

**Contract No:**

This document was prepared in conjunction with work accomplished under Contract No. DE-AC09-08SR22470 with the U.S. Department of Energy (DOE) Office of Environmental Management (EM).

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December 3, 2019

SRNL-STI-2019-00722

RSM Track #: 10560

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**E-AREA LLWF FINAL CLOSURE CAP DESIGN – CONSTRUCTABILITY  
EVALUATION CRITERIA FOR THE PLOT 8 AND NR07E DISPOSAL AREAS**

Scope

SRNS Design Engineering has been asked to complete a constructability evaluation of the proposed final closure cap designs for the Plot 8 (Engineered Trenches ET07, ET08, and ET09) and 643-7E NRCDA<sup>1</sup> (NR07E) disposal areas located outside the original E-Area Low-Level Waste Facility (ELLWF) footprint. This memorandum presents the guidelines and criteria for the constructability evaluation. A new conceptual design for the ELLWF closure cap is not requested at this time.

General Guidelines for Constructability Evaluation

- The proposed final closure cap for the original E-Area Low-Level Waste Facility (ELLWF) footprint is shown in conceptual closure cap design drawings C-CT-E-00083 (2016) and C-CT-E-00084 (2016).
- The E-Area Performance Assessment infiltration data package, which is based upon the final closure cap design for the original ELLWF footprint, will also serve as the source of intact and subsidence infiltration rates for the Plot 8 and NR07E disposal areas.
- The number, type, and sequence of layers for the Plot 8 and NR07E closure caps will be identical to the original E-Area footprint's cap design.
- Runoff from the closure cap's topsoil surface and drainage from the lateral drainage layer must be free draining out the sides of the closure cap (i.e., at the side slopes).

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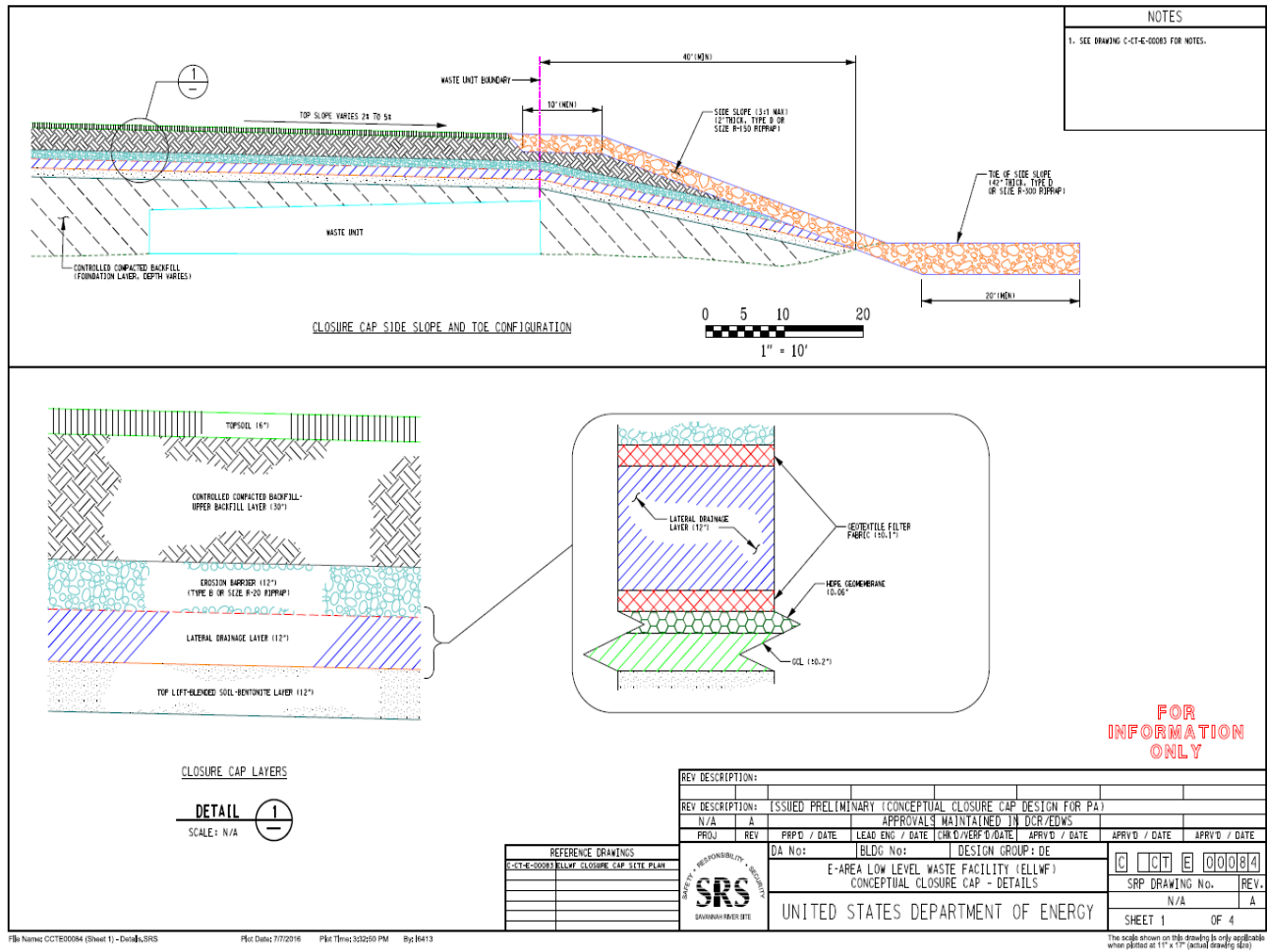
<sup>1</sup> Naval Reactor Component Disposal Areas

