Final Monitoring Report

for

Town of Hamilton Well 14
Stone Eden Well
Hamilton, Virginia

Prepared for:
Mayor Greg Wilmoth
Town of Hamilton

Prepared by:

ANALYTICAL SERVICES, INC.
402 N. West Street
Culpeper, Virginia22701

And

TRIAD ENGINEERING, INC.
21641 Beaumeade Circle
Suite 300
Ashburn, Virginia20147

Date: September 26, 2011

TRIAD Project # 05-07-0092

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William J. Mikalik, CPG
TRIAD Engineering, Inc.

_____
Andrew Carter, Project Manager
Analytical Services, Inc.

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1.0 INTRODUCTION

This Final Quarterly Monitoring Report presents the results of monitoring activities performed during the period between January 6, 2009 and July 28, 2011. This time interval included approximately seven months of background well water level monitoring and two years of monitoring during active pumping of Well 14 by the Town of Hamilton. This report is submitted to the Loudoun County Department of Building and Development to complete the approved Town's Pumping, Monitoring, and Mitigation Plan (PMMP, November 2008). The PMMP addresses the groundwater monitoring requirements of Section 6.240, G., I., J., and K. of the Loudoun County Facility Standards Manual (FSM).

This report includes the water level data and water quality field-testing from the following reports previously submitted by TRIAD:

- "Background and Initial Pump Start-up (30-day) Monitoring Report", dated October 13, 2009 ("30-Day Report"),
- "First Quarterly Monitoring Report" (QMR1), dated November 15, 2009,
- "Second and Third Quarterly Monitoring Report" (QMR3), dated May 10, 2010,
- "Fourth Quarterly Monitoring Report" (QMR4), dated September 29, 2010,
- "Fifth Quarterly Monitoring Report (Revised)" (QMR5), dated April 5, 2011, and
- "Sixth Quarterly Monitoring Report" (QMR6), dated June 29, 2011.

Please refer to the 30-Day Report for details regarding monitoring well information, installation of the probes, and the water quality sampling methods. Relevant information on the monitored wells is summarized in Table 1 below.

Table 1
Domestic Well Monitoring Locations

Well ID	Residence Address	PIN	Well Yield (gpm)	Total Depth (feet)	Depth to Bedrock (feet)	Static Water Level (feet)	Water-Bearing Depths (feet)
2	W. Allen Cochran 17889 Sands Road	419260463	30	200	10	30	134
4	Gaston and Kapsang Gutierrez 38286 Alfalfa Ct	419157282	50	380	20	30	180 (2), 365 (48)
5	Robert and Lori Gammache 38280 Alfalfa Ct	419155183	30	400	10	12	190 (4), 360 (26)
6	Hemadri and Aparna Dasari 38274 Alfalfa Ct	419153482	30	275	10	30	253
7	Edward and Courtney Cooke 38268 Alfalfa Ct	419150980	50	250	8	0	225
9	B. and J. Dedekind 17936 Manassas Gap Ct	454105978	60	383	50	30	381

12	James and Amy Walton 17979 Sands Road	454297930	15	380	25	2	365
13	Brian and Sherri Omara 17969 Sands Road	454302227	15	260	51	40	235
18	Mark and Yufen Zha Hyett 38344 Midnight Sky Place	419163547	15	225	20	30	195
29A	Michael and Nancy Dowgiello 17997 Taylor Road	419153482	30	275	10	30	253
32	Maureen A. Omara 17899 Sands Road	454204465	50	260	20	2	235

2.0 WATER QUALITY MONITORING

Section 4.5 of the PMMP recommended that the monitoring program should include an evaluation of water quality. Laboratory results from the sampling of all the initial monitored domestic wells were reported later in the 30-Day Report. The laboratory results from Well 32 were reported in the QMR1, and results from Well 2 and Well 18 were reported in QMR5. A well water sample was collected from Well 29A on July 28, 2011. The sample was tested by calibrated field instrumentation for the following parameters: pH, specific conductivity, turbidity, and temperature.

2.1 Field Parameters

Field parameters (Temperature, pH, Specific Conductance, and Turbidity) were measured in all well water samples by field meters. Water samples were collected from the residences from an outside spigot of each residence, after purging water from the piping. The results of sampling events have been tabulated in Appendix A. The new results do not appear to change the findings from the 30-Day report that some variations have been recorded in the field measurements; however, no long term trends are readily discernable.

2.2 Laboratory Analysis

Laboratory analysis was conducted for the Well 29A sample. The analytical results indicate that Total coliform was reported to be present and that E. coli bacteria were absent in the sample. The Total Coliform Rule of the EPA's Drinking Water Standards specifies that further testing for fecal coliforms if total Coliforms are detected in public drinking water systems. According to the property owners, Well 29A is used exclusively for irrigation and not for drinking water. It is not uncommon for water samples from wells that have been dormant for weeks at a time, especially those that are not used for drinking water supply, to test positive for coliforms. The laboratory report for Well 29A is provided in Appendix B.

3.0 GROUNDWATER LEVEL MONITORING

TRIAD personnel mobilized to the site on July 28, 2011, to check the operation of the probes and to download data from the probes for the final monitoring period since the most recent site visit on March 31, 2011. The active data log for each probe was terminated, downloaded, and deleted from the probe. A new log was started manually using the same parameters (recording hourly depth readings) as the former log. The positions of the probes were not adjusted.

Water level monitoring began at Well 32 on November 17, 2009. Water level monitoring began at Wells 2, 18, and 29A on December 14, 2010. All water level measurements were recorded by data-logging transducers on an hourly basis. Water level data collected during the final period (April - July, 2011) have been plotted for each monitor well. The probes record the raw data as the height of water in the well over the probe. For clarity purposes, the raw data are converted to express water level in the graphs as a depth of the water level from the top of the well casing. The plots of background phase and the previous pumping periods have been presented in previous reports. Graphs for each individual monitor well have been included in Appendix C. An electronic copy of the monitoring data has been included in Appendix F.

The current data log from Well 2, downloaded on July 28, includes data that are equivalent to negative Depth-to-Water values. This anomaly was most likely caused by an unintended change in the probe height. The probe is suspended on a cable hanging from the internal piping and wiring in the well. It is possible, for example, that slack in the cable could have slipped downward with the rising and falling of the water level in the well. Detailed examination of the Well 2 data showed that an approximately three-foot shift may have occurred after the March 31 site visit.

3.1 Additional Monitoring Locations

No additional monitoring probes were installed during this monitoring period.

3.2 Discussion of Water Level Monitoring Results

As noted in previous monitoring reports, identifiable drawdown events from five wells (Wells 4, 5, 6, 7, and 32) appear to coincide closely with the 14 pumping events for which data are available, as shown in Figure 2. Based on significant drawdowns, interpretation of the water level data from these five wells suggests that there were at least 22 pumping events at Well 14 during the final study period (April 1 – July 28, 2011). Recovery from the drawdowns was generally strong in these five wells, which is consistent with previous results.

Wells 4, 5, 6, 7, and 32 showed remarkably similar responses over this monitoring period. Figure 5 shows the water level responses of these five wells to the Well 14 withdrawal of May 2, 2011, which was a typical example of a drawdown event. In this event, the pumping duration was two hours. The maximum drawdown in Well 32 of

approximately 29 feet coincided closely with the time of pump shut off (hourly sampling frequency probably cannot record the exact pumping start and stop times). Full recovery in Well 32 occurred at approximately 11 AM on May 3, or approximately 24 hours after pumping was stopped. The responses of the other wells in this area (Wells 4, 5, 6, and 7) were very similar to Well 32, though the maximum drawdowns for these wells were somewhat less.

Water levels in Well 13 (Figure 3) show the largest range of fluctuation among the monitored wells. Figure 3 shows four observed drawdown events of approximately 50 to 70 feet from the static level on May 1, May 28, June 30, and July 21, 2011. The timing of the maximum drawdowns in the Well 13 water levels does not correspond well with the times of the operation of Well 14, suggesting that other factors may be contributing to water level fluctuations in Well 13.

Wells 2, 9, and 12 appear to be less affected by withdrawals from Well 14 (Figures 3 and 4). The Well 2 data show two substantial, multi-day drawdown events, one April 11 to April 13, and the second on June 2 to June 6. Both events produced approximately 32 feet of drawdown; however, neither event appeared to be associated with Well 14 pumping times. Both events showed strong recovery back to static levels. Overall, Well 2 water levels do not appear to behave similarly to any other monitored well.

Wells 18 and 29A (Figure 4), which are the most distant from Well 14 among the monitored wells (both approximately 1,750 feet), had drawdowns of ten feet or more which appeared to coincide with Well 14 withdrawals. In the case of Well 18, this could not be easily determined with confidence as there were many drawdown events of similar magnitude that did not appear to be related to Well 14 withdrawals. Many of these events interfered with each other which made the timing of the drawdown difficult to identify.

Recoveries in all of the monitored wells continue to be relatively rapid, with water levels usually re-stabilizing at pre-drawdown levels in most wells. Significant long term trends in “static” (recovered) water levels in the monitored wells are not observed in the data. The continued rapid recovery pattern suggests that production from Well 14 has not significantly impacted recharge of the monitored wells by the local aquifer during the monitoring program.

3.3 Analysis of Drawdown Data

Well 29A was not in use through April and most of May of this monitoring period, so that major drawdown events without significant interference could be easily identified (Figure 4). All of the eight drawdown events in May appeared to coincide closely with the eight reported withdrawals from Well 14. One drawdown event that occurred on May 2 was selected to obtain estimates of aquifer hydraulic characteristics by graphical analysis. The drawdown and recovery curve of Well 29A for the May 2 drawdown event was analyzed using the Hantush-Jacob method for leaky aquifers in the commercial AQTESOLV software package. This graphical method is a theoretical analysis of an ideal system which based on a number of assumptions that are violated in virtually all

actual aquifers; however, the Hantush Method is the most appropriate method for the site conditions.

The Hantush-Jacob method yielded estimates of transmissivity (0.1246 ft^2/min) and storativity (0.0000054). Assuming an aquifer thickness of 250 feet (the length of the water column in Well 29A), the hydraulic conductivity of the local formation near Well 29A is estimated to 0.0005 feet/minute (0.72 feet/day). While these estimates of aquifer characteristics are reasonable for the fractured coarse crystalline bedrock (gneiss) underlying the site, as with any standard drawdown analysis, these values should be regarded with caution. Please refer to Analysis and Evaluation of Pumping Test Data (Kruseman, G.P., and N.A. de Ridder. International Institute for Land Reclamation and Improvement. Wageningen, The Netherlands. 1994) for a detailed description and assumptions of the Hantush method. The Hantush-Jacob Method is referred to as Walton's Method on page 81. The graphical curve-fit and method report are provided in Appendix D.

3.4 Discharge Data from Well 14

Well 14 discharge data were obtained from the Hamilton Water Treatment Plant (WTP) for the period of May through July 2011. Because of monitoring system malfunction, Well 14 data from January and April 2011 were not available for this report; however, withdrawal estimates for these months were estimated from the pumping data for similar drawdown events in Well 29A at times when pumping data were available. The monthly pumpage totals are provided in Table 2 below. Additional data, such as start and stop times for Well 14 pumping, as well as limited water level depth (before start up and before shut down of pumping), are presented in Appendix E.

The operation of Well 14 has continued to be irregularly timed, with variable time-intervals between events. Based on both data obtained from the Hamilton WTP staff, and on the water level data, there appeared to be 22 pumping events in the current monitoring period (April – May 2011), for a total of 38 hours of pumping. Nearly all the pumping events at Well 14 were approximately one to two hours in duration, except for May 31, when the pumping interval was 2.75 hours, and the last reported event on July 25 which was 3.5 hours in duration. Total withdrawals from Well 14 for this period were estimated to be 793,519 gallons.

For the two-year monitoring period, the number of withdrawal events at Well 14 is estimated to be 200, for a total of approximately 279 hours of pumping and approximately 5,089,897 gallons of water withdrawn.

Table 2. Well 14
Pumping Data Summary

Month	Pumping Days	Total Hours	Pumpage (gal)
October '09	12	17.7	287,800
November '09	14	20	294,300
December '09	9	14	231,500
January '10	14	14.4	209,900
February '10	7	9	156,300
March '10	14	23	373,900
April '10	10	15	243,300
May '10	11	10.7	167,100
June '10	10	14.9	313,281
July '10	6	15.1	317,486
August '10	5	3.6	75,692
September '10	5	9.6	79,700
October '10	16	12.3	256,800
November '10	11	8.9	193,300
December '10	12	11.4	236,200
January '11*	5	12.5	263,819
February '11	5	16.8	342,000
March '11	12	10.7	254,000
April '11*	7	13.75	294,519
May '11	8	13.5	284,000
June '11	5	7.7	145,000
July '11	2	4.5	70,000
Totals	200	279.05	5,089,897

Note: * = estimated based on water level data. See discussion in Section 3.4.

