)
CLAY FILL
CLAY FILL & GRAVEL
LIMESTONE
DOLOMITIC LIMESTONE
RESIDIUM CLAY
ALLUVIAL CLAY
RESIDIUM ROCK
WEATHERED LIMESTONE
0 100' 200'
[HORIZONTAL]
0 20' 40'
[VERTICAL]
Information between borings is assumed and actual conditions may vary

Figure 2.5-22: Foundation Interface for Hermes





NOTES:

- Building and foundation interface representation is schematic and shown to illustrate foundation concept; the HERMES building design accounts for applicable environmental and foundation loads including lateral earth pressure.
- Groundwater level shown is observed from boring logs at time of drilling.

Figure 2.5-23: Profile A-A' (Boring Data Summary)

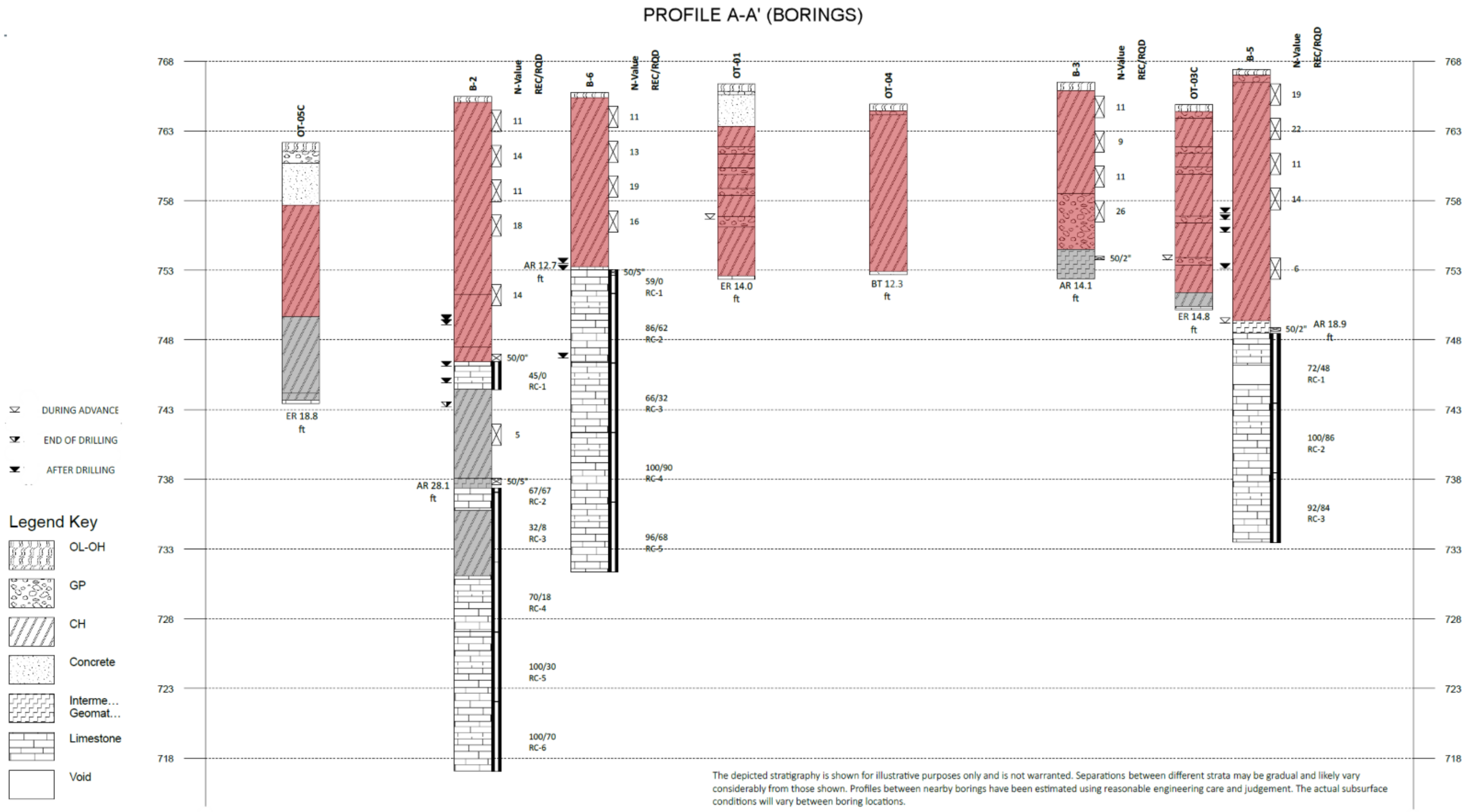
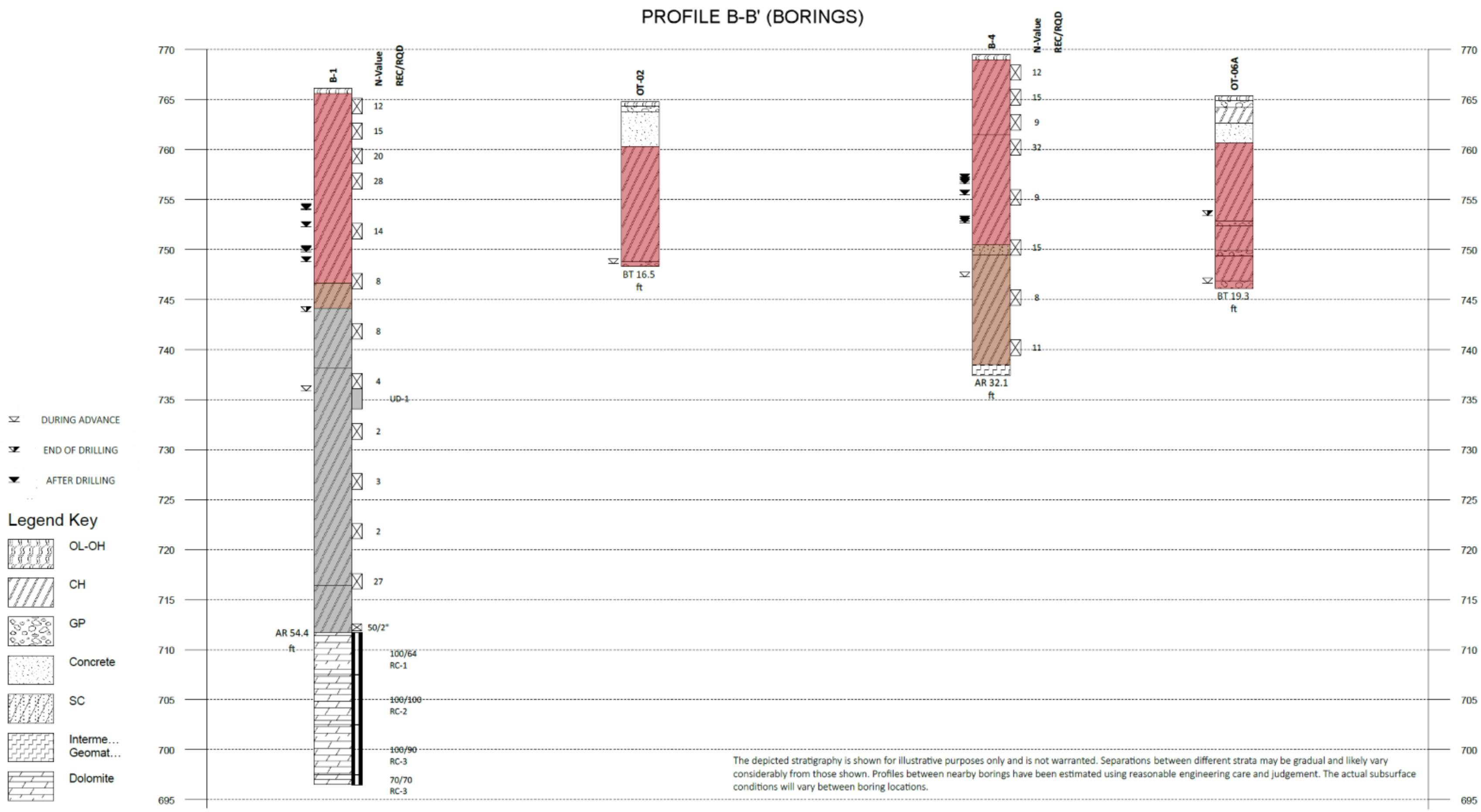