- Drainage from the Plot 8 and NR07E closure caps must tie into the drainage system for the original E-Area footprint; therefore, the long axis of the Plot 8 and NR07E closure caps should be oriented accordingly. The common drainage system can be resized in the future to handle the increased flow volume.
- Drainage ditches for surface runoff and lateral drainage cannot be located over waste units due to the potential for subsidence. This is consistent with the Mixed Waste Management Facility (MWMF) and Low-Level Radioactive Waste Facility (LLRWDF) closure cap designs.
- The closure caps must not interfere with the operation of and drainage from the existing closure cap systems for the MWMF and the LLRWDF, although tying into a common drainage ditch may be necessary. The MWMF and LLRWDF are located adjacent to the current ELLWF, which could introduce a limitation on maximum slope length for the proposed NR07E closure cap in the direction of the MWMF and LLRWDF.
- Except as noted in the bullet above, there will be no physical obstructions to the construction of the Plot 8 and NR07E closure caps and, therefore, no limitations on slope length. Nearby groundwater monitoring wells, perimeter roads and fences, existing buildings and structures, railroad spurs, and existing drainage systems will be evaluated for abandonment, removal, or relocation.

#### General Criteria for Constructability Evaluation

- Figure 1 (lower half) and Table 1 identify the layers included in the proposed final closure cap design for the ELLWF. The minimum thickness of the lower (controlled compacted backfill) foundation layer for Engineered Trenches (ETs) and the NRCDA is given in Table 2.
- The slope of the closure cap surface shall range from a minimum of 2% to a maximum of 5% to be consistent with the closure cap design for the original E-Area footprint and associated HELP infiltration model runs.
- The lateral drainage layer and composite barrier layers [i.e., high-density polyethylene (HDPE) geomembrane, geosynthetic clay liner (GCL), and blended soil-bentonite layer] shall extend a minimum of 40 feet beyond the outline of the waste units to be consistent with recommendations from a modeling overhang study (Hang and Flach, 2016). The 40-foot overhang can include the closure-cap side slopes.
- The maximum top-surface slope length, which includes the 40-foot overhang, shall be 585 feet to be consistent with the bounding intact infiltration case.

- Closure cap slide slopes have a maximum three horizontal to one vertical as shown in the upper half of Figure 1. For slopes greater than 10%, a reinforced GCL will be used to reduce the potential of internal failure.



**Figure 1. Planned Final Closure Cap Design for ELLWF (C-CT-E-00084, 2016).**

**Table 1. ELLWF Final Closure Cap Layers.**

<b>Layer</b>	<b>Layer Thickness (inches)</b>
Vegetative Cover	Not applicable
Topsoil	6
Upper Backfill Layer	30
Erosion Barrier	12
Geotextile Filter Fabric	~0.1
Lateral Drainage Layer	12
Geotextile Fabric	~0.1
HDPE Geomembrane	0.06 (60 mil)
GCL	~0.2
Blended Soil-Bentonite Layer	12
Lower Foundation Layer	Thickness varies

