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GEOLOGIC INPUT ON UNSATURATED ZONE FOR TOTAL-SYSTEM PERFORMANCE ASSESSMENT CODE VERSION 3.1

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Prepared by

H. Lawrence McKague
John A. Stamatakos

Center for Nuclear Waste Regulatory Analyses
San Antonio, Texas

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QUALITY OF DATA, ANALYSES, AND CODE DEVELOPMENT

DATA: CNWRA-generated original data contained in this report meets quality assurance requirements described in the CNWRA Quality Assurance Manual. Sources for other data should be consulted for determining the level of quality for those data.

ANALYSES AND CODES: EarthVision computer code was used for analyses contained in this report. This computer code is controlled under the CNWRA Software Configuration Procedures.

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1 INTRODUCTION

To assess the transportation of radionuclides away from the repository horizon, a conceptual model of potential hydrologic flow was developed with pathways in both the saturated and unsaturated zones. This model is to be used in the Total-system Performance Assessment (TPA) Version 3.1 code. Figure 1-1 schematically shows the conceptualized vertical and horizontal flow paths from the repository. This conceptual model also provides the basis of the saturated flow modeling (Baca et al., 1997). Beneath each subarea in the conceptual model there is a succession of zones that have different hydrologic characteristics. In the following discussion, each zone is called a model zone (MZ) and each is identified by a unique model zone designator (MZD). This is done to distinguish the MZs from stratigraphic units (Buesch et al., 1996; Sawyer et al., 1994) and thermal-mechanical units (Ortiz et al., 1985). The relationships between the lithostratigraphic units, the thermal-mechanical units and the MZ's are given in table 1-1 and discussed later. As is evident from table 1-1, MZDs are components of several stratigraphic and thermal-mechanical units.

To assess a variety of unsaturated flow paths and repository conditions, the proposed repository is divided into 12 subareas with 10 subareas in the western block and 2 subareas (11 and 12) in the eastern block (figure 1-2). At this time, the eastern block is not considered for use as a repository. In addition, the northern blocks, i.e., 8, 9, and 10 are not being considered for repository use at this time. The objectives of this letter report are to document: (i) rationale for selecting the repository subareas, (ii) vertical sections and thicknesses of MZs that constitute the unsaturated flow path beneath each subarea and (iii) distribution of zeolites in the Calico Hills formation.

(iii) [illegible]

The thicknesses of the individual MZs beneath each subarea are based on the thicknesses of the appropriate units in the CNWRA three-dimensional (3D) Geologic Framework model (Stirewalt and Henderson, 1995). The surface of the saturated zone in the 3D Geologic Framework Model is also used to define the water table for conceptual hydrologic model used in TPA Version 3.1.

The conceptual model of the horizontal saturated zones is also shown in figure 1-1. The zonation of the saturated flow is given in Baca et al. (1997). In the TPA version 3.1 software, the MZDs for saturated zones are indicted by an initial "S", i.e., SAL, STC, SUT for saturated alluvium, saturated Tiva Canyon tuff, saturated upper Topopah Spring, respectively.

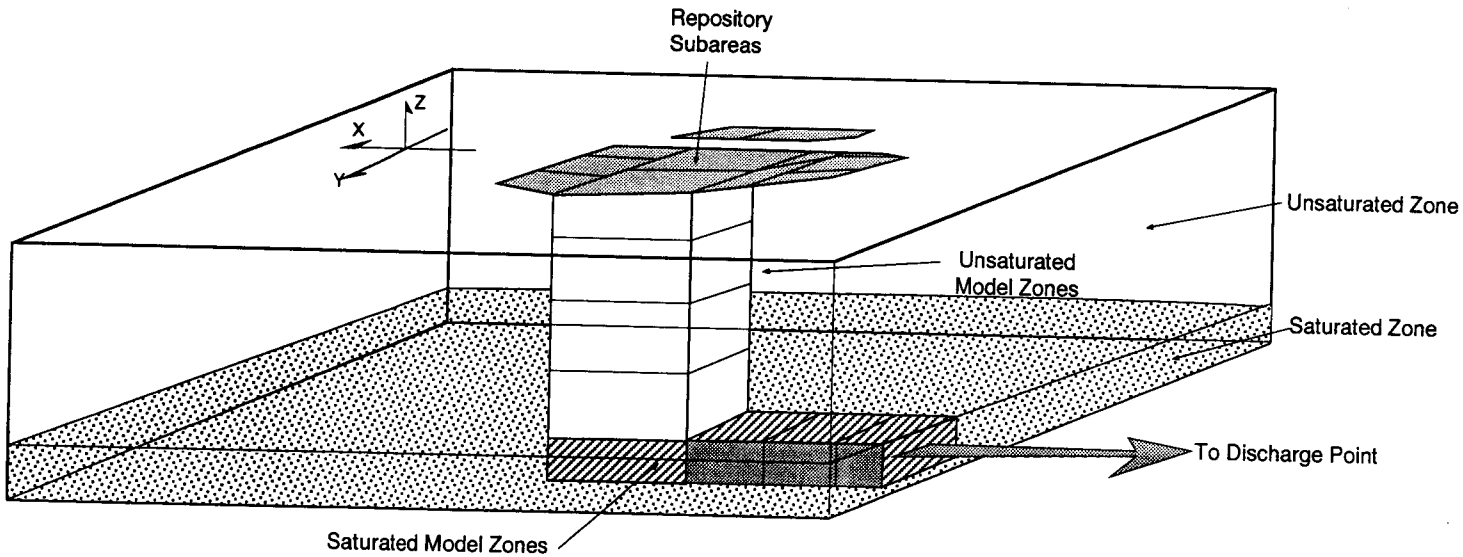

Figure 1-1. Conceptual model of hydrologic flow paths beneath subareas of proposed repository at Yucca Mountain

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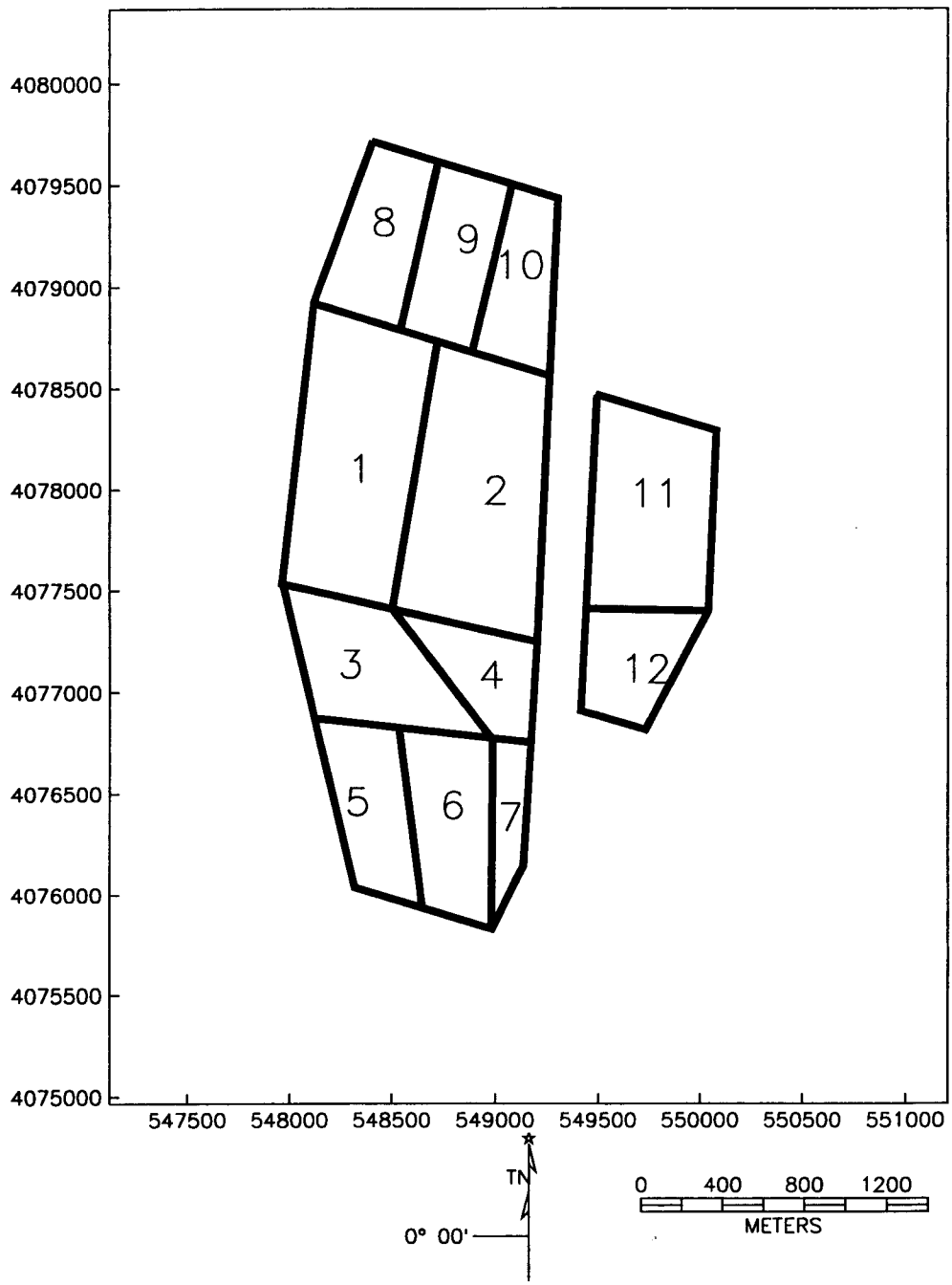

