Analysis of the Litchfield, Minnesota Well 2 (607420) Aquifer Test

CONDUCTED ON JUNE 29, 2017
CONFINED QUATERNARY GLACIAL-FLUVIAL SAND AQUIFER

DEPARTMENT OF HEALTH

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Data Collection and Analysis

The constant-rate pumping test of Litchfield 2 (607420) was conducted as described below. The representative aquifer properties are summarized in Table 1. The specifics of test location, scope, and timing are presented in Table 2 and Table 3. The associated data files and a comparison of manual and transducer measurements are presented in Table 4. The results of analyses are presented in Appendix 1 and are summarized in Table 5. The analyses used standard methods, cited in references. The figures include maps, field notes, other documentation, and records of well construction.

Description

Purpose of Test

The test of Litchfield 2 was conducted by the Minnesota Department of Health (MDH) Source Water Protection Unit as a small part of a long-term project that was led by the United States Geological Survey (USGS). The overall purpose of the study was to assess the rates of groundwater recharge through low-conductivity glacial sediments (till) at various sites in Minnesota.

Specific to Litchfield, nine observation wells were installed by the USGS in 2015. Water elevations were recorded on a one-hour interval in seven of these wells for approximately one-year. The USGS had completed its data collection and was preparing to seal the observation wells. Prior to sealing the wells, notification was provided to the partner agencies relative to the completion of the work. At that time, staff in the Source Water Protection Unit recognized that this configuration of observation wells is nearly ideal for conducting short-term constant-rate aquifer tests on Public Water Supply (PWS) wells so as to estimate vertical groundwater flow. Therefore prior to sealing the wells, MDH proposed to conduct tests that would complement the USGS data collection efforts.

Well Inventory

The well records are presented in Figures 46-62 and the well construction is summarized in Table 22. The site plan is shown in Figure 16.

Hydrogeologic Setting

A schematic section (geologic cross-section) through the test site is shown on Figure 17 to illustrate the three layers that comprise the flow system; water table, aquitard, aquifer, and the construction of wells within these layers.

Other Interfering Wells

Other high capacity wells exist in the area that may cause interference. These wells are associated with the First District dairy processing in the center of Litchfield (to the south of the wellfield), and the Desens crop irrigation well (to the east of the wellfield). Several smaller domestic and non-community supply wells exist in the area. However, based on previous testing these smaller wells are not judged to present significant interference. Mr. Desens was contacted prior to the test to gain access to the observation well on his property. This well contains a transducer and water level data over the test period was obtained with the assistance of Minnesota Department of Natural Resources (MDNR).

Test Setup

The USGS provided the pressure transducers and data loggers used for long-term monitoring, re-programmed to a one-minute interval. MDH hydrologists, Justin Blum and Luke Pickman, traveled to Litchfield on June 13, 2017 to assess site conditions and re-install the transducers to collect background water level and barometric data. Transducers were placed in all existing observation wells, with the exception of USGS 2-E.

Access to Litchfield 2 is provided by a 0.75-inch polyethylene tube. The restricted diameter of this tube did not allow a transducer to be placed in the well to monitor water levels even though manual measurements were easily made. The three additional PWS wells in the wellfield; 3, 4 and 5, are similarly constructed and equipped. A prior test of Litchfield 2 was conducted by a geotechnical consultant (ECAD, 1998) and the observation well from that testing still exists a short distance from Well 2. Because of these factors; access to the wells, prior tests, and the relative distance of the observation wells, Litchfield 2 was selected to be the pumping well for this test.

The water operator, Mr. Herb Watry, was not comfortable with a standard test schedule; 24-hours of rest, 24-hours of pumping and 24-hours of recovery, because of system water demand and the limitations of the city water treatment plant. Extensive discussions with the operator indicated that an abbreviated pumping and recovery period of 4 to 6 hours each was possible and would still provide sufficient capacity. On that basis, the test was tentatively scheduled to begin on June 23, 2017. However, a major storm event on June 22, 2017 and various other public works projects caused the start of testing to be put off for a week. Other preparations for the test continued; on June 22, 2017 an acoustic water level sensor was installed in Litchfield 2, and the transducer in the Desens observation well was set up on a five-minute interval with the assistance of MDNR staff.

Weather Conditions

Conditions were warm and mostly dry during background data collection. Rain events greater 0.2-inches were recorded on June 22th and 27th at the Litchfield Waste Water Treatment Plant. No appreciable precipitation occurred during the pumping and recovery periods of June 29th to June 30th, 2017.

Discharge Monitoring

The pumping rates of the wells were reported by the Litchfield water treatment plant SCADA system. This was supplemented by manual readings of the totalizing flow meter on the Well 2 discharge line.

Data Collection

MDH personnel mobilized for the test on 6/29/2017, arriving on-site at 11:00. Upon arrival, the system was not in a 'rest' state; Litchfield Wells 3 and 5 were pumping, and Wells 2 and 4 were off. [Well 4 remained out of service for repairs until 7/6.] Wells 3 and 5 were turned off at 12:16:30 to place the wellfield into a limited recovery. The Litchfield 2 pump was started at 6/29/2017 14:03:30 by hand control through the SCADA system. Water levels were collected manually from Litchfield Wells 3, 4, and 5 from 12:00 until 15:00. The operator turned off the Litchfield 2 pump at 20:00 and all city wells remained off until 6/30/2017 06:00. At that time the system was critically short of water and Wells 2, 3, and 5 were pumped intensively over the next day to restore reserve capacity.

The USGS transducers remained in the wells until 7/10/2017 when static levels were measured and all equipment was removed. Data were attempted to be downloaded from the transducers at Nest 2 prior to equipment removal but difficulties connecting to the data loggers caused the equipment to be pulled before downloading. Data from the Desens obwell was downloaded on 7/13/2017 by MDNR staff. (personal communication, Ari Berland, MDNR)

The comparisons of manual and transducer measurements are presented in Figures 15 through 33. Only one well saw a decline in water level below the transducer setting, USGS 1-E, Figure 26, affecting data collection after 7/6/2017. The batteries of the acoustic transducer in Litchfield 2 failed during the extended recovery period and data after 7/7/2017 were not recorded. However, the MDH transducer in the Litchfield monitoring well continued to function over the monitoring period to provide a continuous record at that location.

Time signatures of the data files were checked against the computer clock after the equipment was removed from the wells. It was found that the USGS data logger clocks lost between 40 and 58 seconds, an average of 50 seconds, over the 28-day data collection period. This small and nearly uniform time shift was judged to not strongly affect data over the short, 14-hour, test period. Otherwise, the USGS loggers performed as expected and the equipment was returned to the USGS Mounds View office on 7/11/2017.

After the test was complete, precipitation records from the WWTP were obtained and the operator generated reports from the SCADA system for daily pumping from the wells. The daily pumping totals were compared to readings from the totalizing flowmeter on Well 2. There is a significant difference in flow volume between these two sources. The SCADA average cumulative volume reported for Well 2 was 710 gpm. The reading from totalizer, 46 minutes after the start of pumping, was 787 gpm. The appropriate value to use for the analysis was evaluated by comparison to results from the 1998 test of Litchfield 2, ECAD - test 2209. The larger rate produced comparable transmissivity values to the earlier test and is considered to be more accurate.

Qualitative Aquifer Hydraulic Response

A general site plan is shown in Figure 16, identifying the wells monitored for this test. Distances between the pumping and observation wells are presented in Table 3. A schematic cross section is provided for visual context of the test conditions, Figure 17. Comparison of manual and transducer data are shown in, Figures 18 through 33, documenting the proper functioning of the equipment.

The differences between pre and post-test manual and transducer water levels from wells completed in the pumped aquifer were consistent, indicating little effect of cable stretch, transducer 'drift,' or other common problems. This was not the case for observation wells constructed in till, particularly in Nest 2, where static water levels were disturbed by

installation of the transducers. The instrumentation displaced water in the well casings similar to a 'slug' injection. This disturbance dissipated over a time interval that varied according to the hydraulic conductivity of the materials in which the wells are constructed; from seconds to greater than 20 days. The USGS had analyzed these 'slug' tests during earlier parts of this study; therefore, additional slug analyses were not performed on this dataset.

The groundwater elevations in both nests showed a downward gradient, as expected, Figure 34 and Figure 35. There was a clear signal in all wells completed in the aquifer caused by the pumping of Litchfield 2, Figure 36 and Figure 37. As for the response in the till observation wells, the effects of pumping of Litchfield 2 was seen only at Nest 1, Figure 34. No response was seen in any of the till observation wells at Nest 2, Figure 35.

The possible influence on groundwater elevation from barometric pressure changes was evaluated, Figure 40. Barometric pressure varied little over the pumping test period. The range around the mean pressure was +/- 0.03 psi with a small upward trend of 0.05 psi. This variation is considered to have a negligible effect on water elevation and the data were not corrected for barometric efficiency.

Long-term trends in groundwater elevation were evaluated. The groundwater elevation in the shallow water-table observation well, USGS 1-B declined about 0.5 foot over the monitoring period, Figure 23. At Nest-2, the decline in well USGS 2-A was about 2 feet, Figure 28. The declines differed between the well nests; at Nest 1 the decline was linear, whereas Nest 2 saw a curvilinear decline – similar to a stream recession curve. The overall decrease in groundwater elevation at the water table appears to be an area-wide trend.

The vertical groundwater gradient is uniformly downward over the test area. At Nest 1, to the south of the wellfield, the ambient groundwater elevation difference is approximately 25 feet. During the test this difference increased by about 1 foot. Therefore, the incremental difference in the volume of leakage through the till as the result of this test is small relative to the ambient leakage.

Precipitation events are associated with small increases in groundwater elevation at both Nests 1 and 2, Figure 41. At Nest 2, the changes in elevation are seen to propagate downward, decreasing in magnitude with depth, in wells 2-B, 2-C, and 2-D, Figure 29, Figure 30, and Figure 31. This relationship holds true for Nest 1 also but is less pronounced, Figure 24 and Figure 25. The trend in the pumped aquifer is less clear because of the cycling of many pumping wells; but, groundwater elevation was relatively stable until 7/5/2017.

During the extended monitoring period, between 7/5 and 7/8/2017, groundwater elevation in the aquifer declined up to 10 feet, starting to recover on 7/9/2017, Figure 36. This event affected all wells constructed in the aquifer nearly equally. It was not associated with a marked increase in pumping from the Litchfield wellfield, Figure 42. The SCADA system reported an increase in total pumping volume over that period of about ten percent above average. Nor was it associated with any changes in flow from the First District dairy processing; as the waste water flow from that facility to the Litchfield WWTP was within the normal range over that time and no additional pumping was reported from First District wells. (personal communication, M. Geers, city of Litchfield and R. Albrecht, First District, Inc.) It was clearly not associated with pumping of the Desens irrigation well as that well remained off until about 7/12, after the time that water elevations had started to recover, Figure 33. The small differences in the response of the Desens obwell relative to other wells in the aquifer are probably associated with the return to service of Well 4, Figure 43 and Figure 44. Because of the magnitude and uniform effect of this change in water elevation, it can only be caused by a large discharge located at a large distance; greater than 2000 gpm, and at one mile or greater distance. During this analysis, the mystery of the source of this disturbance was referred to MDNR as it clearly has area-wide significance.

Subsequent discussions with the USGS verified that similar declines had occurred the previous year, Figure 45. In 2016, three episodes of water elevation decline similar in magnitude to that observed during this test occurred during the summer months, June, July and August. Comparison of these declines in water elevation to records of precipitation showed that they only occurred during dry times and on two occasions the recovery coincided with rain events. The declines are not strongly related to local pumping because the magnitude of the cycling of local wells is consistent throughout the year. Because these declines 1) regularly occur only in the summer months, 2) start during dry periods, and 3) recover after significant rainfall events, leads to the conclusion that they are the result of cumulative effects of area-wide irrigation pumping.

Quantitative Analysis

Traditional aquifer test analysis utilizes two main types of simple inverse models, transient and steady-state, see: selected references. When both types of models are used for the analysis (data permitting) - the aquifer hydraulic response may be proved consistent from the two perspectives and uncertainty in hydraulic properties is reduced.

Conceptual Model

The conceptual model for this test is of a layered leaky aquifer system with the majority of wells completed in two of three layers, as per the schematic section, Figure 17. The layers have distinctly different hydraulic characteristics. The first layer is composed of glacial drift and alluvium, which contains the water table. The second layer is the till which provides hydraulic confinement and recharge by leakage to the third layer. The third layer is the hydraulically-confined glacial outwash aquifer in which the production wells are constructed.

For the analysis of the confining layer data, it is preferred initially to use the simplest approach so as to introduce as few degrees of freedom as possible. The conceptual model of flow through the till is each well nest is analogous to a column of permeable material in the laboratory and flow is steady-state. For analysis of aquifer properties, the steady-state conceptual model leakage of a two-layer system is used [de Glee (1930) and Hantush-Jacob (1955)]. There is assumed to be no change in storage in these steady-state models. Transient analysis by the Neuman-Witherspoon (1969) method was also done for comparison, as data permitted.

Pumped Aquifer

Analyses are presented in Figures 1 through 10. Adjustments to the data were made prior to analysis to account for the effects of the short rest period before the start of pumping and the abbreviated duration of the test. The first adjustment is made to estimate the impact of previous pumping/recovery cycles by superposition, Figure 16. This correction was applied to the drawdown of each well for the composite transient analyses, Figures 17 through 21.

The recovery period was 10-hours in length and therefore is a bit higher quality. The transient distance drawdown analysis (t/r^2), Figure 7, used recovery data. However, the duration of the 10-hour recovery was not long enough for steady-state conditions to develop. Therefore, recovery data were projected to 10,000 minutes, Figure A1-8, for the steady-state analyses, Figure 9 and Figure 10.

Aquifer transmissivity is best represented by the distance-drawdown analyses between 8,800 to 11,000 ft2/day. The storativity (dimensionless) is in the range of 5.5e-5 at the Nest 2 site to as large as 2.0e-4 at nest 1, to the south of the wellfield. This variation in storativity corresponds to the relative conductivity of the till at the well nests. No wells showed a leaky response, as expected, and the corresponding leakage factor from the steady-state analyses is quite large, approximately 22,000 feet. Comparison of these results to those of the earlier aquifer test shows that the transmissivity and storativity are within the same range but the characteristic leakage factor from the earlier test was significantly smaller. [This may be due in part to a bias in the earlier analysis which used drawdown values after only 1440 minutes of pumping. It also was the result of choices to weight proximal wells more heavily to the fit rather than more distant wells. The uncertainty of the leakage factor from that analysis was quite large.]

There are differences between the response to pumping and recovery for USGS 1-F and Desens Obwell, Figure 5 and Figure 6, that are not seen in the response of wells located within the wellfield. It is believed that these differences are the result of interference from other, more distant, pumping wells. The effect of the differences causes an increase in uncertainty of hydraulic properties at these wells, +/- 30% of the nominal values which are presented on the figures and Table 5.

Aquitard (Confining) Layer

Analyses are presented in Figures 11 – 15. The assessment of the vertical hydraulic conductivity of the till at Nests 1 and 2 depends on the observed response to pumping. There was no observed response to pumping at Nest 2 and the analysis is therefore limited. The observed response to pumping at Nest 1 is shown on Figure 11as four series:

1) pumping,
2) recovery,
3) recovery projected to 1000 minutes, and
4) that caused by the 'unknown pumping.'

The short-term differences in water level caused by pumping are best fit by a log function. As the well nest is expected to react linearly, as a hydraulic column in the laboratory; this indicates that the duration of pumping was insufficient for the system to reach equilibrium. The recovery data projected to 10,000 minutes may be used, as that response was linear, but limited to only two wells. The strongest linear signal was caused by the 'unknown pumping' 7/5 through 7/8/2017. These data indicate that only the deeper observation wells; USGS 1-E, 1-D, and possibly 1-C, may provide a reasonably linear relationship of clay thickness vs. water level change. As water levels drew down below the transducer in USGS 1-E, an estimate of the water level was made from the consistent difference between USGS 1-E and 1-F of 0.6 feet, Figure 26.

Note that on Figure 11, the intersection of all regressions at ~0 feet of drawdown is much less than the full thickness of the till. Therefore, the true thickness of competent till as a confining layer is not its full lithological thickness at the Nest 1 site. It appears that the effective thickness is approximately 48 to 50 feet.

The composite leaky analysis, Figure 12, used the parameter estimation tool in Aqtesolv for the data from the wellfield area. The data from wells 1-F and Desens Obwell plot significantly below the other wells. This indicates that the transmissivity and/or leakage is different for the wells not matched. This is additional confirmation that the aquitard is more permeable in the area near Nest 1.

The Neuman-Witherspoon analysis of recovery data from Nest 1, Figure 13, produces a kV of the aquitard of 1.8e-2 ft/day. However, the match is poor because the test was not conducted long enough to generate a strong signal. Also, this initial analysis assumed that

the thickness of the aquitard is 63 feet rather than that from the well records (114 feet). The smaller effective aquitard thickness from Figure 11 can be verified with this model. On Figure 14, the match to data from well 1-E is much improved if an aquitard thickness of 50 feet is used, with no other change in parameters.

The analysis of the data associated with this abbreviated constant-rate test is limited because of the relatively small signal that only affected wells 1-E and 1-D. However, a very strong signal was generated by the disturbance after 7/5/2017 19:00, Figure 43. Unfortunately, no facts are available to verify the well location(s) or pumping rate(s) that may have caused the disturbance. Modeling the impact of the observed response has inherent uncertainties but is a worthwhile check on the aquitard properties, if only because of the strength of the signal.

If aquifer properties are reasonably consistent in this area, the effects of the 'unknown pumping' well at Nest 1 may be modeled in Aqtesolv. Assuming a well located approximately 8000 feet from Nest 1 and discharging at a rate of 2300 gpm for 5000 minutes, a steady-state model provides similar aquifer properties: T – 9,000 ft2/day, S - 5e-5, and L - 20,000 feet. These assumptions were then used as the basis for a Neuman-Witherspoon analysis of the data after 7/5/2017 19:00, Figure 15. The match was quite good to data from all observation wells in the till: 1-E (estimated), 1-D, and 1-C. The k_V of the aquitard was smaller, 1.0e-3 ft/day, than that calculated from the test of Litchfield 2, Figure 14, but not out of the reasonable range. For comparison, this value is essentially the same as than that from the steady-state analyses, Figure 9 and Figure 10.

Because no response was observed at the Nest 2 site, the k_V of the aquitard is at least one order of magnitude smaller than that at Nest 1, at most 1.0e-4 ft/day or smaller.

Conclusion

The hydraulic properties of the two-layer aquifer and aquitard system are shown in Table 1. These values are a summary of the analyses listed on Table 5. The large range of estimated aquifer properties shown are the result of both the sub-set of the data to which an analysis method was applied and natural lithological variation - particularly within the till.

The bulk aquifer properties were within the expected range given the prior test of Litchfield 2 in 1998. The leakage factor from this test was larger (a lower rate of leakage) than that from the earlier test, with better documentation and a much more robust analysis.

The interesting aspect of these data is that the more conductive portion of the aquitard (Nest 1) appears to dominate the bulk hydraulic response, as represented by the steady-state analyses.

Acknowledgements

There have been few opportunities to collect this level of detailed hydraulic information for the analysis of rates of leakage through till. The test conducted at the Litchfield municipal wellfield described here was successful not simply because of the efforts of MDH but also for the work of many, over decades. This analysis drew heavily on previous testing of Litchfield Well 2 in 1998, data collected by the USGS in 2015 and 2016, the work of MDNR with irrigators in the area, as well as other sources. It is an example of how success may

sometimes result from being there to gather information, taking advantage of coincidental and uncontrolled field conditions, rather than the 'proper conduct' of an aquifer test.

References

Cooper, H.H. and Jacob, C.E. (1946) A Generalized Graphical Method for Evaluating Formation Constants and Summarizing Well-field History, Trans. American Geophysical Union, V. 27, pp. 526 – 534.

Blum, J.L. and Woodside, J. (2017) Analysis of the Litchfield 2 (607420) Pumping Test, June 29, 2017, Confined - Quaternary Glacial-Fluvial Aquifer, Technical Memorandum - Aquifer Test 2617, Minnesota Dept. of Health, pp 93.

de Glee, G. (1930) Over grondwaterstroomingen bij wateronttrekking door middle van putten. Ph.D. thesis, Delft Technische Hogeschool, Delft. In: Kruseman and De Ridder, (1991) Analysis and Evaluation of Pumping Test Data (2nd Edition), Publication 47, International Institute for Land Reclamation and Improvement, P.O. Box 45, 6700 AA Wageningen, The Netherlands, pp. 76-78.

Environmental Concepts and Design, Inc. (1998) Municipal Well-Field Pump Test and Conceptual Design Report - Litchfield Public Works, Meeker County, Minnesota. Aquifer Test Analysis File 2209.

Duffield, G.M. (2007) AQTESOLV for Windows Version 4.5 User's Guide, HydroSOLVE, Inc., Reston, VA.

Jacob, C.E. (1947) Drawdown Test to Determine the Effective Radius of Artesian Wells. Transactions of the American Society of Civil Engineers, 112, pp.1047–1170.

Hantush, M. S. and Jacob, C.E. (1955a) Non-steady Radial Flow in an Infinite Leaky Aquifer, Trans. American Geophysical Union, Vol. 35, pp. 95-100.

Hantush, M. S. and Jacob, C.E. (1955b) Steady Three-dimensional Flow to a Well in a Two-layered Aquifer, Trans. American Geophysical Union, Vol. 36, pp. 286-292.

Neuman, S.P. and Witherspoon, P.A. (1969) Theory of flow in a confined two aquifer system, Water Resources Research, vol. 5, no. 4, pp. 803-816.

Theis, C. V. (1935) The Relation Between the Lowering of the Piezometric Surface and the Rate and Duration of Discharge of a Well Using Ground-Water Storage, Trans. American Geophysical Union, 16th Annual Meeting, April, 1935, pp. 519-24.

Walton, W.C. (1960) Leaky Artesian Aquifer Conditions In Illinois, Illinois State Water Survey, Bulletin 39, pp. 27.

Western Regional Climate Center - Daily Precipitation Data for Weather Station, 214778, Litchfield, Minnesota (2017). Available at: https://wrcc.dri.edu/cgi-bin/cliMAIN.pl?mn4778.

Tables and Figures

Table 1. Summary of Results for Leaky Confined - Radial Porous Media Flow

Parameter	Value	Unit	Range Minimum	Range Maximum	+/- % variation
Top Stratigraphic Elev.	1015	feet (MSL)	1008	1022	
Bottom Stratigraphic Elev.	986	feet (MSL)	978	986	
Transmissivity (T)	9,000	ft2/day	7,000	14,500	
Aquifer Thickness (b)	29	feet	30	44	
Hydraulic Conductivity (k)	310	ft/day	155	310	
Ratio Vertical/Horizontal k (k_V/K_R)	1	0.00 %			
Primary Porosity (ep)	0.25	0.00 %			
Storativity (S)	7.5e-5	dimensionless	5.5e-5	3.3e-4	
Characteristic Leakage (L)	21,000	feet	5,000	24,100	
Hydraulic Resistance (c)	44,400	days	2,800	63,500	
Thickness of till (b')	50	feet	48	130	
Hydraulic Conductivity of till (k_V)	1.0e-3	ft/day	< 1.0e-4	2.0e-2	

Table 2. Aquifer Test Information

Information Type	Information Recorded
Aquifer Test Number	2617
Test Location	Litchfield 2 (607420)
Well Owner	City of Litchfield
Test Conducted By	MDH - J. Blum and J. Woodside
Aquifer	QBAA
Confined / Unconfined	Confined
Date/Time Monitoring Start	06/13/2017 12:10
Date/Time Pump off Before Test	06/29/2017 12:16:30
Date/Time Pumping Start	06/29/2017 14:03:30
Date/Time Recovery Start	06/29/2017 20:00:00
Date/Time Test Finish	7/13/2017 14:35
Pumping time (minutes)	1454.93
Totalizer – end reading	not recorded
Totalizer – start reading	122,434,800
Total volume (gallons)	280,060 gallons
Nominal Flow Rate	787 (gallon per minute)
Number of Observation Wells	8 (see Table 3)

Table 3. Well Information

Well Name (Unique Number)	Easting Location, X[1] (meter)	Northing Location, Y[1] (meter)	Radial Distance (feet)	Ground Surface Elevation, GSE[2] (feet, MSL)	Measuring Point Description GSE+(stick-up) (feet, MSL)	Open Interval Top (feet, MSL)	Open Interval Bottom (feet, MSL)	Aquifer
Wellfield								
Litchfield 2 (607420)	613	481.6	1	1120	1124.35 e	1013	988	QBAA
L-MW (607417)	607.8	496.1	51	1120	1123.7	1001.2	996.2	QBAA
Litchfield 3 (632077)	674.4	711.6	781	1123.2	1127.2	1018	990	QBAA
Litchfield 4 (632078)	538.4	1129.6	2140	1126	1130	1026	1002	QBAA
Litchfield 5 (764258)	466.1	1014.9	1815	1149	1153	1015.5	990.5	QBAA
Desens, D. (800011)	1384.7	947.7	2958	1128.4	1129.4 e	980.4	970.4	QBAA
Nest 1								
USGS 1-B (773062)	1021.8	265.5	1517	1114.5	1118.23	1092.1	1089.2	QWTA
USGS 1-C (773060)	1019.2	267.5	1506	1114.8	1118.35	1064.6	1061.7	Till
USGS 1-D (773059)	1020.4	267.5	1510	1114.7	1118.25	1042.3	1039.4	Till
USGS 1-E (773058)	1021.8	267.5	1514	1114.5	1118.07	1022.1	1019.2	Till
USGS 1-F (773057)	1020.4	265.6	1513	1114.7	1118.1	996.7	987.2	QBAA
Nest 2								
USGS 2-A (773056)	559.8	844	1202	1139.6	1142.82	1122.5	1119.6	QWTA
USGS 2-B (773055)	559.8	842.9	1198	1139.2	1142.24	1106.9	1104.1	Till
USGS 2-C (773054)	561.3	844	1201	1139.4	1142.41	1082.4	1079.6	Till
USGS 2-D (773053)	559.7	841.6	1194	1139.2	1142.15	1058.1	1058.1	Till
USGS 2-E (773052)	561.4	842.9	1197	1139.3	1142.46	1028.3	1025.5	QBAA
USGS 2-F (773051)	561.4	841.6	1193	1139.3	1142.37	986.8	976.9	QBAA

[1] Local Datum

[2] Vertical Datum: NAV88

Table 4. Data Collection

Data File Name: Well Name_Unique Number	Data Logger Type, SN:	Probe Id., Range (psi)	Install 1. Static WL[3]	Install 2. XD[4] Setting	Remove 3. Static WL	Remove 4. XD Setting	Diff. Static WL (1-3)	Diff. XD Setting (4-2)
L-2_(607420)	Acoustic transducer		50.29	49.64	71.04[5]			
Baro_data	Hermit 3000 45333	6, 15 psia						
L-Ob(607417)	Troll 500 145815	17, 30 psi	46.50	61.59	59.70	48.54	-13.2	-13.04
USGS-1-B(773062)	OTT 382929		13.55	12.96	14.17	12.33	-0.62	-0.63
USGS-1-C(773060)	OTT 382931		14.61	13.97	15.46	14.83	0.78	0.79
USGS-1-D(773059)	OTT 382935		28.77	28.30	32.75	32.34	-3.98	4.04
USGS-1-E(773058)	OTT 382934		38.04	37.52	45.29	39.60[6]	-0.21	--
USGS-1-F(773057)	OTT 382937		38.20	37.11	45.45	44.88	7.25	7.77
USGS-2-A(773056)	OTT 382927		13.99	14.19	16.09	16.23	-2.1	2.04
USGS-2-B(773055)	OTT 382932		14.99	16.09	16.39	18.72	1.4	0.35
USGS-2-C(773054)	OTT 382930		17.87	16.06	19.02	18.59	-2.15	2.52
USGS-2-D(773053)	OTT 382933		35.19	34.07	35.90	35.38	-0.71	1.31
USGS-2-E(773052)	None installed		64.36		71.33			
USGS-2-F(773051)	OTT 382938		65.43	64.88	70.88	70.01	-5.45	5.13

[3] WL = water level below measuring point, feet.
[4] XD = pressure transducer depth below water surface, feet.
[5] Pump running
[6] Transducer set above water surface in well at removal

Table 5. Transient Analysis Results

Well Name (Unique Well No.)	Transmissivity, T (ft2/day)	Storativity, S (dimensionless)	Leakage Factor, L (feet)	Hydraulic Conductivity of Aquitard, kV (ft/day)	Analysis Method	Figure No. Remarks
L-2 (607420)	3,440	NA[7]	NA	NA	Theis	2. poor match, T not credible
L-MW (607417)	8,600	2.5e-4	NA	NA	Theis	3. good match
USGS 2-F (773051)	14,700	5.5e-5	NA	NA	Theis	4. good match to pumping data
USGS 1-F (773057)	14,700	3.3e-4	NA	NA	Theis	5. divergence between pumping and recovery data – uncertainty in T & S values +/- 30%
Desens (800011)	14,300	1.5e-4	NA	NA	Theis	6. divergence between pumping and recovery data – uncertainty in T & S values +/- 30%
Aquifer, composite	10,000	1.1e-4	NA	NA	Theis - t/r2	7. good match, inefficiency of pumped well causes divergence from Theis-curve
Aquifer, composite	9,170	2.0e-4			Cooper – Jacob	9. representative bulk aquifer properties
Aquifer, composite	11,000	9.5e-4	20,000	1.4e-3	Hantush-Jacob - t/r2	12. Aqtesolv solution - match to L-MW and USGS 2-F
Nest 1, composite	14,000	1.0e-4	6,700	2.0e-2	Neuman-Witherspoon	13. aquitard thickness of 63 feet - poor match
Nest 1, composite	10,800	1.2e-4	5,500	1.8e-3	Neuman-Witherspoon	14. aquitard thickness of 50 feet - better match to USGS 1-E
Nest 1, composite	8,000	7.4e-5	10,800	1.0e-3	Neuman-Witherspoon	15. aquitard thickness of 50 feet - good match to all till wells

Table 6. Steady-state Analysis Results

Transmissivity, T (ft^2/day)	Leakage Factor, L (feet)	Hydraulic Resistance, c (days)	Hydraulic Conductivity of Aquitard, k_V (ft/day)	Analysis Method	Plot No. Remarks
9,170	24,100	63,500	7.9e-4	Hantush-Jacob	9. representative bulk aquifer properties
8,830	22,000	54,800	9.0e-4	De Glee	10. representative bulk aquifer properties

[7] Not Applicable

Figure 1. Adjustments for pumping-phase data

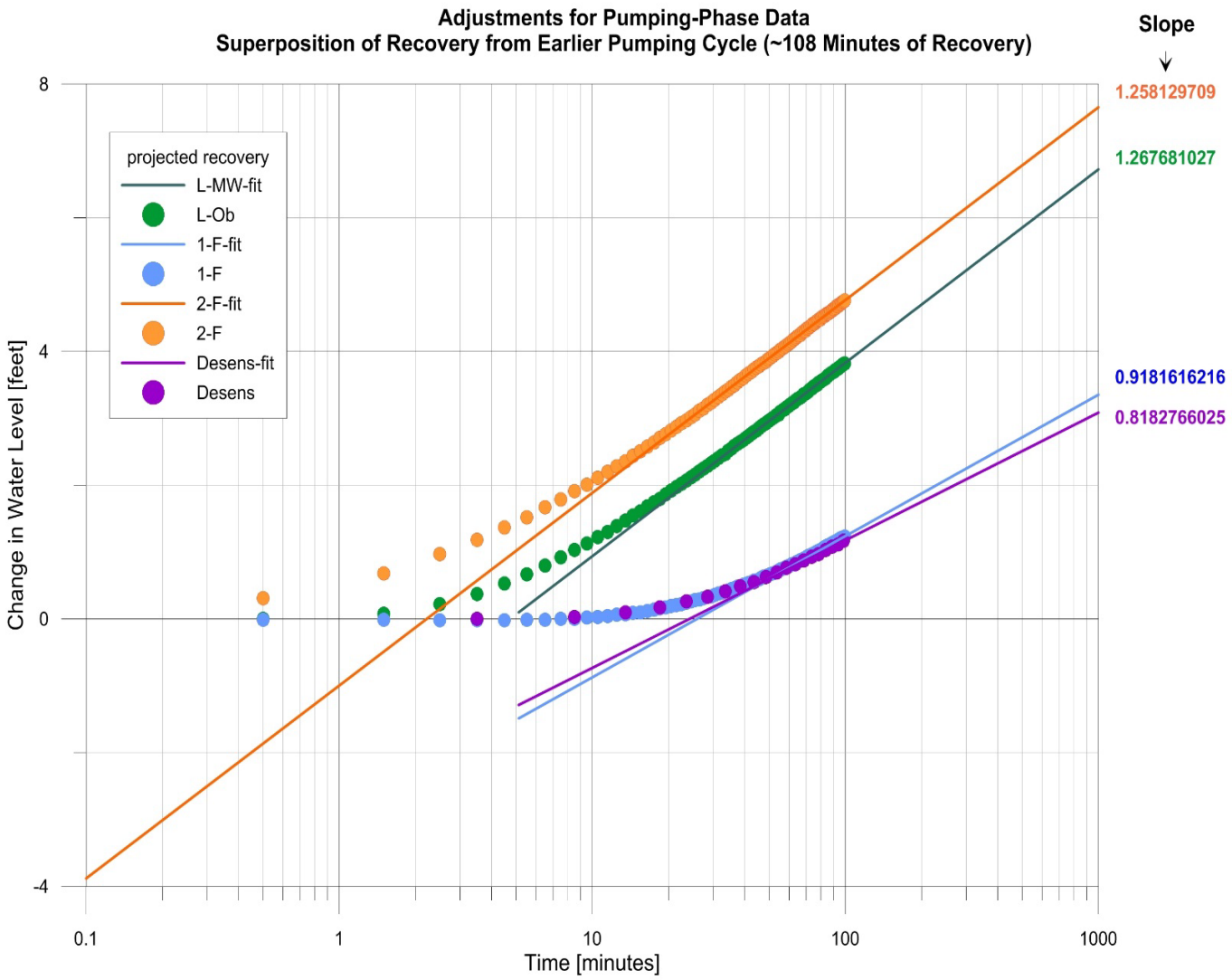


Figure 2. Theis (1935) analysis of pumping and recovery data from Litchfield 2 (607420)

