APPENDIX A

Responses to NRC Requests for Additional Information (RAI)
RAI 25, 31 and 39

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RAI-1

Description of Deficiency

The information provided in TR Section 2.7.2 does not meet the applicable requirements of 10 CFR 40.41(c), using the review procedures in Section 2.7.2 and acceptance criteria in Section 2.7.3 of the SRP.

Basis for Request

For the 80 sand aquifer test at LPW-1, Uranium One provided the water level vs. time curves for the pumping wells and all of the observation wells for the pumping and recovery periods in Figures 6-1 through 6-8 of Appendix A-2. For the 90 sand aquifer test at LPW-2, Uranium One provided the water level vs. time curves for the pumping wells and all of the observation wells for the pumping and recovery periods in Figures 6-9 through 6-16 of Appendix A-2. Uranium One provided electronic files of the water level data for the test on CD for the 80 sand but not the 90 sand. The plots are useful for a quick check of the well response to pumping; however, the plots were insufficient for NRC staff to evaluate the aquifer response as the time scale was oddly set as a log scale of the Julian date which repeated for several points instead of the usual log scale in minutes. Uranium One also provided a Cooper Jacob analysis of the recovery data of only one observation well for each test in Appendix A-4. Uranium One did not provide an analysis of the recovery data from the pumping well or the other observation wells for either test. The staff finds the 2008 80 sand multi-well tests indicate a higher transmissivity than the original Teton tests. The 2008 80 sand multi-well tests did not indicate the leakage seen on the Teton 80 and 90 sand tests. The staff finds the 2008 test did not demonstrate the boundary effects that were noted in the original Teton 80 and 90 sand tests. Staff finds that the information provided for the 80 sand aquifer test at LPW-1 and 90 sand aquifer test at LPW-2 is not sufficient to assess the hydrologic characteristics of these aquifers.

Formulation of RAI

Uranium One should provide traditional time drawdown curves on semi-log time scale for all observation wells for both the 80 and 90 sands aquifer tests at the Leuenberger Satellite. Uranium One should also provide recovery curves on semi-log time scale for the pumping well and the observation wells. Please analyze all curves for transmissivity and storage coefficient and provide these values. If any boundary effects or leakage are noted, describe and reassess the hydrogeologic characteristics of the 80 sand and 90

sands at the Leuenberger Satellite. Provide the water level data for the 90 sand pumping test in electronic form.

RAI-25 Response

Uranium One has re-evaluated and subsequently re-plotted the drawdown curves on semi-log scales for aquifer test pumping wells and related observation wells completed in the 70, 80, and 90 sands located on the Leuenberger (Figures 1 through 8 depicted in this response), North Platte (RAI 31) and Peterson (RAI 39) sites. Curve matching was performed on the new plots, resulting in transmissivity (T), hydraulic conductivity (K), and storativity (S) values that closely match the geologic conditions of the clay, silt, sand and gravel aquifer systems being evaluated.

Pumping Wells - Drawdown

The updated results for the Leuenberger 80 Sand using data acquired from pumping well LPW-1, shows a T value of 46.37 ft^2/day; an S value of 0.0228; and a K value of 0.70 ft/day. The updated results for the Leuenberger 90 Sand using data acquired from pumping well LPW-2, shows a T value of 131.10 ft^2/day; an S value of 0.0576; and a K value of 2.70 ft/day. The updated results for the North Platte 70 Sand using data acquired from pumping well LPW-3A, shows a T value of 36.79 ft^2/day; an S value of 0.0393; and a K value of 0.99 ft/day. The updated results for the Peterson 90 Sand using data acquired from pumping well LPW-4, shows a T value of 34.73 ft^2/day; an S value of 0.0212; and a K value of 0.93 ft/day (Table 1).

Pumping Wells – Recovery

The updated results for the Leuenberger 80 Sand using data acquired from pumping well LPW-1, shows a T value of 49.83 ft^2/day; an S value of 3.94E-04; and a K value of 0.75 ft/day. The updated results for the Leuenberger 90 Sand using data acquired from pumping well LPW-2, shows a T value of 135.70 ft^2/day; an S value of 0.0358; and a K value of 2.78 ft/day. The updated results for the North Platte 70 Sand using data acquired from pumping well LPW-3A, shows a T value of 42.55 ft^2/day; an S value of 1.602E-06; and a K value of 1.14 ft/day. The updated results for the Peterson 90 Sand using data acquired from pumping well LPW-4, shows a T value of 36.69 ft^2/day; an S value of 0.0132; and a K value of 0.98 ft/day (Table 1).

Observation Wells – Drawdown

The updated results for the Leuenberger 80 Sand using data acquired from observation well LMP-1, shows a T value of 65.13 ft^2/day; an S value of 6.87E-05; and a K value of 0.98 ft/day. The updated results for the Leuenberger 90 Sand using data acquired from observation well LMP-3, shows a T value of 111.0 ft^2/day; an S value of 1.04E-04; and a K value of 2.27 ft/day. The updated results for the North Platte 70 Sand using data acquired from observation well LMP-5, shows a T value of 77.03 ft^2/day; an S value of 4.01E-05; and a K value of 2.07 ft/day. The updated results for the Peterson 90 Sand using data acquired from observation well LMP-7, shows a T value of 29.01 ft^2/day; an S value of 6.47E-05; and a K value of 0.78 ft/day (Table 1).

Observation Wells – Recovery

The updated results for the Leuenberger 80 Sand using data acquired from observation well LMP-1, shows a T value of 56.72 ft^2/day; an S value of 8.78E-05; and a K value of 0.86 ft/day. The updated results for the Leuenberger 90 Sand using data acquired from observation well LMP-3, shows a T value of 83.68 ft^2/day; an S value of 2.48E-04; and a K value of 1.71 ft/day. The updated results for the North Platte 70 Sand using data acquired from observation well LMP-5, shows a T value of 52.39 ft^2/day; an S value of 3.62E-04; and a K value of 1.22 ft/day. The updated results for the Peterson 90 Sand using data acquired from observation well LMP-7, shows a T value of 24.48 ft^2/day; an S value of 1.21E-04; and a K value of 0.66 ft/day (Table 1).

Table 1: Pump Test Results for the 70, 80 and 90 Sands

Well Name	Formation	Calculated Aquifer Values		
Pumping Wells - Drawdown		**T (ft^2/day)**	**S**	**K (ft/day)**
LPW-1	80 Sand Leuenberger	46.37	0.0228	0.70
LPW-2	90 Sand Leuenberger	131.10	0.0576	2.69
LPW-3A	70 Sand Peterson	36.79	0.0394	0.99
LPW-4	90 Sand Peterson	34.73	0.0212	0.93
Pumping Wells - Recovery				
LPW-1	80 Sand Leuenberger	49.83	3.94E-04	0.75
LPW-2	90 Sand Leuenberger	135.70	0.0358	2.78
LPW-3A	70 Sand Peterson	42.55	1.6E-06	1.14
LPW-4	90 Sand Peterson	36.69	0.0132	0.98
Observation Wells - Drawdown				
LMP-1	80 Sand Leuenberger	65.13	6.87E-05	0.98
LMP-3	90 Sand Leuenberger	111.00	1.04E-04	2.27
LMP-5	70 Sand Peterson	77.03	4.01E-05	2.07
LMP-7	90 Sand Peterson	29.01	6.47E-05	0.78
Observation Wells - Recovery				
LMP-1	80 Sand Leuenberger	56.72	8.78E-05	0.86
LMP-3	90 Sand Leuenberger	83.68	2.48E-04	1.71
LMP-5	70 Sand Peterson	52.39	3.62E-04	1.22
LMP-7	90 Sand Peterson	24.48	1.21E-04	0.66

Discussion

The T, S, and K values reflect aquifer flow conditions consistent with a fresh, semi-consolidated, fine sand, silt, and gravel geology, with varying degrees of clay, which are related to braided paleo stream channels and outwash fans that were developed from the erosion of local mountains and highlands. Paleo stream channels are remnants of an inactive river or stream channel that has been either filled or buried by younger sediment. The sediments deposited by the ancient channels are either cut into, or buried by, multiple secessions of channel development, and can be unconsolidated, semi-consolidated, consolidated, or lithified. This geologic setting is typical for central and northeast Wyoming. These systems are quite complex given the variability in sediment distribution as the stream channels eroded, reworked, and re-deposited clay, silt, sand and gravel into lenses of various sizes and of varying degrees of sorting.

Pumping wells LPW-1, LPW-2, LPW-3A and LPW-4 all display potentially leaky aquifer characteristics in the 70, 80, and 90 sands, based on drawdown curves developed for each well. Leakey aquifer conditions are typically attributed to the fracturing of consolidated geologic materials by local and regional tectonic stresses exerted upon the host rock formations. An in-depth geophysical study would be required to document the type and areal extent of any fracture and/or joint systems to definitively determine the possibility of leakage from an overlying or underlying aquifer system through a fracture or joint network. In addition, multiple piezometers would have to be installed across the site to determine hydraulic head, including variation in hydraulic head within these aquifer systems, in order to determine the presence and magnitude of vertical hydraulic gradients. Such exercises would be costly and time consuming, and may yield very little additional information to the nature of the leakage between the aquifer systems. Likewise, variation in fracturing and leakage potential would most likely vary considerably across the site. However, the leakage response illustrated in the pump test curves are most likely the result of the cone of depression encountering a recharge boundary condition within the aquifer system being evaluated. Given the presence and geologic nature of deeply buried, braided paleo stream channel systems (composed of lenses of clay, silt, sand and gravel, which are interspersed and lie adjacent to one another), there is a high probability that these lenses can grade from a fine silt and sand into a paleo gravel bar; thus providing a sustained recharge of groundwater to the pumping well. Due to the complex nature of deeply buried paleo stream channel aquifer systems, this would most likely be the most plausible explanation for the leakage/recharge effect illustrated in the drawdown curves.

