Senior Thesis

Groundwater Resources of the Pataskala Area, Southwest Licking County, Ohio

by

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Approved by:

Dr. E. Scott Bair

Acknowledgments

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Introduction

Purpose and Scope

This paper is the result of an ongoing study by the Ohio Department of Natural Resources (ODNR), Water Resources Section (WRS) to determine the availability and need for ground-water resources in the Pataskala area (fig. 1). In July 1992, the WRS began an investigation as a result of homeowners' concerns over the effect of pumping at local wellfields on their private wells. Currently, there are four wellfields in the Pataskala area. The Village of Pataskala has one active and an inactive wellfield and the Southwest Licking Community Water and Sewer District (SLCWSD) also has an active and an inactive wellfield. The goal of this study is to help determine the impact of these wellfields on private water wells, the other wellfields, and other large ground-water users in the area. The study also will help assess the trends of ground-water levels in the Pataskala area.

The Village of Pataskala currently has a working wellfield at the intersection of Mill Street and State Rt. 310, Lima Township, Licking County (plate 1). This wellfield has been operational since the 1930's. They also have a proposed wellfield at the intersection of Creek Road and Watkins Road, Harrison Township, Licking County (plate 1). A pumping test at this wellfield led directly to the

Figure 1. State Map Indicating the Pataskala Study Area

above mentioned investigation due to nearby homeowners experiencing well problems.

The SLCWSD currently has a wellfield approximately 1.5 miles east of the proposed Village of Pataskala wellfield at Watkins Road (plate 1). This wellfield is at the former York Sand and Gravel Company, just southeast of the intersection of York Road and Refugee Road, in Lima Township, Licking County. This wellfield is in a highly productive sand and gravel aquifer and there have been no complaints from nearby homeowners. SLCWSD also has a wellfield at Mill Street (plate 1), which is less than a mile away from the active wellfield of Pataskala on Mill Street.

Population and Water Demand

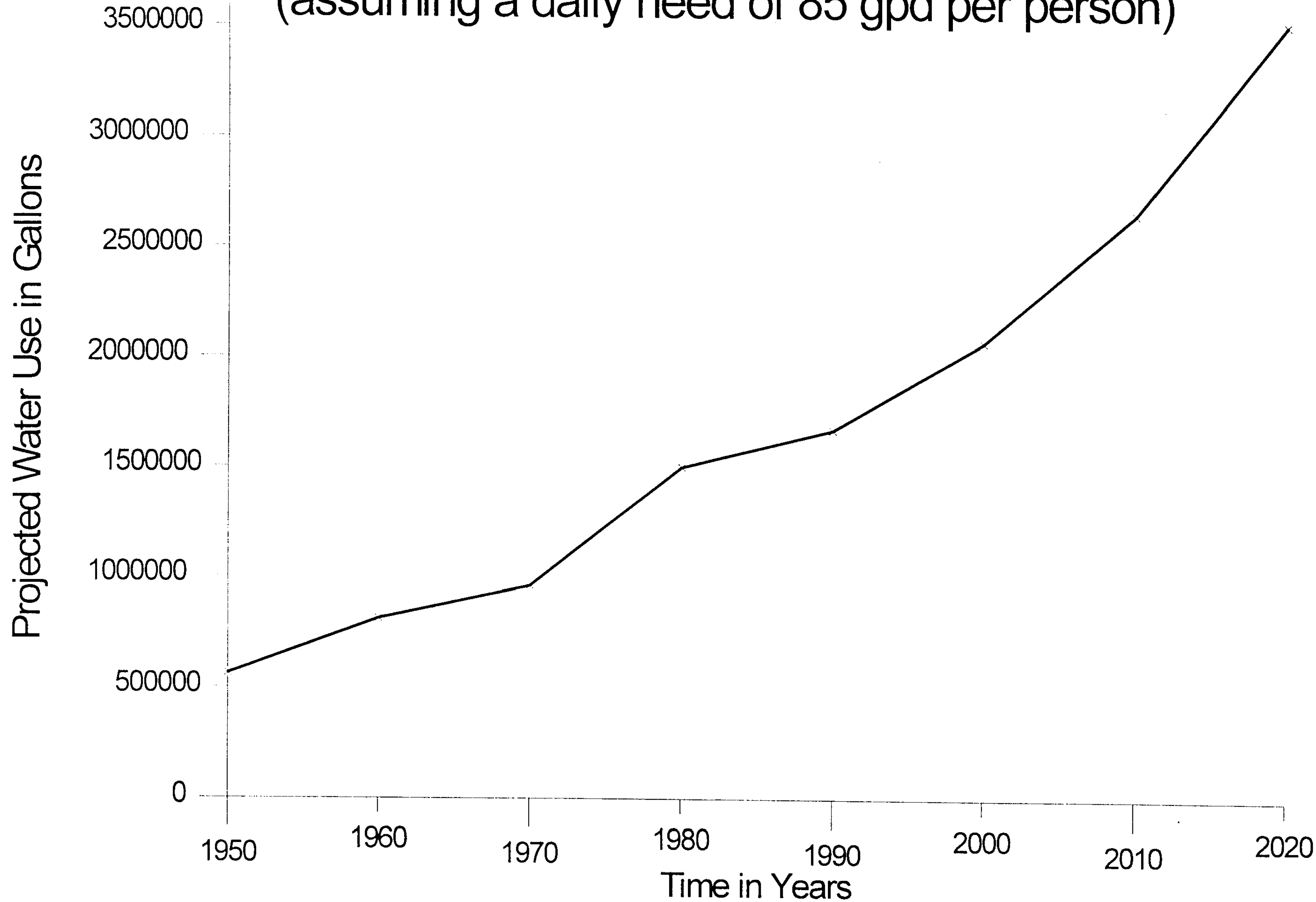
As population increases, there is an additional demand for water resources. The average person uses around 75 to 100 gallons of water per day, that translates into about 300 to 400 gallons per day per household (Jim Raab, ODNR, WRS oral communication). The Pataskala area is growing rapidly and will need more water as development increases. The 1990 Census estimated the population in the Pataskala area to be 18,934. Based on the average amount of water a person uses per day, the Pataskala area used 1,420,000 to 1,900,000 gallons of water per day in 1990. As road improvements provide greater access to rural areas, development will be rapid and water resources will become more important. The Mid-Ohio Regional Planning Commission projects the population in the Pataskala area to climb steadily and more than double in size by the year 2020 (table 1). Figure 2 shows the increasing ground-water resource demand for the area.