4.0 CONCLUSIONS AND RECOMMENDATIONS

The submittal of this Final Quarterly Monitoring Report to the Loudoun County Department of Building and Development is the final submission that completes the PMMP, approved by the county in November 2008.

This report documents 33 months of monitoring data of Well 14 ("Stone Eden Well") during both background (pre-pumping) and active pumping conditions. Automatic data loggers were installed and activated in six wells on January 6, 2011. Seven months of background monitoring data were collected from these wells before active pumping began at Well 14. As indicated in the previously submitted 30-Day report, active pumping operation was determined to have begun (after a short time of preliminary system testing) on July 29, 2009. The last data download for the current monitoring program was completed on July 29, 2011, after 24 months of active production from Well 14.

Approximately simultaneous drops in well water levels during numerous occasions in six (Wells 4, 5, 6, 7, 29A, and 32) of the monitored residential wells are believed to be associated with the withdrawal of groundwater from Well 14. The fluctuations in water levels in these wells associated withdrawals from Well 14 were generally 20 to 30 feet in magnitude for a typical 2-hour pumping duration. Water levels in other monitored wells may also be impacted by Well 14 operations, but the influence appears to be less significant. Recoveries in all wells continue to be strong. Wells 2, 9, and 12 appear to experience relatively minor impacts from the pumping operations. The data show significant water level fluctuations in Well 13 throughout the monitoring period; however, the timing of the largest drawdown events in Well 13 do not appear to coincide with Well 14 operations. Water levels in the monitored wells have continued to recover to approximately background levels; static levels in the in the monitored wells – that is, recovered water depths – at the end of the two-year monitoring program do not appear to be significantly lower than background levels recorded before pumping in well 14 began on July 29, 2009.

Based on review of the data collected for this Well 14 monitoring program, TRIAD makes the following recommendations.

The proper management and operation of Well 14 will be necessary to accommodate the continued use of the well without creating substantial impacts to offsite wells. Limiting the duration of pumping events to 2-3 hours per day enabled substantial recovery in nearby water wells during the monitoring period. Longer pumping durations may avoid harmful impacts if pumping were to occur during night time hours when domestic water use is diminished.

In the event that the pumping schedule changes to increase groundwater production from Well 14 beyond the range of withdrawals established within this monitoring program, new monitoring data from offsite wells should be evaluated and used to refine the pumping schedule as necessary to avoid offsite impact to nearby wells.

5.0 LIMITATIONS

The work performed in conjunction with this project, and the data developed, are intended as a description of available information at the sample locations indicated and the dates specified. Generally accepted industry standards were used in the preparation of this report.

Laboratory data are intended to approximate actual conditions at the time of sampling. Results from future sampling and testing may vary significantly as a result of natural conditions, a changing environment, or the limits of analytical capabilities. This report does not warrant against future operations or conditions, nor does it warrant against operations or conditions present of a type or at a specific location not investigated. The limited sampling conducted was intended to approximate subsurface conditions by extrapolation between data points. Actual conditions may vary.

FIGURES

Figure 1: Site Location Map

Legend

- Pumping Well
- Existing Monitoring Well Locations

N

0 250 500 1,000 Feet

ANALYTICAL SERVICES, INC.
102 N. West Street
Culpeper, Virginia 22701
Telephone: (540) 829-5640 * Fax: (540) 829-5641
www.asincorp.com

Figure 2. Well 4, 5, 6, 7, and 32 with Well 14 Pumpage: Final

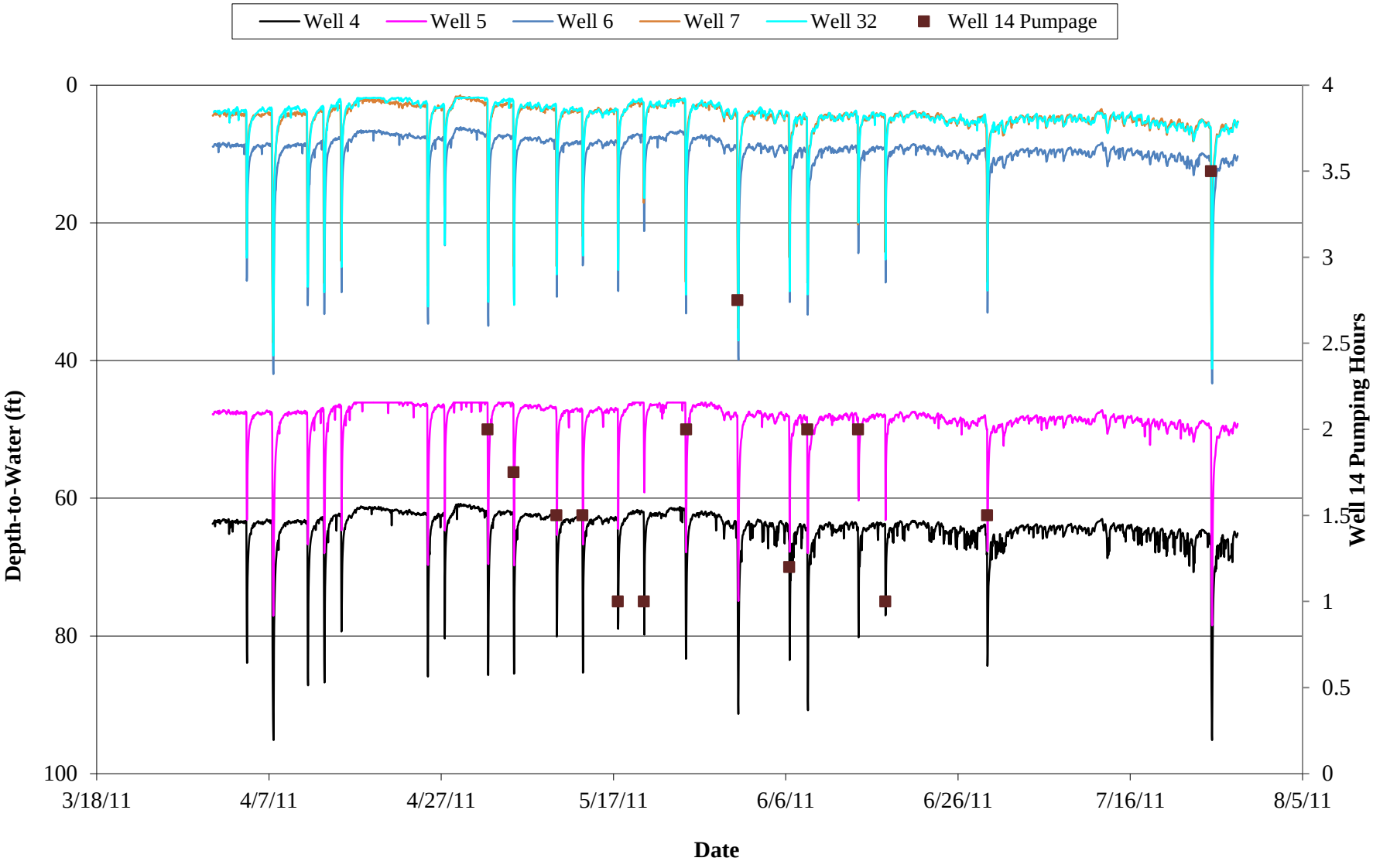
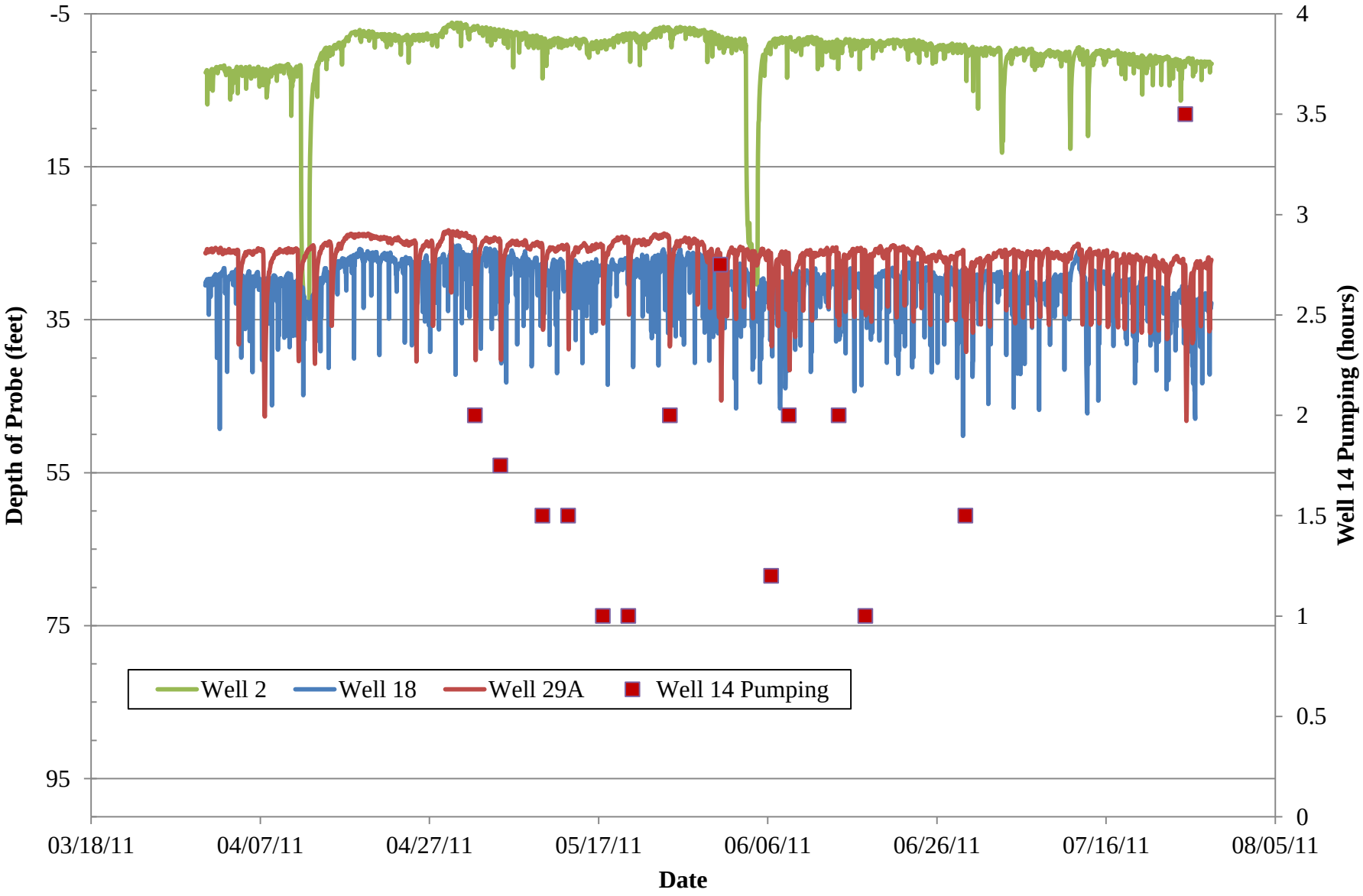


