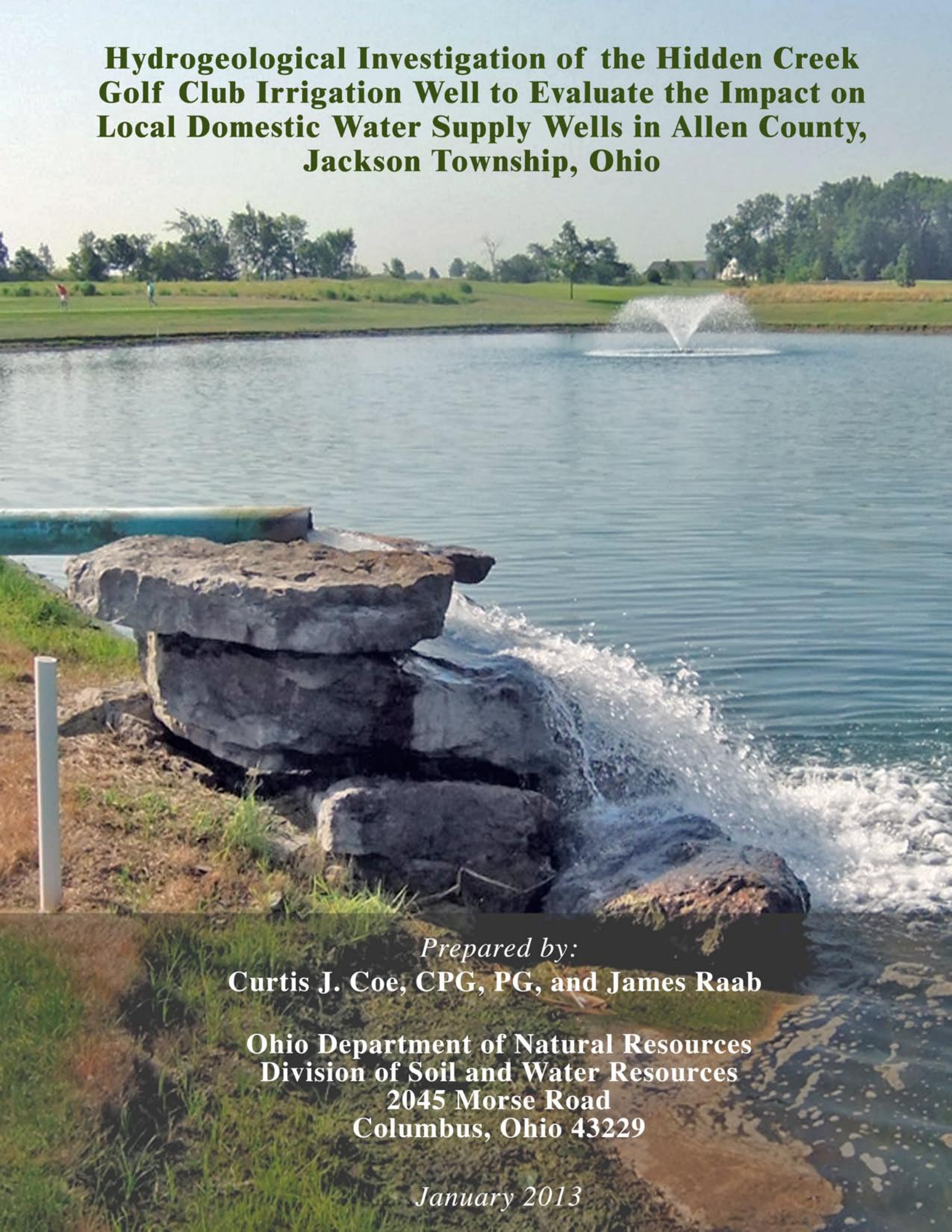
Hydrogeological Investigation of the Hidden Creek Golf Club Irrigation Well to Evaluate the Impact on Local Domestic Water Supply Wells in Allen County, Jackson Township, Ohio



Prepared by:

Curtis J. Coe, CPG, PG, and James Raab

Ohio Department of Natural Resources
Division of Soil and Water Resources
2045 Morse Road
Columbus, Ohio 43229

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ABSTRACT

A ground water investigation of the Hidden Creek Golf Club high-yielding irrigation wells was initiated during July 2012 by the Ohio Department of Natural Resources (ODNR) - Division of Soil and Water Resources (DSWR) at the request of neighboring well owners. The purpose of the investigation was to evaluate the impact of high-yielding irrigation wells on ground water levels in the nearby domestic water supply wells.

Previous work completed in this area confirms that the carbonate bedrock aquifer of northwestern Ohio contains a number of flow zones. The well completion diagram for well M-14 shows the extent to which the flow zones occur in the subsurface. Drilling data shows that the carbonate bedrock aquifer is anisotropic and heterogeneous in its configuration. This gives rise to a number of concerns that need to be considered before long-term pumping rates can be accurately calculated and the data used to design water supply systems.

Pumping test data for the Hidden Creek Golf Club and domestic wells shows that the transmissivity of the aquifer is not uniform throughout the aquifer. It can vary both in the vertical and horizontal directions and may vary over short distances within the carbonate bedrock aquifer when there are significant variations in permeability as well as fracturing. This helps to explain major changes in yield over short distances in both the vertical and horizontal directions.

Field data obtained for this project shows that pumping of the Hidden Creek Golf Club well HPW-1 can have an impact on the local water supply wells. The degree of impact depends on the location of the water well relative to the pumping center and the pumping rate. It also depends on the flow zone from which the water well produces. The cone of depression (radius of impact) around HPW-1 extended approximately 5,000 feet.

To fully define the hydraulic conditions for the Hidden Creek Golf Club high-yielding wells, it is recommended that Hidden Creek Golf Club undertake a hydrogeological assessment to evaluate the impacts that pumping the golf course wells can have on the surrounding domestic water supply wells.

Based on the results of the hydrogeological assessment, the Hidden Creek Golf Club should prepare a report that defines the aquifer characteristics of each well along with a ground water pumping and monitoring plan to prevent dewatering of nearby domestic water supply wells. A mitigation plan should be developed in the event that local domestic water supply wells are affected by pumping associated with the irrigation of the golf course during an irrigation season.

The Hidden Creek Golf Club must complete the ODNR-DSWR Water Withdrawal Facility Registration form and report the ground water usage each year to the ODNR-Division of Soil and Water Resources per ORC 1521.16.

1.0 Introduction

Hidden Creek Golf Club is an 18-hole, public golf course located on Sugar Creek Road northeast of Lima, Ohio. The golf course was built in 1999. At the time that the golf course was built, two high-yielding irrigations wells were installed to water the greens, tees and fairways. Over the last four years, a homeowner (Mr. Dan Stemen) located northwest of the golf course, has complained that the water level in his water well was declining due to over pumping of the Golf Club irrigation wells.

In response to the request of the local homeowner for assistance, the Ohio Department of Natural Resources – Division of Soil and Water Resources (ODNR-DSWR) agreed to conduct an investigation to determine the impact that the irrigation wells were having on local domestic water supply wells.

1.1 SITE LOCATION AND SETTING

Figure 1 is a general site location map that shows the location of the study area in northwestern Ohio. Figure 2 shows the location of the study area relative to important geographic features. Major communities in the area are Lima to the southwest and Beaverdam to the north.

Topographically, the area is characterized by a generally flat, gently rolling appearance. Surface elevation across the area ranges from 840 feet to 900 feet above mean sea level, giving the area a topographic relief of 60 feet.

Physiographically, the study area is located in the Central Ohio Clayey Till Plains (Brockman, 1998). Surface water drainage follows a typical dendritic drainage pattern. In the study area surface water runoff is directed to Sugar Creek which flows to the Auglaize River which in turn flows to the Maumee River. All surface runoff is discharged to Lake Erie.

Land use in the area is dominated by agricultural activity with some minor urban, commercial and industrial development. Home development has occurred mostly along road frontage that crosses the area.

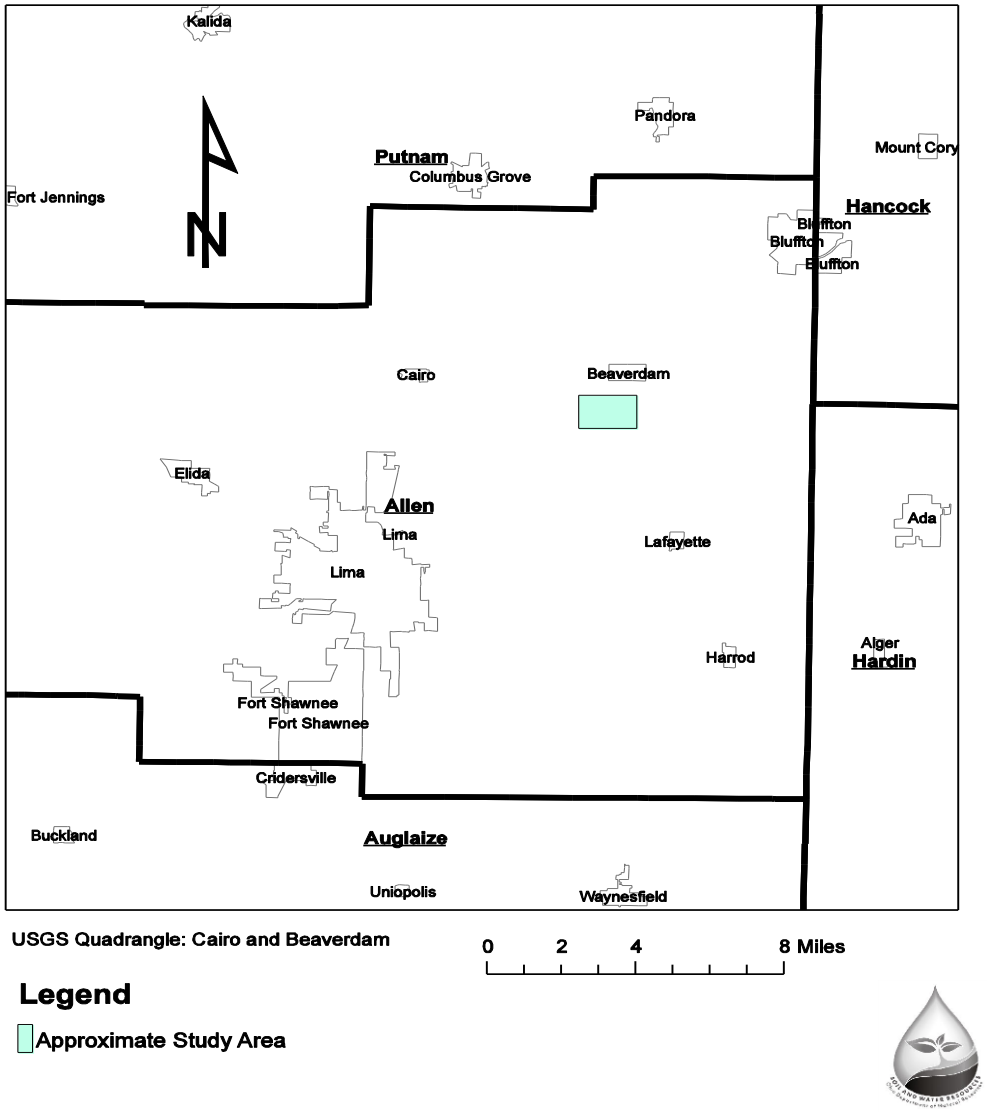
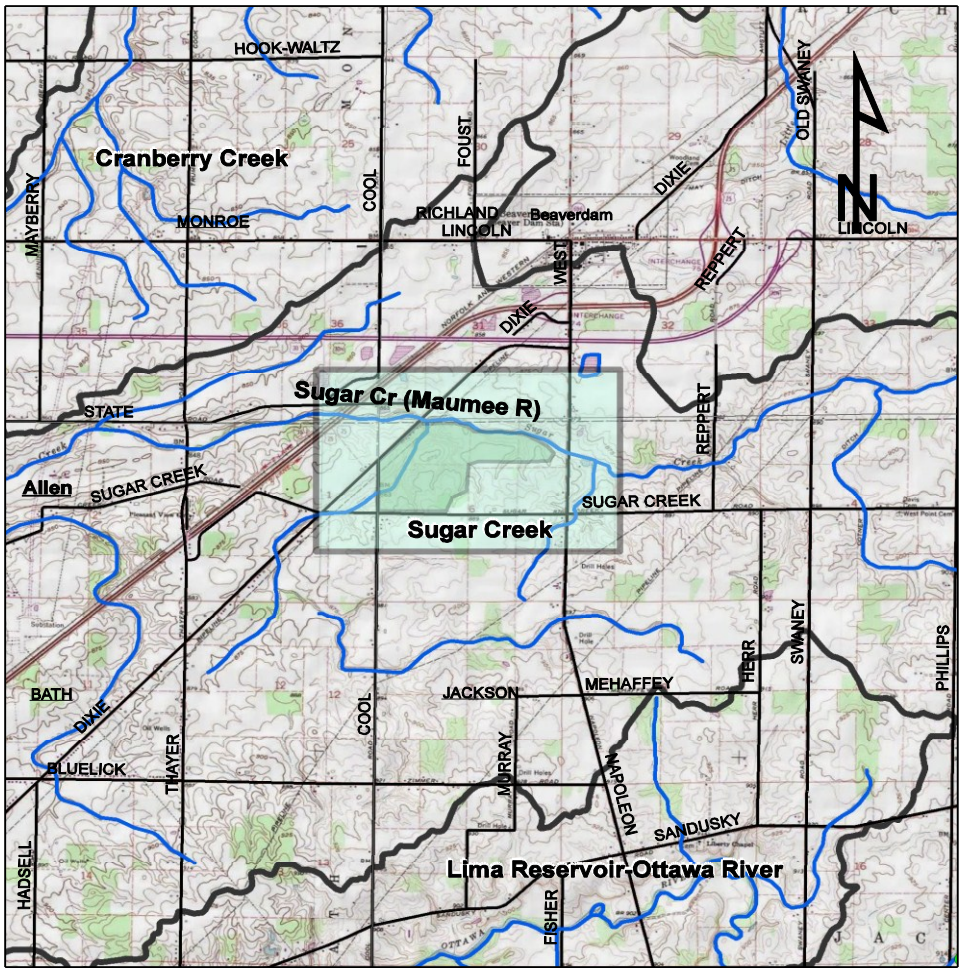


Figure 1. General Site Location Map of the Hidden Creek Golf Club Irrigation Well Study Area



USGS Quadrangle: Cairo and Beaverdam

Legend

- Approximate Study Area
- Hidden Creek Golf Club
- Water Shed Boundaries

0 0.5 1 2 Miles

Figure 2. Topographic Map of Allen County, Jackson Township Study Area

1.2 PURPOSE AND SCOPE OF WORK

The ODNR-DSWR has the authority to collect data to help resolve conflicts between ground water users by conducting technical investigations and preparing related reports to help all ground water users understand the impacts to the resource.

In areas where ground water withdrawals are exceeding natural recharge, the Division can designate ground water stress areas with special reporting requirements for all ground water users. The Division can hold public meetings or hearings upon request from local governments and boards to help disseminate ground water information in conflict areas.

The purpose of this project was to investigate what impact the Hidden Creek Golf Club high-yielding irrigation wells was having on the ground water levels in nearby water supply wells. The ODNR-DSWR assessed the validity of allegations made by local homeowners that the irrigation wells were exceeding reasonable ground water withdrawal rates from the carbonate bedrock aquifer, resulting in the dewatering of the domestic water supply wells.

The scope of work for the project was as follows:

- Review previous work regarding the hydrogeology of the carbonate aquifer in northwest Ohio near Allen County, Jackson Township
- Review well construction and well completion details for the Hidden Creek Golf Club high-yielding wells
- Review well construction and well completion details for domestic water wells in Allen County, Jackson Township near the Hidden Creek Golf Club
- Implement a field investigation to monitor water levels in the high-yielding water wells and selected domestic water wells in the area
- Analyze the data to determine the impact of pumping the high-yielding water wells may have had on the ground water levels in the nearby domestic wells
- Write a report summarizing the conclusions and recommendations obtained from the study to assist with a resolution to the ground water conflict caused by the pumping of the irrigation wells

2.0 PREVIOUS WORK

2.1 HYDROGEOLOGY OF THE STUDY AREA

During the late 1960's, the ODNR- Division of Water (now Division of Soil and Water Resources) implemented a ground water investigation to determine the hydraulic characteristics of the carbonate aquifer of northwestern Ohio (ODNR, 1970). The area of the study included a large part of the Maumee River Basin. The objective of the study was to provide a comprehensive program for the development of the water resources that would give maximum support to the growth and development of the region. To define the subsurface hydraulic characteristics of the limestone and dolomites that compose the carbonate bedrock aquifer, 76 wells were drilled into the subsurface. The study of the carbonate bedrock aquifer system was done as follows:

(1) The lithology of each well was logged.

(2) A 2-hour trial pump test was implemented.

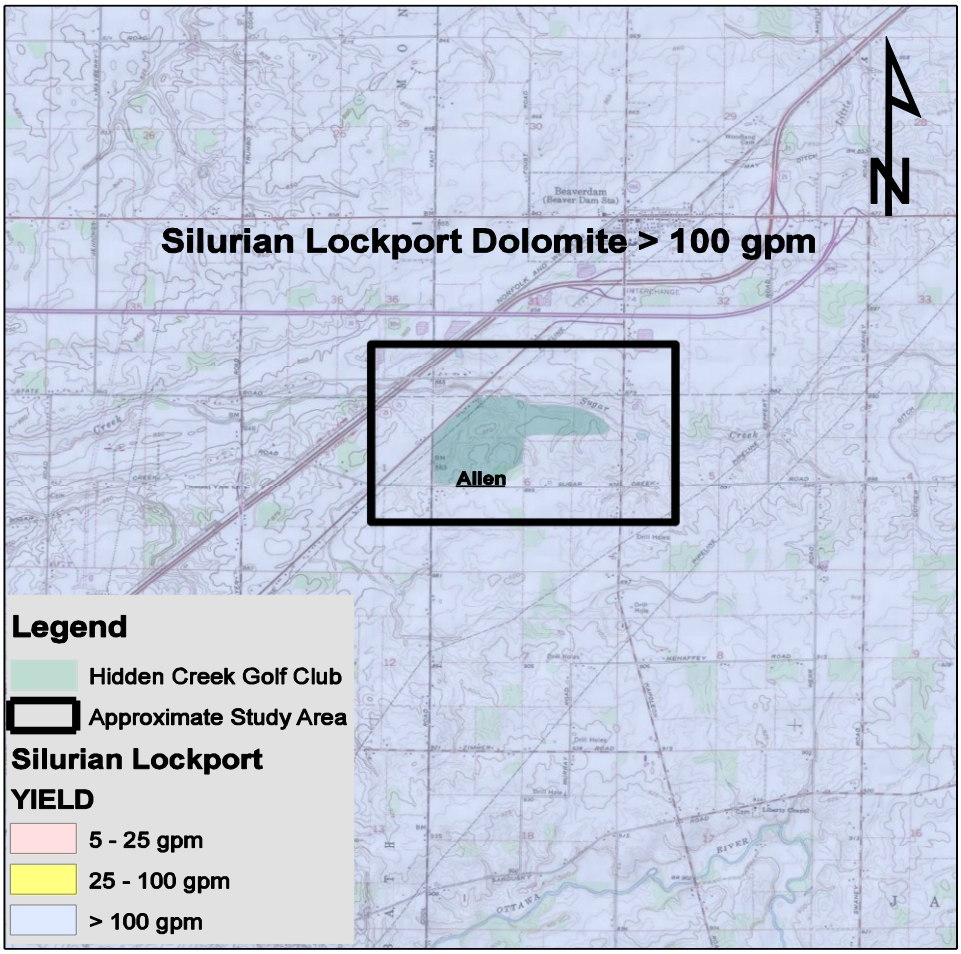
(3) A step test was run to determine well loss and depth of water yielding zones.

(4) A constant rate 24-hour pumping test was implemented to determine carbonate aquifer hydraulic characteristics.

Geologically, the bedrock stratigraphic sequence under the study area consists of the Silurian-age Lockport Dolomite and Tymochtee and Greenfield Dolomites (Slucher et al., 2006). The structure of the bedrock is controlled by the Findlay Arch, which runs just east of the study area. The Findlay Arch separates the bedrock sediments of the Michigan Basin from the Appalachian Basin. Hydrogeologically, the ground water yields from the carbonate bedrock aquifer generally range from 25 to 500 gallons per minute (gpm) with some individual wells producing over 500 gpm (Figure 3).

The carbonate bedrock is overlain by unconsolidated glacial ground moraine sediments of varying thickness as shown on Figure 4. These unconsolidated glacial sediments yield from 5-25 gpm to drilled wells. In some locations where sand and gravel outwash channels exist, the sand and gravel outwash channels can be used as a source of water supply.

Net ground water recharge rates through the glacial ground moraine and lake bed sediment are estimated to be in the range of 4 to 7 inches per year (Angle and Barrett 2005). The recharge occurs in areas where the glacial till is thin or where it contains sand and gravel deposits. Otherwise, the glacial till acts as a confining unit in areas that contain thick clay deposits.



USGS Quadrangle: Cairo and Beaverdam

0 0.5 1 2 Miles

Figure 3. Carbonate Bedrock Aquifer Yield in the Study Area

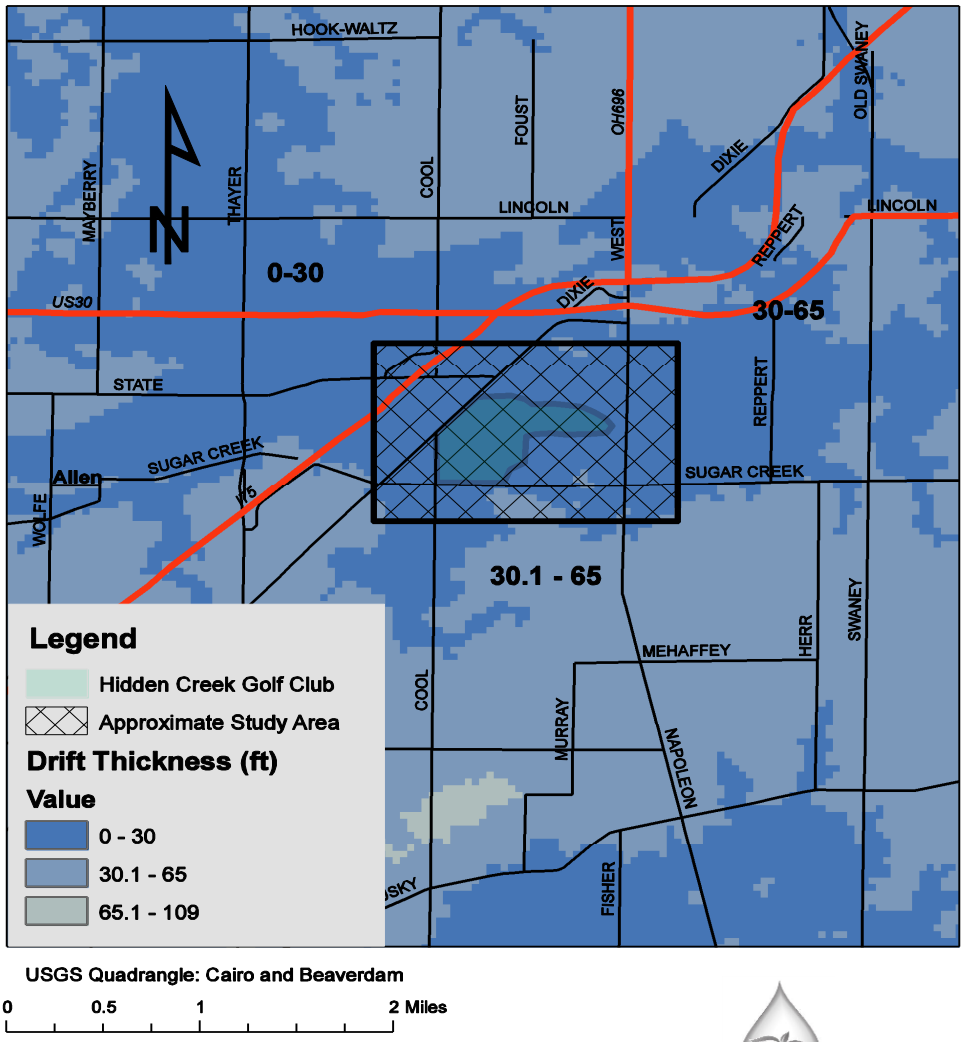


Figure 4. Glacial Aquifer Thickness in the Study Area

It was further noted that the carbonate aquifers in karst terrain are seldom homogenous and need to be interpreted with caution (White and White, 1989 and Eagon and Johe, 1972). As a result, the following characteristics of the carbonate aquifer need to be considered:

(1) The permeability of carbonate aquifers are generally derived from secondary porosity and permeability associated with joints, fractures and solution channels in the bedrock.

(2) The fractures can be connected both vertically and horizontally in ways that are hard to predict.

(3) The occurrence and movement of ground water seldom approach that associated with homogeneous and isotropic aquifer systems.

(4) The carbonate aquifer in Ohio is covered by a layer of glacial ground moraine of varying thickness containing a random mixture of boulder, cobble, gravel, sand, silt and clay-size sediments that were deposited as the glacial ice melted.

(5) Much of the recharge to the underlying carbonate bedrock aquifer is derived from vertical leakage through the overlying unconsolidated glacial sediments.

A number of flow zones in the carbonate bedrock were detected in each of the wells drilled during the northwest Ohio study. The flow zones were an indication of the degree of jointing, fracturing and solutioning in the carbonate sequence encountered in each drilled well. The number of fractures encountered in individual wells could vary from zero up to 10 or more. Ground water yields increased with depth as fracture zones were encountered while drilling the individual water wells (Eagon and Johe, 1972).