Table 1. Population Chart for the Pataskala Area

	Census Population					Projected Population *		
Year	1950	1960	1970	1980	1990	2000 *	2010 *	2020 *
Population	6,410	9,237	10,913	17,012	18,934	23,535	30,188	39,976
% Increase or Decrease from previous decade	----	+44%	+18%	+55.9%	+11.3%	+24.3%	+28.3%	+32.4%

* Projections made by the Mid-Ohio Regional Planning Commission

Figure 2. Projected Daily Water Usage in the Pataskala Area (assuming a daily need of 85 gpd per person)



BACKGROUND INFORMATION

Study Area

The study area is in southwestern Licking County in Lima, Harrison, and Etna townships. The primary areas of interest center around Mill Street south and west of Pataskala, and the area surrounding Refugee Road between Watkins Road and York Road, about three miles east of Pataskala.

Physiography

The study area is part of the Till Plains Section of the Central Lowlands Province (Dove, 1960). The area is characterized by low relief due to the glacial and glaciofluvial deposits filling the pre-existing valleys. The rolling topography in upland areas is due predominately to end moraines and other ice-contact deposits from the last glaciation. The study area is part of the Muskingum River drainage basin. The Muddy and South Forks of the Licking River flow to the Licking River, which in turn, flows into the Muskingum River in Zanesville.

Climate

The closest weather station is at the Newark Water Works. It is approximately 15 miles east to northeast of Pataskala. Based on a 30-year average (1961-1980) at the

Newark Water Works, the mean annual average of precipitation is 41.48 inches (U. S. Department of Commerce, 1992). The average mean annual temperature for the same 30-year period at the Newark Water Works is 51.5 degrees Fahrenheit (U. S. Department of Commerce, 1992).

Well Control

Water well logs were obtained at ODNR, WRS. The information gathered was used for construction of hydrogeologic cross sections and evaluation of historic water levels, which were used in making the potentiometric surface map. Few of these water well logs were logged by geologists, therefore, some information recorded by the drillers is suspect. Many well logs were used to get sufficient interpretive data.

Procedures and Methods

Water well measurements in the Pataskala area began on September 30, 1992 and have been measured quarterly thereafter. The well casing was marked on the inside with permanent marker for accurate readings and unobstructed electric tape access. The electric measuring tape was cleaned with bleach after each measurement to prevent bacterial contamination in the wells. Well measurements are conducted to the nearest hundredth of a foot and casing height was also measured to this accuracy.