Figure 1-2. Repository subareas for Total-system Performance Assessment Code Version 3.1

Table 1-1. Correlation of model zones for TPA Version 3.1 computer code, Yucca Mountain project stratigraphy, and thermal/mechanical units (modified from Clayton et al., 1997, figure 1)

Unsaturated Model Zone Designators	Description of Modeled Units (units are given the names in column 2)	Yucca Mountain Project Stratigraphy, Buesch et al. 1996; Sawyer et al. 1994	Thermal/Mechanical Units (Ortiz et al. 1985)	Hydrologic Units Flint, 1996 (Draft) Table 1
UAL				
	alluvium	NA	UO	n/a
n/a				
	Rainier Mesa Tuff	Trm	UO	n/a
	rhyolite of Comb Peak	Tpk	N/A	n/a
UTC				
	Tiva Canyon Tuff undifferentiated	Tpc	TCw	CW
	crystal-poor densely welded vitric sub-zone of Tiva Canyon Tuff	Tpcpv3	TCw	CMW
UPTN				
	crystal-poor non-partly-welded vitric sub-zones of Tiva Cyn. Tuff	Tpcpv1-2	PTn	CNW
	pre-Tiva Canyon Tuff bedded tuff	Tpbt4	PTn	TB4
	Yucca Mountain Tuff	Tpy	PTn	TPY
	pre-Yucca Mountain Tuff bedded tuff	Tpbt3	PTn	TB3
	Pah Canyon Tuff	Tpp	PTn	TPP
	pre-Pah Canyon Tuff bedded tuff	Tpbt2	PTn	BT2
	Topopah Spring Tuff upper non-partly-welded vitric sub-zones	Tptrv2-3	PTn	BT2

n/a - not applicable

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Table 1-1. Correlation of model zones for TPA Version 3.1 computer code, Yucca Mountain project stratigraphy, and thermal/mechanical units (modified from Clayton et al., 1997, figure 1) (cont'd)

Unsaturated Model Zone Designators	Description of Modeled Units (units are given the names in column 2)	Yucca Mountain Project Stratigraphy, Buesch et al. 1996; Sawyer et al. 1994	Thermal/Mechanical Units (Ortiz et al. 1985)	Hydrologic Units Flint, 1996 (Draft) Table 1
UUT				
	Topopah Spring Tuff upper densely welded vitric sub-zone	Tptrv1	TSw1	TC
	Topopah Spring Tuff xl-rich nonlithophysal zone	Tptrn	TSw1	TC
	Topopah Spring Tuff xl-rich lithophysal zone	Tptr1	TSw1	TUL
	Topopah Spring Tuff lithic rich member	Tptf	TSw1	
	Topopah Spring Tuff upper lithophysal zone	Tptpu1	TSw1	TUL
ULT				
	Topopah Spring Tuff middle nonlithophysal zone	Tptpmn	TSw2	TMN
	Topopah Spring Tuff lower lithophysal zone	Tptp11	TSw2	TLL
	Topopah Spring Tuff lower nonlithophysal zone	Tptp1n	TSw2	TM2-TM1
	Topopah Spring Tuff lower densely welded vitric sub-zone	Tptpv3	TSw3	PV3
UCHZ or UCHV (V - vitric; Z - zeolitic)				
	Topopah Spring Tuff non-partly-welded vitric sub-zones	Tptpv1-2	CHn1	PV2
	pre-Topopah Spring Tuff bedded tuff	Tpbt1	CHn1	BT1-BT1a
	Calico Hills Formation undifferentiated	Tac	CHn1	CHV-CHZ
	pre-Calico Hills Formation bedded tuff	Tacbt	CHn2	BT
	Prow Pass Tuff upper nonwelded zone	Tcp [unw]	CHn3	PP4 (zeolitic)

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Table 1-1. Correlation of model zones for TPA Version 3.1 computer code, Yucca Mountain project stratigraphy, and thermal/mechanical units (modified from Clayton et al., 1997, figure 1) (cont'd)

Unsaturated Model Zone Designators	Description of Modeled Units (units are given the names in column 2)	Yucca Mountain Project Stratigraphy, Buesch et al. 1996; Sawyer et al. 1994	Thermal/Mechanical Units (Ortiz et al. 1985)	Hydrologic Units Flint, 1996 (Draft) Table 1
UPP				
	Prow Pass Tuff welded zone	Tcp [w]	PPw	PP3-2
UC				
	Prow Pass Tuff lower nonwelded zone	Tcp [1nw]	CFUn	PP1 (zeolitic)
	pre-Prow Pass Tuff bedded tuff	[bt]	CFUn	
	Bullfrog Tuff upper nonwelded zone	Tcb [unw]	CFUn	
UBF				
	Bullfrog Tuff welded zone	Tcb [w]	BFw	BF3
n/a				
	Bullfrog Tuff lower nonwelded zone	Tcb [1nw)	CFMn1	BF2
	pre-Bullfrog Tuff bedded tuff	[bt]	CFMn2	
	Tram Tuff undifferentiated	Tct	CFMn2, TRW	
	pre-Tram Tuff bedded tuff	[bt]	n/a	
	lower Tertiary units undifferentiated	n/a	n/a	
	Paleozoic and older units	n/a [pz]	n/a	

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2 SUBAREA DEFINITION

The subarea design (figure 1-2) is loosely based on the combined thicknesses of the Calico Hills formation and Prow Pass tuff, as modified by considerations for the heat load and constrained by a software requirement that each subarea be a quadrilateral polygon defined by only four vertices. The repository boundaries as shown in figure 1-2 were the initial starting conditions. Guidance from the Performance Assessment (PA) Key Technical Issue (KTI) group was that 10–12 subareas were manageable in terms of optimized execution of the TPA Version 3.1 code. The coordinates of the vertices of each subarea are shown in the accompanying table 2-1. Vertice V1 is the northwestern most corner of the quadrilateral polygon. Vertice V2 is in the northeast corner. Vertices V3 and V4 are in the southwest and southeast corners, respectively. In order to compare the results of TPA Version 3.1 with the results of IPA, Phase 2 (NRC, 1995) both east and west block repositories were included and divided into subareas.

As noted above, the initial basis for developing the subareas was the aggregated thickness of the Calico Hills Formation and the Prow Pass tuff. In general, these units thin from north to south from slightly more than 200 m in subareas 8, 9, and 10 to about 150 m in subareas 5 and 6.

Because the heating and cooling regimens of the different parts of the repository will be different (i.e., the central part of the repository will be hotter then the edges), the initial subarea design was modified. Additionally, subarea 7 was designated to represent a fault zone and is therefore narrower than the other zones.

