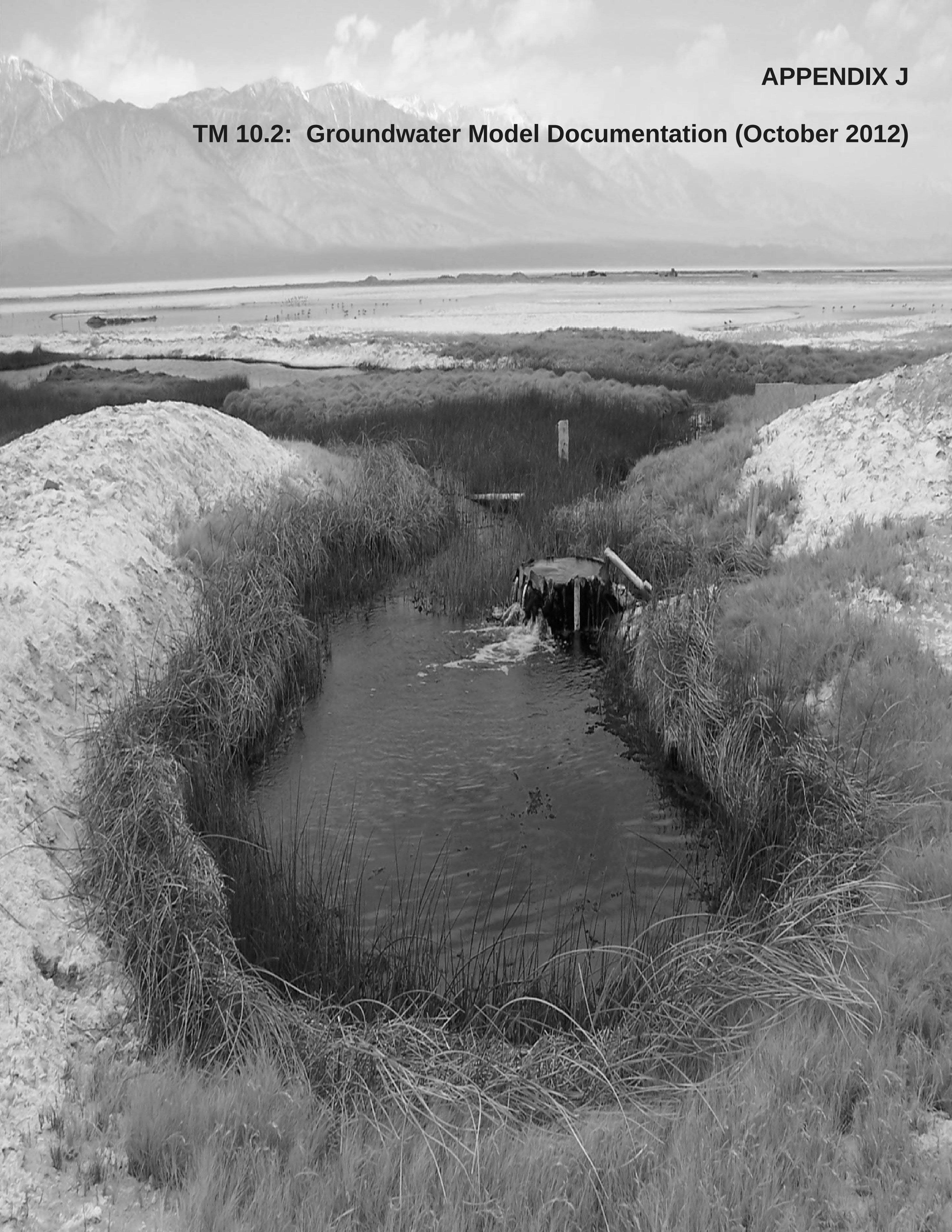
APPENDIX J

TM 10.2: Groundwater Model Documentation (October 2012)



TM 401.10.2 – Final OLGEP Groundwater Model Documentation

List of Attachments

ATTACHMENT A

Sensitivity of Constant Head Assumption for Brine Pool

TECHNICAL MEMORANDUM

TO:	*OLGEP Project Team*	DATE:	*October, 2012*
FROM:	*MWH*	REFERENCE:	
SUBJECT:	*Sensitivity of Constant Head Assumption for Brine Pool*		

Introduction

The size of the Brine Pool varies over time as a function of the variation of runoff. Within the OLGEP groundwater model, a constant head condition has been assumed. Questions have arisen over the reasonableness of this assumption. A constant head can create unrealistic modeling conditions because a constant head boundary condition can create an infinite source of water within a model. Alternatively a constant head can also remove water from a system at an unreasonable rate, e.g., an unrealistic evaporation rate. To determine if a time-varying head condition would be more appropriate for the OLGEP model, a sensitivity analysis was completed. This sensitivity analysis evaluated the impacts of changing the Brine Pool cells in the OLGEP model from constant head boundaries to the Drain and Evapotranspiration (ET) package boundary condition (similar to the Owens Lake Playa).

Assumption and Methodology

MWH investigated the variability in the size of the Brine Pool by reviewing historical aerial photos from the 1980's to present as well as information on the Brine Pool size as documented by Lopes (1988). Aerial photos that illustrate recent extremes in Brine Pool size are shown in **Figure 1** and **Figure 2. Figure 1** shows a large Brine Pool in August of 2005; the area is approximately 19,500 acres. **Figure 2** shows the Brine Pool essentially empty four months later. **Figure 3** shows the change in Brine Pool area and change in Brine Pool surface elevation from 1939 to 1980. From these date, the following conclusions can be made:

- There can be significant changes in the area of the Brine Pool in short periods of time
- Historically and recently, the Brine Pool area varies significantly
- Over the record of published data between 1939 and 1980, the Brine Pool area varied from 0 to almost 30,000 acres
- Over the same period, the elevation varied only 3.5 feet. A small change in elevation can have a large effect on the area of the Brine Pool.

If water levels in the underlying aquifers in the model area are sensitive to the elevation and size of the Brine Pool the constant head boundary condition may not be the most accurate method to model the Brine Pool. To test this MWH conducted two simulations, one with the Brine Pool at a constant head boundary condition and a second with the Brine Pool assumed to be dry and a drain and ET boundary condition applied. With the Brine Pool using a constant head boundary condition, it is analogous to a pool of standing water. The constant head boundary can add or remove water from the system to remain constant.

Figure 1
Owens Lake Brine Pool, August 2005 (Google Earth, 2012a)

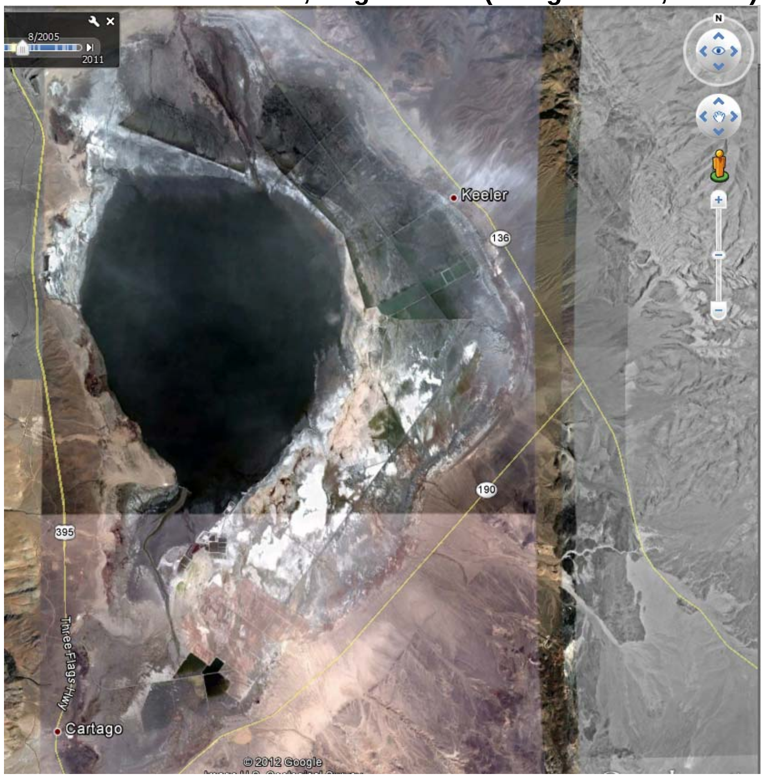


Figure 2
Owens Lake Brine Pool, December 2005 (Google Earth, 2012b)

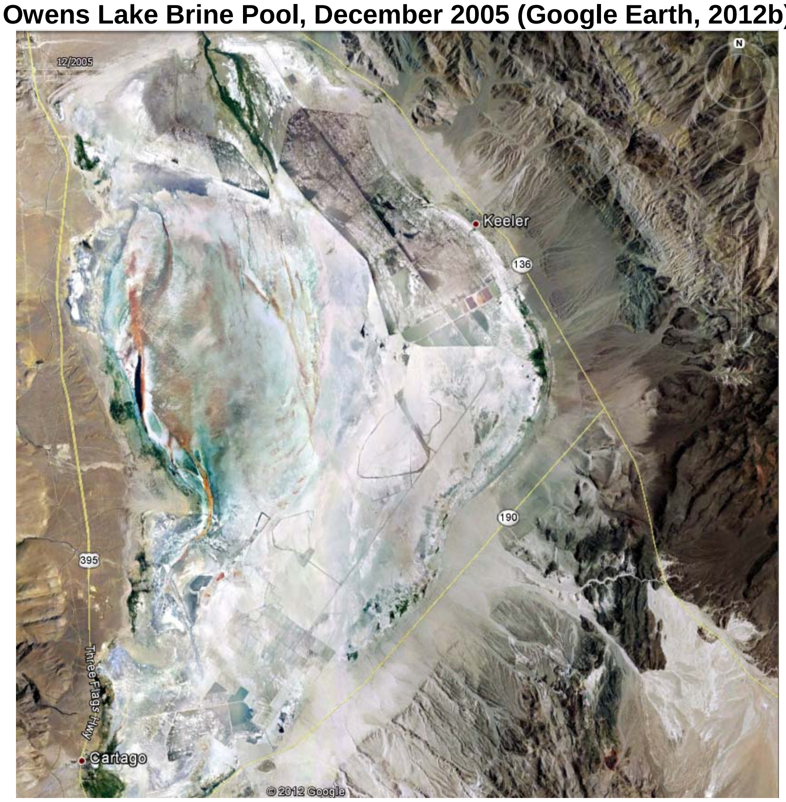
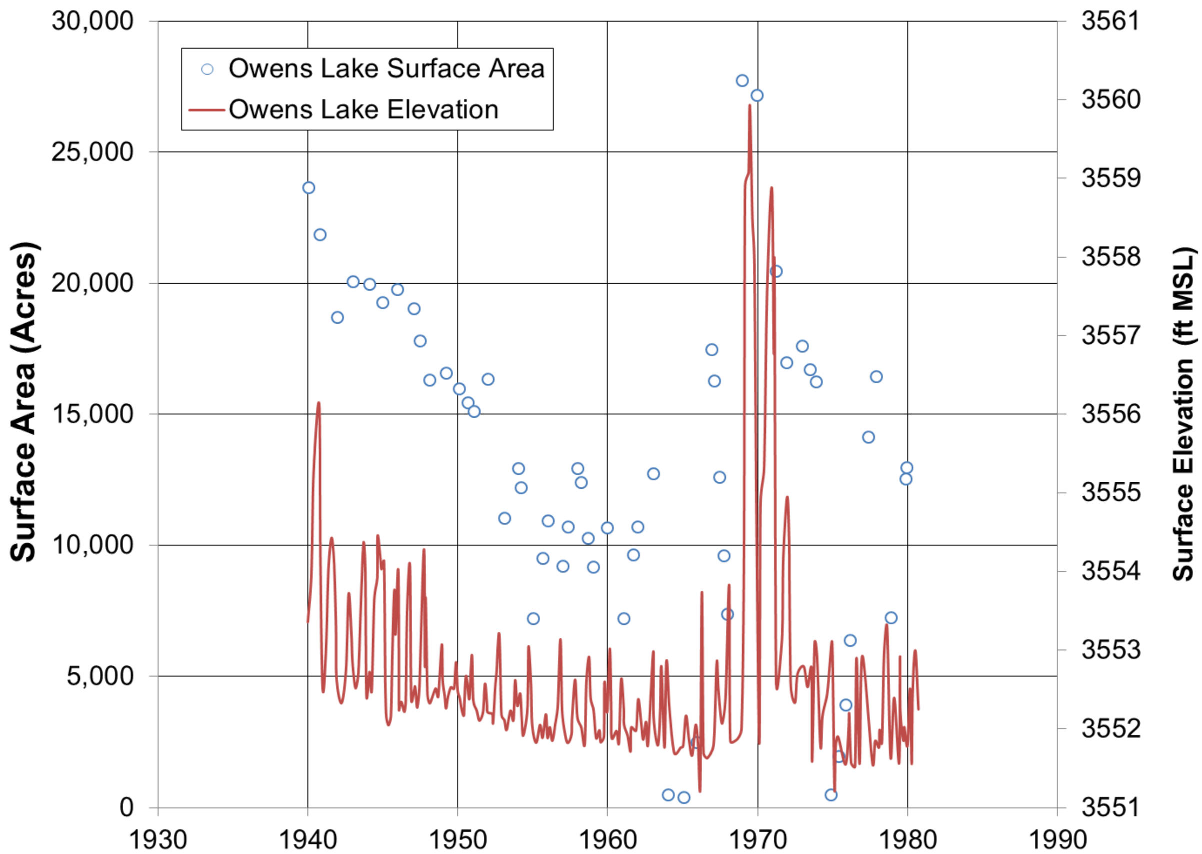


Figure 3
Mean Annual Owens Lake Surface Area and Elevation from 1939-1980 (Lopes 1988)



With a Drain and ET boundary condition, it is similar to a dry Brine Pool that can discharge groundwater if the hydraulic head is above the ground surface or ET extinction depth. This boundary condition is the same that was applied to the Owens Lake Playa. Once the two simulations were conducted, the hydraulic head values were compared at several points.