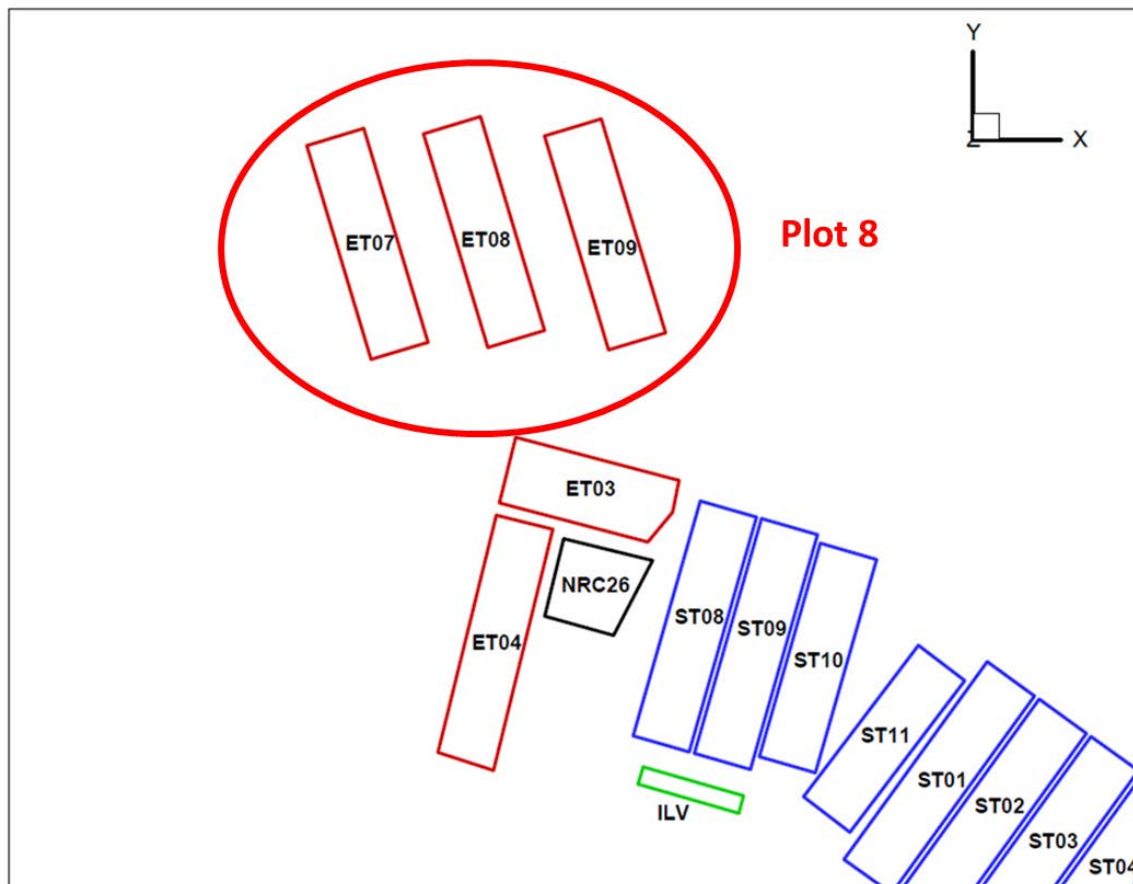
**Table 2. Minimum Lower Foundation Layer Thickness.**

<b>Disposal Unit Type</b>	<b>Minimum Thickness (inches)</b>	<b>Comment</b>
ET07, ET08, and ET09	12	Assumes preexisting minimum four-foot thick operational soil cover (clean) over the waste zone
NR07E	0	Assumes waste is contained in robust casks

Specific Criteria for Plot 8 (ET07, ET08, and ET09)

