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Design Analysis Cover Sheet

Complete only applicable items.

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Page: 1 Of: 22

2. DESIGN ANALYSIS TITLE			
Design Alternative #2: Low Thermal Load, 25 MTU/Acre at 38 Meter Drift Spacing			
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11. REMARKS

2. DESIGN ANALYSIS TITLE	
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TABLES

FIGURES

Page

1. PURPOSE

The objective of this analysis is to develop a proposed repository subsurface layout for *Design Alternative #2: Low Thermal Load, 25 MTU/Acre at 38 Meter Drift Spacing.*

The scope of this analysis covers:

- Integration of the Exploratory Studies Facility (ESF) openings into the proposed repository layout for Design Alternative #2.
- Identification and incorporation of factors influencing the proposed repository layout. These factors include the required drift spacing, total required emplacement length, the number of emplacement drifts, required development, and subsurface ventilation.
- Geometry and configuration of the proposed repository openings.
- Development of a proposed layout showing the required emplacement area.

2. QUALITY ASSURANCE

This design analysis has been evaluated (Reference 5.7) in accordance with QAP-2-0, *Conduct of Activities*, and has been determined to be subject to the requirements of the *Quality Assurance Requirement and Descriptions* (QARD) (Reference 5.5). The *Classification of Permanent Items*, QAP-2-3, evaluation entitled *Classification of the Preliminary MGDS Repository Design* (TBV) has identified the emplacement drifts as important to waste isolation (QA-2) (Reference 5.8, Attachment V, p. 3). Due to the preliminary and conceptual nature of this analysis, unverified and unqualified criteria and engineering data are identified and designated as TBV or TBD. This document was prepared in accordance with QAP-3-9, *Design Analysis* and is subject to QA controls. It has been determined that NLP-2-0, *Determination of Importance*, is not applicable since the design analysis does not include site field activities.

3. METHOD

A purpose and scope were determined for the proposed repository layout for Design Alternative #2. Assumptions relative to the layout were determined, and the various functions of the repository were identified. Based on the assumptions, functions, and inputs a proposed repository layout was generated. First, the possible usable emplacement blocks were identified. Next, the drift spacing that would correspond to an areal mass loading (AML) of 25 metric tons of uranium (MTU)/acre was determined. The required emplacement length was then calculated, followed by the number of emplacement drifts needed to satisfy the calculated emplacement length. Once the drift spacing and the number of emplacement drifts were calculated, the number of emplacement blocks needed to satisfy the drift requirement was determined. Shafts, exhaust mains, Performance Confirmation drifts, and other modifications were added to the layout to meet design requirements.

4. DESIGN INPUTS

Conceptual and preliminary data is marked to be verified (TBV). The data is not required to be tracked per NLP-3-15, To Be Verified (TBV) and To Be Determined (TBD) Monitoring System, because this document is not to be used for procurement, construction, or fabrication.

4.1 DESIGN PARAMETERS

The design parameters used to develop the proposed subsurface layout for Design Alternative #2 are described in the following sections.

4.1.1 Layout (TBV)

The proposed repository for Design Alternative #2 is comprised of three blocks: the Primary Block, the Lower Block, and Area 5. The boundaries for these emplacement areas were obtained from *Identification of Possible Expansion Areas* (Reference 5.6, Figure 1, p. 7). The potential expansion areas are shown on Figure 1.

4.1.2 Openings (TBV)

The openings within the proposed repository shall be sized in accordance with those in the Viability Assessment (VA) reference design. Table 1 shows the diameters of the VA openings.

Table 1. VA Reference Design Opening Diameters

Opening	Diameter (m)	Basis
Emplacement Drifts	5.5	Reference 5.2, p. 73
Access Main	7.62	Reference 5.2, Table 7-2, p. 62
Exhaust Main	7.62	Reference 5.2, Table 7-2, p. 62
PC Drifts	5.5	Reference 5.2, Table 7-4, p. 100

4.1.3 Shaft Diameter (TBV)

The shafts in the proposed repository shall have a diameter of 7.6 meters compared to 6.7 meters in the VA design (Reference 5.2, p.80). The increased diameter is needed to ventilate the additional blocks and emplacement drifts in Design Alternative #2 which are not present in the VA design.

4.1.4 Stand-off Distances (TBV)

A stand-off is a specific area in an emplacement drift where waste packages cannot be placed. The sum of the lengths of all the stand-offs in an emplacement drift is the total stand-off distance for that emplacement drift. The following stand-off distances were considered in the layout design for Design Alternative #2.

Thermal/Radiological - The VA reference design requires the following stand-off distances: a thermal stand-off distance of 15 meters on the west side for drifts 92-120, a radiological stand-off of 13 meters for all drifts on the east side, and a radiological stand-off of 13 meters for drifts 1-91 on the west side (Reference 5.2, Attachment I, p. 1). Since the layout of Design Alternative #2 is different than that of the VA, a simplifying assumption was made to use stand-off distances of 15 meters from the door on the east side and 15 meters from the door on the west side for all emplacement drifts. These stand-off distances will meet both the thermal and radiological requirements.

Fault - Stand-off distances due to faults vary with both the type of fault and the number of faults crossing the emplacement drift. Type 1 faults are defined as those faults whose seismic event could impact repository design and performance (Reference 5.1, Vol. II, p. 6). If a Type 1 fault intersects an emplacement drift, a 15 meter stand-off must be allowed from the edge of the fault zone to the nearest waste package on both sides of the fault. If a non-Type 1 fault crosses an emplacement drift, a 5 meter stand-off on both sides of the fault must be observed (Reference 5.2, Section 4.3.7, p. 19).

Physical - A stand-off distance of 4 m will be used in each emplacement drift to account for the central ventilation raise (Reference 5.2, Attachment I, p.1).

4.1.5 Minimum Turning Radius

A minimum radius of 305 m will be used in ramps and mains where there will be conveyor muck handling. A minimum radius of 100 m for rail transportation will be used in mains and ramps that will not have conveyor muck handling (Reference 5.2, Section 4.3.23, p. 25).

4.1.6 Avoidance of Type 1 Faults

To the extent possible, repository openings will be located to avoid Type 1 faults. Avoidance is assumed to be adequate by using a 60 m offset from the main trace of a fault at the repository level (Ref. 5.9, p. 3-30).

4.2 CRITERIA

The design criteria that apply to this analysis were developed in accordance with the *Subsurface Facility System Description Document* (Reference 5.1).

4.2.1 Ventilation

The ventilation system for the proposed repository shall accommodate construction, development and emplacement operations, and the repository shall have separate ventilation systems for excavation and emplacement operations (Reference 5.1, 1.2.4.1, Vol. I, p. 12).

4.2.2 Performance Confirmation

The proposed repository shall include a performance confirmation system (Reference 5.1, 1.2.1.19, Vol. I, p. 9).

4.2.3 Maximum Extraction Ratio

The maximum extraction ratio for the emplacement drifts is 30 percent (Reference 5.1, 1.2.1.4, Vol. I, p. 7).

4.2.4 Groundwater Standoff (TBV)

The proposed repository shall accommodate a minimum stand-off of 100 m above the groundwater table (Ref. 5.1, Vol. I, Section 1.2.1.7, p. 8).

4.2.5 Overburden

The proposed repository shall provide a minimum 200 m overburden thickness over the underground facility (Ref. 5.1, Vol. I, Section 1.2.1.5, p. 7).

4.3 ASSUMPTIONS

Assumptions relative to Design Alternative #2 are described in the following sections.

4.3.1 Areal Mass Loading (TBV)

The AML of the waste package emplacement is 25 MTU/acre for the commercial spent nuclear fuel (SNF) packages only. The high-level waste (HLW) packages have little heat output and can be emplaced between the commercial SNF waste packages. The basis for using an AML of 25 MTU/acre was a management decision. This assumption is used in Sections 7.2.2 and 7.2.3.

4.3.2 Waste Package Inventory (TBV)

The assumed waste package inventory and waste package characteristics for the proposed repository are shown in Table 2. This waste package distribution was used because it had previously been developed to support another design alternative; no effort was made to optimize the waste package sizes for Design Alternative #2. This assumption is used throughout.

Table 2. Waste Package Inventory for Design Alternative #2

WP Type	# of WP	Mass x # WP's (MTU)
12 PWR (Ref. 5.4)	3794.83	19,221.36
5 PWR (Ref 5.4)	9451.20	20,651.24
12 PWR Long (Ref. 5.4)	6.67	43.33
5 PWR Long (Ref. 5.4)	273.6	736.56
24 BWR (Ref. 5.4)	3460.62	14,859.6
12 BWR (Ref. 5.4)	3434.5	7185.89
5 PWR from "Junk_Bins" (Ref. 5.4)	50.6	116.23
5 PWR Long from "Junk_Bins" (Ref. 5.4)	70.4	189.48
3 pk glass (Ref. 5.10, p. 110)	2082	0
3 pk glass Long (Ref. 5.10, p. 110)	690	0
DOE SNF 3 pk (Ref. 5.11, p. 6)	1064	0
Navy (Ref. 5.12, Vol. I, p. 7)	300	0
SUM	**24,678.42**	**63,003.69**

All data in Table 2 that was obtained from the document *Commercial Waste Stream Studies to Support Blending and Modified Waste Emplacement Mode* (Ref. 5.4) can be found in the Summary Table on page VI-21 of that document. The assemblies labeled "Junk_Bins" in the Summary Table were put into 5 PWR waste packages and are labeled as such in Table 2. The number of waste packages was found by dividing the number of "Junk_Bins" assemblies by 5. The Summary Table (Ref. 5.4, p. VI-21) does not provide a complete listing of the waste package inventory for Design Alternative #2. Other references were used to complete Table 2 and to obtain the total number of waste packages and total MTU for this alternative.

4.3.3 Average Waste Package Spacing (TBV)

The average waste package spacing for the proposed repository is assumed to be the same as that in the 1998 *Repository Subsurface Waste Emplacement and Thermal Management Strategy* (Reference 5.3); this is an engineering judgement based on the conceptual nature of this analysis. To avoid unnecessary repetition, the *Repository Subsurface Waste Emplacement and Thermal Management Strategy* shall be referred to as the Thermal Management Strategy from this point forward. These waste package characteristics will only be used to determine the average waste package spacing for Design Alternative #2. This assumption is used in Section 7.2.2.

