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

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



TEST 2617, L	LITCHFIELD	2 (607420)	JUNE 29,	2017
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## Contents

Analysis of the Litchfield, Minnesota Well 2 (607420) Aquifer Test	1
	1
Data Collection and Analysis	7
Description	7
Purpose of Test	7
Well Inventory	7
Hydrogeologic Setting	7
Other Interfering Wells	8
Test Setup	8
Weather Conditions	8
Discharge Monitoring	8
Data Collection	9
Qualitative Aquifer Hydraulic Response	9
Quantitative Analysis	11
Conceptual Model	11
Pumped Aquifer	11
Aquitard (Confining) Layer	12
Conclusion	13
Acknowledgements	13
References	14
ables and Figures	15

### List of Tables

Table 1. Summary of Results for Leaky Confined - Radial Porous Media Flow	15
Table 2. Aquifer Test Information	16
Table 3. Well Information	17
Table 4. Data Collection	18
Table 5. Transient Analysis Results	19
Table 6. Steady-state Analysis Results	19
List of Figures	
Figure 1. Adjustments for pumping-phase data	20
Figure 2. Theis (1935) analysis of pumping and recovery data from Litchfield 2 (607420)	21
Figure 3. Theis (1935) analysis of pumping and recovery data from Litchfield MW (607417)	22
Figure 4. Theis (1935) analysis of pumping and recovery data from USGS 2-F (773051)	23
Figure 5. Theis (1935) analysis of pumping and recovery data from USGS 1-F (773057)	24
Figure 6. Theis (1935) analysis of pumping and recovery data from Desens (800011)	25
Figure 7. Theis (1935) composite (t/r²) analysis of recovery data	26
Figure 8. Projected recovery to 10,000 minutes for steady-state analysis	27
Figure 9. Cooper-Jacob (1946) transient and Hantush-Jacob (1955) steady-state analyses	28
Figure 10. de Glee (1930) steady-state analysis	29
Figure 11. Difference in water level at USGS Nest-1 during pumping and recovery	30
Figure 12. Aqtesolv composite (t/r2). Hantush-Jacob (1955) model	31
Figure 13. Aqtesolv analysis of data from Nest 1 wells, Neuman-Witherspoon (1969) model. thickness 63 feet.	
Figure 14. Aqtesolv analysis of data from Nest 1 wells, Neuman-Witherspoon (1969) model. thickness 50 feet	
Figure 15. Aqtesolv analysis of data from Nest 1 wells, Neuman-Witherspoon (1969) model.  Drawdown from unknown pumping wells	
Figure 16. Well Location Map: well name and Minnesota unique well number	35
Figure 17. Schematic Section	36
Figure 18. Depth to Water from Top of Casing at Litchfield 2 (607417), Both Manual and Electronic Measurements	37
Figure 19. Depth to Water from Top of Casing at Litchfield MW (607420), Both Manual and	38

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 40
Figure 22. Depth to Water from Top of Casing at Litchfield 5 (764258), Manual Measurements 41
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 Data55
Figure 37. Groundwater elevation at Litchfield-2 and Observation Wells, Test Period 56
Figure 38. Groundwater elevation at Litchfield-2 and Nest 1, Test Period 57
Figure 39. Groundwater elevation at Litchfield-2 and Nest 2, Test Period
Figure 40. Groundwater Elevation in Aquifer Compared to Barometric Pressure, Test Period 59

#### TEST 2617, LITCHFIELD 2 (607420) JUNE 29, 2017

Figure 41. Depth to Water in Water-Table Wells Compared to Rainfall Events	60
Figure 42. Daily Pumping Volume from Community Supply Wells, June 1, to July 10, 2017	61
Figure 43. Expanded View of Groundwater Elevation in Aquifer Wells from July 2 to July 11, 2017	62
Figure 44. Local Effects of Community Supply Wells from July 5 to July 11, 2017	63
Figure 45. Groundwater Elevation at USGS 2-F (773051) Compared to Rainfall Events, Summof 2016	
Figure 46. Well and Boring Report - Litchfield 2 (607420)	65
Figure 47. Well and Boring Report - Litchfield 3 (632077)	66
Figure 48. Well and Boring Report - Litchfield 4 (632078)	67
Figure 49. Well and Boring Report - Litchfield 5 (764258)	68
Figure 50. Well and Boring Report - Litchfield-MW (607417)	69
Figure 51. Well and Boring Report - USGS 1-B (773062)	70
Figure 52. Well and Boring Report - USGS 1-C (773060)	71
Figure 53. Well and Boring Report - USGS 1-D (773059)	72
Figure 54. Well and Boring Report - USGS 1-E (773058)	73
Figure 55. Well and Boring Report - USGS 1-F (773057)	74
Figure 56. Well and Boring Report - USGS 2-A (773056)	75
Figure 57. Well and Boring Report - USGS 1-F (773057)	76
Figure 58. Well and Boring Report - USGS 2-C (773054)	77
Figure 59. Well and Boring Report - USGS 2-D (773053)	78
Figure 60. Well and Boring Report - USGS 2-E (773052)	79
Figure 61. Well and Boring Report - USGS 2-F (773051)	80
Figure 62. Well and Boring Report - Desens Observation (800011)	81

### 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.

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# 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 <sub>V</sub> /K <sub>R</sub> )	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 <sub>V</sub> )	1.0e-3	ft/day	< 1.0e-4	2.0e-2	

#### TEST 2617, LITCHFIELD 2 (607420) JUNE 29, 2017

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 <sup>1</sup> (meter)	Northing Location, Y <sup>1</sup> (meter)	Radial Distance (feet)	Ground Surface Elevation, GSE <sup>2</sup> (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

<sup>&</sup>lt;sup>1</sup> Local Datum

<sup>&</sup>lt;sup>2</sup> Vertical Datum: NAV88

#### TEST 2617, LITCHFIELD 2 (607420) JUNE 29, 2017

Table 4. Data Collection

Data File Name: Well Name_Unique Number	Data Logger Type, SN:	Probe Id., Range (psi)	Install 1. Static WL <sup>3</sup>	Install 2. XD <sup>4</sup> 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 <sup>5</sup>			
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 <sup>6</sup>	-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

<sup>&</sup>lt;sup>3</sup> WL = water level below measuring point, feet.

<sup>&</sup>lt;sup>4</sup> XD = pressure transducer depth below water surface, feet.

<sup>&</sup>lt;sup>5</sup> Pump running

<sup>&</sup>lt;sup>6</sup> 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 <sup>7</sup>	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 (ft²/day)	Leakage Factor, L (feet)	Hydraulic Resistance, c (days)	Hydraulic Conductivity of Aquitard, k <sub>v</sub> (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

<sup>&</sup>lt;sup>7</sup> Not Applicable

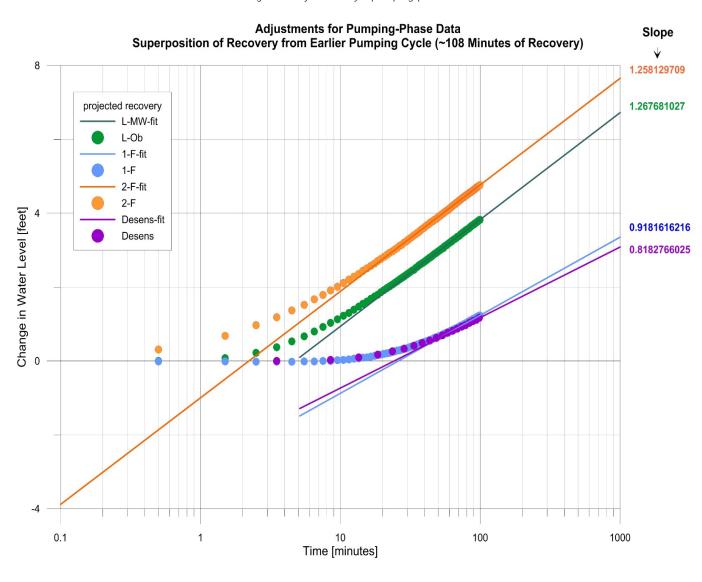


Figure 1. Adjustments for pumping-phase data

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

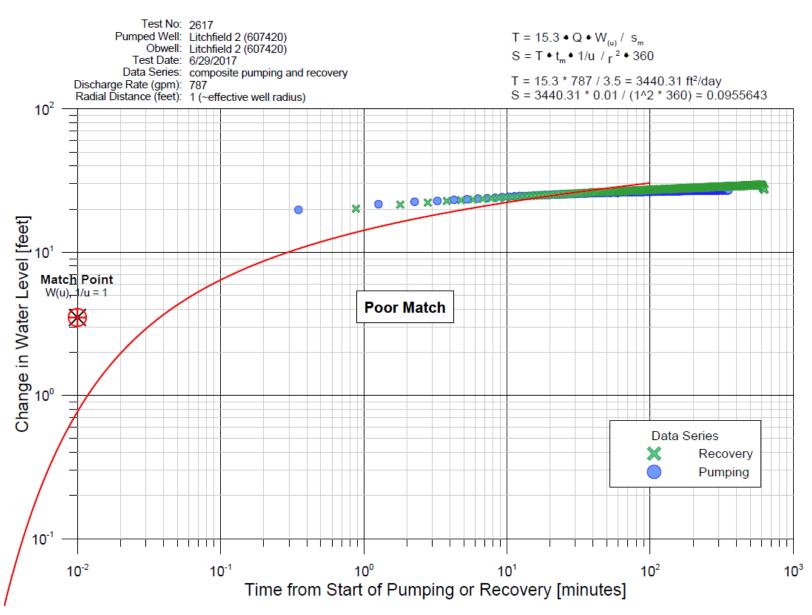


Figure 3. Theis (1935) analysis of pumping and recovery data from Litchfield MW (607417)

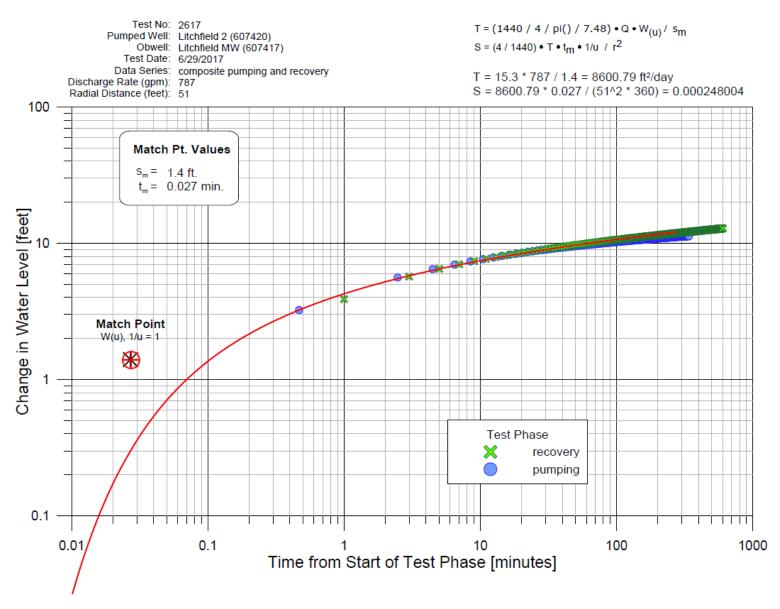


Figure 4. Theis (1935) analysis of pumping and recovery data from USGS 2-F (773051)

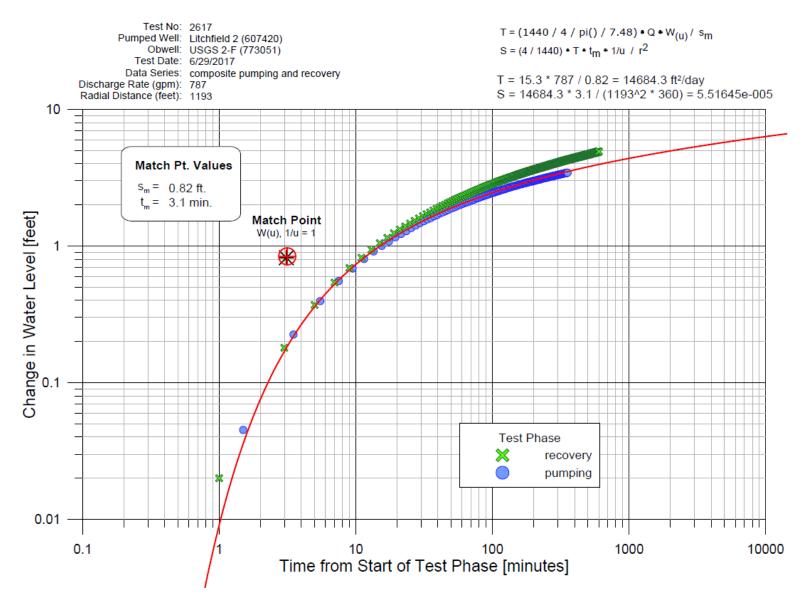


Figure 5. Theis (1935) analysis of pumping and recovery data from USGS 1-F (773057)

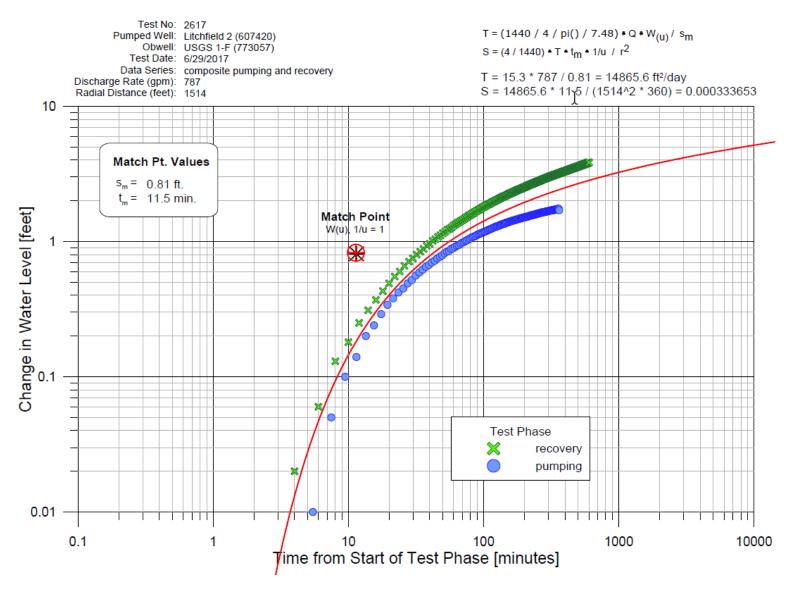


Figure 6. Theis (1935) analysis of pumping and recovery data from Desens (800011)

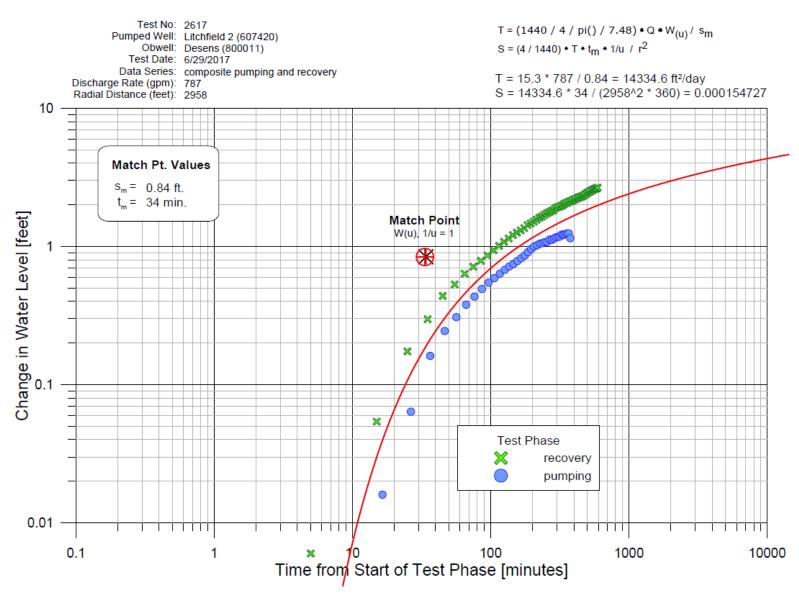
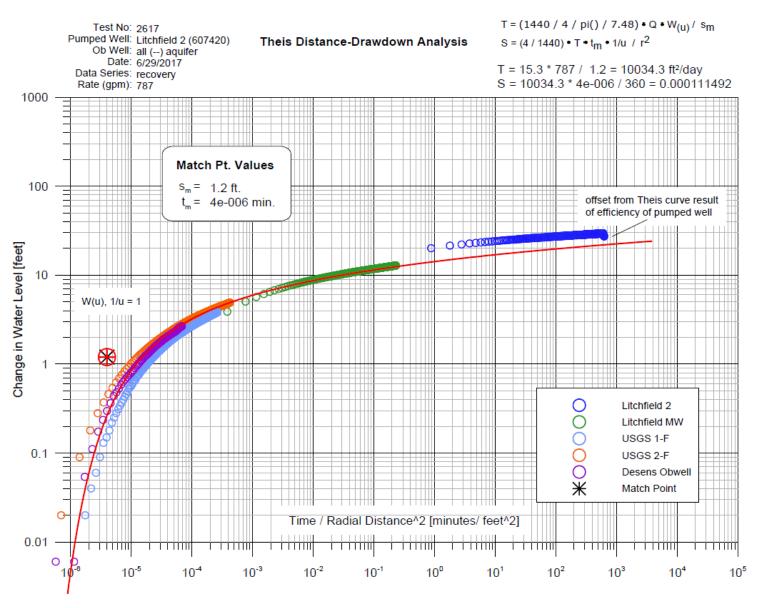