Figure 3. Wells 9, 12, and 13: Final

Figure 4. Wells 2, 18, & 29A: Final



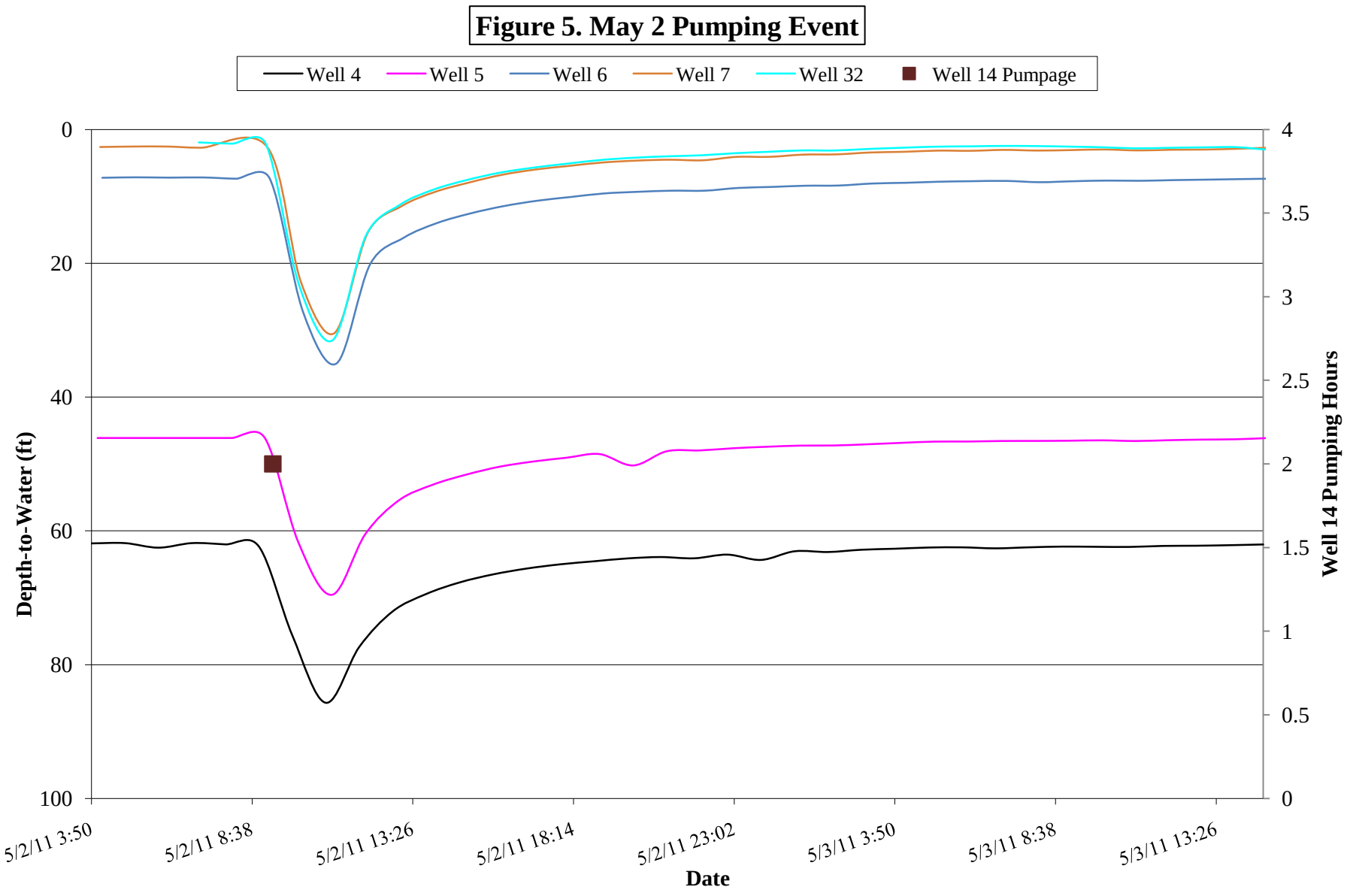


Figure 5. May 2 Pumping Event
Well 4
Well 5
Well 6
Well 7
Well 32
Well 14 Pumpage
Depth-to-Water (ft)
0
20
40
60
80
100
Well 14 Pumping Hours
4
3.5
3
2.5
2
1.5
1
0.5
0
5/2/11 3:50
5/2/11 8:38
5/2/11 13:26
5/2/11 18:14
5/2/11 23:02
5/3/11 3:50
5/3/11 8:38
5/3/11 13:26
Date

APPENDIX A

SUMMARY TABLE OF FIELD PARAMETERS

APPENDIX A. Field Parameters

Date	1/9/09	8/9/09	8/26/09	10/6/09	10/29/09	11/17/09	12/28/09	1/29/10	2/24/10	3/24/10	4/30/10	5/25/10	8/25/10	3/31/11	7/28/11
Well ID															
pH (Standard Units)															
Well 2														6.1	6.1
Well 4	6.79	7.8	7.93	8.17	7.84	7.6	7.66	*	*	*	7.24	7.61	7.57	6.84	6.77
Well 5	7.27	7.15	7.42	7.1	7.46	7.26	7.44	7.18	*	*	7	6.98	7.15	*	6.35
Well 6	6	7.7	7.77	7.61	7.96	7.68	7.86	*	*	*	7.33	7.4	7.34	*	6.8
Well 7													6.63	6.8	6.47
Well 9	6.1	7.9	8.16	7.77	8.22	7.89	7.95	*	*	8.11	7.52	7.39	7.28	*	6.92
Well 12	7.71	7.54	7.37	7.53	7.54	7.23	7.47	*	*	7.27	7.08	6.64	6.47	6.52	6.45
Well 13	7.41	7.4	7.5	7.34	7.42	7.45	7.39	6.96	*	6.94	6.77	6.1	6.16	6.28	6.08
Well 18														6.22	6.22
Well 29A															7.08
Well 32						7.6	7.61	*	*	7.18	7.09	6.76	6.45		6.43
Specific Conductance (µS)															
Well 2														284	269
Well 4	420	288	524	365	424	321	335	*	*	*	466	384	442	350	301
Well 5	342	355	415	390	416	372	381	381	*	*	387	371	431	*	365
Well 6	315	271	322	295	290	281	279	*	*	*	282	300	291	*	270
Well 7													298	282	272
Well 9	270	229	250	263	244	230	254	*	*	281	248	254	231	*	218
Well 12	311	286	260	290	277	247	269	*	*	322	278	279	281	279	260
Well 13	269	284	255	270	333	275	242	243	*	276	255	240	246	251	224
Well 18														292	280
Well 29A															283
Well 32						234	236	*	*	259	270	262	257	*	235
Temperature (°C)															
Well 2														*	26.1
Well 4	16	17.5	21.9	16.3	15.8	15.3	18.9	*	*	*	17.6	21.2	22.8	16.6	23.9
Well 5	13.3	19	21	17.8	15.8	16.1	17	14.2	*	*	18.8	19.1	23.5	*	24.3
Well 6	11	21	25.7	18.3	15.9	15.6	21.4	*	*	*	18.3	20.5	23.1	*	22.8
Well 7													23.1	8.8	25.3
Well 9	11.4	24.5	23.1	19.6	16.9	16.9	17.4	*	*	18.2	18.3	22	21.4	*	25.8
Well 12	12.4	19.5	23.3	18.8	15.7	14.4	12.1	*	*	12.8	17.1	19.8	22.6	8.9	23.7
Well 13	13.3	21	23.2	19	16.3	14.7	10.8	10	*	13.7	17.3	21.7	21.9	10.4	22.7
Well 18														11.9	27.3
Well 29A															24.9
Well 32						16.5	13.8	*	*	17.6	19	22	24.6	*	24.7

APPENDIX A. Field Parameters

Date	1/9/09	8/9/09	8/26/09	10/6/09	10/29/09	11/17/09	12/28/09	1/29/10	2/24/10	3/24/10	4/30/10	5/25/10	8/25/10	3/31/11	7/28/11
Turbidity (NTUs)															
Well 2														3.78	0.89
Well 4	0.08	0.2	1.38	0.005	0.51	10.96	3.59	*	*	*	0.46	0.58	0.66	2.73	0.91
Well 5	0.01	0.55	0.77	2.84	0.46	8.47	0	0.03	*	*	2.73	6.17	1.91	*	1.41
Well 6	0	0.89	0.6	0.61	0.16	10.33	0	*	*	*	0.24	0.54	2	*	0.66
Well 7													2.2	0.58	1.45
Well 9	1.23	1.82	0.45	0.64	1.09	15.23	0.18	*	*	1.64	1.28	0.64	2.3	*	0.84
Well 12	0.01	0.21	4.5	0.59	0.21	14.22	0.01	*	*	0.71	3.78	1.39	5.9	1.61	1.52
Well 13	0.06	0.83	0.75	0.86	0.17	15.62	0	0	*	2.49	0.7	1.17	0.56	1.08	0.97
Well 18														2.05	1.71
Well 29A															0.9
Well 32						15.92	0	*	*	5.29	0.83	0.34	4.74	*	0.95

Note: *: Outdoor spigots were shut off because of freezing weather. No sample was collected. Likewise, samples were not collected during the 12/21/11 site visit.

APPENDIX B

WATER QUALITY ANALYTICAL DATA

(WELL 29A)

Informational Water Quality Report

Loudoun County

National Testing Laboratories, Ltd.
Quality Water Analysis
6571 Wilson Mills Rd
Cleveland, Ohio 44143
1-800-458-3330

Client:

Ordered By:
Analytical Services Inc. 402 N. West Street Culpeper, VA 22701 ATTN: Mike Maloy

Sample Number: 821398

Location:	Well 29 A
Type of Water:	Well Water
Collection Date and Time:	7/28/2011 13:00
Received Date and Time:	7/29/2011 10:30
Date Completed:	8/16/2011

Definition and Legend

This informational water quality report compares the actual test result to national standards as defined in the EPA's Primary and Secondary Drinking Water Regulations.

Primary Standards:	Are expressed as the maximum contaminant level (MCL) which is the highest level of contaminant that is allowed in drinking water. MCLs are enforceable standards.
Secondary standards:	Are non-enforceable guidelines regulating contaminants that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor,or color) in drinking water. Individual states may choose to adopt them as enforceable standards.
Action levels:	Are defined in treatment techniques which are required processes intended to reduce the level of a contaminant in drinking water.
mg/L (ppm):	Unless otherwise indicated, results and standards are expressed as an amount in milligrams per liter or parts per million.
Minimum Detection Level (MDL):	The lowest level that the laboratory can detect a contaminant.
ND:	The contaminant was not detected above the minimum detection level.
NA:	The contaminant was not analyzed.

✓ The contaminant was not detected in the sample above the minimum detection level.

● The contaminant was detected at or above the minimum detection level, but not above the referenced standard.

▲ The contaminant was detected above the standard, which is not an EPA enforceable MCL.

✚ The contaminant was detected above the EPA enforceable MCL.

✖ These results may be invalid.

Status	Contaminant	Results	Units	National Standards		Min. Detection Level
			Microbiologicals			
▲	Total Coliform by P/A	Total coliform was Present in this sample and E. coli bacteria was ABSENT.				
			Inorganic Analytes - Metals			
✓	Aluminum	ND	mg/L	0.2	EPA Secondary	0.1
✓	Arsenic	ND	mg/L	0.010	EPA Primary	0.005
✓	Barium	ND	mg/L	2.00	EPA Primary	0.30
✓	Cadmium	ND	mg/L	0.005	EPA Primary	0.002
●	Calcium	38.7	mg/L	--		2.0
✓	Chromium	ND	mg/L	0.100	EPA Primary	0.010
✓	Copper	ND	mg/L	1.300	EPA Action Level	0.004
●	Iron	0.270	mg/L	0.300	EPA Secondary	0.020
✓	Lead	ND	mg/L	0.015	EPA Action Level	0.002
●	Magnesium	9.60	mg/L	--		0.10
▲	Manganese	0.170	mg/L	0.050	EPA Secondary	0.004
✓	Mercury	ND	mg/L	0.002	EPA Primary	0.001
✓	Nickel	ND	mg/L	--		0.020
✓	Selenium	ND	mg/L	0.050	EPA Primary	0.020
✓	Silver	ND	mg/L	--		0.002
●	Sodium	14	mg/L	--		1
✓	Zinc	ND	mg/L	5.000	EPA Secondary	0.004
			Physical Factors			
●	Alkalinity (Total as CaCO3)	90	mg/L	--		20
✓	Corrosivity	-0.660	SI	--		
✓	Foaming Agents	ND	mg/L	--		0.1
▲	Hardness	140	mg/L	100	NTL Internal	10
✓	pH	7.2	pH Units	6.5 to 8.5	EPA Secondary	
●	Total Dissolved Solids	150	mg/L	500	EPA Secondary	20
●	Turbidity	0.6	NTU	1.0	EPA Action Level	0.1

Status	Contaminant	Results	Units	National Standards		Min. Detection Level
			Inorganic Analytes - Other			
●	Chloride	13.0	mg/L	250.0	EPA Secondary	5.0
●	Fluoride	0.6	mg/L	4.0	EPA Primary	0.5
✓	Nitrate as N	ND	mg/L	10.0	EPA Primary	0.5
✓	Nitrite as N	ND	mg/L	1.0	EPA Primary	0.5
●	Sulfate	20.0	mg/L	250.0	EPA Secondary	5.0
			Organic Analytes - Trihalomethanes			
✓	Bromodichloromethane	ND	mg/L	--		0.002
✓	Bromoform	ND	mg/L	--		0.004
✓	Chloroform	ND	mg/L	--		0.002
✓	Dibromochloromethane	ND	mg/L	--		0.004
✓	Total THMs	ND	mg/L	0.080	EPA Primary	0.002
			Organic Analytes - Volatiles			
✓	1,1,1,2-Tetrachloroethane	ND	mg/L	--		0.002
✓	1,1,1-Trichloroethane	ND	mg/L	0.200	EPA Primary	0.001
✓	1,1,2,2-Tetrachloroethane	ND	mg/L	--		0.002
✓	1,1,2-Trichloroethane	ND	mg/L	0.005	EPA Primary	0.002
✓	1,1-Dichloroethane	ND	mg/L	--		0.002
✓	1,1-Dichloroethene	ND	mg/L	0.007	EPA Primary	0.001
✓	1,1-Dichloropropene	ND	mg/L	--		0.002
✓	1,2,3-Trichlorobenzene	ND	mg/L	--		0.002
✓	1,2,3-Trichloropropane	ND	mg/L	--		0.002
✓	1,2,4-Trichlorobenzene	ND	mg/L	0.070	EPA Primary	0.002
✓	1,2-Dichlorobenzene	ND	mg/L	0.600	EPA Primary	0.001
✓	1,2-Dichloroethane	ND	mg/L	0.005	EPA Primary	0.001
✓	1,2-Dichloropropane	ND	mg/L	0.005	EPA Primary	0.002
✓	1,3-Dichlorobenzene	ND	mg/L	--		0.001
✓	1,3-Dichloropropane	ND	mg/L	--		0.002