Table 3. Waste Package Inventory for the Thermal Management Strategy

WP Type	# of WP	WP Mass (MTU)	Mass x # WP's (MTU)
21 PWR (k = 1.0)	1454 (Ref. 5.3, p. 14)	8.91 (Ref. 5.3, p. 11)	12,955.14
21 PWR (k = 1.13)	2653 (Ref. 5.3, p. 14)	9.01 (Ref. 5.3, p. 11)	23,903.53
21 PWR (k = 1.45)	132 (Ref. 5.3, p. 14)	7.4 (Ref. 5.3, p. 11)	976.8
12 PWR (k = 1.02)	398 (Ref. 5.3, p. 14)	5.32 (Ref. 5.3, p. 11)	2117.36
12 PWR (k = 1.13)	155 (Ref. 5.3, p. 14)	6.25 (Ref. 5.3, p. 11)	968.75
44 BWR (k = 1.0)	707 (Ref. 5.3, p. 14)	7.54 (Ref. 5.3, p. 11)	5330.78
44 BWR (k = 1.37)	2119 (Ref. 5.3, p. 14)	7.81 (Ref. 5.3, p. 11)	16,549.39
24 BWR	49 (Ref. 5.3, p. V-2)	3.34 (Ref. 5.3, p. 11)	163.66
5 HLW	1249 (Ref. 5.3, p. 14)		0
5 HLW (long)	414 (Ref. 5.3, p. 14)		0
Navy (short)	200 (Ref. 5.3, p. 14)		0
Navy (long)	100 (Ref. 5.3, p. 14)		0
Multi Canister	95 (Ref. 5.3, p. 14)		0
DOE	488 (Ref. 5.3, p. V-2)		0
SUM	**10,213**		**62,965**

The number of DOE waste packages is found by taking the total number of DOE-SNF packages in Table V-2 of the Thermal Management Strategy and subtracting the number of naval and multi canister packages.

4.3.4 Empty Emplacement Drifts (TBV)

Fourteen emplacement drifts will remain empty during emplacement operations. Some of the empty drifts will be cross-block drifts used for ventilation, monitoring, emergency egress, and/or performance confirmation. The remaining empty drifts will be used as stand-by drifts for possible relocation of waste packages. The empty drifts are as follows:

Primary Block: #16, #35, #51, #70, and #105,
Lower Block: #16, #35, #51, and #70, and
Area 5: #16, #35, #46, #70, and #102.

The empty drifts listed above do not include contingency drifts. This assumption is based on Reference 5.2, Section 4.3.30, p. 27. This assumption is used in Attachment III.

4.3.5 Emplacement Drift Turnouts (TBV)

The turnout distance is defined as the distance from the intersection of the main and the emplacement drift to the emplacement door. The following turnout distances were used in the VA design (Reference 5.2, Attachment I, p. 6):

East Side: 31 m all drifts,

West Side: 31 m drifts 1-36,
38 m drifts 37-53,
32 m drifts 54-113, and
28 m drifts 114-120.

Since the proposed low thermal load design is significantly different from that of the VA, the VA turnout distances cannot be applied. The turnout distances for the proposed repository were estimated from the layout based on the angle of the intersection of the main and the emplacement drift. The turnout distances used for the low thermal load design are shown in Table 4.

Table 4. Turnout Distances

Block	Side	Drift Number	Length (m)
Primary	East	1-130	27
Primary	West	1-14	36
Primary	West	15-49	25
Primary	West	50-61	32
Primary	West	62-130	26
Lower	East	1-35	40
Lower	East	36-48	32
Lower	East	49-85	27
Lower	West	1-35	26
Lower	West	36-48	32
Lower	West	49-85	27
Area 5	East	1-53	29
Area 5	East	54-102	30
Area 5	West	1-102	30

4.4 CODES AND STANDARDS

Not used.

5. REFERENCES

5.1 CRWMS M&O. 1998. *Subsurface Facility System Description Document.* BCA000000-01717-1705-00014 REV00. Las Vegas, Nevada: CRWMS M&O. MOL.19980826.0161.

5.2 CRWMS M&O. 1997. *Repository Subsurface Layout Configuration Analysis.* BCA000000-01717-0200-00008 REV00. Las Vegas, Nevada: CRWMS M&O. MOL.19971201.0879.

5.3 CRWMS M&O. 1998. *Repository Subsurface Waste Emplacement and Thermal Management Strategy.* B00000000-01717-0200-00173 REV00. Las Vegas, Nevada: CRWMS M&O. MOL.19980918.0084

5.4 CRWMS M&O. 1999. *Commercial Waste Stream Studies to Support Blending and Modified Waste Emplacement Mode.* B00000000-01717-0210-00036 REV00. Las Vegas, Nevada: CRWMS M&O. MOL.19990217.0187

5.5 DOE. 1998. *Quality Assurance Requirements and Description.* DOE/RW-0333P, REV08. Washington, D.C.: U.S. Department of Energy. MOL.19980601.0022

5.6 CRWMS M&O. 1998. *Identification of Potential Repository Expansion Areas.* BCA000000-01717-0210-00002 REV00. Las Vegas, Nevada: CRWMS M&O. MOL.19990126.0231

5.7 CRWMS M&O. 1998. *Activity Evaluation, Support Development of Repository Design Alternatives* (Work Package 12012382M2). Las Vegas, Nevada: CRWMS M&O. MOL.19981224.0055.

5.8 CRWMS M&O. 1998. *Classification of the Preliminary MGDS Repository Design.* B00000000-01717-0200-00134 REV01. Las Vegas, Nevada: CRWMS M&O. MOL.19981103.0546.

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5.10 CRWMS M&O. 1997. *Analytical Support for WP Size System Study.* BBA000000-01717-0200-00058 REV00. Las Vegas, Nevada: CRWMS M&O. MOL.19980107.0227.

5.11 CRWMS M&O. 1998. *DOE SNF Canister Trade Study Repor*t. September 30, 1998. Revision 01. Las Vegas, Nevada: CRWMS M&O. MOL.19981102.0079

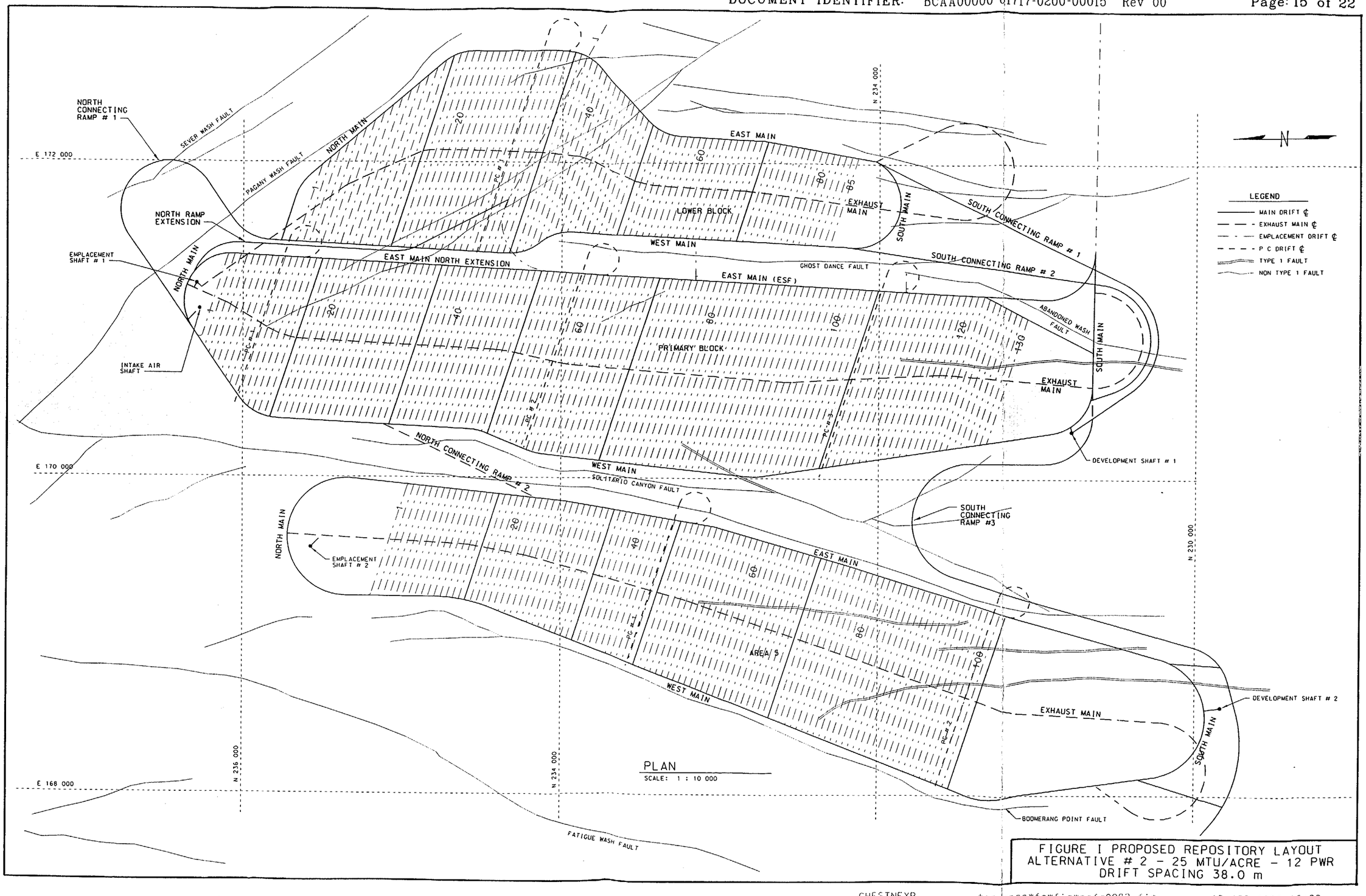
5.12 CRWMS M&O 1998. *Naval Spent Nuclear Fuel Disposal Container System Description Document.* BBA000000-01717-1705-00006 REV00. Las Vegas, Nevada: CRWMS M&O. MOL.19981214.0028.

6. USE OF COMPUTER SOFTWARE

Not used.