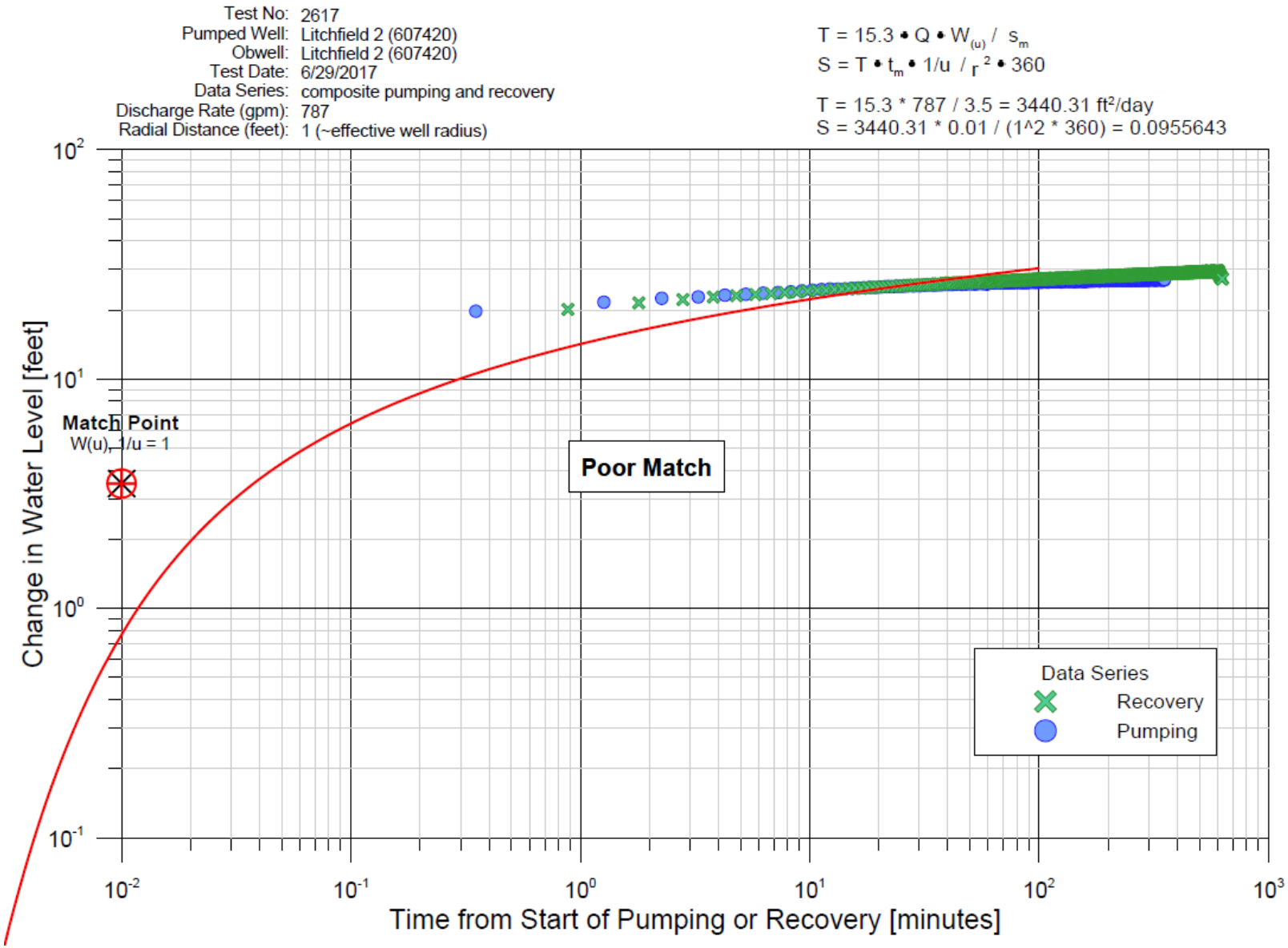


Figure 3. Theis (1935) analysis of pumping and recovery data from Litchfield MW (607417)

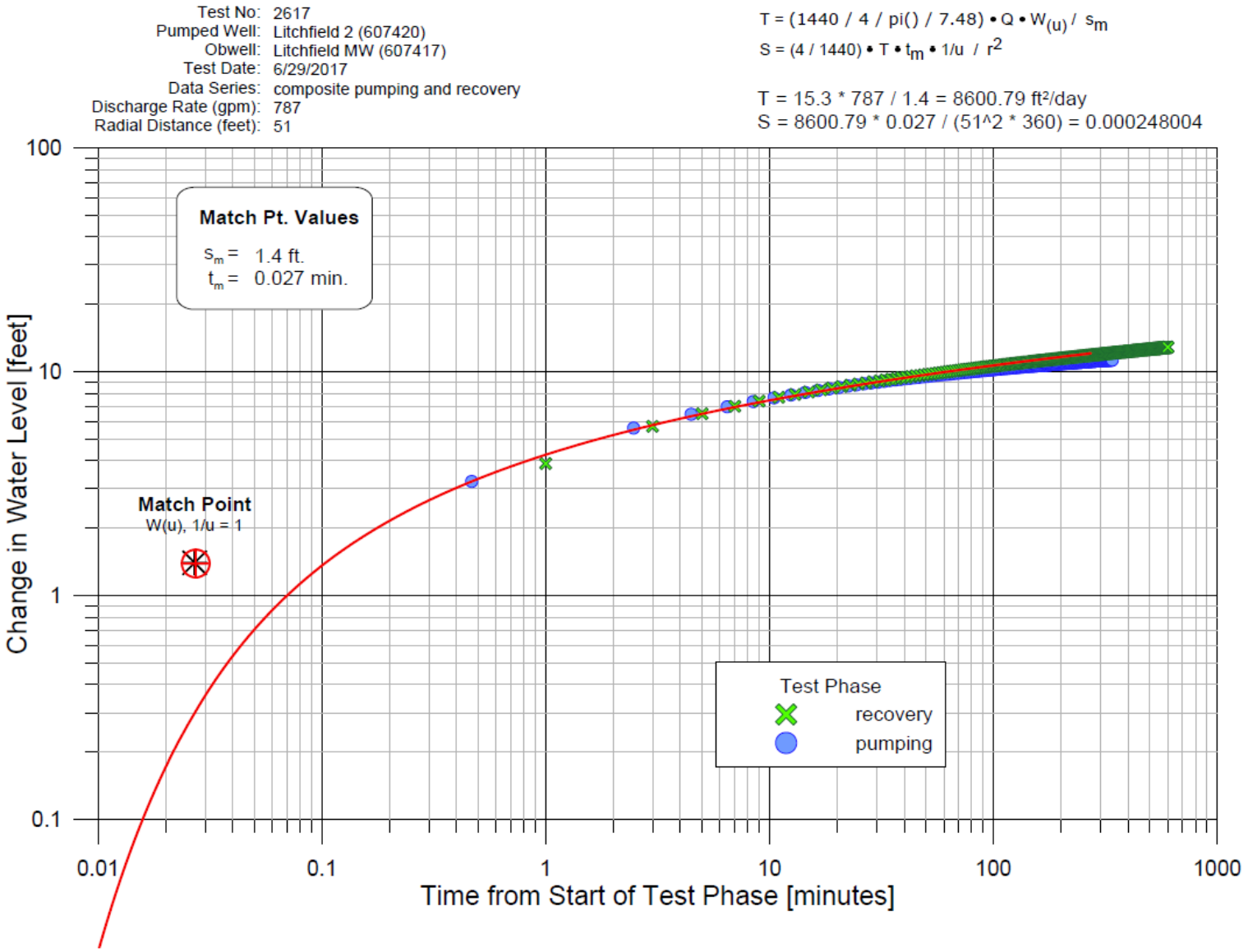


Figure 4. Theis (1935) analysis of pumping and recovery data from USGS 2-F (773051)

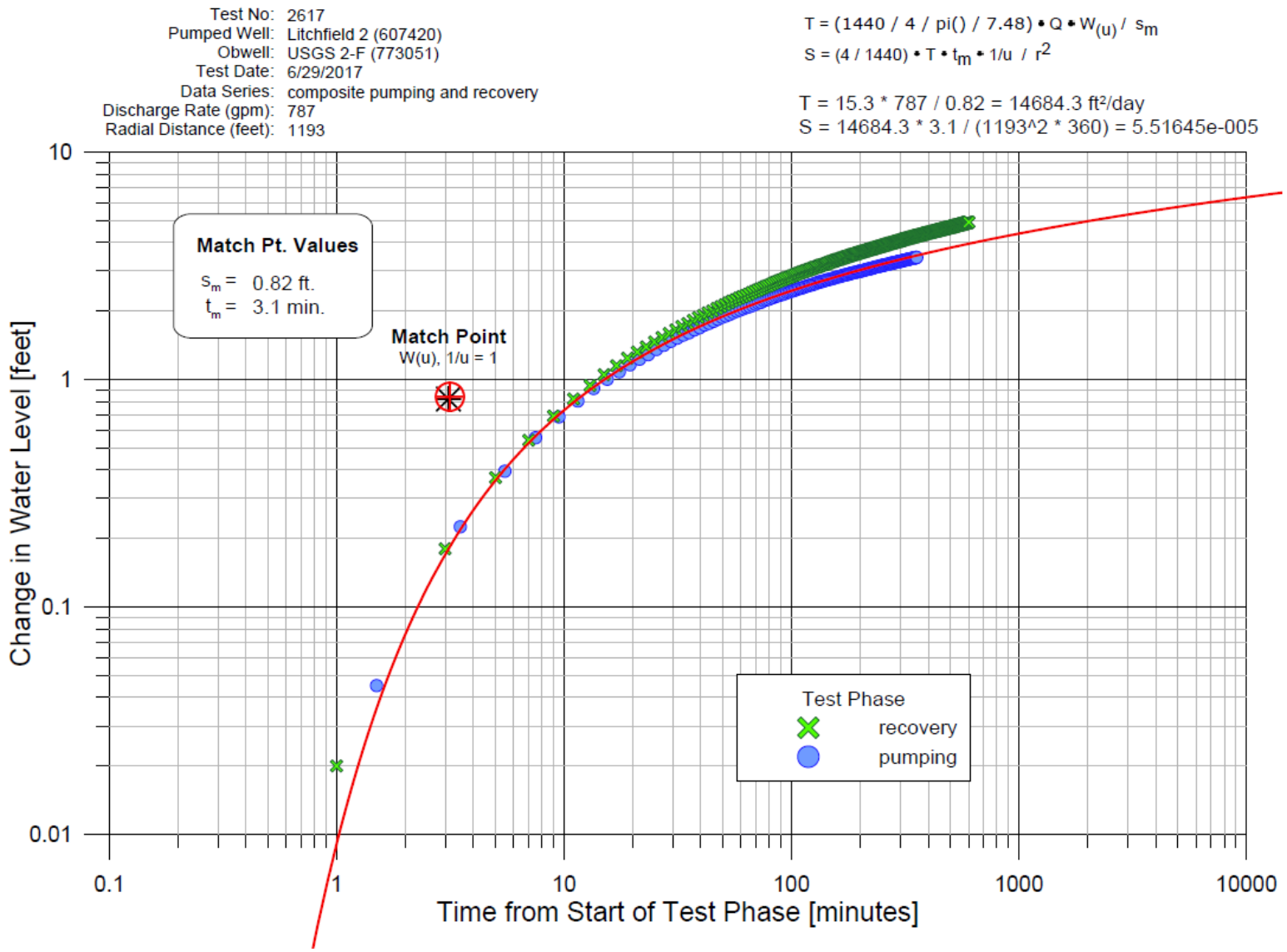


Figure 5. Theis (1935) analysis of pumping and recovery data from USGS 1-F (773057)

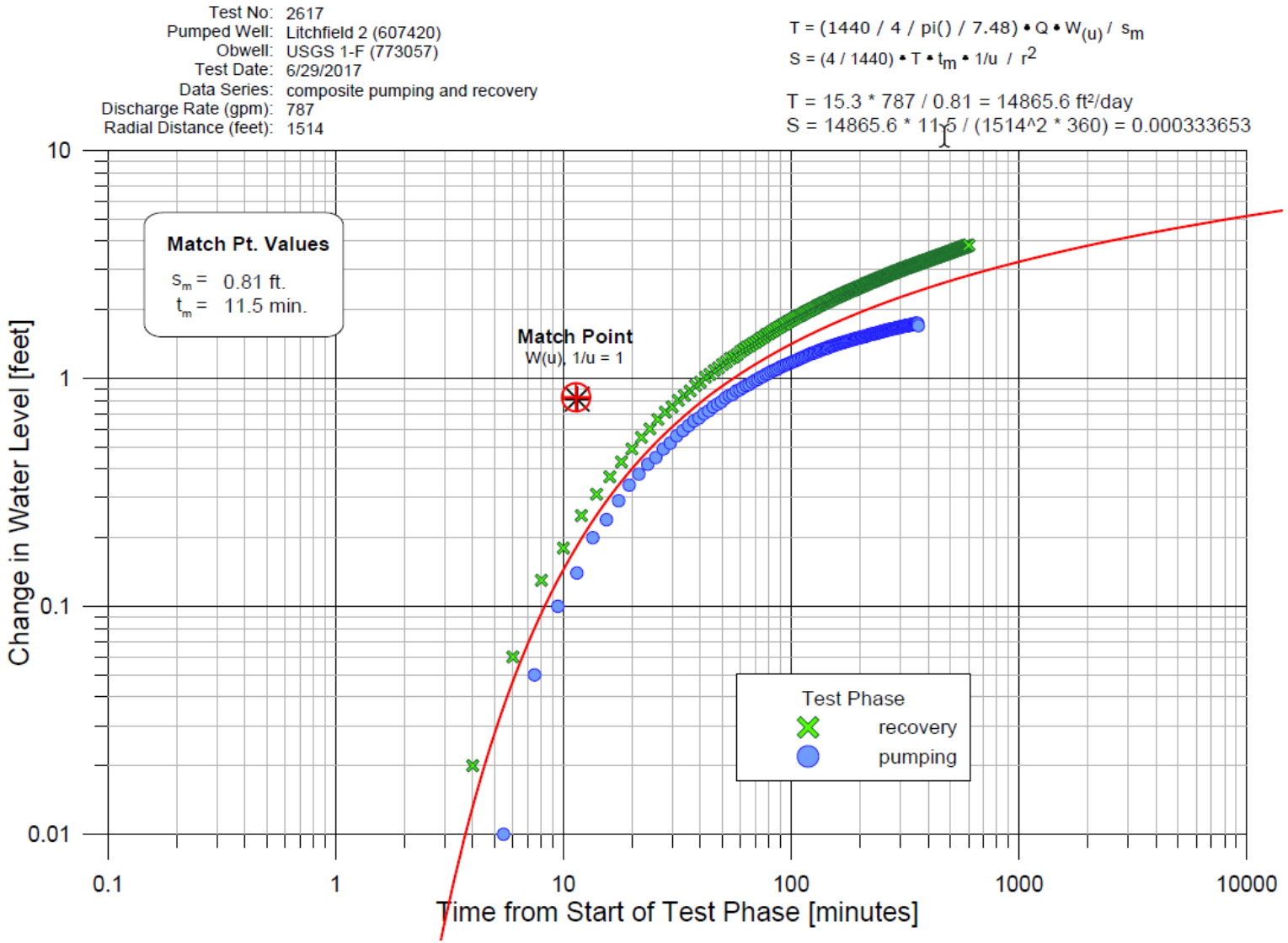


Figure 6. Theis (1935) analysis of pumping and recovery data from Desens (800011)

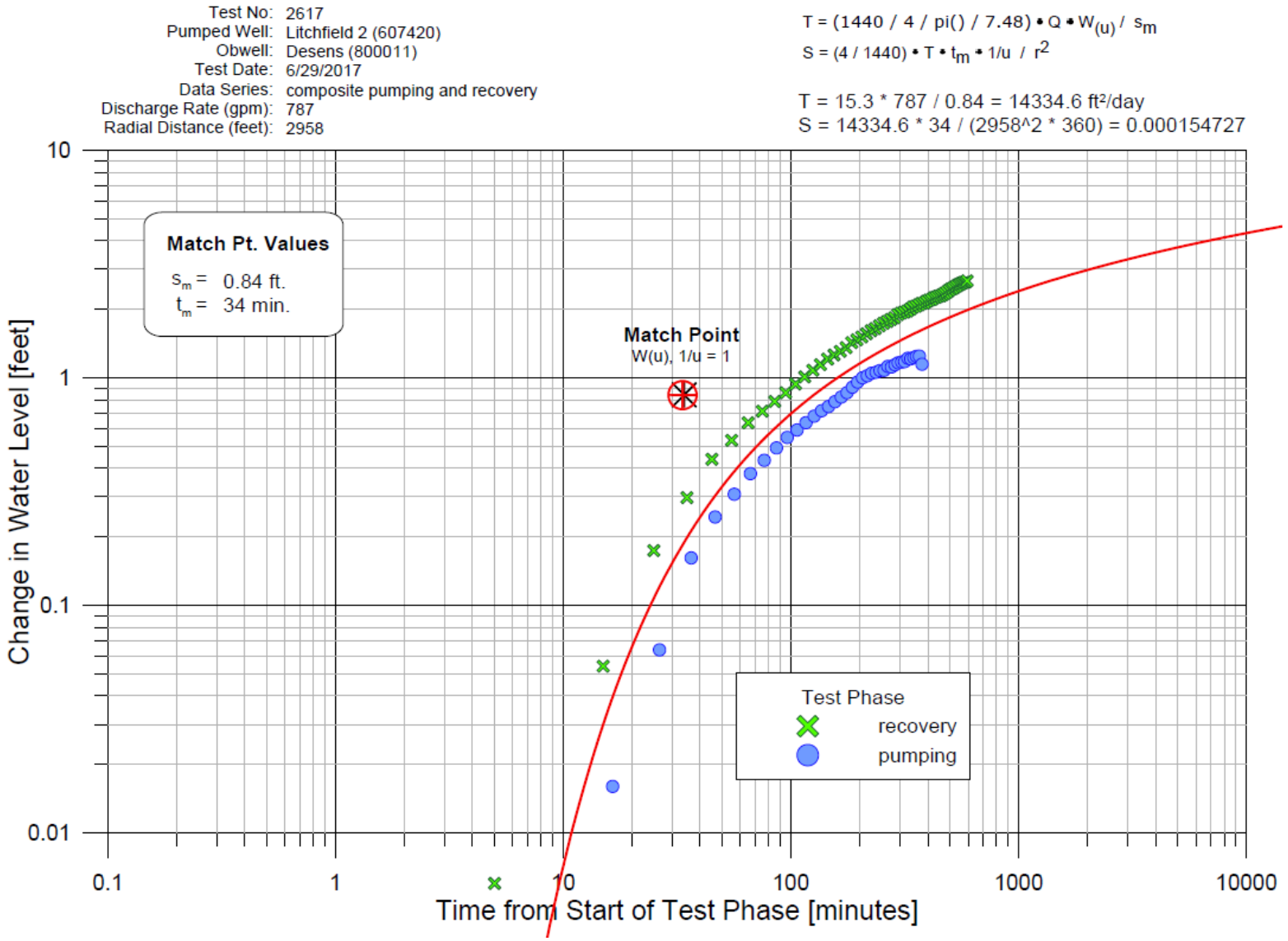


Figure 7. Theis (1935) composite (t/r^2) analysis of recovery data

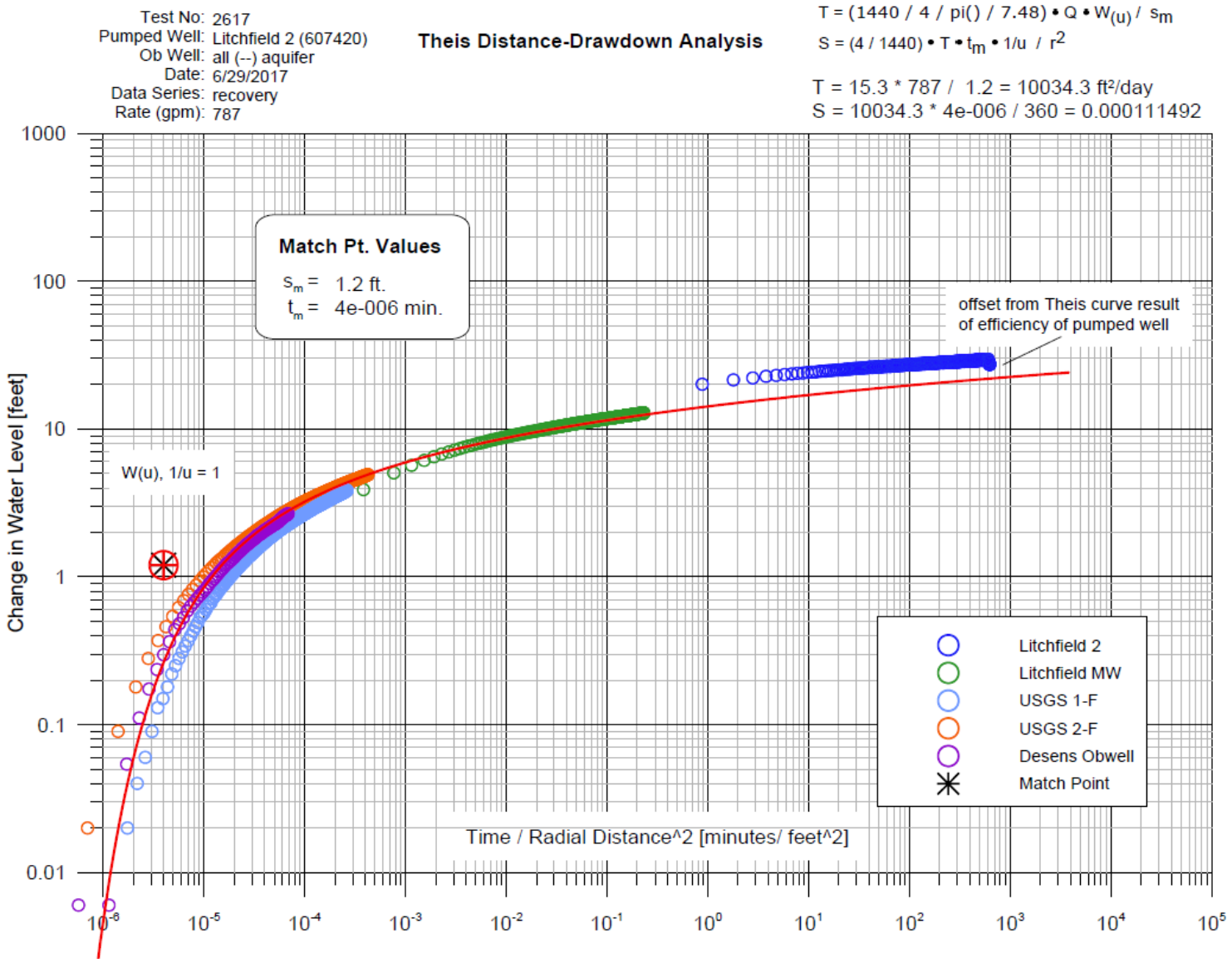


Figure 8. Projected recovery to 10,000 minutes for steady-state analysis

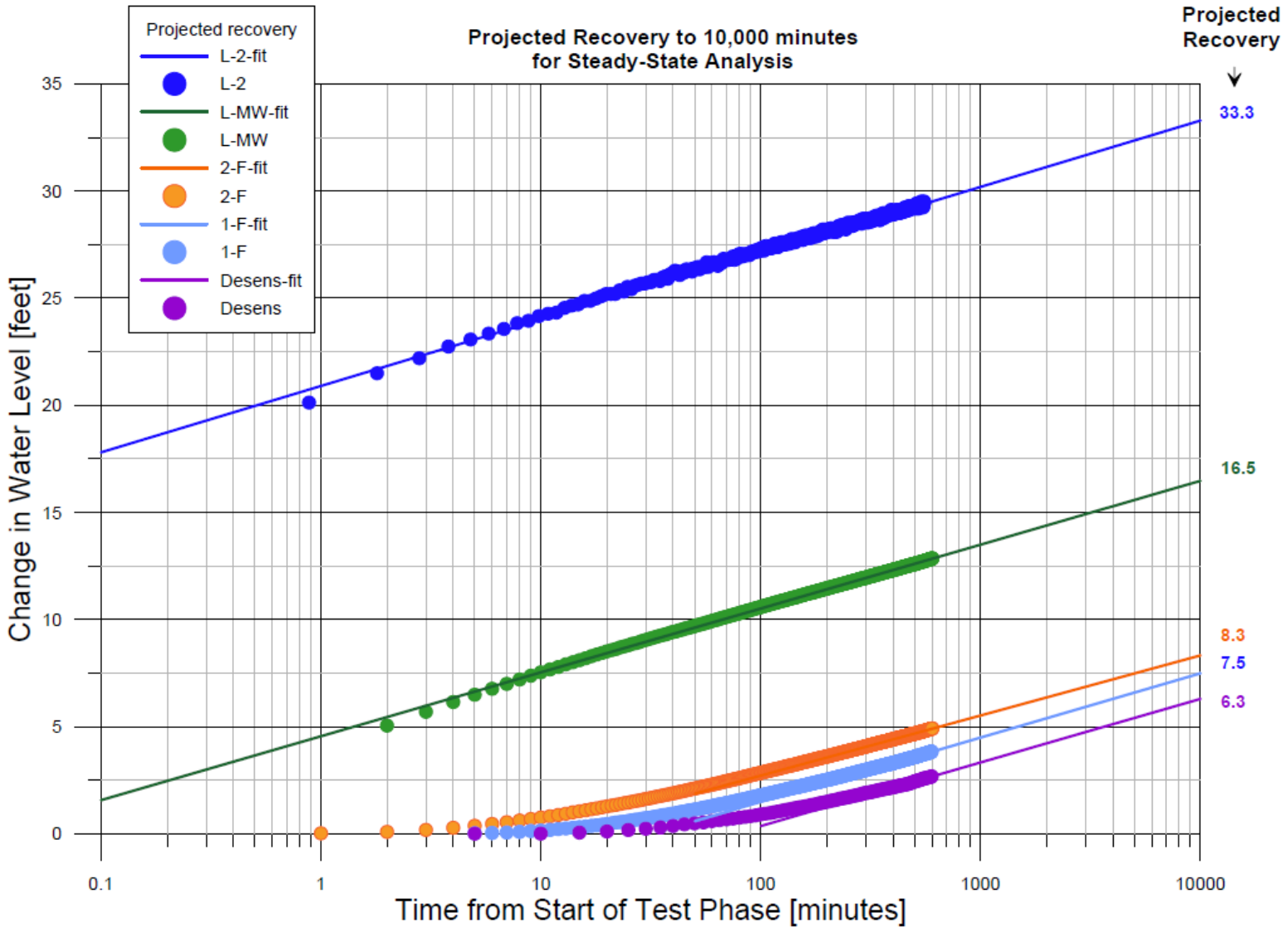


Figure 9. Cooper-Jacob (1946) transient and Hantush-Jacob (1955) steady-state analyses

