Model
Error Resolution Document

Complete only applicable items

QA: QA mah 2-27-09

1. Document Number:	2. Revision/Addendum:	3. ERD:
MDL-NBS-HS-000011	03	04

4. Title:	5. No. of Pages Attached:
Saturated Zone Site-Scale Flow Model	12

6. Description of and Justification for Change (Identify affected pages, applicable CRs and TBVs):

1 Background Information Summary

The purpose of this ERD is to resolve CR 12426 and CR 12950 associated with MDL-NBS-HS-000011 REV 03 [DIRS 177391].

Condition Description (CR 12426):

"The constant head boundary file, which specifies constant head for cells along the boundary of the model, contains 3 extra model nodes that are not supposed to have a constant head. As a result, there are 2.9 kg/s that exit [note: actually enter] the model through these 3 cells because they are erroneously specified as constant head. This condition yields a water-budget discrepancy (Table 6-11) where the net sum of fluxes does not equal the recharge applied. In addition, the North and West fluxes are mislabeled in Table 6-11. The West value is labeled as North and the North value is labeled as West. There is also a missing − sign for the value of 6.5 for the East$_4$ entry of Table 6-11."

Additionally, incorrect information was submitted to the TDMS in DTN: SN0612T0510106.004 [DIRS 178956], in the FEHM input file "`boundary_heads.macro`."

Condition Description (CR 12950):

"The revised text on page 2 of MDL-NBS-HS-000011 ERD 01 indicates that the percolation of 8.5 kg/s is a 49% increase over the previous net infiltration of 5.6 kg/s. The correct percentage increase is 52%, not 49%. Furthermore, it is stated that this higher infiltration remains a small portion of the infiltration budget, 13.2%. The value of 13.2% has too many significant figures and should be changed to 13%. The same error appears on pages 3 and 4 of MDL-NBS-HS-000011 ERD 01."

See attached.

	Printed Name	Signature	Date
7. Checker	Charles Haukwa	[signature]	02/26/2009
8. QCS/QA Reviewer	Robert E. Spencer	Robert E Spencer	02/26/2009
9. Originator	Scott James	Scott James	02/26/2009
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Condition Description (CR 12950):

II Inputs and/or Software

All inputs required to support this analysis were derived from MDL-NBS-HS-000011 REV03 (SNL 2007 [DIRS 177391]) and the calibrated SZ site-scale flow model files were used in this analysis. Files were obtained from the Technical Database Management System as `Q-SZ Flow Model.zip` found in DTN: SN0612T0510106.004 [DIRS 178956]. The only file that was changed was `boundary_heads.macro`. Specifically, the last three entries of the file defining (erroneous) constant heads at nodes 721941, 721942, and 862353 were deleted (the last three input lines above the "`stop`" delimiter).

The computer code used in this work is FEHM v2.24 [DIRS 179539]. All software used is qualified and baselined. SCI-PRO-006 has been followed in planning, conducting, and documenting the modeling activities.

III Analysis

CR 12426:

An analysis was completed to study the impact on the SZ site-scale flow model results of removing the three extraneous constant head nodes from the constant head boundary file upon. Details of this analysis are documented in Appendix J. The analysis resulted in recommendations for the following changes:

1. In Table 6-11, the following footnote is removed: "Mass flows are approximate because of the technique FEHM uses in the *flxz* macro to sum and print boundary flows." Table 6-11 from the MDL-NBS-HS-000011 REV03 is replaced with the following table that resolves CR12426:

2. Submission of an interim DTN "DTN: MO0810BHMSZSFM.000" reflecting the correction of the FEHM input file "`boundary_heads.macro`." As documented in Appendix J, Section J.3, Table J-5, the corrections to constant head boundaries resulted in calibrated fluxes that are well within the model's uncertainty range of factors of 1/8.93 to 8.93 (SNL 2007 [DIRS 183750], Table 6-7[a]).

Table 6-11[a]. Comparison of Target and Site-Scale Volumetric/Mass Flow Rates

Boundary Zone (Range in m)	Target Mass/Volume Flows[a]		Site-Scale Mass/Volume Flows[b]		Calibration Weight
	Flow (kg/s)	Flow (m^3/yr)	Flow (kg/s)	Flow (m^3/yr)	
North (533,000–563,000)	–158.9	-5.0×10^6	–101.0	-3.2×10^6	5
West (4,046,500–4,091,500)	–120.3	-3.8×10^6	–57.1	-1.8×10^6	5
$East_1$ (4,046,500–4,052,500)	–273.1	-8.6×10^6	–232.1	-7.3×10^6	1
$East_2$ (4,052,501–4,058,500)	33.3	1.0×10^6	–97.4	-3.1×10^6	1
$East_3$ (4,058,501–4,069,000)	–127.8	-4.0×10^6	260.9	8.2×10^6	1
$East_4$ (4,069,001–4,079,500)	30.2	9.5×10^5	–206.6	-6.5×10^6	1
$East_5$ (4,079,501–4,091,500)	–0.4	-1.2×10^4	–30.7	-9.7×10^5	1
South (533,000–563,000)	681.9	2.2×10^7	528.1	1.7×10^7	NA

