Tennessee Valley Authority, 1101 Market Street, Chattanooga, TN 37402

CNL-17-055

April 17, 2017

10 CFR 52, Subpart A

ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Clinch River Nuclear Site
NRC Docket No. 52-047

Subject: Submittal of Supplemental Information Related to the Exclusion Area Boundary and Population Distribution Around the Clinch River Nuclear Site in Support of the Early Site Permit Application

References:

1. Letter from TVA to NRC, CNL-16-081, "Application for Early Site Permit for Clinch River Nuclear Site," dated May 12, 2016

2. U.S. Nuclear Regulatory Commission Public Meeting Summary, "Summary of Meeting Between the U.S. Nuclear Regulatory Commission and Tennessee Valley Authority to Discuss Topics Associated With Sections 2.1, 2.2, and 2.3 in Part 2, Site Safety Analysis Report of Tennessee Valley Authority's Early Site Permit Application for the Clinch River Nuclear Site," February 25, 2017.

By letter dated May 12, 2016 (Reference 1), Tennessee Valley Authority (TVA) submitted an application for an early site permit for the Clinch River Nuclear (CRN) Site in Oak Ridge, TN. During a public meeting held on February 13, 2017 (Reference 2), the NRC requested that TVA reconcile differences between the descriptions and depictions of the Exclusion Area Boundary (EAB) in the Site Safety Analysis Report (SSAR) and the Environmental Report (ER). In addition, the NRC requested that TVA reconcile differences between the descriptions and depictions of population distribution in the SSAR and the ER.

The enclosure to this letter provides supplemental information related to the CRN Site EAB and population distribution around the CRN Site.

There are no new regulatory commitments associated with this submittal. If any additional information is needed, please contact Dan Stout at (423) 751-7642.

I declare under penalty of perjury that the foregoing is true and correct. Executed on this 17th day of April 2017.

Respectfully,

J. W. Shea
Vice President, Nuclear Licensing

Enclosure:

Supplemental Information Regarding the Exclusion Area Boundary and Population Distribution Around the Clinch River Nuclear Site

cc (enclosure):

A. Fetter, Project Manager, Division of New Reactor Licensing, USNRC
P. Vokoun, Project Manager, Division of New Reactor Licensing, USNRC

cc (without enclosure):

V. McCree, Executive Director of Operations, USNRC
C. Haney, Regional Administrator, Region II, USNRC
M. Johnson, Deputy Executive Director for Reactor and Preparedness Programs, USNRC
V. Ordaz, Acting Director, Office of New Reactors, USNRC
F. Akstulewicz, Director, Division of New Reactor Licensing, USNRC
J. Donoghue, Acting Branch Chief, Division of New Reactor Licensing, USNRC
M. Sutton, Project Manager, Division of New Reactor Licensing, USNRC
T. Dozier, Project Manager, Division of New Reactor Licensing, USNRC
T. Beville, SMR Licensing Technical Support Program, DOE
M. Shields, SMR Licensing Technical Support Program, DOE
M. M. McIntosh, Regulatory Specialist, Eastern Regulatory Field Office, Nashville District, USACE

ENCLOSURE

Supplemental Information Regarding the Exclusion Area Boundary and Population Distribution Around the Clinch River Nuclear Site

By letter dated May 12, 2016 (Reference 1), Tennessee Valley Authority (TVA) submitted an application for an early site permit for the Clinch River Nuclear (CRN) Site in Oak Ridge, TN. During a public meeting held on February 13, 2017 (Reference 2), the NRC requested that TVA reconcile differences between the descriptions and depictions of the Exclusion Area Boundary (EAB) in the Site Safety Analysis Report (SSAR) and the Environmental Report (ER). In addition, the NRC requested that TVA reconcile differences between the descriptions and depictions of population distribution in certain sectors around the CRN Site in the SSAR and the ER.

This enclosure provides supplemental information to clarify the description and depiction of the CRN Site EAB and the description and depiction of population distribution around the CRN Site. These changes will be incorporated in a future revision of the Early Site Permit Application.

References:

1. Letter from TVA to NRC, CNL-16-081, "Application for Early Site Permit for Clinch River Nuclear Site," dated May 12, 2016. ADAMS accession number: ML16139A752

2. U.S. Nuclear Regulatory Commission Public Meeting Summary, "Summary of Meeting Between the U.S. Nuclear Regulatory Commission and Tennessee Valley Authority to Discuss Topics Associated With Sections 2.1, 2.2, and 2.3 in Part 2, Site Safety Analysis Report of Tennessee Valley Authority's Early Site Permit Application for the Clinch River Nuclear Site," February 25, 2017. ADAMS accession number: ML17054D545

Supplemental Information

Title 10 of the Code of Federal Regulations (10 CFR) 100.3 defines an exclusion area as, "that area surrounding the reactor, in which the reactor licensee has the authority to determine all activities including exclusion or removal of personnel and property from the area." 10 CFR 50.34(a)(1) requires an applicant to determine an exclusion area such that "an individual located at any point on the boundary of the exclusion area for any two-hour period following the onset of the postulated fission product release, would not receive a radiation dose in excess of 25 rem total effective dose equivalent."

SSAR Subsections 2.3.4 and 2.3.5 present the methodology for determining the atmospheric dispersion factors supporting the dose evaluation at the EAB. For conservatism and simplicity, this methodology utilizes circular analytical EABs that have a specified distance from potential effluent release boundaries. Effluent release boundaries are used to encircle the nuclear islands consisting of the reactor service building and associated buildings. The analytical EABs for the site are then encircled by an ellipse to demonstrate that they remain within the actual EAB (CRN Property boundary). However, these terms were not used consistently throughout the ESPA.

Therefore, SSAR Subsection 2.3.4 (including Tables 2.3.4-10, 2.3.4-11, 2.3.4-12, and 2.3.4-14, and Figures 2.3.4-1 and 2.3.4-2) and Subsection 2.3.5 (including Tables 2.3.5-1, 2.3.5-2, 2.3.5-3, and 2.3.5-10, and Figure 2.3.5-2) are being revised to more consistently use the terms associated with the analytical EAB when referring to analysis methodology or results. Similarly, ER Subsection 2.7.5 (including Tables 2.7.5-11, 2.7.5-12, and 2.7.5-13, and Figures 2.7.5-1 and 2.7.5-2) and Subsection 2.7.6 (including Tables 2.7.6-1, 2.7.6-2, 2.7.6-3, and 2.7.6-10, and

Figure 2.7.6-2) are being revised to more consistently use the terms associated with the analytical EAB.

During identification of the above changes, it was determined that the ESPA does not clearly describe that the EAB and the CRN Property boundary are the same as the owner controlled area boundary. Therefore, SSAR Subsections 2.1.1 and 2.1.2 (including Figure 2.1-5) are being revised to provide this clarification.

Regarding population distributions with respect to the EAB, SSAR Table 2.1-2 is being revised and a new figure (SSAR Figure 2.1-9) is being added to clarify the population distribution in and around the EAB. SSAR Section 2.1.3 and SSAR Figure 2.1-6 are being revised to refer to the new figure. In addition, SSAR Figure 2.1-7 is being revised to remove an erroneous reference citation. Similar changes are being made with the revision of ER Table 2.5.1-2 and the addition of new Figure 2.5.1-3. ER Subsection 2.5.1 and ER Figure 2.5.1-1 are being revised to refer to the new ER Figure 2.5.1-3.

SSAR Subsections 2.1.1.1 (paragraph 4), 2.1.1.2 (paragraphs 2 and 3), and 2.1.2 are being revised as indicated. Strikethroughs indicate text to be deleted. Underlines indicate text to be added.

2.1.1.1 Specification of Location

…
The CRN Site is approximately 935 acres (ac) and is located on a peninsula formed by a meander in the Clinch River arm of the Watts Bar Reservoir. The approximately 1200-ac C<u>RN</u>~~linch River~~ Property is bounded on the east, south, and west by the Clinch River arm of the Watts Bar Reservoir, and on the north by the U.S. Department of Energy's Oak Ridge Reservation and Wildlife Management Area. The site is situated on the historical Clinch River Breeder Reactor Project (CRBRP) Site. At the time of the project's cancellation in 1983, preliminary site work was essentially completed for the CRBRP, including all necessary sediment ponds, construction shops, concrete batch plants, the nuclear island excavation, and a foundation for a ringer crane. Approximately three million cubic yards of earth and rock were removed during this excavation. Upon project termination, the main site area of approximately 182 ac was remediated in accordance with the Site Remediation Plan. This included partial backfilling of the nuclear island excavation. The finished elevation for the remediated nuclear island excavation area was set at approximately 810 ft.
…

2.1.1.2 Site Area Map

…
The CRN Property is outlined, and the highways and railroads located within the 5-mi vicinity are shown in Figure 2.1-3. ~~The CRN Property is the same as the owner controlled area.~~ The total area contained by the CRN Property is approximately 1200 ac. Figure 2.1-4 illustrates the cities, counties, transportation network, and states located within the 50-mi region.

ENCLOSURE

Supplemental Information Regarding the Exclusion Area Boundary and Population Distribution Around the Clinch River Nuclear Site

~~The exclusion area boundary (EAB) is shown on Figure 2.1-5. The shortest distance from the EAB to the effluent release boundary is at least 1100 ft. See Subsection 2.3.4 for a detailed description of the EAB.~~

2.1.2 Exclusion Area Authority and Control

The CRN Site is approximately 935 acres within ~~a~~the 1200 acre CRN P~~p~~roperty owned by the United States of America and managed by TVA. TVA is the Applicant for the ESP. As illustrated in Figure 2.1-3, there are no public transportation routes crossing the site. There are no mineral resources, including oil and natural gas, within or adjacent to the site that are being exploited. The only known resource of value located within the property is limestone, and the United States owns all of the mineral rights for the property.

The exclusion area boundary (EAB) is delineated by the boundary of the CRN Property, as shown on Figure 2.1-5.

The CRN Property is the same as the owner controlled area. The CRN Property will be clearly posted with “no trespassing” signs along the property border and river shorelines. All road access points will be controlled. Once inside the owner controlled area, access to the nuclear plant will be controlled with security check-points and barriers. The site’s physical security plan contains information on actions to be taken by security force personnel in the event of unauthorized persons crossing the EAB by land or water. The permanent population distribution within the EAB is zero.

SSAR Subsection 2.1.3 is being revised as indicated. Underlines indicate text to be added.

2.1.3 Population Distribution

The population distribution surrounding the site, up to a 50-mi (80-kilometers [km]) radius, is estimated based upon the most recent 2010 USCB decennial census data. The population distribution is estimated in fifteen concentric bands at 0–0.3 mi (0.5 km), 0.3–1 mi (1.6 km), 1–2 mi (3.2 km), 2–3 mi (4.83 km), 3–4 mi (6.44 km), 4–5 mi (8.05 km), 5–6 mi (9.66 km), 6–7 mi (11.3 km), 7–8 mi (12.9 km), 8–9 mi (14.5 km), 9–10 mi (16.1 km), 10–20 mi (32.2 km), 20–30 mi (48.3 km), 30–40 mi (64.4 km), and 40–50 mi (80.5 km) from the site center point. These bands are subdivided into 16 directional sectors, each centered on one of the 16 compass directions and consisting of 22.5 degrees. Population sectors out to 2 mi (3.2) km are shown in Figure 2.1-9, population sectors out to 10 mi (16 km) are shown in Figure 2.1-6, and population sectors out to 50 mi (80 km) are shown in Figure 2.1-7.

ENCLOSURE

Supplemental Information Regarding the Exclusion Area Boundary and Population Distribution Around the Clinch River Nuclear Site

SSAR Table 2.1-2, Sheet 5, is being revised as indicated. Underlines indicate text to be added.

Table 2.1-2 (Sheet 5 of 5)
Projected Permanent Population for Each Sector 0–10 mi (0–16 km)