Status	Contaminant	Results	Units	National Standards		Min. Detection Level
✓	1,4-Dichlorobenzene	ND	mg/L	0.075	EPA Primary	0.001
✓	2,2-Dichloropropane	ND	mg/L	--		0.002
✓	2-Chlorotoluene	ND	mg/L	--		0.001
✓	4-Chlorotoluene	ND	mg/L	--		0.001
✓	Acetone	ND	mg/L	--		0.01
✓	Benzene	ND	mg/L	0.005	EPA Primary	0.001
✓	Bromobenzene	ND	mg/L	--		0.002
✓	Bromomethane	ND	mg/L	--		0.002
✓	Carbon Tetrachloride	ND	mg/L	0.005	EPA Primary	0.001
✓	Chlorobenzene	ND	mg/L	0.100	EPA Primary	0.001
✓	Chloroethane	ND	mg/L	--		0.002
✓	Chloromethane	ND	mg/L	--		0.002
✓	cis-1,2-Dichloroethene	ND	mg/L	0.070	EPA Primary	0.002
✓	cis-1,3-Dichloropropene	ND	mg/L	--		0.002
✓	DBCP	ND	mg/L	--		0.001
✓	Dibromomethane	ND	mg/L	--		0.002
✓	Dichlorodifluoromethane	ND	mg/L	--		0.002
✓	Dichloromethane	ND	mg/L	0.005	EPA Primary	0.002
✓	EDB	ND	mg/L	--		0.001
✓	Ethylbenzene	ND	mg/L	0.700	EPA Primary	0.001
✓	Methyl Tert Butyl Ether	ND	mg/L	--		0.004
✓	Methyl-Ethyl Ketone	ND	mg/L	--		0.01
✓	Styrene	ND	mg/L	0.100	EPA Primary	0.001
✓	Tetrachloroethene	ND	mg/L	0.005	EPA Primary	0.002
✓	Tetrahydrofuran	ND	mg/L	--		0.01
✓	Toluene	ND	mg/L	1.000	EPA Primary	0.001
✓	trans-1,2-Dichloroethene	ND	mg/L	0.100	EPA Primary	0.002
✓	trans-1,3-Dichloropropene	ND	mg/L	--		0.002

Status	Contaminant	Results	Units	National Standards		Min. Detection Level
✓	Trichloroethene	ND	mg/L	0.005	EPA Primary	0.001
✓	Trichlorofluoromethane	ND	mg/L	--		0.002
✓	Vinyl Chloride	ND	mg/L	0.002	EPA Primary	0.001
✓	Xylenes (Total)	ND	mg/L	10.000	EPA Primary	0.001
			Organic Analytes - Others			
✓	2,4-D	ND	mg/L	0.070	EPA Primary	0.010
✓	Alachlor	ND	mg/L	0.002	EPA Primary	0.001
✓	Aldrin	ND	mg/L	--		0.002
✓	Atrazine	ND	mg/L	0.003	EPA Primary	0.002
✓	Chlordane	ND	mg/L	0.002	EPA Primary	0.001
✓	Dichloran	ND	mg/L	--		0.002
✓	Dieldrin	ND	mg/L	--		0.001
✓	Endrin	ND	mg/L	0.0020	EPA Primary	0.0001
✓	Heptachlor	ND	mg/L	0.0004	EPA Primary	0.0004
✓	Heptachlor Epoxide	ND	mg/L	0.0002	EPA Primary	0.0001
✓	Hexachlorobenzene	ND	mg/L	0.0010	EPA Primary	0.0005
✓	Hexachlorocyclopentadiene	ND	mg/L	0.050	EPA Primary	0.001
✓	Lindane	ND	mg/L	0.0002	EPA Primary	0.0002
✓	Methoxychlor	ND	mg/L	0.040	EPA Primary	0.002
✓	PCB	ND	mg/L	0.0005	EPA Primary	0.0005
✓	Pentachloronitrobenzene	ND	mg/L	--		0.002
✓	Silvex 2,4,5-TP	ND	mg/L	0.050	EPA Primary	0.005
✓	Simazine	ND	mg/L	0.004	EPA Primary	0.002
✓	Toxaphene	ND	mg/L	0.003	EPA Primary	0.001
✓	Trifluralin	ND	mg/L	--		0.002

Status	Contaminant	Results	Units	National Standards	Min. Detection Level

We certify that the analyses performed for this report are accurate, and that the laboratory test were conducted by methods approved by the U.S. Environmental Protection Agency or variations of these EPA methods.

These test results are intended to be used for informational purposes only and may not be used for regulatory compliance.

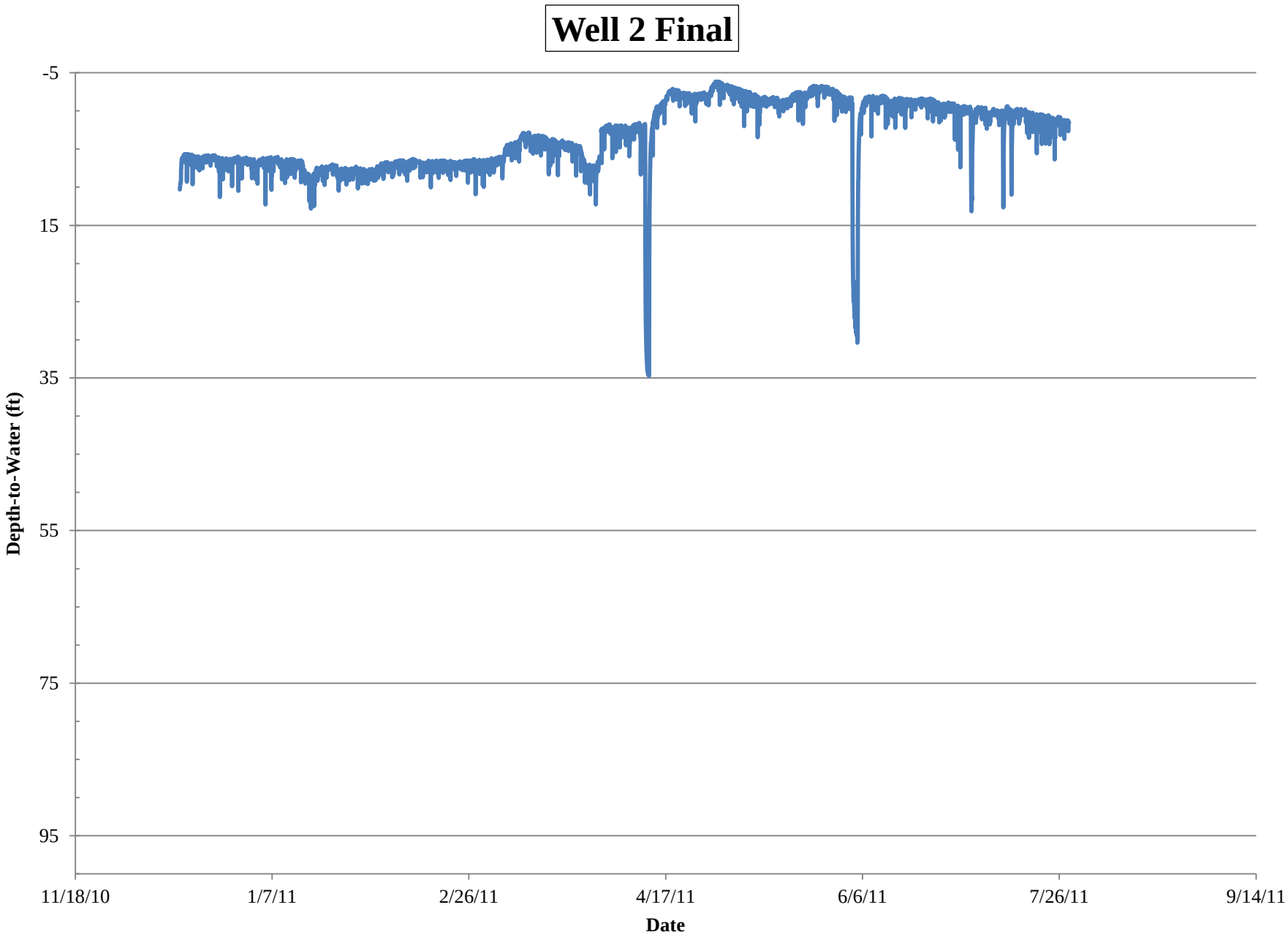
National Testing Laboratories, Ltd.