NOTES: Negative values indicate flow into the model. South boundary volumetric/mass flow rates were not used as targets for the calibration of the SZ site-scale flow model; rather, they were calculated from the balance of infiltration (vertical recharge) and the volumetric/mass flow rates across north, west, and east boundaries.

[a] Source: DTN: MO0602SPAMODAR.000 [DIRS 177371] (see Appendix C).

[b] Output DTN: SN0612T0510106.004, *sz06.pest*.

Conversion factor: $m^3/yr = \frac{m^3}{1,000\,kg} \cdot \frac{86,400\,s}{day} \cdot \frac{365.25\,day}{yr} \cdot \frac{kg}{s}$

3. In Section 6.5.2.2 page 6-73, paragraph 3 of the parent report is revised to the following (only the **bold face** text is changed and the sentence in ~~strikethrough text~~ is deleted).

   "In Section 6.3.1.6, the methodology for applying constant-head lateral boundary conditions to the SZ site-scale flow model was described. With constant-head boundary conditions, the flux through a boundary is a function of the permeabilities on that boundary. Flux targets were derived from the values simulated by the 2004 regional model (Appendix C). A comparison of the calibration target volumetric/mass flow rates and volumetric/mass flow rates derived from the calibrated SZ site-scale flow model is made in Table 6-11[a]. The western boundary, for instance, has a total flux of 120.3 kg/s (3.8×10^6 m^3/yr) across it for the target flux values and **57.1** kg/s (1.8×10^6 m^3/yr) across it in the calibrated model. The difference in southern volumetric/mass flow rates, which is simply a sum of the other boundary volumetric/mass flow rates plus the recharge (528.1 kg/s; **1.7×10^7 m^3/yr**), is a decrease of about 23% **from the regional model target of 681.9 kg/s (2.2×10^7 m^3/yr)**. The weighted RMSE for boundary mass flow rates is **50.0** kg/s. ~~It should be noted that in Table 6-11[a], the sum of all target boundary volumetric/mass flow rates (64.7 kg/s) is not equal to the sum of all volumetric/mass flow rates through the calibrated flow model (**64.2** kg/s) because different infiltration boundary conditions were applied to each model (see Section 6.4.3.9 and Figure 6-14).~~"

CR12950:

CR 12950: In the following text on page 3 of MDL-NBS-HS-000011 ERD 01 "49.6%" must be changed to "52%" and "13.2%" must be changed to "13%".

> "A recent update to infiltration estimates in the region immediately surrounding Yucca Mountain (SNL 2007 [DIRS 174294]) was used to supply new percolation fluxes to the UZ flow model, which yielded a weighted flow through its footprint of 8.5 kg/s under present-day climatic conditions (SNL 2007 [DIRS 184614], Table 6.2-7 and DTN: LB0701PAWFINFM.001 [DIRS 179283], file: factors. doc). While this is a 49.6% increase over the previous net infiltration through the UZ footprint (5.6 kg/s), it remains a small portion of the infiltration budget, 13.2%, and a correspondingly smaller portion of the entire flow budget through the lateral boundaries, equal to about 1%."

The same changes must also be made in MDL-NBS-HS-000011 ERD 01 Sections III.2 and III.9 (pages 4 and 5). In Section III.9, reference to page 5-53 must be changed to 6-53.

There is no impact on any downstream product due to these corrections for both CRs..

IV Impact Evaluation

The following Figures and Tables of MDL-NBS-HS-000011 REV 03 were evaluated for potential impact from addressing CR12426: Figures 6-12, 6-13, 6-15, 6-17, 7-1, 7-2 and Tables 6-7, 6-8, 6-9, 6-10, 6-11, 7-1, 7-2, 7-3, 8-1. All figures and tables cite DTN: SN0612T0510106.004 as the source; however, with the exception of Table 6-11, which is corrected in Section III above, there is no impact to the tables and no visible impact to the figures.

There is no impact on any downstream products by correcting the calculation of the relative percentage of infiltration through the UZ footprint or by adjusting the number of significant digit (CR12950). The changes have already been incorporated into REV 01 of SAR Section 2.3.9.

In summary, the changes and corrections outlined above are minor. There are no impacts to the conclusions or output of the model report *Saturated Zone Site-Scale Flow Model* MDL-NBS-HS-000011 (SNL 2007 [DIRS 177391]), and also no downstream impacts. The following is a list of downstream controlled products. None of these is impacted.