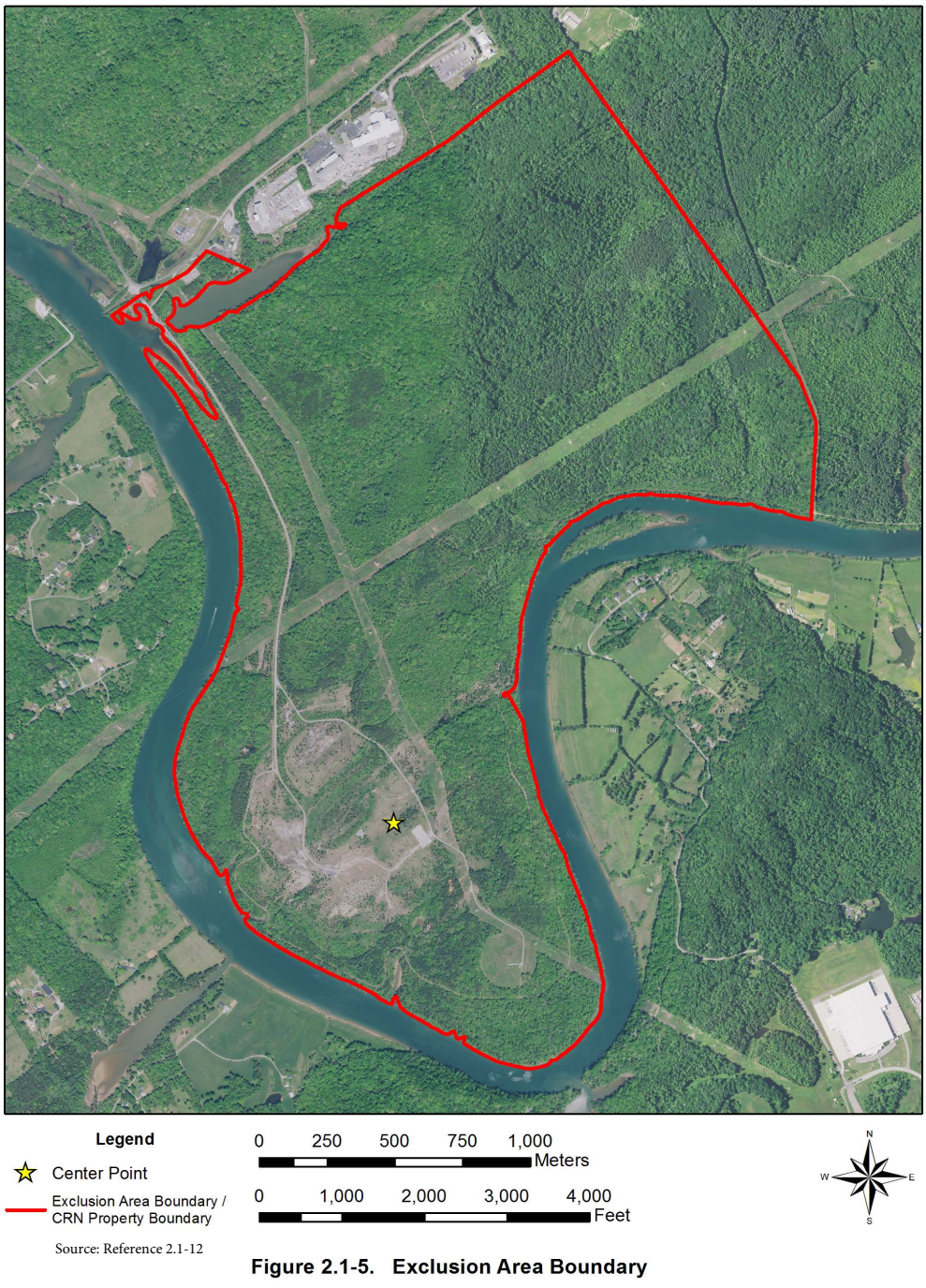
Direction /Year	Sector 0–0.3 (mi)	Sector 0.3–1 (mi)	Sector 1–2 (mi)	Sector 2–3 (mi)	Sector 3–4 (mi)	Sector 4–5 (mi)	Sector 5–10 (mi)	Sector 0–10 (mi)
Totals								
2010	0	149	537	1,091	1,407	2,990	61,029	67,203
2013	0	151	544	1,109	1,437	3,063	63,060	69,364
2021	0	155	560	1,143	1,504	3,225	68,070	74,657
2027	0	157	564	1,155	1,539	3,313	71,161	77,889
2037	0	157	564	1,159	1,570	3,403	75,039	81,892
2047	0	157	564	1,163	1,594	3,469	78,163	85,110
2057	0	157	564	1,168	1,621	3,549	81,759	88,818
2067	0	157	564	1,174	1,658	3,654	86,263	93,470
Cumulative Totals	**0–0.3 (mi)**	**0–1 (mi)**	**0–2 (mi)**	**0–3 (mi)**	**0–4 (mi)**	**0–5 (mi)**	**5–10 (mi)**	**0–10 (mi)**
2010	0	149	686	1,777	3,184	6,174	61,029	67,203
2013	0	151	695	1,804	3,241	6,304	63,060	69,364
2021	0	155	715	1,858	3,362	6,587	68,070	74,657
2027	0	157	721	1,876	3,415	6,728	71,161	77,889
2037	0	157	721	1,880	3,450	6,853	75,039	81,892
2047	0	157	721	1,884	3,478	6,947	78,163	85,110
2057	0	157	721	1,889	3,510	7,059	81,759	88,818
2067	0	157	721	1,895	3,553	7,207	86,263	93,470

Notes:
Based on 2010 USCB data.
No permanent population distribution is within the exclusion area boundary (EAB)
Source: Reference 2.1-12

ENCLOSURE

Supplemental Information Regarding the Exclusion Area Boundary and Population Distribution Around the Clinch River Nuclear Site

SSAR Figure 2.1-5 is being replaced with the figure below.



Source: Reference 2.1-12

Figure 2.1-5. Exclusion Area Boundary

ENCLOSURE

Supplemental Information Regarding the Exclusion Area Boundary and Population Distribution Around the Clinch River Nuclear Site

SSAR Figure 2.1-6 is being replaced with the figure below.

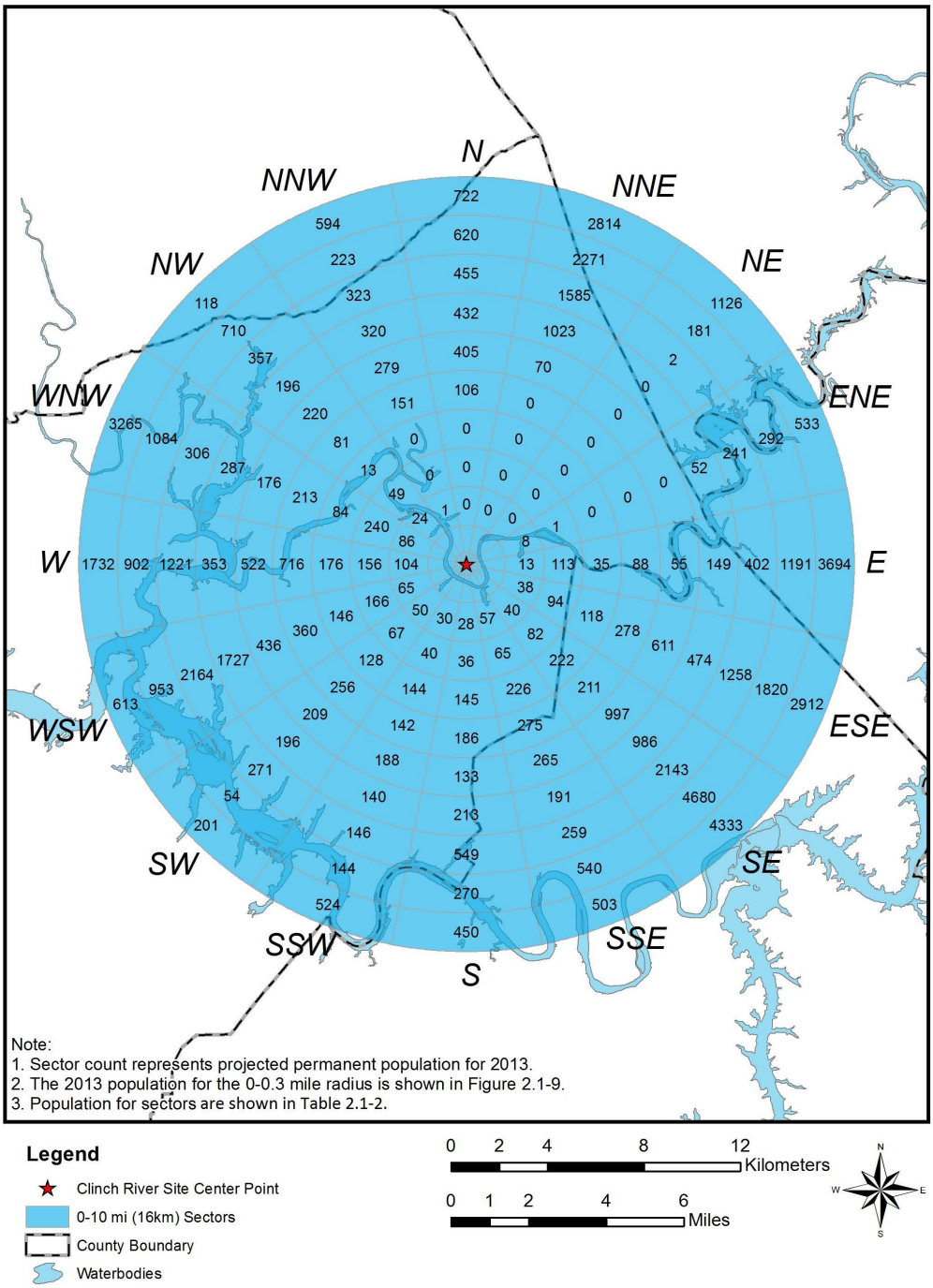


Figure 2.1-6. 0-10 Mile Population Sector Map

ENCLOSURE

Supplemental Information Regarding the Exclusion Area Boundary and Population Distribution Around the Clinch River Nuclear Site

SSAR Figure 2.1-7 is being replaced with the figure below.

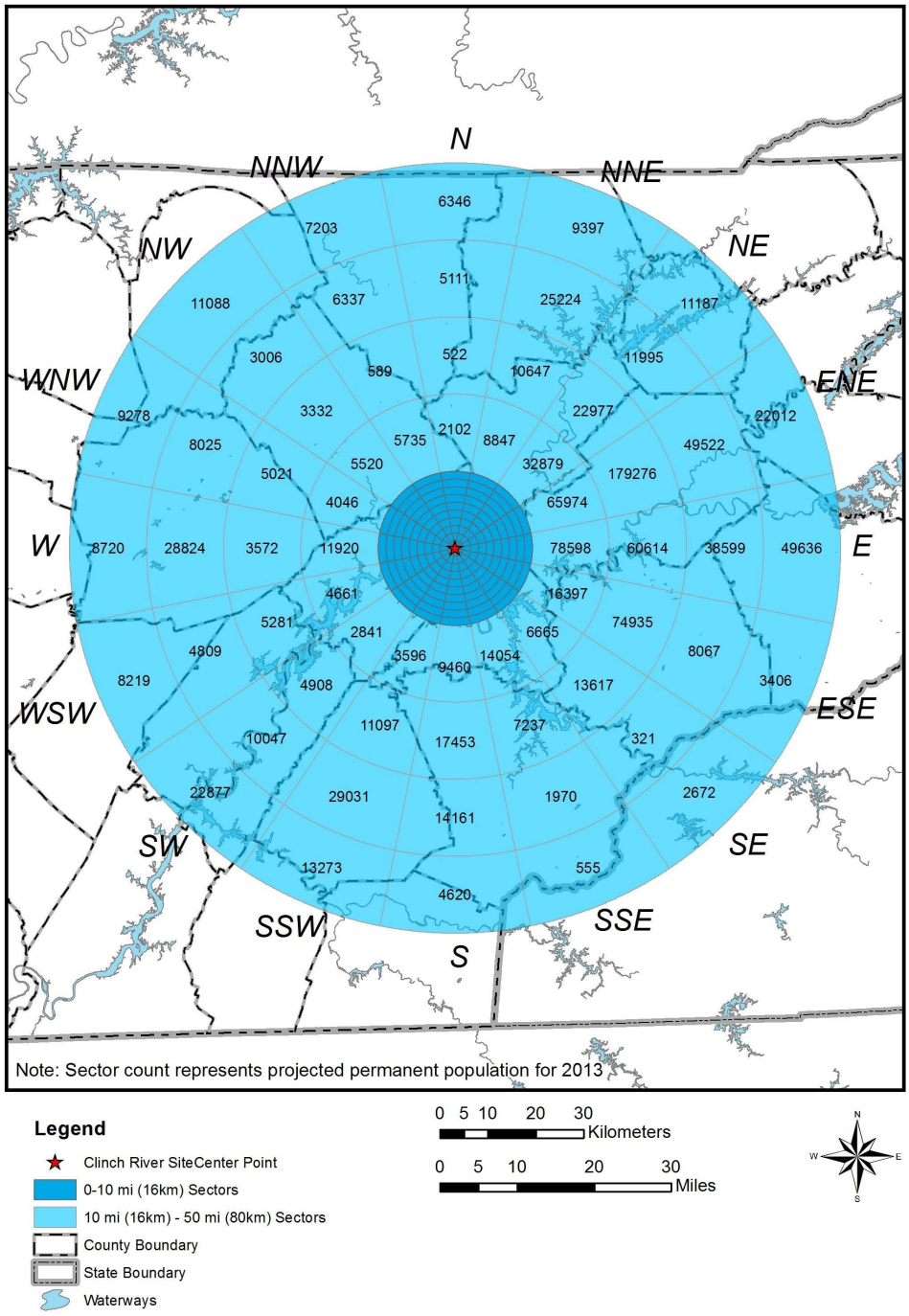


Figure 2.1-7 10–50 Mile Population Sector Map

ENCLOSURE

Supplemental Information Regarding the Exclusion Area Boundary and Population Distribution Around the Clinch River Nuclear Site

New SSAR Figure 2.1-9 (below) is being added.

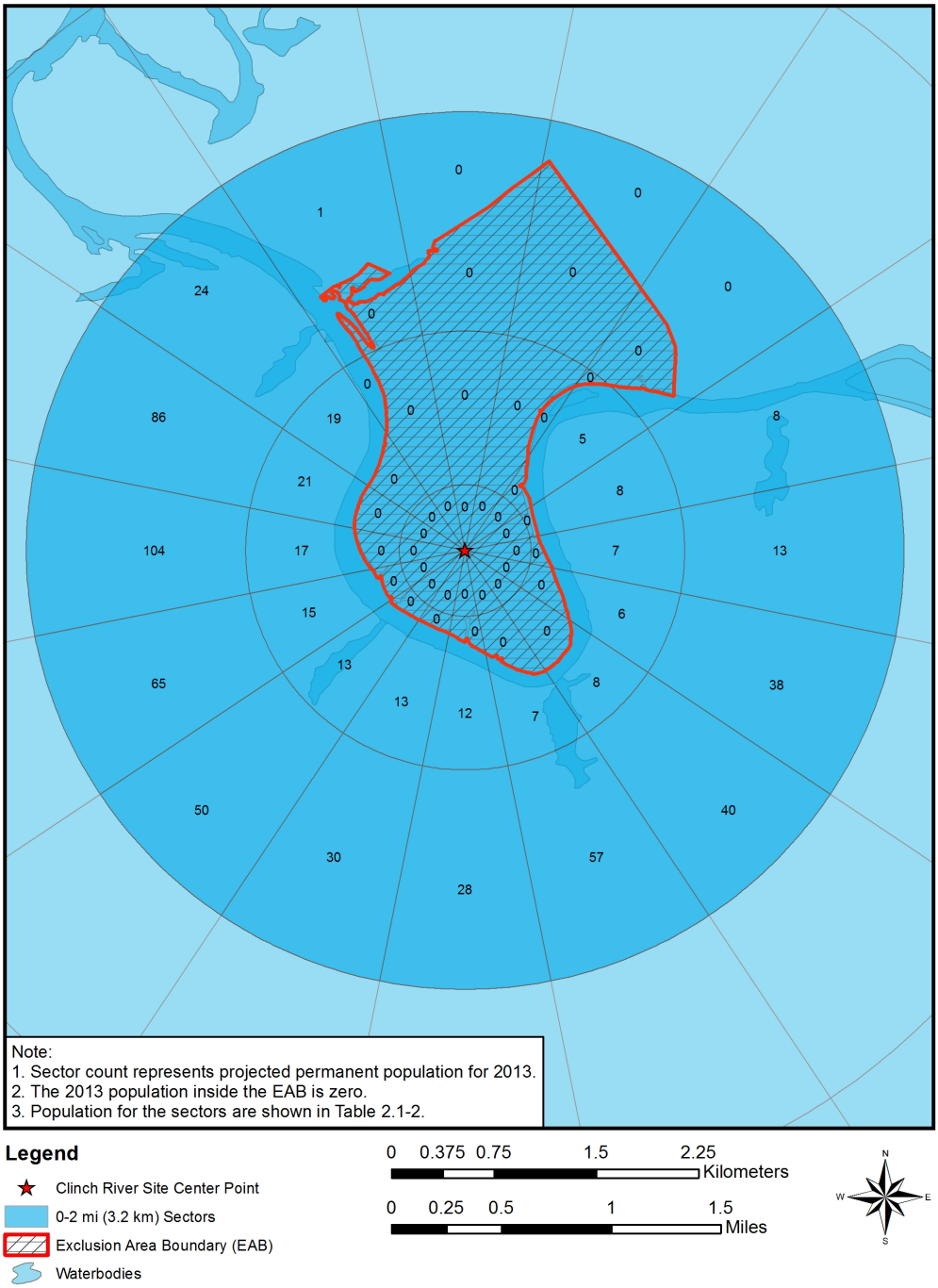


Figure 2.1-9. 0-2 Mile Population Sector Map

ENCLOSURE

Supplemental Information Regarding the Exclusion Area Boundary and Population Distribution Around the Clinch River Nuclear Site

SSAR Subsection 2.3.4.2 (paragraphs 7, 8 and 9) is being revised as indicated. Strikethroughs indicate text to be deleted. Underlines indicate text to be added.