When assuming the Brine Pool as a constant head, a constant head value of 3552.6 feet above mean sea level (average historical elevation) was used for a model simulation.

For the second simulation, the constant head boundary was replaced with drains and ET which allow the water in the Brine Pool to fall below the constant head value (evaporate) of 3,552.6 feet mean sea level, and allows the storage in the Brine Pool to reach the elevation of the drains (ground surface). The model was run for a one year time period with 12 stress periods to observe the differences in head values in in different model layers.

Results

The maximum difference between head values at various well locations are listed below in **Table 1**.

The observation locations that one would expect the greatest sensitivity are adjacent to the Brine Pool. The wells closest to the Brine Pool were the OLSAC Wells, M8(6), and N7(8). These wells had the largest difference from the baseline run with a maximum at about 0.2 feet difference at N7(8).

Removing the constant head boundary and inserting drains and ET created minor head changes throughout the model. The greatest head change is in layer 1, is 0.2 feet. Head changes below layer 1 were all less than 0.2 feet. The model is not sensitive to this change.

These results indicate that if the Brine Pool were to vary in size with time and was simulated with the constant head method, the model results for hydraulic head would not vary significantly. This replicates how the physical system behaves with little changes in groundwater level and large changes in Brine Pool size (MWH, 2011). This indicates that the Brine Pool acts as a separate hydraulic system, as the noted in the conceptual model report (MWH, 2011) and the groundwater system is not sensitive to this boundary condition. Therefore, using the constant head boundary condition that does not vary in size to simulate the Brine Pool is appropriate.

Table 1
Maximum Head Difference between Constant Head (average Bring Pool) Simulation and Drain/ET Boundary Condition (no Brine Pool) Simulation

Model Layer	Well Name	Maximum Head Difference (ft)
11	FTS T1	-0.03
9	Star Trek	-0.05
8	Mill Site Lower	-0.04
7	DVF North Lower	-0.03
5	River Site Lower	-0.05
4	Keeler Swansea Middle	-0.02
3	Keeler Swansea Upper	-0.01
2	Mill Site Upper	-0.04
2	OLSAC MW-1	-0.16
2	OLSAC MW-2S	-0.16
2	OLSAC MW-2D	-0.16
1	Keeler CSD	0.00
1	T347	0.00
1	T348	0.00
1	T349	0.00
1	OLSAC P-1	-0.13
1	OLSAC P-2	-0.12
1	OLSAC P-3	-0.10
1	OLSAC P-4	-0.14
1	OLSAC PPG	-0.14
1	K10(6) 30ft	0.04
1	L9(4) 30ft	0.05
1	M8(6) 30ft	0.17
1	N7(8) 30ft	0.27
1	O6(7) 30ft	0.12
1	P5(7) 30ft	0.00
1	C5(1) 10ft	0.00
1	D.5(1) 10ft	-0.01
1	D.5(2) 10ft	0.00
1	D.5(4) 10ft	0.00
1	D.5(7) 10ft	0.00
1	DELTA East(1) 10ft	0.01
1	DELTA East (3) 10ft	0.02
1	DELTA West(1) 10ft	0.00
1	DELTA West(3) 10ft	0.01
1	F(1) 10ft	-0.01
1	F(3) 10ft	0.00
1	F(5) 10ft	0.00

References

Google Earth, 2012a. Owens Lake, 36° 22’ 29’’ North and 117° 57’ 06’’ East. December 2005. August 2012.

Google Earth, 2012b. Owens Lake, 36° 22’ 29’’ North and 117° 57’ 06’’ East. August 2005. August 2012.

Lopes, 1988. Hydrology and Water Budget of Owens Lake, California, Desert Research Institute, Water Resources Center, Publication #41107, Reno, NV.

MWH, 2011. Updated Conceptual Model Report - Task 401.1.4. November.

ATTACHMENT B

Specific Storage Review

TECHNICAL MEMORANDUM

TO: *OLGEP Project Team*

DATE: *October, 2012*

FROM: *MWH Team*

REFERENCE:

SUBJECT: *Specific Storage Review*

INTRODUCTION

During transient simulations, the storage parameters (specific yield for layer 1 and specific storage for other layers) are important parameters as they characterize the capacity of an aquifer to release groundwater. These parameters thereby have a significant impact on hydraulic head in a numerical model under transient conditions. The storage coefficient is the product of the specific storage and the thickness of the aquifer. Because the thickness of the aquifer is established in a groundwater model, only the specific storage is entered in the model. This memorandum focuses on the specific storage of the deeper (deeper than layer 1 in the OLGEP model) aquifers. The specific storage of a confined aquifer is defined as the volume of water released from storage from a unit volume of aquifer for each unit decline in hydraulic head.

There is little available field information to characterize specific storage, but there is high sensitivity of the model results related to these parameters. This memo provides a summary published values and those used in the model.

PUBLISHED SPECIFIC STORAGE VALUES

MWH assumed the specific storage values based on published literature values. The specific storage is related to the compressibility of the aquifer and water and as shown below:

$$S_s = \rho w g \, (\alpha + n\beta)$$

Where S_s is the specific storage, ρw is the density of water (typically 1000 kg/m^3), g is gravity, α is the compressibility of porous media, n is the effective porosity (approximately 0.5 for clay), and β is the compressibility of water (typically 4.4×10^{-10} m-s^2/kg).

Younger (1993) presented typical order of magnitude values for the compressibility of porous material, indicating the compressibility of clay was 10^{-6} m-s^2/kg (Pa^{-1}). Freeze and Cherry (1979) suggests the typical range of the compressibility of clay is 10^{-6} to 10^{-8} Pa^{-1}. Based on these assumptions, the specific storage of clay ranges from 3×10^{-2} to 3×10^{-4} ft^{-1}.

Table 1 lists published values of specific storage for various geologic materials. Konikow and Neuzil (2007) have developed a chart (**Figure 1**) illustrating the likely range of specific storage for aquitard materials. Specific storage typically ranges from 1.5×10^{-5} ft^{-1} to 6×10^{-3} ft^{-1} for permeable material. These values typically vary from high values for soft clays (6×10^{-3} ft^{-1}), to stiff clays, to sands and rock ($<1 \times 10^{-6}$ ft^{-1}). Assuming the same thickness, the specific storage varies primarily as a function of compressibility.

Table 1
Specific Storage for Various Materials[1]

Material	S_s (ft^{-1})
Plastic Clay	$7.8x10^{-4}$ to $6.2x10^{-3}$
Stiff Clay	$3.9x10^{-4}$ to $7.8x10^{-4}$
Medium Hard Clay	$2.8x10^{-4}$ to $3.9x10^{-4}$
Loose Sand	$1.5x10^{-4}$ to $3.1x10^{-4}$
Dense Sand	$3.9x10^{-4}$ to $6.2x10^{-5}$
Dense Sandy Gravel	$1.5x10^{-5}$ to $3.1x10^{-5}$
Rock, Fissured	$1.0x10^{-6}$ to $2.1x10^{-5}$
Rock, Sound	$<1.0x10^{-6}$

1. (Domenico and Mifflin 1965 as reported in Batu 1998)

According to Konikow and Neuzil (2007), there is a “generalized relationship” between the over consolidated and normally consolidated clayey confining layers.

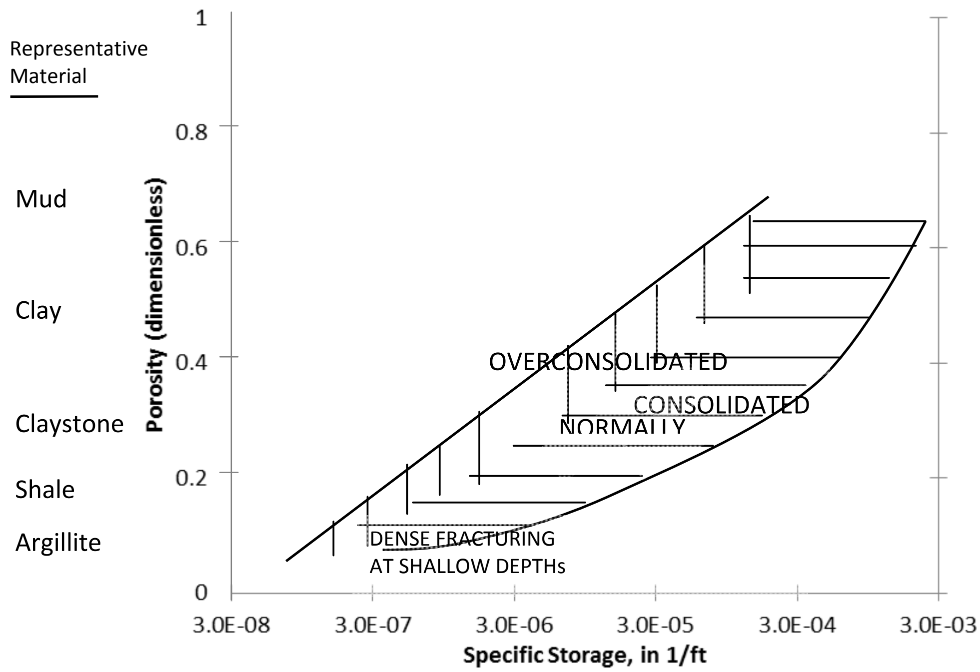


Figure 1
Specific Storage Values for Various Materials

GROUNDWATER MODELS AND STORAGE PARAMETERS

MODFLOW 2000 and MODFLOW 2005 require the user to enter specific storage, as does GMS (MODFLOW pre-processor used for the OLGEP model). The storage coefficient in a confined layer is then computed for each cell by multiplying specific storage by the layer thickness.

OLGEP MODEL AND PUBLISHED STORAGE PARAMETERS

Reviewing the published values for the specific storage of various materials and the equation of specific storage above, MWH used these specific storage values for guidance to parameterize layers of the model. Ultimately the specific storage values were determined during the calibration process and then rechecked against published values. **Table 2** lists the model zone identifier, model layer, and storage parameter used in the model. Model parameters zones are shown on **Figure 2** through **Figure 13** of in the OLGEP model Documentation Report (MWH, 2012).

Layer 1 is an unconfined aquifer and uses specific yield for a storage parameter. All other layers are considered confined and use specific storage. The minimum specific storage used in the model is 1.0×10^{-9} ft^{-1} and represents bedrock or a no flow cell in layers 9 through 12. The zones below the Brine Pool consisting of fines typically have a specific storage near between 1×10^{-4} and 1×10^{-5} ft^{-1}. In areas of a coarser aquifer material, specific storage ranges from 1×10^{-5} to 1×10^{-7} ft^{-1} (immediately adjacent to the Alabama Hills). **Table 3** lists the published specific storage values in relation to model values and conceptual hydrostratigraphic layers. The model values are within the range of published data.