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Table 2-1. Vertices of subareas used in Total-system Performance Assessment Code Version 3.1

Subarea	V1	V2	V3	V4
1	E-547472.81 N-4079323.7	E-548069.24 N-4079136.5	E-547318.4 N-4077934	E-547847.27 N-4077816.2
2	E-548069.24 N-4079136.5	E-548609.7 N-4078968.6	E-547847.27 N-4077816.2	E-548547.93 N-4077654.1
3	E-547318.4 N-4077934	E-547847.27 N-4077816.2	E-547474.74 N-4077281.6	E-548322.71 N-4077192.2
4	E-547847.27 N-4077816.2	E-548547.93 N-4077654.1	E-548322.71 N-4077192.2	E-548504.78 N-4077170.0
5	E-547474.74 N-4077282.6	E-547887.33 N-4077238.1	E-547670.43 N-4076435.5	E-547994.99 N-4076338.9
6	E-547887.33 N-4077238.1	E-548322.71 N-4077192.2	E-547994.99 N-4076338.9	E-548319.54 N-4076220.2
7	E-548322.71 N-4077192.2	E-548504.78 N-4077170.0	E-548319.54 N-4076220.2	E-548473.11 N-4076533.7
8	E-547750.76 N-4080120.9	E-548075.03 N-4080020.5	E-547472.81 N-4079323.7	E-547889.74 N-4079198.3
9	E-548075.03 N-4080020.5	E-548430.19 N-4079904.7	E-547889.74 N-4079198.3	E-548239.1 N-4079084.4
10	E-548430.19 N-4079904.7	E-548652.16 N-4079841.0	E-548239.1 N-4079084.4	E-548609.7 N-4078968.6
11	E-548845.26 N-4078871.9	E-549429.46 N-4078696.1	E-548785.1 N-4077817.6	E-549387.72 N-4077804.6
12	E-548785.1 N-4077817.6	E-549387.72 N-4077804.6	E-548764.52 N-4077314.4	E-549080.73 N-4077220.3

3 ZEOLITE DISTRIBUTION

Broxton et al. (1987) describe the distribution and mineralogy of diagenetic minerals at Yucca Mountain (YM). Within the tuffs of the Southwestern Nevada Volcanic Field (SWNVF) zeolitization commonly occurs in non-welded to slightly-welded tuffs and in bedded tuffs that have been at or below the water table at sometime in their history. Broxton et al. (1987) attribute the zeolitization in the Yucca Mountain region as a response to the thermal pulse associated with the emplacement of the Timber Mountain Caldera magma, although different origins have been proposed in other areas of the SWNVF (Moncure et al., 1981). As in most areas of tuff where zeolitization has occurred, the pervasiveness of the zeolitization increases with depth. Broxton et al. (1987) recognize four diagenetic zones at YM. Only the upper two zones of Broxton et al. (1987) are of interest in the unsaturated flow model. Zone I is characterized by widespread preservation of volcanic glass within vitric tuffs above the water table. Zone II is characterized by the wide spread alteration of volcanic glass to the zeolite minerals clinoptilolite and mordenite. The zones cut across stratigraphic boundaries. At YM the vertical extent and amount of zeolitization increase to the east and north as a result of the thermal effects from the Timber Mountain Caldera.

Zone I, the vitric zone, occurs within the Calico Hills Formation in the southwest portion of the repository and in the younger tuffs above the Calico Hills Formation. Zone II, the clinoptilolite and mordenite zone occur to the north and east (figure 3-1) and in non-welded to slightly-welded tuffs and bedded tuffs below the Calico Hills Formation. The zeolitization decreases across the proposed repository from northeast to southwest (Bodvarsson et al., 1996). As shown in figure 3-1 subareas 5 and 6 are beyond zeolitized zone and the rock is predominantly vitric. Except for the Calico Hills formation in subareas 5 and 6, the non-welded and bedded tuffs of the Calico Hills Formation and older tuffs are zeolitized. The line, as shown in figure 3-1, separating zeolitic Calico Hills formation from the vitric Calico Hills formation roughly corresponds to the less than 10 percent contour in Clayton et al. (1997, Plate 64). In the conceptual unsaturated model they are represented by two mutually exclusive MZDs, UCHV and UCHZ, zones I and II, respectively.

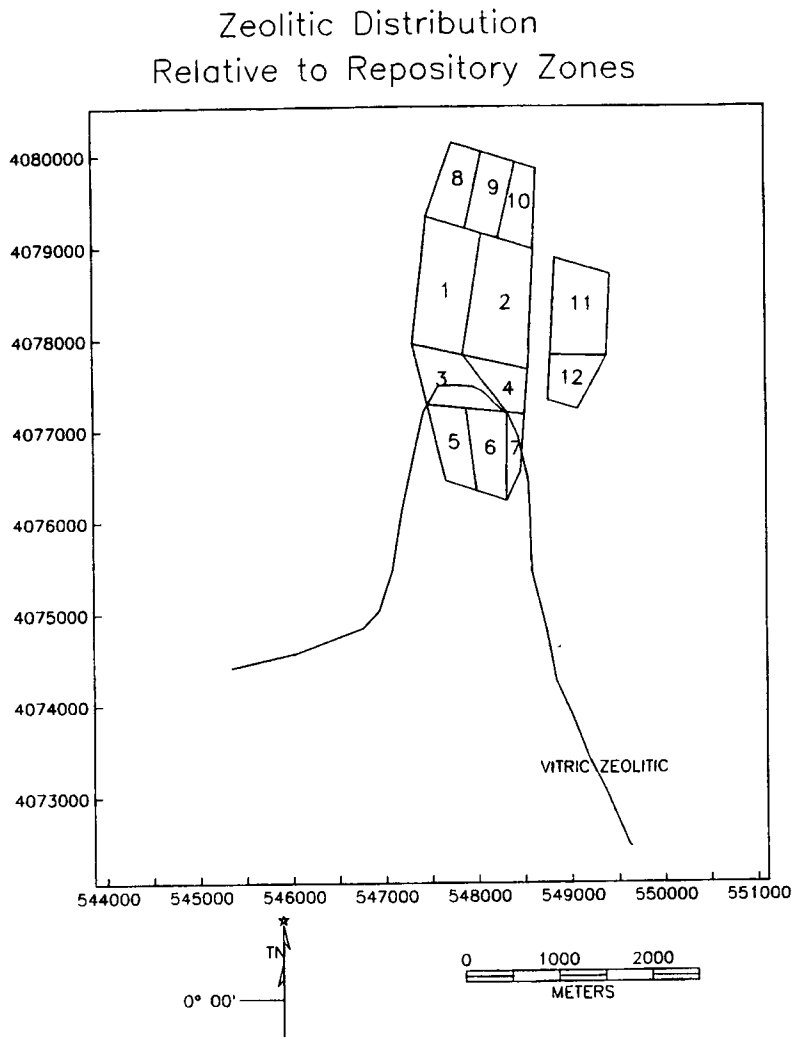

Figure 3-1. Distribution of zeolitic tuffs (UCHZ) and vitric tuffs (UCHV)

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4 DEFINITION AND THICKNESSES OF MODEL ZONES

4.1 DEFINITION

In the conceptual model, MZs extend downward from the repository horizon, through the unsaturated zone, to the water table in each subarea. The sequence of MZs is essentially the same in all subareas (table 4-1).

The repository horizon is lithostratigraphically within the Lower Topopah Spring unit, which is equivalent to the ULT MZ. The thickness of the ULT below the repository floor is given in table 4-1. The individual flow paths through the vertical sequence vary in unit thickness and position relative to the water table (table 4-1). An MZ sequence is supplied for the subarea 7, although for modeling purposes, a single unit with properties consistent with a fault can be substituted. The cumulative thickness of the unsaturated zone beneath the repository in subarea 7, the intended fault subarea, is 341 m.

