I HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER MY SUPERVISION BY Joel Michael Kimball ENTITLED Hydrogeochemistry and Water Quality of Echo Hills BE ACCEPTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF Master of Science.

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ABSTRACT


Ground water of the Echo Hills area in Clark County, Ohio was investigated for common water contaminants such as nitrate and coliform bacteria. Thirty-four water samples were collected from locations including private wells, streams and a spring. Nine of those samples were selected for nitrogen isotope analysis. Three locations were chosen for a tracer test. Additionally, well log data, historical water quality data, and GIS data were obtained from the Clark County Health Department in Springfield, Ohio.

Results show that local agriculture likely has the greatest impact on ground water quality in Echo Hills especially the north-eastern portion, with local septic systems possibly contributing contaminants to the ground water as well. N-15 isotope values indicate that nitrogen found in the ground water originates from synthetic fertilizer along with other sources, possibly human or animal waste. The drinking water quality is also affected by well construction. Open borehole wells allow contaminated water from the upper aquifer to mix with relatively clean water from the lower aquifer. The results suggest that proper well and septic system construction, along with a good understanding of local geology can greatly reduce domestic water quality issues.
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I. INTRODUCTION

The availability of fresh, clean drinking water has become an increasing concern worldwide. In the United States more than 100 million people use ground water as their source of drinking water (Nolan et al., 1997; Arnade 1999; Verstraeten et al, 2004) and ground water is also a source for approximately 40% of all public water use (Drever 1997). Ground water can become contaminated in many ways. One of the most common ground water contaminants, especially in shallow ground water flow systems, is nitrate (DeSimone and Howes, 1998; Kross et al., 1993).

Human activities have led to a worldwide increase of nitrate in the environment (Bohlke and Denver, 1995; Vitousek et al., 1997). These activities include agricultural practices such as row-crop agriculture (Komor and Magner, 1996), fertilizer (Cey et al., 1999; Gustafson 1993; Kalff 2002; Kross et al., 1993; Nolan et al., 1997), use of chemicals on lawns and golf courses (Nolan et al., 1997), animal manure (Kross et al., 1993; Nolan et al., 1997), lime (Nolan et al., 1997), septic systems (Gustafson 1993) and tilling of the soil (Cey et al., 1999). As the result of the previously mentioned activities, nitrate levels in drinking water frequently exceeds the maximum contamination limit (MCL) as 10 mg/L for nitrate-nitrogen ( Freeze and Cherry, 1979; Gustafson 1993; Kross et al., 1993; Nolan et al., 1997; Vitousek et al., 1997 ) or 45 mg/L as nitrate (Freeze and Cherry, 1979; Kross et al., 1993). Consumption of water containing nitrate in excess of these limits can lead to health problems in infants and livestock (Freeze and Cherry, 1979). Methemoglobinemia in infants is an example of a health problem that results from consuming water with high levels of nitrate, which reduces the ability of the blood to carry oxygen (Domenico and Schwartz, 1990; Kross et al., 1993; Nolan et al., 1997; Vitousek et al.,
High nitrate levels can also lead to increased birth defects and lymphoma (Kross et al., 1993).

However, nitrate is also required for many biological processes. Nitrate is usually found in nature at much lower levels than in human-populated areas. Nitrate-nitrogen naturally occurs below 2 mg/L (Nolan et al., 1997) or 1 mg/L (Gustafson 1993) in the environment depending on the study. Agricultural processes usually result in high levels of nitrate in nearby water (Bohlke and Denver, 1995). In drainage channels near farm fields it is common for nitrate levels to exceed 10 mg/L (Komor and Magner, 1996). An Iowa study found that nitrate-nitrogen levels exceeding 3 mg/L usually indicated human influence and most natural aquifers in the state had nitrate-nitrogen levels under 2 mg/L (Kross et al., 1993).

Drinking water in rural areas near agricultural areas is especially susceptible to many types of contamination. Besides agricultural practices, water quality is also influenced by the septic system and well construction. In the past, septic tank use and construction was basically unregulated and uniform standards were not adopted until the 1990s (Barry 2006). For example, older septic systems did not require that at least one meter of unsaturated soil exist between the leach field and the seasonal high water table (Arnade 1999). An improperly functioning septic system could influence the water quality of a nearby well. Local ground water was more likely to become contaminated in an area with the following characteristics: a high density of homes, the septic system overlaid permeable soil such as gravel that overlaid thin and permeable bedrock, or if the water table was within a few feet of the surface (Fetter 2001).
I. 1. PURPOSE

The purposes of this study are to determine the extent and source(s) of well water contamination in Echo Hills, a small community in mid-west Ohio, and to identify the major water flow paths in the area. Domestic water wells in the area have shown a history of contamination from high levels of nitrates, the presence of coliform bacteria, and the presence of herbicides. Currently the Ohio EPA lists the source of high nitrate in many wells to be attributed to nearby agriculture practices and poorly constructed wells (Bendula 2007). However, I hypothesize that well water quality could also be influenced by nearby septic systems.

I. 2. LOCATION

The area of interest is a rural housing development, Echo Hills, located in Clark County, Ohio. The area lies approximately at 83° 54’N and 39° 51’W. The Echo Hills study area lies between the cities of Enon to the west and Springfield to the east. The area currently contains fifty-eight households (with plans for more) that all utilize individual wells for their water and septic systems for waste disposal. Farm fields surround Echo Hills. To the north-east of Echo Hills lies Tecumseh High School. Figure 1 shows the general study location.
Figure 1  Location of study area. Circled area shows the location of Echo Hills. Insert shows where Clark County is within Ohio. Missing stream is shown as identified from an aerial black and white photograph, but missing from the GIS data. (Regional map in the vicinity of Echo Hills is shown in Figure 3.)
II. BEDROCK GEOLOGY AND HYDROLOGY

II. 1. BEDROCK GEOLOGY

The following historical summary of bedrock geology is taken from Ausich (1987). The rock units of interest in the study area resulted from deposition on the Cincinnati Platform during the Silurian Period. Figure 2 summarizes the bedrock stratigraphy. The oldest unit of interest is the Brassfield Limestone which resulted from an initial Silurian transgression during the Llandoverian. A sea level fall and regression ended deposition for the Brassfield. The younger Dayton Limestone resulted from a renewed transgression. Sediment deposition was basically continuous for the Osgood Shale through Cedarville Dolomite formations. The Osgood to Massie Shale formations were deposited in the late Llandoverian, fluctuating between carbonate and fine clastic deposition. Carbonate deposition predominated above the Massie Shale. The Eupehmia and Cedarville Dolomites indicate an offshore environment free of clastics. The Springfield Limestone was the result of a minor regression, with the Cedarville resulting from a return to a normal marine environment.

The local bedrock geology has also been studied by Norris (1952) and Frost (1977). Norris made the most comprehensive study of the Brassfield through the Cedarville formations, whereas Frost and Ausich concentrated more on the Dayton and Brassfield formations. Warren (1988) studied the same rock units in an area to the south of this study area with an emphasis on fractures. Warren (1988) found that there were no major faults in southwestern Ohio. Fractures are mostly site-specific except the Cedarville, which has a fracture orientation of N45W and N70E (Warren 1988). The other dolomite and limestone rock layers show complex and discontinuous fractures and jointing (Warren 1988). The Cedarville Dolomite also is prone to
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<td>gray-white, gray-blue</td>
<td>10+ feet in nearby area</td>
<td>150 massive, porous</td>
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<td>gray</td>
<td>2-6</td>
<td>6 thin-bedded, dense</td>
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End Niagara Group

Brassfield Limestone white to gray-orange gray-pink to gray-orange fossiliferous, massive white or red bottom “Sugar Rock” 29-36

Elkhorn Shale

Figure 2 A comparison of bedrock geology of three local studies.
solution cavities which penetrate vertically and can easily be seen when the Cedarville is exposed at the surface.

Rock outcrops near the study area were studied to better identify and understand them. Figure 3 shows the locations where outcrops were studied. Two outcrops (numbers 1 and 2) near route OH-4, by George Rogers Clark Park and the city of Springfield revealed the Springfield, Euphemia, and Massie rock units. The Springfield has a weathered surface that was a sandy color. The Springfield had medium beds about six inches thick with fractures in two directions at ninety degrees to each other. The fractures of the Euphemia were not as severe. The Euphemia contained medium bedding, except near the bottom, where the bedding was much more massive, knobby, and contained vugs. However, the Euphemia had much finer bedding near the Massie Shale boundary. The Euphemia’s weathered surface was of a grayish color. The Massie Shale was a maroon color and very fissile. The Cedarville can be seen on US Route 68 off of route OH-4 by highway marker number 7, near the intersection of interstate route I-70 and US Route 68 (outcrop number 3). The Cedarville had less fracturing than the Springfield, but also contains many solution cavities filled with clay. The weathered surface was dark gray and dolomitized. An outcrop of the Brassfield unit on Dayton-Xenia road showed medium bedding (outcrop number 4).
Figure 3  Location of rock outcrops studied with reference numbers.
II. 2. SURFACE HYDROLOGY

The major stream in the nearby area is called Mud Run. The two main branches of Mud Run (labeled North and South branch in Figure 4) join south-west of Echo Hills. The north and south branches of Mud Run both originate to the north-east of Echo Hills. Mud Run combines with Clear Creek to the west of Echo Hills before it flows into the Mad River. The northern branch of Mud Run has a surface elevation of approximately 950 feet directly north of Echo Hills, whereas the southern branch of Mud Run has a surface elevation of approximately 900 feet throughout most of its length. The northern branch of Mud Run loses water as the stream flows to the south-west. During the summer, the northern branch often disappears to the west of Hagan Road. The southern branch of Mud Run contains much more water than the northern branch of Mud Run. The water is usually more clear in the northern branch than the southern branch of Mud Run. The southern branch of Mud Run was brown in color except where it was joined by a stream farther to the south. Surface elevation of Echo Hills is approximately 956-988 feet. Surface elevation is higher to the north and east of Echo Hills and lower to the west and south. Contouring the surface elevation around Echo Hills indicates that surface water will generally flow from the north-east to the south-west. Figures 4 shows surface elevation.

II. 3. LANDUSE

The most common land types in the study area are: cropland, residential, barren, and woodland. Residential land use includes homes, multiple buildings, and school property. Any land type with little vegetation that does not fit into the other categories is considered barren. Woodland areas are not the only areas with trees, however the woodland areas contain more tree than any other land-use type. For example, the Missing Stream that flows into the northern
Figure 4  
3D view of surface elevation in feet of thesis area. Branches of Mud Run are labeled North and South Branch.
branch of Mud Run has many trees lining its banks in a narrow line. However, cropland otherwise dominates the area. The residential area of Echo Hills is surrounded by cropland. Figure 5 displays general land-use based on data from 2006. Construction in the Echo Hills area continues through 2008 with the addition of at least one new road and land being developed for new homes.

II. 4. DOMESTIC WATER WELLS IN THE AREA

Well logs of 96 domestic water wells were obtained from the Clark County Combined Health District in Springfield, Ohio. Fifty-two of the well logs were for water wells located in Echo Hills. All water wells were open borehole wells, which means the wells did not have metal casings the entire length of the well. Water wells in the study area varied from 33 to 180 feet in depth. The shallowest wells are located near South Tecumseh Road. Water wells in Echo Hills are at least 70 feet in depth, with most of the wells being over 110 feet deep. The water wells in Echo Hills average 127 feet deep. Most of the wells in Echo Hills had metal casings, with the longest being 81.5 feet. Most of the wells in Echo Hills had metal casings of 28-35 feet long with the average casing length being 31.3 feet. The pre-pumped static water level in the general area varied from 7-120 feet below the surface and 18-120 feet in Echo Hills. The pre-pumped static water level in Echo Hills had an elevation of 856 to 951 feet. The pre-pumped static water level had an average elevation of 902 feet in the Echo Hills area. Appendix D summarizes the well log data organized from the well logs in Appendix E. Figures 6 and 7 show the location of all wells for which data was used in this study.
Figure 5  Type of land-use in the thesis area.  2006 map as obtained from the Clark County Health District in Springfield, Ohio.
Figure 6  Location of well log data available for Echo hills with identification numbers.
Figure 7    Location of well log data available in the area surrounding Echo Hills with identification numbers.
II. 5. SUBSURFACE INTERPRETATION

The subsurface under Echo Hills and nearby areas was approximated using well logs, nearby rock outcrops, and also from nearby areas that were mapped by Frost (1977) and Shrake (1994). The well logs were obtained from the Springfield Health Department. In regards to the subsurface interpretation, the well logs were used primarily for the pre-pumped static water levels, and to obtain an approximate overburden thickness. The subsurface was simplified into four rock units; the overburden, Upper Carbonates, Shales, and the Dayton/Brassfield. The rock units were defined and grouped by taking into account how easily water would normally move through the unit and the how likely the unit could support an aquifer. The units were grouped in this manner, because groundwater flow is affected by a number of variables, such as the configuration of the water table, hydraulic conductivity of the rock units, and the local precipitation (Sophocleous 2002).

The overburden is defined as the layer above the uppermost bedrock. The overburden generally consisted of gravel and broken pieces of rock, sand, or clay. In Echo Hills the overburden thickness varies from 3 to 36 feet. The overburden is thinnest and generally ten feet or less in the north-east portion of Echo Hills. The Upper Carbonates unit includes all bedrock above the Massie shale, such as the Cedarville, Springfield, and Euphemia formations, but does not include the overburden. In the study area the bottom of the Euphemia is found at an elevation from 912 to 938 feet. North of Echo Hills, in Mud Run, the bottom of the Euphemia was found to be no lower than 920 feet in elevation (Shrake 1994). Outcrop numbers 5 and 6 on Figure 3 were of the Euphemia formation. An outcrop showing the boundary between the Cedarville and Springfield formations was found by a spring near outcrop location 8 on Figure 3. The shales unit consists of the Massie Shale, the Laurel Limestone, and the Osgood Shale. The
shales were grouped together, because of shale’s ability to retard vertical water flow and the shale layers did not serve as a local aquifer. The limestone and dolomite formations above and below the shale units allowed ground water to vertically flow easily through fractures or solution cavities. The Laurel Limestone was included in this unit, because it does not serve as a significant source of water, is the thinnest of all the formations, and to simplify the subsurface interpretation. The shales unit has an average thickness of 29 feet, with the bottom of the unit varying from 880 to 909 feet elevation in the study area. The Dayton/Brassfield Limestone unit consists of the two rock layers below the Osgood Shale and above the Elkhorn Shale. This rock unit contains fractures and can serve as a water source. Major water flow occurs in the fractures and solution channels that are common in karts or fractured terrain (Sophocleous 2002). Two major aquifers; the upper and lower were defined to help analyze any patterns in the occurrence of contaminants, since these two aquifers are the most likely places for the local residents to get their water. The upper aquifer is defined as being located in the Upper Carbonates unit above the shales unit in elevation, whereas the lower aquifer occurs in the Dayton/Brassfield unit. Figure 8 depicts the location of the two cross-sections. The location for the upper and lower aquifer as shown by a blue line in Figures 9 and 10, this line approximates the highest elevation that the aquifer is likely to be found.
Figure 8  Location of two geologic cross-sections.
Figure 9  West to east geologic cross-section. Wells are labeled with their ID number.
Figure 10  North-east to south-west geologic cross-section. Wells are labeled with their ID number.
III. BACKGROUND INFORMATION

III. 1. NITRATE TRANSFORMATIONS

Nitrate is a common drinking water contaminant, because it is very water soluble (Canter and Knox, 1986; Freeze and Cherry, 1979; Goosy et al., 1993) and can persist in ground water for decades (Nolan et al., 1997). Nitrate can originate from many different sources, including fertilizers and manure or locations with significant fertilizer application such as lawns, and golf courses (p. 349, Domenici and Schwartz, 1990; Nolan et al., 1997). Agriculture is a major source of nitrate contamination in ground water. Nitrate in agricultural areas approaches zero during the growing season if the ground water is close to the surface (Burns et al., 1998). In an area such as the Midwest United States, soil water usually shows a decline of nitrate in April, lowest nitrate concentrations in July, and then an increase of nitrate until March (Burns et al., 1998).

Denitrification is a key process that affects the amount of nitrate in the environment. Nitrate is naturally removed from water by plant uptake and denitrification (Burns et al., 1998). Nitrate can be reduced by denitrification into nitrous oxide or nitrogen gas in an environment of little or no oxygen (Canter and Knox, 1986; Chapelle 2001; Kalff 2002; Nolan et al., 1997; Verstraeten et al., 2004). Denitrification is a process facilitated by microbes that can occur in the following areas: soil, aquifer, riparian zone, river water, and river sediments (Mayer et al., 2002). Denitrification could result in large nitrate losses in ground water (Oenema et al., 1998). Whereas, nitrification will convert nitrite into nitrate by oxidation (Canter and Knox, 1986; Freeze and Cherry, 1979; Kalff 2002).
III. 2. OCCURRENCE OF BACTERIA IN GROUND WATER

Coliform bacteria is frequently found in ground water. However, drinking water should not contain coliform bacteria (Mathes 2002). Coliform bacteria is generally not pathogenic, however it can indicate the presence of other pathogens (Zimmerman et al., 2001). Two major factors that affect the presence of coliform bacteria in ground water are weather conditions and well construction. A study done at Palm Beach, Florida, found that fecal coliform counts were almost double during the wet season compared to the dry season (Arnaud 1999). Total coliform concentrations have been shown to increase in wells without casings and that were poorly grouted or not grouted at all relative to properly grouted wells with metal casings (Zimmerman et al., 2001).

All the wells in the thesis area were open borehole wells. In many locations, the well casings do not appear to be long enough to reach the first shale layer below the upper aquifer. A study done of fifty wells in Berkeley County, West Virginia, found that fecal coliform such as *E. coli* were greatest in concentration in the most shallow wells (Mathes 2002). Fecal coliform can grow with low nutrient concentrations and at low temperatures according to a study done in Connecticut (Camper et al., 1991). Proper well construction does not always prevent the well water from being contaminated by bacteria. A study done of seventy-eight private wells located close to an agricultural area found that bacteria were as likely to be present in the non-grouted wells as in the properly grouted wells (Zimmerman et al., 2001). The same study shows that the wells underlain by carbonate rocks had the highest detectable total coliform bacterial counts (Zimmerman et al., 2001). *E. coli* was found most often in non-grouted wells underlain by carbonate rocks (Zimmerman et al., 2001).
III. 3. SEPTIC SYSTEM PERFORMANCE

Septic systems are widely used to dispose of domestic sewage in rural areas. Septic systems are used by over seventy million people and seventeen million housing units in the United States (Canter and Knox, 1986). Domestic septic systems can become a local source of ground water contamination, especially units that are older than the recommended design life of ten to fifteen years (Canter and Knox, 1986). A septic system contains a buried tank where water borne waste is collected and a subsurface drain where the sewage percolates into the soil by drainage tiles (Canter and Knox, 1986). Solids are removed by gravity separation (Canter and Knox, 1986). Septic system effluent contains fecal coliform bacteria, nitrates, and phosphates, which can lead to many diseases such as gastroententis and methoglobenemia (Arnade 1999). Septic system effluent contaminating drinking water was responsible for fourteen percent of all water borne diseases in the United States from 1970-1990 (Arnade 1999). Improperly constructed or older septic systems can contaminate ground water with fecal coliform. Even with improperly functioning septic systems, it is rare to find fecal bacteria more than 120 cm below the septic system (Canter and Knox, 1986). Fecal bacteria seldom live beyond ten days in adverse conditions, but can live more than one hundred days under favorable conditions, such as cold and moist soil (Canter and Knox, 1986). The fecal bacteria are more likely to survive in cool and moist soil (Canter and Knox, 1986). Soil moisture was found to be the most important variable influencing bacteria’s survival in a study in Virginia (Canter and Knox, 1986).

Contamination of the ground water by a local septic system may affect nearby wells. Wells that contain water less then ten feet below the ground surface are more likely to be affected by a nearby septic system even if the well is cased (Verstraeten et al., 2004). Uncased
wells have shown contamination from a nearby septic system if the water in the well is less than forty-five feet deep and the well itself is within one hundred feet of a septic system (Verstraeten et al., 2004). To avoid water contamination, it is recommended that septic systems be located on lots with a minimum size of one acre, with two to four feet of unsaturated soil between the bottom of the septic system and the yearly high water table or the local bedrock (Canter and Knox, 1986). This is because high rainfall can adversely affect the septic system performance if the water table reaches to within 25 cm of the surface, resulting in inadequate filtration of the septic tank effluent. To avoid water contamination, the septic system needs to be on a lot of at least one acre, with two to four feet of unsaturated soil between the bottom of the septic system and the yearly high water table or the local bedrock (Arnade 1999). Migration of the septic effluent was found in one study to be controlled by the local water table gradient (Miller 1992). A study found that nutrients from the septic systems in the water wells were found to be higher in the wet season and decreased as the distance between the septic system and the water well increased (Arnade 1999). Local lithology also plays a role in septic system effluent. Septic system effluent was found farther below the septic tank in a limestone aquifer than a system overlaying sand (Waller and Causáras, 1987). Properly constructed septic systems can minimize bacterial contamination of ground water, but they also easily transfer nitrate into the ground water (Drever 1997).