2.3.4.2 Calculation Methodology and Assumptions

…

RG 1.145 requires that, for each of the 16 compass sectors, the distance to the EAB should be the minimum distance between the effluent release point and the EAB within a 45-degree sector centered on the compass direction of interest. For conservatism and simplicity, ~~circular, analytical EABs were defined at a fixed distance from release zones. The release zones were based on circular effluent release boundaries (ERBs) that were determined from a composite of the proposed reactor and engineering structures such that the ERBs bound any potential radionuclide release locations. They also allow for any future changes in the CRN Small Modular Reactor (SMR) footprint. The release zones encompass the SMR nuclear island (Figure 2.3.4-1).~~ the effluent release point is evaluated as a circular effluent release boundary (ERB) that encloses potential release points from the nuclear island as shown in Figure 2.3.4-1. A circular analytical EAB is established 1100 ft (335 m) from the ERB. For X/Q modelling (Table 2.3.4-11), the analytical EAB is used as a bounding representative distance to the EAB. To account for multiple units on site, nuclear islands are positioned at multiple locations within the power block with associated ERBs and EABs as shown in Figure 2.3.4-1 (note that although the nuclear islands for vendors 1 and 4 are depicted in the figure, the nuclear islands, associated ERBs, and analytical EABs for vendors 1, 2, 3, and 4 fit within the EAB ellipse). The analytical EABs can be encompassed by an ellipse fixed completely within the CRN Property boundary, i.e. the actual EAB (Figure 2.3.4-1), which demonstrates that dispersion factor computations are conservative.

The site center point is determined as the centerline midpoint of the EAB ellipse (Figure 2.3.4-1). The ellipse has a short axis of 0.326 mi (524 m) from the site center point and long axis of 0.535 mi (864 m) from the center point.

Although radioactive release from the turbine islands is possible, the effects of postulated releases from nuclear islands will ~~conservatively~~ bound those of the turbine island. Additional discussion regarding postulated accidents is provided in S~~ubs~~ection ~~2.3.5.2~~15.1.

~~Each Release Zone was considered individually in calculating atmospheric dispersion factors at the site boundary. The distance used in the X/Q modeling was 1100 feet (335 m) (Table 2.3.4-11). This distance was measured from the edge of the circular ERBs~~.

~~The various analytical EABs can be encompassed by an ellipse fixed completely within the CRN Property boundary, which demonstrates that the actual EAB conservatively bounds the analytical EAB for radiation dose computations. The ellipse has a short axis of 0.326 mi (524 m) from the site center point and long axis of 0.535 mi (861 m) from the center point. The site center point was determined by the centerline midpoint of the Release Zone EABs.~~

ENCLOSURE

Supplemental Information Regarding the Exclusion Area Boundary and Population Distribution Around the Clinch River Nuclear Site

SSAR Subsection 2.3.4.3 is being revised as indicated. Strikethroughs indicate text to be deleted. Underlines indicate text to be added.

2.3.4.3 Summary of Results and Conclusions

The PAVAN results for the ~~CRN Site Release Zones~~dispersion factors computed at the LPZ and analytical EAB, based on the 2011-2013 meteorological data, are given in Tables 2.3.4-12 through 2.3.4-14. Table 2.3.4-14 provides the bounding values for the ~~analytical~~ EAB~~s~~ and LPZ, respectively.

The results of these computations indicated that the highest concentrations are found in the sectors that lie to the west-northwest (WNW) of the plant, which is consistent with the relatively high percentage of stable (F and G) conditions associated with light winds that blow from the southeast (Subsection 2.3.2).

ENCLOSURE

Supplemental Information Regarding the Exclusion Area Boundary and Population Distribution Around the Clinch River Nuclear Site

SSAR Table 2.3.4-10 is being revised as indicated. Strikethroughs indicate text to be deleted. Underlines indicate text to be added.

Table 2.3.4-10
List of Inputs used in the PAVAN Modeling

PAVAN Model Input Variable	Value
Number of Wind Speed Categories (NVEL)	13
Type of Release	Ground
Building Minimum Cross-Sectional Area (A)	0.0 m^2
Containment Building Height (D)	0.0 m
Release Height (HS)	10.0 m
Wind Sensor Height (TOWERH)	9.78 m
Conversion Correction Factor (UCOR)	150
Lower-T Sensor Height	8.44 m
Upper-T Sensor Height	59.22 m
Distance from Effluent Release Boundary ~~Zone~~ to Analytical Exclusion Area Boundary	335 m
Distance to Low Population Zone	1609 m

Notes:

A release height (HS) of 10 m~~eters~~ is used for ground level release, consistent with NUREG/CR-2858.

ENCLOSURE

Supplemental Information Regarding the Exclusion Area Boundary and Population Distribution Around the Clinch River Nuclear Site

SSAR Table 2.3.4-11 is being revised as indicated. Strikethroughs indicate text to be deleted. Underlines indicate text to be added.

Table 2.3.4-11
Distances and Elevations for the EAB and LPZ in the 16 Wind Direction Sectors

Wind Direction Sector	Distance from Effluent Release Boundary ~~Zone~~ to Analytical EAB		LPZ Distance	
	(~~feet~~)	(~~meters~~)	(mi~~les~~)	(~~meters~~)
S	1100	335	1	1609
SSW	1100	335	1	1609
SW	1100	335	1	1609
WSW	1100	335	1	1609
W	1100	335	1	1609
WNW	1100	335	1	1609
NW	1100	335	1	1609
NNW	1100	335	1	1609
N	1100	335	1	1609
NNE	1100	335	1	1609
NE	1100	335	1	1609
ENE	1100	335	1	1609
E	1100	335	1	1609
ESE	1100	335	1	1609
SE	1100	335	1	1609
SSE	1100	335	1	1609

Notes:

The Effluent Release Boundary~~Zone~~ includes the ~~effluent release boundary (ERB) of the~~ nuclear island, which consists of the reactor service building and associated buildings that are potential sources of radioactive releases.

The low population zone (LPZ) was determined as an area with a 1-mi~~le~~ (1609 m) radius from the site center point.

EAB = exclusion area boundary

ENCLOSURE

Supplemental Information Regarding the Exclusion Area Boundary and Population Distribution Around the Clinch River Nuclear Site

SSAR Table 2.3.4-12 is being revised as indicated. Strikethroughs indicate text to be deleted. Underlines indicate text to be added.

Table 2.3.4-12
CRN SMR Short-Term Exclusion Area Boundary Accident Release X/Q Values

0.5% and 5% *X*/Q Values (s/m^3) at the EAB				
		Direction-Dependent X/Q		Direction Independent *X*/Q
Effluent Release Boundary~~Zone~~ to Analytical EAB	**Time Period**	**0.5% Maximum**	**Sector**	**5% Site Limit**
Effluent Release Boundary~~Zone~~ (335 m)	0–2 Hours	4.96E-03	WNW	4.33E-03

Notes:

Modeling results reflect no building wake credit.

A circular, analytical exclusion area boundary (EAB) was defined at a fixed distance. The distance used ~~for~~from the Effluent Release Boundary ~~Zone~~ to the analytical EAB was 1100 ft (335 m).

The Effluent Release Boundary~~Zone~~ includes the nuclear island, which contains the reactor building and associated structures that are potential sources of radioactive releases.

SSAR Table 2.3.4-14 is being revised as indicated. Strikethroughs indicate text to be deleted. Underlines indicate text to be added.

Table 2.3.4-14
Clinch River Nuclear Site Enveloping Power Block Accident Release Bounding X/Q Values

Bounding *X*/Q Values (s/m^3) at the EAB and LPZ					
Location	**0–2 Hours**	**0–8 Hours**	**8–24 Hours**	**1–4 Days**	**4–30 Days**
Effluent Release Boundary ~~Zone~~ to EAB	4.96E-03	2.94E-03	2.26E-03	1.28E-03	5.67E-04
LPZ	NA	3.10E-04	2.26E-04	1.14E-04	4.30E-05

Notes:

A circular, analytical exclusion area boundary (EAB) was defined at a fixed distance from the Effluent Release Boundary~~Zone~~. The distance used ~~for~~ from the Effluent Release Boundary ~~Zone~~ to the analytical EAB was 1100 ~~feet (~~ft~~)~~ (335 m).

The low population zone (LPZ) was determined as an area with a 1-mi~~le~~ (1609-m) radius, centered on the site.

The Effluent Release Boundary~~Zone~~ includes the nuclear island, which contains the reactor building and associated structures that are potential sources of radioactive releases.

NA = Not Applicable

ENCLOSURE

Supplemental Information Regarding the Exclusion Area Boundary and Population Distribution Around the Clinch River Nuclear Site

SSAR Figure 2.3.4-1 is being replaced with the figure below.

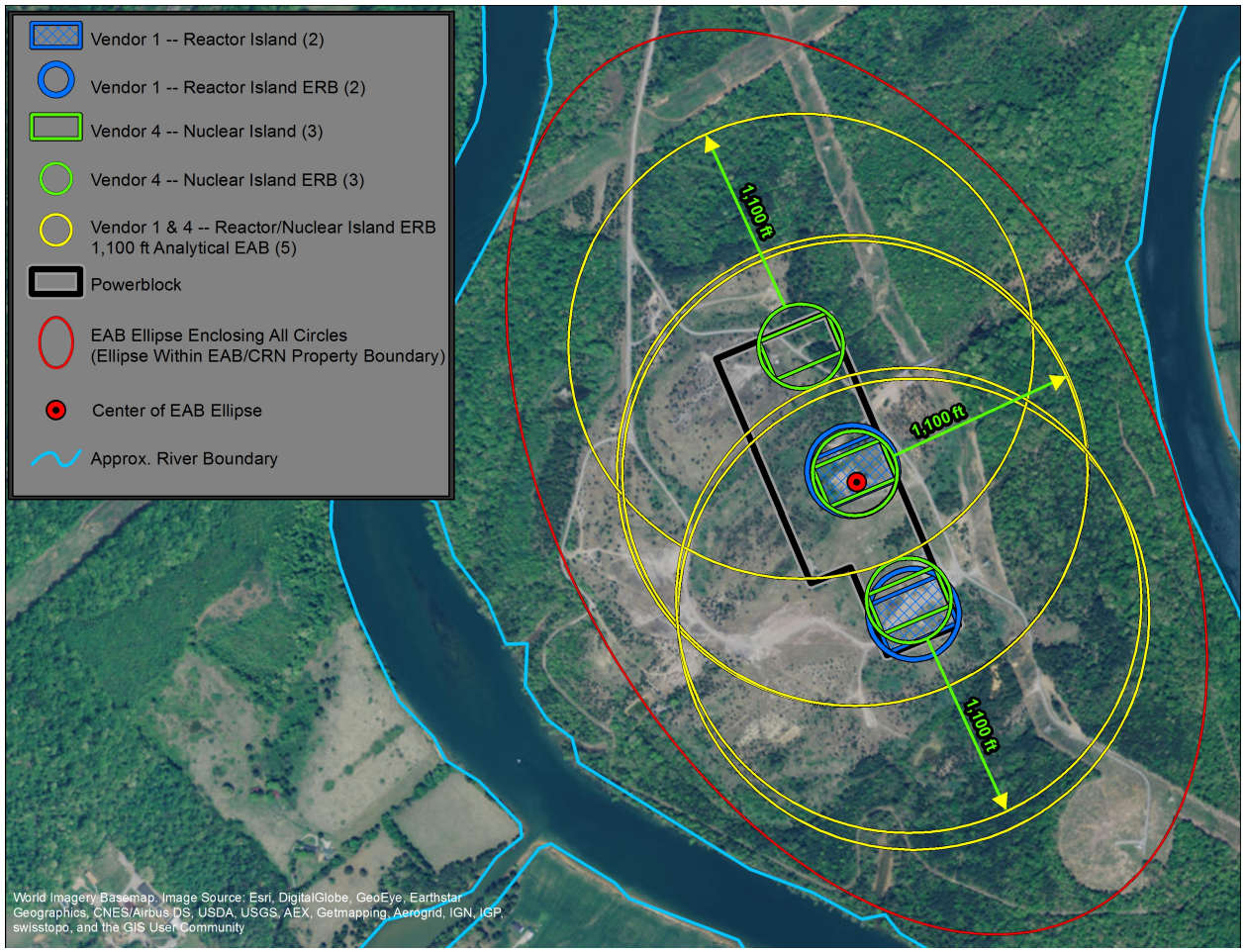
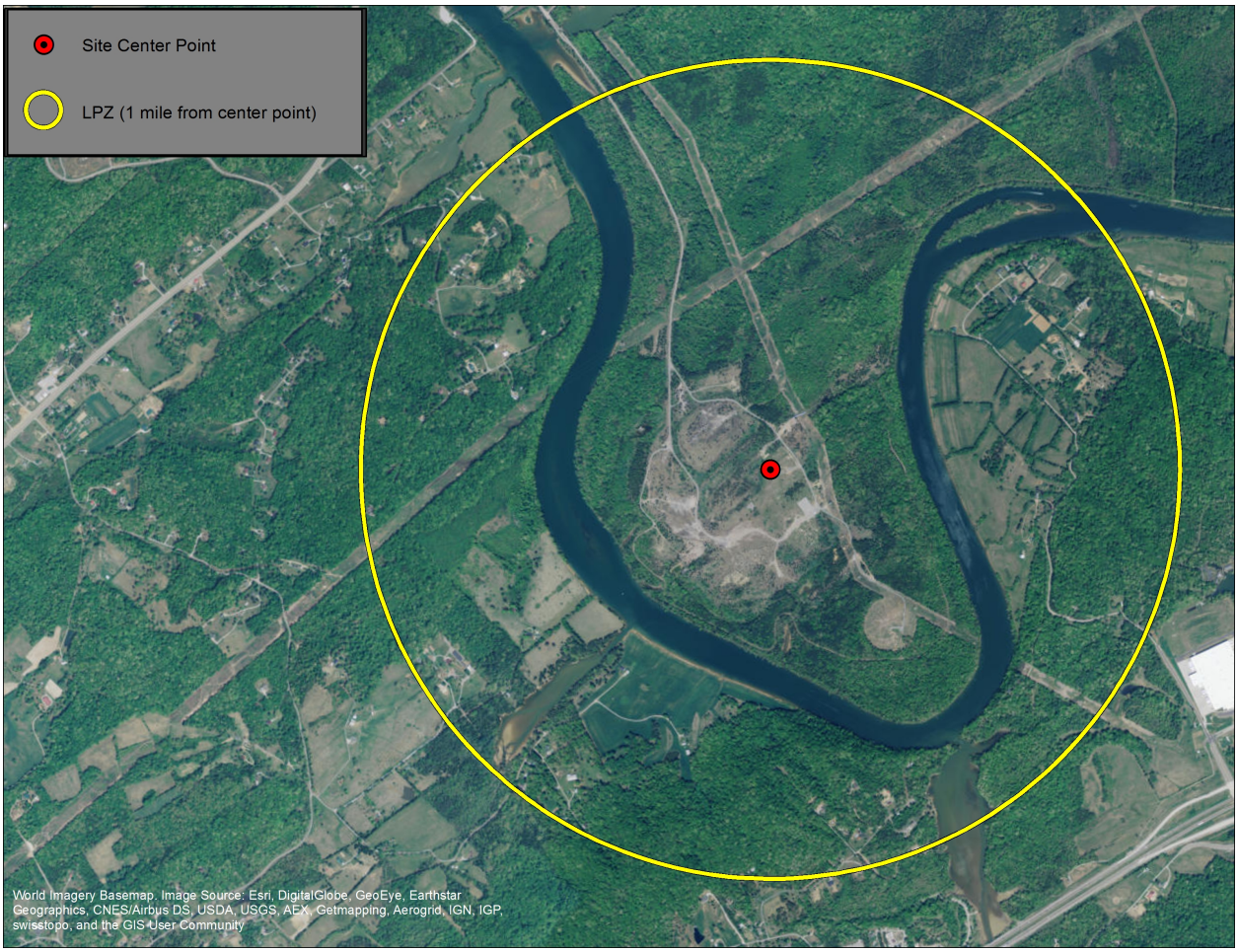