Figure 7. Theis (1935) composite  $(t/r^2)$  analysis of recovery data



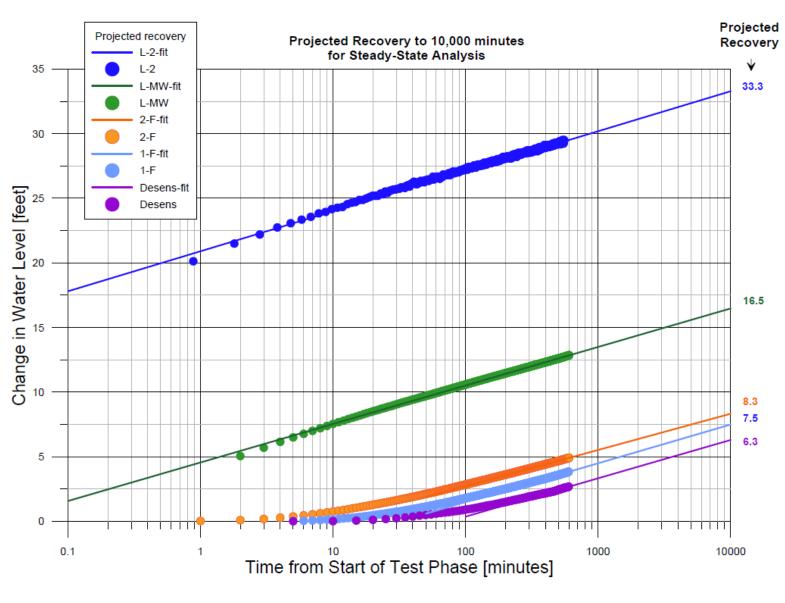
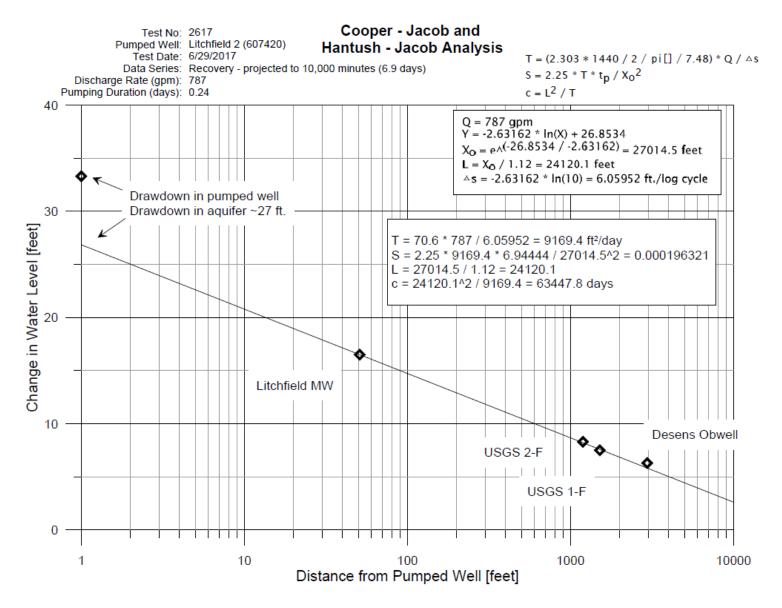
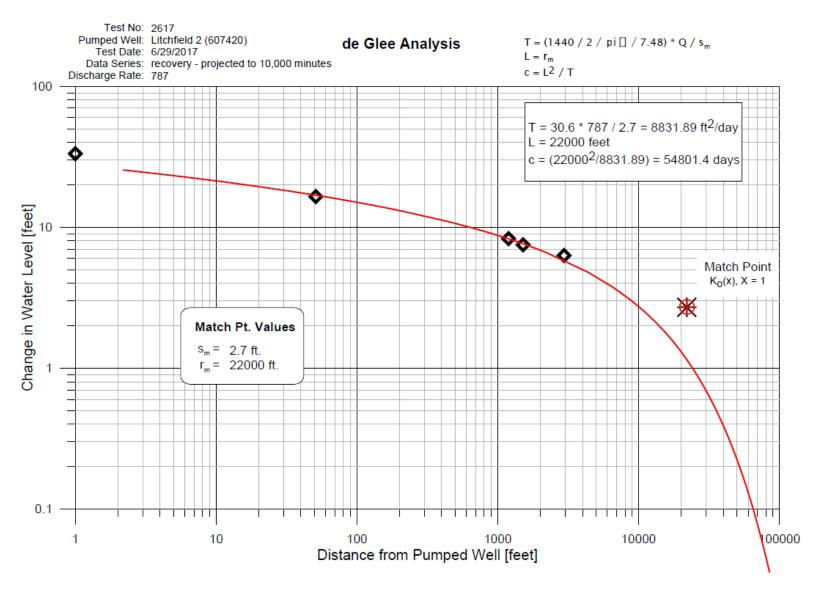


Figure 8. Projected recovery to 10,000 minutes for steady-state analysis

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







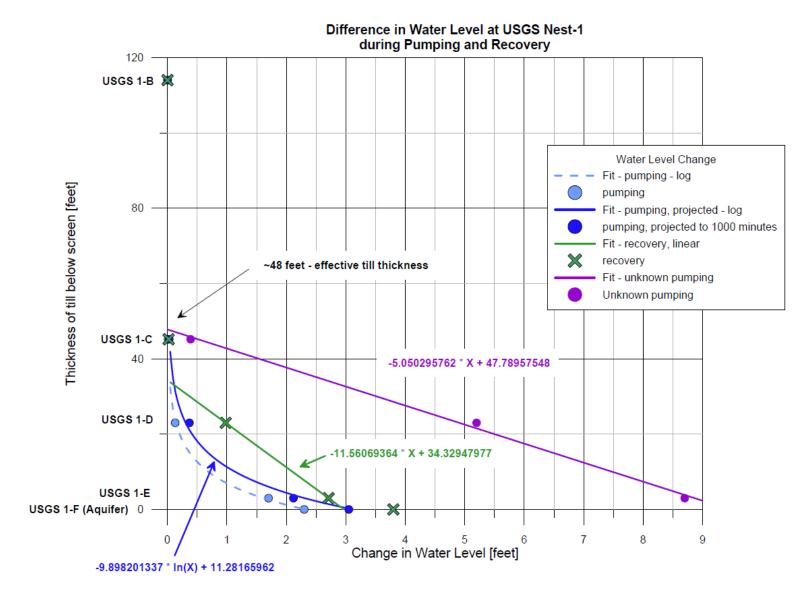
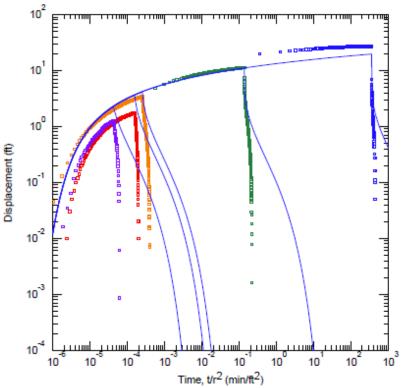
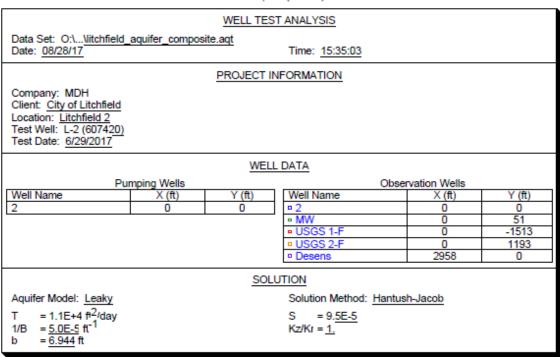


Figure 11. Difference in water level at USGS Nest-1 during pumping and recovery

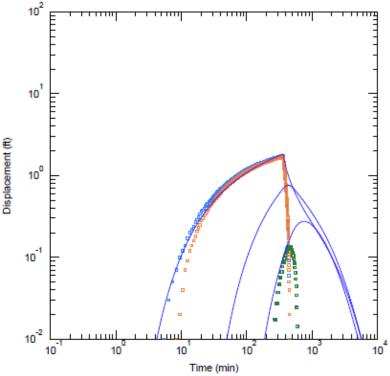
Figure 12. Aqtesolv composite (t/r2). Hantush-Jacob (1955) model

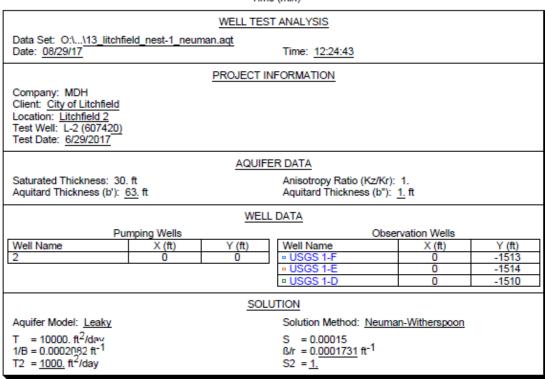




L = 20,000 feet kV = 0.00005 \* 11,000 \* 50 = 0.0014 ft/day

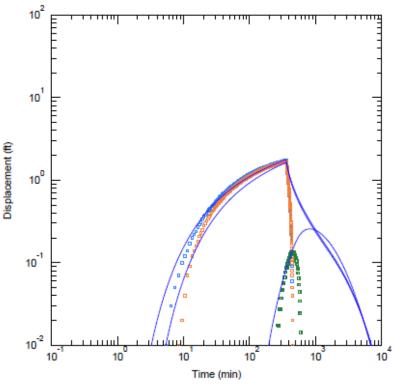
Figure 13. Aqtesolv analysis of data from Nest 1 wells, Neuman-Witherspoon (1969) model. Till thickness 63 feet.

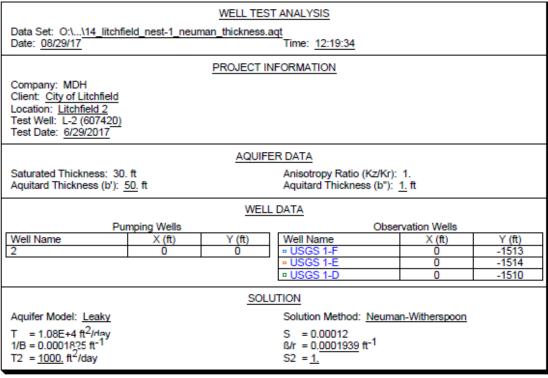




L = 5,000 feet kV = 0.0002 \* 10,000 \* 50 = 0.02 ft/day

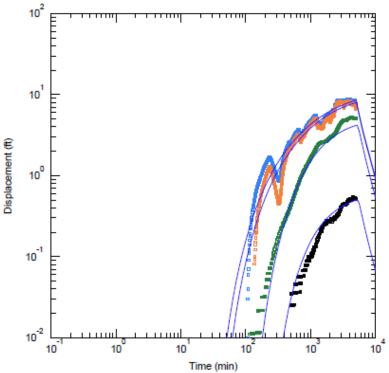
Figure 14. Aqtesolv analysis of data from Nest 1 wells, Neuman-Witherspoon (1969) model. Till thickness 50 feet





L = 5,500 feet k<sub>V</sub> = 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_neum	
Date: 08/29/17	Time: <u>12:16:07</u>
PROJEC	CT INFORMATION
Company: MDH	
Client: City of Litchfield	
Location: Litchfield 2 Test Well: L-2 (607420)	
Test Date: 6/29/2017	
root bate. <u>orboteby</u>	
AQ	UIFER DATA
Saturated Thickness: 30. ft	Anisotropy Ratio (Kz/Kr): 1.
Aquitard Thickness (b'): 50. ft	Aquitard Thickness (b"): 1. ft
V	VELL DATA
Pumping Wells	Observation Wells
Well Name X (ft) Y (ft)	
UnkPump 0 0	□ USGS 1-F 8000 0
	• USGS 1-E 8000 0
	□ USGS 1-D 8000 0 □ USGS 1-C 8000 0
	- 0000 1-0
3	SOLUTION
Aquifer Model: Leaky	Solution Method: Neuman-Witherspoon
T = 8000. ft <sup>2</sup> /day	S = 7.38E-5
1/B = 5.0E-5 ft <sup>-1</sup>	$B/r = 9.198E-6 \text{ ft}^{-1}$
$T2 = 10000$ . $ft^2/day$	S2 = 1.

L = 20,000 feet $k_V = 0.00005 * 8000 * 50 = 0.001 \text{ ft/day}$ 



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

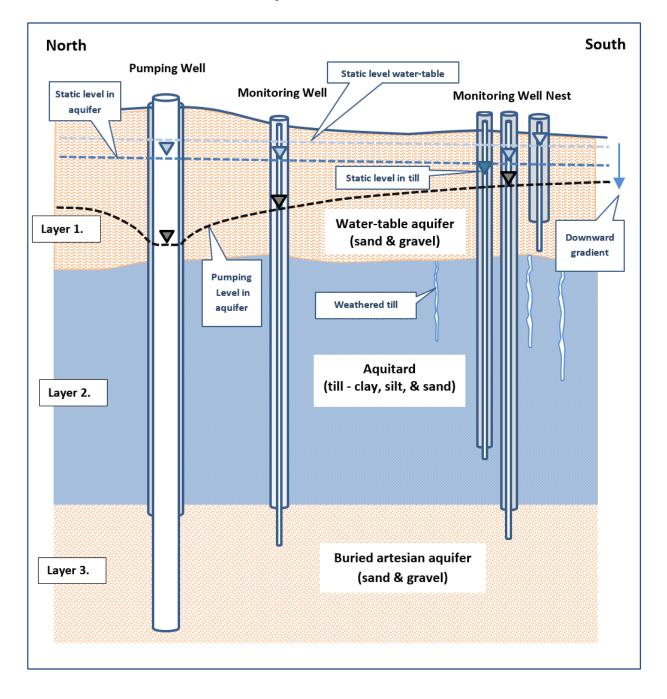


Figure 17. Schematic Section

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

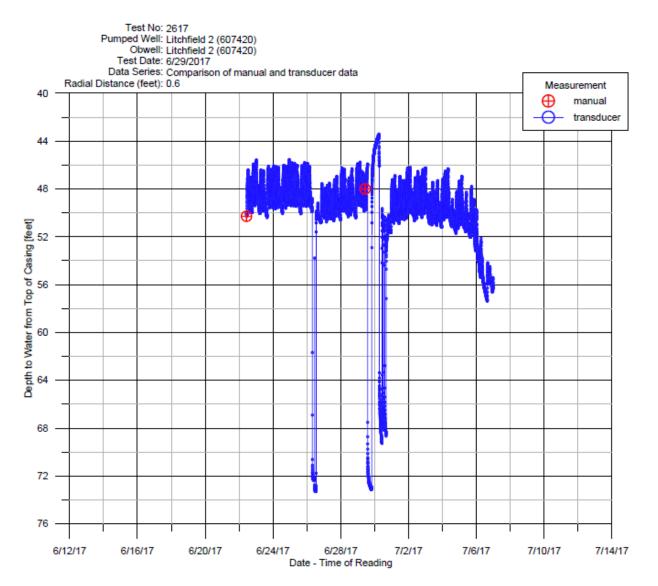


Figure 19. Depth to Water from Top of Casing at Litchfield MW (607420), Both Manual and Electronic Measurements

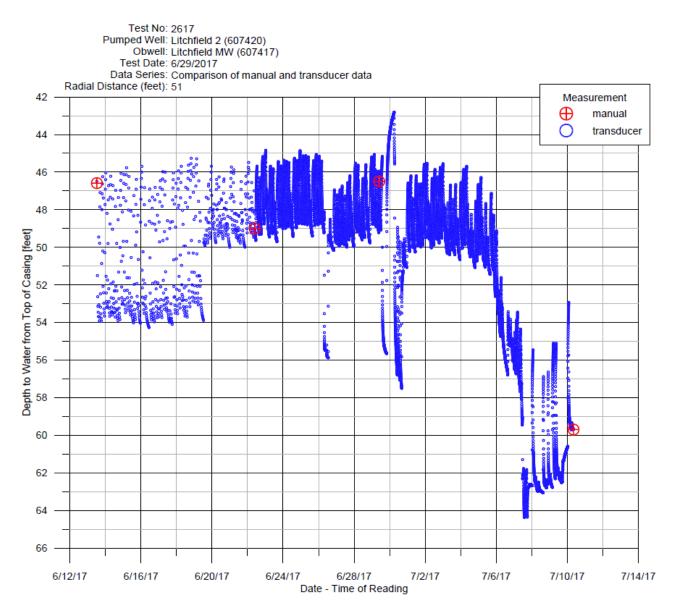


Figure 20. Depth to Water from Top of Casing at Litchfield 3 (632077), Manual Measurements



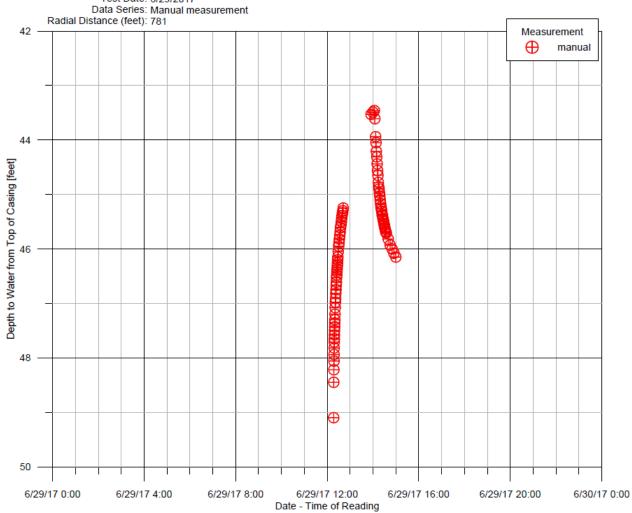


Figure 21. Depth to Water from Top of Casing at Litchfield 4 (632078), Manual Measurements