7. DESIGN ANALYSIS

The proposed repository layout for Design Alternative #2: Low Thermal Load, 25 MTU/Acre at 38 Meter Drift Spacing is shown in Figure 1 and in Figure V-1 in Attachment V. The layout consists of three bodies or blocks; they are the Primary Block, the Lower Block, and Area 5. Each block has its own exhaust main located below the level of the emplacement drifts, as well as its own set of Performance Confirmation Drifts. The Primary Block utilizes the existing ESF, and connecting ramps provide access from the Primary Block to both the Lower Block and Area 5.



PLAN
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FIGURE 1 PROPOSED REPOSITORY LAYOUT
ALTERNATIVE # 2 - 25 MTU/ACRE - 12 PWR
DRIFT SPACING 38.0 m

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7.1 AVAILABLE EMPLACEMENT AREA

The areas available for emplacement are shown in *Identification of Potential Repository Expansion Areas* (Reference 5.6, Figure 1, p. 7). The boundaries shown in this figure were used to develop the proposed repository layout for Design Alternative #2, which includes the Primary Block, Lower Block, and Area 5 (Section 4.1.1). The Primary Block in the proposed layout is comprised of the Drill Hole Wash Block, the Upper Repository Block, and the Abandoned Wash Block, and Area 5 is represented by the Boomerang Point Block. The lower limit of the potential siting volume was found using a 100 meter stand-off above the groundwater level (Reference 5.6, p. 3). This stand-off value is consistent with the groundwater stand-off defined in the *Subsurface Facility System Description Document* (Section 4.2.4). As stated in the *Identification of Potential Repository Expansion Areas* (Reference 5.6, Section 5.2, p. 5), the emplacement blocks in Figure 1 were developed in accordance with the 200 m overburden thickness requirement (Section 4.2.5). The emplacement blocks were also developed in accordance with Key Assumption 023 of the *Controlled Design Assumption Document* (Ref. 5.9, p. 3-30), which refers to Type 1 faults (Section 4.1.6). Type 1 faults were avoided where possible; a 60 m stand-off from the subsurface projection of the fault to the nearest underground opening was used to define the lateral limits of the emplacement blocks (Reference 5.6, p. 3). Unavoidable Type 1 faults, as well as splays associated with Type 1 faults, that intersect emplacement drifts are subject to the fault stand-off distances in Section 4.1.4. The shape of the proposed layout for Design Alternative #2 reflects a minimum turning radius of 305 m for mains and ramps where conveyor muck handling will be used and a minimum radius of 100 meters for rail transportation where conveyor muck handling will not be used (Section 4.1.5).

7.2 DRIFT SPACING

The following sections are calculation steps necessary to determine the drift spacing for the proposed repository. The required drift spacing is found from the predetermined AML of 25 MTU/Acre (Section 4.3.1).

7.2.1 Determination of the Average MTU/Waste Package

The average MTU/WP is found by dividing the total MTU by the total number of waste packages. Table 2 in Section 4.3.2 summarizes the waste packages, waste package lengths, and waste package masses used to develop the proposed repository for Design Alternative #2.

Using the values in Table 2, the average MTU/WP for the low thermal load design is as follows:

$$MTU/WP = \frac{63{,}004\,MTU}{24{,}678\,WP's} = 2.55\,MTU/WP.$$

7.2.2 Determination of the Average Waste Package Spacing

The average waste package spacing is the distance from centerline to centerline of the waste packages. Since the average waste package spacing for Design Alternative #2 is the same as that in the Thermal Management Strategy (Section 4.3.3), it can be determined from the values in Table 3 (Section 4.3.3). As previously mentioned, the values in Table 3 are only used to make the average waste package spacing used in Design Alternative #2 equal to that used in the Thermal Management Strategy.

The average MTU per waste package for the Thermal Management waste packages is

$$MTU/WP = \frac{62{,}965\,MTU}{10{,}213\,WP} = 6.17\,MTU/WP.$$

The average waste package spacing for the Thermal Management Strategy waste package inventory can then be found using the areal mass loading (AML) formula (Reference 5.3, Section 7.4.2.5, p. 34).

$$Waste\,Package\,Spacing = \frac{MTU/WP \times 4047 m^2/acre}{AML(MTU/Acre) \times Drift\,Spacing}$$

$$Waste\,Package\,Spacing = \frac{6.17 MTU/WP \times 4047 m^2/acre}{85\,MTU/Acre \times 28\,m} = 10.5\,m$$

An average waste package spacing of 10.5 meters corresponds to a drift spacing of 28 m and an AML of 85 MTU/acre. For the Design Alternative #2, a drift spacing will be determined that corresponds to an average waste package spacing of 10.5 m and an AML of 25 MTU/acre.

7.2.3 Determination of the Drift Spacing

The drift spacing for the low thermal load design was found using the AML equation (Reference 5.3, Section 7.4.2.5, p. 34).

$$Drift\,Spacing = \frac{MTU/WP \times 4047\,m^2/acre}{WP\,Spacing \times AML}$$

For a proposed repository at 25 MTU/acre:

MTU/WP = 2.55 (Section 7.2.1),
WP Spacing = 10.5 meters (Section 7.2.2), and
AML = 25 MTU/acre (Section 4.3.1).

The drift spacing for the proposed repository is

$$Drift\ Spacing = \frac{2.55\,MTU/WP \times 4047\,m^2/acre}{10.5\,m \times 25\,MTU/acre} = 39.3\,m.$$

A drift spacing of 38 meters was used to develop the proposed repository layout for the low thermal load alternative. The use of this value instead of the calculated value of 39.3 meters should not have a significant impact on the cost, since the development of both the mains and the exhaust mains is the same for both cases. The main difference in the layouts would be that a drift spacing of 39.3 meters would allow less emplacement drifts to be excavated in the Primary and Lower blocks. This loss of emplacement drifts could be accounted for in Area 5, where there is area available for additional emplacement drifts.

A maximum extraction ratio of 30% (Section 4.2.3) imposes a limit on the drift spacing. The extraction ratio relates the area excavated to the total area and is represented by the following equation (Reference 5.2, p.44).

$$ER = \frac{D_{ED}}{DS} \times 100 \leq 30\%$$

Where:

	ER	=	extraction ratio,
	D_{ED}	=	emplacement drift diameter (meters), and
	DS	=	emplacement drift spacing (meters).

For the low thermal load design,

$$ER = \frac{5.5\,m}{38\,m} \times 100 = 14.5\%.$$

The calculation shows that the drift spacing for the proposed repository is within the assumed maximum extraction ratio of 30%.

7.3 NUMBER OF EMPLACEMENT DRIFTS

The following sections are calculation steps used to determine the required number of emplacement drifts for the proposed low thermal load repository.

7.3.1 Required Emplacement Length

The required emplacement length for the proposed repository is calculated from the total number of waste packages and the average waste package spacing. The total number of waste packages is 24,678 (Section 4.3.2, Table 2), and the average waste package spacing is 10.5 meters (Section 7.2.2). The required emplacement length is as follows:

$$Emplacement\ Length = 24{,}678 \times 10.5\,m = 259{,}119\,m.$$

7.3.2 Determination of the Excavation Length

The excavation drift length is defined as the distance from the emplacement door on the west side to the emplacement door on the east side. Excavation lengths for the proposed repository were determined from lengths measured on the layout. Measured lengths are shown in Attachment I. The emplacement drifts were measured from the East Main to the West Main, and the excavation lengths were determined as follows:

$$Excavation\ Length = Measured\ Length - (East\ Main\ Turnout + West\ Main\ Turnout).$$

7.3.3 Determination of Emplacement Drift Turnouts

The length of a turnout is the distance from the intersection of the emplacement drift with the main to the emplacement door. The turnouts for the proposed repository were approximated from the layout (Section 4.3.5) and are shown in Attachment II, along with the calculated excavation lengths.

7.3.4 Determination of the Number of Required Emplacement Drifts

Emplacement length is defined as the excavation length less the stand-off distance (Section 4.1.4), and the required number of emplacement drifts is defined as the number of drifts it takes to satisfy the required emplacement length of 259,119 meters (Section 7.3.1). Emplacement drifts are added first to the Primary Block, then the Lower Block, then Area 5 until the required emplacement length is reached.

The faults that intersect each emplacement drift are shown in Figure VI-1. Non-Type 1 faults are shown as a single line, while Type 1 faults are shown as a double line. Type 1 faults are identified in *Identification of Potential Repository Expansion Areas* (Reference 5.6, p. 3). The stand-off distances required for Non-Type 1 and Type 1 faults are 5 meters and 15 meters, respectively (Section 4.1.4). These stand-off distances must be observed on both sides of the faults. The fault stand-off distances used in developing Design Alternative #2 are shown below; they are based on the faults shown in Figure VI-1.

Primary Block:	10 meters for drifts 11-19, 22-27, and 63-71, 15 meters for drifts 89 and 90, 20 meters for drifts 20 and 21, and 30 meters for drifts 82-88 and 112-130,
Lower Block:	10 meters for drifts 17-25 and drift 47, 20 meters for drift 26 and drifts 37-46, and 30 meters for drifts 27-36, and
Area 5:	30 meters for drifts 54-77, 60 meters for drifts 78-93 and 97-102, and 90 meters for drifts 94-96.

These fault stand-off distances represent stand-off on both sides of the fault. Although drifts 89 and 90 in the Primary Block have a Type 1 fault intersecting them, a fifteen meter stand-off was only needed on one side since the turnouts and thermal/radiological

stand-offs already account for the other side. Also, no fault stand-off was necessary for drifts 28 and 29 in the Primary Block, since the distance is used up in the turnouts and thermal/radiological stand-offs.

The total stand-off distance is the sum of the following stand-offs: thermal/radiological, fault, and physical (Section 4.1.4). Total stand-off distance per emplacement drift is calculated in Attachment III; the stand-off distances are then used to calculate the emplacement lengths in Attachment IV.

The total emplacement lengths available in the Primary and Lower Blocks are 125,487 meters and 64,916 meters, respectively (Attachment IV, p. IV-9). Subtracting these lengths from the total required emplacement length (Section 7.3.1) will give the emplacement length needed in Area 5.

Required Emplacement Length in Area 5 = 259,119 - (125,487+64,916) = 68,716 meters.

Table IV-3 in Attachment IV shows that 89 drifts will satisfy the 68,716 meters of emplacement length needed in Area 5. One more drift will be added to this total to satisfy the empty drift requirement in Area 5. The total number of drifts required for the proposed repository is the sum of the drifts from the Primary Block, the Lower Block, and Area 5 (Attachment IV).