Figure 2.3.4-1. Effluent Release Boundary with Analytical EABs

ENCLOSURE

Supplemental Information Regarding the Exclusion Area Boundary and Population Distribution Around the Clinch River Nuclear Site

SSAR Figure 2.3.4-2 is being replaced with the figure below.



Notes:
LPZ = Low Population Zone

Figure 2.3.4-2. Site Center Point and Distance to the LPZ

ENCLOSURE

Supplemental Information Regarding the Exclusion Area Boundary and Population Distribution Around the Clinch River Nuclear Site

SSAR Subsection 2.3.5.2 (paragraphs 2, 3, and 5) is being revised as indicated. Strikethroughs indicate text to be deleted. Underlines indicate text to be added.

2.3.5.2 Calculation Methodology and Assumptions

…

Using the JFDs, XOQDOQ provides the X/Q values as functions of direction for various time periods at the EAB, at points of maximum individual exposure, and at points within a radial grid of sixteen 22.5 degree sectors extending to a distance of 50 miles (80.5 km). According to RG 4.7, an applicant is required by 10 CFR 100.21(a) to designate an exclusion area and to have authority to determine all activities within that area, including removal of personnel and property. For assessing releases at the site boundary, ~~circular, analytical EABs were defined at a fixed distance from a release zone. The release zone was based on a circular effluent release boundary (ERBs) that was determined as a composite of the proposed reactor and engineering structures that would bound the safety and environmental impact of plant construction and operation on the site~~. ~~The ERB also allowed for any future changes in the CRN Site small modular reactor (SMR) footprint. The release zone encompassed the nuclear island from the largest SMR source.~~ the effluent release point is evaluated as a circular effluent release boundary (ERB) that encloses potential release points from the nuclear island as shown in Figure 2.3.4-1. A circular analytical EAB is established 1100 ft (335 m) from the ERB. For X/Q modelling (Table 2.3.4-11), the analytical EAB is used as a bounding representative distance to the EAB. To account for multiple units on site, nuclear islands are positioned at multiple locations within the power block with associated ERBs and EABs as shown in Figure 2.3.4-1 (note that although the nuclear islands for vendors 1 and 4 are depicted in the figure, the nuclear islands, associated ERBs, and analytical EABs for vendor 1, 2, 3, and 4 fit within the EAB ellipse). The analytical EABs can be encompassed by an ellipse fixed completely within the CRN Property boundary, i.e. the actual EAB (Figure 2.3.4-1), which demonstrates that dispersion factor computations are conservative.

The site center point is determined as the centerline midpoint of the EAB ellipse (Figure 2.3.4-1). The ellipse has a short axis of 0.326 mi (524 m) from the site center point and long axis of 0.535 mi (864 m) from the center point.

~~The radius of the ERB was used in calculating atmospheric dispersion factors at the site boundary. The distance from the ERB to the EAB is 1100 feet (335 meters) (Figure 2.3.4-1). As described in Subsection 2.3.4, the various analytical EABs can be encompassed by an ellipse with the site center point as the center, short axis being 0.326 miles (524 meters) from the site center point, and long axis being 0.535 miles (861 meters) from the center point (Figure 2.3.4-1).~~

…

Other plant specific data used in the XOQDOQ model include building minimum cross-sectional area, building height, and meteorological tower height at which wind speed was measured. The building height and cross-sectional area are considered in the calculation of building wake effects. RG 1.111 identifies the tallest adjacent building as appropriate for use. Building area is defined as the smallest vertical-plane, cross-sectional area of the affected building, in square meters. The dose calculation at the EAB and the low population zone (LPZ) are both located beyond the building wake influence zone, so the height and cross-sectional area had little effect in building wake X/Q values. Therefore, for conservatism, no building wake credit was used in the XOQDOQ model (e.g., cross-sectional area and building height were both set to zero).

ENCLOSURE

Supplemental Information Regarding the Exclusion Area Boundary and Population Distribution Around the Clinch River Nuclear Site

SSAR Subsection 2.3.5.3 (paragraphs 3 and 6) is being revised as indicated. Strikethroughs indicate text to be deleted. Underlines indicate text to be added.

2.3.5.3 Complex Terrain Modeling Analysis

…

The approach used for the CRN Site analysis involved a comparison of estimated long-term X/Q values between the CALPUFF modeling system and the XOQDOQ model at the LPZ and an analytical EAB ~~and LPZ~~. The CALPUFF Version 6.42 dispersion modeling system is an advanced, non-steady-state, meteorological and air quality modeling system used by the U.S. Environmental Protection Agency (EPA) in its Guideline on Air Quality Models that can be applied in near-field applications involving complex meteorological conditions (References 2.3.5-5, 2.3.5-6). The modeling system is comprised of a meteorological processor, CALMET, Version 6.334, which develops hourly wind and temperature fields on a three-dimensional gridded modeling domain, with two-dimensional fields of mixing height, surface characteristics, and dispersion properties (Reference 2.3.5-4). The CALPUFF model is a multi-layer, multi-species, non-steady-state puff dispersion model that simulates the effects of time- and space-varying meteorological conditions on pollution transport, transformation and removal. The concentrations and deposition files produced from CALPUFF are post-processed by the CALPOST, Version 6.292, processor into tables and plot files of concentrations at given receptors. The latest version of CALPUFF was used in order to incorporate the latest chemistry mechanisms and modeling updates.

…

Both the CALPUFF and XOQDOQ models used a single ground-level point source located at the center point of the site with no building wake credit given. To model a ground-level release in CALPUFF, all stack parameters must be set to nonzero values, with the exception of stack height. Therefore, to closely simulate a ground-level release that would be dominated by plume momentum, a stack diameter of 3.28 feet (1.0 m~~eters~~) and an exit velocity of 0.224 mi~~le~~/h~~our~~ (0.1 ~~meters per second~~m/s) was assumed. A stack height of 32.8 f~~eet~~ (10 m~~eters~~) was used to maintain consistency with the XOQDOQ default stack height for ground-level releases (Reference 2.3.5-3). As indicated in NUREG/CR-2919, nuclear power vents generally have ambient temperature plumes, so the source exit temperature in CALPUFF was set to 68°F (293 K). The American Nuclear Society (ANS)-2.15 guidance document, *Criteria for Modeling and Calculating Atmospheric Dispersion of Routine Radiological Releases from Nuclear Facilities*, was also referenced in the modeling setup of the CALPUFF system (Reference 2.3.5-1). With the center point of the site as the source location, both models included discrete receptors at an analytical EAB ~~a site boundary~~ with radius equal to the shorter distance of the EAB ellipse (0.326 mi~~les~~ (524 m~~eters~~)) and at the 1.0 mi~~le~~ (1609 m~~eters~~) LPZ distance for each of the 16 wind direction sectors (Figure 2.3.5-2). The CALPUFF input options are summarized in Table 2.3.5-2.

ENCLOSURE

Supplemental Information Regarding the Exclusion Area Boundary and Population Distribution Around the Clinch River Nuclear Site

SSAR Table 2.3.5-1 is being revised as indicated. Underlines indicate text to be added.

Table 2.3.5-1
List of Inputs Used in the XOQDOQ Modeling for Complex Terrain Analysis

XOQDOQ Input Variable	Value
Wind Sensor Height (PLEV)	9.78 m
Conversion Correction Factor (UCOR)	150
Lower-T Sensor Height	8.44 m
Upper-T sensor Height	59.22 m
Type of Release	Ground
Vent Average Velocity (EXIT)	0.0 m/s
Vent Inside Diameter (DIAMTR)	0.0 m
Vent Release Height (HSTACK)	10.0 m
Containment Building Height (HBLDG)	0.0 m
Building Min. Cross-Sectional Area (CRSEC)	0.0 m^2
Wind Height (SLEV)	10.0 m
Distance From Site Center Point to Analytical EAB	524 m

Notes:

No building wake credit was used in the modeling. Therefore, the building height and cross-sectional area were set to zero.

For a ground-level release, the exit velocity and diameter are set to zero, while the wind height is set to 10 m, consistent with NUREG/CR-2919 (Reference 2.3.5-2).

Vent height is set equal to wind height in the XOQDOQ model (see Reference 2.3.5-3).

ENCLOSURE

Supplemental Information Regarding the Exclusion Area Boundary and Population Distribution Around the Clinch River Nuclear Site

SSAR Table 2.3.5-2 is being revised as indicated. Underlines indicate text to be added.

Table 2.3.5-2
CALPUFF Model Input Configuration for Complex Terrain Analysis

CALPUFF Parameter	Input Value or Source
Episode Modeled	June 1, 2011–May 31, 2013
Domain Size	10-mile (16.09 km) radius
# of Grid Cells	111 x 111
Grid Spacing	382.8 y~~ar~~d (350 m~~eter~~)
# of Vertical (Height) Levels	22
Upper Air Data	Nashville NWS Station
Precipitation Data	Oak Ridge Automated Surface Observing System
Surface Data	Clinch River Met Tower
Source Location	Site Center Coordinates
Base elevation	820.9 f~~eet~~ (250.2 m~~eter~~)
Distance From Site Center Point to Analytical EAB	1719.2 f~~eet~~ (524 m~~eter~~) radius
Distance to LPZ	5278.9 f~~eet~~ (1609 m~~eter~~) radius
# of Stacks (Vents)	1
Stack #1 Height	32.8 f~~eet~~ (10.0 m~~eter~~)
Stack #1 Diameter	3.28 f~~eet~~ (1.0 m~~eter~~)
Stack #1 Exit Velocity	0.3281 f~~eet~~/s (0.1 m~~eter~~/s)
Stack #1 Exit Temperature	68°F (293 K)

Notes:

For the complex terrain modeling, the analytical exclusion area boundary (EAB) was defined as an area with a 0.326-mi~~le~~ (524-m~~eters~~) radius from the center point of the site. The low population zone (LPZ) was defined as an area with a 1-mi~~le~~ (1609-m~~eters~~) radius from the center point of the site.

ENCLOSURE

Supplemental Information Regarding the Exclusion Area Boundary and Population Distribution Around the Clinch River Nuclear Site

SSAR Table 2.3.5-3 is being revised as indicated. Underlines indicate text to be added.