- ANL-NBS-HS-000039 Rev. 02, ACN 01, *SATURATED ZONE IN-SITU TESTING*
- ANL-NBS-HS-000039 Rev. 02, *SATURATED ZONE IN-SITU TESTING*
- ANL-WIS-MD-000024 Rev. 01, *POSTCLOSURE NUCLEAR SAFETY DESIGN BASES*
- ANL-WIS-MD-000027 Rev. 00, *FEATURES, EVENTS, AND PROCESSES FOR THE TOTAL SYSTEM PERFORMANCE ASSESSMENT: ANALYSES*
- DOE/RW-0573 Rev. 01, *YUCCA MOUNTAIN REPOSITORY SAR*
- MDL-EBS-PA-000004 Rev. 03, *WASTE FORM AND IN-DRIFT COLLOIDS-ASSOCIATED RADIONUCLIDE CONCENTRATIONS: ABSTRACTION AND SUMMARY*
- MDL-MGR-HS-000001 Rev. 00, *IRRIGATION RECYCLING MODEL*
- MDL-NBS-HS-000006 Rev. 03, *UZ FLOW MODELS AND SUBMODELS*

- MDL-NBS-HS-000010 Rev. 03, Addendum 01, *SITE SCALE SATURATED ZONE TRANSPORT*
- MDL-NBS-HS-000010 Rev. 03, *SITE-SCALE SATURATED ZONE TRANSPORT*
- MDL-NBS-HS-000021 Rev. 03, Addendum 01, *SATURATED ZONE FLOW AND TRANSPORT MODEL ABSTRACTION*
- MDL-NBS-HS-000024 Rev. 01, *HYDROGEOLOGIC FRAMEWORK MODEL FOR THE SATURATED-ZONE SITE-SCALE FLOW AND TRANSPORT MODEL*
- MDL-WIS-PA-000005 Rev. 00, Addendum 01, *TOTAL SYSTEM PERFORMANCE ASSESSMENT MODEL/ANALYSIS FOR THE LICENSE APPLICATION*
- MDL-WIS-PA-000005 Rev. 00, MiscId 01, *TOTAL SYSTEM PERFORMANCE ASSESSMENT MODEL/ANALYSIS FOR THE LICENSE APPLICATION - Volume I*
- MDL-WIS-PA-000005 Rev. 00, MiscId 03, *TOTAL SYSTEM PERFORMANCE ASSESSMENT MODEL/ANALYSIS FOR THE LICENSE APPLICATION - Volume III*
- TDR-PCS-SE-000001 Rev. 05, Addendum 01, *PERFORMANCE CONFIRMATION PLAN*
- *TDR-WIS-PA-000014 Rev. 00, TSPA INFORMATION PACKAGE FOR THE DRAFT SEIS*

Appendix J: Analysis and Results

J.1 Erroneous constant-head nodes interior to the model domain

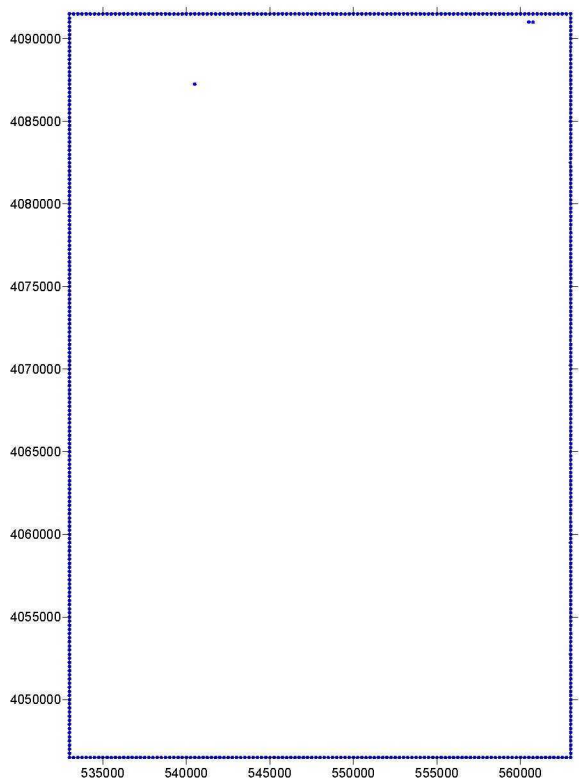
During an impact analysis of the new infiltration estimates on the SZ site-scale flow model, some inconsistencies were discovered in the input files for the License Application (LA) SZ flow model. The inconsistency was discovered when examining system mass balance, which ensures that mass flowing into and out of the lateral boundaries is balanced by net infiltration. Such an inquiry is initiated by requesting that FEHM output all flows through nodes on the north, south, east, and west boundaries, which should exactly equal the net infiltration when summed. Although some discrepancy had been noted in the past (see the note on Table 6-11 of the SZ Flow AMR), this was previously attributed to double counting nodes on the corners of the model domain. That is, nodes on the northeast corner were thought to contribute to the sums of flows out of both the eastern and northern faces of the model domain (and hence were thought to be double counted). At the time, the small mass balance discrepancy was attributed to an accounting issue where corner nodes were (erroneously) thought to be included in two distinct flow summations. Upon further inspection, however, it was determined that FEHM does not double count flows through boundary nodes because a node can only be included in one zone. That is, if it is assigned to Zone A initially and then to Zone B, it is removed from Zone A and only included in the sum of flows through nodes comprising Zone B. Clearly, the mass balance discrepancy must arise elsewhere.