A brief description of the lithologic make up of each MZ and its distinguishing characteristic(s) follows. In most cases porosity is used to place the stratigraphic units within the appropriate MZ. Porosity commonly reflects the welded and non-welded characteristics of the tuffs and is generally distinctive. Lower porosities occur in partially to densely-welded tuffs while non-welded tuffs and bedded tuffs have higher porosities. The average porosity values in Flint (1996, table 7), were used to group most lithologies into the appropriate MZ. The initial capital letter of the MZD, i.e., U indicates that the MZ is an unsaturated model unit. If preceded by S the MZD would indicate a saturated zone unit. The thickness of individual MZDs within each subarea is give in table 4-1.

UAL consists of colluvium and alluvium overlying the Miocene tuffs. This MZ does not appear in the unsaturated zone flow model as it occurs above the repository and is included only for completeness.

UTC represents the welded units of the Tiva Canyon tuff (table 1-1). Tuffs within this unit are distinguished from tuffs in the underlying unit by an average porosity that is less than 25 percent (Flint, 1996). This MZ does not appear in the unsaturated zone flow model as it occurs above the repository and is included only for completeness.

UPTN incorporates the nonpartly-welded tuff at the base of the Tiva Canyon tuff, the pre-Tiva Canyon bedded tuff, Yucca Mountain tuff, pre-Yucca Mountain bedded tuff, Pah Canyon tuff, pre-Pah Canyon bedded tuff, and the upper nonpartly-welded tuffs at the top of the Topopah Spring Tuff (table 1-1). Tuffs in this zone are distinguished from the overlying and underlying zones by an average porosity of greater than 25 percent (Flint, 1996). This MZ does not appear in the unsaturated zone flow model as it occurs above the repository and is included only for completeness.

UUT incorporates the welded tuffs of the Topopah Spring tuff that lie between and include the upper densely welded vitric sub-zone and the upper lithophysal subzone (table 1-1). Tuffs in this model zone are distinguished from tuffs in the underlying ULT by a slightly higher average porosity at its base (Flint, 1996). Tuffs in this MZD have an average porosity of slightly in excess of 15 percent while the tuffs in underlying ULT zone have an average porosity of between 11 and 13 percent (Flint, 1996). This MZ does not appear in the unsaturated zone flow model as it occurs above the repository and is included only for completeness.

Table 4-1. Thicknesses of model zones in meters. Model zones are defined in text.

Model Zone Designators	Subarea 1	Subarea 2	Subarea 3	Subarea 4	Subarea 5	Subarea 6	Subarea 7 (Fault)	Subarea 8	Subarea 9	Subarea 10	Subarea 11	Subarea 12
UAL	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
UTC	90	63	64	70	44	44	39	110	54	84	106	75
UPTN	38	29	22	33	28	33	37	33	49	38	31	23
UUT	112	98	98	98	90	91	94	133	111	118	114	103
ULT	195	212	208	211	193	198	213	185	205	199	198	208
UCHV (vitric)	0	0	0	0	113	125	0	0	0	0	0	0
UCHZ (zeolitic)	163	154	122	132	0	0	114	150	147	148	131	137
UPP	34	39	40	34	38	26	43	53	60	63	37	33
UCF (zeolitic)	148	168	169	165	158	166	157	124	122	128	215	201
UBF	39	68	39	57	41	48	51	37	22	47	44	53
UFZ (Cumulative thickness)							341					
SWL	774.8	747.3	747	738.6	737.1	732.5	731	772.4	751.2	736.6	732	731.8
Repository elevation	1072	1072	1072	1072	1072	1072	1072	1072	1072	1072	1072	1072
Elevation base of ULT	1039	956	1067	962	1078	1019	951	1003	944	902	875	886
Thickness ULT below repository	33	116	5	110	-6	53	121	69	128	170	197	186
Recommended thickness of ULT below repository	33	116	20	110	20	53	121	69	128	170	197	186

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ULT incorporates the welded tuffs of the Topopah Spring Tuff that lie between and include the middle nonlithophysal zone and the lower densely welded vitric sub-zones (table 1-1). Tuffs in the ULT model zone are distinguished from tuffs in the overlying and underlying zones by a lower average porosity (Flint, 1996). The repository is to be constructed in tuffs within this MZ.

UCHZ/UCHV incorporates the basal nonpartly-welded tuffs of the Topopah Spring Tuff, and the underlying pre-Topopah Spring bedded tuff, Calico Hills formation, the pre-Calico Hills formation bedded tuff and the upper non-welded Prow Pass Tuff (table 1-1). Tuffs in this MZ are distinguished from the underlying and overlying MZ by their higher average porosities that range from 26.6 to 34.5 percent (Flint, 1996). Two mutually exclusive MZs, i.e., Broxton's zones I and II, are present in the tuffs in this part of the stratigraphic column. Zone I, the vitric zone (UCHV), occurs in the southwest corner of the proposed repository and underlies subareas 5 and 6 (figure 3-1). Zone II (i.e., the clinoptilolite zone) is present in all other subareas. Thus, the horizon between the base of the welded Topopah Spring Tuff and the top of the welded Prow Pass Tuff can be characterized depending on the presence or absence of glass (vitric and zeolitic). In the model, it is assumed that all lithologic constituents within the model zone are either vitric or zeolitic but in reality, local zeolitization may vary considerably [Clayton et al., (1997, Plates 64 and 65)].

UPP incorporates the Prow Pass Tuff welded zone. The porosities of the rocks in the zones overlap and are not distinctive (table 1-1). The tuffs in the UPP zone, where porosity is less distinctive, can be distinguished from the tuffs in the over- and underlying zones by their higher bulk density and welded nature. The average bulk density of the UPP tuffs is 1.79 mg/m^3 or greater (Flint, 1996) while both the over- and underlying zone rocks have bulk densities of 1.79 mg/m^3 or less.

UCF incorporates the lower non-welded Prow Pass Tuff, pre-Prow Pass Tuff bedded tuff and the upper non-welded zone of the Bullfrog tuff (table 1-1). The tuffs in the UCF zone can be distinguished from the tuffs in the underlying zone by their lower average porosity. The average porosity of tuffs in the UCF zone is 26.3–28 percent, compared with 11.5 percent for welded tuffs in the underlying UBF zone (Flint, 1996). This unit is zeolitic in all subareas based on table 1 of Flint, (1996).

UBF incorporates the welded Bullfrog Tuff.

4.2 MODEL ZONES THICKNESSES

The unsaturated MZ thicknesses are given in table 4-1. The thickness of the ULT between the base of the horizontal repository, at 1,072 m, and the top of the UCHV/UCHV is given in the table. Because of the east dip of the tuffs, the water table intersects successively deeper portions of the stratigraphic column from east to west. In areas 3 and 5 there is less than the minimum thickness. To meet the minimum requirements of the advanced conceptual design (ADC) (Department of Energy, 1996) it would be necessary to raise the repository level a minimum of 25 m and 36 m in subareas 3 and 5, respectively, in the TPA Code Version 3.1.

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4.3 HYDROLOGIC PROPERTIES OF THE UNSATURATED ZONE

Unsaturated flow and transport parameter values are listed in Weldy (1997, table 4-6) are reproduced in the appendix. The MZDs were developed subsequent to the Weldy compilation. Correlation between MDZs in this report and the units used in Weldy's table 4-6 are given in table 4-2. The unit designated, TSv in Weldy's table, is generally identified as a subunit of TSw (Department of Energy, 1995). In DOE's TSPA-1995, the unit is 7–15 m thick. It is not recognized as a separate unit in this report.

Table 4-2. Correlation of model zone designations with units used in Weldy, 1997, table 4-6

Model Zone Designators	Weldy (1997)
UTC	TcW
UPTN	PTn
UUT	TSw
ULT	TSw (TSv)
UCHV	CHnv
UCHZ	CHnz
UC	PPn
UPP	PP
UC	CF (upper)
UBF	BF
n/a	CF (middle)

5 SUMMARY

The repository footprint is subdivided into 12 subareas based on stratigraphic and thermal concerns and modeling constraints. Two of the zones occur east of the Ghost Dance fault and are not under active consideration for use as a repository.