HYDROGEOLOGY

Bedrock Geology

Bedrock in the Pataskala area is Mississippian in age and is comprised of the Raccoon Member of the Cuyahoga Formation. The Raccoon Member is primarily shales interbedded with siltstones to fine-grained sandstones in the Pataskala area, with sandstone and siltstone beds more numerous lower in the formation. In the study area, bedrock depths range from approximately 15 feet to over 400 feet below land surface and gently dip to the east. The bedrock is not the primary aquifer in the area. Well yields in bedrock typically range from 3 to 7 gallons per minute (gpm) (Dove, 1960; Hartzell, 1982). Few wells, if any, are developed in the bedrock within the immediate study area.

Glacial Geology

There were at least three major glacial episodes that advanced and retreated across the area during the Pleistocene Epoch. Each time the resulting terrain became more complex. The deepest underlying glacial deposits are thought to be pre-Illinoian in age and to have been deposited over 700,000 years before present (Y.B.P.). The majority of the glacial deposits are believed to be Illinoian in age and are thought to be over 120,000 Y.B.P.

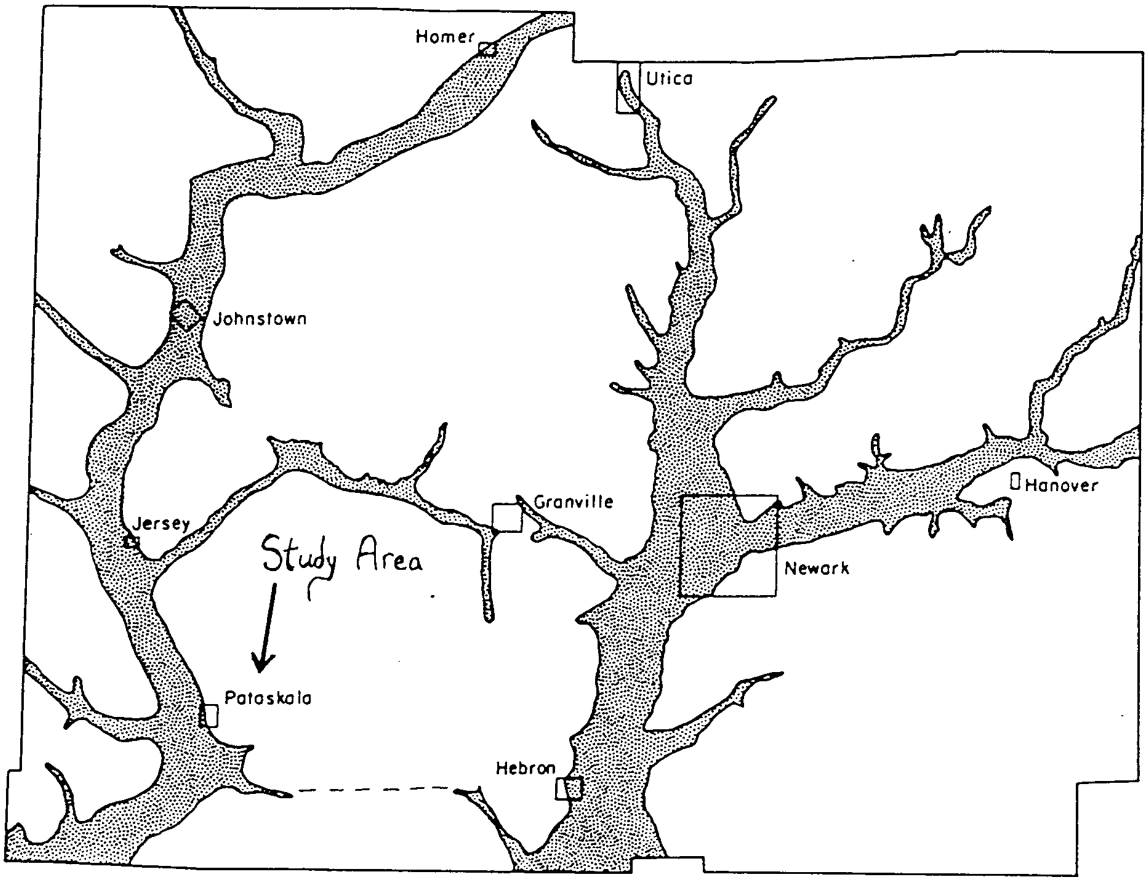
(Szabo et al, 1993). The uppermost deposits are Wisconsinan in age. These deposits are less than 25,000 Y.B.P. Outside the buried valleys, the glacial drift is composed primarily of till overlying the bedrock. The glacial till over the bedrock has some discontinuous sand and gravel lenses with yields seldom exceeding 15 gpm, more likely 5 to 10 gpm (Dove, 1960; Hartzell 1982).