Table 2
OLGEP Model Storage Parameter Summary

Name	Layer	Specfic Storage (1/ft)	Specific Yield [-]
L1-1	1	NA	0.12
L1-2	1	NA	0.20
L1-3	1	NA	0.20
L1-4	1	NA	0.10
L1-5	1	NA	0.20
L1-6	1	NA	0.10
L1-7	1	NA	0.02
L1-8	1	NA	0.15
L1-9	1	NA	0.10
L1-10	1	NA	0.12
L1-11	1	NA	0.02
L1-12	1	NA	0.30
L1-13	1	NA	0.30
L1-14	1	NA	0.20
L1-15	1	NA	0.20
L1-16	1	NA	0.20
L1-17	1	NA	0.30
L1-18	1	NA	0.30
L1-19	1	NA	0.30
L1-20	1	NA	0.20
L1-21	1	NA	0.20
L1-22	1	NA	0.30
L2-1	2	1.00E-04	NA
L2-2	2	1.00E-04	NA
L2-3	2	5.00E-04	NA
L2-4	2	1.00E-04	NA
L2-5	2	1.00E-04	NA
L2-6	2	5.00E-04	NA
L2-7	2	1.00E-05	NA
L2-8	2	1.00E-05	NA
L2-9	2	1.00E-05	NA
L2-10	2	1.00E-05	NA
L2-11	2	2.50E-06	NA
L2-12	2	1.00E-06	NA
L2-13	2	1.00E-05	NA
L2-14	2	1.00E-05	NA
L2-15	2	1.00E-05	NA
L3-1	3	1.00E-04	NA
L3-2	3	1.00E-04	NA
L3-3	3	1.00E-04	NA
L3-4	3	1.00E-04	NA
L3-5	3	1.00E-07	NA
L3-6	3	1.00E-05	NA
L3-7	3	1.00E-04	NA
L3-8	3	1.00E-04	NA
L3-9	3	1.00E-04	NA
L3-10	3	1.00E-05	NA
L3-11	3	1.00E-05	NA
L3-12	3	5.00E-05	NA
L3-13	3	1.00E-07	NA
L3-14	3	5.00E-06	NA
L3-15	3	2.50E-06	NA
L3-16	3	1.00E-06	NA
L3-17	3	1.00E-06	NA
L3-18	3	1.00E-06	NA
L3-19	3	1.00E-06	NA
L4-1	4	1.00E-05	NA
L4-2	4	1.00E-05	NA
L4-3	4	1.00E-04	NA
L4-4	4	1.00E-05	NA
L4-5	4	1.00E-04	NA
L4-6	4	1.00E-05	NA
L4-7	4	1.00E-04	NA
L4-8	4	1.00E-05	NA
L4-9	4	1.00E-05	NA
L4-10	4	1.00E-05	NA
L4-11	4	1.00E-06	NA
L4-12	4	2.50E-06	NA
L4-13	4	1.00E-06	NA
L4-14	4	1.00E-06	NA
L4-15	4	1.00E-06	NA
L5_1	5	1.00E-05	NA
L5_2	5	1.00E-04	NA
L5_3	5	8.00E-05	NA
L5_4	5	1.00E-04	NA
L5_5	5	1.00E-05	NA
L5_6	5	1.00E-04	NA
L5_7	5	1.00E-04	NA
L5_8	5	1.00E-04	NA
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L5_11	5	1.00E-06	NA
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L5_16	5	1.00E-06	NA
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L6-2	6	1.00E-05	NA
L6-3	6	1.00E-06	NA
L6-4	6	1.00E-05	NA
L6-5	6	1.00E-04	NA
L6-6	6	1.00E-06	NA
L6-7	6	1.00E-04	NA
L6-8	6	1.00E-05	NA
L6-9	6	1.00E-04	NA
L6-10	6	1.00E-05	NA
L6-11	6	1.00E-06	NA
L6_12	6	2.50E-06	NA
L6_13	6	1.00E-06	NA
L6_14	6	1.00E-05	NA
L6_15	6	1.00E-06	NA
L7-1	7	3.20E-05	NA
L7-2	7	1.00E-04	NA
L7-3	7	1.00E-04	NA
L7-4	7	3.00E-06	NA
L7-5	7	1.00E-04	NA
L7-6	7	1.00E-04	NA
L7-7	7	1.00E-04	NA
L7-8	7	1.00E-04	NA
L7-9	7	1.00E-04	NA
L7-10	7	1.00E-05	NA
L7-11	7	1.00E-05	NA
L7-12	7	1.00E-06	NA
L7_13	7	2.50E-06	NA
L7_14	7	1.00E-06	NA
L7_15	7	1.00E-07	NA
L7_16	7	1.00E-05	NA
L7_17	7	1.00E-06	NA
L8-1	8	1.00E-05	NA
L8-2	8	1.00E-05	NA
L8-3	8	1.00E-04	NA
L8-4	8	1.00E-06	NA
L8-5	8	1.00E-04	NA
L8-6	8	1.00E-05	NA
L8-7	8	1.00E-04	NA
L8-8	8	1.00E-06	NA
L8-9	8	1.00E-07	NA
L8-10	8	1.00E-05	NA
L8-11	8	1.00E-05	NA
L8-12	8	1.00E-05	NA
L9-1	9	1.00E-04	NA
L9-2	9	1.00E-04	NA
L9-3	9	1.00E-05	NA
L9-4	9	1.00E-05	NA
L9-5	9	1.00E-04	NA
L9-6	9	1.00E-04	NA
L9-7	9	1.00E-04	NA
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L10-4	10	1.00E-05	NA
L10-5	10	1.00E-05	NA
L10-6	10	1.00E-05	NA
L10-7	10	1.00E-05	NA
L10-8	10	1.00E-05	NA
L10-9	10	1.00E-09	NA
L11-1	11	1.00E-05	NA
L11-2	11	1.00E-05	NA
L11_3	11	1.00E-05	NA
L11_4	11	1.00E-05	NA
L11_5	11	1.00E-05	NA
L11_6	11	1.00E-05	NA
L11_7	11	1.00E-09	NA
L11_8	11	1.00E-05	NA
L12_1	12	1.00E-05	NA
L12_2	12	1.00E-05	NA
L12_3	12	1.00E-09	NA
L12_4	12	1.00E-05	NA

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Table 3
Specific Storage Published and Model Values for General Hydrostratigraphy Various Materials

Material	Published S_s (ft^{-1})[1]	Model S_s (ft^{-1})	Model Example[2]	Hydrostratigraphy
Stiff Clay	$3.9x10^{-4}$ to $7.8x10^{-4}$	5.0×10^{-4}	L2-6	Confining Layer
Silty Clayey Sand		1.0×10^{-4}	L3-4	Semi-Aquifer
Dense Sand	$3.9x10^{-4}$ to $6.2x10^{-5}$	1.0×10^{-4}	L3-2, L3-7, L3-9	Aquifer
Dense Sandy Gravel	$1.5x10^{-5}$ to $3.1x10^{-5}$	3.2×10^{-5}	L7-1	Aquifer
		1.0×10^{-5}	L2-7, L2-8, L2-9	Aquifer
Rock, Sound	$<1.0x10^{-6}$	1.0×10^{-9}	L9-12, L10-9, L11-7	Bedrock

1. Domenico and Mifflin 1965 as reported in Batu 1998
2. Model parameters zones are shown on Figure 2 through Figure 13 of in the OLGEP Model Documentation Report (MWH, 2012)

References:

Domenico, P.A. and M.D. Mifflin, 1965. Water from low-permeability sediments and land subsidence, Water Resources Research, vol. 1, no. 4., pp. 563-576

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ATTACHMENT C

Evapotranspiration and Drain Discharge Documentation

TECHNICAL MEMORANDUM

MWH
BUILDING A BETTER WORLD

TO:	*OLGEP Project Team*	DATE:	*October, 2012*
FROM:	*MWH*	REFERENCE:	
SUBJECT:	*Evapotranspiration and Drain Discharge Documentation*		

Purpose

During review of model results and assumptions, the Blue Ribbon Panel suggested that each of the model cells in the model where ET and drains existed, the discharge from these cells should be documented and check to make sure they are reasonable. The purpose of this memorandum is to review evapotranspiration (ET) assumptions for OLGEP model and check model discharge rates from ET and drains to determine if they are reasonable. In this context, reasonableness considers the total rate of discharge and the location of discharge.

Model Assumptions:

The groundwater discharge to the ground surface (seep, evaporation, transpiration) is represented by the drain and ET MODFLOW packages. The drain and ET packages have similarities. The ET package allows the user to specify maximum ET and the drain package allows control of discharge via the conductance term. The ET package allows discharge to occur when the water table is below the surface, which closely represents field conditions. The drain package was used to simulate surface discharge of groundwater that occurs when the hydraulic head is above ground surface.

ET rates applied in the OLGEP model are based in part upon values estimated by Tyler et al. (1997) for three zones in the Owens Lake area (**Table 1**). North of the Owens Lake, the ET developed for the Southern Model was applied. This work is documented in the Southern Model documentation report (MWH, 2010) for the Lone Pine Area.

Table 1
ET Rates Reported by Tyler et al. (1997)

Area Dominated by	ET Rate			
	(mm/yr)	(ft/day)	(in/yr)	(AF/ac/yr)
Wetlands	899	0.00802	35.4	2.92
Clay	104	0.00090	3.9	0.32
Sand	88	0.00080	3.5	0.29

Figure 1 illustrates the zones where differing rates were applied. Areas with depth to water greater than 30 feet are assumed to have no ET. Wetland areas were identified on a case by case basis based upon prior documentation and/or aerial photo review.

Drains remove water from the groundwater system depending on the head gradient between the drain elevation and groundwater system. The flow is calculated based on the gradient and a conductance term. Drains were used in all cells within the historic shoreline (except for the brine pool) as well as wetland-dominated areas. Drains were used in layer 1 of the model within the historical shoreline and within wetland dominated areas. Drains were also used in layers 2, 3, and 5 for deep sourced springs or artesian wells.

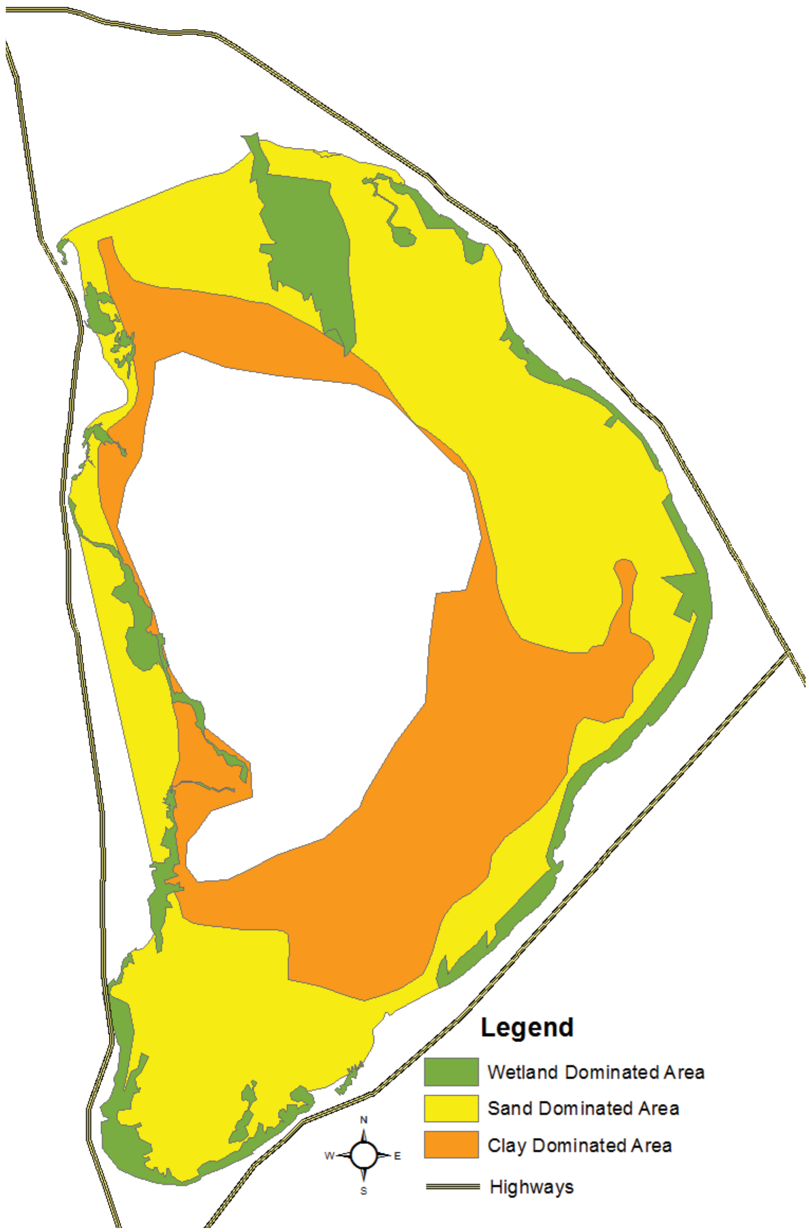


Figure 1
ET Zone Map
(Based on Tyler et al., 1997)

Model Results:

Graduated color maps (**Figure 2** and **Figure 3**) indicate the location of ET and drain discharge, respectively. **Figure 4** shows the combined drain and ET discharge.

The maximum ET rate within the model is located on the periphery of Owens Lake and near the Owens River delta. The maximum ET rate is approximately 35 inches per year, which matches well within the range of published data. For reference, this equates to approximately 3 acre-feet per acre per year, or 10.5 gallons per minute (gpm) per model cell. A cell is 500 feet square.

Within the physical system, ET likely occurs within a cell area from drain discharge as well. Although the total ET for a cell is not the sum of the ET and Drain discharge as drain flows often convert to surface runoff and leave the cell where it was discharged.

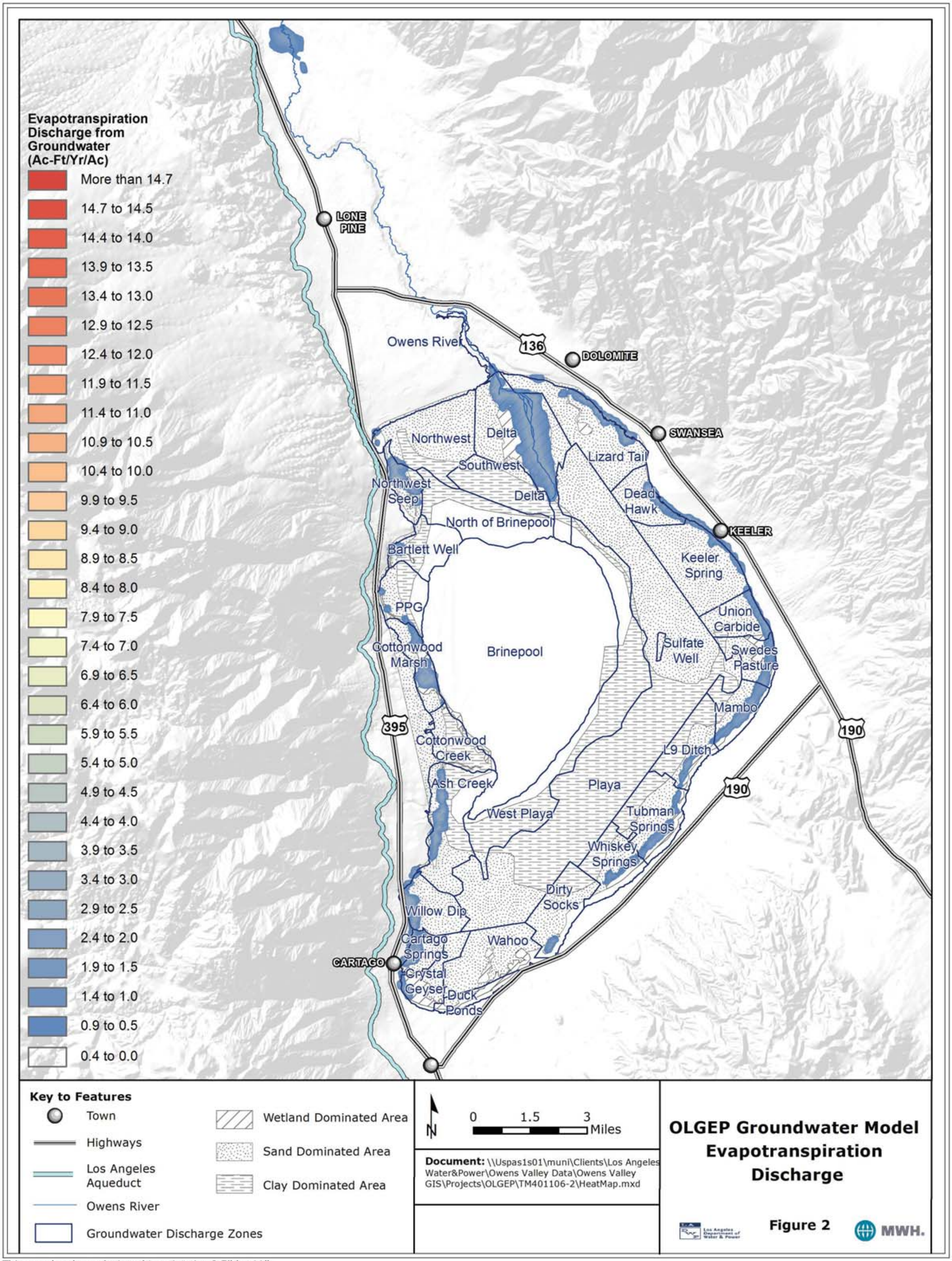
North of the Owens Lake, the ET developed for the Southern Model was applied. In this area the ET ranges from 0 to 2.2 acre-feet per acre per year. The average for this area is 0.007 acre-feet per acre per year.