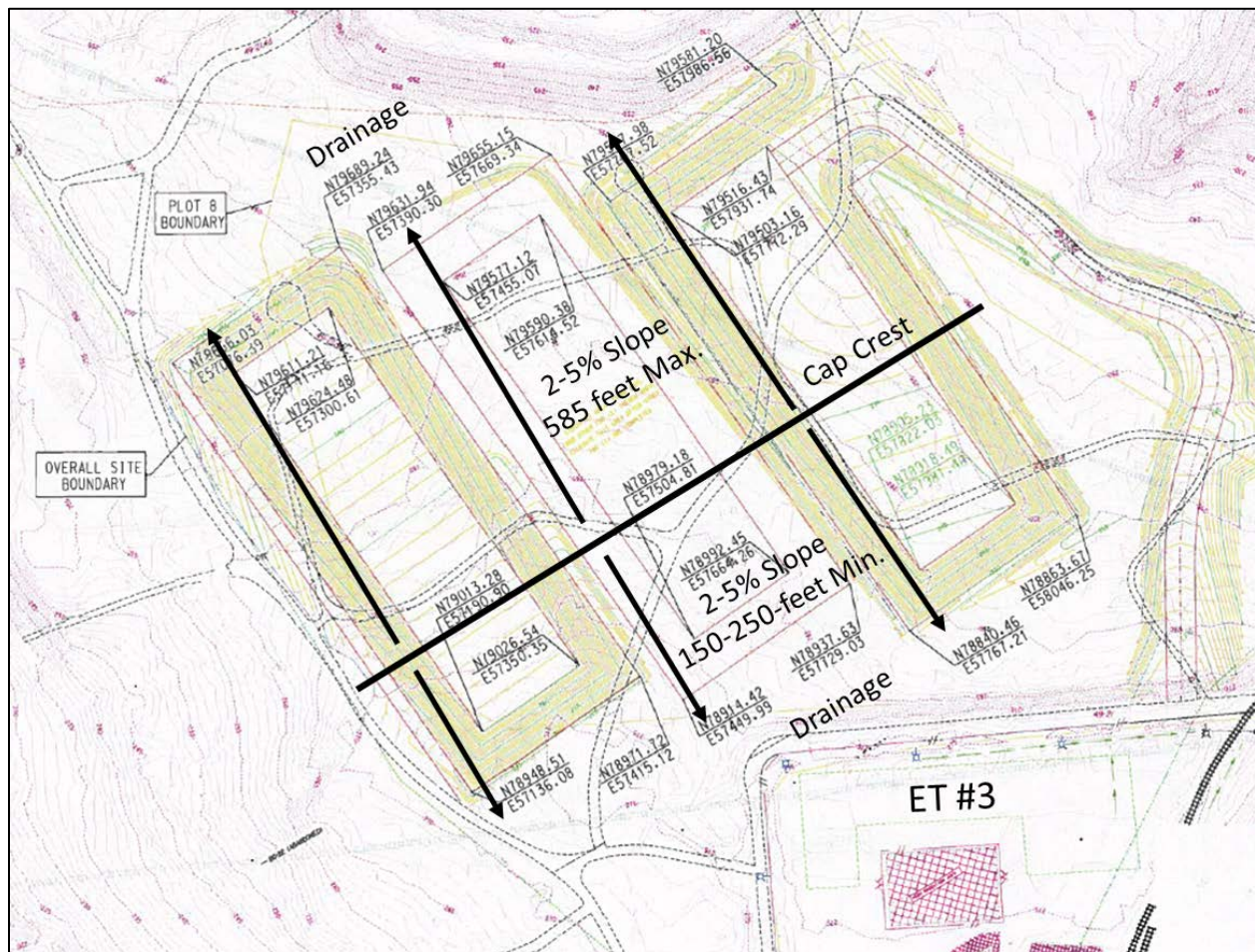
- Figure 2 and Figure 3 show the proposed locations of the three planned ET disposal units in Plot 8.
- SRS coordinates are reported on Figure 3 as well as in Table 3. The inner set of SRS coordinates for each of the three ET disposal units marks the four corners of the interior base of the disposal unit, while the outer set of coordinates marks the ground-level total footprint for each disposal unit (including sloped sides).
- Table 3 also provides the interior base and total outer footprint areas and side lengths for each of the three disposal units, which happen to be the same. The interior base is 160 feet by 600 feet (96,000 square feet) and the outer footprint at ground surface is 280 feet by 720 feet (201,600 square feet). The total footprint area covered by the three ET disposal units is roughly 15 acres.

- Most of the waste packages in ETs are B-25 boxes stacked four high. The overall height of four stacked B-25 boxes is approximately 17.3 feet as illustrated in Figure 4. The top elevation of the four-foot-thick operational soil cover, therefore, will be the toe-of-slope elevation plus 21.3 feet (17.3-foot B-25 stack + 4-foot soil cover).
- The preferred closure cap orientation is for the crest of the cap to run perpendicular to the longitudinal axis of the ETs such that surface run-off and drainage occur to the north and south sides of the disposal units as shown in Figure 3. ET03 is located to the south of Plot 8. The North-South positioning of the closure cap crest in Figure 3 is just one possible location.
- The North Sediment Basin may need to be resized and/or relocated or a new sediment basin may need to be installed near Plot 8 to handle drainage from the Plot 8 closure cap if the topography is not favorable to gravity flow.