Buried Valleys

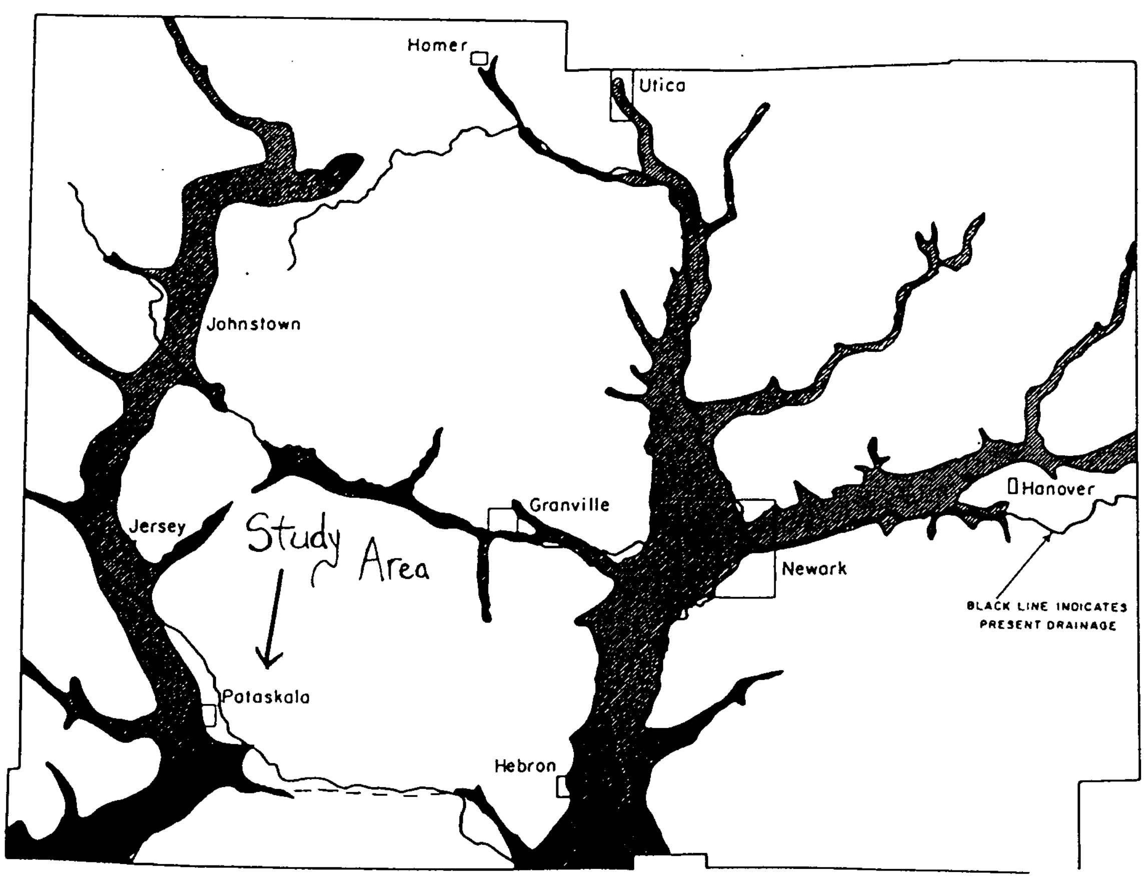
There are two large buried bedrock valleys in southwestern Licking County that reach depths of 300 to over 400 feet below land surface (fig. 3). One buried bedrock valley runs roughly north-south, extending through Johnstown and Jersey through Pataskala and on to the southwest (Dove, 1960). The other large buried bedrock valley in the area is nearly parallel to the first and runs south through Newark and on through Hebron (fig. 3, Dove, 1960; Forsyth, 1966).

The buried valleys are part of the extensive ancient Teays River drainage system. The large buried bedrock valleys are also connected to many smaller buried tributary valleys. A pre-Illinoian glacial advance blocked drainage of the Teays River (Stout, et al. 1943). With the normal flow blocked in the Teays River, many lakes were created. Eventually the water cut new pathways and stream flow was reversed (Dove, 1960).

Figure 3. Location of Buried Valleys (Dove, 1960)



Preglacial (Teays stage) drainage in Licking County, Ohio.



Pre-Illinoian (Deep stage) drainage In Licking County, Ohio.