During individual pumping tests, it was discovered that the upper water-bearing zones could be dewatered, which affected the pumping test results. As the upper water-bearing flow zones were dewatered, the water level in the pumping well would drop substantially. Further, any additional water pumped from the well was obtained from the lower water-bearing flow zones. An erroneously optimistic prediction of ground water yield from individual wells resulted by not accounting for the drop in water level in the pumping well and the increased well loss due to dewatering of the upper flow zones.

Use of the step test and pumping test data provided valuable insight for predicting the safe pumping level and yield from the carbonate aquifer. When predicting the safe pumping level and yield where dewatering of the upper flow zones occurs, there is no substitute for good step test data. In addition, when regional flow concepts were applied with standard methods, it was possible to obtain reasonable values for hydraulic conductivity, pumping water levels, and safe yields for the carbonate aquifers (Eagon and Johe, 1972).

2.2 REGIONAL GROUND WATER OCCURRENCE AND MOVEMENT

Figure 5 was developed from the ODNR-DSWR well log database to show the regional ground water gradient in the subsurface. This figure shows that the regional ground water movement in the carbonate bedrock aquifer is from the southeast toward the northwest. The ground water elevations vary from 900 feet in the southeast corner of the study area to 850 feet above mean sea level in the northwest corner. The ground water discharge is toward the Maumee River (Haiker, 2009).

2.3 PUMPING TEST ANALYSIS FOR WELL M-14 LOCATED IN ALLEN COUNTY JACKSON TOWNSHIP

A review of the 1970 ODNR-Division of Water report on the carbonate bedrock aquifer revealed that well M-14 was drilled near the study area. This well was used to evaluate the hydraulic characteristic of the carbonate aquifer in the study area because there was no long-term pumping test data available for the Hidden Creek Golf Club irrigation wells. Well M-14 was drilled to a depth of 360 feet below the land surface and had well construction and yield similar to the Hidden Creek Golf Club irrigation wells (ODNR unpublished data, 1968).

The location of well M-14 is shown on Figure 5. The well completion diagram for M-14 is shown on Figure 6.

From the unpublished report on well M-14, a well log, step test, and 24-hour pumping test data were available for the well. From the well log, six flow zones were identified as follows:

- Flow zone 1 was noted at 10 to 20 feet, 20 gpm = 20 gpm
- Flow zone 2 was noted at 50 to 60 feet, 40 gpm = 60 gpm
- Flow zone 3 was noted at 70 to 80 feet, 40 gpm =100 gpm
- Flow zone 4 was noted at 90 to 100 feet, 100 gpm = 200 gpm
- Flow zone 5 was noted at 140 to 150 feet, 10 gpm = 210 gpm
- Flow zone 6 was noted at 200 to 210 feet, 40 gpm = 250 gpm

Thus each flow zone produced between 10 to 100 gpm. The cumulative total ground water flow from the well was approximately 250 gpm.

2.3.1 M-14 Step Test Data Results

The step test was run for six (6) hours. Eight (8) steps were run at 45 minutes per step. The initial step was run at 167 gpm, with each step increased by approximately 25 gpm. The

maximum pumping rate was 360 gpm. The maximum drawdown in the well was approximately 265 feet.

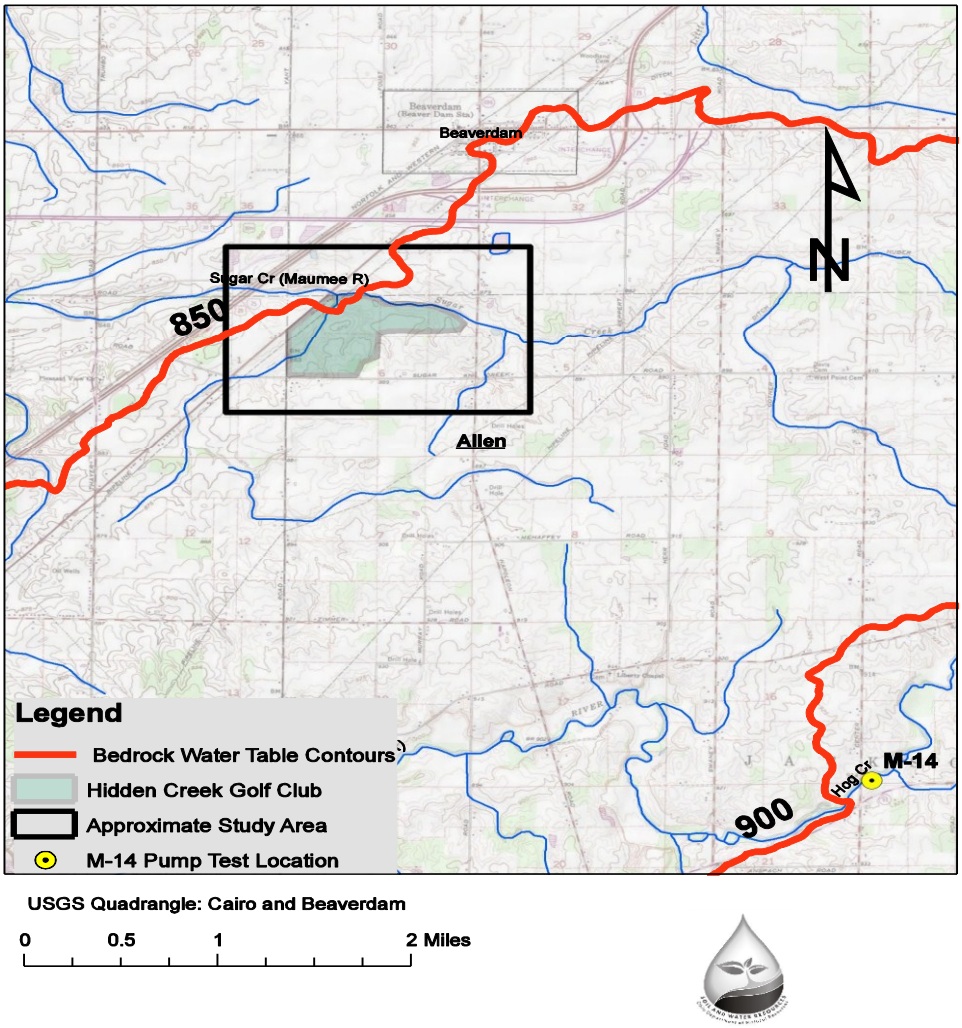


Figure 5. Regional Bedrock Ground Water Flow Gradient Map

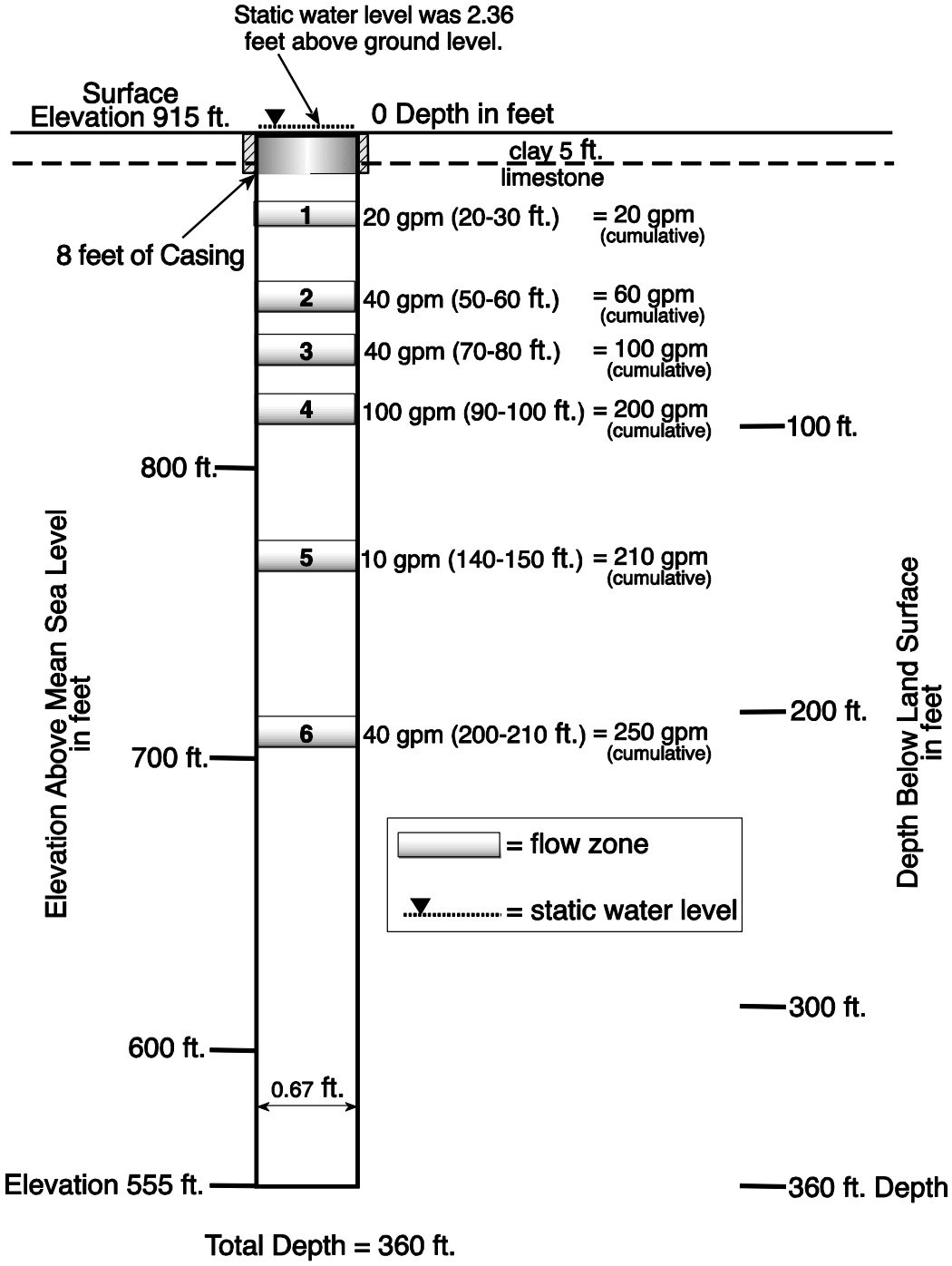


Figure 6. M-14 Well Completion Diagram showing Flow Zones

2.3.2 M-14 24-Hour Pump Test Data Results

Because there was no long term pumping test data for the irrigation wells, it was necessary to turn to literature for the data. The ODNR, Division of Water study *Ground Water for Planning in Northwest Ohio* (1970) provided a wealth of data. The M-14 well characteristics closely matched those of the irrigation wells. Well M-14 was drilled in Allen County, Jackson Township just south of the Hidden Creek Golf Club. The location of M-14 is shown on Figure 5. The pumping test on M-14 was completed as follows:

- A trial pre-pump test was run to estimate the pumping capacity of the well
- A variable-rate step test with six (6) steps was run to estimate the well efficiency
- A 24-hour constant-rate pumping test was run to estimate aquifer characteristics

Based on the results of the step test, the constant rate test was run at 200 gpm for a period of 24 hours. The original static water level in the well was 2.34 feet above the land surface. It was noted that the well flowed at approximately 10 gpm. The total drawdown in the well was measured at 70 feet. The specific capacity for the 24-hour pumping test was approximately 2.8 gpm/foot of drawdown.

Data input from the pumping test taken from the unpublished ODNR report are as follows:

- Pumping rate: 200 gpm
- Well Depth (b): 360 feet
- Original Static Water Level: +2.34 feet
- Specific Capacity: 2.8 gpm/ft.
- Glacial Till Thickness (b’): 38 ft.
- Radius of the Well (rw): 0.42 feet
- Radius of the Casing (rc): 0.50 feet

M-14 pumping test analysis was done using the confined model with the Cooper-Jacob solution. Based on the Cooper-Jacob solution, the original transmissivity was estimated to be 19,000 gallons/day/foot. The original storage coefficient of the aquifer was estimated to be 0.00018.

2.4 GROUND WATER QUALITY OF THE CARBONATE BEDROCK AQUIFER NEAR THE HIDDEN CREEK GOLF CLUB STUDY AREA

During the 1970 ground water investigation of the carbonate bedrock aquifer, the ODNR – Division of Water also studied the ground water quality of the aquifer. Seventy-five of the wells were tested to evaluate the chemical quality of the ground water. Ground water quality of the aquifer is largely controlled by the soluble minerals in the water–bearing unit. The mineralization of the water generally increases with depth. Although bicarbonate and calcium are the predominant ionic constituents in ground water, sulfates and chlorides are the major dissolved substances. Over 70 percent of the wells sampled in the study area contain varying concentrations of hydrogen sulfide (H_2S).

In the study area, the sulfate concentration can range from approximately 295 milligrams per liter (mg/l) up to 404 mg/l. The dissolved solids concentration can range from approximately 530 mg/l up to 920 mg/l. The hydrogen sulfide concentration can vary from 3.7 mg/l up to 22 mg/l.

2.5 WATER WITHDRAWAL FACILITY REGISTRATION PROGRAM

The Water Withdrawal Facility Registration (WWFR) Program, as established in H.B. 662 by the Ohio General Assembly in 1988, implements one of the objectives of the Great Lakes Charter in Ohio. The Great Lakes Charter serves as a good-faith agreement among governors and premiers of the Great Lakes states and provinces to establish a regional approach to Great Lakes water resource management programs. The regional approach will strengthen the states' effort to protect and better manage such a vital resource in this water-rich Great Lakes Region.

The Charter recognized the need for good water resource data as fundamental to water resource planning, management, and protection. The recommendation to create a water withdrawal facility registration program resulted because many states and provinces did not have the necessary authority to collect such data.

The drought of 1988 raised many concerns about water use and management in Ohio. Many communities and businesses sought alternative water sources to supplement depleted supplies. Also, conflicts and questions arose in the competition for a limited water resource. The state did not have adequate information to assist everyone seeking additional water. Without the knowledge of water withdrawals in an area, state officials risked referring water withdrawers to a source of water already limited by current demands.

Section 1521.16 of the Ohio Revised Code requires any owner of a facility, or combination of facilities, with the capacity to withdraw water at a quantity greater than 100,000 gallons per day (gpd) to register such facilities with the ODNR Division of Soil and Water Resources. The WWFR Program will provide information of great importance to the citizens of the state. Water, one of our most basic and precious natural resources, needs to be studied more intensely and water resource planners need reliable information to plan for the future. The state's economy

depends on water and economic development will continue to place increased demands on this critical resource (ODNR-DSWR website).

The ground water stress area legislation, signed in April of 1990, gave the Chief of the Division of Water (now the Division of Soil and Water Resources) the authority to designate an area as a ground water stress area and establish a threshold withdrawal capacity lower than 100,000 gpd for the area in terms of water withdrawal registration. Any person who withdraws water at a rate greater than a specified threshold (for example, 10,000 gpd) in a ground water stress area would be required to register the facility with the Chief. Registration is not intended to regulate use of ground water, but only to gather additional information for resolving conflicts and guiding or advising new users. Annual reports must also be submitted for these facilities. There is currently no ground water stress areas designated in Ohio.

The ground water facilities registration forms can be found on the ODNR-Division of Soil and Water Resources website at:

http://www.dnr.state.oh.us/water/tabid/20441/Default.aspx#WWFR%20Forms

3.0 Methods of the Investigation

Prior to implementing this project, the ODNR-DSWR reviewed the Ohio Revised Code concerning ground water supply development in Ohio. Standard hydrogeological as well as engineering practices were used to carry out all fieldwork and data analysis (Bair and Lahm, 2006; Driscoll, 1986; Fetter, 2001; Kruseman and deRidder, 1990; Merritt, 1983).

A partial glossary has been attached at the end of this report for those who are not familiar with the subject matter. The reader can refer to the Encyclopedic Dictionary of Hydrogeology by Poehls and Smith (2009) for further reference.

3.1 ODNR WEBSITE SEARCH

As part of the investigation, the ODNR-DSWR conducted a search of the water well record database for Allen County, Jackson Township to identify the number of domestic water wells within the study area (ODNR-DSWR website, 2011). The records show that approximately 727 wells have been drilled in Jackson Township since the late 1940's. Items identified in the database are the ODNR well log number, original owner of the well, well depth, test rate, static water level and aquifer type. Figure 7 shows the locations of 20 wells with known coordinates located in the study area.

Data for the 20 wells located within the study area are as follows:

(1) The majority of the wells drilled in the area are completed in the carbonate bedrock aquifer. An occasional well may be completed in the sand and gravel bed within the glacial till.

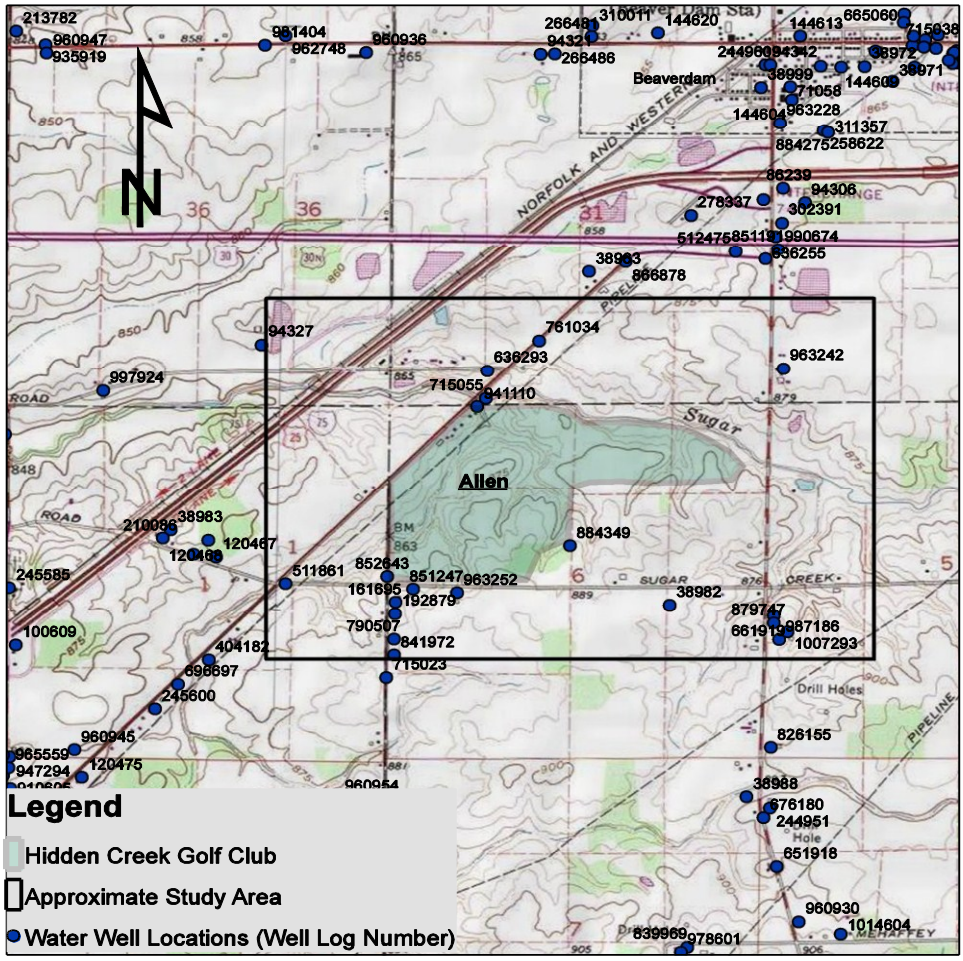
(2) Well depths range from 30 to 114 feet below the land surface with an average well depth of 62 feet.

(3) Pumping rates vary from 4 to 40 gpm with an average pumping rate of 15 gpm.

(4) Static water levels in the wells vary from 14 to 60 feet below the land surface with an average static water level of 25 feet.

Ground water recharge and movement in the subsurface typically occur through the glacial till and migrate to deeper levels in the carbonate bedrock aquifer along fracture patterns within the bedrock.

All water wells in the database were evaluated to select the most appropriate data points for use in the study. A print-out of the ODNR well log database for the 20 wells in the study area is presented in Appendix A.



USGS Quadrangle: Cairo and Beaverdam

0 0.25 0.5 1 Miles

Figure 7. Water Supply Well Locations in the Allen County Study Area

3.2 HIDDEN CREEK GOLF CLUB HIGH-YIELDING IRRIGATION WATER WELL COMPLETION DETAILS

The first step in the study was to define the limits of the study area using the location of the irrigation wells. Figure 8 shows the location of the Hidden Creek Golf Club water wells identified in the Allen County, Jackson Township study area. Information about each well is listed in Table 1. The study area is defined between State Road and Dixie Highway to the north and west, Sugar Creek Road to the south and Napoleon Road to the east.

Individual well completion diagrams for the two Hidden Creek Golf Club irrigation wells are shown on Figures 9 and 10. These data show the individual well completion for each of the wells. The original well logs can be found in Appendix B.

Table 1. Hidden Creek Golf Club irrigation wells, Allen County, Jackson Township

Well-Log No.	Well Symbol	Latitude	Longitude	Well Depth (feet)	Test Rate (gpm)	Casing Length (feet)	Surface Elevation (feet amsl)	Static Water Level (feet)
1014543	HPW1	40.816965	-83.987328	400	400+	28	867	12
1014542	HOB1	40.816736	-83.988861	335	300+	32	868	14

3.3 DOMESTIC WATER WELLS USED TO MEASURE THE EFFECTS OF PUMPING THE HIGH-YIELDING HIDDEN CREEK GOLF CLUB IRRIGATION WATER WELL

Once the study area was defined, observation wells were selected from the available water wells. Each homeowner was approached to gain permission to monitor the water level in their well. Water well records used for this investigation are presented in Appendix C. Figure 8 also shows the locations of water wells in the study area that were used for monitoring purposes. Data regarding these water wells is shown in Table 2.