**Figure 2. New Footprints and Naming Convention for the Western Sector of the ELLWF.**





**Figure 3. Annotated Drawing of Plot 8 ETs showing a possible Final Closure Cap Orientation (C-CDL-E-00001, 2010).**

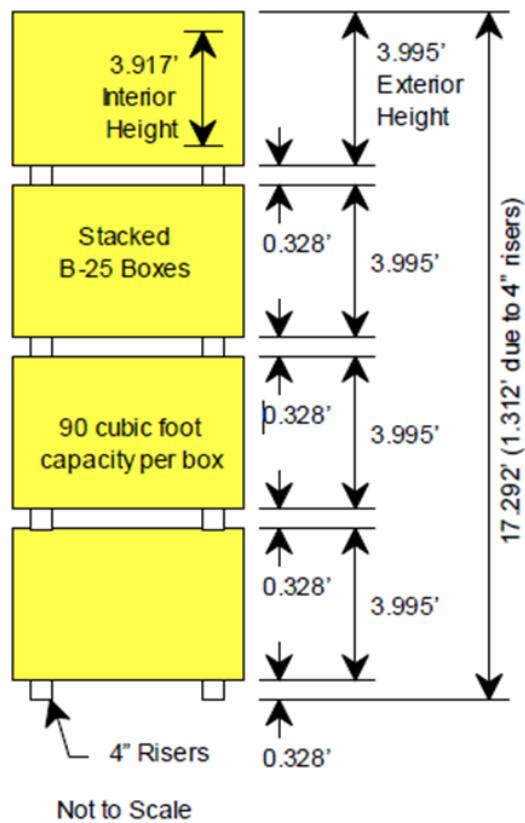
**Table 3. Plot 8 ET Coordinates and Dimensions.**

Low-Level Waste Facility	Calculated Area (ft <sup>2</sup> )	corner #1		corner #2		corner #3		corner #4		Segment 1	Segment 2	Segment 3	Segment 4
		SRS N	SRS E	SRS N	SRS E	SRS N	SRS E	SRS N	SRS E	Length (ft)	Length (ft)	Length (ft)	Length (ft)
Engineered Trench 8A - Base of Unit	96,000	79013.28	57190.9	79026.54	57350.35	79624.48	57300.61	79611	57141.16	160	600	160	600
Engineered Trench 8B - Base of Unit	96,000	78979.18	57504.81	78992.45	57664.26	79590.38	57614.52	79577	57455.07	160	600	160	600
Engineered Trench 8C - Base of Unit	96,000	78905.23	57822.03	78918.49	57981.48	79516.43	57931.74	79503	57772.29	160	600	160	600
Total Footprint around Engineered Trench 8A	201,600	78948.51	57136.08	78971.72	57415.12	79689.24	57355.43	79666	57076.39	280	720	280	720
Total Footprint around Engineered Trench 8B	201,600	78914.42	57449.99	78937.63	57729.03	79655.15	57669.34	79632	57390.3	280	720	280	720
Total Footprint around Engineered Trench 8C	201,600	78840.46	57767.21	78863.67	58046.25	79581.2	57986.56	79558	57707.52	280	720	280	720

Total Area at Base of DU	6.6	acres	
Total Outside Footprint Area at Ground Surface	13.9	acres	Outside footprint will accommodate a 40-foot overhang in all directions

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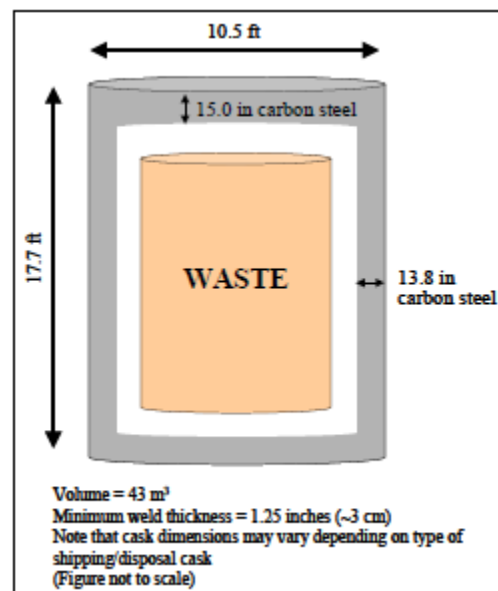