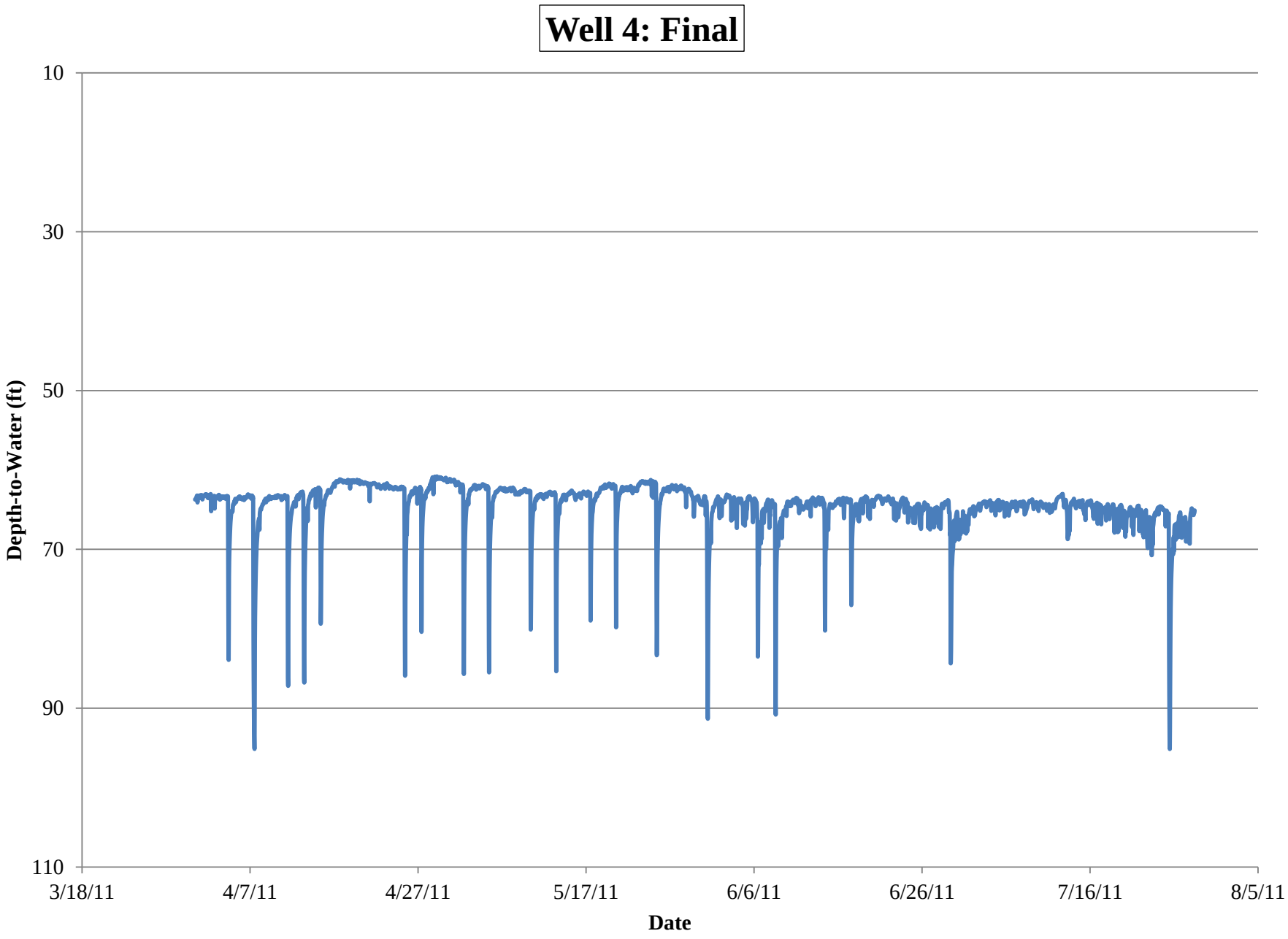
NATIONAL TESTING LABORATORIES, LTD

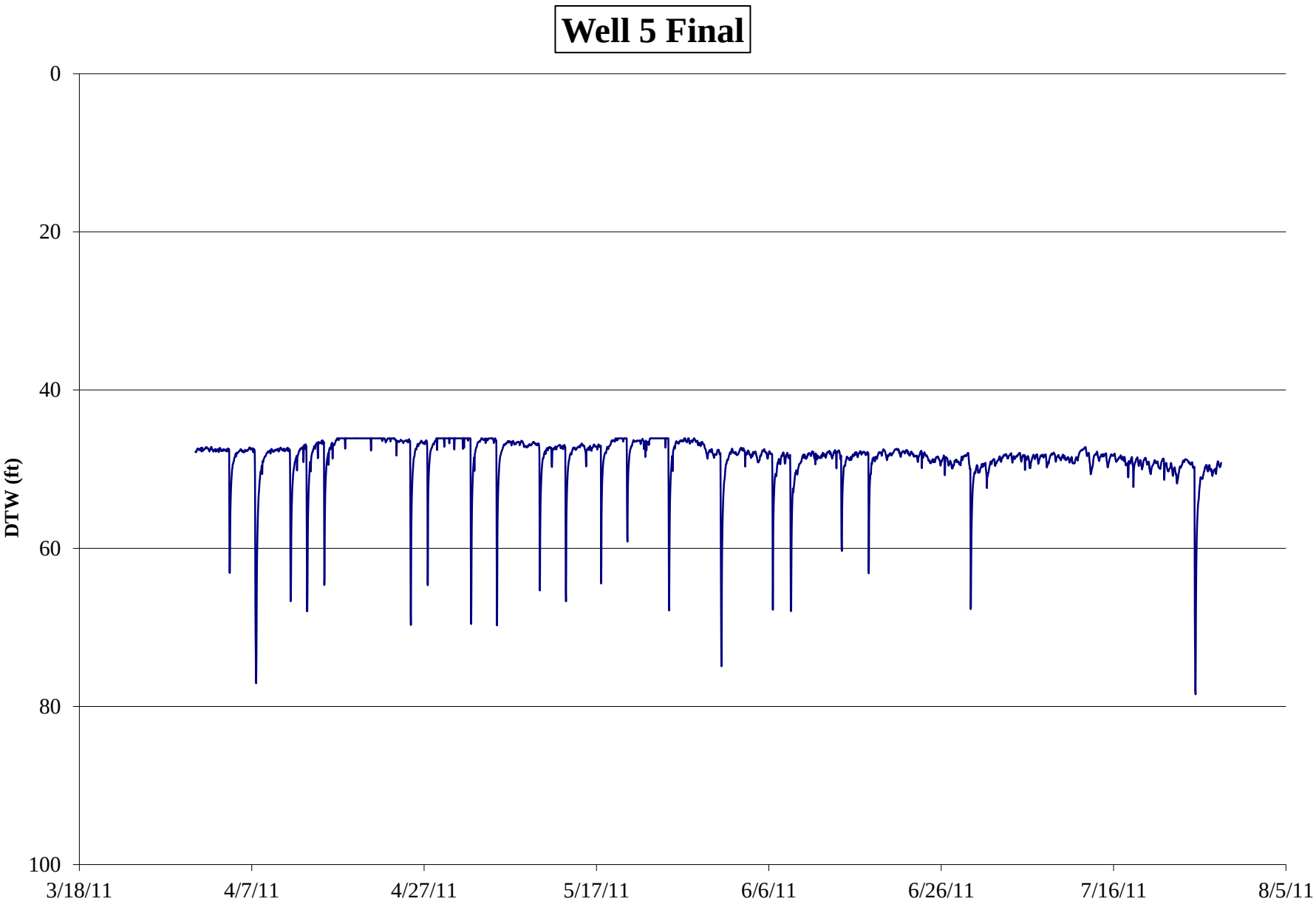
APPENDIX C

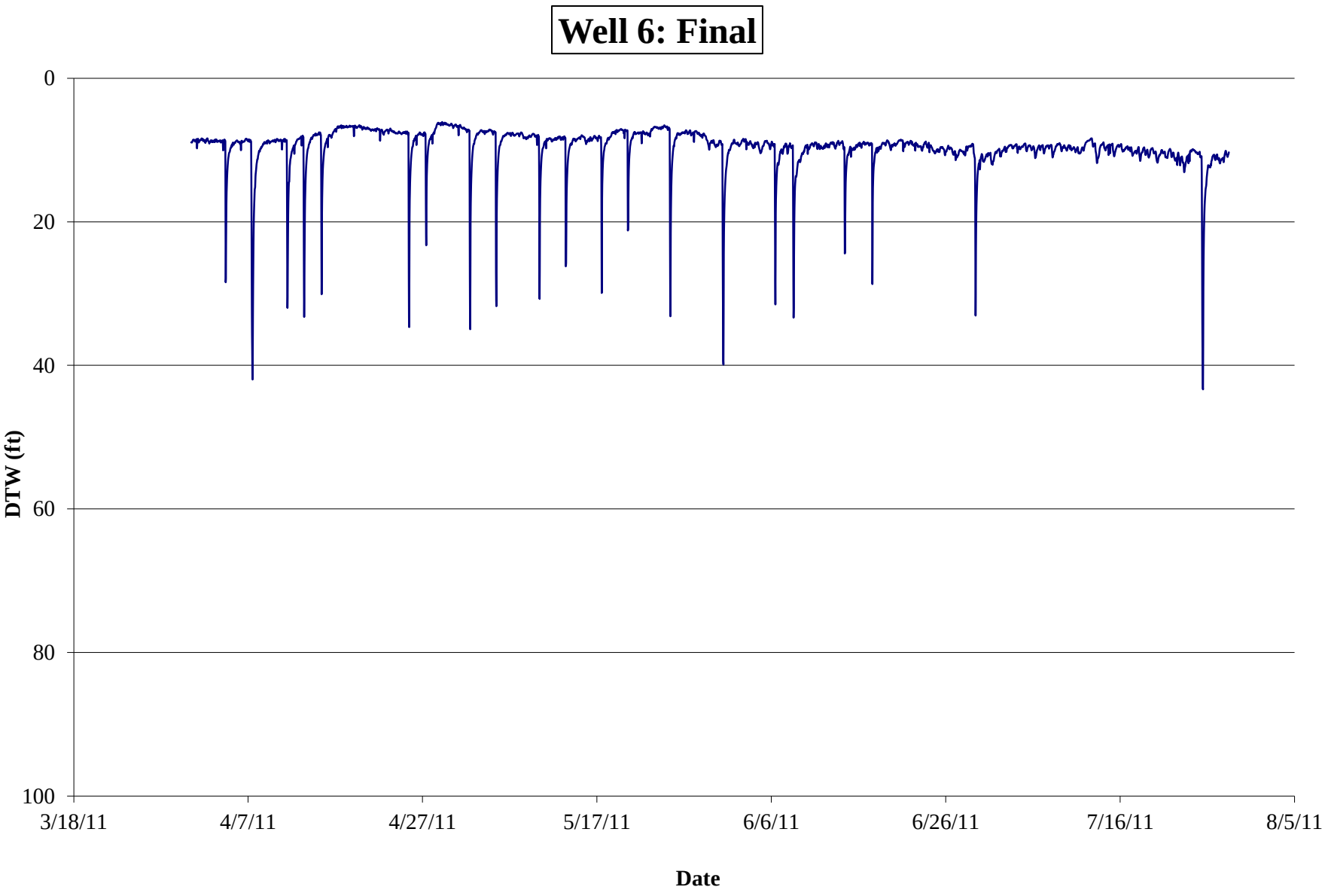
WATER LEVEL GRAPHS FOR INDIVIDUAL WELLS

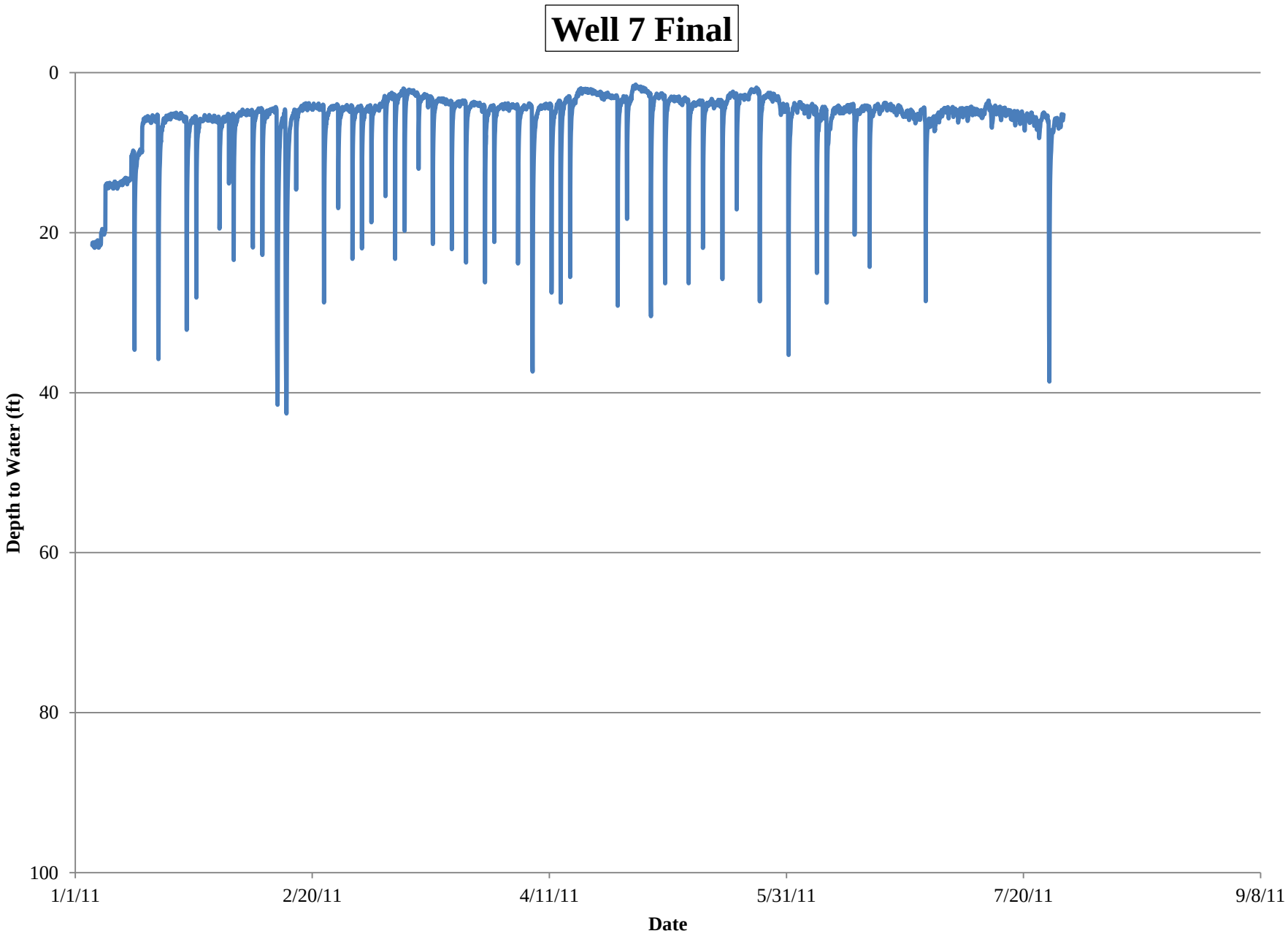
(April, May, June, July 2011)

