Fourth Updated Groundwater Flow Model and Predictive Simulation Results Coso Operating Company Hay Ranch Water Extraction and Delivery System Conditional Use Permit (CUP) 2007-003

**Prepared for** 

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A Simulated and Observed Water Levels



# Fourth Updated Groundwater Flow Model and Predictive Simulation Results Coso Operating Company Hay Ranch Water Extraction and Delivery System Conditional Use Permit (CUP) 2007-003

### 1. Introduction

This report documents the fourth updated groundwater flow model completed by Daniel B. Stephens & Associates, Inc. (DBS&A) and predictive simulation results conducted in May 2021 in accordance with the *Addendum to the Hydrologic Monitoring and Mitigation Plan for Conditional Use Permit #2007-003/Coso Operating Company, LLC* (County of Inyo Water Department, 2011). A base map of the Rose Valley area is provided in Figure 1. The groundwater model grid and monitoring and production well locations are provided in Figure 2.

The model update was completed to account for (1) Coso Operating Company (Coso) Hay Ranch pumping that occurred since the model was last updated in 2017, (2) an updated estimate of average groundwater recharge based on observed climatic conditions for the period 2017 through 2020, and (3) an updated estimate of recharge volume and timing resulting from the release of water from Haiwee Reservoir by the Los Angeles Department of Water and Power (LADWP) in March 2017.

The County of Inyo (County) requested that DBS&A update the existing Rose Valley groundwater model, and if necessary adjust the model calibration to account for the observed conditions since the previous model update. Model calibration is conducted to minimize the differences between observed values (i.e., measured groundwater levels and measured flow amounts) and simulated values to the extent possible. The County also requested that the updated model be used to assess if Coso could pump at an average rate of 800 acre-feet per year (ac-ft/yr) from the Coso Hay Ranch production wells for four years, starting from June 2021, without exceeding the criterion of 10 percent reduction of groundwater flow into Little Lake in accordance with the conditions of CUP #2007-003.



## 2. Previous Rose Valley Groundwater Models

The first groundwater model developed by DBS&A is documented in DBS&A (2011). This model was a significant update and recalibration of prior models developed by MHA (2008a and 2008b) and Brown and Caldwell (2006). The model was developed in accordance with Mitigation Measure Hydrology-4 of the Mitigation Monitoring and Reporting Program of CUP #2007-03. The DBS&A (2011) model has been updated several times, as summarized in Table 1. All model updates included extension of the historical simulation period to include metered pumping from the two Coso Hay Ranch production wells; some model updates included adjusted model input parameters to better simulate estimated groundwater inflow to Little Lake and long-term average groundwater recharge.

## 3. Current (2021) Model Update and Recalibration

For the current model, the most recent model (DBS&A, 2017) was updated as follows:

- The historical simulation period was extended to include the period through the end of May 2021. At the time this work was completed, metered pumping for the Coso Hay Ranch wells was available through February 2021. Metered pumping amounts were included in the model through February 2021. For the period March 2021 through May 2021, pumping was assumed to occur at the February 2021 value.
- Average long-term groundwater recharge was updated by calculating recharge for the period 2017 through September 2020. Therefore, the full period of time used to estimate recharge (including recharge modeling documented in past reports) is October 2000 through September 2020. The Distributed Parameter Watershed model (DPWM) was used to calculate the average recharge. DPWM is documented in prior DBS&A reports (e.g., DBS&A, 2011). Average groundwater recharge in the current groundwater flow model is 3,591 ac-ft/yr, which is a slight reduction from the prior estimate of 3,623 ac-ft/yr (DBS&A, 2017).
- LADWP released water from Haiwee Reservoir in March 2017 was updated from 1,812 acre-feet (the value used in DBS&A, 2017) to 3,862 acre-feet (Rainville, 2021a).



Recharge was assumed to equal 50 percent of the released volume of water, as was assumed in DBS&A (2017). The assumed recharge volume of 1,931 acre-feet was assigned in the model over a 4-month period from March through June 2017 (Rainville, 2021b). In DBS&A (2017), the 3-month period from March through May 2017 was used.