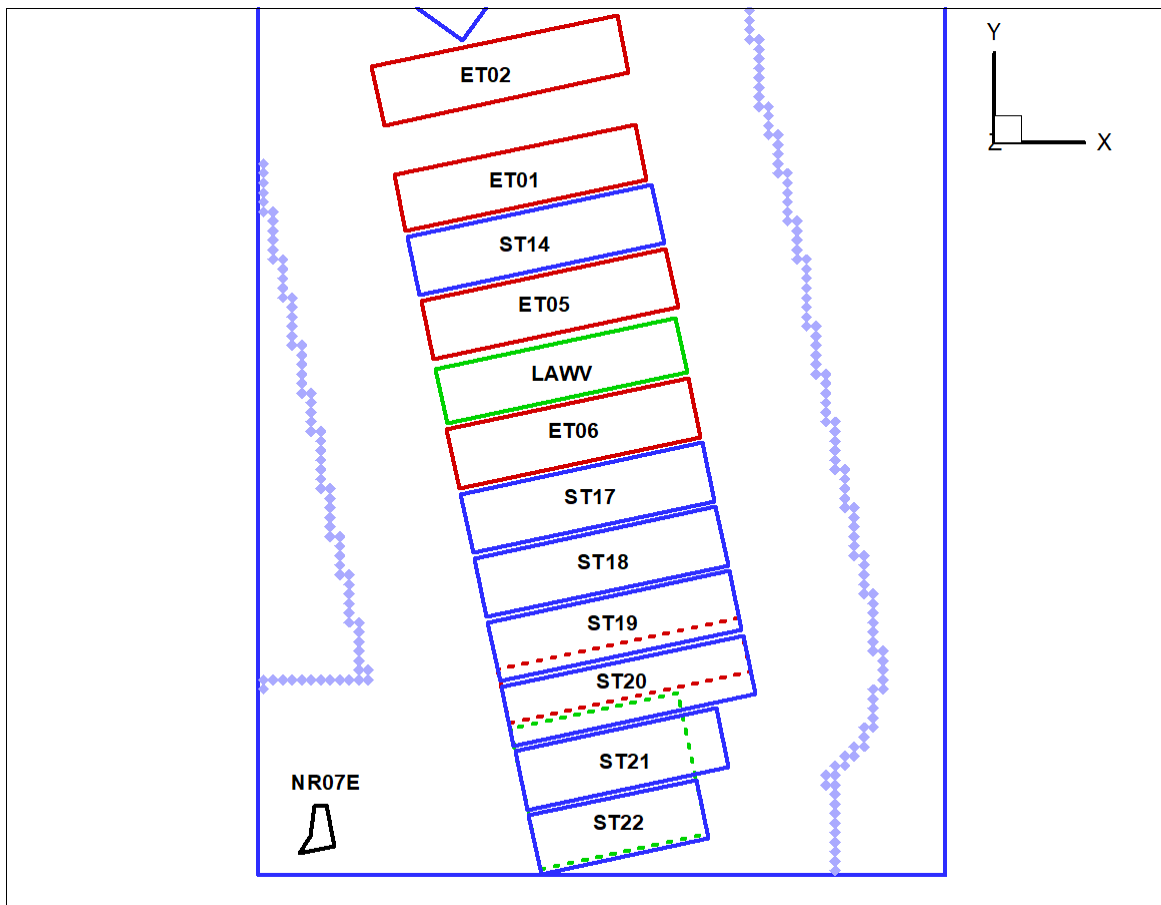
**Figure 4. B-25 Boxes Stacked Four High in ET Disposal Unit (Phifer and Wilhite, 2001).**

### Specific Criteria for NR07E

- A total of 41 large casks (up to 17.7 feet high by 10.5 feet in diameter) containing naval reactor waste were placed on the NR07E pad. A schematic of a representative heavily shielded, welded cask containing KAPL core barrel/thermal shield (CB/TS) activated metal components is shown in Figure 5.
- Figure 6 shows the location of the NR07E disposal unit relative to the Slit and Engineered Trenches in the eastern sector of the ELLWF.
- SRS coordinates are given in Figure 7 and Figure 8. Segment lengths and approximate total footprint areas with and without a closure cap as calculated by the author are also shown in Figure 8.
- Figure 9 and Figure 10 are photographs of the NR07E disposal unit before and after the interim soil cover was added in 2005. The casks will be covered with a final closure cap.
- The building located next to NR07E is Storage Pad No. 6 as shown in Figure 7. The building and fencing located on the south side of NR07E as shown in Figure 9 will be removed before the final closure cap is installed.
- The preferred closure cap orientation is for the crest of the cap to run parallel to the longitudinal axis of the current interim soil cover such that surface run-off and drainage occur to the east and west sides of the disposal unit as shown in Figure 11.