III. 4. HERBICIDES

Herbicides are a type of pesticide that specifically target weeds. Pesticides originate from: spray drift, application near running water or sinkholes, spillage, golf courses, nurseries, agricultural drainage, storage facilities (Gustafson 1993), near highways, and forestry (Barbash
and Resek, 1996). Atrazine and metolachlor are two types of professionally used herbicides in the United States (Goosy et al., 1993). Atrazine is used on field crops (Goolsby et al., 1993) and pastures (Barbash et al., 1999). Metolachlor is used on field crops (Goolsby et al., 1993) and vegetables (Barbash et al., 1999). Atrazine and metolachlor are applied annually to cropland in the Midwest to control undesired vegetation (Squillance et al., 1996). Atrazine and metolachlor are water soluble (Goolsby et al., 1993; Squillance et al., 1996). Pesticides are easier to detect in karst environments and in shallow ground water (Gustafson 1993) with permeable soils compared to soils such as glacial till (Barbash et al., 1999). Pesticide concentrations are usually greater in surface water than in ground water (Barbash and Resek, 1996). Pesticide concentrations vary more in shallow ground water than deeper ground water and detection of atrazine or metalachlor in shallow ground water indicates use in agricultural areas (Barbash et al., 1999). It is rare to find detectable levels of pesticides in deeper wells (Gustafson 1993). Pesticides are more likely to reach the ground water under lower temperatures, since the chemical reactions involved operate at slower rates and the degradation of the pesticides are slower (Barbash and Resek, 1996). Pesticides are more readily absorbed in soils with high levels of organic carbon (Barbash et al., 1999).

Large amounts of herbicides recently applied to crops can be flushed away by storm runoff (Goolsby et al., 1993). Herbicides can be transported through the environment by overland flow, drainage tiles, streams, and ground water (Squillance et al., 1996). Transportation of herbicides depends on their Koc values, half-life in soil, intensity of use, application methods, timing, density, duration of rainfall, and soil moisture (Goolsby et al., 1993). Koc stands for the soil organic carbon partition coefficient, which measures how easily a substance is sorbed by the soil (Barbash and Resek, 1996). Half-life is a measure of how
quickly the herbicides will degrade (Barbash and Resek, 1996). Studies completed in karst aquifers in Iowa have detected the presence of pesticides even in properly constructed wells (Barbash and Resek, 1996). Pumping of ground water has shown to increase the rate of movement of chemicals, including pesticides (Barbash and Resek, 1996).

III. 5. N-15 ISOTOPE

Nitrogen has two stable isotopes: N-14 and N-15. The composition of the nitrogen isotopes is normally expressed as $\delta^N$ notation which is defined as:

$$\delta^{15}\text{N}(%o) = \left[ \frac{\left(\frac{N-15}{N-14}\right)_{\text{sample}} - \left(\frac{N-15}{N-14}\right)_{\text{standard}}}{\left(\frac{N-15}{N-14}\right)_{\text{standard}}} \right] \times 1000 \text{ %o},$$

where standard is atmospheric N$_2$ gas. Water samples commonly contain nitrate from a variety of sources. Each source of nitrate has a corresponding range of isotope values with some overlap. For example, Kreitler and others (1978) found that $\delta^{15}$N values for organic nitrogen ranged from 2 to 8 %o, artificial fertilizer was -8 to 6.2 %o, and animal waste was 10 to 20 %o. The range of N-15 isotope values also differs slightly depending on the literature source. This study will focus on the isotope values for artificial fertilizer and animal waste which do not overlap, and are the most likely sources of nitrate in the study area.
IV. METHODS

IV. 1. SAMPLING PROCEDURES AND COLLECTION

Water samples were collected from household wells, two springs, and Mud Run. Location, date, and time were all recorded as the water samples were collected. Residents were asked if they used any type of household water treatment devices. Water well samples were collected from the outdoor household faucet. Water was run into a bucket with a YSI 556 MPS (Multi Probe System) water probe until the pH, DO (dissolved oxygen), and temperature stabilized. The water readings were then recorded and the water sample collected. The measurements at the time water samples were collected included pH, temperature, DO, Eh, and conductivity. The water was filtered into plastic bottles using filter membrane with 0.45 µm pores. The water samples to be analyzed for total coliform and *E. coli* bacteria were not filtered. The water samples were collected and separated into plastic bottles for anion, cation, and bacterial analysis. Based on a previous history of high nitrate levels and the presence of total coliform bacteria, nine locations were selected for nitrogen isotope analysis. The cation and nitrogen isotope water samples were preserved by adding drops of HCl to reduce the pH below 3. All samples were then placed into a cooler with cooling packs for transport. The water samples for nitrogen isotope and anion analysis were then stored in a refrigerator. Figure 11 displays the location of the field samples collected and their ID reference number. Appendix B shows the locations ID numbers used for the well logs and the historical data.

Two handheld rock samples were collected in place at field location number 24 and 25 in the northern branch of Mud Run. The rock samples were examined with a hand lens and tested with weak hydrochloric acid.
Figure 11  Location of field samples with identification numbers.
A tracer test was performed during April 2008. Permission was obtained from three homeowners in Echo Hills at field locations 7, 11, and 33. The tracer was prepared by dissolving NaBr in DI water in a clean 125 mL plastic bottle. A water sample was collected to determine the normal bromide concentration of the well water before the NaBr tracer was added. All water samples were collected using a clean 125 ml plastic bottle that was rinsed three times with water from the outside faucet. The tracer was then poured into the toilet inside the house where the tracer bottle was rinsed with DI water and again poured into the toilet, which then was flushed. During the two weeks following the addition of the tracer, eight water samples were collected at each location. Water samples were collected on days 1, 2, 45, 7, 9, 11, and 13.

IV. 2. ANALYTICAL METHODS

Ion analysis was done using an ICS 2000 Dionex Ion Chromatograph. Alkalinity was determined by titration using 0.02 N HCl. The presence of total coliform and E. coli. was determined by using a 3M Petrifilm E. coli/Coliform count plate official Method 991.14. Total coliform was recorded after one and two days on incubation at 35 degrees Celsius, while E. coli. growth was counted after two days using the same plates. The amount of ammonia, total phosphorous, and total silica was determined using a Hach DR/4000U spectrophotometer. Hach method 8038 (Nessler) was used to determine ammonia, Hach method 8190 was used to determine total phosphorous, and Hach method 8185 was used for the silica test. Nitrogen isotope analysis was analyzed at Northern Arizona University, using an isotope ratio mass spectrometer after concentration of nitrate with the diffusion method.
V. RESULTS AND DISCUSSION

V. 1. ROCK SAMPLES

Both rock samples from the northern branch of Mud Run were identified to be dolomite, most likely of the Euphemia formation. The rock samples were found at an elevation corresponding to the Euphemia formation and only reacted with the HCl after being scratched.

V. 2. NITRATE-NITROGEN

Water samples were collected from 33 different locations in Echo Hills and the surrounding area from late summer 2006 to fall 2006. The water samples were collected from domestic water wells, streams, and springs. Figure 12 shows the field sample nitrate concentrations labeled with their ID location, whereas, Figure 13 shows the historical maximum nitrate concentrations. The Echo Hills samples ranged from 2.1-7.7 mg/L with the average being 4.6 mg/L. The stream field samples varied from 3.5-6.9 mg/L with an average of 4.8 mg/L. All of these samples for nitrate-nitrogen were below the 10 mg/L recommended level for drinking water. Since these water samples were collected in late summer to early fall, they most likely represent the annual low for nitrate-nitrogen. The only field samples that contained nitrate-nitrogen levels close to or above 10 mg/L were collected during the tracer test at field location 33 during April 2008. Site 33 could easily be affected by surface contamination for the following reasons. A farm field is located within feet of site 33 and the overburden at this site is only about 5 feet thick. There is also a significant difference between the bottom of the well casing and the top of the Massie Shale (more than forty feet), which means that this well is more likely to be affected by surface contamination. Whereas, sites 7 and 11 showed very low levels of nitrate-
Figure 12  Concentration of NO₃⁻ N (nitrate-nitrogen) in mg/L of field samples.
Figure 13  Concentration of NO$_3^-$-N (nitrate-nitrogen) in mg/L for all historical data available in the Echo Hills area. Red and orange color indicates locations where the nitrate-nitrogen is above the 10mg/L recommended drinking water limit. Multiple circles at the same location indicate multiple sampling times. Well site 309 is labeled.
nitrogen during the tracer test (under 2 mg/L). Site number 11 also contained a number of trees in its backyard.

Historic nitrate-nitrogen sample data was obtained from the Clark County Combined Health District in Springfield, Ohio. Most of the data for nitrate-nitrogen in Echo Hill wells were for water samples collected in June. Maximum nitrate-nitrogen levels for these samples varied between 0.8 and 60.8 mg/L with an average of 8.0 mg/L. A number of the locations in Echo Hills were above the recommended maximum of 10 mg/L for nitrate-nitrogen for the historical data. The historical data reveals a large range of nitrate-nitrogen values. This can be partly explained by more historical data being available than field data collected. The large variance of values is probably affected by the following factors: reverse osmosis water purification system, fracture irregularity, overburden thickness, date of sample collection, and well location. Every year more Echo Hill residents install reverse osmosis devices that reduce the amount of nitrate-nitrogen entering their household water. The site specific characteristics of fractures in most of the rock formations (not the Cedarville or shale formations), will cause both the upper and lower aquifers to be more anisotropic. As discussed later, there was no overall statistical correlation between nitrate-nitrogen, bacteria, overburden thickness, or casing difference. However, specific portions of Echo Hills do show a much stronger correlation between some of the variables. While the overburden thickness varies from one portion of Echo Hills to another, the overburden in the north-eastern portion is consistently less than ten feet thick and in many cases less than five feet thick. This portion of Echo Hills has the greatest range of nitrate-nitrogen levels. Well log site 309 in this area had nitrate-nitrogen levels from 7.8 to over 60 mg/L. The north-eastern portion of Echo Hills also contains six sites that were over the recommended drinking water standard of 10 mg/L. Second, the difference in elevation between
the bottom of the metal well casing and the top of the shales unit is at least ten feet for all wells in this area. Third, many of the well in north-east Echo Hills are located within feet of farm fields. Finally, the surface water flow from north to south and from west to east, thus the north-east portion of Echo Hills will be affected first by any contaminants that the surface water might be carrying. The north-east portion of Echo Hills’ ground water is likely the most influenced by surface contamination, resulting in higher nitrate-nitrogen levels in well water.

V. 3. COLIFORM BACTERIA

Total coliform and *E. coli*. bacteria samples collected from August to November 2006, were analyzed for 33 different locations in and around Echo Hills. Coliform bacteria was found in 30 of the 33 locations with the three exceptions being number 7, 18, and a spring at location 30. *E. coli*. was found in all ten stream field samples, but in none of the other field samples. Figures 14 displays the total coliform results for the field data and figure 15 for the historical data.

The historical data collected from the Springfield Health Office covered 73 domestic wells in and near the Echo Hills area. Water samples collected from most of these wells were analyzed in June 2005. Of these 73 wells, 38 were positive for total coliform and five were positive for *E. coli*. In the Echo Hills area itself, 58 wells have been analyzed for coliform bacteria. In the Echo Hills area, 28 wells tested positive for total coliform and three for *E. coli*. The presence of coliform bacteria can change from positive to negative in the same well over the course of the year. *E. coli*. found in domestic water wells in Echo Hills were at locations with a maximum overburden thickness of five, twelve, and fifteen feet respectively, but overall there was no pattern or connection between the presence of coliform bacteria and well depth or
Figure 14  Presence of total coliform bacteria for field data.
Figure 15  Presence of total coliform bacteria from historical data for the Echo Hills area. The red color indicates that the location has only tested positive of coliform bacteria and an orange color indicates that the location has tested positive and negative at different sampling times.
overburden thickness. Also, the three wells positive for *E. coli* were not located next to one another and were located at wells with moderate to low levels of nitrate-nitrogen. An underperforming septic system could account for these isolated results. However, the two positive wells in the eastern portion of Echo Hills are also affected by agriculture which will be mentioned later in this study. Another possible source of water contamination is the local high school which uses a large volume of water during the school year and was also above its permit limit for fecal coliform in its effluent as measured downstream from January to September of 2006. However, the high school is located half a mile from the nearest wells in Echo Hills and this study did not find evidence of the high school directly affecting the well water in Echo Hills. Figures 16 and 17 display the results for *E. coli*. 
Figure 16  Presence of *E. coli* bacteria from field sample data.
Figure 17  Presence of *E. coli* bacteria from historical data. Wells positive for *E. coli* bacteria are shown in red with well log identification numbers.
V. 4. HERBICIDES

The Atrazine and Metolachlor data set was obtained from the Springfield Health Department. Almost all of the chemical data was for samples collected during July 11 and 12 of 2005. Figure 18 summarizes this data. The two chemicals most often found in the 19 domestic water wells tested (16 in the Echo Hills area) were the herbicides Alachlor and Metalachlor. Four wells tested positive for Alachlor and two for Metolachlor. Two wells in Echo Hills tested positive for both Alachlor and Metalachlor. As stated previously, the north-east portion of Echo Hills is likely the area most affected by farming. Thus, it is quite understandable that wells in this area would test positive for herbicides used in agriculture.

V. 5. HYDROGEOCHEMISTRY

Field Data and ion analysis are summarized in Appendix A. It was found that many residents were unsure if they had a domestic water treatment device or if the device was point of use or point of entry. Point of entry devices treat all water before the water enters the household, with a water softener being one example (Andrews et al., 1990). Whereas, a point of use device affects only a portion of water entering the home, such as a carbon filter for the drinking water (Andrews et al., 1990). The concentrations of different ions and personal communication indicated that three of the twenty-one different households had domestic water treatment devices. The two water treatment devices found in some of the homes were water softeners and the use of reverse osmosis (RO). Low concentrations of calcium or magnesium with high concentrations of sodium indicate use of a water softener (Andrews et al., 1990; Parrott et al., 1999). Whereas, low concentrations of chloride, sodium, sulfate, and nitrates indicates the use of reverse osmosis (Andrews et al., 1990; Parrott et al., 1999). It is most likely that field sample numbers 2, 7, 8, and 20 with the high concentrations of sodium and low
concentrations of magnesium resulted from the water passing through the water softener at one time. Field sample number 17 shows unusually high concentrations of the chloride ion, which could be the result of an attempt to disinfect the local drinking water of bacteria.

Silica was found in the water samples, as is to be expected in fresh water samples. Silica results from the chemical weathering of silicate minerals, which is very common in the continental crust (Manning, 1997). The pH for the field samples collected from domestic water wells varied between 6.6 and 7.6, with most very close to 7. Water collected from the streams showed a pH of 7.7 to 8.2. The pH for the field samples was close to the expected range. The pH for the streams was higher than the wells which is to be expected as the result of carbon dioxide degassing. The dissolved oxygen (DO) content for the wells were mostly in the range of 4 to 7 mg/L compared to 8.8 to 34 mg/L for the streams. The pattern of higher levels of DO for the streams was to be expected, since the streams will interact more freely with the atmosphere. DO values for surface water increase with decreasing temperature. However, a few of the stream DO values appear to be much higher than around the 10 mg/L expected (Drever 2001). This might be partially due to the measuring probe being jostled.

Geology is a major factor that influences chemical composition of natural waters. Activity diagrams also known as mineral stability diagrams, can be used to study interactions between soil or rock and water. The activities of solutes were calculated using PHREEQC (Parkurst and Appelo 1999). Figures 19-21 show the distribution of samples on activity-activity diagrams. All three activity-activity diagrams show the field samples to be in equilibrium with kaolinite. All of the samples could also be in equilibrium with Ca-beidellite since they plotted very close to this boundary. However, Ca-beidellite has not been identified in the soil of this region. The clay mineral that affects the water chemistry could be Ca-vermiculite, which has
been identified at Sycamore Farm in Montgomery County (Huang, 1992). The stability diagrams for figures 19-21 show what mineral is most likely to be in equilibrium for a given water sample. Evers (1991) found that kaolinite was also the stable clay weathering product for the same bedrock units, though Evers research area was about eighty miles further to the south. Water samples collected from streams plotted higher up in the kaolinite field on all three activity diagrams than the spring or water well samples. The stream samples on the calcium activity-activity diagram also have higher y-axis values than the well or spring water samples. This is due to surface waters being in contact with the atmosphere, which has a $P_{CO_2}$ about $10^{-3.5}$ atm. This lower $P_{CO_2}$ value will have low $H^+$ concentration and therefore high cation/ $H^+$ ratios. The water well samples collected in Echo Hills all had $P_{CO_2}$ values at or below of $10^{-2.0}$, which could be the average value of the $P_{CO_2}$ found in soil. The dashed $P_{CO_2}=10^{-3.5}$ atm and $P_{CO_2}=10^{-2}$ atm lines represent calcite solubility for the respective $CO_2$ partial pressure. The field samples collected from streams plot on or closer to the $P_{CO_2}=10^{-3.5}$ atm line. This is due to equilibrium with atmospheric $P_{CO_2}$, which is about $10^{-3.5}$ atm. The spring plots near the top of the ground water samples. This is understandable since the source of the spring’s water is underground before it interacts with the atmosphere, whereas the source of the stream water is mostly if not all surface water. Huang (1992) also found illite at Sycamore Farm. Figure 20 shows that illite, a clay mineral, could be influencing the water chemistry, since the delta trend moves toward the kaolinite-illite field (field B).
Figure 18  Historical presence of herbicides in area. Green symbols indicate below detectable levels of chemicals.
Figure 19  Stability relationships among some minerals in the system CaO-Al₂O₃-SiO₂-H₂O at 25°C. Legend indicates source of water.
Figure 20  Stability relationships among some minerals in the system K$_2$O-Al$_2$O$_3$-SiO$_2$-H$_2$O at 25°C. Legend indicates source of water.
Figure 21  Stability relationships among some minerals in the system Na$_2$O-Al$_2$O$_3$-SiO$_2$-H$_2$O at 25°C. Legend indicates source of water.
V. 6. NITROGEN ISOTOPE ANALYSIS

Nine field samples were analyzed for nitrogen isotopes of nitrate. The sources of water included: four samples from domestic water wells, one from a high school, one from a spring, and three from streams. Sample locations were chosen at sites with previously high nitrate concentrations and the presence of coliform bacteria. The sample locations were also chosen based on the water source. Sample locations can be seen on Figure 22. Each sample underwent three runs of which the average nitrogen isotope values are listed in Appendix A, with the result rounded to the nearest tenth. The data indicate that the nitrate-nitrogen present in wells in Echo Hills probably originated from a number of sources. See Table 1 for a comparison of nitrogen isotope values.

<table>
<thead>
<tr>
<th>Source of Nitrate</th>
<th>Cey et al., 1999</th>
<th>Mayer et al., 2002</th>
<th>Kreitler et al., 1978</th>
</tr>
</thead>
<tbody>
<tr>
<td>synthetic fertilizer</td>
<td>-1 to 4</td>
<td>0 to 3</td>
<td>-8 to 6.2</td>
</tr>
<tr>
<td>human / animal waste</td>
<td>9 to 20</td>
<td>7 to 20</td>
<td>10 to 20</td>
</tr>
</tbody>
</table>

The nitrate-nitrogen in samples numbers 11 and 30 are consistent with the hypothesis that synthetic fertilizers are a major source, because of their low nitrogen isotope values. Stream sample numbers 31 and 32 had the highest nitrogen isotope values corresponding with animal waste. Field sample number 31 was obtained from a stream flowing through land that contained pastures and horses. The high solubility of nitrate in water allows the nitrate to easily flow overland during rainstorms. Sample numbers 0, 8, 9, 10, and 23 isotope values indicate that the nitrate is probably from multiple sources such as synthetic fertilizers and animal or human waste.
Figure 22  Nitrogen isotope values with corresponding field sample identification numbers.
The nitrogen isotope values for these samples fall between or near the ranges for synthetic fertilizers and animal waste. Depending on the research source, sample numbers 0, 8, 9, and 23 are in the range for synthetic fertilizer according to Kreitler et al., (1978). Stream sample number 23 is located downstream of stream sample 32 and was located at a position amongst cropland, where nitrogen fertilizer could lower the nitrogen isotope value. Nitrate originating from mixing of two sources will have a linear relationship on a plot of nitrogen isotope versus \( \frac{1}{\text{total nitrate-nitrogen concentration}} \) (Appendix C). The linear relationship as shown on Figure 22, for sample numbers 8, 9, 10, 11, and 23 indicate their nitrate-nitrogen originated from a mixed source. Sample numbers 31 and 32 have isotope values that indicate manure as the dominant source of nitrate-nitrogen, such as human or animal waste. The pre-pumped static water levels suggests that field sample numbers 9 and 10 are located at wells that are drawing more of their water from the upper aquifer and numbers 0, 8 and 11 are getting more water from the lower aquifer. All four open borehole wells are located at a similar surface elevation with metal casings that appear to be many feet short of the upper shale layer. The well casing depth is much higher for field sample numbers 9 and 10, leaving more room for the wells to draw water from the upper aquifer. 9 and 10 are also located in an area of Echo Hills with an overburden of about five feet. Sample numbers 0, 8, and 11 are located at wells with much thicker overburdens of 18 feet or more.