In carefully going through all FEHM input files, it was discovered that the file defining the constant-head boundary conditions (`boundary_heads.macro`) contained three extraneous lines defining constant head nodes that are not on the boundary of the model as listed in Table J-1. Two of these nodes are in the northeast of the model domain, and one is in the northwest as shown in Figure J-1. The first two nodes listed in the table (721941 and 721942) are nearly adjacent to the model boundary (500 m) and hence extremely unlikely to impact results. The third node in the table (862353) is reasonably far from the boundary (4,250 m) and has the potential to impact the model results to a greater degree (although it should be noted that the head specified for this node is consistent with boundary heads and therefore it will not force an inconsistent result).

Table J-1. Erroneous Constant-Head Nodes in File `boundary_heads.macro` with Related Data. Note That the Location of the Erroneous Nodes are Obvious in Figure J-1.

Node	Head (m)	X (m)	Y (m)	Z (m)	Dist from boundary (m)	Net Flow (kg/s)*
721941	1186.5	560500	4091000	730	500	−0.0582
721942	1182.5	560750	4091000	730	500	−0.0281
862353	1154.9	540500	4087250	880	4,250	−2.82

*Flows into these nodes are from unspecified outside sources at precisely the rate needed to maintain their specified heads. These flows, from unspecified outside sources, flow into the nodes and then flow into adjacent neighboring nodes.



Note: Cells falling on the border of the figure are the correct boundary nodes.

Figure J-1. Location of All Constant-Head Boundary Nodes (Including the Three Erroneous Cells Visible in the Interior of the Model Domain)

Upon deletion of these nodes from the `boundary_heads.macro` input file, a forward run of the LA flow model yields results summarized in Table J-2 for these nodes.

Table J-2. Forward Run Results Without the Erroneous Constant-Head Nodes

Node	Head (m)	Δ head (m)	Flow (kg/s)
721941	1156	−30.5	0.0
721942	1149	−33.5	0.0
862353	1060	−94.9	0.0

J.2 Water Levels

Because of the notable difference in heads between the erroneous run with the constant heads (Table J-1) and the corrected run with no internal nodes having specified heads (Table J-2), additional model analyses were undertaken. Specifically, heads at all calibration targets are compared in Table J-3. Table J-3 also lists the difference between the two computed water levels.

Table J-3. Comparison of Corrected Computed Hydraulic Heads (no erroneous BC nodes) and the LA SZ Site-Scale Flow Model Computed Head Data (LA Head Data)