**Figure 5. KAPL CB/TS Cask Schematic.**



**Figure 6. New Footprints and Naming Convention for the Eastern Sector of the ELLWF (NR07E is shown in the lower left-hand corner of the diagram).**

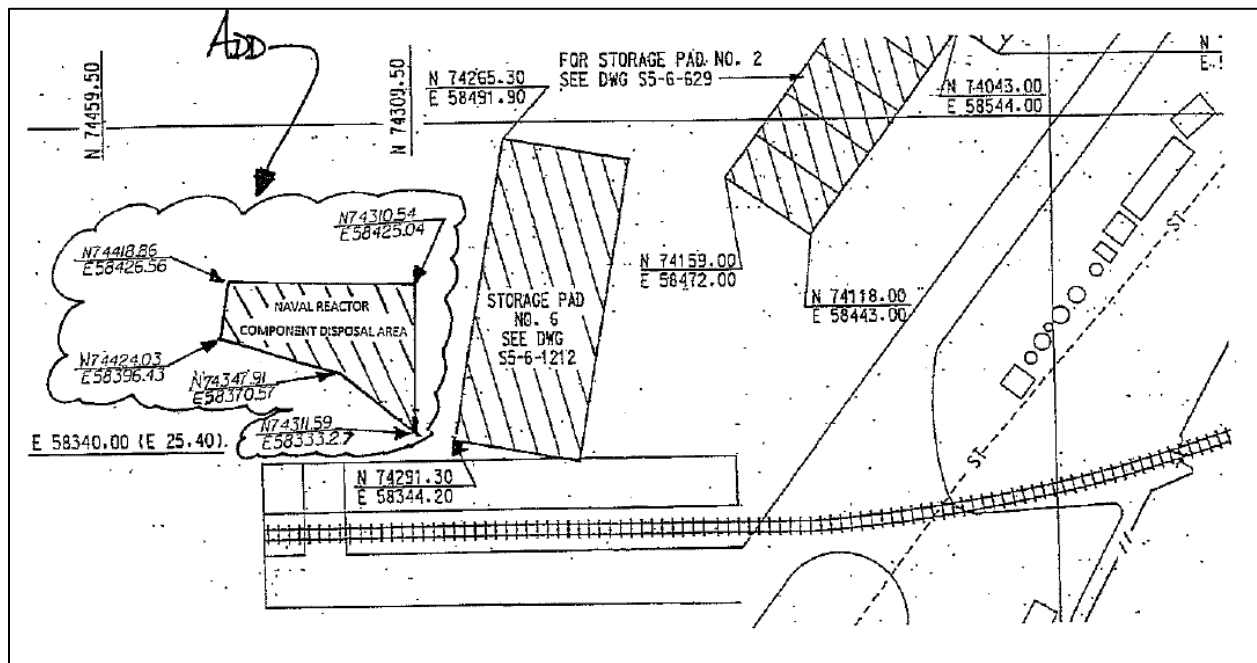


Figure 7. NR07E NRCDA shown with SRS Coordinates (C-DCF-E-00367, 2013).

NRCDA 643-7E						
Corner	Coordinates		Segment	Segment Lengths (ft)	Area Section	Area (ft2)
	SRS N	SRS E				
1	74424.03	58396.43	1-2	80.4	A	10415
2	74347.91	58370.57	2-3	52.1	B	-677
3	74311.59	58333.27	3-4	91.8	C	-2839
4	74310.54	58425.04	4-5	108.3	D	-984
5	74418.86	58426.56	5-1	30.6	E	-78
					F	-82
					G	-48
					Rounded Total	6000
					Total DU Area	0.14 acres

With closure cap and 40-foot overhangs (approximate)						
Corner	Coordinates		Segment	Segment Lengths (ft)	Area Section	Area (ft2)
	SRS N	SRS E				
1	74464.03	58356.43	1-2	80.4	A	33236
2	74387.91	58330.57	2-3	122.2	B	-2169
3	74271.59	58293.27	3-4	171.8	C	-2839
4	74270.54	58465.04	4-5	188.3	D	-984
5	74458.86	58466.56	5-1	110.3	E	-285
					F	-143
					G	-90
					Rounded Total	27000
					Total Cap Area	0.62 acres (approx.)