Table 1, compares the values of nitrogen isotope analysis from three different studies. Low isotope values (under 7) indicate that the nitrate is predominately originating from synthetic fertilizer. Whereas, isotope values above 7 indicate that the nitrate is originating from a predominately human or animal waste source. Nitrate originating from a mixture of sources including synthetic fertilizer and animal waste will have nitrogen isotope values between 3 to 10
‰. However, because of the wide ranges of $\delta^{15}\text{N}$ for each category of nitrogen sources, the $\delta^{15}\text{N}$ of animal wastes and synthetic fertilizers still need to be established for the local study.
Figure 23  Graph of Nitrogen Isotope Value in (δ‰) vs. 1 / Total Concentration of nitrate-nitrogen. Numbers on graph show the field location. Water originating primarily from the lower aquifer are shown in red, whereas blue indicates water originating primarily from the upper aquifer. Points 8-11 and 23 on the line indicate a mixing of the source water. Triangles indicate streams as the water source and the square a spring.
V. 7. STATISTICAL CORRELATION

SPSS (a software statistics program) for Windows (2007) was used to look for overall patterns in the data, such as how overburden thickness relates to nitrate nitrogen concentrations across the entire data set. The data analyzed included historic and field data. The variables used were aquifer type, overburden thickness, difference in feet between the bottom of the metal casing and the top of the Massie shale, occurrence of total coliform bacteria and E. coli bacteria, and the nitrate-nitrogen concentration. A bivariate correlation analysis was done using the Pearson, Tau, and Spearman methods. The bivariate correlation compares two variables at a time to determine how closely they are related. The Pearson method is more useful for continuous data such as concentration of a substance, whereas the Spearman and Kendall methods are better for comparing ordinal data. Values close to zero indicate little or no statistical correlation and a negative correlation implies that as one variable is increasing, while the other variable is decreasing.

Overall, the statistical results reveal little or no correlation between contamination variables such as coliform bacteria and nitrate nitrogen concentrations and possible influencing variables such as overburden thickness, difference in metal casing, or aquifer location. There is enough scattering in the data that one correlation does not hold true for the entire data set. A lack of an overall correlation is not too surprising considering that at different sampling times a number of sites tested both positive and negative for coliform bacteria. Also, different sites were tested at different times of the year.
V. 8. TRACER TEST

A tracer test was done at three locations to see how readily possible contaminants could move from the septic system into nearby well water. The tracer used was bromide in the form of NaBr. The results of the tracer test were inconclusive. The amount of bromide varied very little before and after the tracer were added. The slight variations of bromide are easily within the possible error of the ion chromatograph. It is not possible to tell if water from the septic system is entering the well with this tracer test. There are several reasons why bromide levels did not increase after the tracer was added. They include dilution and movement of the groundwater. About 3 grams of NaBr was added at each site, which could be diluted below detection levels. The tracer could actually be entering the well, but not easily detected, because a lack of measurement sensitivity and the low amounts of bromide added (under 3 g at each location). Also, if the groundwater is moving away from the well then the tracer is indeed entering the aquifer, but would not be measured. Lastly, the water collection could have missed the tracer peak. See table 2 for the tracer test results.

The tracer test did reveal that the chloride/bromide ratio is quite high (over 1300) at two sites. Studies have found that the chloride/bromide ratio is around 50-150 for precipitation, 100-200 for shallow ground water, 300-600 for domestic sewage, and over 1000 for halite dissolution (Davies et al., 1998; Vengosh and Pankratov 1998). The high chloride/bromide ratio in the Echo Hills area could be due to halite or road salt dissolution. Another possibility is the use of a household water softener, which will increase the amount of chloride in the ground water. The household at field location 33 does use a water softener.
Table 2  Tracer Test Results

(All amounts are in mg/L. ND stands for not detected or below detection.)

<table>
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Figure 24  Tracer test locations with field ID numbers.
VI. FACTORS AFFECTING GROUNDWATER QUALITY

A number of factors are known to affect drinking water quality in a rural setting. These factors include: thickness of overburden, well construction and maintenance, nearby land use, and septic system construction.

VI. 1. OVERBURDEN THICKNESS

A thinner overburden can allow surface water to more easily influence groundwater quality and in less time. As stated previously, the overburden in Echo Hills can be quite thin, as little as a few feet. Also a gap between the bottom of the metal well casing and the top of the shales unit could allow surface water to penetrate deeper into the aquifer. Figure 24 displays the overburden thickness and well casing difference. The ground water in the north-eastern portion of Echo Hills appears most sensitive to changes in surface water. Most of the wells in Echo Hills have a casing difference over ten feet, especially in the north-eastern portion which also has a thin overburden (well Id numbers 306-310). Only the north-eastern portion of Echo Hills shows the presence of farm chemicals in the ground water. Historically the north-eastern portion of Echo Hills also has had high nitrate concentrations (over 10mg/L nitrate-nitrogen), though other portions of Echo Hills have had high nitrate concentrations as well.
Figure 25  Difference in feet of the distance from the bottom of the well casing to the top of
the Massie shale. A positive number indicates that the casing does not penetrate the shale layer
and a negative number indicates that the casing does. Also shown as colored lines are
overburden thickness. For example, all the area inside the red line indicates 0-5 feet of
overburden thickness, inside the orange is 6-10, and inside the yellow 11-20 feet. Numbers
identify locations of specific wells.
VI. 2. Agriculture

Agriculture in the area definitely has an effect on ground water quality in the Echo Hills area. The north-eastern portion of Echo Hills appears to be the most heavily affected, with a number of wells showing the presence of coliform bacteria and herbicides. Isotope data for field sample number 11, which is located in the south-east portion of Echo Hills indicates a fertilizer source. This well was also positive for coliform bacteria. These results are understandable since the land to the west of Echo Hills is almost all used for agriculture and is generally at a higher elevation. Finally, many of the wells in Echo Hills, especially in the north-eastern portion, are probably not cased into the shale layers below the upper aquifer. This allows water from the upper and lower aquifers to mix in the open borehole of the well, increasing the probability of the well being contaminated from surface water.

VI. 3. Septic Systems

The residents of Echo Hills use septic systems exclusively to remove household sewage. Contamination of ground water from septic systems in Echo Hills is possible. The presence of \textit{E. coli.} in Echo Hills was found in three wells (289, 299, 306) as shown in Figure 17. All three wells are located apart from each other. The rarity of \textit{E. coli.} present in the Echo Hills’ wells would seem to indicate a localized contamination source such as an under-performing septic system. Otherwise, more wells should show a presence of \textit{E. coli.} if the bacteria was aided by a more general source of contamination such as agriculture. However, since the water is drawn from a fractured carbonate aquifer the situation becomes more complex. Wells numbers 299 and 306 are also located near the eastern edge of Echo Hills, which is also affected by nearby
agricultural processes, with herbicides being detected in nearby wells. Well number 289 is most likely to be affected by the septic system, since it is located in the western portion of Echo Hills, away from wells in which agricultural herbicides have been found. Field sample numbers 9 and 10 located in the north-east portion of Echo Hills, are probably being affected by septic systems as well, since their nitrogen isotope results fall into or near the animal waste range and the overburden is thinner than in other locations of Echo Hills. The western portion of Echo Hills is the oldest, with many of the wells being 10 to 20 years old, with septic systems of similar ages. Another source of ground water contaminants in Echo Hills could be a local high school. It was found by the EPA that a local high school within half a mile to the north-east of Echo Hills was releasing water with above the recommended amounts of coliform bacteria during a thirty day period of 2006. The high volume of water used and discharged by the high school, which is located at a higher elevation, could have an affect on groundwater quality in Echo Hills. The historical and field data show that nitrate-nitrogen concentrations are highest in the north-east portion of Echo Hills (see figures 11 and 13). The north-east portion of Echo Hills is located to the closest point of the high school.
VII. WATER WELL CONTAMINATION PREVENTION STRATEGIES

The abundance of ground water contamination worldwide has led to strategies for protecting water wells from contamination. Solutions on reducing ground water contamination include: riparian zones, crop rotation, and proper maintenance of the water well and the septic system. One way to reduce possible water well contamination is with areas of natural vegetation called riparian zones can be very important in reducing the amount of contaminants entering the ground water from sources such as agriculture. Vegetative strips of at least thirty feet in width can filter agriculture runoff (Gustafson 1993). Riparian zones have been found to reduce the amount of nitrate existing in nearby groundwater (Bohlke and Denver, 1995; Vitousek et al., 1997) and reduce the nutrient loading into nearby streams (Komor and Magner, 1996) by denitrification, vegetative uptake, and dilution (Cey et al., 1999). Another strategy is crop rotation, which can reduce the amount of fertilizer and pesticide application needed and prevents pests from becoming chemically resistant. Lastly, proper well and septic system construction can reduce water well contamination. Domestic water wells with a surface seal, concrete pad, and grouted casing are less susceptible to contamination from surface water (Mathes 2002). Pump testing the septic system will reveal if the system is leaking and needs to be replaced.
VIII. CONCLUSIONS

Ground water quality in Echo Hills has been an issue for many years. Drinking water in the area has been contaminated from high levels of nitrate, coliform bacteria, and herbicides used in agriculture. This contamination has led many residents to install devices to help clean or filter their drinking water. The major sources of contamination are most likely local agricultural and animal waste aided by inadequate well construction. Septic systems look to be contributing to ground water contamination as well. Herbicides used in agriculture were found in three wells in the north-eastern portion of Echo Hills. The nitrogen isotope values reveal nitrate-nitrogen most likely originating from multiple sources including animal waste, synthetic fertilizer, and naturally occurring nitrogen. At least one well in Echo Hills appears to also be affected by an under-performing septic system, since the well that was positive for *E. coli.* was not near other wells with herbicides present. Ground water contamination at Echo Hills most likely reflects decades of agriculture in the study area and then additional contamination from household septic systems as Echo Hills grew in population. This is evidenced by the linear relationship on a plot of nitrogen isotope versus (1 / total nitrate-nitrogen concentration), which indicates mixing of the lower nitrogen isotope values of nitrogen synthetic fertilizers with the higher nitrogen isotope values of human or animal waste. The upper aquifer is more enriched in N-15 than the lower aquifer. The most likely interpretation is that nitrate in the region has been influenced by agriculture activity and then septic systems superimpose N-15 enriched nitrate from human waste on the regional aquifer, preferentially the upper aquifer.

Regardless of the source of ground water contamination, well construction appears to play an important role in the area. Most of the wells in Echo Hills appear to have metal casings that do not go into or past the shale rock units below the upper aquifer. This open borehole well
construction will allow water from the upper and lower aquifers to mix. Well water is more likely to be affected by surface contamination whether it originate from agriculture or a nearby underperforming septic system. A well built septic system will not perform correctly if the local climate and geology are not properly understood. If not enough overburden overlies a carbonate aquifer, then the local water well can easily become contaminated by the septic system’s effluent, especially during elevated ground water levels. The overburden appears to be minimal in a few locations in Echo Hills, especially the north-eastern portion.

The following are suggestions for future studies to better understand the ground water contamination in the Echo Hills. First, an isotope composition study that could better measure the difference between nitrate sources of fertilizer, animal, and human waste, and uncontaminated water, since sources of nitrate have overlapping values in current literature. Secondly, the local high school uses large amounts of water annually, but this study could not determine the high school’s affect if any on the ground water quality in Echo Hills. Lastly, a more comprehensive tracer test could help determine possible ground water contaminant flow. In conclusion, having a good understanding of the local geology, maintaining proper well and septic system construction standards, and utilizing proper zoning will greatly reduce drinking water health concerns for the local residents in a rural area.
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Miller, W. L.  1992.  Hydrogeology and migration of septic-tank effluent in the surficial aquifer system in the northern midlands area, Palm Beach County, Florida.  

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APPENDIX A: SUMMARY OF FIELD SAMPLE COLLECTION DATA

Table headings for appendix A are defined as follows:

ID               identification number used for field samples
Date            date of sample collection
Temp            temperature in degrees Celcius
DO               amount of dissolved oxygen in mg/L

All ions are listed in amounts of mg/L.

Nitrate-N concentration of nitrate-nitrogen in mg/L
RP               amount of reactive phosphate in mg/L
Table 3  Summary of data analyzed from field samples.

| ID | Nitrates | Temp | Cond | DO | ORP | pe | pH | Alkalinity | Na | NH4N | K | Mg | Ca | Cl | Br | SO4 | Coli | Ecoli |
|----|----------|------|------|----|-----|----|----|------------|----|-------|---|----|----|----|----|-----|-----|------|------|
|    | units    | mg/L | °C   | μS/cm | mg/L | mV | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L |
| 0  | 1.5      | 6.8  | 11/06/06 | 12.87 | 597 | 5.21 | 275.7 | 4.63 | 6.66 | 6.87 | 2.02 | 0.13 | 13.38 | 23.06 | 29.67 | 52.22 | 1 | 0 |
| 1  | 5.4      | 09/19/06 | 16.35 | 627 | 4.14 | 178.7 | 3.08 | 7.31 | 6.47 | 10.02 | 1.13 | 36.82 | 87.7 | 22.44 | 35.07 | 4 | 0 |
| 2  | 8.7      | 09/19/06 | 16.22 | 831 | 9.18 | 144.2 | 4.08 | 7.58 | 6.73 | 242.1 | 2.33 | 1.44 | 14.29 | 81.54 | 32.39 | 18 | 0 |
| 3  | 8.7      | 09/19/06 | 14.55 | 633 | 5.61 | 232.9 | 2.51 | 7.17 | 6.6 | 19.92 | 1.12 | 40.1 | 94.22 | 38.01 | 32.39 | 1 | 0 |
| 4  | 5.6      | 11/06/06 | 12.3  | 617 | 11.45 | 247.6 | 4.27 | 6.66 | 6.73 | 13.78 | 0.11 | 13.46 | 25.35 | 35.66 | 39.77 | 1 | 0 |
| 5  | 5       | 08/29/06 | 19.14 | 749 | 6.92 | 180.2 | 2.85 | 6.82 | 6.93 | 15.22 | 2.36 | 1.53 | 44.46 | 91.47 | 34.54 | 27.79 | 5 | 0 |
| 6  | 4.6      | 08/29/06 | 14.35 | 702 | 7.59 | 140.6 | 1.93 | 6.95 | 7.33 | 16.63 | 2.01 | 42.34 | 91.36 | 39.32 | 0.73 | 42.24 | 8 | 0 |
| 7  | 2.1      | 08/29/06 | 18.3  | 615 | 6.99 | 70.7 | 3.56 | 7.23 | 6.4 | 161.02 | 0.43 | 0 | 10.21 | 13.4 | 25.71 | 0 | 0 |
| 8  | 3.2      | 09/04/06 | 20.25 | 838 | 4.44 | 137.6 | 3.66 | 6.6 | 7.53 | 197.2 | 1.2 | 0 | 15.93 | 46.67 | 38.93 | 4 | 0 |
| 9  | 5.1      | 09/04/06 | 15.71 | 892 | 7.4 | 207.6 | 3.62 | 7.04 | 7.67 | 44.19 | 5.36 | 43.17 | 91.27 | 100.16 | 26.61 | 16 | 0 |
| 10 | 6.4      | 09/04/06 | 20.99 | 999 | 2.52 | 166.4 | 3.84 | 7.04 | 6.67 | 48.1 | 6.33 | 2.33 | 45.16 | 90.82 | 111.37 | 26.95 | 200 | 0 |
| 11 | 7.2      | 09/04/06 | 16.31 | 726 | 7.07 | 220.3 | 2.93 | 6.94 | 6.93 | 20.09 | 6.78 | 28.39 | 93.21 | 45.71 | 26.56 | 5 | 0 |
| 12 | 5.2      | 09/05/06 | 17.51 | 724 | 4.81 | 211.3 | 11.16 | 6.76 | 7.13 | 14.68 | 9.21 | 40.55 | 94.72 | 37.94 | 37.97 | 5 | 0 |
| 13 | 3.6      | 09/05/06 | 14.78 | 708 | 5.2 | 203.5 | 2.36 | 6.91 | 7 | 22.67 | 3.57 | 38.76 | 88.82 | 58.66 | 40.69 | 3 | 0 |
| 14 | 4.8      | 08/29/06 | 14.58 | 714 | 6.8 | 72.2 | 4.37 | 6.82 | 6.4 | 12.95 | 2.01 | 43.42 | 98.26 | 59.54 | 41.81 | 17 | 0 |
| 15 | 2.2      | 09/04/06 | 18.1  | 708 | 7.35 | 169.5 | 1.22 | 7.24 | 6.2 | 4.65 | 0.39 | 7.78 | 29.39 | 55.75 | 32.14 | 46 | 0 |
| 16 | 7.8      | 11/08/06 | 14.27 | 853 | 24.68 | 264.5 | 1.27 | 6.9 | 7.13 | 12.81 | 0.14 | 13.42 | 22.56 | 27.71 | 26.84 | 5 | 0 |
| 17 | 2.4      | 11/08/06 | 15.86 | 1454 | 11.02 | 245.2 | 1.75 | 6.5 | 9.27 | 34.71 | 0.16 | 17.53 | 28.39 | 314.76 | 41.39 | 24 | 0 |
| 18 | 3.8      | 08/29/06 | 16.9  | 637 | 5.07 | 85.6 | 4.51 | 6.98 | 6.13 | 9.37 | 1.88 | 36.53 | 87.52 | 0 | 0 | 0 | 0 |
| 19 | 3       | 08/29/06 | 14.24 | 600 | 5.89 | 100.4 | 4.86 | 6.72 | 6.85 | 1.29 | 1.83 | 37.01 | 88.6 | 27.93 | 39.09 | 4 | 0 |
| 20 | 7.7      | 08/29/06 | 14.79 | 637 | 5.8 | 210.4 | 2.47 | 7.16 | 6.27 | 170.28 | 1.63 | 0 | 10.31 | 32.33 | 41.57 | 1 | 0 |
| 21 | 3.7      | 11/08/06 | 16.2  | 683 | 6.04 | 258.6 | 1.49 | 6.6 | 7.07 | 38.57 | 0.04 | 0.31 | 1.84 | 36.64 | 26.64 | 33 | 0 |
| 22 | 3.5      | 09/21/06 | 11.08 | 661 | 8.84 | 216.7 | 3.84 | 7.78 | 6.93 | 23.14 | 3.48 | 2.01 | 42.38 | 96.83 | 45.63 | 34.11 | 250 | 1 |
| 23 | 4.4      | 09/21/06 | 11.19 | 664 | 9.38 | 216.3 | 3.83 | 7.75 | 6.93 | 22.57 | 1.89 | 42.39 | 97.06 | 45.49 | 34.2 | 300 | 4 |
| 24 | 4.2      | 09/21/06 | 12.36 | 644 | 10.75 | 196.3 | 3.47 | 8.09 | 6.73 | 22.26 | 2.45 | 39.28 | 94.9 | 47.29 | 27.82 | 300 | 2 |

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Appendix C: Mathematical Proof for Linear Relationship of Isotope Concentration vs.
1 / Total nitrate-nitrogen Concentration

The following information is summarized from Faure 1977 using nitrogen instead of strontium:

A and B are two components
NA and NB are the concentrations of N
Ab and Ab are the isotopic abundances of 15N
WA and WB are the atomic weights of N in components A and B
G is Avogadro’s number
f is the mixing parameter as defined by:

\[ f = \frac{A}{A + B} \]

Assume two mixtures of two components A and B that have different concentrations of nitrogen and different 15N/14N ratios. Then the total number of 15N atoms in a unit weight of such a mixture is:

\[ \frac{15N}{N} = \frac{N_A A B^{15} G f}{W_A} + \frac{N_B B^{15} G (1-f)}{W_B} \]

After eliminating Avogadro’s number and eliminating f the equation becomes:

\[ \frac{^{15}N}{^{14}N}_M = \frac{N_A N_B \left[ \left( \frac{^{15}N}{^{14}N} \right)_A - \left( \frac{^{15}N}{^{14}N} \right)_B \right]}{N_M \left( N_A - N_B \right)} + \frac{N_A N_B \left[ \left( \frac{^{15}N}{^{14}N} \right)_A - \left( \frac{^{15}N}{^{14}N} \right)_B \right]}{N_M \left( N_A - N_B \right)} \]

The following equation plots as a hyperbola in coordinates of \( \frac{^{15}N}{^{14}N} \) \( M \) and \( N_M \), where a and b are constants:

\[ \frac{^{15}N}{^{14}N}_M = \frac{a}{N_M} + b \]

The mixing hyperbola can be transformed into a straight line by plotting:

\[ \left( \frac{^{15}N}{^{14}N} \right)_M \text{ VS.} \frac{1}{N_M} \]
### Appendix D: Summary of Data Obtained From Well Logs

Table headings for appendix C are defined as follows with all elevation measurements in feet:

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APPENDIX E

WELL LOGS

A handwritten number, usually located on the top-right of the well log is the identification number used for the well log data tables.
**WELL LOG AND DRILLING REPORT**

State of Ohio  
DEPARTMENT OF NATURAL RESOURCES  
Division of Water  
Fountain Square  
Columbus, Ohio 43214  

**COUNTY** Clark  
**TOWNSHIP** New River  
**SECTION OF TOWNSHIP** 24  
**OWNER** Metro Contracting Inc.  
**ADDRESS** 7562 Dayton Rd., Fairborn, Ohio 45324  
**LOCATION OF PROPERTY** Lot # 1, Chico Ct. East of Tecumseh Rd. (42.104950 N, 84.116091 W)

**CONSTRUCTION DETAILS**

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**BAILING OR PUMPING TEST**

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**WELL LOG**

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<tbody>
<tr>
<td>Clay</td>
<td>0 ft.</td>
<td>9 ft.</td>
</tr>
<tr>
<td>Clay &amp; Gravel</td>
<td>9 ft.</td>
<td>12 ft.</td>
</tr>
<tr>
<td>Limestone</td>
<td>12 ft.</td>
<td>38 ft.</td>
</tr>
</tbody>
</table>

**SKETCH SHOWING LOCATION**

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

**DRILLING FIRM** C.R. HAMILTON  
**REGISTRATION NUMBER** 32  
**DATE** Oct 3, 1986

Address: 16 Hanby Ave., Dayton, Ohio 45404

Completion of this form is required by 1921.05, Ohio Revised Code—file within 30 days after completion of this well. The original copy is for the building department.
WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1939 Fountain Square Drive
Columbus, Ohio 43224
(614) 265-8799

COUNTY Clark
TOWNSHIP Mad River
SECTION/LOT NO. 30
(CIRCLE ONE)

OWNER/Builder Kinge Farmers
PROPERTY ADDRESS 5496 Robert PK N
ADDRESS OF WELL LOCATION N. E. corner of Robert PK & Tauleich Rd.