Figure 2.5-24: Profile B-B' (Boring Data Summary)



K_d = wind directionality factor equal to 1.0

V = maximum tornado wind speed as determined by RG 1.76, Revision 1, equal to 230 mph

The design basis atmospheric pressure change, or tornado differential pressure, is 1.2 pounds per square inch (psi) as determined by Table 1 of RG 1.76.

Finally, the procedure used for transforming the tornado-generated missile impact into an effective or equivalent static load on the safety-related portions of the structure is consistent with NUREG-0800, Section 3.5.3, Subsection II. Tornado-generated missile impact effects are based on the design missile spectrum from RG 1.76.

3.2.3 Hurricane Loading

The meteorological characterization of the facility site defined the normal and high wind characteristics for the facility site (See Section 2.3). This section describes the approach to translating the characteristics of design basis hurricanes for the site into loads on the safety-related portion of the Reactor Building. Hurricane characteristics include high wind speed and hurricane-generated missile impacts. The design basis hurricane loading conditions are discussed in the following subsections.

3.2.3.1 Applicable Design Parameters

The guidance from RG 1.221, Revision 0, "Design-Basis Hurricane and Hurricane Missiles for Nuclear Power Plants," is used to determine applicable design parameters for hurricane loads on safety-related portion of the Reactor Building. RG 1.221 provides wind speeds for the facility location that are consistent with the definitions used in ASCE/SEI 7-10. Since ASCE/SEI 7-10 is the code of record for the facility location's local building code, the method from ASCE/SEI 7-10 is used to determine the applied forces from hurricanes, using the wind speeds from RG 1.221.

3.2.3.2 Determination of Applied Forces

The maximum hurricane wind speed, V, is 130 mph, consistent with the guidance in RG 1.221 for the site location. Velocity pressure is determined using the maximum hurricane wind speed and the guidance of RG 1.221 for peak gust wind speed in Equation 3.2-1 (see Section 3.2.1) from ASCE/SEI 7-10. The procedure used for transforming the hurricane-generated missile impact into an effective or equivalent static load on the safety-related portions of the structure is consistent with NUREG-0800, Section 3.5.3, Subsection II. Hurricane-generated missile impact effects are based on the design missile spectrum from RG 1.221.

3.2.4 Precipitation Loads

The meteorological characterization of the facility site defined the precipitation characteristics for the facility site (See Section 2.3). This section describes the approach to translating the characteristics of design basis precipitation for the site into loads on the safety-related portion of the Reactor Building. Precipitation categories include rain, snow, and ice. Grading and drainage on the site preclude loads from precipitation accumulation on the ground affecting the safety-related portion of the Reactor Building. Design features of the site to address precipitation accumulation are discussed in Section 3.5. The non-safety related exterior shell of the Reactor Building has a sloped roof, therefore, loads due to rain accumulation are not considered as a structural load in the structural design. Similarly, as a result of the lack of rain accumulation, load due to ice is anticipated to be minimal and is therefore enveloped by the snow load. The design basis precipitation loading conditions are discussed in the following subsections.

3.3 WATER DAMAGE

This section describes the approach to establishing loads on the safety-related portion of the Reactor Building from internal and external flooding postulated events.

3.3.1 Internal Flooding

Internal flooding postulated events consider the flow rates and quantities of water from sources inside the safety-related portions of the Reactor Building. Section 3.5.3.2 describes design features that prevent internal flooding from affecting a safety-related SSC's ability to perform its safety function.