Table 2.3.5-3
Long-Term Average X/Q Values at the Exclusion Area Boundary

Long-Term Average X/Q Values (s/m^3)									
Analytical EAB Sector	Undepleted			2-Day Decay			8-Day Decay		
	XOQDOQ	CALPUFF	Ratio	XOQDOQ	CALPUFF	Ratio	XOQDOQ	CALPUFF	Ratio
S	2.70E-05	2.01E-06	0.07	2.70E-05	2.01E-06	0.07	2.50E-05	2.01E-06	0.08
SSW	2.40E-05	1.95E-06	0.08	2.40E-05	1.95E-06	0.08	2.30E-05	1.95E-06	0.08
SW	2.80E-05	1.32E-06	0.05	2.80E-05	1.32E-06	0.05	2.60E-05	1.32E-06	0.05
WSW	4.20E-05	1.17E-06	0.03	4.10E-05	1.17E-06	0.03	3.80E-05	1.17E-06	0.03
W	6.70E-05	1.15E-06	0.02	6.60E-05	1.14E-06	0.02	6.10E-05	1.15E-06	0.02
WNW	9.10E-05	6.51E-07	0.01	9.10E-05	6.49E-07	0.01	8.40E-05	6.51E-07	0.01
NW	7.80E-05	1.38E-06	0.02	7.70E-05	1.38E-06	0.02	7.20E-05	1.38E-06	0.02
NNW	4.60E-05	3.01E-06	0.07	4.50E-05	3.01E-06	0.07	4.20E-05	3.01E-06	0.07
N	3.10E-05	2.93E-06	0.09	3.10E-05	2.92E-06	0.09	2.90E-05	2.92E-06	0.10
NNE	2.20E-05	3.75E-06	0.17	2.20E-05	3.74E-06	0.17	2.00E-05	3.75E-06	0.19
NE	2.20E-05	2.11E-06	0.10	2.20E-05	2.11E-06	0.10	2.00E-05	2.11E-06	0.11
ENE	3.30E-05	2.26E-06	0.07	3.30E-05	2.26E-06	0.07	3.10E-05	2.26E-06	0.07
E	4.10E-05	2.78E-06	0.07	4.10E-05	2.77E-06	0.07	3.80E-05	2.78E-06	0.07
ESE	5.70E-05	3.68E-06	0.06	5.60E-05	3.67E-06	0.07	5.20E-05	3.68E-06	0.07
SE	4.60E-05	2.23E-06	0.05	4.60E-05	2.23E-06	0.05	4.20E-05	2.23E-06	0.05
SSE	2.90E-05	2.57E-06	0.09	2.90E-05	2.57E-06	0.09	2.70E-05	2.57E-06	0.10

Notes:

Long-term average values are reflective of a multi-year average from the Clinch River Nuclear Site June 1, 2011– May 31, 2013 meteorological episode. Both the XOQDOQ and CALPUFF X/Q values reflect the undepleted, 2-day decay, and 8-day decay cases.

For the complex terrain analysis, the analytical exclusion area boundary (EAB) was defined as an area with a 0.326-mi~~le~~ (524-m~~eters~~) radius from the center point of the site.

The ratio is determined by the CALPUFF concentration divided by the XOQDOQ concentration.

ENCLOSURE

Supplemental Information Regarding the Exclusion Area Boundary and Population Distribution Around the Clinch River Nuclear Site

SSAR Table 2.3.5-10 (Sheets 1 and 4) is being revised as indicated. Underlines indicate text to be added.

Table 2.3.5-10 (Sheet 1 of 4)
X/Q and D/Q Values for No Decay, Decay, and Undepleted, at Each Receptor Location

RECEPTOR	SECTOR	DISTANCE		X/Q Values (s/m^3)			D/Q
				No Decay	2.26 Day Decay	8.00 Day Decay	
		(Miles)	(Meters)	Undepleted	Undepleted	Depleted	(m^{-2})
Analytical EAB	S	0.21	335	6.000E-05	5.900E-05	5.600E-05	3.000E-08
Analytical EAB	SSW	0.21	335	5.400E-05	5.400E-05	5.100E-05	3.200E-08
Analytical EAB	SW	0.21	335	6.300E-05	6.300E-05	5.900E-05	4.700E-08
Analytical EAB	WSW	0.21	335	9.200E-05	9.200E-05	8.600E-05	4.700E-08
Analytical EAB	W	0.21	335	1.500E-04	1.500E-04	1.400E-04	4.600E-08
Analytical EAB	WNW	0.21	335	2.000E-04	2.000E-04	1.900E-04	5.200E-08
Analytical EAB	NW	0.21	335	1.700E-04	1.700E-04	1.600E-04	4.500E-08
Analytical EAB	NNW	0.21	335	1.000E-04	1.000E-04	9.500E-05	3.000E-08
Analytical EAB	N	0.21	335	7.000E-05	7.000E-05	6.500E-05	3.400E-08
Analytical EAB	NNE	0.21	335	4.900E-05	4.900E-05	4.600E-05	2.700E-08
Analytical EAB	NE	0.21	335	4.900E-05	4.900E-05	4.600E-05	4.200E-08
Analytical EAB	ENE	0.21	335	7.400E-05	7.400E-05	6.900E-05	7.600E-08
Analytical EAB	E	0.21	335	9.200E-05	9.100E-05	8.500E-05	6.800E-08
Analytical EAB	ESE	0.21	335	1.300E-04	1.300E-04	1.200E-04	7.900E-08
Analytical EAB	SE	0.21	335	1.000E-04	1.000E-04	9.500E-05	7.200E-08
Analytical EAB	SSE	0.21	335	6.500E-05	6.500E-05	6.100E-05	3.200E-08

ENCLOSURE

Supplemental Information Regarding the Exclusion Area Boundary and Population Distribution Around the Clinch River Nuclear Site

Table 2.3.5-10 (Sheet 4 of 4)
X/Q and D/Q Values for No Decay, Decay, and Undepleted, at Each Receptor Location

RECEPTOR	SECTOR	DISTANCE		X/Q Values (s/m^3)			D/Q
				No Decay	2.26 Day Decay	8.00 Day Decay	
		(Miles)	(Meters)	Undepleted	Undepleted	Depleted	(m^{-2})
BEEF ANIMAL	S	1.95	3144	1.300E-06	1.300E-06	1.100E-06	7.700E-10
BEEF ANIMAL	SSW	2.79	4488	7.100E-07	6.700E-07	5.600E-07	4.400E-10
BEEF ANIMAL	SW	2.92	4695	7.600E-07	7.300E-07	6.000E-07	6.000E-10
BEEF ANIMAL	WSW	0.71	1138	1.000E-05	1.000E-05	9.300E-06	6.900E-09
BEEF ANIMAL	W	3.1	4984	1.700E-06	1.600E-06	1.300E-06	5.300E-10
BEEF ANIMAL	WNW	0.7	1120	2.300E-05	2.300E-05	2.100E-05	7.800E-09
BEEF ANIMAL	NW	1.01	1627	1.100E-05	1.000E-05	9.200E-06	3.600E-09
BEEF ANIMAL	NNW	4.87	7833	6.300E-07	5.800E-07	4.600E-07	1.500E-10
BEEF ANIMAL	E	2.88	4629	1.200E-06	1.100E-06	9.100E-07	8.800E-10
BEEF ANIMAL	ESE	2.79	4492	1.700E-06	1.600E-06	1.300E-06	1.100E-09
BEEF ANIMAL	SE	2.59	4171	1.500E-06	1.400E-06	1.200E-06	1.100E-09
BEEF ANIMAL	SSE	1.93	3106	1.500E-06	1.400E-06	1.200E-06	8.400E-10

Notes:

A circular, analytical exclusion area boundary (EAB) was defined at a fixed distance from an effluent release boundary ~~zone~~. The distance used between the boundaries ~~for the effluent release boundary (ERB)~~ was 1100 ft (335 m~~eters~~).

The nearest garden is defined as the minimum distance from the center point of the site.

The nearest residence is defined as the minimum distance from the center point of the site.

There were no milk-producing animals within 5 mi~~les~~ (8.05 km) of the site. Therefore, the nearest beef animal was analyzed.

Sectors without applicable receptors are not shown.

ENCLOSURE

Supplemental Information Regarding the Exclusion Area Boundary and Population Distribution Around the Clinch River Nuclear Site

SSAR Figure 2.3.5-2 is being replaced with the figure below.

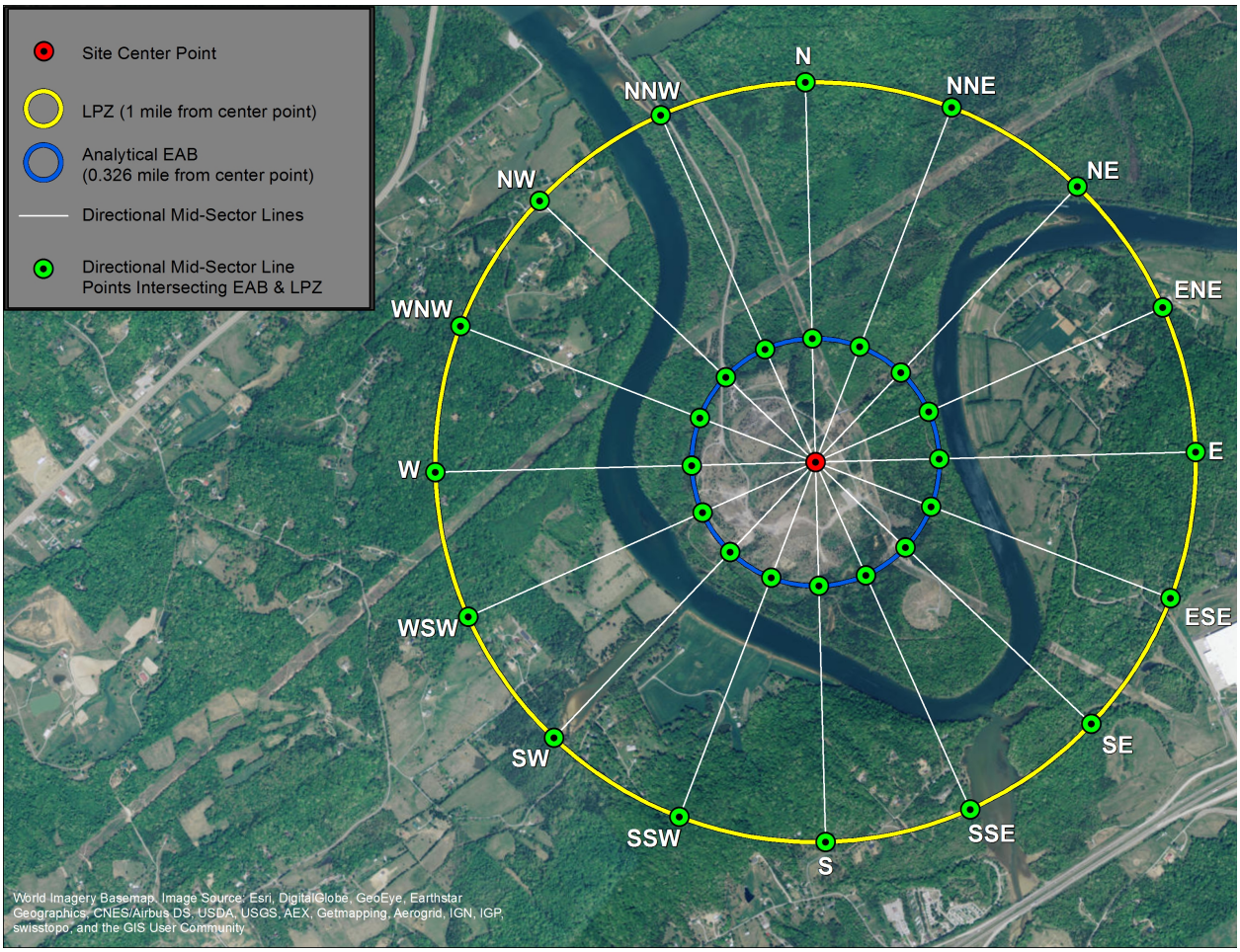


Figure 2.3.5-2. LPZ and Analytical EAB Distances Used for Terrain Analysis

ENCLOSURE

Supplemental Information Regarding the Exclusion Area Boundary and Population Distribution Around the Clinch River Nuclear Site

ER Subsection 2.5.1.1 is being revised as indicated. Strikethroughs indicate text to be deleted. Underlines indicate text to be added.

2.5.1.1 Population Data by Sector

The population distribution surrounding the CRN Site, up to a 50-mi radius, is estimated based upon the 2010 U.S. Census Bureau decennial census data. The population distribution is estimated in fifteen concentric bands at 0 to 0.3 mi, 0.3 to 1 mi, 1 to 2 mi, 2 to 3 mi, 3 to 4 mi, 4 to 5 mi, 5 to 6 mi, 6 to 7 mi, 7 to 8 mi, 8 to 9 mi, 9 to 10 mi, 10 to 20 mi, 20 to 30 mi, 30 to 40 mi, and 40 to 50 mi from the CRN Site center point. These bands are subdivided into 16 directional sectors, each centered on one of the 16 compass directions and consisting of 22.5 degrees. Population sectors out to 2 mi are shown in Figure 2.5.1-3, population sectors out to 10 mi are shown in Figure 2.5.1-1, and population sectors out to 50 mi are shown in Figure 2.5.1-2.

The population projections are derived from county estimates obtained from the states and based on cohort component (Kentucky and Tennessee) and cohort survey (North Carolina) methodologies. The counties that were used for the population projections are listed in Table 2.5.1-1 . Using linear or polynomial regression, an equation was derived to analyze population growth for each county. The equation was used in conjunction with the 2010 census data to produce a growth ratio. Ratios were calculated for each county and for each year, then weighted by area and summed into sectors. The ratio set was then used to produce a sector-level population projection ratio set for the 50-mi region. For a county with a projected negative growth rate, the 2010 population values for that county are held constant to produce conservative results without overestimating (a growth ratio of one is used). For counties predicting a decline at the end of the states' projection data set, the highest population value in the projection period is held constant (i.e., the ratio calculated for the last data point of the states' data set was used for the remaining projected years).

The census population counts were then sorted into the radial grid. In instances where census blocks were divided by sector boundary lines, the population was weighted by area to produce proportionate data values. These values were summed and multiplied by their projection ratio to produce the final permanent population radial grid maps (Figures 2.5.1-1, ~~and~~ 2.5.1-2, and 2.5.1-3). The years selected for the projection period represent the 2010 census, calculation development year (2013), projected start of construction date (2021), projected commencement of operation date for the last unit (2027), and 40 years (yr) beyond the last date.