Figure 1: Leuenberger 80 Sand LPW-1 Pumping Well Drawdown

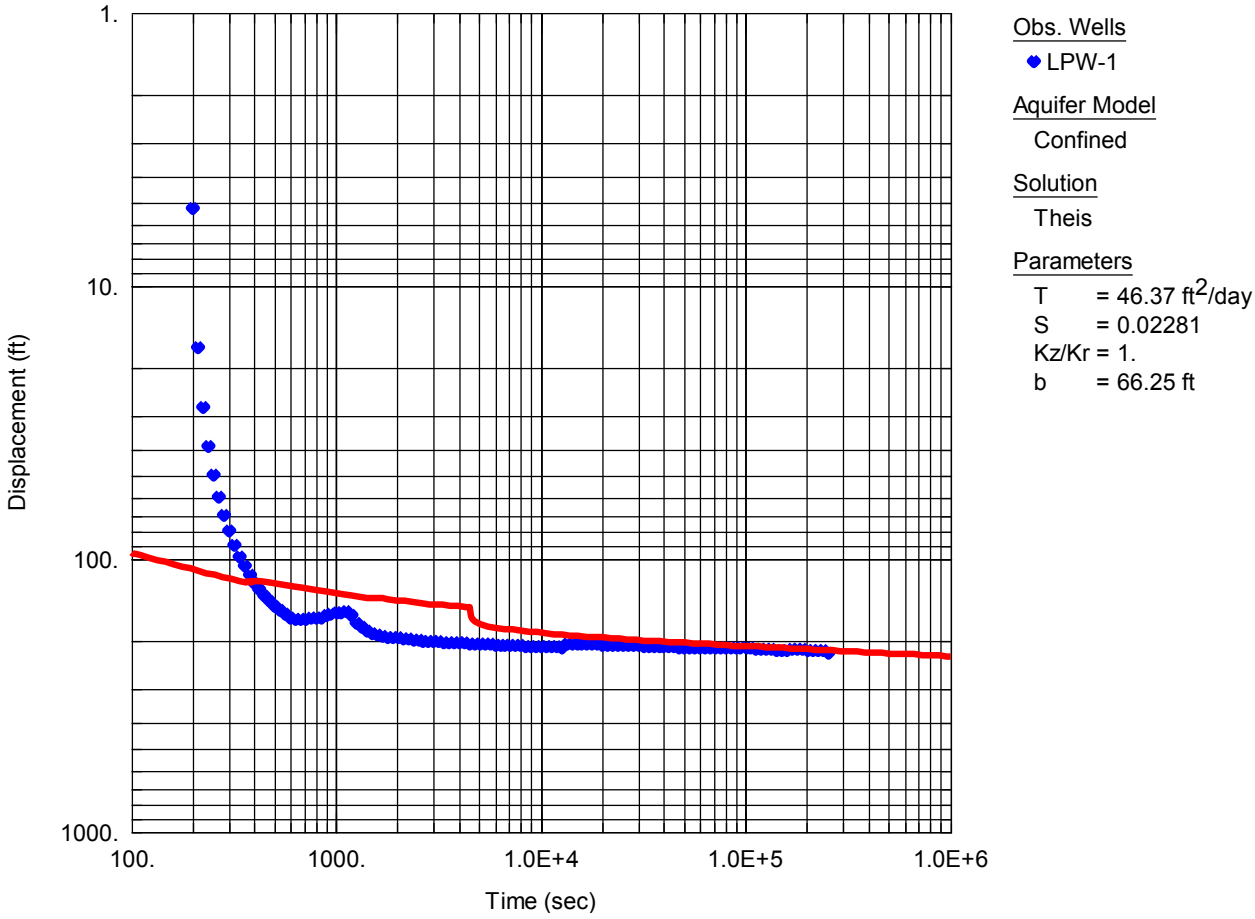


Figure 2: Leuenberger 80 Sand LPW-1 Pumping Well Recovery

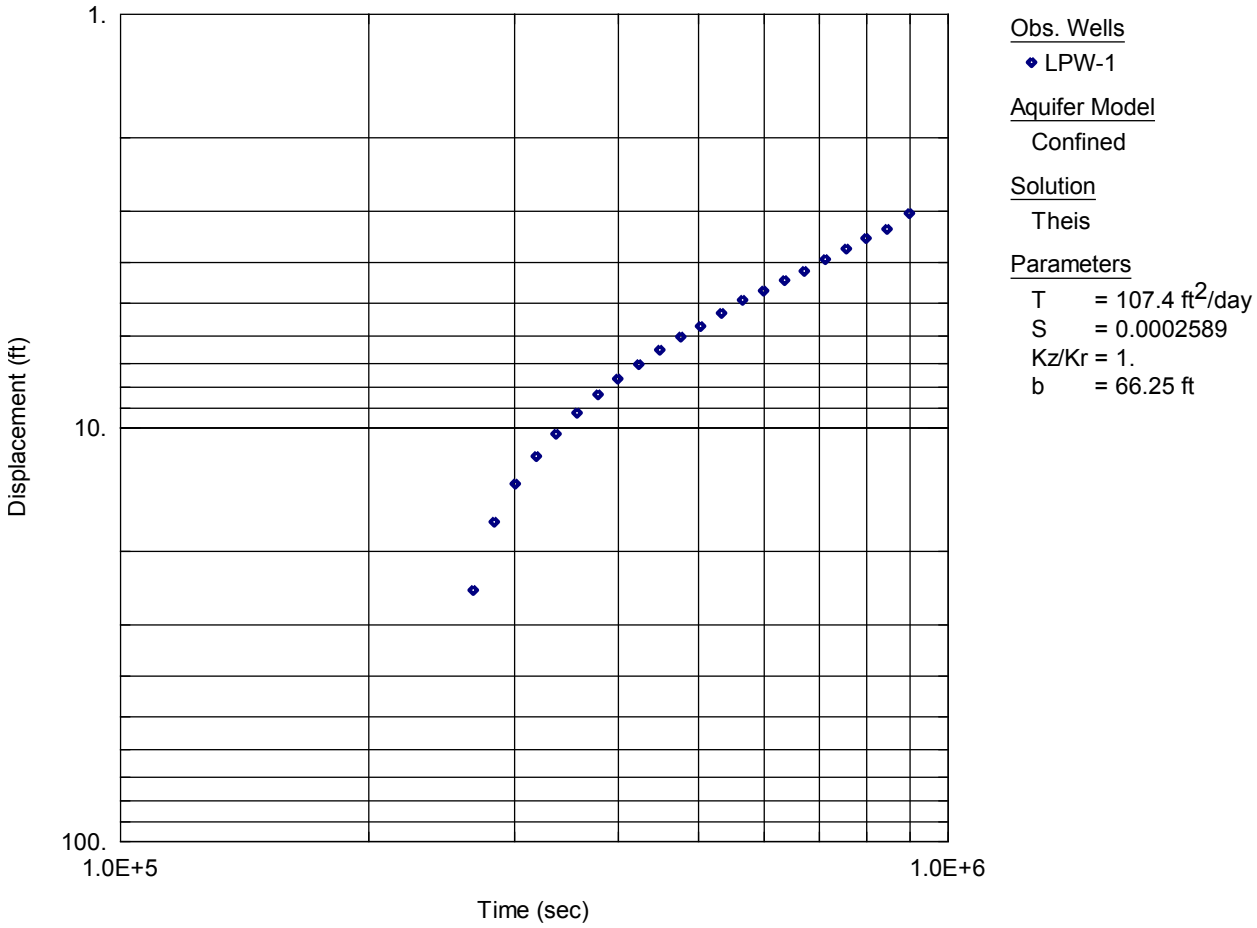


Figure 3: Leuenberger 80 Sand LMP-1 Observation Well Drawdown

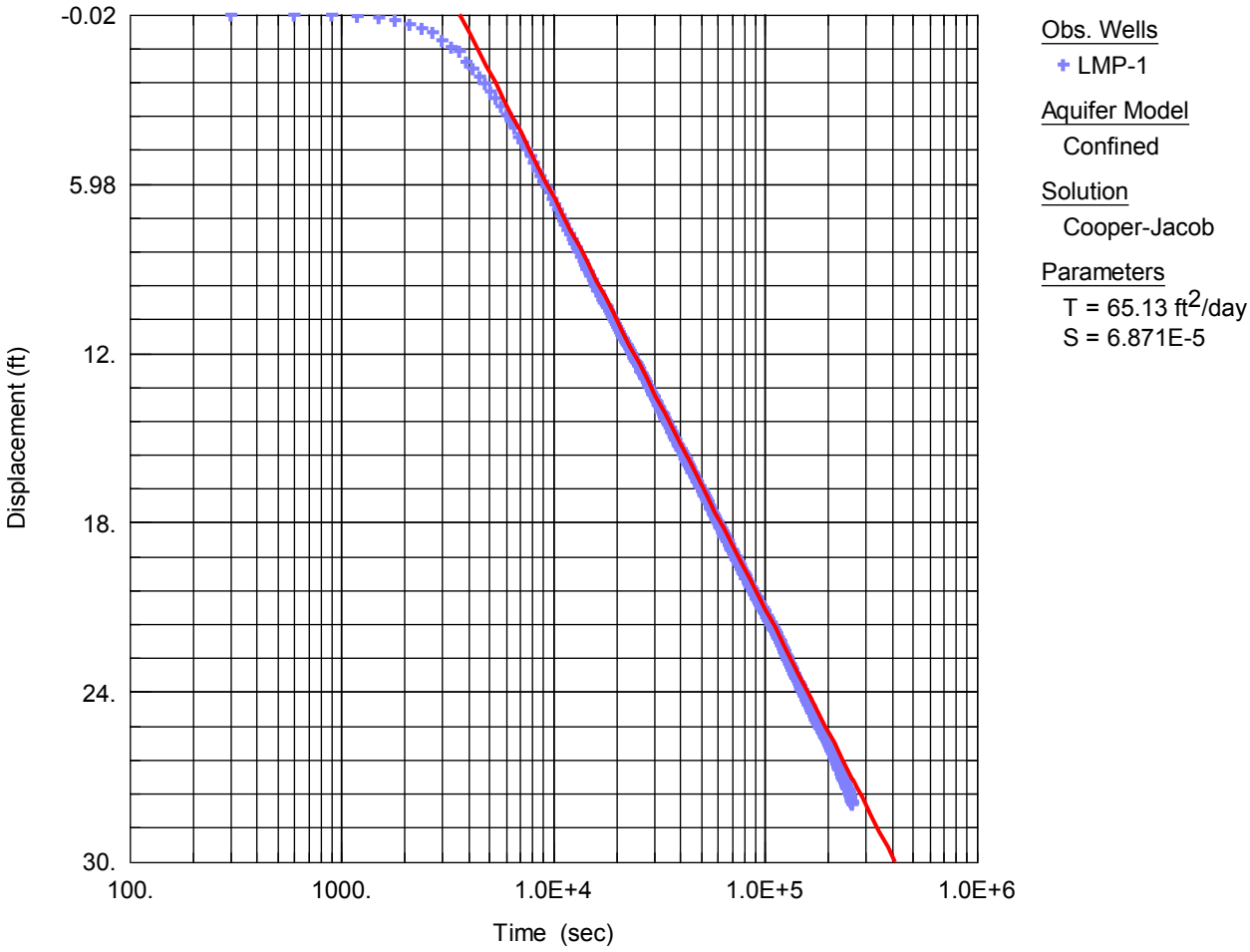


Figure 4: Leuenberger 80 Sand LMP-1 Observation Well Recovery

