4.0 MODIFIED MODEL CALIBRATION

The calibration of the modified Central Carbonate-Rock Province (CCRP) numerical model is presented in this section, followed by a description of the results.

4.1 Model Calibration

BLM indicated it was acceptable for calibration of the modified numerical model described in Section 3.0 to be limited to adjustments in the representation and properties of Big Springs and removal of the smaller springs because they were relatively small changes at the scale of this model. The modifications to the model were evaluated as described in this section. The starting model was the original numerical model described in SNWA (2009b).

The location of the Southern Snake Range HFB was changed as shown in Figure 3-1 and a simulation was conducted without any other model modifications. As expected, this resulted in a zero discharge from Big Springs because there was no barrier to force flow from the spring. Several configurations of the stream representing Big Springs were tested as described below.

The first Big Springs configuration tested consisted of extending the stream segment across the Southern Snake Range HFB within model layer 7. This caused the model to simulate some discharge from Big Springs, but not as much as the predevelopment steady-state discharge observed in the field. Increasing the stream conductance increased the discharge rate closer to the observed value. However, unexplained fluctuations occurred in the discharge with time (transient).

Subsequent simulations consisted of extending the stream segment into deeper model layers. Once the segment extended to layer 9 or deeper the fluctuations were eliminated. Deepening the stream segment also increased discharge from Big Springs. Although extending the stream segment to model layers deeper than layer 9 increased the simulated spring flow, the layer 9 configuration was selected to be consistent with the temperature and chemistry of the Big Springs water source. Consequently, this configuration, which simulates discharge of about one-half of the observed discharge at Big Springs, was used in the modified numerical model. It was not possible to simulate a larger spring discharge without additional changes to the numerical model. This fit to the observed discharge is similar to the quality of fit at other intermediate spring locations represented in the model. The modified numerical model files are provided on the DVD under simulation ucth935.

4.2 Calibration Results

The results of the calibrated modified numerical model (ucth935) are presented in terms of model fit and overall groundwater water budget. The results are compared to those of the original numerical model (ucth814), as documented in SNWA (2009b).

4.2.1 Model Fit

A comparison of the overall fit of the two calibrated transient models is made be comparing their SoSWR values. This value increased from 30,772 for the original model (ucth814) to 41,464 for the modified numerical model (ucth935); or an increase of about 35 percent. The detailed statistics for the unweighted observations are presented in Table 4-1.

Table 4-1
Unweighted Observation Statistics for Modified Numerical Model

Observation Type	Unit	Number of Samples	Mean Error	Mean Absolute Error	Root Mean Square Error	Standard Deviation	Target Data Range	RMSE/ Range (%)	Expected Error Size with Increasing Target Size[a]
Boundary Flux	afy	16	1,173	1,707	2,275	2,013	20,000	11	Increasing
Gage Flow[b]	afy	140	255	1,211	1,687	1,674	35,672	5	Increasing
Ground Surface[c]	ft	2,145	-0	0	5	5	---	NA	Constant
Regional ET Discharge	afy	108	-250	1,765	2,908	2,910	69,431	4	Increasing
Spring Flow[d]	afy	29	-1,146	1,293	2,208	1,921	12,833	13	Increasing
Well Drawdown	ft	4,301	-1	4	9	9	238	4	Constant
Well Head	ft	2,707	15	45	92	90	6,461	1	Constant

[a]The error associated with head would be expected to be constant with elevation. The error associated with spring flow would be expected to increase with larger flows.
[b]Ash, Big Springs, Crystal, and Hiko Spring measurements removed from gage statistics.
[c]Because all ground surface measurements were expected to be 0.0 (no mounding), the target data range is 0.0, and RMSE/Range cannot be calculated.
[d]Ash, Big Springs, Crystal, and Hiko Spring measurements added to spring statistics.

A comparison of the statistics of the unweighted residuals calculated as the difference between the original (SNWA, 2009b) and modified numerical models (Figure 4-1) is presented in Table 4-2. As shown in this table. The comparison of the two models is also shown in graphical form displaying the simulated versus observed values (Figure 4-1). This figure shows that the fit of the modified model is essentially identical to the fit of the original model.