ENCLOSURE

Supplemental Information Regarding the Exclusion Area Boundary and Population Distribution Around the Clinch River Nuclear Site

ER Table 2.5.1-2 (Sheet 5) is being revised as indicated. Underlines indicate text to be added.

Table 2.5.1-2 (Sheet 5 of 5)
Projected Permanent Population for Each Sector 0 to 10 Miles (0 to 16 km)

Year	Direction							
	Sector 0-0.3 (mi)	Sector 0.3-1 (mi)	Sector 1-2 (mi)	Sector 2-3 (mi)	Sector 3-4 (mi)	Sector 4-5 (mi)	Sector 5-10 (mi)	Sector 0-10 (mi)
Northwest								
2010	0	19	24	48	13	80	1574	1758
2013	0	19	24	49	13	81	1602	1788
2021	0	19	25	50	14	83	1664	1855
2027	0	20	25	50	14	84	1692	1885
2037	0	20	25	50	14	84	1714	1907
2047	0	20	25	50	14	84	1728	1921
2057	0	20	25	50	14	84	1743	1936
2067	0	20	25	50	14	84	1771	1964
North-Northwest								
2010	0	0	1	0	0	149	1700	1850
2013	0	0	1	0	0	151	1739	1891
2021	0	0	1	0	0	155	1831	1987
2027	0	0	1	0	0	156	1883	2040
2037	0	0	1	0	0	156	1936	2093
2047	0	0	1	0	0	156	1972	2129
2057	0	0	1	0	0	156	2008	2165
2067	0	0	1	0	0	156	2077	2234
Totals								
2010	0	149	537	1091	1407	2990	61,029	67,203
2013	0	151	544	1109	1437	3063	63,060	69,364
2021	0	155	560	1143	1504	3225	68,070	74,657
2027	0	157	564	1155	1539	3313	71,161	77,889
2037	0	157	564	1159	1570	3403	75,039	81,892
2047	0	157	564	1163	1594	3469	78,163	85,110
2057	0	157	564	1168	1621	3549	81,759	88,818
2067	0	157	564	1174	1658	3654	86,263	93,470

Note: Based on 2010 USCB data. See Section 2.5.1.1 for methodology used to generate permanent population projections. No permanent population distribution is within the exclusion area boundary.

ENCLOSURE

Supplemental Information Regarding the Exclusion Area Boundary and Population Distribution Around the Clinch River Nuclear Site

ER Figure 2.5.1-1 is being replaced with the figure below.

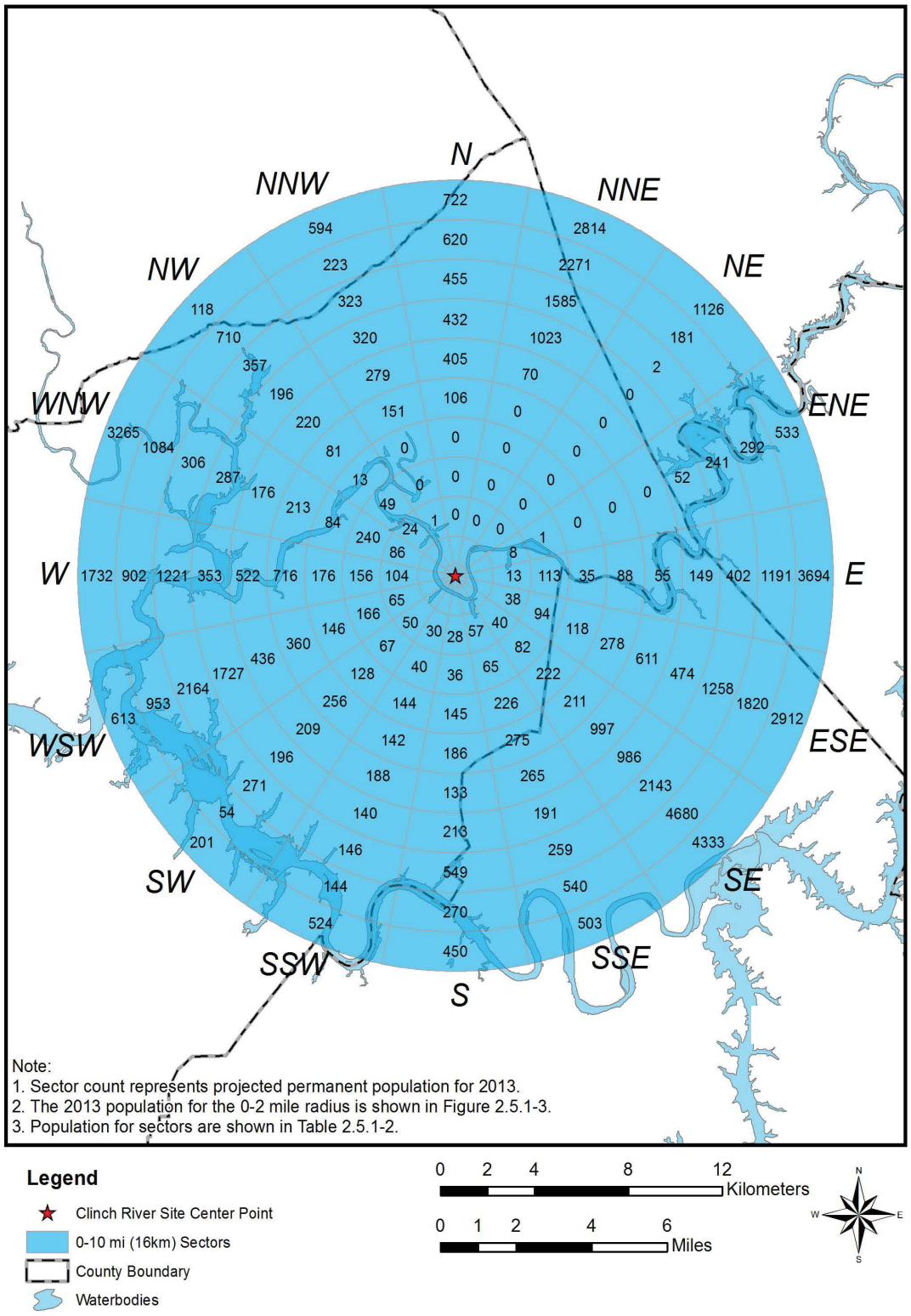


Figure 2.5.1-1. 0 to 10 Mile Population Sector Map

ENCLOSURE

Supplemental Information Regarding the Exclusion Area Boundary and Population Distribution Around the Clinch River Nuclear Site

New ER Figure 2.5.1-3 (below) is being added.

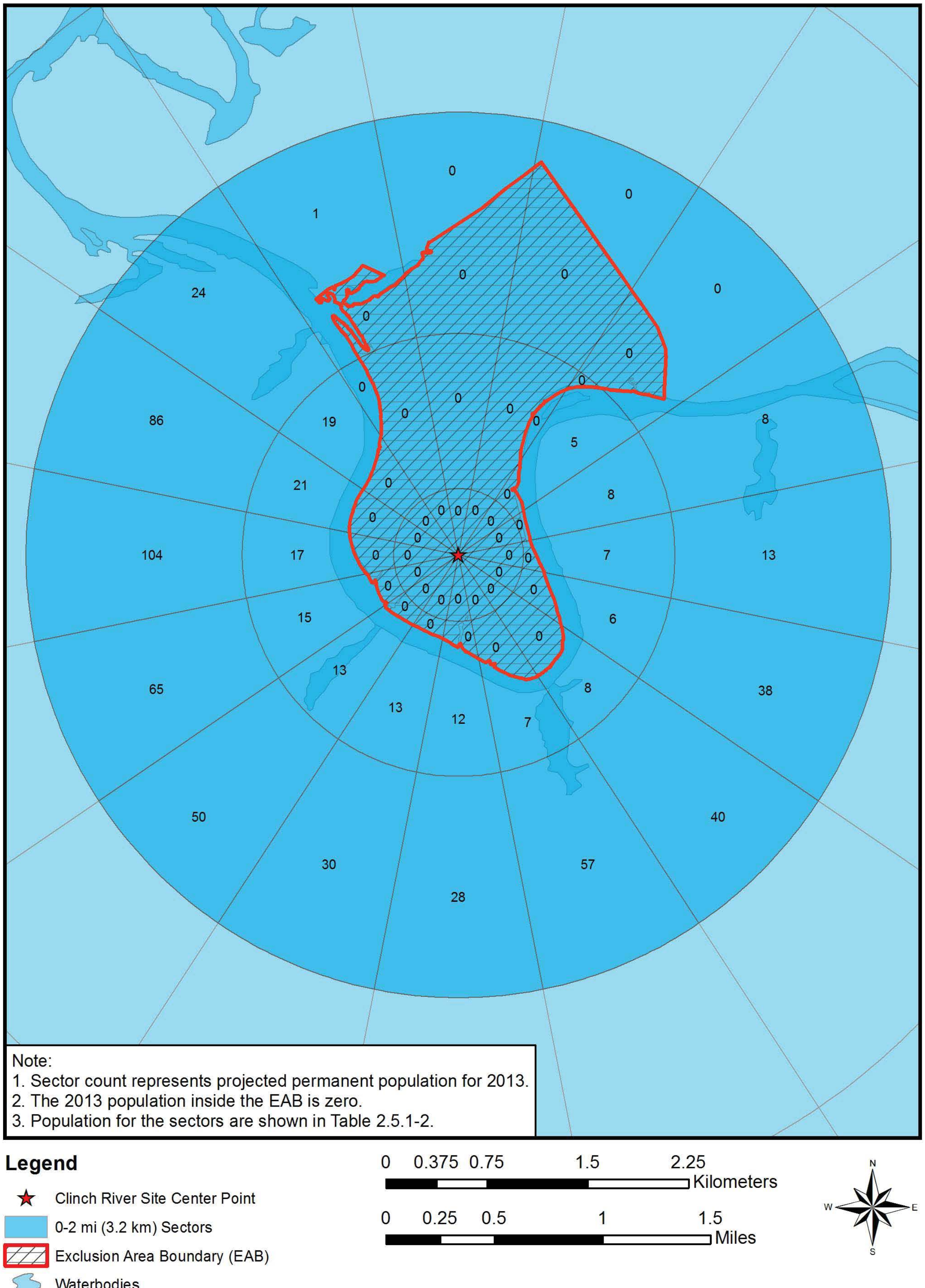


Figure 2.5.1-3. 0 to 2 Mile Population Sector Map

ENCLOSURE

Supplemental Information Regarding the Exclusion Area Boundary and Population Distribution Around the Clinch River Nuclear Site

ER Subsection 2.7.5.2 (paragraphs 5 through 8) is being revised as indicated. Strikethroughs indicate text to be deleted. Underlines indicate text to be added.

2.7.5.2 Calculation Methodology and Assumptions

…

NRC RG 1.145 requires that, for each of the 16 compass sectors, the distance to the EAB should be the minimum distance between the effluent release point and the EAB within a 45-degree sector centered on the compass direction of interest. For conservatism and simplicity, the effluent release point is evaluated as a circular effluent release boundary (ERB) that encloses potential release points from the nuclear island as shown in Figure 2.7.5-1. A circular analytical EAB is established 1100 ft (335 m) from the ERB. For X/Q modelling (Table 2.7.5-11), the analytical EAB is used as a bounding representative distance to the EAB.

To account for multiple units on site, nuclear islands are positioned at multiple locations within the power block with associated ERBs and EABs as shown in Figure 2.7.5-2 (note that although the nuclear islands for vendors 1 and 4 are depicted in the figure, the nuclear islands, associated ERBs, and analytical EABs for vendors 1, 2, 3, and 4 fit within the EAB ellipse). The analytical EABs can be encompassed by an ellipse fixed completely within the CRN Property boundary, i.e. the actual EAB (Figure 2.7.5-2), which demonstrates that dispersion factor computations are conservative.

The site center point is determined as the centerline midpoint of the EAB ellipse (Figure 2.7.5-2). The ellipse has a short axis of 0.326 mi (524 m) from the site center point and long axis of 0.535 mi (864 m) from the center point. ~~a circular, analytical EAB was defined at a fixed distance from the release zone. The release zone was based on circular effluent release boundaries (ERBs) that were determined as a composite of the proposed reactor and engineering structures that bound the safety and environmental impact of facility construction and operation on the CRN Site. The ERBs also allow for any future changes in the CR SMR Project's footprint. The ERBs encompassed the nuclear island from the largest two SMR sources of potential vendors (Figure 2.7.5-1).~~

~~The ERB was modeled to calculate the atmospheric dispersion factors at the EAB. The distance used in the *X/Q* modeling was 1100 ft (335 m) as shown in Table 2.7.5-11. This distance was measured from the edge of the circular nuclear ERB to the EAB.~~

~~The CRN Site center point for the PAVAN modeling was determined by finding the midpoint of a centerline of an ellipse that enveloped the release zone ERBs (Figure 2.7.5-2).~~

ENCLOSURE

Supplemental Information Regarding the Exclusion Area Boundary and Population Distribution Around the Clinch River Nuclear Site

ER Table 2.7.5-11 is being revised as indicated. Strikethroughs indicate text to be deleted. Underlines indicate text to be added.

Table 2.7.5-11
Distances for the EAB and LPZ at the 16 Wind Direction Sectors

Wind Direction Sector	Distance from ~~Release Zone~~ ERB to Analytical EAB		LPZ Distance	
	(~~feet~~)	(~~meters~~)	(mi~~les~~)	(~~meters~~)
S	1100	335	1	1609
SSW	1100	335	1	1609
SW	1100	335	1	1609
WSW	1100	335	1	1609
W	1100	335	1	1609
WNW	1100	335	1	1609
NW	1100	335	1	1609
NNW	1100	335	1	1609
N	1100	335	1	1609
NNE	1100	335	1	1609
NE	1100	335	1	1609
ENE	1100	335	1	1609
E	1100	335	1	1609
ESE	1100	335	1	1609
SE	1100	335	1	1609
SSE	1100	335	1	1609

Notes:
1. ~~Release zone includes the ERB of the~~The Effluent Release Boundary (ERB) includes the nuclear island, which consists of the reactor service building and all associated buildings.
2. The LPZ was determined as an area with a 1-mi~~le~~ (1609 m~~eters~~) radius from the CRN Site center point.