The maximum drain discharge rates from layer 1 are located on the periphery of the Owens Lake near the historical shoreline where groundwater flow intercepts the lower-conductivity lakebed materials and discharges to the surface. For the majority of drains within the OLGEP model area the discharge is zero. The maximum rate is about 107 AF/year, or 66 gpm from a single cell. A discharge rate of 66 gpm from a single cell is reasonable as maximum discharge rates from springs can reach as high as 1,160 gpm. Total discharge from a seep or spring consists of ET and drain discharge. Large spring sites consist of aggregated discharge from multiple cells. Deep sourced flowing well (drains not located in layer 1) are not summarized in herein.

References:

MWH, 2010. Southern Groundwater Model Calibration Documentation, Tasks A.2.6 and A.2.1, April.

Tyler S.W., S. Kranz, M.B. Parlange, J. Albertson, G.G. Katul, G.F. Cochran, B.A. Lyles, and G. Holder., 1997. Estimation of Groundwater Evaporation and Salt Flux from Owens Lake, California, USA, Journal of Hydrology 200 (1997) 110-135.



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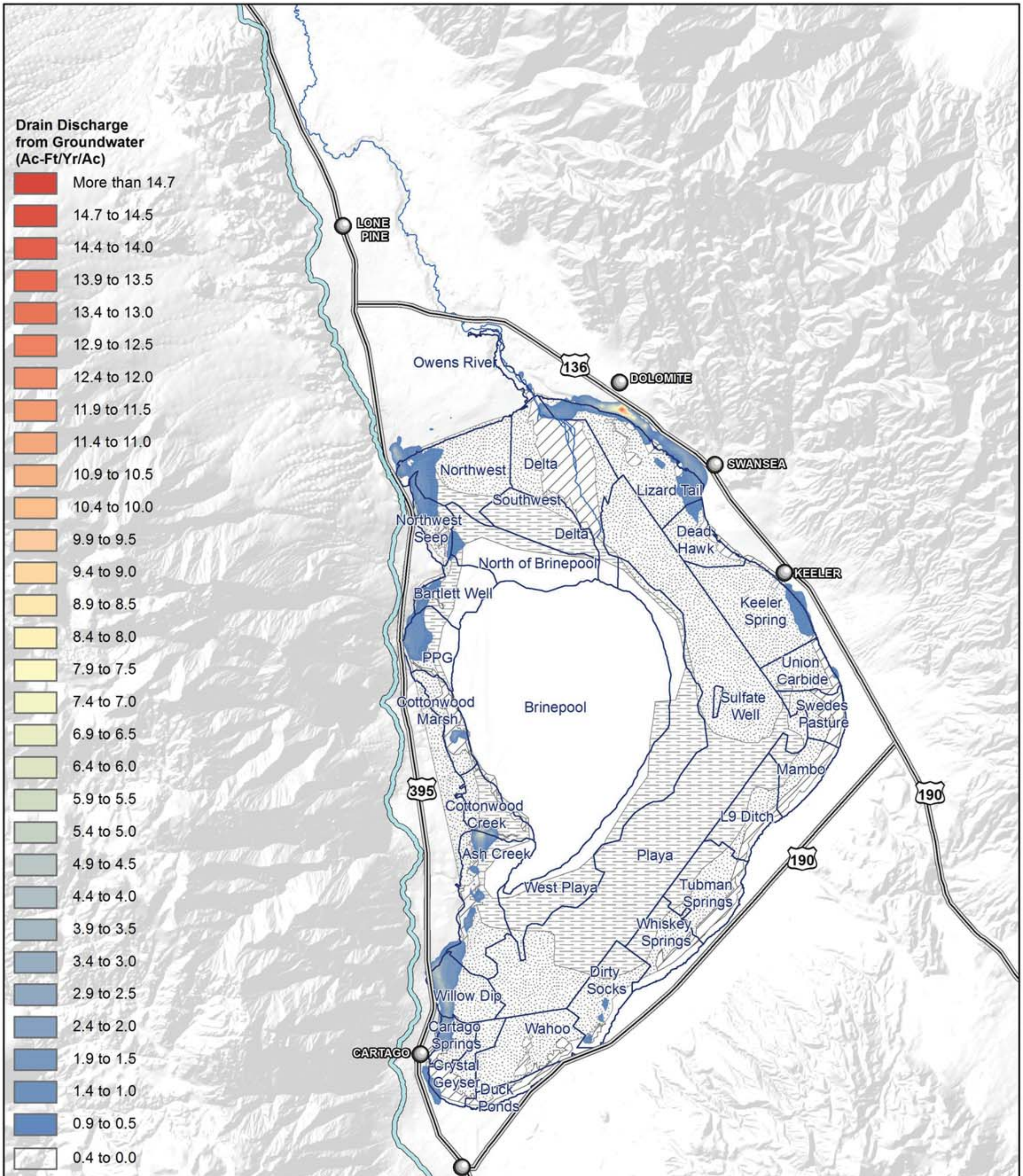

Key to Features

- Town
- Highways
- Los Angeles Aqueduct
- Owens River
- Groundwater Discharge Zones
- Wetland Dominated Area
- Sand Dominated Area
- Clay Dominated Area

N

0 1.5 3 Miles

Document: \\Uspas1s01\muni\Clients\Los Angeles Water&Power\Owens Valley Data\Owens Valley GIS\Projects\OLGEP\TM401106-2\HeatMap.mxd

OLGEP Groundwater Model Drain Discharge

Los Angeles Department of Water & Power

Figure 3

MWH.

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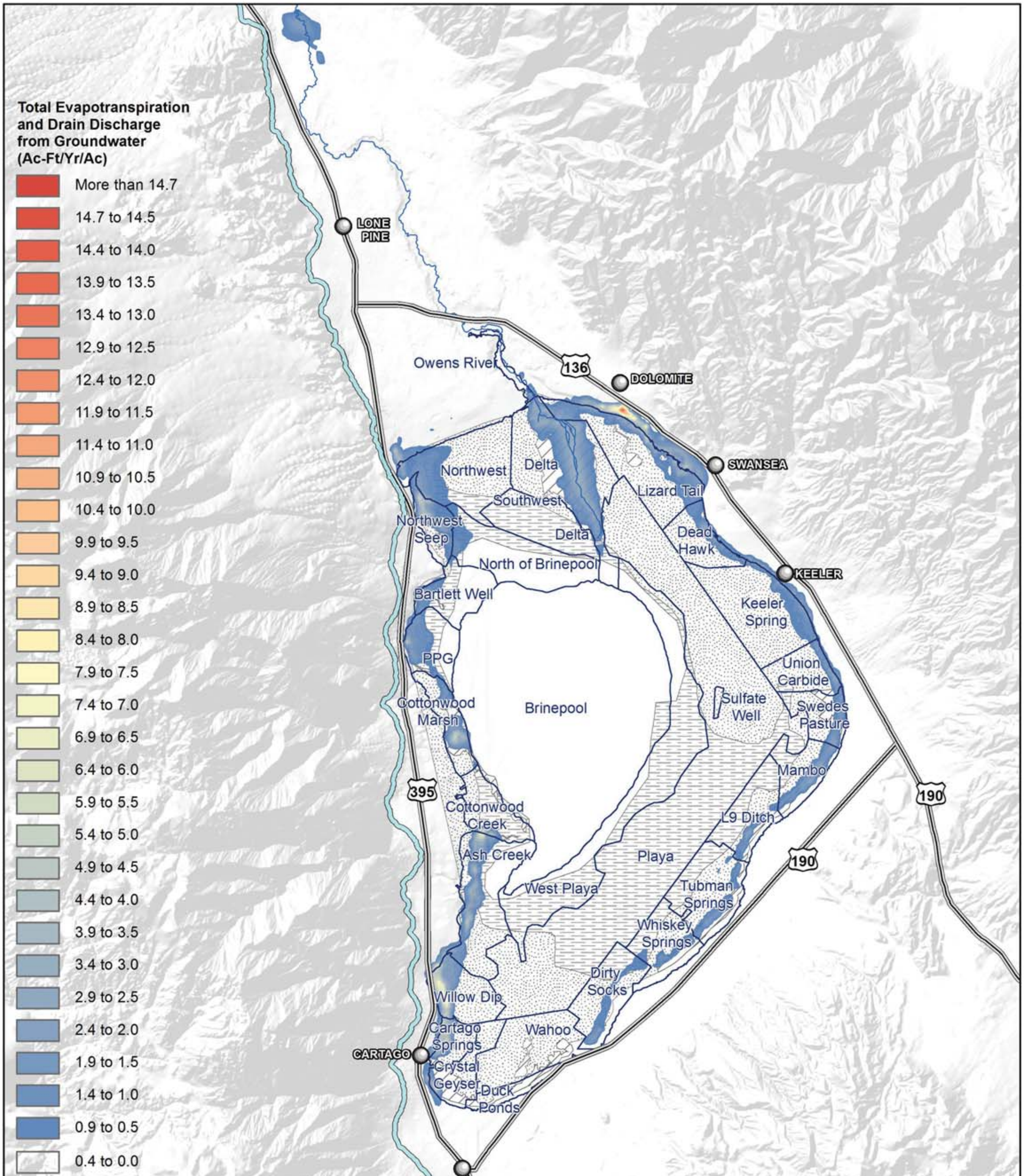

Key to Features

- Town
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- Owens River
- Groundwater Discharge Zones
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N

0 1.5 3 Miles

Document: \\Uspas1s01\muni\Clients\Los Angeles Water&Power\Owens Valley Data\Owens Valley GIS\Projects\OLGEP\TM401106-2\HeatMap.mxd

OLGEP Groundwater Model Total Evapotranspiration and Drain Discharge

Los Angeles Department of Water & Power

Figure 4

MWH.

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ATTACHMENT D

Transient Calibration Hydrographs

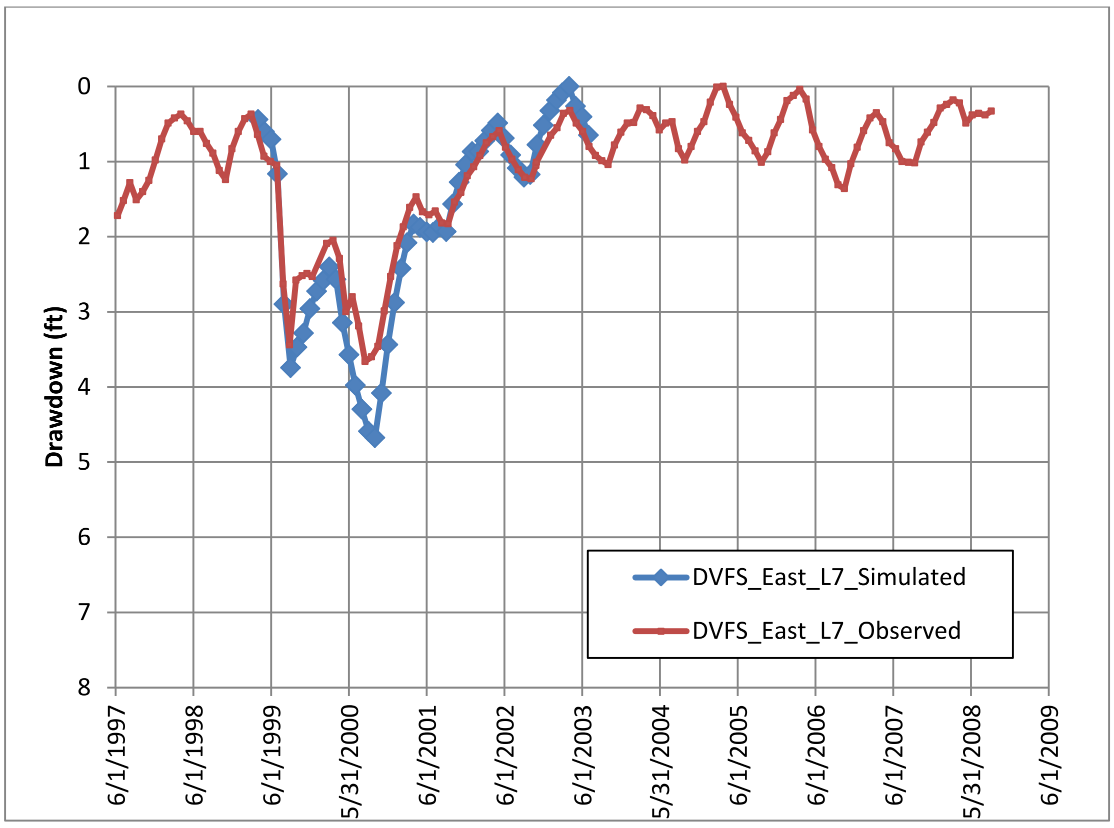
TECHNICAL MEMORANDUM

TO:	*OLGEP Project Team*	DATE:	*October, 2012*
FROM:	*MWH Team*	REFERENCE:	
SUBJECT:	*Calibration Graphs*		

Introduction

Provided herein are OLGEP model calibration graphs. These calibration graphs compare simulated and observed drawdown for pump tests. Table 11 of the main report summarizes maximum drawdown observed, observation well distance from pumping well, and simulated maximum drawdown at each monitoring well. The model cell spacing is a uniform 500 feet; therefore, monitoring data at a radius of greater than 1,000 feet were preferred for the calibration. Using an observation well within two model cells is not recommended for model calibration as drawdown will not be representative. For this reason, calibration efforts focused on simulating the general pattern of drawdown, but reproducing the exact absolute value of drawdown as needed at a single point was neither attempted, nor recommended.