CONSTRUCTION DETAILS

CASING
Diameter: 52.00 in.
Length: 101 ft.
Wall Thickness: 0.125

Type: Steel

Material: PSC

GROUT
Material: Benscel
Volume used: 10.00 cu.

Method of installation: Brome

Depth: placed from 0 ft. to 30 ft.

SCREEN
Type (wires-wrapped, louvered, etc.): Slot

Material: PRC

Length: 52.00 in.

Set between 0 ft. and 96 ft.

Diameter: 7.85 in.

Date of completion: 4-18-89

Type of pump: Submersible
Capacity: 10 gpm

Pump set at 60 ft.

Pump installed by

WELL LOG

SANDS

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED.

Show color, texture, hardness, and formation:
sandstone, shale, limestone, gravel, clay, sand, etc.

From To

Topsoil: 0 ft. 4 ft.

Coarse gravel: 4 ft. 39 ft.

Sharkley Gray clay: 39 ft. 81 ft.

Coarse gravel: 81 ft. 101 ft.

WELL TEST

Bailing 0 Pumping 0

Test rate: 25 gpm

Duration of test: 1 hour

Measured from: top of casing

Static Level: 36 ft.

Quality (clear, cloudy, taste, odor) (Attach a copy of the pumping test record, per 1521.05, ORC)

WELL SHOWING LOCATION

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

RECEIVED

DEC 18 1989

SIGNED

LOIS MILLER

DATE

12-14-89

ODH REGISTRATION NUMBER # 41

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

ODNR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, Cols., Ohio 43224

90
WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1939 Fountain Square Drive
Columbus, Ohio 43224
(614) 265-6739

COUNTY             ________________  TOWNSHIP    ________________  SECTION/LOT NO.  ________________
OWNER/CONTRACTOR   Rich Morgan     PROPERTY ADDRESS  4412 Robert Pike
LOCATION OF PROPERTY

CONSTRUCTION DETAILS

CASING
- Material: ___________
- Type:  □ Steel  □ Galv.  □ PVC  □ Other
- Ports:  □ Threaded  □ Welded  □ Solvent  □ Other
- Screen type (wire wrapped, louvered, etc.):  ___________
- Screen length: ___________ ft.  Diameter: ___________ in.
- Screen Set between: ___________ ft. and ___________ ft. Sickt.
- Attach a copy of the shaving record per 4521.05, ORC
- Date of completion: 9-2-89

GROUT
- Method of installation: ___________
- Tension pressure: ___________ ft. to ___________ ft.

GRAVEL PACK
- Material: ___________
- Volume used: ___________
- Method of installation: ___________
- Depth placed from: ___________ ft. to ___________ ft.
- Prefilled Device:  □ Adapter  □ Preassembled unit
- Use of Well: ___________

PUMP
- Type of pump: ___________
- Capacity: ___________ gpm
- Pump set at: ___________ ft.
- Pump installed by: ___________

WELL TEST
- Beating:  □ or  □ Pumping:  □  Test rate: 15 gpm  Duration of test: 2 hrs.
- Drawdown: 15 ft.
- Measured from:  □ Top of casing  □ Ground level  □ Other  □ Static Level (depth to water): 20 ___________ ft.  Date: ___________ 9-2-89
- Quality (clear, cloudy, taste, odor): ___________

WELL LOG*
- Indicate depth(s) at which water is encountered:
  - Show color, textural, hardness, and formation:
  - Sandstone, shale, limestones, gravel, clay, sand, etc.
  - From: ___________ ft.  To: ___________ ft.
- Clay: 0 ft.  10 ft.
- Gravel: 10 ft.  18 ft.
- Limestone: 18 ft.  80 ft.

SKETCH SHOWING LOCATION
- Show distances well lies from numbered:
  - State highways, street intersections, county roads, etc.

RECEIVED
SEP 15 1989

DNR 7802.88

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

DRILLING FIRM  C. E. HAMILTON
ADDRESS  9449 Hilton Carlisle Rd.
CITY, STATE, ZIP  New Carlisle, Ohio 45344

SIGNED  Shirley Hamilton
DATE  9-2-89
ODH REGISTRATION NUMBER  32

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

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

91
CONSTRUCTION DETAILS

CASING
Length below grade: Borehole Diameter 7 7/8 in.
2 Diameter: in. Length: ft. Wall Thickness

Type: Steel Galv. PVC Other

JOINTS:
Threaded Welded Solvent Other

Liner: Length Type Wall Thickness

GROUT
Material: Bentonite Volume used: 150 gal.
Method of installation: Trench pitched
Depth: placed from: 30 ft. to 0 ft.

GRAVEL PACK (Filter Pack)
Material: None Volume used
Method of installation
Depth: placed from: ft. to ft.

SCREEN
Type (wire wrapped, louvered, etc.): Name Material
Length: Diameter in. String Diameter ft. Slot

WELL LOG

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED.

Show color, texture, hardness, and formation:
sandstone, shale, limestone, gravel, clay, sand, etc.

<table>
<thead>
<tr>
<th>Depth</th>
<th>From</th>
<th>To</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brown Clay</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Limestone</td>
<td>6</td>
<td>19</td>
</tr>
<tr>
<td>Shale</td>
<td>19</td>
<td>25</td>
</tr>
<tr>
<td>Limestone</td>
<td>25</td>
<td>97</td>
</tr>
</tbody>
</table>

WELL TEST

Bailing Pumping Other Air

Test rate: 20 gpm Duration of test: 2

Drawdown: 57 ft.

Measured from top of casing: ground level Other

Static Level (depth to water): 40 ft. Date: 1/21/97 Clear

Quality (clear, cloudy, taste, odor):

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

PUMP

Type of pump: Capacity

Pump set at: Pump installed by:

WELL LOCATION

Location of well in State Plane coordinates, if available:

Zone: x y

Elevation of well: Datum plane: NAD27 NAD83

Source of coordinates: GPS Survey Other

Sketch a map showing distance well is from numbered state highways, street intersections, county roads, buildings, or other notable landmarks.

RECEIVED

FEB - 3 1997

*If additional space is needed to complete well log, use next consecutively numbered form. I hereby certify the information given is accurate and correct to the best of my knowledge.

Drilling Firm: Crabtree Well & Pump
Address: 3822 Snyder-Domer Rd.
City, State, Zip: Springfield, Ohio 45502
ODH Registration Number: 264

Signed: January 23, 1997

Completion of this form is required by section 1521.05, Ohio Revised Code. File within 30 days after completion of drilling.
**WELL LOG AND DRILLING REPORT**
Ohio Department of Natural Resources
Division of Water, 1999 Fountain Square Drive
Columbus, Ohio 43224 Phone (614) 255-4421

**LOCATION OF PROPERTY**
- County: Clark
- Township: Mad River
- Section/Lot: 28
- Address: 4553 Fairfield Pike

**CONSTRUCTION DETAILS**
- **Casing**
  - Depth: 30 ft
  - Diameter: 5 in
  - Type: Galv
  - Joints: Threaded
  - Liner: PVC

- **Screen**
  - Depth: 30 ft
  - Material: Grout
  - Type: Residential

- **Indicate depth(s) at which water is encountered:**
  - Clay: 10 ft
  - Limestone: 100 ft

- **Bailing**
  - From: 0 ft
  - To: 2 ft

- **Pumping**
  - From: 2 ft
  - To: 100 ft

- **Date of Completion:** Oct 22, 1996

**WELL TEST**
- Test rate: 45 gpm
- Duration of test: 2 hrs
- Drawdown: 20 ft
- Measured from: top of casing
- Ground level: 35 ft
- Static level (depth to water): 35 ft
- Quality (clear, cloudy, taste, odor): clear

**PUMP**
- Type of pump: Capacity: 70 gpm
- Pump set at: 70 ft
- Pump installed by: HAMILTON WELL DRILLING

**WELL LOCATION**
- Location of well in State Plane coordinates: if available:
- Zone: X
- Elevation of well: ft
- Datum plane: NAD83
- Source of coordinates: GPS
- Survey: Other

**Signature:**
- **C.W. HAMILTON WELL DRILLING**
- Signed: Stanley Hamilton
- Date: 10-22-96
- City, State, Zip: New Carlisle, OH 45344

**ODR Registration Number:** 32

**Compliance:**
Completion of this form is required by section 1521.06, Ohio Revised Code, 61 days after completion of drilling.

**Original Copy To:** ODNR, Division of Water, 1999 Fountain Sq. Drive, Cols., Ohio 43224
WELL LOG AND DRILLING REPORT
Ohio Department of Natural Resources
Division of Water, 1939 Fountain Square Drive
Columbus, Ohio 43224-9971 Voice (614) 265-6740 Fax (614) 265-6767

WELL LOCATION

County: Clark
Township: Wind River
Section: 25
Rangt: 1N

WELL DRILLER

Robert Beard

4505 S. Teunisen

Fairfield Village

ZIP Code: 45502

Location of Well in State Plane coordinates: N:\ 135751.69 ft. E:\ 505620.33 ft.

Elevation of Well: 1247.6 ft.
Datum Plane: NAD 83 Elevation Source: Other

WELL DRILLER: Robert Beard

SOURCED BY

Teunisen, N.

January

WELL TEST:

Pre-Pumping Static Level: 104.9 ft.
Water level: 8/10/04

Test Rate: 10 gpm
Duration of Test: 1 hour
Sustained Yield: 10 gpm

PUMP/PITLESS

Type of Pump: Submersible
Capacity: 10 gpm

Pump set at: 10 ft.

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

DATE: 8/10/04

SIGNATURE: J. Beard

DOH Registration Number: N0305

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

RECEIVED SEP 17 2004

ORIGINAL COPY TO - ODNR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224-9971
**WELL LOCATION**

- **County:** Clark
- **Township:** Mad River
- **Owner/Builder:** Fisher
- **Well Location:** 4896 S. Tecumseh Rd.
- **City:** Springfield
- **Address of Well Location:** 4896 S. Tecumseh Rd.
- **Zip Code:** 45502

**LOCATION OF WELL IN STATE PLANE COORDINATES (IF AVAILABLE)**

- **Use of Well:** Residential
- **Datum Plane:** NAD27
- **Elevation:** ft
- **Elevation Source:** Survey

**SCREEN**

- **Diameter:** ft
- **Type:** Steel
- **Length:** ft
- **Material:** Screen

**GROUND**

- **Type:** Bentonite
- **Volume Weight Used:** 429 lbs

**DRILLING LOG**

<table>
<thead>
<tr>
<th>Material</th>
<th>Volume Weight Used</th>
<th>Method of Installation</th>
<th>Depth</th>
<th>Surface</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sandstone</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Limestone</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**WELL TEST**

- **Pre-Pumping Static Level:** 10 ft
- **Test Rate:** 50 gpm
- **Sustainable Yield:** 10 gpm

**PUMP/PITLESS**

- **Type of Pump:** Capacity
- **Pump Set:** 65 ft
- **Pitless Type:** gpm

**CLOSING**

- **Signed:** Shirley Hamilton
- **Date:** 6-13-00
- **ODH Registration Number:** 0032

**Completion of this form is required by section 1521.05, Revised Code.**

---

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

**ORIGINAL COPY TO:** ODN, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224-9971
**CONSTRUCTION DETAILS**

- **Casing**
  - Diameter: 6 in.
  - Length: 27 ft.
  - Wall Thickness: 6 in.

- **Grout**
  - Material: Bentonite
  - Volume used: 35 gals.

- **Graavel Pack (Filter Pack)**
  - Material: Volume used

- **Well Completion**
  - Depth placed from: 27 ft. to surface

**SCREEN**

- **Type**
  - Material:
  - Length: 6 in.
  - Overall length: 20 ft.
  - **Casing:**
    - Diameter: 6 in.
    - Length: 27 ft.
    - Wall Thickness: 6 in.

**WELL LOG**

- **Indicate depth(s) at which water is encountered**
  - Limestone: 0 to 105 ft.

**WELL TEST**

- **Bailing/Drain Down**
  - Test rate: 50 gpm
  - Duration of test: 1 hr.

- **Drawdown**
  - Measured from top of casing: 2 ft.

- **Static Level (Depth to water)**
  - 65 ft.

- **Quality (clear, cloudy, taste, odor)**
  - Clear

**PUMP**

- **Type of pump**
  - **Capacity**

**SKETCH SHOWING WELL LOCATION**

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

**RECEIVED**

- **JUN - 1, 1994**
- **CLARK COUNTY HEALTH DEPT. SPRINGFIELD, OHIO**

**C.R. HAMILTON WELL DRILLING**

- **9449 Hilton Carlisle Rd.**
- **New Carlisle, OH 45344**

**GOSH Registration Number**

- **32**

**Signature**

- **Please verify the information given is accurate and correct to the best of my knowledge.**

**Signed**

- **Shirley Hamilton**
  - **5-17-94**

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

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

---

97
WELL LOG AND DRILLING REPORT

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

Permit Number 2712

COUNTY Clark TOWNSHIP Mad River SECTION OF TOWNSHIP
OWNER Paul D. Tyree ADDRESS 5014 S Tecumseh Rd, Spt Ht, 043902
LOCATION OF PROPERTY 5060 S Tecumseh Rd, Springfield, Oh 45502

CONSTRUCTION DETAILS
Casing diameter 6" O.D. Length of casing 11
Type of screen - Length of screen -
Type of pump -
Capacity of pump -
Depth of pump setting -
Date of completion 5-16-91

BAILING OR PUMPING TEST
(specify one by circling)
Test rate 15 gpm Duration of test 20 hr
Drawdown 1 ft 6" ft Date 5-17-91 7 ft
Static level (depth to water) -
Quality (clear, cloudy, taste, odor) clear
Pump installed by -

WELL LOG*

<table>
<thead>
<tr>
<th>Formation</th>
<th>From</th>
<th>To</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay</td>
<td>0 ft</td>
<td>10 ft</td>
</tr>
<tr>
<td>Limestone</td>
<td>10 ft</td>
<td>32 ft</td>
</tr>
<tr>
<td>Gray Shaly Limestone</td>
<td>32 ft</td>
<td>33 ft</td>
</tr>
</tbody>
</table>

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

SKETCH SHOWING LOCATION

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

CLARK COUNTY HEALTH DEPT.
SPRINGFIELD, OHIO

RECEIVED
MAY 2, 1991

CLARK COUNTY HEALTH DEPT.
SPRINGFIELD, OHIO

DNR 7802

DRILLING FIRM Levi DePauw REGISTRATION NUMBER 288
ADDRESS 4315 W Nath Rd, Spt Ht, 043904 SIGNED Levi DePauw

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

May 26, 1991
**CONSTRUCTION DETAILS**

<table>
<thead>
<tr>
<th>Casing</th>
<th>GROUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Borehole Diameter</td>
<td>SDR21</td>
</tr>
<tr>
<td>Diameter</td>
<td>Material</td>
</tr>
<tr>
<td>93 ft.</td>
<td>Wall Thickness</td>
</tr>
<tr>
<td>Wall Thickness</td>
<td>Method of Installation</td>
</tr>
<tr>
<td>93 ft.</td>
<td>Depth, placed from</td>
</tr>
<tr>
<td>Type</td>
<td>Material</td>
</tr>
</tbody>
</table>
- Steel | | |
- PVC | | |
- Other | | |
- Solvent | | |
- Other | | |
- Other | | |
| Screen | Use of Well | Domestic |
| Type: wire wrapped, louvered, etc. | | |
| Length | Material | |
| 7 ft. and | | |
| ft. Sid | | |
| Wells Log | WELL TEST |
| Depths at which water is encountered | Water level | Clear |
| Sand and Gravel | Depth | July 6, 1994 |
| 0 | 30 | ft. |
| Brown Clay | 30 | 60 |
| Gray Clay | 60 | 93 |
| Limestone | 93 | 140 |
| WELL TEST | | |
| Test rate | Duration of test | 2 |
| 7 gpm | 2 | |
| Drawdown Bottom | Measured from X top of casing | |
| X | | |
| | ground level | |
| | Other | |
| Static level (depth to water) | ft. | Date |
| 50 | July 6, 1994 | |
| Quality (clear, cloudy, taste, odor) | | |
| Other | | |

**SKETCH SHOWING WELL LOCATION**

Show distances well lies from numbered state highways, street intersections, county roads, etc.
WELL LOG AND DRILLING REPORT
OHIO DEPARTMENT OF NATURAL RESOURCES
Division of Water, 1939 Fountain Square Drive
Columbus, Ohio 43224-8971. Voice: (614) 285-6739 Fax: (614) 285-6767

WELL LOCATION

<table>
<thead>
<tr>
<th>County</th>
<th>CLARK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Township</td>
<td>MADRIVER</td>
</tr>
<tr>
<td>CurrentBuilder</td>
<td>Jim Kelly</td>
</tr>
<tr>
<td>Well Location</td>
<td>5220 S. Tocumesh Rd.</td>
</tr>
<tr>
<td>City</td>
<td>Springfield</td>
</tr>
<tr>
<td>Permit #:</td>
<td>7454</td>
</tr>
<tr>
<td>Section:</td>
<td></td>
</tr>
<tr>
<td>Location in State Plane: Use of well:</td>
<td>DOMESTIC</td>
</tr>
<tr>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>Elevation of Well:</td>
<td>984 Feet</td>
</tr>
<tr>
<td>Datum Plane:</td>
<td>WGS</td>
</tr>
<tr>
<td>Elevation Source:</td>
<td>GPS</td>
</tr>
<tr>
<td>Source of Coordinates:</td>
<td>GPS</td>
</tr>
</tbody>
</table>

Map Sketch | Latitude: | 39.8528 | Longitude: | -83.8891 |

CONSTRUCTION DETAILS

Drilling Method: Rotary

<table>
<thead>
<tr>
<th>BORE HOLE/CASING</th>
<th>(Measured from ground surface)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Borehole Diameter: 7.675 Inches</td>
</tr>
<tr>
<td>Casing Diameter: 5.5 Inches</td>
<td>Length: 85 Ft</td>
</tr>
<tr>
<td>2</td>
<td>Borehole Diameter: 4.5 Inches</td>
</tr>
<tr>
<td>Casing Diameter: 4.5 Inches</td>
<td>Length: 85 Ft</td>
</tr>
<tr>
<td>Casing Height above Ground:</td>
<td>10 Feet</td>
</tr>
</tbody>
</table>

Type 1 PVC plastic

JOINS

| 1 | Solvent welded |

SCREEN

Diameter: | In |
Slot size: | Length: | Ft |

Type & Material:

Set between: | Ft and | Ft |

GRAVEL PACK

Volume/Weight Used: | 2 |

Method of Installation:

Depth: Placed From | Feet |
To: Feet |

SPROUT

Material: Cement Grout

Volume/Weight Used: | 200 | Pounds |

Method of installation: | Triton Pipe |

Depth: Placed From | 85 Feet |
To: 0 Feet |

WELL TEST

Pre-pumping Static Level: | 85 ft |
Date: | 4/26/05 |

Test Method: Air

Test Rate: | 5-7 gpm |
Duration of Test: | 1 hr |

FT of Drawdown: | 40 Feet |
Sustainable Yield: | 5 gpm |

Attach a copy of the pumping test report, per section 1521.09, ORC
In Copy Attached? | No |
Flowing Well: | No |
Water Quality: | clear |

PUMP/FITNESS

Pump Type: | Submersible |
Capacity: | 5-7 gpm |
Pump set at: | 140 Ft |
Pitless Type: | PITLESS ADAPTOR |
Pump installed by: | Gottard Pump |

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

Drilling Firm: Eaton Well Drilling, Inc.
Address: 10343 County Rd. 41
City, State, Zip: West Liberty, OH 43357

Jennifer Eaton Date: 4/29/05
Registered Representative
ODM Registration Number: 2882