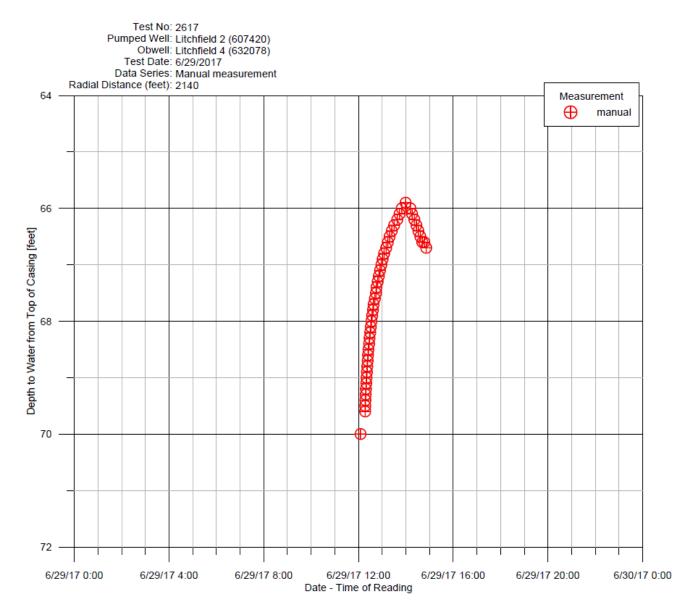
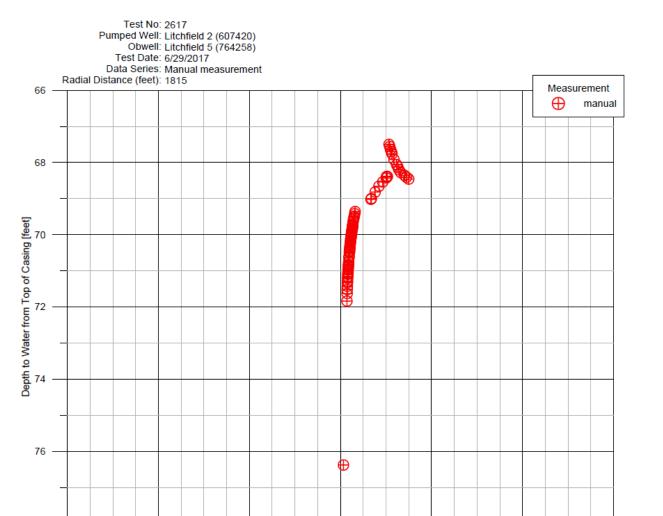


Figure 22. Depth to Water from Top of Casing at Litchfield 5 (764258), Manual Measurements



6/29/17 12:00

Date - Time of Reading

6/29/17 16:00

6/29/17 20:00

6/30/17 0:00

6/29/17 8:00

6/29/17 0:00

6/29/17 4:00

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

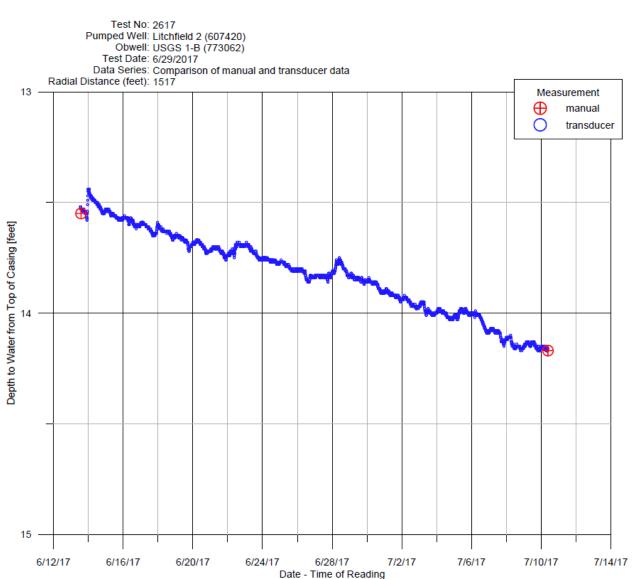


Figure 24. Depth to Water from Top of Casing at USGS 1-C (773060), Both Manual and Electronic Measurements



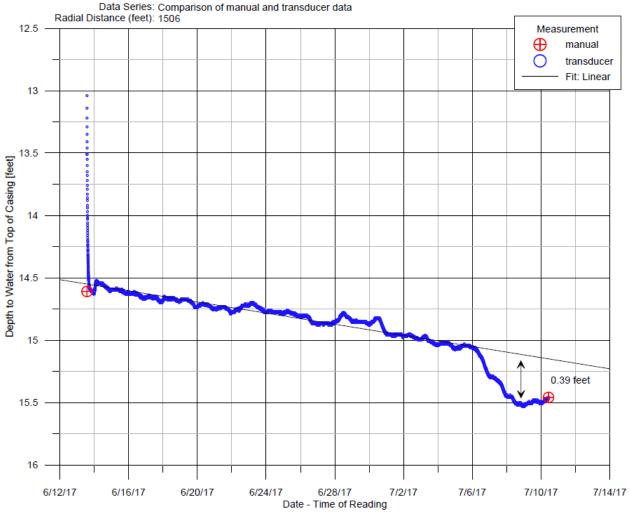


Figure 25. Depth to Water from Top of Casing at USGS 1-D (773059), Both Manual and Electronic Measurements

Test No: 2617 Pumped Well: Litchfield 2 (607420) Obwell: USGS 1-D (773059) Test Date: 6/29/2017

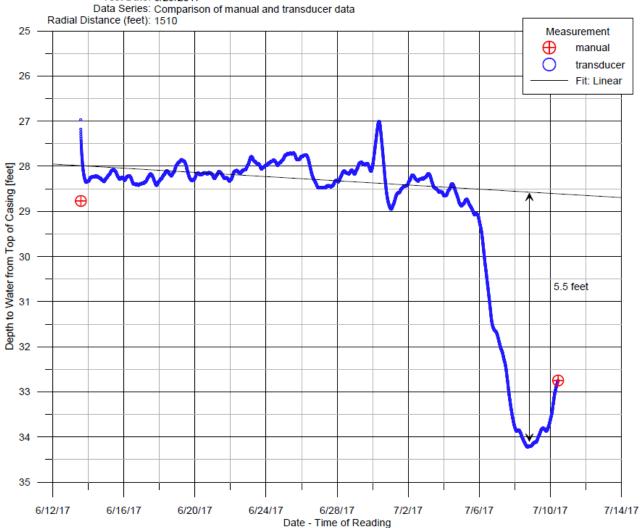


Figure 26. Depth to Water from Top of Casing at USGS 1-E (773058), Both Manual and Electronic Measurements

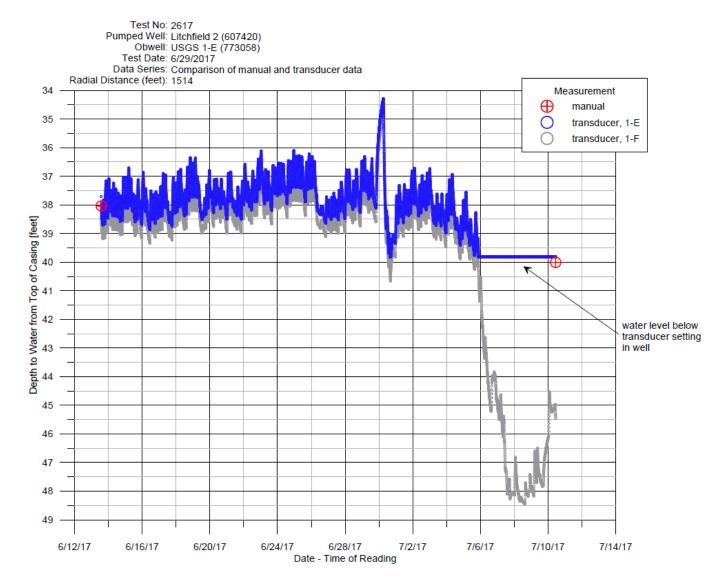


Figure 27. Depth to Water from Top of Casing at USGS 1-F (773057), Both Manual and Electronic Measurements

Test No: 2617 Pumped Well: Litchfield 2 (607420) Obwell: USGS 1-F (773057) Test Date: 6/29/2017

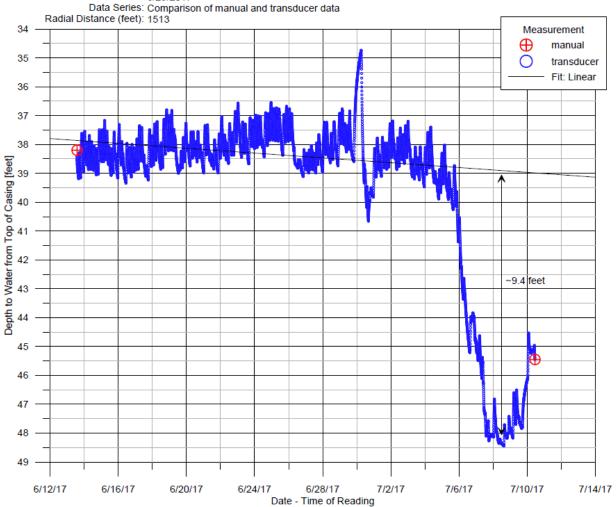


Figure 28. Depth to Water from Top of Casing at USGS 2-A (773056), Both Manual and Electronic Measurements

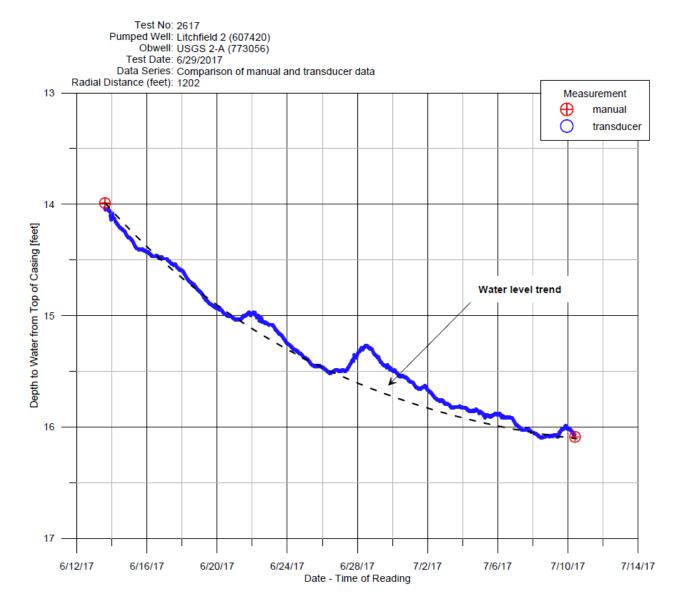


Figure 29. Depth to Water from Top of Casing at USGS 2-B (773055), Both Manual and Electronic Measurements

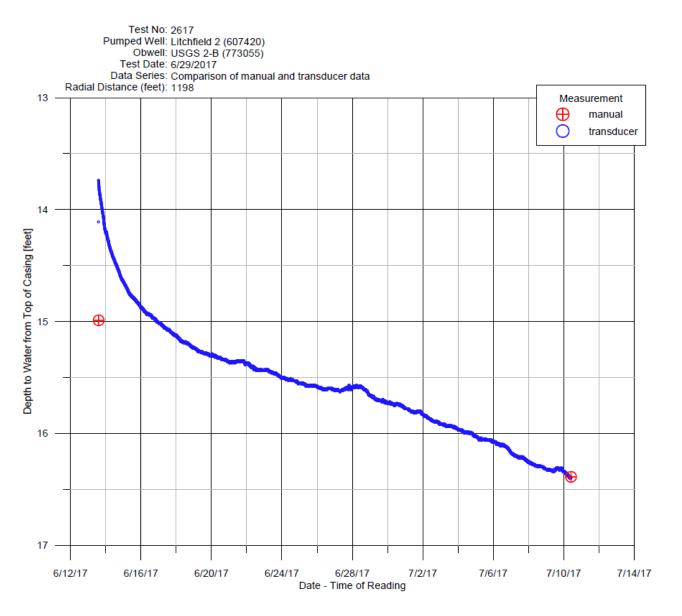


Figure 30. Depth to Water from Top of Casing at USGS 2-C (773054), Both Manual and Electronic Measurements

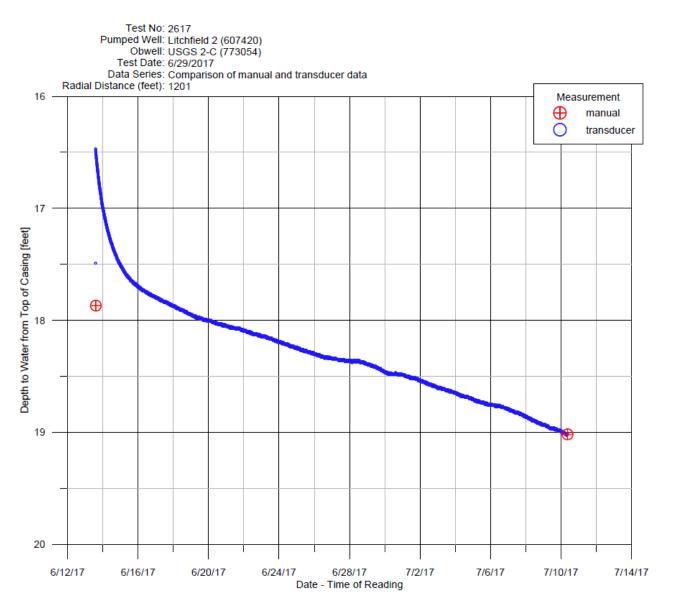


Figure 31. Depth to Water from Top of Casing at USGS 2-D (773053), Both Manual and Electronic Measurements

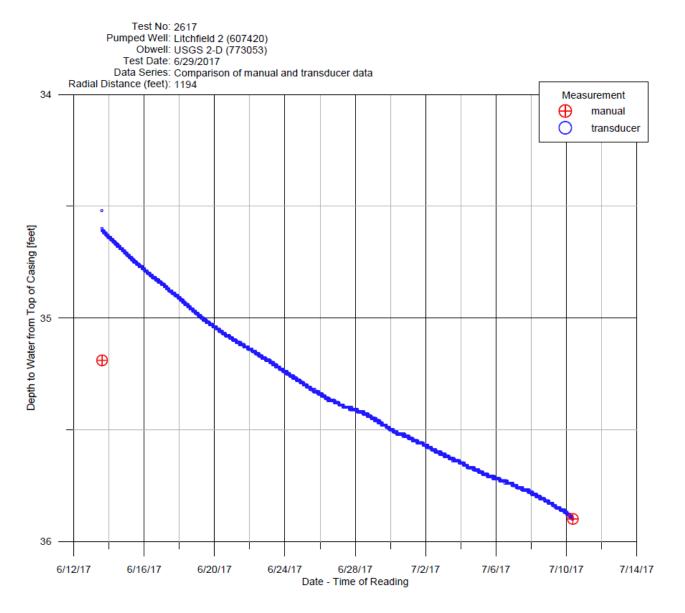


Figure 32. Depth to Water from Top of Casing at USGS 2-F (773051), Both Manual and Electronic Measurements

Test No: 2617 Pumped Well: Litchfield 2 (607420) Obwell: USGS 2-F (773051) Test Date: 6/29/2017

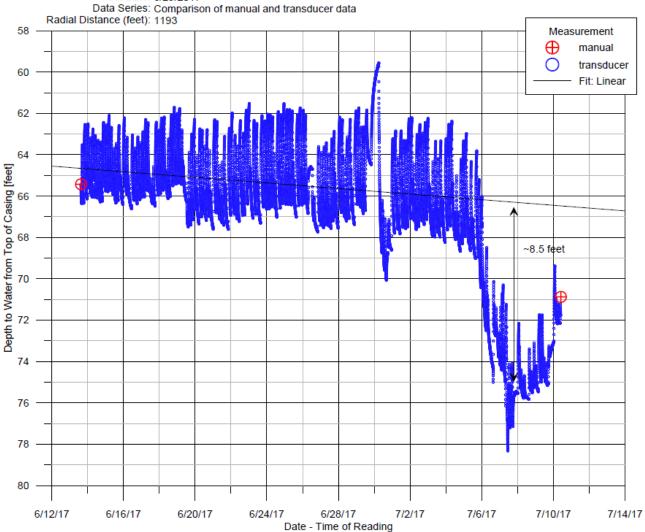


Figure 33. Depth to Water from Top of Casing at Desens Observation (800011), Both Manual and Electronic Measurements

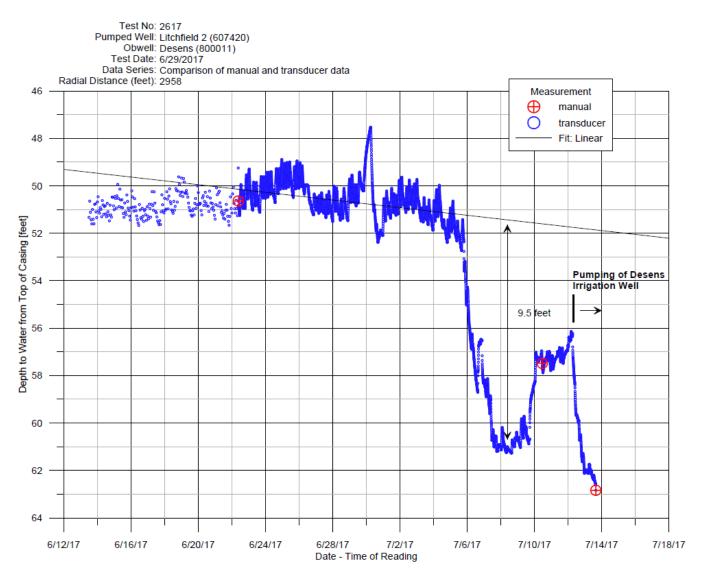


Figure 34. Groundwater elevation at Litchfield-2 and Nest 1

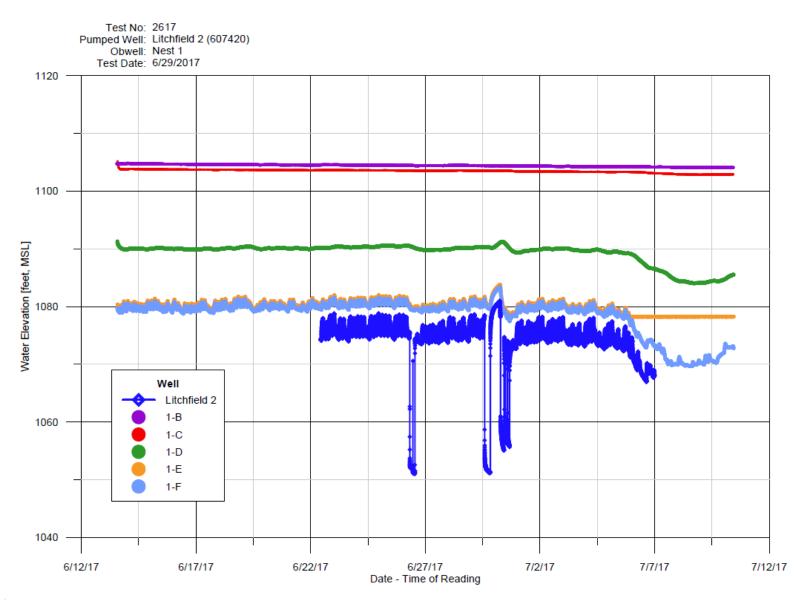
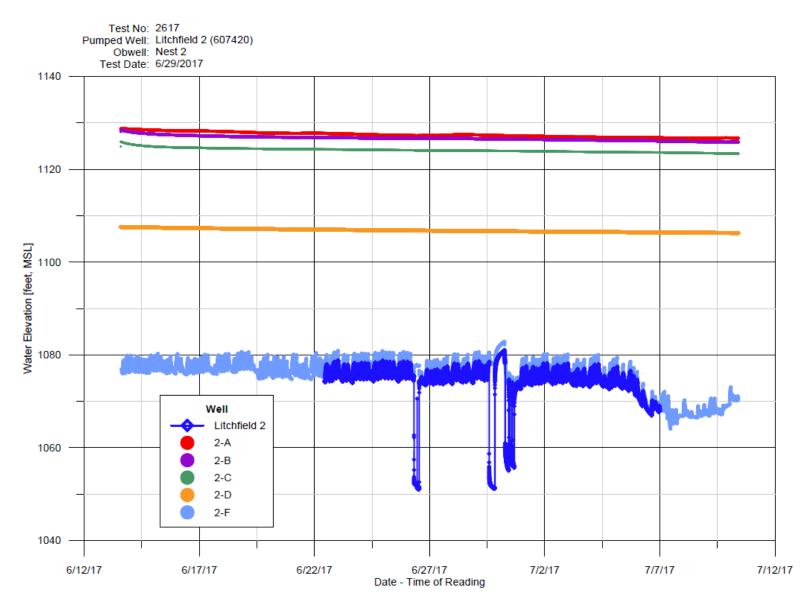