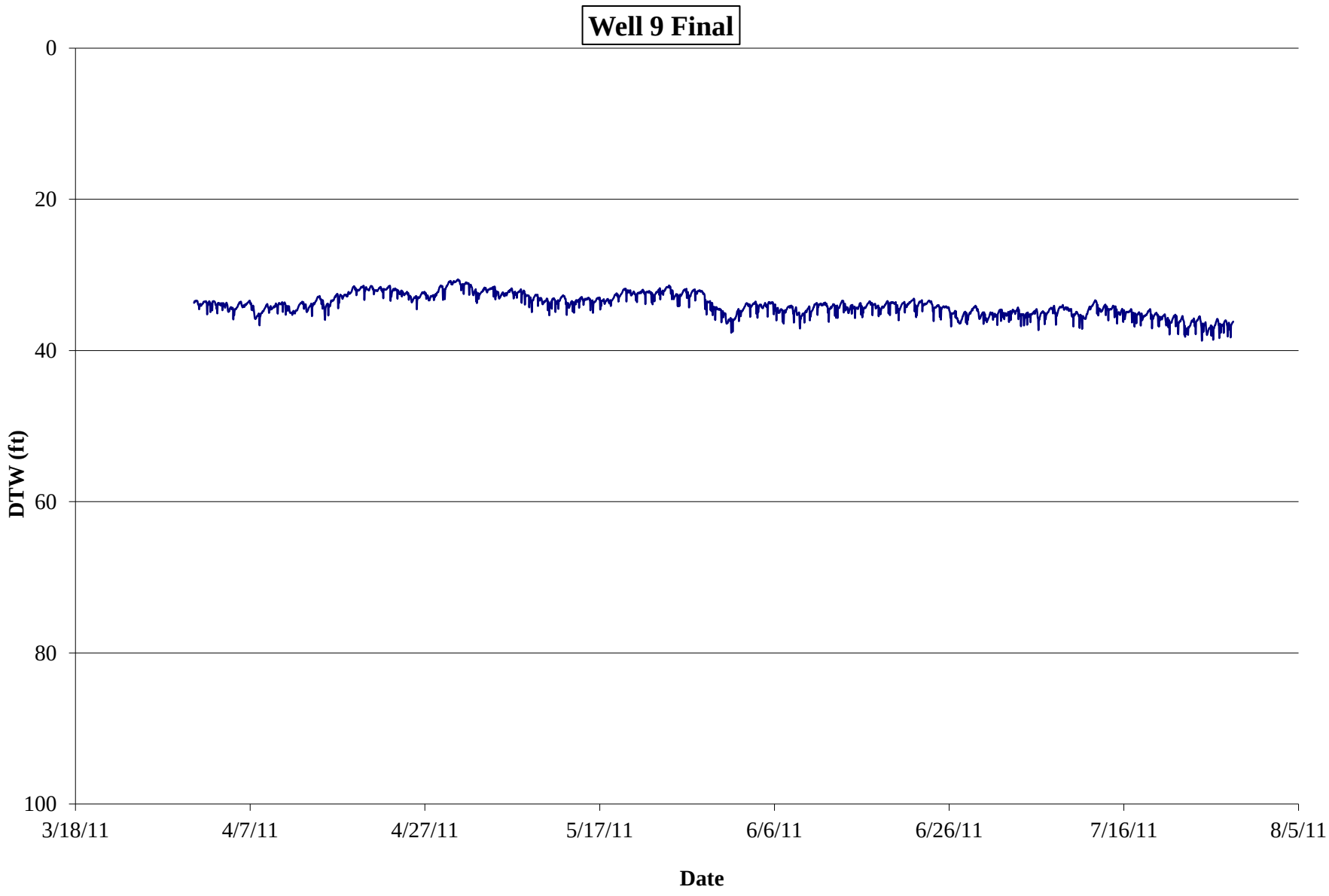

Well 2 Final
-5
15
35
55
75
95
Depth-to-Water (ft)
11/18/10
1/7/11
2/26/11
4/17/11
6/6/11
7/26/11
9/14/11
Date

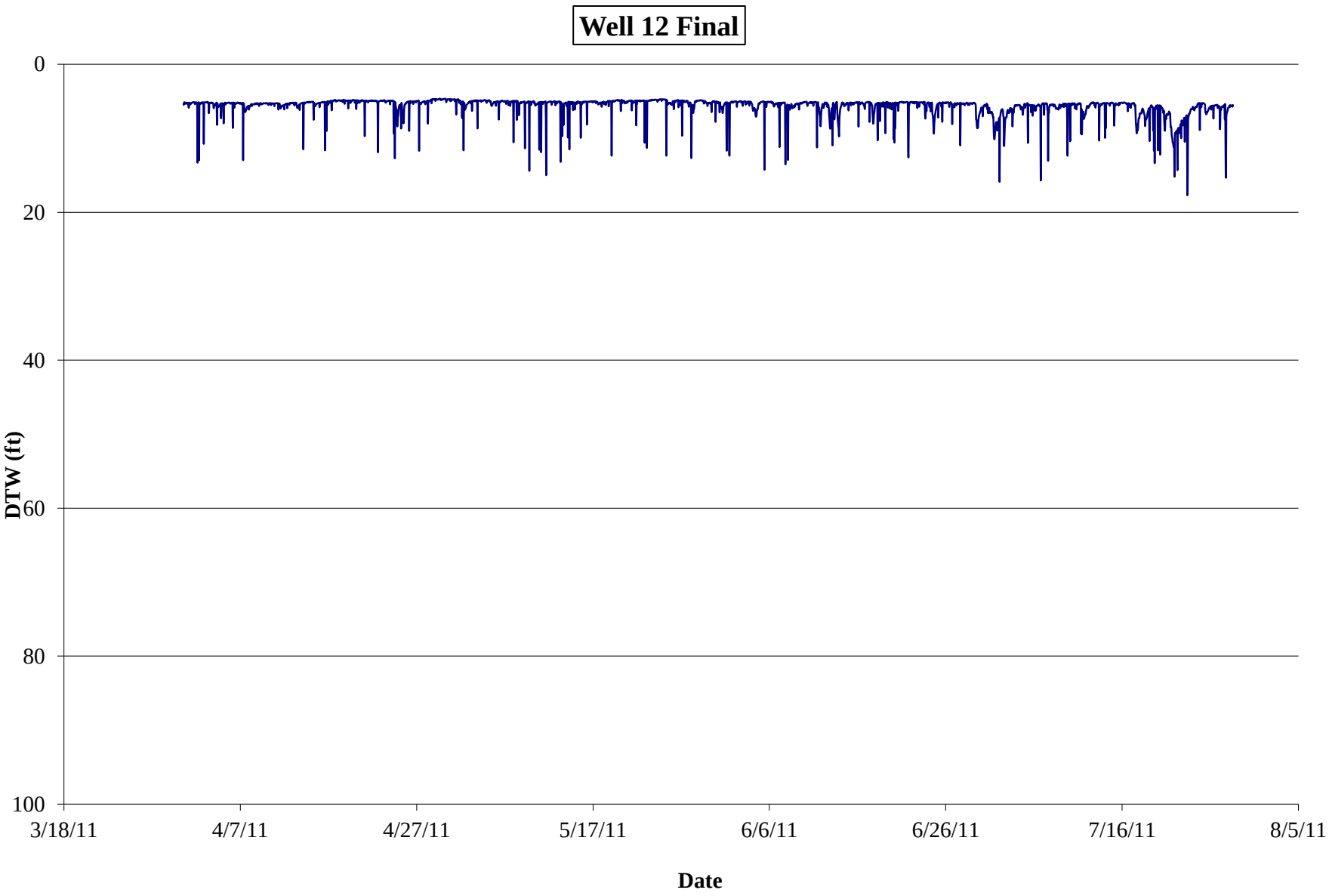

Well 4: Final
10
30
50
70
90
110
Depth-to-Water (ft)
3/18/11
4/7/11
4/27/11
5/17/11
6/6/11
6/26/11
7/16/11
8/5/11
Date

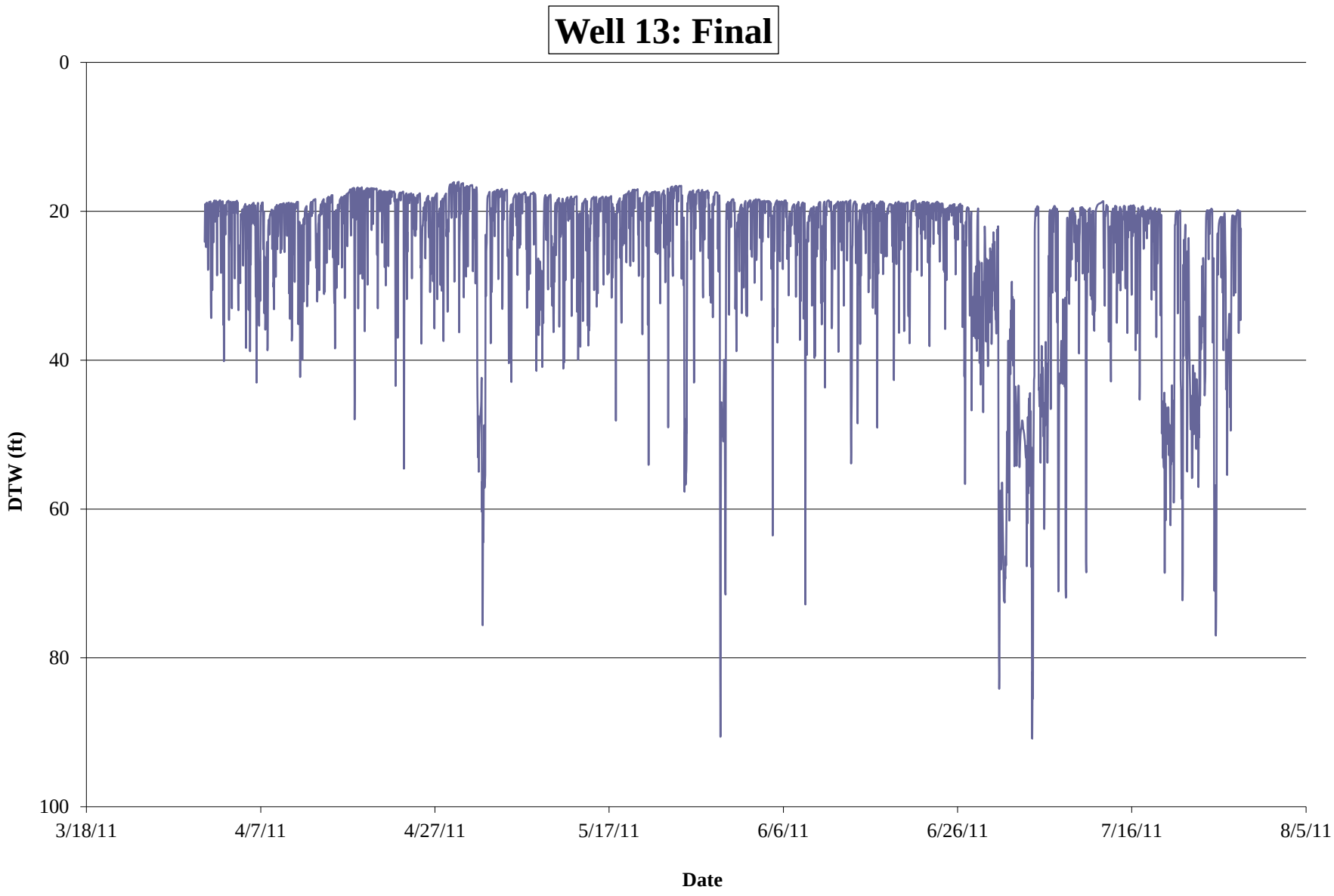

Well 5 Final
DTW (ft)
0
20
40
60
80
100
3/18/11
4/7/11
4/27/11
5/17/11
6/6/11
6/26/11
7/16/11
8/5/11