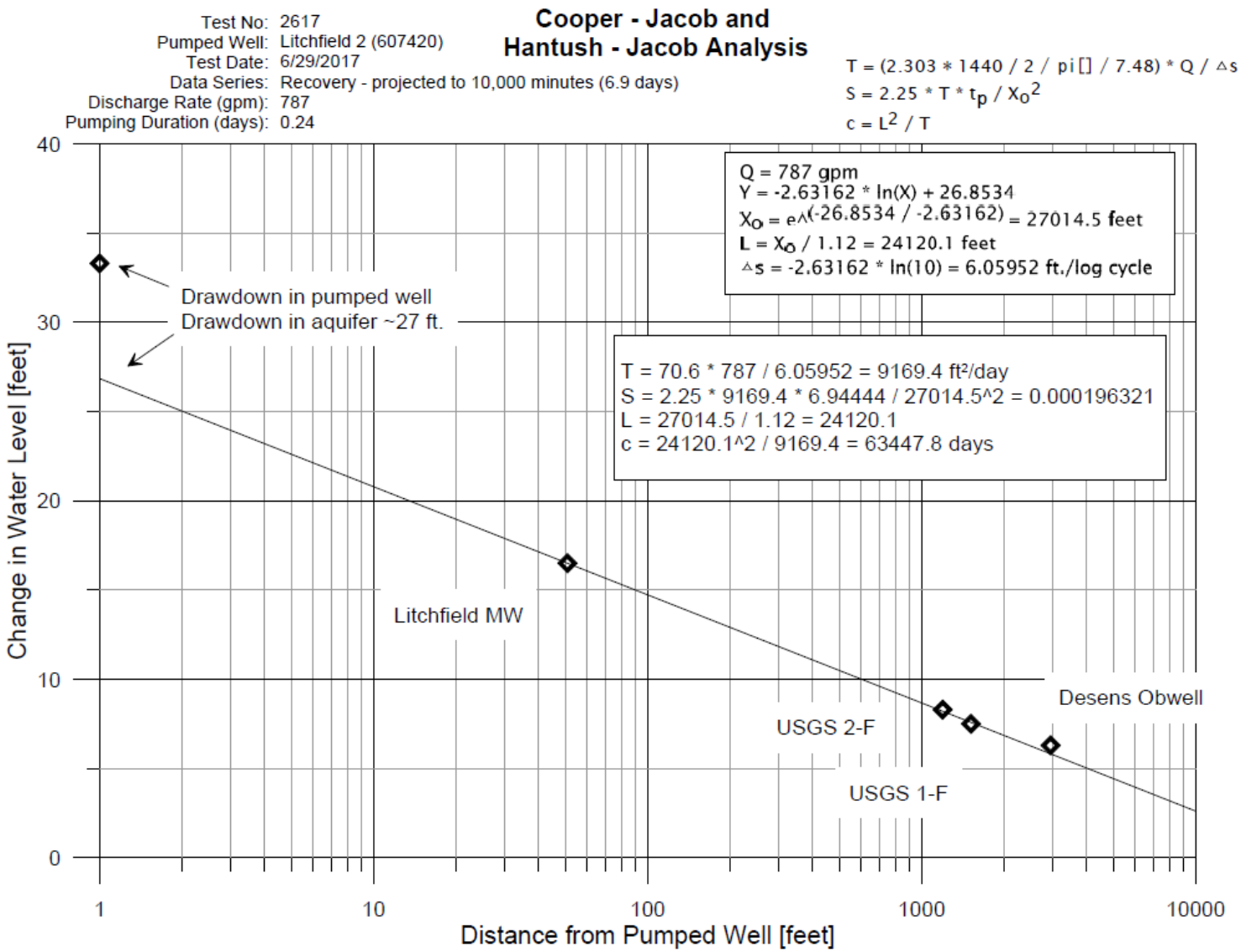


Figure 10. de Glee (1930) steady-state analysis

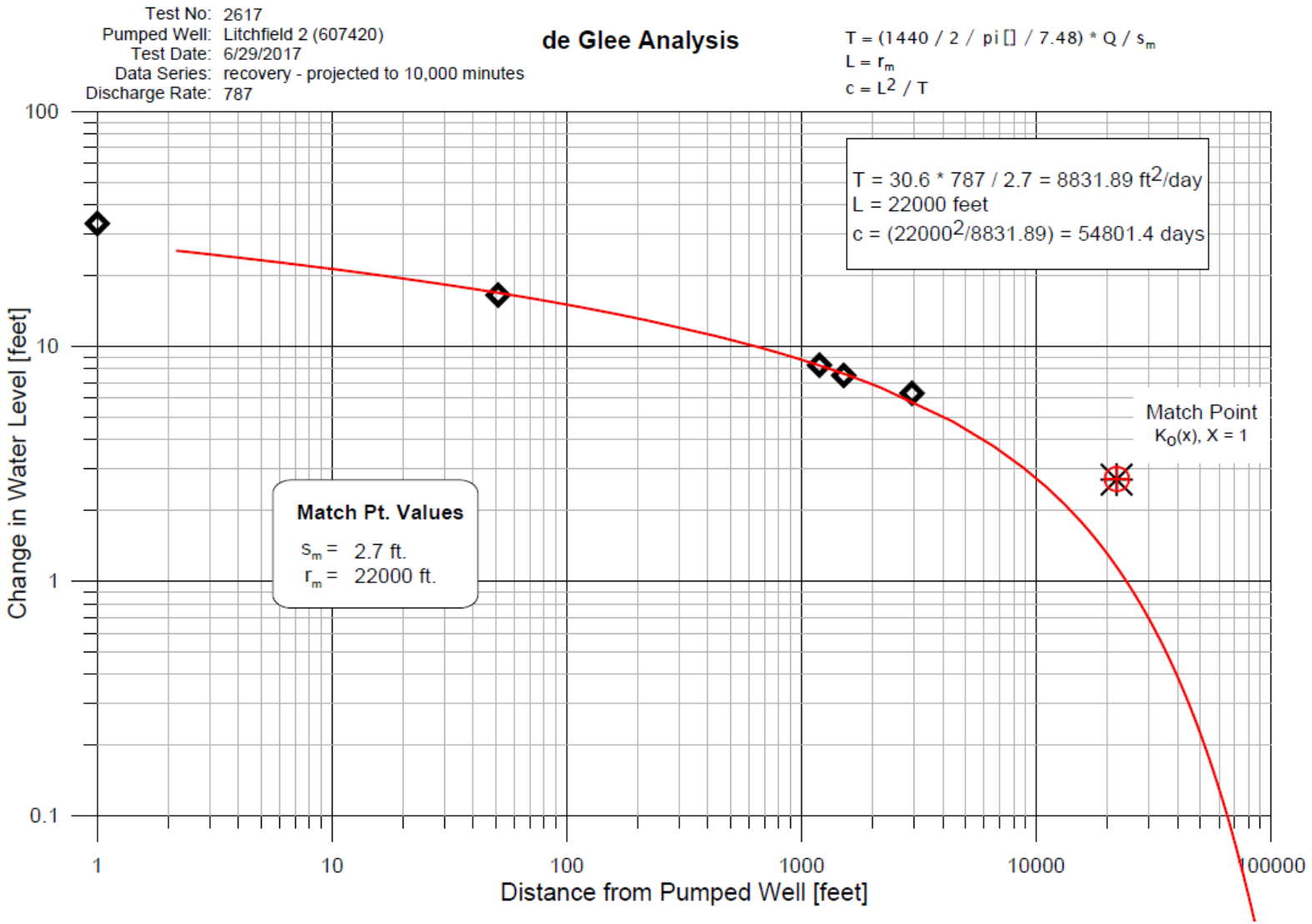


Figure 11. Difference in water level at USGS Nest-1 during pumping and recovery

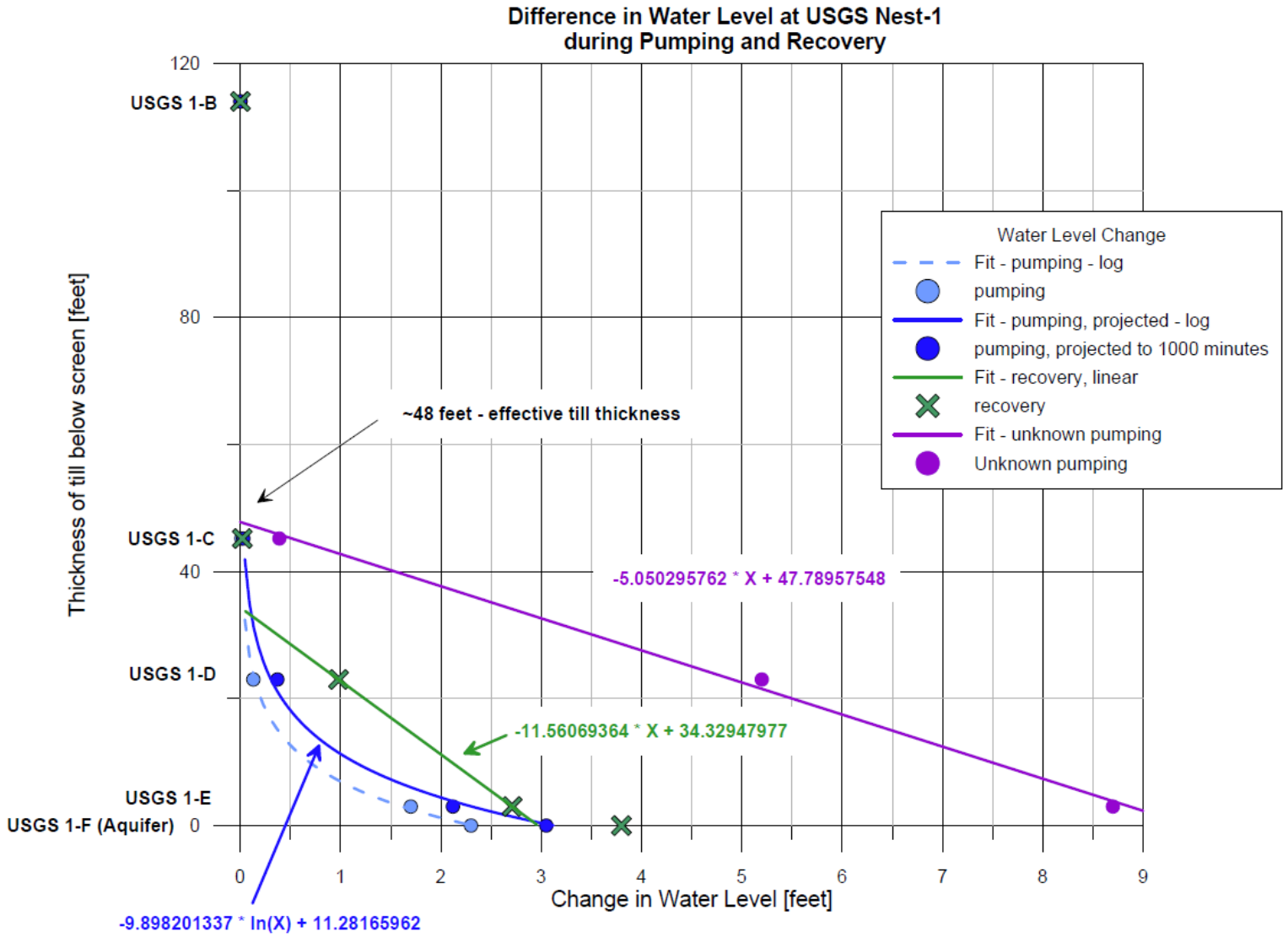
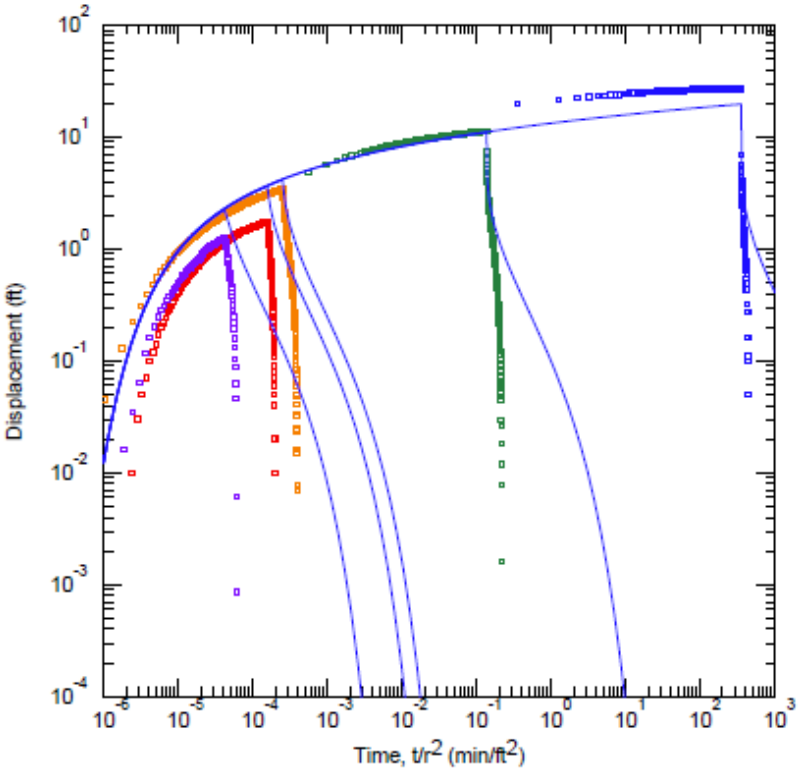


Figure 12. Aqtesolv composite (t/r2). Hantush-Jacob (1955) model



WELL TEST ANALYSIS

Data Set: O:\...\litchfield_aquifer_composite.aqt
Date: 08/28/17 Time: 15:35:03

PROJECT INFORMATION

Company: MDH
Client: City of Litchfield
Location: Litchfield 2
Test Well: L-2 (607420)
Test Date: 6/29/2017

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
2	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
2	0	0
MW	0	51
USGS 1-F	0	-1513
USGS 2-F	0	1193
Desens	2958	0

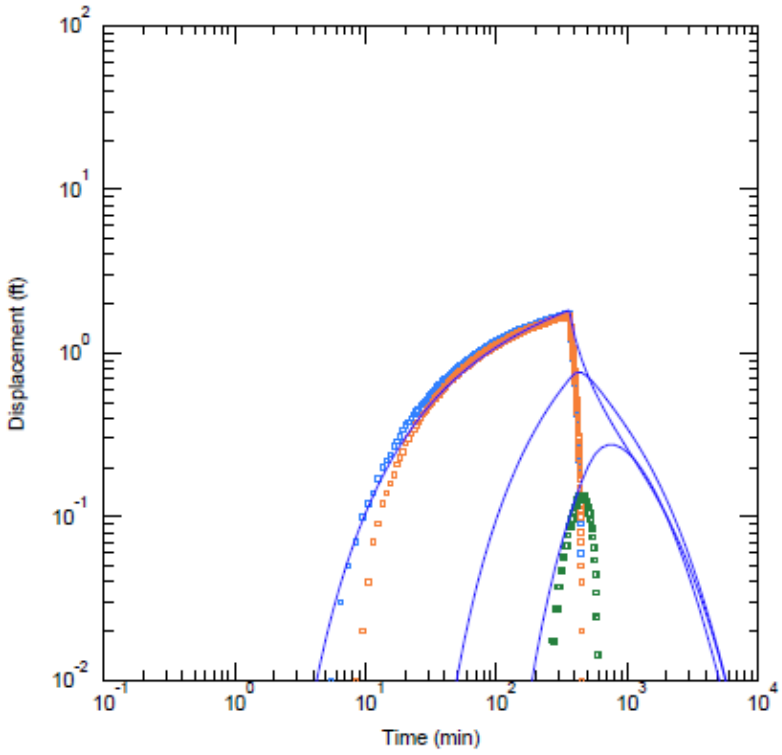
SOLUTION

Aquifer Model: Leaky
Solution Method: Hantush-Jacob

T = 1.1E+4 ft^2/day
1/B = 5.0E-5 ft^{-1}
b = 6.944 ft
S = 9.5E-5
Kz/Kr = 1.

L = 20,000 feet
kV = 0.00005 * 11,000 * 50 = 0.0014 ft/day

Figure 13. Aqtesolv analysis of data from Nest 1 wells, Neuman-Witherspoon (1969) model. Till thickness 63 feet.



WELL TEST ANALYSIS

Data Set: O:\...\13_litchfield_nest-1_neuman.aqt
Date: 08/29/17 Time: 12:24:43

PROJECT INFORMATION

Company: MDH
Client: City of Litchfield
Location: Litchfield 2
Test Well: L-2 (607420)
Test Date: 6/29/2017

AQUIFER DATA

Saturated Thickness: 30. ft
Aquitard Thickness (b'): 63. ft
Anisotropy Ratio (Kz/Kr): 1.
Aquitard Thickness (b"): 1. ft

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
2	0	0

Observation Wells

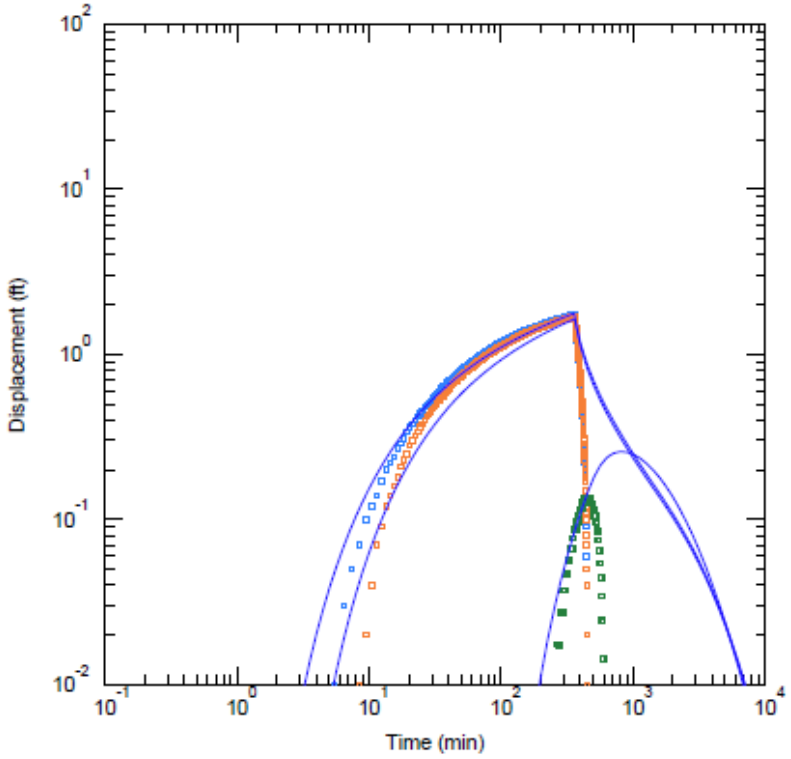
Well Name	X (ft)	Y (ft)
USGS 1-F	0	-1513
USGS 1-E	0	-1514
USGS 1-D	0	-1510

SOLUTION

Aquifer Model: Leaky
Solution Method: Neuman-Witherspoon
T = 10000. ft^2/day
1/B = 0.0002082 ft^{-1}
T2 = 1000. ft^2/day
S = 0.00015
ß/r = 0.0001731 ft^{-1}
S2 = 1.

L = 5,000 feet
kV = 0.0002 * 10,000 * 50 = 0.02 ft/day

Figure 14. Aqtesolv analysis of data from Nest 1 wells, Neuman-Witherspoon (1969) model. Till thickness 50 feet



WELL TEST ANALYSIS

Data Set: O:\...\14_litchfield_nest-1_neuman_thickness.aqt
Date: 08/29/17 Time: 12:19:34

PROJECT INFORMATION

Company: MDH
Client: City of Litchfield
Location: Litchfield 2
Test Well: L-2 (607420)
Test Date: 6/29/2017

AQUIFER DATA

Saturated Thickness: 30. ft
Aquitard Thickness (b'): 50. ft
Anisotropy Ratio (Kz/Kr): 1.
Aquitard Thickness (b"): 1. ft

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
2	0	0

Observation Wells

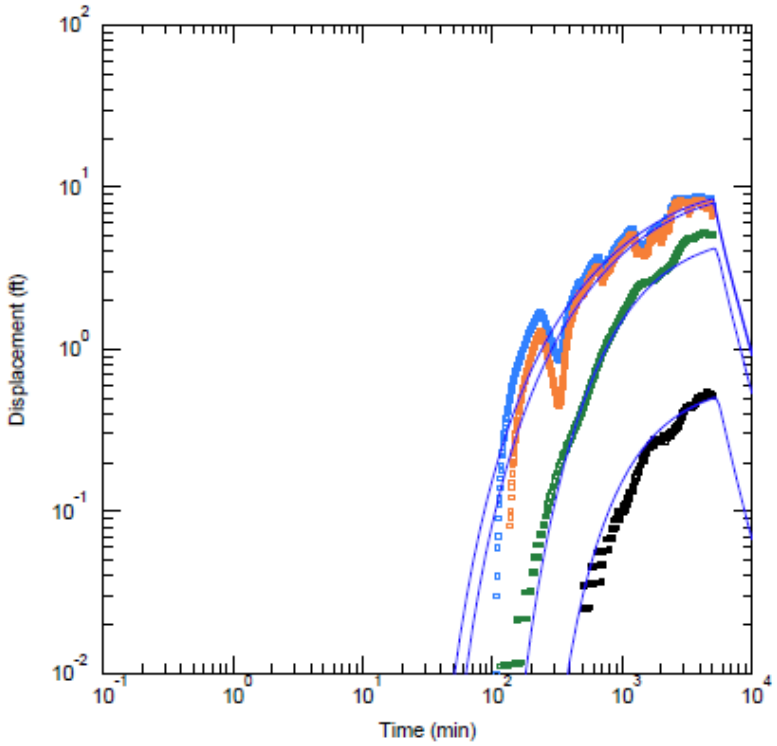
Well Name	X (ft)	Y (ft)
USGS 1-F	0	-1513
USGS 1-E	0	-1514
USGS 1-D	0	-1510

SOLUTION

Aquifer Model: Leaky
T = 1.08E+4 ft^2/day
1/B = 0.0001825 ft^{-1}
T2 = 1000. ft^2/day
Solution Method: Neuman-Witherspoon
S = 0.00012
ß/r = 0.0001939 ft^{-1}
S2 = 1.

L = 5,500 feet
k_V = 0.0001825 * 10,800 * 50 = 0.018 ft/day

Figure 15. Aqtesolv analysis of data from Nest 1 wells, Neuman-Witherspoon (1969) model. Drawdown from unknown pumping wells.



WELL TEST ANALYSIS

Data Set: O:\...\15_litchfield_unkpump_nest-1_neuman.aqt
Date: 08/29/17 Time: 12:16:07

PROJECT INFORMATION

Company: MDH
Client: City of Litchfield
Location: Litchfield 2
Test Well: L-2 (607420)
Test Date: 6/29/2017

AQUIFER DATA

Saturated Thickness: 30. ft
Aquitard Thickness (b'): 50. ft
Anisotropy Ratio (Kz/Kr): 1.
Aquitard Thickness (b"): 1. ft

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
UnkPump	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
USGS 1-F	8000	0
USGS 1-E	8000	0
USGS 1-D	8000	0
USGS 1-C	8000	0

SOLUTION

Aquifer Model: Leaky
T = 8000. ft^2/day
1/B = 5.0E-5 ft^{-1}
T2 = 10000. ft^2/day

Solution Method: Neuman-Witherspoon
S = 7.38E-5
ß/r = 9.198E-6 ft^{-1}
S2 = 1.

L = 20,000 feet

$k_V = 0.00005 * 8000 * 50 = 0.001$ ft/day

Figure 16. Well Location Map: well name and Minnesota unique well number

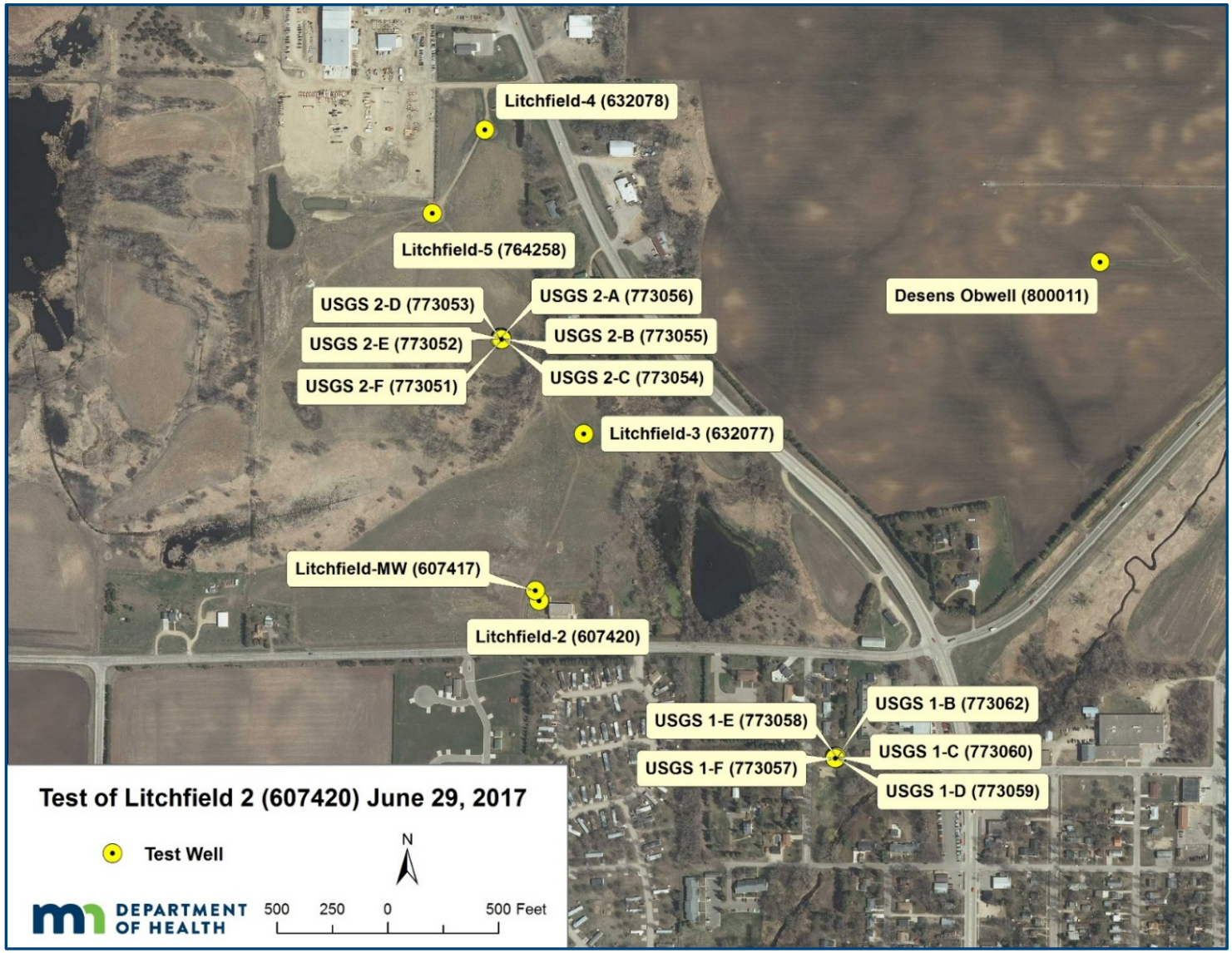


Figure 17. Schematic Section

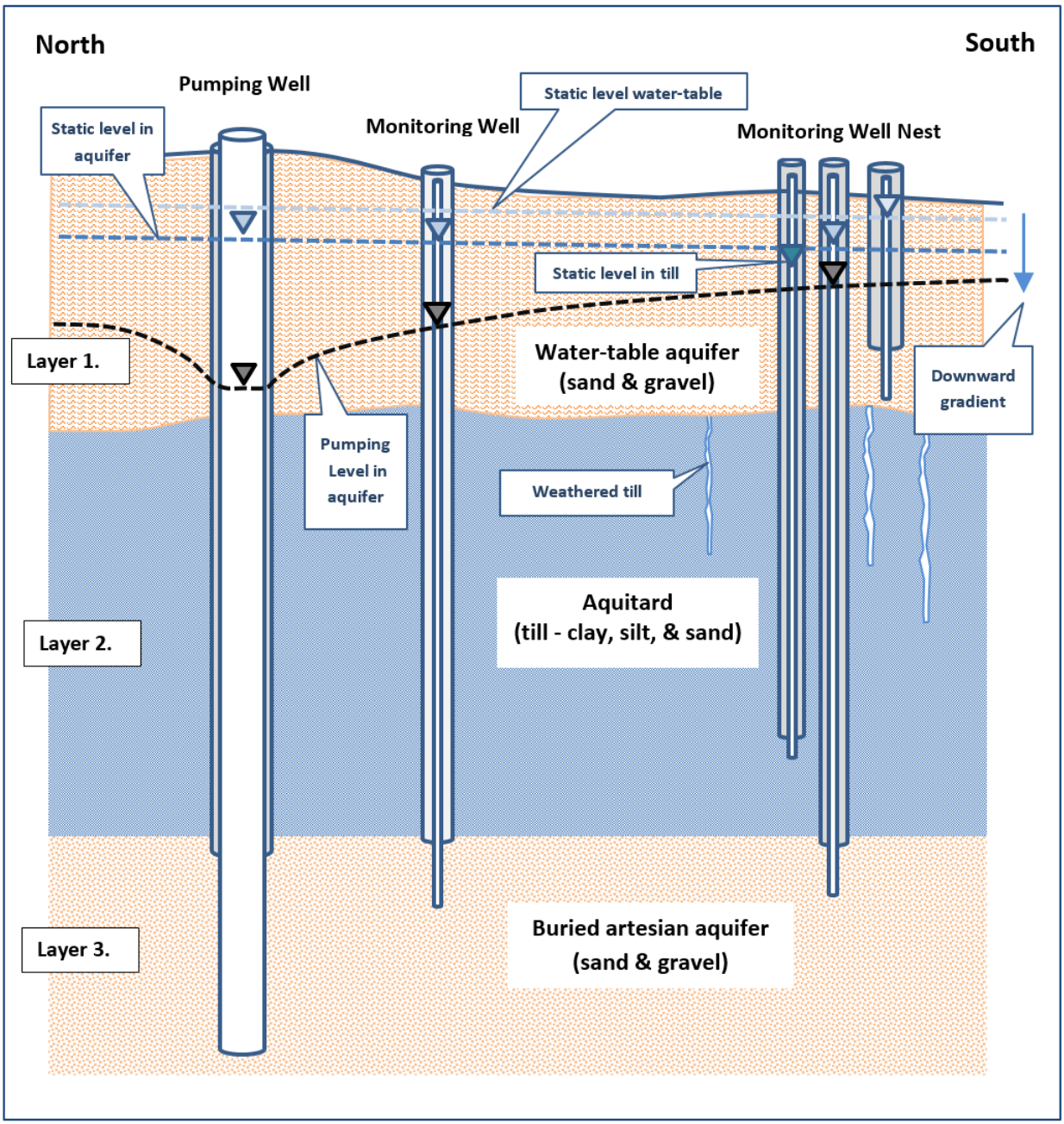


Figure 18. Depth to Water from Top of Casing at Litchfield 2 (607417), Both Manual and Electronic Measurements

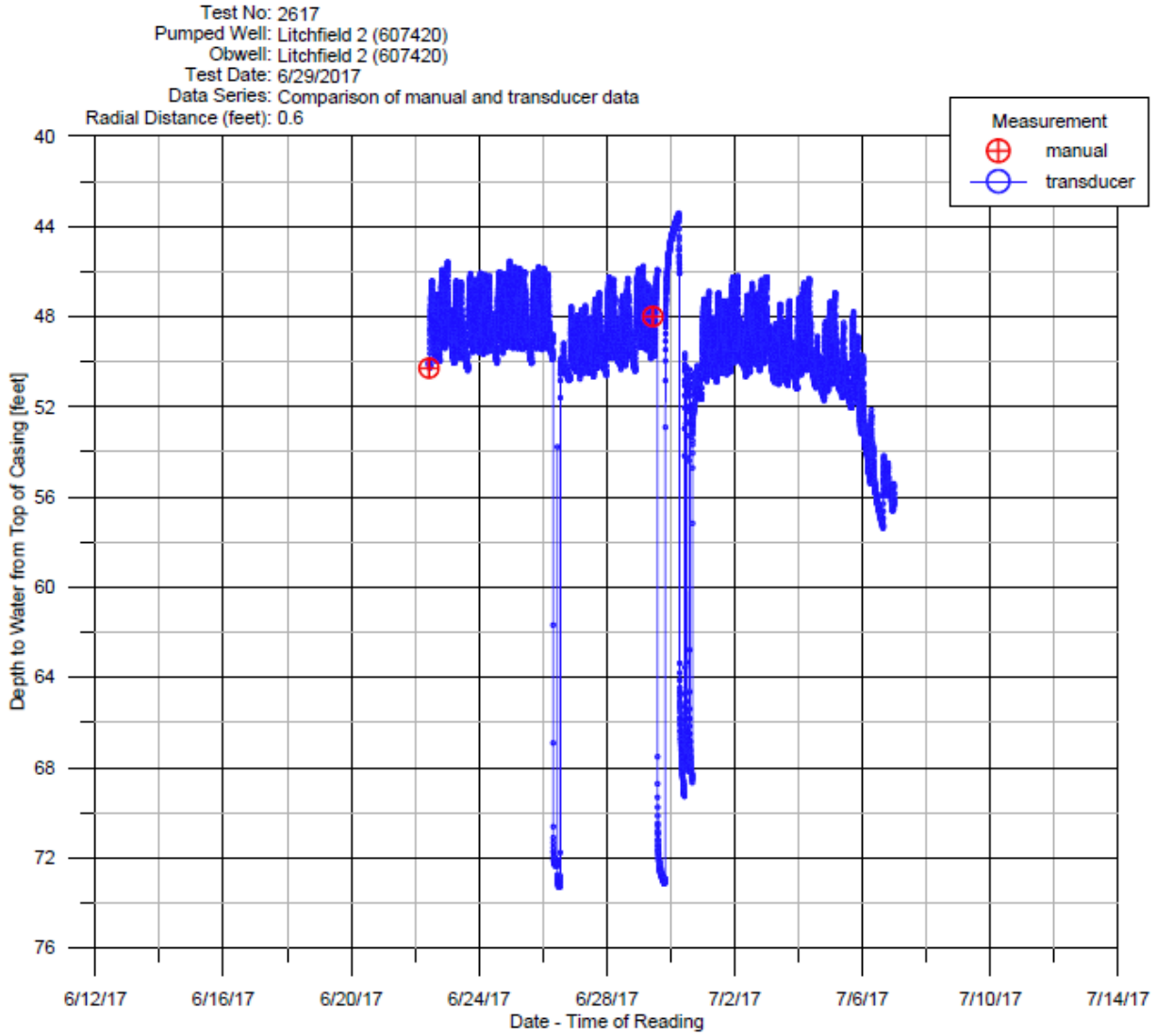


Figure 19. Depth to Water from Top of Casing at Litchfield MW (607420), Both Manual and Electronic Measurements