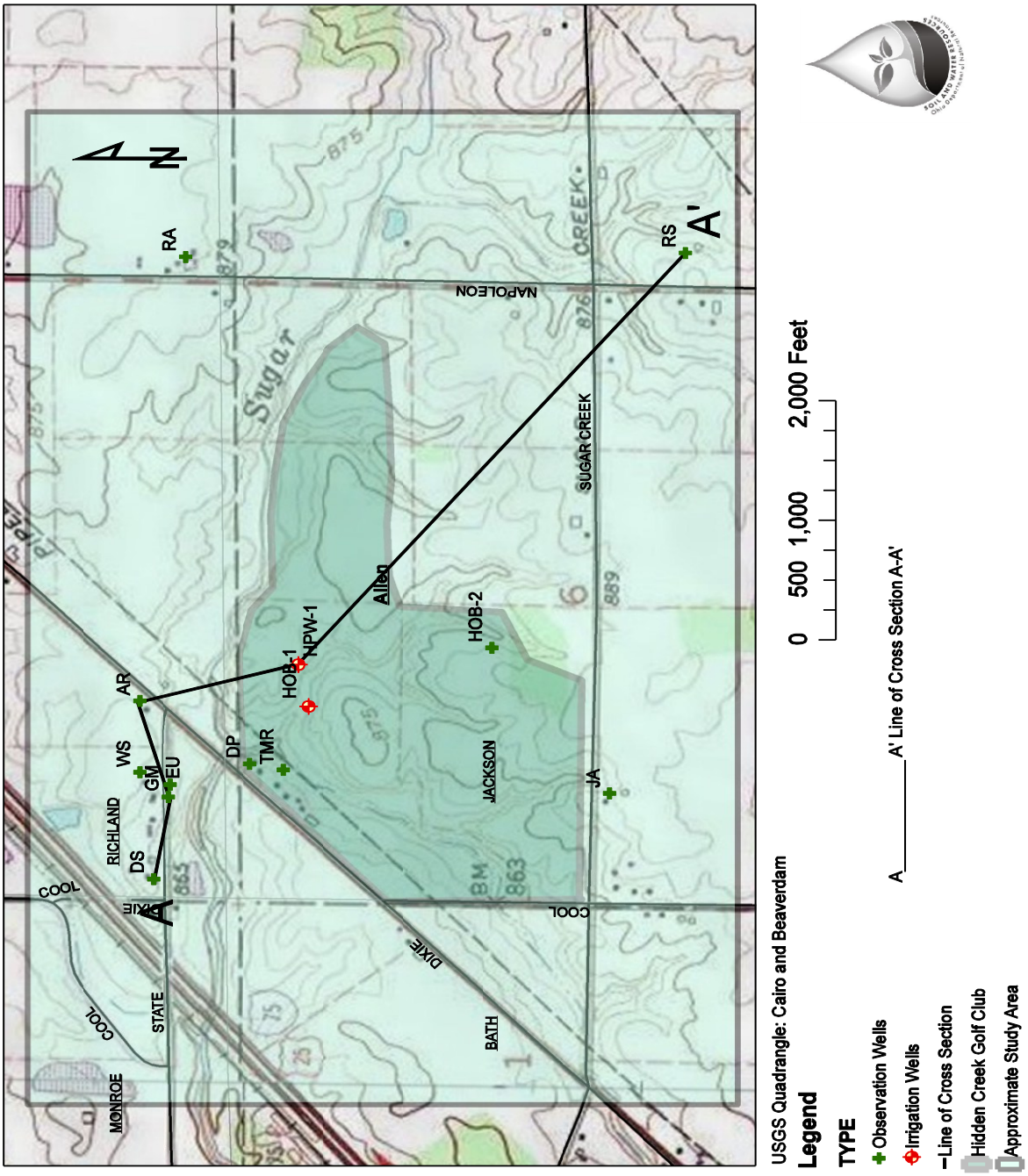


Figure 8. Location of Irrigation and Water Supply Wells Used to Monitor Ground Water Levels in the Carbonate Bedrock Aquifer

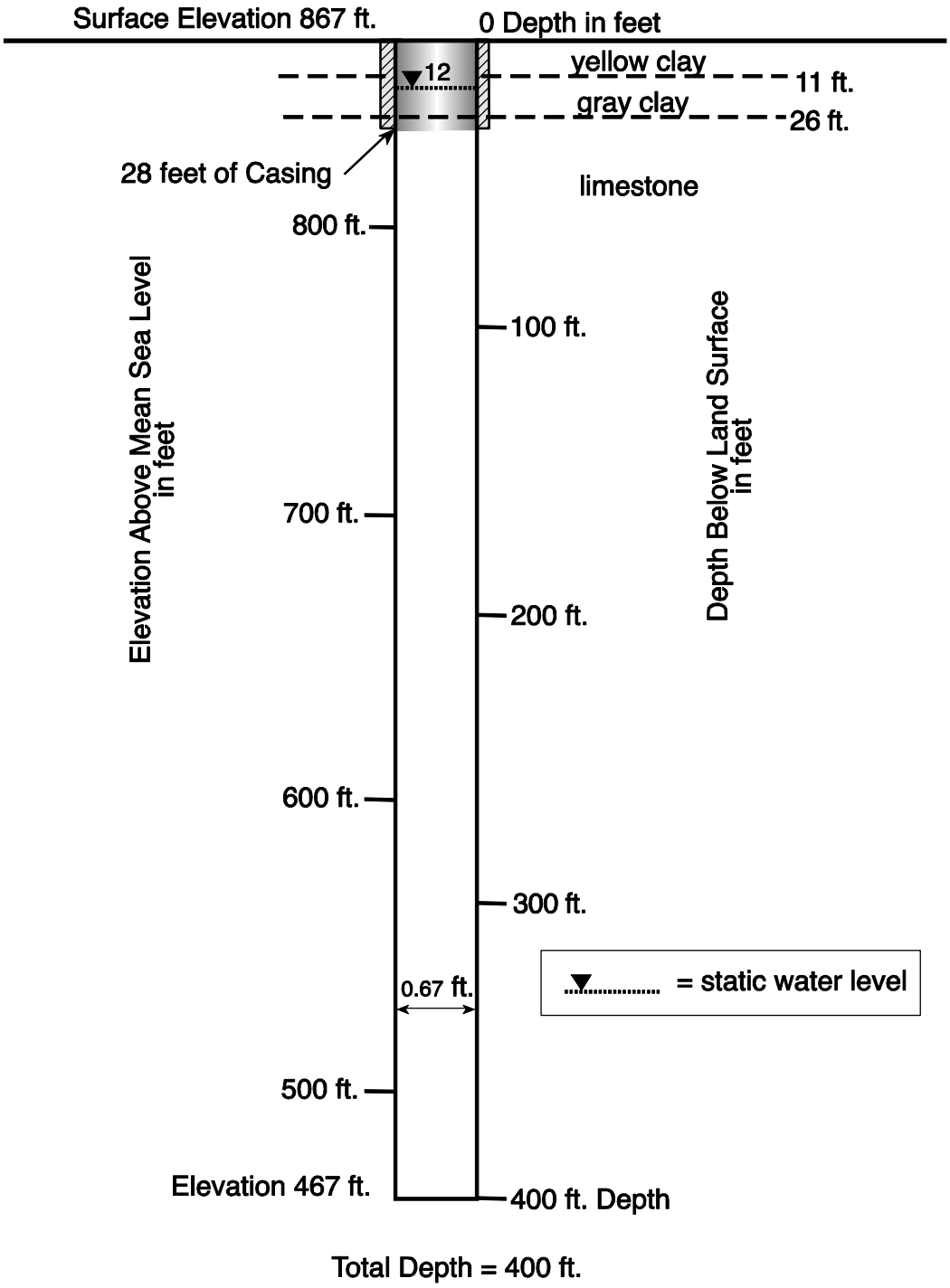


Figure 9. Hidden Creek Irrigation Well (HPW-1) Completion Diagram - ODNR Well Log Number 1014543

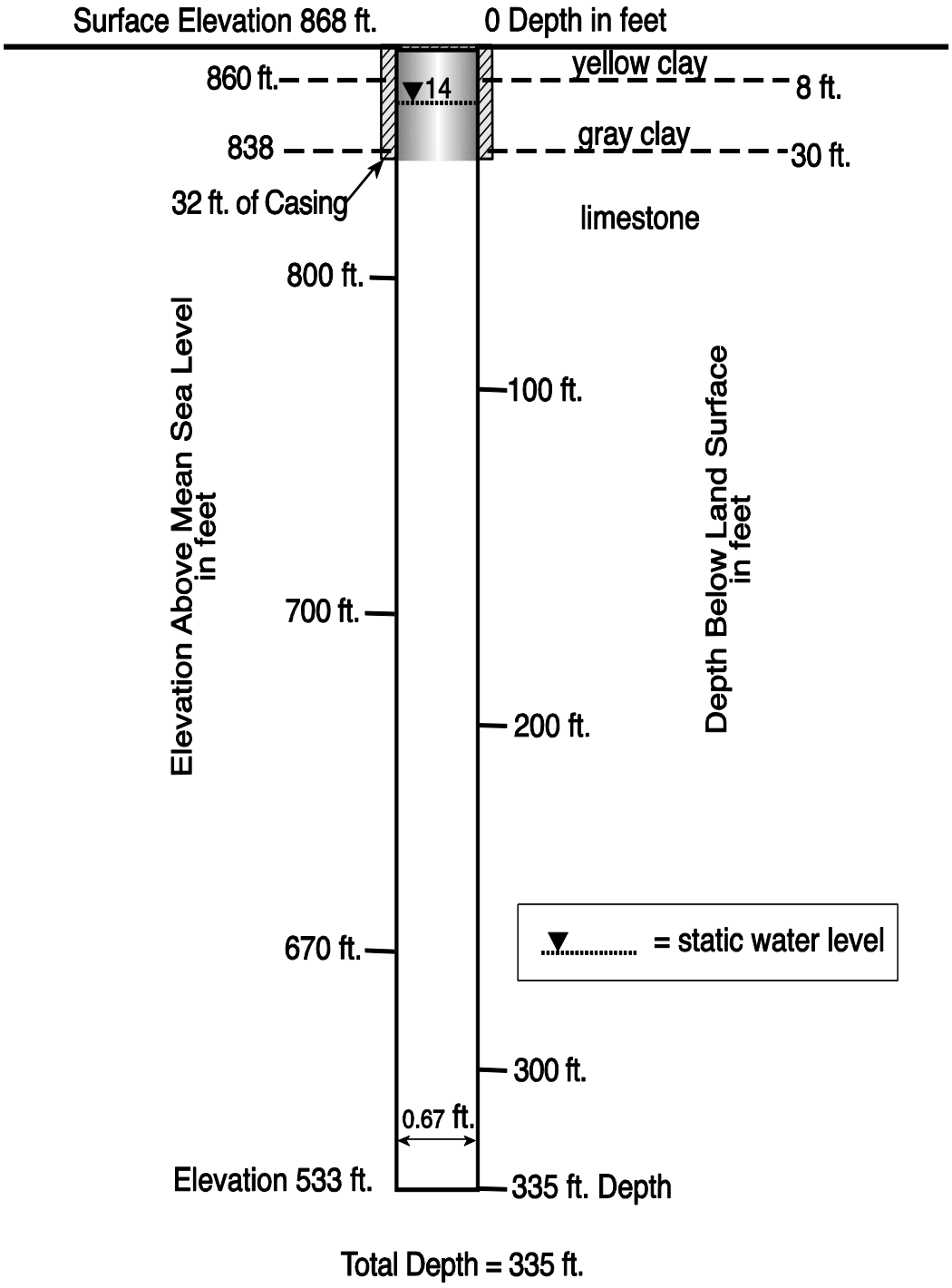


Figure 10. Hidden Creek Irrigation Well (HOB-1) Completion Diagram - ODNR Well Log Number 1014542

Table 2. Water supply wells monitored during this study.

Well-Log No.	Well Symbol	Latitude	Longitude	Well Depth (feet)	Test Rate (gpm)	Casing Length (feet)	Surface Elevation (feet amsl)	Static Water Level (feet)
715055	DP	40.81793	-8399036	30	15	25	864	14
761034	AR	40.820217	-83.98851	34	12	34	872	18
941110	TMR	4081724	-83.99052	30	10	26	866	14
	RA	40.81944	-83.97509	75	15	37	887	24
1007293	RS	40.80915	-83.97476	70	25	30	886	24
636293	EU	40.819559	-83.99103	47	6	28	876	14
852625	GM	40.81959	-83.9914	43	10	26	866	06
	WS	40.820191	-83.99067				870	
	DS	40.81986	-83.99389	31			876	
884349	HOB2	40.812984	-83.98675	70	40	36	884	26
963252	JA	40.41051	-83.9911	63	15	48	890	26

3.4 HIDDEN CREEK GOLF CLUB GROUND WATER USAGE

As part of this investigation, a review of the irrigation practices and ground water supply needs was conducted. Historically, six ponds were built on the property. These ponds were built by damming up surface water runoff from within the natural drainage tributaries to Sugar Creek. Irrigation of the golf course occurs out of the largest pond. Two water supply wells were drilled to supplement the water in the ponds for irrigation; HPW-1 and HOB1. Well HPW-1 is the primary well used for irrigation and filling the ponds on the golf course. Well HOB-1 is used only as a backup well and is used primarily for ground water level observation.

Ground water is pumped from well HPW-1 to fill the main irrigation pond with water. Water is pumped from the pond to irrigate the golf course. The primary irrigation season occurs over a five month period from approximately May to September of each year. Presently, Hidden Creek personnel do not keep any records of how much water is pumped from the water wells into the pond. Water is pumped from the irrigation wells as needed to keep the pond full.

3.5 FIELD MEASURMENTS

Ground water levels were measured in each of the high-yielding and selected water supply wells on July 5, 6 and 9. A monitoring well network was set up (Sanders, 1998). The *State of Ohio Technical Guidance for Well Construction and Ground Water Protection Manual* was consulted along with the *Midwest Planning Service Private Water System Handbook*. Field data showing the water level measurements are presented in Appendix D.

3.6 DEVELOPMENT OF HYDROGRAPHS FOR THE STEMEN DOMESTIC WATER SUPPLY WELL

In response to running out of water on September 4, 2009, Mr. Stemen began monitoring ground water levels in his well on September 6, 2009. Mr. Stemen chose to use an air bubbler tube to monitor the ground water level in his well.

Air bubbler systems are a method by which the water level in a tank or well can be measured when the water is open to atmospheric pressure. A constant volumetric rate of gas flow (usually air) is fed through the bubble tube submerged in the liquid. The amount of pressure required to force the bubble gas out of the bottom of the tube is equal to the hydrostatic or atmospheric pressure. In the Stemen well, the bottom of the tube was placed at the top of the pump. Therefore, this method measures the water level above the top of the pump. The equation for measuring the air pressure is as follows:

$P = x(sg)$

Where P = pressure in feet (or inches) of water

x = Height in feet (or inches) of water above pump

sg = specific gravity of liquid (The specific gravity of air is one.)

The level of the water above the top of the pump was measured in inches. These data were converted to depth of water from the land surface. Mr. Stemen's well data are presented in Appendix E.

It should be noted that the ODNR does not have a well log and drilling report for the Stemen well. Information provided by Mr. Stemen estimates the depth of the well at 31 feet. He has a submersible pump in the well. The pump sits approximately one foot off of the bottom of the well. The well is located in a well pit that is approximately 4 feet deep. The air bubbler tube sits at a reference point approximately 24 feet 11¼ inches from the bottom of the well pit.

3.7 GROUND WATER QUALITY OF THE LIMESTONE AQUIFER

An investigation of the water quality of the water supply wells in the study area is beyond the scope of this investigation. Mr. Stemen reports that the ground water produced from his water well is free of color, odor and taste and dissolved solids. He did not want water with the smell of hydrogen sulfide.

3.8 PUMPING TEST ANAYLSIS METHODS FOR HPW-1

As part of this investigation, the ODNR-DSWR decided to conduct a pumping test on HPW-1. The purpose of the pumping test was to establish the hydraulic characteristics of the well. The

pumping test was conducted by pumping HPW-1 at a rate of 440 gpm for 24 hours. The drawdown was measured in the pumping well, the nearby observation wells HOB-1 and HOB-2, and the selected domestic wells. The ground water levels were allowed to recover for 72 hours after the pumping test. The ground water hydraulic calculations for the carbonate bedrock aquifer were analyzed using AQTESOLV version 4.5 (Duffield, 2007). AQTESOLV pump test data analyses are available upon request.

3.9 IMPACT ASSESSMENT

An impact assessment was done to evaluate the effect that pumping the Hidden Creek production wells would have on the nearby domestic water supply wells. This was done by measuring the actual drawdown in the monitoring wells during the July 5 and July 6 pumping test. However, since the ground water levels in the subsurface had not recovered completely at the time of the pump test, it was decided to allow the ground water levels to recover for at least 72 hours. The recovery in all the monitor wells was from July 6 to July 9, 2012. The irrigation well HPW-1 was turned off at approximately 12 noon on July 6 and remained off until the round of measurements taken on July 9 was completed.

4.0 FIELD INVESTIGATION RESULTS

To evaluate the subsurface conditions in the study area, cross sections, ground water gradient maps, and hydrographs were drawn to represent the data. The important trends in the data are presented for review.

4.1 SITE HYDROGEOLOGY OF THE STUDY AREA

Figure 11 represents a hydrogeological cross section drawn through the study area. Shown on the cross section is the stratigraphic section for each well relative to sea level. The location of the cross section is shown on Figure 8. Shown on the cross section is the:

- Limestone bedrock
- Glacial till over the bedrock
- Depth to water in each well that was measured on July 6, 2012
- Recovered water level on July 9 after the pump was off for approximately 72 hours
- Dewatered zone resulting from pumping HPW1

The cross section shows the carbonate bedrock aquifer is actually one hydrogeological unit from the base of the glacial till to the top of the Rochester Shale (present below an elevation of 460 feet) . The cross section also reveals the importance of measuring the thickness and flow rate from each zone encountered in the well bore during drilling. Ground water recharge is controlled by infiltration through the glacial till.

4.2 RESULTS OF THE GROUND WATER LEVEL MEASUREMENTS FOR JULY 5 THROUGH JULY 9, 2012

Figure 8 shows locations of the irrigation wells and the water supply wells used to evaluate ground water levels in the subsurface during this investigation. The field work to set up the monitoring locations for the wells was completed on July 5, 2012. Water level measurements were obtained on July 5, 6, and 9, 2012.

4.2.1 Ground Water Elevation Levels for July 5, 2012

Figure 12 shows the ground water elevation in the irrigation and domestic monitoring wells as measured on July 5, 2012. These data were obtained prior to pumping the irrigation well. As a result, these data represent background data. The only active pumping wells were the domestic water supply wells. It should be noted that the irrigation well HPW-1 had been running for a

couple days prior to this and had only been off for a few hours so the water table was still returning to static conditions.

These data are consistent with the regional ground water flow gradient mapped by Haiker (2009) as shown in Figure 5. The ground water flow gradient is generally to the northwest. In the study area the ground water discharges to Sugar Creek. Up-gradient wells are RS and RA wells along Napoleon Road. Down-gradient wells are located along Dixey Highway and State Road.

4.2.2 Ground Water Elevation Levels for July 6, 2012

Figure 13 represents a map showing ground water elevations as measured on July 6, 2012. These data were obtained when irrigation well HPW-1 had been pumping at a rate of approximately 440 gpm. Irrigation well HOB-1 was turned off and used for observation purposes only.

The cone of depression for irrigation well HPW-1 is shown on the map along with the regional ground water flow pattern. The general ground water flow gradient in the region is similar to that measured on July 5, 2012. However, it should be noted that the ground water discharge to Sugar Creek has been reversed and the new ground water flow gradient is now toward the Hidden Creek irrigation well HPW-1.

4.2.3 Ground Water Elevation Levels for July 9, 2012

Figure 14 represents a map showing the ground water elevations as measured on July 9, 2012. The Hidden Creek irrigation well had been off for approximately 72 hours and was not in use. As a result, ground water levels had recovered and returned to their pre-pumping levels higher than those established on July 5, 2012.

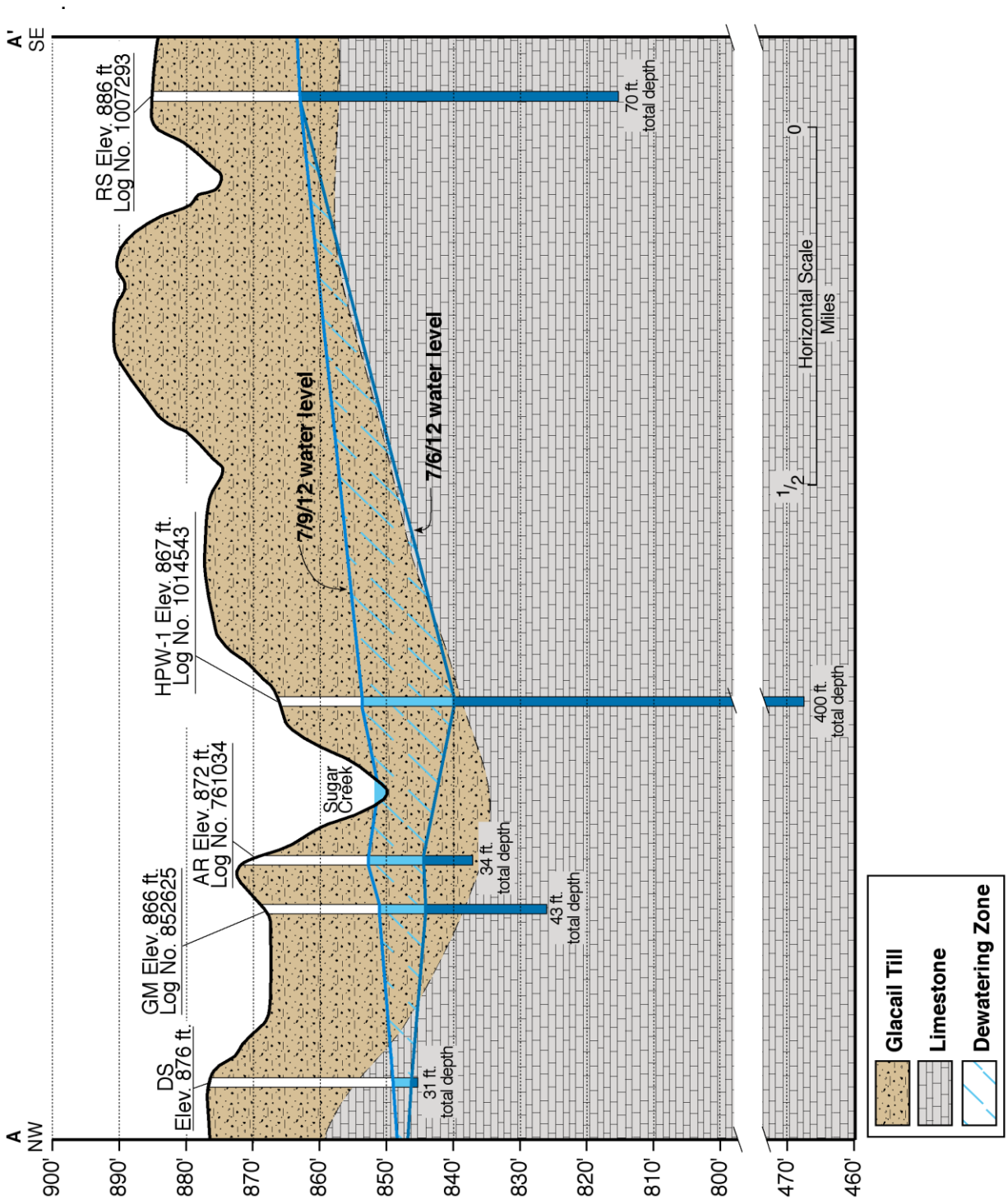


Figure11. Hydrogeological Cross Section A-A' Extended West to East across the Study Area (see Figure 8 for the cross section location)