The average estimated groundwater inflow to Little Lake for the period 2010 through 2020 is 1,247 ac-ft/yr, with values ranging from one year to another between 1,063 and 1,449 ac-ft/yr (Table 2). The general head boundary (GHB) conductance at the southern end of the model was decreased from 2,625 square feet per day (ft<sup>2</sup>/d) (DBS&A, 2017) to 2,410 ft<sup>2</sup>/d. The current model simulates groundwater inflow of 1,257 ac-ft/yr to Little Lake at the end of 2009, and an average simulated groundwater inflow of 1,247 ac-ft/yr for the 11-year period from 2010 through 2020. These values are similar to estimates of groundwater inflow to Little Lake derived from monitoring data (Table 2).

Steady-state, historical, and predictive simulations were all rerun using the above-listed updates. The model calibration is similar to that in DBS&A (2017), with the root mean squared error (RMSE) of the difference between measured and simulated water levels as of May 2017 at 11.8 feet, slightly higher than the 11.7 feet in DBS&A (2017). Table 3 shows calculated RMSE values from different models and at different times. Appendix A shows plots of the observed and simulated water levels at different monitor wells. The current model calibration is comparable to that of previous models; as such, there was no need to change hydraulic parameters in the model other than the GHB conductance values as described above.

## 4. Predictive Simulations Using the 2021 Updated Model

Predictive simulations were run for the period June 2021 through the end of 2047 using the updated model. Two predictive simulations were conducted, as follows:

• Scenario A: The model was run without any additional pumping from the two Coso Hay Ranch wells.



• Scenario B: The model was run with additional pumping from the southern Hay Ranch well at a rate of 800 ac-ft/yr starting in June 2021 for four years.

The simulated groundwater flow to Little Lake for each scenario is plotted in Figure 3. As indicated in the figure, Scenario A (no future pumping scenario) resulted in a maximum reduction in groundwater inflow to Little Lake (relative to 2009 values) of about 7.7 percent in October 2026. The 7.7 percent reduction is similar to estimate in DBS&A, 2017 under similar scenario of no future pumping at the time. There is continued decline in groundwater outflow to Little Lake under this scenario due to the residual effects of past Coso pumping.

Scenario B, with simulated 800 ac-ft/yr for four years, resulted in a maximum reduction of 8.9 percent in July 2030 (Figure 3). The simulated reduction of 8.9 percent is less than the 10 percent reduction in groundwater outflow criterion.

In addition to the simulation of groundwater flow to Little Lake, Rose Valley monitor well trigger levels were also recalculated based on the updated groundwater flow model for Scenario B (Table 4).

### 5. Summary and Conclusions

The Rose Valley groundwater flow model historical simulation period was extended to include metered Coso pumping through February 2021, recharge estimates through September 2020, and the LADWP release of 3,862 acre-feet along the axis of the valley from Haiwee Reservoir in March 2017. The updated average recharge decreased slightly from 3,623 ac-ft/yr (DBS&A, 2017) to 3,591 ac-ft/yr. Consideration of the updated average groundwater inflow to Little Lake required changes to GHB cell conductance to maintain an appropriate simulated amount of groundwater inflow to Little Lake.

Predictive scenarios were conducted to illustrate the effects of the model changes and to assess whether Coso could pump 800 ac-ft/yr for four years, starting in June 2021. The simulation results indicate that this amount of pumping can occur without exceeding the 10 percent maximum allowable reduction in groundwater outflow to Little Lake. Updated trigger



levels for the Hay Ranch project monitor wells were also computed using the updated model and the assumed pumping of 800 ac-ft/yr.

## References

- Brown and Caldwell. 2006. *Rose Valley groundwater model, Coso Operating Company, LLC, Rose Valley, California*. Prepared for Coso Operating Company, LLC, Coso Junction, California. Project Number 129778.001. April 10, 2006.
- County of Inyo Water Department. 2011. Addendum to the hydrologic monitoring and mitigation plan for Conditional Use Permit #2007-003/Coso Operating Company, LLC. April 1, 2011.
- Daniel B. Stephens & Associates, Inc. (DBS&A). 2011. Revised groundwater flow model and predictive simulation results, Coso Operating Company, Hay Ranch Water Extraction and Delivery System, Conditional Use Permit (CUP 2007-003). Prepared for County of Inyo, Independence, California.
- DBS&A. 2013. Updated groundwater flow model and predictive simulation results, Coso Operating Company, Hay Ranch Water Extraction and Delivery System, Conditional Use Permit (CUP) 2007-003. Prepared for County of Inyo, Independence, California.
- DBS&A. 2014. Second updated groundwater flow model and predictive simulation results, Coso Operating Company Hay Ranch water extraction and delivery system, Conditional use permit (CUP) 2007-003. Prepared for the County of Inyo, Independence California. June 27, 2014.
- DBS&A. 2017. Third updated groundwater flow model and predictive simulation results, Coso Operating Company Hay Ranch water extraction and delivery system, Conditional use permit (CUP) 2007-003. Prepared for the County of Inyo, Independence California. August 24, 2017.