Figure D-1
Historical Pumping at W390, W344, W346 and River Site Production Wells:
Simulated and Observed Drawdown at Down Valley Flow Site East Monitoring Wells (Lower, Middle and Upper)



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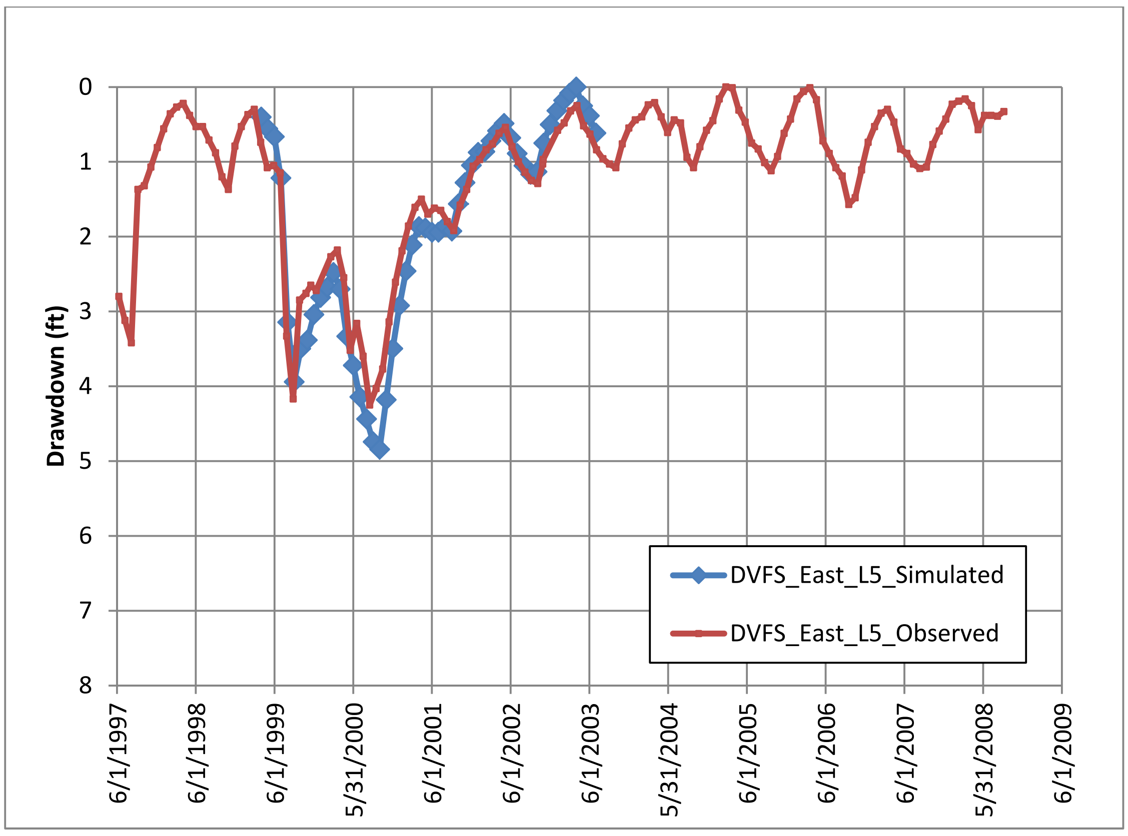

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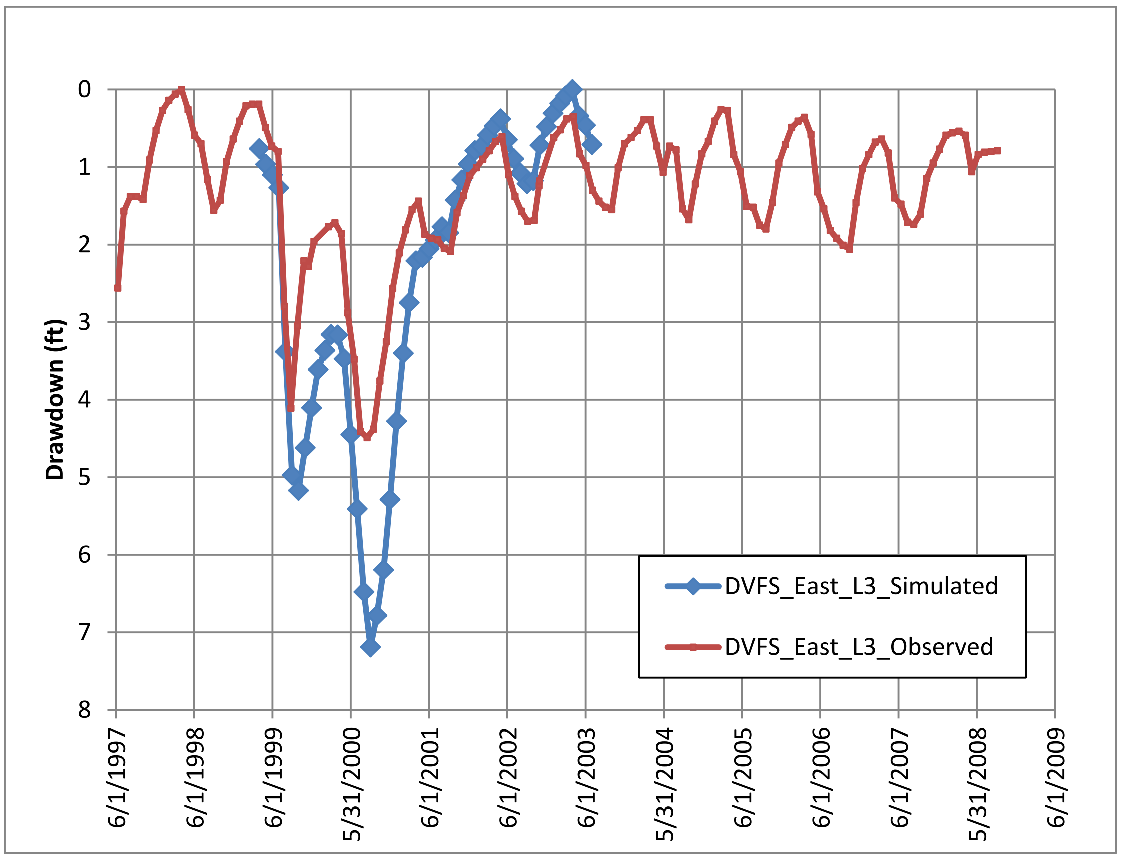

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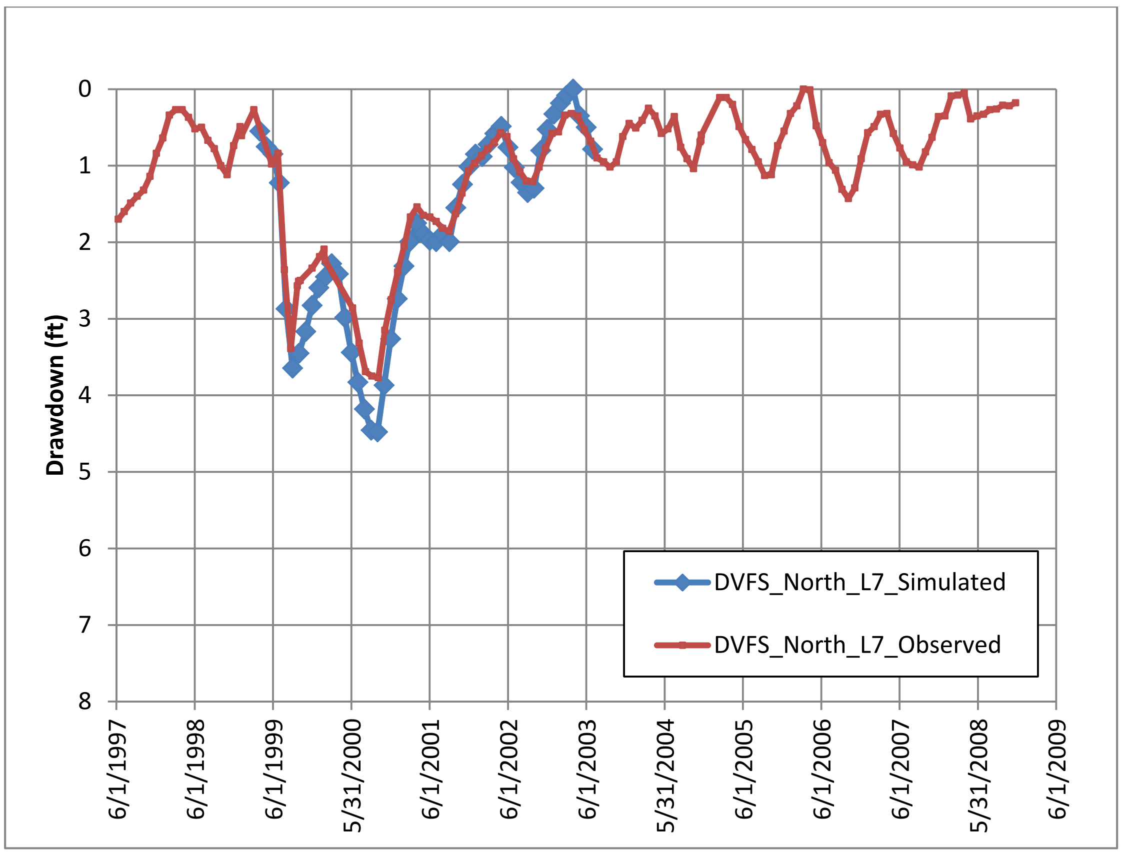
Figure D-2
Historical Pumping at W390, W344, W346 and River Site Production Wells:
Simulated and Observed Drawdown at Down Valley Flow Site North Monitoring Wells (Lower, Middle and Upper)



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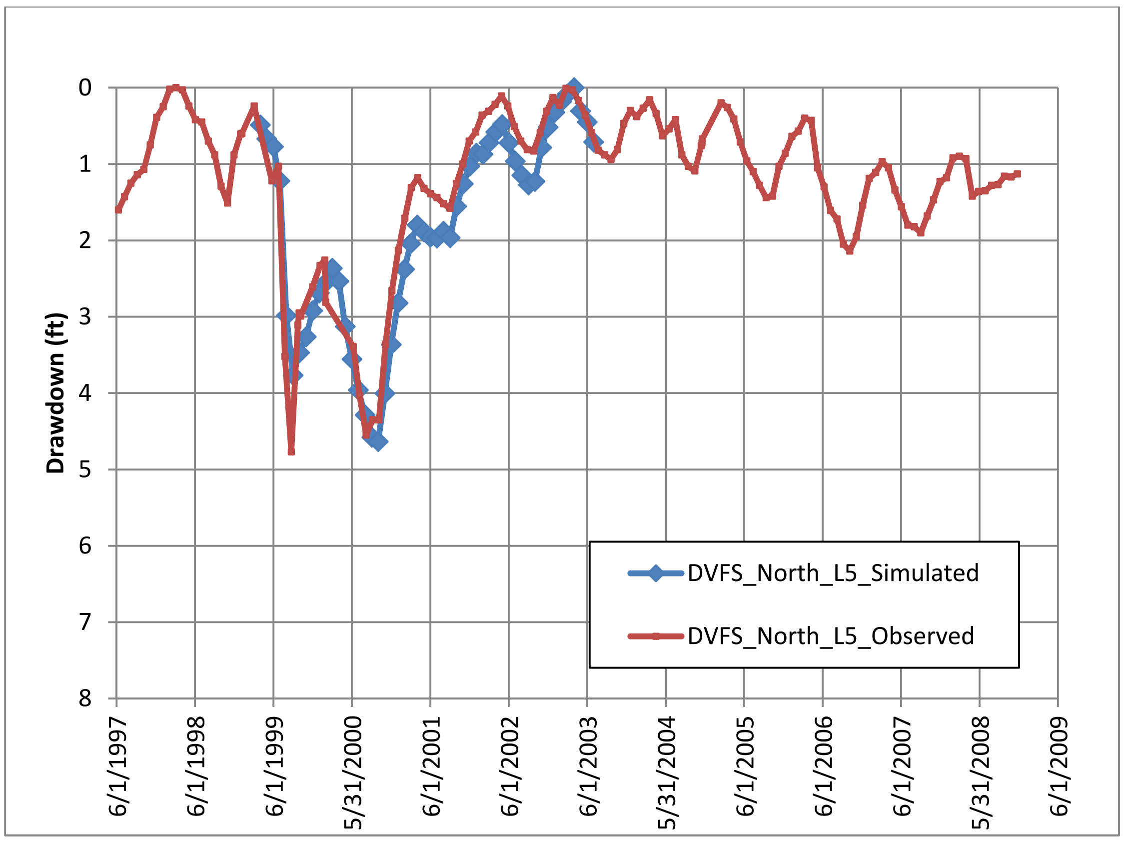