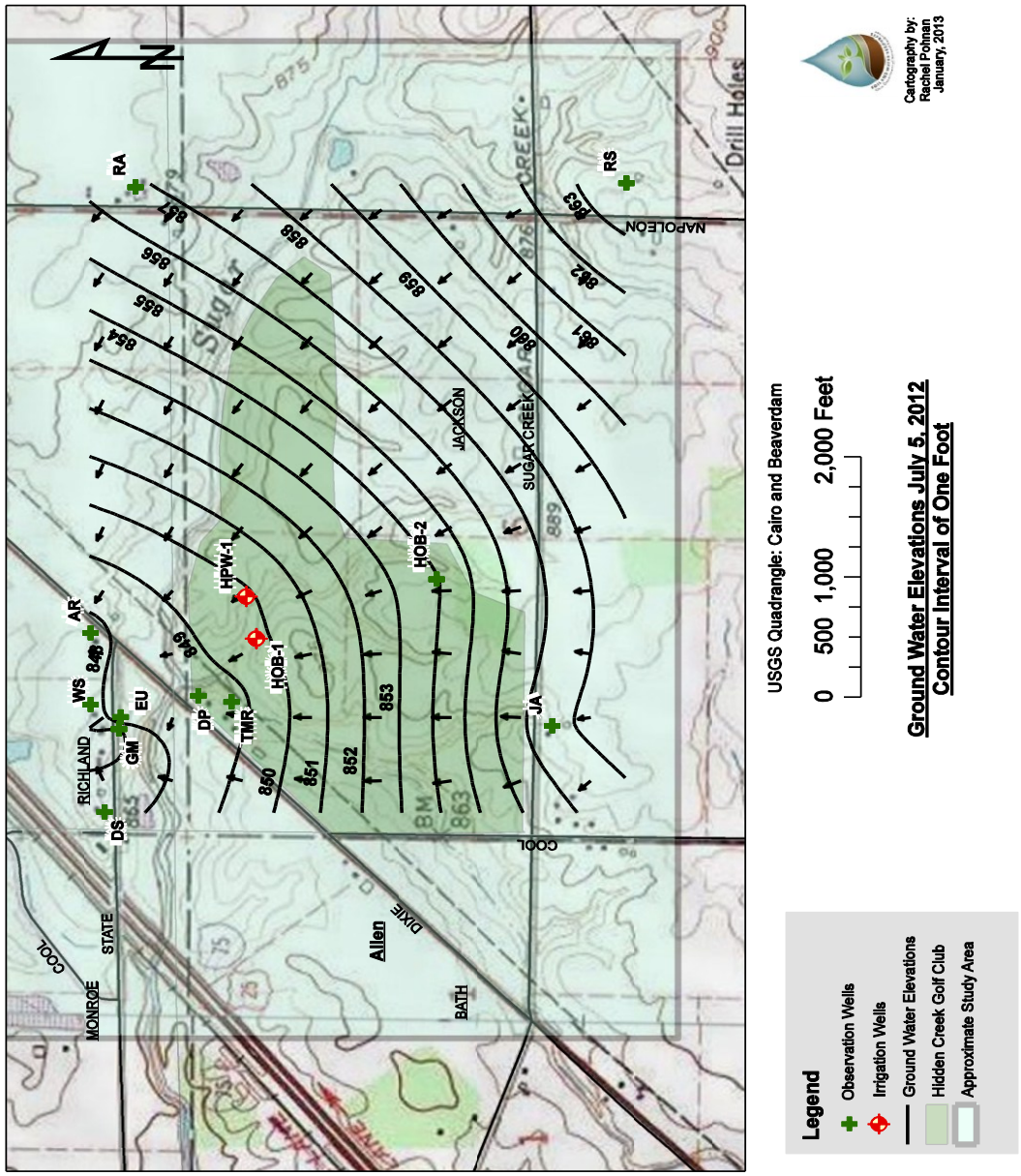


Figure 12. Ground Water Levels measured on July 5, 2012

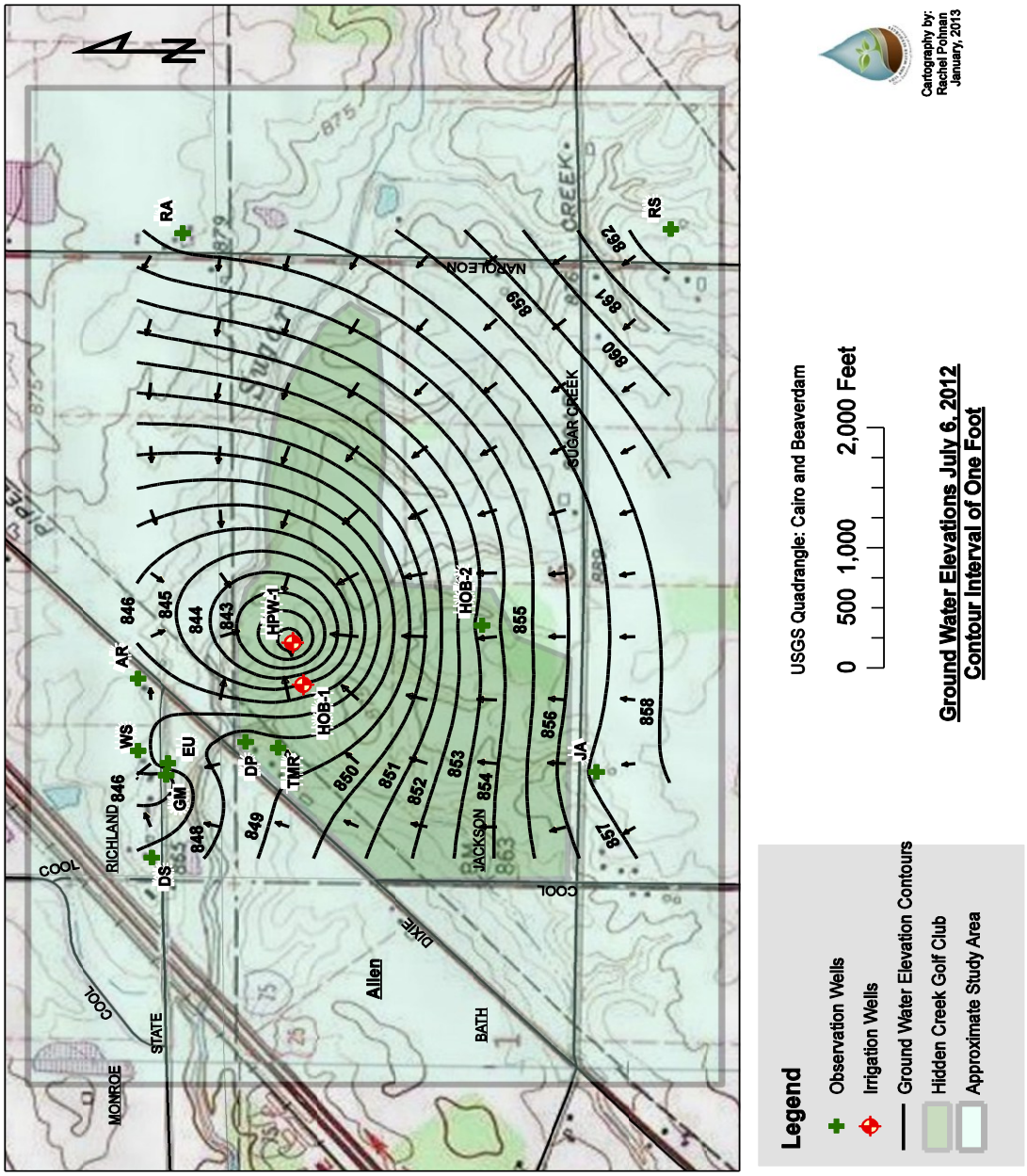


Figure 13. Ground Water Levels Measured on July 6, 2012

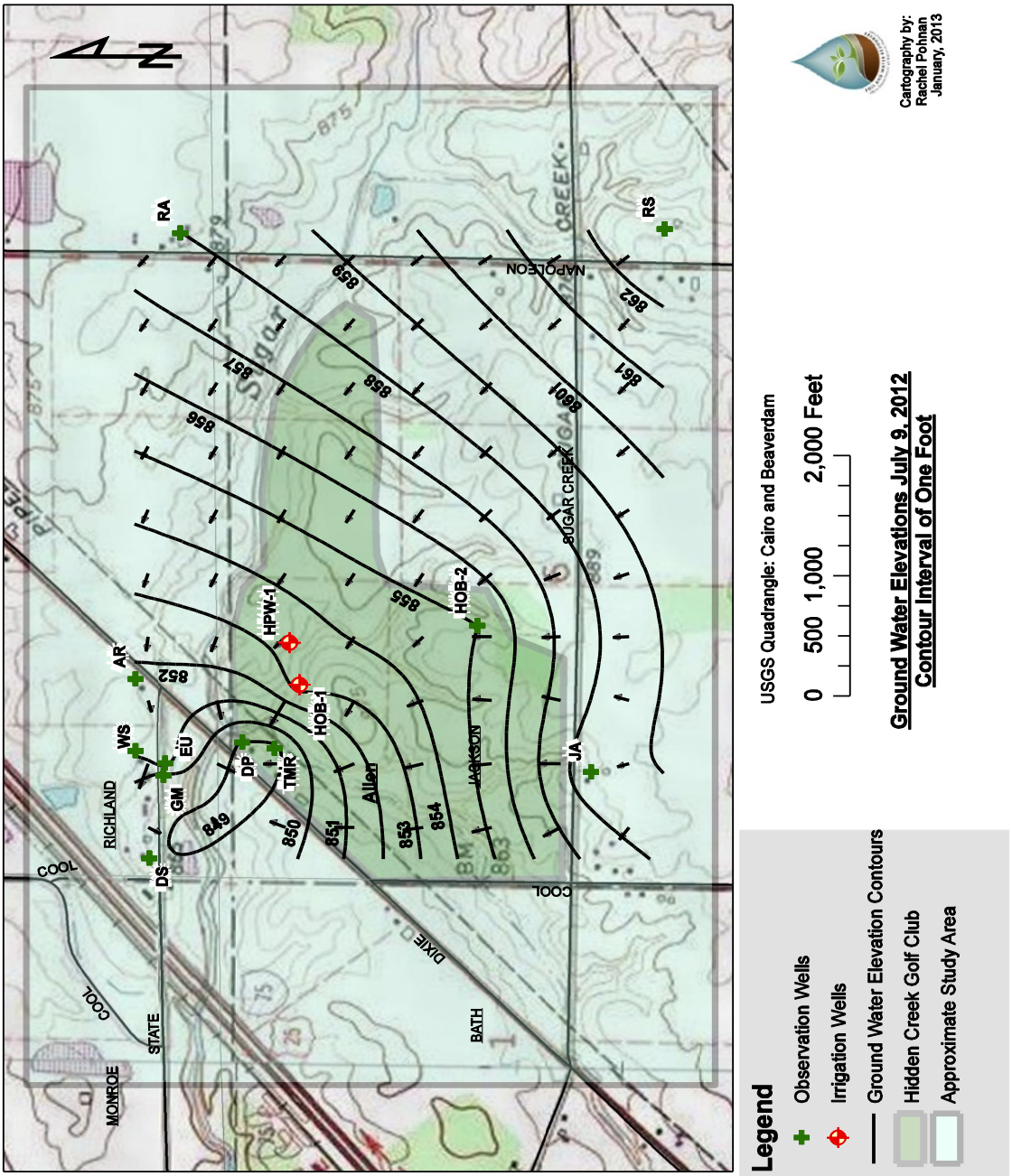


Figure 14. Ground Water Levels measured on July 9, 2012

4.3 HYDROGRAPH OF THE STEMEN WELL SHOWING GROUND WATER LEVEL FLUCTATIONS WITH TIME

Figure 15 was developed based on the ground water level monitoring done by Mr. Stemen. This hydrograph depicts the ground water levels in Mr. Stemen's well from September 6, 2009 to July 14, 2012. Approximately four (4) irrigation seasons are shown on the hydrograph.

Trends in the data are as follows:

1. During the 2009 irrigation season, the ground water levels in the well declined from approximately 26.5 to 28.5 feet below the land surface. Thus the overall decline in the ground water level was approximately 2 feet.

2. After the 2009 irrigation season ended, the ground water level in the well rose from 28.5 feet to 24 feet below the ground surface. The overall recovery in the ground water level was approximately 4.5 feet.

3. During the 2010 irrigation season, the ground water level in the well declined from 24 feet to 29 feet below the land surface. Thus the overall decline in the ground water level was approximately 5 feet.

4. After the 2010 irrigation season ended, the ground water level in the well rose from 29 feet to a high of 22 feet below the land surface. The overall recovery in ground water levels in the well were approximately 7 feet.

5. During the 2011 irrigation season, the ground water level in the well declined from approximately 22 feet to a low of 28.9 feet below the land surface. Thus the ground water level declined approximately 6.9 feet.

6. After the 2011 irrigation season ended, the ground water level in the well rose from 28.9 feet to approximately 23.8 feet below the land surface. The overall recovery in ground water levels in the well were approximately 5.1 feet.

7. During the 2012 irrigation season, the ground water level in the well declined from 23.8 feet to a low of 29 feet below the land surface. Thus, the ground water level in the well declined approximately 5.2 feet.

During the pumping test conducted by ODNR from July 5 through July 6, 2012, the water level declined 0.38 feet. From July 6 through July 9, the water level recovered 1.71 feet in response to the Hidden Creek well being turned off.

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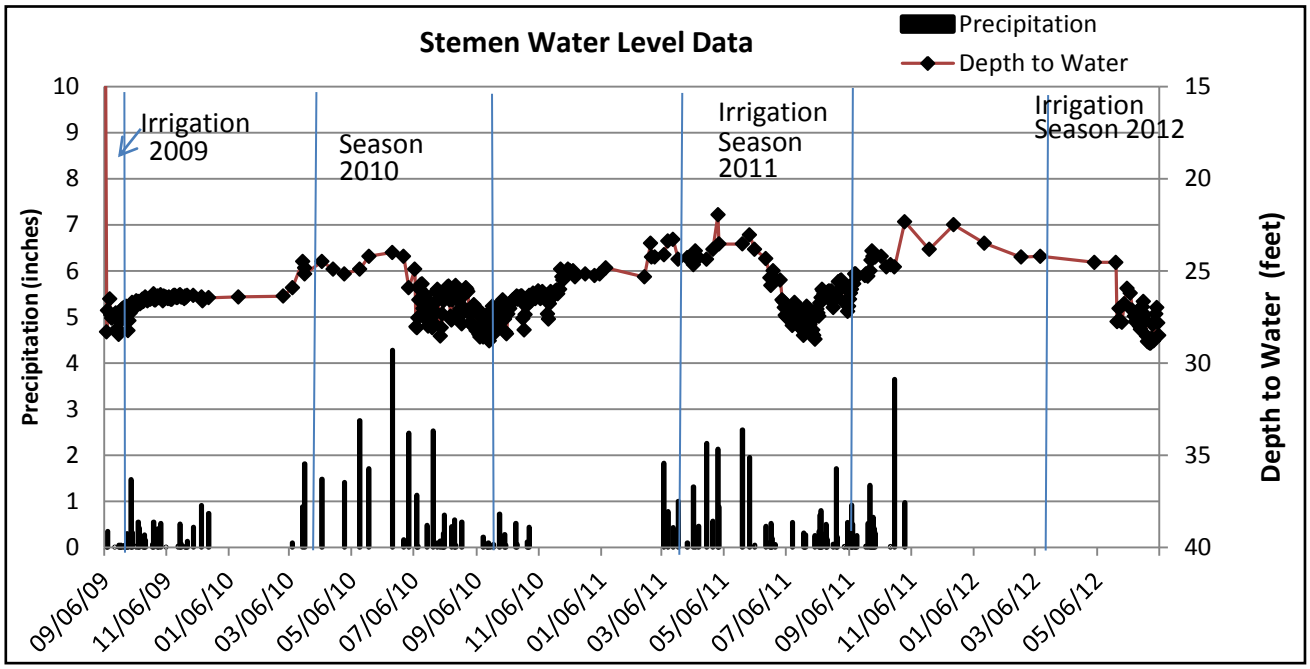

Figure 15. Hydrograph Showing Ground Water Level Fluctuations in the Stemen Water Supply Well

In addition, the ODNR compared the fluctuations in the ground water level in the Stemen well to rainfall data over the four irrigation seasons. These data confirm that the ground water level in the Stemen well tend to rise with natural recharge from rainfall. The ground water levels in the Stemen well declined during the irrigation season in response to pumping of HPW-1.

4.4 WATER SUPPLY WELL HYDRAULIC CHARACTERISTICS FOR DOMESTIC AND IRRIGATION WELLS BASED ON ODNR WELL LOG DATA

In addition to the ground water level measurements, the ODNR-DSWR made an attempt to evaluate the well hydraulics of both the domestic water supply wells and the irrigation wells based on the data supplied by the well driller at the time that each individual well was drilled. This was done by analyzing the data from the well log and drilling report on record with the ODNR-DSWR. The drillers' pumping/bail-down test data was used to calculate the specific capacity of each well.

When each well is drilled, the driller estimated the pumping capacity for the well by conducting a short term pumping/bail-down test on the well. These tests are generally done by pumping, bailing, or blowing air into the well to extract water at a known rate in gallons per minute (gpm). Prior to conducting the test, the driller measured the static water level in the well. Near the end

of the test, the driller measured the pumping water level in the well. The driller then determined the total drawdown in the well during pumping. These tests are generally done to estimate a sustainable yield of the well and to determine the depth at which to set the pump.

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4.4.1 Domestic Well Hydraulics Based on Driller Pumping/Bail-Down Test

Table 3 shows the results of the pumping/bail-down tests done by the well driller at the time that the well was drilled. Based on the analysis, the specific capacity of each well in terms of gallon per minute per foot of drawdown (gpm/ft.) was estimated. These data were used to determine how much water was flowing into the well for every foot of drawdown based on the pumping rate.

Trends in the data for the domestic water wells are as follows:

1. Pumping rates varied from 6 to 40 gpm.
2. Pre-pumping water levels varied from 6 to 26 feet below the land surface depending on elevation.
3. Drawdown in the well during pumping varied from 4 to 30 feet.
4. Specific capacity of the wells varied from 0.33 gpm/foot to 3.75 gpm/foot of drawdown.

Table 3. Domestic well hydraulics based on driller bail-down test data

Well Log Number.	Well ID	Pumping Rate (gpm)	Pre-Pumping Level (feet)	Pumping* Level (feet)	Drawdown (feet)	Specific Capacity* (gpm/foot)
715055	DP	15	14	18	4	3.75
761034	AR	12	18	----	---	---
94110	TMR	10	14	20	6	1.67
1007293	RS	25	24	34	10	2.5
636293	EU	06	14	23	9	0.67
852625	GM	10	06	36	30	0.33
884349	HOB2	40	26	----	----	----
963252	JA	15	24	----	----	----

*Calculated value from well log data - parameter not provided by driller

4.4.2 Irrigation Well Hydraulics Based on Driller Pumping Test

Table 4 show the data provided from the driller for the Hidden Creek Golf Club irrigation wells. The driller provided only the approximate pumping rate and the pre-pumping static water level in each well. The results of the pumping test were not reported on the ODNR-DSWR well log and drilling report. Because the historic data for the pumping test were not reported, the specific capacity of the well could not be calculated. As a result, it was necessary to conduct a pumping test on HPW-1 to determine the pumping capacity and hydraulic characteristics of the well.

Table 4. ODNR-DSWR well evaluation for Hidden Creek Irrigation Wells

Well Log Number.	Well ID	Pumping Rate (gpm)	Pre-Pumping Level (feet)	Pumping* Level (feet)	Drawdown (feet)	Specific Capacity* (gpm/foot)
1014543	HPW1	400+	12	----	----	----
1014542	HOB1	300+	14	----	----	----

5.0 RESULTS OF HPW-1 PUMPING TEST ANALYSIS

Because there was no long-term pumping test data for the Hidden Creek irrigation wells, it was necessary to conduct a pumping test on one of the irrigation wells. The pumping test was conducted over a 24 hour period with water level measurements taken in HPW-1, HOB-1, HOB-2 and the domestic wells listed in Table 3. Based on the pump capacity, it was decided to run the test at a constant rate of 440 gpm for 24 hours. The hydraulic characteristics of the carbonate bedrock aquifer beneath the Hidden Creek Golf Club were analyzed using the water well measurements from the observation well HOB-1.

The pumping test data from HPW-1 were used as a starting point for estimating the hydraulic properties of the aquifer by using the AQTESOLV computer program. AQTESOLV 4.5 version was used to estimate the hydraulic properties of the aquifer (Duffield, 2007). To be consistent with the historical pumping test data analysis for the carbonate bedrock aquifer, the Cooper-Jacob solutions use the following assumptions:

- Aquifer has an infinite areal extent.
- Aquifer is homogeneous and isotropic with a uniform thickness.
- Pumping well is fully or partially penetrating.
- Flow to the pumping well is horizontal.
- Water is released instantaneously from storage.

In addition, it was assumed that the hydraulic conductivities are the same in the horizontal and vertical directions, thus Kh/Kr = 1.

5.1 TIME-DRAWDOWN CONFINED MODEL COOPER-JACOB SOLUTION RESULTS

Figure 16 shows the results of the time-drawdown plot for HOB-1 using the confined aquifer model and the Cooper-Jacob solution. These data show that the transmissivity of the limestone aquifer was estimated to be 61,600 gallons/day/foot (8,234.2 ft^2/day). The storage coefficient was estimated to be on the order of 0.0002918. The specific capacity for HPW-1 as shown in Table 5 is 44.09 gpm/foot of drawdown in the well.

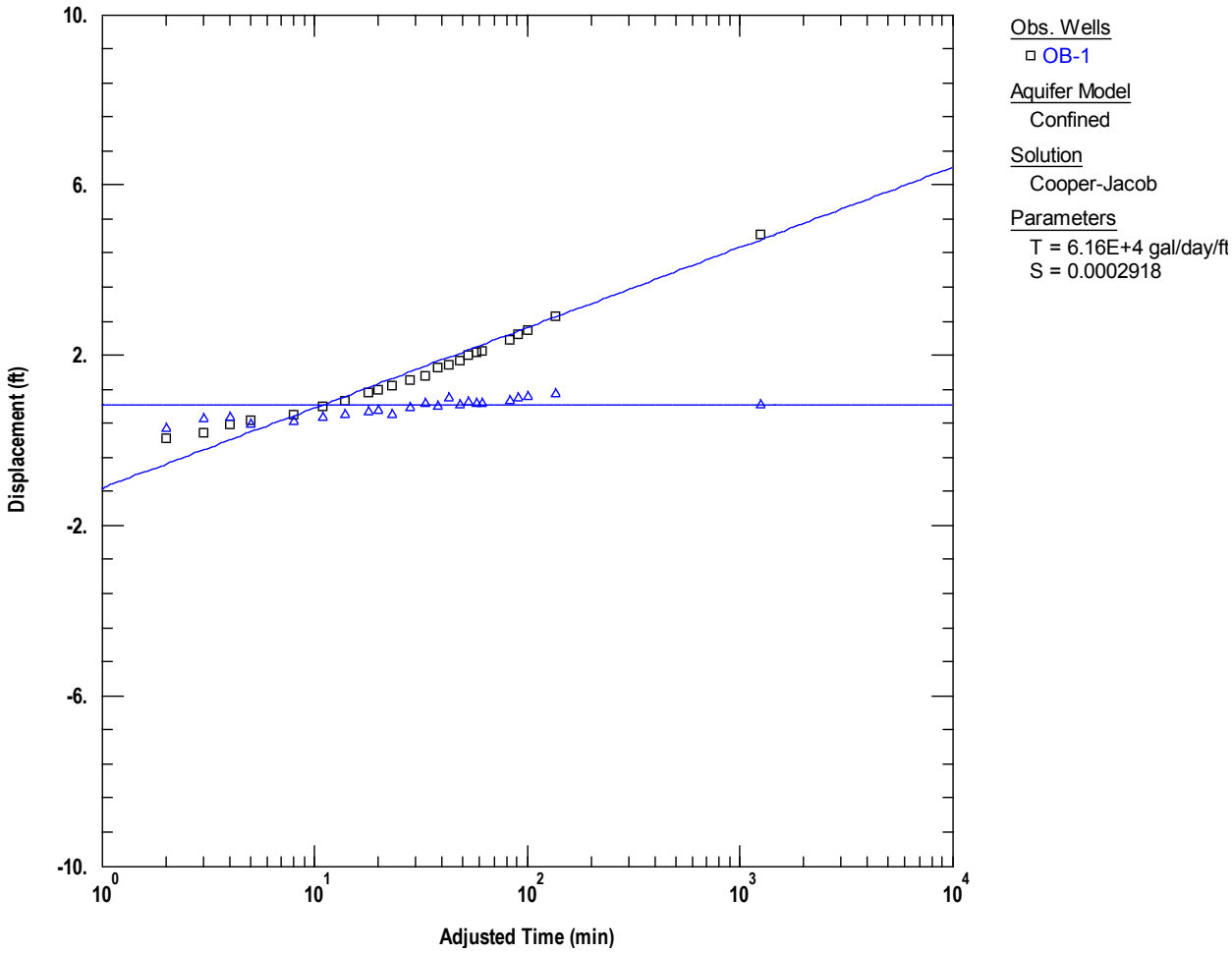

Figure 16. HOB-1 Time Drawdown Confined Aquifer Model Cooper Jacob Solution

5.2 DISTANCE-DRAWDOWN RESULTS

Table 5 shows the observation well data used for the distance-drawdown plot. Shown in the table are the pre-pumping water levels, pumping water levels, observed drawdown, maximum recovery, and the distance each observation well is from the pumping well HPW-1.

Based on the observation well data, the following trends in the data are presented for review:

1. The drawdown in HPW-1 was approximately 9.71 feet.
2. The drawdown in HOB-1 was approximately 4.5 feet at a distance of 419 feet from the pumping well.
3. In the down-gradient well DS at a distance of approximately of 2076 feet from the pumping well, a drawdown of 0.38 foot was recorded.

4. In the up-gradient well JA at a distance of 2586 feet, a drawdown of 0.57 foot was recorded.

Table 5. HPW-1 Pumping Test Distance Drawdown Observation Well Data.

Well ID	Pumping Rate (gpm)	Pre-Pumping Water Level on 7/5 (feet)	Pumping Water Level on 7/6 (feet)	Recovered Water Level 7/9 (feet)	Maximum Recovery 7/6-7/9 (feet)	Drawdown Ground Water Levels 7/6–7/5 (feet)	Distance from HPW-1 (feet)	Specific Capacity (gpm/ft)
HPW-1	440	17.22	26.93	13.73	13.2.	9.71	0	44.09
HOB-1	-------	18.25	22.75	14.65	8.1	4.5	419	-----
HOB-2	-------	30.13	30.65	29.03	1.62	0.52	1434	-----
AR		24.36	25.43	20.25	5.18	1.07	1234	
DP		15.2	15.3	15.08	0.22	0.1	908	
TMR		17.45	17.56	17.32	0.24	0.11	921	
RS		22.18	22.31	23	0.16	0.13	4546	
RA		30.18	30.41	29.03	1.38	0.23	3523	
WS		22.65	23.7	18.9	4.8	1.05	1508	
EU		16.98	17.85	14.58	3.27	0.87	1349	
GM		18.38	19.69	15.57	4.12	1.31	1473	
DS		28.27	28.65	26.94	1.71	0.38	2076	
JA		32.2	32.77	31.33	1.44	0.57	2586	

Figure 17 was developed to show the amount of recovery in the surrounding wells that occurred with distance from the pumping well from July 6 through July 9, 1012 when the main irrigation well HPW-1 was not pumping. Observations in these data are as follows:

1. In the pumping well HPW-1, the ground water level increased 13.2 feet.
2. In observation well HOB-1, the ground water level increased 8.1 feet.
3. In the down-gradient well DS, the ground water level increased 1.71 feet.
4. In the up-gradient well RS, the ground water level increased 0.16 foot.
5. Not all of the points fall on a straight line. This indicates that the limestone aquifer is not homogeneous and isotropic.

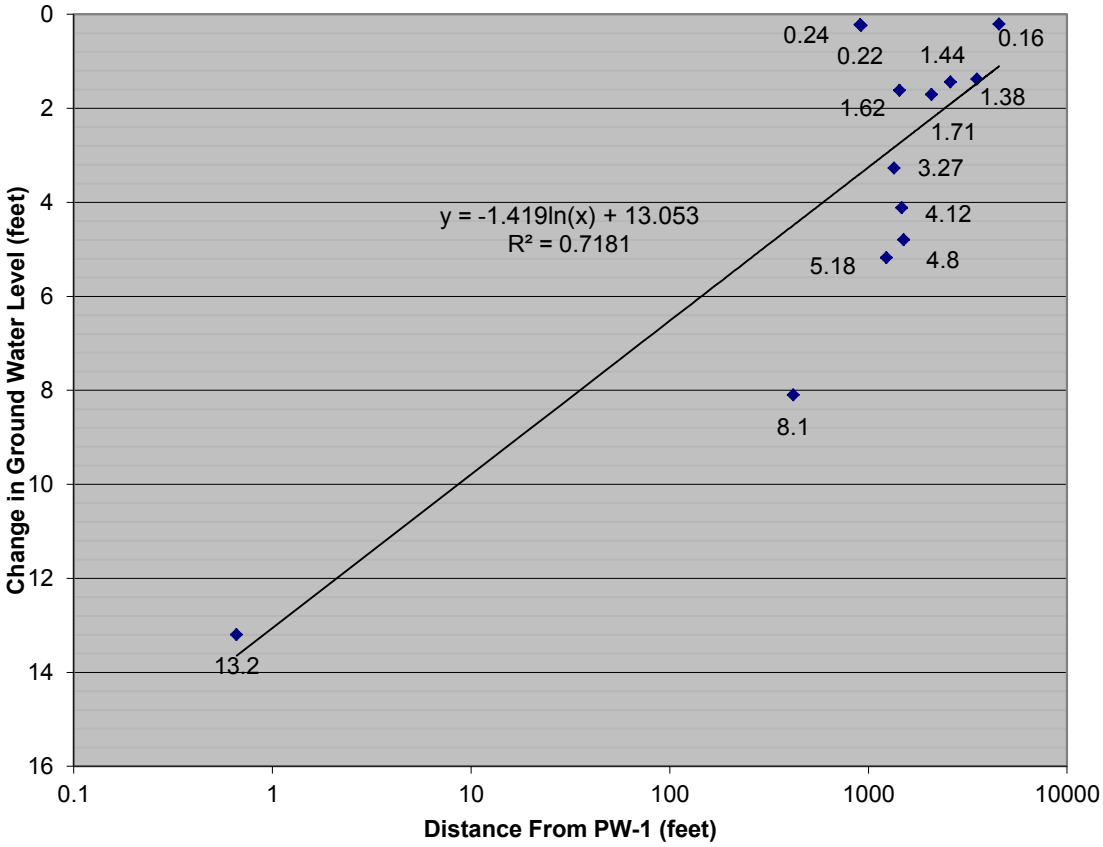

Figure 17. Distance Recovery Plot for the Hidden Creek Pumping Test

6.0 IMPACT ASSESSMENT

Figure 18 was developed to show the drawdown in the irrigation and domestic water supply wells from July 5 to July 6, 2012. These data show that pumping the Hidden Creek Production well HPW-1 can have an impact on the surround domestic ground water supply wells. However, since the pumping well had been in use for the few days prior to July 5 and the pump had only been off for a few hours, it was determined that the water table was still recovering on the morning of July 5. Because of this, recovery data was collected to determine the true degree of impact.