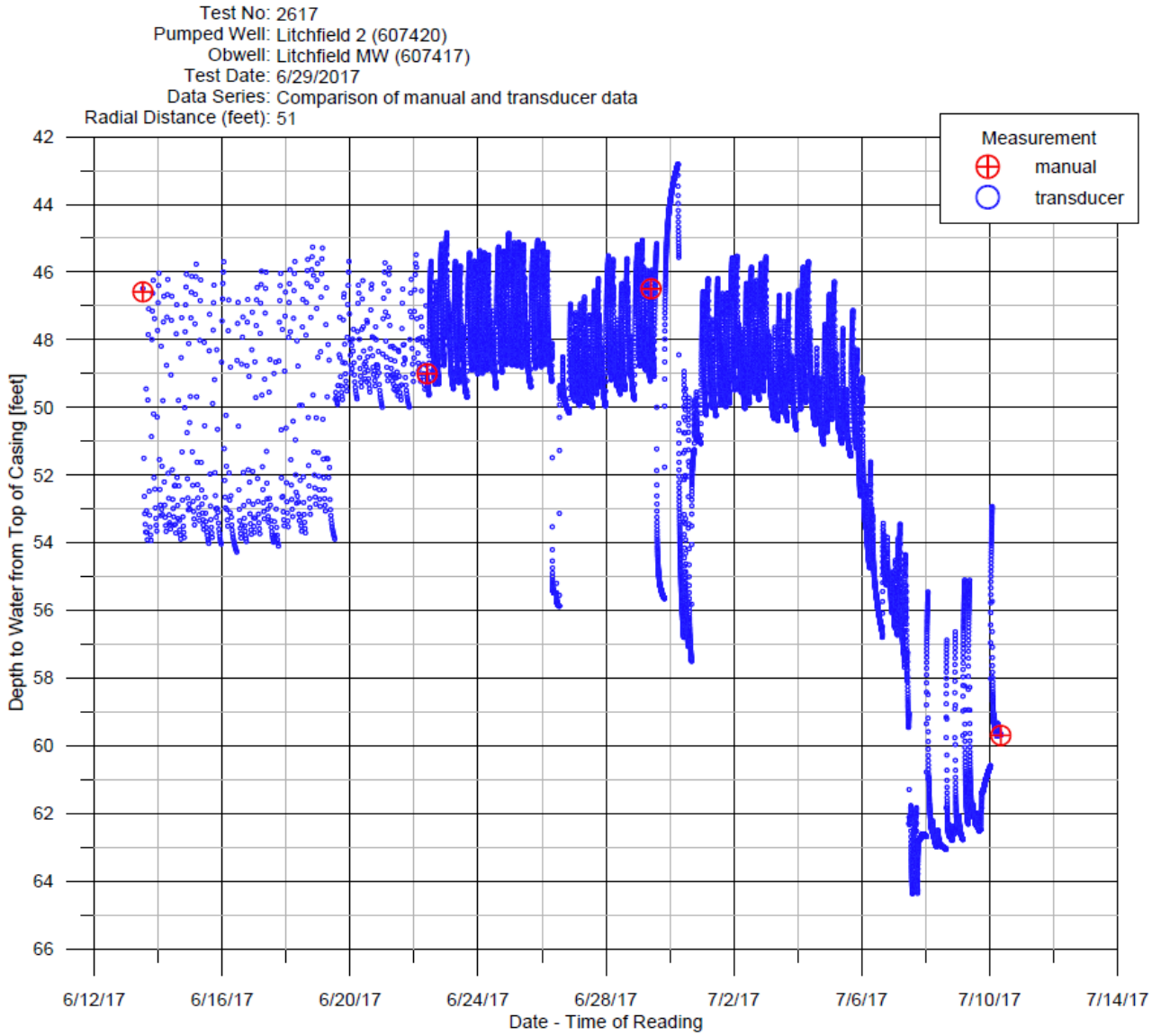


Figure 20. Depth to Water from Top of Casing at Litchfield 3 (632077), Manual Measurements

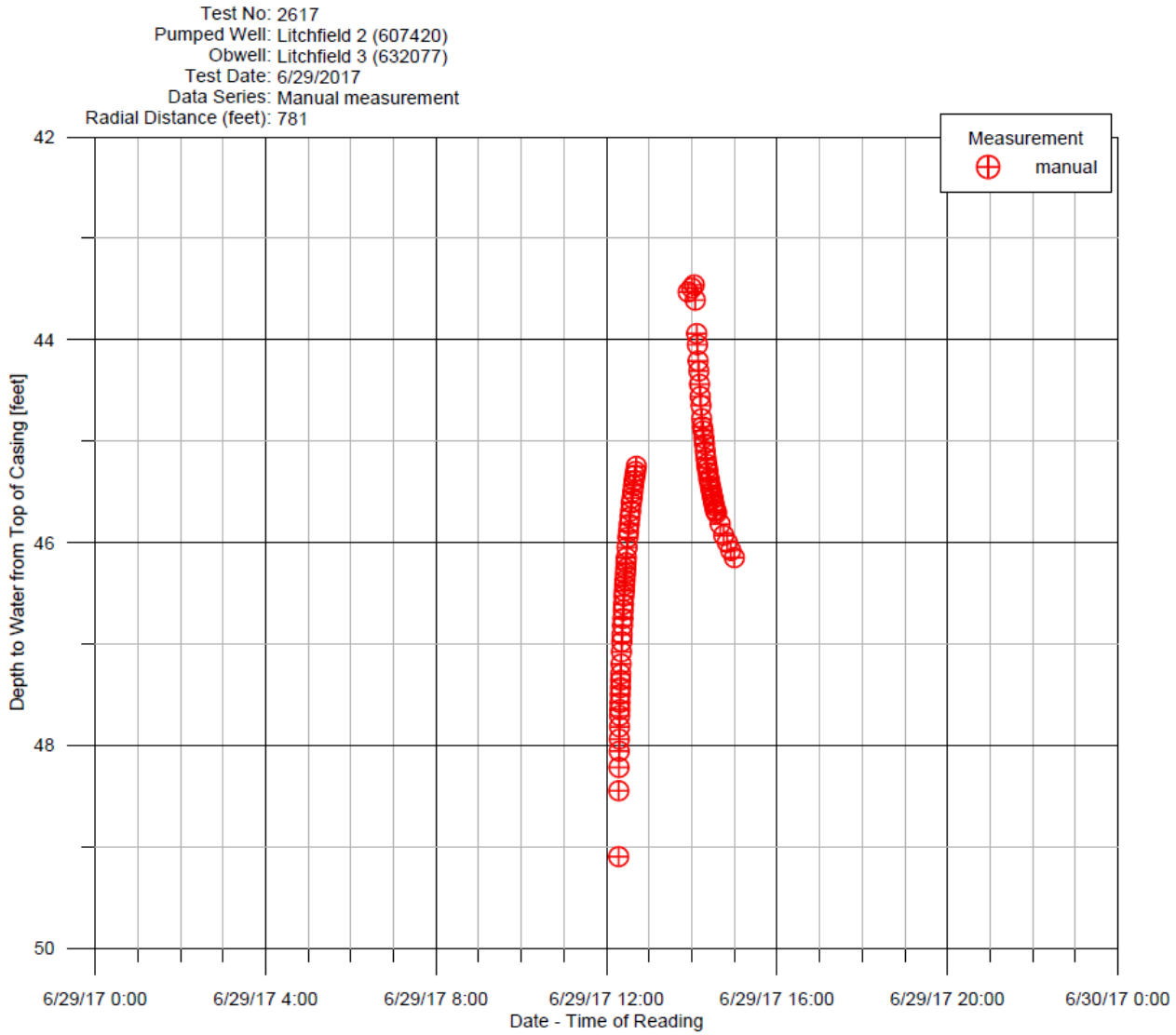


Figure 21. Depth to Water from Top of Casing at Litchfield 4 (632078), Manual Measurements

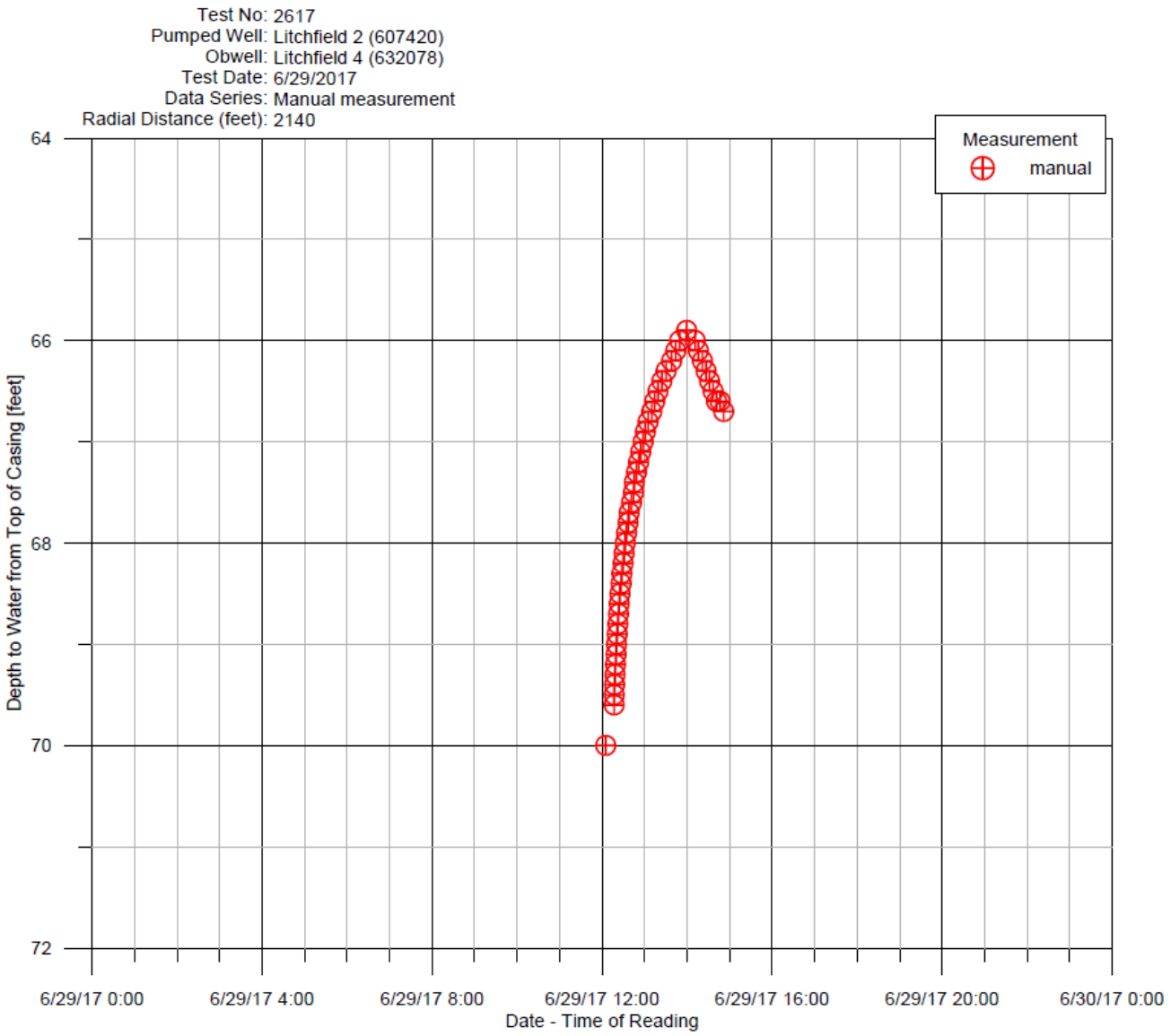


Figure 22. Depth to Water from Top of Casing at Litchfield 5 (764258), Manual Measurements

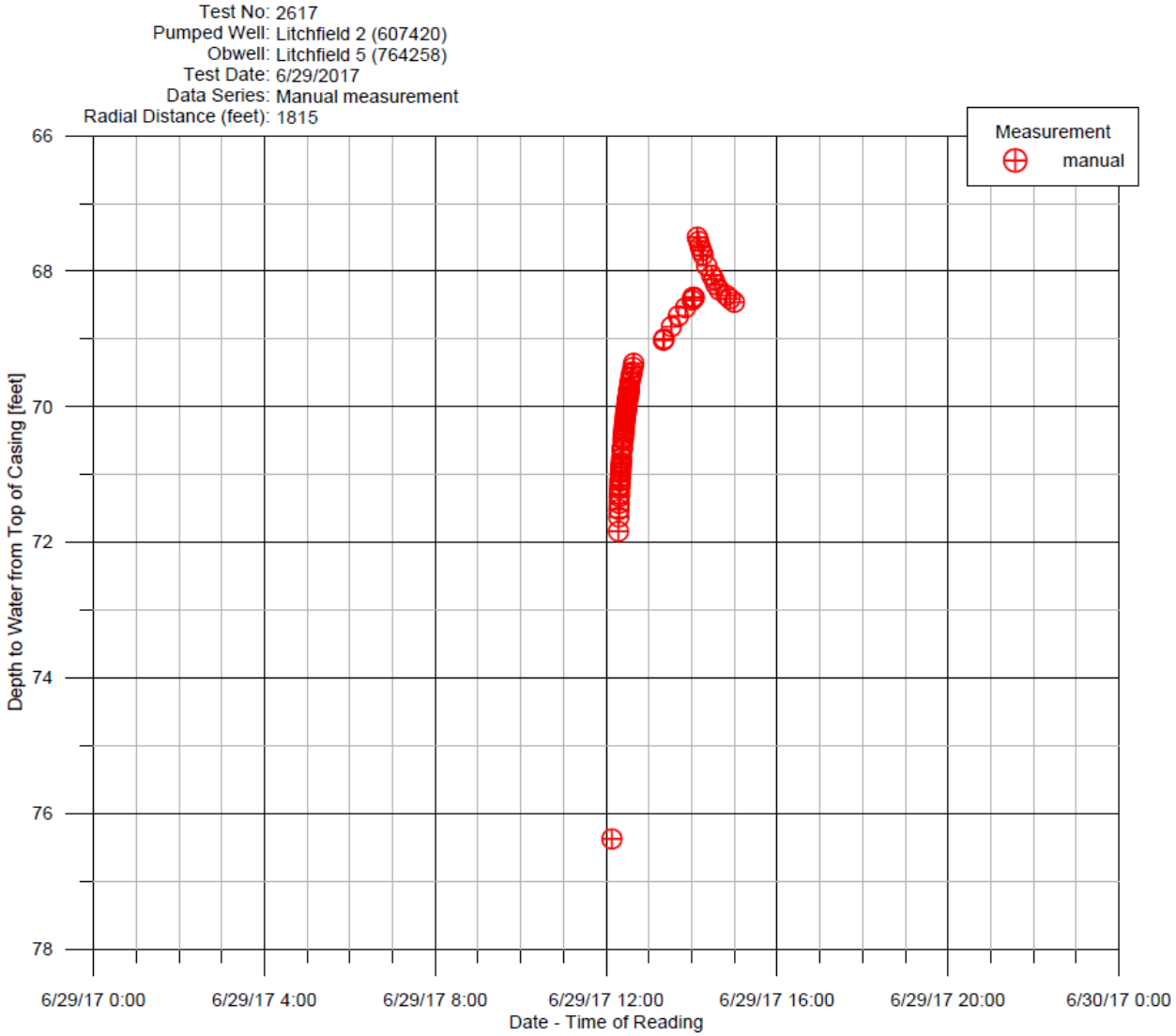


Figure 23. Depth to Water from Top of Casing at USGS 1-B (773062), Both Manual and Electronic Measurements

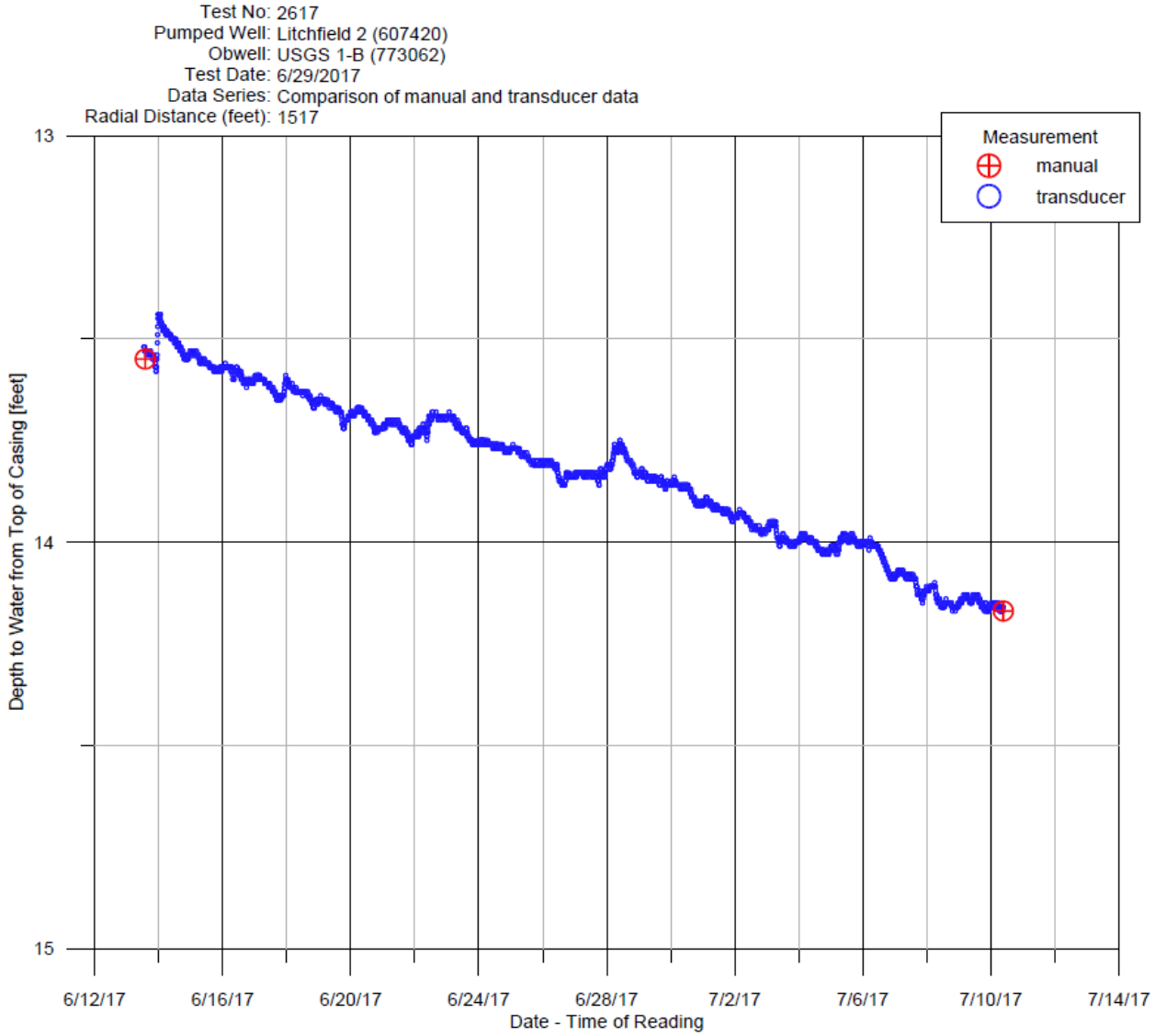


Figure 24. Depth to Water from Top of Casing at USGS 1-C (773060), Both Manual and Electronic Measurements

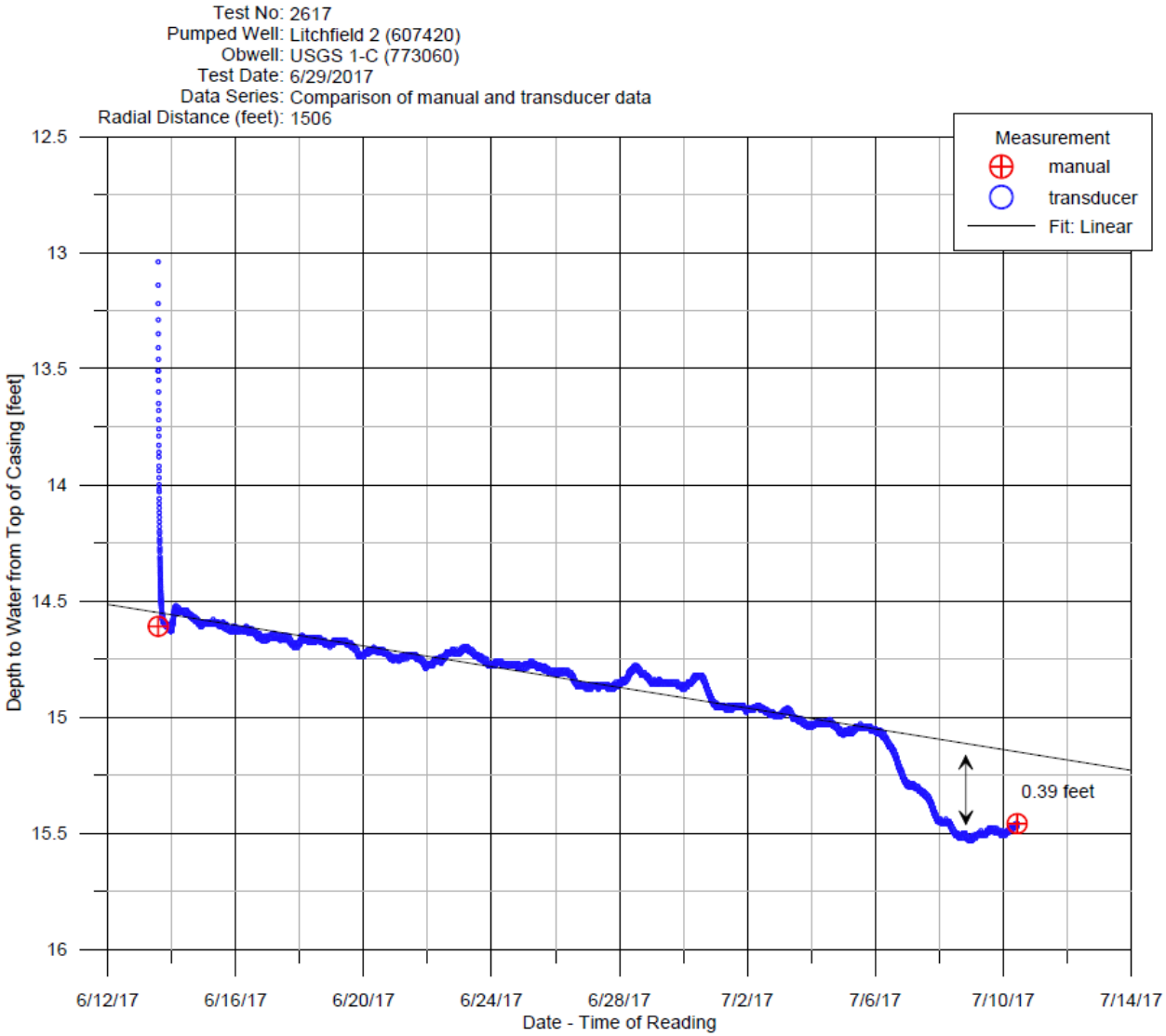


Figure 25. Depth to Water from Top of Casing at USGS 1-D (773059), Both Manual and Electronic Measurements

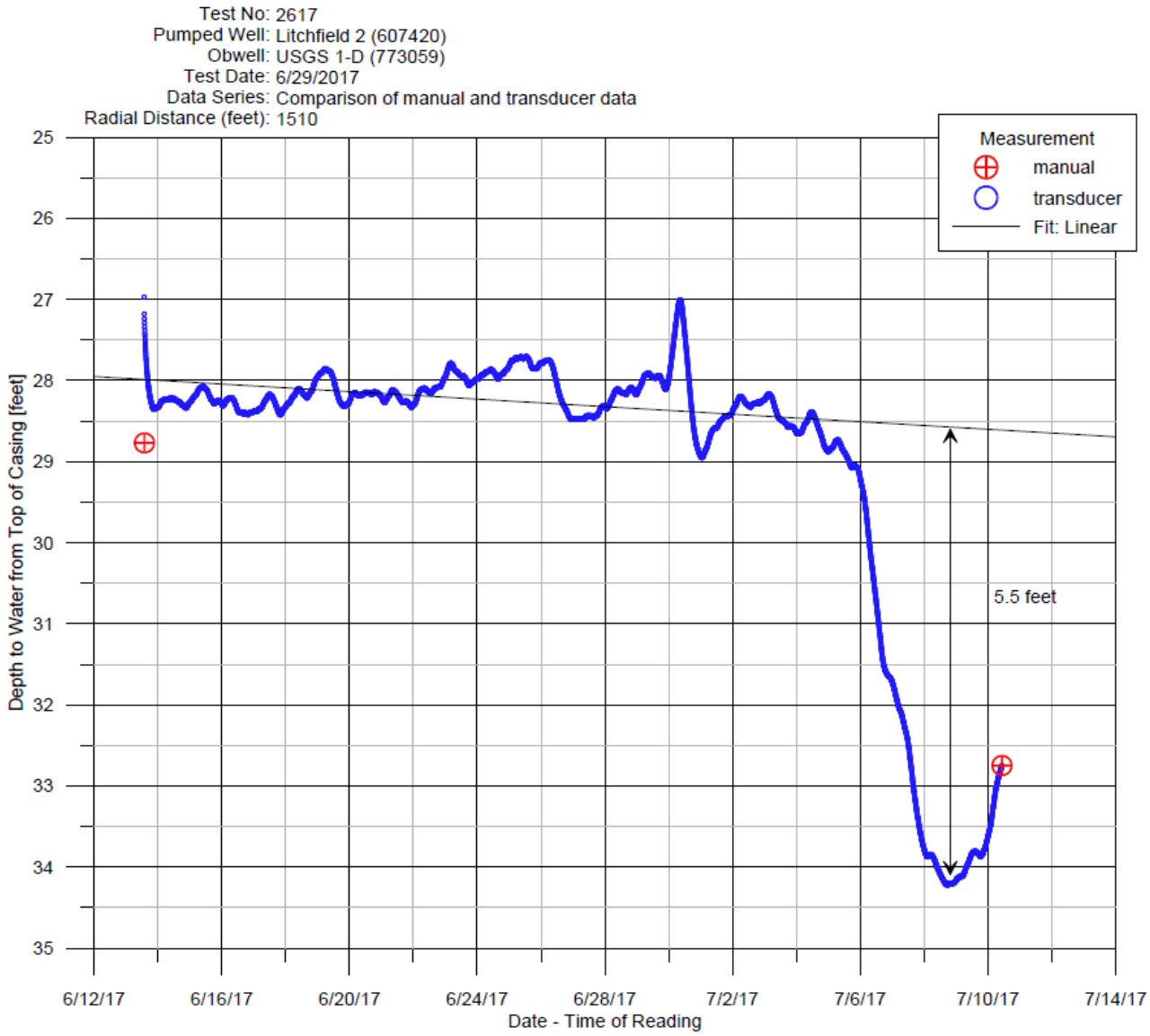


Figure 26. Depth to Water from Top of Casing at USGS 1-E (773058), Both Manual and Electronic Measurements

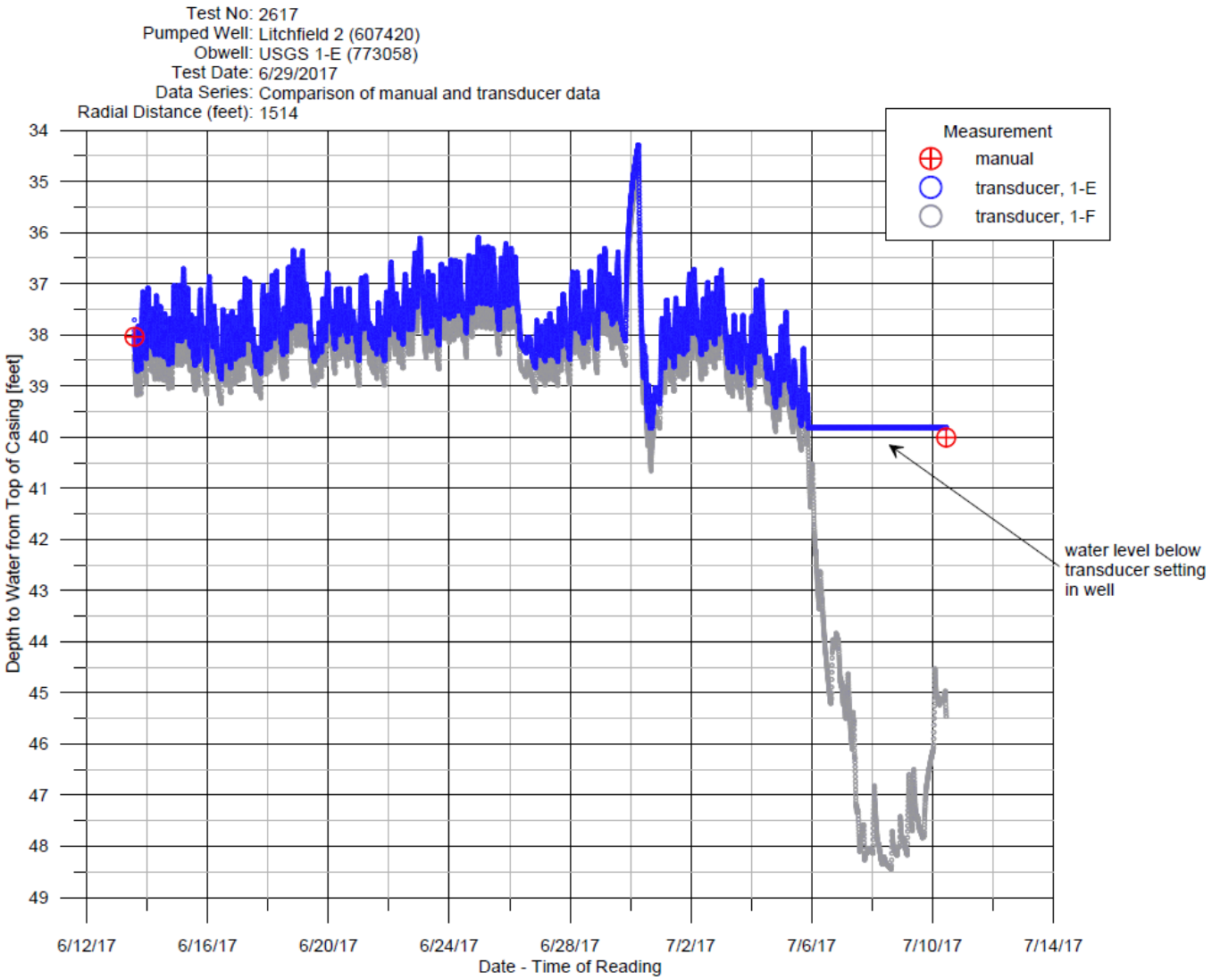


Figure 27. Depth to Water from Top of Casing at USGS 1-F (773057), Both Manual and Electronic Measurements

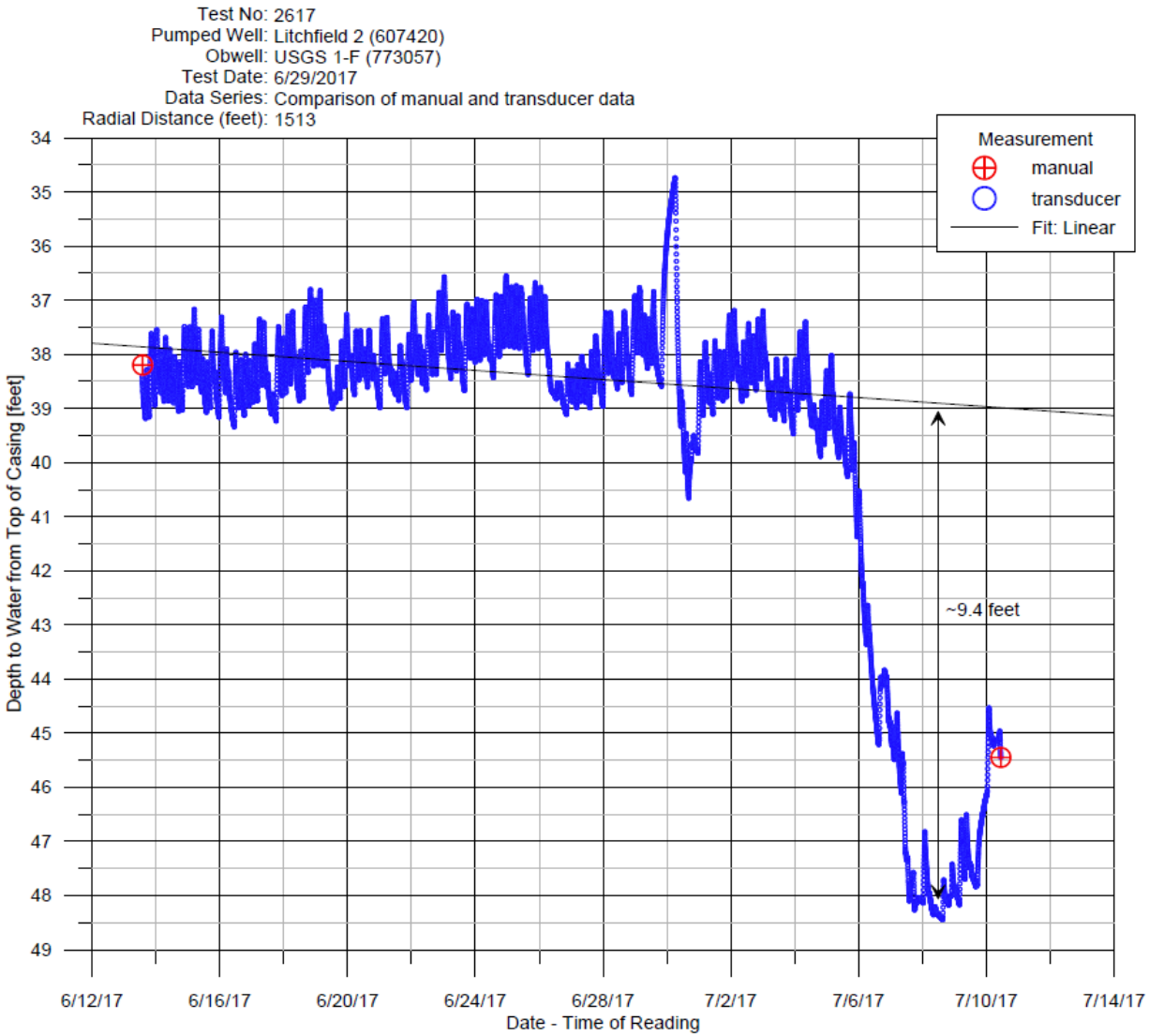


Figure 28. Depth to Water from Top of Casing at USGS 2-A (773056), Both Manual and Electronic Measurements