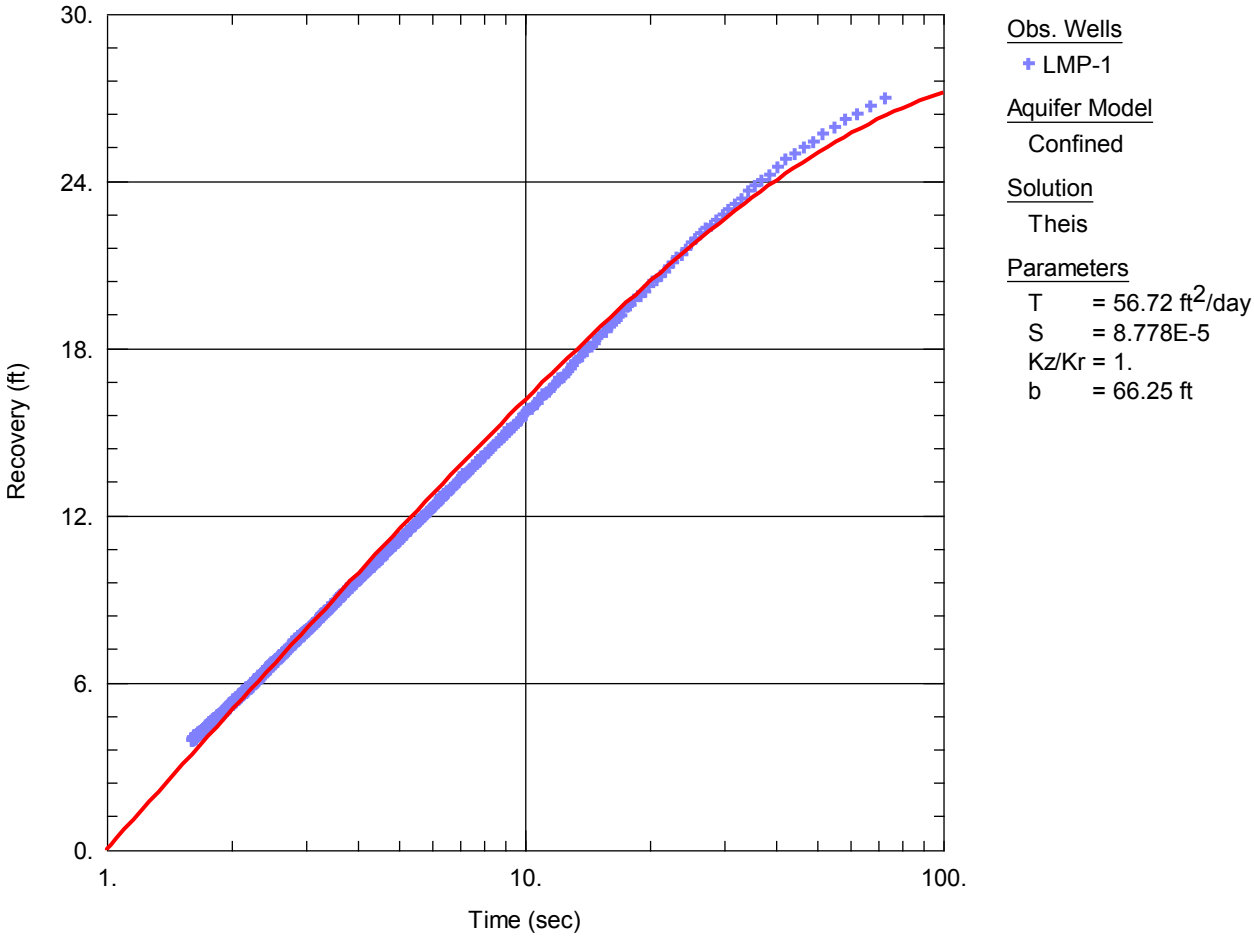


Figure 5: Leuenberger 90 Sand LPW-2 Pumping Well Drawdown

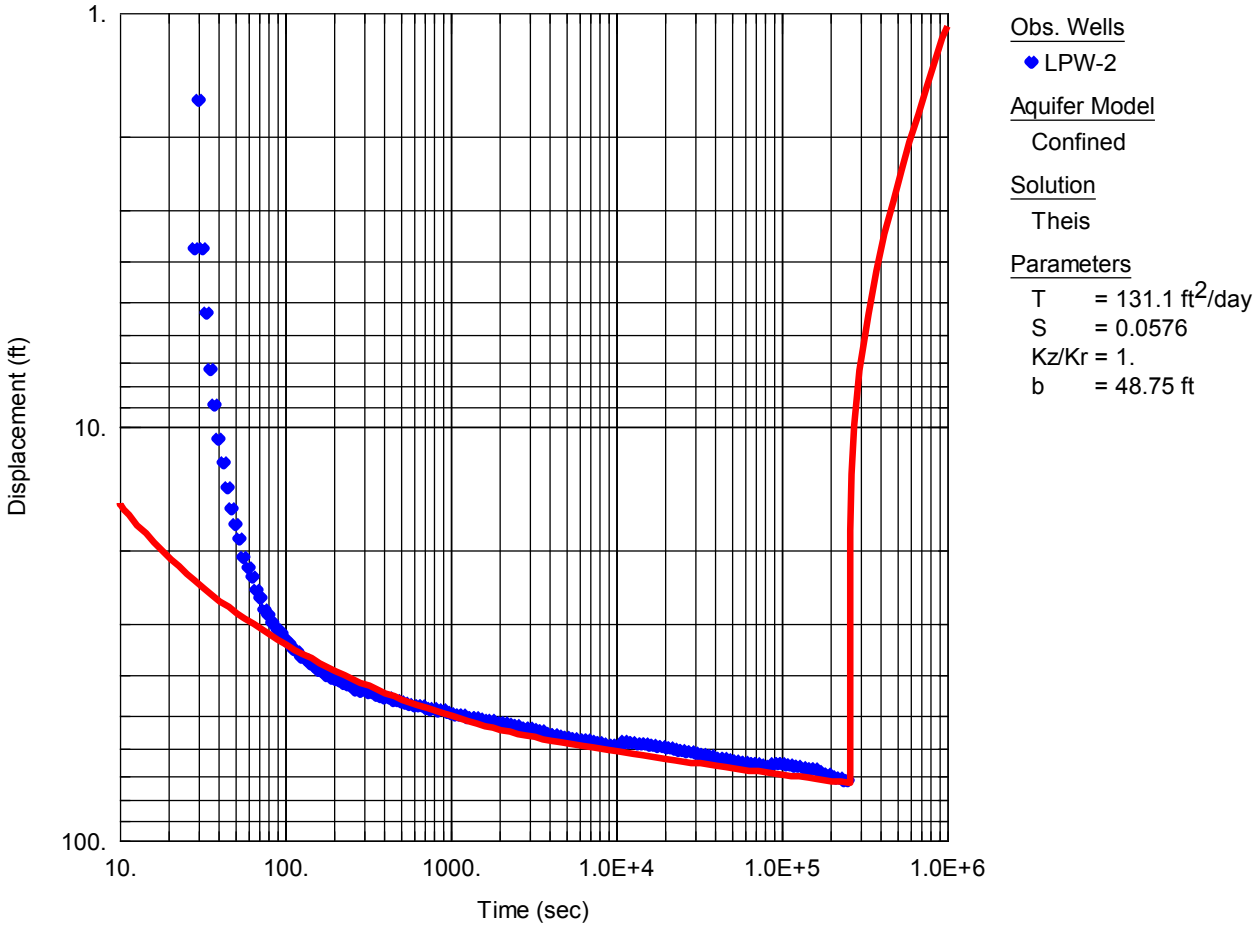


Figure 6: Leuenberger 90 Sand LPW-2 Pumping Well Recovery

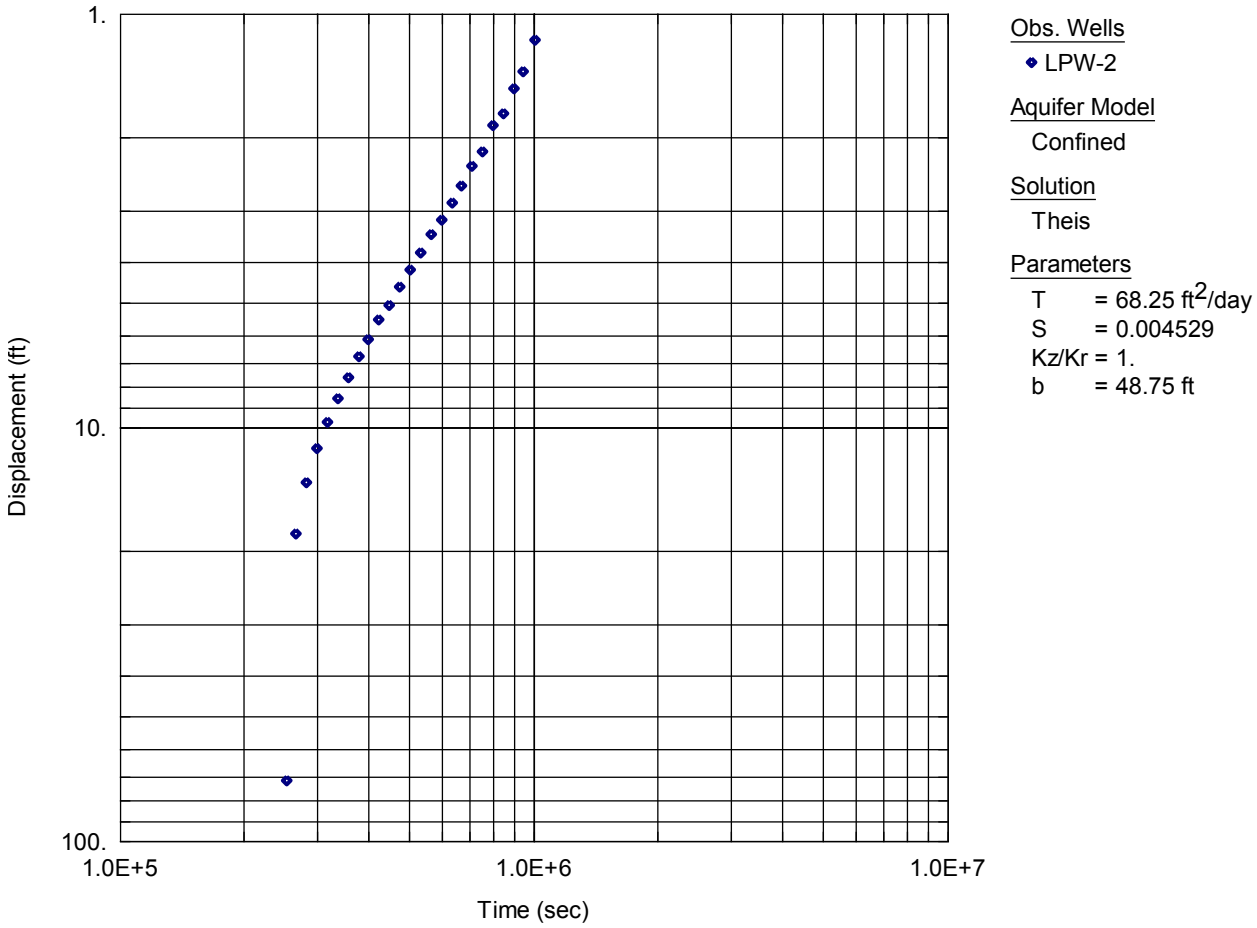


Figure 7: Leuenberger 90 Sand LMP-3 Observation Well Drawdown

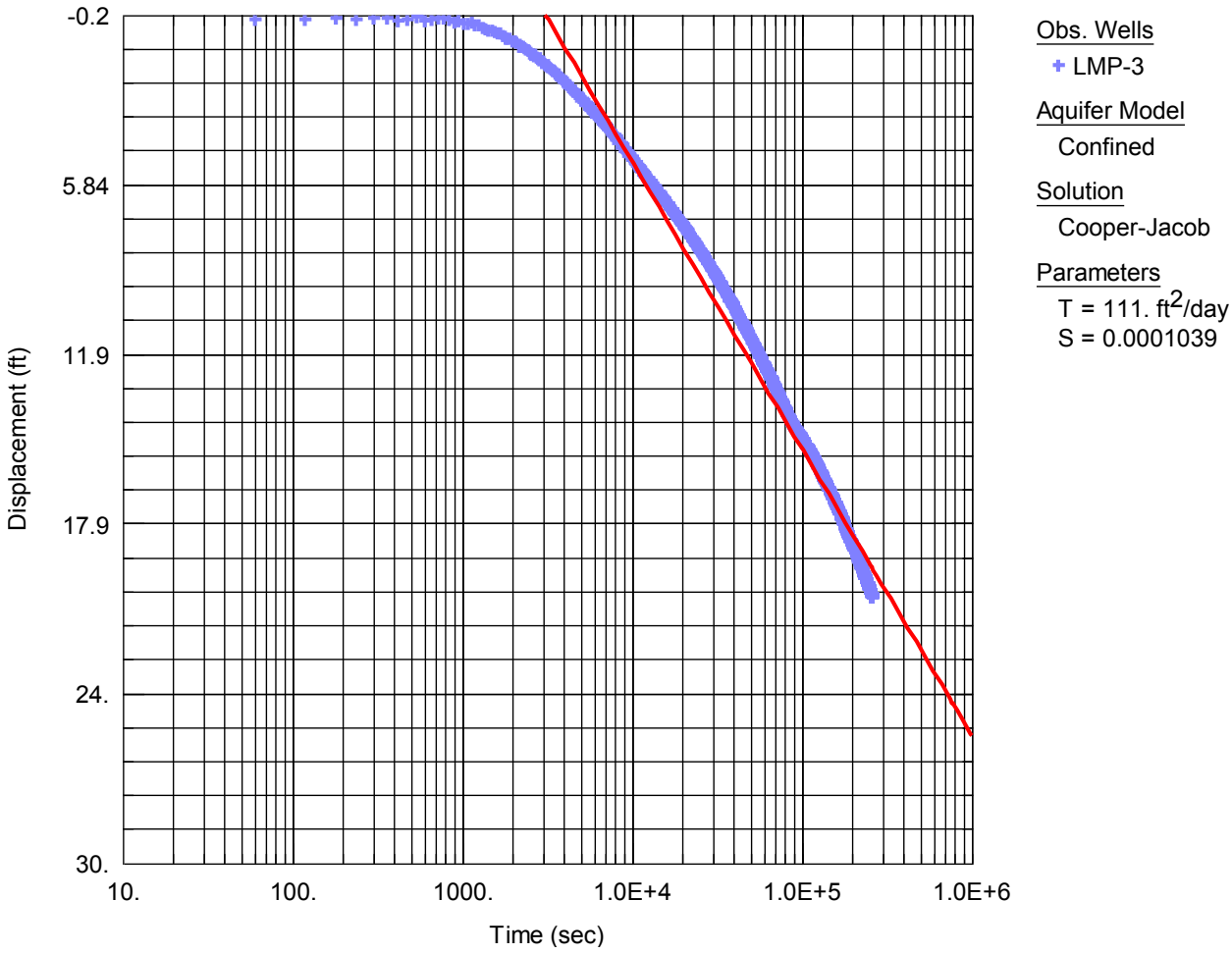