Deep-Stage drainage was a result of increased downcutting within the existing Teays-stage valleys. Dove (1960) suggests that during the Illinoian, stream-flow reversal accounted for the easterly drainage of the South Licking Fork. This deepened the tributary connecting the channel through Pataskala with the one through Newark. Unconsolidated sediment filling the valley consists of glacial till, sand, gravel, lacustrine deposits, and silt. Glacial till can be deposited directly under an active glacier and is composed of unsorted clay and other larger particles. Well sorted sands and gravels are deposited as glacial outwash by meltwater. The buried bedrock valleys are the primary aquifers in the area, producing up to 100 to 500 gpm (Hartzell, 1982).

DISCUSSION

Geologic Cross Sections

The cross sections dissect the two main areas of interest where the wellfields are currently pumping or are proposed. The orientation of the hydrogeologic cross sections is shown on plate 2. Cross section A to A' runs along York Road (fig. 4). Cross section B to B' runs along Watkins Road (fig. 5). Cross section C to C' runs east-to-west through the study area (fig. 6). The cross sections show that the major glacial aquifer appears to be extensive and well connected. Due to lack of reliable drilling logs and fine detail, the cross sections are generalized. One aspect not shown on the cross sections is the many lenses of less permeable units that are interstratified with the aquifer. These lenses decrease the vertical hydraulic conductivity of the glacial material. Lenses of sand and gravel within the clay layers are also not totally represented.

Potentiometric-Surface Map

Plate 3 is the generalized potentiometric-surface map for the study area. Ground-water flow is southeast in the Pataskala area, flowing more easterly at Watkins Road, generally in the direction of the South Licking Fork. This direction corresponds to the buried valley tributary that links the two main buried bedrock valleys in the area (fig.

Figure 4.
York Road, Generalized Cross Section, A to A'