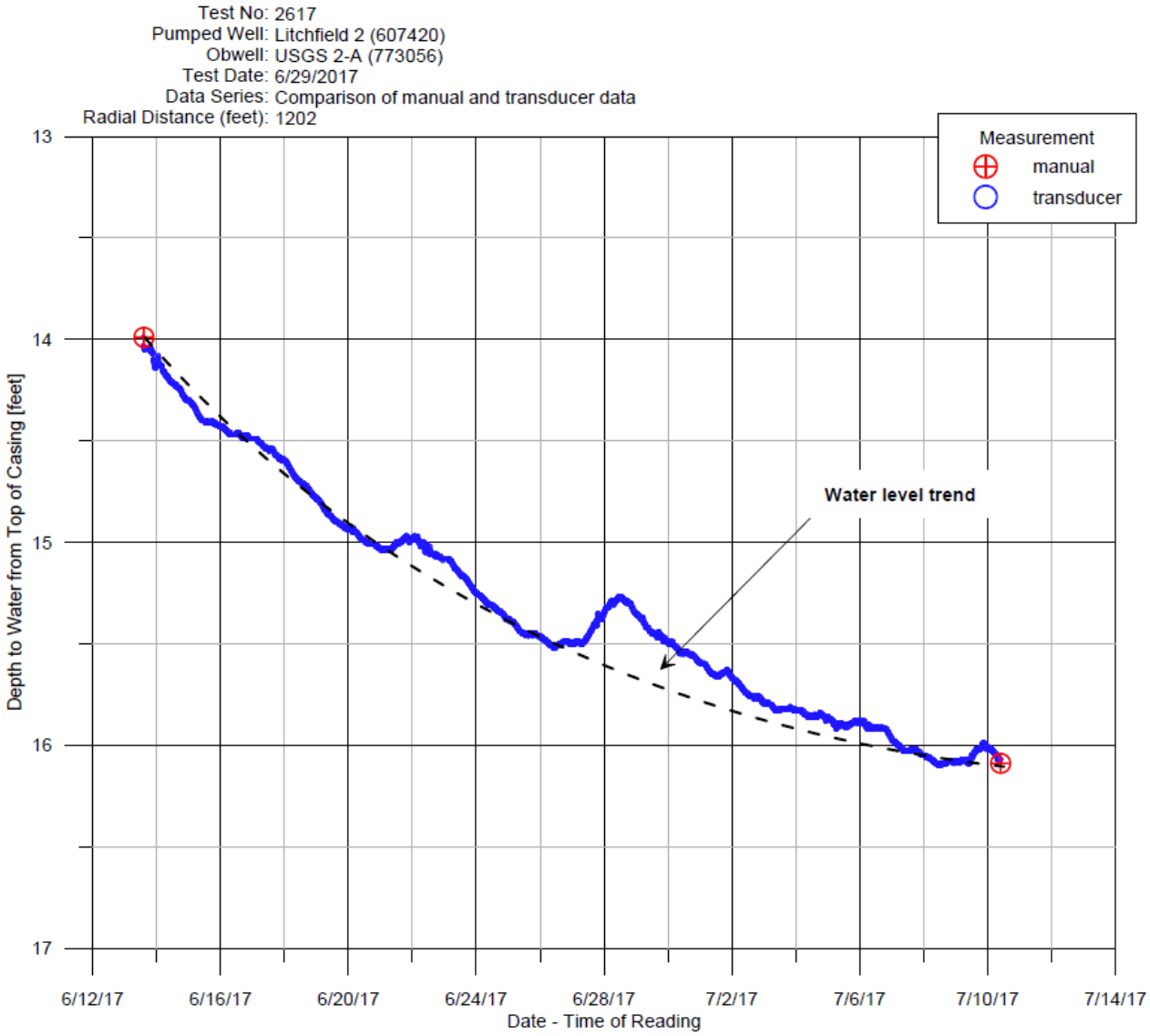


Figure 29. Depth to Water from Top of Casing at USGS 2-B (773055), Both Manual and Electronic Measurements

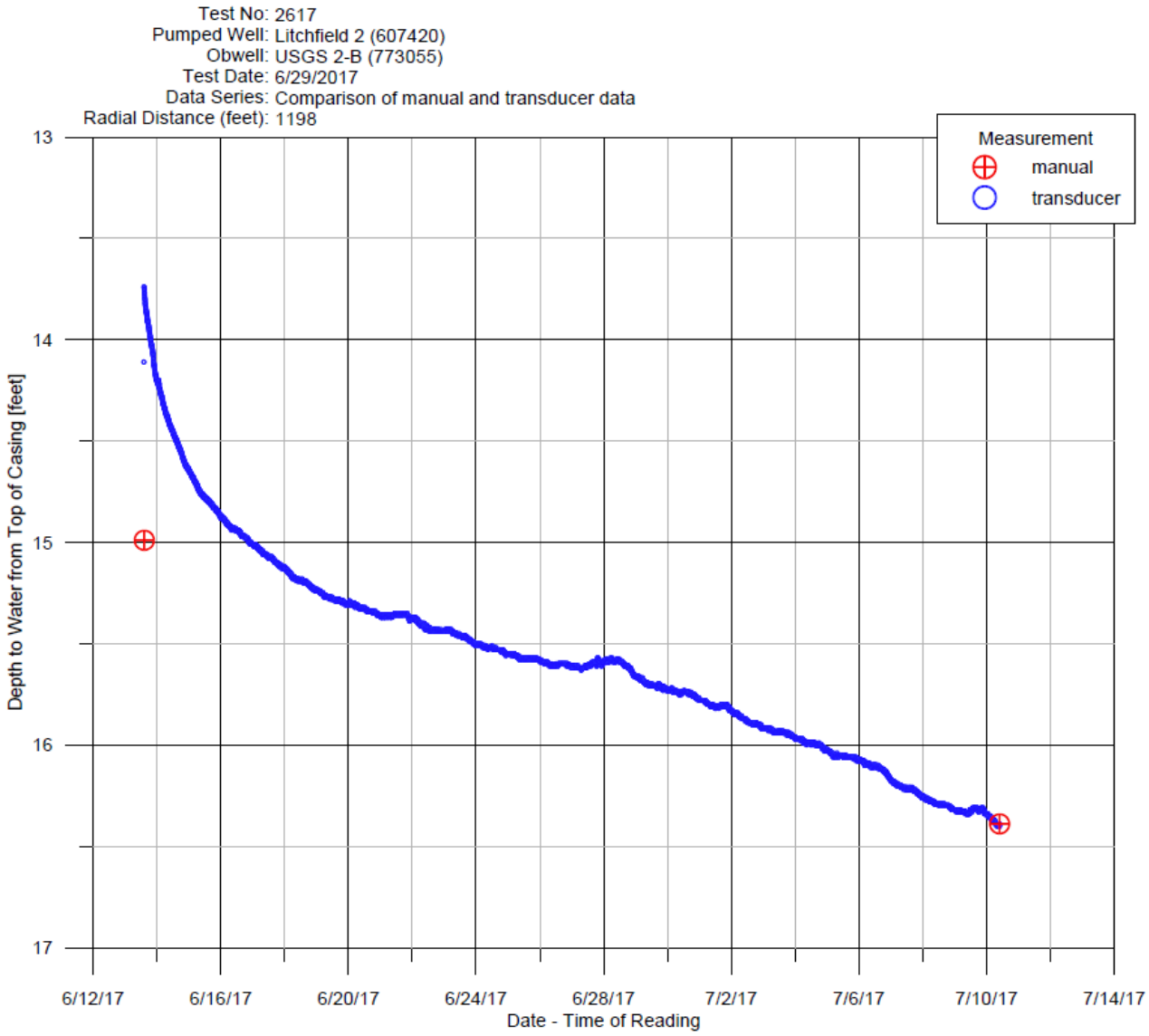


Figure 30. Depth to Water from Top of Casing at USGS 2-C (773054), Both Manual and Electronic Measurements

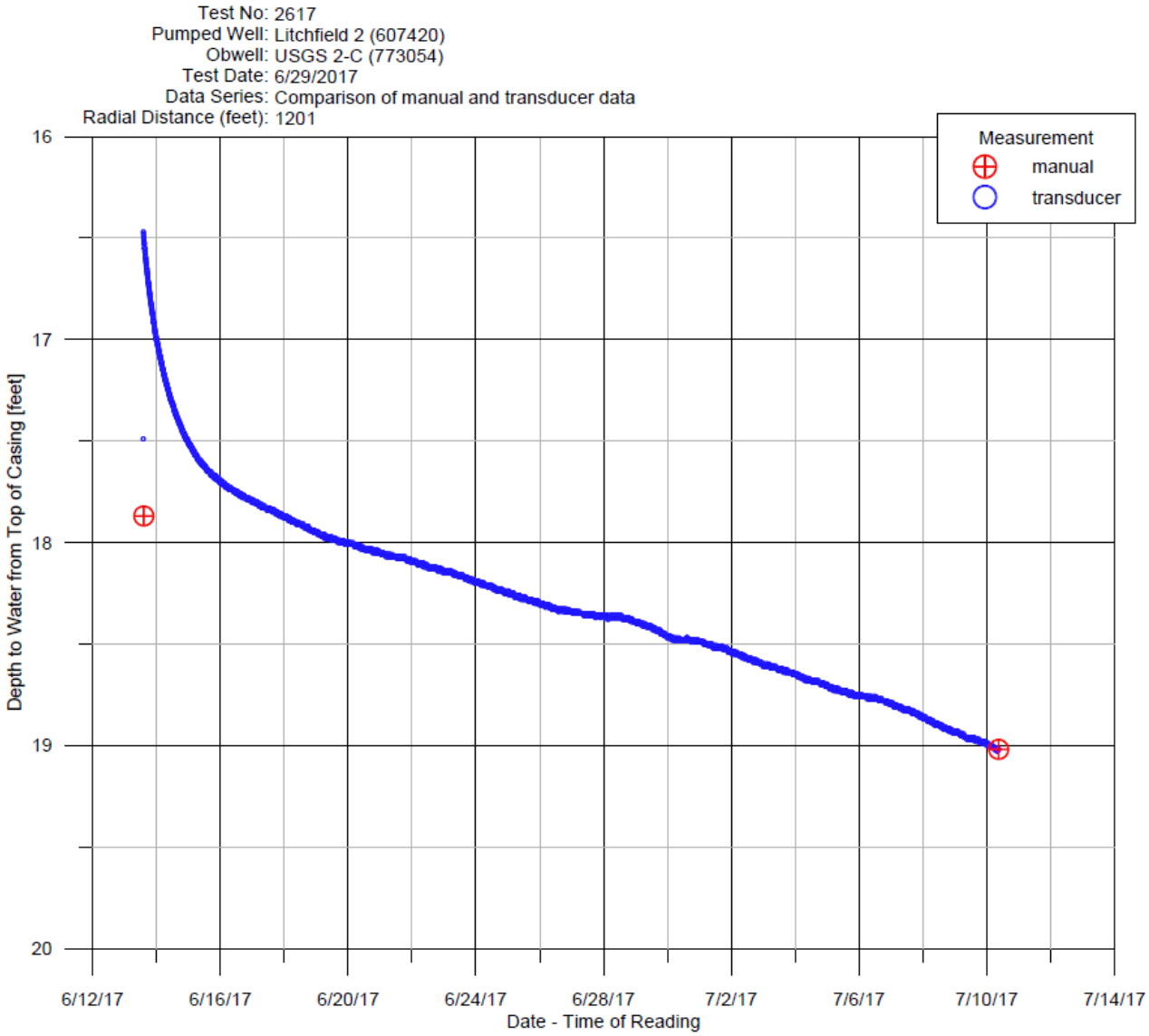


Figure 31. Depth to Water from Top of Casing at USGS 2-D (773053), Both Manual and Electronic Measurements

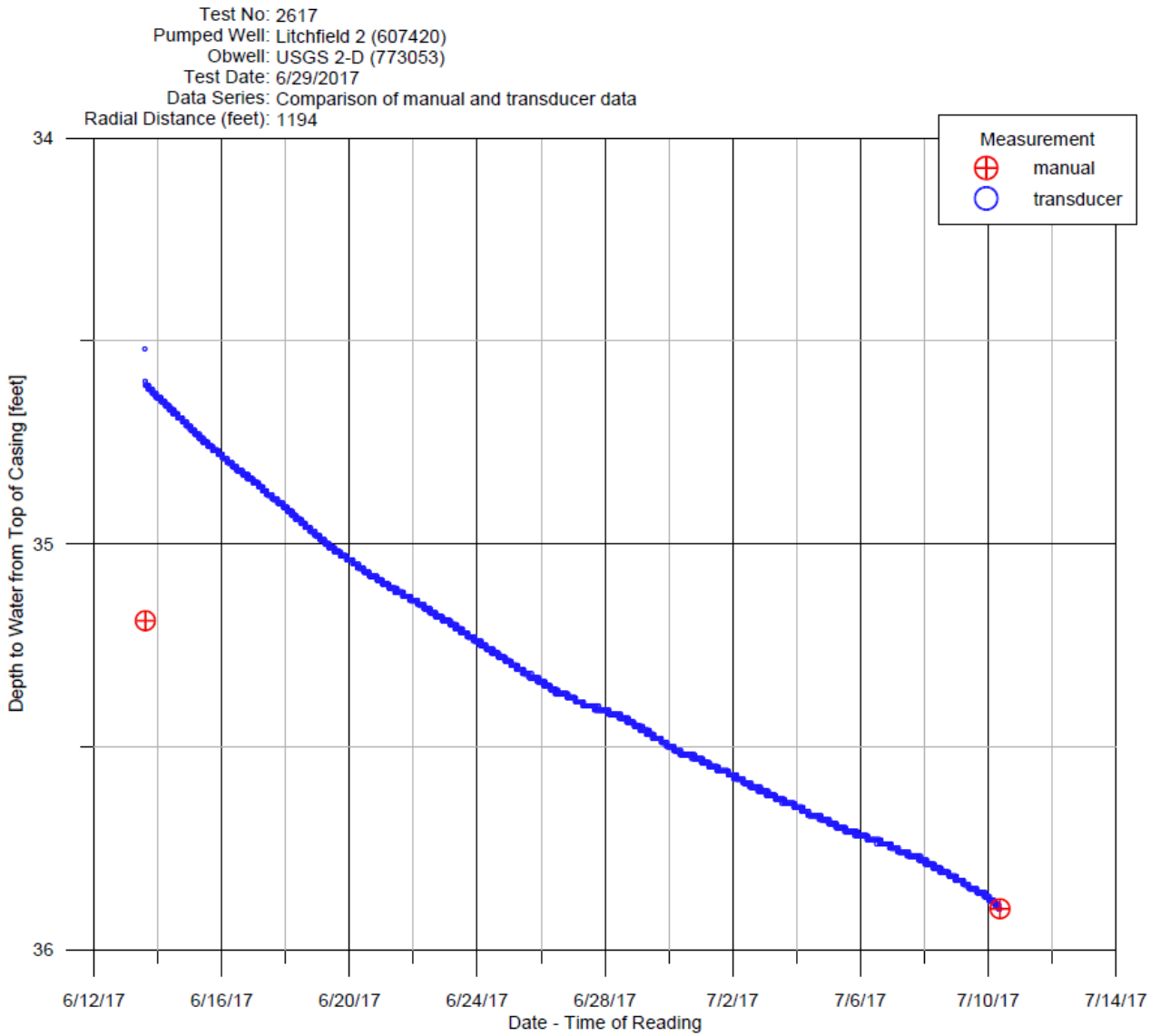


Figure 32. Depth to Water from Top of Casing at USGS 2-F (773051), Both Manual and Electronic Measurements

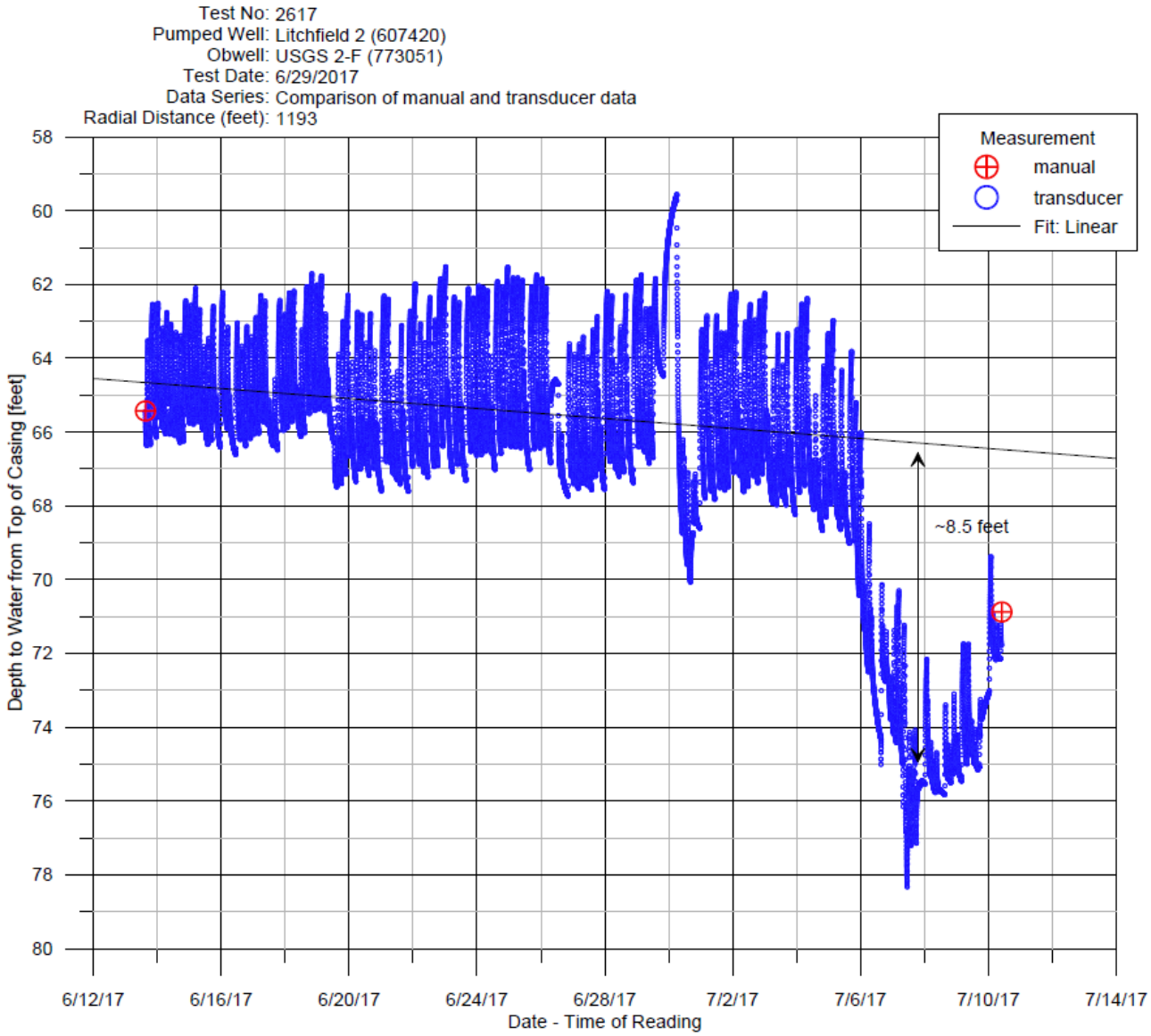


Figure 33. Depth to Water from Top of Casing at Desens Observation (800011), Both Manual and Electronic Measurements

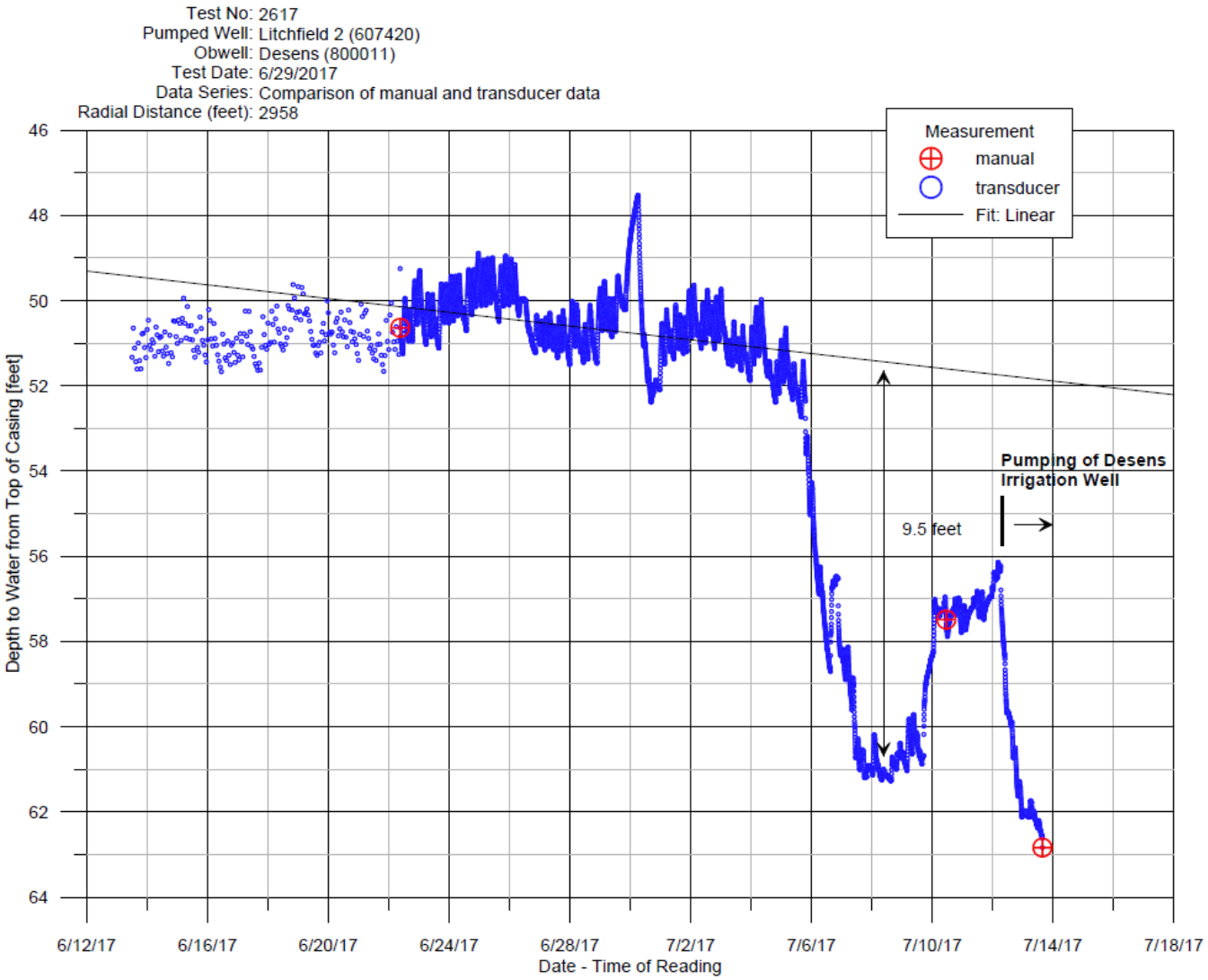


Figure 34. Groundwater elevation at Litchfield-2 and Nest 1

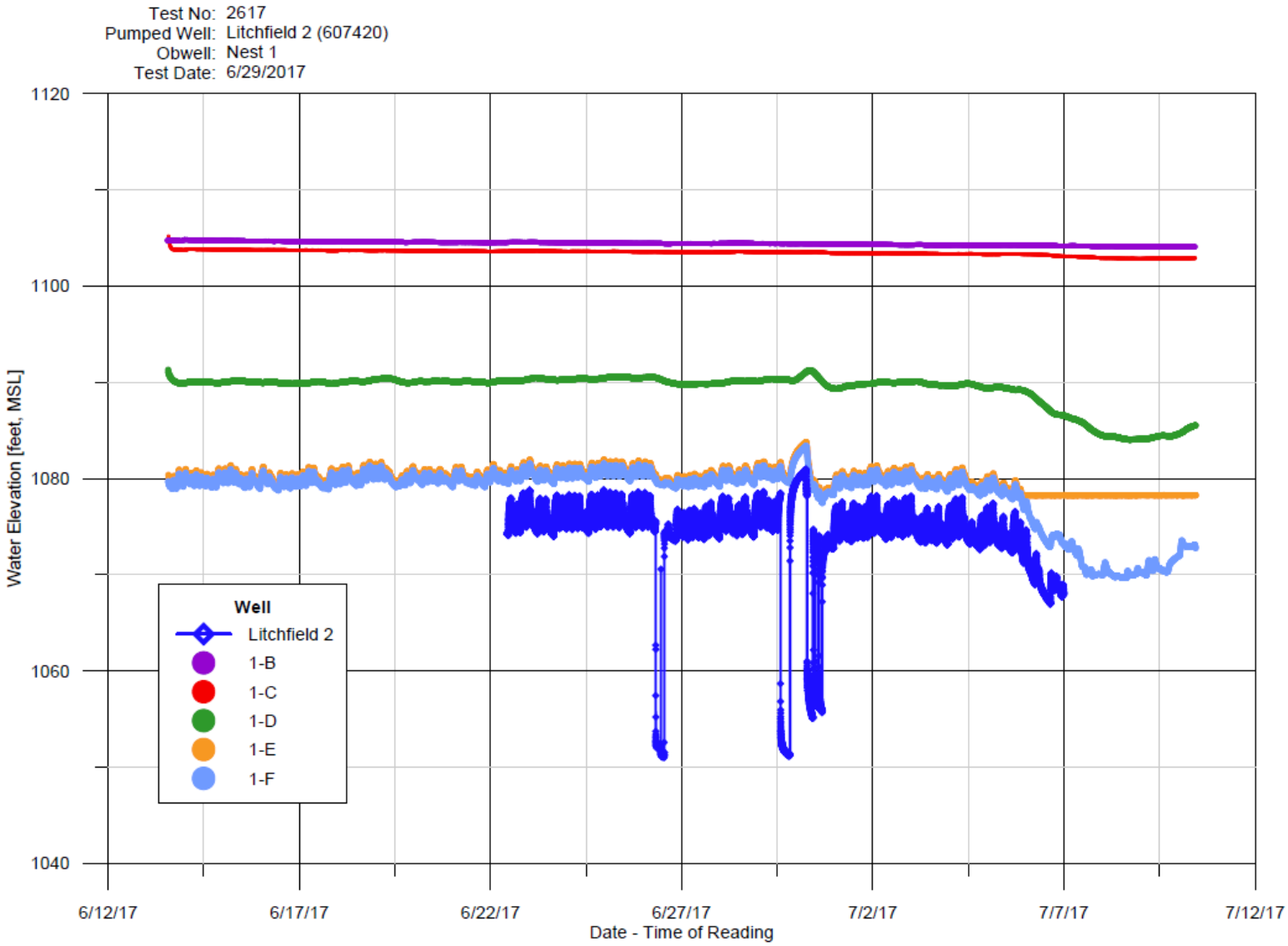


Figure 35. Groundwater elevation at Litchfield-2 and Nest 2

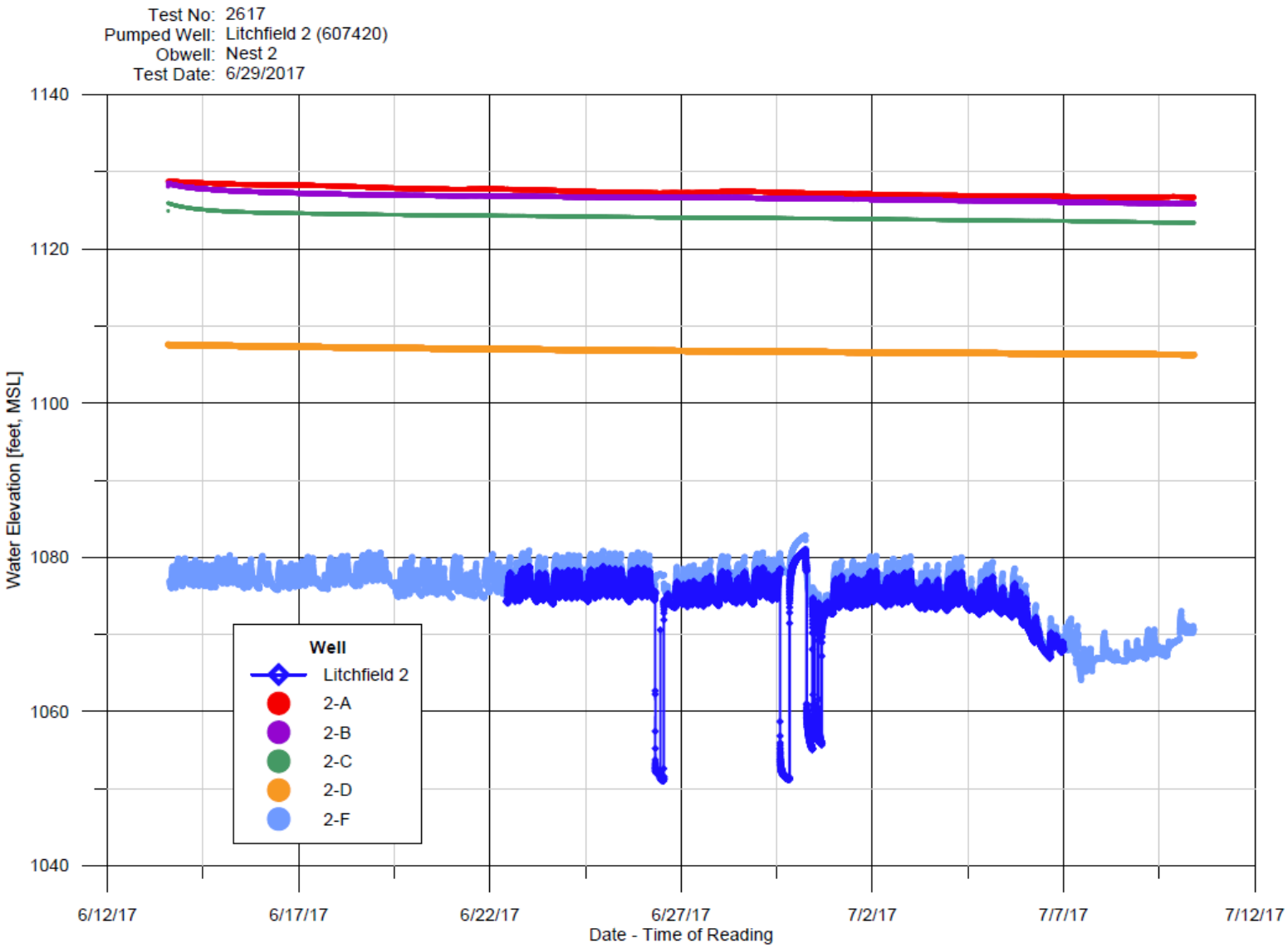


Figure 36. Groundwater elevation at Litchfield-2 and Observation Wells Constructed in Aquifer, All Data