Total Required Emplacement Drifts = 130 + 85 + 90 = 305.

The 305 drifts satisfy the required emplacement length as well as the empty drift requirement (Section 4.3.4). Twelve additional drifts were added for contingency, making the total number of emplacement drifts 317. The contingency drifts increase the total available emplacement length to 271,370 meters (See Attachment IV).

7.4 DETERMINATION OF THE EMPLACEMENT ACREAGE

The acreage required for waste emplacement is calculated as the total drift length available for emplacement multiplied by the drift spacing (Reference 5.2, Attachment I, p. 2). The emplacement length used in this calculation will be the required emplacement length of the proposed repository (Section 7.3.4).

$$Acreage = \frac{E_L \times D_S}{(0.09290304 \frac{m^2}{ft^2}) \times (43{,}560 \frac{ft^2}{acre})}$$

Where: E_L = total emplacement length (meters) and
D_S = drift spacing (meters).

When: E_L = 259,119 meters (Section 7.3.1) and
D_S = 38 meters (Section 7.2.3),

$$Acreage = \frac{259{,}119 meters \times 38 meters}{(0.09290304 \frac{m^2}{ft^2}) \times (43{,}560 \frac{ft^2}{acre})}.$$

$$Emplacement\ Acreage = 2433.13\ acres.$$

Because the drift spacing used to develop the layout for Design Alternative #2 is slightly different than the calculated value of 39.3 (Section 7.2.3), the above emplacement acreage does not correspond to an AML of 25 MTU/acre. A drift spacing of 38 meters with package spacing at 10.5 m (Section 7.2.2) and a total load of 63,004 MTU (Section 4.3.3) corresponds to the following AML:

AML = 63,004 MTU/2433.13 acres = 25.9 MTU/acre.

The contingency acreage is determined using the value of the additional emplacement length provided by the contingency drifts. The additional emplacement length is equal to the total available emplacement length (271,370) less the required emplacement length (259,119).

$$Acreage = \frac{12{,}251 meters \times 38 meters}{(0.09290304 \frac{m^2}{ft^2}) \times (43{,}560 \frac{ft^2}{acre})}$$

Contingency acreage = 115 acres.

7.5 SHAFTS

Five shafts are required for the subsurface ventilation system. The shafts provide separate ventilation systems for development and emplacement operations (Section 4.2.1). The shafts are Emplacement Shaft #1, Intake Air Shaft, Development Shaft #1, Emplacement Shaft #2, and Development Shaft #2. The general locations of the shafts are shown in Figure 1. Table 5 shows the functions of each shaft as well as the area that each shaft serves.

Table 5. Shaft Functions

Shaft	Block(s)	Function
Emplacement Shaft #1	Primary & Lower	Exhaust Shaft During Emplacement
Intake Air Shaft	Primary, Lower, & Area 5	Fresh Air During Emplacement
Development Shaft #1	Primary & Lower	Fresh Air During Development
Emplacement Shaft #2	Area 5	Exhaust Shaft During Emplacement
Development Shaft #2	Area 5	Fresh Air During Development

7.6 PERFORMANCE CONFIRMATION

Performance Confirmation (PC) drifts for the proposed repository are shown in Figure V-1 (Section 4.2.2). Each block has its own PC drifts, which are located above the

emplacement drifts. Access mains for the PC drifts begin on the East Main of each block and curve upward until the desired elevation is reached. The PC drifts are spread over the length of each block to minimize the number of drifts needed.

8. CONCLUSIONS (TBV)

The proposed layout for Design Alternative #2: Low Thermal Load, 25 MTU/Acre at 38 Meter Drift Spacing is illustrated in Figure 1 and in Figure V-1 in Attachment V. It is necessary to develop the Primary Block, the Lower Block, and Area 5 to satisfy the required emplacement length of 259,119 meters (Section 7.3.1). The layout has been developed with emplacement drift spacing at 38 meters (Section 7.2.3) and an extraction ratio of 14.5% (Section 7.2.3). Three hundred five emplacement drifts are required; twelve more were added for contingency, making the total available emplacement length 271,370 meters (Section 7.3.4). The emplacement acreage is 2433 acres, and the contingency acreage is 115 acres (Section 7.4). Five shafts are required for the ventilation system (Section 7.5). The excavation lengths for the proposed repository are shown in Table 6 below.

Table 6. Summary of Excavation Lengths

Description	Length (m)	Section
317 Emplacement Drifts	299,111	Attachment II
Mains and Connecting Ramps	69,260	Attachment I, Table I-4
Performance Confirmation Drifts	10,420	Attachment I, Table I-5

9. ATTACHMENTS

Attachment I:
Measured Linear Lengths

Attachment II:
Calculation of Excavation Length

Attachment III:
Calculation of Stand-off Distances

Attachment IV:
Calculation of Emplacement Length

Attachment V:
Proposed Repository Layout

ATTACHMENT I
MEASURED LINEAR LENGTHS

MEASURED LINEAR LENGTHS

The lengths in Tables I-1, I-2, and I-3 were scaled from the proposed repository layout (See Figure V-1). The distances measured were from the East Main to the West Main and were measured with an accuracy of five meters. Table I-1 summarizes the measured emplacement drift lengths for the Primary Block.

Table I-1. Primary Block Measured Emplacement Drift Lengths

Drift Number	Measured Length (m)	Drift Number	Measured Length (m)	Drift Number	Measured Length (m)
1	580	45	1060	89	1260
2	625	46	1060	90	1265
3	660	47	1060	91	1270
4	700	48	1060	92	1270
5	740	49	1070	93	1270
6	780	50	1080	94	1280
7	820	51	1090	95	1280
8	855	52	1100	96	1270
9	900	53	1110	97	1260
10	935	54	1130	98	1255
11	970	55	1140	99	1250
12	1000	56	1150	100	1240
13	1020	57	1170	101	1230
14	1040	58	1180	102	1215
15	1050	59	1190	103	1210
16	1060	60	1200	104	1200
17	1060	61	1200	105	1190
18	1060	62	1200	106	1185
19	1060	63	1210	107	1170
20	1060	64	1210	108	1165
21	1060	65	1210	109	1160
22	1060	66	1210	110	1145
23	1060	67	1210	111	1140
24	1060	68	1215	112	1130
25	1060	69	1220	113	1120
26	1060	70	1220	114	1110
27	1060	71	1220	115	1100
28	1060	72	1225	116	1090
29	1060	73	1230	117	1080
30	1060	74	1230	118	1075
31	1060	75	1230	119	1070
32	1060	76	1235	120	1060
33	1060	77	1240	121	1050
34	1060	78	1240	122	1040
35	1060	79	1240	123	1015
36	1060	80	1240	124	990
37	1060	81	1250	125	960
38	1060	82	1250	126	935
39	1060	83	1250	127	910
40	1060	84	1250	128	885
41	1060	85	1250	129	960
42	1060	86	1255	130	840
43	1060	87	1260		
44	1060	88	1260		

Table I-2 summarizes the measured emplacement drift lengths for the Lower Block.

Table I-2. Lower Block Measured Emplacement Drift Lengths

Drift Number	Measured Length (m)	Drift Number	Measured Length (m)
1	510	44	945
2	560	45	910
3	610	46	880
4	660	47	845
5	710	48	815
6	760	49	780
7	810	50	750
8	860	51	720
9	920	52	700
10	1020	53	680
11	1070	54	660
12	1120	55	655
13	1170	56	655
14	1230	57	655
15	1260	58	655
16	1280	59	655
17	1295	60	655
18	1300	61	655
19	1300	62	655
20	1305	63	655
21	1305	64	655
22	1305	65	655
23	1310	66	655
24	1310	67	655
25	1310	68	655
26	1315	69	655
27	1320	70	650
28	1325	71	640
29	1325	72	640
30	1325	73	635
31	1325	74	630
32	1330	75	630
33	1330	76	620
34	1330	77	620
35	1330	78	610
36	1315	79	605
37	1290	80	600
38	1250	81	600
39	1190	82	600
40	1120	83	600
41	1070	84	590
42	1020	85	580
43	980		

Table I-3 summarizes the measured emplacement drift lengths for Area 5.

Table I-3. Area 5 Measured Emplacement Drift Lengths

Drift Number	Measured Length (m)	Drift Number	Measured Length (m)
1	750	52	1000
2	750	53	1010
3	740	54	1010
4	740	55	1015
5	740	56	1020
6	730	57	1020
7	730	58	1020
8	720	59	1030
9	720	60	1030
10	720	61	1030
11	710	62	1040
12	710	63	1040
13	710	64	1045
14	710	65	1050
15	710	66	1050
16	710	67	1055
17	720	68	1055
18	725	69	1060
19	730	70	1065
20	740	71	1070
21	750	72	1070
22	760	73	1070
23	770	74	1080
24	780	75	1080
25	790	76	1085
26	800	77	1090
27	810	78	1090
28	820	79	1095
29	830	80	1100
30	835	81	1100
31	840	82	1100
32	850	83	1105
33	860	84	1105
34	870	85	1110
35	880	86	1110
36	880	87	1110
37	890	88	1115
38	900	89	1120
39	905	90	1120
40	910	91	1125
41	920	92	1125
42	930	93	1130
43	935	94	1130
44	940	95	1135
45	950	96	1135
46	960	97	1140
47	970	98	1145
48	980	99	1145
49	980	100	1150
50	980	101	1150
51	1000	102	1150

Table I-4 summarizes the measured excavation lengths of the mains and connecting ramps for the proposed repository layout (see Attachment V). Figure V-1 shows the start and finish points for the measured distances.

Table I-4. Measured Excavation Lengths

Location	Description	Length (m)
Primary Block	South Main	1280
Primary Block	West Main	5830
Primary Block	North Main	680
Primary Block	North Ramp Extension	2130
Primary Block	East Main North Extension	1930
Primary Block	Exhaust Main	6770
Lower Block	North Main	460
Lower Block	East Main	4020
Lower Block	South Main	830
Lower Block	West Main	3590
Lower Block	Exhaust Main	6720
Area 5	North Main	1210
Area 5	East Main	5240
Area 5	South Main	1040
Area 5	West Main	5330
Area 5	Exhaust Main	7070
Area 5	Connectors	890
Primary Block/Lower Block	North Connecting Ramp #1	2130
Area 5/Primary Block	North Connecting Ramp #2	1070
Primary Block/Lower Block	South Connecting Ramp #1	3030
Lower Block/Primary Block	South Connecting Ramp #2	2730
Primary Block/Area 5	South Connecting Ramp #3	4920
Primary Block/Area 5	Shaft Access	360
TOTAL		**69,260**

Table I-5 summarizes the Performance Confirmation excavation lengths for the proposed repository.