Figure 35. Groundwater elevation at Litchfield-2 and Nest 2



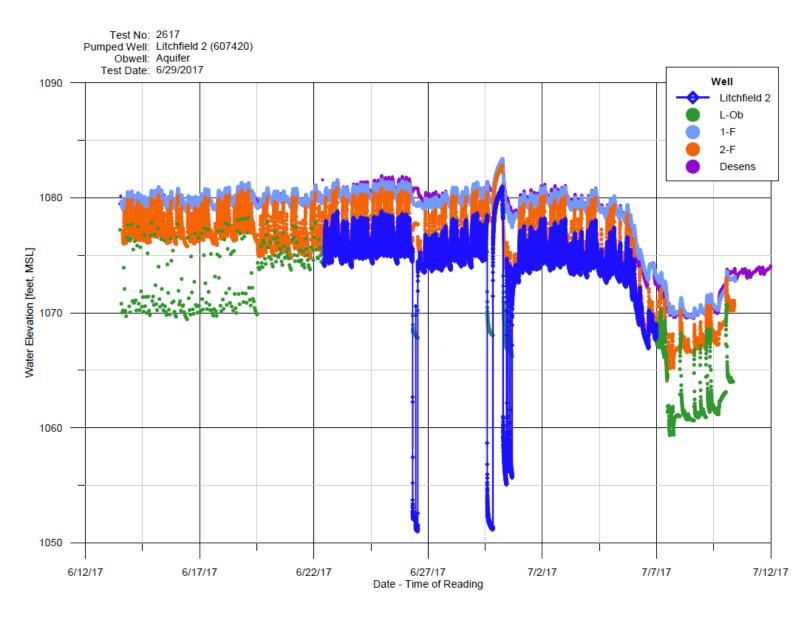


Figure 36. Groundwater elevation at Litchfield-2 and Observation Wells Constructed in Aquifer, All Data

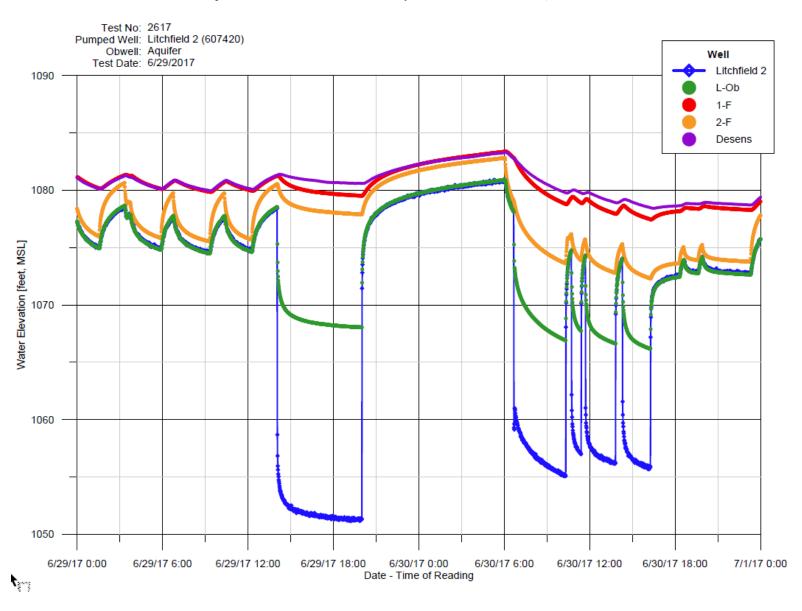


Figure 37. Groundwater elevation at Litchfield-2 and Observation Wells, Test Period

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

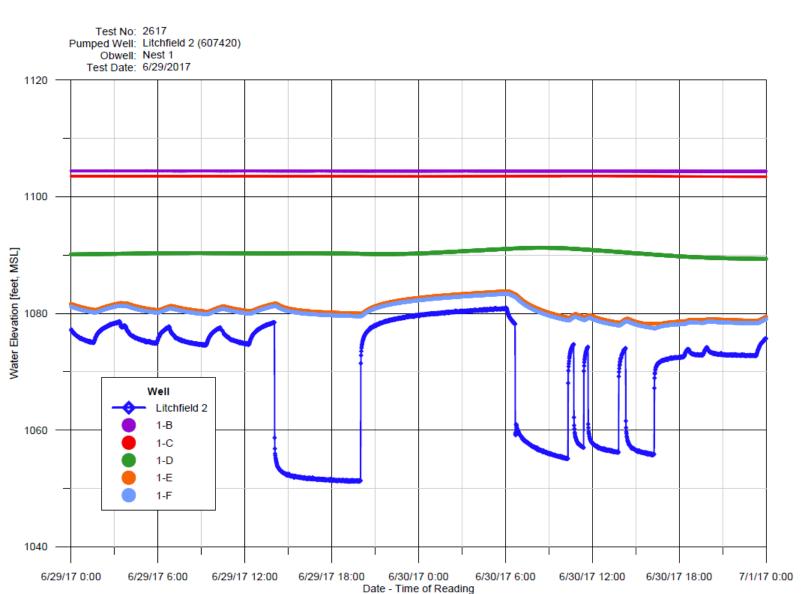
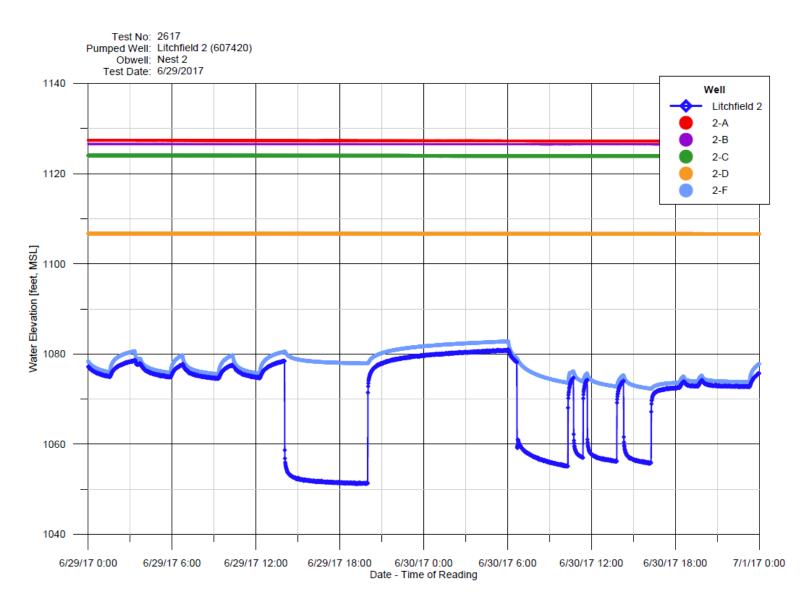


Figure 39. Groundwater elevation at Litchfield-2 and Nest 2, Test Period



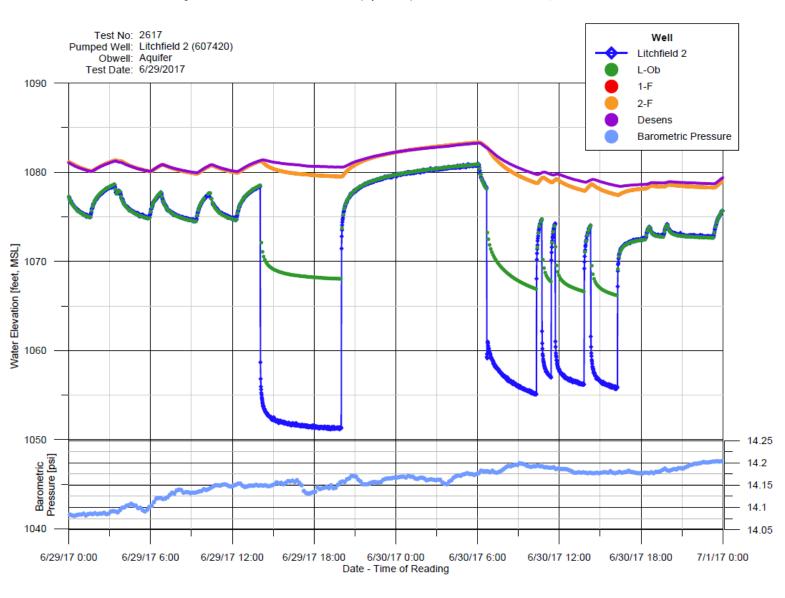


Figure 40. Groundwater Elevation in Aquifer Compared to Barometric Pressure, Test Period

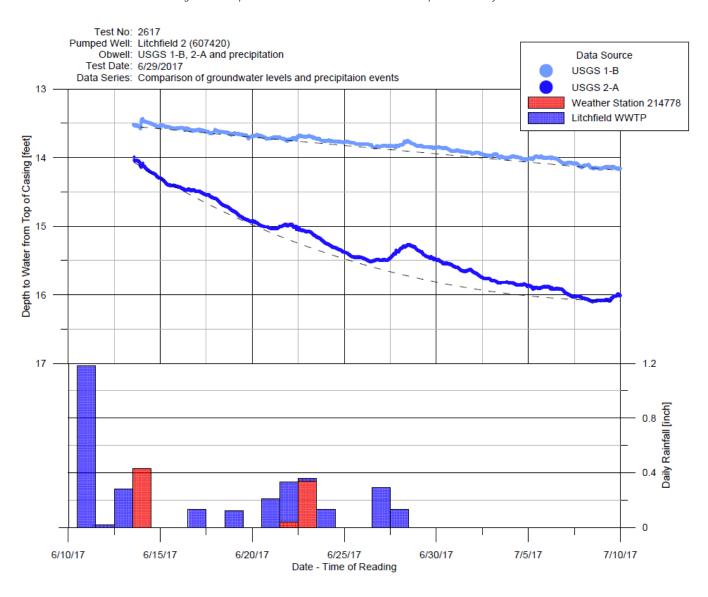


Figure 41. Depth to Water in Water-Table Wells Compared to Rainfall Events

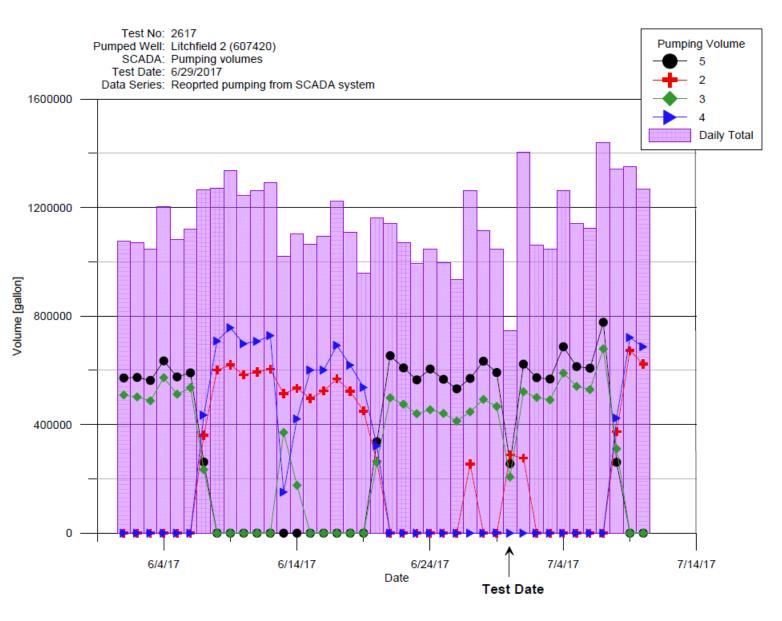


Figure 42. Daily Pumping Volume from Community Supply Wells, June 1, to July 10, 2017

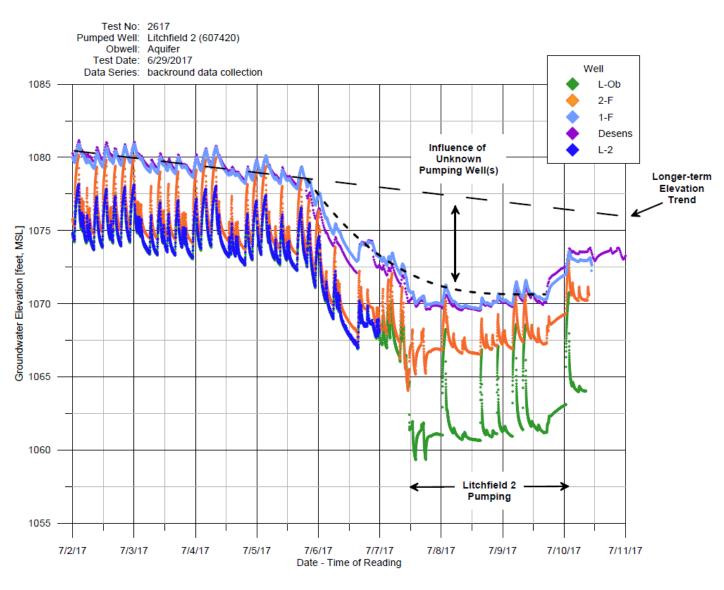


Figure 43. Expanded View of Groundwater Elevation in Aquifer Wells from July 2 to July 11, 2017

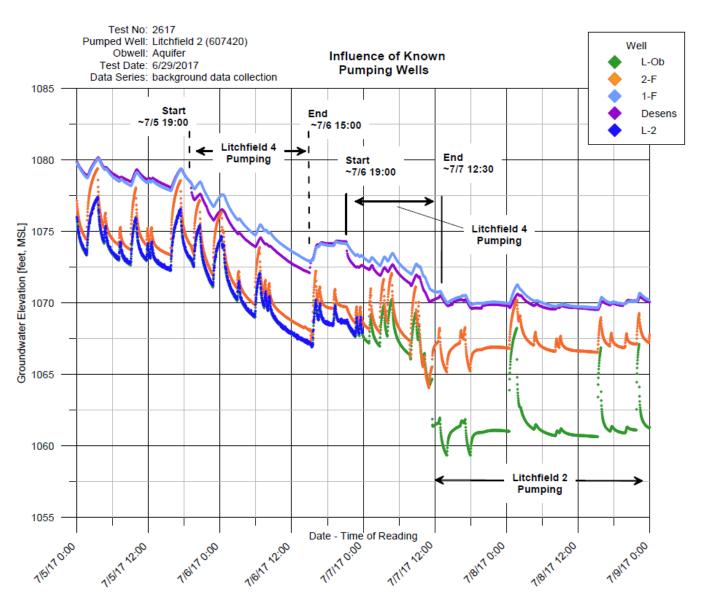


Figure 44. Local Effects of Community Supply Wells from July 5 to July 11, 2017

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

## Annual Variation in Groundwater Elevation at USGS 2-F (773051) and Association of Rainfall Events with Changes in Groundwater Elevation During the Summer of 2016 Data from: USGS and Western Regional Climate Center

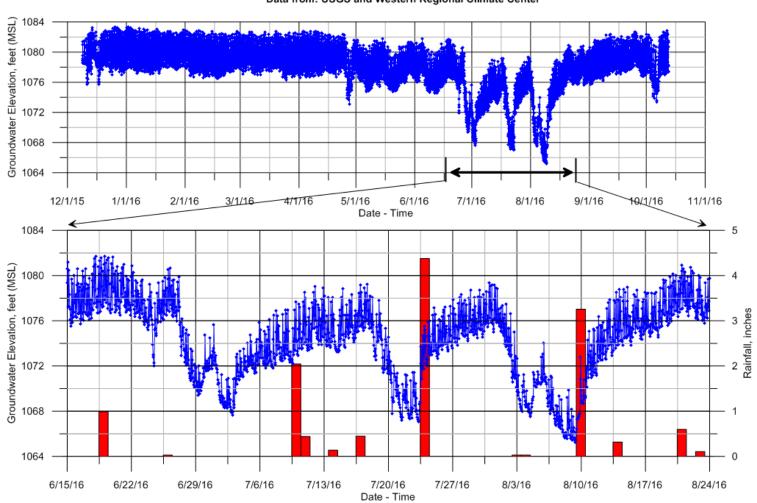


Figure 46. Well and Boring Report - Litchfield 2 (607420)