To determine the impact of the pumping, it was decided to use the recovery data from July 6 to July 9, 2012 while HPW-1 was turned off to determine the actual impact the pumping was having on the surrounding ground water supply wells. On the morning of July 9, a round of water level measurements was obtained. Figure 19 shows the ground water level recovery in the subsurface for a 72 hour period of time.

These data show the effects of pumping HPW-1 on the surrounding water supply wells. Based on the data, the effects of pumping HPW-1 can be observed out to 5,000 feet from the pumping well. Recovery of between 1.7 and 5.1 feet was observed in the domestic water supply wells along State Road.

A search of the water well database was conducted to make sure there were no other high capacity wells in the area. No wells were identified. Also, no precipitation had occurred during this time period, which could have affected ground water levels. Because of these factors, all of the ground water level fluctuations observed can be attributed to pumping of the Hidden Creek Golf Club irrigation well HPW-1.

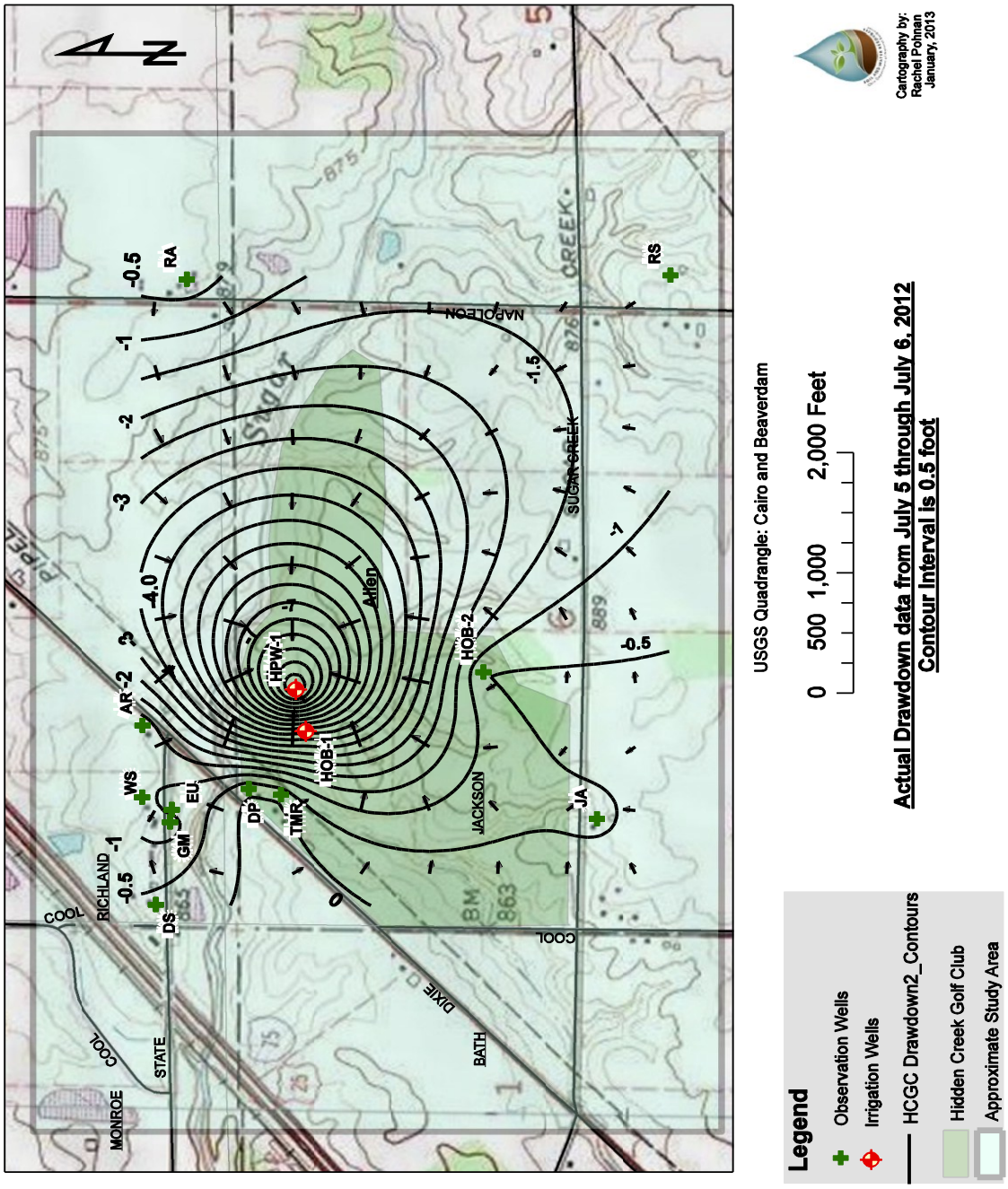

Figure 18. Actual Ground Water Level Drawdown Measured Between July 5, and July 6, 2012

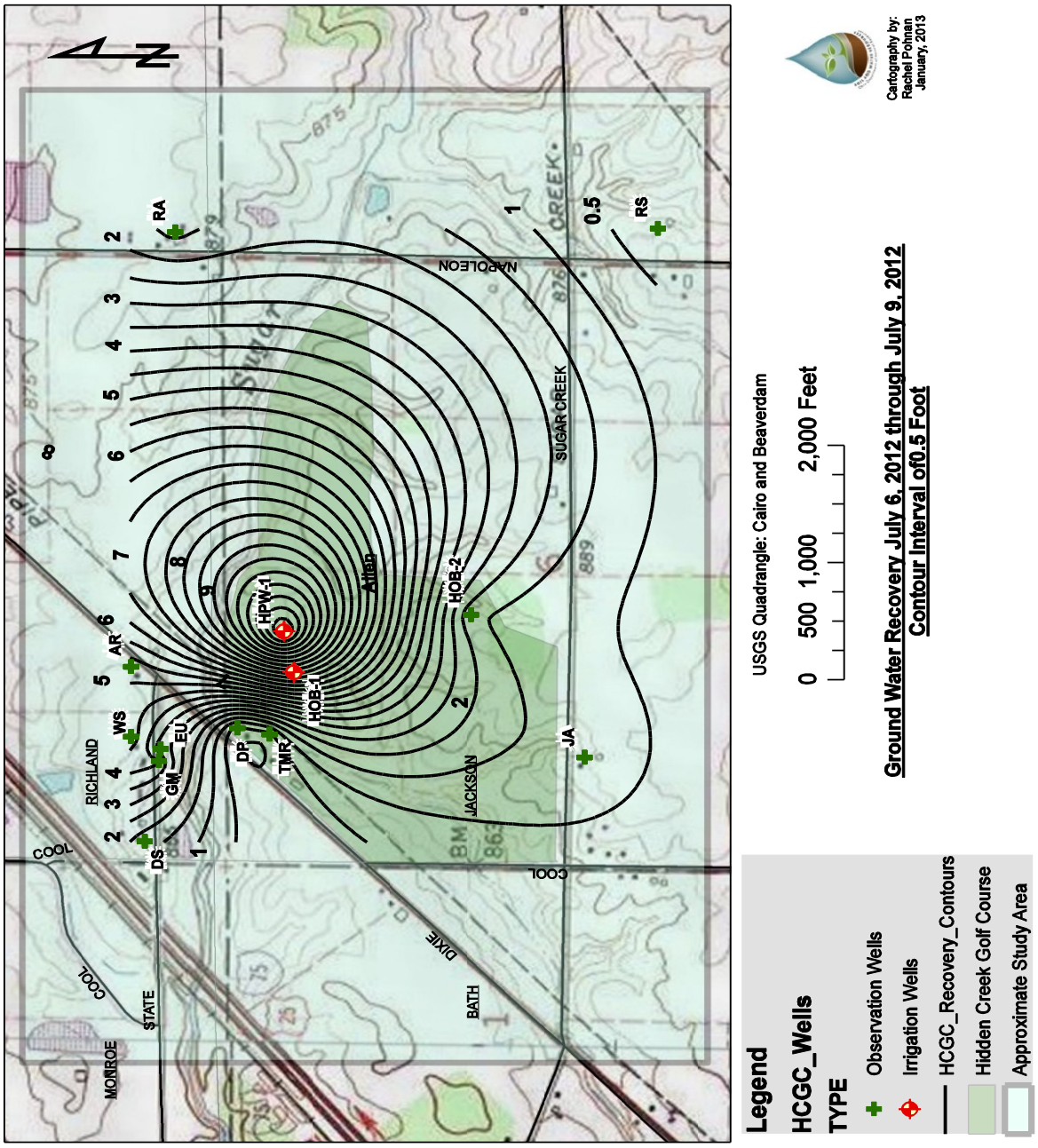

Figure 19. Actual Ground Water Level Recovery Measured Between July 6, and July 9, 2012

7.0 Conclusions

7.1 SITE HYDROGEOLOGY CONCLUSIONS

Ground water occurrence and movement in the carbonate bedrock aquifer of northwestern Ohio is complex and poorly understood. Previous work shows that there are a number of flow zones in the subsurface. The well completion diagram for well M-14 shows the extent to which the flow zones occur in the subsurface (Figure 6). Drilling data shows that the carbonate bedrock aquifer is anisotropic and heterogeneous in its configuration. This gives rise to a number of concerns that need to be considered before long-term pumping rates can be accurately calculated and the data used to design water supply systems.

The overall porosity and permeability within the carbonate bedrock aquifer in northwest Ohio is composed of three (3) types:

1. Primary porosity and permeability resulting from the three-dimensional interconnection of the micro-fractures that compose the matrix of the bedrock.

2. Secondary permeability resulting from the three-dimensional network of joints, fractures and bedding planes.

3. Secondary permeability also resulting from the three-dimensional cavernous nature of the openings.

This helps explain major changes in yield and drawdown within short distances. Field data results confirm that diffuse, laminar, and turbulent conduit flow are present within the carbonate bedrock aquifer of northwestern Ohio. The hydraulic characteristics of the aquifer are not uniform; there are significant variations in permeability that need to be accounted for within the carbonate bedrock aquifer (i.e. degree of fracturing as well as variation in cementation). This helps to explain major changes in yield over short distances in both the vertical and horizontal directions.

Overall, because of the degree of interconnectedness of the fractures and conduits in both the vertical and horizontal directions, it must be assumed that the carbonate bedrock aquifer acts as a continuous water bearing unit from the surface to the top of the Rochester Shale at a depth of over 400 feet below the land surface.

7.2 HPW-1 PUMP TEST CONCLUSIONS

The flow zones encountered in the subsurface for Hidden Creek Golf Club irrigation wells HPW-1 and HOB-1 were not documented on the well log and drilling reports. As a result, it was not possible to determine the exact horizons from which the ground water was pumped.

The time-drawdown data using the Cooper-Jacob confined model solution confirmed a transmissivity of 61,600 gallons/day/foot (8,234.2 ft^2/day). The storage coefficient of the aquifer was approximately 0.0002918.

7.3 FIELD DATA MEASUMENTS CONCLUSIONS

The regional direction of ground water flow across the study area is from the southeast to the northwest in the direction of the Maumee River. However, the local ground water flow direction in the study area is toward the Sugar Creek, which acts as a natural ground water discharge point.

As shown on Figures 13, 17, 18, and 19, the pumping of the Hidden Creek irrigation well HPW-1 can have an impact on ground water levels in nearby domestic water supply wells in addition to the regional ground water flow direction. The cone of depression caused by pumping HPW-1 extended approximately 5,000 feet from the well.

Ground water level measurements were made on July 5, 6, and 9, 2012. The water level difference between the July 6 measurement and the July 9 measurement would be the impact due to pumping of well HPW-1. This data is shown in Table 5 under the Maximum Recovery column. Off-site wells fluctuated as much as 5.18 feet. Because of the anisotropic nature of the limestone, there was not a direct correlation between distance from the pumping well and the impact.

7.4 STEMEN WELL HYDROGRAPH CONCLUSIONS

Based on the data obtained for this investigation, the Stemen well was found to be drilled to a depth of approximately 31 feet below the land surface. This well penetrates the top of the carbonate bedrock aquifer.

The ground water level data obtained from Mr. Stemen (well DS) shows that the ground water level in his well has fluctuated approximately 4 to 7 feet annually (Figure 15). Based on the hydrograph, approximately 2-4 feet of the ground water fluctuation in the well is due to natural ground water recharge from rainfall. During the irrigation seasons, approximately 2-4 feet of additional ground water fluctuation can be attributed to pumping by the Hidden Creek Golf Club

irrigation well HPW-1. Multiple rises and declines have been observed throughout the irrigation season each year since measurements began in 2009.

Examining the data collected from 2009 to the present, it does not appear that there is a downward trend in the ground water levels. This would indicate that Hidden Creek Golf Club is not dewatering the aquifer. There is ample time in between irrigation seasons to recharge the limestone aquifer.

7.5 GROUND WATER QUALITY ISSUE

The problems with the hydrogen sulfide content of the water are beyond the scope of this report. However, historic data for the carbonate bedrock aquifer indicated that depending on drilling location and depth, hydrogen sulfide can be a problem. However, it is possible to treat the ground water using a number of treatment methods that are available off-the-shelf for relatively low cost.

7.6 IMPACT ASSESSMENT CONCLUSIONS

Field data obtained for this project show that the pumping of the Hidden Creek Golf Club irrigation well can have an impact on the ground water levels in nearby domestic water supply wells. The degree of impact depends on the location as well as the depth of the water well relative to the HPW-1 pumping center. It also depends on the flow zone from which the water well produces. Based on the data result, it is possible for a deeper high-yielding well to dewater a domestic well completed in an upper flow zone in the carbonate bedrock aquifer.

The cone of depression extended approximately 5,000 feet from well HPW-1 during the pumping test period. Off-site wells experienced as much as 5.18 feet of drawdown.

8.0 Recommendations

Within the context of the results and conclusions for this study, pumping the Hidden Creek irrigation well had an impact on ground water levels in the water wells completed in the shallow flow zones (Figures 13, 17, 18, and 19). In the event of drought conditions in the area, pumping both irrigation wells simultaneously has the potential to exceed the safe yield of the carbonate bedrock aquifer. If the safe yield of the aquifer is exceeded, the upper flow zones in the carbonate bedrock aquifer system will most likely become dewatered.

Accordingly, it is recommended that a best management plan be implemented to control the pumping from Hidden Creek Golf Club high-yielding irrigation water wells. Any depletion of the ground water supplies in the shallow flow zones could cause dewatering of the shallow wells in the area. Recommendations are as follows:

- To fully define the hydraulic conditions for each of the Hidden Creek high-yielding irrigation wells, the flow zones present in each well with depth should be identified. Geophysical well logging of the well using caliper and gamma logs or the use of a down hole camera are recommended to identify the number and thickness of each flow zone present in the wells. Other geophysical well logs could also be used as appropriate.

- A step test should be conducted on each irrigation well to determine the well efficiency. This would be done by pumping the well between 4 to 8 different pumping rates (or steps).

- A 24-hour constant rate pumping test should be conducted on each well independently to determine the long-term sustainable yield of the well. Both drawdown and recovery data should be obtained during the 24-hour pumping test. A ground water level monitoring program should also be designed and implemented to determine the effects of pumping the high-yielding water well on individual nearby water supply wells.

- The Hidden Creek Golf Club should prepare a report that defines the aquifer characteristics, a ground water level monitoring plan, and a best management plan for protecting the ground water supplies in the carbonate bedrock aquifer. The plan when implemented should show how the operator of the high-yielding well will prevent dewatering of nearby water supply wells. A mitigation plan should be developed in the event that local domestic water supply wells are affected by pumping of the high-yielding water well.

- To allow for accurate measurements when the irrigation wells are being pumped, at least 200 feet of one-inch diameter pipe should be installed in the wells to provide access for the monitoring equipment. Obstructions and turbulence in the well made it difficult to obtain accurate measurements in the pumping well. The pipe should be centered under the access port in the well cap.

- The Hidden Creek Golf Club must complete the ODNR-DSWR Water Withdrawal Facility Registration form and report the ground water usage each year to the ODNR-Division of Soil and Water Resources per ORC 1521.16.
- To minimize impacts to wells located northwest of the golf course, Hidden Creek could drill an additional irrigation well on the south or east side of the golf course and then use two wells to fill the irrigation ponds. Pumping two wells at lower rates will result in less impact than one well pumping the same rate.
- In lieu of drilling another irrigation well, the three wells along State Road and Dixie Highway that experienced problems could be drilled deeper into a lower section of the carbonate bedrock aquifer to obtain a reliable source of supply. In the event that water high in sulfur is encountered, it is recommended that a water treatment system be designed to treat the water to correct any water quality problems.

9.0 References

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10.0 Partial Glossary of Terms used in the Report

Anisotropic: A material that changes in its physical properties with direction as well as having non-uniform spatial distribution of properties throughout the substance. An anisotropic medium displays directional differences in hydraulic conductivity with direction. A property of a material in which spatial characteristic can change with both the distance and the direction between two locations.

Aquifer: A consolidated or unconsolidated geologic formation or series of formations that have the ability to receive, store or transmit water.

Aquifer (artesian): An aquifer that is bounded above and below by impermeable rock or sediment layers. The water in the aquifer is also under enough pressure that, when the aquifer is tapped by a well, the water rises up the well bore to a level that is above the top of the aquifer. The water may or may not flow onto the land surface.

Bedrock: Solid rock present beneath any soil, sediment or other surface cover. In some locations it may be exposed at Earth's surface.

Carbonate Rock: A rock made up primarily of carbonate minerals (minerals containing the CO3 anionic structure). Limestone (made up primarily of calcite (CaCO3) and dolomite (CaMg CO3)2 are the most common examples.

Confined Aquifer : An aquifer that is bounded above and below by impermeable rock or sediment layers. There may or may not be enough pressure in the aquifer to make it an "artesian aquifer".

Contour Line: A line on a map that traces locations where the value of a variable is constant. For example, contour lines of elevation trace points of equal elevation across the map. All points on the "ten foot" contour line are ten feet above sea level.

Discharge: The volume of water in a flowing stream that passes a given location in a unit of time. It is frequently expressed in cubic feet per minute or gallons per minute (gpm). Calculated by the formula Q = A x V where Q is the discharge, A is the cross sectional area of the channel and V is the average velocity of the stream.

Datum: A reference location or elevation which is used as a starting point for subsequent measurements. Sea level is a datum for elevation measurements. Datums can also be arbitrary such as the starting point for stream stage measurements or based upon a physical feature such as the base of a rock unit.

Drawdown: A lowering of the water table around a producing well. The drawdown at any given location will be the vertical change between the original water table and the level of the water table reduced by pumping.

Heterogeneous: A material consisting of dissimilar or diverse ingredients or constituents.

Homogeneous: A material consisting of uniform structure or composition throughout.

Hydraulic Conductivity (K): The ability of a porous material to transmit a fluid. It is usually expressed as gallons/day/foot sqared or feet per day.

Hydrogeology: The study of the interrelationship of geologic material and processes with water that control the distribution and character of water bodies.

Hydrograph: A graph that shows the change of a water-related variable over time. Example: A stream discharge hydrograph shows the change in discharge of a stream over time.

Impermeable Layer: A layer of rock, sediment or soil that does not allow water to pass through. This could be caused by a lack of pore space or pore spaces that are so small that water molecules have difficulty passing through.

Infiltration: The movement of surface water into porous soil.

Isotropic: A material that is uniform in its physical properties with direction as well as having uniform spatial distribution throughout the substance. An isotropic medium displays uniform hydraulic conductivity in all direction. A property of a material in which spatial characteristic do not change with the direction between two locations.

Joint: A fracture in rock along which there has been no displacement.

Karst: A landscape that is characterized by the features of solution weathering and erosion in the subsurface. These features include caves, sinkholes, disappearing streams, and subsurface drainage.

Porosity: The volume of pore space in a rock, sediment, or soil usually expressed as a percentage of pore space that containing water. This pore space can include openings between grains, fracture openings and caverns.

Recharge: Water added to an aquifer or other water body. An aquifer is recharged by precipitation in an area where the aquifer has a porous connection to the surface.

Recharge Area: The geographic area where water infiltrates into the ground and enters an aquifer.

Seepage: The slow movement of water through the pore spaces of a solid material. This term is also applied to a loss of water by infiltration through the bottom of a stream, canal, irrigation ditch, reservoir or other body of water.

Specific Capacity: The quantity of water produced in a well per unit foot of drawdown. Specific capacity is commonly expressed as gallons per minute per foot of drawdown (gpm/foot) over a specific time interval.

Storativity (S): A dimensionless quantity also called the storage coefficient. It is the volume of water that an aquifer released from storage or takes into storage per unit surface area of the aquifer per unit change in head

Stratification: A layered structure of sedimentary rocks in which the individual layers can be traced a considerable distance. The layers can be caused by many differences which include materials of different composition, color, grain size or orientation.

Stratigraphic Sequence: The sequence of sedimentary rock layers found in a specific geographic area, arranged in the order of their deposition.

Topographic Map: A map that shows the change in elevation over a geographic area through the use of contour lines. The contour lines trace points of equal elevation across the map. See also: contour line and contour map.

Transmissivity (T): The rate of movement of water at a prevailing viscosity through an aquifer of unit width under a unit hydraulic gradient. It is usually defined a gallons/day/foot or feet squared per day.

Water Table: A level beneath the Earth's surface, below which all pore spaces are filled with water and above which the pore spaces are filled with air. It is the top of the zone of saturation in a subsurface rock, soil or sediment unit.

Withdrawal: A removal of water from a surface or ground water source for use.

Yield (Q): The quantity of water that can be produced from an aquifer. It is generally expressed as gallons per minute.

Zone of Saturation: The zone beneath the water table where all pore spaces are completely filled with water. Water that exists within this zone is known as "ground water".

11.0 Appendix A -Water Wells in the Allen County, Jackson Township Hidden Creek Golf Club Study Area

Table 1 Nearby Water Well Logs to Hidden Creek Golf Course, Allen County Jackson Township

WELL_LOG_NO	NAME	ST_NO	ST_DIR_CODE	ST_NAME	ST_TYPE_CODE	CNTY	TWP_DESC	TOTAL_DEPTH	S_WATER_LEVEL	TEST_RATE	AQUIFER_TYPE_DESC
38982	MARION DRIVER			SUGAR CREEK	RD	ALLEN	JACKSON	60	23		LIMESTONE
94327	EUGENE LIPPINCOTT		N	COOL	RD	ALLEN	MONROE	55	26	33	LIMESTONE
161695	MARION DRIVER		N	COOL	RD	ALLEN	JACKSON	63	19		LIMESTONE
192879	CLYDE KOOGLER		N	COOL	RD	ALLEN	JACKSON	58	23	20	LIMESTONE
511861	BARRY SWALLOW	5000	S	DIXIE	HGWY	ALLEN	SHAWNEE	90	60	15	GRAVEL
636293	EUGENE MCCALL	6080	E	STATE	RD	ALLEN	RICHLAND	47	14	6	LIMESTONE
661919	BUD DOWNEY	4930	N	NAPOLEON	RD	ALLEN	JACKSON	50	17	20	LIMESTONE
715023	DONNA BURKHOLDER	4233	N	COOL	RD	ALLEN	BATH	110	14	12	LIMESTONE
715055	JEFFREY SHOCKEY	5494	N	DIXIE	HGWY	ALLEN	JACKSON	30	14	15	LIMESTONE
761034	ADAM RAYL	5621	N	DIXIE	HGWY	ALLEN	RICHLAND	34	18	12	LIMESTONE
790507	STEVE HARRIS	4386	N	COOL	RD	ALLEN	JACKSON	59	30	7	LIMESTONE
841972	AMY GRABER	4322	N	COOL	RD	ALLEN	JACKSON	103	25	4	LIMESTONE
851247	TOM MCDANIEL	5950		SUGAR CREEK	RD	ALLEN	JACKSON	60	39	6	LIMESTONE
852643	ED WEBER	4611	N	COOL	RD	ALLEN	BATH	114	56	7	LIMESTONE
879747	DAVID MARSTELLER	4910	N	NAPOLEON	RD	ALLEN	JACKSON	40	15	15	LIMESTONE
884349	SUGAR CREEK GOLFCOUR			SUGAR CREEK	RD	ALLEN	JACKSON	70	26	40	LIMESTONE
941110	TIM/MEGAN RUNK	5468	N	DIXIE	HGWY	ALLEN	RICHLAND	30	14	10	LIMESTONE
963242	RONALD ANDERSON	5600	N	NAPOLEON	RD	ALLEN	RICHLAND	75	24	15	LIMESTONE
963252	JACK ADAMS	6060		SUGAR CREEK	RD	ALLEN	JACKSON	63	24	15	LIMESTONE
1013041	DAVID DEEDS	5726		NAPOLEON	RD	ALLEN	RICHLAND	35	18	12	LIMESTONE
							Max	114	60	40	
							Min	30	14	4	
							Average	62	25	15	

Appendix B –High-Yielding Irrigation Well Logs for Hidden Creek Golf Club Study

DNR 7802.10

TYPE OR USE PEN
SELF TRANSCRIBING
PRESS HARD

WELL LOG AND DRILLING REPORT

Ohio Department of Natural Resources
Divison of Soil and Water Resources, 2045 Morse Road Building B
Columbus, Ohio 43229-6693 Voice (614) 265-6740 Fax (614) 265-6767

1014542
OB-1

WELL LOCATION

County Allen Township Jackson

Owner/Builder (Circle One or Both) First Sugar Last Creek Golf

Address of Well Location Number 5420 Street Name N. Dixie Hwy

City Lima Ohio Zip Code +4 45807

Permit No. Section/Lot No. (Circle One or Both)

Location of Well in State Plane coordinates, if available: Use of Well Irrigation

N ☐ X _____ . _____ +/- _____ ft. or m

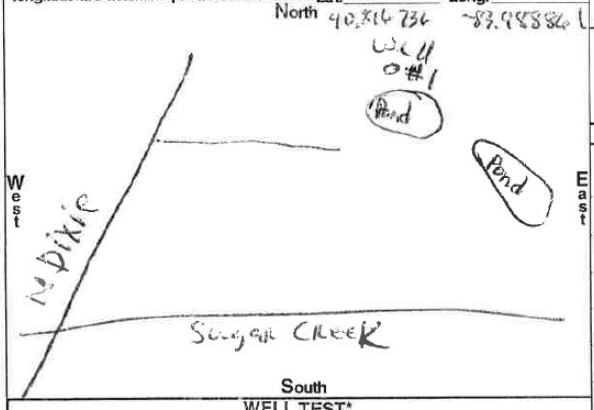
S ☐ Y _____ . _____ +/- _____ ft. or m

Elevation of Well 868 . _____ +/- _____ ft. or m

Datum Plain: ☐ NAD27 ☐ NAD83 Elevation Source Google

Source of Coordinates: ☐ GPS ☐ Survey ☐ Other

Sketch a map showing distance well lies from numbered state highways, street intersections, county roads, buildings or other notable landmarks. If latitude and longitude are available please include here: Lat: _____ Long: _____
North 40.816736 -83.988826



WELL TEST*

Pre-Pumping Static Level 14 ft. Date 5-21-1998

Measured from: ☒ Top of Casing ☐ Ground Level ☐ Other

☒ Air ☐ Bailing ☐ Pumping* ☐ Other

Test Rate 300+ gpm Duration of Test 1 hrs.