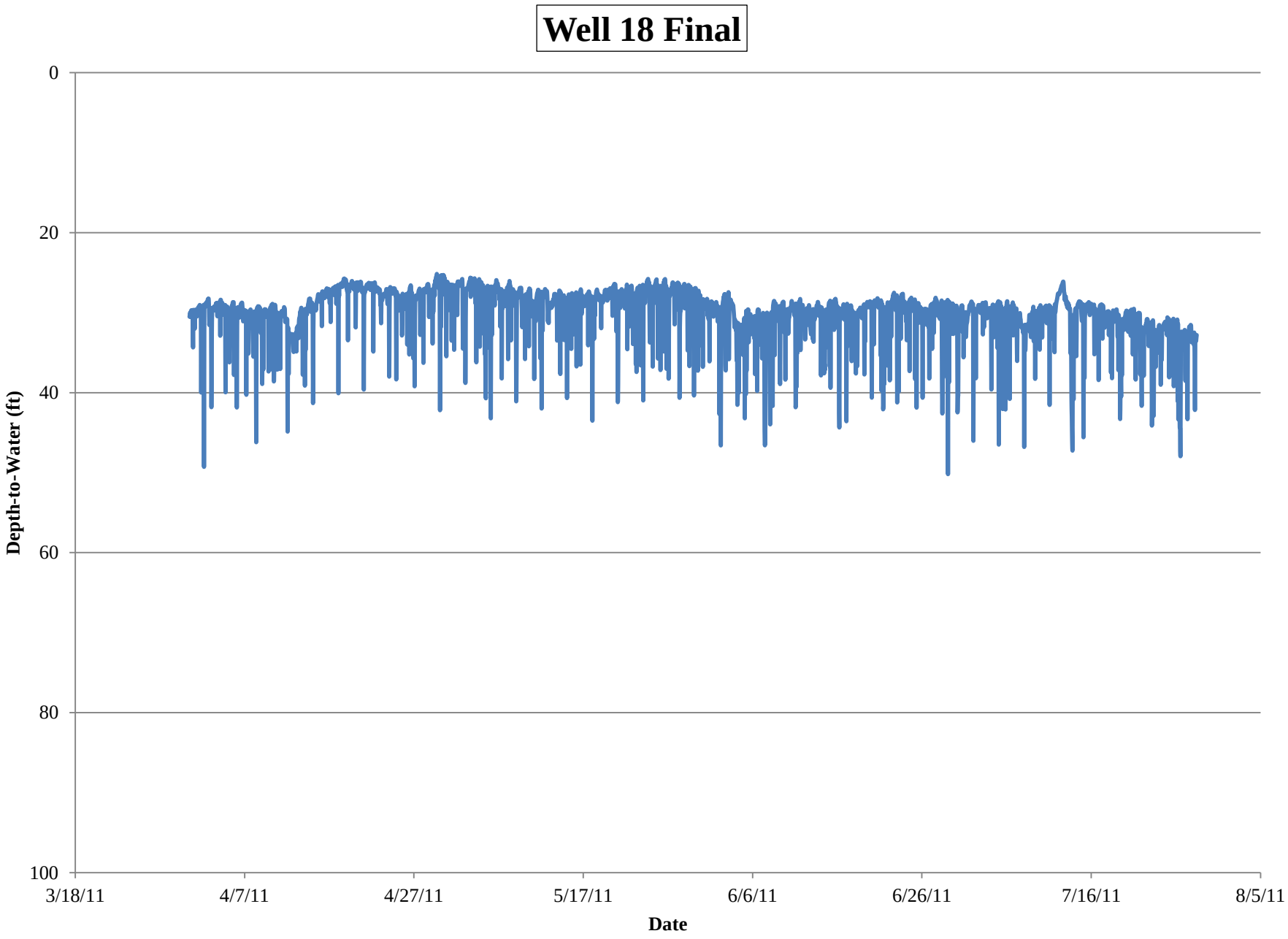

Well 6: Final
0
20
40
60
80
100
DTW (ft)
3/18/11
4/7/11
4/27/11
5/17/11
6/6/11
6/26/11
7/16/11
8/5/11
Date

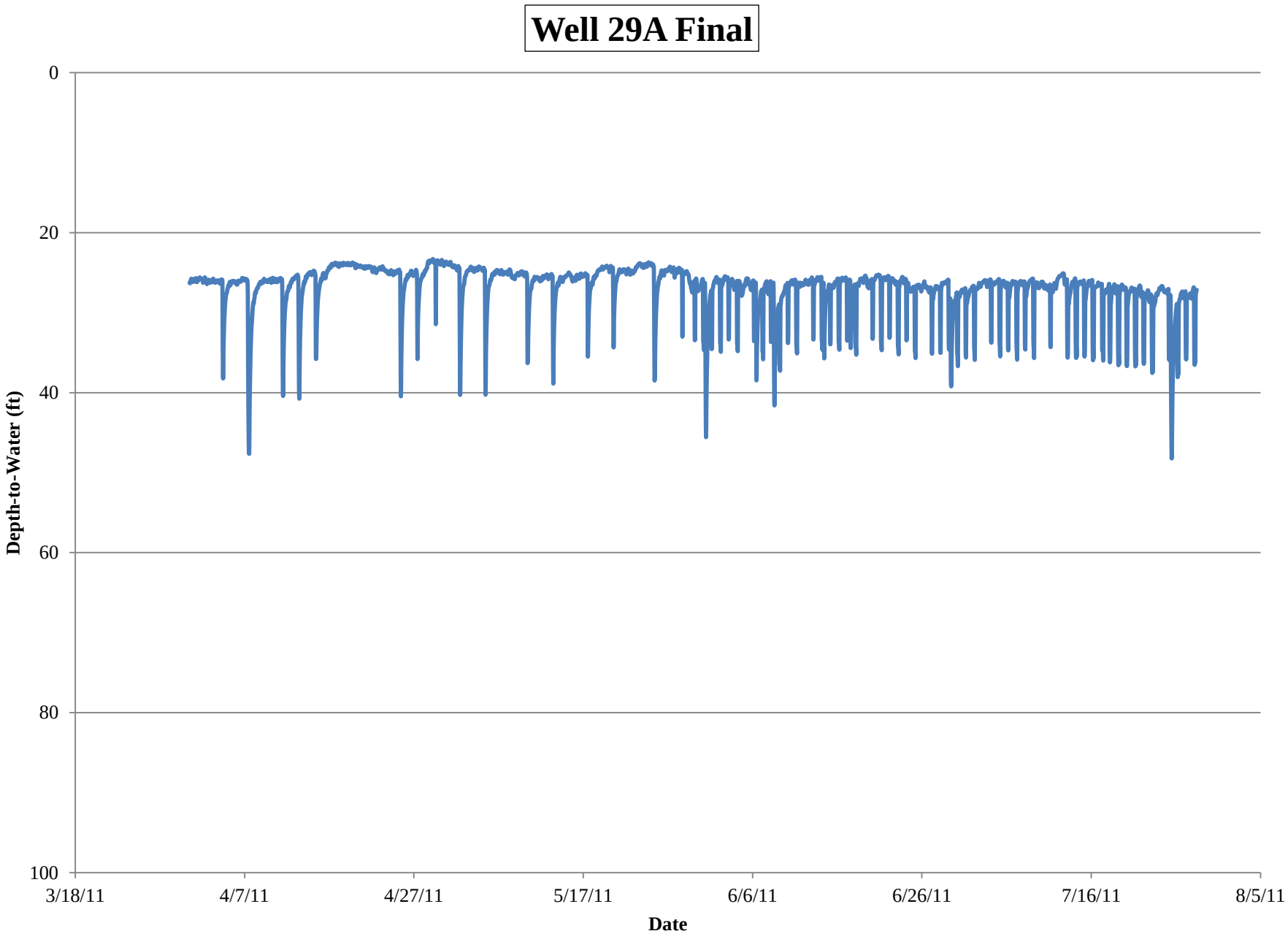

Well 7 Final
0
20
40
60
80
100
Depth to Water (ft)
1/1/11
2/20/11
4/11/11
5/31/11
7/20/11
9/8/11
Date

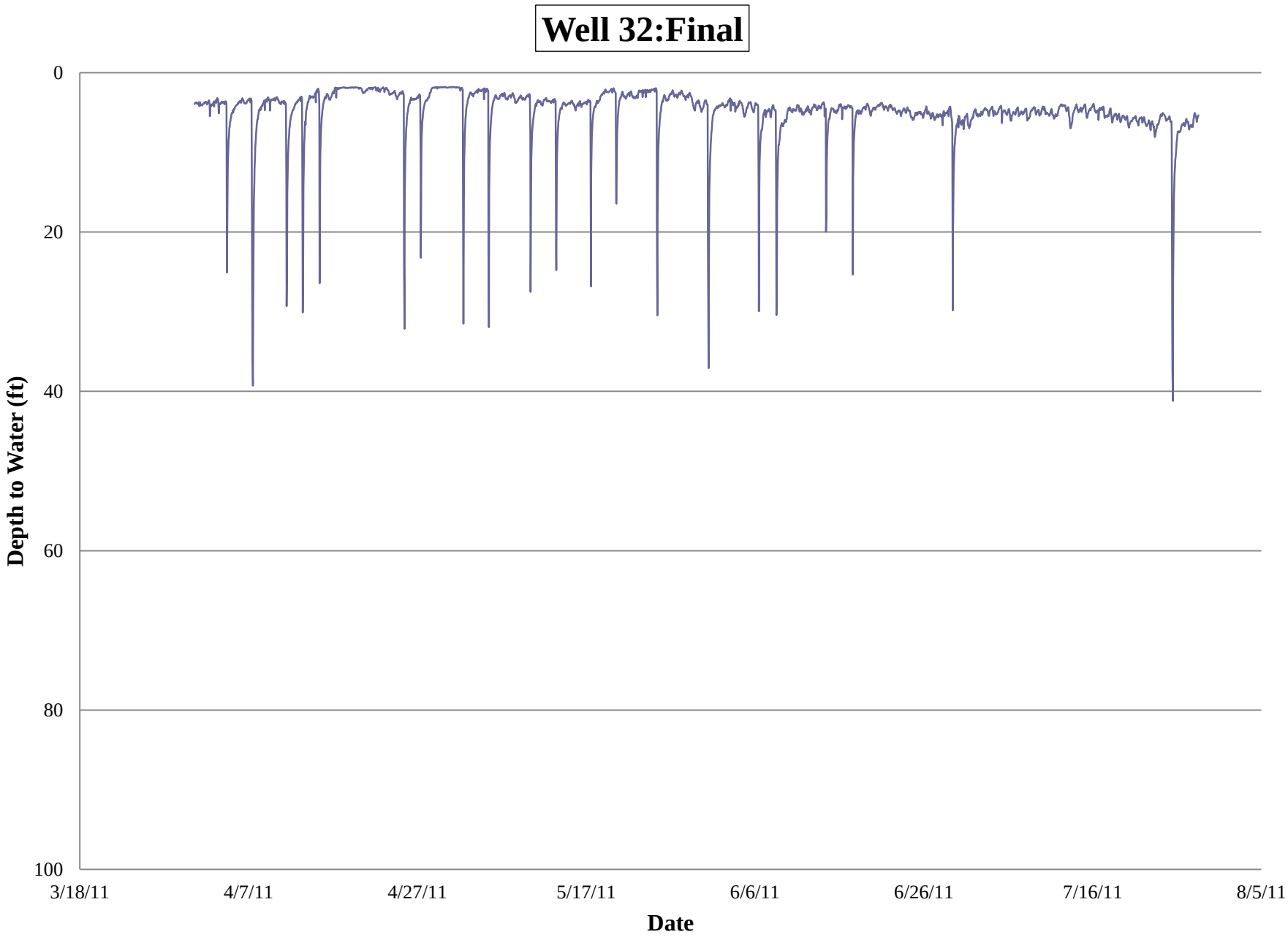

Well 9 Final
0
20
40
60
80
100
DTW (ft)
3/18/11
4/7/11
4/27/11
5/17/11
6/6/11
6/26/11
7/16/11
8/5/11
Date


Well 12 Final
0
20
40
60
80
100
DTW (ft)
3/18/11
4/7/11
4/27/11
5/17/11
6/6/11
6/26/11
7/16/11
8/5/11
Date


Well 13: Final
0
20
40
60
80
100
DTW (ft)
3/18/11
4/7/11
4/27/11
5/17/11
6/6/11
6/26/11
7/16/11
8/5/11
Date