607420	-	itchfield	WEL	ESOTA DEP. L AND I Innesota Sta	BORING	G REPO		Entry Date Update Date	03/23/1999 06/16/2017
	Quad ID	125A		ininabola ola	inite cinq.			Received Date	•
Well Name Towns	hip Rang	e Dir Sect	on Subsecti	on.	Well Depth	1	epth Completed	Date W	ell Completed
LITCHFIELD 2 119	31	W 2	CDCDA	A	134 ft.	1	32 ft.	02/19/19	98
Elevation 1120 Elev	. Method	7.5 minute to	pographic map (+	/- 5 feet)	Drill Method	Non-specif	ied Rotary	Drill Fluid Bent	onite
Address					Use commi	unity supply(z	municipal)		Status Active
Contact 126 MAI	RSHALL AV	N LITCHFI	ELD MN 55355	i	Well Hydrofra	ctured?	Yes No	X From	To
	IELD MN 5	5355			Casing Type		_	Joint	
Stratigraphy Information	E	T- (A)	Color I	Tardness	Drive Shoe?		No X	Above/Below	
Geological Material CLAY	From 0	1 To (ft.) 24	BROWN	lardness	Casing Diame				Hole Diameter
CLAY	24	29	GRAY		12 in To	107 ff.	lbs/ft.		18 in. To 134 ft.
SAND & GRAVEL	29	35	BROWN						
CLAY	35	65	GRAY						
SAND & GRAVEL	65	71	BROWN						
CLAY	71	105	GRAY		Open Hole	From	ft.	То	ft.
SAND & GRAVEL	105	134	BROWN		Screen?		Type stainles		OHNSON
CLAY	134	134	GRAY		Diameter 12 in.	Slot/Gauze	Langth 25 ft.	Set 107 ft.	132 ft.
							20 11.	107 11.	132 11.
					Static Water	Level			
					42 ft.	land surfa	CO CO	Measure	02/19/1998
					Pumping Let	rel (below las	nd surface)		
					132 ft.	7.5 hrs.	Pumping at	1000 g	p.m.
					Wellhead Co	mpletion			
					Pidess adapter		(ST)		odel
					Casing I		ntal Wells and Bo	n. above grade	
					Grouting Inf	-	Well Grouted?	X Yes No	Not Specified
					Material			ount	From To
					neat cement		85	Sacks	0 ft. 87 ft.
					high solids b	entonite	50	Sacks	87 ft. 132 ft.
					V V.		Contamination		ft. ft.
						wn source of et	Direction		Туре
					Well disinfe	cted upon con	mpletion?	X Yes [	No No
					Pump	X Not 1	Installed D	ate Installed	
					Manufacturer'				
					Model Number		HP	Vol	
					Length of drop Abandoned	p pipe	ft Capacity	g.p.	Тур
					I	have any not in	use and not sealed	well(s)?	Yes X No
					Variance			_	
						_	the MDH for this we	:117	Yes X No
					Miscellaneou First Bedrock	15		Amifor	Quat. buried
					Last Strat	clay-gray		Depth to Be	
					Located by		esota Department	_	_
Remarks					Locate Method	1 Digiti	zation (Screen) - !	Map (1:24,000)	
MDH AQUIFER TEST, 20017					System		83, Zone 15, Meters		
					_	er Verification	Informatio	on from In	put Date 09/19/2000
					Angled Drill	Hole			
					Well Contra	rtor			
					Traut M.J.			71536	ROBBIE/DON
					Licensee B		Lic.	or Reg. No.	Name of Driller
Minnesot- W-UT	dan Da			607	420				Printed on 06/19/2017
Minnesota Well In	ner Veb	n't							HE-01205-15

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

Minnesota Unique Weil	144	County N	fooker		NESOTA DEP				Entry Date	03/22/2000
63207	7		atchfield	WEI	LL AND I	BOKINO	G REP	ORT	Update Date	03/10/2014
03207	,	Quad ID 1	25A		Minnesota Sta	tutes Chapt	er 1031		Received Date	
me n v			W. C .					46 1.1		310-1-1
Well Name LITCHFIELD 3	Townsh 119	ip Range 31	Dir Sect	on Subsec		Well Depth 140 ft.		Depth Completed 36 ft.	12/09/1	ell Completed
Elevation 112		Method		pographic map		Drill Method				
Address	o Elev.	Alethou	7.5 111111111111111111111111111111111111	hothadran mah	(1,1-3 100)			-	Drill Fluid Ben	Status Active
						Use comm				Status Active
Contact			NLITCHFE	11D MN 333	33	Well Hydrofra		Yes No	From	To
Well		ELD MN 55	333			Casing Type Drive Shoe?		No	Joint Above/Below	Welded
Stratigraphy Inf Goological Mater		From	To (ft.)	Color	Hardness				Above Desow	
TOP SOIL	_	0	2	BLACK		Casing Diame 12 in To		ight		Hole Diameter 18 in. To 140 ft.
CLAY		2	18	YELLOW			100 11. 1.	9.5 10151L		10 III. 10 140 II.
CLAY		18	98	GRAY						
DIRTY SAND		98	106	GRAY						
SAND		106	117	GRAY		n 17.1.			_	
SAND COARSE	R.	117	130	GRAY		Open Hole Screen? N	From	ft. Type stainles	To Make	ft. JOHNSON
SAND FINER		130	136	GRAY		Screen? Diameter	Slot/Gauze	Length	Set	JOIL 43014
CLAY		136	140	GRAY		12 in.	70	28 ft.	108 ft.	136 ft.
						Static Water	Level			
						43.6 ft.	mull		Measure	11/22/1999
						Pumping Let	ul /halour las	nd surface)		
						65.5 ft.	•	Pumping at	750 s	
								Fumping at	730 8	.p.m.
						Wellhead Co				(-1-1
						Pitless adapter Casing I		MONITOR IXI 12 is	( above grade	Iodel 7PS1214WBW
								ntal Wells and Bo		
						Grouting Inf	ormation	Well Grouted?	X Yes N	o Not Specified
						Material		Am	ount	From To
						neat cement		3	Cubic yards	12 ft. 98 ft.
						Nearest Kno fo		f Contamination Direction		T
						_	et cted upon cor		X Yes	Type □ No
						Pump			ate Installed	
						Manufacturer'				
						Model Numbe	ar .	HP	Vo	lt
						Length of dro	p pipe	ft Capacity	g.p.	Тур
						Abandoned				
							have any not i	n use and not sealed	well(s)?	Yes X No
						Variance		de Maria de de con	r	Yes X No
						Miscellaneou	-	the MDH for this we	aur .	145 K NO
						First Bedrock	-		Amifor	Quat. buried
						Last Strat	clay-gray	,	Depth to Be	
						Located by		esota Department		
Remarks GAMMA LOGGEI	10.5.1000	DV GRACE						SA Off (averaged)		
GAMMA LOGGEL	10-3-1999	DT SUMMII				System		083, Zone 15, Meters		
							er Verification		li .	put Date 09/19/2000
						Angled Drill	Hole			
						Well Contra				
						L.tp. Enter Licensee B		1:-	91686 or Reg. No.	VERDECK, D. Name of Driller
						Landing D		1.00.	rag. 110.	Anna of Dilling
					632	077				
Minnesota V	Well In	dex Repo	rt		0.52					Printed on 06/12/2017
										HE-01205-15

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

Manage College West Production	County	Mooker		NESOTA DEP.				Entry Date	03/22/2000
632078	Quad	Litchfield		L AND I			OKI	Update Date	03/10/2014
032070	Quad ID	125A	M	linnesota Sta	tutes Chapt	ter 1031		Received Dat	
W. I. V		W- 6			MV II N A				
Well Name Towns LITCHFIELD 4 119	hip Ran 31	ige Dir Seci W 2	ion Subsecti CABAC		Well Depth 159 ft.		Depth Complete 147 ft.	12/09/1	'ell Completed
	v. Method		pographic map (4		Drill Method	Non one			
Elevation 1149 Elec	v. Alethou	7.5 Handon II	dolladure mah (	(1-3 tool)				Drill Fluid Ben	Status Active
					Use comm		y(municipal)		Status Active
			ELD MN 55355	5	Well Hydrofra	ctured?	Yes No		To
	TELD MN	55355			Casing Type			Joint	Welded
Stratigraphy Information		T. (A)	C-1 1	Hardness	Drive Shoe?		No	Above/Below	
Geological Material TOP SOIL SILTY	Fro 0	ип 10(п.) 1	Color I BLACK	naroness	Casing Diame		Veight		Hole Diameter
SANDY CLAY/GRAVEL		10	BROWN		12 in. To	123 ft.	49.5 lbs./ft.		18 in. To 147 ft. 6.2 in. To 159 ft.
CLAY SANDY/PEBBLES			GRAY						0.2 m. 10 139 m.
SANDY CLAY/SAND	42	-	GRAY						
SANDY CLAY/PEBBLES	48	97	GRAY						
SANDY CLAY	97	113	BROWN	V.SOFT	Open Hole	From	£.	To	ft.
SANDY CLAY/PEBBLES	11	3 121	GRAY		Screen? Diameter	Slot/Gauz	Type stainle	ss Make Set	JOHNSON
SAND & GRAVEL	12	1 128	GRAY		12 in.	70	e Length 24 ft.	123 ft.	147 ft.
SAND & GRAVEL	12	8 136	GRAY			,,,	21 11	123 11.	147 11.
SAND & GRAVEL	13	6 146	GRAY		Static Water	Level			
SANDY CLAY/PEBBLES	14	6 150	GRAY		61.2 ft.	land sur	rface	Measure	12/08/1999
CLAY	15	0 159	GRAY						
						rel (below l	land surface)		
					77.8 ft.	21 hrs.	Pumping at	750 g	, p.m.
					Wellhead Co	mpletion			
					Pidess adapter				fodel 7PS1214WBW
					Casing l		12   X nental Wells and B	in. above grade	
					Grouting Inf	•	Well Grouted?		lo Not Specified
					Material			mount	From To
					neat cement		4.3		8 ft. 113 ft.
								•	
					Nearest Kno	wn Source	of Contamination		
					_	et	Direction		Туре
					Well disinfe			Yes Yes	No No
					Pump		ot Installed	Date Installed	
					Manufacturer  Model Numbe		HP	Vo	
					Length of dro		ft Capacity		Тур
					Abandoned	rre	- equally	DT-	-72
					Does property	have any no	t in use and not sealer	d well(s)?	Yes X No
					Variance				
					Was a variance	e granted fro	om the MDH for this v	vell?	Yes X No
					Miscellaneou	15			
					First Bedrock				Quat. buried
					Last Strat	clay-bn		Depth to Be	drock ft
Remarks					Located by Locate Metho		nnesota Departmen S SA Off (average)		
BOTTON 12 FT. OF HOLE G	ROUTED W	HIGH SOLIDS.			System		AD83, Zone 15, Mete		172 Y 5000196
					Unique Numb				nput Date 09/19/2000
					Angled Drill	Hole			
					Well Contra	ctor			
					L.tp. Enter			91686	VERDECK, D.
					Licensee B			. or Reg. No.	Name of Driller
NG	J D			632	078				Printed on 06/19/2017
Minnesota Well In	idex Kep	ort							HE-01205-15

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

Minnesota Unique Well Number	Country	Mooker	MI	NNESOTA DEF	ARTMENT O	F HEALTH		F-t D-t-		
County Modele WELL AN					BORING	G REPO	ORT	Entry Date	01/29/200	
/6175X Ouad Literation					atutes Chapt			Update Date 04/16/2015		
	Quad ID	1234			-			Received Date	01/21/200	19
I .	hip Ran	ge Dir Sect			Well Depth	D	epth Completed	Date Wel	l Completed	
LITCHFIELD 5 119	31	W 2	CABC	CA	165 ft.	16	51.5 ft.	10/30/200	8	
Elevation 1152 Elev	. Method	7.5 minute to	pographic map	(+/- 5 feet)	Drill Method	Non-specifi	ed Rotary	Drill Fluid Benton	nite	
Address					Use comm	unity supply(n	nunicipal)		Status	Active
Contact 126 MAI	RSHALL A	V NE LITCHE	TELD MN 55	3355	Well Hydrofra	ctured?	Yes No	X From	7-	
	IELD MN 5				Casing Type			Joint	To	
Stratigraphy Information					Drive Shoe?		No X	Above/Below		
Geological Material	From	m To(ft.)	Color	Hardness	Casing Diame				Hole Diamete	
TOPSOIL	0	1 '	BLACK			136. ft. 0	lbs/ft.		18 in To	
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		Open Hole	From	ft.	То	ft.	
SANDY CLAY	20	36	GRAY		Screen? Diameter	Slot/Ganze	Type stainless Length	Make JO	MINSON	
SANDY CLAY WITH	36	47	GRAY		12 in.	60	25 ft.	36.5 ft.	161.5 ft.	
SANDY CLAY WITH	47	121	GRAY				20 11			
SOFT SANDY CLAY	121	1 123	BROWN	SOFT	Static Water	Level				
SANDY CLAY WITH	123	3 125	GRAY		70.4 ft.	land surfac		Measure	08/12/2008	
COARSE SAND AND	123	5 128	VARIED							
SANDY CLAY	128	8 131	GRAY		Pumping Let	rel (below lan	d surface)			
SAND WITH CLAY	131	1 135	GRAY		88.5 ft.	24 hrs.	Pumping at	900 g.p	m.	
SAND SOME PEA ROCK	13:	144	GRAY	MEDIUM	Wellhead Co	mpletion				
FINER SAND	144		GRAY		Pidess adapter	manufacturer	MONITOR	L Mor	del 9PS121	4
COARSE SAND-	147		VARIED			Protection		. above grade		
GRAVEL	158		VARIED			•	ital Wells and Bo			
SANDY CLAY	163	2 165	GRAY		Grouting Inf	ormation		X Yes No		pecified
					Material		Amo		From To	
					neat cement		4.5	Cubic yards	10 ft. 12	6.5 ft.
					N		Contamination			
						wm Source of et	Direction			
					_	et cted upon con		X Yes	No	Туре
					Pump		-		0/30/2008	
					Manufacturer		RUNDFOS	are installed 1	W.30/2008	
					Model Number			10 Volt	460	
					Length of dro			_	yp Submers	able
					Abandoned					
					Does property	have any not in	use and not scaled	well(s)?	Yes	X No
					Variance					
					Was a variance	e granted from t	he MDH for this we	117	Yes	X No
					Miscellaneou	В				
					First Bedrock				uat. buried	_
					Last Strat	clay+sand		Depth to Bedr	ock	ft
Remarks					Located by Locate Methor		sota Department			
					System		A Off (averaged) 83, Zone 15, Meters		0 Y 500	0084
					1 -	er Verification	on, mount in, mounts			13/2008
					Angled Drill					
					W. B.C.					
					Well Contra			2167		
					LTP Enterp Licensee B		T-	2157 or Reg. No.	Name of D	
					La. ellisee D		Ldc.	on 200g, 140.	Annua of Di	
				76	1258					
Minnesota Well In	dex Rep	ort		/0-	200					on 06/12/2017
										HE-01205-15

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

Manage College Well (Vallot)	County Me	oker		NESOTA DEP				Entry Date	04/22/2003
607417	Quad Lite	hfield		LL AND I			OKI	Update Date	08/18/2014
007417	Quad ID 125	A.	1	Minnesota Sta	tutes Chapt	er 1031		Received Date	
Well Name Towns	in Passa	Dir Sect	ion Subsec	e	man nasa		Depth Completed	Data W.	ell Completed
Well Name Towns LITCHFIELD MW 119	31	W 2	CDCAL		Well Depth 130 ft.		127 ft.	12/18/19	•
Elevation 1123.2 Elev		Surveyed			Drill Method			Drill Fluid Bent	
Address		sarreyea			Use monito			Dim Pinn Deal	Status Active
					Well Hydrofra		V		
					Casing Type		Yes No	X From Joint	To
Stratigraphy Information					Drive Shoe?		No X	Above/Below	
Geological Material	From	To (ft.)	Color	Hardness	Casing Diamet	ter W	eight		Hole Diameter
SANDY CLAY	0	22	BROWN		2 in To		Ibs/ft.		6.5 in. To 130 ft.
CLAY	22	29	GRAY						
SAND & GRAVEL	29	37	BROWN						
CLAY	37	40	GRAY						
SAND	40	45	BROWN		Open Hole	From	£.	То	ft.
ROCK	45	47	BLK/WHT		Screen?		Type stainles		OHNSON
CLAY	47	72	GRAY		Diameter	Slot/Gauze	Length	Set	
SAND & GRAVEL	72	76	BROWN		2 in.	10	10 ft.	122 ft.	127 ft.
CLAY SAND & GRAVEL	76 107	107 130	GRAY BROWN						
SAIND & GICAVEL	107	130	DROWN		Static Water				
					40 ft.	land surf	ace	Measure	12/18/1997
					Pumping Lev	rel (below la	and surface)		
					Wellhead Co	mpletion			
					Pidess adapter	manufacturer	_	M	odel
					X Casing I			above grade	
						_	ental Wells and Bo		- N-6-3-1
					Grouting Info	ormanon	Well Grouted?	X Yes No	
					Material high solids be	it-	Am 7	ount Sacks	From To 3 ft. 120 ft.
					nigh solids o		,	Secas	3 IL 120 IL
					Nearest Kno	wn Source o	of Contamination		
					fe	et	Direction		Туре
					Well disinfer	cted upon co	mpletion?	Yes [	No
					Pump		Installed D	ate Installed	
					Manufacturer's		HP	***	
					Model Number Length of drop		ft Capacity	Vol	t Тур
					Abandoned	, Jule	Zi Capacity	g.p.	-15
						have any not	in use and not sealed	well(s)?	Yes X No
					Variance		4-15		7 Var. 107
					Was a variance Miscellaneou		n the MDH for this we	:117	Yes X No
					First Bedrock	-		Acuifor	Quat. buried
					Last Strat	sand +la	rger-brown	Depth to Bed	
P1-					Located by	Min	nesota Geological	Survey	
Remarks WELL OBS #1					Locate Method		tization (Screen) - l		
WELL OBS #1					System		D83, Zone 15, Meters		
					Unique Numbe		Into/GPS	from data In	put Date 10/22/1998
					Angled Drill	11006			
					Well Contrac	ctor			
					Traut M.J.			71536	ROBBIE & DON
					Licensee Br	usiness	Lic.	or Reg. No.	Name of Driller
Minney W.D.T.	J P			607	417				Printed on 06/19/2017
Minnesota Well In	uex repor								HE-01205-15
	_	_	_	_		_			