4.2.2 Calibrated Parameters

Characteristics of the stream segment used to simulate Big Springs were changed, but no changes were made to other parameters. As the stream segment conductance is unknown, the values used in both models are arbitrary.

As requested by the BLM reviewers, a map of the total transmissivity of the model including the effect of the decrease of horizontal hydraulic conductivity with depth is presented in Figure 4-2.

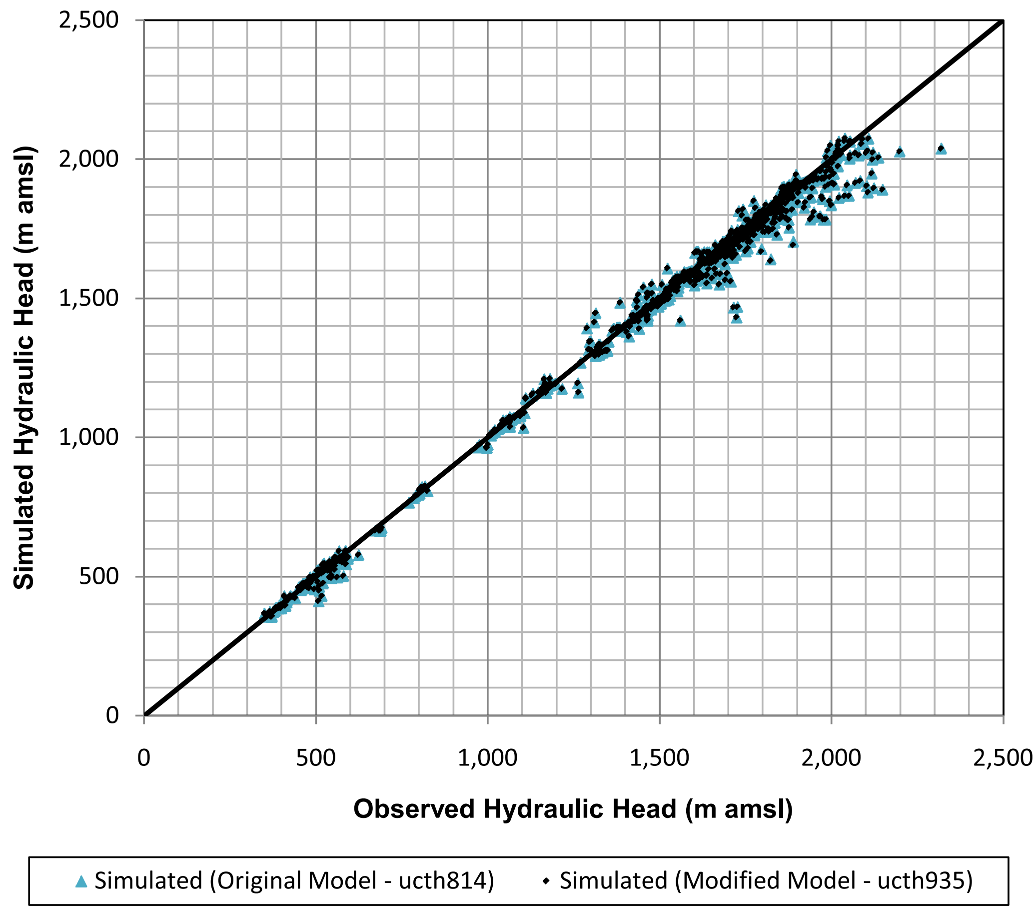

Figure 4-1
Simulated Versus Observed Unweighted Hydraulic Head Values in Original (ucth814)and Modified (ucth935) Numerical Models

Table 4-2
Comparison of Unweighted Observation Statistics for Original and Modified Models

Observation Type	Units	Number of Samples	Mean Error	Mean Absolute Error	Root Mean Square Error	Standard Deviation	Target Data Range	RMSE/ Range
Boundary Flux	afy	---	-4	-4	-2	0	---	---
Gage Flow	afy	---	-0	0	0	0	---	---
Ground Surface	ft	---	-0	0	0	0	---	NA
Regional ET Discharge	afy	---	-0	4	5	5	---	---
Spring Flow	afy	19	461	-477	-543	-387	194	---
Well Drawdown	ft	---	-0	0	0	0	---	---
Well Head	ft	---	-0	-0	-0	-0	---	---