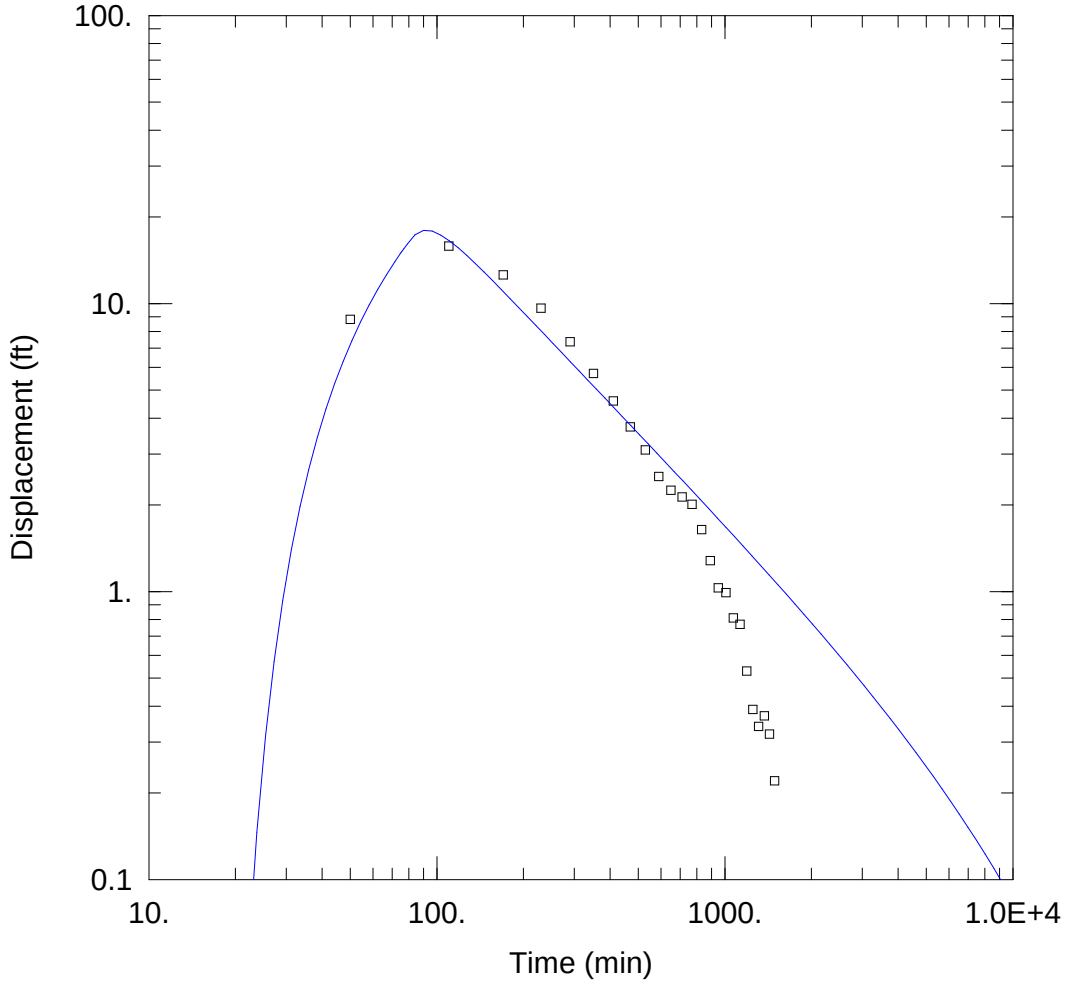

Well 18 Final
0
20
40
60
80
100
Depth-to-Water (ft)
3/18/11
4/7/11
4/27/11
5/17/11
6/6/11
6/26/11
7/16/11
8/5/11
Date


Well 29A Final
0
20
40
60
80
100
Depth-to-Water (ft)
3/18/11
4/7/11
4/27/11
5/17/11
6/6/11
6/26/11
7/16/11
8/5/11
Date


Well 32:Final
0
20
40
60
80
100
Depth to Water (ft)
3/18/11
4/7/11
4/27/11
5/17/11
6/6/11
6/26/11
7/16/11
8/5/11
Date

APPENDIX D

GRAPHICAL ANALYSIS OF MAY 2, 2011, PUMPING EVENT



WELL 29A DRAWDOWN

Data Set: E:\Well 29A.aqt
Date: 09/01/11 Time: 21:09:27

PROJECT INFORMATION

Company: ASI
Client: Town of Hamilton
Project: 3221-2
Location: Hamilton, VA
Test Well: Well 14
Test Date: 5/2/2011

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
Well 14	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
▫ Well 29A	1750	0

SOLUTION

Aquifer Model: Leaky
Solution Method: Hantush-Jacob

T = 0.1246 ft^2/min
r/B = 0.1
b = 250. ft

S = 5.376E-6
Kz/Kr = 1.

Data Set: E:\Well 29A.aqt
Title: Well 29A Drawdown
Date: 09/01/11
Time: 21:12:35

PROJECT INFORMATION

Company: ASI
Client: Town of Hamilton
Project: 3221-2
Location: Hamilton, VA
Test Date: 5/2/2011
Test Well: Well 14

AQUIFER DATA

Saturated Thickness: 250. ft
Anisotropy Ratio (Kz/Kr): 1.
Aquitard Thickness (b'): 1. ft
Aquitard Thickness (b''): 1. ft

PUMPING WELL DATA

No. of pumping wells: 1

Pumping Well No. 1: Well 14

X Location: 0. ft
Y Location: 0. ft

Casing Radius: 0.25 ft
Well Radius: 0.3 ft

Fully Penetrating Well

No. of pumping periods: 2

Pumping Period Data

Time (min)	Rate (gal/min)	Time (min)	Rate (gal/min)
15.	350.	75.	0.

OBSERVATION WELL DATA

No. of observation wells: 1

Observation Well No. 1: Well 29A

X Location: 1750. ft
Y Location: 0. ft

Radial distance from Well 14: 1750. ft

Fully Penetrating Well

No. of Observations: 25

Observation Data

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
50.07	8.8	830.1	1.64
110.1	15.83	890.1	1.28
170.1	12.56	950.1	1.03
230.1	9.64	1010.1	0.99
290.1	7.37	1070.1	0.81
350.1	5.72	1130.1	0.77
410.1	4.59	1190.1	0.53
470.1	3.73	1250.1	0.39
530.1	3.1	1310.1	0.34
590.1	2.51	1370.1	0.37

Time (min)	Displacement (ft)	Time (min)	Displacement (ft)
650.1	2.25	1430.1	0.32
710.1	2.13	1490.1	0.22
770.1	2.01		

SOLUTION

Pumping Test
Aquifer Model: Leaky
Solution Method: Hantush-Jacob

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
T	0.1246	ft^2/min
S	5.376E-6	
r/B	0.1	
Kz/Kr	1.	
b	250.	ft

K = T/b = 0.0004985 ft/min (0.0002532 cm/sec)
Ss = S/b = 2.15E-8 1/ft
K'/b' = 4.069E-10 min^{-1}
K' = 4.069E-10 ft/min

APPENDIX E

WELL 14 PUMPING DATA

APPENDIX C.WELL 14 PUMPING DATA

Date	Gallons Pumped	Well Level (ft)	Pumping Hours
9/1/10		0.0	0
9/2/10	11900	0.0	0.6
9/3/10	0	0.0	0
9/4/10	0	0.0	0
9/5/10	0	0.0	0
9/6/10	0	0.0	0
9/7/10	20400	0.0	0.9
9/8/10	0	0.0	0
9/9/10	15800	0.0	0.8
9/10/10	0	0.0	0
9/11/10	0	0.0	0
9/12/10	0	0.0	0
9/13/10	31600	0.0	1.5
9/14/10	0	0.0	0
9/15/10	0	0.0	0
9/16/10	0	0.0	0
9/17/10	0	0.0	0
9/18/10	0	0.0	0
9/19/10	0	0.0	0
9/20/10	0	151.0	0
9/21/10	0	87.0	1.4
9/22/10	0	50.9	0
9/23/10	0	27.1	2.9
9/24/10		28.0	0.6
9/25/10			
9/26/10	0		
9/27/10	0	42.4	
9/28/10	0	41.7	0.9
9/29/10	0	43.9	0.0
9/30/10		44.0	
September	**79,700**		**9.6**
10/1/10	13300	42.7	0.6
10/2/10	0	44.2	0.0
10/3/10	0	54.3	0.0
10/4/10	11400	57.2	0.6
10/5/10	32800	55.6	1.6
10/6/10	0	60.2	0.0
10/7/10	14300	65.1	0.6
10/8/10	10700	67.6	0.6
10/9/10	0	70.3	0.0
10/10/10	0	71.8	0.0
10/11/10	10100	72.6	0.4
10/12/10	20900	72.2	1.0

APPENDIX C.WELL 14 PUMPING DATA

Date	Gallons Pumped	Well Level (ft)	Pumping Hours
10/13/10	14600	79.7	0.7
10/14/10	15200	80.0	0.8
10/15/10	0	85.0	0.0
10/16/10	0	81.5	0.0
10/17/10	0	86.6	0.0
10/18/10	0	84.8	0.0
10/19/10	27600	88.4	1.3
10/20/10	0	86.5	0.0
10/21/10	17500	87.8	0.8
10/22/10	13100	94.1	0.7
10/23/10	0	98.2	0.0
10/24/10	0	96.1	0.0
10/25/10	13300	98.1	0.6
10/26/10	0	94.9	0.0
10/27/10	16400	89.6	0.8
10/28/10	9700	99.2	0.4
10/29/10	15900	109.0	0.8
10/30/10	0	123.0	0.0
10/31/10	0	137.0	
October	**256,800**		**12.3**
11/1/10	6100	184.0	0.7
11/2/10	0		0.0
11/3/10	0		0.0
11/4/10	8900		0.4
11/5/10	31400		1.5
11/6/10	0		0.0
11/7/10	0		0.0
11/8/10	27300		1.4
11/9/10	0		0.0
11/10/10	0		0.0
11/11/10	0		0.0
11/12/10	35000		1.6
11/13/10	0		0.0
11/14/10	0		0.0
11/15/10	9600		0.5
11/16/10	0		0.0
11/17/10	27000		1.3
11/18/10	0		0.0
11/19/10	16900		
11/20/10			
11/21/10	0		
11/22/10	13800		0.7
11/23/10	100		0.0
11/24/10	0		0.0
11/25/10	0		0.0

APPENDIX C.WELL 14 PUMPING DATA

Date	Gallons Pumped	Well Level (ft)	Pumping Hours
11/26/10	0		0.0
11/27/10	0		0.0
11/28/10	0		0.0
11/29/10	17200		0.8
11/30/10	0		
November	**193,300**		**8.9**
12/1/10	56300		2.8
12/2/10	0		0.0
12/3/10	18300		0.8
12/4/10	0		0.0
12/5/10	0		0.0
12/6/10	0		0.0
12/7/10	10000		0.5
12/8/10	11900		0.6
12/9/10	0		0.0
12/10/10	19600		0.9
12/11/10	0		0.0
12/12/10	0		0.0
12/13/10	28600		1.4
12/14/10	3200		0.2
12/15/10	8400		0.4
12/16/10	0		0.0
12/17/10	19800		0.9
12/18/10	0		0.0
12/19/10	0		0.0
12/20/10	14800		0.7
12/21/10	15600		0.8
12/22/10	0		0.0
12/23/10	0		0.0
12/24/10	0		0.0
12/25/10	0		0.0
12/26/10	0		0.0
12/27/10	29700		1.4
12/28/10	0		0.0
12/29/10	0		0.0
12/30/10	0		0.0
12/31/10	0		
December	**236,200**		**11.4**
January	**NA**		**NA**
2/11/11	-		-
2/12/11	112000		5.5
2/14/11	0		6.3
2/22/11	142000		2.0
2/25/11	42000		1.0
2/26/11	22000		1.0

APPENDIX C.WELL 14 PUMPING DATA

Date	Gallons Pumped	Well Level (ft)	Pumping Hours
2/28/11	24000		1.1
February	**342,000**		**16.8**
3/2/11	0		1.2
3/4/11	24000		0.7
3/7/11	16000		0.7
3/9/11	16000		1.0
3/11/11	21000		1.2
3/15/11	25000		0.7
3/16/11	14000		0.1
3/17/11	3000		1.3
3/21/11	30000		0.1
3/24/11	23000		1.3
3/28/11	27000		1.6
3/30/11	34000		1.0
3/31/11	21000		-
March	**254,000**		**10.7**

APPENDIX E: WELL 14 PUMPING DATA

Date	Totalizer (MGal)	Total Gal.	Well Level Start (ft)*	Well Level Finish (ft)*	Hours Run	Pumps On (time)	Pumps Off (time)
April Total	NA	NA	NA	NA	NA	NA	NA
Mon, 05-02-2011	1.916	42,000	364	291	2.0	09:15	11:15
Thu, 05-05-2011	1.953	37,000	365	291	1.8	09:20	11:05
Tue, 05-10-2011	1.984	31,000	365	295	1.5	09:00	10:30
Fri, 05-13-2011	2.016	32,000	365	296	1.5	09:30	11:00
Tue, 05-17-2011	2.039	23,000	360	296	1.0	12:10	13:10
Fri, 05-20-2011	2.061	22,000	365	296	1.0	12:45	13:45
Wed, 05-25-2011	2.102	41,000	364	286	2.0	10:35	12:35
Tue, 05-31-2011	2.158	56,000	360	282	2.8	09:30	12:15
May Total		**284,000**			**13.5**		
Mon, 06-06-2011	2.185	27,000	360	291	1.2	09:50	11:10
Wed, 06-08-2011	2.227	42,000	356	286	2.0	11:50	13:50
Tue, 06-14-2011	2.249	22,000	360	296	2.0	09:40	10:40
Fri, 06-17-2011	2.27	21,000	360	296	1.0	13:20	14:20
Wed, 06-29-2011	2.303	33,000	364	291	1.5	09:10	10:30
June Total		**145,000**			**7.7**		
Mon, 07-25-2011	2.373	70,000	360	282	3.5	09:15	11:00
July Total		**70,000**			**3.5**		

Note: Air line set at 370 feet below top of casing. NA = Not Available

APPENDIX F

ELECTRONIC MONITORING DATA

Digital monitoring data have been submitted to

Loudoun County Department of Building and Development