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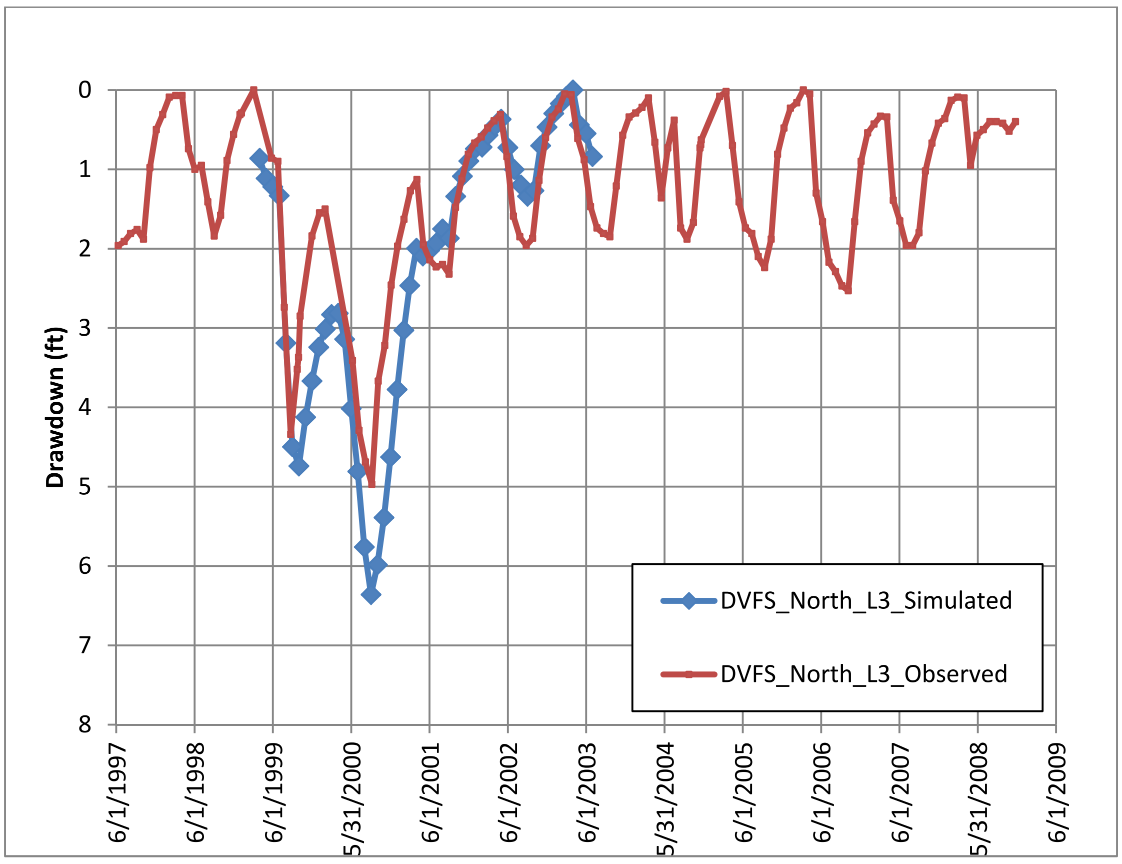

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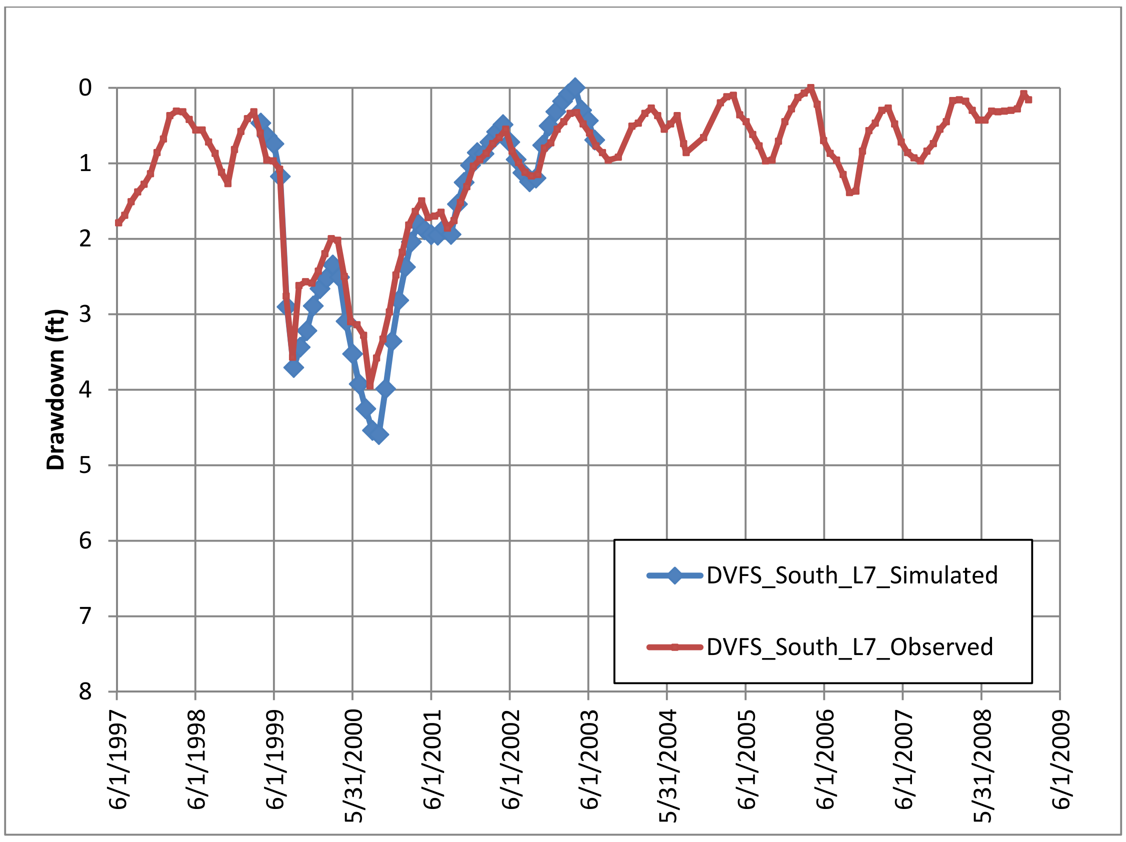
Figure D-3
Historical Pumping at W390, W344, W346 and River Site Production Wells:
Simulated and Observed Drawdown at Down Valley Flow Site South Monitoring Wells (Lower, Middle and Upper)



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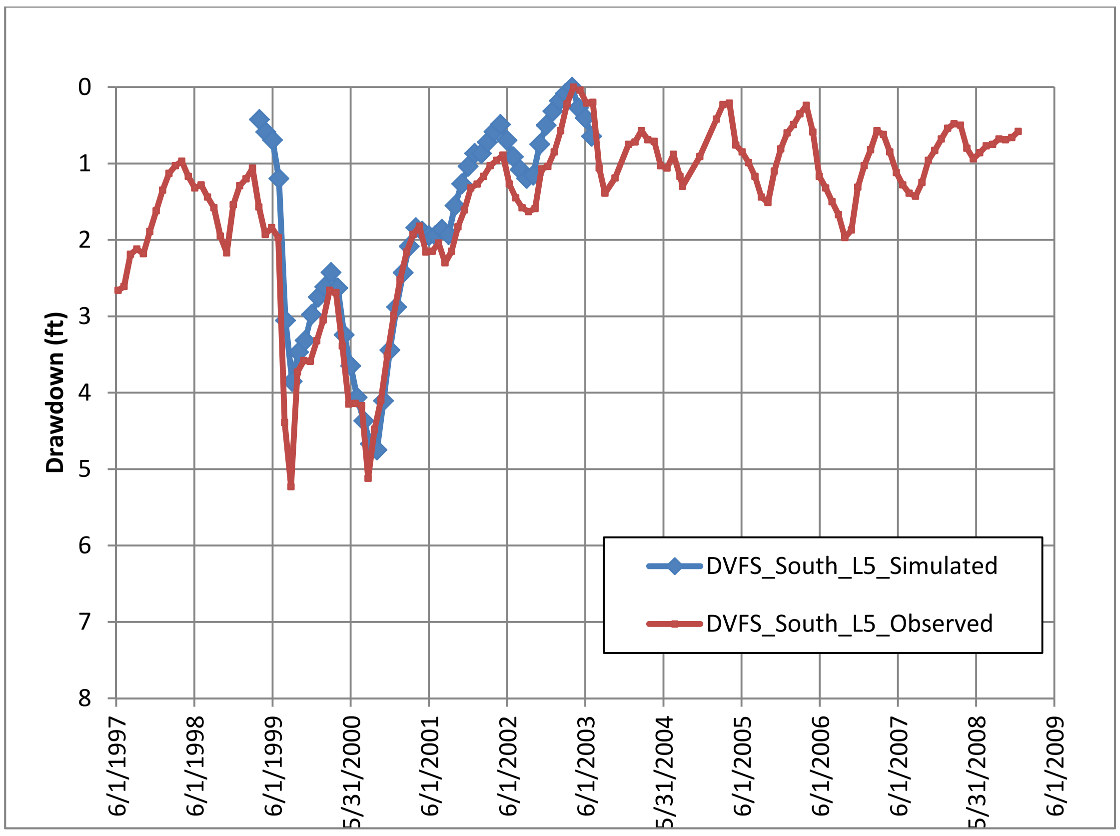

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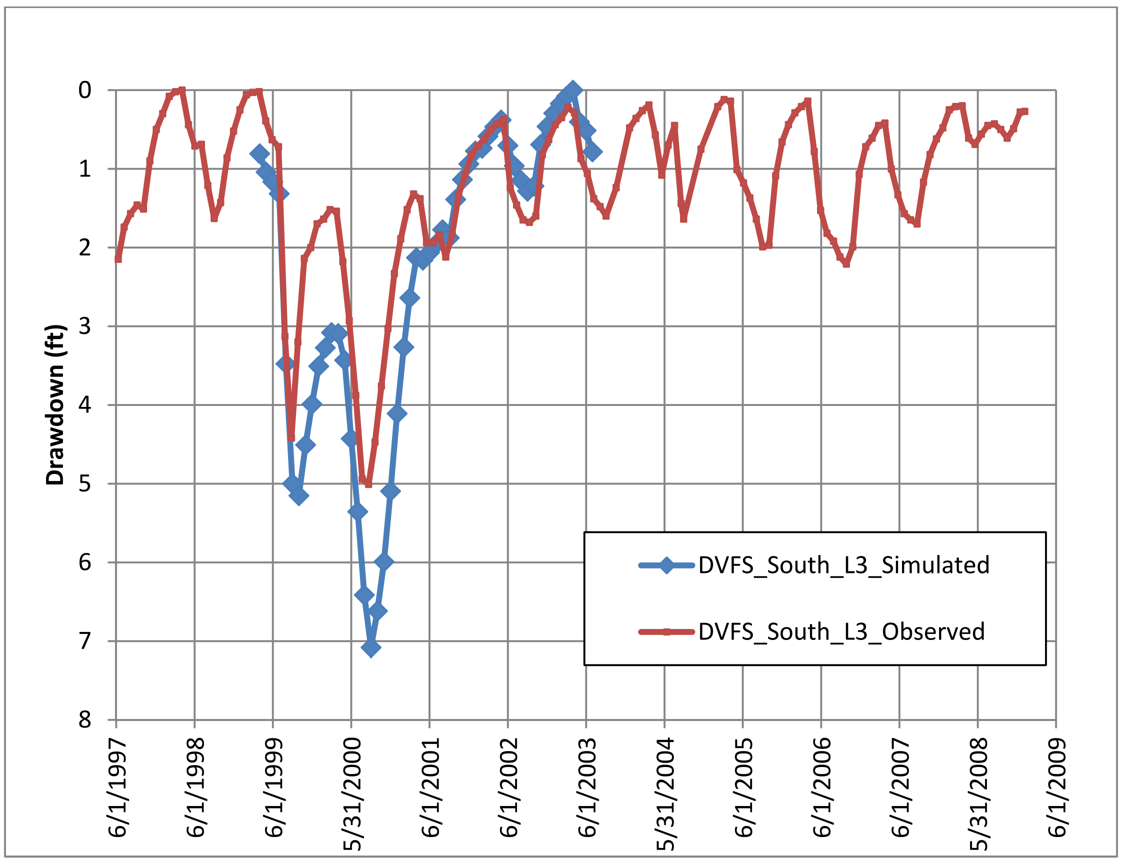

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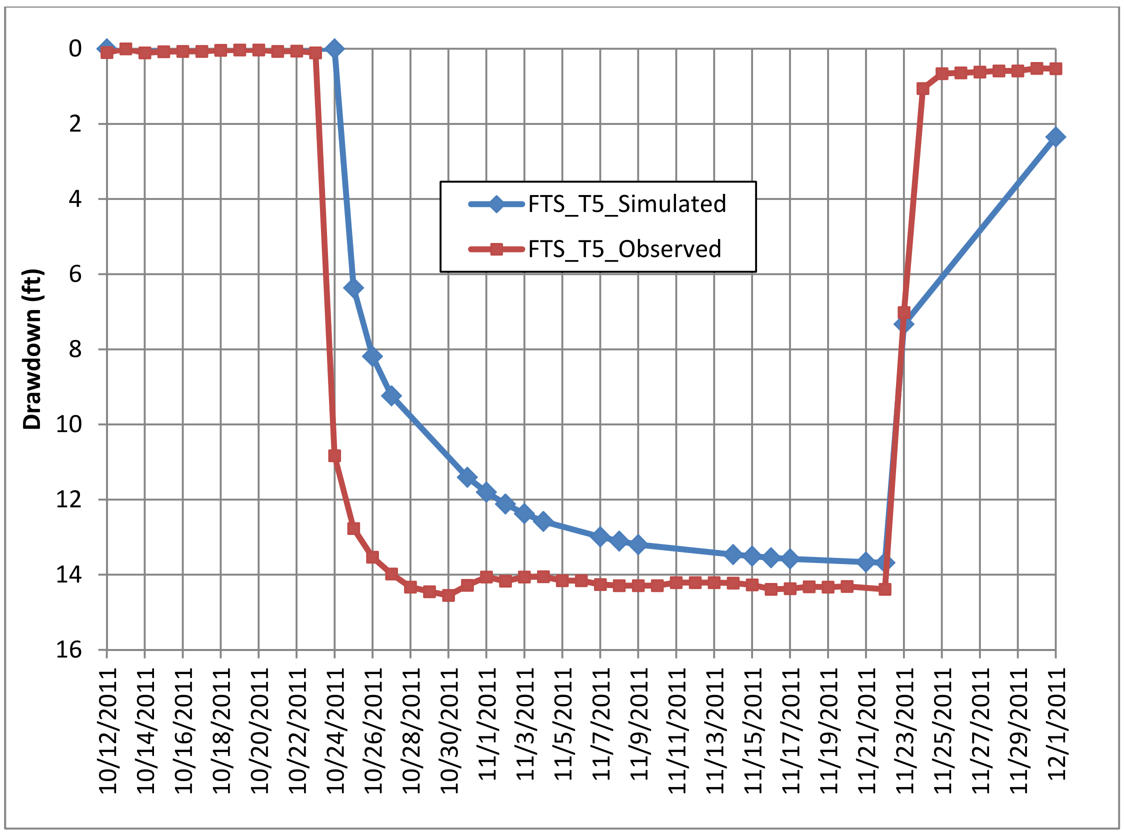
Figure D-4
Fault Test Site – T5 Pump Test: Simulated and Observed Drawdown at T5