Feet of Drawdown _____ ft. Sustainable Yield _____ gpm

*(Attach a copy of the pumping test record, per section 1521.05, ORC)

Is Copy Attached? ☐ Yes ☐ No Flowing Well? ☐ Yes ☐ No

Quality

PUMP/PITLESS

Type of pump Submersible Capacity 240 gpm

Pump set at 320 ft. Pitless Type NA

Pump installed by

I hereby certify the information given is accurate and correct to the best of my knowledge.

Drilling Firm G-H Bierly Inc.

Address 10933 Ada Rd

City, State, Zip Ada Ohio 45810

Signed Bruce Chum Date 7-18-92

ODH Registration Number 715

CONSTRUCTION DETAILS

☒ Rotary ☐ Cable ☐ Augered ☐ Driven ☐ Other

BOREHOLE/CASING (measured from ground surface)

1 ☐ Borehole Diameter 12 inches Depth 335 ft.

Casing Diameter 8 in. Length 32 ft. Thickness SDR 21 in.

2 ☐ Borehole Diameter _____ inches Depth _____ ft.

Casing Diameter _____ in. Length _____ ft. Thickness _____ in.

Casing Height Above Ground 18 ft.

Type: 1 ☐ 2 ☐ Steel; 1 ☐ 2 ☐ Galv.; 1 ☒ 2 ☐ PVC; 1 ☐ 2 ☐ Other

Joints: 1 ☐ 2 ☐ Threaded; 1 ☐ 2 ☐ Welded; 1 ☒ 2 ☐ Solvent; 1 ☐ 2 ☐ Other

SCREEN

Diameter _____ Slot Size _____ Screen Length _____ ft.

Type _____ Material _____

Set Between _____ ft. and _____ ft.

GRAVEL PACK (Filter Pack)

Material/Size _____ Volume/Weight Used _____

Method of Installation _____

Depth: Placed FROM _____ ft. TO _____ ft.

GROUT

Material Bentonite Volume/Weight Used 20 gal

Method of Installation pump

Depth: Placed FROM 0 ft. TO 32 ft.

DRILLING LOG*

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED. Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand, etc.	From	To
Yellow Clay	0	8
Blue Clay	8	30
Limestone	30	32
8" Casing	32	
Limestone	32	335

*(If more space is needed to complete drilling log, use next consecutively numbered form.)

Date of Well Completion 5-21-1998 Total Depth of Well 335 ft.

Completion of this form is required by section 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.

ORIGINAL COPY TO - ODNR, DIVISION OF SOIL AND WATER RESOURCES, 2045 MORSE ROAD BLD. B, COLS., OHIO 43229-669

Blue - Customer's copy Pink - Driller's copy Green - Local Health Dept. copy

DNR 7802.10

TYPE OR USE PEN
SELF TRANSCRIBING
PRESS HARD

WELL LOG AND DRILLING REPORT

Ohio Department of Natural Resources
Divison of Soil and Water Resources, 2045 Morse Road Building B
Columbus, Ohio 43229-6693 Voice (614) 265-6740 Fax (614) 265-6767

1014543
PW-1

WELL LOCATION

County Allen Township Jackson

Owner/Builder (Circle One or Both) First Sugar Creek Golf Last

Address of Well Location Number 5420 Street Name N. Dixie Hwy

City Lima Ohio Zip Code +4 45807

Permit No. Section/Lot No. (Circle One or Both)

Location of Well in State Plane coordinates, if available: Use of Well Irrigation

N ☐ X _____ . _____ +/- _____ ft. or m

S ☐ Y _____ . _____ +/- _____ ft. or m

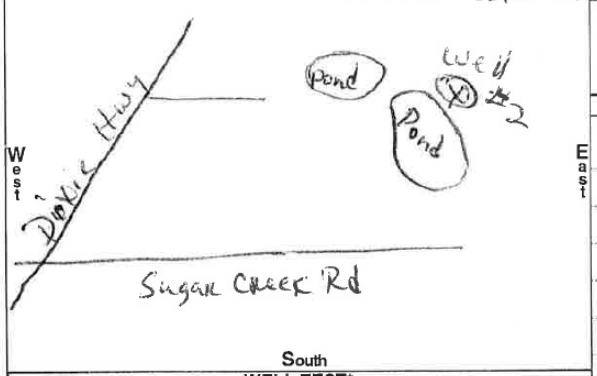
Elevation of Well 867 . _____ +/- _____ ft. or m

Datum Plain: ☐ NAD27 ☐ NAD83 Elevation Source Google E

Source of Coordinates: ☐ GPS ☐ Survey ☐ Other

Sketch a map showing distance well lies from numbered state highways, street intersections, county roads, buildings or other notable landmarks. If latitude and longitude are available please include here: Lat: _____ Long: _____

North 40.816965 -83.987352



WELL TEST*

Pre-Pumping Static Level 12 ft. Date 6-28-1999

Measured from: ☒ Top of Casing ☐ Ground Level ☐ Other

☒ Air ☐ Bailing ☐ Pumping* ☐ Other

Test Rate 400+ gpm Duration of Test 1 hrs.

Feet of Drawdown _____ ft. Sustainable Yield _____ gpm

*(Attach a copy of the pumping test record, per section 1521.05, ORC)

Is Copy Attached? ☐ Yes ☐ No Flowing Well? ☐ Yes ☒ No

Quality Clear

PUMP/PITLESS

Type of pump Submersible Capacity 350 gpm

Pump set at 300 ft. Pitless Type NA

Pump installed by

I hereby certify the information given is accurate and correct to the best of my knowledge.

Drilling Firm G-H Bierly Inc

Address 10933 Ada Rd

City, State, Zip Ada Ohio 45810

Signed Brice Clum Date 7-18-12

ODH Registration Number 715

CONSTRUCTION DETAILS

☒ Rotary ☐ Cable ☐ Augered ☐ Driven ☐ Other

BOREHOLE/CASING (measured from ground surface)

1 ☐ Borehole Diameter 12 inches Depth 400 ft.

Casing Diameter 8 in. Length 28 ft. Thickness SDR24 in.

2 ☐ Borehole Diameter _____ inches Depth _____ ft.

Casing Diameter _____ in. Length _____ ft. Thickness _____ in.

Casing Height Above Ground 18 ft.

Type: 1 ☐ 2 ☐ Steel; 1 ☐ 2 ☐ Galv.; 1 ☒ 2 ☐ PVC; 1 ☐ 2 ☐ Other

Joints: 1 ☐ 2 ☐ Threaded; 1 ☐ 2 ☐ Welded; 1 ☒ 2 ☐ Solvent; 1 ☐ 2 ☐ Other

SCREEN

Diameter _____ Slot Size _____ Screen Length _____ ft.

Type _____ Material _____

Set Between _____ ft. and _____ ft.

GRAVEL PACK (Filter Pack)

Material/Size _____ Volume/Weight Used _____

Method of Installation _____

Depth: Placed FROM _____ ft. TO _____ ft.

GROUT

Material Bentonite Volume/Weight Used 70 gal

Method of Installation Pump

Depth: Placed FROM 0 ft. TO 28 ft.

DRILLING LOG*

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED. Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand, etc.	From	To
Yellow Clay	0	11
Blue Clay	11	26
Limestone	26	28
8" PVC Casing	28	
Limestone	28	400

*(If more space is needed to complete drilling log, use next consecutively numbered form.)

Date of Well Completion 6-28-1999 Total Depth of Well 400 ft.

Completion of this form is required by section 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.

ORIGINAL COPY TO - ODNR, DIVISION OF SOIL AND WATER RESOURCES, 2045 MORSE ROAD BLD. B, COLS., OHIO 43229-669

Blue - Customer's copy Pink - Driller's copy Green - Local Health Dept. copy

Appendix C –Domestic Water Supply Well Logs Used for Observation During the Hidden Creek Golf Club Study

WELL LOG AND DRILLING REPORT

E.V

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
Fountain Square
Columbus, Ohio 43224

NO CARBON PAPER NECESSARY – SELF-TRANSCRIBING

636293

COUNTY Allen TOWNSHIP Richland SECTION OF TOWNSHIP 31

OWNER Eugene McCall ADDRESS 6080 E State Rd

LOCATION OF PROPERTY Same

CONSTRUCTION DETAILS

Casing diameter 6 Length of casing 28

Type of screen _____ Length of screen _____

Type of pump _____

Capacity of pump _____

Depth of pump setting _____

Date of completion _____

BAILING OR PUMPING TEST

(quantity see by circling)

Test rate 6 gpm Duration of test 1 hrs

Drawdown 9 ft Date 7 June 85

Static level (depth to water) 14 ft

Quality (clear, cloudy, taste, odor) Clear

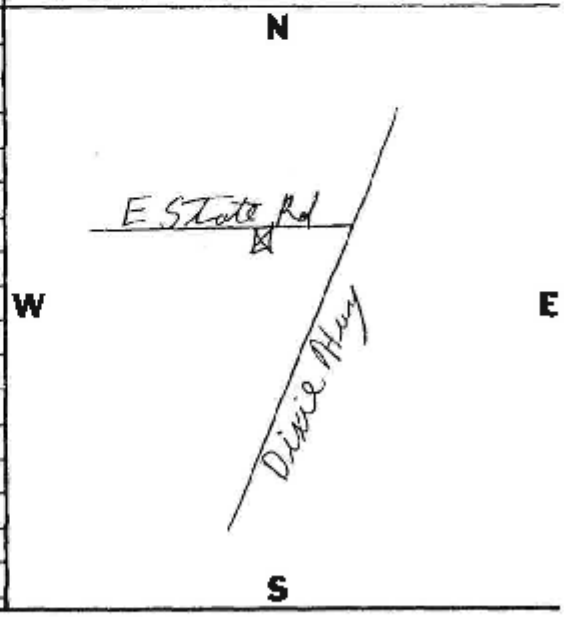
Pump installed by _____

WELL LOG*

Formations: sandstone, shale, limestone, gravel, clay	From	To
Top Soil + Clay	0 ft	6 ft
Blue Mud	6	25
Limestone	25	47

SKETCH SHOWING LOCATION

Locate in reference to numbered state highways, street intersections, county roads, etc.



DRILLING FIRM W H Bailey Inc DATE 30 Oct 86

ADDRESS Lafayette SIGNED Gary Bailey

*If additional space is needed to complete well log, use next consecutive numbered form.

ORIGINAL COPY - ODNR, DIVISION OF WATER, FOUNTAIN SQ., COLS., OHIO 43224

DP

715055

WELL LOG AND DRILLING REPORT

Ohio Department of Natural Resources, Divison of Water
1939 Fountain Square Drive, Columbus, Ohio 43224 Phone (614) 265-6739

TYPE OR USE PEN
SELF TRANSCRIBING
PRESS HARD

Permit Number 139-90

COUNTY Allen TOWNSHIP Jackson SECTION/LOT No. 6 (CIRCLE ONE)

OWNER/BUILDER (CIRCLE ONE OR BOTH) Jeffrey S Rocky PROPERTY ADDRESS (ADDRESS OF WELL LOCATION A)

LOCATION OF PROPERTY 5494 N Dixie Hwy

CONSTRUCTION DETAILS

CASING
[1] Diameter 6 in. Length 25 ft. Wall Thickness .316 in.
[2] Diameter ____ in. Length ____ ft. Wall Thickness ____ in.
Type: [1] Steel [2] Galv. [2] PVC [1] [2] Other
Joints: [1] Threaded [1] Welded [2] Solvent [1] [2] Other
Liner: Length ____ Type ____ Wall Thickness ____ in.

Borehole Diameter 9 in.

SCREEN
Type (wire wrapped, louvered, etc.) ____ Material ____
Length ____ ft. Diameter ____ in.
Set between ____ ft. and ____ ft. Slot ____

GROUT
Material Bentonite Volume used ____
Method of installation Pump
Depth: placed from 0 ft. to 25 ft.

GRAVEL PACK (Filter Pack)
Material ____ Volume used ____
Method of installation ____
Depth: placed from ____ ft. to ____ ft.

Pitless Device ☐ Adapter ☐ Preassembled unit

Use of Well ____
☒ Rotary ☐ Cable ☐ Augered ☐ Driven ☐ Dug ☐ Other ____

Date of Completion ____

WELL LOG*

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED.

Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand, etc.	From	To
Topsoil & Clay	0	4
Blue Mud	4	18
Limestone	18	30

WELL TEST

☐ Bailing ☐ Pumping* ☐ Other ____
Test rate 15 gpm Duration of test 1 hrs.
Drawdown 4 ft.
Measured from: ☒ top of casing ☐ ground level ☐ Other ____
Static Level (depth to water) 14 ft. Date: 8 Sept 90
Quality (clear, cloudy, taste, odor) Clear

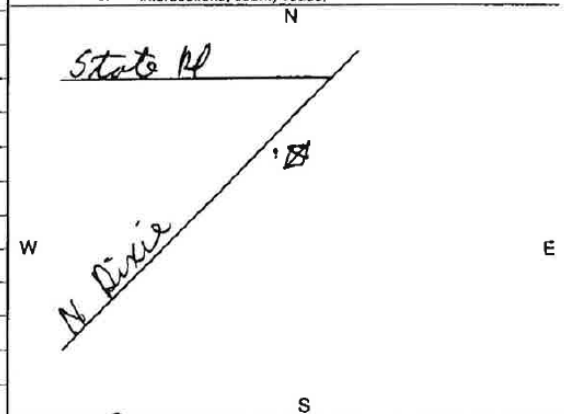
*(Attach a copy of the pumping test record, per section 1521.05, ORC)

PUMP

Type of pump ____ Capacity ____ gpm
Pump set at ____ ft.
Pump installed by ____

SKETCH SHOWING WELL LOCATION

Show distances well lies from numbered state highways, street intersections, county roads, etc.



*If additional space is needed to complete well log, use next consecutively numbered form.

DNR 7802.90

Drilling Firm G.H. BIERLY INC.
Address Box 7171
City, State, Zip Lafayette, Ohio 45854

Signed Gary Bierly
Date 15 Sept 90
ODH Registration Number 715

Completion of this form is required by section 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.

ORIGINAL COPY TO - ODNR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224

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761034 AR

DNR 7802.92
TYPE OR USE PEN
SELF TRANSCRIBING
PRESS HARD

WELL LOG AND DRILLING REPORT

Ohio Department of Natural Resources, Divison of Water
1939 Fountain Square Drive, Columbus, Ohio 43224 Phone (614) 265-6739

Permit Number 183-92

COUNTY Allen TOWNSHIP Richland SECTION/LOT No. (CIRCLE ONE)

OWNER/BUILDER (CIRCLE ONE OR BOTH) Adam Rayl PROPERTY ADDRESS 5621 North Dixie Hwy (ADDRESS OF WELL LOCATION A)

LOCATION OF PROPERTY

CONSTRUCTION DETAILS

CASING
Borehole Diameter ____ in.
[1] Diameter 6 in. Length 34 ft. Wall Thickness .240 in.
[2] Diameter ____ in. Length ____ ft. Wall Thickness ____ in.
Type: [1] Steel [2] Galv. [1] PVC [2] Other
Joints: [1] Threaded [2] Welded [1] Solvent [2] Other
Liner: Length ____ Type ____ Wall Thickness ____ in.

SCREEN
Type (wire wrapped, louvered, etc.) ____ Material ____
Length ____ ft. Diameter ____ in.
Set between ____ ft. and ____ ft. Slot ____

GROUT
Material ____ Volume used ____
Method of installation ____
Depth: placed from ____ ft. to ____ ft.

GRAVEL PACK (Filter Pack)
Material ____ Volume used ____
Method of installation ____
Depth: placed from ____ ft. to ____ ft.

Pitless Device [1] Adapter ☐ Preassembled unit
Use of Well ____
☐ Rotary [1] Cable ☐ Augered ☐ Driven ☐ Dug ☐ Other ____
Date of Completion ____

WELL LOG*

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED.
Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand, etc.

From	To	
0	3	Top Soil
3	12	Brown Clay
12	30	Blue Clay
30	34	Sand - Shale

Water AT 34 FT

*If additional space is needed to complete well log, use next consecutively numbered form.

WELL TEST

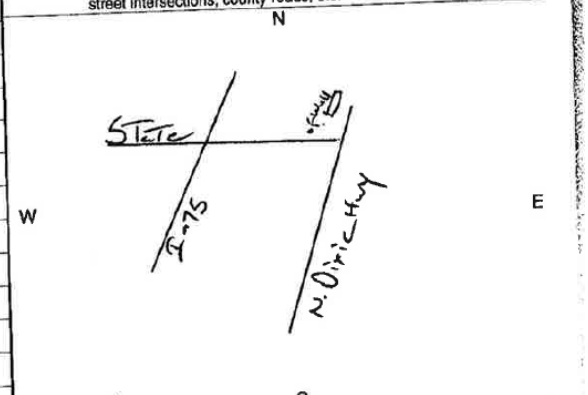
[1] Bailing [1] Pumping* ☐ Other ____
Test rate 12 gpm Duration of test 2 hrs.
Drawdown ____ ft.
Measured from: [1] top of casing ☐ ground level ☐ Other ____
Static Level (depth to water) 18 ft. Date: ____
Quality (clear, cloudy, taste, odor) ____
*(Attach a copy of the pumping test record, per section 1521.05, ORC)

PUMP

Type of pump Submersible Capacity 10 gpm
Pump set at 28 FT ft.
Pump installed by Waldron Well Drilling

SKETCH SHOWING WELL LOCATION

Show distances well lies from numbered state highways, street intersections, county roads, etc.



I hereby certify the information given is accurate and correct to the best of my knowledge.

Drilling Firm Waldron Well Drilling
Address 4000 Slabtown Rd
City, State, Zip Lima, Ohio 45801

Signed Justin Waldron
Date 2-16-93
ODH Registration Number ____

Completion of this form is required by section 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.
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Need #

Page 1/1

DNR 7802.96

TYPE OR USE PEN
SELF TRANSCRIBING
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WELL LOG AND DRILLING REPORT

Ohio Department of Natural Resources
Divison of Water, 1939 Fountain Square Drive
Columbus, Ohio 43224-9971 Voice (614) 265-6739 Fax (614) 447-9503

GM
852625

WELL LOCATION

County Allen Township Richland

Owner/Builder (Circle One or Both) First Gene Last McCall

Address of Well Location Number 6050 E Street Name State Rd

City Elida Zip Code +4 45807

Permit No. 83-97 Section/Lot No. (Circle One or Both) 12

Location of Well in State Plane coordinates, if available: Use of Well Domestic

N ☐ X _____ . _____ +/- _____ ft. or m

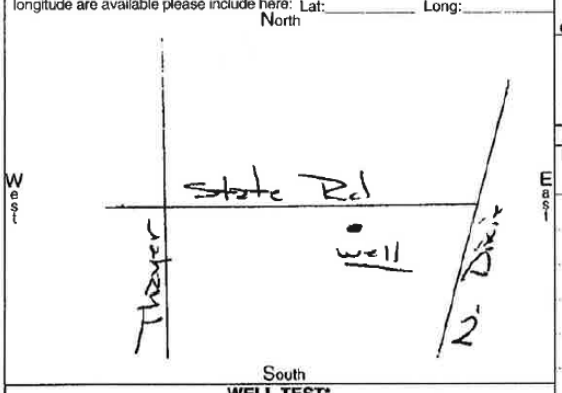
S ☐ Y _____ . _____ +/- _____ ft. or m

Elevation of Well _____ . _____ +/- _____ ft. or m

Datum Plain: ☐ NAD27 ☐ NAD83 Elevation Source _____

Source of Coordinates: ☐ GPS ☐ Survey ☐ Other _____

Sketch a map showing distance well lies from numbered state highways, street intersections, county roads, buildings or other notable landmarks. If latitude and longitude are available please include here: Lat: _____ Long: _____



WELL TEST*

Pre-Pumping Static Level 6 ft. Date 7/30/97

Measured from: ☑ Top of Casing ☐ Ground Level ☐ Other _____

☑ Air ☐ Bailing ☐ Pumping* ☐ Other _____

Test Rate 10 gpm Duration of Test 1 hrs.

Feet of Drawdown 30 ft. Sustainable Yield 10 gpm

*(Attach a copy of the pumping test record, per section 1521.05, ORC)

Is Copy Attached? ☐ Yes ☐ No Flowing Well? ☐ Yes ☐ No

Quality _____

PUMP/PITLESS

Type of pump _____ Capacity _____ gpm

Pump set at _____ ft. Pitless Type _____

Pump installed by _____

I hereby certify the information given is accurate and correct to the best of my knowledge.

Drilling Firm Sever Well Drilling

Address 1830 Ft Jennings Rd

City, State, Zip Delphos Ohio

Signed Dan Sever Date 7/30/97

ODH Registration Number 116

CONSTRUCTION DETAILS

☑ Rotary ☐ Cable ☐ Augered ☐ Driven ☐ Other _____

BOREHOLE/CASING (measured from ground surface)

1 ☐ Borehole Diameter 9 inches Depth 25 ft.

Casing Diameter 6 in. Length 26 ft. Thickness SDR21 in.

2 ☐ Borehole Diameter _____ inches Depth _____ ft.

Casing Diameter _____ in. Length _____ ft. Thickness _____ in.

Casing Height Above Ground 1 ft.

Type 1 ☐ 2 ☐ Steel 1 ☐ 2 ☐ Galv. 1 ☑ 2 ☐ PVC 1 ☐ 2 ☐ Other _____

Joints 1 ☐ 2 ☐ Threaded 1 ☐ 2 ☐ Welded 1 ☑ 2 ☐ Solvent 1 ☐ 2 ☐ Other _____

SCREEN

Diameter Slot Size Screen Length _____ ft.

Type Material

Set Between ft. and ft.

GRAVEL PACK (Filter Pack)

Material/Size Volume/Weight Used

Method of Installation

Depth: Placed FROM ft. TO ft.

GROUT

Material Bentonite Volume/Weight Used 50lbs

Method of Installation Pump

Depth: Placed FROM 25 ft. TO 0 ft.

DRILLING LOG*

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED.

Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand, etc.	From	To
clay	0	23
Limestone	23	43

*(If more space is needed to complete drilling log, use next consecutively numbered form.)

Date of Well Completion 7/30/97 Total Depth of Well 43 ft.

Completion of this form is required by section 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.

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HDB-2

884349

DNR 7802.96
TYPE OR USE PEN
SELF TRANSCRIBING
PRESS HARD

WELL LOG AND DRILLING REPORT

Ohio Department of Natural Resources
Divison of Water, 1939 Fountain Square Drive
Columbus, Ohio 43224-9971 Voice (614) 265-6739 Fax (614) 447-9503

WELL LOCATION

County Allen Township Jackson

Owner/Builder (Circle One or Both) First Sugar Creek Golf Course Last

Address of Well Location Number Street Name

City Zip Code +4

Permit No. Section/Lot No. (Circle One or Both)

Location of Well in State Plane coordinates, if available: Use of Well

N X . +/- ft. or m

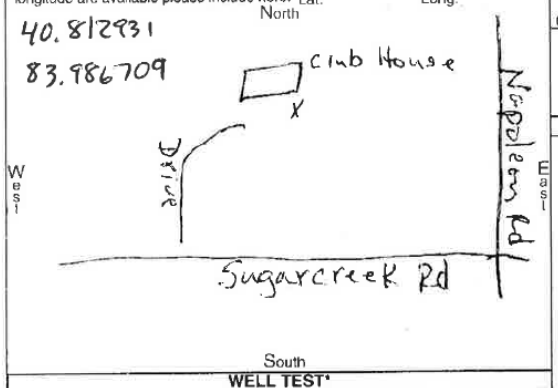
S Y . +/- ft. or m

Elevation of Well . +/- ft. or m

Datum Plain: [ ] NAD27 [ ] NAD83 Elevation Source

Source of Coordinates: [ ] GPS [ ] Survey [ ] Other

Sketch a map showing distance well lies from numbered state highways, street intersections, county roads, buildings or other notable landmarks. If latitude and longitude are available please include here: Lat: Long:



WELL TEST*

Pre-Pumping Static Level 26 ft. Date 2-18-99

Measured from: [X] Top of Casing [ ] Ground Level [ ] Other

[X] Air [ ] Bailing [ ] Pumping* [ ] Other

Test Rate 40 gpm Duration of Test 1 hrs.