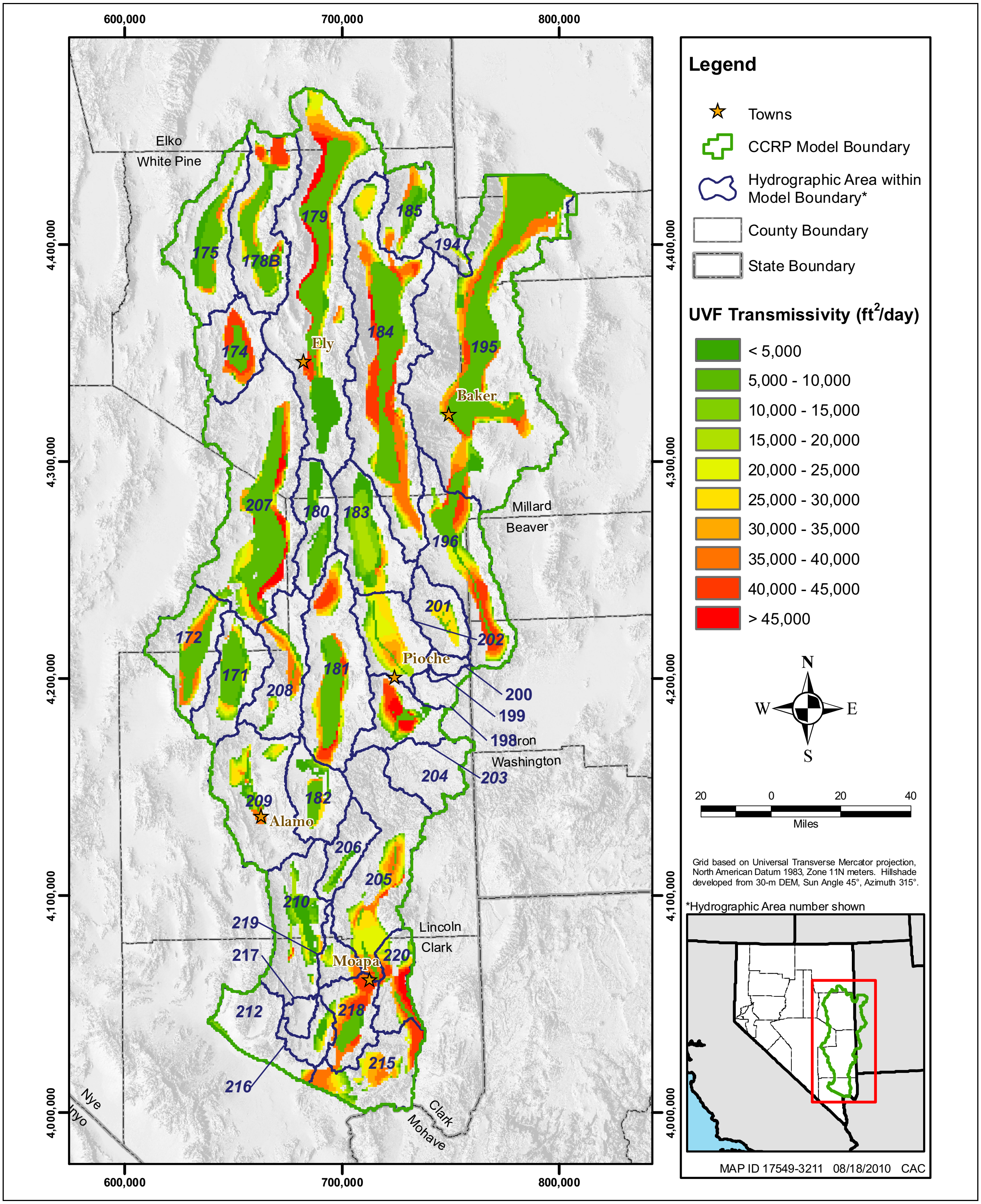

Figure 4-2
Spatial Distribution of Upper-Valley-Fill Transmissivity Simulated by the Modified Numerical Model

4.2.3 Simulated Discharge

The simulated groundwater discharges are the same as in the transient calibrated model (ucth814 in SNWA, 2009b), except in areas affected by the changes made in the Big Spring area. The effects of these changes are mostly noticeable in the water budgets and the spring discharge from Big Springs.