ENCLOSURE

Supplemental Information Regarding the Exclusion Area Boundary and Population Distribution Around the Clinch River Nuclear Site

ER Table 2.7.5-12 is being revised as indicated. Strikethroughs indicate text to be deleted. Underlines indicate text to be added.

Table 2.7.5-12
PAVAN Modeling Inputs

PAVAN Model Input Variable	Value
Number of Wind Speed Categories (NVEL)	13
Type of Release	Ground
Building Min. Cross Sectional Area (A)	0.0 m^2
Containment Building Height (D)	0.0 m
Release Height (HS)	10.0 m
Wind Sensor Height (TOWERH)	9.78 m
Conversion Correction Factor (UCOR)	150
Lower-T Sensor Height	8.44 m
Upper-T Sensor Height	59.22 m
Distance from Effluent Release ~~Zone~~ Boundary to Analytical EAB	335 m
Distance to LPZ	1609 m

Note: According to NUREG/CR-2858, for a groundlevel release, a release point height (HS) of 10 m~~eters~~ is to be used.

ER Table 2.7.5-13 is being revised as indicated. Strikethroughs indicate text to be deleted. Underlines indicate text to be added.

Table 2.7.5-13
CRN Site SMR 50 Percent Probability Level *X*/Q Values

50% Probability Level *X*/Q Values (sec/m^3) at the EAB and LPZ					
Location	**0-2 Hours**	**0-8 Hours**	**8-24 Hours**	**1-4 Days**	**4-30 Days**
Release Zone to EAB	5.58E-04	NA	NA	NA	NA
LPZ	NA	4.27E-05	3.80E-05	2.94E-05	2.04E-05

Notes:

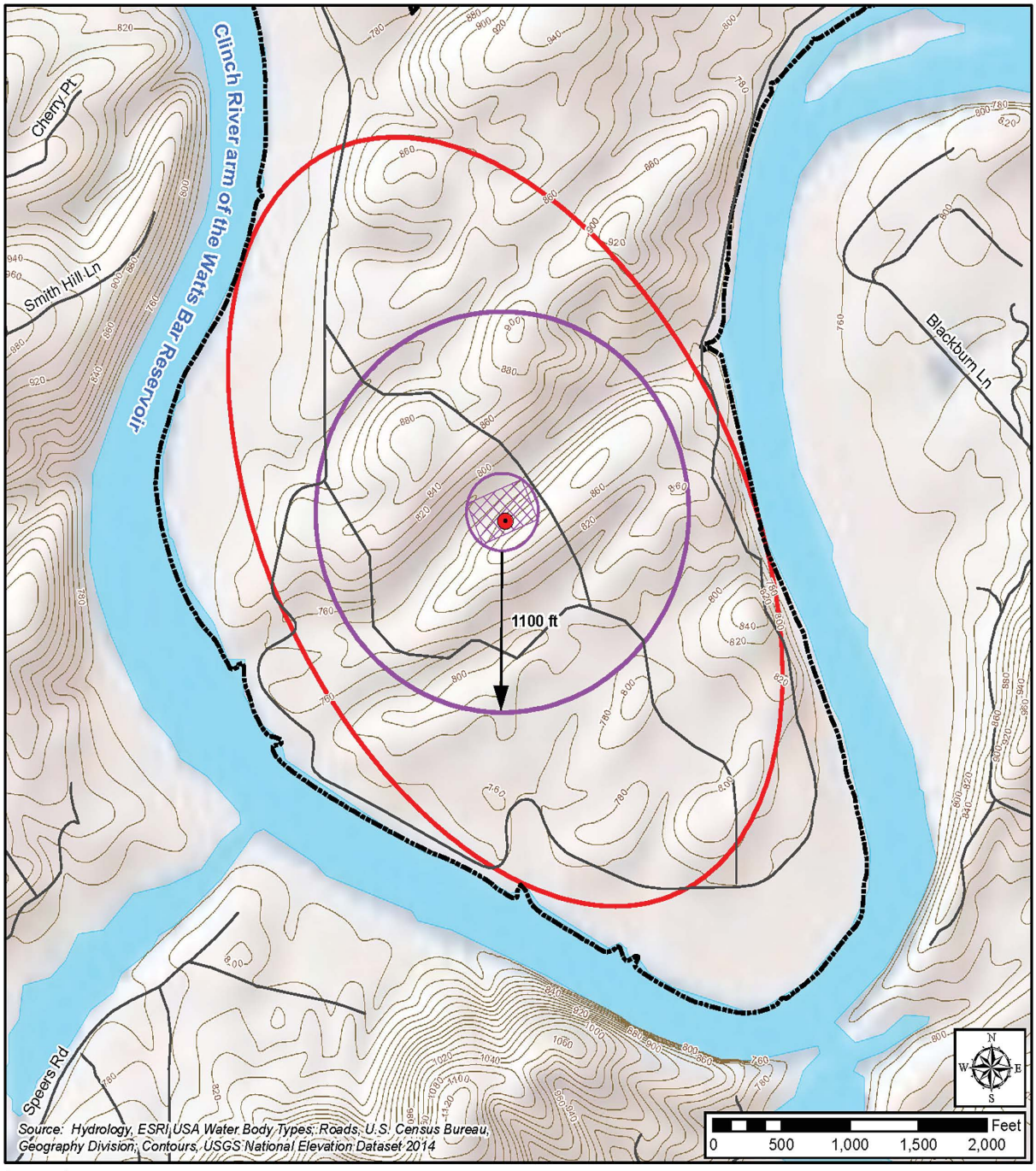
1. A circular, analytical EAB was defined at a fixed distance from the ~~release zone~~ effluent release boundary. The distance used ~~for the release zone to EAB~~ from the effluent release boundary to the analytical EAB was 1100 f~~ee~~t (335 m~~eters~~).
2. The LPZ was determined as an area with a 1-mi~~le~~ (1609-m~~eter~~) radius, centered on the site.

NA = Not Applicable

ENCLOSURE

Supplemental Information Regarding the Exclusion Area Boundary and Population Distribution Around the Clinch River Nuclear Site

ER Figure 2.7.5-1 is being replaced with the figure below.



Legend

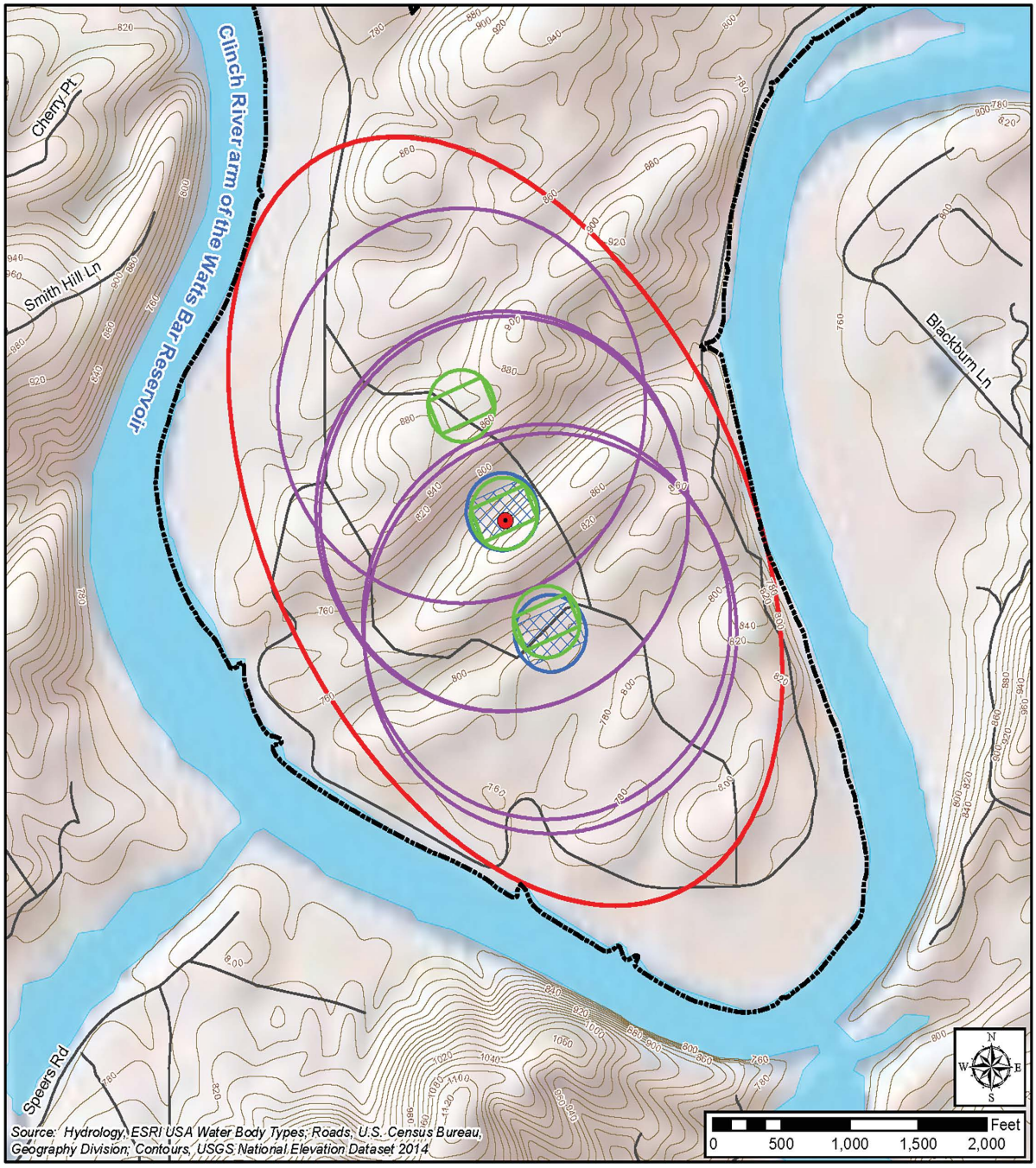
- Center of EAB Ellipse
- EAB Ellipse Enclosing All Circles
- EAB/CRN Property Boundary
- Rivers and Lakes
- Nuclear Island
- Effluent Release Boundary
- Analytical EAB
- Local Roads
- 20' Contour Lines

Figure 2.7.5-1. Effluent Release Boundary with Analytical EAB

ENCLOSURE

Supplemental Information Regarding the Exclusion Area Boundary and Population Distribution Around the Clinch River Nuclear Site

ER Figure 2.7.5-2 is being replaced with the figure below.



Legend

- Center of EAB Ellipse
- EAB Ellipse Enclosing All Circles
- Vendor 1 - Reactor Island (2)
- Vendor 1 - Effluent Release Boundary ERB (2)
- Vendor 1 & 4 –1100 ft Analytical EAB (5)
- Vendor 4 - Nuclear Island (3)
- Vendor 4 - Effluent Release Boundary ERB (3)
- EAB/CRN Property Boundary
- Rivers and Lakes
- Local Roads
- 20' Contour Lines

Figure 2.7.5-2. Effluent Release Boundaries (ERBs), Analytical EAB, and Site EAB

ENCLOSURE

Supplemental Information Regarding the Exclusion Area Boundary and Population Distribution Around the Clinch River Nuclear Site

ER Subsection 2.7.6.1 (paragraph 3) is being revised as indicated. Strikethroughs indicate text to be deleted. Underlines indicate text to be added.

2.7.6.1 Calculation Methodology and Assumptions

…
The ERB was considered in calculating atmospheric dispersion factors at the analytical EAB. A distance of 1100 f~~ee~~t (~~ft; ~~335 m~~eters [m]~~) was modeled from the ERB ~~release zone~~ to the analytical EAB (Figure 2.7.5-1).

ER Subsection 2.7.6.2 (paragraphs 3, 6, and 7) is being revised as indicated. Strikethroughs indicate text to be deleted. Underlines indicate text to be added.

2.7.6.2 Complex Terrain Modeling Analysis

…
This evaluation involved a comparison of estimated long-term *X*/Q values between the CALPUFF variable trajectory model system and the XOQDOQ model at the LPZ and an analytical EAB~~ and LPZ~~. The CALPUFF Version 6.42 dispersion modeling system is an advanced, non-steady-state, meteorological and air quality modeling system listed by the U.S. Environmental Protection Agency in its Guideline on Air Quality Models that can be applied in near-field applications involving complex meteorological conditions (Reference 2.7.6-2; Reference 2.7.6-3). The modeling system is comprised of a meteorological processor, CALMET, Version 6.334, which develops hourly wind and temperature fields on a three-dimensional gridded modeling domain, with two-dimensional fields of mixing height, surface characteristics, and dispersion properties (Reference 2.7.6-4). The CALPUFF model is a multi-layer, multi-species, non-steady-state puff dispersion model that simulates the effects of time- and space-varying meteorological conditions on pollution transport, transformation and removal. The concentrations and deposition files produced from CALPUFF are post-processed by the CALPOST, Version 6.292, processor program into tables and plot files of concentrations at given receptors. The latest version of CALPUFF was used in order to incorporate the latest chemistry mechanisms and modeling updates.

…
Both the CALPUFF and XOQDOQ models used a single groundlevel point source located at the center point of the site with no building wake credit. To model a groundlevel release in CALPUFF, stack parameters must be set to nonzero values, with the exception of stack height. Therefore, to closely simulate a groundlevel release that would be dominated by plume momentum, a stack diameter of 1.0 m and an exit velocity of 0.1 meter per second (m/s) was assumed. A stack height of 10 m was used to maintain consistency with the XOQDOQ default stack height for groundlevel releases. As indicated in NUREG/CR-2919, nuclear power vents generally have ambient temperature plumes, so the source exit temperature in CALPUFF was set to 68 degrees Fahrenheit (ºF; 293 K). With the center point of the site as the source location, both models included discrete receptors at ~~a site boundary~~ an analytical EAB with radius equal to the shorter distance of the EAB ellipse (0.326 mi (524 m)) and at the 1.0 mi (1609 m) LPZ distance for each of the 16 wind direction sectors (Figure 2.7.6-2). The CALPUFF input options are summarized in Table 2.7.6-2.