Feet of Drawdown ft. Sustainable Yield gpm

*(Attach a copy of the pumping test record, per section 1521.05, ORC)

Is Copy Attached? [ ] Yes No Flowing Well? Yes [ ] No

Quality Clear

PUMP/PITLESS

Type of pump Capacity gpm

Pump set at ft. Pitless Type

Pump installed by

I hereby certify the information given is accurate and correct to the best of my knowledge.

Drilling Firm G.H. Bierly Inc.

Address Box 2171

City, State, Zip Lafayette OH 45854

Signed Bruce Clum Date 2-18-99

ODH Registration Number 715

CONSTRUCTION DETAILS

[X] Rotary Cable Augered Driven Other

BOREHOLE/CASING (measured from ground surface)

1: Borehole Diameter 9 inches Depth 36 ft.

Casing Diameter 6 in. Length 36 ft Thickness .316 in.

2: Borehole Diameter inches Depth ft.

Casing Diameter in. Length ft Thickness in.

Casing Height Above Ground 2 ft.

Type 1 Steel 1 Galv. 1 [X] PVC 1 Other

2 2 2 2

Joints 1 Threaded 1 Welded 1 [X] Solvent 1 Other

2 2 2 2

SCREEN

Diameter 6 Slot Size .020 Screen Length 3 ft.

Type Material PVC

Set Between 33 ft. and 36 ft.

GRAVEL PACK (Filter Pack)

Material/Size 3/8 Volume/Weight Used

Method of Installation Pour

Depth: Placed FROM 33 ft. TO 36 ft.

GROUT

Material Bentonite Volume/Weight Used

Method of Installation Pump

Depth: Placed FROM 0 ft. TO 33 ft.

DRILLING LOG*

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED.

Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand, etc.	From	To
Yellow Clay	0	9
Blue Clay	9	33
Gravel	33	36
Limestone	36	70

*(If more space is needed to complete drilling log, use next consecutively numbered form.)

Date of Well Completion 2-18-99 Total Depth of Well 70 ft.

Completion of this form is required by section 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.
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Page 1/1

DNR 7802.96

TYPE OR USE PEN
SELF TRANSCRIBING
PRESS HARD

WELL LOG AND DRILLING REPORT

Ohio Department of Natural Resources
Divison of Water, 1939 Fountain Square Drive
Columbus, Ohio 43224-9971 Voice (614) 265-6739 Fax (614) 447-9503

TMR
941110

WELL LOCATION

County Allen Township Richland

Owner/Builder (Circle One or Both) Tim+Megan Prunk (First / Last)

Address of Well Location 5468 N Dixie Hwy (Number / Street Name)

City Lima Zip Code +4 58073

Permit No. 23-02 Section/Lot No. (Circle One or Both) 1

Location of Well in State Plane coordinates, if available: Use of Well Domestic

N ☐ X _____ +/- _____ ft. or m

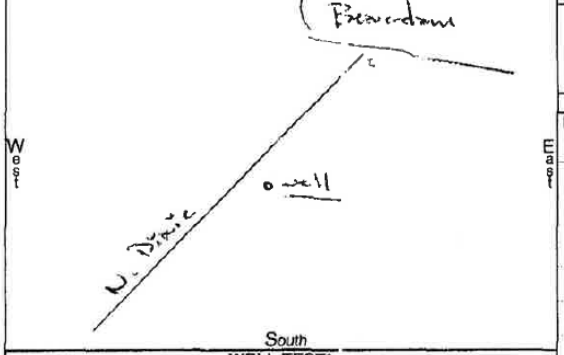
S ☐ Y _____ +/- _____ ft. or m

Elevation of Well _____ +/- _____ ft. or m

Datum Plain: ☐ NAD27 ☐ NAD83 Elevation Source _____

Source of Coordinates: ☐ GPS ☐ Survey ☐ Other _____

Sketch a map showing distance well lies from numbered state highways, street intersections, county roads, buildings or other notable landmarks. If latitude and longitude are available please include here: Lat: _____ Long: _____



WELL TEST*

Pre-Pumping Static Level 14 ft. Date 3/13/02

Measured from: ☒ Top of Casing ☐ Ground Level ☐ Other _____

☒ Air ☐ Bailing ☐ Pumping* ☐ Other _____

Test Rate 10 gpm Duration of Test 1 hrs.

Feet of Drawdown 6 ft. Sustainable Yield 10 gpm

*(Attach a copy of the pumping test record, per section 1521.05, ORC)

Is Copy Attached? ☐ Yes ☐ No Flowing Well? ☐ Yes ☒ No

Quality Clear

PUMP/PITLESS

Type of pump _____ Capacity _____ gpm

Pump set at _____ ft. Pitless Type _____

Pump installed by _____

I hereby certify the information given is accurate and correct to the best of my knowledge.

Drilling Firm Seven Well Drilling

Address _____

City, State, Zip Delphos Ohio

Signed Dave Sum Date 3/13/02

ODH Registration Number 116

CONSTRUCTION DETAILS

☒ Rotary ☐ Cable ☐ Augered ☐ Driven ☐ Other _____

BOREHOLE/CASING (measured from ground surface)

1 ☐ Borehole Diameter 9 1/2 inches Depth 30 ft.

Casing Diameter 6 in. Length 36 ft. Thickness .280 in.

2 ☐ Borehole Diameter _____ inches Depth _____ ft.

Casing Diameter _____ in. Length _____ ft. Thickness _____ in.

Casing Height Above Ground 1 ft.

Type: 1 ☐ 2 ☐ Steel; 1 ☐ 2 ☐ Galv.; 1 ☒ 2 ☐ PVC; 1 ☐ 2 ☐ Other _____

Joints: 1 ☐ 2 ☐ Threaded; 1 ☐ 2 ☐ Welded; 1 ☒ 2 ☐ Solvent; 1 ☐ 2 ☐ Other

SCREEN

Diameter _____ Slot Size _____ Screen Length _____ ft.

Type _____ Material _____

Set Between _____ ft. and _____ ft.

GRAVEL PACK (Filter Pack)

Material/Size _____ Volume/Weight Used _____

Method of Installation _____

Depth: Placed FROM _____ ft. TO _____ ft.

GROUT

Material Bentonite Volume/Weight Used 85 cpl

Method of Installation Pump

Depth: Placed FROM 25 ft. TO 0 ft.

DRILLING LOG*

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED.

Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand, etc.	From	To
Clay	0	18
Broken stone, sand	18	23
Limestone	23	30

*(If more space is needed to complete drilling log, use next consecutively numbered form.)

Date of Well Completion 3/13/02 Total Depth of Well 30 ft.

Completion of this form is required by section 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.

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DNR 7602.96

TYPE OR USE PEN
SELF TRANSCRIBING
PRESS HARD

WELL LOG AND DRILLING REPORT

Ohio Department of Natural Resources
Divison of Water, 1939 Fountain Square Drive
Columbus, Ohio 43224-9971 Voice (614) 265-6739 Fax (614) 447-9503

JA
963252

WELL LOCATION

County Allen Township Jackson

Owner/Builder (Circle One or Both) Jack (First) Adams (Last)

Address of Well Location 6060 (Number) SugarCreek Rd (Street Name)

City Lima OH Zip Code +4 45801

Permit No. 49-03 Section/Lot No. (Circle One or Both)

Location of Well in State Plane coordinates, if available: Use of Well Residental

N ☐ X _____ . _____ +/- _____ ft. or m

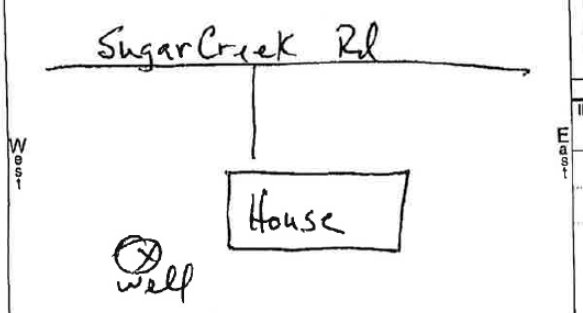
S ☐ Y _____ . _____ +/- _____ ft. or m

Elevation of Well _____ . _____ +/- _____ ft. or m

Datum Plain: ☒ NAD27 ☐ NAD83 Elevation Source _____

Source of Coordinates: ☐ GPS ☐ Survey ☐ Other _____

Sketch a map showing distance well lies from numbered state highways, street intersections, county roads, buildings or other notable landmarks. If latitude and longitude are available please include here: Lat 40 48' 37.9" Long 83 39' 27.8"



WELL TEST*

Pre-Pumping Static Level 24 ft. Date 7-17-03

Measured from: ☒ Top of Casing ☐ Ground Level ☐ Other _____

☒ Air ☐ Bailing ☐ Pumping* ☐ Other _____

Test Rate 15 gpm Duration of Test 1 hrs.

Feet of Drawdown _____ ft. Sustainable Yield _____ gpm

*(Attach a copy of the pumping test record, per section 1521.05, ORC)

Is Copy Attached? ☐ Yes ☐ No Flowing Well? ☐ Yes ☒ No

Quality Clear

PUMP/PITLESS

Type of pump _____ Capacity _____ gpm

Pump set at _____ ft. Pitless Type _____

Pump installed by _____

I hereby certify the information given is accurate and correct to the best of my knowledge.

Drilling Firm GH Bierly Inc.

Address Box 717

City, State, Zip Lafayette OH. 45854

Signed Bruce Blum Date 7-17-03

ODH Registration Number 715

CONSTRUCTION DETAILS

☒ Rotary ☐ Cable ☐ Augered ☐ Driven ☐ Other _____

BOREHOLE/CASING (measured from ground surface)

1 ☐ Borehole Diameter 9 inches Depth 63 ft.

Casing Diameter 6 in. Length 48 ft. Thickness SDR 21 in.

2 ☐ Borehole Diameter _____ inches Depth _____ ft.

Casing Diameter _____ in. Length _____ ft. Thickness _____ in.

Casing Height Above Ground 1 ft.

Type 1 ☐ Steel 1 ☐ Galv. 1 ☒ PVC 1 ☐ 2 ☐ Other _____

Joints 1 ☐ Threaded 1 ☐ Welded 1 ☒ Solvent 1 ☐ 2 ☐ Other _____

SCREEN

Diameter _____ Slot Size _____ Screen Length _____ ft.

Type _____ Material _____

Set Between _____ ft. and _____ ft.

GRAVEL PACK (Filter Pack)

Material/Size _____ Volume/Weight Used _____

Method of Installation _____

Depth: Placed FROM _____ ft. TO _____ ft.

GROUT

Material Bentonite Volume/Weight Used 75gal

Method of Installation Pump

Depth: Placed FROM 0 ft. TO 48 ft.

DRILLING LOG*

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED. Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand, etc.	From	To
Yellow Clay	0	11
Blue Clay	11	48
Limestone	48	63
Water	61	

*(If more space is needed to complete drilling log, use next consecutively numbered form.)

Date of Well Completion 7-17-03 Total Depth of Well 63 ft.

Completion of this form is required by section 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.
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DNR 7802.05

TYPE OR USE PEN
SELF TRANSCRIBING
PRESS HARD

WELL LOG AND DRILLING REPORT

Ohio Department of Natural Resources
Division of Water, 2045 Morse Road
Columbus, Ohio 43229-6605 Voice (614) 265-6740 Fax (614) 265-6767

RS
1007293

WELL LOCATION

County Allen Township Jackson

Owner/Builder (Circle One or Both) First Richard Last Stewart

Address of Well Location Number 4850 Street Name N. Napoleon Rd

City Lima Oh Zip Code +4 45801

Permit No. 39-09 Section/Lot No. (Circle One or Both)

Location of Well in State Plane coordinates, if available: Use of Well Residental

N X ___ +/- ___ ft. or m

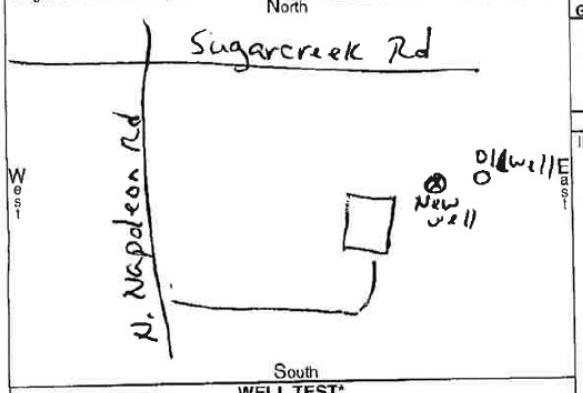
S Y ___ +/- ___ ft. or m

Elevation of Well 845 +/- ___ ft. or m

Datum Plain: NAD27 NAD83 Elevation Source GPS

Source of Coordinates: GPS Survey Other

Sketch a map showing distance well lies from numbered state highways, street intersections, county roads, buildings or other notable landmarks. If latitude and longitude are available please include here: Lat 40 48, 549 Long 83 58, 485



WELL TEST*

Pre-Pumping Static Level 24 ft. Date 9-9-09

Measured from: Top of Casing Ground Level Other

Air Bailing Pumping* Other

Test Rate 25 gpm Duration of Test 1 hrs.

Feet of Drawdown 20 ft. Sustainable Yield 25 gpm

*(Attach a copy of the pumping test record, per section 1521.05, ORC)

Is Copy Attached? Yes No Flowing Well? Yes No

Quality Clear

PUMP/PITLESS

Type of pump ___ Capacity ___ gpm

Pump set at ___ ft. Pitless Type ___

Pump installed by ___

I hereby certify the information given is accurate and correct to the best of my knowledge.

Drilling Firm G.H. Bierly Inc

Address 10933 Ada Rd

City, State, Zip Ada Ohio 45810

Signed Bruce Clem Date 9-9-09

ODH Registration Number 715

CONSTRUCTION DETAILS

Rotary Cable Augered Driven Other

BOREHOLE/CASING (measured from ground surface)

1 Borehole Diameter 9 inches Depth 70 ft.

Casing Diameter 6 in. Length 30 ft. Thickness SDR21 in.

2 Borehole Diameter ___ inches Depth ___ ft.

Casing Diameter ___ in. Length ___ ft. Thickness ___ in.

Casing Height Above Ground 1 ft.

Type: Steel, Galv., PVC, Other

Joints: Threaded, Welded, Solvent, Other

SCREEN

Diameter ___ Slot Size ___ Screen Length ___ ft.

Type ___ Material ___

Set Between ___ ft. and ___ ft.

GRAVEL PACK (Filter Pack)

Material/Size ___ Volume/Weight Used ___

Method of Installation ___

Depth: Placed FROM ___ ft. TO ___ ft.

GROUT

Material Bentonite Volume/Weight Used 50 gal

Method of Installation pump

Depth: Placed FROM 0 ft. TO 30 ft.

DRILLING LOG*

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED.

Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand, etc.	From	To
Yellow Clay	0	11
Blue Clay	11	30
Limestone	30	70

*(If more space is needed to complete drilling log, use next consecutively numbered form.)

Date of Well Completion 9-9-09 Total Depth of Well 70 ft.

Completion of this form is required by section 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.
ORIGINAL COPY TO - ODNR, DIVISION OF WATER, 2045 MORSE ROAD, COLS., OHIO 43229-6605
Blue - Customer's copy Pink - Driller's copy Green - Local Health Dept. copy

DNR 7602.96

TYPE OR USE PEN
SELF TRANSCRIBING
PRESS HARD

WELL LOG AND DRILLING REPORT

Ohio Department of Natural Resources
Divison of Water, 1939 Fountain Square Drive
Columbus, Ohio 43224-9971 Voice (614) 265-6739 Fax (614) 447-9503

RA
963242

WELL LOCATION

County Allen Township Richland

Owner/Builder (Circle One or Both) First Ronald Last Anderson

Address of Well Location Number 5600 Street Name N. Napoleon Rd.

City Elida Oh. Zip Code +4 45807

Permit No. 88-03 Section/Lot No. (Circle One or Both)

Location of Well in State Plane coordinates, if available: Use of Well

N ☐ X _____ . _____ +/- _____ ft. or m

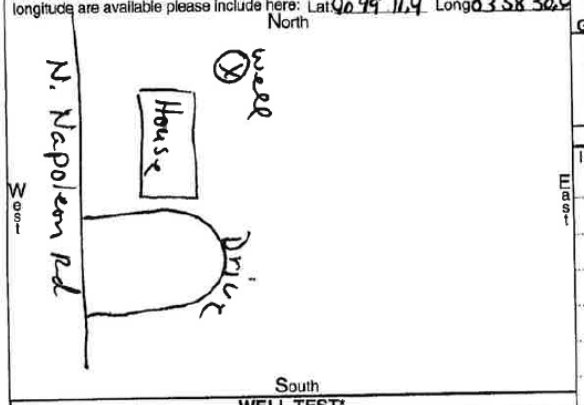
S ☐ Y _____ . _____ +/- _____ ft. or m

Elevation of Well _____ . _____ +/- _____ ft. or m

Datum Plain: ☒ NAD27 ☐ NAD83 Elevation Source

Source of Coordinates: ☐ GPS ☐ Survey ☐ Other

Sketch a map showing distance well lies from numbered state highways, street intersections, county roads, buildings or other notable landmarks. If latitude and longitude are available please include here: Lat 40 49 11.4 Long 83 58 30.6



WELL TEST*

Pre-Pumping Static Level 24 ft. Date 8-12-03

Measured from: ☒ Top of Casing ☐ Ground Level ☐ Other

☒ Air ☐ Bailing ☐ Pumping* ☐ Other

Test Rate 15 gpm Duration of Test 1 hrs.

Feet of Drawdown 5 ft. Sustainable Yield 10 gpm

*(Attach a copy of the pumping test record, per section 1521.05, ORC)

Is Copy Attached? ☐ Yes ☐ No Flowing Well? ☐ Yes ☒ No

Quality Clear

PUMP/PITLESS

Type of pump _____ Capacity _____ gpm

Pump set at _____ ft. Pitless Type

Pump Installed by

I hereby certify the information given is accurate and correct to the best of my knowledge.

Drilling Firm G H Bierly Inc

Address Box 7171

City, State, Zip Lafayette Oh. 45854

Signed Bruce Chum Date 8-12-03

ODH Registration Number 715

CONSTRUCTION DETAILS

☒ Rotary ☐ Cable ☐ Augered ☐ Driven ☐ Other

BOREHOLE/CASING (measured from ground surface)

1 ☐ Borehole Diameter 9 inches Depth 75 ft.

Casing Diameter 6 in. Length 37 ft. Thickness SDR21 in.

2 ☐ Borehole Diameter _____ inches Depth _____ ft.

Casing Diameter _____ in. Length _____ ft. Thickness _____ in.

Casing Height Above Ground 1 ft.

Type 1 ☐ 2 ☐ Steel 1 ☐ 2 ☐ Galv. 1 ☒ 2 ☐ PVC 1 ☐ 2 ☐ Other

Joints 1 ☐ 2 ☐ Threaded 1 ☐ 2 ☐ Welded 1 ☒ 2 ☐ Solvent 1 ☐ 2 ☐ Other

SCREEN

Diameter _____ Slot Size _____ Screen Length _____ ft.

Type _____ Material _____

Set Between _____ ft. and _____ ft.

GRAVEL PACK (Filter Pack)

Material/Size _____ Volume/Weight Used _____

Method of Installation _____

Depth: Placed FROM _____ ft. TO _____ ft.

GROUT

Material Bentonite Volume/Weight Used 60 gal

Method of Installation Pump

Depth: Placed FROM 0 ft. TO 37 ft.

DRILLING LOG*

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED. Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand, etc.	From	To
Yellow Clay	0	9
Blue Clay	9	37
Limestone	37	75
Water	73	

*(If more space is needed to complete drilling log, use next consecutively numbered form.)

Date of Well Completion 8-12-03 Total Depth of Well 75 ft.

Completion of this form is required by section 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.
ORIGINAL COPY TO - ODNR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224-9971
Blue - Customer's copy Pink - Driller's copy Green - Local Health Dept. copy

12.0 Appendix D –Hidden Creek Golf Club Ground Water Level Measurements from July 5 through July 9, 2012

WELL LOG NUMBER	HOUSE NO.	STREET NAME	OWNER'S FIRST NAME	OWNER'S LAST NAME	Well ID	COUNTY	TOWNSHIP	LATITUDE	LONGITUDE	HORIZ Y
761034	5621	DIXIE	ADAM	RAYL	AR	ALLEN	RICHLAND	40.820217	-83.988514	1030696
715055	5494	DIXIE	DAN	PELLEGRINI	DP	ALLEN	JACKSON	40.81793	-83.99036	1029871
941110	5468	DIXIE	TIM/MEGAN	RUNK	TMR	ALLEN	JACKSON	40.81724	-83.990529	1029620
1007293	4850	NAPOLEON	RICHARD	STEWART	RS	ALLEN	JACKSON	40.80915	-83.97476	1026601
	5600	NAPOLEON	RONALD	ANDERSON	RA	ALLEN	RICHLAND	40.81944	-83.975099	1030352
	6111	STATE		SCHNIEDER	WS	ALLEN	RICHLAND	40.820191	-83.99067	1030696
636293	6080	STATE	EUGENE	MCCALL	EU	ALLEN	RICHLAND	40.819559	-83.99103	1030468
852625	6050	STATE	GENE	MCCALL	GM	ALLEN	RICHLAND	40.81959	-83.9914	1030481
	5933	STATE	DAN	STEMEN	DS	ALLEN	RICHLAND	40.81986	-83.99389	1030590
884349	6245	SUGAR CREEK		HIDDEN CREEK GOLF	HOB-2	ALLEN	JACKSON	40.812984	-83.98675	1028052
1014543	6245	SUGAR CREEK		HIDDEN CREEK GOLF 2	HPW-1	ALLEN	JACKSON	40.816965	-83.987352	1029506
1014542	6245	SUGAR CREEK		HIDDEN CREEK GOLF 1	HOB-1	ALLEN	JACKSON	40.816736	-83.98861	1029428
963252	6060	SUGAR CREEK	JACK	ADAMS	JA	ALLEN	JACKSON	40.81051	-83.9911	1027171

WELL LOG NUMBER	HOUSE NO.	STREET NAME	OWNER'S FIRST NAME	OWNER'S LAST NAME	Well ID	HORIZ X	SURFACE ELEVATION	TOTAL DEPTH	CASE LENGTH	TEST RATE
761034	5621	DIXIE	ADAM	RAYL	AR	1556421	872	34	34	12
715055	5494	DIXIE	DAN	PELLEGRINI	DP	1555896	864	30	25	15
941110	5468	DIXIE	TIM/MEGAN	RUNK	TMR	1555845	866	30	26	10
1007293	4850	NAPOLEON	RICHARD	STEWART	RS	1560163	886	70	30	25
	5600	NAPOLEON	RONALD	ANDERSON	RA	1560130	887	75	37	15
	6111	STATE		SCHNIEDER	WS	1555824	870			
636293	6080	STATE	EUGENE	MCCALL	EU	1555721	876	47	28	6
852625	6050	STATE	GENE	MCCALL	GM	1555618	866	43	26	10
	5933	STATE	DAN	STEMEN	DS	1554931	876			
884349	6245	SUGAR CREEK		HIDDEN CREEK GOLF	HOB-2	1556866	884	70	36	40
1014543	6245	SUGAR CREEK		HIDDEN CREEK GOLF 2	HPW-1	1556723	867	400	28	400
1014542	6245	SUGAR CREEK		HIDDEN CREEK GOLF 1	HOB-1	1556374	868	335	32	300
963252	6060	SUGAR CREEK	JACK	ADAMS	JA	1555647	890	63	48	15

WELL LOG NUMBER	HOUSE NO.	STREET NAME	OWNER'S FIRST NAME	OWNER'S LAST NAME	Well ID	STATIC WATER LEVEL	AQUIFER TYPE	SWL7512A	SWL7512B	SWL7612A
761034	5621	DIXIE	ADAM	RAYL	AR	18	LIMESTONE	24.36	23.96	25.43
715055	5494	DIXIE	DAN	PELLEGRINI	DP	14	LIMESTONE	15.2	15.2	15.3
941110	5468	DIXIE	TIM/MEGAN	RUNK	TMR	14	LIMESTONE	17.45	17.44	17.56
1007293	4850	NAPOLEON	RICHARD	STEWART	RS	24	LIMESTONE	22.1	23.25	23.21
	5600	NAPOLEON	RONALD	ANDERSON	RA	24	LIMESTONE	30.18	30.1	30.41
	6111	STATE		SCHNIEDER	WS		LIMESTONE	22.65	22.41	23.7
636293	6080	STATE	EUGENE	MCCALL	EU	14	LIMESTONE	16.98	16.91	17.85
852625	6050	STATE	GENE	MCCALL	GM	6	LIMESTONE	18.38	18.4	19.69
	5933	STATE	DAN	STEMEN	DS		LIMESTONE	28.27	28.4	28.65
884349	6245	SUGAR CREEK		HIDDEN CREEK GOLF	HOB-2	26	LIMESTONE	30.13	30.16	30.65
1014543	6245	SUGAR CREEK		HIDDEN CREEK GOLF 2	HPW-1	12	LIMESTONE	17.22	27.3	26.93
1014542	6245	SUGAR CREEK		HIDDEN CREEK GOLF 1	HOB-1	14	LIMESTONE	18.25	20.85	22.75
963252	6060	SUGAR CREEK	JACK	ADAMS	JA	24	LIMESTONE	32.2	32.23	32.77