Name	Model node	LA heads (m)	New Heads (m)	Δ Heads (m)
UE-29a#2	897244	1150.49	1150.23	−0.26
GEXA_Well_4	847393	1006.00	1005.61	−0.39
UE-25WT#6	846002	870.98	870.34	−0.65
USW_G-2	845756	880.22	879.65	−0.56
UE-25WT#16	673914	734.94	734.93	−0.01
USW_UZ-14	695253	734.72	734.71	−0.01
UE-25WT#18	695259	734.61	734.61	−0.01
USW_G-1	279088	745.79	745.75	−0.04
UE-25a#3	607533	773.85	773.85	0.00
UE-25WT#4	673064	734.57	734.57	−0.01
UE-25WT#15	650823	735.82	735.82	0.00
USW_G-4	431672	734.59	734.58	−0.01
UE-25a#1	453456	734.55	734.54	−0.01
UE-25WT#14	650092	734.37	734.36	0.00
USW_WT-2	649954	734.58	734.57	−0.01
UE-25c#1	386668	734.45	734.44	−0.01
UE-25c#3	386668	734.45	734.44	−0.01
UE-25c#2	430349	734.44	734.44	−0.01
UE-25WT#13	649370	734.30	734.30	0.00
USW_WT-7	735215	783.70	783.46	−0.24
USW_WT-1	670881	734.51	734.51	−0.01
USW_G-3	320225	735.53	735.52	−0.01
UE-25_J-13	341668	734.25	734.24	0.00
USW_WT-10	713413	781.37	781.14	−0.23
UE-25WT#17	670037	734.42	734.42	−0.01
USW_VH-2	319581	915.88	915.71	−0.17
UE-25WT#3	669682	734.25	734.25	0.00
USW_VH-1	406468	779.19	778.98	−0.21
UE-25WT#12	646936	734.32	734.32	−0.01
USW_WT-11	624903	734.56	734.55	−0.01
UE-25_J-12	558381	733.53	733.52	0.00
UE-25_JF#3	558018	733.34	733.34	0.00
Cind-R-Lite_Well	663479	737.30	737.25	−0.05
PW-1 Ben Bossingham	639932	718.58	718.58	0.00
PW-2 Fred Cobb	595767	717.89	717.89	0.00
PW-3 Bob Whellock	595768	718.08	718.08	0.00
PW-4 Louise Pereidra	639571	718.30	718.30	0.00
PW-5 Joe Richards	595647	717.80	717.80	0.00
NDOT_Well	595646	717.61	717.61	0.00
PW-6 James H. Shaw	551707	716.24	716.24	0.00
Airport_Well	507917	716.86	716.85	0.00
TW-5	617340	724.33	724.33	0.00
PW-7 Richard Washburn	573003	713.55	713.55	0.00
PW-8 Richard Washburn	594178	703.37	703.37	0.00
Nye County Development Co	505460	698.58	698.58	0.00
PW-9 Fred Wooldridge	571134	696.21	696.20	0.00
PW-10 Fred J. Keefe	593053	702.58	702.57	−0.01
PW-11 Leslie Nickels	527353	701.67	701.66	−0.01
PW-12 Mason	636785	709.95	709.95	0.00

PW-13 Unknown	570929	694.29	694.29	0.00
PW-14 Davidson Well	570772	694.41	694.41	0.00
PW-15 Eugene J. Mankinen	592562	694.96	694.96	0.00
PW-16 Donald O. Heath	526872	693.55	693.55	0.00
PW-17 Elvis Kelley	614213	692.66	692.66	0.00
PW-18 Manuel Rodela	614373	693.33	693.33	0.00
PW-19 Charles C. DeFir Jr.	614218	693.79	693.79	0.00
PW-20 William R. Monroe	570423	699.29	699.28	−0.01
PW-21 DeFir Well	570410	692.52	692.52	0.00
PW-22 Edwin H. Mankinen	548282	696.01	696.00	0.00
PW-23 Bill Strickland	592062	690.31	690.31	0.00
PW-24 M. Meese	548308	692.58	692.58	0.00
PW-25 Theo E. Selbach	570092	693.09	693.09	0.00
PW-26 C.L. Caldwell	526249	691.67	691.66	0.00
PW-27 Leonard Siegel	570110	705.39	705.39	0.00
PW-28 James K. Pierce	548045	690.91	690.91	0.00
PW-29 James K. Pierce	591846	691.05	691.05	0.00
PW-30 Cooks West Well	613916	709.66	709.66	0.00
PW-31 Cooks East Well	613918	711.53	711.53	0.00
Nye County Land Company	591753	693.28	693.28	0.00
Amargosa Town Complex	569731	693.46	693.46	0.00
Nye County Develop. Co.	482135	692.56	692.56	0.00
PW-32 Lewis C. Cook	635454	709.90	709.90	0.00
PW-33 Lewis C. Cook	613554	711.26	711.26	0.00
Amargosa Valley Water	569731	693.46	693.46	0.00
PW-34 Earl N. Selbach	569573	693.60	693.60	0.00
PW-35 Lewis N. Dansby	547675	693.53	693.53	0.00
PW-36 Edwin H. Mankinen	613381	692.83	692.83	0.00
PW-37 Willard Johns	591646	699.88	699.88	0.00
USW H-1 tube 1	213387	756.58	756.53	−0.06
USW H-1 tube 2	300991	734.61	734.60	−0.01
USW H-1 tube 3	454298	734.62	734.62	−0.01
USW H-1 tube 4	607605	734.62	734.62	−0.01
USW H-5 upper	650798	734.92	734.91	−0.01
USW H-5 lower	387986	734.73	734.73	−0.01
UE-25b#1 lower	256468	734.59	734.58	−0.01
UE-25b#1 upper	344072	734.55	734.55	−0.00
USW H-6 upper	562704	786.24	785.98	−0.26
USW H-6 lower	321793	781.84	781.61	−0.23
USW H-4 upper	365365	734.56	734.55	−0.01
USW H-4 lower	255860	739.49	739.47	−0.02
USW H-3 upper	452236	734.61	734.61	−0.01
USW H-3 lower	342731	736.09	736.08	−0.01
UE-25p#1 (Lwr Intrvl)	211341	740.55	740.53	−0.02
USW SD-7	518306	734.57	734.56	−0.01
USW SD-9	607241	734.61	734.61	−0.01
USW SD-12	650196	734.59	734.58	−0.01
NC-EWDP-1DX shallow zone	768353	782.98	782.85	−0.13
NC-EWDP-1S probe 1	749061	782.96	782.83	−0.13
NC-EWDP-1S probe 2	708052	782.85	782.71	−0.14
NC-EWDP-2D	399481	716.64	716.64	0.00
NC-EWDP-2DB	246174	717.94	717.93	−0.01
NC-EWDP-3D	334841	736.40	736.35	−0.05