RECEIVED APR 29 2005

DRILLING LOG

From | To
Red Clay | 0 | 11
Gravel & Clay | 11 | 82
Limestone | 82 | 160

Water encountered at 160'
## WELL LOG AND DRILLING REPORT

**County:** Clark  
**Township:** Mad River  
**Owner/Builder:** Chuck Legge  
**Address:** 5246 S. Technums Rd.  
**City:** Springfield  
**Zip Code:** 45502  
**Permit No.:** 207  
**Section/Lot No.:** 6  
**Rotation No.:** 6  
**Location of Well in State Plane Coordinates, if available:**  
**Datum Plane:** NAD 83  
**Source of Coordinates:** GPS  
**Use of Well:**  

### SCREEN
- **Diameter**: 6 inches  
- **Slot Size**: 62  
- **Screen Length**: 62 ft.  
- **Material**: Other  
- **Type**:  

### GRAVEL PACK
- **Method of Installation**: Other  
- **Depth**: Placed FROM  
- **Volume/Weight Used**:  

### DRILLING LOG
- **Indicate Depth(s) at which water is encountered:**  
  - **Brown Clay**: 0.8'  
  - **Brown Sand & Gravel**: 8.38'  
  - **Gray Clay**: 30.62'  
  - **Gray Limestone**: 62.95'  

### RECEIVED
**DEC 19 1997**

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

**ORIGINAL COPY TO:** ODRN, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224-9971

**BLUE:** Customer's copy  
**PURPLE:** Driller's copy  
**GREEN:** Local Health Dept. copy

[Signature]

Date: 12-17-97

**Date of Well Completion:** 12-17-97  
**Total Depth of Well:** 95 ft.
**WELL LOG AND DRILLING REPORT**

State of Ohio  
DEPARTMENT OF NATURAL RESOURCES  
Division of Water  
1939 Fountain Square Drive  
Columbus, Ohio 43224  
(614) 265-6739

**Permit Number** 2293

**Location of Property**

<table>
<thead>
<tr>
<th>COUNTY</th>
<th>Clark</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOWNSHIP</td>
<td>Mad River</td>
</tr>
<tr>
<td>OWNER/-builder</td>
<td>Madden Construction</td>
</tr>
<tr>
<td>PROPERTY ADDRESS</td>
<td>4850 Popon Rd.</td>
</tr>
</tbody>
</table>

**Construction Details**

<table>
<thead>
<tr>
<th>CASING</th>
<th>GROUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter</td>
<td>5 in.</td>
</tr>
<tr>
<td>Length</td>
<td>20 ft.</td>
</tr>
<tr>
<td>Wall Thickness</td>
<td>in.</td>
</tr>
</tbody>
</table>
| Type: | □ Steel  
□ Galv.  
□ PVC  
□ Other |
| Joints: | □ Threaded  
□ Welded  
□ Solvent  
□ Other |

<table>
<thead>
<tr>
<th>SCREEN</th>
<th>GRAVEL PACK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type (wire wrapped, louvered, etc.):</td>
<td>Material</td>
</tr>
<tr>
<td>Length</td>
<td>ft.</td>
</tr>
<tr>
<td>Diameter</td>
<td>in.</td>
</tr>
<tr>
<td>Set between</td>
<td>ft and</td>
</tr>
<tr>
<td>Slot</td>
<td>ft.</td>
</tr>
</tbody>
</table>
| Rotary | □ Cable  
□ Augered  
□ Driven  
□ Dug  
□ Other |
| Date of completion | 3-19-90 |

**PUMP**

| WELL TEST |
| --- | --- |
| Type of pump | □ Bailing  
□ or  
□ Pumping  
□ |
| Capacity | gpm |
| Pump set at | ft. |
| Pump installed by | |

**WELL LOG**

<table>
<thead>
<tr>
<th>Indicates depth(s) at which water is encountered.</th>
<th>From</th>
<th>To</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay</td>
<td>0 ft.</td>
<td>12 ft.</td>
</tr>
<tr>
<td>Limestone</td>
<td>12 ft.</td>
<td>120 ft.</td>
</tr>
</tbody>
</table>

**Sketch Showing Location**

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

N  
W  
S  
Xwell  
Echo Hills  
Hagen Rd.  
Hagan Rd.

**Drilling Firm**  O. E. HAMILTON

**Address**  9449 Milton-Olive Rd.

**City, State, Zip**  New Carlisle, Ohio 45344

**Completion of this form is required by 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.**
WELL LOG AND DRILLING REPORT

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

Permit Number: 1543

COUNTY: Clark
TOWNSHIP: MadLisa
SECTION OF TOWNSHIP:
OWNER: Tony Adams
ADDRESS: 2750 South 150th East

LOCATION OF PROPERTY:

CONSTRUCTION DETAILS

<table>
<thead>
<tr>
<th>Casing diameter</th>
<th>5 5/8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of casing</td>
<td>29'</td>
</tr>
<tr>
<td>Type of screen</td>
<td></td>
</tr>
<tr>
<td>Length of screen</td>
<td></td>
</tr>
<tr>
<td>Type of pump</td>
<td></td>
</tr>
<tr>
<td>Capacity of pump</td>
<td></td>
</tr>
<tr>
<td>Depth of pump setting</td>
<td></td>
</tr>
<tr>
<td>Rate of completion</td>
<td></td>
</tr>
<tr>
<td>Rotary [ ]</td>
<td>Cable [ ]</td>
</tr>
</tbody>
</table>

WELL LOG

<table>
<thead>
<tr>
<th>Formations: sandstone, shale, limestone, gravel, clay</th>
<th>From</th>
<th>To</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous</td>
<td>0 ft</td>
<td>23 ft</td>
</tr>
<tr>
<td>Due to soft shale formation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liner casing was installed to</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bottom of bore hole</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SKETCH SHOWING LOCATION

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

Completion of this form is required by 1521.05, Ohio Revised Code - file within 30 days after completion.
# WELL LOG AND DRILLING REPORT

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

**COUNTY** Clark  
**TOWNSHIP** Nod Hill  
**SECTION OF TOWNSHIP**  
**OWNER** Mr. Brown  
**ADDRESS** 4890 Riley Rd.  
**LOCATION OF PROPERTY** 4741 Echo Hills Rd. off Ranger Rd.  

## CONSTRUCTION DETAILS

<table>
<thead>
<tr>
<th>Diameter</th>
<th>Length of Casing</th>
<th>Type of Screen</th>
<th>Length of Screen</th>
<th>Type of Pump</th>
<th>Capacity of Pump</th>
<th>Depth of Pump Setting</th>
<th>Date of Completion</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 in.</td>
<td>25 ft.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>July 7, 1986</td>
</tr>
</tbody>
</table>

## BAILING OR PUMPING TEST

**Test Rate** 20 gpm  
**Duration of Test** 14  
**Drawdown** 15 ft  
**Date** July 7, 1986  
**Static Level (Depth to Water)** 50 ft  
**Quality (clear, cloudy, taste, odor)** Clear  

## SKETCH SHOWING LOCATION

[Sketch showing location]

---

**DRILLING FIRM** C.E. Hamilton Well Drilling  
**ADDRESS** 616 Vanater Ave. Dayton, Ohio 45406  
**DATE** July 8, 1986  
**SIGNED**  

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

**OAHU HEALTH DEPT COPY**

104
WELL LOG AND DRILLING REPORT

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

Permit Number 1676

COUNTY Clark
TOWNSHIP New River
SECTION OF TOWNSHIP
OWNER Phillip Hole
ADDRESS 9735 E. 111 1/2 Dr.

LOCATION OF PROPERTY Same

CONSTRUCTION DETAILS
Casing diameter 6" Length of casing 26"
Type of screen
Type of pump
Capacity of pump
Depth of pump setting
Date of completion
Rotary for Cable

BAILING OR PUMPING TEST (specify one by circling)
Test rate 10 gpm Duration of test 1 hrs
Drawdown ft Date
Static level (depth to water) ft
Quality (clear, cloudy, taste, odor) Clear

Pump installed by

WELL LOG
Formations: sandstone, shale, limestone, gravel, clay
From To
Clay+gravel 0 ft 22 ft
Limestone 22 ft 100 ft

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

Graphical representation of location

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

DRILLING FIRM Crabtree Well & Pump
REGISTRATION NUMBER 844
SIGNED
DATE 7/22/80

Completion of this form is required by 1521.05, Ohio Revised Code • File within 30 days after completion.

WHITE ORIGINAL COPY - ODNR, DIVISION OF WATER, FOUNTAIN SQ., COLS., OHIO 43224 / Blue - Customer’s Copy / Pink - Driller’s Copy / Green - Local Health Dept. Copy
### Construction Details

**Casing**
- Diameter: 6 in.
- Length: 30 ft.
- Wall Thickness: in.
- Type: Steel
- Galv.
- PVC
- Solvent
- Other
- Joints: Threading
- Welded
- Solvent
- Other

**Screen**
- Type (wire wrapped, louvered, etc.): Material
- Length
- Diameter: ft.
- Slot: in.
- Rotary
- Cable
- Augered
- Drilled
- Dug
- Other
- Rate of completion: 9-1-89

**GROUT**
- Material: bentonite
- Volume used: 150 cu ft
- Method of installation: Poured
- Depth: placed from 30 ft. to surface

**Gravel Pack**
- Material: Volume used
- Method of installation
- Depth: placed from ft. to
- Filter Device: Adapter
- Preassembled unit
- Use of Well: Domestic

**Pump**
- Type of pump
- Capacity: gpm
- Pump set at
- Pump installed by

**WELL LOG**
- Indicate depth(s) at which water is encountered,
- How color, texture, hardness, and formation:
- sandstone, shale, limestone, gravel, clay, sand, etc.,
- From: To
  - Brown Clay: 0 ft. to 5 ft.
  - Brown Clay & Gravel: 5 ft. to 18 ft.
  - Brown Sandy Clay & Gravel: 18 ft. to 23 ft.
  - Limestone: 23 ft. to 120 ft.

**Test Well**
- Bailing or Pumping: Test
- Test rate: 35 gpm
- Duration of test: 1 hr
- Drawdown: ft.

- Measured from: Top of casing
- Ground level
- Other
- Static Level (depth to water): 25 ft.
- Date:
- Quality (clear, cloudy, taste, odor): Clear

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

### Sketch Showing Location
- Show distances well lies from numbered state highways, street intersections, county roads, etc.

### Received
- SEP 21 1989

### Signed
- 9-11-89

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

**Original Copy - ODNR, Division of Water, 1939 Fountain Sq. Drive, Cols., Ohio 43224**
**WELL LOG AND DRILLING REPORT**

**Ohio Department of Natural Resources**
Division of Water, 1939 Fountain Square Drive
Columbus, Ohio 43224-9971 Voice (614) 466-2399 Fax (614) 466-9503

<table>
<thead>
<tr>
<th>WELL LOCATION</th>
<th>CONSTRUCTION DETAILS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>County</strong></td>
<td>Clark</td>
</tr>
<tr>
<td><strong>Township</strong></td>
<td>Mad River</td>
</tr>
<tr>
<td><strong>Owner/Builder</strong></td>
<td>Sandy Weiss</td>
</tr>
<tr>
<td><strong>Address of Well Location</strong></td>
<td>4697 Echo Hills Dr.</td>
</tr>
<tr>
<td><strong>City</strong></td>
<td>Springfield</td>
</tr>
<tr>
<td><strong>Zip Code</strong></td>
<td>45502</td>
</tr>
</tbody>
</table>

### BOREHOLE/CASING
- **Borehole Diameter**: 7 1/8 inches  
- **Depth**: 28 ft.  
- **Casing Diameter**: 5 1/2 in. Length: 17 ft.  
- **Thick**: 1 in.  
- **Casing Height Above Ground**: 17 ft.  
- **Type**: Steel  
- **Material**: PVC  
- **Joint**: Threaded  

### SCREEN
- **Diameter**: 2 1/2 in.  
- **Slot Size**: 1/2 in.  
- **Screen Length**: 17 ft.  
- **Type**: Material  
- **Material**: Sand  
- **Set Between**: 1 ft. and 2 ft.  

### GRANULAR PACK/FILTER PACK
- **Volume/Weight Used**: 50 lbs.  

### GROUT
- **Material**: Bentonite  
- **Volume/Weight Used**: 65 lbs.  
- **Method of Installation**:  
- **Depth**: 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.  

### WELL TEST
- **Pre-Pumping Static Level**: 35 ft.  
- **Date**: 7-17-03  
- **GPM**: 45  
- **Sustainable Yields**: 15 gpm  
- **Flowing Well?**: Yes  

### PUMP/PITLESS
- **Type of pump**: Submersible  
- **Capacity**: 10 gpm  

### SIGNATURES
- **Signed**:  
- **Date**: 7/17/03  
- **Driller**: John W. Kinney  
- **Completion of this form is required by section 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.**
## WELL LOG AND DRILLING REPORT
Ohio Department of Natural Resources, Division of Water
1939 Fountain Square Drive, Columbus, OH 43224 Phone (614) 265-6739 Permit Number 4175

**COUNTY:** Clark  
**TOWNSHIP:** Mad River  
**SECTION/LOT:** No. 29B  
**PROPERTY ADDRESS:** 4492 Echo Hills Ave

**LOCATION OF PROPERTY:** 4492 Echo Hills Ave, Springfield, OH 45506

### CONSTRUCTION DETAILS

<table>
<thead>
<tr>
<th>CASING</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter</td>
<td>Length</td>
</tr>
<tr>
<td>6&quot; O.D.</td>
<td>142 ft.</td>
</tr>
<tr>
<td>Wall Thickness</td>
<td>1.42 in.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>GROUT</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Material</td>
<td>Volume used</td>
</tr>
<tr>
<td>PVC</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SCREEN</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Type (wire wrapped, louvered, etc.)</td>
<td>Material</td>
</tr>
<tr>
<td>Length</td>
<td>Diameter</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WELL LOG</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Indicate depth(s) at which water is encountered.</td>
<td></td>
</tr>
<tr>
<td>Show color, texture, hardness, and formation: sandstone, shale, limestone, gravel, clay, sand, etc.</td>
<td></td>
</tr>
<tr>
<td>From</td>
<td>To</td>
</tr>
<tr>
<td>0</td>
<td>21 ft.</td>
</tr>
<tr>
<td>Light gray limestone</td>
<td>21 to 40 ft.</td>
</tr>
<tr>
<td>Dark gray shaley limestone</td>
<td>40 to 70 ft.</td>
</tr>
<tr>
<td>Water between 25 to 40 ft.</td>
<td></td>
</tr>
</tbody>
</table>

### WELL TEST

<table>
<thead>
<tr>
<th>Test</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate</td>
<td>8 gpm</td>
</tr>
<tr>
<td>Duration of test</td>
<td>1 hr</td>
</tr>
<tr>
<td>Drawdown</td>
<td>30</td>
</tr>
</tbody>
</table>

- Measured from: top of casing  
- Static level (depth to water): 18 ft.  
- Quality (clear, cloudy, taste, odor): clear

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

### PUMP

- Type of pump: Submersible  
- Capacity: 12  
- Pump set at: 62 ft.  
- Pump installed by: Levi DePew

### SKETCH SHOWING WELL LOCATION

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

---

Drilling Firm: Levi DePew  
Address: 4315 W National Rd  
City, State, Zip: Springfield, OH 45504  
ODH Registration Number: 288

Signed:  
April 8, 1995

Completion of this form is required by section 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.
## WELL LOG AND DRILLING REPORT

**State of Ohio**
**DEPARTMENT OF NATURAL RESOURCES**
**Division of Water**
**1939 Fountain Square Drive**
**Columbus, Ohio 43224**
**(614) 265-6739**

**Permit Number:** 702248

**COUNTY:** Clark  
**TOWNSHIP:** Mad River  
**SECTION/LOT NO.:** ID394

**OWNER/BUILDER:** Patricia Blazos  
**PROPERTY ADDRESS:** 4642 Echo Hills Ave

### CONSTRUCTION DETAILS

**Casing**
- **Diameter:** 6 in.  
- **Length:** 50 ft.  
- **Wall Thickness:** in.  
- **Type:** Steel  
- **Orifice:** Threaded  
- **Material:** Type (wire wrapped, louvered, etc.)

**Screen**
- **Material:**  
- **Length:**  
- **Diameter:**  
- **Set between** ft.  
- **Slot:**  
- **Rotary:**  
- **Cable:**  
- **Augered:**  
- **Driven:**  
- **Dug:**  
- **Other:**

**Type of pump**
- Capacity

**Method of installation**
- **Volume used:** 150 cu ft

**Use of Well**
- **Pumping Adjacent to Property:**  
- **Preassembled unit:**

### WELL TEST

**Method of production:**  
- **Test rate:** 20 gpm  
- **Duration of test:** hrs.

**Test rate:**  
- **Inlet water:**  
- **Outlet water:**

**Static Level (depth to water):** 30 ft.

**Quality (clear, cloudy, taste, odor):**

### WELL LOG

**Indicate depth(s) at which water is encountered.**
- **Clay:** 0 ft.  
- **Gravel:** 20 ft.  
- **Limestone:** 24 ft.  
- **Total:** 125 ft.

### RECEIVED

**APR - 2-1999**

**CLARK COUNTY HEALTH DEPT.**
**SPRINGFIELD, OHIO**

### SKETCH SHOWING LOCATION

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

---

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

**ORIGINAL COPY - ODNR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224**
WELL LOG AND DRILLING REPORT

COUNTY: Clark  TOWNSHIP: Mad River  ID # 45  SECTION/LOT No. (Chk One)
OWNER/CONTRACTOR: Madden Const.  PROPERTY ADDRESS: 4643 Echo Hills Dr.
LOCATION OF PROPERTY:

CONSTRUCTION DETAILS
Type: Steel  Galv.  PVC  Other
Joint: Threaded  Grooved  Other
Liner: Length: in. Type: Wall Thickness: in.

Grout
Material: Bentonite  Volume used: 37 gals.
Method of installation: Tremie pipe
Depth: placed from: 28 ft. to surface: ft.

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

Pitless Device
Use of Well
Residential

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

Clay  0  6
Gravel  6  14
Limestone  14  118

WELL TEST
Bailing  × Pumping
Test rate: 30 gpm  Duration of test: 2 hrs.
Drawdown: 0 ft.
Measured from:  at top of casing × ground level  Other
Static Level (depth to water): 90 ft. Date: 
Quality (clear, cloudy, tannin, odor): clear

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

PUMP
Type of pump Capacity gpm
Pump set at: 105 ft.
Pump installed by:

WELL LOCATION
Location of well in State Plane coordinates, if available:
Zone:  x
Elevation of well: ft. Datum: NAD27 NAD83 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:

Echo Hills Dr

Bolin Dr.

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

Drilling Firm: C.E. HAMILTON WELL DRILLING
Address: 9449 Milton Carlisle Rd.