Table I-5. Performance Confirmation Excavation Lengths

Location	Description	Length (m)
Primary Block	PC Drift #1	1580
Primary Block	PC Drift #2	1770
Primary Block	PC Drift #3	1850
Lower Block	PC Drift #1	1940
Area 5	PC Drift #1	1550
Area 5	PC Drift #2	1730
TOTAL		**10,420**

ATTACHMENT II
CALCULATION OF EXCAVATION LENGTHS

CALCULATION OF EXCAVATION LENGTHS

Tables II-1, II-2, and II-3 show the excavation lengths for the emplacement drifts for the Primary Block, Lower Block, and Area 5, respectively. The excavation length is equal to the measured length minus the lengths of the turnouts. The measured drift lengths (Attachment I) are used as inputs in the following tables.

Table II-1. Primary Block Excavation Lengths

Drift Number	Measured Length (m)	East Turnout Length (m)	West Turnout Length (m)	Excavation Length (m)	Cumulative Excavation Length (m)
1	580	27	36	517	517
2	625	27	36	562	1,079
3	660	27	36	597	1,676
4	700	27	36	637	2,313
5	740	27	36	677	2,990
6	780	27	36	717	3,707
7	820	27	36	757	4,464
8	855	27	36	792	5,256
9	900	27	36	837	6,093
10	935	27	36	872	6,965
11	970	27	36	907	7,872
12	1000	27	36	937	8,809
13	1020	27	36	957	9,766
14	1040	27	36	977	10,743
15	1050	27	25	998	11,741
16	1060	27	25	1008	12,749
17	1060	27	25	1008	13,757
18	1060	27	25	1008	14,765
19	1060	27	25	1008	15,773
20	1060	27	25	1008	16,781
21	1060	27	25	1008	17,789
22	1060	27	25	1008	18,797
23	1060	27	25	1008	19,805
24	1060	27	25	1008	20,813
25	1060	27	25	1008	21,821
26	1060	27	25	1008	22,829
27	1060	27	25	1008	23,837
28	1060	27	25	1008	24,845
29	1060	27	25	1008	25,853
30	1060	27	25	1008	26,861
31	1060	27	25	1008	27,869
32	1060	27	25	1008	28,877
33	1060	27	25	1008	29,885
34	1060	27	25	1008	30,893
35	1060	27	25	1008	31,901
36	1060	27	25	1008	32,909
37	1060	27	25	1008	33,917
38	1060	27	25	1008	34,925
39	1060	27	25	1008	95,933
40	1060	27	25	1008	36,941
41	1060	27	25	1008	37,949
42	1060	27	25	1008	38,957
43	1060	27	25	1008	39,965
44	1060	27	25	1008	40,973
45	1060	27	25	1008	41,981
46	1060	27	25	1008	42,989
47	1060	27	25	1008	43,997

Table II-1. Primary Block Excavation Lengths (Continued)

Drift Number	Measured Length (m)	East Turnout Length (m)	West Turnout Length (m)	Excavation Length (m)	Cumulative Excavation Length (m)
48	1060	27	25	1008	45,005
49	1070	27	25	1018	46,023
50	1080	27	32	1021	47,044
51	1090	27	32	1031	48,075
52	1100	27	32	1041	49,116
53	1110	27	32	1051	50,167
54	1130	27	32	1071	51,238
55	1140	27	32	1081	52,319
56	1150	27	32	1091	53,410
57	1170	27	32	1111	54,521
58	1180	27	32	1121	55,642
59	1190	27	32	1131	56,773
60	1200	27	32	1141	57,914
61	1200	27	32	1141	59,055
62	1200	27	26	1147	60,202
63	1210	27	26	1157	61,359
64	1210	27	26	1157	62,516
65	1210	27	26	1157	63,673
66	1210	27	26	1157	64,830
67	1210	27	26	1157	65,987
68	1215	27	26	1162	67,149
69	1220	27	26	1167	68,316
70	1220	27	26	1167	69,483
71	1220	27	26	1167	70,650
72	1225	27	26	1172	71,822
73	1230	27	26	1177	72,999
74	1230	27	26	1177	74,176
75	1230	27	26	1177	75,353
76	1235	27	26	1182	76,535
77	1240	27	26	1187	77,722
78	1240	27	26	1187	78,909
79	1240	27	26	1187	80,096
80	1240	27	26	1187	81,283
81	1250	27	26	1197	82,480
82	1250	27	26	1197	83,677
83	1250	27	26	1197	84,874
84	1250	27	26	1197	86,071
85	1250	27	26	1197	87,268
86	1255	27	26	1202	88,470
87	1260	27	26	1207	89,677
88	1260	27	26	1207	90,884
89	1260	27	26	1207	92,091
90	1265	27	26	1212	93,303
91	1270	27	26	1217	94,520
92	1270	27	26	1217	95,737
93	1270	27	26	1217	96,954
94	1280	27	26	1227	98,181
95	1280	27	26	1227	99,408
96	1270	27	26	1217	100,625
97	1260	27	26	1207	101,932
98	1255	27	26	1202	103,034
99	1250	27	26	1197	104,231
100	1240	27	26	1187	105,418
101	1230	27	26	1177	106,595

Table II-1. Primary Block Excavation Lengths (Continued)

Drift Number	Measured Length (m)	East Turnout Length (m)	West Turnout Length (m)	Excavation Length (m)	Cumulative Excavation Length (m)
102	1215	27	26	1162	107,757
103	1210	27	26	1157	108,914
104	1200	27	26	1147	110,061
105	1190	27	26	1137	111,198
106	1185	27	26	1132	112,330
107	1170	27	26	1117	113,447
108	1165	27	26	1112	114,559
109	1160	27	26	1107	115,666
110	1145	27	26	1092	116,758
111	1140	27	26	1087	117,845
112	1130	27	26	1077	118,922
113	1120	27	26	1067	119,989
114	1110	27	26	1057	121,046
115	1100	27	26	1047	122,093
116	1090	27	26	1037	123,130
117	1080	27	26	1027	124,157
118	1075	27	26	1022	125,179
119	1070	27	26	1117	126,196
120	1060	27	26	1007	127,203
121	1050	27	26	997	128,200
122	1040	27	26	987	129,187
123	1015	27	26	962	130,149
124	990	27	26	937	131,086
125	960	27	26	907	131,993
126	935	27	26	882	132,875
127	910	27	26	857	133,732
128	885	27	26	832	134,564
129	860	27	26	807	135,371
130	840	27	26	787	136,158

Table II-2. Lower Block Excavation Lengths

Drift Number	Measured Length (m)	East Turnout Length (m)	West Turnout Length (m)	Excavation Length (m)	Cumulative Excavation Length (m)
1	510	40	26	444	444
2	560	40	26	494	938
3	610	40	26	544	1,482
4	660	40	26	594	2,076
5	710	40	26	644	2,720
6	760	40	26	694	3,414
7	810	40	26	744	4,158
8	860	40	26	794	4,952
9	920	40	26	854	5,806
10	1020	40	26	954	6,760
11	1070	40	26	1004	7,764
12	1120	40	26	1054	8,818
13	1170	40	26	1104	9,922
14	1230	40	26	1164	11,086
15	1260	40	26	1194	12,280
16	1280	40	26	1214	13,494
17	1295	40	26	1229	14,723
18	1300	40	26	1234	15,957
19	1300	40	26	1234	17,191
20	1305	40	26	1239	18,430
21	1305	40	26	1239	19,669
22	1305	40	26	1239	20,908
23	1310	40	26	1244	22,152
24	1310	40	26	1244	23,396
25	1310	40	26	1244	24,640
26	1315	40	26	1249	25,889
27	1320	40	26	1254	27,143
28	1325	40	26	1259	28,402
29	1325	40	26	1259	29,661
30	1325	40	26	1259	30,920
31	1325	40	26	1259	32,179
32	1330	40	26	1264	33,443
33	1330	40	26	1264	34,707
34	1330	40	26	1264	35,971
35	1330	40	26	1264	37,235
36	1315	32	32	1251	38,486
37	1290	32	32	1226	39,712
38	1250	32	32	1186	40,898
39	1190	32	32	1126	42,024
40	1120	32	32	1056	43,080
41	1070	32	32	1006	44,086
42	1020	32	32	956	45,042
43	980	32	32	916	45,958
44	945	32	32	881	46,839
45	910	32	32	846	47,685
46	880	32	32	816	48,501
47	845	32	32	781	49,282
48	815	32	32	751	50,033
49	780	27	27	726	50,759
50	750	27	27	696	51,455
51	720	27	27	666	52,121
52	700	27	27	646	52,767
53	680	27	27	626	53,393

Table II-2. Lower Block Excavation Lengths (Continued)

Drift Number	Measured Length (m)	East Turnout Length (m)	West Turnout Length (m)	Excavation Length (m)	Cumulative Excavation Length (m)
54	660	27	27	606	53,999
55	655	27	27	601	54,600
56	655	27	27	601	55,201
57	655	27	27	601	55,802
58	655	27	27	601	56,403
59	655	27	27	601	57,004
60	655	27	27	601	57,605
61	655	27	27	601	58,206
62	655	27	27	601	58,807
63	655	27	27	601	59,408
64	655	27	27	601	60,009
65	655	27	27	601	60,610
66	655	27	27	601	61,211
67	655	27	27	601	61,812
68	655	27	27	601	62,413
69	655	27	27	601	63,014
70	650	27	27	596	63,610
71	640	27	27	586	64,196
72	640	27	27	586	64,782
73	635	27	27	581	65,363
74	630	27	27	576	65,939
75	630	27	27	576	66,515
76	620	27	27	566	67,081
77	620	27	27	566	67,647
78	610	27	27	556	68,203
79	605	27	27	551	68,754
80	600	27	27	546	69,300
81	600	27	27	546	69,846
82	600	27	27	546	70,392
83	600	27	27	546	70,938
84	590	27	27	536	71,474
85	580	27	27	526	72,000