In order to develop a flow model for the unsaturated zone beneath each subarea, 10 MZ's were developed that represent the variation of flow properties in the unsaturated tuffs at YM. Five of the MZs occur between the base of the repository and the water table. The horizon between the base of the welded Topopah Spring Tuff and the top of the welded Prow Pass Tuff is represented by one of two mutually exclusive MZs depending on the presence or absence of glass. The vitric zone occurs in subareas 5 and 6. In all other MZs beneath the repository, which represent non-welded and bedded tuffs the tuffs are zeolitic. If the advanced conceptual design requirement for thickness of ULT beneath the repository is considered the repository horizon should be raised 25 and 36 m in subareas 5 and 6 respectively in the unsaturated flow model.

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APPENDIX

The following are Section 4.5.3 COMPARISON OF UNSATURATED ZONE FLOW AND TRANSPORT INPUT PARAMETER VALUES and Table 4.6 Comparison of the unsaturated zone flow and transport reference parameter values used in TSPA-95 and proposed to be used in IPA Phase 3 from Weldy, 1997.

A.1 COMPARISON OF THE UNSATURATED ZONE FLOW AND TRANSPORT INPUT PARAMETER VALUES

The largest difference in the input parameter values for the two studies is the physical layout of the repository. TSPA-95 modeled not only the main repository area but also the optional additional areas that would be needed if the lower areal loading is used. The proposed IPA Phase 3 model assumes the higher areal loading, so only the smaller repository area needed to be modeled. The division of the repository area is made differently in the two codes. TSPA-95 divided the main repository area into seven columns for the high areal loading case, while the proposed IPA Phase 3 model divides it into seven subareas. For comparison purposes only, these subareas and columns can be matched in the following manner based on locations: Subarea 1 = Column 1; Subarea 2 = Column 2; Subarea 3 = Column 3; Subarea 4 = Column 4; Subarea 5 = Column 5; Subarea 6 = Column 6; Subarea 7 = Column 6. Columns 7–10 in TSPA-95 are used only for the 25 MTU/acre case only and therefore, the proposed IPA Phase 3 reference set of parameter values does not have corresponding subareas. The total thickness of the unsaturated zone varies considerably between TSPA-95 and the values proposed for IPA Phase 3. TSPA-95 employed a much larger thickness (1.28 to 1.39 times as large) for all of the columns. The use of a smaller unsaturated zone is a more conservative estimate because radionuclides will travel through the unsaturated zone faster and reach the critical group sooner.

Studies are currently being conducted to determine the hydrologic parameters in the unsaturated zone of the mountain. Until these studies completed, the best estimate for these parameters are the values in TSPA-95. Those parameters in TSPA-95 comparable to the TPA Version 3.1 code parameters are used as input values. Thus, there are no significant differences between the input values of the two studies at this time. The comparison between the unsaturated zone transport reference parameter values used in TSPA-95 and proposed to be used in IPA Phase 3 can be seen in table 4-6.

Table 4-6. Comparison of the unsaturated zone flow and transport reference parameter values used in TSPA-95 and proposed to be used in IPA Phase 3

UZFT Input Values						
	TSPA-95 Values			Proposed IPA Phase 3 Reference Values		
Parameter	Distribution	Parameter	Source	Distribution	Value	Source
Tiva Canyon (TCw) matrix van Genuchten alpha (1/m)	constant	0.0081	Schenker et al. (1995)	(not needed — method of Mualem, 1976)	—	NRC (1995)
Paintbrush (PTn) matrix van Genuchten alpha (1/m)	constant	0.0735	Schenker et al. (1995)	(not needed — method of Mualem, 1976)	—	NRC (1995)
Topopah Spring welded (TSw) matrix van Genuchten alpha (1/m)	constant	0.0130	Schenker et al. (1995)	(not needed — method of Mualem, 1976)	—	NRC (1995)
Topopah Sprint vitric (TSv) matrix van Genuchten alpha (1/m)	constant	0.0024	Schenker et al. (1995)	(not needed — method of Mualem, 1976)	—	NRC (1995)
Calico Hills vitric (CHnv) matrix van Genuchten alpha (1/m)	constant	0.0227	Schenker et al. (1995)	(not needed — method of Mualem, 1976)	—	NRC (1995)

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Table 4-6. Comparison of the unsaturated zone flow and transport reference parameter values used in TSPA-95 and proposed to be used in IPA Phase 3 (cont'd)

UZFT Input Values						
	TSPA-95 Values			Proposed IPA Phase 3 Reference Values		
Parameter	Distribution	Parameter	Source	Distribution	Value	Source
Calico Hills zeolitic (CHnz) matrix van Genuchten alpha (1/m)	constant	0.0054	Schenker et al. (1995)	(not needed — method of Mualem, 1976)	—	NRC (1995)
TCw matrix van Genuchten beta	constant	1.607	Schenker et al. (1995)	constant	1.607	Schenker et al. (1995)
PTn matrix van Genuchten beta	constant	2.223	Schenker et al. (1995)	constant	2.223	Schenker et al. (1995)
TSw matrix van Genuchten beta	constant	1.710	Schenker et al. (1995)	constant	1.71	Schenker et al. (1995)
TSv matrix van Genuchten beta	constant	2.234	Schenker et al. (1995)	constant	2.234	Schenker et al. (1995)
CHnv matrix van Genuchten beta	constant	2.361	Schenker et al. (1995)	constant	2.361	Schenker et al. (1995)
CHnz matrix van Genuchten beta	constant	1.671	Schenker et al. (1995)	constant	1.671	Schenker et al. (1995)
Prow Pass (PP) matrix van Genuchten beta	—	—	—	uniform	Min = 2.0 Max = 3.4	NRC (1995); Klavetter and Peters (1986)

Table 4-6. Comparison of the unsaturated zone flow and transport reference parameter values used in TSPA-95 and proposed to be used in IPA Phase 3 (cont'd)

UZFT Input Values						
	TSPA-95 Values			Proposed IPA Phase 3 Reference Values		
Parameter	Distribution	Parameter	Source	Distribution	Value	Source
Upper Crater Flat (CF) matrix van Genuchten beta	—	—	—	uniform	Min = 1.5 Max = 2.4	NRC (1995); Klavetter and Peters (1986)
Bullfrog (BF) matrix van Genuchten beta	—	—	—	uniform	Min = 2.3 Max = 4.2	NRC (1995); Klavetter and Peters (1986)
Middle CF matrix van Genuchten beta	—	—	—	uniform	Min = 1.5 Max = 2.4	NRC (1995); Klavetter and Peters (1986)
TCw residual saturation	constant	0.021	Schenker et al. (1995)	—	—	—
PTn residual saturation	constant	0.154	Schenker et al. (1995)	—	—	—
TSw residual saturation	constant	0.045	Schenker et al. (1995)	—	—	—
TSv residual saturation	constant	0.118	Schenker et al. (1995)	—	—	—
CHnv residual saturation	constant	0.097	Schenker et al. (1995)	—	—	—
CHnz residual saturation	constant	0.121	Schenker et al. (1995)	—	—	—

Table 4-6. Comparison of the unsaturated zone flow and transport reference parameter values used in TSPA-95 and proposed to be used in IPA Phase 3 (cont'd)

UZFT Input Values						
	TSPA-95 Values			Proposed IPA Phase 3 Reference Values		
Parameter	Distribution	Parameter	Source	Distribution	Value	Source
TCw matrix permeability (m^2)	constant	1.3e−18	Schenker et al. (1995)	—	—	—
PTn matrix permeability (m^2)	constant	1.1e−15	Schenker et al. (1995)	—	—	—
TSw matrix permeability (m^2)	constant	2.0e−18	Schenker et al. (1995)	constant	2.0e−18	Schenker et al. (1995)
TSv matrix permeability (m^2)	constant	1.0e−18	Schenker et al. (1995)	constant	1.0e−18	Schenker et al. (1995)
CHnv matrix permeability (m^2)	constant	1.0e−16	Schenker et al. (1995)	constant	1.0e−16	Schenker et al. (1995)
CHnz matrix permeability (m^2)	constant	1.6e−18	Schenker et al. (1995)	constant	1.6e−18	Schenker et al. (1995)
PP matrix permeability (m^2)	—	—	—	log-normal	0.1 percentile = 1.9e−16 99.9 percentile = 9.6e−16	NRC (1995); Peters et al. (1984)
Upper CF matrix permeability (m^2)	—	—	—	log-normal	0.1 percentile = 5.1e−18 99.9 percentile = 1.5e−17	NRC (1995); Peters et al. (1984)
BF matrix permeability (m^2)	—	—	—	log-normal	0.1 percentile = 3.5e−16 99.9 percentile = 4.4e−16	NRC (1995); Peters et al. (1984)
Middle CF matrix permeability (m^2)	—	—	—	log-normal	0.1 percentile = 4.1e−18 99.9 percentile = 1.6e−17	NRC (1995); Peters et al. (1984)