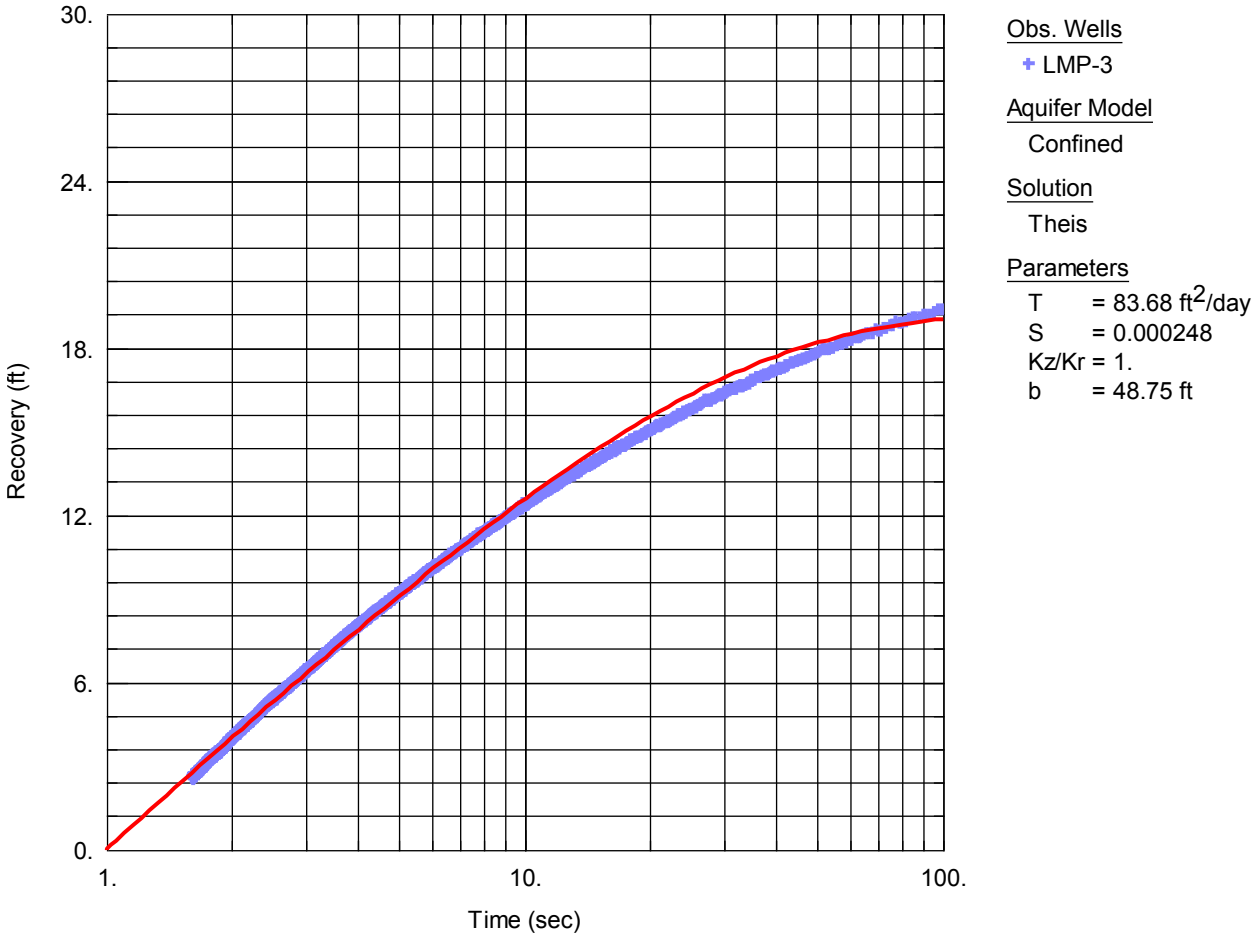


Figure 8: Leuenberger 90 Sand LMP-3 Observation Well Recovery



RAI-2

Description of Deficiency

The information provided in TR Section 2.7.2 does not meet the applicable requirements of 10 CFR 40.41(c), using the review procedures in Section 2.7.2 and acceptance criteria in Section 2.7.3 of the SRP.