- MHA Environmental Consulting (MHA). 2008a. Coso Operating Company Hay Ranch water extraction and delivery system, Conditional use permit (CUP 2007-003) application, SCH#2007101002, Draft EIR, Inyo County, California. Prepared for Inyo County Planning Department, Independence, California. July 2008.
- MHA. 2008b. Coso Operating Company Hay Ranch water extraction and delivery system, Conditional use permit (CUP 2007-003) application, SCH#2007101002, Final EIR, Inyo County, California. Prepared for Inyo County Planning Department, Independence, California. December 2008.
- Rainville. 2020a. E-mail from Keith Rainville, Inyo County Water Department, to Neil Blandford, DBS&A. February 18, 2021.
- Rainville. 2020b. E-mail from Keith Rainville, Inyo County Water Department, to Neil Blandford, DBS&A. April 15, 2021.

Figures







Figure 3

Tables



#### Table 1. Previous DBS&A Rose Valley Groundwater Models

Model	Major Features and Updates	Model Calibration
DBS&A (2011)	Original model. Long-term average groundwater recharge was estimated using climatic data for the period 2000 through 2009. Recharge estimate was 4,455 ac-ft/yr.	Original model calibration
DBS&A (2013)	Estimated groundwater recharge was updated using climatic data for the period 2000 through 2012. This resulted in updated recharge estimate of 4,001 ac-ft/yr. Conductance of the GHB model cells at the southern end of the model was decreased from 26,400 ft <sup>2</sup> /d to 15,000 ft <sup>2</sup> /d.	Similar but deteriorated model calibration statistics compared to DBS&A (2011)
DBS&A (2014)	The estimated average groundwater inflow to Little Lake for the period 2010 through 2013 was updated based on monitoring data. The updated estimate was 1,256 ac-ft/yr; the original estimate in DBS&A (2011) was 918 ac-ft/yr. Conductance of GHB model cells at the southern end of the model was decreased from 15,000 ft <sup>2</sup> /d to 4,125 ft <sup>2</sup> /d to better match estimated groundwater inflow to Little Lake.	Slightly improved model calibration relative to DBS&A (2013), but slightly deteriorated calibration relative to DBS&A (2011)
DBS&A (2016)	The DBS&A (2014) model was extended to June 2016 by adding metered pumping from the two Hay Ranch production wells. This model update was not documented in a formal report. Estimated groundwater recharge was not updated.	Same as DBS&A (2014)
DBS&A (2017)	<ul> <li>The DBS&amp;A (2014) model was extended to May 2017 by adding metered pumping from the two Hay Ranch production wells. Estimated groundwater recharge was updated to represent the average estimate from 2000 through 2017. The updated recharge dropped from 4,001 to 3,623 ac-ft/yr.</li> <li>Conductance of GHB model cells at the southern end of the model was decreased from 4,125 ft<sup>2</sup>/d to 2,625 ft<sup>2</sup>/d to better match estimated groundwater inflow to Little Lake.</li> <li>50 percent of LADWP release of 1,812 ac-ft from Haiwee Reservoir in March 2017 through May 2017.</li> </ul>	Similar to DBS&A (2014)

GHB= General head boundaryft²/d= Square feet per dayac-ft/yr= Acre-feet per yearLADWP= Los Angeles Department of Water and Power