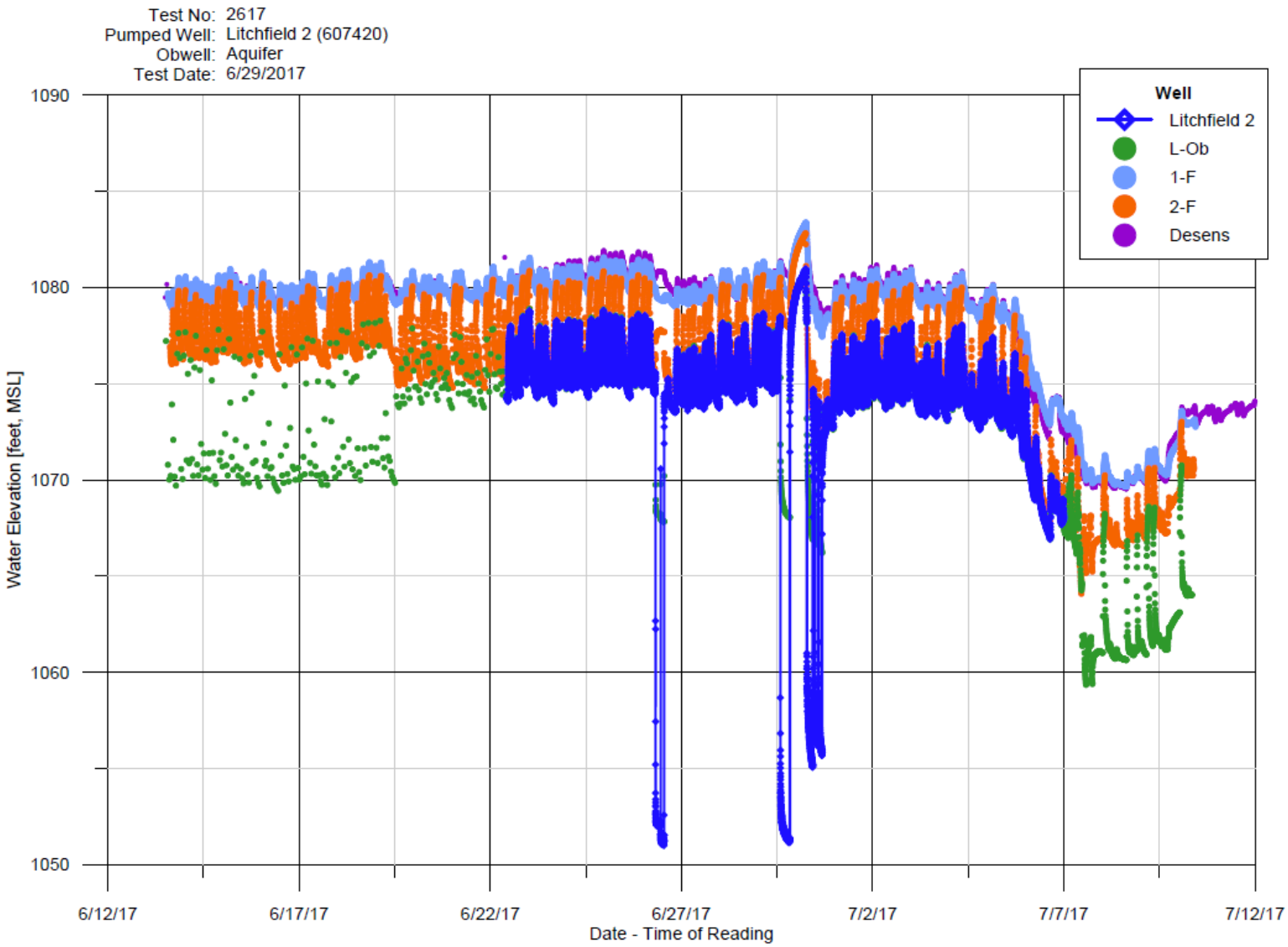


Figure 37. Groundwater elevation at Litchfield-2 and Observation Wells, Test Period

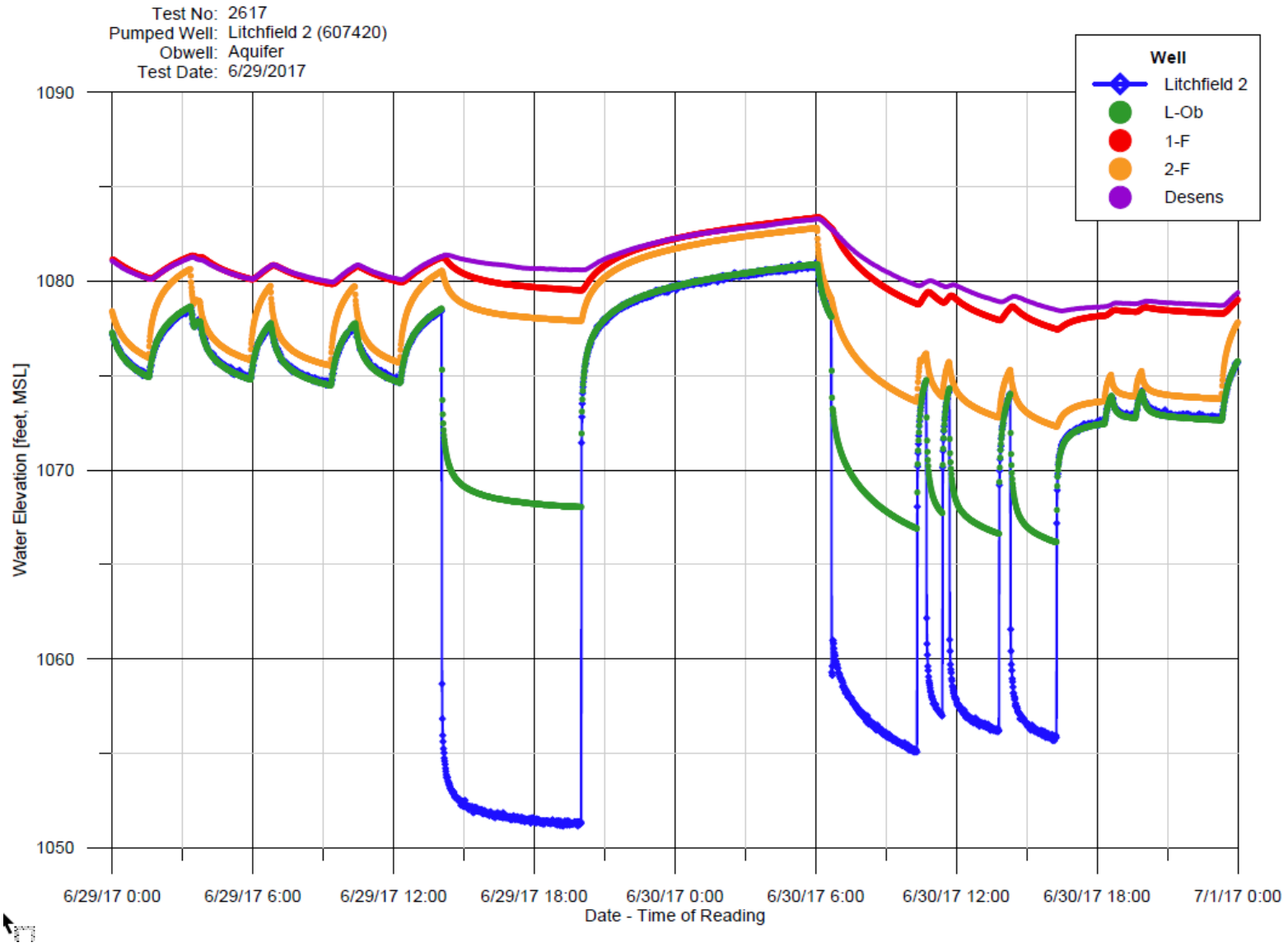


Figure 38. Groundwater elevation at Litchfield-2 and Nest 1, Test Period

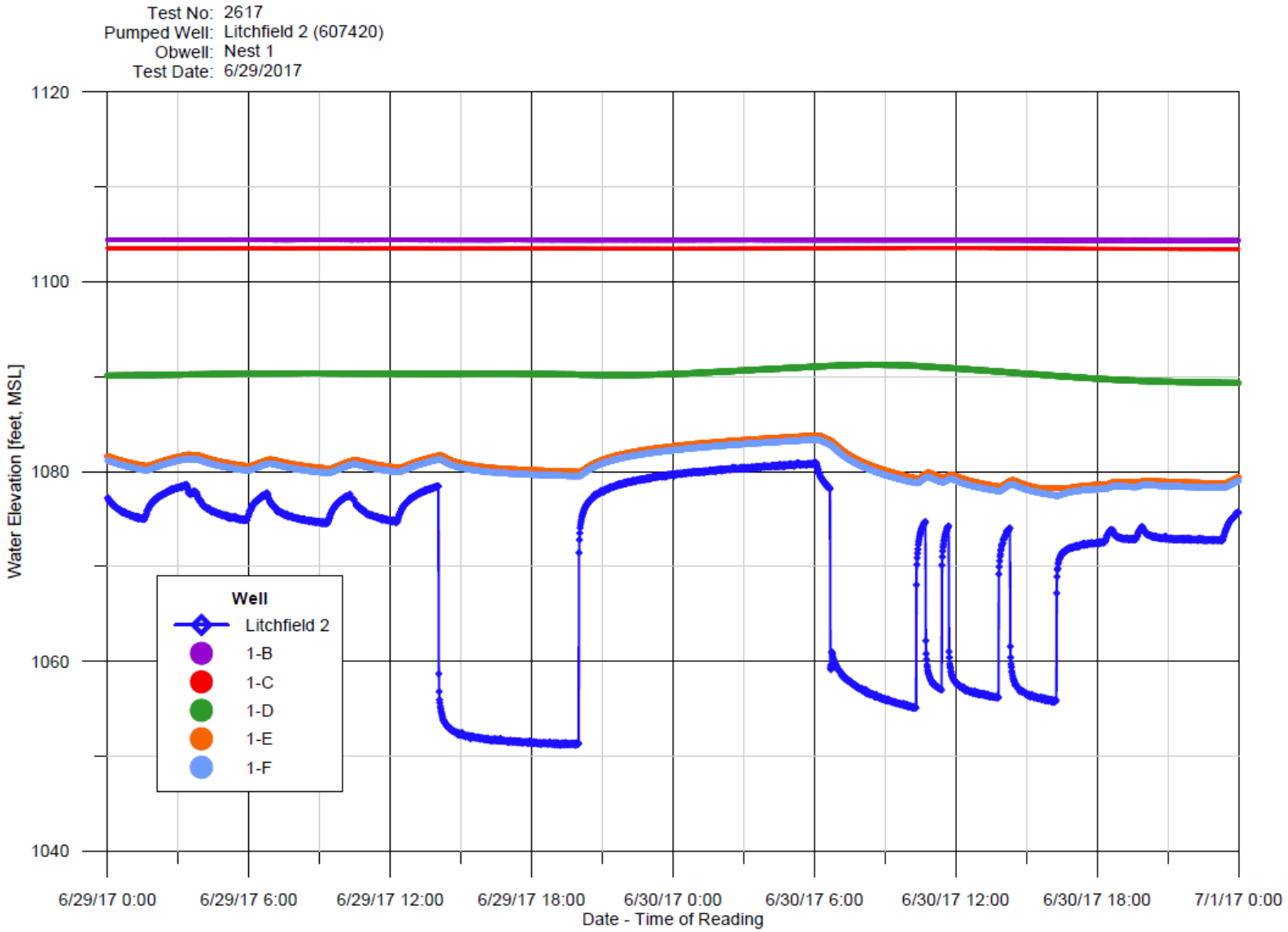


Figure 39. Groundwater elevation at Litchfield-2 and Nest 2, Test Period

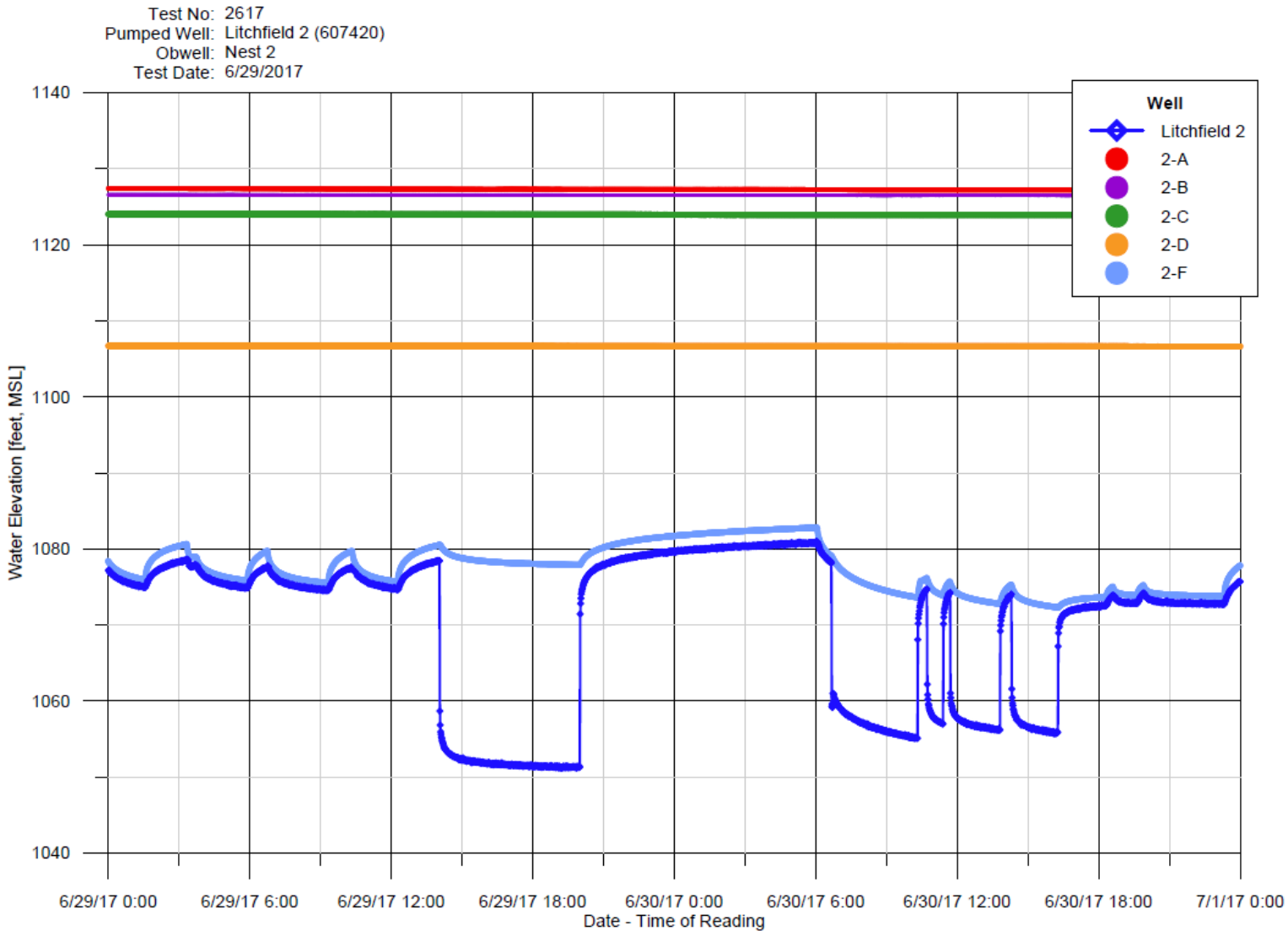


Figure 40. Groundwater Elevation in Aquifer Compared to Barometric Pressure, Test Period

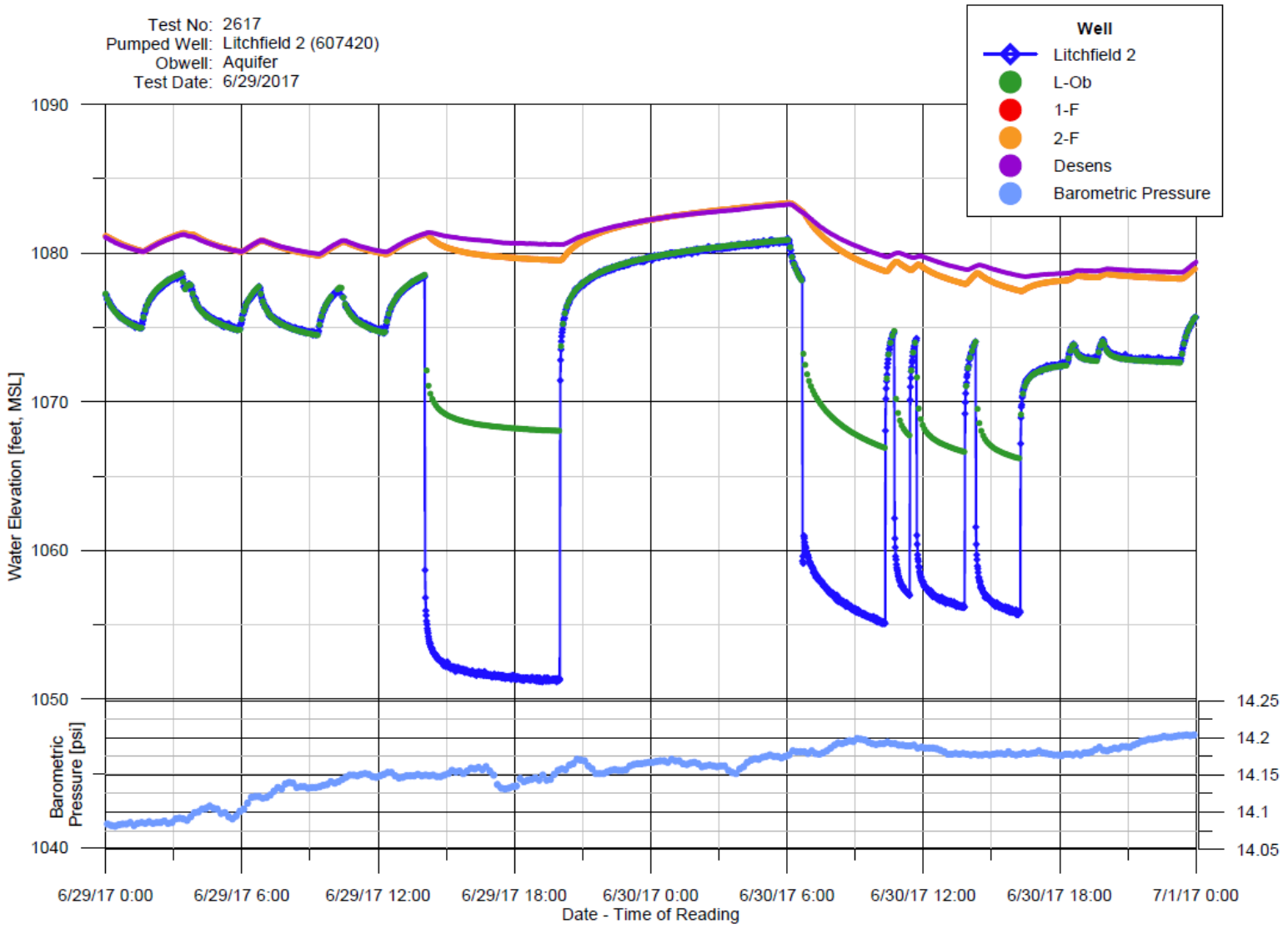


Figure 41. Depth to Water in Water-Table Wells Compared to Rainfall Events

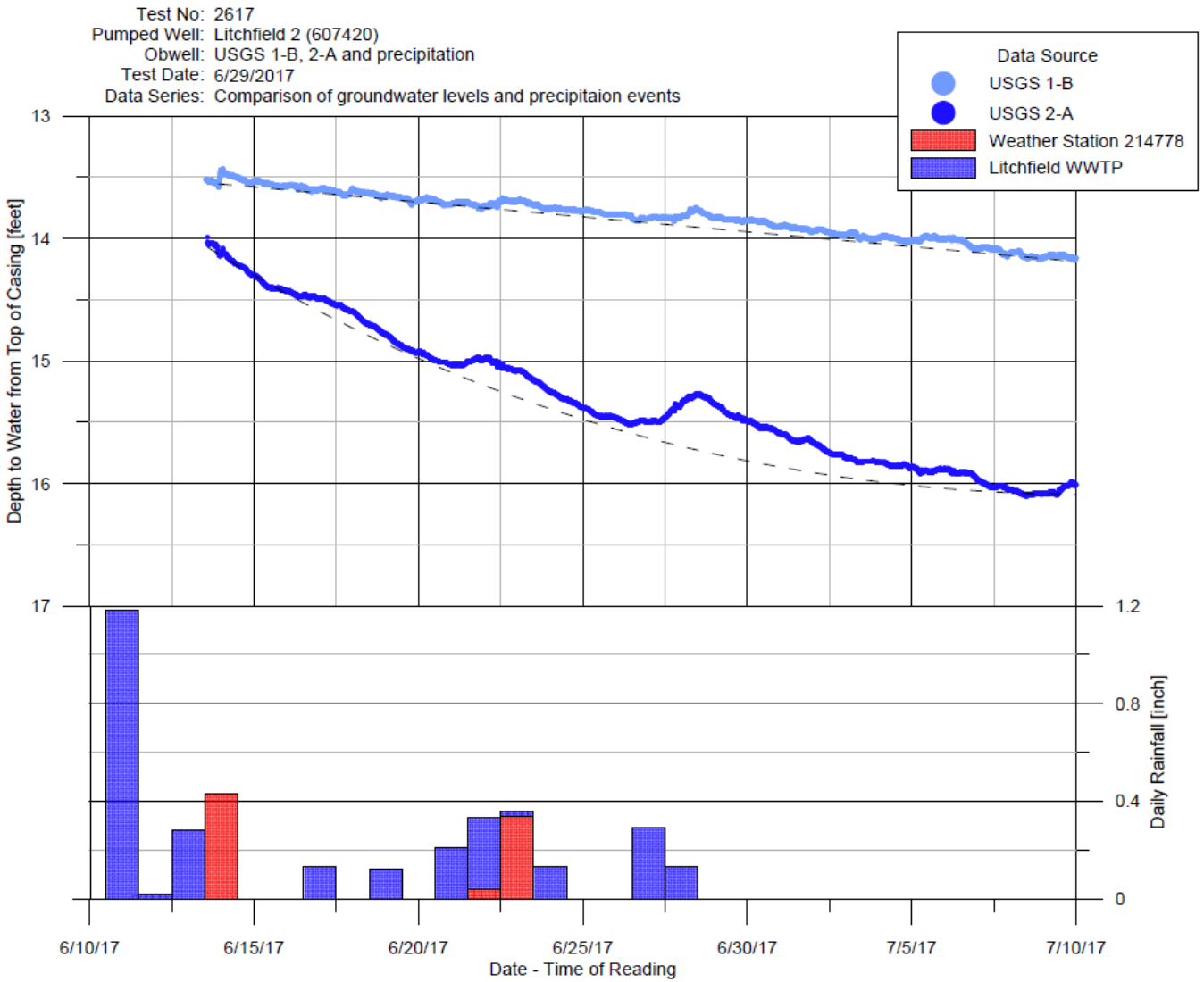


Figure 42. Daily Pumping Volume from Community Supply Wells, June 1, to July 10, 2017

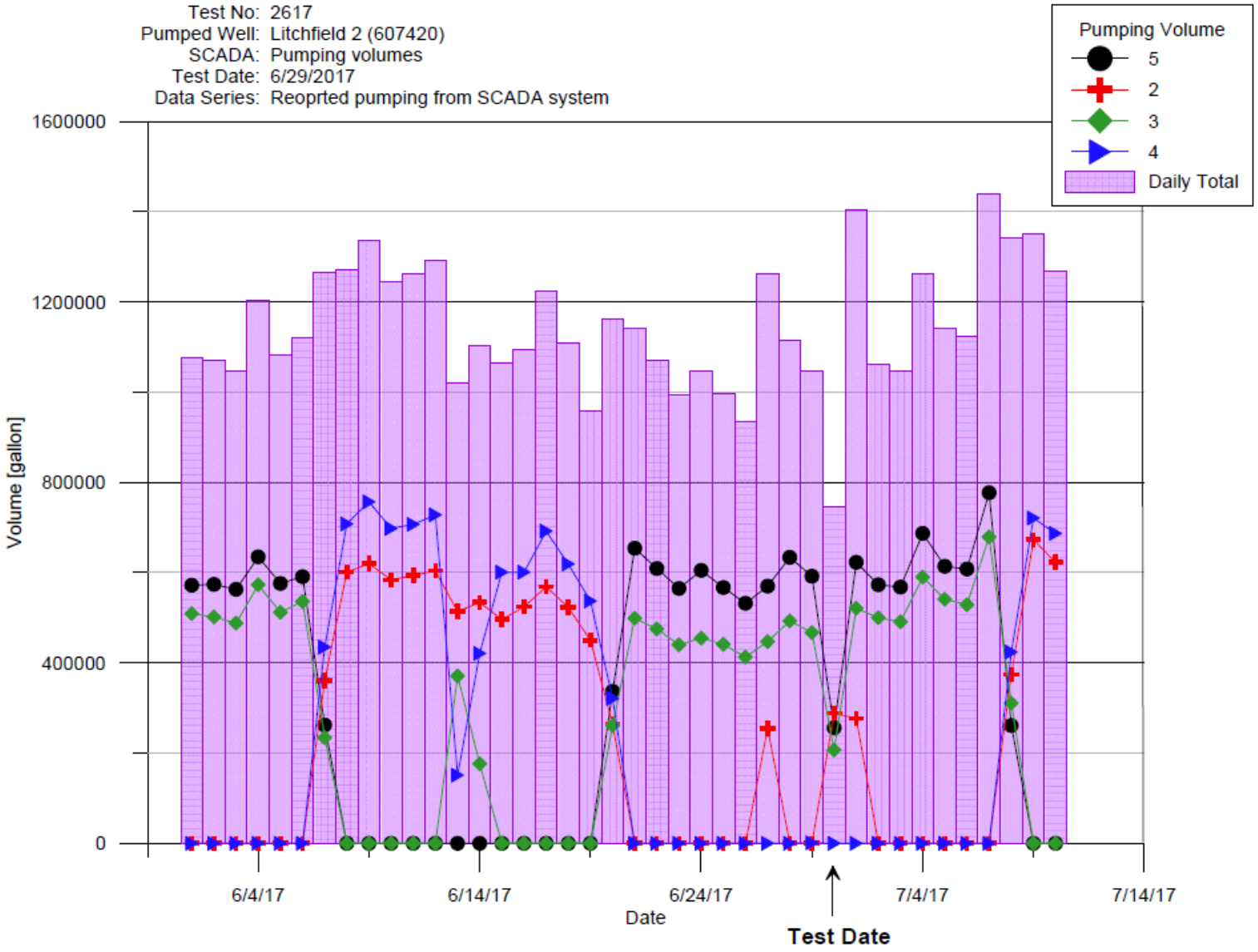


Figure 43. Expanded View of Groundwater Elevation in Aquifer Wells from July 2 to July 11, 2017

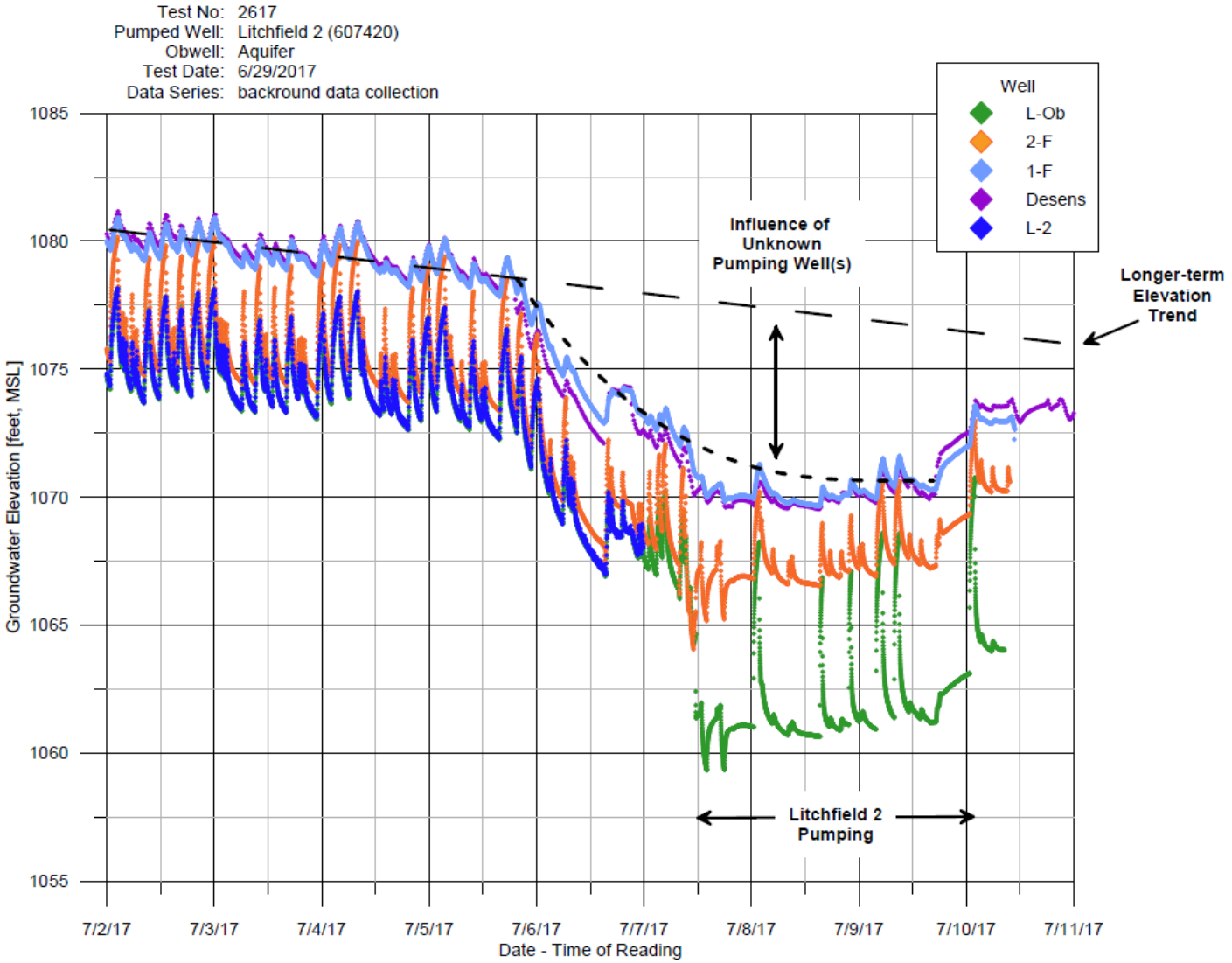


Figure 44. Local Effects of Community Supply Wells from July 5 to July 11, 2017

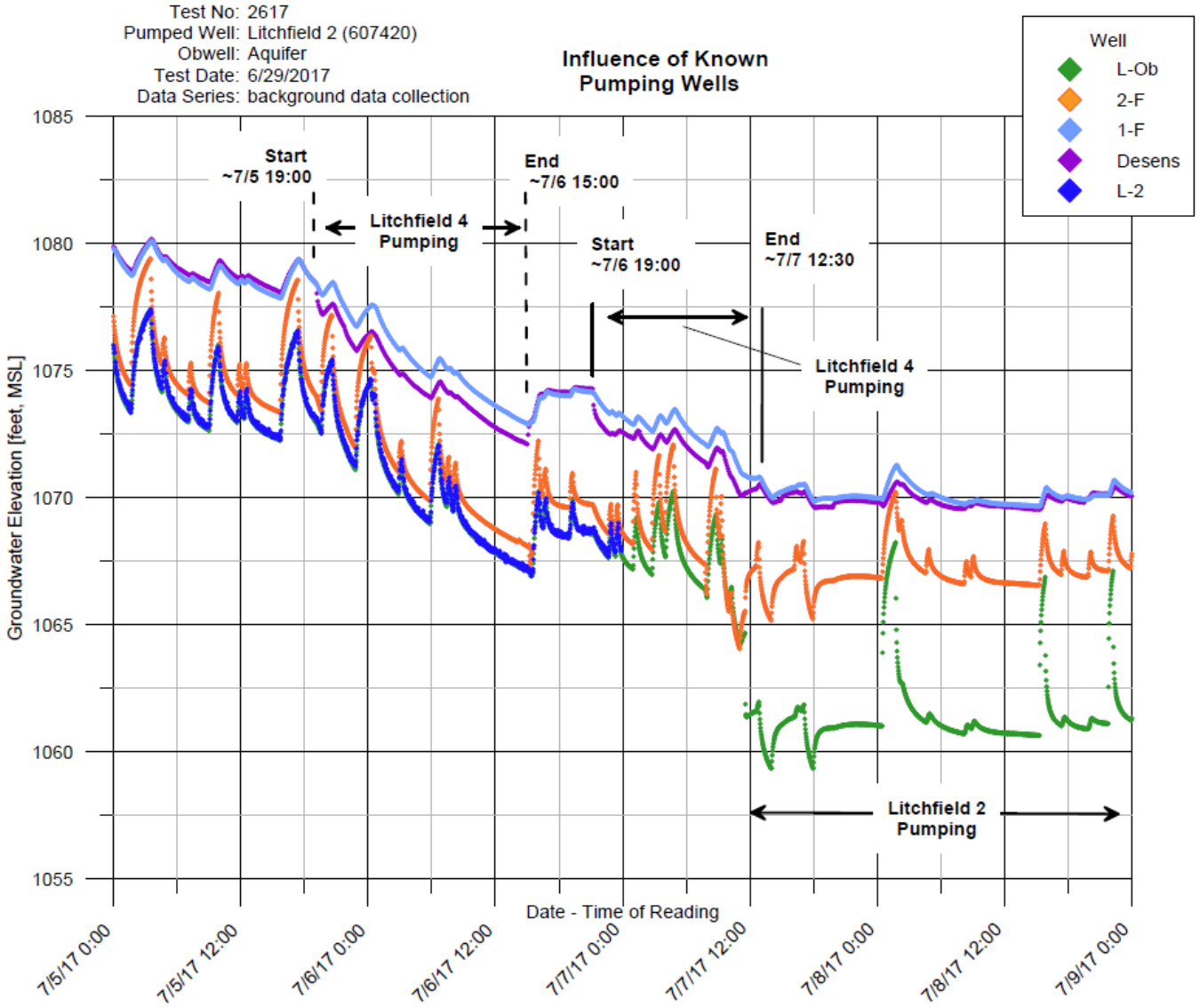


Figure 45. Groundwater Elevation at USGS 2-F (773051) Compared to Rainfall Events, Summer of 2016