Basis for Request

For the 70 sand aquifer test at LPW-3a, Uranium One provided the water level vs time curves for the pumping well and all of the observation wells for the pumping and recovery periods in Figure 6-17 through 6-21 of Appendix A-2. Uranium One also provided the aquifer test data in electronic form on CD. These plots are useful for a quick check of the well response to pumping and atmospheric conditions; however, the plots were insufficient for the staff to evaluate the aquifer response as the time scale was oddly set as a log scale of the Julian date which repeated for several points instead of the usual log scale in minutes. Uranium One also provided a Cooper Jacob analysis of the recovery data of one observation well, LMP-5 in Appendix A-4. The residual drawdown of greater than one at t/t'= 1 and value of S/S' =0.57 value for this analysis is outside the range considered acceptable for the assumptions inherent to this analysis and may be indicative of a limited aquifer (Driscoll, 1986). The TR did not address this issue. Staff finds that the information provided for the 70 sand aquifer test at LPW-3a is not sufficient to assess the hydrologic characteristics of these aquifers.

Formulation of RAI

Uranium One should provide traditional time drawdown curves on semi-log time scale for all observation wells for the 70 sand aquifer test at North Platte Satellite. Provide recovery curves on semi-log time scale for the pumping well and the observation wells. In addition, analyze all curves for transmissivity and storage coefficient and provide these values. If any boundary effects or leakage are noted, describe and reassess the hydrogeologic characteristics of the 70 sand at the North Platte Satellite.

RAI-31 Response

Uranium One has re-evaluated and subsequently re-plotted the drawdown curves on semi-log scales for aquifer test pumping wells and related observation wells completed in the 70, 80, and 90 sands located on the Leuenberger, Peterson, and North Platte sites.

Curve matching was performed on the new plots, resulting in transmissivity (T), hydraulic conductivity (K), and storativity (S) values that closely match the geologic conditions of the clay, silt, sand and gravel aquifer systems being evaluated.

The discussion plus Figures 8 through 12 relating to the North Platte 70 Sand pumping well LPW-3A and observation well LMP-5 can be found in this response. Other discussions and figures related to drawdown and recovery of pumping wells and observation wells can be found in the responses to RAIs 25 and 39.

Discussion

Uranium One has performed a reanalysis of recovery for Observation Well LMP-5 utilizing Theis analysis. Results for T, S and K for LMP-5 have been re-calculated and are as follows: T value of 52.39 ft^2/day; an S value of 3.62E-04; and a K value of 1.22 ft/day. An S value of 3.62E-04 falls in the range of an aquifer matrix composed of silt, sand and clay. A K value of 1.22 ft/day falls in the range of a semi-consolidated, moderately sorted, fine, silty to clean sand. A K value in this range may also possess a minor clay component to the matrix. A T value of 52.39 ft^2/day is consistent with the above K value 1.22 ft/day. T is the volume of water flowing through a cross-sectional area of an aquifer that is 1 ft. multiplied by the aquifer thickness (b), under a hydraulic gradient of 1 ft/1 ft in a given amount of time (typically 1 day). Given the definition of hydraulic conductivity, T is actually equal to hydraulic K multiplied by the aquifer thickness (b). This can be denoted as T = Kb. Also, T can be expressed as ft^2/day because if T = Kb, then T = (ft/day)(ft/1). In this example for LMP-5, T = 1.22 ft/day X 42.75 ft = 52.16 ft^2/day. This value is equivalent to the calculated value for T (by Theis analysis) of 52.39 ft^2/day. Given the presence and geologic nature of deeply buried, braided paleo stream channel systems (composed of lenses of clay, silt, sand and gravel, which are interspersed and lie adjacent to, and can grade into one another), the new recalculated values for T, S, and K with respect to LMP-5 are consistent with this type of geologic environment and aquifer characteristics.