WELL LOG NUMBER	HOUSE NO.	STREET NAME	OWNER'S FIRST NAME	OWNER'S LAST NAME	Well ID	SWL7612B	SWL7912	GWE7512A	GWE7512B	GWE7612A
761034	5621	DIXIE	ADAM	RAYL	AR	24.88	20.25	847.64	848.04	846.57
715055	5494	DIXIE	DAN	PELLEGRINI	DP	15.3	15.08	848.80	848.80	848.7
941110	5468	DIXIE	TIM/MEGAN	RUNK	TMR	17.57	17.32	848.55	848.56	848.44
1007293	4850	NAPOLEON	RICHARD	STEWART	RS		23	863.90	862.75	862.79
	5600	NAPOLEON	RONALD	ANDERSON	RA	30.42	29.03	856.82	856.90	856.59
	6111	STATE		SCHNIEDER	WS	23.27	18.9	847.35	847.59	846.3
636293	6080	STATE	EUGENE	MCCALL	EU	17.62	14.58	859.02	859.09	858.15
852625	6050	STATE	GENE	MCCALL	GM	19.2	15.57	847.62	847.60	846.31
	5933	STATE	DAN	STEMEN	DS	28.6	26.94	847.73	847.60	847.35
884349	6245	SUGAR CREEK		HIDDEN CREEK GOLF	HOB-2	30.47	29.03	853.87	853.84	853.35
1014543	6245	SUGAR CREEK		HIDDEN CREEK GOLF 2	HPW-1	18.27	13.73	849.78	839.70	840.07
1014542	6245	SUGAR CREEK		HIDDEN CREEK GOLF 1	HOB-1	19.92	14.65	849.75	847.15	845.25
963252	6060	SUGAR CREEK	JACK	ADAMS	JA	32.64	31.33	857.80	857.77	857.23

WELL LOG NUMBER	HOUSE NO.	STREET NAME	OWNER'S FIRST NAME	OWNER'S LAST NAME	Well ID	GWE7612B	GWE7912	Drawdown 7/5-7/6	Recovery 7/6-7/9	Distance from PW-1
761034	5621	DIXIE	ADAM	RAYL	AR	847.12	851.75	-1.07	5.18	1234
715055	5494	DIXIE	DAN	PELLEGRINI	DP	848.7	848.92	-0.1	0.22	908
941110	5468	DIXIE	TIM/MEGAN	RUNK	TMR	848.43	848.68	-0.11	0.24	921
1007293	4850	NAPOLEON	RICHARD	STEWART	RS	886	863	-1.11	0.21	4546
	5600	NAPOLEON	RONALD	ANDERSON	RA	856.58	857.97	-0.23	1.38	3523
	6111	STATE		SCHNIEDER	WS	846.73	851.1	-1.05	4.8	1508
636293	6080	STATE	EUGENE	MCCALL	EU	858.38	861.42	-0.87	3.27	1349
852625	6050	STATE	GENE	MCCALL	GM	846.8	850.43	-1.31	4.12	1473
	5933	STATE	DAN	STEMEN	DS	847.4	849.06	-0.38	1.71	2076
884349	6245	SUGAR CREEK		HIDDEN CREEK GOLF	HOB-2	853.53	854.97	-0.52	1.62	1434
1014543	6245	SUGAR CREEK		HIDDEN CREEK GOLF 2	HPW-1	848.73	853.27	-9.71	13.2	0
1014542	6245	SUGAR CREEK		HIDDEN CREEK GOLF 1	HOB-1	848.08	853.35	-4.5	8.1	419
963252	6060	SUGAR CREEK	JACK	ADAMS	JA	857.36	858.67	-0.57	1.44	2586

Appendix E -Stemen Ground Water Well Data

ApendixE_2009-2012 Data

STEMEN WELL LEVELS FROM 9/6/2009 to 7/5/12
Dan Stemen, 5933 E. State Rd., Lima, Ohio 45807 419-643-8144
PROBLEM = *Discovered no water pressure in house & pump ruined during Friday 9/4/09 overnight softening
Well level sucked below pump inlet by -assume- new golf course owners Hidden Creek.
Had no problem with first owner Sugar Creek. We are about 1/3 mile from their wells.
Sunday- 9/6/09, first measured well level at 7.25" above top pump.
Assumed levels had come back from below pump inlet at that time.
DATA: *Well depth 27'-3/4", Sulfur free water. Average water use = 25 gallons/day.
*Biggest usage - softening = 200 gallons once per week – drops well level by 3" or 4" -
which recovers to original level in about 12 hrs.
*Well provided water through severe drought of 1988 plus outside tree watering - OK
*Black pipe rust stains indicate historic levels at about 108" above top pump
*Bierly -expert driller says drilling a deeper well will give you terrible sulfur like all others in this area!!
*Bierly says the chance of hitting sulfur free water going deeper is 1 in a million.
*** It appears they pump heavily at night. We start to notice the drop the following morning and
the level continues on down for the next day or two before it stabilizes then starts up
– unless they pump again. The well pumps are on level control and refill pond as they irrigate
at night.

Reference is 2' – 4 3/4" from well bottom
Reference is 24' – 11 1/4" from top well casing
Reference is 13.25" above suction top window

Measurement DATE	Water inches above top of reference	Inches below land surface	Feet below land surface
09/06/09	7.25	339.75	28.31
09/08/09	21.25	325.75	27.15
09/09/09	28.75	318.25	26.52
09/11/09	18.25	328.75	27.40
09/12/09	16.25	330.75	27.56
09/13/09	17.00	330.00	27.50
09/14/09	18.00	329.00	27.42
09/15/09	17.50	329.50	27.46
09/16/09	19.50	327.50	27.29
09/17/09	9.00	338.00	28.17
09/18/09	9.00	338.00	28.17
09/19/09	5.50	341.50	28.46
09/20/09	14.00	333.00	27.75
09/21/09	18.50	328.50	27.38
09/22/09	21.00	326.00	27.17
09/22/09	22.00	325.00	27.08
09/23/09	22.00	325.00	27.08
09/24/09	23.00	324.00	27.00
09/25/09	23.50	323.50	26.96
09/26/09	24.00	323.00	26.92
09/27/09	18.50	328.50	27.38
09/28/09	8.00	339.00	28.25
09/29/09	14.50	332.50	27.71
09/30/09	19.50	327.50	27.29
10/01/09	23.00	324.00	27.00
10/02/09	26.50	320.50	26.71
10/03/09	24.00	323.00	26.92
10/04/09	24.00	323.00	26.92
10/05/09	26.00	321.00	26.75
10/06/09	27.50	319.50	26.63

ApendixE_2009-2012 Data

Measurement DATE	Water inches above top of reference	Inches below land surface	Feet below land surface
10/07/09	24.50	322.50	26.88
10/08/09	27.00	320.00	26.67
10/09/09	26.00	321.00	26.75
10/10/09	25.50	321.50	26.79
10/11/09	26.50	320.50	26.71
10/12/09	28.50	318.50	26.54
10/13/09	27.00	320.00	26.67
10/14/09	28.50	318.50	26.54
10/15/09	30.00	317.00	26.42
10/16/09	28.50	318.50	26.54
10/17/09	27.50	319.50	26.63
10/18/09	28.50	318.50	26.54
10/19/09	29.00	318.00	26.50
10/20/09	28.50	318.50	26.54
10/21/09	29.50	317.50	26.46
10/22/09	29.50	317.50	26.46
10/23/09	32.00	315.00	26.25
10/24/09	28.00	319.00	26.58
10/25/09	28.00	319.00	26.58
10/26/09	30.00	317.00	26.42
10/27/09	30.50	316.50	26.38
10/28/09	29.50	317.50	26.46
10/29/09	30.00	317.00	26.42
10/30/09	31.50	315.50	26.29
10/31/09	29.50	317.50	26.46
11/01/09	27.50	319.50	26.63
11/02/09	30.50	316.50	26.38
11/03/09	29.00	318.00	26.50
11/04/09	30.00	317.00	26.42
11/05/09	29.50	317.50	26.46
11/06/09	29.00	318.00	26.50
11/07/09	30.00	317.00	26.42
11/08/09	29.00	318.00	26.50
11/09/09	28.50	318.50	26.54
11/10/09	28.50	318.50	26.54
11/11/09	30.50	316.50	26.38
11/12/09	31.00	316.00	26.33
11/13/09	31.00	316.00	26.33
11/14/09	30.00	317.00	26.42
11/15/09	29.50	317.50	26.46
11/16/09	30.00	317.00	26.42
11/17/09	31.00	316.00	26.33
11/18/09	31.50	315.50	26.29
11/19/09	30.00	317.00	26.42
11/20/09	30.00	317.00	26.42
11/21/09	29.00	318.00	26.50
11/23/09	30.50	316.50	26.38
11/24/09	30.00	317.00	26.42
11/25/09	31.00	316.00	26.33
11/26/09	31.00	316.00	26.33

Reference is 24' – 11 1/4" from top well casing
Reference is 13.25" above suction top window

ApendixE_2009-2012 Data

Measurement DATE — Water inches above top of — Reference is 24' – 11 1/4" from top well casing; Reference is 13.25" above suction top window

	reference	Inches below land surface	Feet below land surface
12/02/09	30.00	317.00	26.42
12/10/09	27.50	319.50	26.63
12/11/09	29.50	317.50	26.46
12/17/09	30.00	317.00	26.42
01/15/10	30.50	316.50	26.38
02/28/10	36.00	311.00	25.92
03/09/10	53.00	294.00	24.50
03/19/10	49.00	298.00	24.83
03/21/10	45.00	302.00	25.17
03/21/10	53.00	294.00	24.50
04/07/10	48.00	299.00	24.92
04/18/10	45.00	302.00	25.17
04/29/10	48.00	299.00	24.92
05/14/10	56.50	290.50	24.21
05/23/10	59.00	288.00	24.00
06/15/10	56.50	290.50	24.21
06/26/10	36.00	311.00	25.92
07/01/10	48.00	299.00	24.92
07/07/10	10.50	336.50	28.04
07/08/10	10.00	337.00	28.08
07/09/10	16.50	330.50	27.54
07/10/10	28.00	319.00	26.58
07/11/10	35.00	312.00	26.00
07/12/10	38.00	309.00	25.75
07/13/10	38.60	308.40	25.70
07/14/10	22.50	324.50	27.04
07/15/10	18.00	329.00	27.42
07/16/10	28.00	319.00	26.58
07/17/10	31.00	316.00	26.33
07/18/10	14.50	332.50	27.71
07/19/10	11.00	336.00	28.00
07/20/10	26.50	320.50	26.71
07/21/10	22.50	324.50	27.04
07/22/10	16.00	331.00	27.58
07/23/10	10.00	337.00	28.08
07/24/10	13.00	334.00	27.83
07/25/10	21.00	326.00	27.17
07/26/10	26.50	320.50	26.71
07/27/10	33.50	313.50	26.13
07/28/10	35.00	312.00	26.00
07/29/10	28.50	318.50	26.54
07/30/10	4.50	342.50	28.54
08/01/10	10.00	337.00	28.08
08/02/10	19.00	328.00	27.33
08/03/10	27.50	319.50	26.63
08/04/10	30.00	317.00	26.42
08/05/10	32.00	315.00	26.25
08/06/10	34.00	313.00	26.08
08/07/10	36.50	310.50	25.88
08/08/10	37.00	310.00	25.83

ApendixE_2009-2012 Data

Measurement DATE — Water inches above top of — Reference is 24' – 11 1/4" from top well casing; Reference is 13.25" above suction top window

	reference	Inches below land surface	Feet below land surface
08/09/10	28.00	319.00	26.58
08/10/10	17.50	329.50	27.46
08/11/10	15.00	332.00	27.67
08/12/10	28.00	319.00	26.58
08/13/10	35.00	312.00	26.00
08/14/10	36.50	310.50	25.88
08/15/10	37.50	309.50	25.79
08/16/10	35.50	311.50	25.96
08/17/10	33.50	313.50	26.13
08/18/10	20.00	327.00	27.25
08/19/10	27.50	319.50	26.63
08/19/10	22.00	325.00	27.08
08/20/10	18.00	329.00	27.42
08/21/10	12.50	334.50	27.88
08/22/10	23.50	323.50	26.96
08/23/10	31.00	316.00	26.33
08/24/10	34.50	312.50	26.04
08/25/10	36.00	311.00	25.92
08/26/10	35.00	312.00	26.00
08/27/10	33.50	313.50	26.13
08/28/10	19.50	327.50	27.29
08/29/10	13.00	334.00	27.83
08/30/10	19.50	327.50	27.29
08/31/10	12.50	334.50	27.88
09/01/10	11.00	336.00	28.00
09/02/10	25.00	322.00	26.83
09/03/10	22.50	324.50	27.04
09/04/10	8.00	339.00	28.25
09/05/10	22.50	324.50	27.04
09/06/10	21.50	325.50	27.13
09/07/10	5.50	341.50	28.46
09/08/10	4.00	343.00	28.58
09/09/10	16.50	330.50	27.54
09/10/10	19.00	328.00	27.33
09/11/10	4.00	343.00	28.58
09/12/10	12.00	335.00	27.92
09/13/10	14.50	332.50	27.71
09/14/10	18.00	329.00	27.42
09/15/10	8.00	339.00	28.25
09/16/10	15.00	332.00	27.67
09/17/10	1.50	345.50	28.79
09/18/10	13.00	334.00	27.83
09/19/10	20.00	327.00	27.25
09/20/10	24.00	323.00	26.92
09/21/10	14.00	333.00	27.75
09/22/10	6.50	340.50	28.38
09/23/10	17.50	329.50	27.46
09/24/10	22.50	324.50	27.04
09/25/10	23.00	324.00	27.00
09/26/10	10.50	336.50	28.04

ApendixE_2009-2012 Data

Measurement DATE	Water inches above top of reference	Inches below land surface	Feet below land surface
09/27/10	21.00	326.00	27.17
09/28/10	24.00	323.00	26.92
09/29/10	26.50	320.50	26.71
09/30/10	28.00	319.00	26.58
10/01/10	26.50	320.50	26.71
10/02/10	15.50	331.50	27.63
10/03/10	7.00	340.00	28.33
10/04/10	6.00	341.00	28.42
10/05/10	19.00	328.00	27.33
10/06/10	24.50	322.50	26.88
10/07/10	22.50	324.50	27.04
10/08/10	25.50	321.50	26.79
10/09/10	26.50	320.50	26.71
10/10/10	28.00	319.00	26.58
10/11/10	28.50	318.50	26.54
10/12/10	28.00	319.00	26.58
10/13/10	29.50	317.50	26.46
10/14/10	30.50	316.50	26.38
10/15/10	28.50	318.50	26.54
10/16/10	30.00	317.00	26.42
10/17/10	29.50	317.50	26.46
10/18/10	30.50	316.50	26.38
10/19/10	30.50	316.50	26.38
10/20/10	16.00	331.00	27.58
10/21/10	8.50	338.50	28.21
10/22/10	18.50	328.50	27.38
10/23/10	24.00	323.00	26.92
10/24/10	28.00	319.00	26.58
10/25/10	29.00	318.00	26.50
10/26/10	31.00	316.00	26.33
10/27/10	29.00	318.00	26.50
10/28/10	27.50	319.50	26.63
10/29/10	29.50	317.50	26.46
10/30/10	32.50	314.50	26.21
10/31/10	29.00	318.00	26.50
11/01/10	29.00	318.00	26.50
11/02/10	32.00	315.00	26.25
11/03/10	32.50	314.50	26.21
11/04/10	34.00	313.00	26.08
11/05/10	30.50	316.50	26.38
11/06/10	29.00	318.00	26.50
11/07/10	32.50	314.50	26.21
11/08/10	33.50	313.50	26.13
11/09/10	31.50	315.50	26.29
11/10/10	30.50	316.50	26.38
11/11/10	30.00	317.00	26.42
11/12/10	31.00	316.00	26.33
11/13/10	19.00	328.00	27.33
11/14/10	15.50	331.50	27.63
11/15/10	25.50	321.50	26.79

Reference is 24' – 11 1/4" from top well casing
Reference is 13.25" above suction top window

ApendixE_2009-2012 Data

Measurement DATE — Water inches above top of — Reference is 24' – 11 1/4" from top well casing; Reference is 13.25" above suction top window

	reference	Inches below land surface	Feet below land surface	
11/16/10	33.50	313.50	26.13	
11/17/10	29.50	317.50	26.46	
11/18/10	30.50	316.50	26.38	
11/19/10	32.00	315.00	26.25	
11/20/10	31.40	315.60	26.30	
11/21/10	34.00	313.00	26.08	
11/22/10	34.50	312.50	26.04	
11/23/10	32.00	315.00	26.25	
11/24/10	35.00	312.00	26.00	
11/26/10	48.00	299.00	24.92	
11/27/10	43.00	304.00	25.33	
11/28/10	41.00	306.00	25.50	
11/29/10	43.00	304.00	25.33	
11/30/10	48.00	299.00	24.92	
12/04/10	47.00	300.00	25.00	
12/06/10	47.00	300.00	25.00	
12/09/10	43.00	304.00	25.33	
12/11/10	45.00	302.00	25.17	
12/21/10	44.00	303.00	25.25	
12/30/10	45.00	302.00	25.17	
01/04/11	49.00	298.00	24.83	
01/10/11	43.00	304.00	25.33	
02/17/11	65.00	282.00	23.50	
02/23/11	56.00	291.00	24.25	
02/24/11	56.00	291.00	24.25	
02/27/11	57.50	289.50	24.13	
03/08/11	66.50	280.50	23.38	
03/12/11	67.50	279.50	23.29	
03/17/11	54.50	292.50	24.38	
03/22/11	55.50	291.50	24.29	
03/31/11	51.00	296.00	24.67	
04/06/11	60.00	287.00	23.92	
04/08/11	55.50	291.50	24.29	
04/11/11	54.50	292.50	24.38	
04/19/11	61.00	286.00	23.83	
04/25/11	83.50	263.50	21.96	
04/30/11	64.50	282.50	23.54	
05/01/11	64.50	282.50	23.54	
05/24/11	70.50	276.50	23.04	
05/31/11	61.00	286.00	23.83	
06/05/11	55.00	292.00	24.33	
06/16/11	42.50	304.50	25.38	
06/20/11	37.50	309.50	25.79	
06/21/11	42.00	305.00	25.42	
06/22/11	47.00	300.00	25.00	
06/23/11	41.50	305.50	25.46	installed pumptec protector
06/25/11	41.00	306.00	25.50	
06/30/11	28.00	319.00	26.58	
07/02/11	27.00	320.00	26.67	
07/03/11	23.00	324.00	27.00	

ApendixE_2009-2012 Data

Measurement DATE	Water inches above top of reference	Inches below land surface	Feet below land surface
			Reference is 24' – 11 1/4" from top well casing
			Reference is 13.25" above suction top window
07/04/11	18.00	329.00	27.42
07/05/11	17.00	330.00	27.50
07/06/11	18.00	329.00	27.42
07/07/11	18.50	328.50	27.38
07/08/11	17.00	330.00	27.50
07/09/11	18.50	328.50	27.38
07/10/11	15.50	331.50	27.63
07/11/11	11.50	335.50	27.96
07/12/11	21.00	326.00	27.17
07/13/11	26.50	320.50	26.71
07/14/11	23.00	324.00	27.00
07/15/11	21.00	326.00	27.17
07/16/11	14.50	332.50	27.71
07/17/11	11.00	336.00	28.00
07/18/11	10.50	336.50	28.04
07/19/11	20.00	327.00	27.25
07/20/11	21.00	326.00	27.17
07/21/11	11.00	336.00	28.00
07/22/11	5.00	342.00	28.50
07/23/11	15.00	332.00	27.67
07/24/11	16.00	331.00	27.58
07/25/11	24.00	323.00	26.92
07/26/11	20.00	327.00	27.25
07/27/11	14.50	332.50	27.71
07/28/11	12.00	335.00	27.92
07/29/11	15.50	331.50	27.63
07/30/11	6.00	341.00	28.42
07/31/11	8.50	338.50	28.21
08/01/11	5.00	342.00	28.50
08/02/11	2.50	344.50	28.71
08/03/11	17.00	330.00	27.50
08/04/11	22.00	325.00	27.08
08/05/11	19.50	327.50	27.29
08/06/11	17.50	329.50	27.46
08/07/11	26.00	321.00	26.75
08/08/11	29.50	317.50	26.46
08/09/11	35.00	312.00	26.00
08/10/11	34.00	313.00	26.08
08/11/11	32.00	315.00	26.25
08/12/11	32.00	315.00	26.25
08/14/11	32.00	315.00	26.25
08/15/11	33.50	313.50	26.13
08/16/11	34.00	313.00	26.08
08/17/11	33.00	314.00	26.17
08/18/11	34.00	313.00	26.08
08/19/11	30.50	316.50	26.38
08/20/11	26.50	320.50	26.71
08/20/11	23.00	324.00	27.00
08/21/11	29.00	318.00	26.50
08/22/11	30.00	317.00	26.42

ApendixE_2009-2012 Data

Measurement DATE	Water inches above top of reference	Inches below land surface	Feet below land surface
			Reference is 24' – 11 1/4" from top well casing
			Reference is 13.25" above suction top window
08/23/11	30.50	316.50	26.38
08/24/11	33.00	314.00	26.17
08/25/11	40.00	307.00	25.58
08/26/11	40.50	306.50	25.54
08/28/11	41.00	306.00	25.50
08/29/11	39.00	308.00	25.67
08/30/11	38.00	309.00	25.75
09/01/11	25.50	321.50	26.79
09/02/11	27.50	319.50	26.63
09/03/11	20.50	326.50	27.21
09/04/11	24.00	323.00	26.92
09/05/11	28.50	318.50	26.54
09/06/11	32.50	314.50	26.21
09/07/11	35.00	312.00	26.00
09/08/11	39.00	308.00	25.67
09/09/11	38.50	308.50	25.71
09/10/11	45.00	302.00	25.17
09/11/11	45.00	302.00	25.17
09/12/11	43.00	304.00	25.33
09/13/11	44.00	303.00	25.25
09/21/11	45.00	302.00	25.17
09/22/11	43.50	303.50	25.29
09/24/11	47.00	300.00	25.00
09/26/11	54.00	293.00	24.42
09/27/11	60.00	287.00	23.92
09/28/11	56.50	290.50	24.21
09/29/11	56.50	290.50	24.21
09/30/11	56.00	291.00	24.25
10/01/11	56.50	290.50	24.21
10/07/11	49.50	297.50	24.79
10/12/11	51.00	296.00	24.67
10/16/11	49.50	297.50	24.79
10/20/11	79.00	268.00	22.33
10/30/11	61.00	286.00	23.83
11/23/11	77.00	270.00	22.50
12/17/11	65.00	282.00	23.50
01/16/12	56.00	291.00	24.25
02/21/12	56.50	290.50	24.21
03/11/12	52.50	294.50	24.54
05/03/12	52.50	294.50	24.54
05/24/12	14.00	333.00	27.75
05/25/12	22.50	324.50	27.04
05/27/12	14.50	332.50	27.71
05/28/12	13.50	333.50	27.79
05/30/12	25.50	321.50	26.79
06/01/12	35.50	311.50	25.96
06/04/12	32.50	314.50	26.21
06/07/12	21.50	325.50	27.13
06/09/12	17.50	329.50	27.46
06/11/12	14.00	333.00	27.75

ApendixE_2009-2012 Data

Measurement DATE	Water inches above top of reference	Inches below land surface	Feet below land surface	
				Reference is 24' – 11 1/4" from top well casing
				Reference is 13.25" above suction top window
06/12/12	21.50	325.50	27.13	
06/15/12	11.00	336.00	28.00	
06/16/12	9.00	338.00	28.17	
06/17/12	13.00	334.00	27.83	
06/18/12	23.50	323.50	26.96	
06/19/12	27.00	320.00	26.67	
06/20/12	18.50	328.50	27.38	
06/21/12	14.50	332.50	27.71	
06/22/12	4.50	342.50	28.54	
06/23/12	1.00	346.00	28.83	
06/24/12	0.50	346.50	28.88	
06/25/12	0.00	347.00	28.92	NO water level
06/26/12	0.00	347.00	28.92	
06/27/12	3.00	344.00	28.67	
06/28/12	12.00	335.00	27.92	
06/29/12	1.50	345.50	28.79	.4" rain at 4:30 PM
06/30/12	14.00	333.00	27.75	.17" rain morning
07/01/12	19.00	328.00	27.33	
07/02/12	23.00	324.00	27.00	
07/03/12	13.00	334.00	27.83	
07/04/12	5.00	342.00	28.50	
07/05/12	3.50	343.50	28.63	
07/06/12	5.50		28.48	
07/07/12	16.00		27.60	
07/08/12	21.50		27.15	
07/09/12	24.00		26.94	
07/10/12	15.50		27.65	
07/11/12	5.50		28.48	
07/12/12	1.50		28.81	
07/13/12	4.00		28.60	
07/14/12	4.00		28.60	

Prepared by:

Curtis J Coe, CPG, PG, and James Raab

Ohio Department of Natural Resources
Division of Soil and Water Resources
2045 Morse Road
Columbus Ohio 43229

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John Kasich,*Governor* James Zehringer, *Director* Karl Gebhardt, *Chief*