NC-EWDP-3S probe 2	597653	737.18	737.13	−0.05
NC-EWDP-3S probe 3	510049	737.18	737.14	−0.05
NC-EWDP-4PA	618271	718.66	718.65	0.00
NC-EWDP-4PB	443063	718.66	718.66	0.00
NC-EWDP-5SB	662800	720.98	720.98	0.00
NC-EWDP-7S	769212	767.23	767.07	−0.16
NC-EWDP-9SX probe 1	767636	757.61	757.48	−0.13
NC-EWDP-9SX probe 2	748344	757.58	757.45	−0.13
NC-EWDP-9SX probe 4	620271	757.47	757.34	−0.13
NC-EWDP-12PA	576340	755.87	755.75	−0.12
NC-EWDP-12PB	576340	755.87	755.75	−0.12
NC-EWDP-12PC	663935	755.69	755.57	−0.12
NC-EWDP-15P	684593	720.60	720.58	−0.02
NC-EWDP-19P	618981	717.66	717.66	0.00
NC-EWDP-19D	421872	717.65	717.65	0.00
USW WT-24	717538	836.49	836.21	−0.28
NC-Washburn-1X	618627	718.00	718.00	0.00
BGMW-11	577177	711.16	711.15	0.00
PW-38 Richard Washburn	638100	703.75	703.75	0.00
PW-39 L. Cook	613786	698.34	698.34	0.00
PW-40 Unknown	591999	693.04	693.04	0.00
Amargosa Water	613771	692.58	692.58	0.00
PW-41 Lewis C. Cook	635820	712.42	712.42	0.00
PW-42 Unknown	614463	694.96	694.96	0.00
USW_UZ-N91	921140	1184.05	1183.79	−0.26
NC-EWDP-7SC	687476	767.20	767.04	−0.16
NC-EWDP-7SC Z1	769212	767.23	767.07	−0.16
NC-EWDP-7SC Z2	769212	767.23	767.07	−0.16
NC-EWDP-7SC Z3	729744	767.22	767.06	−0.16
NC-EWDP-7SC Z4	643748	767.18	767.02	−0.16
NC-EWDP-10P Deep	534660	730.56	730.55	0.00
NC-EWDP-10P Shallow	644165	730.55	730.55	0.00
NC-EWDP-10S Z1	644165	730.55	730.55	0.00
NC-EWDP-10S Z2	534660	730.56	730.55	0.00
NC-EWDP-18P	645239	732.67	732.66	−0.01
NC-EWDP-19IM1 Z1	618981	717.66	717.66	0.00
NC-EWDP-19IM1 Z2	553278	717.66	717.65	0.00
NC-EWDP-19IM1 Z3	487575	717.65	717.65	0.00
NC-EWDP-19IM1 Z4	443773	717.64	717.64	0.00
NC-EWDP-19IM1 Z5	421872	717.65	717.65	0.00
NC-EWDP-19IM2	465674	717.64	717.64	0.00
NC-EWDP-22PA Deep	533203	724.55	724.55	0.00
NC-EWDP-22PA Shallow	642708	724.55	724.55	0.00
NC-EWDP-22PB Deep	401797	724.71	724.71	0.00
NC-EWDP-22PB Shallow	445599	724.56	724.56	0.00
NC-EWDP-22S Z1	642708	724.55	724.55	0.00
NC-EWDP-22S Z2	533203	724.55	724.55	0.00
NC-EWDP-22S Z3	445599	724.56	724.56	0.00
NC-EWDP-22S Z4	401797	724.71	724.71	0.00
NC-EWDP-23P Deep	532122	721.93	721.93	0.00
NC-EWDP-23P Shallow	641627	721.93	721.93	0.00
NC-EWDP-16P	687500	739.28	739.24	−0.04
NC-EWDP-19PB Deep	553278	717.66	717.65	0.00

NC-EWDP-19PB Shallow	640882	717.66	717.66	0.00
NC-EWDP-24P	686426	725.30	725.30	0.00
NC-EWDP-27P	687981	739.54	739.50	−0.04
NC-EWDP-28P	686653	738.83	738.78	−0.05
NC-EWDP-29P	663380	719.12	719.12	0.00
NOTE: LA heads: DTN: SN0612T0510106.004 [DIRS 178956]. Heads after removal of the erroneous constant head nodes within the model domain: DTN: MO0810BHMSZSFM.000. Heads and head differences are in meters (m). Numbers are rounded to two significant digits.				