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

773062 Qua	nnty Mooker nd Litchfield nd ID 125A	WELL AND	PARTMENT OF HEALTH BORING REPORT  atutes Chapter 1031  Entry Date 08/14/2015  Update Date 10/20/2015  Received Date
LFO1-B 119		ABACBB	Well Depth Depth Completed Date Well Completed 25.27 ft. 25.27 ft. 06/12/2015
Elevation 1114.5 Elev. Met	thod LiDAR Im DEM (N	(NDNR)	Drill Method Auger (non-specified) Drill Fluid
Address			Use monitor well Status Active
	LL AV N LITCHFIELD N		Well Hydrofractured? Yes No X From To
	AV N LITCHFIELD MN 5		Casing Type Single casing Joint Glued
Strattigt ap hy Info?18601866OODA Geological Material	From To (ft.) Colo		Drive Shoe? Yes No X Above/Below
SAND, WELL SORTED	0 12 GRA		Casing Diameter Weight Hole Diameter 1.2 in. To 22.4 ft. 0.74 lbs/ft. 8.2 in. To 25.2 ft.
SAND WELLSORTED	12 14 GRA		12 III 10 22.7 II. 0.77 105/II. 82 III 10 25/2 II.
SAND, WELL SORTED,	14 19 GRA	Y SOFT	
SAND, MED. TO	19 25 GRA	Y SOFT	
			Diameter   Static Water Level   11 ft.   land surface   Measure   Model
			Nearest Known Source of Contamination foot Direction Type Well disinfected upon completion? Yes X No
			Pump Not Installed Date Installed  Manufacturer's name  Model Number HP Volt  Length of drop pipe fit 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 Aquifur Quat. Water  Last Strat sand+silt-gray Depth to Bedrock fit  Located by Minnesota Geological Survey
Remarks			Locate Method Digitization (Screen) - Map (1:24,000)
SEE DRILLERS LOG FOR DETAIL	ED INFORMATION.		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 1548 HUCKABY, J.  Licensee Business Lic. or Reg. No. Name of Driller
Minnesota Well Index	Report	77.	3062 Printed on 06/19/201 HE-01205-1

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

Minnesota Uniqu	se Well Number	Соп	ntv M	ooker	1	MINNESOTA DEI	PARTMENT (	OF HEALTH	I	Entry Date	08/14/2015	
773060 Quad Litchfield WELL AN							BORIN	G REP(	ORT	Update Date 10/20/2015		
11	3000	_	IID 12			Minnesota St	atutes Chap	ter 1031		Received Da		,
										Received D	ate	
Well Name		nship	Range			section	Well Depth		Depth Completed		Well Completed	
LFO1-C	119		31	W 11	AB	ACBB	53.1 ft.		3.1 ft.	06/12	/2015	
Elevation	1114.8 E	ev. Meti	ood	LiDAR 1m I	EM (MND	NR)	Drill Method	Auger (nor	n-specified)	Drill Fluid		
Address							Use monit	or well			Status	Active
Contact	126 M	ARSHA	LL AV	NLITCHFE	ELD MN S	55355	Well Hydrofra	ictured?	Yes No	X From	To	
Well	982 M	ILLER A	VNL	TCHFIELD	MN 5535	5	Casing Type	Single ca		Joint	Glued	
Strattigtraph							Drive Shoe?		No X	Above/Below		
Geological M			From	To (ft.)		Hardness	Casing Diame	ter We	ight		Hole Diameter	
SAND, WEI	LL SORTED	1	0	12	GRAY	SOFT		50.2 ft. 0.			8.2 in. To	
SAND WEL	LL SORT		12	14	GRAY	SOFT	1					
SAND, WEI	LL SORTED	L	14	19	GRAY	SOFT	1					
SAND, MEI	D. TO		19	22	GRAY	SOFT	1					
SAND, MEI	DIUM WELL	L	22	43	GRAY	SOFT						
SILT & CLA	AY WITH		43	53	GRAY	MEDIUM	Open Hole	From	ft.	То	ft.	
							Screen? Diameter	Slot/Gauze	Type slotted p Length	upe Annance Set	ENVIRONMEN	IAL
							1.2 in.	10	2.7 ft.	50.2 ft.	52.8 ft.	
							1	10	2.7	N.2 II.	72.0 IL	
							Static Water	Taval				
							12.5 ft.	land surfa	re.	Measure	08/17/2015	
							Pumping Le	vel (below lai	nd surface)			
							£.	1.9 hrs.	Pumping at	0.21	g.p.m.	
							Wellhead Co	ompletion				
							1	manufacturer			Model	
							X Casing		X 12 in	. above grade		
							At-grad	le (Environme	ntal Wells and Bor	ings ONLY)		
							Grouting Inf	formation	Well Grouted?	X Yes	No Not Sp	ecified
							Material		Amo	out	From To	
							bentonite		3.5	Sacks	3.5 ft. 4.7	
							concrete		2.5	Sacks	£. 3.5	ft.
									f Contamination			
							_	eet .	Direction	_ v	FFF 35	Туре
								cted upon cor	-	Yes	X No	
							Pump		Installed Da	ate Installed		
							Manufacturer		HP		Volt	
							Model Numb Length of dro		ft Capacity		Тур	
							Abandoned	p pipe	II Capacity	g.p.	*JP	
								v have any not i	n use and not sealed v	vell(s)?	Yes	X No
							Variance	, and any make				
								ce granted from	the MDH for this we	117	Yes X	No
							Miscellaneor					
							First Bedrock			Aquife	ar Ouat, buried	
							Last Strat		nd/silt/clay-gray	Depth to		ft
							Located by		esota Geological S	urvey		
Remarks				D) (1 T)			Locate Metho		ization (Screen) - N			
SEE DRILLE	RS LOG FOR	DETAIL	ED INFO	RMATION			System		083, Zone 15, Meters			
							_	er Verification	Informatio	n from	Input Date 08/1	14/2015
							Angled Drill	Hole				
							Well Contra	ctor				
								rical Survey		1548	HUCKAB	Y. J.
							Licensee B		Lic.	or Reg. No.	Name of Dri	
										_		
						77.	3060					ocuene:
Minneso	ota Well I	Index l	Repor	rt								06/19/2017
I						1		ı			F	IE-01205-15

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

Trigon   Trigon   Township   Range   Dir Section   Subsection   Subsection   Trigon   Township   Township   Range   Dir Section   Subsection   Trigon   Township	Minnesota Unique Well Number	County	Mooker		NESOTA DEP				Entry Date	08/14/2015
Well Name   Tourish   Range   Dis Section   Subsection   LPO1-D   119   31   W 11   ARACBB   15.5 2.   To 77.2 ft.   Soft   Dupth Completed   Dust Well Completed   Dis Well Co	773050			WEL	L AND	BORING	G REPO	ORT	•	
Well Name Yownship Range Dr Section Subsection LFO1-D 119 31 W 11 ABACEB LFO1-D 120 SAPA Well LOOR INDIA INDIA HOLM SOND SUBSE Well SQL MILLER AV NILTCHFELD MOY 53355 Will SQL MILLER AV NILTCHFELD	113039	_	125A	Λ	Linnesota Sta	itutes Chapi	ter 1031		-	
EROSE					_					
Delit Method   Liddar In DEM (ADDAR) in DEM (ADDAR)		•	-							•
Discrete   126 MARSHALL AV NLITCHFEELD MN 53355   Well   962 MILLER AV N LITCHFEELD MN 53355   Well   964 MILLER AV N LITCHFEELD MN 53555   Well   964 MILLER AV N LITCHFEELD MN 53555   Well   964 MIL										013
Contact   126 MARSHALL AV N LITCHFIELD MN 55355   Wolf   System		v. Method	LiDAR 1m1	DEM (MNDNR)	1			r-specified)	Drill Fluid	
SEED SMILLER AV M LITCHSPIELD MON 59355  Caming Typy Single casing Joint Control of the Control	Address					Use monito	or well			Status Active
Device Share  Ver   No   K   Above/Below					55	Well Hydrofra	ctured?	Yes No	X From	To
Society   Material   From   To (pt)   Color   Hurbases   SAND, WELL SONTE   12   14   GRAY   SOFT   SAND, WELL SONTE   12   14   GRAY   SOFT   SAND, WELL SONTE   19   22   GRAY   SOFT   SAND, WELL SONTE   19   22   GRAY   SOFT   SAND, MEDIUM WELL   22   43   GRAY   SOFT   SAND, MEDIUM WELL   22   43   GRAY   SOFT   SAND, WELL SONTE   24   37   6   GRAY   SOFT   SAND, MEDIUM WELL   25   43   GRAY   SOFT   SAND, MEDIUM WELL   27   47   76   GRAY   MEDIUM   Street   Type slotted pips   Make   ENVIRONMENTAL   Distance   Stot Grams   Length   Set   12 in . 10   27   ft   73.4   ft   75   ft   Static Water Level   23.5   ft   land surface   Measure   08/17/2015								_		Glued
SAND, WELL SORTED									Above/Below	
SAND WELL SORT 12 14 GRAY SOFT SAND, MEDIUM WELL 14 19 GRAY SOFT SAND, MEDIUM WELL 22 43 GRAY SOFT SAND, MEDIUM WELL 22 43 GRAY SOFT SAND, MEDIUM WELL 22 43 GRAY MEDIUM SETUP SAND, MEDIUM WELL 22 43 GRAY MEDIUM SETUP SAND, MEDIUM 27 ft. 75 ft. Type dotted pips Make ENVIRONMENTAL Dismoster Dotted State Setup Set	_									
SAND, MEDILM WELL  14 19 GRAY SOFT SAND, MEDIUM WELL  22 43 GRAY SOFT SAND, MEDIUM WELL  23 43 GRAY SOFT SAND, MEDIUM WELL  24 5 GRAY SOFT SAND, MEDIUM WELL  25 6 GRAY SOFT SAND, MEDIUM WELL  26 7 Type Identalpsys Make ENVISIONMENTAL Diamater ShotGrass Length  Series* Kill Type Identalpsys Make ENVISIONMENTAL Diamater ShotGrass Length  Series* Kill Type Identalpsys Make ENVISIONMENTAL Diamater ShotGrass Length  Series* Kill Type Identalpsys Make ENVISIONMENTAL  Statis Water Level  25 8 ft. Int 10 C 2.7 ft. 73.4 ft. 75 ft.  Statis Water Level  25 8 ft. Int surface  Pumping Level (below land surface)  ft. 3.6 lbs. Pumping at 0.2 gp.m.  Wellbrad Completion  Well Grant Statis  Media United Statis						1.2 m. To	72.4 ft. 0.	/4 lbs/ff.		8.2 m. To 75.5 ft.
SAND, MEDIUM WELL 22 43 GRAY SOFT SOLT & CLAY WITH 43 76 GRAY MEDIUM  STEER CLAY WITH 43 76 GRAY MEDIUM  Department of the company of the class of t	1									
SAND, MEDIUM WELL 22 43 GRAY MEDIUM  Silt & CLAY WITH 43 76 GRAY MEDIUM  Silt & CLAY WITH 12 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1										
Static CLAY WITH 19 19 (ShAT MELDION SECRET   Type aldered pipe Make ENVENONMENTAL Diameter   Tolk Computer   Type   Type	SAND, MEDIUM WELL	22	43	GRAY	SOFT					
Diameter SlockGames Longth Set  1.2 in. 10 2.7 ft. 73.4 ft. 75 ft.  Static Water Level 2.8 ft. land surface Measure 06/17/2015  Pumping Level (below land surface) ft. 3.6 lar. Pumping at 0.2 gp.m.  Wellbead Completion Poles adapter smanfacturer Expande (Environmental Wells and Borings ONLT)  Growing Information Well Greater Very No. 10 No. 10 Not Specified Material Model  Expande (Environmental Well sund Borings ONLT)  Growing Information Well Greater Very No. 10 No. 10 Not Specified Material	SILT & CLAY WITH	43	76	GRAY	MEDIUM					
1.2 in. 10							Slot/Green			ENVIRONMENTAL
Static Water Level  21.8 ft. land surface  Pumping Level (below land surface) ft. 3.6 lars. Pumping at 0.2 gp.m.  Wellhead Completion Pittess adapter manufacturer								_		75 ft.
25.8 ft. land surface Measure 08/17/2015  Pamping Level (below land surface) ft. 3.6 lar. Pumping at 0.2 g.p.m.  Wellbead Completies Piles adapter manufacturer Piles adapter manufacturer Regards (Environmental Walls and Borings ONLY) Greening Information Well Ground? Yes No Not Specified Maturial Assembly Section To Continue Assembly Section Type Well disinfaced upon completion? Yes No Pemp Not Installed Data Installed Manufacturer's name Model Number HP Volt Length of drop pipe ft Capacity g.p. Typ Abandoned Does proporty have says not in use and not sealed well(s)? Yes No Variance Was a variance guarted from the MDH for this well? Yes No Miscellaneous First Bodotock Last Stort public years of the Member of Content Section Section Information from Imput Date O8/14/2015 Angled Drill Hole  Mell Centractor US Geological Survey Licensee Business Lic. or Neg. No. Name of Driller Well Centractor US Geological Survey Licensee Business Lic. or Neg. No. Name of Driller  Minnescota Well Index Report										-
Pumping Level (below land surface) ft 3.6 lar. Pumping at 0.2 g.p.m.  Wellhead Completion Piless adapter manufacturer Consideration At sgrade (Environmental Well and Borings OUL) Growting Information Well consult? My fix No Not Specified Material Control of the fixed Discisses Well dissinfected upon completion?  Nearest Known Source of Contamination for Discisses Well dissinfected upon completion? Yes No Pemp Not Installed Manufacturers name Model Number HP Volt Length of drop pipe ft Capacity g.p. Typ Abandoned Does properly have say not in use and not scaled well(s)?  Variance Well avaisance guared from the MDH for this well? Yes No Miccellaneous Fine Bostock Last Stret pubbly sand/ult/clay-gray Depth to Bedrock ft Located by Minnesotta Geological Survey Locate Method Disgination (Screan) - Map (1.24,000) Systum UM-NADRI, Zone 13, Menters Angled Drill Hole  Well Contractor US Geological Survey 1548 HUCKABY, I. Angled Drill Hole  Minnesota Well Index Report  Minnesota Well Index Report						Static Water	Level			
### Wellbead Completion   Wellbead Completion   Wellbead Completion   Pitters adapter manufacturer   Model						25.8 ft.	land surfa	ce .	Measure	08/17/2015
Wellhead Completion						Pumping Le	vel (below las	ıd surface)		
Piless adapter manufacturer    Model						£.	3.6 hrs.	Pumping at	0.2 g	; p.m.
Casing Protection						Wellhead Co	ompletion			
Ar-grada (Environmental Wells and Borings ONLY)  Growting Information Well Growth   No   Not Specified  Material Amount From To  cuttings 5 4 ft. 70.2 ft. concrets 2.5 ft. 4 ft.  Nearest Known Source of Contamination  feet Direction  Well distincted upon completion?   Yes   No  Pump   Not Installed Data Installed  Manufacture's name  Model Number HP Volt  Length of drop pipe ft. Capacity g.p. Typ  Abandoned  Does properly have say not in use and not scaled well(s)?   Yes   No  Wise a variance granted from the MDH for this well?   Yes   No  Miccellances:  Finst Bedreck  Last Strat   pubbly sand/ult/clay-gray Depth to Bedreck   ft  Located by Minnesota Geological Survey  Locate Method   Digritzation (Screen) - Map (1.24,000)  Systam UTM - NADR3, Zene 15, Meters X 379654 Y 4999334  Unique Number Verification   Information from lapat 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								-		fodel
Grouting Information Well Crossed? Yes No Not Specified Material Amount From To cuttings 5 5 4 ft. 70.2 ft. concrete 2.5 ft. 4 ft. Nearest Known Source of Contamination feet Direction 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 properly lave sary not in use and not sealed well(s)? Yes No Variance Was a variance granted from the MDH for this well? Yes No Miccellaneous First Bedrock Last Strest pubbly sand/ult/clay-gray Depth to Bedrock Last Strest pubbly sand/ult/clay-gray Depth to Bedrock Cast Strest pubbly sand/ult/clay-gray Depth to Bedrock Cast Strest pubbly sand/ult/clay-gray Depth to Bedrock ft Located by Minnesorta Geological Survey Locate Method Digitization (Scroun) - Map (1:24,000) System UTM-NADSR, Zone 15, Meters X 379654 Y 4999334 Unique Number Verification Information from Imput Date 08/14/2015 Angled Drill Hole  Well Contractor US Geological Survey 1548 HUCKABY, J. Licensee Business Lic. or Reg. No. Name of Driller  Minnesorta Well Index Report										
Material Amount From To cuttings 5 4 ft. 70.2 ft. cuttings 5 4 ft. 70.2 ft. 4 ft. 70.2 ft. 70										n Not Specified
cuttings 5 4 ft. 70.2 ft. concrete 2.5 ft. 4 ft. 70.2 ft. Nearest Known Source of Contamination foot Direction Well disinfected upon completion? You X No Pump Not Installed Date Installed Manufacturer's name Model Number HP Volt Length of drop pipe ft Capacity g.p. Typ Abandoned Does properly have any not in use and not scaled well(s)? You X No Variance Was a variance granted from the MDH for this well? You X No Miccellaneous: First Bodrock Last Strat publishy sand/silt/clay-gray Depth to Bedrock ft Located by Minnesota Geological Survey Located by Minnesota Geological Survey Located Method Digitization (Screan) - Map (1:24,000) System UTM-NADR, Zone 13, Meters X 379654 Y 4999334 Unique Number Verification Information from Input Date 08/14/2015 Angled Drill Hole  Well Contractor US Geological Survey Licenses Business Lic. or Reg. No. Name of Drillar  Minnesota Well Index Report						_				
Nearest Known Source of Contamination  fiset    Direction   Direction   Type   Well disaffected upon completion?   Yes   No						ı				
Well distinfected upon completion?   Yes   X   No						concrete		2.5		ft. 4 ft.
Well disimfected upon completion?   Yes   X   No						Nagrant Kno	arm Saurce of	Contemination		
Well disinfected upon completion? Yes No  Pump X Not Installed Date Installed  Manufacturer's name  Model Namber HP Volt  Length of drop pipe ft Capacity g.p. Typ  Abandoned  Does property have any not in use and not scaled well(s)? Yes X No  Variance  Was a variance granted from the MDH for this well? Yes X No  Miccellaneous  First Bedrock  Last Strast pebbly sand/ulit/clay-gray Depth to Bedrock ft  Located by Minnesota Geological Survey  Located Method Digitization (Screen) - Map (1:24,000)  System UTM - NADRS, Zone 15, Moters X 379654 Y 4999334  Unique Number Verification Information from Input Date 08/14/2015  Angled Drill Hole  Well Contractor  US Geological Survey  US Geological Survey  Lic. or Reg. No. Name of Driller  Minnesota Well Index Report										Type
Manufacturer's name  Model Number HP Volt Length of top pipe ft Capacity g.p. Typ  Abandomed 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 No  Miscellance First Bednock Last Stret pubbly sand/silt/clay-gray Depth to Bedrock ft Leasted by Minnesota Geological Survey Located by Minnesota Geological Survey Locate Method Digitization (Screan) - Map (1:24,000) System UTM - NADRS, Zone 15, Meters X 379654 Y 49999334 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						Well disinfe	cted upon con	mpletion?	Yes	
Manufacturer's name  Model Number 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 Last Street public sand/silt/clay-gray Depth to Bedrock ft Located by Minnesota Geological Survey Located the Model Digitization (Screan) - Map (1:24,000) System UTM - NADRS, 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						Pump	X Not 1	Installed Da	ate Installed	
Length of drop pipe ft Capacity g.p. Typ  Abandoned  Does property have any not in use and not sealed well(s)? You No  Variance  Was a variance granted from the MDH for this well? You No  Miscellaneous  First Bedrock  Last Strat pabbly 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  Ampled Drill Hole  Well Contractor  US Geological Survey 1548 HUCKABY, J.  Licensee Business Lic. or Rag. No. Name of Driller  Minnesota Well Index Report						Manufacturer				
Abandoned  Does property have any not in use and not scaled well(s)?  Yes X No  Variance  Was a variance granted from the MDH for this well?  Yes X No  Miscellaneous  First Bedrock  Last Street publicly sand/silt/clay-gray Depth to Bedrock ft  Located by Minnesota Geological Survey  Locate Method Digitization (Screen) - Map (1:24,000)  System UTM - NADR3, 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									Vo	
Does properly have any not in use and not sealed well(s)?							p pipe	ft Capacity	g.p.	Тур
Variance Was a variance granted from the MDH for this well?  Yes X No  Miscellaneous First Bedrock Last Street publicly sand/silt/clay-gray Depth to Bedrock ft Located by Minnesota Geological Survey Locate Method Digitization (Screen) - Map (1:24,000) System UTM - NADR3, 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							have any not in	use and not scaled v	well(s)?	Yes X No
Miscellaneous First Bedrock Last Strat pubbly sand/silt/clay-gray Depth to Bedrock ft Located by Minnesota Geological Survey Locate Method Digitization (Scrown) - Map (1:24,000) Systam 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						Variance				
First Bedrock Last Strat publicy sand/silt/clay-gray Depth to Bedrock ft Located by Minnesota Geological Survey Locate Method Digitization (Scroon) - 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							-	the MDH for this we	117	Yes X No
Lest Strat pubbly sand/silt/clay-gray Depth to Bedrock ft Located by Minnestota Geological Survey Locate Method Digitization (Screen) - Map (1:24,000) System UTM - NADE3, Zene 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							15		Amifor	Oust buried
Remark:  SEE DRILLERS LOG FOR DETAILED INFORMATION.  Locate Method Digitization (Scroon) - Map (1:24,000)  System UTM - NAD83, Zene 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							pobbly sa	nd/silt/clav-grav		
Locate Method Digitization (Screen) - Map (1:24,000)  System UTM - NAD83, Zone 15, Meters X 379654 Y 4999334  Unique Number Verification Information from Imput 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										_
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  773059  Printed on 06/19/2017	1	-	TODA ( ) TO ( )				d Digiti	zation (Screen) - N	Map (1:24,000)	
Angled Drill Hole  Well Contractor US Geological Survey 1548 HUCKABY, J. Licensee Business Lic. or Reg. No. Name of Driller  773059  Printed on 06/19/2017	SEE DRILLERS LOG FOR D	ÆTAILED I	RECHEMATION.							
Well Contractor US Geological Survey 1548 HUCKABY, J. Licensee Business Lic. or Reg. No. Name of Driller  773059 Printed on 06/19/2017						_		Informatio	on from 1	put Date 08/14/2015
US Geological Survey 1548 HUCKABY, J. Licensee Business Lic. or Reg. No. Name of Driller  773059 Printed on 06/19/2017						Angled Drill	Hole			
US Geological Survey 1548 HUCKABY, J. Licensee Business Lic. or Reg. No. Name of Driller  773059  Printed on 06/19/2017										
US Geological Survey 1548 HUCKABY, J. Licensee Business Lic. or Reg. No. Name of Driller  773059  Printed on 06/19/2017						Well Contro	ctor			
Licensee Business Lic. or Reg. No. Name of Driller  773059  Printed on 06/19/2017									1548	HUCKABY, J.
Minnesota Well Index Report								Lic.		
Minnesota Well Index Report										
Minnesotta Well Index Report	Minnesote Wall I	der P	nont.		773	059				Printed on 06/19/2017
	Minnesota Well II	idex Kej	ort							