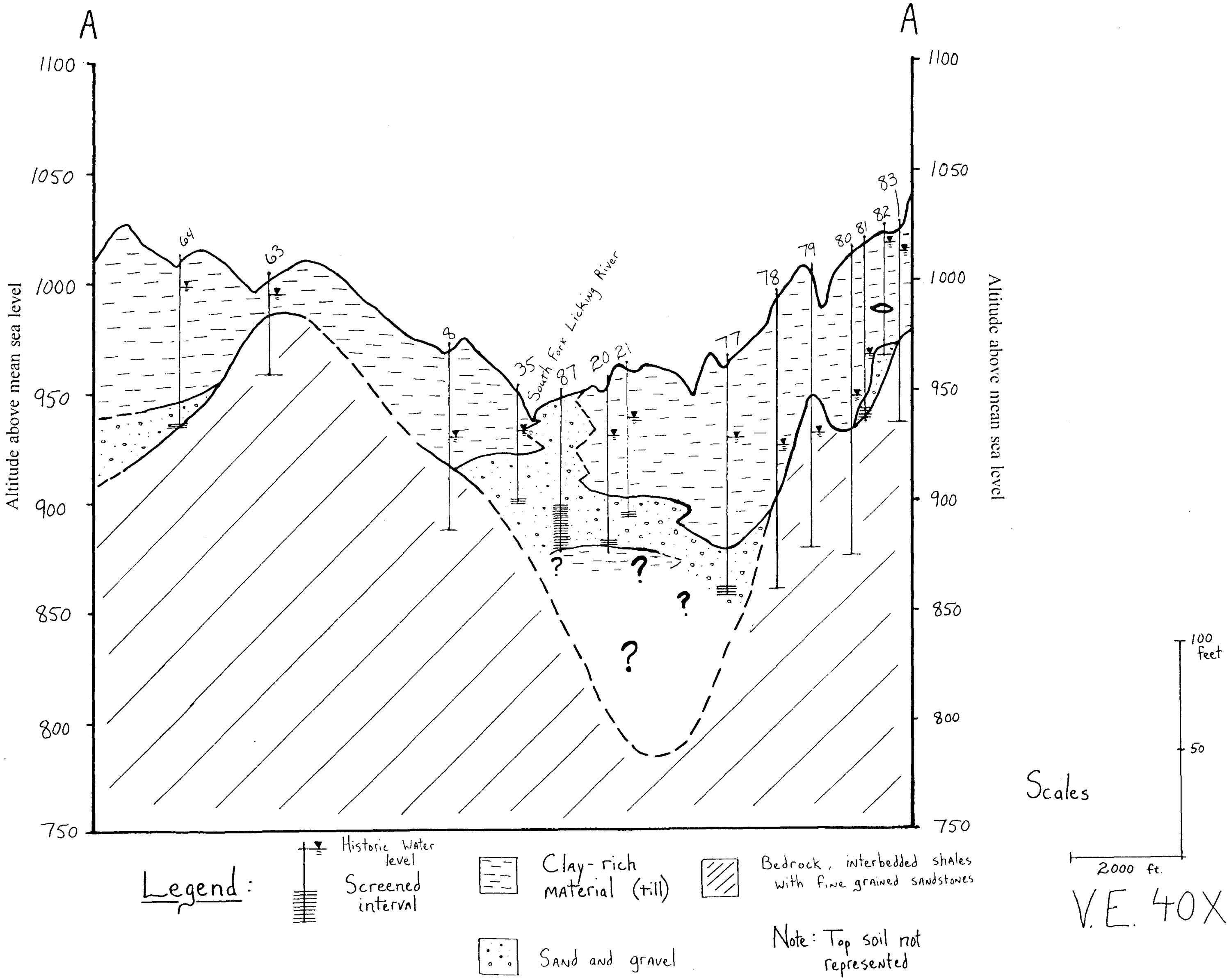


Figure 5.
Watkins Road, Generalized Cross Section, B to B′

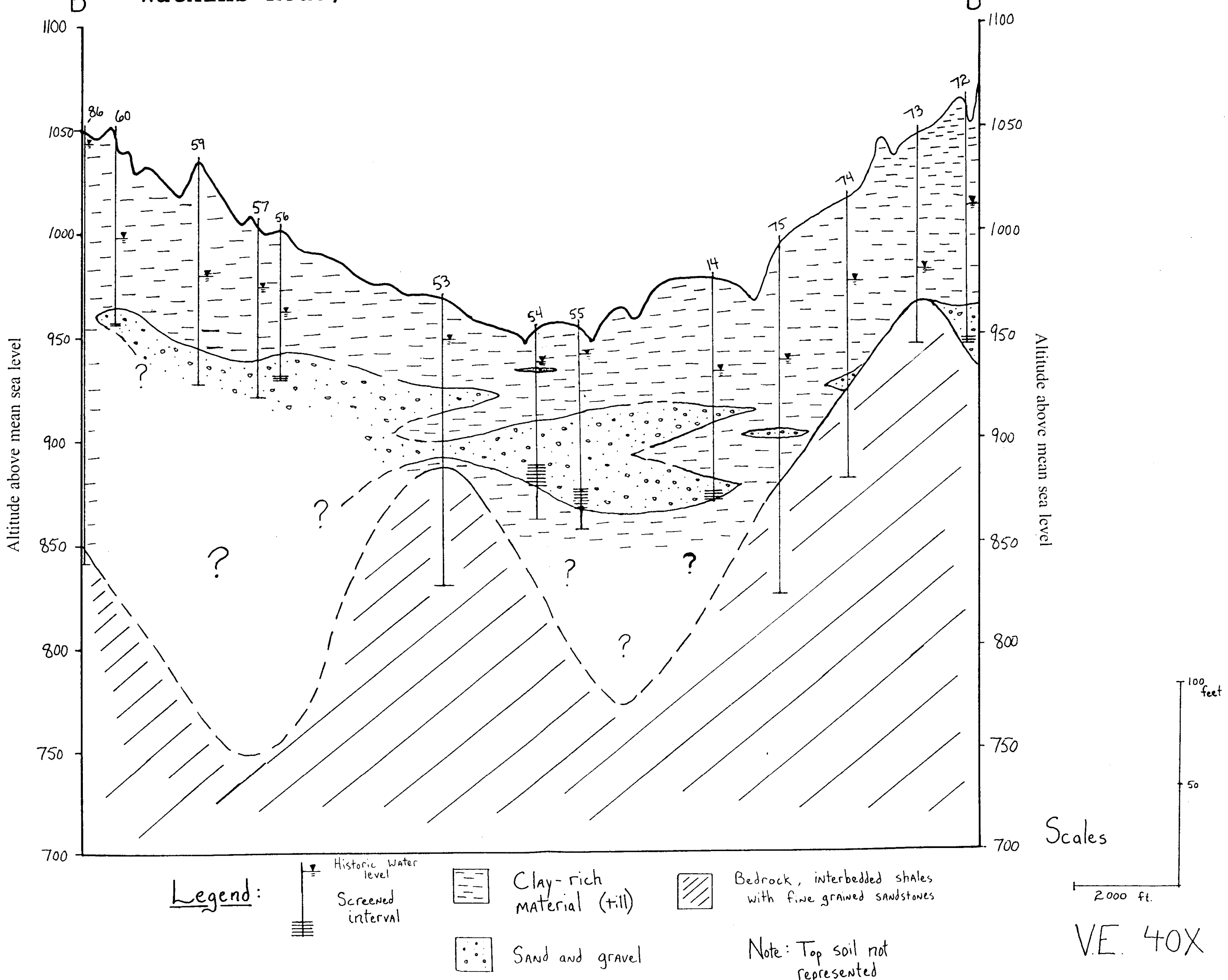
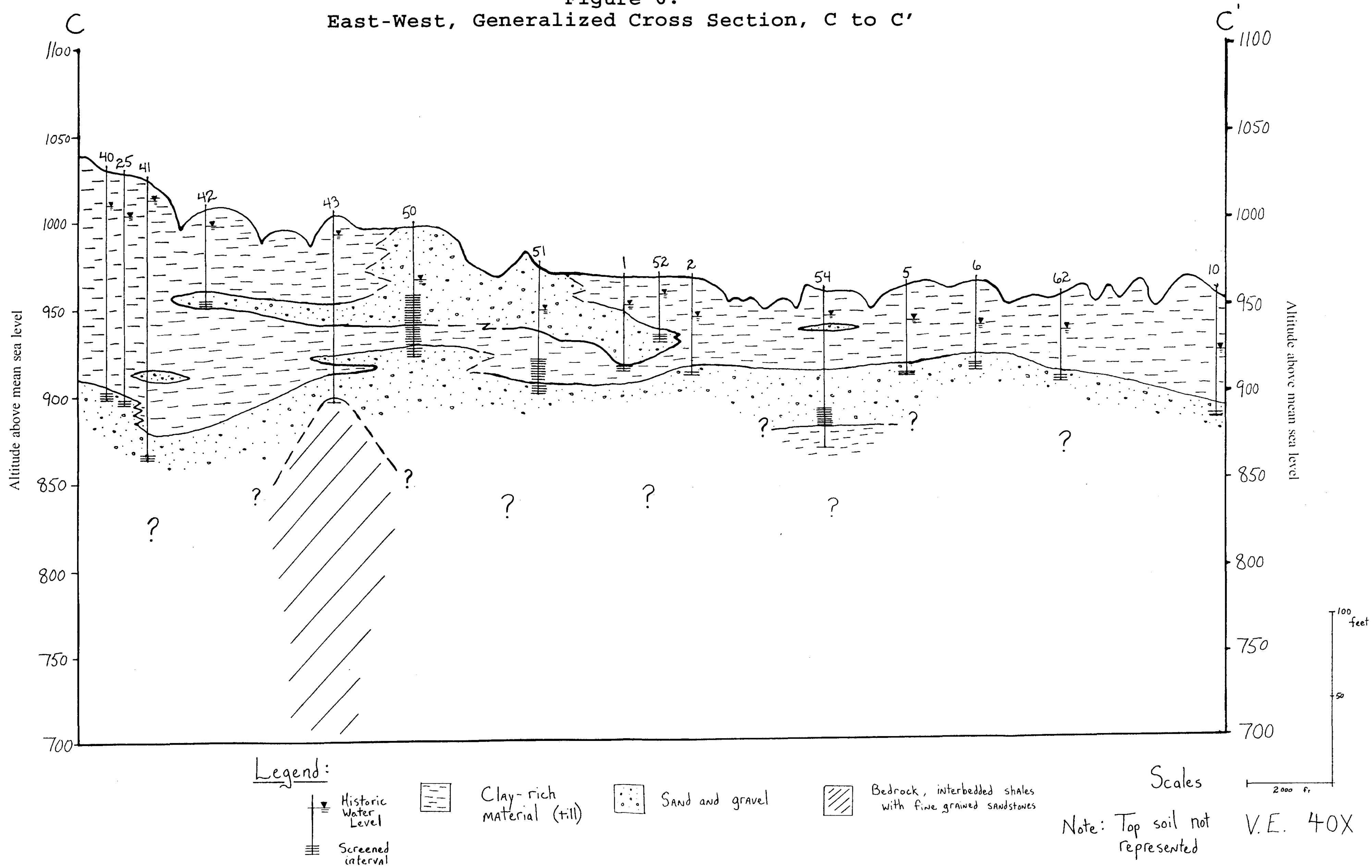


Figure 6.
East-West, Generalized Cross Section, C to C'



2). A slight cone of depression is shown around the active wellfield of the Village on Mill Street. Historic water levels obtained from water well logs and water levels measured by the WRS on July 29, 1994, were used in making the potentiometric-surface map. The only active wellfield at the time of the WRS measurements of July 29, 1994, was the Mill Street wellfield of the Village.