Figure 9: North Platte 70 Sand LPW-3A Pumping Well Drawdown

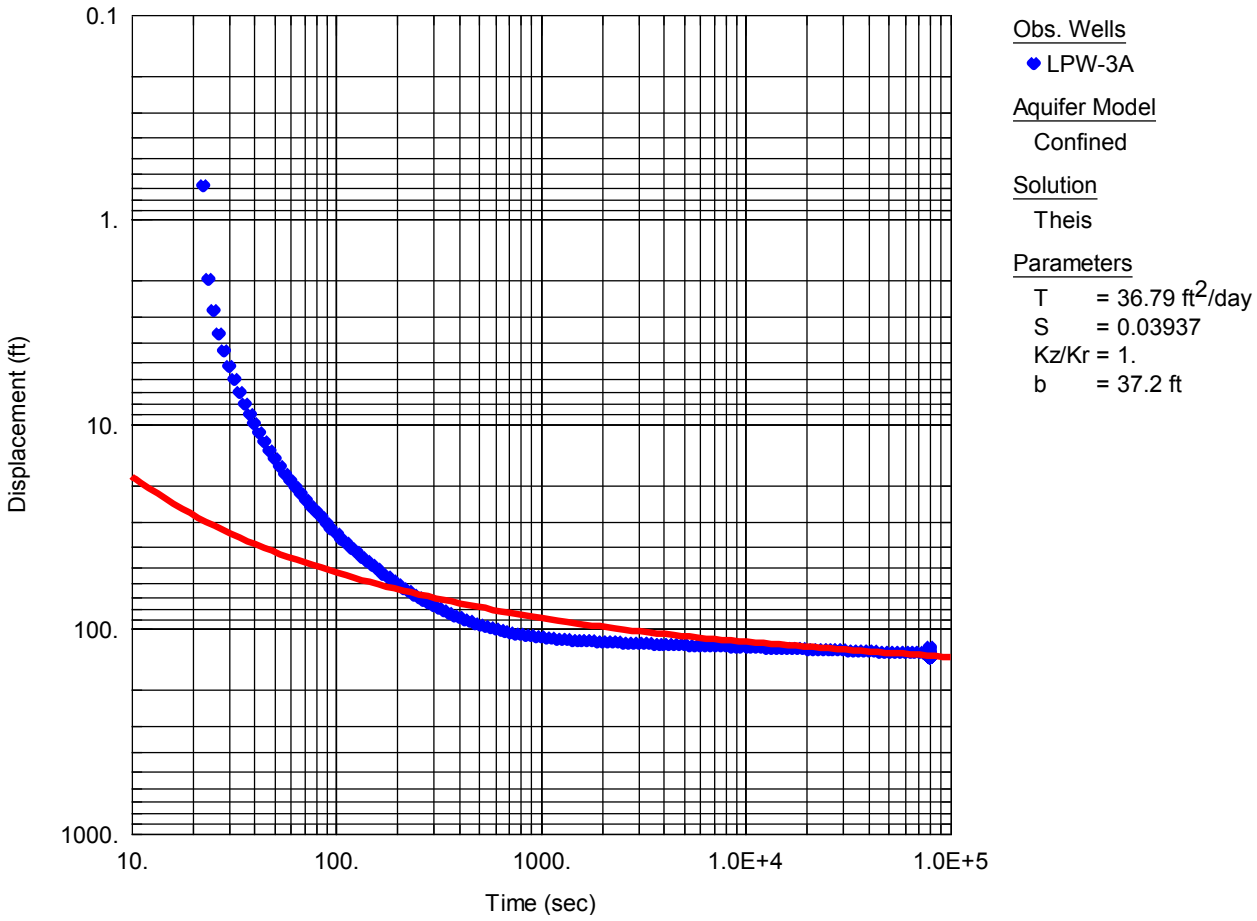


Figure 10: North Platte 70 Sand LPW-3A Pumping Well Recovery

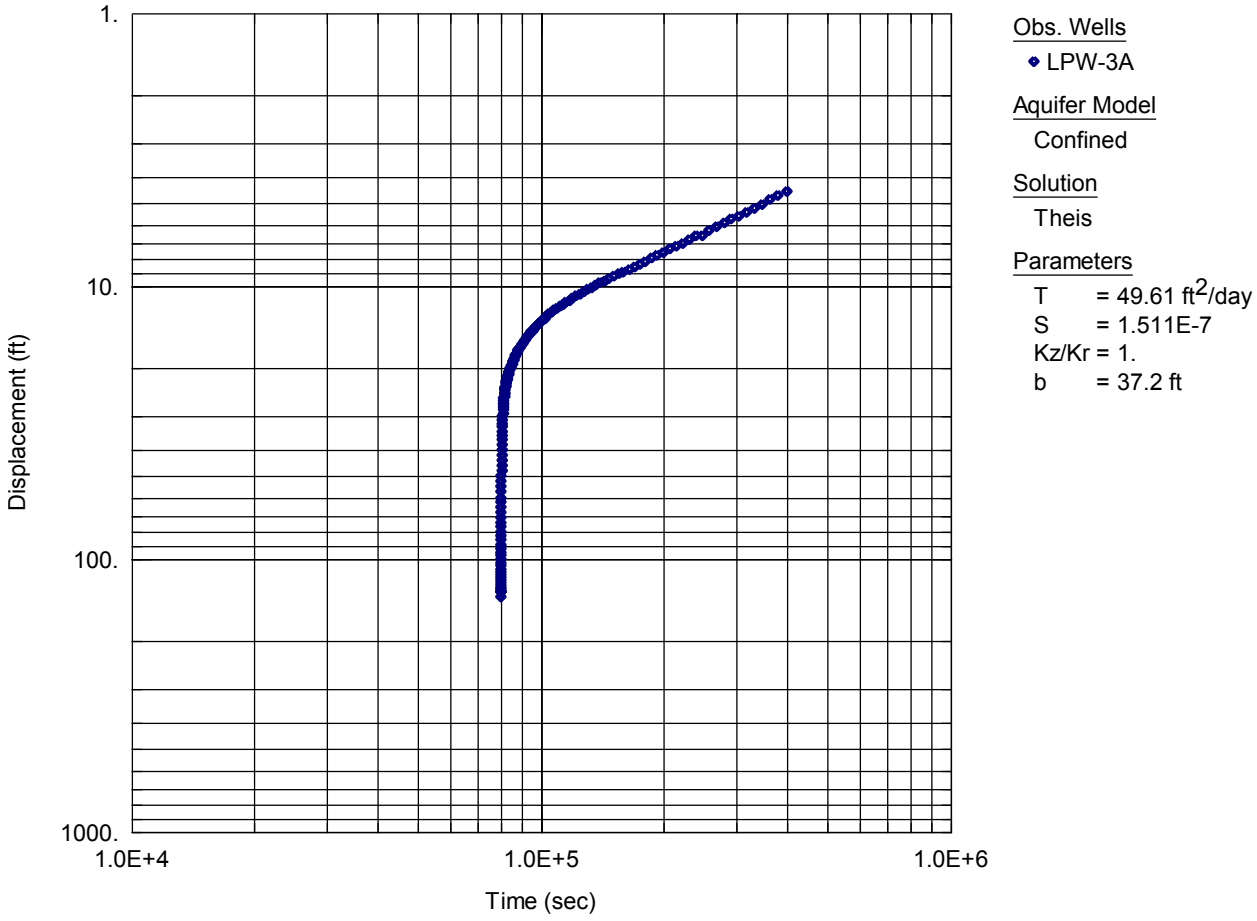


Figure 11: North Platte 70 Sand LMP-5 Observation Well Drawdown

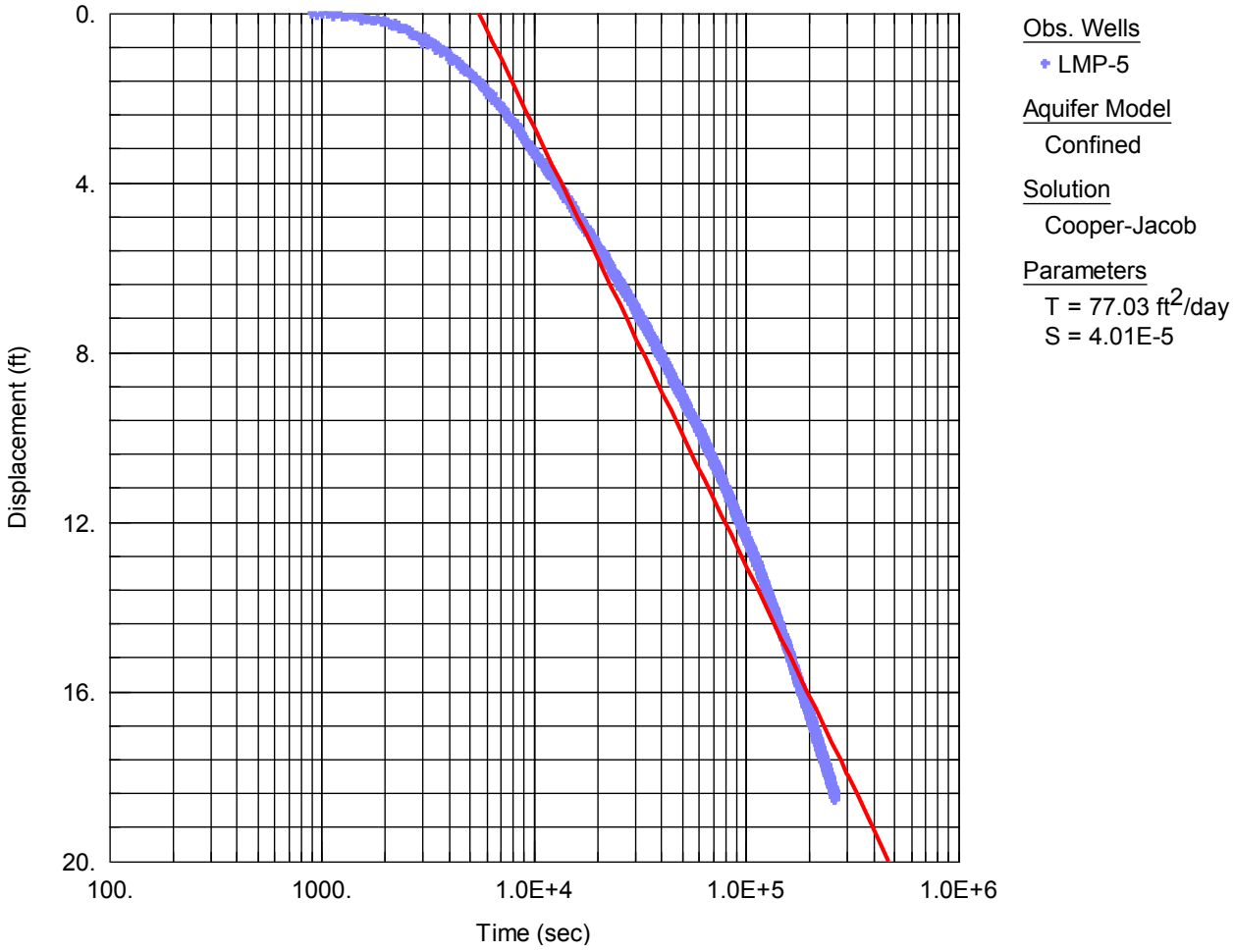
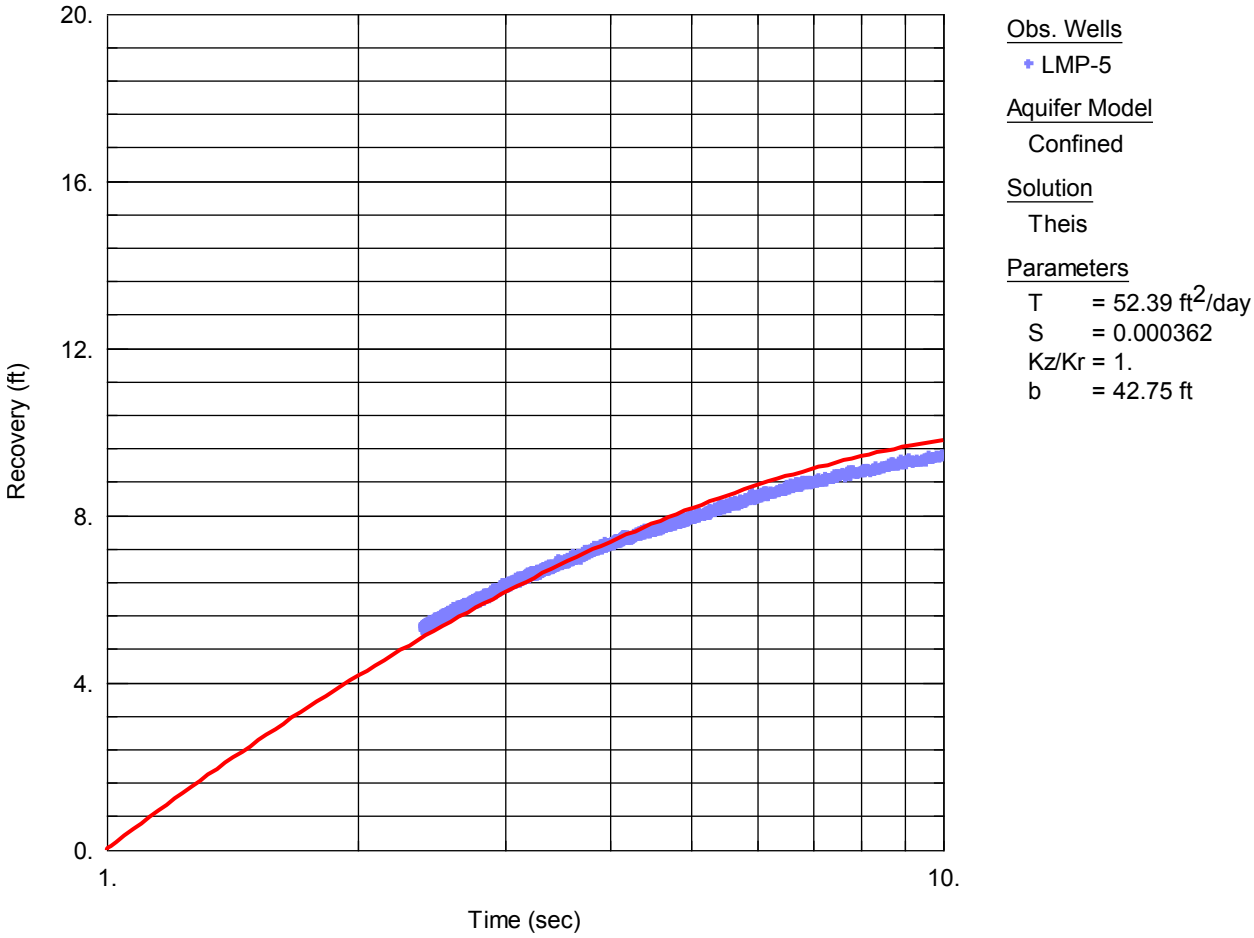


Figure 12: North Platte 70 Sand LMP-5 Observation Well Recovery



RAI-3

Description of Deficiency

The information provided in TR Section 2.7.2 does not meet the applicable requirements of 10 CFR 40.41(c), using the review procedures in Section 2.7.2 and acceptance criteria in Section 2.7.3 of the SRP.