4.2.4 Water Budgets

Water budgets simulated by the modified numerical model (ucth935) for all flow systems and basins in the model area are presented in pdf files located on the DVD. Changes from the original model (ucth814) are presented below.

Water budgets for all basins except the ones located in the Meadow Valley and Great Salt Lake Desert flow systems are the same as in the original numerical model (ucth814 in SNWA, 2009b). For the Meadow Valley flow system, the only changes are in Lake Valley: (1) the net interbasin flow increased by 100 afy from the 5,000 afy simulated by the original model; and (2) the groundwater discharge by ET and springs decreased by 100 afy from the 2,400 afy simulated by the original model. The changes in the Great Salt Lake Desert Flow System are larger. The simulated values for the water budget components of this flow system are presented in Table 4-3. A comparison (Table 4-4) is presented to show the differences between the results of the modified numerical model (ucth935) as compared to the original model (ucth814). As can be seen from Table 4-4, the differences are relatively small. The large absolute change (1,100 afy) occurs in the ET value simulated for Snake Valley. This change represents an increase from the 104,700 afy simulated by the original model (ucth814).

Table 4-3
Simulated Groundwater-Budget Components for the Great Salt Lake Desert Flow System in afy for 2004

HA Number	HA Name	Net Interbasin Flow	Change in Storage	Groundwater Withdrawals	Constant Head	ET and Springs	Recharge	Stream Flow
184	Spring Valley	-5,300	2,000	-5,600	0	-73,700	82,600	0
185	Tippett Valley	-1,600	0	0	-4,200	0	5,700	0
194	Pleasant Valley	-4,400	0	0	0	0	4,400	0
195	Snake Valley	49,500	3,000	-21,600	-31,900	-105,800	106,900	-100
196	Hamlin Valley	-21,500	600	0	0	-200	21,100	0
258	Fish Springs Flat	-2,300	0	0	2,200	0	100	0
	Totals	**14,400**	**5,600**	**-27,200**	**-33,900**	**-179,700**	**220,800**	**-100**

Table 4-4
Comparison Between Water Budget Components as Difference in afy Between Values Simulated by Original (ucth814) and Modified (ucth935) Models

HA Number	HA Name	Net Interbasin Flow	Change in Storage	Groundwater Withdrawals	Constant Head	ET and Springs	Recharge	Stream Flow
184	Spring Valley	400	0	0	0	-400	0	0
185	Tippett Valley	0	0	0	0	0	0	0
194	Pleasant Valley	0	0	0	0	0	0	0
195	Snake Valley	-900	-200	0	100	1,100	0	-100
196	Hamlin Valley	500	0	0	0	-500	0	0
258	Fish Springs Flat	0	0	0	0	0	0	0
	Great Salt Lake Desert Totals	**0**	**-200**	**0**	**100**	**200**	**0**	**-100**

4.2.5 Big Springs Discharge

Input for the two numerical models (original and modified) is the same, except for the HFB in the Big Springs area, the location and properties of the first Big Springs stream segment, and the omission of the inadequately simulated springs. The most significant difference in the calibration is the simulated discharge from Big Springs. Only one observed discharge value is available for this spring: 7,431 afy with an uncertainty range of 6,609 to 8,252 afy. The original numerical model (ucth814) simulated a value of 7,192 afy. The modified numerical model (ucth935) simulated a discharge of only 3,170 afy, a value that is outside of the uncertainty range. Whereas the original model simulated the historical discharge of Big Springs rather closely, the modified model simulates approximately only half of the historical discharge. This fit to the observed discharge is similar to the quality of fit at other intermediate spring locations represented by this regional model.