As indicated in Table J-3 for the corrected boundary conditions (deletion of the three extraneous nodes), there were some minor decreases in water levels; most notably in wells WT-6, G-2, GEXA-Well 4, and WT-24. The greatest decrease was in well WT-6 (0.65 m). There were no increases in modeled heads at calibration wells because the removal of the erroneous constant-head nodes resulted in the model returning to its preferred heads at these cells, which was less than the erroneously specified heads (see Table J-2). Table J-4 demonstrates that the average head residual, the RMSE, and the weighted RMSE are nearly identical (within 0.03 m) across LA and new model runs. This suggests that the model calibration has not changed as a result of the removal of the three erroneous constant-head nodes within the model domain.

Table J-4. Comparison of Model Residuals

Value	Old (m)	New (m)
Average head residual	11.57	11.58
Root-mean-square-error	24.39	24.44
Weighted root-mean-square-error	0.82	0.82

J.3 Boundary Fluxes and Specific Discharge

Because constant-head boundary conditions are implemented such that they provide as much additional water to the specified node as required to meet the head specified at the node, an additional 2.91 kg/s (see Table J-1) was erroneously supplied to the model domain. With the erroneous boundary-head nodes removed, mass balance out of the lateral model boundaries is such that the sum of lateral flows equals that from the supplied infiltration (net recharge).

Additional differences between the LA model and the model without the erroneous specified-head nodes are presented in Table J-5. The results show only a minimal change in model boundary fluxes when the three erroneous constant-head nodes are removed from a forward model run. These changes are small compared to the uncertainty in recharge rates from net infiltration (SNL 2007 [DIRS 174294]; SNL 2007 [DIRS 175177], Table 6.2-7) and the uncertainty in lateral boundary fluxes (SNL 2007 [DIRS 177391], Table 6-11 and Appendix C).

Table J-5. Comparison of model outputs between the LA model and the corrected model.