Wellfields and Water Supply

The Mill Street area (plate 1) contains the active Village of Pataskala wellfield and the proposed SCLWSD wellfield. The aquifer is semi-confined to confined in this area (see fig. 6). Wellfield interference could be a problem in this area due to the proximity of the wells. A 48.5 hour pumping test was performed by SS&S for the SLCWSD on August 10-12, 1992. Average transmissivity (T) and storativity (S) calculated by SS&S are 62,600 gpd/ft and 0.00011, respectively (SS&S, 1992). The S value indicates the aquifer is semi-confined to confined. The ground-water flow velocity River from the proposed SLCWSD site to the active Village of Pataskala wellfield (arrow 1, plate 3) is estimated at 10 feet per day (fpd). The hydraulic gradient here is steep due to the cone of depression created around the active Pataskala wellfield. One concern of the pumping test was the additional 6 to 7 feet of drawdown experienced at the current Village of Pataskala wellfield (Ray Withers, Village of Pataskala, oral communication). This amount of drawdown is similar to that predicted in the ODNR report written in 1993 by Angle and Raab (1993). This is a potential problem for both the wellfields and nearby homeowners. The most accurate way to determine the amount of well interference would be to pump both wellfields on Mill Street simultaneously, while monitoring nearby water wells to determine drawdowns. Infiltration from the Muddy Fork in the Mill Street area is minimal due to the large amount of till overlying the aquifer. Recharge from precipitation is also limited due to the overlying clays (fig. 6). The cone of depression from the Village wellfield is elongated in the ground-water flow direction (plate 3).

The proposed Village of Pataskala wellfield at Watkins Road (plate 1) is a semi-confined to confined aquifer (see fig. 5). A 96-hour pumping test performed by Hydro Group from March 20-24, 1992, at a rate of 696 gpm. The transmissivity for this wellfield is 53,900 gpd/ft and the storativity is 0.00044 (Hydro Group, 1992). The storativity value indicates the aquifer is semi-confined to confined. Infiltration from the South Fork Licking River is minimal due to the amount of clayey till overlying the aquifer. The ground-water flow velocity in the vicinity of Watkins Road along the South Fork Licking River is around 1.6 fpd (arrow

2, plate 3). A concern of this site is the extensive cone of depression created during this pumping test (Hydro Group, 1992; Angle and Raab, 1993). Another concern of this wellfield is its close proximity to the other large quantity ground-water users including Watkins Memorial High School and the Jardine Estates subdivision (plate 1).

The SLCWSD wellfield on York Road is an excellent producer of water. A 48-hour pumping test was performed by SS&S at this wellfield on November 18-20, 1991, at a rate of 1000 gpm. Average T and S values calculated by SS&S are 107,000 gpd/ft and 0.0062 respectively (SS&S, 1991). The aquifer in this area is unconfined (fig. 4) and probably receives some infiltration from the South Fork Licking River (SS&S, 1991). Due to the high transmissivities and buried bedrock walls, the cone of depression is shallow and also elongated along the buried valley axis. Ground-water flow velocity in this area is 4.2 fpd (arrow 3, plate 3). A short-term pumping test performed by the WRS produced different results. Without accounting for the effects of partial penetration, the average values of T and S are 187,000 gpd/ft and 0.000017 respectively. It is recognized that by not accounting for partial penetration the value of T is a slight overestimate and the value of S is a slight underestimate. Another factor for skewed results is the short duration of the test. The pumping test lasted 180 minutes and showed a negative boundary. Figures 7 and 8 show time-drawdown graphs for the observation wells measured during the short-term pumping test. Well P-1 is 39 feet from the pumping well, whereas well P-2 is 82 feet from the pumping well. The cone of depression here should be elongate, due to the buried bedrock valley walls pinching out the sand and gravel aquifer.

SUMMARY AND RECOMMENDATIONS

As population growth continues in the Pataskala area, demand for water resources will also grow. The Village of Pataskala and the SLCWSD will have to determine the water needs for the area and how they will move to fill those needs. The Mill Street wellfields should be pumped to determine well interference if both are going to be actively used. The Village of Pataskala should also consider trying to obtain ground water at another site other than at Watkins Road, if it needs a large quantity of water, or pump a low amount due to the limitations of the aquifer there. The SLCWSD could continue to develop a greater production capacity at the York Sand and Gravel site. They could also develop the Mill Street Site, although there are limitations to this site.

Wellhead protection measures, in accordance with OEPA policies, should be established at the active wellfields. Wellhead protection measures are tantamount at the York Sand and Gravel Site, due to the unconfined nature of the aquifer. The sand and gravel aquifer in the area is laterally continuous, with varying amounts of overburden that directly affect infiltration from streams and recharge. The planning commission in the area should evaluate the availability of water resources with the growing need as more housing developments are proposed in the area. Quarterly monitoring of ground-water levels should continue to help define ground-water level trends in the Pataskala area for future insight.

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