Table 4-6. Comparison of the unsaturated zone flow and transport reference parameter values used in TSPA-95 and proposed to be used in IPA Phase 3 (cont'd)

UZFT Input Values						
	TSPA-95 Values			Proposed IPA Phase 3 Reference Values		
Parameter	Distribution	Parameter	Source	Distribution	Value	Source
TCw matrix bulk density (kg/m^3)	constant	2285	Schenker et al. (1995)	—	—	—
PTn matrix bulk density (kg/m^3)	constant	1419	Schenker et al. (1995)	—	—	—
TSw matrix bulk density (kg/m^3)	constant	2247	Schenker et al. (1995)	constant (grain density)	2247	Schenker et al. (1995)
TSv matrix bulk density (kg/m^3)	constant	2308	Schenker et al. (1995)	constant (grain density)	2308	Schenker et al. (1995)
CHnv matrix bulk density (kg/m^3)	constant	1737	Schenker et al. (1995)	constant (grain density)	1737	Schenker et al. (1995)
CHnz matrix bulk density (kg/m^3)	constant	1746	Schenker et al. (1995)	constant (grain density)	1746	Schenker et al. (1995)
density (kg/m^3)	—	—	—	constant (grain density)	2590	Peters et al. (1984)
Upper CF matrix bulk density (kg/m^3)	—	—	—	constant (grain density)	2270	Peters et al. (1984)

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Table 4-6. Comparison of the unsaturated zone flow and transport reference parameter values used in TSPA-95 and proposed to be used in IPA Phase 3 (cont'd)

UZFT Input Values						
	TSPA-95 Values			Proposed IPA Phase 3 Reference Values		
Parameter	Distribution	Parameter	Source	Distribution	Value	Source
BF matrix bulk density (kg/m^3)	—	—	—	constant (grain density)	2630	Peters et al. (1984)
Middle CF matrix bulk density (kg/m^3)	—	—	—	constant (grain density)	2270	Peters et al. (1984)
Inlet area (m^2)	—	—	—	constant	Subarea 1: 5.4e5 Subarea 2: 5.4e5 Subarea 3: 5.4e5 Subarea 4: 5.4e5 Subarea 5: 5.4e5 Subarea 6: 5.4e5	CNWRA staff best estimate
TCw matrix porosity	constant	0.087	Schenker et al. (1995)	—	—	—
PTn matrix porosity	constant	0.421	Schenker et al. (1995)	—	—	—
TSw matrix porosity	constant	0.139	Schenker et al. (1995)	constant	0.139	Schenker et al. (1995)
TSv matrix porosity	constant	0.065	Schenker et al. (1995)	constant	0.065	Schenker et al. (1995)
CHnv matrix porosity	constant	0.331	Schenker et al. (1995)	constant	0.331	Schenker et al. (1995)

Table 4-6. Comparison of the unsaturated zone flow and transport reference parameter values used in TSPA-95 and proposed to be used in IPA Phase 3 (cont'd)

UZFT Input Values						
	TSPA-95 Values			Proposed IPA Phase 3 Reference Values		
Parameter	Distribution	Parameter	Source	Distribution	Value	Source
CHnz matrix porosity	constant	0.306	Schenker et al. (1995)	constant	0.306	Schenker et al. (1995)
PP matrix porosity	—	—	—	uniform	Min = 0.24 Max = 0.40	NRC (1995); Peters et al. (1984)
Upper CF matrix porosity	—	—	—	uniform	Min = 0.18 Max = 0.30	NRC (1995); Peters et al. (1984)
BF matrix porosity	—	—	—	uniform	Min = 0.19 Max = 0.32	NRC (1995); Peters et al. (1984)
Middle CF matrix porosity	—	—	—	uniform	Min = 0.18 Max = 0.30	NRC (1995); Peters et al. (1984)
TCw fracture permeability (m^2)	constant (Bulk)	1.8e−12	Schenker et al. (1995)	constant	1.8e−12	Schenker et al. (1995)
PTn fracture permeability (m^2)	constant (Bulk)	5.4e−13	Schenker et al. (1995)	constant	5.4e−13	Schenker et al. (1995)
TSw fracture permeability (m^2)	constant (Bulk)	1.8e−12	Schenker et al. (1995)	constant	1.8e−12	Schenker et al. (1995)
Tsv fracture permeability (m^2)	constant (Bulk)	1.8e−12	Schenker et al. (1995)	constant	1.8e−12	Schenker et al. (1995)
CHnv fracture permeability (m^2)	constant (Bulk)	5.4e−13	Schenker et al. (1995)	constant	5.4e−13	Schenker et al. (1995)

Table 4-6. Comparison of the unsaturated zone flow and transport reference parameter values used in TSPA-95 and proposed to be used in IPA Phase 3 (cont'd)

UZFT Input Values						
	TSPA-95 Values			Proposed IPA Phase 3 Reference Values		
Parameter	Distribution	Parameter	Source	Distribution	Value	Source
CHnz fracture permeability (m^2)	constant (Bulk)	1.2e−13	Schenker et al. (1995)	constant	1.2e−13	Schenker et al. (1995)
PP fracture permeability (m^2)	—	—	—	log-normal	0.1 percentile = 3.9−17 99.9 percentile = 8.1e−17	NRC (1995); Klavetter and Peters (1986)
Upper CF fracture permeability (m^2)	—	—	—	log-normal	0.1 percentile = 6.7e−16 99.9 percentile = 9.8e−16	NRC (1995); Klavetter and Peters (1986)
BF fracture permeability (m^2)	—	—	—	log-normal	0.1 percentile = 4.9e−17 99.9 percentile = 6.4e−17	NRC (1995); Klavetter and Peters (1986)
Middle CF fracture permeability (m^2)	—	—	—	log-normal	0.1 percentile = 6.7e−16 99.9 percentile = 9.8e−16	NRC (1995); Klavetter and Peters (1986)
Fracture porosity	constant (all units)	1.00e−3	Schenker et al. (1995)	constant (all units)	1.00e−3	Schenker et al. (1995)
Fracture van Genuchten alpha (1/m)	constant	10	Schenker et al. (1995)	(not needed - method of Mualem, 1976)	—	NRC (1995)

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Table 4-6. Comparison of the unsaturated zone flow and transport reference parameter values used in TSPA-95 and proposed to be used in IPA Phase 3 (cont'd)

UZFT Input Values						
	TSPA-95 Values			Proposed IPA Phase 3 Reference Values		
Parameter	Distribution	Parameter	Source	Distribution	Value	Source
Fracture van Genuchten beta	constant	5	Schenker et al. (1995)	constant	5	Schenker et al. (1995)
Fracture residual saturation	constant	0	Schenker et al. (1995)	constant	0	Ortiz et al. (1985)
Column 1 TSw thickness (m)	constant	105	Wittwer et al. (1995)	constant (Subarea 1)	0	CNWRA staff best estimate
Column 1 TSv thickness (m)	constant	8	Wittwer et al. (1995)	constant (Subarea 1)	0	CNWRA staff best estimate
Column 1 CHnv thickness (m)	constant	92	Wittwer et al. (1995)	constant (Subarea 1)	125	CNWRA staff best estimate
Column 1 CHnz thickness (m)	constant	24	Wittwer et al. (1995)	(CHnv and CHnz combined)	—	CNWRA staff best estimate
Column 1 PPn thickness (m)	constant	115	Wittwer et al. (1995)	constant (Subarea 1)	30	CNWRA staff best estimate
Column 1 upper CF thickness (m)	constant	0	Wittwer et al. (1995)	constant (Subarea 1)	113	CNWRA staff best estimate
Column 1 BF thickness (m)	constant	0	Wittwer et al. (1995)	constant (Subarea 1)	0	CNWRA staff best estimate
Column 1 middle CF thickness (m)	constant	0	Wittwer et al. (1995)	constant (Subarea 1)	0	CNWRA staff best estimate