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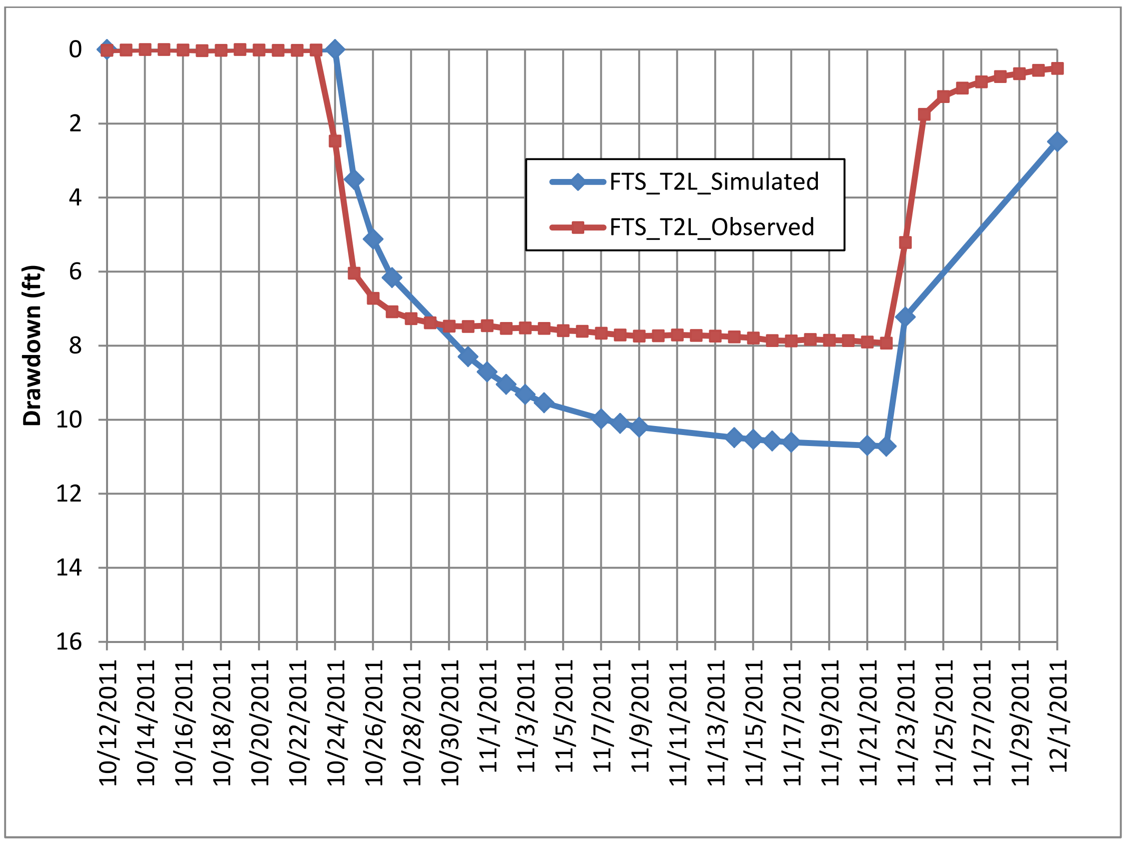

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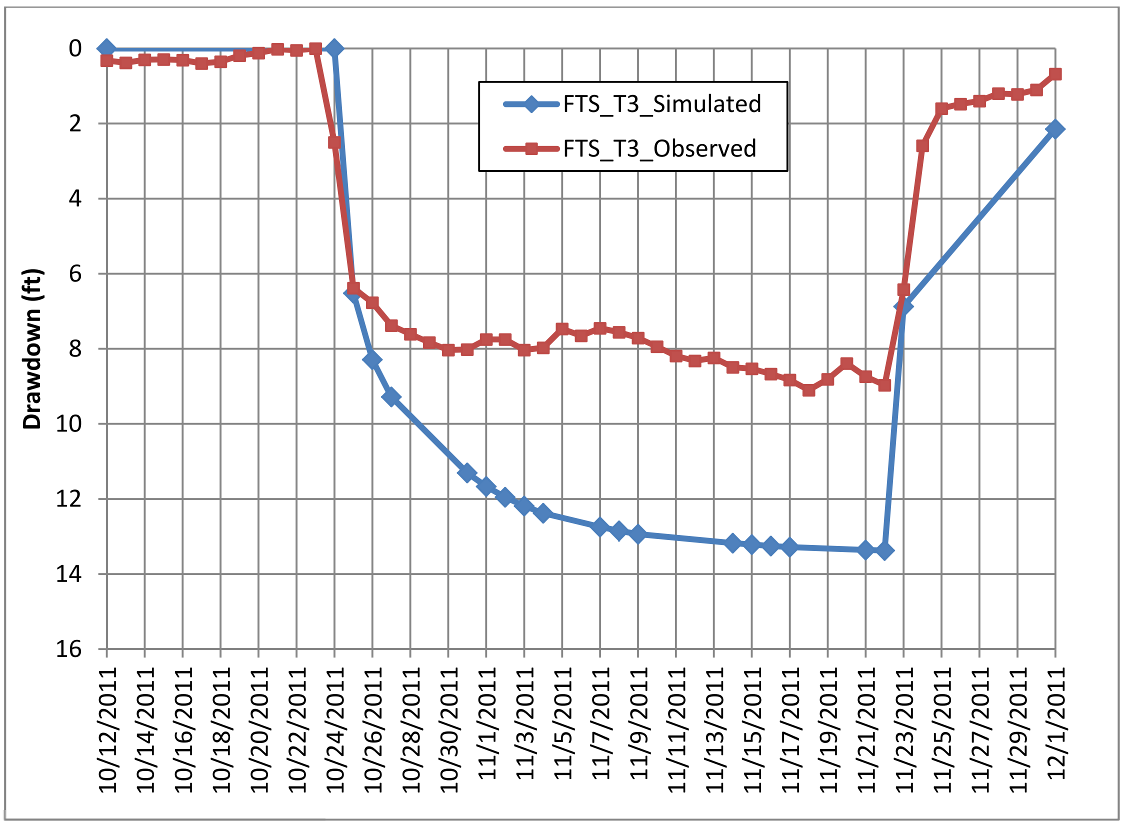

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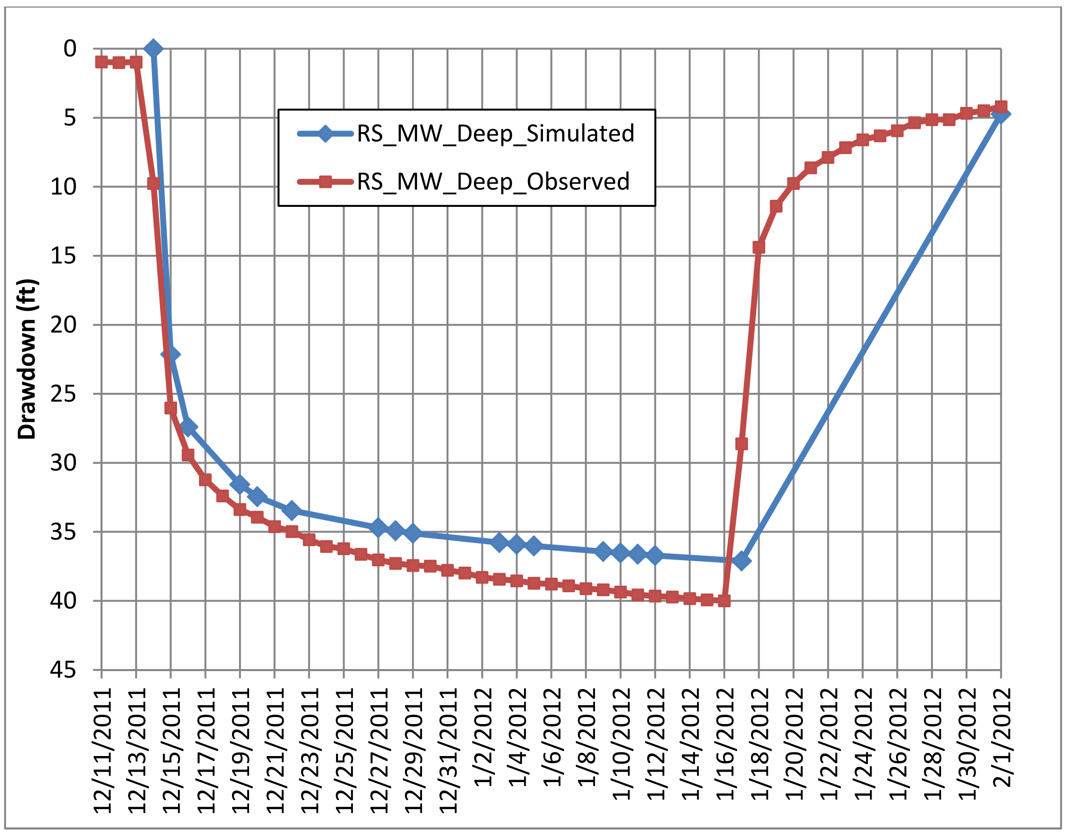
Figure D-5
Deep River Site Pump Test: Simulated and Observed Drawdown at RS_MW_Deep, DVFS_South_Middle and T903



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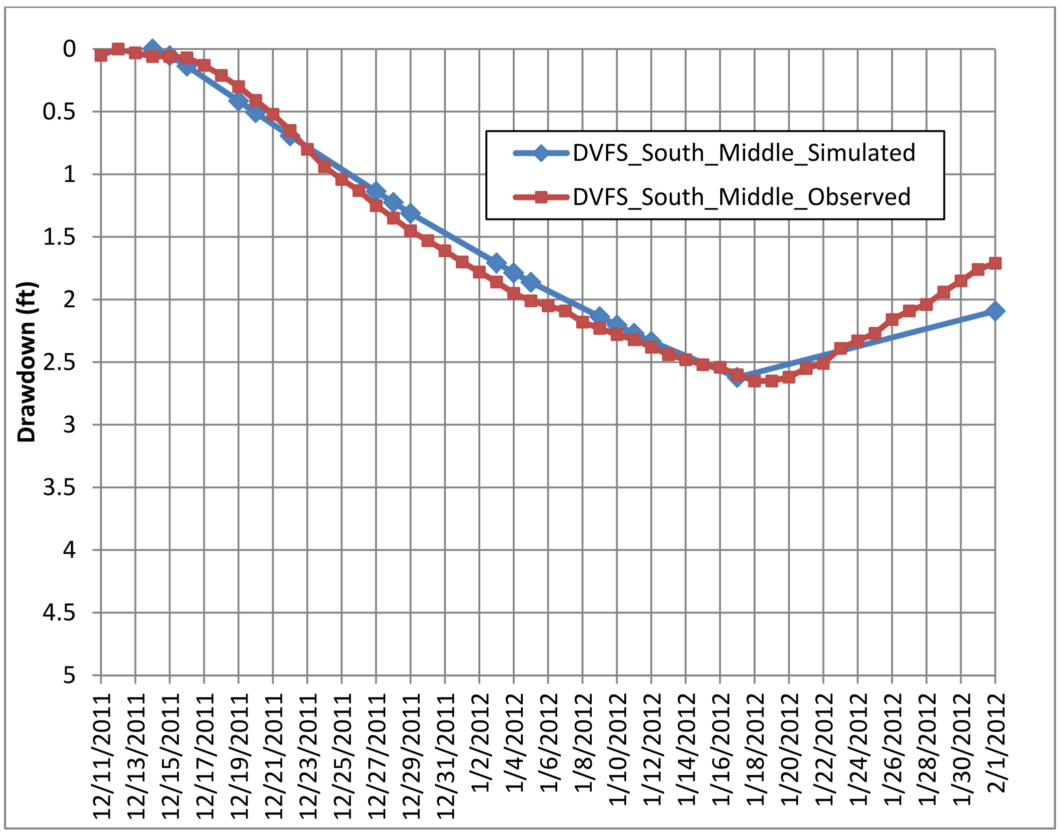