Table II-3. Area 5 Excavation Lengths

Drift Number	Measured Length (m)	East Turnout Length (m)	West Turnout Length (m)	Excavation Length (m)	Cumulative Excavation Length (m)
1	750	29	30	691	691
2	750	29	30	691	1,382
3	740	29	30	681	2,063
4	740	29	30	681	2,744
5	740	29	30	681	3,425
6	730	29	30	671	4,096
7	730	29	30	671	4,767
8	720	29	30	661	5,428
9	720	29	30	661	6,089
10	720	29	30	661	6,750
11	710	29	30	651	7,401
12	710	29	30	651	8,052
13	710	29	30	651	8,703
14	710	29	30	651	9,354
15	710	29	30	651	10,005
16	710	29	30	651	10,656
17	720	29	30	661	11,317
18	725	29	30	666	11,983
19	730	29	30	671	12,654
20	740	29	30	681	13,335
21	750	29	30	691	14,026
22	760	29	30	701	14,727
23	770	29	30	711	15,438
24	780	29	30	721	16,159
25	790	29	30	731	16,890
26	800	29	30	741	17,631
27	810	29	30	751	18,382
28	820	29	30	761	19,143
29	830	29	30	771	19,914
30	835	29	30	776	20,690
31	840	29	30	781	21,471
32	850	29	30	791	22,262
33	860	29	30	801	23,063
34	870	29	30	811	23,874
35	880	29	30	821	24,695
36	880	29	30	821	25,516
37	890	29	30	831	26,347
38	900	29	30	841	27,188
39	905	29	30	846	28,034
40	910	29	30	851	28,885
41	920	29	30	861	29,746
42	930	29	30	871	30,617
43	935	29	30	876	31,493
44	940	29	30	881	32,374
45	950	29	30	891	33,265
46	960	29	30	901	34,166
47	970	29	30	911	35,077
48	980	29	30	921	35,998
49	980	29	30	921	36,919
50	980	29	30	921	37,840
51	1000	29	30	941	38,781

Table II-3. Area 5 Excavation Lengths (Continued)

Drift Number	Measured Length (m)	East Turnout Length (m)	West Turnout Length (m)	Excavation Length (m)	Cumulative Excavation Length (m)
52	1000	29	30	941	39,722
53	1010	29	30	951	40,673
54	1010	30	30	950	41,623
55	1015	30	30	955	42,578
56	1020	30	30	960	43,538
57	1020	30	30	960	44,498
58	1020	30	30	960	45,458
59	1030	30	30	970	46,428
60	1030	30	30	970	47,398
61	1030	30	30	970	48,368
62	1040	30	30	980	49,348
63	1040	30	30	980	50,328
64	1045	30	30	985	51,313
65	1050	30	30	990	52,303
66	1050	30	30	990	53,293
67	1055	30	30	995	54,288
68	1055	30	30	995	55,283
69	1060	30	30	1000	56,283
70	1065	30	30	1005	57,288
71	1070	30	30	1010	58,298
72	1070	30	30	1010	59,308
73	1070	30	30	1010	60,318
74	1080	30	30	1020	61,338
75	1080	30	30	1020	62,358
76	1085	30	30	1025	63,383
77	1090	30	30	1030	64,413
78	1090	30	30	1030	65,443
79	1095	30	30	1035	66,478
80	1100	30	30	1040	67,518
81	1100	30	30	1040	68,558
82	1100	30	30	1040	69,598
83	1105	30	30	1045	70,643
84	1105	30	30	1045	71,688
85	1110	30	30	1050	72,738
86	1110	30	30	1050	73,788
87	1110	30	30	1050	74,838
88	1115	30	30	1055	75,893
89	1120	30	30	1060	76,953
90	1120	30	30	1060	78,013
91	1125	30	30	1065	79,078
92	1125	30	30	1065	80,143
93	1130	30	30	1070	81,213
94	1130	30	30	1070	82,283
95	1135	30	30	1075	83,358
96	1135	30	30	1075	84,433
97	1140	30	30	1080	85,513
98	1145	30	30	1085	86,598
99	1145	30	30	1085	87,683
100	1150	30	30	1090	88,773
101	1150	30	30	1090	89,863
102	1150	30	30	1090	90,953

Table II-4 below summarizes the emplacement drift excavation lengths for the Primary Block, the Lower Block, and Area 5.

Table II-4. Summary of Excavation Lengths

Location	Excavation Length (m)
Primary Block	136,158
Lower Block	72,000
Area 5	90,953
TOTAL	**299,111**

ATTACHMENT III
CALCULATION OF STAND-OFF DISTANCES

CALCULATION OF STAND-OFF DISTANCES

The stand-off distance represents a specific length within the emplacement drift that cannot be used for emplacement. The total stand-off distance is due to thermal and radiological requirements, faults, and physical requirements (Section 4.1.4). Tables III-1, III-2, and III-3 show the total stand-off distances for emplacement drifts in the Primary Block, Lower Block, and Area 5, respectively. The total stand-off distance is the sum of the following stand-off distances: thermal/radiological, ventilation raise, and fault.

Table III-1. Primary Block Stand-off Distances

Drift Number	Thermal/ Radiological Stand-off (m)	Ventilation Raise Stand-off (m)	Fault Stand-off (m)	Total Stand-off Distance (m)
1	30	4	0	34
2	30	4	0	34
3	30	4	0	34
4	30	4	0	34
5	30	4	0	34
6	30	4	0	34
7	30	4	0	34
8	30	4	0	34
9	30	4	0	34
10	30	4	0	34
11	30	4	10	44
12	30	4	10	44
13	30	4	10	44
14	30	4	10	44
15	30	4	10	44
16	30	4	10	44
17	30	4	10	44
18	30	4	10	44
19	30	4	10	44
20	30	4	20	54
21	30	4	20	54
22	30	4	10	44
23	30	4	10	44
24	30	4	10	44
25	30	4	10	44
26	30	4	10	44
27	30	4	10	44
28	30	4	0	34
29	30	4	0	34
30	30	4	0	34
31	30	4	0	34
32	30	4	0	34
33	30	4	0	34
34	30	4	0	34
35	30	4	0	34
36	30	4	0	34
37	30	4	0	34
38	30	4	0	34
39	30	4	0	34
40	30	4	0	34
41	30	4	0	34

Table III-1. Primary Block Stand-off Distances (Continued)

Drift Number	Thermal/ Radiological Stand-off (m)	Ventilation Raise Stand-off (m)	Fault Stand-off (m)	Total Stand-off Distance (m)
42	30	4	0	34
43	30	4	0	34
44	30	4	0	34
45	30	4	0	34
46	30	4	0	34
47	30	4	0	34
48	30	4	0	34
49	30	4	0	34
50	30	4	0	34
51	30	4	0	34
52	30	4	0	34
53	30	4	0	34
54	30	4	0	34
55	30	4	0	34
56	30	4	0	34
57	30	4	0	34
58	30	4	0	34
59	30	4	0	34
60	30	4	0	34
61	30	4	0	34
62	30	4	0	34
63	30	4	10	44
64	30	4	10	44
65	30	4	10	44
66	30	4	10	44
67	30	4	10	44
68	30	4	10	44
69	30	4	10	44
70	30	4	10	44
71	30	4	10	44
72	30	4	0	34
73	30	4	0	34
74	30	4	0	34
75	30	4	0	34
76	30	4	0	34
77	30	4	0	34
78	30	4	0	34
79	30	4	0	34
80	30	4	0	34
81	30	4	0	34
82	30	4	30	64
83	30	4	30	64
84	30	4	30	64
85	30	4	30	64
86	30	4	30	64
87	30	4	30	64
88	30	4	30	64
89	30	4	15	49
90	30	4	15	49
91	30	4	0	34
92	30	4	0	34

Table III-1. Primary Block Stand-off Distances (Continued)

Drift Number	Thermal/ Radiological Stand-off (m)	Ventilation Raise Stand-off (m)	Fault Stand-off (m)	Total Stand-off Distance (m)
93	30	4	0	34
94	30	4	0	34
95	30	4	0	34
96	30	4	0	34
97	30	4	0	34
98	30	4	0	34
99	30	4	0	34
100	30	4	0	34
101	30	4	0	34
102	30	4	0	34
103	30	4	0	34
104	30	4	0	34
105	30	4	0	34
106	30	4	0	34
107	30	4	0	34
108	30	4	0	34
109	30	4	0	34
110	30	4	0	34
111	30	4	0	34
112	30	4	30	64
113	30	4	30	64
114	30	4	30	64
115	30	4	30	64
116	30	4	30	64
117	30	4	30	64
118	30	4	30	64
119	30	4	30	64
120	30	4	30	64
121	30	4	30	64
122	30	4	30	64
123	30	4	30	64
124	30	4	30	64
125	30	4	30	64
126	30	4	30	64
127	30	4	30	64
128	30	4	30	64
129	30	4	30	64
130	30	4	30	64

Table III-2. Lower Block Stand-off Distances

Drift Number	Thermal/ Radiological Stand-off (m)	Ventilation Raise Stand-off (m)	Fault Stand-off (m)	Total Stand-off Distance (m)
1	30	4	0	34
2	30	4	0	34
3	30	4	0	34
4	30	4	0	34
5	30	4	0	34
6	30	4	0	34
7	30	4	0	34
8	30	4	0	34
9	30	4	0	34
10	30	4	0	34
11	30	4	0	34
12	30	4	0	34
13	30	4	0	34
14	30	4	0	34
15	30	4	0	34
16	30	4	0	34
17	30	4	10	44
18	30	4	10	44
19	30	4	10	44
20	30	4	10	44
21	30	4	10	44
22	30	4	10	44
23	30	4	10	44
24	30	4	10	44
25	30	4	10	44
26	30	4	20	54
27	30	4	30	64
28	30	4	30	64
29	30	4	30	64
30	30	4	30	64
31	30	4	30	64
32	30	4	30	64
33	30	4	30	64
34	30	4	30	64
35	30	4	30	64
36	30	4	30	64
37	30	4	20	54
38	30	4	20	54
39	30	4	20	54
40	30	4	20	54
41	30	4	20	54
42	30	4	20	54
43	30	4	20	54
44	30	4	20	54
45	30	4	20	54
46	30	4	20	54
47	30	4	10	44
48	30	4	0	34
49	30	4	0	34
50	30	4	0	34
51	30	4	0	34