Date Range	Little Lake Sta Start of Period	age (feet msl) End of Period	Change in Stage (feet)	Change in Little Lake Storage <sup>a</sup> (acre-feet)	Flow at North Culvert <sup>b</sup> (acre-feet)	Precipitation at Haiwee <sup>°</sup> , 11/01–10/31 (feet)	Evaporation, 11/01–10/31 (feet)	Groundwater Inflow to Little Lake <sup>d</sup> (ac-ft/yr)
11/1/2009-10/31/2010	3,147.23	3,147.19	-0.04	-3.6	754	0.68	6.09	1,265
11/1/2010-10/31/2011	3,147.19	3,147.11	-0.08	-7.2	791	0.70	6.09	1,296
11/1/2011–10/31/2012	3,147.11	3,146.97	-0.14	-12.5	743	0.25	6.09	1,285
11/1/2012-10/31/2013	3,146.97	3,147.07	0.10	8.9	610	0.07	6.09	1,190
11/1/2013–10/31/2014	3,147.07	3,146.83	-0.24	-21.8	754	0.23	6.09	1,289
11/1/2014–10/31/2015	3,146.83	3,147.17	0.34	30.4	590	0.33	6.09	1,168
11/1/2015–10/31/2016	3,147.17	3,146.60	-0.57	-51.2	738	0.19	6.09	1,247
11/1/2016–10/31/2017	3,146.60	3,146.86	0.26	23.6	692	1.02	6.09	1,197
11/1/2017–10/31/2018	3,146.86	3,146.73	-0.13	-11.5	531	0.36	6.09	1,063
11/1/2018–10/31/2019	3,146.76	3,147.02	0.26	23.4	742	0.84	6.09	1,264
11/1/2019-10/31/2020	3,147.03	3,146.30	-0.73	-65.7	995	0.62	6.09	1,449
Mean								1,247

#### Table 2. Estimated Groundwater Inflow to Little Lake

<sup>a</sup> Little Lake acreage assumed to be 90 acres, acreage of the two ponds assumed to be 5 acres. Change in lake storage is change in lake stage multiplied by 90 acres; negative storage corresponds to drop in lake stage. <sup>b</sup> North Culvert outflow from daily average values at flume.

<sup>c</sup> Precipitation from the LADWP station at Haiwee.

<sup>d</sup> Groundwater inflow to LLR area = Change in Storage + North Culvert Flow +(Evaporation – Precipitation) \* 95

= Above mean sea level msl

ac-ft/yr = Acre-feet per year



	Root Mean Square Error					
Calculation Date	DBS&A (2011)	DBS&A (2013)	DBS&A (2014)	DBS&A (2016)	DBS&A (2017)	DBS&A (2021)
December 2009	8.23	9.66	9.45	9.45	9.23	9.59
September 2010	11.06	10.74	10.68	10.68	10.99	11.16
May 2013	—	13.16	13.07	13.07	13.09	13.31
May 2014	—	_	11.33	11.33	11.46	11.69
February 2016	—	—	—	12.42	12.49	12.79
May 2017	—	—	—	—	11.70	11.80

#### Table 3. Root Mean Square Error for DBS&A Rose Valley Groundwater Models

	Scenario B (Pumping 800 ac-ft/yr for four years)			
Monitor Well	Maximum Acceptable Drawdown (feet)	Date of Maximum Acceptable Drawdown (years since pumping began)	Drawdown at Cessation of Pumping (feet)	
Dunmovin Well (RV040)	21.3	Oct-2013 (3.9)	12.6	
Cal Pumice Well (RV030)	22.5	Oct-2013 (3.9)	12.6	
HR1 Shallow Cluster Well (RV060)	24.2	Aug-2013 (3.7)	14.7	
HR2 Shallow Cluster Well (RV080)	17.6	Mar-2012 (2.3)	13.6	
Coso Junction Ranch Well (RV090)	9.4	Aug-2016 (6.7)	8.3	
Coso Junction Store #1 Well (RV100)	8.4	Oct-2016 (6.9)	7.6	
Red Hill Well (RV120)	3.5	Nov-2026 (16.9)	3.4	
Well G36 (RV130)	3.1	Oct-2027 (17.9)	3.0	
Lego Well (RV140)	2.5	Feb-2031 (21.2)	2.1	
Cinder Road Well (RV150)	2.2	Jan-2029 (19.1)	2.0	
Well 18-28 GTH (RV160)	2.1	Feb-2030 (20.2)	1.9	
Little Lake North Well (RV180)	1.3	Mar-2030 (20.3)	1.1	

#### Table 4. Predictive Simulation Results

*Italics* indicate that maximum drawdown has already occurred.

Appendix A

Simulated and Observed Water Levels





