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

Minnesota Unique W	ell Number	County	Mooker		ESOTA DEP				Entry Date	08/14/2015
5520			Litchfield	WEL	L AND I	BORIN	G REPO	ORT	•	
7730	158	Quad ID		M	innesota Sta	itutes Chap	ter 1031		Update Date	
		Quad ID	1234			_			Received Da	te
Well Name	Tow	nship Ra	nge Dir Sect	tion Subsecti	on.	Well Depth	1	Depth Completed	Date V	Vell Completed
LFO1-E	119	31	W 11	ABACBI	3	95.3 ft.	9	5.28 ft.	06/10/2	2015
Elevation 11	114.5 E	lev. Method	LiDAR 1m1	DEM (MNDNR)		Drill Method	Auger (nor	ı-specified)	Drill Fluid	
Address						Use monit	or well			Status Active
Contact	126 M	ARSHALL	AV N LITCHFI	ELD MN 55355		Well Hydrofr	actured?	Yes No	From	To
Well	982 M	ILLER AV 1	LITCHFIELD	MN 55355		Casing Type	Single ca	sing	Joint	
				VIEW MN 5511		Drive Shoe?	Yes	No X	Above/Below	
Geological Mat					Iardness	Casing Diam	eter Wei	ight		Hole Diameter
SAND, WELL			12		OFT	1.2 in. To	92.4 ft. 0.	74 lbs/ft.		8.2 in.To 95 ft.
SAND, WELL					OFT					
SAND, MEDIU					OFT					
SAND, MED. 1		19			OFT					
SAND, MEDIL					OFT	Open Hole	From	ft.	То	ft.
SILT & CLAY	WITH	43	95	GRAY S	FT-HRD	-	X	Type slotted p		ENVIRONMENTAL
						Diameter	Slot/Gauze	Length	Set	
						1.2 in.	10	2.7 ft.	92.4 ft.	95 <u>ft</u> .
						Static Water	Level			
						36.3 ft.	land surfa	CO CO	Measure	08/17/2015
						Pumping Le	vel (below lar	nd surface)		
						£.	11. hrs.	Pumping at	0.28	g.p.m.
						Wellhead C	•			
							r manufacturer	197		Model
						X Casing		I2 in ntal Wells and Bor	above grade	
						Grouting In				No Not Specified
						Material		Amo		From To
						bentonite		7	Sacks	4 ft. 89.5 ft.
						concrete		2.5	Sacks	£.4 £.
						Nearest Kn	own Source of	Contamination		
							oot	Direction		Туре
							ected upon cor		Yes	X No
						Pump		Installed Da	ste Installed	
						Manufacture		170		
						Model Numb		HP Country		olt T
						Length of dre Abandoned	ib bibe	ft Capacity	g.p.	Тур
						Does propert	y have any not it	n use and not sealed v	vell(s)?	Yes X No
						Variance Was a varian	ce granted from	the MDH for this wel	17	Yes X No
						Miscellaneo	us			
						First Bedrock			Aquifer	Quat. buried
						Last Strat	pebbly sa	nd/silt/clay-gray	Depth to B	edrock ft
Remarks						Located by		esota Geological S	-	
SEE DRILLER L	OG EOR I	DETAILED IN	FORMATION			Locate Metho		zation (Screen) - N		
			0101011			System Unione Mont		983, Zone 15, Meters Informatio		
						_	ber Verification	Intermatio	n trom	Input Date 08/14/2015
						Angled Dril	i riote			
						Well Contra	ctor			
						l	zical Survey		1548	HUCKABY, J.
						Licensee I		Lic. (	or Reg. No.	Name of Driller
10	***				773	058				Printed on 06/19/2017
Minnesota	Well	index Kej	port							HE-01205-15

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

Minnesota Unique W	es reamour	County	Mooker		NESOTA DEP				Entry Date	08/14/2015	
7730	57	Quad	Litchfield	WEL	L AND 1	BOKIN	G REPO	OKT	Update Date	10/22/2015	
1130	131	Quad ID	125A	Λ	dinnesota Sta	itutes Chap	ter 1031		Received Dat		
Well Name	Townsh 119	uip Ran 31	ige Dir Sect W 11	ion Subsect ABACE		Well Depth 130 ft.		Depth Completed 27.46 ft.		Tell Completed	
LFO1-F	119 114.7 Elev.					I			06/15/2	013	
Elevation 11 Address	17./ Elev.	Method	LiDAR Im I	DEM (MNDNR)	)		Auger (nor	r-specmed)	Drill Fluid	F A	ctive
						Use monit				Status A	cuve
Contact			V N LITCHFI		55	Well Hydrofra		Yes No		To	
Well			LITCHFIELD		110	Casing Type Drive Shoe?		No X	Joint Above/Below	Glued	
Stratigraphy In Geological Mat		Fre			Hardness				ADOVE DESOW	TT-1- TV	
WELL SORT, S		0	12	GRAY	SOFT	Casing Diame	118 ft. 1.			Hole Diameter 8.2 in. To 130	0 0
SAND WELL S		12	14	GRAY	SOFT						
SAND, MEDIU	M WELL	14	19	GRAY	SOFT						
SAND, MED. 1	то	19	22	GRAY	SOFT						
SAND, MEDIU	M WELL	22	43	GRAY	SOFT					_	
SILT & CLAY	W/ SAND	43	98	GRAY	SFT-HRD	Open Hole	From	ft. Type slotted p	To Make	ft. ENVIRONMENTA	1
SAND & GRA	VEL,	98	130	GRAY	MEDIUM	Screen? Diameter	Slot/Gauze	Length	Set		_
						1.9 in.	20	9.6 ft.	118 ft.	127.4 ft.	
						Static Water	Level				
						36.6 ft.	land surfa	ce	Measure	08/17/2015	
						Pumping Le	vel (below lar	nd surface)			
						£.	2.9 hrs.	Pumping at	1.11 g	p.m.	
						Wellhead Co	ompletion				
							r manufacturer	_	N	fodel	
						X Casing	Protection		. above grade		
						Grouting Inf	_	utal Wells and Bor Well Grouted?		lo Not Speci	£2
						Material	отшанов	Ame		From To	mod
						bentonite		9	Sacks	3.4 ft. 95	ft.
						concrete		2.5	Sacks	ft. 3.4	ft.
						N . T					
							own Source of out	Contamination Direction			T
						_	ected upon con		Yes	X No	Туре
						Pump		-	ate Installed		
						Manufacturer					
						Model Numb	er	HP	Vo	olt	
						Length of dro	p pipe	ft Capacity	g.p.	Тур	
						Abandoned					
							y have any not i	use and not sealed	well(s)?	Yes X	No
						Variance Was a varian	ce granted from	the MDH for this we	117	Yes X	No
						Miscellaneo	05				
						First Bedrock				Quat. buried	
						Last Strat	sand +lar		Depth to Bo	edrock	ft
Remarks						Located by Locate Metho		esota Geological S	•		
SEE DRILLERS	LOG FOR DE	TAILED II	FORMATION.			System	_	zation (Screen) - I 83, Zone 15, Meters		654 Y 499933	12
GAMMA & EM	INDUCTION	LOGGED 6	-24-2015, LOGG	ED FOR USGS.			er Verification	Informatio		nput Date 08/14/	
						Angled Drill	Hole				
						-					
						Well Contra	ctor				
							ical Survey		1548	HUCKABY,	
						Licensee B	usmoss	Lic.	ar Reg. No.	Name of Drille	
					553	057					
Minnesota	Well Inc	dex Rer	oort		773	057				Printed on 0e	6/19/2017
										HE-	01205-15

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

Minnesota Unique	West (Wallcook		Mooker		NNESOTA DEP				Entry Date	09/09/201	5
773	3056	Quad Quad ID	Litchfield 125A		LL AND I Minnesota Sta			JKI	Update Date Received Da		.5
Well Name	Townsh	ip Ra	nge Dir Se	tion Subse	tion	Well Depth	1	Pepth Complete	ed Date V	Vell Completed	
LFO2-A	119	31	W 2	CACE	BD	20 ft.		9.99 ft.	06/24/	2015	
	1139.6 Elev.	Method	LiDAR In	DEM (MNDNR	)	Drill Method		r-specified)	Drill Fluid		
Address						Use monito				Status	Active
Well			ITCHFIELD 1			Well Hydrofra		Yes N		To	
Contact	126 MAK Info <del>2260 Mi</del> O			TELD MN 553		Casing Type Drive Shoe?	Single ca Yes	sing No	Joint Above/Below	Glued	
Goological M				Color	Hardness	Casing Diame			Above below	Hole Diamete	
SILT&CLAY	W/SAND,	0	20	GRAY	MEDIUM	1.2 in To	17.1 ft. 0.			8.2 in. To	
						Open Hole	From	ft.	To d pipe Make	ft. ENVIRONME	Name of the last
						Screen? Diameter	Slot/Gauze	Type slotte Length	Set	ENVIRONME	VIAL
						1.2 in.	10	2.7 ft.	17.1 ft.	19.7 ft.	
						Static Water 17.3 ft.	Level land surfa	ce	Measure	08/17/2015	
						Pumping Let ft.		ed surface) Pumping at	0.08	g.p.m.	
						Wellhead Co	-				
						Pitless adapter  X Casing I		<b>IX</b> 1 12	in. above grade	Model	
								ntal Wells and E			
						Grouting Inf	ormation	Well Grouted?	X Yes 1		pecified
						Material		A: 2	mount	From To 3 ft. 15	
						bentonite concrete		_	Sacks 5 Sacks	3 ft. 15 ft. 3	ft. ft.
						Nearest Kno	wn Source of	Contamination			
						fo Wall disinfo	et cted upon con	Direction replation?	☐ Yes	No No	Туре
						Pump			Date Installed	A 140	
						Manufacturer'			Daily Milanda		
						Model Number	ar .	HP	v	olt	
						Length of drop Abandoned	p pipe	ft Capacity	g.p.	Тур	
						1	have any not in	n use and not seale	ed well(s)?	Yes	X No
						Variance					
							•	the MDH for this	well?	Yes	X No
						Miscellaneou First Bedrock	15		Acuifor	Quat. buried	
						Last Strat	pebbly sar	nd/silt/clay-gray			ft
Remarks						Located by		esota Geologica			
	S LOG FOR DE	TAILED II	NFORMATION			Locate Method System		zation (Screen) 183, Zone 15, Met	- Map (1:24,000) es X 379	193 Y 499	0010
						1 -	er Verification				09/2015
						Angled Drill	Hole				
						Well Contra	ctor				
						US Geologi Licensee B		Li	1548 c. or Reg. No.	Name of D	
Minneso	ta Well Ind	lex Rej	port		773	3056					on 06/12/2017 HE-01205-15

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

77.	3055	_	Meeker Litchfield 125A	WEI	NESOTA DEP LL AND I Minnesota Sta	BORING	G REPO	ORT	Entry Date Update Date	09/09/201: 10/20/201:	
		Quad ID				•			Received Dat	e	
Well Name	Townsh	•	-			Well Depth		epth Completed		ell Completed	
LFO2-B	119	31	W 2	CACDI	BD	35.5 ft.	3:	5.13 ft.	06/24/2	015	
	1139.2 Elev.	Method	LiDAR 1m	DEM (MNDNR)		Drill Method	Auger (non	-specified)	Drill Fluid		
Address						Use monito	r well			Status	Active
Well			ITCHFIELD N			Well Hydrofra	ctured?	Yes No	X From	To	
Contact				IELD MN 5535		Casing Type			Joint	Glued	
Coological M	Info <b>rmatio</b>	ODALE I	DR MOUNDS	VIEW MN 551 Color	Hardness	Drive Shoe?	Yes	No	Above/Below		
SILT&CLAY		0		GRAY	MEDIUM	Casing Diamet 1.2 in. To				Hole Diameter 8.2 in. To	
						Open Hole	From	£L.	To	£t.	
						Screen?	1	Type slotted	• •	ENVIRONMEN	TAL
						Diameter 1.2 in.	Slot/Gauze 10	Lungth 2.7 ft.	Set 32.2 ft.	34.9 ft.	
						Static Water 23.8 ft.	Level land surfa	:e	Measure	08/17/2015	
						Pumping Lev ft.	•	d surface) Pumping at	1.43 g	çp.m.	
						Wellhead Co	•		_		
						Pitless adapter  X Casing I		W 12 :	n. above grade	fodel	
								ntal Wells and Bo	rings ONLY)		
						Grouting Inf	ormation	Well Grouted?	X Yes N	lo Not Sp	ecified
						Material			ount	From To	
						bentonite concrete		4 1.5	Sacks Sacks	3 ft. 30. ft. 3	5 ft. ft.
						l		Contamination			
						fe Well disinfe	et cted upon con	Direction upletion?	Yes	X No	Туре
						Pump			ate Installed		
						Manufacturer'	s name	_			
						Model Numbe		HP	Vo		
						Length of drop Abandoned	p pipe	ft Capacity	g.p.	Тур	
						l	have any not in	use and not sealed	well(s)?	Yes	X No
						Variance Was a posicione	a constant from	the MOU See this -	_100 F	Yes 5	( No
						Miscellaneou		the MDH for this w	car		NO 140
						First Bedrock			Aquifer	Quat. buried	
						Last Strat		nd/silt/clay-gray	Depth to Be	edrock	ft
Remarks						Located by Locate Method		esota Geological zation (Screen) -			
SEE DRILLER	IS LOG FOR DE	TAILED I	NFORMATION.			System		83, Zone 15, Meter		193 Y 4999	909
							er Verification	Informati	on from I	nput Date 09/	09/2015
						Angled Drill	Hole				
						Well Contrac US Geologi Licensee B	ical Survey	Lic	1548 . or Reg. No.	HUCKAB Name of Dr	
Minneso	ta Well Inc	lex Re	port		773	055					n 06/12/2017
										1	E-01205-15