Basis for Request

The TR provides pumping test data and results from a 2008 pumping test conducted in the 90 sand in the Peterson Satellite. The pumping well, LPW-4 and observation wells, LMP-6 and LMP-7 for the 90 sand were located in proposed Wellfield 2 as shown on application Figure 2.7-22. Only one observation well was located in the underlying 80 sand next to the pumping well. The TR indicates there was no overlying monitoring well as there is no overlying aquifer in the location. Two ore zone aquifer observation wells, LMP-6 and LMP-7 were located in the 90 sand at 334 and 228 ft, respectively, from the pumping well. For the 90 sand aquifer test at LPW-4, the TR provides the water level vs time curves for the pumping wells and all of the observation wells for the pumping and recovery periods in Figures 6-22 through 6-25 of Appendix A-2. These plots are useful for a quick check of the well response to pumping and atmospheric conditions; however, the plots are insufficient for staff to evaluate the aquifer response as the time scale was oddly set as a log scale of the Julian date which repeated for several points instead of the usual log scale in minutes.

The TR provides a Cooper Jacob analysis of the recovery data of one observation well, LMP-7, in Appendix A-4. The value is substantially lower than the transmissivity reported in the 90 sand at the Leuenberger Satellite, 94.85 vs 18.11 ft2/day. The staff is concerned with the analysis and results of this aquifer test for several reasons. The recovery plot analysis of LMP-7 in Appendix A-4 shows a large t/t' at zero drawdown and an S/S' =1.34. Both of these values are outside the range considered acceptable for the assumptions inherent to this analysis. These values are indicative of an aquifer with a varying storage coefficient which may indicate the aquifer is unconfined (Driscoll, 1986). The staff evaluated the recovery water level data provided by Uranium One for both the pumping well and the LMP-7 monitoring well. Staff's analysis indicates that the curves show evidence of the delayed yield expected in an unconfined aquifer in the recovery. Finally, the test was conducted at rate of 8.9 gpm, which is half the aquifer test rate at the other satellites. The staff is concerned that Uranium One used this lower rate to avoid drawdown which would dewater the 90 sand aquifer. The Staff finds the information

provided is not sufficient to review the 90 sand aquifer test at LPW-4 at the Peterson Satellite. Staff cannot evaluate or provide reasonable assurance for the safety of operations at this satellite without an evaluation of unconfined aquifer behavior in the 90 sand at the Peterson Satellite.

Formulation of RAI

Uranium One should:

- *Provide traditional time drawdown curves on semi-log time scale for all observation wells;*
- *Provide recovery curves on semi-log time scale for the pumping well and the observation wells;*
- *Analyze all curves for unconfined aquifer behavior;*
- *Provide transmissivity, specific yield and storage coefficient values from the analysis for all wells; and*
- *Describe and reassess the hydrogeologic characteristics of the 90 sand at the Peterson Satellite, if unconfined behavior is demonstrated.*

RAI-39 Response

Uranium One has re-evaluated and subsequently re-plotted the drawdown curves on semi-log scales for aquifer test pumping wells and related observation wells completed in the 70, 80, and 90 sands located on the Leuenberger, Peterson, and North Platte sites. Curve matching was performed on the new plots, resulting in transmissivity (T), hydraulic conductivity (K), and storativity (S) values that closely match the geologic conditions of the clay, silt, sand and gravel aquifer systems being evaluated.

The following discussion in addition to Figures 13 through 16 relating to the Peterson 90 Sand pumping well LPW-4 and observation well LMP-7 can be found in this response. Other discussions and figures related to drawdown and recovery of pumping wells and observation wells can be found in the responses to RAIs 25 and 31.

Discussion

Uranium One has performed a reanalysis of recovery for Observation Well LMP-7 utilizing Theis analysis. From this reanalysis, there are no indicators in the recovery curve to indicate a delayed yield characterize by an “S” shaped curvature to the recovery curve’s profile. Likewise, there are no similar indicators in the drawdown or recovery

data to denote an unconfined aquifer system at this location with respect to LMP-4 and LMP-7. Since unconfined aquifer conditions have not been proven to exist with the current data analysis, specific yields for unconfined, water table, aquifer systems were therefore not calculated.

Results for T, S and K for LMP-7 have been re-calculated and are as follows: T value of 24.48 ft^2/day; an S value of 1.21E-04; and a K value of 0.66 ft/day. An S value of 1.21E-04 falls in the range of an aquifer matrix composed of silt, sand and clay. A K value of 0.66 ft/day falls in the range of a semi-consolidated, moderate to poorly sorted, fine, silty to clean sand. A K value in this range may also possess a minor clay component to the matrix. A T value of 24.48 ft^2/day is consistent with the above K value 0.66 ft/day. T is the volume of water flowing through a cross-sectional area of an aquifer that is 1 ft. multiplied by the aquifer thickness (b), under a hydraulic gradient of 1 ft/1 ft in a given amount of time (typically 1 day). Given the definition of hydraulic conductivity, T is actually equal to hydraulic K multiplied by the aquifer thickness (b). This can be denoted as T = Kb. Also, T can be expressed as ft^2/day because if T = Kb, then T = (ft/day)(ft/1). In this example for LMP-7, T = 0.66 ft/day X 37.20 ft = 24.55 ft^2/day. This value is equivalent to the calculated value for T (by Theis analysis) of 24.48 ft^2/day. Given the presence and geologic nature of deeply buried, braided paleo stream channel systems (composed of lenses of clay, silt, sand and gravel, which are interspersed and lie adjacent to, and can grade into one another), the new recalculated values for T, S, and K with respect to LMP-7 are consistent with this type of geologic environment and aquifer characteristics.

The results of aquifer properties with respect to Observation Well LMP-3 (90 Sand – Leuenberger) and Observation Well LMP-7 (90 Sand – Peterson) were performed. Results for T, S and K for LMP-3 have been re-calculated and are as follows: T value of 83.68 ft^2/day; an S value of 2.48E-04; and a K value of 1.71 ft/day. An S value of 2.48E-04 falls in the range of an aquifer matrix composed of silt, sand and clay. A K value of 1.71 ft/day falls in the range of a semi-consolidated, moderately sorted, fine, silty to clean sand. A K value in this range may also possess a minor clay component to the matrix. From the above analysis, results for T, S and K for LMP-7 have been re-calculated and are as follows: T value of 24.48 ft^2/day; an S value of 1.21E-04; and a K value of 0.66 ft/day. An S value of 1.21E-04 falls in the range of an aquifer matrix composed of silt, sand and clay. A K value of 0.66 ft/day falls in the range of a semi-consolidated, moderate to poorly sorted, fine, silty to clean sand. A K value in this range may also possess a minor clay component to the matrix. As previously stated, these values are

consistent with an aquifer composed of deeply buried, braided paleo stream channel systems (composed of lenses of clay, silt, sand and gravel, which are interspersed and lie adjacent to, and grade into one another), indicative of aquifers present in this region of Wyoming. Given the highly variable nature of such aquifer systems as previously discussed, it is expected and not unusual to see values for T, S, and K to vary to some degree. Given the considerable distance between LMP-3 and LMP-7 (34,862 ft), and when taking into consideration this type of geologic environment and aquifer characteristics that can change substantially over short distances, it would be unreasonable to expect these two wells to display near equivalent parameters. Additionally, the thickness of the 90 Sand aquifer between LMP-3 (48.75 ft) and LMP-7 (37.2 ft), a difference of 11.55 feet, will also have an effect on aquifer characteristics and performance. However, as previously discussed in detail, both LMP-3 and LMP-7 illustrate an aquifer system composed of similar earth materials in its matrix, and T, S, and K values are consistent with the aquifer systems present (paleo braided stream channels and outwash fans) at this location and in this region of Wyoming.