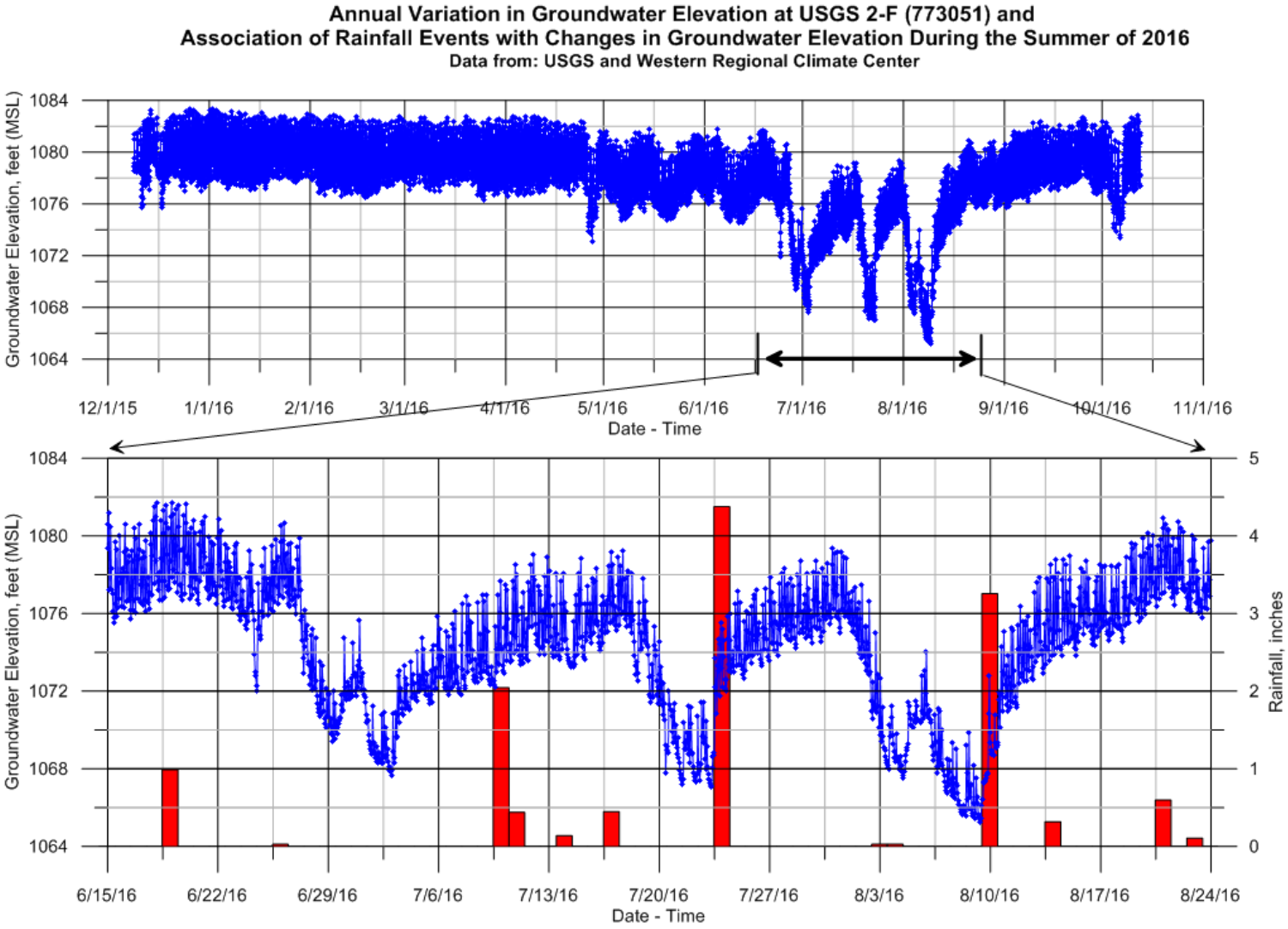


Figure 46. Well and Boring Report - Litchfield 2 (607420)

Minnesota Unique Well Number: 607420

County: Meeker
Quad: Litchfield
Quad ID: 125A

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING REPORT
Minnesota Statutes Chapter 1031

Entry Date: 03/23/1999
Update Date: 06/16/2017
Received Date:

Well Name	Township	Range	Dir Section	Subsection
LITCHFIELD 2	119	31	W 2	CDCDAA

Elevation: 1120 Elev. Method: 7.5 minute topographic map (+/- 5 feet)

Address
Contact: 126 MARSHALL AV N LITCHFIELD MN 55355
Well: LITCHFIELD MN 55355

Stratigraphy Information

Geological Material	From	To (ft.)	Color	Hardness
CLAY	0	24	BROWN	
CLAY	24	29	GRAY	
SAND & GRAVEL	29	35	BROWN	
CLAY	35	65	GRAY	
SAND & GRAVEL	65	71	BROWN	
CLAY	71	105	GRAY	
SAND & GRAVEL	105	134	BROWN	
CLAY	134	134	GRAY	

Remarks
MDH AQUIFER TEST, 20017

Well Depth: 134 ft. Depth Completed: 132 ft. Date Well Completed: 02/19/1998
Drill Method: Non-specified Rotary Drill Fluid: Bentonite
Use: community supply(municipal) Status: Active
Well Hydrofractured? Yes [ ] No [X] From To
Casing Type: Single casing Joint
Drive Shoe? Yes [ ] No [X] Above/Below
Casing Diameter: 12 in. To 107 ft. Weight: lbs./ft. Hole Diameter: 18 in. To 134 ft.
Open Hole From ft. To ft.
Screen? [X] Type stainless Make JOHNSON
Diameter: 12 in. Slot/Gauze: 115 Length: 25 ft. Set: 107 ft. 132 ft.
Static Water Level: 42 ft. land surface Measure 02/19/1998
Pumping Level (below land surface): 132 ft. 7.5 hrs. Pumping at 1000 g.p.m.
Wellhead Completion
Pitless adapter manufacturer Model
[ ] Casing Protection [X] 12 in. above grade
[ ] At-grade (Environmental Wells and Borings ONLY)
Grouting Information Well Grouted? [X] Yes [ ] No [ ] Not Specified

Material	Amount		From	To
neat cement	85	Sacks	0 ft.	87 ft.
high solids bentonite	50	Sacks	87 ft.	132 ft.
			ft.	ft.

Nearest Known Source of Contamination: feet Direction Type
Well disinfected upon completion? [X] Yes [ ] No
Pump [X] Not Installed Date Installed
Manufacturer's name
Model Number HP Volt
Length of drop pipe ft Capacity g.p. Typ
Abandoned
Does property have any not in use and not sealed well(s)? [ ] Yes [X] No
Variance
Was a variance granted from the MDH for this well? [ ] Yes [X] No
Miscellaneous
First Bedrock Aquifer Quat. buried
Last Strat clay-gray Depth to Bedrock ft
Located by Minnesota Department of Health
Locate Method Digitization (Screen) - Map (1:24,000)
System UTM - NAD83, Zone 15, Meters X 379247 Y 4999548
Unique Number Verification Information from Input Date 09/19/2000
Angled Drill Hole
Well Contractor
Trant M.J. Well Co. 71536 ROBBIE/DON
Licensee Business Lic. or Reg. No. Name of Driller

Minnesota Well Index Report 607420 Printed on 06/19/2017
HE-01205-15

Figure 47. Well and Boring Report - Litchfield 3 (632077)

Minnesota Unique Well Number: 632077

County: Meeker
Quad: Litchfield
Quad ID: 125A

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING REPORT
Minnesota Statutes Chapter 1031

Entry Date: 03/22/2000
Update Date: 03/10/2014
Received Date:

Well Name	Township	Range	Dir	Section	Subsection
LITCHFIELD 3	119	31	W	2	CDABDC

Elevation: 1126 Elev. Method: 7.5 minute topographic map (+/- 5 feet)

Address:
Contact: 126 MARSHALL AV N LITCHFIELD MN 55355
Well: LITCHFIELD MN 55355

Stratigraphy Information

Geological Material	From	To (ft.)	Color	Hardness
TOP SOIL	0	2	BLACK	
CLAY	2	18	YELLOW	
CLAY	18	98	GRAY	
DIRTY SAND	98	106	GRAY	
SAND	106	117	GRAY	
SAND COARSER	117	130	GRAY	
SAND FINER	130	136	GRAY	
CLAY	136	140	GRAY	

Remarks:
GAMMA LOGGED 10-5-1999 BY SUMMIT.

Well Depth: 140 ft. Depth Completed: 136 ft. Date Well Completed: 12/09/1999
Drill Method: Non-specified Rotary Drill Fluid: Bentonite
Use: community supply(municipal) Status: Active
Well Hydrofractured? Yes ☐ No ☐ From To
Casing Type: Single casing Joint: Welded
Drive Shoe? Yes ☐ No ☐ Above/Below

Casing Diameter: 12 in. To 108 ft. Weight: 49.5 lbs./ft. Hole Diameter: 18 in. To 140 ft.

Open Hole From ft. To ft.
Screen? ☒ Type: stainless Make: JOHNSON
Diameter: 12 in. Slot/Gauze: 70 Length: 28 ft. Set: 108 ft. 136 ft.

Static Water Level: 43.6 ft. mill Measure: 11/22/1999

Pumping Level (below land surface): 65.5 ft. 20 hrs. Pumping at: 750 g.p.m.

Wellhead Completion
Pitless adapter manufacturer: MONITOR Model: 7PS1214WBW
☐ Casing Protection ☒ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

Grouting Information: Well Grouted? ☒ Yes ☐ No ☐ Not Specified

Material	Amount		From	To
neat cement	3	Cubic yards	12 ft.	98 ft.

Nearest Known Source of Contamination: foot Direction Type
Well disinfected upon completion? ☒ Yes ☐ No

Pump ☒ Not Installed Date Installed
Manufacturer's name
Model Number HP Volt
Length of drop pipe ft Capacity g.p. Typ

Abandoned: Does property have any not in use and not sealed well(s)? ☐ Yes ☒ No

Variance: Was a variance granted from the MDH for this well? ☐ Yes ☒ No

Miscellaneous
First Bedrock: Aquifer: Quat. buried
Last Strat: clay-gray Depth to Bedrock: ft
Located by: Minnesota Department of Health
Locate Method: GPS SA Off (averaged)
System: UTM - NAD83, Zone 15, Meters X 379308 Y 4999778
Unique Number Verification: Input Date: 09/19/2000

Angled Drill Hole:

Well Contractor
L.t.p. Enterprises, Inc. 91686 VERDECK, D.
Licensee Business Lic. or Reg. No. Name of Driller

Minnesota Well Index Report | 632077 | Printed on 06/12/2017 HE-01205-15

Figure 48. Well and Boring Report - Litchfield 4 (632078)

Minnesota Unique Well Number: 632078

County: Meeker
Quad: Litchfield
Quad ID: 125A

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING REPORT
Minnesota Statutes Chapter 1031

Entry Date: 03/22/2000
Update Date: 03/10/2014
Received Date:

Well Name	Township	Range	Dir Section	Subsection
LITCHFIELD 4	119	31	W 2	CABACB

Elevation: 1149 Elev. Method: 7.5 minute topographic map (+/- 5 feet)

Address
Contact: 126 MARSHALL AV N LITCHFIELD MN 55355
Well: LITCHFIELD MN 55355

Stratigraphy Information

Geological Material	From	To (ft.)	Color	Hardness
TOP SOIL SILTY	0	1	BLACK	
SANDY CLAY/GRAVEL	1	10	BROWN	
CLAY SANDY/PEBBLES	10	42	GRAY	
SANDY CLAY/SAND	42	48	GRAY	
SANDY CLAY/PEBBLES	48	97	GRAY	
SANDY CLAY	97	113	BROWN	V.SOFT
SANDY CLAY/PEBBLES	113	121	GRAY	
SAND & GRAVEL	121	128	GRAY	
SAND & GRAVEL	128	136	GRAY	
SAND & GRAVEL	136	146	GRAY	
SANDY CLAY/PEBBLES	146	150	GRAY	
CLAY	150	159	GRAY	

Remarks:
BOTTON 12 FT. OF HOLE GROUTED W/HIGH SOLIDS.

Well Depth: 159 ft. Depth Completed: 147 ft. Date Well Completed: 12/09/1999
Drill Method: Non-specified Rotary Drill Fluid: Bentonite
Use: community supply(municipal) Status: Active
Well Hydrofractured? Yes ☐ No ☐ From To
Casing Type: Single casing Joint: Welded
Drive Shoe? Yes ☐ No ☐ Above/Below

Casing Diameter	Weight	Hole Diameter
12 in. To 123 ft.	49.5 lbs./ft.	18 in. To 147 ft.
		6.2 in. To 159 ft.

Open Hole From ft. To ft.
Screen? ☒ Type: stainless Make: JOHNSON

Diameter	Slot/Gauze	Length	Set	
12 in.	70	24 ft.	123 ft.	147 ft.

Static Water Level: 61.2 ft. land surface Measure: 12/08/1999
Pumping Level (below land surface): 77.8 ft. 21 hrs. Pumping at 750 g.p.m.
Wellhead Completion
Pitless adapter manufacturer: MONITOR Model: 7PS1214WBW
☐ Casing Protection ☒ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)
Grouting Information Well Grouted? ☒ Yes ☐ No ☐ Not Specified

Material	Amount		From	To
neat cement	4.5	Cubic yards	8 ft.	113 ft.

Nearest Known Source of Contamination: foot Direction: Type:
Well disinfected upon completion? ☒ Yes ☐ No
Pump ☒ Not Installed Date Installed:
Manufacturer's name:
Model Number: HP: Volt:
Length of drop pipe: ft Capacity: g.p. Typ:
Abandoned
Does property have any not in use and not sealed well(s)? ☐ Yes ☒ No
Variance
Was a variance granted from the MDH for this well? ☐ Yes ☒ No
Miscellaneous
First Bedrock: Aquifer: Quat. buried
Last Strat: clay-brown Depth to Bedrock: ft
Located by: Minnesota Department of Health
Locate Method: GPS SA Off (averaged)
System: UTM - NAD83, Zone 15, Meters X: 379172 Y: 5000196
Unique Number Verification: Input Date: 09/19/2000
Angled Drill Hole
Well Contractor
L.t.p. Enterprises, Inc. 91686 VERDECK, D.
Licensee Business Lic. or Reg. No. Name of Driller

Minnesota Well Index Report | 632078 | Printed on 06/19/2017
HE-01205-15

Figure 49. Well and Boring Report - Litchfield 5 (764258)

Minnesota Unique Well Number: 764258

County: Meeker
Quad: Litchfield
Quad ID: 125A

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING REPORT
Minnesota Statutes Chapter 1031

Entry Date: 01/29/2009
Update Date: 04/16/2015
Received Date: 01/21/2009

Well Name	Township	Range	Dir	Section	Subsection
LITCHFIELD 5	119	31	W	2	CABCCA

Elevation: 1152 Elev. Method: 7.5 minute topographic map (+/- 5 feet)

Address

Contact: 126 MARSHALL AV NE LITCHFIELD MN 55355
Well: LITCHFIELD MN 55355

Stratigraphy Information

Geological Material	From	To (ft.)	Color	Hardness
TOP SOIL	0	1	BLACK	
SANDY CLAY	1	2	BROWN	
SANDY CLAY WITH	2	7	YELLOW	
SANDY CLAY	7	11	TAN	
SANDY CLAY WITH	11	14	GRAY	
SANDY CLAY-SAND &	14	20	GRAY	
SANDY CLAY	20	36	GRAY	
SANDY CLAY WITH	36	47	GRAY	
SANDY CLAY WITH	47	121	GRAY	
SOFT SANDY CLAY	121	123	BROWN	SOFT
SANDY CLAY WITH	123	125	GRAY	
COARSE SAND AND	125	128	VARIED	
SANDY CLAY	128	131	GRAY	
SAND WITH CLAY	131	135	GRAY	
SAND SOME PEA ROCK	135	144	GRAY	MEDIUM
FINER SAND	144	147	GRAY	
COARSE SAND-	147	158	VARIED	
GRAVEL	158	162	VARIED	
SANDY CLAY	162	165	GRAY	

Remarks:

Well Depth: 165 ft. Depth Completed: 161.5 ft. Date Well Completed: 10/30/2008
Drill Method: Non-specified Rotary Drill Fluid: Bentonite
Use: community supply(municipal) Status: Active
Well Hydrofractured? Yes ☐ No ☒ From To
Casing Type: Single casing Joint
Drive Shoe? Yes ☐ No ☒ Above/Below
Casing Diameter: 12 in. To 136. ft. Weight: 0 lbs./ft. Hole Diameter: 18 in. To 165 ft.
Open Hole From ft. To ft.
Screen? ☒ Type: stainless Make: JOHNSON
Diameter: 12 in. Slot/Gauze: 60 Length: 25 ft. Set: 136.5 ft. 161.5 ft.
Static Water Level: 70.4 ft. land surface Measure: 08/12/2008
Pumping Level (below land surface): 88.5 ft. 24 hrs. Pumping at: 900 g.p.m.
Wellhead Completion
Pitless adapter manufacturer: MONITOR Model: 9PS1214
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)
Grouting Information Well Grouted? ☒ Yes ☐ No ☐ Not Specified

Material	Amount	From	To
neat cement	4.5 Cubic yards	10 ft.	126.5 ft.

Nearest Known Source of Contamination: 0 foot Direction: Type:
Well disinfected upon completion? ☒ Yes ☐ No
Pump ☐ Not Installed Date Installed: 10/30/2008
Manufacturer's name: GRUNDFOS
Model Number: 800S400- HP: 40 Volt: 460
Length of drop pipe: 120 ft Capacity: 800 g.p. Typ: Submersible
Abandoned
Does property have any not in use and not sealed well(s)? ☐ Yes ☒ No
Variance
Was a variance granted from the MDH for this well? ☐ Yes ☒ No
Miscellaneous
First Bedrock: Aquifer: Quat. buried
Last Strat: clay+sand-gray Depth to Bedrock: ft
Located by: Minnesota Department of Health
Locate Method: GPS SA Off (averaged)
System: UTM - NAD83, Zone 15, Meters X: 379100 Y: 5000084
Unique Number Verification: Input Date: 11/13/2008
Angled Drill Hole
Well Contractor
LTP Enterprises, Inc. 2157 THEISEN, R.
Licensee Business Lic. or Reg. No. Name of Driller

Minnesota Well Index Report 764258 Printed on 06/12/2017
HE-01205-15

Figure 50. Well and Boring Report - Litchfield-MW (607417)

Minnesota Unique Well Number: 607417

County: Meeker
Quad: Litchfield
Quad ID: 125A

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING REPORT
Minnesota Statutes Chapter 1031

Entry Date: 04/22/2003
Update Date: 08/18/2014
Received Date:

Well Name	Township	Range	Dir	Section	Subsection
LITCHFIELD MW	119	31	W	2	CDCADB

Elevation: 1123.2 Elev. Method: Surveyed

Address:

Stratigraphy Information

Geological Material	From	To (ft.)	Color	Hardness
SANDY CLAY	0	22	BROWN	
CLAY	22	29	GRAY	
SAND & GRAVEL	29	37	BROWN	
CLAY	37	40	GRAY	
SAND	40	45	BROWN	
ROCK	45	47	BLK/WHT	
CLAY	47	72	GRAY	
SAND & GRAVEL	72	76	BROWN	
CLAY	76	107	GRAY	
SAND & GRAVEL	107	130	BROWN	

Remarks: WELL OBS #1

Well Depth: 130 ft. Depth Completed: 127 ft. Date Well Completed: 12/18/1997
Drill Method: Auger (non-specified) Drill Fluid: Bentonite
Use: monitor well Status: Active
Well Hydrofractured? Yes [ ] No [X] From To
Casing Type: Single casing Joint
Drive Shoe? Yes [ ] No [X] Above/Below

Casing Diameter	Weight	Hole Diameter
2 in. To 122 ft.	lbs./ft.	6.5 in. To 130 ft.

Open Hole From ft. To ft.
Screen? [X] Type: stainless Make: JOHNSON

Diameter	Slot/Gauze	Length	Set
2 in.	10	10 ft.	122 ft. 127 ft.

Static Water Level: 40 ft. land surface Measure: 12/18/1997
Pumping Level (below land surface):
Wellhead Completion
Pitless adapter manufacturer: Model:
[X] Casing Protection [X] 12 in. above grade
[ ] At-grade (Environmental Wells and Borings ONLY)
Grouting Information: Well Grouted? [X] Yes [ ] No [ ] Not Specified

Material	Amount	From	To
high solids bentonite	7 Sacks	3 ft.	120 ft.

Nearest Known Source of Contamination: foot Direction: Type:
Well disinfected upon completion? [X] Yes [ ] No
Pump [X] Not Installed Date Installed:
Manufacturer's name:
Model Number: HP: Volt:
Length of drop pipe: ft Capacity: g.p. Typ:
Abandoned
Does property have any not in use and not sealed well(s)? [ ] Yes [X] No
Variance
Was a variance granted from the MDH for this well? [ ] Yes [X] No
Miscellaneous
First Bedrock: Aquifer: Quat. buried
Last Strat: sand +larger-brown Depth to Bedrock: ft
Located by: Minnesota Geological Survey
Locate Method: Digitization (Screen) - Map (1:24,000)
System: UTM - NAD83, Zone 15, Meters X: 379227 Y: 4999595
Unique Number Verification: Info/GPS from data Input Date: 10/22/1998
Angled Drill Hole:
Well Contractor
Traut M.J. Well Co. (Licensee Business) 71536 (Lic. or Reg. No.) ROBBIE & DON (Name of Driller)

Minnesota Well Index Report | 607417 | Printed on 06/19/2017 HE-01205-15

Figure 51. Well and Boring Report - USGS 1-B (773062)

Minnesota Unique Well Number: 773062

County: Meeker
Quad: Litchfield
Quad ID: 125A

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING REPORT
Minnesota Statutes Chapter 1031

Entry Date: 08/14/2015
Update Date: 10/20/2015
Received Date:

Well Name	Township	Range	Dir	Section	Subsection
LFO1-B	119	31	W	11	ABACBB

Elevation: 1114.5 Elev. Method: LiDAR 1m DEM (MNDNR)

Address
Contact: 126 MARSHALL AV N LITCHFIELD MN 55355
Well: 982 MILLER AV N LITCHFIELD MN 55355

Stratigraphy Information: [illegible]OODALE DR MOUNDS VIEW MN 55112

Geological Material	From	To (ft.)	Color	Hardness
SAND, WELL SORTED	0	12	GRAY	SOFT
SAND WELLSORTED	12	14	GRAY	SOFT
SAND, WELL SORTED,	14	19	GRAY	SOFT
SAND, MED. TO	19	25	GRAY	SOFT

Remarks:
SEE DRILLERS LOG FOR DETAILED INFORMATION.

Well Depth: 25.27 ft. Depth Completed: 25.27 ft. Date Well Completed: 06/12/2015
Drill Method: Auger (non-specified) Drill Fluid:
Use: monitor well Status: Active
Well Hydrofractured? Yes [ ] No [X] From To
Casing Type: Single casing Joint: Glued
Drive Shoe? Yes [ ] No [X] Above/Below:
Casing Diameter: 1.2 in. To 22.4 ft. Weight: 0.74 lbs./ft. Hole Diameter: 8.2 in. To 25.2 ft.
Open Hole From ft. To ft.
Screen? [X] Type: slotted pipe Make: ENVIRONMENTAL

Diameter	Slot/Gauze	Length	Set
1.2 in.	10	2.7 ft.	22.4 ft. 25 ft.

Static Water Level: 11 ft. land surface Measure: 08/17/2015
Pumping Level (below land surface): ft. 3.7 hrs. Pumping at: 0.21 g.p.m.
Wellhead Completion
Pitless adapter manufacturer: Model:
[X] Casing Protection [X] 12 in. above grade
[ ] At-grade (Environmental Wells and Borings ONLY)
Grouting Information: Well Grouted? [X] Yes [ ] No [ ] Not Specified

Material	Amount	From	To
bentonite	1.67 Sacks	4.5 ft.	19.2 ft.
concrete	2 Sacks	ft.	4.5 ft.

Nearest Known Source of Contamination: foot Direction: Type:
Well disinfected upon completion? [ ] Yes [X] No
Pump [X] Not Installed Date Installed:
Manufacturer's name:
Model Number: HP: Volt:
Length of drop pipe: ft Capacity: g.p. Type:
Abandoned
Does property have any not in use and not sealed well(s)? [ ] Yes [X] No
Variance
Was a variance granted from the MDH for this well? [ ] Yes [X] No
Miscellaneous
First Bedrock: Aquifer: Quat. Water
Last Strat: sand+silt-gray Depth to Bedrock: ft
Located by: Minnesota Geological Survey
Locate Method: Digitization (Screen) - Map (1:24,000)
System: UTM - NAD83, Zone 15, Meters X 379655 Y 4999332
Unique Number Verification: Information from: Input Date: 08/14/2015
Angled Drill Hole:
Well Contractor
US Geological Survey (Licensee Business) 1548 (Lic. or Reg. No.) HUCKABY, J. (Name of Driller)

Minnesota Well Index Report | 773062 | Printed on 06/19/2017 HE-01205-15

Figure 52. Well and Boring Report - USGS 1-C (773060)

Minnesota Unique Well Number: 773060

County: Meeker
Quad: Litchfield
Quad ID: 125A

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING REPORT
Minnesota Statutes Chapter 1031

Entry Date: 08/14/2015
Update Date: 10/20/2015
Received Date:

Well Name	Township	Range	Dir	Section	Subsection
LFO1-C	119	31	W	11	ABACBB

Elevation: 1114.8 Elev. Method: LiDAR 1m DEM (MNDNR)

Address
Contact: 126 MARSHALL AV N LITCHFIELD MN 55355
Well: 982 MILLER AV N LITCHFIELD MN 55355
[illegible]OODALE DR MOUNDS VIEW MN 55112

Stratigraphy Information

Geological Material	From	To (ft.)	Color	Hardness
SAND, WELL SORTED	0	12	GRAY	SOFT
SAND WELL SORT	12	14	GRAY	SOFT
SAND, WELL SORTED,	14	19	GRAY	SOFT
SAND, MED. TO	19	22	GRAY	SOFT
SAND, MEDIUM WELL	22	43	GRAY	SOFT
SILT & CLAY WITH	43	53	GRAY	MEDIUM

Remarks
SEE DRILLERS LOG FOR DETAILED INFORMATION

Well Depth: 53.1 ft. Depth Completed: 53.1 ft. Date Well Completed: 06/12/2015
Drill Method: Augur (non-specified) Drill Fluid:
Use: monitor well Status: Active
Well Hydrofractured? Yes [ ] No [X] From To
Casing Type: Single casing Joint: Glued
Drive Shoe? Yes [ ] No [X] Above/Below:
Casing Diameter: 1.2 in. To 50.2 ft. Weight: 0.74 lbs./ft. Hole Diameter: 8.2 in. To 53 ft.
Open Hole From ft. To ft.
Screen? [X] Type: slotted pipe Make: ENVIRONMENTAL

Diameter	Slot/Gauze	Length	Set	
1.2 in.	10	2.7 ft.	50.2 ft.	52.8 ft.

Static Water Level: 12.5 ft. land surface Measure: 08/17/2015
Pumping Level (below land surface): ft. 1.9 hrs. Pumping at: 0.21 g.p.m.
Wellhead Completion
Pitless adapter manufacturer: Model:
[X] Casing Protection [X] 12 in. above grade
[ ] At-grade (Environmental Wells and Borings ONLY)
Grouting Information: Well Grouted? [X] Yes [ ] No [ ] Not Specified

Material	Amount		From	To
bentonite	3.5	Sacks	3.5 ft.	4.7 ft.
concrete	2.5	Sacks		ft. 3.5 ft.

Nearest Known Source of Contamination: foot Direction: Type:
Well disinfected upon completion? [ ] Yes [X] No
Pump [X] Not Installed Date Installed:
Manufacturer's name:
Model Number: HP: Volt:
Length of drop pipe: ft Capacity: g.p. Typ:
Abandoned
Does property have any not in use and not sealed well(s)? [ ] Yes [X] No
Variance
Was a variance granted from the MDH for this well? [ ] Yes [X] No
Miscellaneous
First Bedrock: Aquifer: Quat. buried
Last Strat: pebbly sand/silt/clay-gray Depth to Bedrock: ft
Located by: Minnesota Geological Survey
Locate Method: Digitization (Screen) - Map (1:24,000)
System: UTM - NAD83, Zone 15, Meters X 379653 Y 4999334
Unique Number Verification: Information from: Input Date: 08/14/2015
Angled Drill Hole:
Well Contractor
US Geological Survey 1548 HUCKABY, J.
Licensee Business Lic. or Reg. No. Name of Driller

Minnesota Well Index Report | 773060 | Printed on 06/19/2017 HE-01205-15

Figure 53. Well and Boring Report - USGS 1-D (773059)

Minnesota Unique Well Number: 773059

County: Meeker
Quad: Litchfield
Quad ID: 125A

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING REPORT
Minnesota Statutes Chapter 1031

Entry Date: 08/14/2015
Update Date: 10/20/2015
Received Date:

Well Name	Township	Range	Dir	Section	Subsection
LFO1-D	119	31	W	11	ABACBB

Elevation: 1114.7 Elev. Method: LiDAR 1m DEM (MNDNR)

Address:
Contact: 126 MARSHALL AV N LITCHFIELD MN 55355
Well: 982 MILLER AV N LITCHFIELD MN 55355
[redacted]WOODALE DR MOUNDS VIEW MN 55112

Stratigraphy Information

Geological Material	From	To (ft.)	Color	Hardness
SAND, WELL SORTED	0	12	GRAY	SOFT
SAND WELL SORT	12	14	GRAY	SOFT
SAND, MEDIUM WELL	14	19	GRAY	SOFT
SAND, MED. TO	19	22	GRAY	SOFT
SAND, MEDIUM WELL	22	43	GRAY	SOFT
SILT & CLAY WITH	43	76	GRAY	MEDIUM

Remarks:
SEE DRILLERS LOG FOR DETAILED INFORMATION.

Well Depth: 75.5 ft. Depth Completed: 75.27 ft. Date Well Completed: 06/11/2015
Drill Method: Augur (non-specified) Drill Fluid:
Use: monitor well Status: Active
Well Hydrofractured? Yes [ ] No [X] From To
Casing Type: Single casing Joint: Glued
Drive Shoe? Yes [ ] No [X] Above/Below:
Casing Diameter: 1.2 in. To 72.4 ft. Weight: 0.74 lbs./ft. Hole Diameter: 8.2 in. To 75.5 ft.
Open Hole From ft. To ft.
Screen? [X] Type: slotted pipe Make: ENVIRONMENTAL

Diameter	Slot/Gauze	Length	Set
1.2 in.	10	2.7 ft.	73.4 ft. 75 ft.