Signed: Shirley Hamilton
Date: 8-8-96

City, State, Zip: New Carlisle, OH 45344  ODH Registration Number: 32

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

ORIGINAL COPY TO - ODNR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224
110
**WELL LOG AND DRILLING REPORT**

State of Ohio  
DEPARTMENT OF NATURAL RESOURCES  
Division of Water  
1939 Fountain Square Drive  
Columbus, Ohio 43224

<table>
<thead>
<tr>
<th>CONSTRUCTION DETAILS</th>
<th>BAILING OR PUMPING TEST</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CASING</strong></td>
<td><strong>WELL TEST</strong></td>
</tr>
<tr>
<td>Casing Diameter</td>
<td>Test rate</td>
</tr>
<tr>
<td></td>
<td>10.0</td>
</tr>
<tr>
<td>Length of Casing</td>
<td>Duration of test</td>
</tr>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>hrs.</td>
</tr>
<tr>
<td>Type:</td>
<td>Drawdown (water level during pumping)</td>
</tr>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>ft.</td>
</tr>
<tr>
<td>Steel</td>
<td>Measured from:</td>
</tr>
<tr>
<td></td>
<td>top of casing</td>
</tr>
<tr>
<td>Galv.</td>
<td>Other</td>
</tr>
<tr>
<td>PVC</td>
<td>Other</td>
</tr>
<tr>
<td>Other</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SCREEN</strong></td>
<td><strong>Static Level</strong></td>
</tr>
<tr>
<td>Type (wire wrapped, louvered, etc.)</td>
<td>(depth to water)</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>54</td>
</tr>
<tr>
<td>Material</td>
<td>Date</td>
</tr>
<tr>
<td></td>
<td>10-12-88</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>PUMP</strong></td>
</tr>
<tr>
<td></td>
<td>Type of pump</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Capacity</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pump set at</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pump installed by</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pitless Device</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ Adapter</td>
</tr>
<tr>
<td></td>
<td>□ Preassembled unit</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Use of Well</strong></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>House</td>
</tr>
</tbody>
</table>

**GROUT**

<table>
<thead>
<tr>
<th>Material</th>
<th>Volume used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dacronite</td>
<td>42 gals.</td>
</tr>
</tbody>
</table>

**WELL LOG**

<table>
<thead>
<tr>
<th></th>
<th>From</th>
<th>To</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay</td>
<td>0 ft</td>
<td>20</td>
</tr>
<tr>
<td>Gravel</td>
<td>20</td>
<td>22</td>
</tr>
<tr>
<td>Limestone</td>
<td>22</td>
<td>123</td>
</tr>
</tbody>
</table>

**SKETCH SHOWING LOCATION**

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

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

PRINTED NAME: Charles E. Hamilton Jr.  
SIGNATURE: Charles E. Hamilton Jr.  
DATE: 10-12-88  
ODH REGISTRATION NUMBER: 32
## WELL LOG AND DRILLING REPORT

**Ohio Department of Natural Resources**
Division of Water: 1939 Fountain Square Drive
Columbus, Ohio 43224
Phone (614) 265-8726

<table>
<thead>
<tr>
<th>Permit Number</th>
<th>4449</th>
</tr>
</thead>
<tbody>
<tr>
<td>COUNTY</td>
<td>Clark</td>
</tr>
<tr>
<td>TOWNSHIP</td>
<td>Mad River</td>
</tr>
<tr>
<td>OWNER/CONTRACTOR</td>
<td>Madden Const.</td>
</tr>
<tr>
<td>PROPERTY ADDRESS</td>
<td>4560 Echo Hills Dr.</td>
</tr>
<tr>
<td>LOT/SECTION/LOT</td>
<td>#44 Echo Hills Platt</td>
</tr>
</tbody>
</table>

### CONSTRUCTION DETAILS

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Diameter</td>
<td>5</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>2 Diameter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type</td>
<td>Galv. PVC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Joints</td>
<td>Threaded</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liner</td>
<td>Slotted</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCREEN</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type (wire wrapped, glued, etc.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length</td>
<td>ft.</td>
<td>ft.</td>
<td></td>
</tr>
<tr>
<td>Set between</td>
<td>ft.</td>
<td>ft.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>GROUT</th>
<th>Material</th>
<th>Volume used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bentonite</td>
<td>42 gals.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Method of Installation</th>
<th>32 ft. to surface</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>GRAVEL PACK (Filter Pack)</th>
<th>Material</th>
<th>Volume used</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Depth placed from</th>
<th>32 ft. to surface</th>
</tr>
</thead>
</table>

### WELL LOG

**INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED.**

<table>
<thead>
<tr>
<th>Rock Type</th>
<th>Depth From</th>
<th>Depth To</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>Clay &amp; Gravel</td>
<td>8</td>
<td>15</td>
</tr>
<tr>
<td>Limestone</td>
<td>15</td>
<td>150</td>
</tr>
<tr>
<td>Shale</td>
<td>150</td>
<td>160</td>
</tr>
</tbody>
</table>

**SHOW COLOR, TEXTURE, HARDNESS AND FORMATION:**
- Sandstone, shale, limestone, gravel, clay, sand, etc.

### WELL TEST

**Bailing**

- Test rate (gpm): 10
- Duration of test (hrs): 2

**Pumping**

- Test rate (gpm): 2
- Duration of test (hrs): 2

**Quality (clear, cloudy, taste, odor):**
- Clear

### WELL LOCATION

**Location of well in State Plane coordinates, if available:**
- Zone: 
- Elevation of well: ft.
- Datum plane: NAD27, NAD83
- Source of coordinates: GPS

**Sketch a map showing distance well lies from numbered state highways, public intersections, county roads, buildings or other notable landmarks:**

**C.E. HAMILTON WELL DRILLING**

**Address:**

9449 Milton Carlisle Rd.

**City, State, Zip:**

New Carlisle, OH 45344

**Date:**

10-26-95

**Signatures:**

**Drilling Firm:**

**Shirley Hamilton**

**Completion of this form is required by section 1521.08, Ohio Revised Code. File within 30 days after completion of drilling.**

**ODNR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224**

**DNR 7902-94**

**031 Registration Number:**

32
**WELL LOG**

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 15</td>
<td>Brown Clay</td>
</tr>
<tr>
<td>15 - 63</td>
<td>Limestone</td>
</tr>
<tr>
<td>63 - 114</td>
<td>Limestone</td>
</tr>
<tr>
<td>114 - 151</td>
<td>Limestone</td>
</tr>
<tr>
<td>151 - 910</td>
<td>Sandstone, gravel, clay, sand, etc.</td>
</tr>
</tbody>
</table>

**WELL TEST**

- **Test rate**: 15 gpm
- **Duration of test**: 2 hrs
- **Drawdown**: 60 ft
- **Measured from**: Top of casing
- **Quality (clean, cloudy, taste, odor)**: Clean

**PUMP**

- **Type of pump**: Capacity: 40 gpm
- **Pump set at**: 91 ft

---

**SKETCH SHOWING WELL LOCATION**

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

---

**Owner/Builder**: Greg Hückelbergher

**Additional Information**:

- **ODH Registration Number**: 24189
- **Completion of form is required by section 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.**
WELL LOG AND DRILLING REPORT
Ohio Department of Natural Resources
Division of Water, 1939 Fountain Square Drive
Columbus, Ohio 43224
Phone (614) 264-8769
Permit Number: 4197

COUNTY: Clark
TOWNSHIP: Mad River
SECTION/LOT No: 1D300

OWNERS: Calvin Watts
PROPERTY ADDRESS: Lot #43 Echo Hills Dr.

LOCATION OF PROPERTY: Echo Hills Plat
Lot #43 Echo Hills Dr. Echo Hills Plat

CONSTRUCTION DETAILS

CASING: Length: 32 ft, Diameter: 4.5 in
Borehole Diameter: 8 in

1 Diameter: 5 in, Length: 32 ft, Wall Thickness: 32 in
2 Diameter: 4.5 in, Length: 32 ft, Wall Thickness: 8 in

Material: Steel, Type: PVC

Joints: 2, Type: Threaded

Well Length: 60 ft, Type: Screen

Depth placed from: 32 ft to surface

Bentonite: Volume used: 42 gals.

Method of installation: Silted-in

Treated water pressure: Depth: 32 ft

GRAVEL PACK (Filter Pack): Material: Other
Volume used: Other

Method of installation: Other

Depth placed from: 32 ft to surface

SCREEN: Depth: 32 ft, Diameter: 6 in

Material: Screen

Plates Device: Adapter

Use of Well: Residential

Date of Completion: 3-21-95

WELL LOG

WELL TEST

Indicate depth(s) at which water is encountered:

Depth of water: Description: Sandstone, shale, limestone, gravel, clay, sand, etc.

From: 0 To: 15
Clay

From: 15 To: 135
Limestone

From: 135 To: 160
Shale

Test rate: 10 gpm
Donation of test: 2 hrs

Bailing: X
Pumping: Other

Drawdown: 2 ft

Measured from: Top of casing

Ground level: Other

Static Level: Depth to water: 30 ft
Danes:

Quality (new: cloudy, taste, odor): Clear

* (Attach a copy of the pumping test record, per section 1521.06, O.R.C.)

PUMP

Type of pump: Capacity: 135 gpm

Pump set at: 135 ft
Pump installed by:

WELL LOCATION

Location of well in State Plane coordinates, if available:

Elevation of well: ft

Datum plane: NAD27

Source of coordinates: GPS

Sketch a map showing distance well is from numbered state highways, street intersections, county roads, buildings or other notable landmarks:

Addition: space is needed to complete well log, use next consecutively numbered form.

C.H. HAMILTON WELLL DRILLING

9449 Milton Carlisle Rd.
New Carlisle, OH 45344

Signed: Shirley Hamilton

Date: 3-21-95

ODR Registration Number: 32

Completion of this form is required by section 1521.06, Ohio Revised Code - file within 30 days after completion of drilling.

ORIGINAL COPY TO: ODRR - DIVISION OF WATER, 1939 FOUNTAIN SQUARE DRIVE, COLUMBUS, OH 43224
**WELL LOG AND DRILLING REPORT**

**County:** Clark  
**TOWNSHIP:** Mad River

**Owner:** Sizemore & Sons  
**PROPERTY ADDRESS:** 4532 Echo Hills Ave., OH

**LOCATION OF PROPERTY:**

**CONSTRUCTION DETAILS**

| Casing | Diameter in. | Length ft. | Wall Thickness in. | Material | Volume used
|--------|--------------|------------|--------------------|----------|-------------
| Steel  | 3 1/8        | 180        | 2 1/2              | BENTONITE| 100         |

**GROUT**

- **Type:** TRENTE PIPE
- **Method of installation:**
- **Depth:** placed from 40 ft. to 0 ft.

**Gravel Pack (Filter Pack)**

- **Material:**
- **Volume used:**

**SCREEN**

- **Type:** (wire wrapped, louvered, etc.)
- **Material:**
- **Length:** ft.
- **Type:**
- **Wall Thickness:** in.

**Use of Well**

- **Type:** DOMESTIC
- **Use:**
- **Pitless Device:**
- **System:**
- **Date of Completion:** 05/14/85

**WELL LOG**

<table>
<thead>
<tr>
<th>Depth (ft.)</th>
<th>From</th>
<th>To</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brown Clay</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>Gravel &amp; Sand</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>Gray Clay</td>
<td>12</td>
<td>13</td>
</tr>
<tr>
<td>Limestone</td>
<td>19</td>
<td>87</td>
</tr>
<tr>
<td>Shale</td>
<td>87</td>
<td>117</td>
</tr>
<tr>
<td>Limestone</td>
<td>117</td>
<td>140</td>
</tr>
</tbody>
</table>

**WELL TEST**

- **Bailing:**
- **Pumping:**
- **Other:**

- **Test rate:** 15 gpm  
  **Duration of test:** 1 hr
  **Drawdown:** 140
  **Measured from:**
  **Top of casing:**
  **Ground level:**
  **Other:**

- **Static Level:**
  **Depth to water:** 120 ft.
  **Date:** 06/14/85
  **Quality (clear, cloudy, taste, odor):**
  **Clear:**

**PUMP**

- **Type of pump:**
- **Capacity:**
  **gpm:**
- **Pump set at:**
- **Pump installed by:**

**WELL LOCATION**

- **Location of well in State Plane coordinates:**
- **Elevation of well:**
  **ft.:**
  **Datum plane:**
  **NA27:**
  **NAD83:**

- **Source of coordinates:**
  **GPS:**
  **Survey:**
  **Other:**

**Map Sketch:**

**Signature:**

**Completion:**

- **Date:** 05/14/85

**Registration:**

- **City, State:** Springfield, OH 45502
- **ODH Registration Number:** 264
- **Completion:** within 90 days after completion of drilling

**Blue:**  
**Green:**  
**Local Health Dept.**  
**Permit:**  
**Division of Water, 1939 Fountain Square, Columbus, Ohio 43224**

**Page 1 of 1**
WELL LOG AND DRILLING REPORT
Ohio Department of Natural Resources, Division of Water
1939 Fountain Square Drive, Columbus, Ohio 43224 Phone (614) 265-8739
Permit Number: 3529

COUNTY: Clark TOWNSHIP: Mad River SECTION/LOT No.: 43

OWNER/CONTRACTOR: Cooper Homes Inc. PROPERTY ADDRESS: 4496 Echo Hills Dr.

LOCATION OF PROPERTY: Echo Hills Plat.

CONSTRUCTION DETAILS
CASING
- Diameter: 5 in. Wall Thickness:
- In: Length 50 ft. Wall Thickness:
- Type: □ Steel □ Galv. □ PVC □ Other
- Joints: □ Threaded □ Welded □ Solvent □ Other
- Liner: Length Type Wall Thickness

GROUT
- In: Material: Bentonite Volume used: 65 gals.
- Method of Installation: Tremie Pressure
- Depth: placed from: 50 ft. to surface:

GRAVEL PACK (FILTER PACK)
- Material: Volume used:
- Method of Installation:
- Depth: placed from:

SCREEN
- Type (wire wrapped, louvered, etc.): Material
- Length Diameter
- Depth between ft. and Slot ft.

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
    - Clay: 0 13
    - Limestone: 13 140

WELL TEST
- □ Bailing □ Pumping* □ Other
  - Test rate: gpm Duration of test: 2 hrs.
  - Drawdown: Measured from: □ top of casing □ ground level □ Other
  - Static Level (depth to water): 90 ft. Date: 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: 130 ft.
- Pump installed by:

SKETCH SHOWING WELL LOCATION
- Show distances well lies from numbered state highways, street intersections, county roads, etc.

RECEIVED
JUL 3 1993
CLARK COUNTY HEALTH DEPT.
SPRINGFIELD, OHIO

C.P. HAMILTON WELL DRILLING
9449 Milton Carlisle Rd.
New Carlisle, Ohio 45344

State, Zip.

Compilations of this form are required by section 1521.08, 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

[Signature]
Date: 6-24-93

CDH Registration Number 32
**WELL LOG AND DRILLING REPORT**

**WELL LOCATION**
- **County:** Clark
- **Township:** Mad River
- **Owner/Operator:** Calvin Watts
- **Address of Well Location:** 4017 #45 Jeremy Dr.

**CONSTRUCTION DETAILS**
- **Borehole/Casing:**
  - **Borehole Diameter:** 6 in.
  - **Casing Diameter:** 6 in.
  - **Casing Height Above Ground:** 48 ft.

**SCREEN**
- **Diameter:** 6 in.
- **Slot Size:** 1.5 in.
- **Screen Length:** 36 ft.

**GROUT**
- **Material:** Bentonite
- **Volume/Weight Used:** 24,488 lb.

**DRILLING LOG**
- **INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED:**
  - **From:** 0 ft.
  - **To:** 10 ft.
  - **Clay**
  - **Limestone**
  - **From:** 10 ft.
  - **To:** 110 ft.

**WELL TEST**
- **Pre-Pumping Static Level:** 50 ft.
- **Test Rate:** 10 gpm
- **Feet of Drawdown:** 5 ft.
- **Sustainable Yield:** 1,200 gpm

**PUMP/PITNESS**
- **Type of pump:** 1 HP
- **Capacity:** 10 gpm

**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**

**Date stamps and numbers:**
- **872594**
- **303**
- **57602.96**
- **8-24-95**
- **8-24-95**
- **10-10**
- **303**
- **032**
WELL LOG AND DRILLING REPORT
Ohio Department of Natural Resources
Division of Water, 1939 Fountain Square Drive
Columbus, Ohio 43224-9971 Voice (614) 265-6739 Fax (614) 447-9603

WELL LOCATION

- County: Clark
- Township: Mad River
- Owner(s): Calvin Watts
- Address of Well Location: 1049 Jeremy Dr.
- City: 
- Permit No.: 49
- Location of Well in State Plane coordinates, if available: N X ft. or m, S Y ft. or m
- Datum Plane: NAD27
- Elevation of Well: ft. or m
- Source of Coordinates: GPS

BOREHOLE/CASING
- Borehole Diameter: inches
- Casing Diameter in. Length ft.
- Casing Diameter in. Length ft.
- Casing Height Above Ground ft.
- Type: 1 Steel, 2 Galv., 3 PVC, 4 Other
- Joints: 1 Threaded, 2 Welded, 3 Other

SCREEN
- Diameter: 
- Slot Size: 
- Screen Length: ft.
- Type: 
- Material: 
- Set Between ft. and ft.

GRAVEL PACK
- Method of Installation: 
- Depth: Placed FROM ft. TO ft.
- Material: Bentonite
- Volume/Weight Used: 36.9 gal

GROUT
- Method of Installation: 
- Depth: Placed FROM ft. TO ft.

DRILLING LOG
- Indicate depth(s) at which water is encountered:
  - Sandstone, shale, limestone, gravel, clay, sand, etc.
  - From: 
  - To: 

PUMPS/PITNESS
- Type of Pump: 
- Capacity: gpm
- Pump installed by: 
- Date: 8-31-98

WELL TEST
- Pre-Pumping Static Level ft.
- Measured from: 
- Top of Casing
- Ground Level
- Other
- Air
- Bailing
- Pumping
- Other
- Test Rate 
- Duration of Test hr.
- Feet of Drawdown ft.
- Sustainable Yield gpm

EDITORIAL NOTE: (Attach a copy of the pumping test record, per section 1521.05, ORC)

QUALITY
- Is Copy Attached? Yes
- Flowing Well? Yes
- Quality: 

SIGNATURE
- Printed Name: Shirley Hamilton
- Signature: 
- Date: 8-31-98
- Date of Well Completion: 8-31-98
- Total Depth of Well: 110 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
WELL LOG AND DRILLING REPORT

Ohio Department of Natural Resources
Division of Water, 1939 Fountain Square Drive
Columbus, Ohio 43224-9971 Voice (614) 266-6739 Fax (614) 447-9503

WELL LOCATION

County: Clark
Township: Mad River
Gross: Calvin Watts
Lot: 480
Jersey Dr.

City: Zip Code: 44

Location of Well: NAD27
Datum Plane: NAVD88
Elevation Source: Other
Source of Coordinates: GPS
Survey: Other

Use of Well: Residential

CONSTRUCTION DETAILS

BOREHOLE/CASING:

1. Borehole Diameter: Inches
   Depth: ft

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

Casing Diameter: 2 in. Length: 30 ft.
Thickness: in.

Casing Height Above Ground:

Type:
- Steel
- Galv.
- PVC
- Other

Joints:
- Threaded
- Welded
- Solvent
- Other

SCREEN:

Diameter:
Slot Size:
Screen Length:

Type:
Material:
Set Between:
ft. and:

GRavel PACK:

Type:
Material:
Volume/Weight Used:

Method of Installation:
Depth: Placed FROM:
TO:

GROUT:

Material:
Volume/Weight Used:

Method of Installation:
Depth: Placed FROM:
TO:

DRILLING LOG:

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED:
Type of pump:
Capacity:
gpm

PUMP/PITLESS:

Type of pump:
Capacity:
gpm

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

C.E. HAMILTON WELL DRILLING
9449 Milton-Carlisle Road
New Carlisle, Ohio 45344
Phone (937) 845-0425

Date: 3-15-99

SHARLEY HAMILTON

Date: 3-15-99

OH Registration Number: 0032

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
## WELL LOG AND DRILLING REPORT

**Well Location**

- **County**: Clark
- **Township**: Mad River
- **Owner**: Shugart Closes Co.
- **Address of Well Location**: 4437 Oakwood Rd.
- ** Permit No**: SP 69
- **Zip Code**: 45344
- **Location of well in State Plane coordinates, if available**:
  - N 118,925
  - E 85,299
- **Elevation of Well**: 4 ft
- **Datum Plane**: NAVD 88
- **Source of Coordinate**: GPS

**Construction Details**

- **Borehole/Casing**:
  - Borehole Diameter: 4.5 in
  - Casing Diameter: 3.5 in
  - Casing Height Above Ground: 16 ft
- **Material/Size**:
  - Volume/Weight Used: 120

**Drilling Log**

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Clay</td>
</tr>
<tr>
<td>3.61</td>
<td>Limestone</td>
</tr>
<tr>
<td>68.72</td>
<td>Shale</td>
</tr>
<tr>
<td>155.18</td>
<td>Sandstone</td>
</tr>
</tbody>
</table>

**RECEIVED MAY 9, 2002**
## WELL LOG AND DRILLING REPORT

**County:** Clark  
**Township:** Mud River  
**Owner:** Calvin Walls  
**Address:** 449 E Maldon Dr

### WELL LOCATION

- **City:** Zip Code: +
- **Permit No.:** SodcoDr No:  
- **Location of Well in State Plane coordinates, if available:**  
- **Datum Plane:** NAD83  
- **Source of Coordinates:** GPS  
- **Elevation of Well:**  
- **GEOLOGY:**  

### CONSTRUCTION DETAILS

- **Boresite:**  
- **Well Name:** Residential  
- **BOREHOLE/CASING:**  
- **Casing Diameter:**  
- **Casing Length:**  
- **Casing Thickness:**  
- **Casing Height Above Ground:**  
- **Type:**  
- **Screen Diameter:**  
- **Screen Length:**  
- **Type:**  
- **Gravel Pack:**  

### WELL TEST

- **Static or Pumping Static Level:** 100 ft  
- **Gpm:**  
- **Duration of Test:**  
- **Sustainable Yield:** gpm  
- **Flowing Well?** Yes  
- **PUMP/IT/LESS:**  

### 0.65% ACID FOR WELL DRILLING

- **Address:** 9440 Maltby Road  
- **New Carlisle, OH 45344**

### GEOLOGY

- **Clay:**  
- **Limestone:**  

**Completion of this form is required by section 1521.08, 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**
WELL LOG AND DRILLING REPORT
Ohio Department of Natural Resources,
Division of Water, 1939 Fountain Square Drive,
Columbus, OH 43224-9971 • Voice (614) 265-6739 Fax (614) 447-9503

WELL LOCATION

County: Clark
Township: Morristown
Range: 21
WELL LOCATION:

340 Oakwood

BORING/LOCATING

Diameter: 7 1/2 inches
Depth: 275 ft.

Casing Diameter: 5 in. Length:
11 in. Thickness:

SCREEN


GRAVEL PACK (Filter Pack)

Material: Sand
Volume/Weight Used: 15 cu ft.

GROUT

Material: Bentonite
Volume/Weight Used: 15 cu ft.

INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED:

0 to 10 ft. D.D. (Dry Drilling) Limestone
10 to 20 ft. D.D. Sandstone
20 to 100 ft. D.D. Limestone
100 to 140 ft. D.D. Limestone

PUMP/FILTERLESS

Capacity: 20 gpm

DATE:

11/1/99

WELL TEST:

Flow Rate: 20 gpm
Duration of Test: 3 hrs.
Sustained Yield: 50 gallons per minute

Pump Type: Cleaver
Pump Size: 3/4 horse power

Completion of this form is required by section 1531.05, Ohio Revised Code - file within 90 days after completion of drilling.

ODNR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224-9971

122
WELL LOG AND DRILLING REPORT

Ohio Department of Natural Resources
Division of Water, 1939 Fountain Square Drive
Columbus, Ohio 43224-9971. Voic (614) 265-6739 Fax (614) 447

WELL LOCATION

County: Clark
Township: Mud River
Owner/Builder: Calvin Watts
Address of Well Location: 4397 Oakwood Dr.
City: Ebon
State Code: 44
Zip Code: 45323

CONSTRUCTION DETAILS

□ Rotary □ Cable □ Augered □ Driven □ Other

□ Borehole Diameter 7 1/2 inches Depth 26.5 ft.
□ Casing Diameter 7 1/2 in. Length 26.5 ft. Thickness 1 1/8 in.
□ Borehole Diameter 7 1/4 inches Depth 26.5 ft.
□ Casing Diameter 7 1/4 in. Length 26.5 ft. Thickness 1 1/8 in.

Casing Height Above Ground: 11 ft.
Type: 1 □ Steel 1 □ Other
□ PVC 1 □ Other
2 □ Galv 2 □ Other
□ Other
□ Threading 2 □ Welded 2 □ heather 2 □ Other
□ Other

SCREEN

□ Diameter 2 ft. □ Slot Size: 2 in. □ Screen Length 2 ft.
Type: 1 □ Material 1 □ Other
□ Other
□ Sat Between 2 ft. and 1 ft.

GRANITE PACK

Material Size: 1 □ Volume/Weight Used 1 □ Other
□ Other
Method of Installation: □ Other
□ Other
Depth: Placed FROM 2 ft. TO 2 ft.

GRAIN

Material: Boulter 1 □ Volume/Weight Used 39.62 gals.
□ Other
Method of Installation: Other
□ Other
Depth: Placed FROM 2 ft. TO Surface 2 ft.

DRILLING LOG

INDICATE DEPT(1) AT WHICH WATER IS ENCOUNTERED.
Show color, texture, hardness, and formation: sandstone, shale, limestone, granite, clay, sand, etc.
From □ To □
□ Clay
□ Lime
□ 0 
□ 8
□ 8 
□ 102

PUMP/PITLESS

on efficiency: Capacity gpm
on set at 2 ft. Pitless Type
mp installed by
I hereby certify the information given is accurate and correct to the best of my knowledge:
Firm: C.E. Hamilton
Address 9449 Hilton Carliste Rd
y, State, Zip: New Carlisle, OH 45344
nd: Shirley Hamilton Date: 5/30/01
H Registration Number: 0032

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

ORIGIQ RL CO. TO - ODNH, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224-9971

## WELL LOG AND DRILLING REPORT

**County:** Clark  
**Township:** Mad River

**Pumped From:** 124

**WELL LOCATION**

<table>
<thead>
<tr>
<th>Location of Well</th>
<th>Use of Well</th>
</tr>
</thead>
<tbody>
<tr>
<td>State Plane North</td>
<td>Residential</td>
</tr>
<tr>
<td>State Plane East</td>
<td></td>
</tr>
</tbody>
</table>

**CONSTRUCTION DETAILS**

**BOREHOLE/CASING**

<table>
<thead>
<tr>
<th>Diameter</th>
<th>Length</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>inches</td>
<td>ft.</td>
<td>in.</td>
</tr>
<tr>
<td>inches</td>
<td>ft.</td>
<td>in.</td>
</tr>
</tbody>
</table>

**Casing Height Above Ground**

<table>
<thead>
<tr>
<th>Diameter</th>
<th>Length</th>
<th>Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>inches</td>
<td>ft.</td>
<td>in.</td>
</tr>
</tbody>
</table>

**SCREEN**

<table>
<thead>
<tr>
<th>Diameter</th>
<th>Slot Size</th>
<th>Screen Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>ft.</td>
<td>ft.</td>
<td>ft.</td>
</tr>
</tbody>
</table>

**GRAVEL PACK**

<table>
<thead>
<tr>
<th>Material/Size</th>
<th>Volume/Weight Used</th>
</tr>
</thead>
</table>

**Drilling Log**

<table>
<thead>
<tr>
<th>Depth Placed FROM</th>
<th>TO</th>
</tr>
</thead>
<tbody>
<tr>
<td>ft.</td>
<td>ft.</td>
</tr>
</tbody>
</table>

**PRE-PUMPING STATIC LEVEL**

<table>
<thead>
<tr>
<th>Date</th>
<th>Measured from</th>
<th>Test Rate</th>
<th>Duration of Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>45</td>
<td>Top of casing</td>
<td>90 gpm</td>
<td>1 hrs.</td>
</tr>
</tbody>
</table>

**WELL TEST**

<table>
<thead>
<tr>
<th>Date</th>
<th>Measured from</th>
<th>Test Rate</th>
<th>Duration of Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>45</td>
<td>Top of casing</td>
<td>90 gpm</td>
<td>1 hrs.</td>
</tr>
</tbody>
</table>

**PUMPING TEST**

<table>
<thead>
<tr>
<th>Type of pump</th>
<th>Capacity</th>
<th>gpm</th>
</tr>
</thead>
<tbody>
<tr>
<td>60 ft.</td>
<td>Pitted Type</td>
<td></td>
</tr>
</tbody>
</table>

## Geochemical Analysis

- **Clay:** 0 ft. 10 ft.
- **Limestone:** 10 ft. 100 ft.

**Signature:** Shirley Hamilton  
**Date:** 11-32-99

**Completion:**

- Date of Well Completion: 11-32-99
- Total Depth of Well: 100 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, 1999 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224-9971**

---

124
### WELL LOG AND DRILLING REPORT

**Ohio Department of Natural Resources**
Division of Water, 1939 Fountain Square Drive
Columbus, Ohio 43224 Phone (614) 265-6767

**COUNTY**
Clark

**TOWNSHIP**
Mad River

**SECTIONLOT No.**

**OWNER/BUILDER**
Calvin Watts

**PROPERTY ADDRESS**

**LOCATION OF PROPERTY**
Echo Hills Subdivision
Lot 47 Howell

**CONSTRUCTION DETAILS**

<table>
<thead>
<tr>
<th>Casing</th>
<th>Diameter</th>
<th>Length</th>
<th>Wall Thickness</th>
<th>Material</th>
<th>Volume used</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6 in.</td>
<td>28 ft.</td>
<td></td>
<td>Steel</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>4 in.</td>
<td></td>
<td></td>
<td>Galv.</td>
<td></td>
</tr>
</tbody>
</table>

**COAT** |
Bentonite |
Volume used | 36 gals.

**Method of installation** |
Tremie pipe

**Depth placed from** |
28 ft. to surface

**GRAVEL PACK (Filter Pack)**

<table>
<thead>
<tr>
<th>Material</th>
<th>Volume used</th>
</tr>
</thead>
</table>

**Use of Well** |
Residential

**Pitless Device** |
Adapts

**Date of Completion**

### WELL LOG

**Indicate depth(s) at which water is encountered:**

- Clay: 0 - 8 ft.
- Clay & Gravel: 8 - 15 ft.
- Limestone: 15 - 110 ft.

**Show color, texture, hardness, and formation:**

- Sandstone, shale, limestone, gravel, clay, sand, etc.

**WELL TEST**

<table>
<thead>
<tr>
<th>Test</th>
<th>Rate</th>
<th>Duration of test</th>
<th>Drawdown</th>
<th>Measured from</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bailing</td>
<td>12 gpm</td>
<td>2 hrs.</td>
<td>10 ft.</td>
<td>Top of casing</td>
</tr>
</tbody>
</table>

**Static Level (depth to water):** 40 ft. Date: 11/21/05, ORC

**Quality (clear, cloudy, taste, odor):** Clear

**PUMP**

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Type of pump</th>
<th>Pump set at</th>
</tr>
</thead>
<tbody>
<tr>
<td>80 gpm</td>
<td></td>
<td>80 ft.</td>
</tr>
</tbody>
</table>

**WELL LOCATION**

**Location of well in State Plane coordinates, if available:**

- Zone:  15
- Datum: NAD83

**Source of coordinates:** GPS

**Sketch a map showing distance well lies from numbered state highways, street intersections, county roads, buildings or other notable landmarks.**
WELL LOG AND DRILLING REPORT
Ohio Department of Natural Resources, Division of Water
1939 Fountain Square Drive, Columbus, Ohio 43224 Phone (614) 295-6738
Permit Number

COUNTY: Clark
TOWNSHIP: Mad River
SECTION/LOT: 10
PROPERTY ADDRESS: Lot # 45 Hollywood Dr.

OWNER/CONTRACTOR: Calvin Watts
LOCATION OF PROPERTY: Echo Hills Platt

CONSTRUCTION DETAILS:

- CASING:
  - Diameter: 5 in
  - Length: 33 ft
  - Wall Thickness: 5 in
- GROUT:
  - Material: Bentonite
  - Volume used: 43 gals
  - Method of Installation: Trench pressure
  - Depth placed from: 33 ft to surface
- GRAVEL PACK (Filter Pack):
  - Material: Bentonite
  - Volume used:
  - Method of Installation:
  - Depth placed from:
- SCREEN:
  - Type (wire wrapped, louvered, etc.):
  - Length: 42 in
  - Diameter: 3 in
  - Steel
  - Liner: 2 in
  - Type: PVC
  - Wall Thickness:

WELL LOG:

INDICATE DEPTHS AT WHICH WATER IS ENCOUNTERED.

- Sandstone, silt, shale, limestone, gravel, clay, sand, etc.
- From: 0 feet
- To: 5 feet
  - Clay
  - 0 feet
  - 5 feet
  - Gravel
  - 5 feet
  - 13 feet
  - Clay
  - 13 feet
  - 25 feet
  - Limestone
  - 25 feet
  - 170 feet

WELL TEST:

- Test rate: 12 gpm
- Duration of test: 1 hour
- Drilled: 10 feet
- Measured from:
  - Top of casing
  - Ground level
  - Other
  - Static level (depth to water): 90 feet
  - Date:
  - Quality:
    - Clear
    - Cloudy
    - Taste
    - Odor

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

PUMP:

- Type of pump:
- Capacity: gpm
- Pump set at: 132 feet
- Pump installed by:

SKETCH SHOWING WELL LOCATION:

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

C.E. HAMILTON WELL DRILLING

9449 Milton Carlisle Rd.
New Carlisle, OH 45344

Signed: Shirley Hamilton
Date: 8/24/94

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

5255

ORIGINAL COPY TO: ODR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224

(Blue - Customer's copy Pink - Order's copy Green - Local Health Dept copy)
WELL LOG

<table>
<thead>
<tr>
<th>Depth</th>
<th>Material</th>
<th>Wall Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>49.9 ft</td>
<td>Material</td>
<td>Wall Thickness</td>
</tr>
</tbody>
</table>

GROUT

<table>
<thead>
<tr>
<th>Material</th>
<th>Volume Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>49.9 ft</td>
<td>100#</td>
</tr>
</tbody>
</table>

CONSTRUCTION DETAILS

<table>
<thead>
<tr>
<th>CASING</th>
<th>Diameter</th>
<th>Length</th>
<th>Wall Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 in</td>
<td>29 ft</td>
<td>3 in</td>
<td>12 in</td>
</tr>
</tbody>
</table>

SCREEN

<table>
<thead>
<tr>
<th>Type</th>
<th>Length</th>
<th>Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wire Screen</td>
<td>7 ft</td>
<td>4 in</td>
</tr>
</tbody>
</table>

WELL TEST

<table>
<thead>
<tr>
<th>Depth</th>
<th>Test Rate</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 ft</td>
<td>15 gpm</td>
<td>1 hour</td>
</tr>
</tbody>
</table>

PUMP

<table>
<thead>
<tr>
<th>Type of Pump</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 ft</td>
<td>15 gpm</td>
</tr>
</tbody>
</table>

SKETCH SHOWING WELL LOCATION

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

MAY 17 1994

CLARKE COUNTY HEALTH DEPT.
GREENFIELD WATER DEPT.
WELL LOG AND DRILLING REPORT

Ohio Department of Natural Resources, Division of Water
1939 Fountain Square Drive, Columbus, Ohio 43224 Phone (614) 265-7639

Permit Number 3384

COUNTY Clark
TOWNSHIP Mad River
SECTION/LOT No: 10
OWNER/CONTRACTOR Gudorf Bros Const
PROPERTY ADDRESS 4531 Bolin Dr

LOCATION OF PROPERTY Echo Hills

CONSTRUCTION DETAILS

CASING

GROUT
Material: Bentonite Volume used: 65 gal.

Method of installation: Terrene Pressure

Depth placed from: 50 ft. to Surface ft.

GRAVEL PACK (Filter Pack)
Material: Volume used:

Method of Installation:

Depth placed from: ft. to ft.

SCREEN
Type: (wire wrapped, louvered, etc.) Material:

WELL LOG*  

WELL TEST

CLAY

From To
0 5

Sand
3 8

Gravel
8 23

Limestone
23 135

Shale
135 150

[Diagram of well location]

Additional space is needed to complete well log; use next consecutively numbered form.

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

SIGNATURE

Original Copy to: ODNR, Division of Water, 1939 Fountain Sq. Drive, Cols., Ohio 43224

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

129
WELL LOG AND DRILLING REPORT
Ohio Department of Natural Resources, Division of Water
1939 Fountain Square Drive, Columbus, Ohio 43224 Phone (614) 265-6739

Permit Number

COUNTY  Clark  TOWNSHIP  Mad River  SECTION NO. 35
OWNER/CONTRACTOR  Bair Construction  PROPERTY ADDRESS  Lot # 35 Bolin Dr.
LOCATION OF PROPERTY  Echo Hills Plat

CONSTRUCTION DETAILS

Casing
1. Diameter  5  in.  Length  50  ft.  Wall Thickness  in.
2. Diameter  5  in.  Length  50  ft.  Wall Thickness  in.

Type:  
1. Steel  1/2
2. Galv.  1/2
3. Pvc  3/8
4. Other  3/8

Liner:  
1. Length  5  ft.  Type  2  in.  Wall Thickness  in.

GROUT
Material  Bentonite  Volume used  65 gals.
Method of installation  Trench pressure
Depth: placed from  50  ft.  to  surface

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

Pitless Device  
Use of Well  Residential
Date of Completion  6-9-93

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
Clay  0  15
Clay & Gravel  15  21
Limestone  21  125
Shale  125  140

WELL TEST

Test rate  10  gpm  Duration of test  2  hrs
Drawdown  2  ft.
Measured from:  top of casing  90  ft.  Date:  Ground level
Static Level (depth to water)  90  ft.  Date:  clear
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  125  ft.
Pump installed by

SKETCH SHOWING WELL LOCATION
Show distances well lies from numbered state highways, street intersections, county roads, etc.

N

Echo Hills Dr.

W

Hagen Rd.

Bolin Dr.

E

S

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

Drilling Firm  C. E. HAMILTON WELL DRILLING
Address  9449 Milton Carlisle Rd.
City, State, Zip  New Carlisle, Ohio 45344

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

Signed  Shirley Hamilton
Date  6-9-93
ODH Registration Number  32

Completion of this form is required by section 1521.05, Ohio Revised Code - file within 30 days after completion of drilling.
WELL LOG AND DRILLING REPORT
Ohio Department of Natural Resources
Division of Water, 1939 Fountain Square Drive
Columbus, Ohio 43224 Phone (614) 265-6500 Permit Number

COUNTY: Clark  TOWNSHIP: Mad River  ID No.: 1D362  SECTION/LOT No.: 2
OWNER/BUILDER: Harry Madden  PROPERTY ADDRESS: 4566 Bolin Dr.

LOCATION OF PROPERTY:

CONSTRUCTION DETAILS:

GROUT: Material: Bentonite  Volume used: 40 fl. oz.

Method of installation: Tremie pressure

Depth: placed from: 40 ft. to surface ft.

Gravel Pack (Filter Pack):

Material: Volume used:

Method of installation:

Depth: placed from: ft. to ft.

Screen:

Type (wire wrapped, louvered, etc.): Material: Residential

Length: Diameter: in.

Set between ft. and ft. Slot:

WELL LOG:
INDICATE DEPTH(S) AT WHICH WATER IS ENCOUNTERED:

<table>
<thead>
<tr>
<th>Sandstone, shale, limestone, gravel, clay, sand, etc.</th>
<th>From</th>
<th>To</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>Sand &amp; Gravel</td>
<td>8</td>
<td>17</td>
</tr>
<tr>
<td>Clay</td>
<td>17</td>
<td>36</td>
</tr>
<tr>
<td>Limestone</td>
<td>36</td>
<td>140</td>
</tr>
</tbody>
</table>

WELL TEST:

| Bailing| 11     | 2 hrs.
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Test rate gpm</td>
<td>Duration of test h</td>
<td>Drawdown ft.</td>
</tr>
<tr>
<td>Pumping*</td>
<td>Other</td>
<td>Other</td>
</tr>
</tbody>
</table>

Measured from:

Top of casing: ft.

Static level (depth to water): 90 ft.

Quality (clear, cloudy, taste, color): clear

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

PUMP:

Type of pump: gpm

Capacity: Pump set at ft.

Pump installed:

WELL LOCATION:

Location of well in State Plane coordinates, if available:

Zone: Datum: NAD27  NAD83

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:

North

South

W

E

Echo Hills Dr.

Bolin Dr.

Xwell

Welling Rd.

C.E. HAMILTON WELL DRILLING
9449 Milton Carlisle Rd.

Signed:

Shirley Hamilton

Date: 6-21-95

ODH Registration Number: 5255

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

Date: 6-21-95

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

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

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## WELL LOG AND DRILLING REPORT

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

**Permit Number:** 3596

**COUNTY:** CLARK  
**TOWNSHIP:** MAD RIVER  
**SECTION/LOT No.:** Lot #33

**OWNER/BUILDER:** Burgaway Builders  
**PROPERTY ADDRESS:** 4563 Berlin Ave.

**LOCATION OF PROPERTY**

### CONSTRUCTION DETAILS

<table>
<thead>
<tr>
<th>CASING</th>
<th>Diameter</th>
<th>in.</th>
<th>Length</th>
<th>ft.</th>
<th>Wall Thickness</th>
<th>in.</th>
<th>Type</th>
<th>Other</th>
<th>Joints</th>
<th>Length</th>
<th>Pittess Device</th>
<th>Use of Well</th>
<th>Date of Completion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Diameter</td>
<td>5</td>
<td>35</td>
<td>5 0.21 in.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8-24-93</td>
</tr>
<tr>
<td>2 Diameter</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### GROUT

- **Material:** Bentonite
- **Volume used:** 100#
- **Method of installation:** Pumped
- **Depth:** placed from 35 ft. to 10 ft.

### GRAVEL PACK

- **Material:** Other
- **Volume used:** ~

### SCREEN

- **Type (wire wrapped, louvered, etc.):** Material
- **Length:** ~
- **Diameter:** ~
- **Slot:** ~

### WELL LOG

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

<table>
<thead>
<tr>
<th>From</th>
<th>To</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brown Clay</td>
<td>0 7</td>
</tr>
<tr>
<td>Clay Sand</td>
<td>7 15</td>
</tr>
<tr>
<td>Brown Clay</td>
<td>15 25</td>
</tr>
<tr>
<td>Limestone</td>
<td>25 65</td>
</tr>
<tr>
<td>Shale</td>
<td>65 73</td>
</tr>
<tr>
<td>Limestone</td>
<td>73 105</td>
</tr>
<tr>
<td>Shale</td>
<td>105 110</td>
</tr>
<tr>
<td>Limestone</td>
<td>110 129</td>
</tr>
</tbody>
</table>

### WELL TEST

**Test rate:** 15 gpm  
**Duration of test:** 2 hrs.

**Drawdown Bottom:**

**Measured from:** top of casing

**Static Level (depth to water):** 100 ft.  
**Date:** 8-23-93

**Quality (clear, cloudy, taste, odor):** CLEAR

### PUMP

- **Type of pump:** Other
- **Capacity:**  
- **Pump set at:** ~
- **Pump installed by:**

### SKETCH SHOWING WELL LOCATION

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

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

**ORIGINAL COPY TO: ODR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224**

---

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

**Drilling Firm:** CRABTREE Well & Pump  
**Address:** 3852 Sugar Corners  
**City, State, Zip:** S P E 1 0 0 1 4 5 0 0

**Signed:**  
**Date:** 8-24-93

**OCH Registration Number:** 369

**Mark Log**

---

**ORIGINAL COPY TO: ODR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224**

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

---

**NOTE:** I hereby certify the information given is accurate and correct to the best of my knowledge.
WELL LOG AND DRILLING REPORT
Ohio Department of Natural Resources, Division of Water
1939 Fountain Square Drive, Columbus, Ohio 43224 Phone (614) 265-6739

Permit Number

COUNTY

TOWNSHIP

SECTION LOT NO.