Table III-2. Lower Block Stand-off Distances (Continued)

Drift Number	Thermal/ Radiological Stand-off (m)	Ventilation Raise Stand-off (m)	Fault Stand-off (m)	Total Stand-off Distance (m)
52	30	4	0	34
53	30	4	0	34
54	30	4	0	34
55	30	4	0	34
56	30	4	0	34
57	30	4	0	34
58	30	4	0	34
59	30	4	0	34
60	30	4	0	34
61	30	4	0	34
62	30	4	0	34
63	30	4	0	34
64	30	4	0	34
65	30	4	0	34
66	30	4	0	34
67	30	4	0	34
68	30	4	0	34
69	30	4	0	34
70	30	4	0	34
71	30	4	0	34
72	30	4	0	34
73	30	4	0	34
74	30	4	0	34
75	30	4	0	34
76	30	4	0	34
77	30	4	0	34
78	30	4	0	34
79	30	4	0	34
80	30	4	0	34
81	30	4	0	34
82	30	4	0	34
83	30	4	0	34
84	30	4	0	34
85	30	4	0	34

Table III-3. Area 5 Stand-off Distances

Drift Number	Thermal/ Radiological Stand-off (m)	Ventilation Raise Stand-off (m)	Fault Stand-off (m)	Total Stand-off Distance (m)
1	30	4	0	34
2	30	4	0	34
3	30	4	0	34
4	30	4	0	34
5	30	4	0	34
6	30	4	0	34
7	30	4	0	34
8	30	4	0	34
9	30	4	0	34
10	30	4	0	34
11	30	4	0	34
12	30	4	0	34
13	30	4	0	34
14	30	4	0	34
15	30	4	0	34
16	30	4	0	34
17	30	4	0	34
18	30	4	0	34
19	30	4	0	34
20	30	4	0	34
21	30	4	0	34
22	30	4	0	34
23	30	4	0	34
24	30	4	0	34
25	30	4	0	34
26	30	4	0	34
27	30	4	0	34
28	30	4	0	34
29	30	4	0	34
30	30	4	0	34
31	30	4	0	34
32	30	4	0	34
33	30	4	0	34
34	30	4	0	34
35	30	4	0	34
36	30	4	0	34
37	30	4	0	34
38	30	4	0	34
39	30	4	0	34
40	30	4	0	34
41	30	4	0	34
42	30	4	0	34
43	30	4	0	34
44	30	4	0	34
45	30	4	0	34
46	30	4	0	34
47	30	4	0	34
48	30	4	0	34
49	30	4	0	34
50	30	4	0	34
51	30	4	0	34

Table III-3. Area 5 Stand-off Distances (Continued)

Drift Number	Thermal/ Radiological Stand-off (m)	Ventilation Raise Stand-off (m)	Fault Stand-off (m)	Total Stand-off Distance (m)
52	30	4	0	34
53	30	4	0	34
54	30	4	30	64
55	30	4	30	64
56	30	4	30	64
57	30	4	30	64
58	30	4	30	64
59	30	4	30	64
60	30	4	30	64
61	30	4	30	64
62	30	4	30	64
63	30	4	30	64
64	30	4	30	64
65	30	4	30	64
66	30	4	30	64
67	30	4	30	64
68	30	4	30	64
69	30	4	30	64
70	30	4	30	64
71	30	4	30	64
72	30	4	30	64
73	30	4	30	64
74	30	4	30	64
75	30	4	30	64
76	30	4	30	64
77	30	4	30	64
78	30	4	60	94
79	30	4	60	94
80	30	4	60	94
81	30	4	60	94
82	30	4	60	94
83	30	4	60	94
84	30	4	60	94
85	30	4	60	94
86	30	4	60	94
87	30	4	60	94
88	30	4	60	94
89	30	4	60	94
90	30	4	60	94
91	30	4	60	94
92	30	4	60	94
93	30	4	60	94
94	30	4	90	124
95	30	4	90	124
96	30	4	90	124
97	30	4	60	94
98	30	4	60	94
99	30	4	60	94
100	30	4	60	94
101	30	4	60	94
102	30	4	60	94

ATTACHMENT IV
CALCULATION OF EMPLACEMENT LENGTHS

CALCULATION OF EMPLACEMENT LENGTHS

The emplacement length is equal to the excavation length minus the total stand-off distance. Tables III-1 III-2, and III-3 show the calculated emplacement lengths for the Primary Block, Lower Block, and Area 5, respectively. The excavation lengths (Attachment II) and the total stand-off distances (Attachment III) are used as inputs in these tables. The emplacement drifts with no emplacement length are the empty drifts used for performance confirmation and ventilation (Section 4.3.4).

Table IV-1. Primary Block Emplacement Lengths

Drift Number	Excavation Length (m)	Stand-off Distance (m)	Emplacement Length (m)	Cumulative Emplacement Length (m)
1	517	34	483	483
2	562	34	528	1,011
3	597	34	563	1,574
4	637	34	603	2,177
5	677	34	643	2,820
6	717	34	683	3,503
7	757	34	723	4,226
8	792	34	758	4,984
9	837	34	803	5,787
10	872	34	838	6,625
11	907	44	863	7,488
12	937	44	893	8,381
13	957	44	913	9,294
14	977	44	933	10,227
15	998	44	954	11,181
16	1008	44	0	11,181
17	1008	44	964	12,145
18	1008	44	964	13,109
19	1008	44	964	14,073
20	1008	54	954	15,027
21	1008	54	954	15,981
22	1008	44	964	16,945
23	1008	44	964	17,909
24	1008	44	964	18,873
25	1008	44	964	19,837
26	1008	44	964	20,801
27	1008	44	964	21,765
28	1008	34	974	22,739
29	1008	34	974	23,713
30	1008	34	974	24,687
31	1008	34	974	25,661
32	1008	34	974	26,635
33	1008	34	974	27,609
34	1008	34	974	28,583
35	1008	34	0	28,583
36	1008	34	974	29,557
37	1008	34	974	30,531
38	1008	34	974	31,505
39	1008	34	974	32,479
40	1008	34	974	33,453
41	1008	34	974	34,427

Table IV-1. Primary Block Emplacement Lengths (Continued)

Drift Number	Excavation Length (m)	Stand-off Distance (m)	Emplacement Length (m)	Cumulative Emplacement Length (m)
42	1008	34	974	35,401
43	1008	34	974	36,375
44	1008	34	974	37,349
45	1008	34	974	38,323
46	1008	34	974	39,297
47	1008	34	974	40,271
48	1008	34	974	41,245
49	1018	34	984	42,229
50	1021	34	987	43,216
51	1031	34	0	43,216
52	1041	34	1007	44,223
53	1051	34	1017	45,240
54	1071	34	1037	46,277
55	1081	34	1047	47,324
56	1091	34	1057	48,381
57	1111	34	1077	49,458
58	1121	34	1087	50,545
59	1131	34	1097	51,642
60	1141	34	1107	52,749
61	1141	34	1107	53,856
62	1147	34	1113	54,969
63	1157	44	1113	56,082
64	1157	44	1113	57,195
65	1157	44	1113	58,308
66	1157	44	1113	59,421
67	1157	44	1113	60,534
68	1162	44	1118	61,652
69	1167	44	1123	62,775
70	1167	44	0	62,775
71	1167	44	1123	63,898
72	1172	34	1138	65,036
73	1177	34	1143	66,179
74	1177	34	1143	67,322
75	1177	34	1143	68,465
76	1182	34	1148	69,613
77	1187	34	1153	70,766
78	1187	34	1153	71,919
79	1187	34	1153	73,072
80	1187	34	1153	74,225
81	1197	34	1163	75,388
82	1197	64	1133	76,521
83	1197	64	1133	77,654
84	1197	64	1133	78,787
85	1197	64	1133	79,920
86	1202	64	1138	81,058
87	1207	64	1143	82,201
88	1207	64	1143	83,344
89	1207	49	1158	84,502
90	1212	49	1163	85,665
91	1217	34	1183	86,848
92	1217	34	1183	88,031

Table IV-1. Primary Block Emplacement Lengths (Continued)

Drift Number	Excavation Length (m)	Stand-off Distance (m)	Emplacement Length (m)	Cumulative Emplacement Length (m)
93	1217	34	1183	89,214
94	1227	34	1193	90,407
95	1227	34	1193	91,600
96	1217	34	1183	92,783
97	1207	34	1173	93,956
98	1202	34	1168	95,124
99	1197	34	1163	96,287
100	1187	34	1153	97,440
101	1177	34	1143	98,583
102	1162	34	1128	99,711
103	1157	34	1123	100,834
104	1147	34	1113	101,947
105	1137	34	0	101,947
106	1132	34	1098	103,045
107	1117	34	1083	104,128
108	1112	34	1078	105,206
109	1107	34	1073	106,279
110	1092	34	1058	107,337
111	1087	34	1053	108,390
112	1077	64	1013	109,403
113	1067	64	1003	110,406
114	1057	64	993	111,399
115	1047	64	983	112,382
116	1037	64	973	113,355
117	1027	64	963	114,318
118	1022	64	958	115,276
119	1017	64	953	116,229
120	1007	64	943	117,172
121	997	64	933	118,105
122	987	64	923	119,028
123	962	64	898	119,926
124	937	64	873	120,799
125	907	64	843	121,642
126	882	64	818	122,460
127	857	64	793	123,253
128	832	64	768	124,021
129	807	64	743	124,764
130	787	64	723	125,487