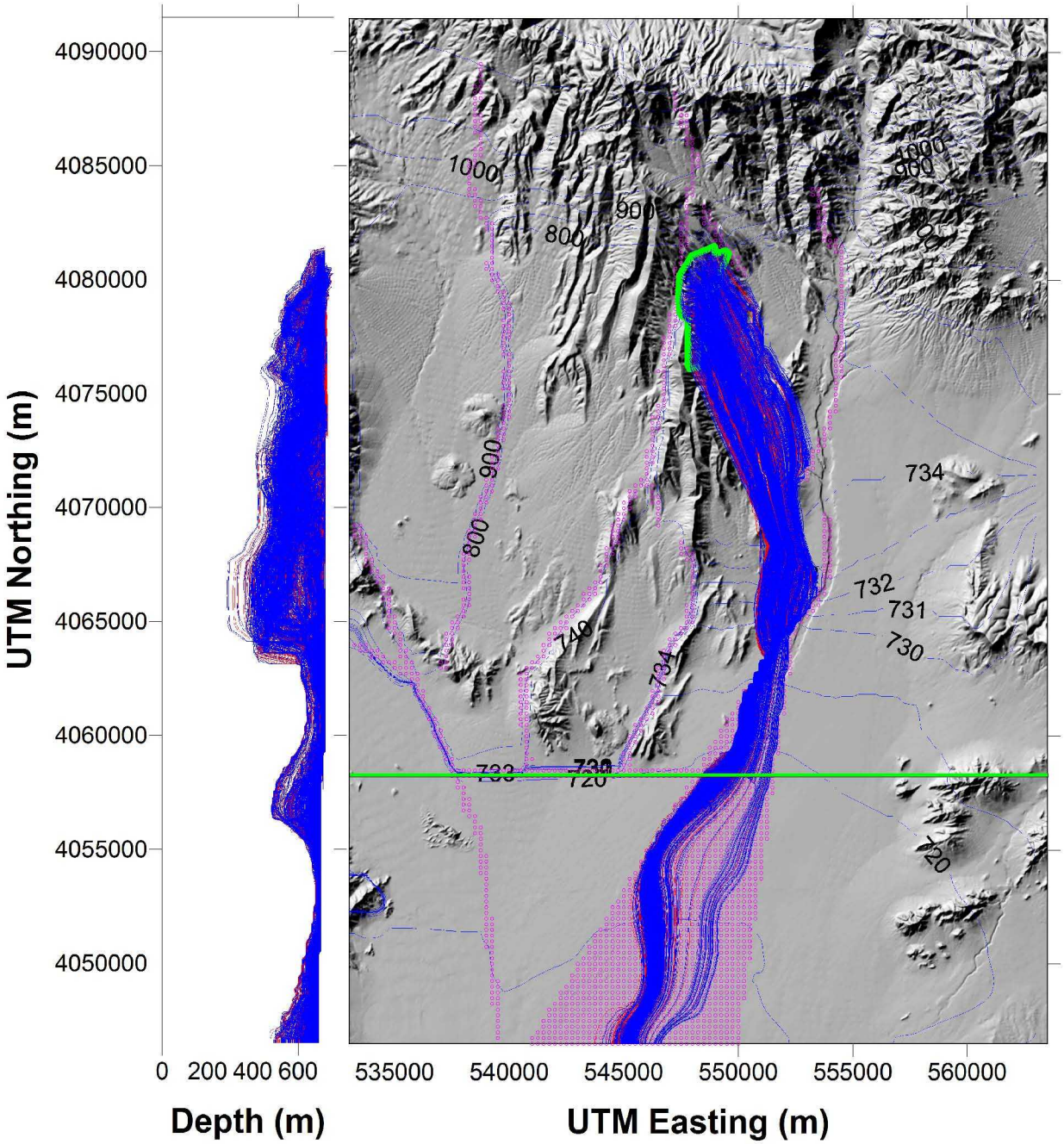
Model output	LA model	Corrected model	% difference
North flux (kg/s)	−101.02	−102.72	−1.68%
West flux (kg/s)	−57.13	−57.87	−1.30%
$East_1$ flux (kg/s)	−232.10	−232.11	0.00%
$East_2$ flux (kg/s)	−97.36	−97.36	0.00%
$East_3$ flux (kg/s)	260.92	260.91	0.01%
$East_4$ flux (kg/s)	−206.58	−206.89	−0.16%
$East_5$ flux (kg/s)	−30.69	−30.71	0.09%
South flux (kg/s)	528.14	528.07	0.01%
Average head residual (m)	11.57	11.58	0.13%
RMSE (m)	24.39	24.44	−0.22%
Weighted RMSE (m)	0.82	0.82	0.04%
Median transport time (yr)	7359601	7414386	−0.74%
Specific discharge (m/yr)	0.34	0.33	0.74%
Avg. specific discharge 5-km (m/yr)	0.36	0.36	0%
Max. specific discharge 5-km (m/yr)	0.74	0.72	2.70%
Avg. specific discharge 18-km (m/yr)	0.56	0.55	1.79%
Max. specific discharge 18-km (m/yr)	0.87	0.87	0%
Output: DTN: MO0810BHMSZSFM.000			

J.4 Flow Paths

Flow paths were generated from the model run without the three erroneous constant head nodes identified in Table J-1. Figure J-2 shows flow paths emanating from below the repository without the three erroneous constant-head nodes (blue) overlying the LA (red) particle tracks. The red flow paths are not visible because they are almost completely covered by the blue flow paths. Thus the figure indicates the flow paths from the two runs are essentially identical.

J.5 Conclusions

Calculations were carried out with the *Saturated Zone Site-Scale Flow Model* MDL-NBS-HS-000011 (SNL 2007 [DIRS 177391] after the three erroneous boundary-condition head nodes were deleted from the input file `boundary_heads.macro`. The results show that there is only a minimal impact on forward runs of the SZ site-scale flow model due to correction (deletion) of the three erroneously assigned constant head nodes. These erroneous constant-head nodes are reasonably close to the boundary and also had assigned heads consistent with their nearest neighbors on the model boundary. Overall, there is not a significant impact on flows around and downgradient from the repository, which was specifically placed near the center of the model domain to minimize boundary condition effects. Specific discharges and head residuals were only minimally affected throughout the model domain.



Output derived from DTN: SN0612T0510106.004 [DIRS 178956] and DTN MO0810BHMSZSFM.000.

NOTE: Source for repository outline: SNL (2009 [DIRS 185407]). Source for LA model flow paths is Figure 6-17 DTN SN0704T0510106.008 (particle tracks). The green line across the model at UTM Northing equal to 4,058,256 m represents the 18-km compliance boundary.

UTM = Universal Transverse Mercator.

Figure J-2. Particle Tracks for 1,000 Particles Released below the Repository Uniformly but Randomly Distributed over the Repository Area for the LA Model (Red) and Corrected Model (Blue)