Figure 8. SRS Coordinates and Areal Coverage for NR07E Disposal Unit with and without Final Closure Cap (coordinates are approximate for closure cap case).

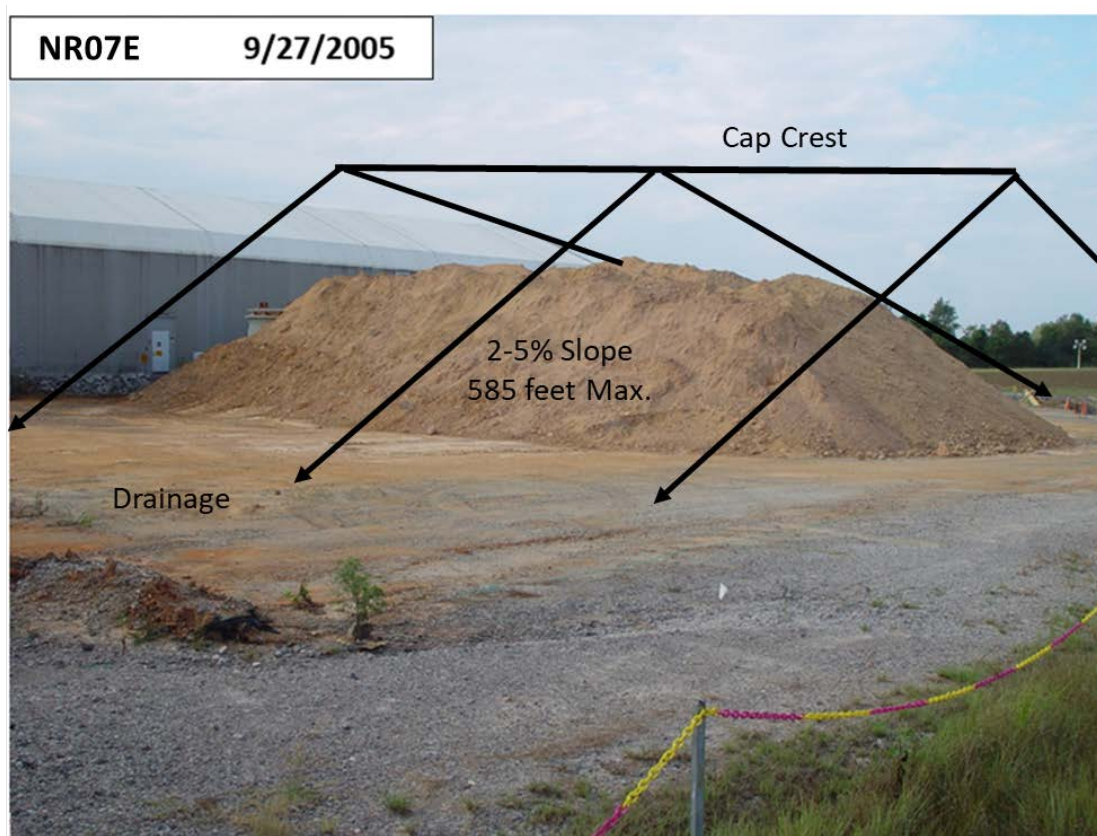


**Figure 9. NR07E with Temporary Soil Cover (Storage Pad No. 6 is shown next to the soil pile).**





**Figure 10. NR07E with Temporary Soil Cover in 2005 (upper) versus Aerial Photograph of NR07E in 2001 (lower).**



**Figure 11. Final Closure Cap Crest and Slope Concept for NR07E.**

## References

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C-CT-E-00083. (2016) Preliminary E-Area Low Level Waste Facility (ELLWF) Conceptual Closure Cap – Overall Site Plan (Sheets 1 of 5 through 5 of 5, Rev. A) Savannah River Nuclear Solutions, Aiken, SC.

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C-DCF-E-00367. (2013) Design Change Form for Solid Waste Disposal Facility Layout Drawing: Add 643-7E NRCDA to Drawing (Page 3 of 3). Savannah River Nuclear Solutions, Aiken, SC.

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