Table 4-6. Comparison of the unsaturated zone flow and transport reference parameter values used in TSPA-95 and proposed to be used in IPA Phase 3 (cont'd)

UZFT Input Values						
	TSPA-95 Values			Proposed IPA Phase 3 Reference Values		
Parameter	Distribution	Parameter	Source	Distribution	Value	Source
Total thickness Column 1 (m)	constant	345	Wittwer et al. (1995)	constant (Subarea 1)	268	CNWRA staff best estimate
Column 2 TSw thickness (m)	constant	176	Wittwer et al. (1995)	constant (Subarea 2)	43	CNWRA staff best estimate
Column 2 TSv thickness (m)	constant	8	Wittwer et al. (1995)	constant (Subarea 2)	0	CNWRA staff best estimate
Column 2 CHnv thickness (m)	constant	72	Wittwer et al. (1995)	constant (Subarea 2)	153	CNWRA staff best estimate
Column 2 CHnz thickness (m)	constant	50	Wittwer et al. (1995)	(CHnv and Chnz combined)	0	CNWRA staff best estimate
Column 2 PPn thickness (m)	constant	38	Wittwer et al. (1995)	constant (Subarea 2)	37	CNWRA staff best estimate
Column 2 upper CF thickness (m)	constant	0	Wittwer et al. (1995)	constant (Subarea 2)	35	CNWRA staff best estimate
Column 2 BF thickness (m)	constant	0	Wittwer et al. (1995)	constant (Subarea 2)	0	CNWRA staff best estimate
Column 2 middle CF thickness (m)	constant	0	Wittwer et al. (1995)	constant (Subarea 2)	0	CNWRA staff best estimate
Total thickness Column 2 (m)	constant	344	Wittwer et al. (1995)	constant (Subarea 2)	268	CNWRA staff best estimate

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Table 4-6. Comparison of the unsaturated zone flow and transport reference parameter values used in TSPA-95 and proposed to be used in IPA Phase 3 (cont'd)

UZFT Input Values						
	TSPA-95 Values			Proposed IPA Phase 3 Reference Values		
Parameter	Distribution	Parameter	Source	Distribution	Value	Source
Column 3 TSw thickness (m)	constant	87	Wittwer et al. (1995)	constant (Subarea 3)	0	CNWRA staff best estimate
Column 3 TSv thickness (m)	constant	8	Wittwer et al. (1995)	constant	0	CNWRA staff best estimate
Column 3 CHnv thickness (m)	constant	105	Wittwer et al. (1995)	constant (Subarea 3)	53	CNWRA staff best estimate
Column 3 CHnz thickness (m)	constant	32	Wittwer et al. (1995)	(CHnv and Chnz combined)	—	CNWRA staff best estimate
Column 3 PPn thickness (m)	constant	126	Wittwer et al. (1995)	constant (Subarea 3)	40	CNWRA staff best estimate
Column 3 upper CF thickness (m)	constant	0	Wittwer et al. (1995)	constant (Subarea 3)	169	CNWRA staff best estimate
Column 3 BF thickness (m)	constant	0	Wittwer et al. (1995)	constant (Subarea 3)	6	CNWRA staff best estimate
Column 3 middle CF thickness (m)	constant	0	Wittwer et al. (1995)	constant (Subarea 3)	0	CNWRA staff best estimate
Total thickness Column 3 (m)	constant	358	Wittwer et al. (1995)	constant (Subarea 3)	268	CNWRA staff best estimate
Column 4 TSw thickness (m)	constant	147	Wittwer et al. (1995)	constant (Subarea 4)	36	CNWRA staff best estimate

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Table 4-6. Comparison of the unsaturated zone flow and transport reference parameter values used in TSPA-95 and proposed to be used in IPA Phase 3 (cont'd)

UZFT Input Values						
	TSPA-95 Values			Proposed IPA Phase 3 Reference Values		
Parameter	Distribution	Parameter	Source	Distribution	Value	Source
Column 4 TSv thickness (m)	constant	8	Wittwer et al. (1995)	constant (Subarea 4)	0	CNWRA staff best estimate
Column 4 CHnv thickness (m)	constant	87	Wittwer et al. (1995)	constant (Subarea 4)	136	CNWRA staff best estimate
Column 4 CHnz thickness (m)	constant	57	Wittwer et al. (1995)	(CHnv and CHnz combined)	—	CNWRA staff best estimate
Column 4 PPn thickness (m)	constant	61	Wittwer et al. (1995)	constant (Subarea 4)	31	CNWRA staff best estimate
Column 4 upper CF thickness (m)	constant	0	Wittwer et al. (1995)	constant (Subarea 4)	66	CNWRA staff best estimate
Column 4 BF thickness (m)	constant	0	Wittwer et al. (1995)	constant (Subarea 4)	0	CNWRA staff best estimate
Column 4 middle CF thickness (m)	constant	0	Wittwer et al. (1995)	costant (Subarea 4)	0	CNWRA staff best estimate
Total thickness Column 4 (m)	constant	359	Wittwer et al. (1995)	constant (Subarea 4)	269	CNWRA staff best estimate
Column 5 TSw thickness (m)	constant	35	Wittwer et al. (1995)	constant (Subarea 5)	0	CNWRA staff best estimate

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Table 4-6. Comparison of the unsaturated zone flow and transport reference parameter values used in TSPA-95 and proposed to be used in IPA Phase 3 (cont'd)

UZFT Input Values						
	TSPA-95 Values			Proposed IPA Phase 3 Reference Values		
Parameter	Distribution	Parameter	Source	Distribution	Value	Source
Column 5 TSv thickness (m)	constant	7	Wittwer et al. (1995)	(TSv and TSw combined)	0	CNWRA staff best estimate
Column 5 CHnv thickness (m)	constant	132	Wittwer et al. (1995)	constant (Subarea 5)	35	CNWRA staff best estimate
Column 5 CHnz thickness (m)	constant	40	Wittwer et al. (1995)	(CHnv and CHnz combined)	—	CNWRA staff best estimate
Column 5 PPn thickness (m)	constant	158	Wittwer et al. (1995)	constant (Subarea 5)	37	CNWRA staff best estimate
Column 5 upper CF thickness (m)	constant	0	Wittwer et al. (1995)	constant (Subarea 5)	158	CNWRA staff best estimate
Column 5 BF thickness (m)	constant	0	Wittwer et al. (1995)	constant (Subarea 5)	38	CNWRA staff best estimate
Column 5 middle CF thickness (m)	constant	0	Wittwer et al. (1995)	constant (Subarea 5)	0	CNWRA staff best estimate
Total thickness Column 5 (m)	constant	372	Wittwer et al. (1995)	constant (Subarea 5)	268	CNWRA staff best estimate
Column 6 TSw thickness (m)	constant	113	Wittwer et al. (1995)	constant (Subarea 6)	0	CNWRA staff best estimate

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Table 4-6. Comparison of the unsaturated zone flow and transport reference parameter values used in TSPA-95 and proposed to be used in IPA Phase 3 (cont'd)