Table IV-2. Lower Block Emplacement Lengths

Drift Number	Excavation Length (m)	Stand-off Distance (m)	Emplacement Length (m)	Cumulative Emplacement Length (m)
1	444	34	410	410
2	494	34	460	870
3	544	34	510	1,380
4	594	34	560	1,940
5	644	34	610	2,550
6	694	34	660	3,210
7	744	34	710	3,920
8	794	34	760	4,680
9	854	34	820	5,500
10	954	34	920	6,420
11	1004	34	970	7,390
12	1054	34	1020	8,410
13	1104	34	1070	9,480
14	1164	34	1130	10,610
15	1194	34	1160	11,770
16	1214	34	0	11,770
17	1229	44	1185	12,955
18	1234	44	1190	14,145
19	1234	44	1190	15,335
20	1239	44	1195	16,530
21	1239	44	1195	17,725
22	1239	44	1195	18,920
23	1244	44	1200	20,120
24	1244	44	1200	21,320
25	1244	44	1200	22,520
26	1249	54	1195	23,715
27	1254	64	1190	24,905
28	1259	64	1195	26,100
29	1259	64	1195	27,295
30	1259	64	1195	28,490
31	1259	64	1195	29,685
32	1264	64	1200	30,885
33	1264	64	1200	32,085
34	1264	64	1200	33,285
35	1264	64	0	33,285
36	1251	64	1187	34,472
37	1226	54	1172	35,644
38	1186	54	1132	36,776
39	1126	54	1072	37,848
40	1056	54	1002	38,850
41	1006	54	952	39,802
42	956	54	902	40,704
43	916	54	862	41,566
44	881	54	827	42,393
45	846	54	792	43,185
46	816	54	762	43,947
47	781	44	737	44,684
48	751	34	717	45,401
49	726	34	692	46,093
50	696	34	662	46,755

Table IV-2. Lower Block Emplacement Lengths (Continued)

Drift Number	Excavation Length (m)	Stand-off Distance (m)	Emplacement Length (m)	Cumulative Emplacement Length (m)
51	666	34	0	46,755
52	646	34	612	47,367
53	626	34	592	47,959
54	606	34	572	48,531
55	601	34	567	49,098
56	601	34	567	49,665
57	601	34	567	50,232
58	601	34	567	50,799
59	601	34	567	51,366
60	601	34	567	51,933
61	601	34	567	52,500
62	601	34	567	53,067
63	601	34	567	53,634
64	601	34	567	54,201
65	601	34	567	54,768
66	601	34	567	55,335
67	601	34	567	55,902
68	601	34	567	56,469
69	601	34	567	57,036
70	596	34	0	57,036
71	586	34	552	57,588
72	586	34	552	58,140
73	581	34	547	58,687
74	576	34	542	59,229
75	576	34	542	59,771
76	566	34	532	60,303
77	566	34	532	60,835
78	556	34	522	61,357
79	551	34	517	61,874
80	546	34	512	62,386
81	546	34	512	62,898
82	546	34	512	63,410
83	546	34	512	63,922
84	536	34	502	64,424
85	526	34	492	64,916

Table IV-3. Area 5 Emplacement Lengths

Drift Number	Excavation Length (m)	Stand-off Distance (m)	Emplacement Length (m)	Cumulative Emplacement Length (m)
1	691	34	657	657
2	691	34	657	1,314
3	681	34	647	1,961
4	681	34	647	2,608
5	681	34	647	3,255
6	671	34	637	3,892
7	671	34	637	4,529
8	661	34	627	5,156
9	661	34	627	5,783
10	661	34	627	6,410
11	651	34	617	7,027
12	651	34	617	7,644
13	651	34	617	8,261
14	651	34	617	8,878
15	651	34	617	9,495
16	651	34	0	9,495
17	661	34	627	10,122
18	666	34	632	10,754
19	671	34	637	11,391
20	681	34	647	12,038
21	691	34	657	12,695
22	701	34	667	13,362
23	711	34	677	14,039
24	721	34	687	14,726
25	731	34	697	15,423
26	741	34	707	16,130
27	751	34	717	16,847
28	761	34	727	17,574
29	771	34	737	18,311
30	776	34	742	19,053
31	781	34	747	19,800
32	791	34	757	20,557
33	801	34	767	21,324
34	811	34	777	22,101
35	821	34	0	22,101
36	821	34	787	22,888
37	831	34	797	23,685
38	841	34	807	24,492
39	846	34	812	25,304
40	851	34	817	26,121
41	861	34	827	26,948
42	871	34	837	27,785
43	876	34	842	28,627
44	881	34	847	29,474
45	891	34	857	30,331
46	901	34	0	30,331
47	911	34	877	31,208
48	921	34	887	32,095
49	921	34	887	32,982
50	921	34	887	33,869
51	941	34	907	34,776

Table IV-3. Area 5 Emplacement Lengths (Continued)

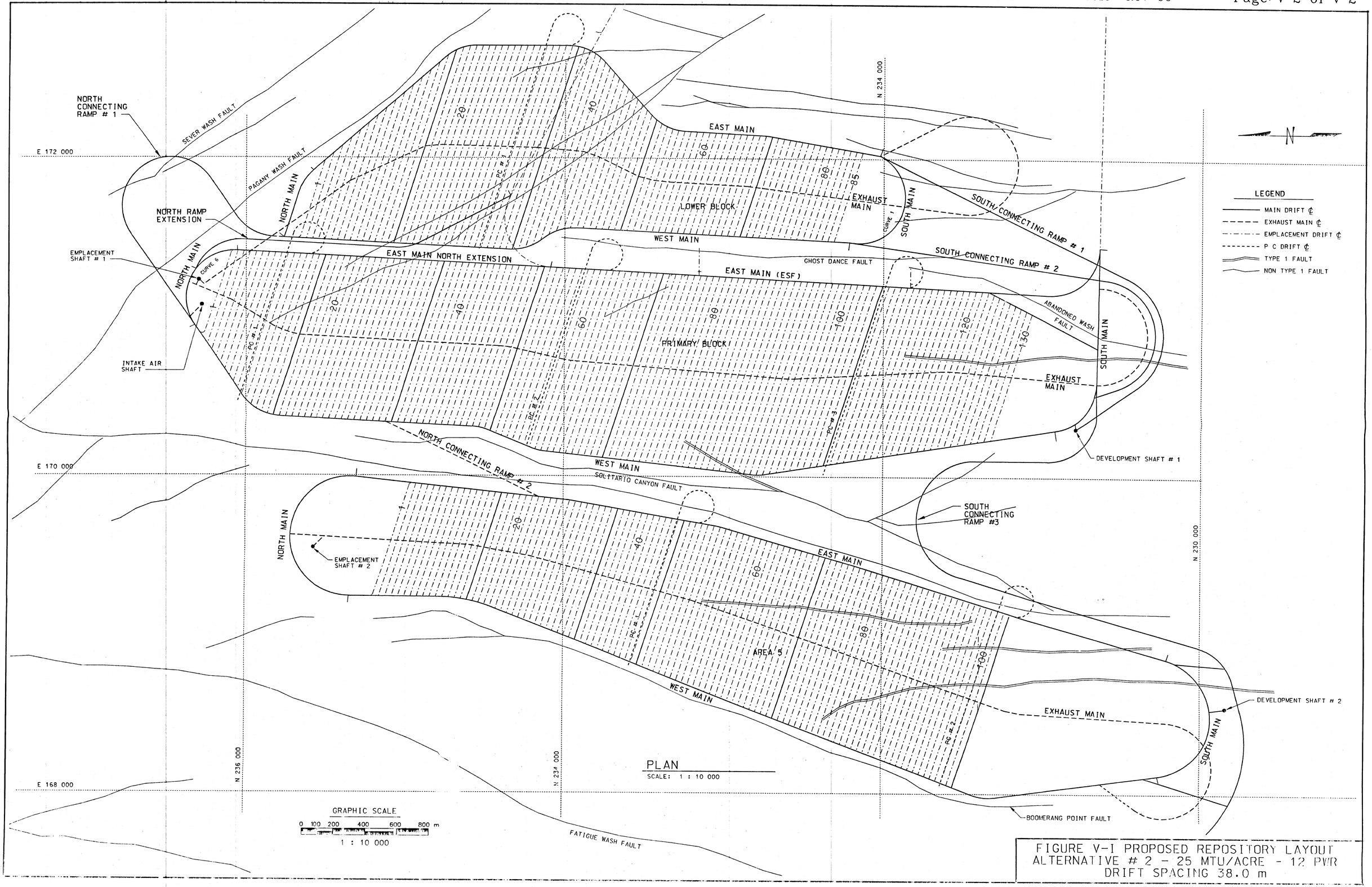
Drift Number	Excavation Length (m)	Stand-off Distance (m)	Emplacement Length (m)	Cumulative Emplacement Length (m)
52	941	34	907	35,683
53	951	34	917	36,600
54	950	64	886	37,486
55	955	64	891	38,377
56	960	64	896	39,273
57	960	64	896	40,169
58	960	64	896	41,065
59	970	64	906	41,971
60	970	64	906	42,877
61	970	64	906	43,783
62	980	64	916	44,699
63	980	64	916	45,615
64	985	64	921	46,536
65	990	64	926	47,462
66	990	64	926	48,388
67	995	64	931	49,319
68	995	64	931	50,250
69	1000	64	936	51,186
70	1005	64	0	51,186
71	1010	64	946	52,132
72	1010	64	946	53,078
73	1010	64	946	54,024
74	1020	64	956	54,980
75	1020	64	956	55,936
76	1025	64	961	56,897
77	1030	64	966	57,863
78	1030	94	936	58,799
79	1035	94	941	59,740
80	1040	94	946	60,686
81	1040	94	946	61,632
82	1040	94	946	62,578
83	1045	94	951	63,529
84	1045	94	951	64,480
85	1050	94	956	65,436
86	1050	94	956	66,392
87	1050	94	956	67,348
88	1055	94	961	68,309
89	1060	94	966	69,275
90	1060	94	966	70,241
91	1065	94	971	71,212
92	1065	94	971	72,183
93	1070	94	976	73,159
94	1070	124	946	74,105
95	1075	124	951	75,056
96	1075	124	951	76,007
97	1080	94	986	76,993
98	1085	94	991	77,984
99	1085	94	991	78,975
100	1090	94	996	79,971
101	1090	94	996	80,967
102	1090	94	0	80,967

Table IV-4 below summarizes the emplacement lengths for the Primary Block, Lower Block, and Area 5.

Table IV-4. Summary of Emplacement Lengths

Location	Emplacement Length (m)
Primary Block	125,487
Lower Block	64,916
Area 5	80,967
TOTAL	**271,370**

ATTACHMENT V
PROPOSED REPOSITORY LAYOUT



PLAN
SCALE: 1 : 10 000

FIGURE V-1 PROPOSED REPOSITORY LAYOUT
ALTERNATIVE # 2 - 25 MTU/ACRE - 12 PWR
DRIFT SPACING 38.0 m

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