OWNER/-builder

PROPERTY ADDRESS

LOCATION OF PROPERTY

CONSTRUCTION DETAILS

CASING

Borehole Diameter

in.

1

2

Diameter

in.

Length

ft.

Wall Thickness

in.

Material

Bentonite

Volume used

74 gals.

Method of installation

Tremie pressure

Depth placed from

ft. to

ft.

Type

Steel

1

Galv.

2

PVC

2

Other

1

Joints

Threaded

1

Welded

2

Solvent

1

Other

2

Liner

Length

ft.

Type

Wall Thickness

in.

Material

Volume used

Use of Well

Residential

Use of Well Device

Adapter

Preassembled unit

Screen

Type (wire, wrapped, louvered, etc.)

Material

GROUT

Length

ft.

Diameter

in.

Set between

ft.

and

ft.

Socket

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

Clay

0

14

Sand & Gravel

14

21

Limestone

21

130

WELL TEST

Bailing

9

gpm

Other

Test rate

Duration of test

1

hrs.

Drawdown

2

ft.

Measured from:

top of casing

Ground level

Other

Static Level (depth to water)

90

ft.

Date:

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.

Drilling Firm

C. E. HAMILTON WELL DRILLING

Address

9449 Milton Carlisle Rd.

City, State, Zip

New Carlisle, Ohio 45344

ODH Registration Number

32

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

Signed

Sharon Hamilton

Date

6-3-93

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

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

134
WELL LOG AND DRILLING REPORT

State of Ohio
DEPARTMENT OF NATURAL RESOURCES
Division of Water
1939 Fountain Square Drive
Columbus, Ohio 43224

COUNTY
TOWNSHIP
SECTION OF TOWNSHIP
OWNER
PROPERTY ADDRESS
LOCATION OF PROPERTY

CONSTRUCTION DETAILS

Casing
Diameter in
Length of Casing ft
Type: \( \square \) Steel \( \square \) Galv \( \square \) PVC \( \square \) Other
Finish: \( \square \) Threaded \( \square \) Welded \( \square \) Solvent \( \square \) Other
SCREEN
Texture (wire wrapped, louvered, etc)
Material
Length ft
Diameter in
Slot ft

ROUT
Material: Bentonite
Volume used: \( 35 \text{ gal} \)
Method of Installation: Trench Pressure
Depth placed from: \( 27 \) ft
To: \( \) ft

WELL LOG*

Show color, texture, hardness, and formation:
sandstone, shale, limestone, gravel, clay, sand:

<table>
<thead>
<tr>
<th>From</th>
<th>To</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 ft</td>
<td>5 ft</td>
</tr>
<tr>
<td>Clay</td>
<td>5 ft</td>
</tr>
<tr>
<td>Gravel</td>
<td>14 ft</td>
</tr>
<tr>
<td>Clay</td>
<td>18 ft</td>
</tr>
<tr>
<td>Limestone</td>
<td>130 ft</td>
</tr>
<tr>
<td>Shale</td>
<td>140 ft</td>
</tr>
</tbody>
</table>

SKETCH SHOWING LOCATION

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

Echo Hills Rd.

Signed
Charles E. Hamilton

Address
9440 Milton Carroll Rd.
New Carrollton, Ohio 43144

Date
12-20-88

ODH REGISTRATION NUMBER
22

Completion of this form is required by 1521.05, Ohio Revised Code, file within 30 days after completion of drilling.
**WELL LOG AND DRILLING REPORT**

**WELL LOG**

<table>
<thead>
<tr>
<th>Casing</th>
<th>In. Diameter</th>
<th>In. Length</th>
<th>Wall Thickness</th>
<th>Ft.</th>
<th>Wall Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel</td>
<td>5</td>
<td>28</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Galv.</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PVC</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**GROUT**

- Material: Bentonite
- Volume used: 37 gals.
- Method of installation: Tremie pipe
- Depth: placed from 28 ft. to surface

**SCREEN**

- Type: Wire wrapped, louvered, etc.
- Material: Not specified
- Length: 115 ft.
- Diameter: Not specified

**WELL TEST**

- Bailing type: Pumping
- Test rate: 15 gpm
- Duration of test: 2 hr
- Drawdown: 5 ft.
- Measured from: Top of casing
- Sound level: 68 ft.
- Static level (depth to water): Clear
- Quality (clear, cloudy, taste, odor): Clear

**PUMP**

- Type of pump: Not specified
- Capacity: 100 gpm
- Pump set at: 100 ft.
- Pump installed by: C.B. Hamilton Well Drilling

**WELL LOCATION**

- Location of well in State Plane coordinates, if available: Not specified
- Elevation of well: Not specified
- Datum plane: Not specified
- Source of coordinates: Not specified

**Drilling Firm**

C.B. Hamilton Well Drilling

**Address**

9449 Milton Carlisle Rd.

**City, State, Zip**

New Carlisle, OH 45344

**ODH Registration Number**

32

**Permit Number**

4448

**CONSTRUCTION DETAILS**

- Use of Well: Residential
- Well Type: Rotiary
- Cable Augered
- Driven
- Dug
- Other

**Date of Completion**

11-8-95

**Signature**

Shirley Hamilton

**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 Square Drive, Columbus, Ohio 43224**
# WELL LOG AND DRILLING REPORT

**Type or Use Pen**

**Pen:**

**Press Hard**

## COUNTY
- Clark

## TOWNSHIP
- Mad River

## SECTION/LOT NO.
- 30

## OWNER/CONTRACTOR
- William Parrill

## PROPERTY ADDRESS
- Lot # 30 Bolin Dr.

## LOCATION OF PROPERTY
- Echo Hills Platt

### CONSTRUCTION DETAILS

#### CASING
- Diameter: 5 in.
- Borehole Diameter: 5 in.

#### GROUT
- Material: Cement
- Volume used: 65 gals.
- Method of installation: Grout pressure
- Depth: placed from 50 ft. to surface

#### GRAVEL PACK (Filter Pack)
- Material: Cement
- Volume used: 65 gals.

### SCREEN
- Length: 100 ft.
- Type (wire wrapped, louvered, etc.): Material

### WELL LOG

<table>
<thead>
<tr>
<th>Depth Range</th>
<th>From</th>
<th>To</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay</td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>Limestone</td>
<td>11</td>
<td>115</td>
</tr>
<tr>
<td>Shale</td>
<td>115</td>
<td>122</td>
</tr>
</tbody>
</table>

### WELL TEST

- Bailing
- Test rate: 5 gpm
- Duration of test: 2 hrs.
- Drawdown: 2 ft.
- Measured from: Top of casing
- Ground water level: 40 ft.
- Other: Quality (color, cloudy, taste, odor)
- Clear

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

### PUMP

- Record: 110 to 112 gpm
- Pump set at: 110 to 112 ft.
- Pump installed by: G. P. Hamilton Well Drilling

### SKETCH SHOWING WELL LOCATION

**Received**
- Jun 16 1993

**Clark County Health Dept.**

**Springfield, Ohio**

**C. P. Hamilton Well Drilling**

**Signed**

**Date:** 5-4-93

**Address:**
- New Carlisle, OH 45344

**ODH Registration Number:** 32

**ODR Registration Number:** 32

**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**

---

**138**
WELL LOG AND DRILLING REPORT
Ohio Department of Natural Resources
Division of Water, 1939 Fountain Square Drive,
Columbus, Ohio 43224 Phone (614) 264-1403

WELL LOCATION

COUNTY: Clark TOWNSHIP: Mad River
OWNER/BUILDER: Calvin Watts PROPERTY ADDRESS: 4726 Bolin Dr.

CONSTRUCTION DETAILS
Casing: (Length below grade) Borehole Diameter: in. Length: ft.

Grout:
Material: Bentonite Volume used: 36 gals.
Method of installation: Tremie pipe

Depth: placed from: 28 ft. to surface

Gravel Pack (Filter Pack):
Material: (Filter Used), Volume used: gals.
Method of installation:

Depth: placed from: ft. to

Preassembled unit

Pitless Device: Residential Use of Well: Rotory:
Cable:
Augered:
Driven:
Dug:
Other:

SCREEN
Type (wire wrapped, louvered, etc.): Material:
Set between: ft. and ft. Slot:

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

From To
Clay
Limestone

WELL TEST
Bailing:
Test rate:
Duration of test:

Drawdown:
Measured from:
Top of casing:
Ground level:
Other:

Static Level (depth to water):
ft. Date:

Quality (clear, cloudy, taste, odor):
clear

PUMP
Type of pump:
Capacity:
Pump set at:
Pump installed by:

WELL LOCATION
Location of well in State Plane coordinates, if available:
Zone:
Elevation of well:
t.
Datum plane:

Source of coordinates:
GPS:
Survey:
Other:

Sketch a map showing distance well lies from numbered state highway
street intersections, county roads, buildings or other notable landmarks:

North

Echo Hills

Fairfield Pike

W.

Bolin Dr.

S.

Driller Firm:
C.E. HAMILTON WELL DRILLING
9449 Milton Carlisle Rd.

Signed:
Sharily HAMILTON
7-3-96

City, State, Zip:
New Carlisle, OH 45344
ODNR Registration Number:
32

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

ORIGINAL COPY TO: ODNR, DIVISION OF WATER, 1939 FOUNTAIN SQ. DRIVE, COLS., OHIO 43224
### WELL LOG AND DRILLING REPORT

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

**COUNTY**  
**TOWNSHIP**  
**SECTION OF TOWNSHIP**  
**OWNER**  
Tomma Buss  
**ADDRESS**  
4933 Riley Dr  
**LOCATION OF PROPERTY**  
4746 Bolin Dr, Euclid, Ohio

### CONSTRUCTION DETAILS
- **Diameter:** 5"  
- **Length of casing:** 06'  
- **Size of screen:**  
- **Length of screen:**  
- **Packing of pump:**  
- **Pump setting:**  
- **Date of completion:** June 5, 1984  
- **Pump installed by:**

### BAILING OR PUMPING TEST
- **Test rate:** 15 gpm  
- **Duration of test:** 2  
- **Drawdown:** 30 ft  
- **Date:** June 5, 1984  
- **Static level (depth to water):**  
- **Quality (clear, cloudy, taste, odor):** Clear

### SKETCH SHOWING LOCATION
- Locate in reference to numbered state highways, street intersections, county roads, etc.

### WELL LOG

<table>
<thead>
<tr>
<th>Formation</th>
<th>Sandstone, shale, limestone, gravel, clay</th>
<th>From</th>
<th>To</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 ft</td>
<td>110 ft</td>
<td>120 ft</td>
<td></td>
</tr>
</tbody>
</table>

### DRILLING FIRM
Hammel, Well Drill, Inc.

**DATE**  
June 5, 1984

**ADDRESS**  
18131 Winton Dr

**SIGNED**  
[Signature]

*If additional space is needed to complete well log, use next consecutive numbered form.*
WELL LOG AND DRILLING REPORT

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

COUNTY: Clark  TOWNSHIP: Mad River  SECTION OF TOWNSHIP: 30
OWNER: Building & Home's  ADDRESS: 1150 Cardinal, Etna, OH

LOCATION OF PROPERTY:
Lot 1, Echo Hills, on Hagan Rd.

CONSTRUCTION DETAILS

<table>
<thead>
<tr>
<th>Casing diameter</th>
<th>Length of casing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>21 ft</td>
</tr>
</tbody>
</table>

Type of screen
Type of pump
Capacity of pump
Depth of pump setting
Date of completion

BAILING OR PUMPING TEST

Test rate: 40 gpm  Duration of test: 1
Drawdown: 80 ft  Date: 8/01
Static level (depth to water):
Quality (clear, cloudy, taste, odor):
Pump installed by:

WELL LOG

<table>
<thead>
<tr>
<th>Formations</th>
<th>From</th>
<th>To</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay</td>
<td>0 ft</td>
<td>15 ft</td>
</tr>
<tr>
<td>Limestone</td>
<td>15 ft</td>
<td>120 ft</td>
</tr>
</tbody>
</table>

8" bore hole, 182' in formation,ackeron bottom, pipe grounded

SKETCH SHOWING LOCATION

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

RECEIVE
MAY 2 1973

CLARK HEALTH DEPT.

LOCAL HEALTH DEPT. COPY
# WELL LOG AND DRILLING REPORT

**State of Ohio**

**DEPARTMENT OF NATURAL RESOURCES**

**Division of Water**

**Fountain Square**

**Columbus, Ohio 43224**

---

**COUNTY:**

**TOWNSHIP:**

**SECTION OF TOWNSHIP:**

**OWNER:** Jerry E. Flowers

**ADDRESS:** 7777 Boler Ave

**LOCATION OF PROPERTY:**

---

**CONSTRUCTION DETAILS**

- Diameter: 6 in
- Length of casing: 30 ft
- Type of screen: Sandstone, shale, limestone, gravel, clay
- Length of screen: 96 ft
- Type of pump: Submersible
- Capacity of pump: 1,000 gpm
- Depth of pump setting: 126 ft
- Date of completion: Aug 13, 1964

**BAILING OR PUMPING TEST**

- Test rate: 100 gpm
- Duration of test: 12 days
- Drawdown: 5 ft
- Static level (depth to water): 96 ft
- Quality (clear, cloudy, taste, odor): Clear

**Pump installed by:**

---

**WELL LOG**

- Formations: Sandstone, shale, limestone, gravel, clay
- From: 0 ft
- To: 126 ft

---

**SKETCH SHOWING LOCATION**

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

---

**RECEIVED**

**Aug 14, 1964**

**CLARK COUNTY HEALTH DEPT.**

---

**DRILLING FIRM:**

Chas. E. Hamilton

**Well Contractor:**

Well 616 Wager Ave

**ADDRESS:** Dayton, Ohio 45404

---

*If additional space is needed to complete this log, use next consecutive numbered form.*
## WELL LOG AND DRILLING REPORT

**Ohio Department of Natural Resources**  
Division of Water, 1529 Fountain Square Drive  
Columbus, Ohio 43224  
Phone (614) 265-6700  

### General Information
- **Permit Number**: 4339
- **Owner/Builder**: Bill Pitman
- **Property Address**: 4943 Riley Rd.
- **Location of Property**: Echo Hills Plat

### Construction Details
- **CASING**:  
  - **Length** (in ft): 28 ft  
  - **Wall Thickness** (in ft): 1.0 in  
  - **Type**: Steel, Salv, Other  
  - **Joints**: Threaded, Welded, Other  
  - **Liner**: Length, Type, Wall Thickness  

- **GROUT**:  
  - **Material**: Bentonite  
  - **Volume used**: 36 gals  
  - **Depth**: placed from  
  - **GRAVEL PACK (Filter Pack)**: Material, Volume used  
  - **Depth**: placed from  

- **SCREEN**:  
  - **Type (wire wrapped, boulder, etc.)**: Material  
  - **Length**: in ft  
  - **Diameter**: in  
  - **Set between**: in ft and in ft  

### WELL LOG

<table>
<thead>
<tr>
<th>Material</th>
<th>From</th>
<th>To</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>Gravel</td>
<td>7</td>
<td>16</td>
</tr>
<tr>
<td>Limestone</td>
<td>16</td>
<td>120</td>
</tr>
</tbody>
</table>

### WELL TEST
- **Pumping**:  
  - **Test rate**: 15 gpm  
  - **Duration of test**: 2 hrs  
  - **Drawdown**: 5  
  - **Measured from**: top of casing, ground level, other  
  - **Static Level (depth to water)**:  
  - **Date**:  
  - **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**: 100 ft  
- **Pump installed by**:  

### WELL LOCATION
- **Location of well in State Plane coordinates, if available**:  
  - **Zone**:  
  - **Elevation of well**: ft  
  - **Datum plane**: NAD27, NAD83  
  - **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**:  

**alements**

*Signature of responsible person*

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

**ORIGINAL COPY TO: ODH, DIVISION OF WATER, 1529 FOUNTAIN SQ. DRIVE, COLUMBUS, OHIO 43224.**

---

If additional space is needed to complete well log, use next consecutively numbered form.  
I hereby certify the information given is accurate and correct to the best of my knowledge.  
Signed by Shirley Hamilton, date 12-1-95  

---

C.E. HAMILTON WELL DRILLING  
9449 Milton Carlisle Rd.  
New Carlisle, OH 45344  

OH Registration Number 32
**WELL LOG AND DRILLING REPORT**

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

**Permit Number** 1553

**COUNTY** Clark  
**TOWNSHIP** Madras  
**SECTION OF TOWNSHIP** 30

**OWNER** Allen Wood  
**ADDRESS** 4944 Riley Road Springfield

**LOCATION OF PROPERTY** Corner of Civic and Riley Roads

### CONSTRUCTION DETAILS

- **Casing diameter**: 5 3/4" OD  
- **Length of casing**: 30 ft
- **Type of screen**:  
- **Length of screen**:  
- **Type of pump**: Submersible  
- **Capacity of pump**: 10 gpm  
- **Depth of pump setting**: 110 ft  
- **Date of completion**: 4-12-88  
- **Rotary or Cable**:

### BAILING OR PUMPING TEST

- **Test rate**: 12 gpm  
- **Duration of test**: 1 hr  
- **Drawdown**: 15 ft  
- **Date**: 4-12-88  
- **Static level (depth to water)**: 18 ft  
- **Quality (clear, cloudy, taste, odor)**: Clear

**Pump installed by**: Home owner

### WELL LOG

**Formations**: sandstone, shale, limestone, gravel, clay

<table>
<thead>
<tr>
<th>From</th>
<th>To</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 ft</td>
<td>17 ft</td>
</tr>
<tr>
<td>17 ft</td>
<td>130 ft</td>
</tr>
</tbody>
</table>

**Sketch Showing Location**

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

**DNR 7802**

**DATE**: 4-13-88

**SIGNED**

Completion of this form is required by 1521.05, Ohio Revised Code - file within 30 days after completion.
# WELL LOG AND DRILLING REPORT

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

COUNTY  CLARK  
TOWNSHIP  Section of Township  Fake Hill  
OWNER  Tomax Count  
ADDRESS  4943 Ridley R.d  
LOCATION OF PROPERTY  4915 Ridley Rd  Springfield OH 45505  

## CONSTRUCTION DETAILS

<table>
<thead>
<tr>
<th>Casing diameter</th>
<th>5 1/8</th>
<th>Length of casing</th>
<th>36 ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of screen</td>
<td></td>
<td>Length of screen</td>
<td></td>
</tr>
<tr>
<td>Type of pump</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capacity of pump</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depth of pump setting</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Date of completion</td>
<td>March 17, 1984</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## BAILING OR PUMPING TEST

(specify one by circling)

- Test rate 160 gpm  
- Duration of test 1 hr  
- Drawdown 5 ft  
- Date 3-14-84  
- Static level (depth to water) 60 ft  
- Quality (clear, cloudy, taste, odor)  
- Pump installed by  

## WELL LOG*

<table>
<thead>
<tr>
<th>Formations: sandstone, shale, limestone, gravel, clay</th>
<th>From</th>
<th>To</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inertial arkhyal</td>
<td>0 ft</td>
<td>18 ft</td>
</tr>
<tr>
<td>Lime breke</td>
<td>18 ft</td>
<td>109 ft</td>
</tr>
<tr>
<td>Sand stone</td>
<td>109 ft</td>
<td>115 ft</td>
</tr>
<tr>
<td>Limestone</td>
<td>115 ft</td>
<td>120 ft</td>
</tr>
</tbody>
</table>

## SKETCH SHOWING LOCATION

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

---

DRILLING FIRM  Hamilton Well Dril  
ADDRESS  6511 North Ave  
DATE  March 17, 1984  
SIGNED  

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

LOCAL HEALTH DEPT COPY
**WELL LOG AND DRILLING REPORT**

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

<table>
<thead>
<tr>
<th>COUNTY</th>
<th>Clark</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOWNSHIP</td>
<td>Mad River</td>
</tr>
<tr>
<td>SECTION OF TOWNSHIP</td>
<td>29</td>
</tr>
<tr>
<td>OWNER</td>
<td>Ron Gregory</td>
</tr>
<tr>
<td>ADDRESS</td>
<td>4891 Riley Rd., Springfield</td>
</tr>
<tr>
<td>LOCATION OF PROPERTY</td>
<td>Well in Echo Hills</td>
</tr>
</tbody>
</table>

### CONSTRUCTION DETAILS

- **Casing diameter:** 6" PVC  
- **Length of casing:** 25 ft  
- **Type of screen:**  
- **Length of screen:**  
- **Type of pump:**  
- **Capacity of pump:**  
- **Depth of pump setting:**  
- **Date of completion:**

### BAILING OR PUMPING TEST

- **Test rate:** 30 gpm  
- **Duration of test:** 1 hr  
- **Drawdown:** 25 ft  
- **Date:** Aug. 12, 1983  
- **Static level (depth to water):**  
- **Quality (clear, cloudy, taste, odor):** clear  
- **Pump installed by:**

### WELL LOG*

<table>
<thead>
<tr>
<th>Formations</th>
<th>From</th>
<th>To</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay</td>
<td>0 ft</td>
<td>10 ft</td>
</tr>
<tr>
<td>Limestone</td>
<td>10 ft</td>
<td>120 ft</td>
</tr>
</tbody>
</table>

### SKETCH SHOWING LOCATION

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

---

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

LOCAL HEALTH DEPT. COPY