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

County Mooker MINNESOTA D									Entry Date	08/14/201	5
773054		Quad	Litchfield				BORING REPORT			10/20/201	5
		Quad ID	125A	Λ	Ainnesota Sta	itutes Chapt	er 1031		Received Dat	e	
Well Name	Townsh	ip Ran	nge Dir Sect	ion Subsect	tion	Well Depth	-	epth Completed	Date W	ell Completed	
LFO2-C	119	31	W 2	CACDE		70 ft.		9.84 ft.	06/22/2	_	
Elevation	1139.4 Elev.	Method	LiDAR 1m I	EM (MNDNR)		Drill Method	Auger (nor	-specified)	Drill Fluid		
Address						Use monito	r well			Status	Active
Well	61656 27	OTH ST L	ITCHFIELD M	N 55355		Well Hydrofrae	ctured?	Yes No	X From	To	
Contact	126 MAR	SHALL A	AV N LITCHFI	ELD MN 5535	55	Casing Type	Single ca		Joint	Glued	
			OR MOUNDS V			Drive Shoe?	Yes	No	Above/Below		
Goological M SILT & CLA		Fro 0	naa To(ft.) 70		Hardness MEDIUM	Casing Diamet				Hole Diameter	
SILI & CLA	II WSAND,		70	GAI	MEDIUM	1.2 in To		74 lbs/ft.		8.2 in. To	70 ft.
						Open Hole Screen?	From	ft. Type slotted	To nine Make	fl. ENVIRONMEN	ITAL.
						Screen? X Diameter	Slot/Gauze	Length	Set		
						1.2 in.	10	2.7 ft.	56.9 ft.	59.6 ft.	
						Static Water : 31.8 ft.	Level land surfa	ce	Measure	06/22/2015	
						Pumping Lev ft.	•	nd surface) Pumping at	0.14	ŗp.m.	
						Wellhead Co	mpletion				
						Pidess adapter	manufacturer	_	N	fodel	
						X Casing F		X 12 i ntal Wells and Bo	in. above grade		
						Grouting Info		Well Grouted?		io Not Sp	ecified
						Material			sount	From To	
						bentonite		7	Sacks	3 ft. 54	.7 ft.
						concrete		2	Sacks	£. 3	ft.
								Contamination Direction	ı		
						Well disinfer			Yes	X No	Туре
						Pump			Date Installed		
						Manufacturer's					
						Model Numbe		HP	Ve		
						Length of drop Abandoned	p pipe	ft Capacity	g.p.	Тур	
							have any not in	use and not scaled	l well(s)?	Yes	X No
						Variance					
								the MDH for this w	ell?	Yes	X No
						Miscellaneou First Bedrock	15		Amifor	Quat. buried	
						Last Strat	pebbly sa	nd/silt/clay-gray	Depth to Bo	•	ft
Para -						Located by	Minn	esota Geological	Survey		
Remarks SEE DRILLEI	RS LOG FOR DE	TAILED D	NEORMATION			Locate Method		zation (Screen) -			
July Dividuals	NO LOG FOR DE		u ordanion.			System  Hoise Number	UTM - NAD er Verification	83, Zone 15, Meter Informati			9910 14/2015
						Angled Drill		шота	ion nom .	igna Date 00	14/2017
						Well Contrac	ctor				
						US Geologi	ical Survey		1548	HUCKAE	
						Licensee Br	usimess	Lic	. or Rog. No.	Name of Dr	iller
					773	3054 I					
Minneso	ta Well Inc	dex Rej	port		///	7004					a 06/12/2017 HE-01205-15

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

773053	_	Meeker Litchfield 125A	WEI	LL AND : Minnesota St	BORIN	G REPO	ORT	Entry Date Update Date Received Dat		
Well Name Townsi LFO2-D 119			tion Subsec		Well Depth 85.5 ft.		Pepth Completes		ell Completed	
Elevation 1139.2 Elev	Method		DEM (MNDNR		Drill Method			Drill Fluid		
Address				,	Use monit	or well			Status	Active
Well 61656 27	OTH ST L	ITCHFIELD M	IN 55355		Well Hydrofra	ctured?	Yes No	X From	To	
Contact 126 MAI	SHALL A	V N LITCHFI	ELD MN 553	55	Casing Type	Single ca		Joint	Glued	
Stratigraphy Info?2000Mid					Drive Shoe?	Yes	No	Above/Below		
Geological Material SILT& CLAY W/SAND,	Fro 0	m. To(ft.) 80	Color GRAY	Hardness MEDIUM	Casing Diame				Hole Diamet	
SAND& CLAY W/SAND,	80		GRAY	HARD	1.2 m. 10	\$1.1 ft. 0.	/4 Ibs./ff.		8.2 in. To	80.5 ff.
					Open Hole	From	ft.	То	ft.	
					Screen? Diameter 1.2 in.	K] Slot/Gauze 10	Type slotted Length 2.7 ft.		81.1 ft.	NTAL
					Static Water 78 ft.	land surfa		Measure	08/17/2015	ı
					£.		d surface) Pumping at	0.1	<u>, p.m.</u>	
					X Casing	r manufacturer Protection	X 12 intal Wells and B	in. above grade	fodel	
					Grouting Inf Material bentonite concrete	formation	6.5	X Yes Nount Sacks Sacks		
					1	own Source of	Contamination	1		Туре
						cted upon con		Yes	X No	-74-
					Pump Manufacturer Model Numb	's name	installed I HP	Date Installed Vo	olt	
					Length of dro	p pipe	ft Capacity	g.p.	Тур	
					Abandoned Does property	y have any not in	use and not scaled	I well(s)?	☐ Yes	X No
					Variance					
						_	the MDH for this w	vell?	Yes	X No
Remarks					Miscellaneou First Bedrock Last Strat Located by	pebbly sa Minn	nd/silt/clay-gray esota Geological	Depth to Bo Survey	Quat. buried edrock	£
SEE DRILLERS LOG FOR DE	TAILED II	NFORMATION.			Locate Metho System		zation (Screen) - 83, Zone 15, Meter	• •	103 Y 40	99908
						er Verification	Informat			99908 9/14/2015
					Well Contra	ctor				
						ical Survey	Lie	1548 c. or Reg. No.	HUCKA Name of I	
Minnesota Well In	dex Rej	port		773	3053				Printed	on 06/12/2017 HE-01205-15

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

773052			Meeker Litchfield	WELI	L AND I	BORING REPORT			Entry Date Update Date	08/14/2015 10/20/2015	
		Quad ID	125A	M	innesota Sta	tutes Chapt	er 1031		Received Dat	e	
Well Name	Townsh	ip Ra	ige Dir Sect	ion Subsectio	on a	Well Depth	D	epth Completed	Date W	Tell Completed	
LFO2-E	119	31	W 2	CACDBI	)	113.9 ft.	1	13.82 ft.	06/20/2	015	
	1139.3 Elev.	Method	LiDAR 1m I	DEM (MNDNR)		Drill Method	Auger (non	-specified)	Drill Fluid		
Address						Use monito	r well			Status Acti	170
Well			ITCHFIELD M			Well Hydrofra	ctured?	Yes No		To	
Contact				ELD MN 55355		Casing Type		sing No 🗆	Joint	Glued	
Geological M		ODALE I		/IEW MN 5511: Color E	2 Iardness	Drive Shoe?	Yes 📙		Above/Below	Hole Diameter	
SILT&CLAY		0	80		ŒDIUM	Casing Diamet	ter Wei 111 ft. 0.7			8.2 in. To 113.	ft.
SILT&CLAY	( W/SAND,	80	114	GRAY F	IARD						
						Open Hole	From	£.	То	£.	
						Screen? Diameter	Slot/Gauze	Type slotted Length	pipe Make Set	ENVIRONMENTAL	1
						1.2 in.	10	2.7 ft.	110.9 ft.	113.6 ft.	
						Static Water 95.6 ft.	Level land surfac	ce .	Measure	08/17/2015	
						Pumping Lev ft.	•	d surface) Pumping at	0.47 g	<u>, р.т.</u>	
						Wellhead Co	•			£-1-1	
						X Casing I At-grade	rotection	X 12 i	n. above grade	fodel	
						Grouting Info	ormation	Well Grouted?	X Yes N	lo Not Specifie	ed.
						Material		Am	ount	From To	_
						concrete			Sacks Sacks	3 ft. 108.6 ft. 3	ft. ft.
						Nearest Kno	wn Source of	Contamination	l		
						fe Well disinfe	et cted upon con	Direction upletion?	Yes	X No	ype
						Pump Manufacturer		installed I	Date Installed		
						Model Number		HP	Vo	olt	
						Length of drop		ft Capacity	g.p.	Тур	
						Abandoned				□ v ( <b>v</b> )	M-
						Variance	nave any not ii	use and not sealed	weathy	Yes X	.40
						Was a variano Miscellaneou		the MDH for this w	ell?	Yes X	No
						First Bedrock	-		Aquifer	Quat. buried	
						Last Strat	-	nd/silt/clay-gray	Depth to Be		ft
Remarks						Located by Locate Method		esota Geological zation (Screen) -			
SEE DRILLES	RS LOG FOR DE	TAILED II	NFORMATION.			System		83, Zone 15, Meter	s X 379		
						Angled Drill		Informati	on nom a	nput Date 08/14/20	13
						Well Contrac	ctor				
						US Geologi Licensee Br		Lic	1548 . or Reg. No.	HUCKABY, J. Name of Driller	_
Minneso	ta Well Inc	dex Rej	port		773	052				Printed on 06/1: HE-01:	2/2017

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

County Monker			IINNESOTA DEPARTMENT OF HEALTH					08/14/2015			
552051			Litchfield	WEL	L AND I	BORING	G REPO	ORT	Entry Date		
77.	3051			M	innesota Sta	tutes Chapt	er 1031		Update Date		
		Quad ID	125A			•			Received Da	ite	
Well Name	Towns	hip Ra	ige Dir Sect	ion Subsectio	10.	Well Depth	1	Depth Completed	Date	Well Completed	
LFO2-F	119	31	W 2	CACDBI	)	162.5 ft.	1	62.42 ft.	06/18/	2015	
Elevation	1139.3 Elev	. Method	LiDAR 1m I	DEM (MNDNR)		Drill Method	Auger (nor	n-specified)	Drill Fluid		
Address						Use monito		• •		Status	Active
Well	61656 27	OTH ST L	ITCHFIELD M	IN 55355		Well Hydrofra	ctured?	Yes No	X From	To	
Contact	126 MA	RSHALL A	V N LITCHFI	ELD MN 55355		Casing Type	Single ca		Joint	Glued	
Strattigt aph		DODALE	OR MOUNDS V	VIEW MN 5511:	2	Drive Shoe?	Yes	No	Above/Below	,	
Geological N	Material	Fr	na To(ft.)	Color F	lardness	Casing Diame	ter Wei	ight			
SILT&CLAY	Y W/SAND,	0	80	GRAY N	ŒDIUM	2 in To	152. ft. 1.	02 Ibs./ft.			
SILT&CLAY	Y W/SAND,	80	117	GRAY F	IARD						
SAND & GE	RAVEL,	11	7 161	GRAY F	IARD						
SILT&CLAY	Y W/SAND,	16	163	GRAY F	IARD						
						0 17.1.			_		
						Open Hole	From	ft. Type slotted p	To Make	ENVIRONMEN	PAT
						Screen? Diameter	Slot/Gauze	Length	Set	LIVEROPRIEN	iau
						1.9 in.	20	9.6 ft.	152.4 ft.	162 ft.	
						Static Water	Level				
						61 ft.	land surfa	ce	Measure	08/17/2015	
						Pumping Lev		-			
						ft.		Pumping at	0.86	g.p.m.	
						Wellhead Co	•			V-1-1	
						Pidess adapter  X Casing I		W 12 in	above grade	Model	
								ntal Wells and Bor			
						Grouting Inf				No Not Spe	cified
						Material		Amo		From To	
						bentonite		10	Sacks	2 ft. 137	ft.
						concrete		2	Sacks	ft. 2	£.
								f Contamination			_
						fo Wall divinfo	et :ted upon cor	Direction	Yes	X No	Туре
										A 140	
						Pump Manufacturer		Installed Da	ite Installed		
						Model Numbe		HP	•	olt	
						Length of drop		ft Capacity	g.p.	Тур	
						Abandoned	r pripe	a capacity	DT.	-7F	
							have any not it	n use and not sealed v	vell(s)?	Yes	X No
						Variance Was a variance	e granted from	the MDH for this wel	17	Yes X	No
						Miscellaneou	5				
						First Bedrock			Aquife	Quat. buried	
						Last Strat	pebbly sa	nd/silt/clay-gray	Depth to E	Bedrock	ft
Remarks						Located by	Minn	esota Geological S	urvey		
1	RS LOG FOR D	PTAILED II	PORMATION			Locate Method		ization (Screen) - M	• •		
			2015. LOGGED	POR USGS		System		083, Zone 15, Meters			
O'L' III II II I	10001101120	0000	2010. 200022	011 0000		Unique Numb		Informatio	n from	Input Date 08/1	4/2015
						Angled Drill	Hole				
						Well Contract US Goologi			1548	HUCKAB	v 1
						Licensee B		Lic.	or Reg. No.	Name of Dri	
Minneso	ta Well In	dex Re	nort		773	051				Printed on	06/19/2017
- Table 30	en III	aca rec								н	E-01205-15

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

Minnesota Unique We	ell Number	County	Mooker		NESOTA DEP				Entry Date	01/13/2014
800011			Litchfield	WEI	LL AND I	BORING	G REPO	ORT	Update Date	08/26/2014
8000	11	Quad ID		1	Minnesota Sta	itutes Chapt	er 1031		Received Date	
		Quad ID							Received Dat	e 10/02/2015
Well Name	Town	•	_			Well Depth		Depth Completed		ell Completed
DESEN, DOUG		31	W 2	DACA	AC	158 ft.		58 ft.	07/29/2	
	28.4 Ele	v. Method	Surveyed			Drill Method	Non-specif	fied Rotary	Drill Fluid Ben	
Address						Use monito	r well			Status Active
Contact	28003 (	520TH AV L	ITCHFIELD M	IN 55355		Well Hydrofra	ctured?	Yes No	X From	To
Well	620TH	AV LITCHE	TELD MN 553	55		Casing Type	Single ca	sing	Joint	Glued
Stratigraphy In		_				Drive Shoe?	Yes	No X	Above/Below	
Geological Mate	erial	Fro			Hardness	Casing Diame		ight		Hole Diameter
TOPSOIL		0	3	BLACK	SOFT	2 in To	148 ft.	Ibs./ft.		6.2 in. To 158 ft.
CLAY		3 5	5	BROWN	SOFT					
GRAVEL		9	9	GRAY	SOFT MED-HRD					
CLAY DIRTY GRAVE		11:	112 2 117	GRAY	SOFT					
CLAY	eL.	11		GRAY	SFT-MED	Open Hole	From	£.	To	ft.
SAND/GRAVE	т	12		GRAY	SOFT	Screen?	(	Type plastic		JOHNSON
CLAY/GRAVE		15		GRAY	SOFT	Diameter	Slot/Gauze	Length	Set	
CENTIFORCIVE	_			GIGTI	5011	2 in.	10	10 ft.	148 ft.	158 ft.
						Static Water 59.8 ft.	Level land surfa	ice	Measure	07/29/2013
						Pumping Let	rel (below la	nd surface)		
						Wellhead Co	•			
						Pitless adapter  X Casing I		□ 12 in		fodel
								ntal Wells and Bo	i. above grade rings ONLY)	
						Grouting Inf	-	Well Grouted?		lo Not Specified
						Material		Ame		From To
						bentonite				4 ft. 142 ft.
						neat cement		2	Sacks	£.4 £.
								f Contamination	_	
						900 fe Well disinfe		est Direction upletion?	Yes Seg	ptic tank/drain field Type  No
						Pump Manufacturer		Installed D	ate Installed	
						Model Number		HP	Vo	Je
						Length of dro		ft Capacity	g.p.	Тур
						Abandoned	rrr	- capacity	01	-72
						Does property	have any not i	in use and not sealed	well(s)?	Yes X No
						Variance				
								the MDH for this we	II?	Yes X No
						Miscellaneou	15		4	
						First Bedrock Last Strat	makhka	nd/silt/clay-gray	Depth to Be	Quat. buried strock ft
						Located by		mu sur ciay-gray sesota Geological S		
Remarks						Locate Method		ization (Screen) - 1	•	
DRILLERS: STE	VE WEISB	RICH & DRE	W BATES.			System		083, Zone 15, Meters		018 Y 5000014
						Unique Numb	er Verification	Info/GPS	from data l	nput Date 08/18/2014
						Angled Drill	Hole			
						Well Contra			1404	OFFICE CAPTURE
						Mark J Tra Licensee B	ut Wells, Inc. usiness		1404 or Reg. No.	Name of Driller
Minerant	Well T	adan P.			800	011				Printed on 06/12/2017
Minnesota	well I	ndex Kep	ort							HE-01205-15