Figure 13: Peterson 90 Sand Pumping Well LPW-4 Drawdown

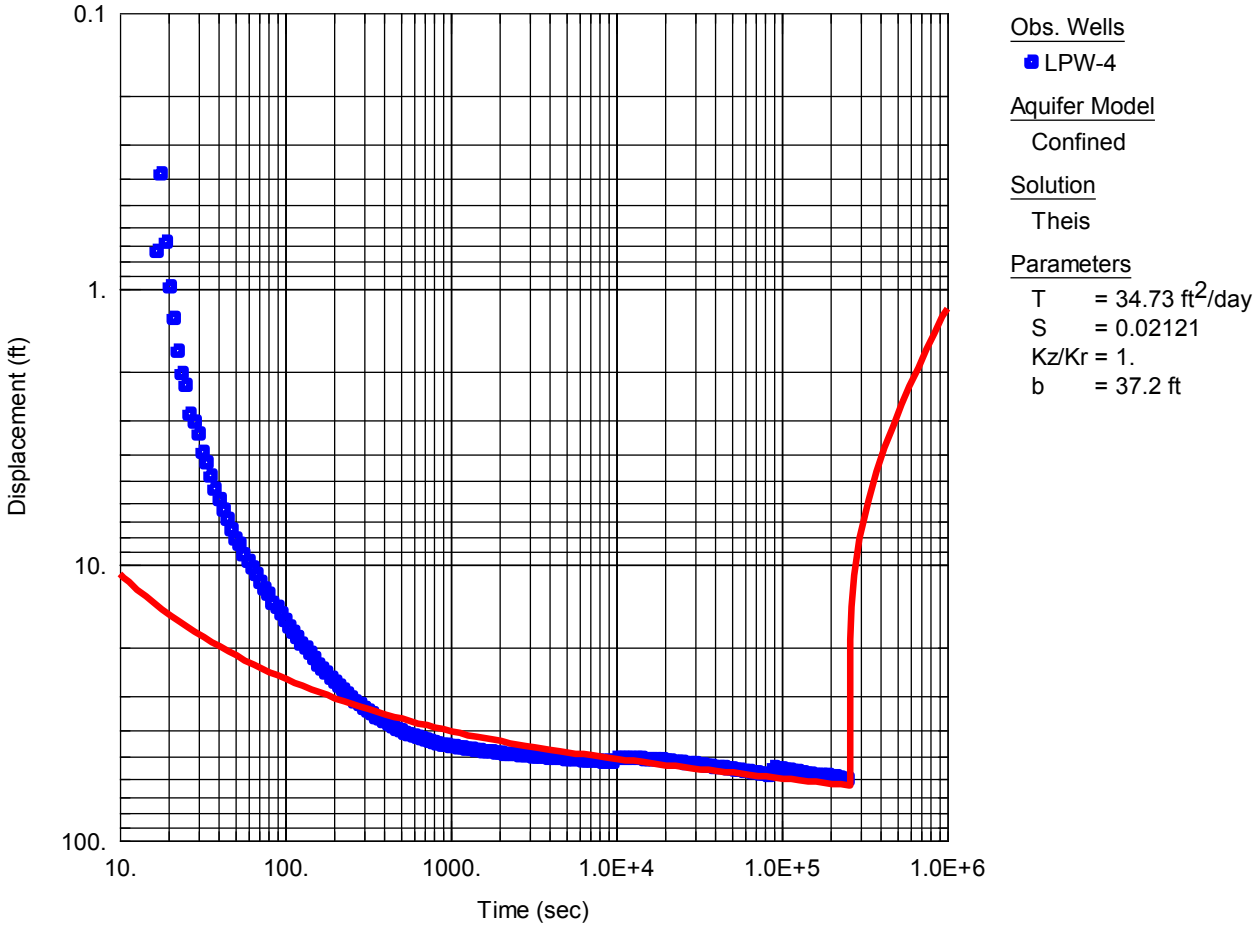


Figure 14: Peterson 90 Sand LPW-4 Pumping Well Recovery

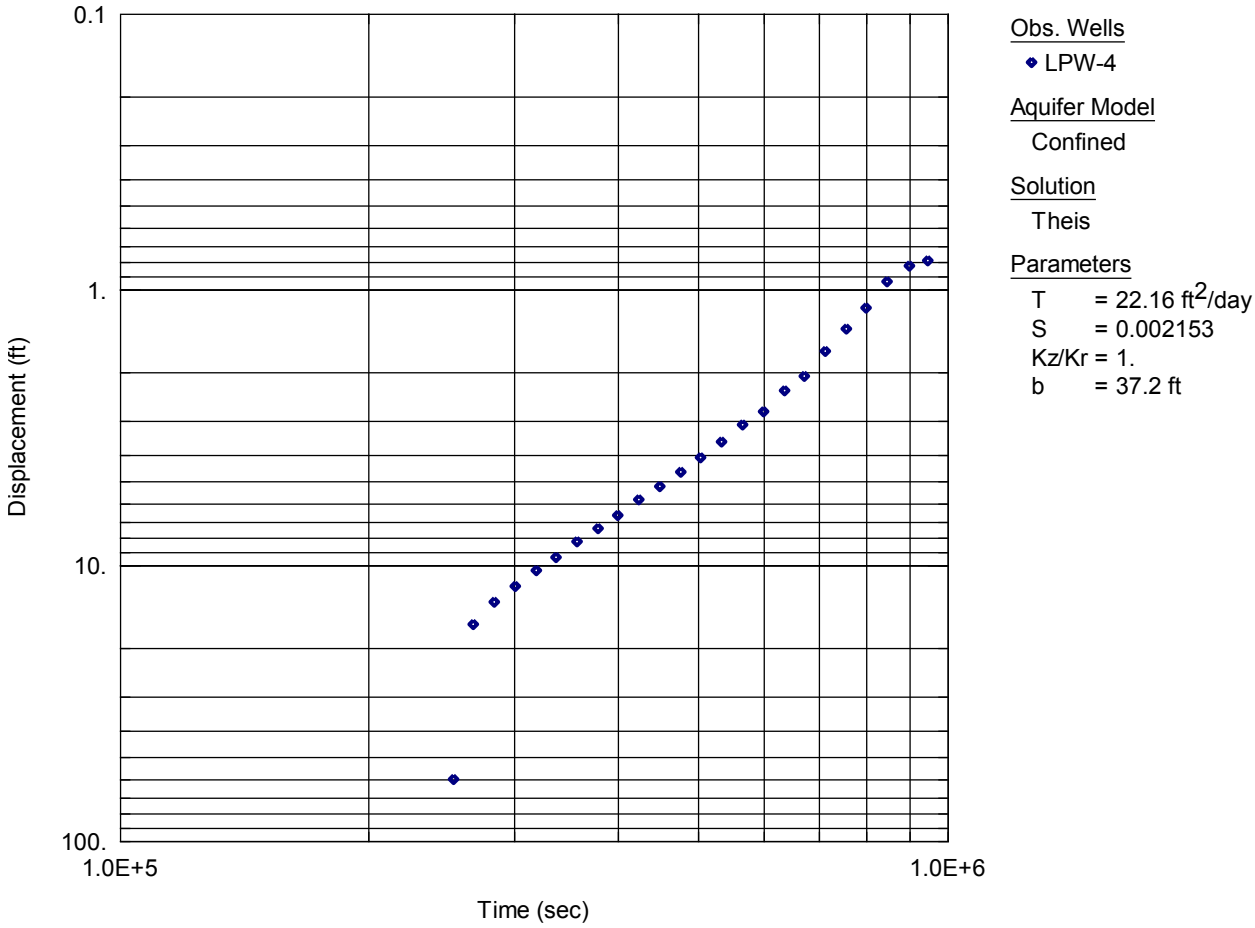


Figure 15: Peterson 90 Sand LMP-7 Observation Well Drawdown

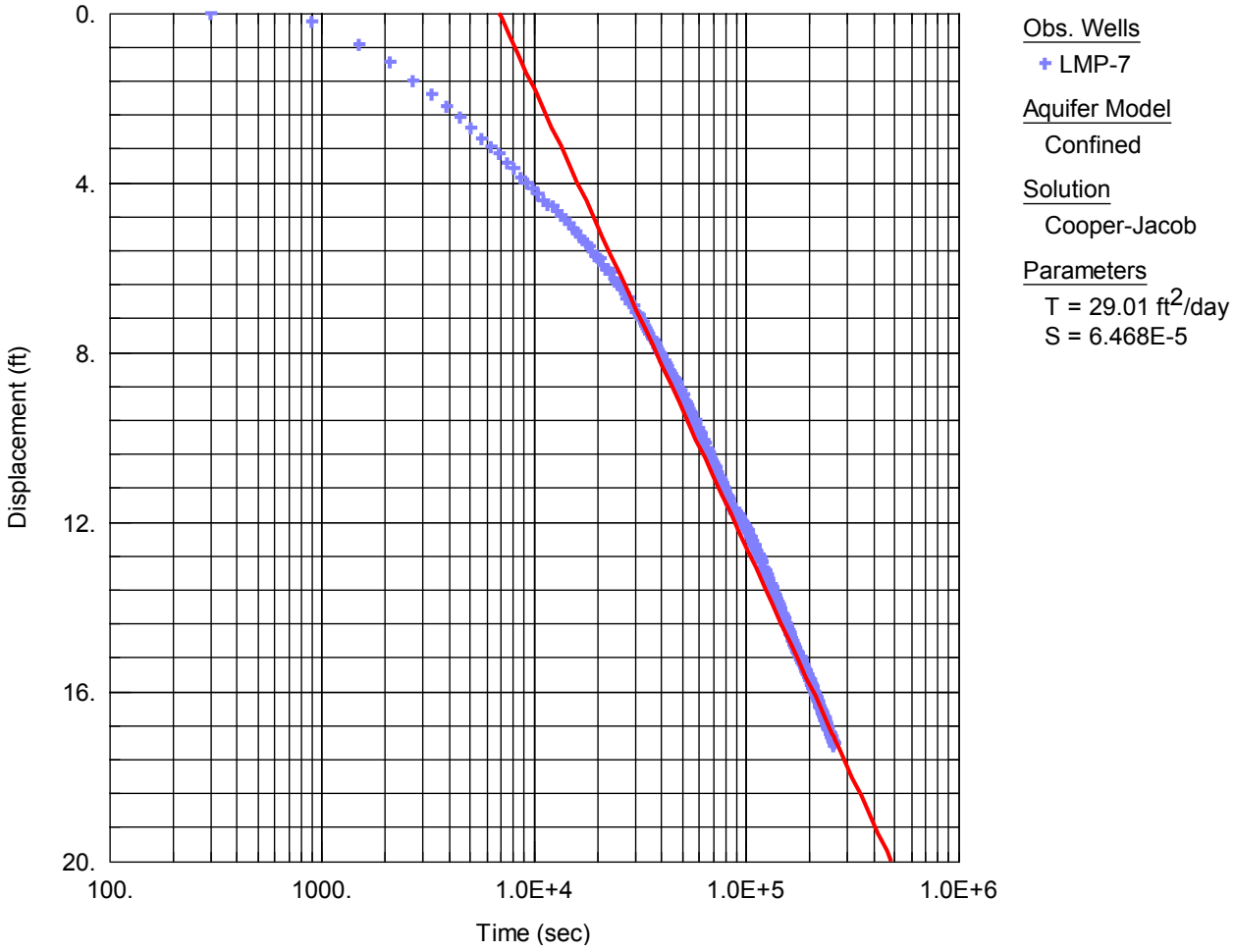


Figure 16: Peterson 90 Sand LMP-7 Observation Well Recovery