Static Water Level: 25.8 ft. land surface Measure: 08/17/2015
Pumping Level (below land surface): ft. 3.6 hrs. Pumping at: 0.2 g.p.m.
Wellhead Completion:
Pitless adapter manufacturer: Model:
[X] Casing Protection [X] 12 in. above grade
[ ] At-grade (Environmental Wells and Borings ONLY)
Grouting Information: Well Grouted? [X] Yes [ ] No [ ] Not Specified

Material	Amount	From	To
cuttings	5	4 ft.	70.2 ft.
concrete	2.5	ft.	4 ft.

Nearest Known Source of Contamination: foot Direction: Type:
Well disinfected upon completion? [ ] Yes [X] No
Pump [X] Not Installed Date Installed:
Manufacturer's name:
Model Number: HP: Volt:
Length of drop pipe: ft Capacity: g.p. Typ:
Abandoned: Does property have any not in use and not sealed well(s)? [ ] Yes [X] No
Variance: Was a variance granted from the MDH for this well? [ ] Yes [X] No
Miscellaneous:
First Bedrock: Aquifer: Quat. buried
Last Strat: pebbly sand/silt/clay-gray Depth to Bedrock: ft
Located by: Minnesota Geological Survey
Locate Method: Digitization (Screen) - Map (1:24,000)
System: UTM - NAD83, Zone 15, Meters X 379654 Y 4999334
Unique Number Verification: Information from: Input Date: 08/14/2015
Angled Drill Hole:
Well Contractor:
US Geological Survey 1548 HUCKABY, J.
Licensee Business Lic. or Reg. No. Name of Driller

Minnesota Well Index Report | 773059 | Printed on 06/19/2017
HE-01205-15

Figure 54. Well and Boring Report - USGS 1-E (773058)

Minnesota Unique Well Number: 773058

County: Meeker
Quad: Litchfield
Quad ID: 125A

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING REPORT
Minnesota Statutes Chapter 1031

Entry Date: 08/14/2015
Update Date: 10/20/2015
Received Date:

Well Name	Township	Range	Dir	Section	Subsection
LFO1-E	119	31	W	11	ABACBB

Elevation: 1114.5 Elev. Method: LiDAR 1m DEM (MNDNR)

Address
Contact: 126 MARSHALL AV N LITCHFIELD MN 55355
Well: 982 MILLER AV N LITCHFIELD MN 55355
Stratigraphy Info: [illegible]OODALE DR MOUNDS VIEW MN 55112

Geological Material	From	To (ft.)	Color	Hardness
SAND, WELL SORTED,	0	12	GRAY	SOFT
SAND, WELL SORTED,	12	14	GRAY	SOFT
SAND, MEDIUM WELL	14	19	GRAY	SOFT
SAND, MED. TO	19	22	GRAY	SOFT
SAND, MEDIUM WELL	22	43	GRAY	SOFT
SILT & CLAY WITH	43	95	GRAY	SFT-HRD

Remarks:
SEE DRILLER LOG FOR DETAILED INFORMATION.

Well Depth: 95.3 ft. Depth Completed: 95.28 ft. Date Well Completed: 06/10/2015
Drill Method: Auger (non-specified) Drill Fluid:
Use: monitor well Status: Active
Well Hydrofractured? Yes ☐ No ☐ From To
Casing Type: Single casing Joint
Drive Shoe? Yes ☐ No ☒ Above/Below

Casing Diameter	Weight	Hole Diameter
1.2 in. To 92.4 ft.	0.74 lbs./ft.	8.2 in. To 95 ft.

Open Hole From ft. To ft.
Screen? ☒ Type: slotted pipe Make: ENVIRONMENTAL

Diameter	Slot/Gauze	Length	Set
1.2 in.	10	2.7 ft.	92.4 ft. 95 ft.

Static Water Level: 36.3 ft. land surface Measure: 08/17/2015
Pumping Level (below land surface): ft. 11. hrs. Pumping at: 0.28 g.p.m.
Wellhead Completion
Pitless adapter manufacturer: Model:
☒ Casing Protection ☒ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)
Grouting Information: Well Grouted? ☒ Yes ☐ No ☐ Not Specified

Material	Amount		From	To
bentonite	7	Sacks	4 ft.	89.5 ft.
concrete	2.5	Sacks	ft.	4 ft.

Nearest Known Source of Contamination: foot Direction: Type:
Well disinfected upon completion? ☐ Yes ☒ No
Pump ☒ Not Installed Date Installed:
Manufacturer's name:
Model Number: HP: Volt:
Length of drop pipe: ft Capacity: g.p. Typ:
Abandoned
Does property have any not in use and not sealed well(s)? ☐ Yes ☒ No
Variance
Was a variance granted from the MDH for this well? ☐ Yes ☒ No
Miscellaneous
First Bedrock: Aquifer: Quat. buried
Last Strat: pebbly sand/silt/clay-gray Depth to Bedrock: ft
Located by: Minnesota Geological Survey
Locate Method: Digitization (Screen) - Map (1:24,000)
System: UTM - NAD83, Zone 15, Meters X: 379655 Y: 4999334
Unique Number Verification: Information from: Input Date: 08/14/2015
Angled Drill Hole

Well Contractor
US Geological Survey 1548 HUCKABY, J.
Licensed Business Lic. or Reg. No. Name of Driller

Minnesota Well Index Report 773058 Printed on 06/19/2017
HE-01205-15

Figure 55. Well and Boring Report - USGS 1-F (773057)

Minnesota Unique Well Number: 773057

County: Meeker
Quad: Litchfield
Quad ID: 125A

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING REPORT
Minnesota Statutes Chapter 1031

Entry Date: 08/14/2015
Update Date: 10/22/2015
Received Date:

Well Name	Township	Range	Dir	Section	Subsection
LFO1-F	119	31	W	11	ABACBB

Elevation: 1114.7 Elev. Method: LiDAR 1m DEM (MNDNR)

Address

Contact: 126 MARSHALL AV N LITCHFIELD MN 55355
Well: 982 MILLER AV N LITCHFIELD MN 55355
[redacted]OODALE DR MOUNDS VIEW MN 55112

Stratigraphy Information

Geological Material	From	To (ft.)	Color	Hardness
WELL SORT, SAND,	0	12	GRAY	SOFT
SAND WELL SORT	12	14	GRAY	SOFT
SAND, MEDIUM WELL	14	19	GRAY	SOFT
SAND, MED. TO	19	22	GRAY	SOFT
SAND, MEDIUM WELL	22	43	GRAY	SOFT
SILT & CLAY W/ SAND	43	98	GRAY	SFT-HRD
SAND & GRAVEL,	98	130	GRAY	MEDIUM

Remarks:
SEE DRILLERS LOG FOR DETAILED INFORMATION.
GAMMA & EM INDUCTION LOGGED 6-24-2015. LOGGED FOR USGS.

Well Depth: 130 ft.
Depth Completed: 127.46 ft.
Date Well Completed: 06/15/2015
Drill Method: Auger (non-specified) Drill Fluid:
Use: monitor well Status: Active
Well Hydrofractured? Yes [ ] No [X] From To
Casing Type: Single casing Joint: Glued
Drive Shoe? Yes [ ] No [X] Above/Below:
Casing Diameter: 2 in. To 118 ft. Weight: 1.02 lbs./ft. Hole Diameter: 8.2 in. To 130 ft.
Open Hole From ft. To ft.
Screen? [X] Type: slotted pipe Make: ENVIRONMENTAL
Diameter: 1.9 in. Slot/Gauze: 20 Length: 9.6 ft. Set: 118 ft. 127.4 ft.
Static Water Level: 36.6 ft. land surface Measure: 08/17/2015
Pumping Level (below land surface): ft. 2.9 hrs. Pumping at: 1.11 g.p.m.
Wellhead Completion
Pitless adapter manufacturer: Model:
[X] Casing Protection [X] 12 in. above grade
[ ] At-grade (Environmental Wells and Borings ONLY)
Grouting Information: Well Grouted? [X] Yes [ ] No [ ] Not Specified

Material	Amount		From	To
bentonite	9	Sacks	3.4 ft.	95 ft.
concrete	2.5	Sacks	ft.	3.4 ft.

Nearest Known Source of Contamination: foot Direction: Type:
Well disinfected upon completion? [ ] Yes [X] No
Pump [X] Not Installed Date Installed:
Manufacturer's name:
Model Number: HP: Volt:
Length of drop pipe: ft Capacity: g.p. Type:
Abandoned
Does property have any not in use and not sealed well(s)? [ ] Yes [X] No
Variance
Was a variance granted from the MDH for this well? [ ] Yes [X] No
Miscellaneous
First Bedrock: Aquifer: Quat. buried
Last Strat: sand +larger-gray Depth to Bedrock: ft
Located by: Minnesota Geological Survey
Locate Method: Digitization (Screen) - Map (1:24,000)
System: UTM - NAD83, Zone 15, Meters X: 379654 Y: 4999332
Unique Number Verification: Information from: Input Date: 08/14/2015
Angled Drill Hole

Well Contractor
US Geological Survey (Licensee Business) 1548 (Lic. or Reg. No.) HUCKABY, J. (Name of Driller)

Minnesota Well Index Report | 773057 | Printed on 06/19/2017 HE-01205-15

Figure 56. Well and Boring Report - USGS 2-A (773056)

Minnesota Unique Well Number: 773056

County: Meeker
Quad: Litchfield
Quad ID: 125A

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING REPORT
Minnesota Statutes Chapter 1031

Entry Date: 09/09/2015
Update Date: 10/20/2015
Received Date:

Well Name	Township	Range	Dir	Section	Subsection
LFO2-A	119	31	W	2	CACDBD

Elevation: 1139.6 Elev. Method: LiDAR 1m DEM (MNDNR)

Address

Well: 61656 270TH ST LITCHFIELD MN 55355
Contact: 126 MARSHALL AV N LITCHFIELD MN 55355

Stratigraphy Info: [illegible]OODALE DR MOUNDS VIEW MN 55112

Geological Material	From	To (ft.)	Color	Hardness
SILT&CLAY W/SAND,	0	20	GRAY	MEDIUM

Remarks:
SEE DRILLERS LOG FOR DETAILED INFORMATION.

Well Depth: 20 ft. Depth Completed: 19.99 ft. Date Well Completed: 06/24/2015
Drill Method: Augur (non-specified) Drill Fluid:
Use: monitor well Status: Active
Well Hydrofractured? Yes ☐ No ☐ From To
Casing Type: Single casing Joint: Glued
Drive Shoe? Yes ☐ No ☐ Above/Below:
Casing Diameter: 1.2 in. To 17.1 ft. Weight: 0.74 lbs./ft. Hole Diameter: 8.2 in. To 20 ft.
Open Hole From ft. To ft.
Screen? ☒ Type: slotted pipe Make: ENVIRONMENTAL

Diameter	Slot/Gauze	Length	Set	
1.2 in.	10	2.7 ft.	17.1 ft.	19.7 ft.

Static Water Level: 17.3 ft. land surface Measure: 08/17/2015
Pumping Level (below land surface): ft. 1.2 hrs. Pumping at: 0.08 g.p.m.
Wellhead Completion
Pitless adapter manufacturer: Model:
☒ Casing Protection ☒ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)
Grouting Information: Well Grouted? ☒ Yes ☐ No ☐ Not Specified

Material	Amount		From	To
bentonite	2	Sacks	3 ft.	15 ft.
concrete	1.5	Sacks	ft.	3 ft.

Nearest Known Source of Contamination: foot Direction: Type:
Well disinfected upon completion? ☐ Yes ☒ No
Pump: ☒ Not Installed Date Installed:
Manufacturer's name:
Model Number: HP: Volt:
Length of drop pipe: ft Capacity: g.p. Type:
Abandoned
Does property have any not in use and not sealed well(s)? ☐ Yes ☒ No
Variance
Was a variance granted from the MDH for this well? ☐ Yes ☒ No
Miscellaneous
First Bedrock: Aquifer: Quat. buried
Last Strat: pebbly sand/silt/clay-gray Depth to Bedrock: ft
Located by: Minnesota Geological Survey
Locate Method: Digitization (Screen) - Map (1:24,000)
System: UTM - NAD83, Zone 15, Meters X: 379193 Y: 4999910
Unique Number Verification: Information from: Input Date: 09/09/2015
Angled Drill Hole

Well Contractor
US Geological Survey — 1548 — HUCKABY, J.
Licensee Business — Lic. or Reg. No. — Name of Driller

Minnesota Well Index Report | 773056 | Printed on 06/12/2017 HE-01205-15

Figure 57. Well and Boring Report - USGS 1-F (773057)

Minnesota Unique Well Number: 773055
County: Meeker
Quad: Litchfield
Quad ID: 125A

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING REPORT
Minnesota Statutes Chapter 1031

Entry Date: 09/09/2015
Update Date: 10/20/2015
Received Date:

Well Name	Township	Range	Dir	Section	Subsection
LFO2-B	119	31	W	2	CACDBD

Elevation: 1139.2 Elev. Method: LiDAR 1m DEM (MNDNR)

Address:
Well: 61656 270TH ST LITCHFIELD MN 55355
Contact: 126 MARSHALL AV N LITCHFIELD MN 55355

Stratigraphy Info: [redacted]OODALE DR MOUNDS VIEW MN 55112

Geological Material	From	To (ft.)	Color	Hardness
SILT&CLAY W/SAND,	0	36	GRAY	MEDIUM

Remark:
SEE DRILLERS LOG FOR DETAILED INFORMATION.

Well Depth: 35.5 ft. Depth Completed: 35.13 ft. Date Well Completed: 06/24/2015
Drill Method: Auger (non-specified) Drill Fluid:
Use: monitor well Status: Active
Well Hydrofractured? Yes ☐ No ☒ From To
Casing Type: Single casing Joint: Glued
Drive Shoe? Yes ☐ No ☐ Above/Below

Casing Diameter	Weight	Hole Diameter
1.2 in. To 32.3 ft.	0.74 lbs./ft.	8.2 in. To 35.5 ft.

Open Hole: From ft. To ft.

Screen?	Type	Make	Diameter	Slot/Gauze	Length	Set
☒	slotted pipe	ENVIRONMENTAL	1.2 in.	10	2.7 ft.	32.2 ft. 34.9 ft.

Static Water Level: 23.8 ft. land surface Measure: 08/17/2015
Pumping Level (below land surface): ft. 1.4 hrs. Pumping at: 1.43 g.p.m.
Wellhead Completion:
Pitless adapter manufacturer: Model:
☒ Casing Protection ☒ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

Grouting Information: Well Grouted? ☒ Yes ☐ No ☐ Not Specified

Material	Amount		From	To
bentonite	4	Sacks	3 ft.	30.5 ft.
concrete	1.5	Sacks	ft.	3 ft.

Nearest Known Source of Contamination: foot Direction: Type:
Well disinfected upon completion? ☐ Yes ☒ No
Pump: ☒ Not Installed Date Installed:
Manufacturer's name:
Model Number: HP: Volt:
Length of drop pipe: ft Capacity: g.p. Type:
Abandoned:
Does property have any not in use and not sealed well(s)? ☐ Yes ☒ No
Variance:
Was a variance granted from the MDH for this well? ☐ Yes ☒ No
Miscellaneous:
First Bedrock: Aquifer: Quat. buried
Last Strat: pebbly sand/silt/clay-gray Depth to Bedrock: ft
Located by: Minnesota Geological Survey
Locate Method: Digitization (Screen) - Map (1:24,000)
System: UTM - NAD83, Zone 15, Meters X: 379193 Y: 4999909
Unique Number Verification: Information from: Input Date: 09/09/2015
Angled Drill Hole:
Well Contractor:
US Geological Survey 1548 HUCKABY, J.
Licensee Business Lic. or Reg. No. Name of Driller

Minnesota Well Index Report 773055 Printed on 06/12/2017
HE-01205-15

Figure 58. Well and Boring Report - USGS 2-C (773054)

Minnesota Unique Well Number: 773054

County: Meeker
Quad: Litchfield
Quad ID: 125A

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING REPORT
Minnesota Statutes Chapter 1031

Entry Date: 08/14/2015
Update Date: 10/20/2015
Received Date:

Well Name	Township	Range	Dir	Section	Subsection
LFO2-C	119	31	W	2	CACDBD

Elevation: 1139.4 Elev. Method: LiDAR 1m DEM (MNDNR)

Address
Well: 61656 270TH ST LITCHFIELD MN 55355
Contact: 126 MARSHALL AV N LITCHFIELD MN 55355

Stratigraphy Information: [redacted]WOODALE DR MOUNDS VIEW MN 55112

Geological Material	From	To (ft.)	Color	Hardness
SILT & CLAY W/SAND,	0	70	GRAY	MEDIUM

Remarks
SEE DRILLERS LOG FOR DETAILED INFORMATION.

Well Depth: 70 ft. Depth Completed: 59.84 ft. Date Well Completed: 06/22/2015
Drill Method: Auger (non-specified) Drill Fluid:
Use: monitor well Status: Active
Well Hydrofractured? Yes [ ] No [X] From To
Casing Type: Single casing Joint: Glued
Drive Shoe? Yes [ ] No [ ] Above/Below:

Casing Diameter	Weight	Hole Diameter
1.2 in. To 57 ft.	0.74 lbs./ft.	8.2 in. To 70 ft.

Open Hole From ft. To ft.
Screen? [X] Type: slotted pipe Make: ENVIRONMENTAL

Diameter	Slot/Gauze	Length	Set	
1.2 in.	10	2.7 ft.	56.9 ft.	59.6 ft.

Static Water Level
31.8 ft. land surface Measure 06/22/2015

Pumping Level (below land surface)
ft. 1.2 hrs. Pumping at 0.14 g.p.m.

Wellhead Completion
Pitless adapter manufacturer: Model:
[X] Casing Protection [X] 12 in. above grade
[ ] At-grade (Environmental Wells and Borings ONLY)

Grouting Information: Well Grouted? [X] Yes [ ] No [ ] Not Specified

Material	Amount		From	To	
bentonite	7	Sacks	3 ft.	54.7 ft.	
concrete	2	Sacks	ft.	3 ft.	

Nearest Known Source of Contamination
feet Direction Type
Well disinfected upon completion? [ ] Yes [X] No

Pump [X] Not Installed Date Installed:
Manufacturer's name:
Model Number: HP: Volt:
Length of drop pipe: ft Capacity: g.p. Type:

Abandoned
Does property have any not in use and not sealed well(s)? [ ] Yes [X] No

Variance
Was a variance granted from the MDH for this well? [ ] Yes [X] No

Miscellaneous
First Bedrock: Aquifer: Quat. buried
Last Strat: pebbly sand/silt/clay-gray Depth to Bedrock: ft
Located by: Minnesota Geological Survey
Locate Method: Digitization (Screen) - Map (1:24,000)
System: UTM - NAD83, Zone 15, Meters X: 379195 Y: 4999910
Unique Number Verification: Information from: Input Date: 08/14/2015

Angled Drill Hole

Well Contractor
US Geological Survey (Licensee Business) 1548 (Lic. or Reg. No.) HUCKABY, J. (Name of Driller)

Minnesota Well Index Report 773054 Printed on 06/12/2017
HE-01205-15

Figure 59. Well and Boring Report - USGS 2-D (773053)

Minnesota Unique Well Number: 773053

County: Meeker
Quad: Litchfield
Quad ID: 125A

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING REPORT
Minnesota Statutes Chapter 1031

Entry Date: 08/14/2015
Update Date: 10/20/2015
Received Date:

Well Name	Township	Range	Dir	Section	Subsection
LFO2-D	119	31	W	2	CACDBD

Elevation: 1139.2 Elev. Method: LiDAR 1m DEM (MNDNR)

Address
Well: 61656 270TH ST LITCHFIELD MN 55355
Contact: 126 MARSHALL AV N LITCHFIELD MN 55355
Contractor: [illegible]OODALE DR MOUNDS VIEW MN 55112

Stratigraphy Info

Geological Material	From	To (ft.)	Color	Hardness
SILT& CLAY W/SAND,	0	80	GRAY	MEDIUM
SAND& CLAY W/SAND,	80	86	GRAY	HARD

Remarks: SEE DRILLERS LOG FOR DETAILED INFORMATION.

Well Depth: 85.5 ft. Depth Completed: 81.14 ft. Date Well Completed: 06/23/2015
Drill Method: Auger (non-specified) Drill Fluid:
Use: monitor well Status: Active
Well Hydrofractured? Yes [ ] No [X] From To
Casing Type: Single casing Joint: Glued
Drive Shoe? Yes [ ] No [ ] Above/Below:

Casing Diameter	Weight	Hole Diameter
1.2 in. To 81.1 ft.	0.74 lbs./ft.	8.2 in. To 85.5 ft.

Open Hole: From ft. To ft.
Screen? [X] Type: slotted pipe Make: ENVIRONMENTAL

Diameter	Slot/Gauze	Length	Set	
1.2 in.	10	2.7 ft.	81.1 ft.	81.1 ft.

Static Water Level: 78 ft. land surface Measure: 08/17/2015
Pumping Level (below land surface): ft. 1.4 hrs. Pumping at: 0.1 g.p.m.
Wellhead Completion
Pitless adapter manufacturer: Model:
[X] Casing Protection [X] 12 in. above grade
[ ] At-grade (Environmental Wells and Borings ONLY)
Grouting Information: Well Grouted? [X] Yes [ ] No [ ] Not Specified

Material	Amount	From	To
bentonite	6.5 Sacks	3 ft.	78.5 ft.
concrete	1.5 Sacks	ft.	3 ft.

Nearest Known Source of Contamination: foot Direction: Type:
Well disinfected upon completion? [ ] Yes [X] No
Pump [X] Not Installed Date Installed:
Manufacturer's name:
Model Number: HP: Volt:
Length of drop pipe: ft Capacity: g.p. Typ:
Abandoned
Does property have any not in use and not sealed well(s)? [ ] Yes [X] No
Variance
Was a variance granted from the MDH for this well? [ ] Yes [X] No
Miscellaneous
First Bedrock: Aquifer: Quat. buried
Last Strat: pebbly sand/silt/clay-gray Depth to Bedrock: ft
Located by: Minnesota Geological Survey
Locate Method: Digitization (Screen) - Map (1:24,000)
System: UTM - NAD83, Zone 15, Meters X: 379193 Y: 4999908
Unique Number Verification: Information from: Input Date: 08/14/2015
Angled Drill Hole:
Well Contractor
US Geological Survey (Licensee Business) 1548 (Lic. or Reg. No.) HUCKABY, J. (Name of Driller)

Minnesota Well Index Report 773053 Printed on 06/12/2017
HE-01205-15

Figure 60. Well and Boring Report - USGS 2-E (773052)

Minnesota Unique Well Number: 773052

County: Meeker
Quad: Litchfield
Quad ID: 125A

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING REPORT
Minnesota Statutes Chapter 1031

Entry Date: 08/14/2015
Update Date: 10/20/2015
Received Date:

Well Name	Township	Range	Dir	Section	Subsection
LFO2-E	119	31	W	2	CACDBD

Elevation: 1139.3 Elev. Method: LiDAR 1m DEM (MNDNR)

Address
Well: 61656 270TH ST LITCHFIELD MN 55355
Contact: 126 MARSHALL AV N LITCHFIELD MN 55355

Stratigraphy Info: [illegible]ODALE DR MOUNDS VIEW MN 55112

Geological Material	From	To (ft.)	Color	Hardness
SILT&CLAY W/SAND,	0	80	GRAY	MEDIUM
SILT&CLAY W/SAND,	80	114	GRAY	HARD

Remarks:
SEE DRILLERS LOG FOR DETAILED INFORMATION.

Well Depth: 113.9 ft. Depth Completed: 113.82 ft. Date Well Completed: 06/20/2015
Drill Method: Augr (non-specified) Drill Fluid:
Use: monitor well Status: Active
Well Hydrofractured? Yes ☐ No ☒ From To
Casing Type: Single casing Joint: Glued
Drive Shoe? Yes ☐ No ☐ Above/Below

Casing Diameter	Weight	Hole Diameter
1.2 in. To 111 ft.	0.74 lbs./ft.	8.2 in. To 113. ft.

Open Hole From ft. To ft.
Screen? ☒ Type: slotted pipe Make: ENVIRONMENTAL

Diameter	Slot/Gauze	Length	Set	
1.2 in.	10	2.7 ft.	110.9 ft.	113.6 ft.

Static Water Level: 95.6 ft. land surface Measure: 08/17/2015
Pumping Level (below land surface): ft. 0.6 hrs. Pumping at: 0.47 g.p.m.
Wellhead Completion
Pitless adapter manufacturer: Model:
☒ Casing Protection ☒ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

Grouting Information: Well Grouted? ☒ Yes ☐ No ☐ Not Specified

Material	Amount	From	To
bentonite	Sacks	3 ft.	108.6 ft.
concrete	Sacks	ft.	3 ft.

Nearest Known Source of Contamination: foot Direction: Type:
Well disinfected upon completion? ☐ Yes ☒ No
Pump: ☒ Not Installed Date Installed:
Manufacturer's name:
Model Number: HP: Volt:
Length of drop pipe: ft Capacity: g.p. Typ:
Abandoned
Does property have any not in use and not sealed well(s)? ☐ Yes ☒ No
Variance
Was a variance granted from the MDH for this well? ☐ Yes ☒ No
Miscellaneous
First Bedrock: Aquifer: Quat. buried
Last Strat: pebbly sand/silt/clay-gray Depth to Bedrock: ft
Located by: Minnesota Geological Survey
Locate Method: Digitization (Screen) - Map (1:24,000)
System: UTM - NAD83, Zone 15, Meters X: 379195 Y: 4999909
Unique Number Verification: Information from: Input Date: 08/14/2015
Angled Drill Hole:
Well Contractor
US Geological Survey 1548 HUCKABY, J.
Licensee Business Lic. or Reg. No. Name of Driller

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Figure 61. Well and Boring Report - USGS 2-F (773051)

Minnesota Unique Well Number: 773051

County: Meeker
Quad: Litchfield
Quad ID: 125A

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING REPORT
Minnesota Statutes Chapter 1031

Entry Date: 08/14/2015
Update Date: 10/23/2015
Received Date:

Well Name	Township	Range	Dir	Section	Subsection
LFO2-F	119	31	W	2	CACDBD

Elevation: 1139.3 Elev. Method: LiDAR 1m DEM (MNDNR)

Address
Well: 61656 270TH ST LITCHFIELD MN 55355
Contact: 126 MARSHALL AV N LITCHFIELD MN 55355
Stratigraphy Info: [redacted]OODALE DR MOUNDS VIEW MN 55112

Geological Material	From	To (ft.)	Color	Hardness
SILT&CLAY W/SAND,	0	80	GRAY	MEDIUM
SILT&CLAY W/SAND,	80	117	GRAY	HARD
SAND & GRAVEL,	117	161	GRAY	HARD
SILT&CLAY W/SAND,	161	163	GRAY	HARD

Remarks:
SEE DRILLERS LOG FOR DETAILED INFORMATION.
GAMMA & INDUCTION LOGGED 8-19-2015. LOGGED FOR USGS.

Well Depth: 162.5 ft. Depth Completed: 162.42 ft. Date Well Completed: 06/18/2015
Drill Method: Auger (non-specified) Drill Fluid:
Use: monitor well Status: Active
Well Hydrofractured? Yes ☐ No ☒ From To
Casing Type: Single casing Joint: Glued
Drive Shoe? Yes ☐ No ☐ Above/Below:
Casing Diameter: 2 in. To 152. ft. Weight: 1.02 lbs./ft.
Open Hole From ft. To ft.
Screen? ☒ Type: slotted pipe Make: ENVIRONMENTAL

Diameter	Slot/Gauze	Length	Set	
1.9 in.	20	9.6 ft.	152.4 ft.	162 ft.

Static Water Level: 61 ft. land surface Measure: 08/17/2015
Pumping Level (below land surface): ft. 6.4 hrs. Pumping at: 0.86 g.p.m.
Wellhead Completion
Pitless adapter manufacturer: Model:
☒ Casing Protection ☒ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)
Grouting Information: Well Grouted? ☒ Yes ☐ No ☐ Not Specified

Material	Amount		From	To
bentonite	10	Sacks	2 ft.	137 ft.
concrete	2	Sacks	ft.	2 ft.

Nearest Known Source of Contamination: feet Direction: Type:
Well disinfected upon completion? ☐ Yes ☒ No
Pump ☒ Not Installed Date Installed:
Manufacturer's name:
Model Number: HP: Volt:
Length of drop pipe: ft Capacity: g.p. Typ:
Abandoned
Does property have any not in use and not sealed well(s)? ☐ Yes ☒ No
Variance
Was a variance granted from the MDH for this well? ☐ Yes ☒ No
Miscellaneous
First Bedrock: Aquifer: Quat. buried
Last Strat: pebbly sand/silt/clay-gray Depth to Bedrock: ft
Located by: Minnesota Geological Survey
Locate Method: Digitization (Screen) - Map (1:24,000)
System: UTM - NAD83, Zone 15, Meters X: 379195 Y: 4999908
Unique Number Verification: Information from: Input Date: 08/14/2015
Angled Drill Hole

Well Contractor
US Geological Survey — 1548 — HUCKABY, J.
Licensed Business — Lic. or Reg. No. — Name of Driller

Minnesota Well Index Report | 773051 | Printed on 06/19/2017 HE-01205-15

Figure 62. Well and Boring Report - Desens Observation (800011)

Minnesota Unique Well Number: 800011

County: Meeker
Quad: Litchfield
Quad ID: 125A

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING REPORT
Minnesota Statutes Chapter 1031

Entry Date: 01/13/2014
Update Date: 08/26/2014
Received Date: 10/02/2013

Well Name	Township	Range	Dir	Section	Subsection
DESEN, DOUG	119	31	W	2	DACAAC

Elevation: 1128.4 Elev. Method: Surveyed

Address
Contact: 28003 620TH AV LITCHFIELD MN 55355
Well: 620TH AV LITCHFIELD MN 55355

Stratigraphy Information

Geological Material	From	To (ft.)	Color	Hardness
TOP SOIL	0	3	BLACK	SOFT
CLAY	3	5	BROWN	SOFT
GRAVEL	5	9	BROWN	SOFT
CLAY	9	112	GRAY	MED-HRD
DIRTY GRAVEL	112	117	GRAY	SOFT
CLAY	117	120	GRAY	SFT-MED
SAND/GRAVEL	120	158	GRAY	SOFT
CLAY/GRAVEL	158	158	GRAY	SOFT

Remarks:
DRILLERS: STEVE WEISBRICH & DREW BATES.

Well Depth: 158 ft. Depth Completed: 158 ft. Date Well Completed: 07/29/2013
Drill Method: Non-specified Rotary Drill Fluid: Bentonite
Use: monitor well Status: Active
Well Hydrofractured? Yes ☐ No ☒ From To
Casing Type: Single casing Joint: Glued
Drive Shoe? Yes ☐ No ☒ Above/Below

Casing Diameter	Weight	Hole Diameter
2 in. To 148 ft.	lbs./ft.	6.2 in. To 158 ft.

Open Hole From ft. To ft.
Screen? ☒ Type: plastic Make: JOHNSON

Diameter	Slot/Gauze	Length	Set
2 in.	10	10 ft.	148 ft. 158 ft.

Static Water Level: 59.8 ft. land surface Measure: 07/29/2013
Pumping Level (below land surface):
Wellhead Completion
Pitless adapter manufacturer: Model:
☒ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

Grouting Information: Well Grouted? ☒ Yes ☐ No ☐ Not Specified

Material	Amount	From	To
bentonite		4 ft.	142 ft.
neat cement	2 Sacks	ft.	4 ft.

Nearest Known Source of Contamination
200 foot West Direction Septic tank/drain field Type
Well disinfected upon completion? ☐ Yes ☐ No
Pump ☒ Not Installed Date Installed:
Manufacturer's name:
Model Number: HP: Volt:
Length of drop pipe: ft Capacity: g.p. Type:
Abandoned
Does property have any not in use and not sealed well(s)? ☐ Yes ☒ No
Variance
Was a variance granted from the MDH for this well? ☐ Yes ☒ No
Miscellaneous
First Bedrock: Aquifer: Quat. buried
Last Strat: pebbly sand/silt/clay-gray Depth to Bedrock: ft
Located by: Minnesota Geological Survey
Locate Method: Digitization (Screen) - Map (1:12,000)
System: UTM - NAD83, Zone 15, Meters X: 380018 Y: 5000014
Unique Number Verification: Info/GPS from data Input Date: 08/18/2014
Angled Drill Hole:
Well Contractor
Mark J Traut Wells, Inc. 1404 STEVE/DREW
Licensee Business Lic. or Reg. No. Name of Driller

Minnesota Well Index Report | 800011 | Printed on 06/12/2017 HE-01205-15