UZFT Input Values						
	TSPA-95 Values			Proposed IPA Phase 3 Reference Values		
Parameter	Distribution	Parameter	Source	Distribution	Value	Source
Column 6 TSv thickness (m)	constant	7	Wittwer et al. (1995)	(TSv and TSw combined)	0	CNWRA staff best estimate
Column 6 CHnv thickness (m)	constant	102	Wittwer et al. (1995)	constant (Subarea 6)	103	CNWRA staff best estimate
Column 6 CHnz thickness (m)	constant	43	Wittwer et al. (1995)	(CHnv and CHnz combined)	—	CNWRA staff best estimate
Column 6 PPn thickness (m)	constant	105	Wittwer et al. (1995)	constant (Subarea 6)	26	CNWRA staff best estimate
Column 6 upper CF thickness (m)	constant	0	Wittwer et al. (1995)	constant (Subarea 6)	138	CNWRA staff best estimate
Column 6 BF thickness (m)	constant	0	Wittwer et al. (1995)	constant (Subarea 6)	0	CNWRA staff best estimate
Column 6 Middle CF thickness (m)	constant	0	Wittwer et al. (1995)	constant (Subarea 6)	0	CNWRA staff best estimate
Total thickness Column 6 (m)	constant	370	Wittwer et al. (1995)	constant (Subarea 6)	267	CNWRA staff best estimate
Column 7 TSw thickness (m)	constant (25 MTU/acre Case only)	151	Wittwer et al. (1995)	—	—	—

Table 4-6. Comparison of the unsaturated zone flow and transport reference parameter values used in TSPA-95 and proposed to be used in IPA Phase 3 (cont'd)

UZFT Input Values						
	TSPA-95 Values			Proposed IPA Phase 3 Reference Values		
Parameter	Distribution	Parameter	Source	Distribution	Value	Source
Column 7 TSv thickness (m)	constant (25 MTU/acre Case only)	8	Wittwer et al. (1995)	—	—	—
Column 7 CHnv thickness (m)	constant (25 MTU/acre Case only)	55	Wittwer et al. (1995)	—	—	—
Column 7 CHnz thickness (m)	constant (25 MTU/acre Case only)	68	Wittwer et al. (1995)	—	—	—
Column 7 PPn thickness (m)	constant (25 MTU/acre Case only)	0	Wittwer et al. (1995)	—	—	—
Column 7 Upper CF thickness (m)	constant (25 MTU/acre Case only)	0	Wittwer et al. (1995)	—	—	—
Column 7 BF thickness (m)	constant (25 MTU/acre Case only)	0	Wittwer et al. (1995)	—	—	—
Column 7 Middle CF thickness (m)	constant (25 MTU/acre Case only)	0	Wittwer et al. (1995)	—	—	—

Table 4-6. Comparison of the unsaturated zone flow and transport reference parameter values used in TSPA-95 and proposed to be used in IPA Phase 3 (cont'd)

UZFT Input Values						
	TSPA-95 Values			Proposed IPA Phase 3 Reference Values		
Parameter	Distribution	Parameter	Source	Distribution	Value	Source
Total thickness Column 7 (m)	constant (25 MTU/acre Case only)	282	Wittwer et al. (1995)	—	—	—
Column 8 TSw thickness (m)	constant (25 MTU/acre Case only)	105	Wittwer et al. (1995)	—	—	—
Column 8 TSv thickness (m)	constant (25 MTU/acre Case only)	15	Wittwer et al. (1995)	—	—	—
Column 8 CHnv thickness (m)	constant (25 MTU/acre Case only)	54	Wittwer et al. (1995)	—	—	—
Column 8 CHnz thickness (m)	constant (25 MTU/acre Case only)	18	Wittwer et al. (1995)	—	—	—
Column 8 PPn thickness (m)	constant (25 MTU/acre Case only)	48	Wittwer et al. (1995)	—	—	—
Total thickness Column 8 (m)	constant (25 MTU/acre Case only)	240	Wittwer et al. (1995)	—	—	—

Table 4-6. Comparison of the unsaturated zone flow and transport reference parameter values used in TSPA-95 and proposed to be used in IPA Phase 3 (cont'd)

UZFT Input Values						
	TSPA-95 Values			Proposed IPA Phase 3 Reference Values		
Parameter	Distribution	Parameter	Source	Distribution	Value	Source
Column 9 TSw thickness (m)	constant (25 MTU/acre Case only)	80	Wittwer et al. (1995)	—	—	—
Column 9 TSv thickness (m)	constant (25 MTU/acre Case only)	15	Wittwer et al. (1995)	—	—	—
Column 9 CHnv thickness (m)	constant (25 MTU/acre Case only)	63	Wittwer et al. (1995)	—	—	—
Column 9 CHnz thickness (m)	constant (25 MTU/acre Case only)	21	Wittwer et al. (1995)	—	—	—
Column 9 PPn thickness (m)	constant (25 MTU/acre Case only)	56	Wittwer et al. (1995)	—	—	—
Total thickness Column 9 (m)	constant (25 MTU/acre Case only)	235	Wittwer et al. (1995)	—	—	—
Column 10 TSw thickness (m)	constant (25 MTU/acre Case only)	85	Wittwer et al. (1995)	—	—	—

Table 4-6. Comparison of the unsaturated zone flow and transport reference parameter values used in TSPA-95 and proposed to be used in IPA Phase 3 (cont'd)

UZFT Input Values						
	TSPA-95 Values			Proposed IPA Phase 3 Reference Values		
Parameter	Distribution	Parameter	Source	Distribution	Value	Source
Column 10 TSv thickness (m)	constant (25 MTU/acre Case only)	15	Wittwer et al. (1995)	—	—	—
Column 10 CHnv thickness (m)	constant (25 MTU/acre Case only)	47	Wittwer et al. (1995)	—	—	—
Column 10 CHnz thickness (m)	constant (25 MTU/acre Case only)	16	Wittwer et al. (1995)	—	—	—
Column 10 PPn thickness (m)	constant (25 MTU/acre Case only)	42	Wittwer et al. (1995)	—	—	—
Total thickness Column 10 (m)	constant (25 MTU/acre Case only)	205	Wittwer et al. (1995)	—	—	—
Subarea 7 Total TSw thickness (welded + vitric) (m)	—	—	—	constant	48	CNWRA staff best estimate
Subarea 7 Total CHn thickness (welded + vitric) (m)	—	—	—	constant	113	CNWRA staff best estimate

Table 4-6. Comparison of the unsaturated zone flow and transport reference parameter values used in TSPA-95 and proposed to be used in IPA Phase 3 (cont'd)

UZFT Input Values						
	TSPA-95 Values			Proposed IPA Phase 3 Reference Values		
Parameter	Distribution	Parameter	Source	Distribution	Value	Source
Subarea 7 PPn thickness (m)	—	—	—	constant	44	CNWRA staff best estimate
Subarea 7 upper CF thickness (m)	—	—	—	constant	63	CNWRA staff best estimate
Subarea 7 BF thickness (m)	—	—		constant	0	CNWRA staff best estimate
Subarea 7 Total thickness (m)	—	—	—	constant	268	CNWRA staff best estimate
Repository Area upper block (m^2)	constant (25 and 83 MTU /acre Cases)	3.766e6	CRWMS M&O (1994b)	constant	3.77e6	CRWMS M&O (1994b)
Repository Area lower block (m^2)	constant (25 MTU/acre Case only)	8.83e5	CRWMS M&O (1994b)	—	—	—
Repository Area optional area B (m^2)	constant (25 MTU/acre Case only)	1.777e6	CRWMS M&O (1994b)	—	—	—
Repository Area optional Area C (m^2)	constant (25 MTU/acre Case only)	1.467e6	TSPA 95	—	—	—

Table 4-6. Comparison of the unsaturated zone flow and transport reference parameter values used in TSPA-95 and proposed to be used in IPA Phase 3 (cont'd)

UZFT Input Values						
	TSPA-95 Values			Proposed IPA Phase 3 Reference Values		
Parameter	Distribution	Parameter	Source	Distribution	Value	Source
Repository Area optional Area D (m^2)	constant (25 MTU/acre Case only)	2.369e6	CRWMS M&O (1994b)	—	—	—
Fracture Rd values	—	—	—	constant (for all nuclides and areas)	1.0	CNWRA staff conservative estimation of no retardation
Longitudinal dispersivity for fracture and matrix flow	—	—	—	log-normal	Min = 0.3 Max = 30.0	Assumed in NRC (1995). Matrix dispersivity is conservatively assumed to be equal to fracture dispersivity