3.3.2 External Flooding Events

The hydrologic evaluation of the site described in Section 2.4 found that the flood elevation for the site does not exceed grade elevation at an annual frequency of 4~~1~~E-05. Therefore, grade elevation is used as the design basis flood elevation and external floods do not result in loads on the safety-related portion of the Reactor Building above grade. In the ~~probable maximum~~ design basis flood ~~(PMF)~~ event, the portion of the safety-related structure that is below grade could be subjected to hydrological loads. Section 3.5.3.2 discusses how hydrological loads are evaluated in the design~~. The meteorological characterization from Section 2.3 provides a probable maximum precipitation accumulation of water. Grading and drainage on the site preclude loads from precipitation affecting the safety-related portion of the Reactor Building. Design features of the site to address precipitation accumulation are discussed in Section 3.5.~~

3.3.3 References

None

The facility is a passively dry site with respect to external flooding hazards. Section 3.3 describes that in the design basis flood ~~PMF~~ event, there are no loads on the safety-related portion of the Reactor Building that is above grade. The basement containing the seismic isolator units is about 20 feet below grade. The safety-related portion of the Reactor Building is designed to withstand buoyant forces and groundwater, including groundwater associated with the design basis flood ~~PMF~~.

No SSCs located in the basement are credited to mitigate the effects of a postulated external flood event. The basemat of the safety related portion of the Reactor Building, which is supported by the base isolators, as discussed in Section 3.5.1, is at grade level and there are no safety-related SSCs ~~in the safety-related portion of the reactor building are~~ located below ~~that~~ the basemat elevation that are classified as safety-related for flooding events. Therefore, PDC 2 is met for design basis flood ~~PMF~~ events based on the location above grade level of all safety-related SSCs that are credited to mitigate the effects of a postulated external flood.

Although they do not perform a safety function to mitigate the adverse effects of a postulated external flood event, the seismic isolator units are on elevated pedestals above the foundation slab. The base isolation basement is a reinforced concrete safety-related structure with the following features:

- Water stops are provided in construction joints below flood level.
- External surfaces exposed to flood level have waterproof coating.

Furthermore, the safety-related portion of the Reactor Building is a reinforced concrete structure designed to meet ACI 349-2013. ACI 349-2013 is specific to the design of safety-related nuclear structures and has built-in margin. ACI 349 is used to design a structure that can withstand the postulated external flooding water loads from Section 3.3. With respect to buoyant forces from a postulated external flood event on the basement area of the safety-related portion of the Reactor Building, based on a flood level no higher than grade, the weight of the building offsets the potential buoyant forces on the basement. By designing in accordance with ACI 349-2013, the safety-related portion of the Reactor Building satisfies PDC 2 for design basis loads from external flooding as discussed in Section 3.3.

Finally, consistent with PDC 2, grading and drainage on the site preclude loads from precipitation affecting the safety-related portion of the Reactor Building. Specific grading and drainage features will be described in the application for an Operating License.

3.5.3.2.2 Internal Flood Design Features

This section describes the design features that satisfy PDC 2 with respect to protection from internal flooding for safety-related SSCs. Safety-related SSCs that are vulnerable to water damage from internal floods are elevated above the floor. Water is directed away from enclosures for safety-related equipment and sloped floors and curbs preclude water entry into these areas. Where there is a potential for pebbles to be on a sloped or curbed floor, features prevent pebbles from rolling so that pebbles on the floor of the safety-related portion of the Reactor Building maintain a geometrically safe configuration for criticality.

Internal flooding in the safety-related portion of the Reactor Building has three potential sources: water system with SSCs located in the safety-related portion of the reactor building, water system SSCs located in the non-safety related portion of the Reactor Building, and fire protection water.

For water systems with SSCs located in the safety-related portion of the Reactor Building, the amount of water is limited by design. The maximum flow rate and the volume of water available for release from a break in the safety-related portion of the Reactor Building, is used to determine the effect of internal flooding on safety-related equipment. The quantity and flow rate of water is limited to the gravity-