ENCLOSURE

Supplemental Information Regarding the Exclusion Area Boundary and Population Distribution Around the Clinch River Nuclear Site

The multiple-year average *X/Q* values for the undepleted case, the 2-day decay case, and the 8-day decay case at the LPZ and analytical EAB ~~and LPZ~~ were compared between the two models, and the results are summarized in Tables 2.7.6-3 and 2.7.6-4, respectively. The *X/Q* values at both distances demonstrated that the highest *X/Q* values were estimated by the XOQDOQ model for the 16 wind direction sectors. Therefore, it was concluded that the XOQDOQ model did not underestimate the annual average *X/Q* values, and no nonlinear adjustment factors were applied to the XOQDOQ annual average *X/Q* and *D/Q* values at the CRN Site.

ENCLOSURE

Supplemental Information Regarding the Exclusion Area Boundary and Population Distribution Around the Clinch River Nuclear Site

ER Table 2.7.6-1 is being revised as indicated. Strikethroughs indicate text to be deleted. Underlines indicate text to be added.

Table 2.7.6-1
List of Inputs used in the XOQDOQ Modeling

XOQDOQ Input Variable	Value
Wind Sensor Height (PLEV)	9.78 m
Conversion Correction Factor (UCOR)	150
Lower-T Sensor Height	8.44 m
Upper-T sensor Height	59.22 m
Type of Release	Ground
Vent Average Velocity (EXIT)	0.0 m/s
Vent Inside Diameter (DIAMTR)	0.0 m
Vent Release Height (HSTACK)	10.0 m
Containment Building Height (HBLDG)	0.0 m
Building Min. Cross Sectional Area (CRSEC)	0.0 m^2
Wind Height (SLEV)	10.0 m

Notes:

1. No building wake credit was used in the modeling. Therefore, the building height and cross-sectional area were set to zero.
2. According to NUREG/CR-2919, for a groundlevel release, the exit velocity and diameter are set to zero, while the wind height is set to 10 m.
3. Vent height should be equal to wind height (Reference 2.7.6-5).
4. For the complex terrain modeling, radial receptors were modeled at 524 m and 1609 m consistent with the CALPUFF modeling (see Table 2.7.6-2). For the routine release modeling of actual CRN Site conditions ~~the release zone EAB~~, the analytical EAB of 1100 ft was modeled, along with sector based sensitive receptors (at the nearest residences, nearest gardens, and nearest meat animals) and sector based receptors out to 50 mi~~les~~.

ENCLOSURE

Supplemental Information Regarding the Exclusion Area Boundary and Population Distribution Around the Clinch River Nuclear Site

ER Table 2.7.6-2 is being revised as indicated. Strikethroughs indicate text to be deleted. Underlines indicate text to be added.

Table 2.7.6-2
CALPUFF Model Input Configuration for Complex Terrain Analysis

CALPUFF Parameter	Input Value
Episode Modeled	June 1, 2011 to May 31, 2013
Domain Size	10-mi~~le~~ radius
No. of Grid Cells	111 x 111
Grid Spacing	350 m
# of Vertical (Height) Levels	22
Upper Air Data	Nashville NWS
Precipitation Data	Oak Ridge ASOS
Surface Data	CRN Met Tower
Source Location	Site Center Coordinates (NAD27)
Base Elevation	250.2 m
Distance to Analytical EAB	524 m radius
Distance to LPZ	1609 m radius
# of Stacks (Vents)	1
Stack #1 Height	10.0 m
Stack #1 Diameter	1.0 m
Stack #1 Exit Velocity	0.1 m/s
Stack #1 Exit Temperature	293 K (68ºF)

Note: For the complex terrain modeling, the analytical EAB was defined as an area with a 0.326-mi~~le~~ (524-m) radius from the center point of the CRN Site. The LPZ was defined as an area with a 1-mi~~le~~ (1609-m) radius from the center point of the CRN Site.

ENCLOSURE

Supplemental Information Regarding the Exclusion Area Boundary and Population Distribution Around the Clinch River Nuclear Site

ER Table 2.7.6-3 is being revised as indicated. Strikethroughs indicate text to be deleted. Underlines indicate text to be added.

Table 2.7.6-3
Long-Term Average X/Q Values Estimated from XOQDOQ and CALPUFF at the EAB

	Long-Term Average *X*/Q Values (sec/m^3)								
EAB Sector	**Undepleted**			**2-Day Decay**			**8-Day Decay**		
	XOQDOQ	**CALPUFF**	**Ratio**	**XOQDOQ**	**CALPUFF**	**Ratio**	**XOQDOQ**	**CALPUFF**	**Ratio**
S	2.70E-05	2.01E-06	0.07	2.70E-05	2.01E-06	0.07	2.50E-05	2.01E-06	0.08
SSW	2.40E-05	1.95E-06	0.08	2.40E-05	1.95E-06	0.08	2.30E-05	1.95E-06	0.08
SW	2.80E-05	1.32E-06	0.05	2.80E-05	1.32E-06	0.05	2.60E-05	1.32E-06	0.05
WSW	4.20E-05	1.17E-06	0.03	4.10E-05	1.17E-06	0.03	3.80E-05	1.17E-06	0.03
W	6.70E-05	1.15E-06	0.02	6.60E-05	1.14E-06	0.02	6.10E-05	1.15E-06	0.02
WNW	9.10E-05	6.51E-07	0.01	9.10E-05	6.49E-07	0.01	8.40E-05	6.51E-07	0.01
NW	7.80E-05	1.38E-06	0.02	7.70E-05	1.38E-06	0.02	7.20E-05	1.38E-06	0.02
NNW	4.60E-05	3.01E-06	0.07	4.50E-05	3.01E-06	0.07	4.20E-05	3.01E-06	0.07
N	3.10E-05	2.93E-06	0.09	3.10E-05	2.92E-06	0.09	2.90E-05	2.92E-06	0.10
NNE	2.20E-05	3.75E-06	0.17	2.20E-05	3.74E-06	0.17	2.00E-05	3.75E-06	0.19
NE	2.20E-05	2.11E-06	0.10	2.20E-05	2.11E-06	0.10	2.00E-05	2.11E-06	0.11
ENE	3.30E-05	2.26E-06	0.07	3.30E-05	2.26E-06	0.07	3.10E-05	2.26E-06	0.07
E	4.10E-05	2.78E-06	0.07	4.10E-05	2.77E-06	0.07	3.80E-05	2.78E-06	0.07
ESE	5.70E-05	3.68E-06	0.06	5.60E-05	3.67E-06	0.07	5.20E-05	3.68E-06	0.07
SE	4.60E-05	2.23E-06	0.05	4.60E-05	2.23E-06	0.05	4.20E-05	2.23E-06	0.05
SSE	2.90E-05	2.57E-06	0.09	2.90E-05	2.57E-06	0.09	2.70E-05	2.57E-06	0.10

Notes:
1. Long-term average values are reflective of a multi-year average from the CRN June 1, 2011 - May 31, 2013 meteorological episode. Both the XOQDOQ and CALPUFF *X*/Q values reflect the undepleted, 2-day decay, and 8-day decay cases.
2. For the complex terrain analysis, the analytical EAB was defined as an area with a 0.326-mile (524-m) radius from the center point of the CRN Site.
3. The ratio is determined by the CALPUFF concentration divided by the XOQDOQ concentration.

ENCLOSURE

Supplemental Information Regarding the Exclusion Area Boundary and Population Distribution Around the Clinch River Nuclear Site

ER Table 2.7.6-10 (Sheet 1) is being revised as indicated. Strikethroughs indicate text to be deleted. Underlines indicate text to be added.

Table 2.7.6-10 (Sheet 1 of 4)
X/Q and D/Q Values for No Decay, Decay, and Undepleted, at Each Receptor Location

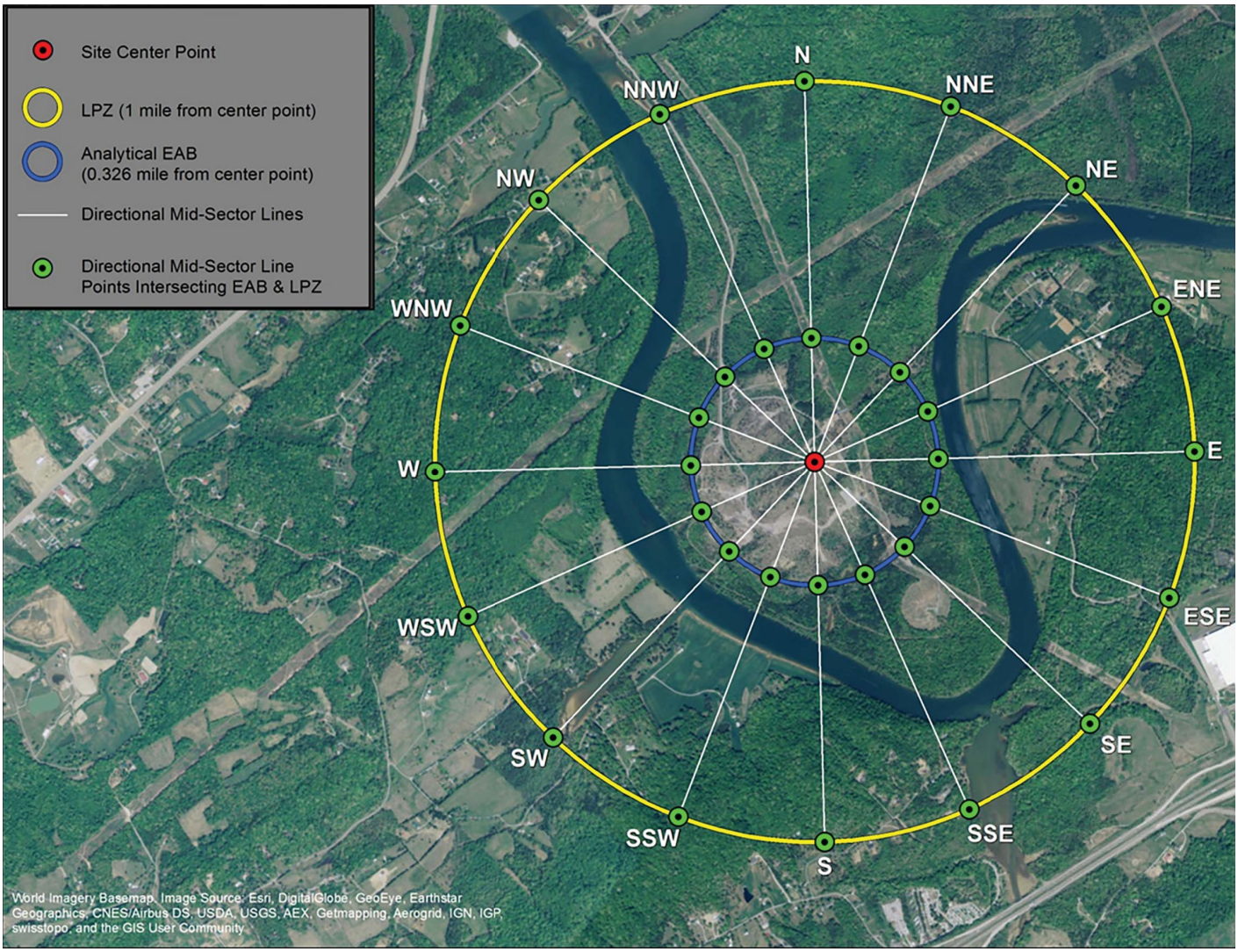
RECEPTOR	SECTOR	DISTANCE		*X*/Q Values (sec/m^3)			D/Q
				No Decay	2.26 Day Decay	8.00 Day Decay	
		(Miles)	(Meters)	Undepleted	Undepleted	Depleted	(m^{-2})
Analytical EAB~~ - Release Zone~~	S	0.21	335	6.0E-05	5.9E-05	5.6E-05	3.0E-08
Analytical EAB~~ Release Zone~~	SSW	0.21	335	5.4E-05	5.4E-05	5.1E-05	3.2E-08
Analytical EAB~~ Release Zone~~	SW	0.21	335	6.3E-05	6.3E-05	5.9E-05	4.7E-08
Analytical EAB~~ Release Zone~~	WSW	0.21	335	9.2E-05	9.2E-05	8.6E-05	4.7E-08
Analytical EAB~~ - Release Zone~~	W	0.21	335	1.5E-04	1.5E-04	1.4E-04	4.6E-08
Analytical EAB~~ Release Zone~~	WNW	0.21	335	2.0E-04	2.0E-04	1.9E-04	5.2E-08
Analytical EAB~~ Release Zone~~	NW	0.21	335	1.7E-04	1.7E-04	1.6E-04	4.5E-08
Analytical EAB~~ - Release Zone~~	NNW	0.21	335	1.0E-04	1.0E-04	9.5E-05	3.0E-08
Analytical EAB~~ Release Zone~~	N	0.21	335	7.0E-05	7.0E-05	6.5E-05	3.4E-08
Analytical EAB~~ Release Zone~~	NNE	0.21	335	4.9E-05	4.9E-05	4.6E-05	2.7E-08
Analytical EAB~~ Release Zone~~	NE	0.21	335	4.9E-05	4.9E-05	4.6E-05	4.2E-08
Analytical EAB~~ Release Zone~~	ENE	0.21	335	7.4E-05	7.4E-05	6.9E-05	7.6E-08
Analytical EAB~~ - Release Zone~~	E	0.21	335	9.2E-05	9.1E-05	8.5E-05	6.8E-08
Analytical EAB~~ Release Zone~~	ESE	0.21	335	1.3E-04	1.3E-04	1.2E-04	7.9E-08
Analytical EAB~~ Release Zone~~	SE	0.21	335	1.0E-04	1.0E-04	9.5E-05	7.2E-08
Analytical EAB~~ - Release Zone~~	SSE	0.21	335	6.5E-05	6.5E-05	6.1E-05	3.2E-08

Note: A circular, analytical EAB was defined at a fixed distance from the effluent release ~~zone~~boundary. The distance used ~~for the release zone~~ from the effluent release boundary to the analytical EAB was 1100 f~~ee~~t (335 m~~eters~~).

ENCLOSURE

Supplemental Information Regarding the Exclusion Area Boundary and Population Distribution Around the Clinch River Nuclear Site

ER Figure 2.7.6-2 is being replaced with the figure below.



Notes:

The ArcGIS software package (www.esri.com) was used to determine the coordinates of the EAB and LPZ for each of the 16 directional sectors.

Figure 2.7.6-2. LPZ and analytical EAB distances used for the Complex Terrain Analysis