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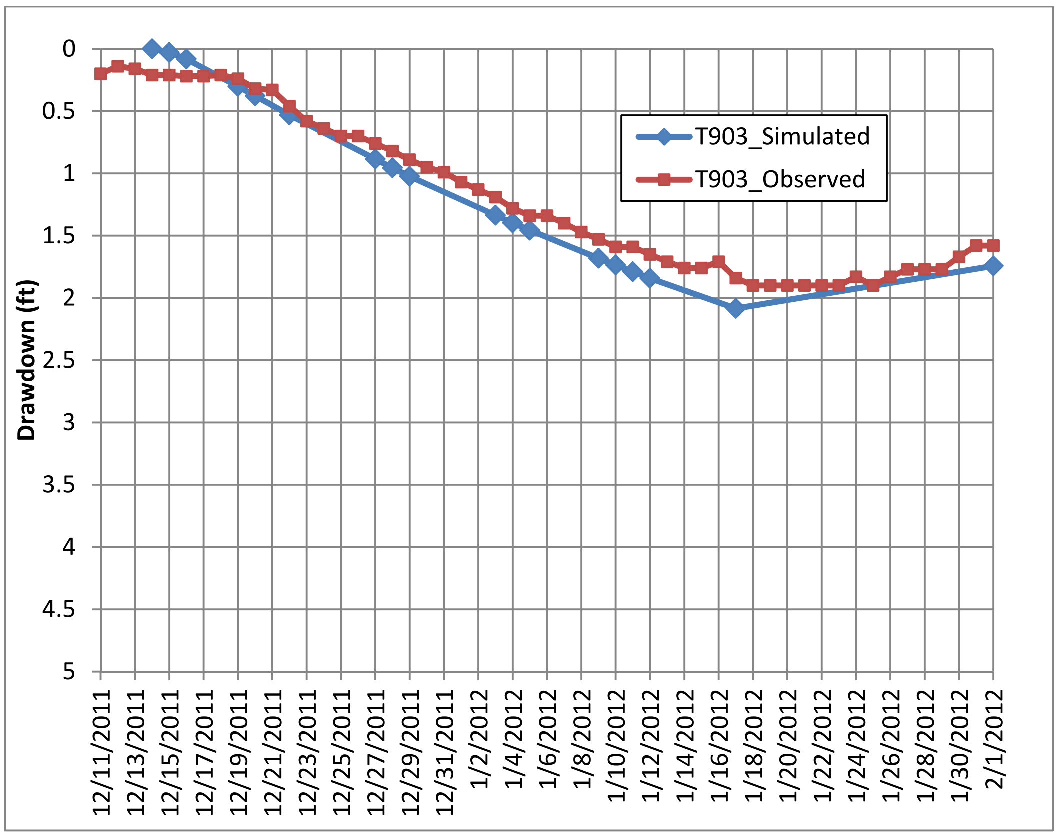

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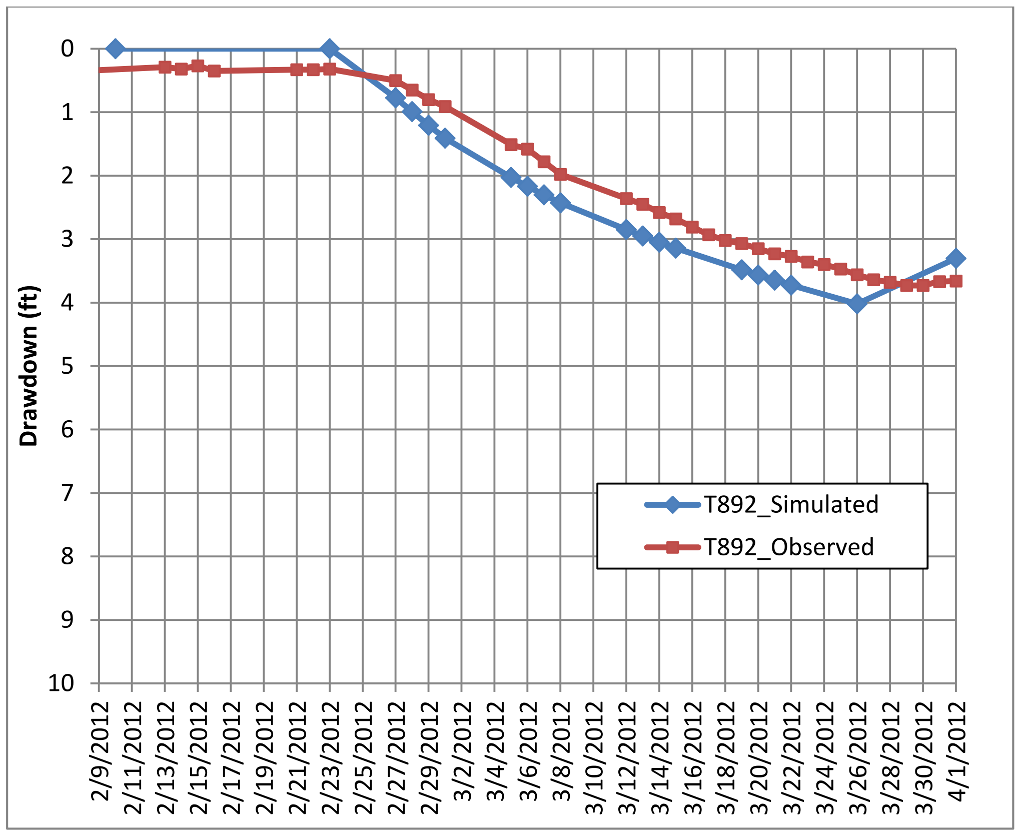
Figure D-6
Shallow River Site Pump Test: Simulated and Observed Drawdown at T892, T898 and T904



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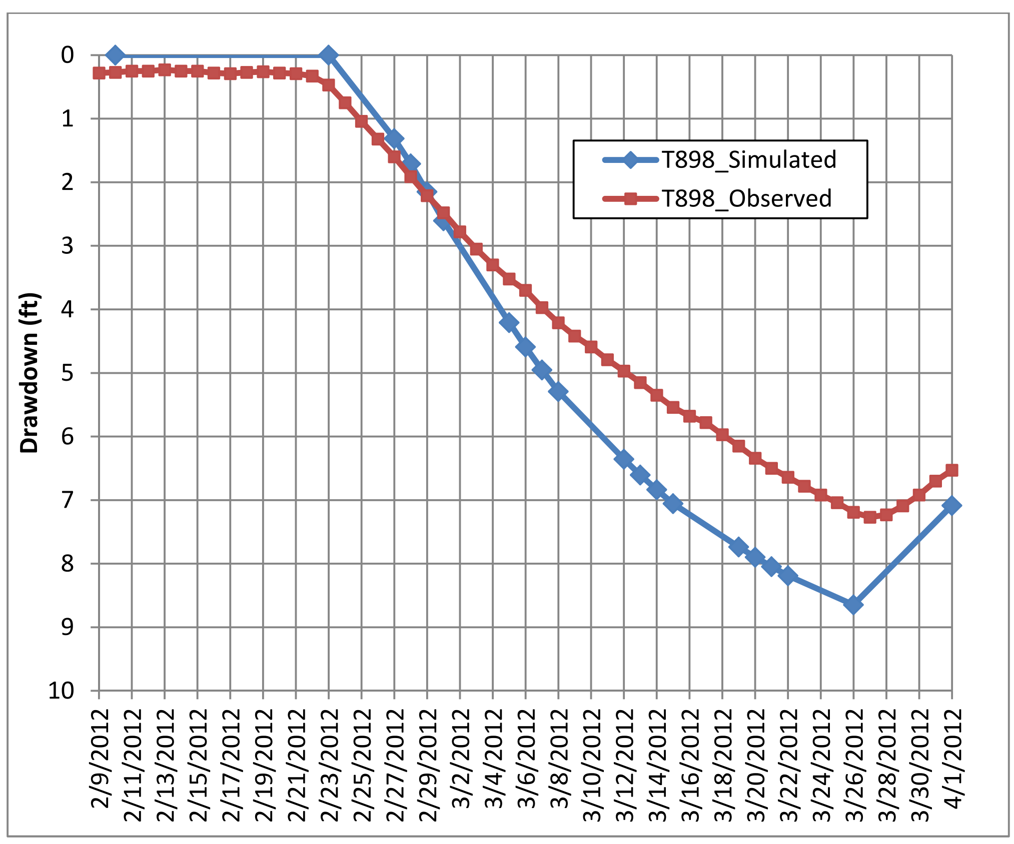

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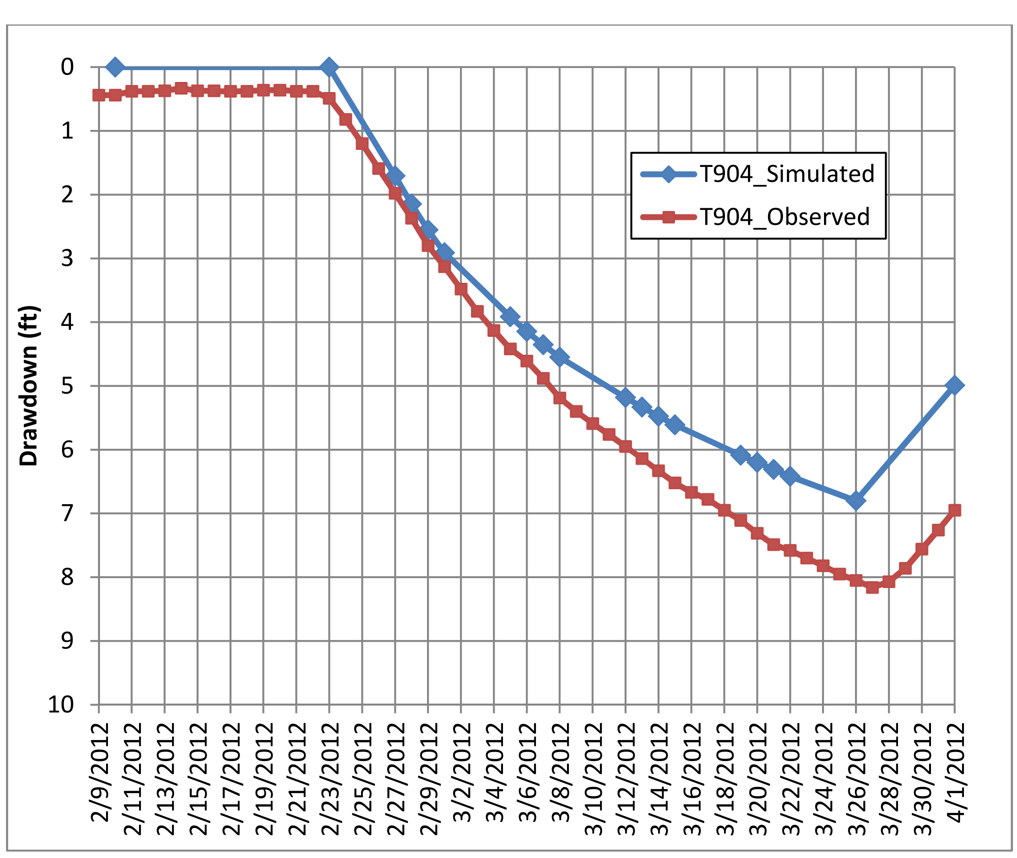

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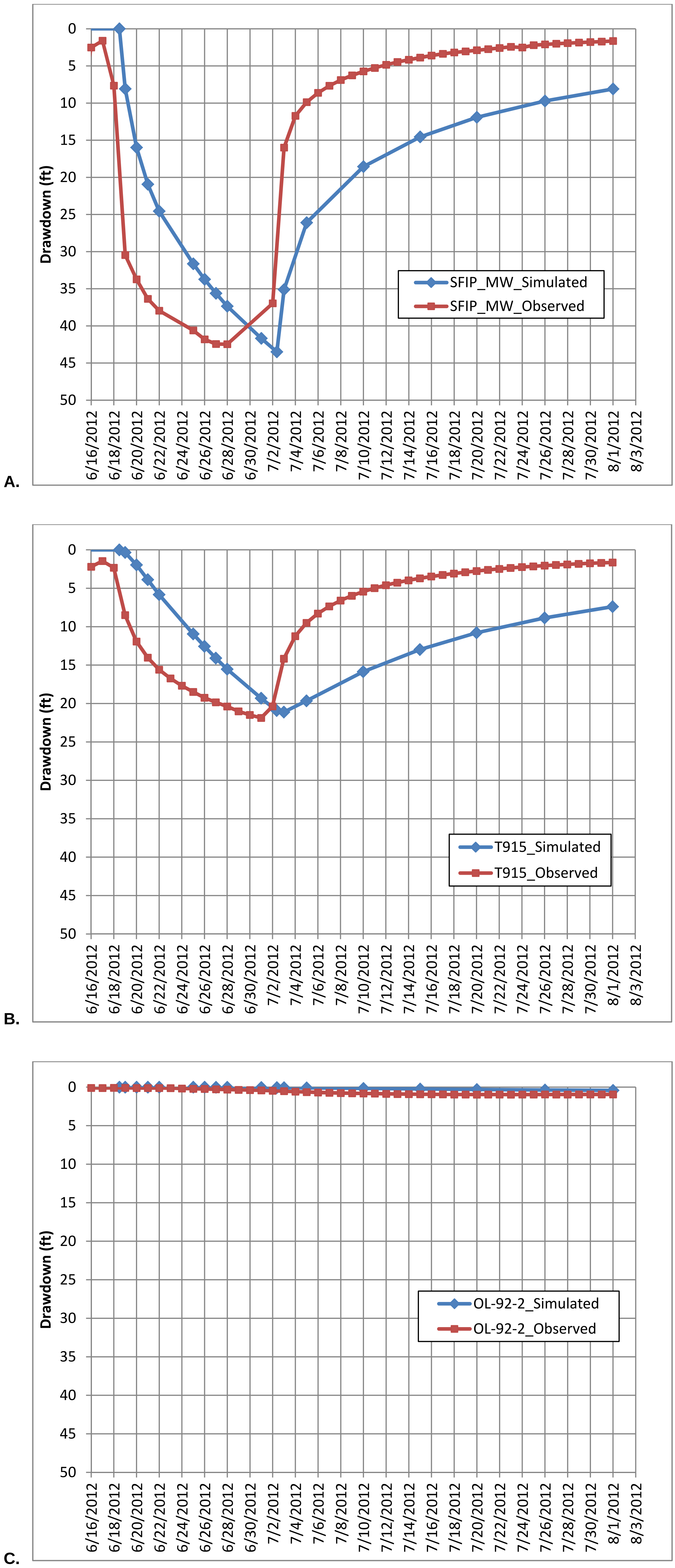
Figure D-7
SFIP Pump Test: Simulated and Observed Drawdown at SFIP_MW, T915 and OL-92-2



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